Rampion 2 Wind Farm
Category 6: Environmental Statement
Appendix 11.4: Bottlenose Dolphin Population Modelling

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B	30/10/2024	Updated following Examination.	GoBe	RED	RED

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Contents

Tables

Figures

1. Applicant's Response to Action Point 22 - Bottlenose Dolphin Population Modelling

1.1 Bottlenose Dolphin Modelling Data

1.1.1 As a response to **Action points arising from Issue Specific Hearing 2** **[EV5-018],** Natural England provided the following comments relating to the bottlenose dolphin assessment in **Appendix C3 - Natural England's advice on 8.42.1 Applicant's Response to Action Points Arising from Issue Specific Hearing 1: Marine Mammals** **[REP3-081]**:

We note that the Applicant has not provided any evidence to support their assertion that this percentage of the population disturbed correlates to the definition of Medium impact magnitude. Therefore, we advise that based on the information currently provided, we cannot agree with this impact magnitude, and the subsequent impact assessment conclusion.

We advise that the Applicant should therefore present evidence to support their assessment of Medium impact magnitude. We advise that this should include iPCoD population modelling, as this would provide evidence on the population trajectory following the disturbance impact. We advise that if population modelling is done for this population, both project-alone and cumulative impacts should be modelled.

1.1.2 The purpose of this report is to provide population modelling for bottlenose dolphins in the Coastal West Channel (CWC) Management Unit using the Interim Population Consequences of Disturbance (iPCoD) model to support the conclusions for the magnitude score, both for the Project alone, and cumulatively with other projects. While Rampion 2 is located within both the CWC MU and the OCWS MU, this report focusses on impacts to the CWC MU only, as impacts to the OCWS MU are to a much lower proportion of the MU (maximum impact to 1.2% MU compared to 10% CWC MU).

2. Method

2.1 iPCoD model

2.1.1 The potential risk of injury and/or disturbance to marine mammals during construction of offshore renewable energy developments has been identified as a key consenting risk for projects in UK waters. Possible consequences of exposure to underwater noise from piling include disturbance that could cause marine mammals to either move away or change behaviour or suffer temporary and permanent hearing damage.

2.1.2 To address this, the Scottish Government Marine Directorate Science, Evidence Data and Digital (MD-SEDD formerly Marine Scotland Science) and other UK partners have supported the development of the iPCoD. This development has been carried out by a team of researchers at the University of St Andrews, led by Prof. John Harwood (King *et al.*, 2015, Harwood *et al*., 2014). The framework was developed in the computing language "R" and the original model was released in 2013. This assessment was conducted using v5.2 of the iPCoD model[1].

2.1.3 The model can be used to assess the impacts of disturbance, auditory injury in the form of permanent threshold shift (PTS) and collision mortality (e.g. from tidal turbines) on marine mammal populations. The inputs include information about the management unit (MU) (for the species and population in question) and the developments that could impact them (e.g. a calendar of days of activity, the numbers of animals impacted etc.). The outputs provide the forecast of the population trajectory with and without the simulated disturbance.

2.2 Limitations of iPCoD

2.2.1 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) 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.

2.2.2 There are several precautions built into the iPCoD model that mean that the results are considered to be highly precautionary and likely over-estimate the true population level effects. These include:

[1] https://www.smruconsulting.com/population-consequences-of-disturbance-pcod

- The fact that the model assumes a bottlenose dolphin will not forage for 24 hours after being disturbed[2],
- The lack of density dependence in the model (meaning the population will not respond to any reduction in population size),
- The level of environmental and demographic stochasticity in the model, and
- The estimates of the number of animals disturbed come from noise impact assessments with many levels of precaution.

Duration of disturbance: bottlenose dolphins

2.2.3 The iPCoD model for bottlenose dolphin disturbance was last updated following the expert elicitation in 2013 (Harwood *et al*., 2014). When this expert elicitation was conducted, the journal authors provided responses on the assumption that a disturbed individual would not forage for 24 hours. However, the most recent expert elicitation in 2018 highlighted that this was an unrealistic assumption for harbour porpoises (generally considered to be more responsive than minke whales and bottlenose dolphins), and was amended to assume that disturbance resulted in 6 hours of non-foraging time (Booth *et al*., 2019). Unfortunately, bottlenose dolphins were not included in the updated expert elicitation for disturbance, and thus the iPCoD model still assumes 24 hours of non-foraging time for bottlenose dolphins. This is unrealistic considering what we now know about marine mammal behavioural responses to pile driving. A recent study estimated energetic costs associated with disturbance from sonar, where it was assumed that 1 hour of feeding cessation was classified as a mild response, 2 hours of feeding cessation was classified as a strong response and 8 hours of feeding cessation was classified as an extreme response (Czapanskiy *et al*., 2021). Assuming 24 hours of feeding cessation for bottlenose dolphins in the iPCoD model is significantly beyond that which is considered to be an extreme response; therefore, this assumption is considered to be unrealistic and will over-estimate the true disturbance levels expected from the Proposed Development.

Lack of density dependence

2.2.4 Density dependence is described as "*the process whereby demographic rates change in response to changes in population density, resulting in an increase in the population growth rate when density decreases and a decrease in that growth rate when density increases*" (Harwood et al., 2014). The iPCoD scenario run assumes no density dependence, because previously there has been no means to

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[2] In the updated expert elicitation in 2018, the duration of disturbance for harbour porpoise, harbour seals and grey seals was assumed to be 6 hours Booth, C. G., Heinis, F. & J., H. (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). Unfortunately, bottlenose dolphins were not included in the updated expert elicitation, so the duration of disturbance remains 24 hours, as used in the original expert elicitation in 2013.

parameterise this relationship for UK marine mammal species). Essentially, what this means is that there is no ability for the modelled impacted population to increase in size back up to carrying capacity following disturbance (carrying capacity is typically assumed to be equal to the size of un-impacted population – i.e., it is assumed the un-impacted population is at carrying capacity). At a recent expert elicitation, conducted for the purpose of modelling population impacts of the Deepwater Horizon oil spill (Schwacke et al., 2021), experts agreed that there would likely be a concave density dependence on fertility, which means that in reality, it would be expected that the impacted population would recover to carrying capacity, rather than continuing at a stable trajectory that is smaller than that of the un-impacted population.

Environmental and demographic stochasticity

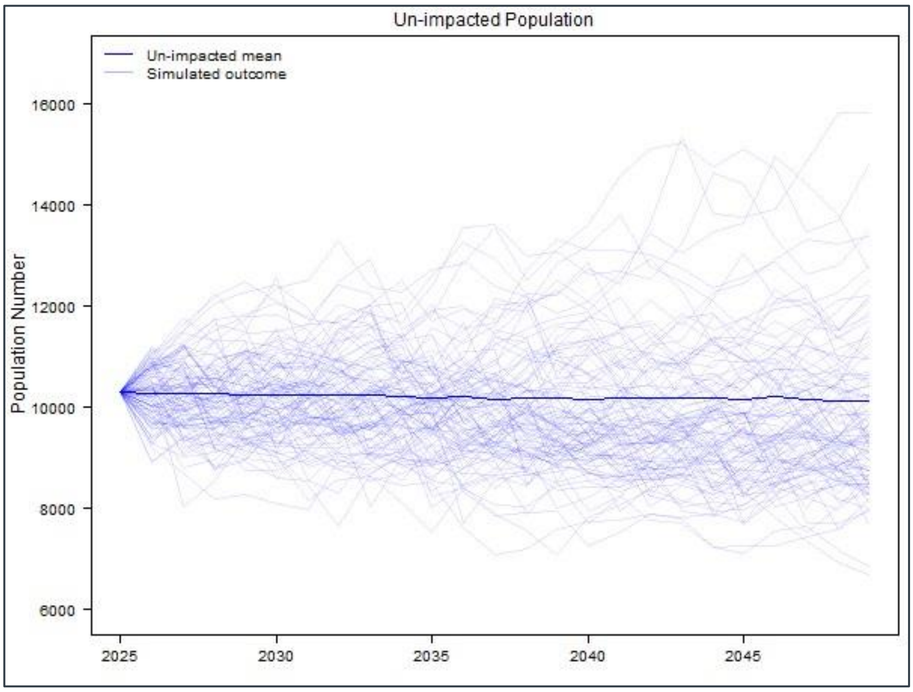
2.2.5 The iPCoD model attempts to model some of the sources of uncertainty inherent in the calculation of the potential effects of disturbance on marine mammal populations. This includes demographic stochasticity and environmental variation. Environmental variation is defined as "*the variation in demographic rates among years as a result of changes in environmental conditions*" (Harwood *et al*., 2014). Demographic stochasticity is defined as "*variation among individuals in their realised vital rates as a result of random processes*" (Harwood *et al*., 2014).

2.2.6 The iPCoD protocol describes this in further detail:

"*Demographic stochasticity is caused by the fact that, even if survival and fertility rates are constant, the number of animals in a population that die and give birth will vary from year to year because of chance events. Demographic stochasticity has its greatest effect on the dynamics of relatively small populations, and we have incorporated it in models for all situations where the estimated population within an MU is less than 3000 individuals. One consequence of demographic stochasticity is that two otherwise identical populations that experience exactly the same sequence of environmental conditions will follow slightly different trajectories over time. As a result, it is possible for a "lucky" population that experiences disturbance effects to increase, whereas an identical undisturbed but "unlucky" population may decrease*" (Harwood et al., 2014).

2.2.7 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 2-1**, 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 2-1 Simulated un-impacted (baseline) population size over the 25 years modelled



Summary

2.2.8 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.

2.3 Bottlenose dolphin parameters

2.3.1 **Table 2-1** provides a summary of the parameter values used in the iPCoD simulations. The demographic parameters were obtained from those recommended in Sinclair *et al.* (2020), and assumes a stable population. Please see the iPCoD version 5 helpfile for full details on each user-selected parameter in the model (Sinclair *et al*., 2019).

Table 2-1 Bottlenose dolphin parameters used in the iPCoD modelling for the CWC MU

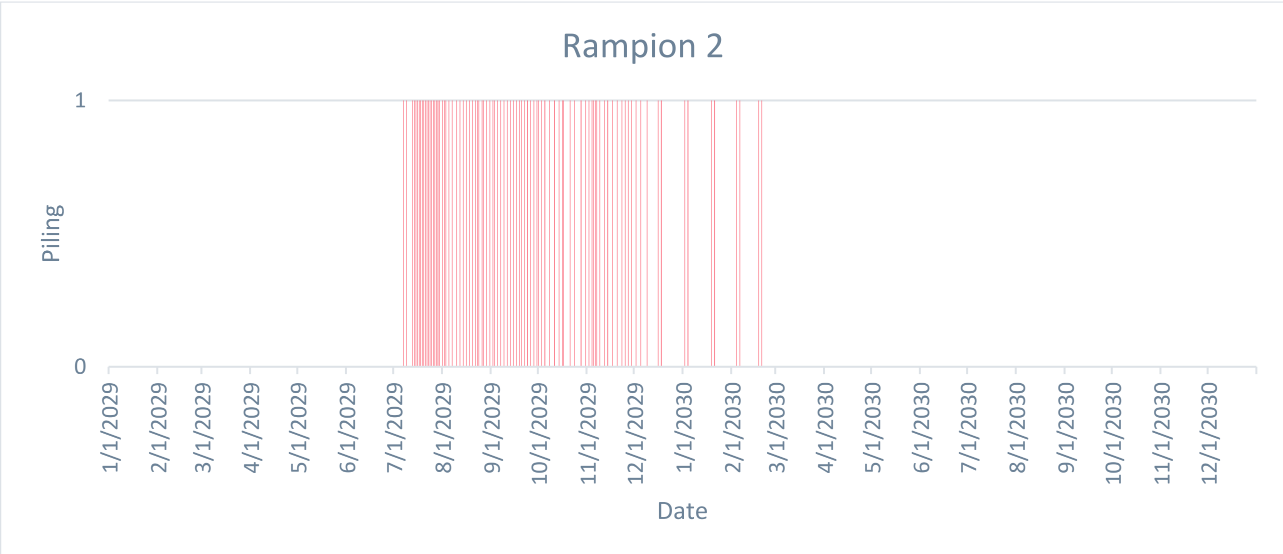
Parameter	Definition	Value
nboot	Number of simulations run	1000
spec	Species	BND

Parameter	Definition	Value
propfemale	Proportion of the population that is female	0.5
pmean	Population size	40
Surv[1]	Calf survival rate	0.86
Surv[7]	Juvenile survival rate	0.94
Surv[13]	Adult survival rate	0.94
Fertility	Fertility rate	0.25
age1	Age at independence from mother	2
age2	Age at first birth	9
vulnmean	Proportion of animals in each vulnerable component of the population (1 = entire population is vulnerable)	c(1)
days	Number of days of "residual" disturbance associated with each day of actual disturbance	0
prop_days_dist	Proportion of disturbed animals that experience the number of days of residual disturbance specified by "days"	1
Avoid	Whether disturbed animals will avoid ALL piling operations when experiencing residual disturbance (FALSE = will NOT avoid all operations)	FALSE
years	Number of years for simulation	25

3. Project Alone

3.1.1 An indicative piling schedule for the installation of monopiles (single vessel only) was provided by the Applicant for the modelling. This assumes the installation of 90 monopile WTGs and 2 monopile OSS, resulting in a total of 93 piling days, between July (year 1) and February (year 2) (**Figure 3-1**). For the iPCoD modelling, it was assumed that 3 dolphins would be disturbed on every one of the 93 piling days (as estimated using the SCANS IV block NS-A density estimate of 0.0029 dolphins/km^2 (Gilles *et al.*, 2023), see Table 3-1 in **Applicant's Response to Action Points Arising from Issue Specific Hearing 1: Marine Mammals [REP2-019]**).

Figure 3-1 Rampion 2 indicative piling schedule for the installation of 90 monopile WTGs and 2 monopile OSS, resulting in 93 piling days between July (year 1) and February (year 2)



3.2 Results

3.2.1 The iPCoD modelling, assuming disturbance to 3 bottlenose dolphins on 93 piling days, results in no impact to the CWC MU at a population level. The impacted population is expected to continue on a stable trajectory at 98-100% of the size of the un-impacted population (**Figure 3-2** and **Table 3-1**). This aligns with a magnitude score of Low: Survival and reproductive rates very unlikely to be impacted to the extent that the population trajectory will be altered.

3.2.2 As presented **in Appendix 11.2: Marine mammal quantitative underwater noise impact assessment [APP-148]**, the sensitivity of bottlenose dolphins to disturbance from pile driving is **Low**.

3.2.3 Therefore, the resulting impact significance for behavioural disturbance to bottlenose dolphins in the CWC MU from Rampion 2 alone is **Minor (Not Significant).**

Figure 3-2 Results of the Project Alone iPCoD simulations for the CWC MU. Blue (left panel) shows the trajectory of the un-impacted population (i.e. no disturbance) with a dark line representing the median (and range of uncertainty shown), Red (middle panel) shows the impacted population with a dark line representing the median (and range of uncertainty shown). The right panel shows both these forecasts together in a single frame.

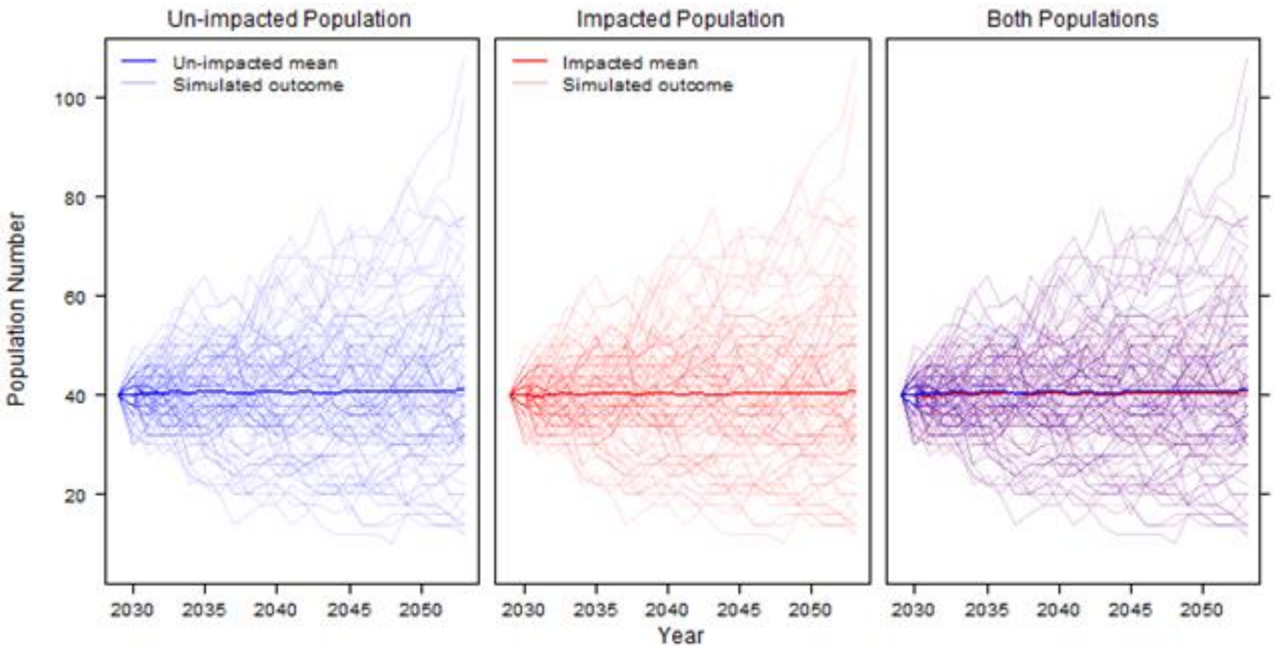


Table 3-1 Results of the Project Alone iPCoD simulations for the CWC MU at different timesteps. The mean un-impacted and impacted population sizes are shown, along with the counterfactual of the two metrics at each timestep.

	Unimpacted population mean size	Impacted population mean size	Impacted relative to un-impacted population size
Start year 1 (before piling)	40	40	100%
End year 1 (piling in year 1)	40	40	100%
End year 2 (piling in year 2)	40	40	100%
End year 3 (1 year after piling stops)	40	40	100%

	Unimpacted population mean size	Impacted population mean size	Impacted relative to un-impacted population size
End year 8 (6 years after piling stops	41	40	98%
End year 14 (12 years after piling stops)	41	40	98%
End year 20 (18 years after piling stops)	41	40	98%

4. Cumulative assessment

4.1 Projects included

4.1.1 The cumulative impact assessment provided in **Chapter 11: Marine Mammals, Volume 2** **[REP5-031]** (updated at Deadline 6), included 20 offshore developments in addition to Rampion 2 **(Figure 4-1**). However, only three of these were located within the CWC MU, or have expected impact areas that overlap with the CWC MU: the Perpetus Tidal Energy Centre (PTEC), the Aquind Interconnector and Wave Hub (TwinHub) (**Figure 4-2**).

Figure 4-1 Offshore developments included in the bottlenose dolphin CEA – including those in the OCSW MU and the CWC MU

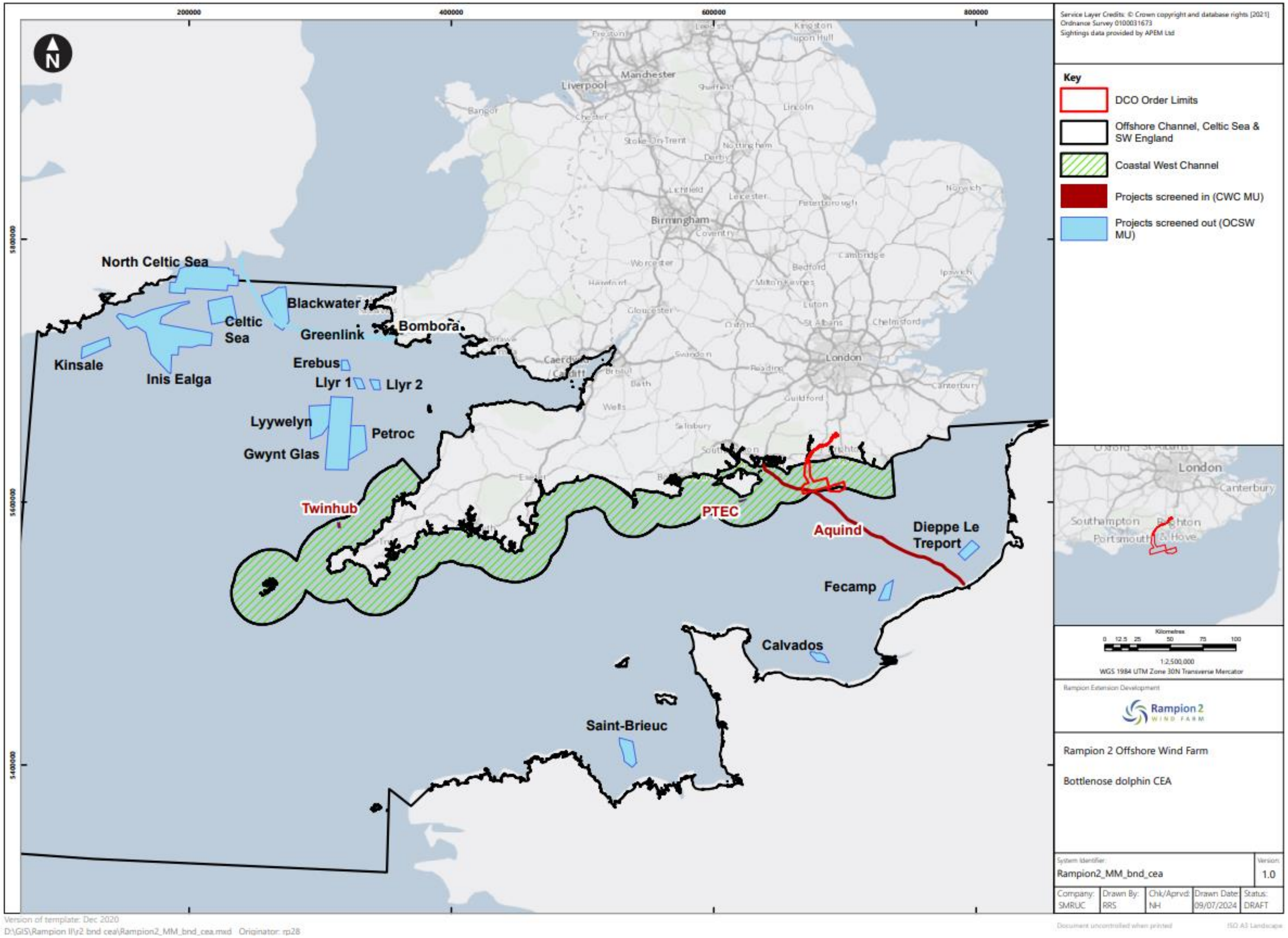
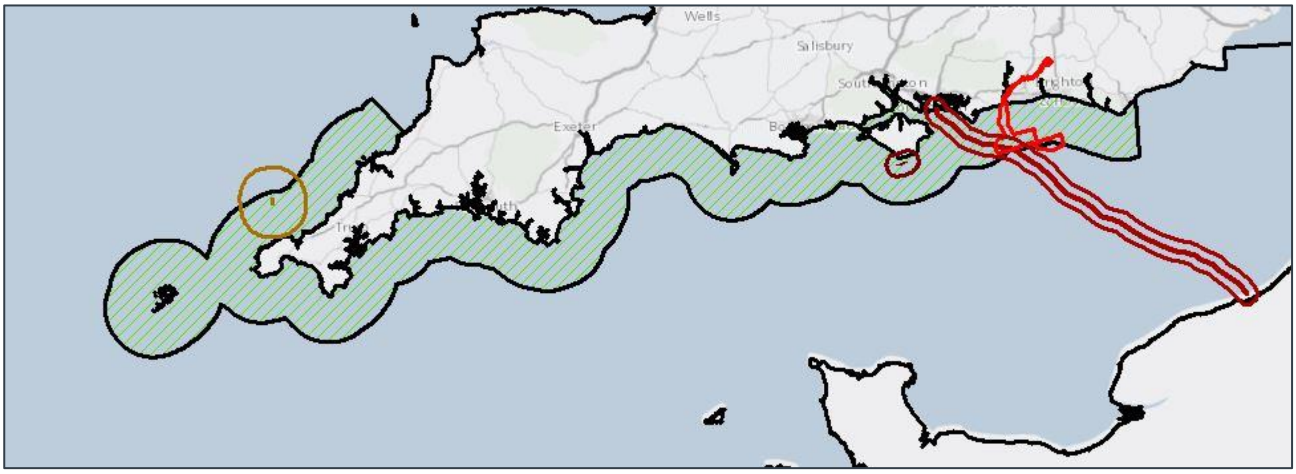


Figure 4-2 Offshore developments located within the CWC MU, or with impact contours that overlap the CWC MU



4.1.2 The following sections outline information available from respective Environmental Impact Assessments (EIAs) for the Perpetus Tidal Energy Centre (PTEC), the Aquind Interconnector and Wave Hub (TwinHub) developments that were used to inform their consideration in the cumualtve assessment.

Perpetuus Tidal Energy Centre

Data source:

- Perpetuus Tidal Energy Centre. Environmental Statement Chapter 13: Marine Mammals. November 2014

4.1.3 Foundation installation by drilling represents the worst case scenario. Noise modelling (Appendix 5A) was completed for percussive drilling of the maximum pile diameter of 4m.

4.1.4 the construction phase will be a maximum of 18 months of construction activity during a maximum construction window of 3 years.

4.1.5 The worst case scenario for drilling consecutively is 300 days within the construction phase for the 30MW PTEC development site capacity. Assuming worst case, there will be short breaks in drilling within the 300 days whilst moving between foundations.

4.1.6 The noise assessment considers the 90dBht (Species) to assess disturbance that may lead to a strong aversive response (with virtually all animals leaving the area).

4.1.7 The maximum impact range for percussive drilling presented in the ES chapter was 200 m (0.126 km^2). Assuming a uniform density of 0.002 dolphins/km^2 within the CWC MU, this equates to 0.00025 dolphins disturbed per day. Given the fact that <1 dolphin is predicted to be impacted, alongside the fact that iPCoD is not parameterised to assess the potential impacts from drilling, disturbance from construction at Perpetuus was not included quantitatively in the iPCoD CEA.

Aquind Interconnector

Data source:

- AQUIND Limited. AQUIND INTERCONNECTOR Environmental Statement – Volume 1 – Chapter 10 Marine Mammals and Basking Sharks. November 2019.

4.1.8 The ES scoped in the following impacts: geophysical surveys, vibro-piling at the Horizontal Directional Drilling (HDD) locations and sheet piling at the HDD.

4.1.9 Sheet piling is expected to occur on land only, and thus will not have underwater noise impacts.

4.1.10 Geophysical surveys were assessed in the ES as having a maximum impact range of 5 km, which equates to an impact area of 78.5 km^2. Assuming a uniform density of 0.002 dolphins/km^2 within the CWC MU, this equates to 0.157 dolphins disturbed per day. Given the fact that <1 dolphin is predicted to be impacted, this was not included quantitatively in the iPCoD CEA.

4.1.11 Vibro-piling was assessed in the ES as having a maximum impact range of 1.024 km, which equates to an impact area of 3.29 km^2. Assuming a uniform density of 0.002 dolphins/km^2 within the CWC MU, this equates to 0.007 dolphins disturbed per day. Given the fact that <1 dolphin is predicted to be impacted, alongside the fact that iPCoD is not parameterised to assess the potential impacts from vibro-piling, disturbance from construction at the Aquind Interconnector was not included quantitatively in the iPCoD CEA.

TwinHub (wave hub floating)

Data sources:

- Wave Hub Limited. Wave Hub Floating Wind Consent Application. Environmental Statement. August 2018. Assignment Number: A302237-S00. Document Number: A-302237-S00-REPT-003.
- TwinHub Marine Licence Support. Marine Mammals Technical Report. July 2021. ASSIGNMENT A303349-S00. DOCUMENT A-303349-S00-REPT-001.

4.1.12 The 2018 ES assessed the potential impact from 4 floating WTGs, totalling up to 24 piled anchors over a 6 month construction period.

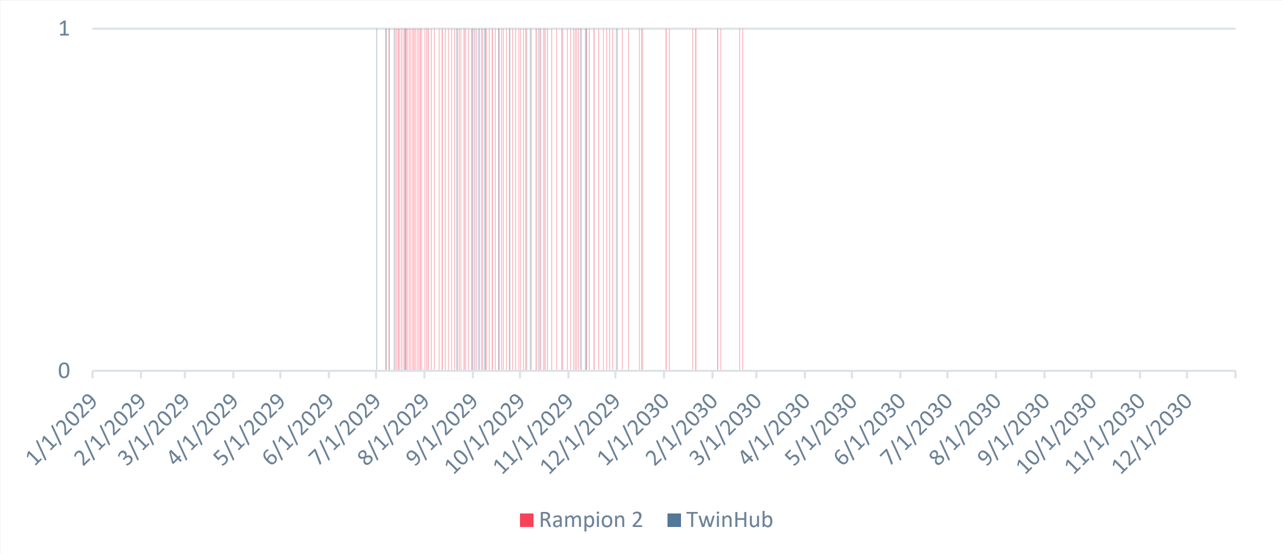
4.1.13 If it is assumed that 1 piled anchor is installed per day, this results in 24 piling days over a 6 month period. If a 15 km EDR is assumed for disturbance range, then this results in an impacted area of 706.85 km^2. Given that TwinHub is located on the boundary of the CWC MU, not all of the impact contour will be located within the CWC MU. The overlap of the impact area within the CWC MU is 596.6 km^2 (see **Figure 4-2**). Assuming a uniform density of 0.002 dolphins/km^2 within the CWC MU, this equates to 1.2 dolphins disturbed per day. Therefore, piling of anchors at TwinHub has been included in the iPCoD CEA.

4.2 Inputs

4.2.1 The following piling details were assumed in the cumulative modelling:

- Rampion 2: 93 piling days between July (year 1) and February (year 2), 3 dolphins disturbed on every piling day.
- TwinHub: 24 piling days randomly distributed between July (year 1) and December (year 1), 1 dolphin disturbed on every piling day.

Figure 4-3 Rampion 2 and TwinHub indicative piling schedule (start Jan year 1 to end Dec year 2 inclusive)



4.3 Results

4.3.1 The modelling results in no impact to the CWC MU at a population level from cumulative disturbance from Rampion 2 and TwinHub. The impacted population is expected to continue on a stable trajectory at 98-100% of the size of the un-impacted population (**Figure 4-4** and **Table 4-1**). This aligns with a magnitude score of **Low**: Survival and reproductive rates very unlikely to be impacted to the extent that the population trajectory will be altered.

4.3.2 As presented in **Appendix 11.2: Marine mammal quantitative underwater noise impact assessment** **[APP-148]**, the sensitivity of bottlenose dolphins to disturbance from pile driving is **Low**.

4.3.3 Therefore, the resulting impact significance for behavioural disturbance to bottlenose dolphins in the CWC MU from Rampion 2 cumulatively with TwinHub is **Minor (not significant)**.

Figure 4-4 Results of the Rampion 2 and TwinHub cumulative iPCoD simulations for the CWC MU. Blue (left panel) shows the trajectory of the un-impacted population (i.e. no disturbance) with a dark line representing the median (and range of uncertainty shown), Red (middle panel) shows the impacted population with a dark line representing the median (and range of uncertainty shown). The right panel shows both these forecasts together in a single frame

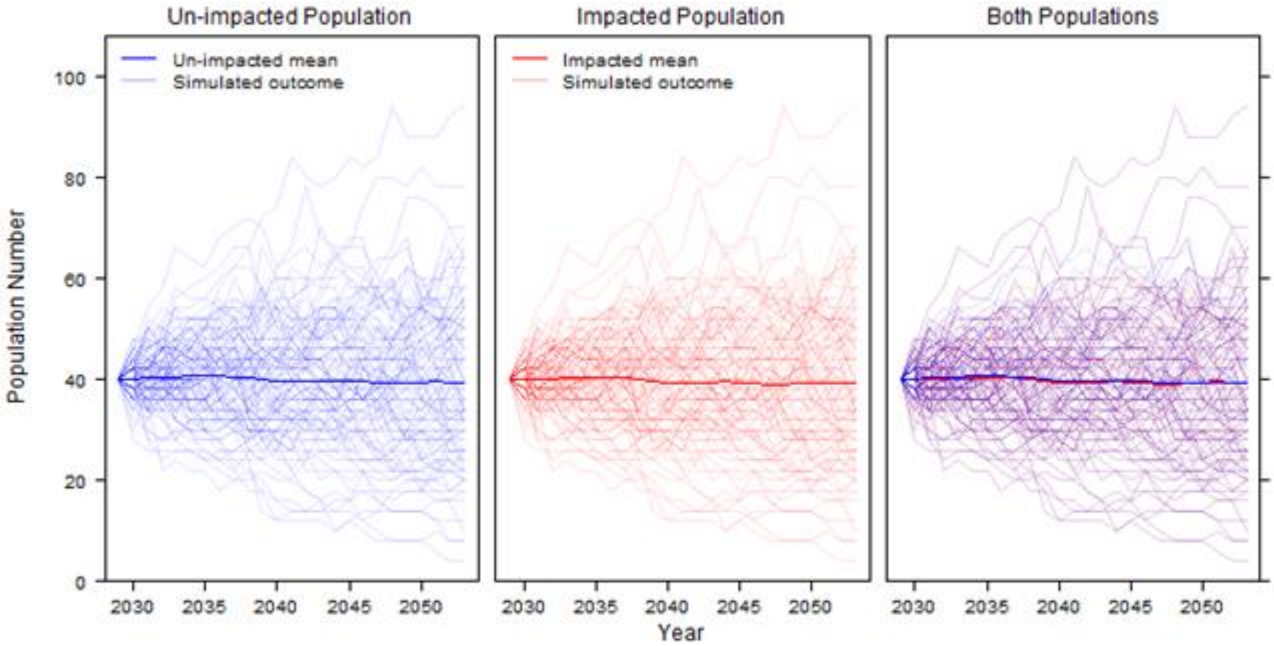


Table 4-1 Results of the Rampion 2 and TwinHub cumulative iPCoD simulations for the CWC MU at different timesteps. The mean un-impacted and impacted population sizes are shown, along with the counterfactual of the two metrics at each timestep.

	Unimpacted population mean size	Impacted population mean size	Impacted relative to un-impacted population size
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End year 1 (piling in year 1)	40	40	100%
End year 2 (piling in year 2)	40	40	100%
End year 3 (1 year after piling stops)	40	40	100%
End year 8 (6 years after piling stops)	40	40	100%
End year 14 (12 years after piling stops)	40	39	98%
End year 20 (18 years after piling stops)	39	39	100%

5. Conclusion

5.1.1 Simulations using the latest version of iPCoD and the best evidenced parameters do not predict impacts to the bottlenose dolphin CWC MU at a population level, either from Rampion 2 alone, or cumulatively with TwinHub.

6. References

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