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Volume 7C Caledonia North Appendices

Appendix 7-1 Marine Mammals Population Modelling (iPCoD)

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Volume 7C Appendix 7-1 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 evaluation 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), specifically the Caledonia North Site. This includes results for piling scenarios for Caledonia North alone and cumulatively with other projects.

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 3, Chapter 7: Marine Mammals.

1.2 iPCoD Model

1.2.1 Overview

1.2.1.1 The Interim Population Consequences of Disturbance (iPCoD) model 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.

1.2.2 Precaution in the iPCoD for Caledonia North

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 3, Chapter 7: Marine Mammals. The maximum temporal design scenario, further discussed in Section 1.4, is based on a piling schedule which assumes that only four pin piles for jackets will be installed per day, resulting in up to 79 piling days. These worst-case number of animals and worst-case number of piling days are expected to decrease once the final piling parameters are known post-consent.

1.2.2.2 The iPCoD modelling will therefore be rerun when parameters of Caledonia North 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 1.3.4), 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: 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 Caledonia North.

1.3.3 Lack of Density Dependence

1.3.3.1 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.

1.3.3.2 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).

1.3.4 Environmental and Demographic Stochasticity

1.3.4.1 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]).

1.3.4.2 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 3,000 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]).

1.3.4.3 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.

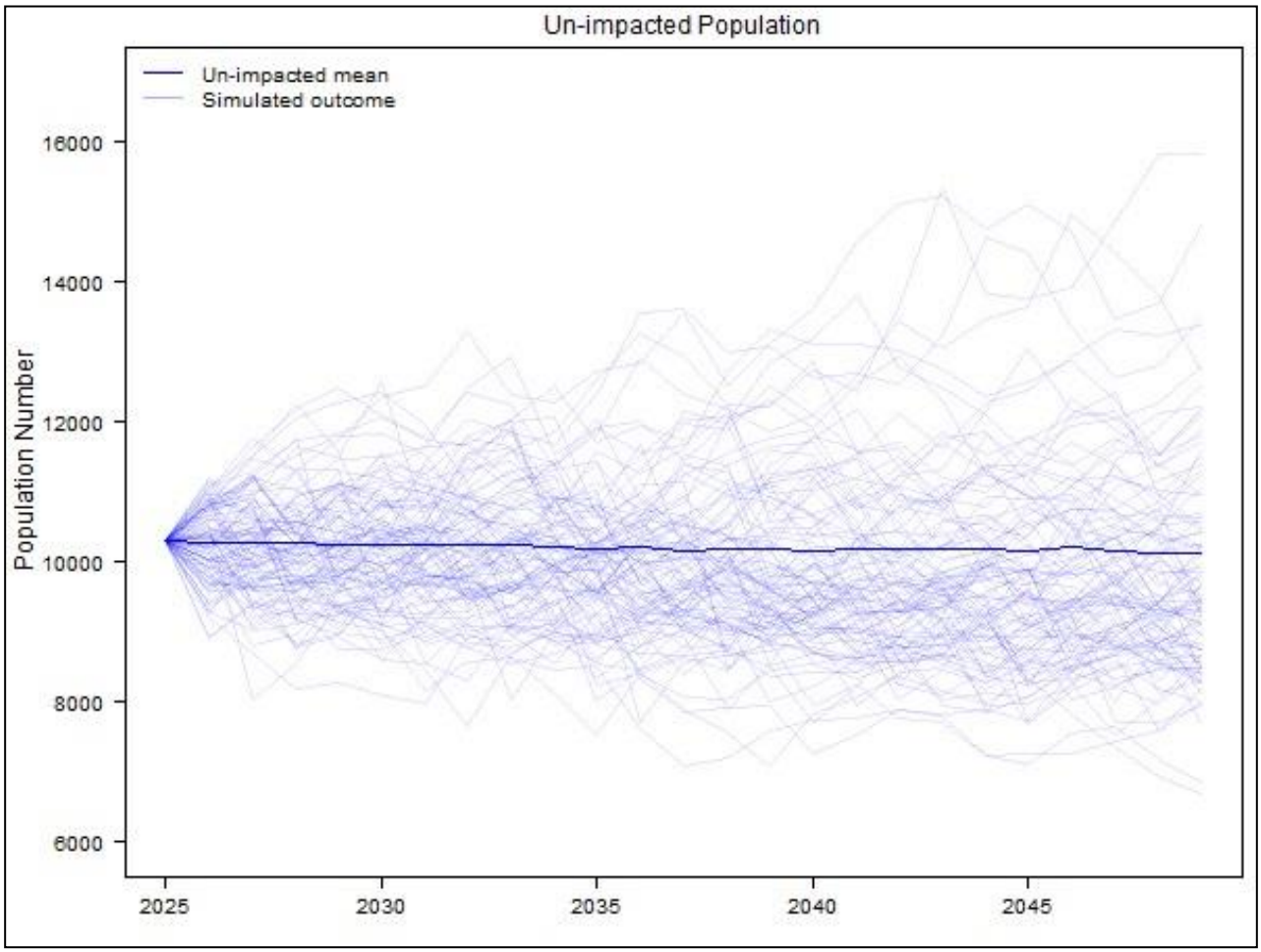

Figure 1-1: Simulated un-impacted (baseline) population size over the 25 years modelled.

1.3.5 Summary

1.3.5.1 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 Caledonia North Alone

1.4.2.1 Two foundation designs have been considered in the underwater noise modelling, including monopiles for bottom-fixed foundations and multi-leg foundations for bottom-fixed jacket 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 compared to monopiles, and, given that the piling process for jackets (79 days) can take up to two times longer than for monopiles (40 piling days), piling at pin piles for jackets 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 3, Chapter 7: Marine Mammals. It is important to note that, based on the DE, concurrent piling at two jacket locations at the same time is possible during installation of Caledonia North; however, applying this assumption would reduce the overall time required for installation. Since the iPCoD scenario aims to represent the worst-case temporal scenario, the modelling assumes no concurrent piling activities within the Caledonia North Site at any given time, ensuring the maximum possible installation duration is assessed.

1.4.2.2 The assessment provided in Volume 3, 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 One piling scenario was considered for the installation of Caledonia North. The scenario assumes installation of jackets in the Caledonia North Site with four pin piles installed per day (one full substructure jacket per day), resulting in 79 piling days (77 for wind turbine generators (WTGs), two for Offshore Substation Platforms (OSPs)) between October 2028 and February 2030, inclusive.

Number of Animals Impacted and Demographic Parameters

1.4.2.4 The number of animals disturbed used in the modelling is based on the maximum number of animals predicted for pin piles at jackets across locations 1, 2, 3 and 4. 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 installation. See paragraph 1.4.2.1 for discussion regarding scenario taken forward to the iPCoD.

1.4.2.5 The number of animals disturbed taken forward to the iPCoD is described for each species in Sections 1.5.1, 1.6.1, 1.7.1, 1.8.1 and 1.9.1, see Volume 7B, Appendix 7-3: Full Piling Results (Auditory Injury and Disturbance) for complete set of numbers for each location.

1.4.2.6 The demographic parameters used in the iPCoD modelling were obtained from Sinclair *et al*. (2020[7]) and are summarised in Table 1-2.

Table 1-2: 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

1.4.2.7 The time points presented in Table 1-3 have been selected to represent as best as possible, a level of periodicity on population estimates following piling.

Table 1-3: Time points selected for the presentation of iPCoD modelling results.

Time Points Selected (Indicative Year)	Time Point Description
2027	Before piling starts at Caledonia North
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
2036	6-years after piling ends
2042	12-years after piling ends
2048	18-years after piling ends

1.4.3 Cumulative Impact Assessment (CIA)

Projects Scoped In or Out of the Assessment

1.4.3.1 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 Caledonia North (Table 1-4). Projects with no offshore construction timeline available in the public domain at the time of final Cumulative Impact Assessment (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 Caledonia North is shown in Table 1-4. 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.

1.4.3.2 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 3, Chapter 7: Marine Mammals (2027 to 2031). This is to reflect the baseline conditions before any piling has started (2026) and account for the whole duration of piling at projects with temporal overlap with Caledonia North (Table 1-4).

Table 1-4: 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
Caledonia North			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								
Sinclair			P	P	P	P							
Bellrock			P	P	P	P							
Spiorad na Mara			P	P	P	P							

1.4.3.3 Only projects with physical overlap between the respective array areas and relevant species' MU were screened into the cumulative iPCoD (Table 1-5). The cumulative iPCoD was carried out only for the whole MUs for harbour porpoise and minke whale (rather than the UK portion of the MU). For grey seal, the cumulative iPCoD was carried out for the combined MUs only (MF, ES and NC&O). The iPCoD for Caledonia North showed potential population reduction in the size impacted CES MU bottlenose dolphin population compared to un-impacted population (see Section 1.6.1). 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 1-5: 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
Spiorad na Mara	No	No	No	Yes	No	No	No
Green Volt	Yes	No	Yes	Yes	No	No	Yes

Project-specific Piling Days

1.4.3.4 For projects with indicative piling schedules available in the public domain (Berwick Bank, Ossian, Salamander, West of Orkney) these were used in the modelling (Table 1-6).

1.4.3.5 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 wind turbine generators (WTGs) and/or number of piles to be installed available in the public domain (in line with screening discussed in paragraph 1.4.3.1). 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 1-6). The number of piling days was evenly distributed throughout the construction years.

Table 1-6: 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 project-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
Morven	191 WTGs	2,292	1,146
Muir Mhor	67 WTGs	804	402

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

Number of Animals Impacted and Reference Populations

1.4.3.6 For the Caledonia North scenarios taken forward to the cumulative iPCoD, the assumptions regarding the number of animals are the same as for the Caledonia North alone iPCoD (see paragraph 0).

1.4.3.7 For the projects listed in Table 1-6 and 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 Deterrent 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 1-8, Table 1-13, Table 1-18, Table 1-23 and Table 1-29).

1.4.3.8 The MU specific demographic parameters used in the iPCoD modelling were obtained from Sinclair *et al*. (2020[7]) and are summarised in Table 1-2.

Selected Time Points from iPCoD Simulations

1.4.3.9 The 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 North Site, final year of piling at the Caledonia North Site, 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 North Site.

1.4.3.10 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 (Table 1-9, Table 1-14, Table 1-19, Table 1-24 and Table 1-30).

1.5 Harbour Porpoise

1.5.1 Caledonia North Alone

1.5.1.1 The disturbance values used in the modelling were based on the worst case in terms of number of animals disturbed during single piling across all modelling locations in the Caledonia North Site for the installation of pin piles at jackets:

- Modelling for the whole NS MU assumed 7,274 harbour porpoise disturbed per day; and
- Modelling for the UK proportion of the NS MU assumed 7,213 harbour porpoise disturbed per day.

1.5.1.2 The results of the iPCoD modelling for both the whole NS MU and the UK portion of the NS MU, show that the impacted population is predicted to continue at a stable trajectory and at 99.85 – 99.98% of the size of the un-impacted population (Table 1-7 and Figure 1-2).

Table 1-7: Results of iPCoD modelling for harbour porpoise (NS MU/UK portion of the NS MU).

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	346,833	346,833	100.00%
2029	346,658	346,590	99.98%
2030	346,901	346,721	99.95%
2031	346,454	346,303	99.96%
2036	347,408	347,283	99.96%
2042	345,545	345,422	99.96%
2048	345,886	345,763	99.96%
UK portion of the NS MU			
2027	159,634	159,634	100.00%
2028	159,359	159,539	100.00%
2029	159,115	159,013	99.94%
2030	159,279	159,043	99.85%
2031	159,106	158,904	99.87%
2036	159,138	158,972	99.90%
2042	158,596	158,432	99.90%
2048	159,042	158,880	99.90%
Note, time point description is provided in Table 1-3.			

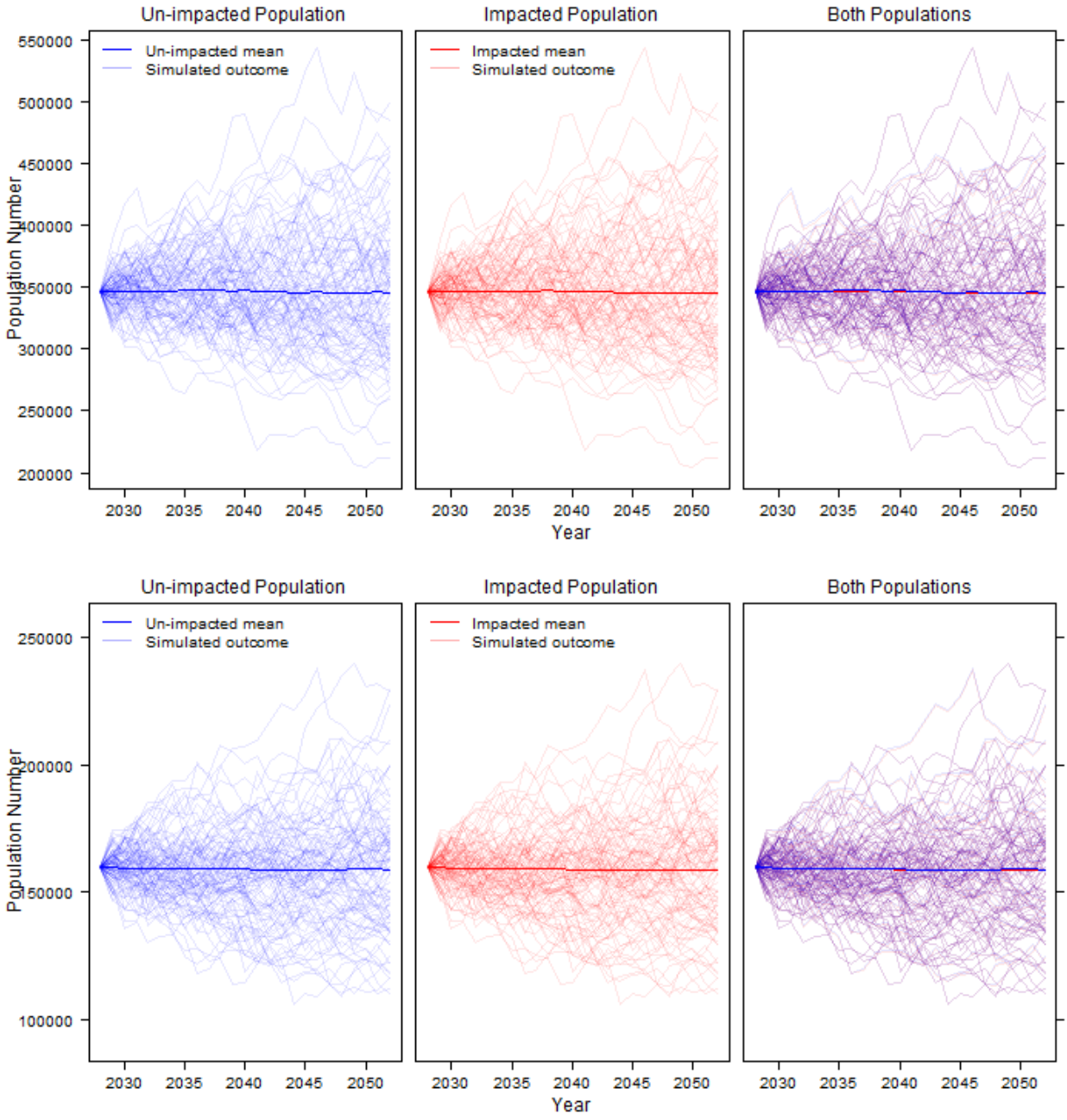

Figure 1-2: Predicted population trajectories for the un-impacted (baseline) and impacted harbour porpoise iPCoD simulations (top graph - NS MU and bottom graph – UK portion of the NS MU).

1.5.2 Cumulative Impact

Number of Animals Impacted

1.5.2.1 For cumulative scenario, the disturbance numbers for harbour porpoise used in the modelling are presented in Table 1-8.

Table 1-8: 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

1.5.2.2 The time points selected for the presentation of cumulative iPCoD modelling results are presented in Table 1-9.

Table 1-9: Time points selected for the presentation of cumulative iPCoD modelling results for cumulative impacts on the NS MU for harbour porpoise.

Time Points Selected (Indicative Year)	Time Point Description
2025	Population size at the end of the year 2025, before all piling starts
2028	End of 1st year of piling at Caledonia North, piling at projects considered for harbour porpoise within the NS MU
2030	End of final year of piling at Caledonia North, piling at projects considered for harbour porpoise within the NS MU
2036	6-years after piling ends at Caledonia North, piling at projects considered for harbour porpoise within the NS MU
2038	8-years after piling ends at Caledonia North and the end of piling at all projects considered for harbour porpoise within the NS MU
2042	12-years after piling has ended at Caledonia North 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 Caledonia North 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 Caledonia North 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.	

Results

1.5.2.3 The results of cumulative iPCoD modelling show that impacted NS MU population is predicted to continue at a stable trajectory (Figure 1-3). In the year 2038, the impacted population as a proportion of the unimpacted population reaches its lowest (98.77%), which coincides with the end of piling at projects screened in for the cumulative iPCoD for this MU and 8-years after piling at the Caledonia North Site ends (Table 1-10). The population then continues at a proportion of 98.78% into the year 2048 and 2050 (Table 1-10).

Table 1-10 Results of cumulative iPCoD modelling for harbour porpoise (NS MU).

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	346,446	345,516	99.73%
2030	345,887	343,147	99.21%
2036	346,474	342,310	98.80%
2038	345,782	341,537	98.77%
2042	345,418	341,206	98.78%
2048	344,742	340,542	98.78%
2050	345,524	341,321	98.78%
Note, time point descriptions are provided in Table 1-9.			

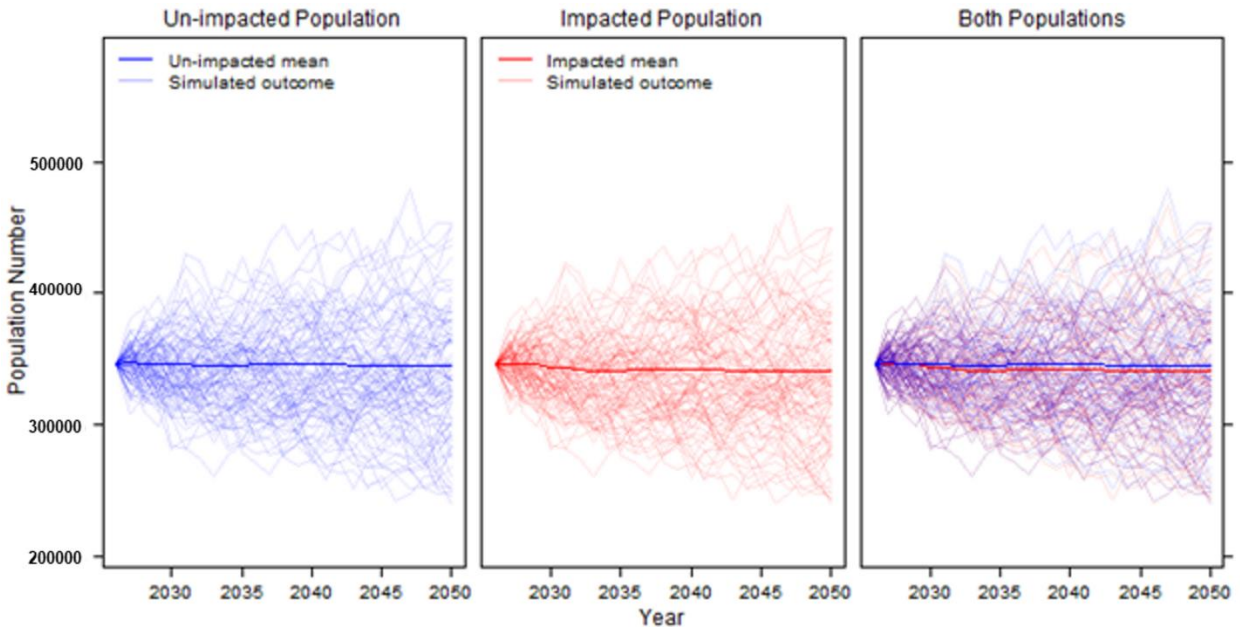

Figure 1-3: Predicted population trajectories for the un-impacted (baseline) and impacted harbour porpoise cumulative iPCoD simulations (NS MU).

1.6 Bottlenose Dolphin

1.6.1 Caledonia North Alone

1.6.1.1 The disturbance values used in the modelling were based on the worst case in terms of number of animals disturbed during single piling across all modelling locations in the Caledonia North Site for the installation of pin piles at jackets:

- Modelling for the CES MU assumed 48 bottlenose dolphins disturbed per day; and
- Modelling for the GNS MU assumed 30 bottlenose dolphins disturbed per day.

CES MU

1.6.1.2 The results of the iPCoD modelling show that for CES MU the level of disturbance has the potential to result in changes at the population level. In the year 2030, the impacted population size as a proportion of the un-impacted population size is at its lowest (97.43%) for the CES MU, before increasing back up to 98.07% by 2048 (Table 1-11). The impacted population is predicted to continue on an increasing trajectory, the same as the un-impacted population (Figure 1-4).

Table 1-11: Results of iPCoD modelling for bottlenose dolphin for the CES MU.

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	258	98.47%
2030	272	265	97.43%
2031	282	275	97.52%
2036	337	331	98.22%
2042	417	409	98.08%
2048	517	507	98.07%
Note, time point description is provided in Table 1-3.			

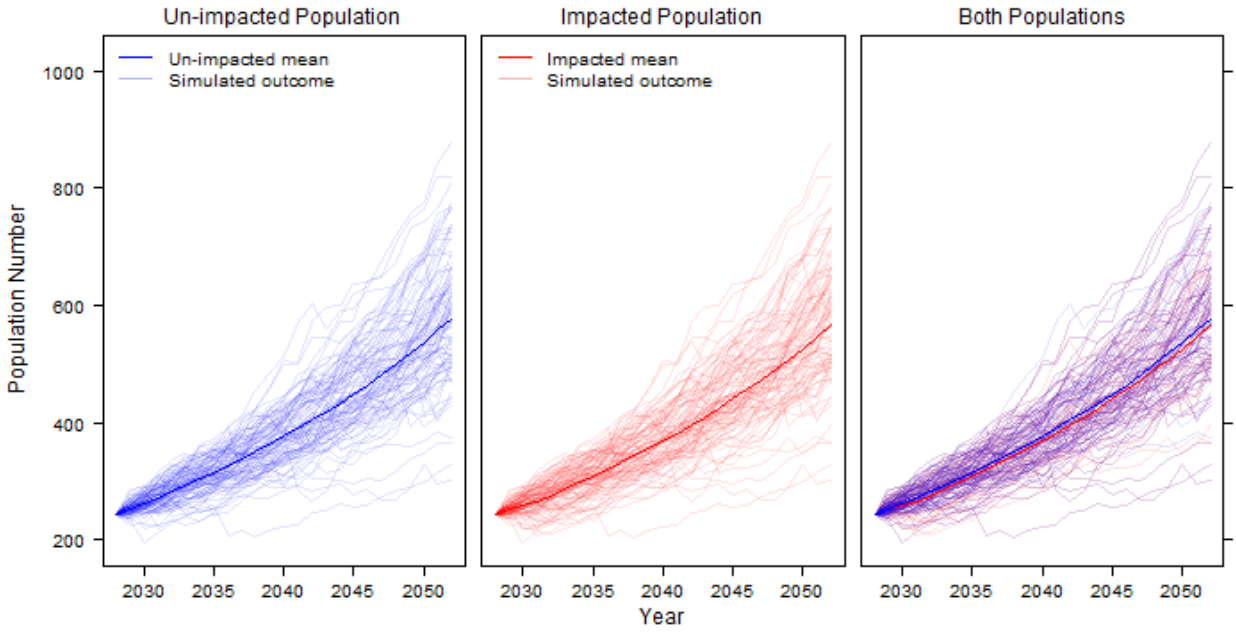

Figure 1-4: Predicted population trajectories for the un-impacted (baseline) and impacted bottlenose dolphin iPCoD simulations for the CES MU.

GNS MU

1.6.1.3 The results of the iPCoD modelling show that for the GNS MU, the impacted population is predicted to continue at a stable trajectory and at 99.95% – 100.00% of the size of the un-impacted population (Table 1-12 and Figure 1-5).

Table 1-12: Results of iPCoD modelling for bottlenose dolphin for the GNS MU.

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	2,025	2,025	100.00%
2029	2,027	2,026	99.95%
2030	2,029	2,028	99.95%
2031	2,032	2,031	99.95%
2036	2,043	2,043	100.00%
2042	2,046	2,045	99.95%
2048	2,049	2,048	99.95%
Note, time point description is provided in Table 1-3.			

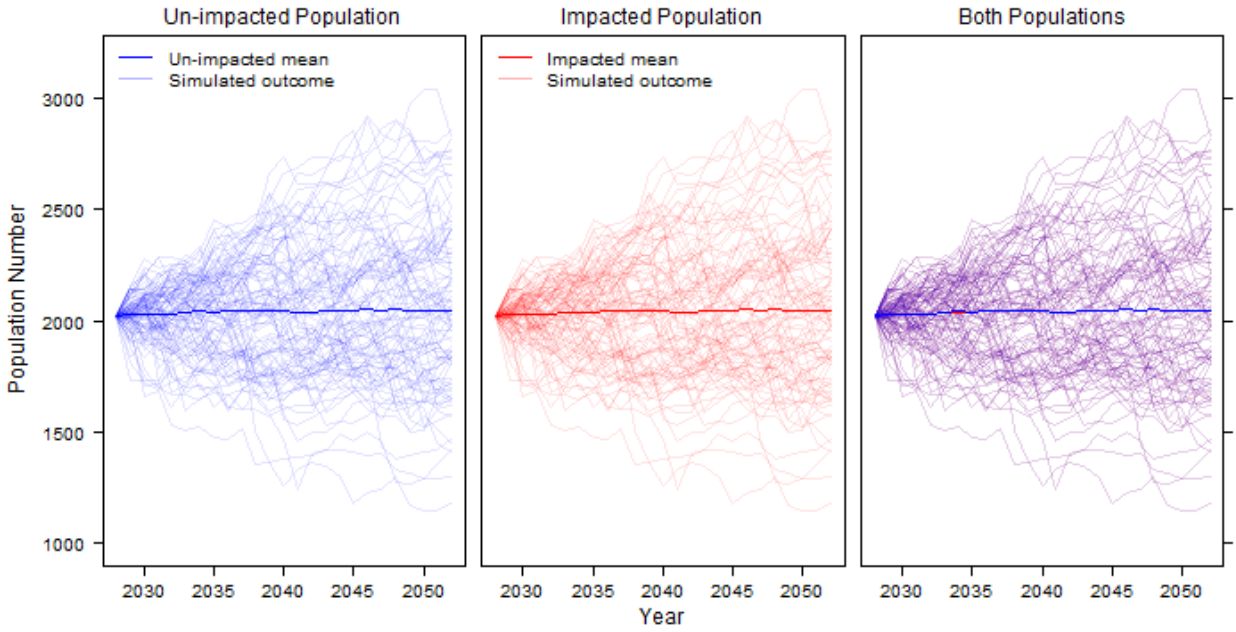

Figure 1-5: Predicted population trajectories for the un-impacted (baseline) and impacted bottlenose dolphin iPCoD simulations for the GNS MU.

1.6.2 Cumulative Impact

Number of Animals Impacted

1.6.2.1 For cumulative scenario the disturbance numbers for bottlenose dolphin used in the modelling are presented in Table 1-13.

Table 1-13: 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

1.6.2.2 The time points selected for the presentation of cumulative iPCoD modelling results are presented in Table 1-14 for the CES MU and GNS MU.

Table 1-14: Time points selected for the presentation of cumulative iPCoD modelling results for cumulative impacts on the CES MU and GNS MU for bottlenose dolphin.

Time Points Selected (Indicative Year)	Time Point Description
CES MU	
2025	Population size at the end of the year 2025, before all piling starts
2028	End of 1st year of piling at Caledonia North, piling at projects considered for bottlenose dolphin within the CES MU
2030	End of final year of piling at Caledonia North, piling at projects considered for bottlenose dolphin within the CES MU
2036	6-years after piling ends at Caledonia North, piling at projects considered for bottlenose dolphin within the CES MU
2038	8-years after piling ends at Caledonia North and the end of piling at all projects considered for bottlenose dolphin within the CES MU
2042	12-years after piling has ended at Caledonia North 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 Caledonia North 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 Caledonia North and 12-years after piling has ended at all projects considered for bottlenose dolphin within the CES MU
GNS MU	
2025	Population size at the end of the year 2025, before all piling starts
2028	End of 1st year of piling at Caledonia North, piling at projects considered for bottlenose dolphin within the GNS MU
2030	End of final year of piling at Caledonia North, piling at projects considered for bottlenose dolphin within the GNS MU
2031	1-year after piling ends at Caledonia North and the end of piling at all projects considered for bottlenose dolphin within the GNS MU

Time Points Selected (Indicative Year)	Time Point Description
2036	6-years after piling ends at Caledonia North 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 Caledonia North 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 Caledonia North 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 Caledonia North 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.	

Results

CES MU

1.6.2.3 The results of the cumulative 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 (Figure 1-6).

1.6.2.4 In the year 2030, the impacted population size as a proportion of the un-impacted population size is at its lowest (95.89%) for the CES MU, which coincides with the final year of piling at the Caledonia North Site, before increasing back up to 96.69% by 2036 (Table 1-10). The population then continues on an increasing trajectory, at 96.66% of the un-impacted population size into the year 2050 (Table 1-10).

Table 1-15: Results of cumulative iPCoD modelling for bottlenose dolphin (CES MU).

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	292	280	95.89%
2036	363	351	96.69%
2038	390	377	96.67%
2042	450	435	96.67%
2048	557	539	96.77%
2050	598	578	96.66%
Note, time point descriptions are provided in Table 1-14.			

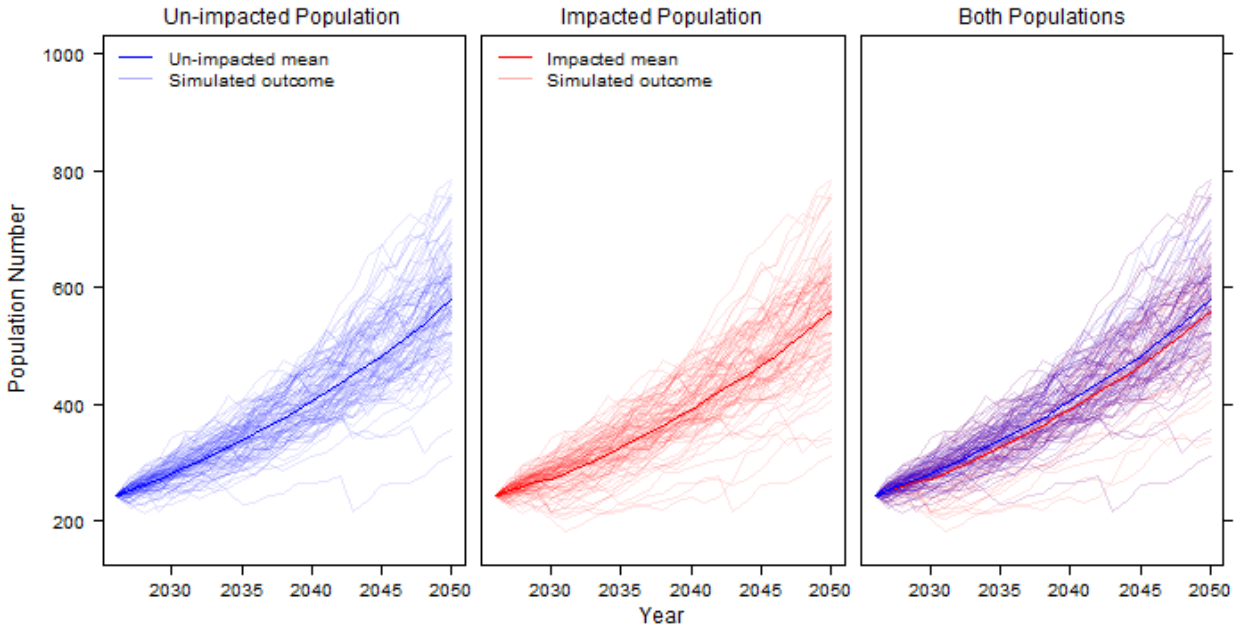

Figure 1-6: Predicted population trajectories for the un-impacted (baseline) and impacted bottlenose dolphin cumulative iPCoD simulations (CES MU).

GNS MU

1.6.2.5 The results of cumulative iPCoD modelling show that impacted GNS MU population is predicted to continue at a stable trajectory (Figure 1-7). In the year 2050, the impacted population size as a proportion of the un-impacted population size reaches its lowest (98.19%, Table 1-16), which coincides with the final time point in the cumulative iPCoD scenario for the

GNS MU (20-years after piling has ended at the Caledonia North Site and 19-years after piling has ended at all projects considered for bottlenose dolphin within the GNS MU).

Table 1-16: Results of cumulative iPCoD modelling for bottlenose dolphin (GNS MU).

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	2,020	1,988	98.42%
2030	2,016	1,988	98.61%
2031	2,015	1,986	98.56%
2036	2,021	1,986	98.27%
2042	2,037	2,001	98.23%
2048	2,040	2,004	98.24%
2050	2,042	2,005	98.19%
Note, time point descriptions are provided in Table 1-14.			

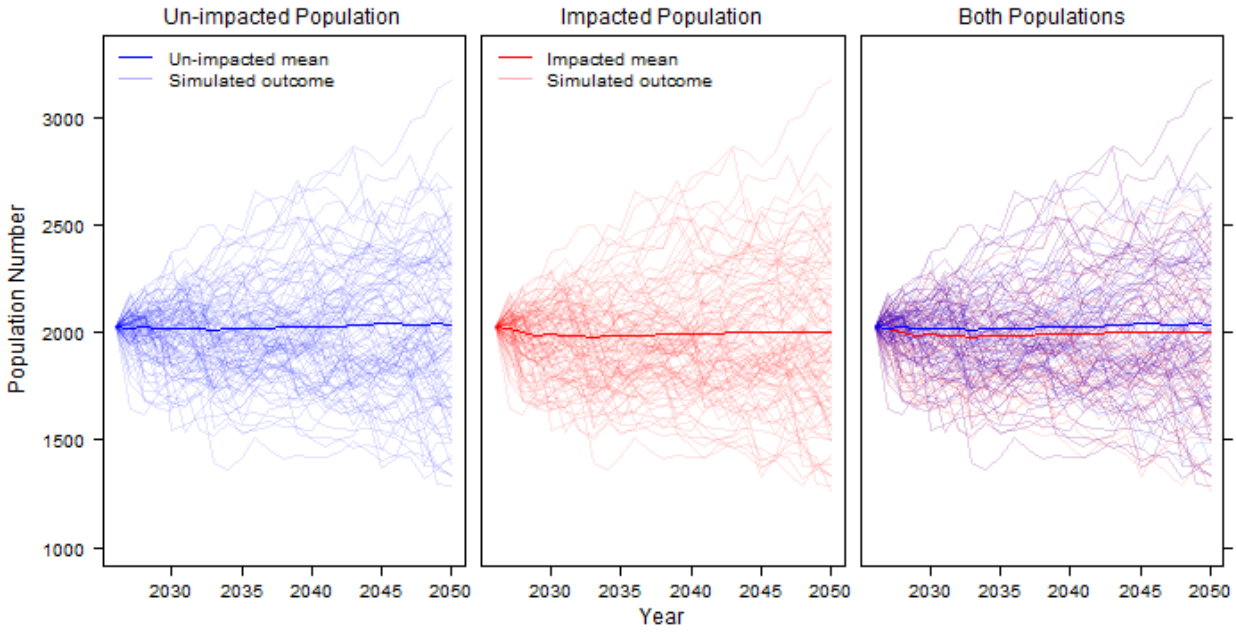

Figure 1-7: Predicted population trajectories for the un-impacted (baseline) and impacted bottlenose dolphin cumulative iPCoD simulations (GNS MU).

1.7 Minke Whale

1.7.1 Caledonia North Alone

1.7.1.1 The disturbance values used in the modelling were based on the worst case in terms of number of animals disturbed during single piling across all modelling locations in the Caledonia North Site for the installation of pin piles at jackets:

- Modelling for the whole CGNS MU assumed 458 minke whales disturbed per day; and
- Modelling for the UK proportion of the CGNS MU assumed 455 minke whales disturbed per day.

1.7.1.2 The results of the iPCoD modelling for both the whole MU and the UK portion of the MU show that the impacted population is predicted to continue at a stable trajectory and at 100% of the size of the un-impacted population (Table 1-17 and Figure 1-8).

Table 1-17: Results of iPCoD modelling for minke whale (GCNS MU/UK portion of the GCNS MU).

Time Point	Unimpacted Population Mean Size	Impacted Population Mean Size	Impacted Population as a Proportion of the Unimpacted Population
GCNS MU			
2027	20,120	20,120	100.00%
2028	20,063	20,063	100.00%
2029	20,053	20,053	100.00%
2030	20,082	20,082	100.00%
2031	20,121	20,121	100.00%
2036	19,983	19,983	100.00%
2042	19,984	19,984	100.00%
2048	19,976	19,976	100.00%
UK portion of the GCNS MU			
2027	10,288	10,288	100.00%
2028	10,304	10,304	100.00%
2029	10,294	10,294	100.00%
2030	10,285	10,285	100.00%
2031	10,284	10,284	100.00%
2036	10,182	10,182	100.00%
2042	10,153	10,153	100.00%
2048	10,131	10,131	100.00%
Note, time point description is provided in Table 1-3.			

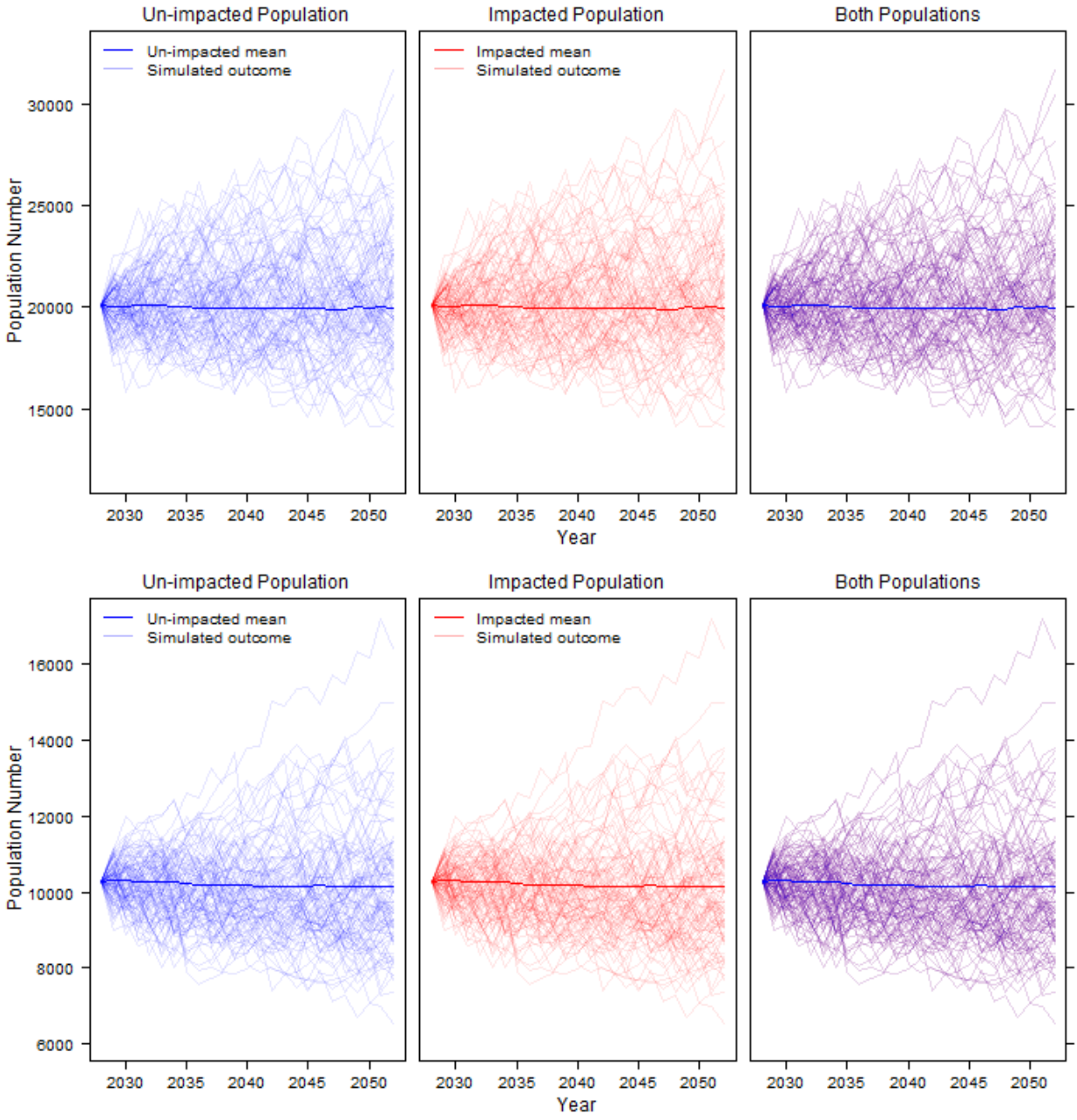

Figure 1-8: Predicted population trajectories for the un-impacted (baseline) and impacted minke whale iPCoD simulations (top graph – GCNS MU, bottom graph – UK portion of the GCNS MU).

1.7.2 Cumulative Impact

Number of Animals Impacted

1.7.2.1 For cumulative scenario, the disturbance numbers for minke whale used in the modelling are presented in Table 1-18.

Table 1-18: 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[11])
Green Volt	265	EIA (Royal HaskoningDHV, 2023[12])
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
Spiorad na Mara	63	SCANS IV & EDR

Time Points

1.7.2.2 The time points selected for the presentation of cumulative iPCoD modelling results are presented in Table 1-19.

Table 1-19: Time points selected for the presentation of cumulative iPCoD modelling results for cumulative impacts on the CGNS MU for minke whale.

Time Points Selected (Indicative Year)	Time Point Description
2025	Population size at the end of the year 2025, before all piling starts
2028	End of 1st year of piling at Caledonia North, piling at projects considered for minke whale within the CGNS MU
2030	End of final year of piling at Caledonia North, piling at projects considered for minke whale within the CGNS MU
2036	6-years after piling ends at Caledonia North, piling at projects considered for minke whale within the CGNS MU
2038	8-years after piling ends at Caledonia North and the end of piling at all projects considered for minke whale within the CGNS MU
2042	12-years after piling has ended at Caledonia North 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 Caledonia North 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 Caledonia North 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	

Results

1.7.2.3 The results of the cumulative iPCoD modelling show that the impacted population is predicted to continue at a stable trajectory, the same as the un-impacted population, and at 99.99% – 100% of the size of the un-impacted population (Table 1-20 and Figure 1-9).

Table 1-20: Results of cumulative iPCoD modelling for minke whale (CGNS MU).

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	20,249	20,248	100.00%
2030	20,151	20,148	99.99%
2036	20,078	20,077	100.00%
2038	20,077	20,076	100.00%
2042	20,102	20,101	100.00%
2048	19,988	19,987	100.00%
2050	20,032	20,031	100.00%
Note, time point descriptions are provided in Table 1-19.			

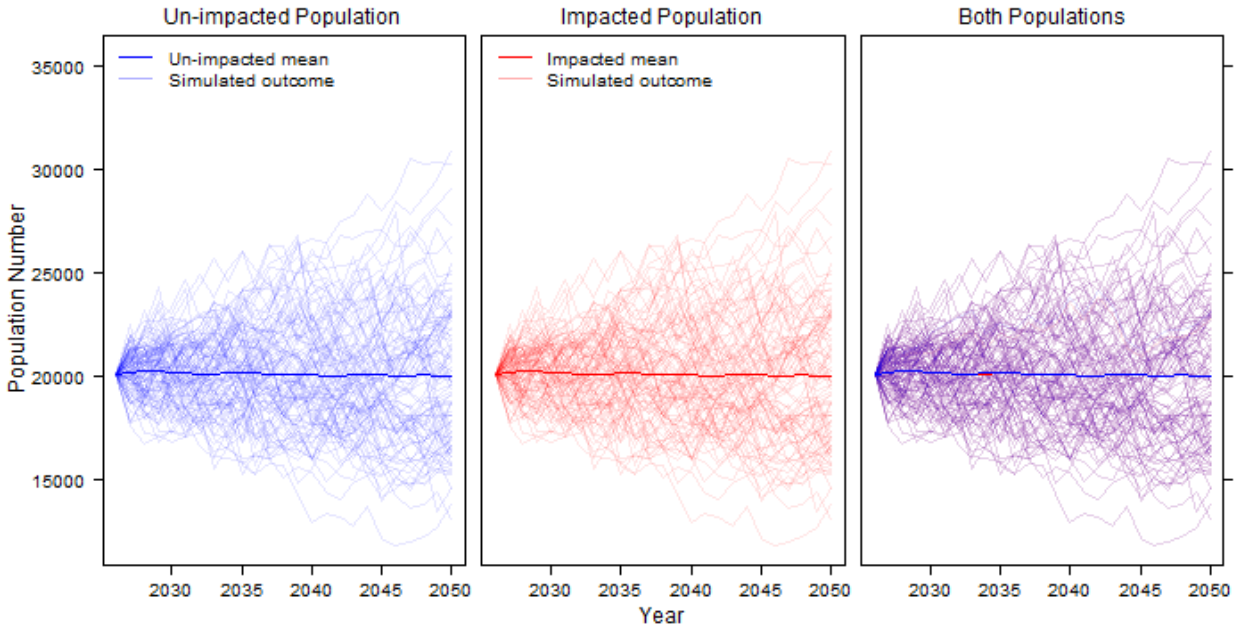

Figure 1-9: Predicted population trajectories for the un-impacted (baseline) and impacted minke whale cumulative iPCoD simulations (CGNS MU).

1.8 Harbour Seal

1.8.1 Caledonia North Alone

1.8.1.1 The disturbance values used in the modelling were based on the worst case in terms of number of animals disturbed during single piling across all modelling locations in the Caledonia North Site for the installation of pin piles at jackets:

- Modelling for the Moray Firth Seal Management Unit (SMU) assumed 53 harbour seals disturbed per day; and
- Modelling for the North Coast and Orkney SMU assumed 86 harbour seals disturbed per day.

1.8.1.2 It is important to note when considering the iPCoD results for harbour seals, that the NC&O MU is currently in decline with an average rate of decrease over the last 5 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 it is therefore necessary to understand that the un-impacted baseline MU is predicted to significantly decline in the absence of any impacts.

Moray Firth MU

1.8.1.3 The results of the iPCoD modelling show that for the MF MU, the impacted population is predicted to continue at a stable trajectory and at 100% of the size of the un-impacted population (Table 1-21 and Figure 1-10).

Table 1-21: Results of iPCoD modelling for harbour seal for the MF SMU.

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	955	955	100.00%
2029	954	954	100.00%
2030	954	954	100.00%
2031	954	954	100.00%
2036	951	951	100.00%
2042	957	957	100.00%
2048	958	958	100.00%
Note, time point description is provided in Table 1-3.			

Figure 1-10: Predicted population trajectories for the un-impacted (baseline) and impacted harbour seal for the MF SMU iPCoD simulations.

North Coast and Orkney MU

1.8.1.4 The results of the iPCoD modelling show that for the NC&O SMU, 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 1-22 and Figure 1-11).

Table 1-22: Results of iPCoD modelling for harbour seal for the NC&O SMU.

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	1,744	1,744	100.00%
2029	1,564	1,564	100.00%
2030	1,399	1,399	100.00%
2031	1,256	1,256	100.00%
2036	654	654	100.00%
2042	336	336	100.00%
2048	174	174	100.00%
Note, time point description is provided in Table 1-3.			

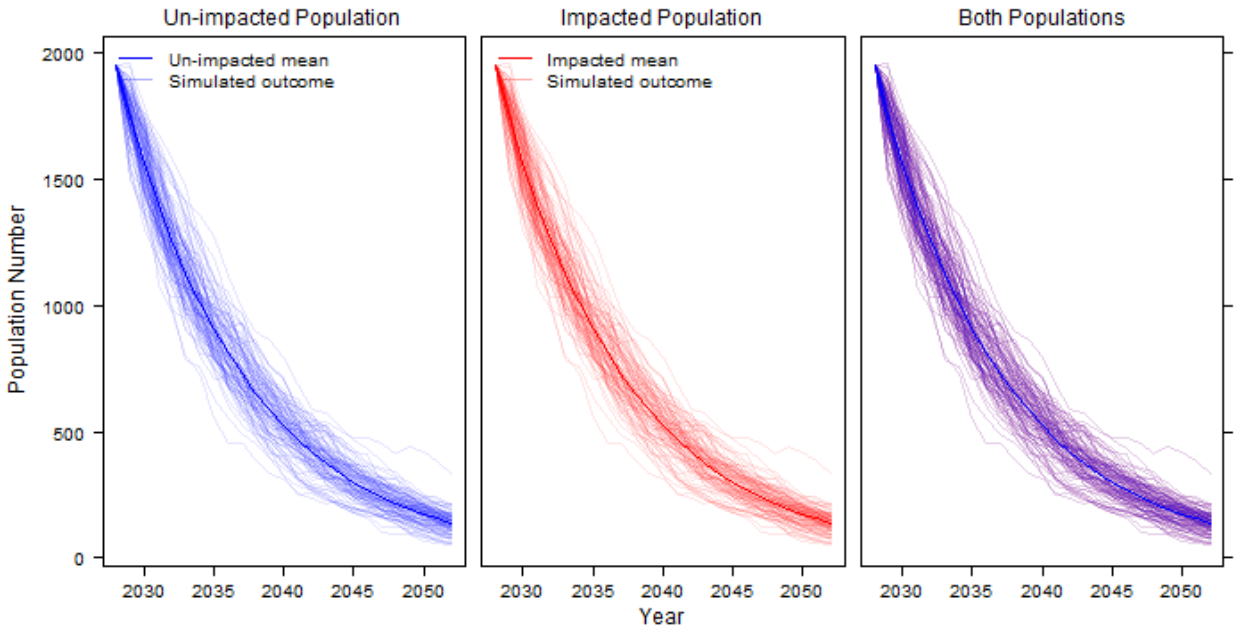

Figure 1-11: Predicted population trajectories for the un-impacted (baseline) and impacted harbour seal for the NC&O SMU iPCoD simulations.

1.8.2 Cumulative Impacts

Number of Animals Impacted

1.8.2.1 For cumulative scenarios the disturbance numbers for harbour seal used in the modelling are presented in Table 1-23.

Table 1-23: 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

1.8.2.2 The time points selected for the presentation of cumulative iPCoD modelling results are presented in Table 1-24 for MF and NC&O SMUs.

Table 1-24: Time points selected for the presentation of cumulative iPCoD modelling results for cumulative impacts on the MF SMU and NC&O SMU for harbour seals.

Time Points Selected (Indicative Year)	Time Point Description
MF SMU	
2025	Population size at the end of the year 2025, before all piling starts
2028	End of 1st year of piling at Caledonia North, piling at projects considered for harbour seal within the MF SMU
2030	End of final year of piling at Caledonia North, piling at projects considered for harbour seal within the MF SMU
2031	1-year after piling ends at Caledonia North and the end of piling at all projects considered for harbour seal within the MF SMU

Time Points Selected (Indicative Year)	Time Point Description
2036	6-years after piling ends at Caledonia North and 5-years after piling has ended at all projects considered for harbour seal within the MF SMU
2042	12-years after piling has ended at Caledonia North 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 Caledonia North 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 Caledonia North and 19-years after piling has ended at all projects considered for harbour seal within the MF SMU
NC&O SMU	
2025	Population size at the end of the year 2025, before all piling starts
2028	End of 1st year of piling at Caledonia North, piling at projects considered for harbour seal within the NC&O SMU
2030	End of final year of piling at Caledonia North, piling at projects considered for harbour seal within the NC&O SMU
2033	3-years after piling ends at Caledonia North and the end of piling at all projects considered for harbour seal within the NC&O SMU
2036	6-years after piling ends at Caledonia North 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 Caledonia North 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 Caledonia North 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 Caledonia North 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	

MF SMU

1.8.2.3 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 and at 100% of the size of the un-impacted population (Table 1-25 and Figure 1-12).

Table 1-25: Results of cumulative iPCoD modelling for harbour seals (MF SMU).

Time Point	Unimpacted Population Mean Size	Impacted Population Mean Size	Impacted Population as a Proportion of the Unimpacted Population
2025	956	956	100%
2028	958	958	100%
2030	962	962	100%
2031	964	964	100%
2036	961	961	100%
2042	965	965	100%
2048	969	969	100%
2050	972	972	100%
Note, time point descriptions are provided in Table 1-24.			

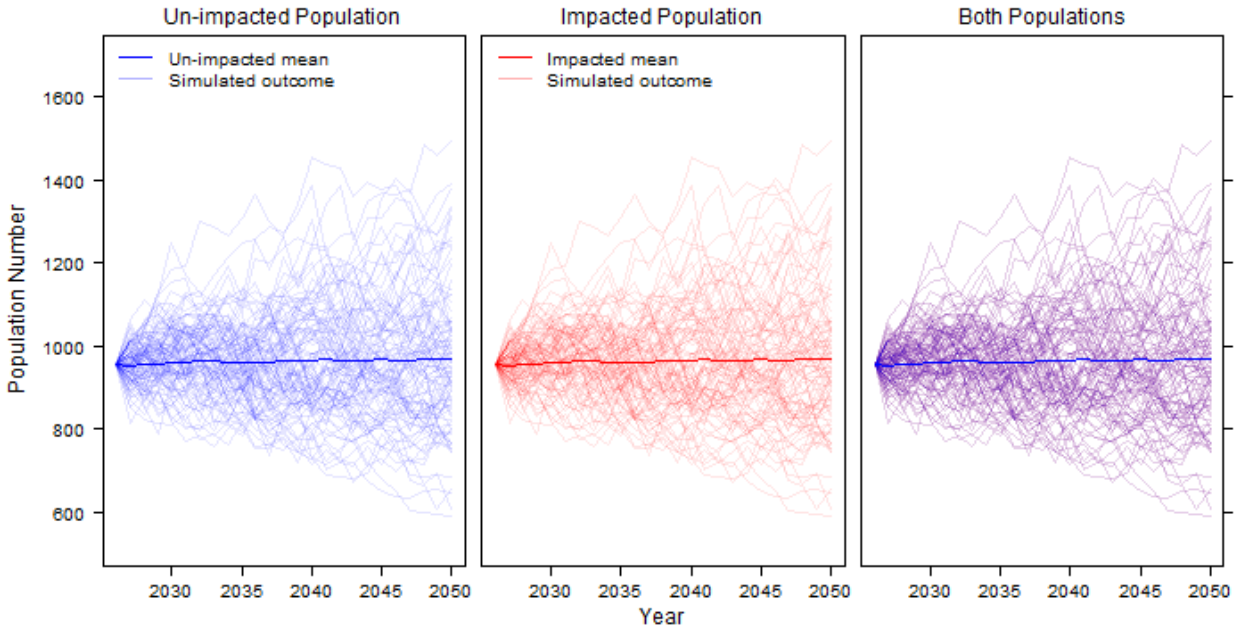

Figure 1-12: Predicted population trajectories for the un-impacted (baseline) and impacted harbour seal cumulative iPCoD simulations (MF SMU).

NC&O MU

1.8.2.4 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 1-13 and Table 1-26).

Table 1-26: Results of cumulative iPCoD modelling for harbour seals (NC&O SMU).

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	1,399	1,399	100%
2030	1,122	1,122	100%
2033	805	805	100%
2036	579	579	100%
2042	299	299	100%
2048	154	154	100%
2050	123	123	100%
Note, time point descriptions are provided in Table 1-24.			

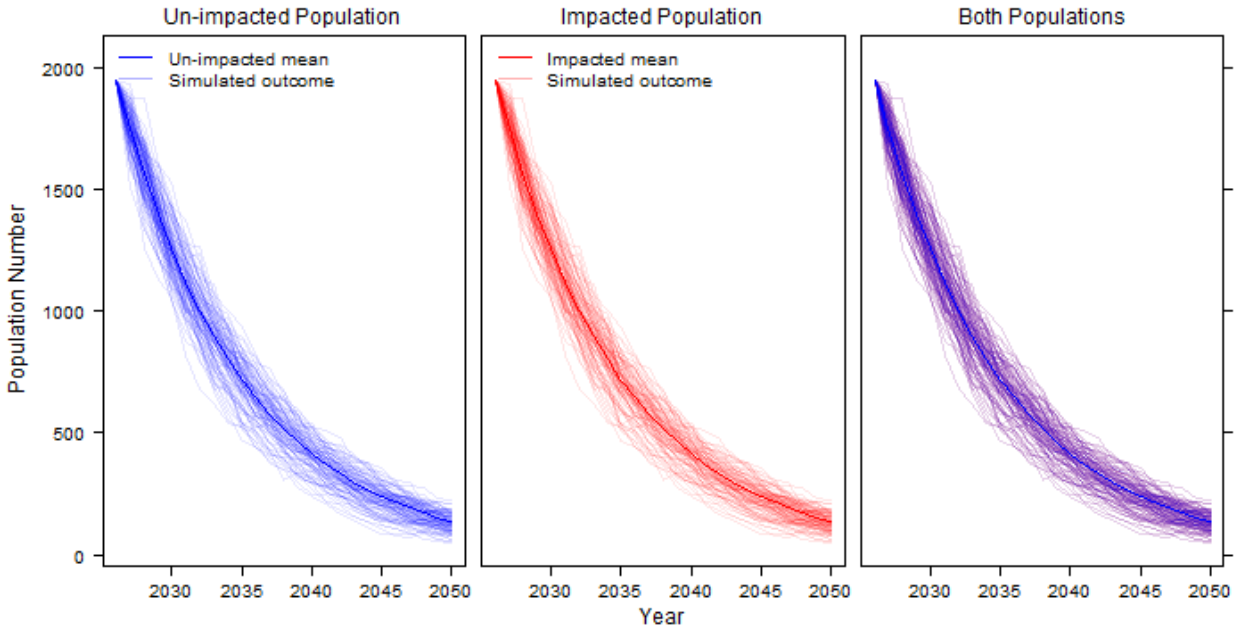

Figure 1-13: Predicted population trajectories for the un-impacted (baseline) and impacted harbour seal cumulative iPCoD simulations (NC&O SMU).

1.9 Grey Seal

1.9.1 Caledonia North Alone

1.9.1.1 The disturbance values used in the modelling were based on the worst case in terms of number of animals disturbed during single piling across all modelling locations in the Caledonia North Site for the installation of pin piles at jackets:

- Modelling for the Moray Firth SMU assumed 1,921 grey seals disturbed per day; and
- Modelling for the Moray Firth, East Scotland and North Coast and Orkney SMUs assumed 4,426 grey seals disturbed per day.

MF SMU

1.9.1.2 The results of the iPCoD modelling show that for the Moray Firth MU, the impacted population is predicted to continue at a stable trajectory and at 99.99% - 100% of the size of the un-impacted population (Table 1-27 and Figure 1-14).

Table 1-27: Results of iPCoD modelling for grey seal (MF SMU).

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	7,423	7,423	100.00%
2029	7,475	7,475	100.00%
2030	7,505	7,505	100.00%
2031	7,549	7,549	100.00%
2036	7,836	7,835	99.99%
2042	8,161	8,161	100.00%
2048	8,469	8,469	100.00%
Note, time point description is provided in Table 1-3.			

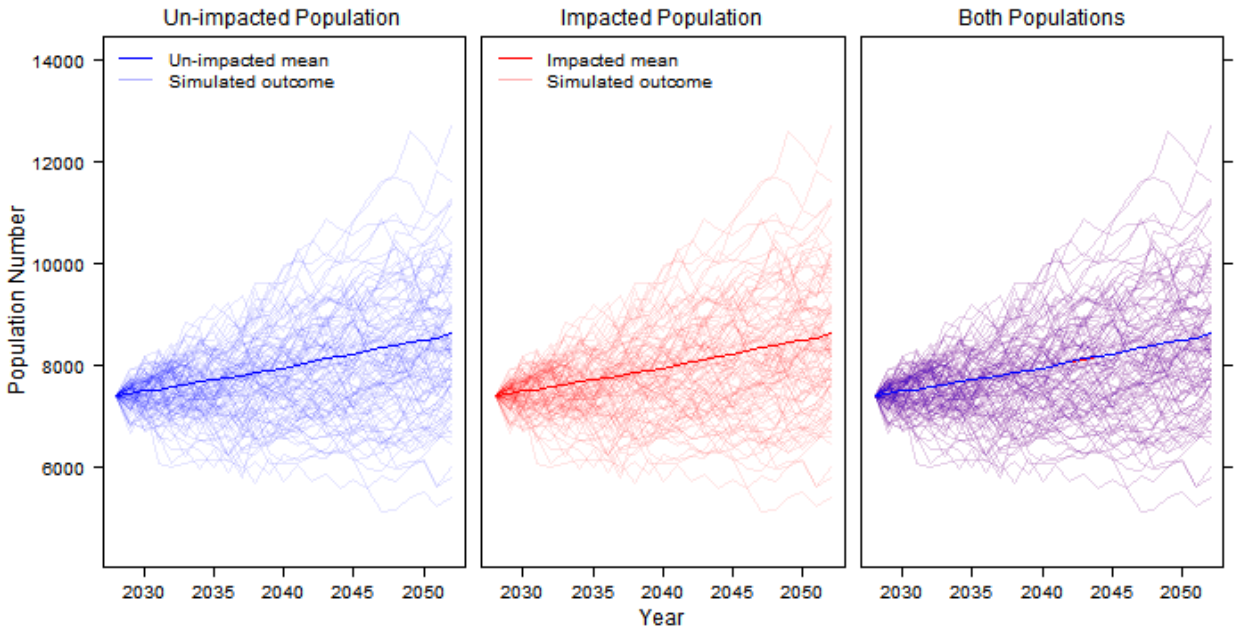

Figure 1-14: Predicted population trajectories for the un-impacted (baseline) and impacted grey seal iPCoD simulations (MF SMU)

SMUs Combined (MF, ES and NC&O)

1.9.1.3 The results of the iPCoD modelling show that for all seal MUs combined, the impacted population is predicted to continue at a stable trajectory and at 100% of the size of the un-impacted population (Table 1-28 and Figure 1-15).

Table 1-28: Results of iPCoD modelling for grey seal (MF, ES and NC&O SMUs combined).

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	52,679	52,679	100.00%
2029	52,812	52,812	100.00%
2030	53,262	53,262	100.00%
2031	53,648	53,648	100.00%
2036	55,451	55,451	100.00%
2042	57,822	57,822	100.00%
2048	60,126	60,126	100.00%
Note, time point description is provided in Table 1-3.			

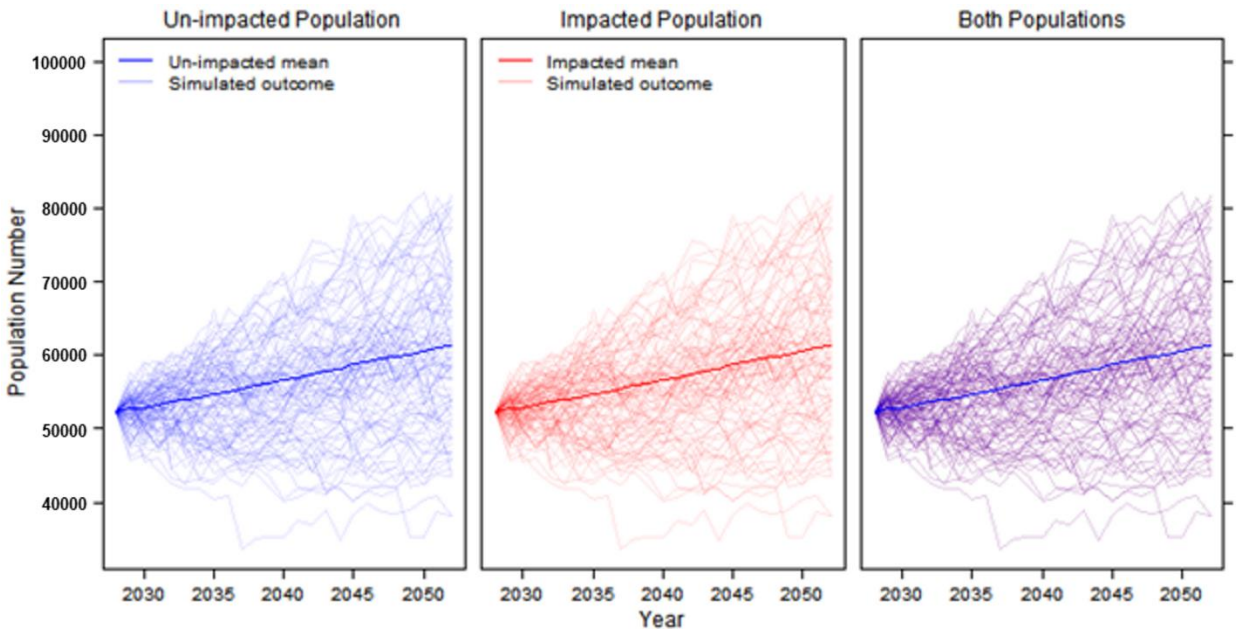

Figure 1-15: Predicted population trajectories for the un-impacted (baseline) and impacted grey seal iPCoD simulations (MF, ES and NC&O SMUs combined)

1.9.2 Cumulative Impacts

Number of Animals Impacted

1.9.2.1 For cumulative scenarios the disturbance numbers for grey seal used in the modelling are presented in Table 1-29.

Table 1-29: 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[12])
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

1.9.2.2 The time points selected for the presentation of cumulative iPCoD modelling results are presented in Table 1-30.

Table 1-30: Time points selected for the presentation of cumulative iPCoD modelling results for cumulative impacts on the combined SMUs for grey seals.

Time Points Selected (Indicative Year)	Time Point Description
2025	Population size at the end of the year 2025, before all piling starts
2028	End of 1st year of piling at Caledonia North, piling at projects considered for grey seal within the SMUs combined
2030	End of final year of piling at Caledonia North, piling at projects considered for grey seal within the SMUs combined
2036	6-years after piling ends at Caledonia North, piling at projects considered for grey seal within the SMUs combined
2038	8-years after piling ends at Caledonia North and the end of piling at all projects considered for grey seal within the SMUs combined
2042	12-years after piling has ended at Caledonia North 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 Caledonia North 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 Caledonia North and 12-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.	

Results

SMUs combined (MF, ES and NC&O)

1.9.2.3 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 and at 99.9% – 100% of the size of the un-impacted population (Table 1-31 and Figure 1-16).

Table 1-31: Results of cumulative iPCoD modelling for grey seals (combined SMUs).

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	53,402	53,402	100.00%
2030	54,188	54,185	99.99%
2036	56,406	56,403	99.99%
2038	57,115	57,112	99.99%
2042	58,423	58,421	100.00%
2048	60,658	60,656	100.00%
2050	61,614	61,611	100.00%
Note, time point descriptions are provided in Table 1-30.			

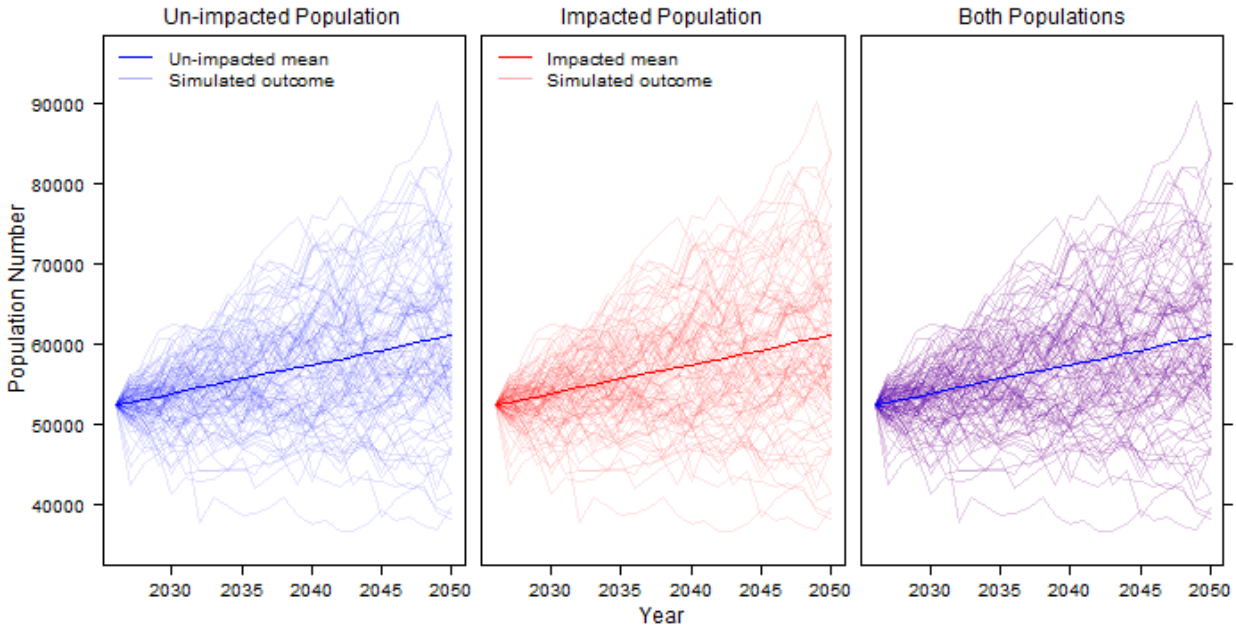

Figure 1-16: Predicted population trajectories for the un-impacted (baseline) and impacted grey seal cumulative iPCoD simulations (combined SMUs).

1.10 References

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