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Volume 8 Additional Information

Appendix 24: Marine Mammals iPCoD Results (Caledonia North)

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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
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 Introduction

- 1.1.1.1 This appendix provides a full set of results for the re-assessment of the disturbance and potential for population level effects to harbour porpoise, bottlenose dolphin, minke whale and harbour seal as a result of the underwater noise during piling at the Caledonia North Site (i.e., Array Area of Caledonia North). This includes results for Caledonia North alone (bottlenose dolphin only), and cumulatively with other projects.
- 1.1.1.2 The methodology used for the re-assessment is presented in Volume 8, Appendix 22: Marine Mammals Clarifications and Piling Re-Assessment Methodology. Detailed information about the iPCoD model used, including precaution and model limitations is presented in Volume 7C, Appendix 7-4: Marine Mammals Population Modelling iPCoD.

2 Caledonia North Alone

2.1 Time Points

- 2.1.1.1 For the Caledonia North installation scenario, discussed in detail in Volume 8, Appendix 22: Marine Mammals Clarifications and Piling Re-Assessment Methodology, selected time points have been used to present the results on bottlenose dolphin Coastal East Scotland (CES) Management Unit (MU) population trajectory (modelled as increasing and stable). 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 are provided in Table 2-1.

Table 2-1: Time points selected for the presentation of iPCoD modelling results.

Time Points Selected (Indicative Year)	Time Point Description
Start 2028	Before piling starts at Caledonia North Site
End 2028	The end of first year of piling at Caledonia North Site
2029	The end of second year of piling at Caledonia North Site
2030	The end of third (final) year of piling at Caledonia North Site
2031	1-year after piling ends
2036	6-years after piling ends
2042	12-years after piling ends
2048	18-years after piling ends

2.2 Bottlenose Dolphin

- 2.2.1.1 As detailed in Volume 8, Appendix 22: Marine Mammals Clarifications and Piling Re-Assessment Methodology, three disturbance methods were used in the iPCoD modelling for bottlenose dolphins for Caledonia North alone. The number of dolphins disturbed for each threshold is presented in Table 2-2.

Table 2-2: Numbers of bottlenose dolphins affected taken forward to iPCoD.

Parameter	Dose-response	Deterrence Function	26km EDR
Number of animals disturbed	44	5	1

Dose-response

- 2.2.1.2 The numbers of animals disturbed presented in this section are based on the modelled numbers presented in Section 1.3.2 of Volume 7C, Appendix 7-3: Marine Mammal Piling Results. However, NatureScot requested that the numbers are scaled to the population size of 226. As such, the numbers of animals affected presented above are scaled from population size of 245 individuals to population size of 226 individuals.
- 2.2.1.3 The disturbance number used in the modelling was based on the worst case (single piling) across all modelling locations, e.g., 44 bottlenose dolphins per piling day for installation of pin piles at jackets in Caledonia North Site (total 79 piling days).
- 2.2.1.4 The results of the iPCoD modelling show that, although the predicted level of disturbance has the potential to result in changes at the population level, the impacted population is predicted to continue on an increasing or stable trajectory, the same as the un-impacted population (Table 2-3 and Figure 2-1). At the end of the year 2030 coinciding with the end of the third and last year of piling at Caledonia North Site, the mean impacted population size as a proportion of the mean unimpacted population size is at its lowest (96.85% increasing, 98.24% stable), before increasing to 97.94% (increasing) or remaining stable at 98.67% (stable) by 2048.

Table 2-3: Results of iPCoD modelling for bottlenose dolphin (Dose-response) (Scenario: 44 dolphins disturbed per day, for a total of 79 piling days).

Time Point	Unimpacted Population Mean Size	Impacted Population Mean Size	Impacted Population as a Proportion of the Unimpacted Population
Increasing population			
Start 2028	228	228	100.00%
End 2028	236	236	100.00%
2029	245	241	98.37%
2030	254	246	96.85%
2031	263	256	97.34%
2036	316	310	98.10%
2042	393	385	97.96%
2048	486	476	97.94%
Stable population			
Start 2028	228	228	100.00%
End 2028	228	228	100.00%
2029	228	226	99.12%
2030	227	223	98.24%
2031	227	223	98.24%
2036	227	224	98.68%
2042	227	224	98.68%
2048	226	223	98.67%
Note, time point descriptions are provided in Table 2-1.			

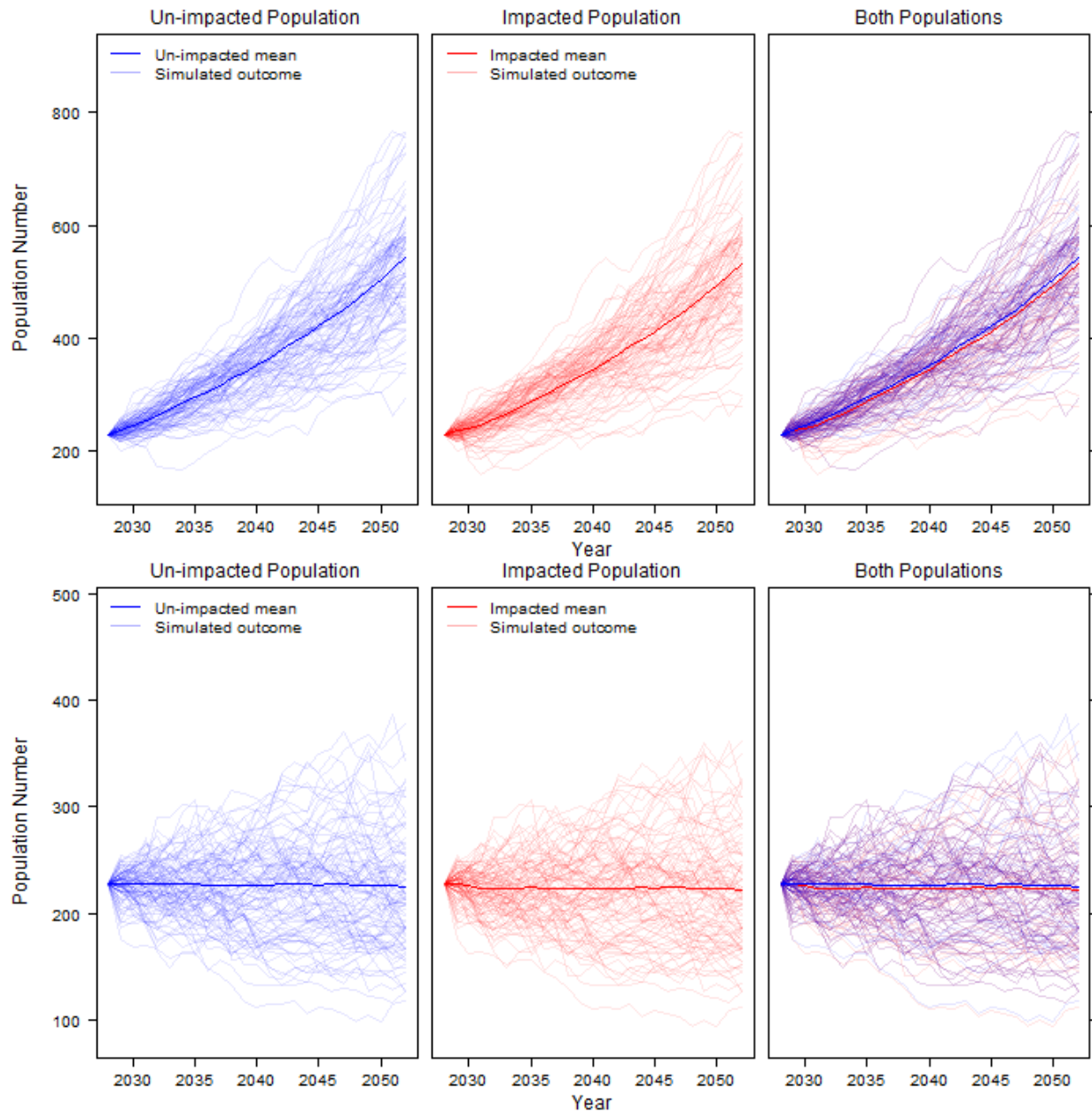


Figure 2-1: Predicted population trajectories for the un-impacted (baseline) and impacted bottlenose dolphin iPCoD simulations (Dose-response; top graph – increasing population and bottom graph – stable population) (Scenario: 44 dolphins disturbed per day, for a total of 79 piling days).

Deterrence Function

- 2.2.1.5 The number of animals affected was calculated using methodology described in Volume 8, Appendix 22: Marine Mammals Clarifications and Piling Re-Assessment Methodology. The disturbance value used in the modelling is five bottlenose dolphins per piling day for installation in Caledonia North Site (total 79 piling days).
- 2.2.1.6 The results of the iPCoD modelling show that the impacted population is predicted to continue at an increasing and stable trajectory with a mean population size that is 99.61-100% (increasing) and 99.56-100% (stable) of the size of the mean un-impacted population size (Table 2-4 and Figure 2-2).

Table 2-4: Results of iPCoD modelling for bottlenose dolphin (deterrence function) (Scenario: five dolphins disturbed per day, for a total of 79 piling days).

Time Point	Unimpacted Population Mean Size	Impacted Population Mean Size	Impacted Population as a Proportion of the Unimpacted Population
Increasing Population			
Start 2028	228	228	100.00%
End 2028	236	236	100.00%
2029	245	245	100.00%
2030	255	254	99.61%
2031	264	264	100.00%
2036	315	315	100.00%
2042	392	391	99.74%
2048	488	488	100.00%
Stable Population			
Start 2028	228	228	100.00%
End 2028	228	228	100.00%
2029	227	227	100.00%
2030	228	228	100.00%
2031	228	228	100.00%
2036	228	227	99.56%
2042	227	227	100.00%
2048	227	227	100.00%
Note, time point descriptions are provided in Table 2-1.			

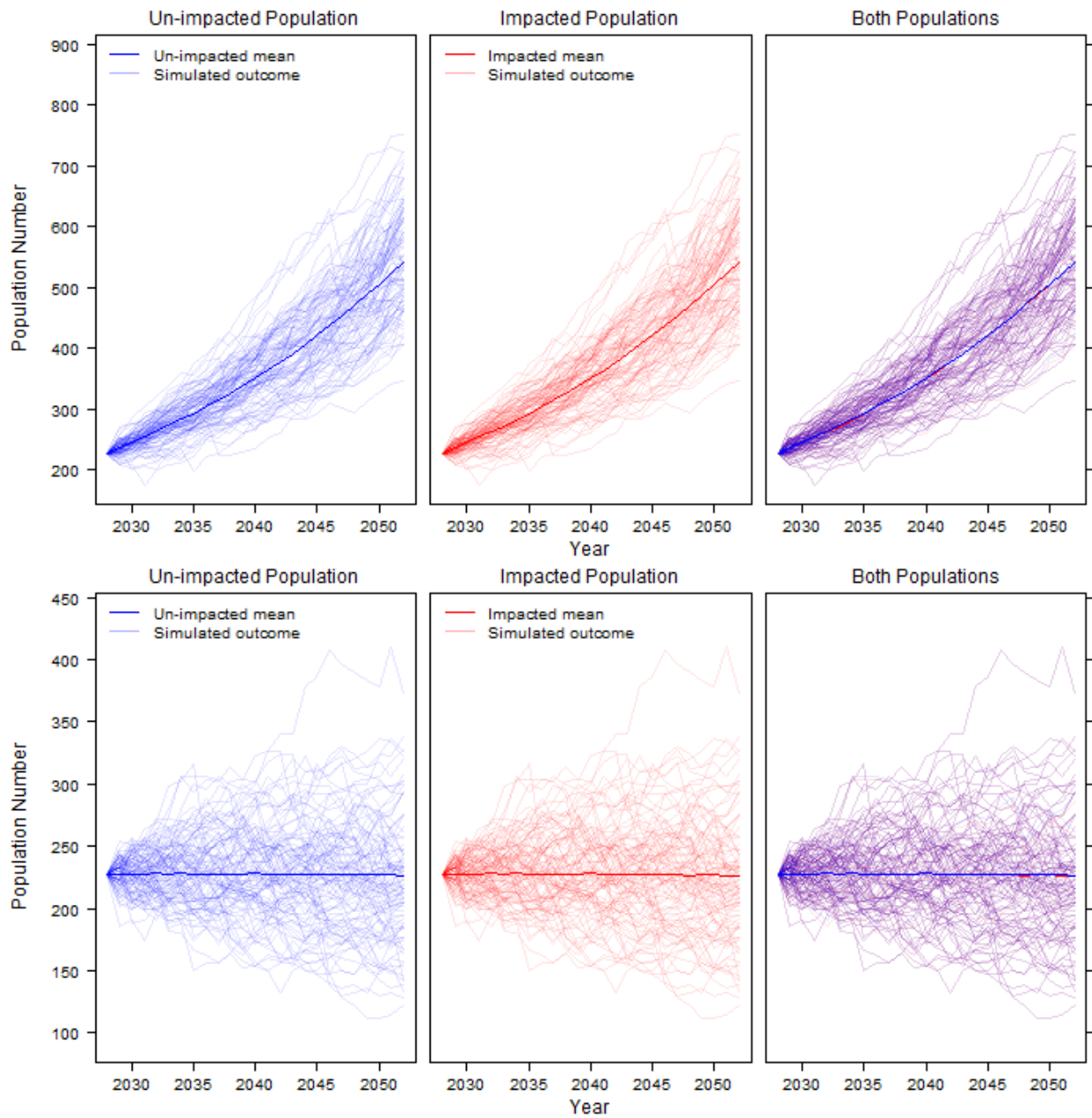


Figure 2-2: Predicted population trajectories for the un-impacted (baseline) and impacted bottlenose dolphin iPCoD simulations (Deterrence function; top graph – increasing population and bottom graph – stable population) (Scenario: 5 dolphins disturbed per day, for a total of 79 piling days).

26 km EDR

- 2.2.1.7 The number of animals affected was calculated based on 26km EDR. The disturbance value used in the modelling is one bottlenose dolphin per piling day for installation in Caledonia North Site (total 79 piling days).
- 2.2.1.8 The results of the iPCoD modelling show that the impacted population is predicted to continue at 100% (increasing and stable) of the size of the un-impacted population (Table 2-5 and Figure 2-3).

Table 2-5: Results of iPCoD modelling for bottlenose dolphin (EDR). Scenario: 1 dolphin disturbed per day, for a total of 79 piling days.

Time Point	Unimpacted Population Mean Size	Impacted Population Mean Size	Impacted Population as a Proportion of the Unimpacted Population
Increasing Population			
Start 2028	228	228	100%
End 2028	236	236	100%
2029	245	245	100%
2030	254	254	100%
2031	263	263	100%
2036	315	315	100%
2042	392	392	100%
2048	488	488	100%
Stable Population			
Start 2028	228	228	100%
End 2028	228	228	100%
2029	227	227	100%
2030	227	227	100%
2031	227	227	100%
2036	226	226	100%
2042	226	226	100%
2048	225	225	100%
Note, time point descriptions are provided in Table 2-1.			

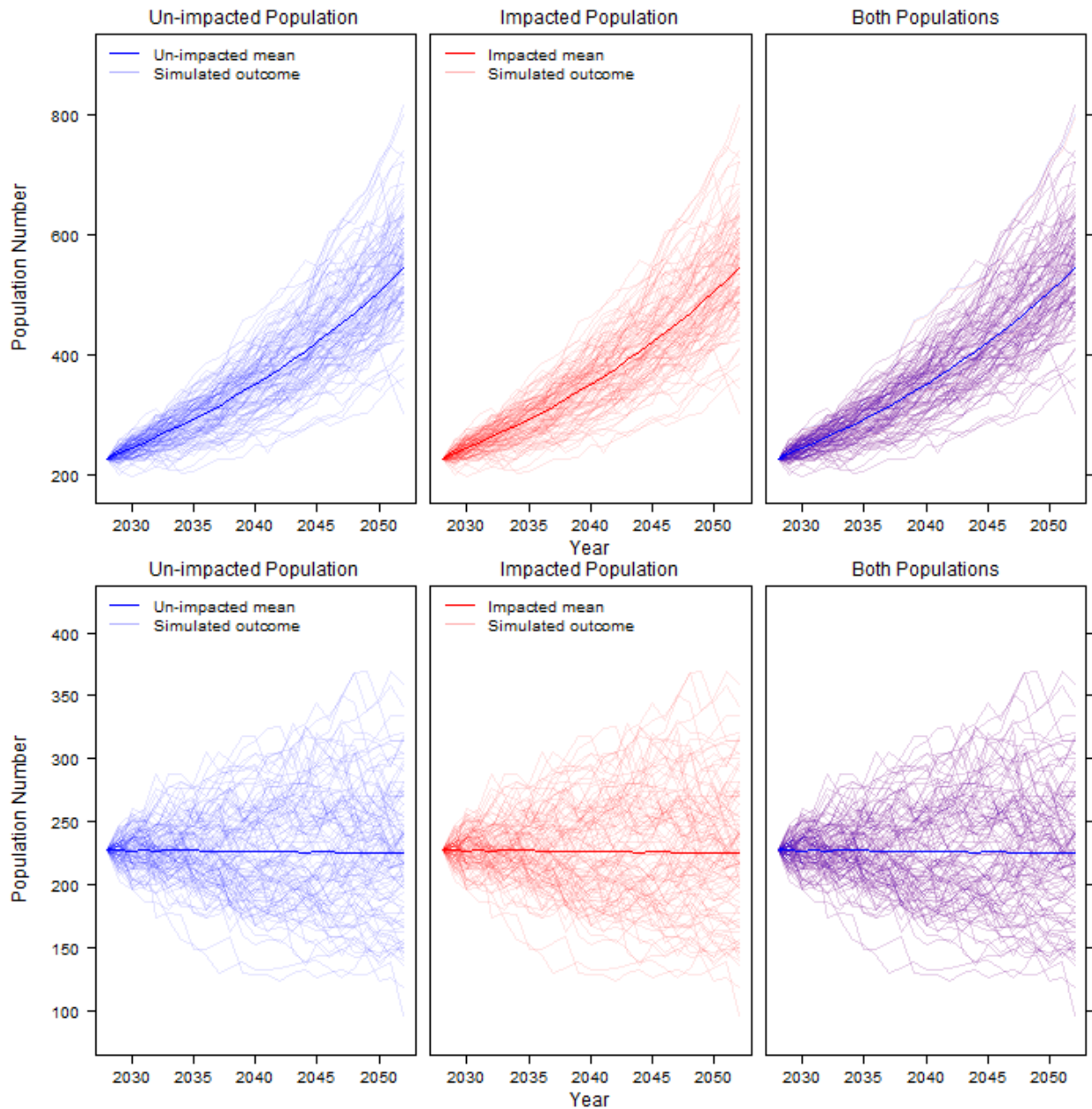


Figure 2-3: Predicted population trajectories for the un-impacted (baseline) and impacted bottlenose dolphin iPCoD simulations (26km EDR; top graph – increasing population and bottom graph – stable population) (Scenario: one dolphin disturbed per day, for a total of 79 piling days).

3 Cumulative Re-assessment

3.1 Time Points

- 3.1.1.1 The time points selected for the presentation of cumulative iPCoD modelling results are presented in Table 3-1. The timepoints are the same for harbour porpoise, bottlenose dolphin and minke whale.

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

Time Points Selected (Indicative Year)	Time Point Description
2026	Population size at the start of the year 2026, before all piling starts
2028	End of 1st year of piling at Caledonia North, piling at other projects
2030	End of final year of piling at Caledonia North, piling at other projects
2036	6-years after piling ends at Caledonia North, piling at other projects
2038	8-years after piling ends at Caledonia North and the end of piling at other projects
2039	9-years after piling has ended at Caledonia North and 1-year after piling has ended at other projects
2044	14-years after piling has ended at Caledonia North and 6-years after piling has ended at other projects
2050	20-years after piling has ended at Caledonia North and 12-years after piling has ended at other projects

- 3.1.1.2 The time points selected for the presentation of cumulative iPCoD modelling results for harbour seals are presented in Table 3-2 for MF, NC&O and ES SMUs.

Table 3-2: Time points selected for the presentation of cumulative iPCoD modelling results for cumulative impacts on the MF SMU, NC&O SMU and ES SMU for harbour seal.

Time Points Selected (Indicative Year)	Time Point Description
MF SMU	
Start 2028	Population size at the beginning of the year 2028, before all piling starts
End 2028	End of 1st year of piling at Caledonia North, piling at all projects considered for harbour seal within the MF SMU
2030	End of final year of piling at Caledonia North and the end of piling at all projects considered for harbour seal within the MF SMU
2031	1-year after piling ends at Caledonia North and at all projects considered for harbour seal within the MF SMU
2036	6-years after piling ends at Caledonia North and at all projects considered for harbour seal within the MF SMU
2042	12-years after piling has ended at Caledonia North and at all projects considered for harbour seal within the MF SMU
2048	18-years after piling has ended at Caledonia North and at all projects considered for harbour seal within the MF SMU
NC&O SMU	
Start 2028	Population size at the beginning of the year 2028, before all piling starts
End 2028	End of 1st year of piling at Caledonia North, piling at all projects considered for harbour seal within the NC&O SMU
2030	End of final year of piling at Caledonia North, piling at all 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
2034	4-years after piling ends at Caledonia North Site and 1-years after piling has ended at other projects considered for harbour seal within the NC&O SMU
2039	9-years after piling ends at the Caledonia North Site and 6-years after piling has ended at other projects considered for harbour seal within the NC&O SMU

Time Points Selected (Indicative Year)	Time Point Description
2045	15-years after piling ends at Caledonia North Site and 12-years after piling has ended at other projects considered for harbour seal within the NC&O SMU
2051	21-years after piling ends at Caledonia North Site and 18-years after piling has ended at other projects considered for harbour seal within the NC&O SMU
ES SMU	
2026	Population size at the beginning of the year 2026, before all piling starts
2028	End of 1st year of piling at Caledonia North, piling at all projects considered for harbour seal within the ES SMU
2030	End of final year of piling at Caledonia North, piling at all projects considered for harbour seal within the ES SMU
2033	3-years after piling ends at Caledonia North and the end of piling at all projects considered for harbour seal within the ES SMU
2034	4-years after piling ends at Caledonia North and 1-year after piling at all projects considered for harbour seal within the ES SMU
2039	9-years after piling ends at Caledonia North Site and 6-years after piling has ended at other projects considered for harbour seal within the ES SMU
2045	15-years after piling ends at Caledonia North Site and 12-years after piling has ended at other projects considered for harbour seal within the ES SMU

3.2 Harbour Porpoise

Number of Animals Impacted

3.2.1.1 The numbers of harbour porpoise at risk of experiencing disturbance due to piling at each project used in the modelling are presented in Table 3-3 (using the Graham *et al.* (2019¹) deterrence function).

Table 3-3: The number of harbour porpoise predicted to be disturbed for each project based on deterrence function (Graham *et al.*, 2019).

Project	Number Animals Impacted
Caledonia North	367
Berwick Bank	732
Cenos	1114
Green Volt	675
Ossian	733
Salamander	681
West of Orkney	155
Muir Mhòr	731
Ayre	397
Bowdun	715
Broadshore	523
Buchan	614
Morven	733
Sinclair	543
Bellrock	733
Stromar	414

iPCoD Results

3.2.1.2 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 with a mean population size that is greater than 99% of the mean size of the un-impacted population (Table 3-4 and Figure 3-1).

Table 3-4: 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
UK Portion of the NS MU			
2026	159,607	159,588	99.99%
2028	159,445	159,262	99.89%
2030	159,463	158,914	99.66%
2036	159,264	158,408	99.46%
2038	158,836	157,957	99.45%
2039	158,786	157,911	99.45%
2044	158,848	157,978	99.45%
2050	158,302	157,431	99.45%
NS MU			
2026	346,602	346,602	100.00%
2028	346,620	346,498	99.96%
2030	345,374	344,959	99.88%
2036	345,340	344,687	99.81%
2038	344,580	343,906	99.80%
2039	345,144	344,468	99.80%
2044	343,694	343,023	99.80%
2050	345,592	344,919	99.81%
Note, time point descriptions are provided in Table 3-1.			

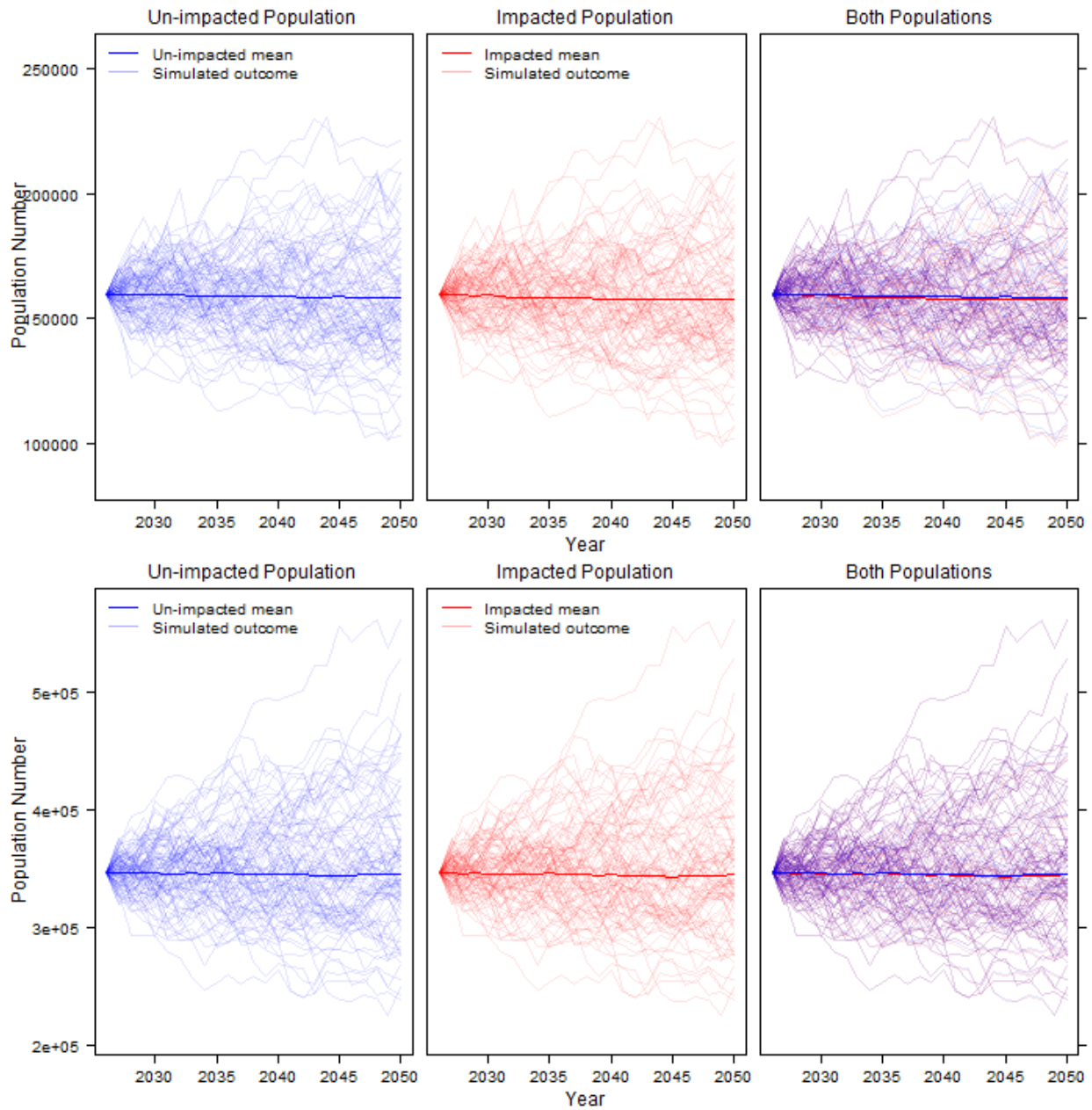


Figure 3-1: Predicted population trajectories for the un-impacted (baseline) and impacted harbour porpoise iPCoD simulations (top graph – UK portion of the NS MU and bottom graph – NS MU).

3.3 Bottlenose Dolphin

Number of Animals Impacted

3.3.1.1 The numbers of bottlenose dolphins at risk of experiencing disturbance due to piling at each project used in the modelling are presented in Table 3-5 (using the Graham *et al.* (2019¹) deterrence function).

Table 3-5: The number of bottlenose dolphins predicted to be disturbed for each project calculated based on deterrence function (Graham *et al.*, 2019).

Project	Number Animals Impacted
Caledonia North	5
Berwick Bank	12
Green Volt	1
Ossian	1
Salamander	8
Muir Mhòr	2
Ayre	1
Bowdun	9
Broadshore	3
Buchan	1
Morven	3
Sinclair	1
Stromar	1

iPCoD Results

3.3.1.2 The results of the cumulative iPCoD modelling show that for the CES MU, although the level of disturbance has the potential to result in changes at population level, the impacted population is predicted to continue on an increasing or stable trajectory (depending on the modelled population), the same as the unimpacted population (Table 3-6 and Figure 3-2). In the year 2044, six years after all cumulative piling has ended, the mean impacted population size as a proportion of the mean unimpacted population size is at its lowest (94.90% increasing, 95.11% stable; Table 3-6).

Table 3-6: 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
Increasing Population			
2026	228	228	100.00%
2028	245	239	97.55%
2030	273	261	95.60%
2036	338	321	94.97%
2038	363	345	95.04%
2039	377	358	94.96%
2044	451	428	94.90%
2050	558	530	94.98%
Stable Population			
2026	228	228	100.00%
2028	226	221	97.79%
2030	225	216	96.00%
2036	224	214	95.54%
2038	225	215	95.56%
2039	225	215	95.56%
2044	225	214	95.11%
2050	226	215	95.13%
Note, time point descriptions are provided in Table 3-1.			

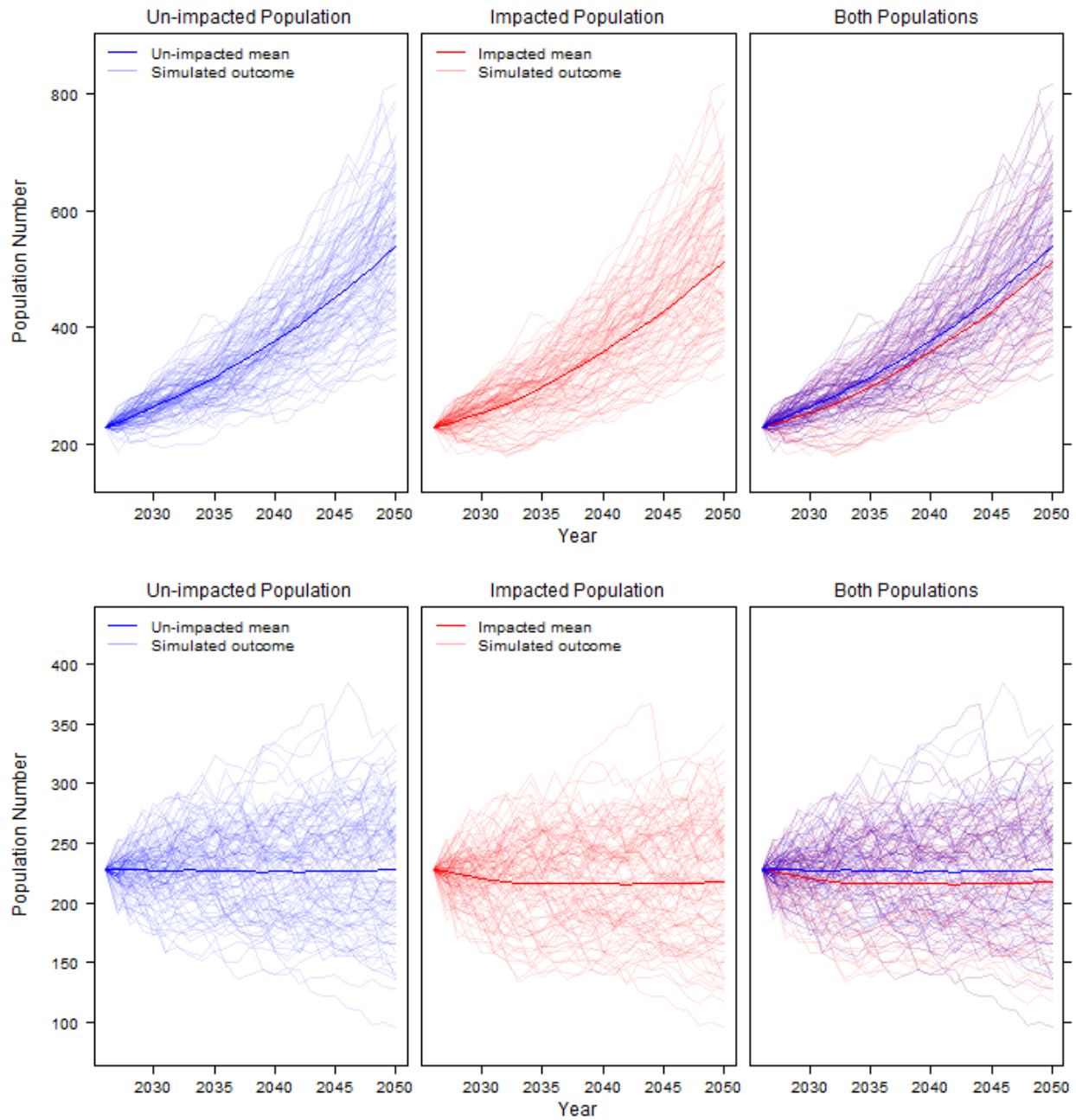


Figure 3-2: Predicted population trajectories for the un-impacted (baseline) and impacted bottlenose dolphin iPCoD simulations (top graph – increasing population and bottom graph – stable population).

3.4 Minke Whale

Number of Animals Impacted

3.4.1.1 The numbers of minke whales at risk of experiencing disturbance due to piling at each project used in the modelling are presented in Table 3-7 (using the Graham *et al.* (2019¹) deterrence function).

Table 3-7: The number of minke whales predicted to be disturbed for each project based on deterrence function (Graham *et al.*, 2019).

Project	Number Animals Impacted
Caledonia North	36
Berwick Bank	28
Cenos	54
Green Volt	34
Ossian	35
Salamander	26
West of Orkney	31
Muir Mhòr	34
Ayre	25
Bowdun	29
Broadshore	30
Buchan	32
Morven	32
Sinclair	30
Bellrock	41
Stromar	31
Havbredey	27
Talisk	23
Spiorad na Mara	17

iPCoD Results

3.4.1.2 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 3-8 and Figure 3-3).

Table 3-8: 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
UK Portion of the CGNS MU			
2026	10,288	10,288	100.00%
2028	10,271	10,271	100.00%
2030	10,258	10,258	100.00%
2036	10,223	10,223	100.00%
2038	10,205	10,205	100.00%
2039	10,176	10,176	100.00%
2044	10,171	10,171	100.00%
2050	10,142	10,142	100.00%
CGNS MU			
2026	20,120	20,120	100.00%
2028	20,026	20,026	100.00%
2030	20,057	20,057	100.00%
2036	19,982	19,982	100.00%
2038	19,968	19,968	100.00%
2039	20,000	20,000	100.00%
2044	19,925	19,924	99.99%
2050	19,872	19,872	100.00%
Note, time point descriptions are provided in Table 3-1.			

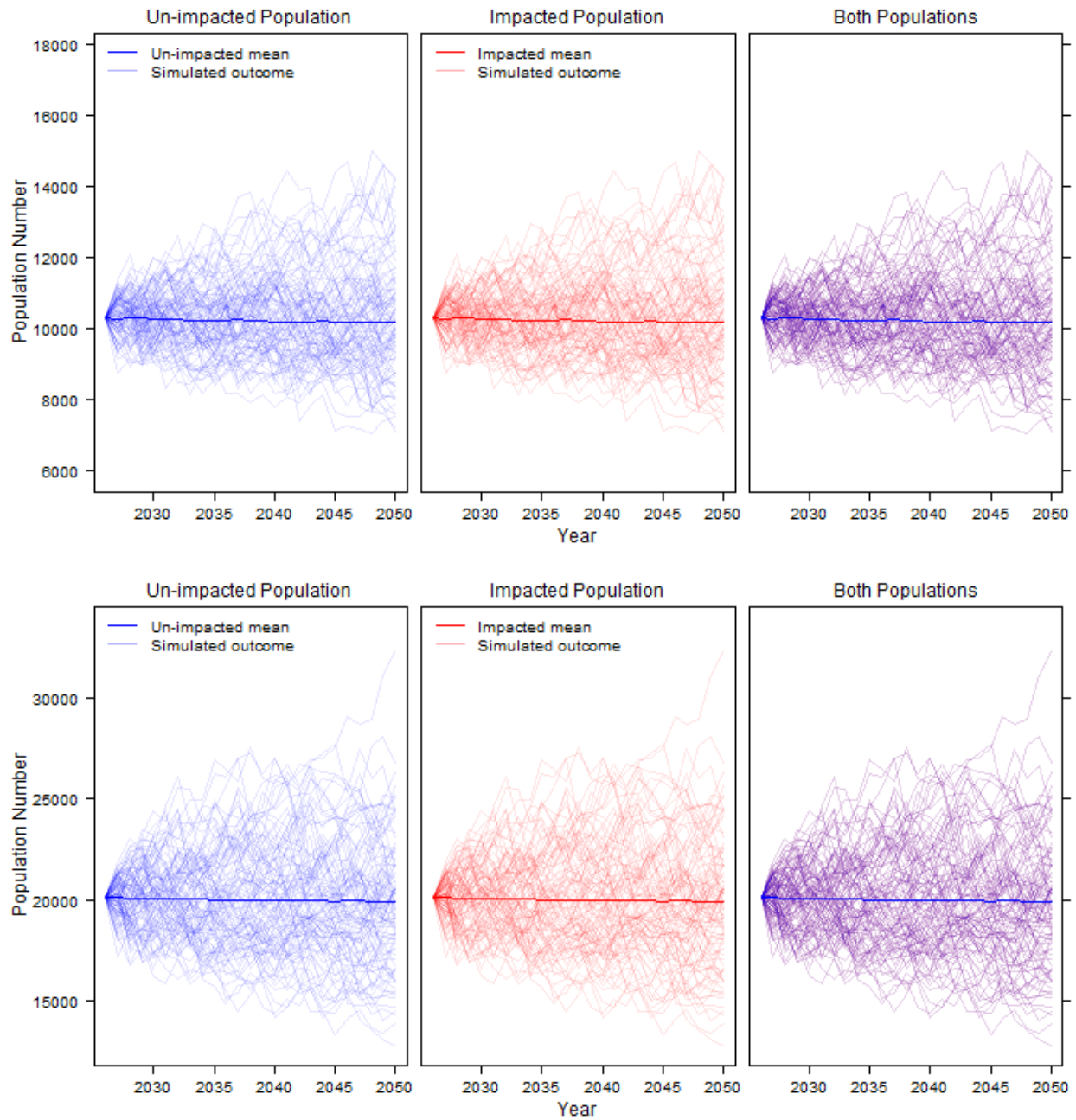


Figure 3-3: Predicted population trajectories for the un-impacted (baseline) and impacted minke whale iPCoD simulations (top graph – UK portion of the CGNS MU and bottom graph – CGNS MU).

3.5 Harbour Seal

3.5.1.1 It is important to note when considering the iPCoD results for harbour seals, that the NC&O SMU is currently in decline (SCOS, 2022²). It is noted in SCOS (2022²) 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 SMU is predicted to significantly decline in the absence of any impacts.

Number of Animals Impacted

3.5.1.2 The numbers of harbour seal at risk of experiencing disturbance due to piling at each project used in the modelling are presented in Table 3-9.

Table 3-9: The number of harbour seal predicted to be disturbed for each project, based on the project-specific values presented in EIARs or calculated based on the EDRs and Carter *et al.* (2025).

Project	Number Animals Impacted	Data Source
MF SMU		
Caledonia North	77	Whyte <i>et al.</i> (2020 ³); Carter <i>et al.</i> (2025 ⁴)
Broadshore	1	EDR; Carter <i>et al.</i> (2025 ⁴)
Sinclair	1	EDR; Carter <i>et al.</i> (2025 ⁴)
NC&O SMU		
Caledonia North	6	Whyte <i>et al.</i> (2020 ³); Carter <i>et al.</i> (2025 ⁴)
West of Orkney	176	EIAR (Xodus Group Ltd, 2023 ⁵)
Ayre	12	EDR; Carter <i>et al.</i> (2025 ⁴)
Buchan	1	EDR; Carter <i>et al.</i> (2025 ⁴)
Stromar	1	EDR; Carter <i>et al.</i> (2025 ⁴)
ES SMU		
Caledonia North	1	Whyte <i>et al.</i> (2020 ³); Carter <i>et al.</i> (2025 ⁴)
Berwick Bank	5	EIAR (RPS, 2022 ⁶)
Green Volt	1	EIAR (Royal HaskoningDHV, 2023 ⁷)
Salamander	4	EIAR (Salamander Offshore Wind Farm, 2023 ⁸)
Muir Mhòr	1	EIAR (SMRU Consulting, 2024 ⁹)
Bowdun	1	EDR; Carter <i>et al.</i> (2025 ⁴)
Morven	1	EDR; Carter <i>et al.</i> (2025 ⁴)

MF SMU

3.5.1.3 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 3-10 and Figure 3-4).

Table 3-10: 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
Start 2028	1,360	1,360	100%
End 2028	1,363	1,363	100%
2030	1,360	1,360	100%
2031	1,362	1,362	100%
2036	1,366	1,366	100%
2042	1,375	1,375	100%
2048	1,387	1,387	100%
Note, time point descriptions are provided in Table 3-2.			

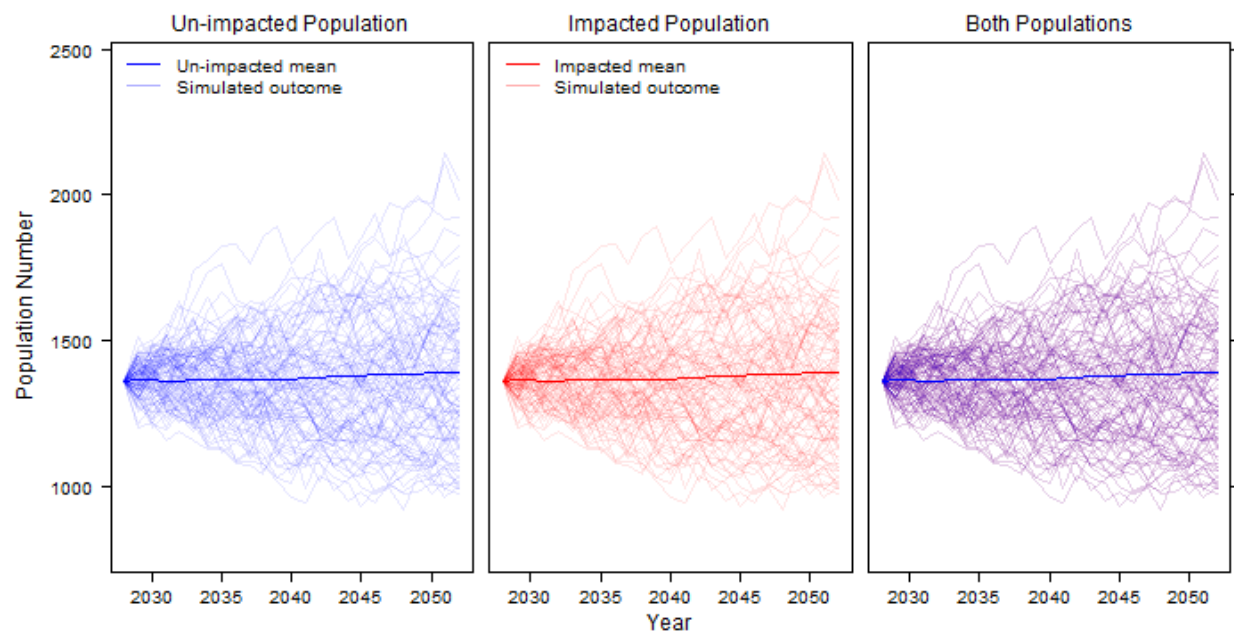


Figure 3-4: Predicted population trajectories for the un-impacted (baseline) and impacted harbour seal iPCoD simulations for the MF SMU.

NC&O SMU

3.5.1.4 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 (Table 3-11 and Figure 3-5).

Table 3-11: 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
Start 2028	1,950	1,950	100%
End 2028	1,746	1,746	100%
2030	1,401	1,401	100%
2033	1,003	1,003	100%
2034	896	896	100%
2039	513	513	100%
2045	265	265	100%
2051	137	137	100%
Note, time point descriptions are provided in Table 3-2.			

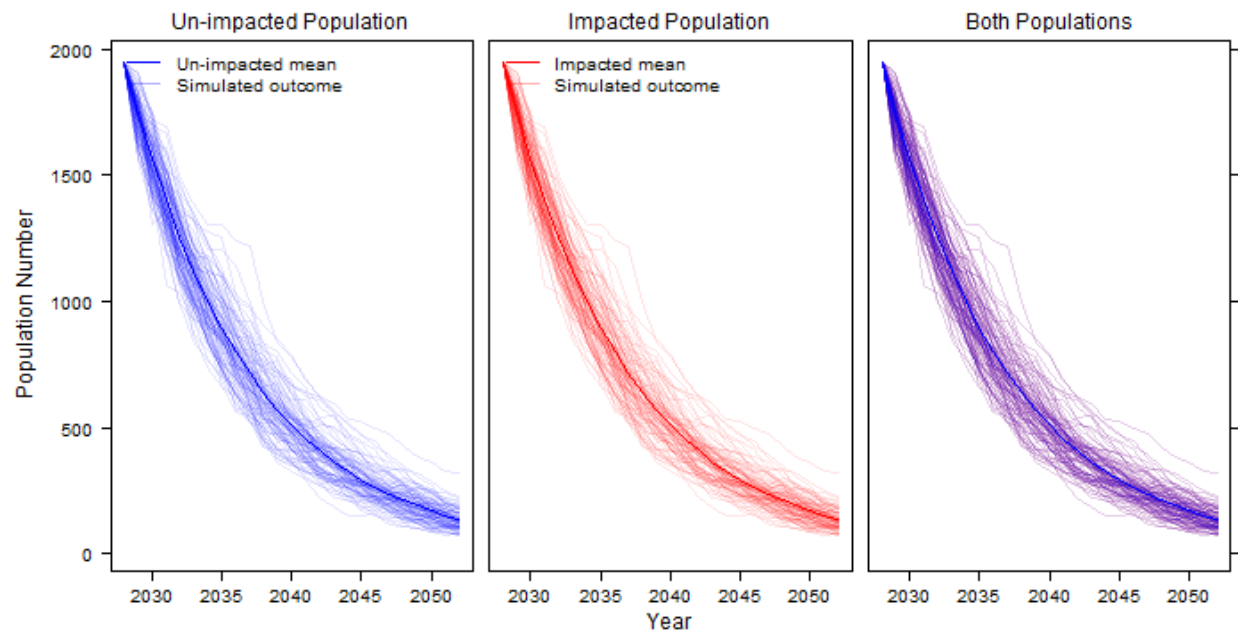


Figure 3-5: Predicted population trajectories for the un-impacted (baseline) and impacted harbour seal iPCoD simulations for the NC&O SMU.

ES SMU

3.5.1.5 The results of the cumulative iPCoD modelling show that for the ES 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 3-12 and Figure 3-6).

Table 3-12: Results of cumulative iPCoD modelling for harbour seals (ES SMU)

Time Point	Unimpacted Population Mean Size	Impacted Population Mean Size	Impacted Population as a Proportion of the Unimpacted Population
2026	385	385	100%
2028	384	384	100%
2030	384	384	100%
2033	385	385	100%
2034	386	386	100%
2039	388	388	100%
2045	390	390	100%
Note, time point descriptions are provided in Table 3-2.			

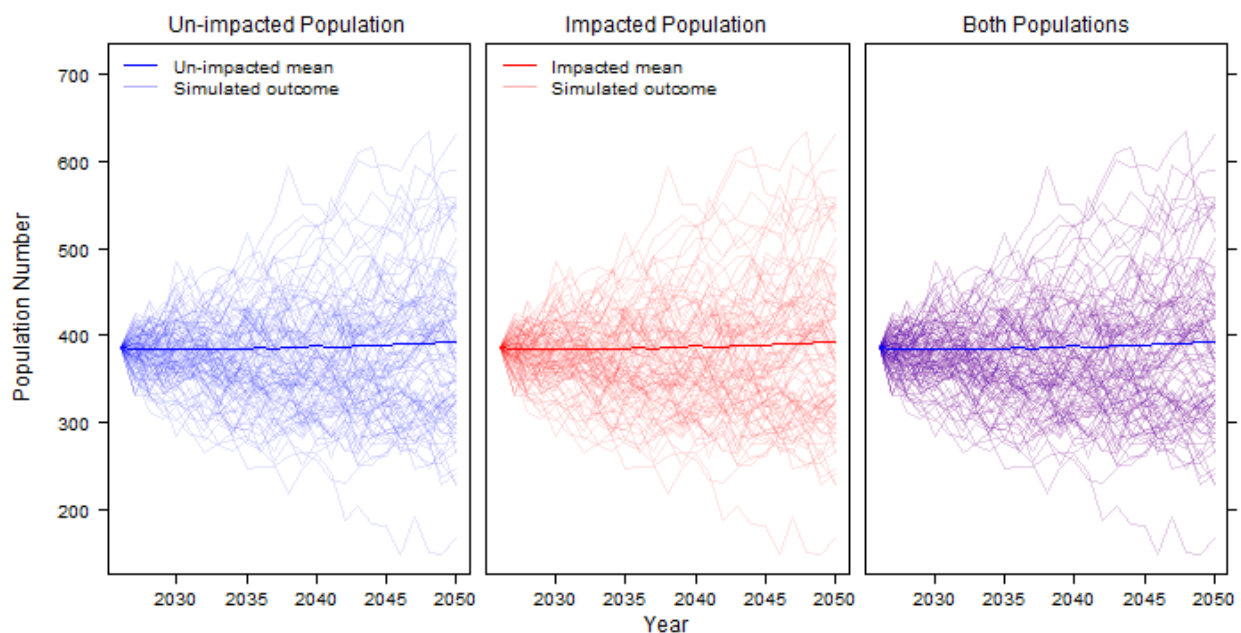


Figure 3-6: Predicted population trajectories for the un-impacted (baseline) and impacted harbour seal iPCoD simulations for the ES SMU.

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