Awel y Môr Offshore Wind Farm

Marine Mammal Clarification Note

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1 Introduction

1 This clarification note has been drafted to support the Awel y Môr Offshore Wind Farm Limited (the Applicant) response to the Relevant Representation (RR) and Marine Licence consultation response made by Natural Resources Wales (NRW) on the Awel y Môr Offshore Wind Farm (AyM) application documentation in relation to marine mammal ecology.

2 Specifically, this clarification note has been drafted to provide further justification in response to NRW comments regarding:

- RR-015-2.1.2ii (Cumulative Permanent Threshold Shift (PTS));
- RR-015-2.1.2iv (Special Area of Conservation (SAC) disturbance); and
- RR-015-2.1.3 (vessel collision).

2 Response to NRW Relevant Representations

2.1 RR-015-2.1.2ii (Cumulative PTS)

3 NRW stated in its RR: *"There are insufficient grounds to conclude that PTS-onset risk has a negligible impact on harbour porpoise when cumulative PTS-onset has been excluded from the Marine Mammal Mitigation Protocol (MMMP) (APP-107)."*

4 The Applicant provided a full quantitative assessment of cumulative PTS in the Environmental Statement (ES), however, based on the level of precaution inherent in the modelling for cumulative PTS, the draft MMMP did not recommend mitigation for cumulative PTS impact ranges. It is noted that mitigation will be required as part of EPS licensing to avoid injury offences and will be finalised at that stage, rather than being necessary to mitigate any significant effects identified in the EIA conclusions.

5 The Applicant maintains that, at present, the estimation of Cumulative Sound Exposure Level (SEL_{CUM}) PTS onset ranges is highly over-precautionary and as such there should not be a requirement to implement mitigation based on SEL_{cum} until these conservatisms have been quantified and addressed. The current underwater noise modelling for SEL_{cum} PTS onset using the Southall et al., (2019) criteria assumes the following:

- the amount of sound energy an animal is exposed to within 24 hours will have the same effect on its auditory system, regardless of whether it is received all at once (i.e. within a single bout of sound) or in several smaller doses spread over a longer period; and,
- the sound retains its impulsive character, regardless of the distance to the sound source.

6 However, in practice:

- Several studies (on bottlenose dolphins, harbour porpoise and California sea lions) have shown that for the same SEL_{cum}, if duty cycle decreases (i.e. increased interval between successive impulses, such as gaps between hammer strikes of piles), then the magnitude of Temporary Threshold Shift (TTS) decreases (Finneran et al., 2010b, Finneran et al., 2010a, Kastelein et al., 2014, Kastelein et al., 2015, Kastelein et al., 2021, Kastelein et al., 2022). Recovery of a threshold shift between pulses will lead to an onset of PTS at a higher energy level than assumed with the given SEL_{cum} threshold; and,
- impulsive sound loses its impulsive characteristics while propagating away from the sound source, resulting in a slower shift of an animal's hearing threshold than would be predicted for an impulsive sound (e.g. Hastie et al., 2019).

7 Both assumptions therefore lead to a conservative determination of the impact ranges.

8 As stated in ES Volume 4 Annex 7.3 Marine Mammal Quantitative Assessment Assumptions (APP-108), for the first 20 minutes of pile driving at AyM, a strike rate of 10 strikes per minute is planned. Assuming a signal duration of around 0.5 sec for a pile strike, this relates to an 8% duty cycle (0.5 sec pulse followed by 5.5 sec silence). For the remaining part of the ramp-up and at full hammer energy, the duty cycle will be 28% (0.5 sec pulse followed by a 1.26 sec silent period) at a strike rate of 34 strikes per minute. In the study of Kastelein et al., (2014), a silent period of 1.5 seconds corresponds to a duty cycle of 40%. The reduction in TTS at a duty cycle of 40% is greater than 6 dB, and at a duty cycle of 25% more than 8 dB. Southall et al., (2019) calculates the PTS-onset thresholds based on the assumption that a TTS of 40 dB will lead to PTS, and an animal's hearing threshold will shift by 2.3 dB per dB SEL received from an impulsive sound. This means, to elicit the same threshold shift with a 40% or 25% duty cycle as with a sound of 100% duty cycle, more than 2.6 dB (6 dB/2.3) will need to be added to the SEL of the 100% duty cycled sound. The threshold for PTS can therefore be raised by a minimum of 2.6 dB. Table 2 provides an illustration of how the predicted cumulative PTS impact ranges can change if the PTS onset threshold is increased by 2 and 3 dB, respectively.

Table 1: Difference in PTS impact ranges when using the current Southall et al., (2019) thresholds, compared to increasing the threshold by 2 and 3 dB, respectively.

SPECIES	THRESHOLD (DB RE 1 µPA²S SEL_{CUM})	MAX IMPACT RANGE (KM)	
		MONOPILE	PINPILE X2
Minke whale	183	8.225	9.425
	185 (+2 dB)	5.950	7.100
	186 (+3 dB)	4.900	6.025
Harbour porpoise	155	4.625	6.050
	157 (+2 dB)	3.050	4.275
	158 (+3 dB)	2.375	3.475

9 The Applicant acknowledges that the assessment of cumulative PTS is an area of active research. Ongoing studies are seeking to better understand the effects of duty cycle and how the impulsive characteristics of noise change with range. For example, further investigation of how duty cycle influences TTS in harbour porpoise and seals (R. Kastelein, pers. comm., April 2022), and the newly awarded 2022 ORJIP RaDIN (range-dependent nature of impulsive noise) project. It is anticipated that these, and other studies, will reduce existing uncertainties and sources of conservatism, and will result in developments to the process of estimating SEL_{CUM}.

10 As such, the Applicant will maintain awareness of current research and maintain ongoing dialogue with NRW post-consent to ensure that the final MMMP presents an updated assessment of cumulative PTS impact ranges and mitigation measures reflecting the state of knowledge and best modelling practice available at the time. Thus, the Applicant can confirm that cumulative PTS will be mitigated in the final MMMP unless evidence and guidance at the time suggest that it is not appropriate to do so. This will ensure that the potential risk of PTS is reduced to negligible levels for all species.

11 Potential mitigation options that were presented in the draft MMMP, and will be considered in the final MMMP, to mitigate PTS (both instantaneous and cumulative) include:

- Alternative foundation options;
- Marine mammal observers to ensure the mitigation zone is free of marine mammals prior to piling commencing;
- Acoustic deterrent device to ensure the mitigation zone is free of marine mammals prior to piling commencing;
- Passive Acoustic monitoring to ensure the mitigation zone is free of marine mammals prior to piling commencing;
- At-source noise abatement systems (e.g. bubble curtains, casings, resonators); and
- Alternative hammer types (e.g. vibro-piling, BLUE piling technology).

2.2 RR-015-2.1.2iv (SAC disturbance)

12 NRW stated: *"NRW does not recommend the use of dose/response curves to conduct an area-based assessment to estimate area of harbour porpoise habitat disturbed. Given that disturbance for harbour porpoise Special Area of Conservation (SACs) is defined through spatial and temporal thresholds of 20% daily and 10% seasonal disturbance, as set out in the supporting advice for the disturbance conservation objective (CO2) for porpoise sites, we advise that an area-based assessment should be carried out where the extent of habitat that is insonified to a level that might produce significant disturbance is determined. Although there is a strong link between area lost and numbers disturbed, directly equating the probability of population response to loss of habitat / loss of habitat quality (i.e. using a dose response curve to calculate habitat loss) is currently not possible"*.

13 The Report to Inform Appropriate Assessment (RIAA) presented two different approaches to the assessment of disturbance from pile driving on the North Anglesey Marine SAC: the dose-response approach (Graham et al., 2017), and the 26 km (Effective Deterrence Range) EDR approach (JNCC et al., 2020). Assuming that the proportion of animals responding to underwater noise was proportional to the loss of habitat within the SAC, the dose-response approach estimated that 5.31% of the SAC area would be impacted by pile driving noise at the worst-case location. The footprint of disturbance based on an EDR of 26 km at the worst-case location would at most be 0.41% of the total SAC area. It is noted that the RIAA (APP-027) described this overlap incorrectly as 0.4%, and concluded that the impact of disturbance (irrespective of method) was well within the daily 20% threshold and thus there would be no potential for an Adverse Effect on Integrity (AEoI) to the conservation objectives of the harbour porpoise feature of the North Anglesey Marine SAC. The corrected footprint of disturbance still results in an overlap well eblow the daily 20% threshold and therefore the conclusion of the RIAA remains valid. This error is also noted in the Application Errata List (Document 1.4 of the Applicant's Deadline 1 submission).

14 Since there is no agreed threshold to assess disturbance impacts to SACs (other than the 26 km EDR approach outlined JNCC et al., 2020 - which NRW does not subscribe to), the Applicant has provided a selection of different disturbance criteria that could be applied to expand the assessment presented in the RIAA. These are outlined in Table 2 and include:

- the ~50% response threshold using the dose-response curve approach (Graham et al., 2017),
- the 26 km EDR (JNCC, 2020),
- the Southall et al., (2019) TTS-onset 140 dB re 1 μPa²s SEL_{cum} threshold (as a proxy for disturbance),
- the Lucke et al., (2009) 145 dB re 1 μPa²s SEL_{ss} threshold for consistent aversive behavioural reactions,
- the Brandt et al., (2018) and Heinis et al., (2019) 143 dB re 1 μPa²s SEL_{ss} threshold for a decline in porpoise detection rates from the first seven OWF in German waters, and
- the ASCOBANS (2014) 140 dB re 1 μPa²s SEL_{ss} threshold.

15 Using the dose-response approach, 50.9% of porpoise are predicted to respond between 145<150 dB SEL_{ss} (Graham et al., 2017). If 50% response is assumed to be considered as "significant disturbance" then 17.8 km^2 of the North Anglesey Marine SAC area (0.5%) is predicted to experience "significant disturbance" from pile driving (from a 5,000 kJ monopile at the NW location). This is significantly below the 20% area threshold for significant noise disturbance within an SAC. This is exactly the same threshold as presented in Lucke et al., (2009) for consistent aversive behavioural reactions and thus the resulting impact to the SAC is the same.

16 Using the recommended 140 dB re 1 $\mu Pa^2 s$ SEL_{ss} (ASCOBANS, 2014), then disturbance is predicted to occur within 3.7% of the North Anglesey Marine SAC area. Again, this is significantly below the 20% area threshold for significant noise disturbance within an SAC.

17 The 143 dB re 1 $\mu Pa^2 s$ SEL_{ss} threshold (Brandt et al., 2018 and Heinis et al., 2019) has not been specifically modelled and presented here. However, since this threshold sits between the 140 and the 145 dB re 1 $\mu Pa^2 s$ SEL_{ss} thresholds the predicted impact to the North Anglesey Marine SAC would be between that predicted for the 140 threshold (3.7%) and the 145 threshold (0.5%)

18 If it is assumed that the 26 km EDR represents significant disturbance (as stated in the JNCC et al., 2020 guidance), then only 0.41% of the North Anglesey Marine SAC area is predicted to be impacted based on piling a the point closest to the SAC within the array area). Again, this is significantly below the 20% area threshold for significant noise disturbance within an SAC.

19 There is no overlap between the 140 dB re 1 $\mu Pa^2 s$ SEL_{cum} TTS-onset threshold and the North Anglesey Marine SAC.

20 These impact ranges are percentage overlap with the SAC assume piling at the Northwest location. As other piling locations are further from the SAC, this represents the worst-case overlap, and all other locations are expected to result in less overlap with the SAC. Given the minimal overlap between disturbance ranges and the SAC (no matter which approach to assessing disturbance is considered), there is no potential for an AEoI to the conservation objectives of the harbour porpoise feature. Therefore, subject to natural change, the harbour porpoise feature will be maintained in the long term.

Table 2: Assessment of impact to the North Anglesey Marine SAC assuming different criteria for disturbance (assuming worst case monopile installation at the NW location).

THRESHOLD		AREA WITHIN IMPACT THRESHOLD (KM^2)	OVERLAP WITH SAC (KM^2)	% SAC	% MU
50.9% response using the D-R function (Graham et al., 2017)	145 dB re 1 µPa^{2}s SEL_{ss}	2,153.2	17.8	0.5	3.44
Aversive reactions (Lucke et al., 2009)	145 dB re 1 µPa^{2}s SEL_{ss}	2,153.2	17.8	0.5	3.44
Sound Protection Concept (ASCOBANS, 2014)	140 dB re 1 µPa^{2}s SEL_{ss}	3,080.8	121	3.7	4.93
EDR (JNCC et al., 2020)	26 km	2,026.9	13.2	0.41	3.24

THRESHOLD		AREA WITHIN IMPACT THRESHOLD (KM^2)	OVERLAP WITH SAC (KM^2)	% SAC	% MU
TTS as a proxy (Southall et al., 2019)	140 dB re 1 μPa^2s SEL_{cum}	1,100	0.0	0.0	1.76

2.3 RR-015-2.1.3 (vessel collision)

21 NRW stated: *"There is insufficient justification to support a conclusion of no Likely Significant Effect from vessel collision for bottlenose dolphin, grey seal or harbour porpoise features of relevant SACs"*.

22 The Applicant notes that the issue of concern here is the fact that the Applicant used the commitment to best practice vessel handing protocols to scope out LSE. NRW has highlighted that commitment to embedded mitigation cannot be used to scope out an impact from LSE. Thus, additional text is provided here for the assessment of vessel collisions for the RIAA.

23 A vessel collision is defined as any impact between any part of a vessel and a marine mammal (Schoeman et al., 2020). Vessel collisions can result in physical trauma or mortality of the individual involved. The risk of vessel collisions has been most widely documented/studied for large whales, though there is increasing evidence that suggests that other marine mammal species are vulnerable to the risk of collision in coastal areas by smaller vessel types (Schoeman et al., 2020). The collision risk is heightened when you have:

- a high density of mammals and vessels in the same area at the same time,
- reduced detection and reaction times, e.g. rapidly travelling vessels offer less time for the operator to detect and potentially avoid the marine mammal, as well as for the marine mammal to detect and avoid the vessel,

- reduced detection and reaction conditions, e.g. at night or in reduced visibility the ability for the operator to detect and avoid the marine mammal is lower and likewise in noisier ambient conditions or when the animals are engaged in other activities such as foraging, the animals ability to detect and avoid the vessel are likely reduced,
- larger animals since they typically have a slower response time for any avoidance actions, increasing the risk of a strike versus a near miss.

24 The risk of collision can be lowered by:

- reducing vessel speed: increasing likelihood of detection and avoidance by either marine mammals or vessel operator, while also likely decreasing the severity of any blunt force trauma should a strike occur;
- increasing predictability of vessel movements (simple direct repeated path at reduced speeds likely reduce collision risk); and
- minimizing transits after dark.

25 The Applicant has committed to embedded mitigation in the form of the adoption of best practice vessel handing protocols during construction to minimise the potential for any impact (e.g. following the Codes of Conduct provided by the WiSe Scheme, Scottish Marine Wildlife Watching Code or Guide to Best Practice for Watching Marine Wildlife). This is expected to be secured as a Marine Licence condition as noted within Section 1.9 of the ES chapter on Marine Mammals (AS-026). This commitment will ensure that the potential risk of vessel collision is minimised as far as practically possible. Therefore, given this commitment, the risk of vessel collisions occurring is of negligible adverse magnitude. As such, there is no potential for an AEoI to the conservation objectives of any of the marine mammal SACs included in the RIAA.

2.4 RR-015-2.1.2iii (iPCoD)

26 NRW stated: *"In order to allow a more comprehensive analysis of PTS and disturbance, NRW considers that additional modelling should be carried out and additional model details provided in order to inform assessments of underwater noise and PTS onset. This includes carrying out Interim Population Consequences of Disturbance (iPCoD) modelling for harbour porpoise disturbance and PTS injury, including modelling parameters used"*.

27 In the marine mammal impact assessment (ES Volume 2, Chapter 7 marine mammals), iPCoD modelling was used where the portion of the MU predicted to be disturbed was >1% (bottlenose dolphins and grey seals). For harbour porpoise, the predicted impact (using the more reliable JCP density estimate) was to a maximum of 0.44% MU and as such iPCoD modelling was not conducted.

28 Using the SWF density estimate, the proportion of the MU predicted to be impacted reached 3.38%, however, since this density estimate was considered to be highly precautionary, iPCoD was not run. For completeness, this has now been run and the results presented here. The following parameters were used:

- Demographic parameters: as per Sinclair et al., (2020)
- Disturbance to 2112 porpoise per day
- 201 piling days

29 Even under this worst-case scenario (using the highly conservative density estimate), the population size of the impacted population remains as 99.9% of the size of the unimpacted population after 1 year of pile driving, and 99.8% of the size of the unimpacted population at the end of the 25-year simulation (Figure 1). The conclusions presented in the marine mammal impact assessment (ES Volume 2, Chapter 7; AS-026) therefore remain the same:

- Using the SWF density estimate (1.0 porpoise/km^2, averaged across the coastal and offshore areas), the number of harbour porpoise predicted to experience behavioural disturbance is higher. The maximum level of disturbance results from a monopile foundation at the NW modelling location, which results in a predicted 2,112 porpoise experiencing disturbance on each day of pile driving activities (3.38% MU). Using the SWF density estimate, the number of porpoise predicted to be impacted and the proportion of the population this represents, results in a precautionary **medium adverse magnitude**, where any changes to individual vital rates are very unlikely to affect the population trajectory over a generational scale.
- Disturbance as result of pile driving may temporarily affect harbour porpoise fertility and the probability of calf survival. Due to observed responsiveness to piling, and their income breeder life history, harbour porpoise are considered to have a **low sensitivity** to disturbance from pile driving.

- The magnitude of the impact has been assessed as low adverse (using the JCP density estimate) or medium (using the SWF density estimate) and the sensitivity of receptor as low. Therefore, the significance of the effect of disturbance from pile driving on harbour porpoise is concluded to be of **minor adverse significance, which is not significant in terms of the EIA regulations.**

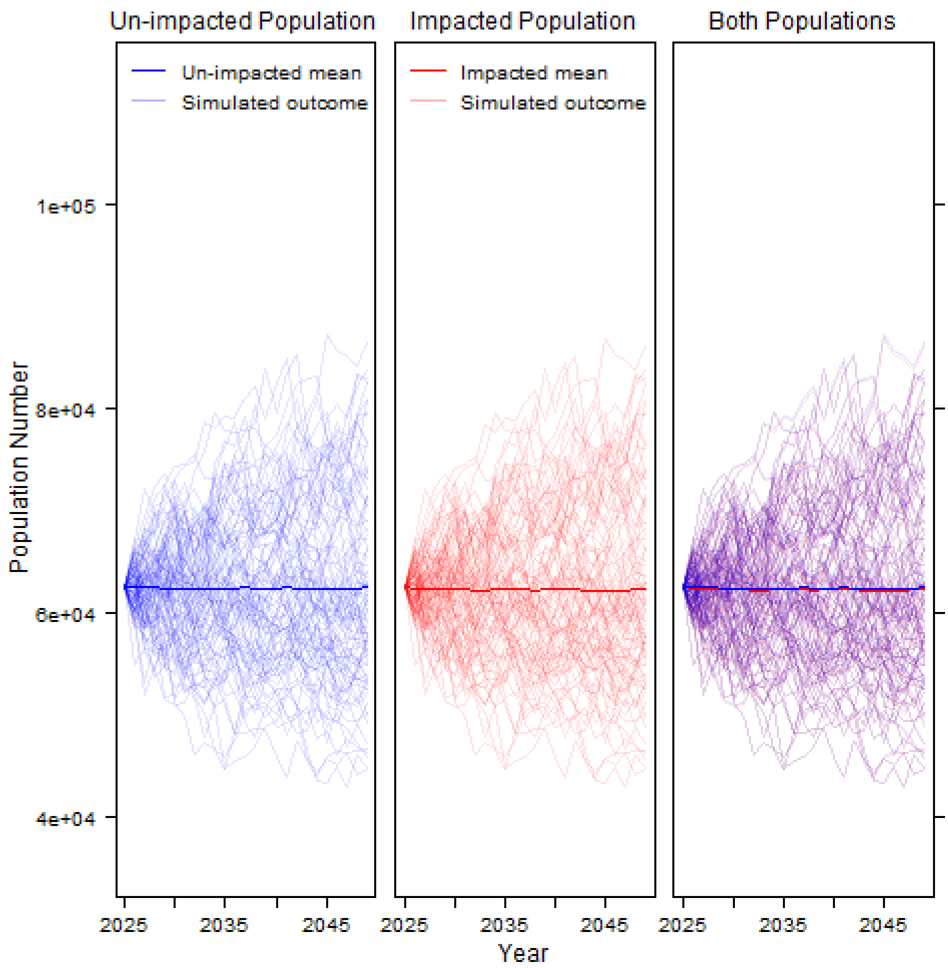

Figure 1: Population trajectory for both the impacted and un-impacted harbour porpoise population resulting from 201 days of piling disturbance

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