Morlais Project

Fish Ecology
Response to ABPmer comments

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Introduction

This document provides information on underwater noise impacts to fish and shellfish in response to ABPmer comments and is inclusive of the results of project-specific underwater noise modelling.

Project-specific underwater noise modelling has been undertaken by Subacoustech Ltd. and has been used here to inform a response to comments from ABPmer on the Marine Licence Application. Subacoustech Environmental undertook acoustic propagation modelling for the three main sources of underwater noise at the MDZ; operational tidal turbines, drilling, and acoustic deterrent devices. For specifics on how the underwater noise modelling was undertaken, please refer to Subacoustech (2020).

Brief overview of sensitivity and thresholds, as per Popper *et al* (2014)

The sensitivity of fish species to noise is poorly understood though it is thought to vary between species, depending on several factors including the auditory 'threshold', presence of and physical coupling of any swim bladder to ear structures, resonance frequency of the otolith system, and behavioural traits (Popper *et al.,* 2014). Popper *et al.* (2014) grouped fish into the following groups:

- Fish: no swim bladder (particle motion detection), e.g. dab and other flatfish;
- Fish where swim bladder is not involved in hearing (particle motion detection), e.g. Atlantic salmon;
- Fish where swim bladder is involved in hearing (primarily pressure detection), e.g. Atlantic cod, herring and relatives;
- Eggs and larvae.

The most sensitive of these groups to underwater noise is fish where a swim bladder is involved in hearing. This group has the lowest thresholds for experiencing effects from underwater noise, and therefore have been used in this assessment as a worst-case parameter.

Popper *et al.* (2014) assessed the thresholds of each of the groups to receive the following different levels of effect (in decreasing order of magnitude):

- Mortality and potential mortal injury;
- Recoverable injury;
- Temporary threshold shift (TTS);
- Masking;
- Behavioural change.

Popper *et al.* (2014) only provided thresholds for a limited number of noise sources that have the greatest amount of data available, such as seismic surveys. The proposed noisy activities in the MDZ were not assessed directly by Popper *et al.* (2014), therefore a proxy for the noise source has been chosen based on expert judgement.

Note that the thresholds for masking and behaviour provided by Popper *et al.* (2014) are qualitative in that they assess the relative risk (high, moderate, low) for animals at three distances from the source (near (in the tens of metres from the source), intermediate (in the 100s of metres), or far (in the 1000s of metres)). Popper *et al.* (2014) state that "*No assumptions are made about source or received levels because there are insufficient data to quantify what these distances might be*". Though these thresholds are not fully quantified, and the effects are of lower importance than potential auditory injuries, the potential for masking and behaviour changes is also considered.

It should be noted that underwater noise impacts upon shellfish in the context of sensitivity to particle motion have been considered already in this response. Therefore, they are excluded from this specific assessment.

Underwater noise impact during Construction: drilling

With regards to underwater noise, the worst-case construction method is drilling of pin piles. The worst-case parameters of drilling in terms of duration is detailed in the ES, and the specific drill specifications are detailed in the Underwater Noise Modelling Report (Subacoustech (2020), document MOR/RHDHV/DOC/0116).

Based on the noise modelling by Subacoustech (2020), the unweighted source level (RMS) of the percussive drilling is 175.9 dB re 1 µPa @ 1 m.

Popper *et al.* (2014) did not directly assess the thresholds associated with drilling, therefore the thresholds for the similar activity of piling have been used. The sound levels at which different effects may be seen in fish where the swim bladder is involved in the hearing (the worst-case scenario) are as follows (Popper *et al.,* 2014):

- Mortality and potential mortal injury: >207 dB peak;
- Recoverable injury: >207 dB peak;
- TTS: 186 dB SEL_{cum};
- Behaviour and masking changes: High (near and intermediate distances), Moderate (far).

It is apparent that the peak source levels produced during drilling will not exceed the threshold for injury in the most sensitive of the fish hearing groups, and therefore by extension any of the fish hearing groups, include eggs and larvae.

The effects of cumulative noise from drilling operations on fish groups were not investigated by Subacoustech (2020). However, Subacoustech (2020) modelled the impact ranges based on cumulative SEL received over a worst-case duration of 24-hour for different marine mammal hearing groups. They reported that the maximum distance for which any marine mammal hearing group would experience TTS was <10 m (Subacoustech, 2020). Though it is acknowledged that there are considerable differences between the hearing of marine mammals and fish, marine mammals are considered more sensitive to underwater sound and therefore the distances associated with impacts to marine mammals from cumulative sound are likely to be greater than the worst-case scenario to fish. It is considered that the maximum distance at which the cumulative threshold for TTS in fish would be exceeded is 10 m; any effects will therefore be highly localised and negligible at a population level. This highly precautionary conclusion supports the determination reported in the ES, that effects from drilling operations will be minor adverse.

Following the qualitative descriptions of Popper *et al.* (2014), it can be inferred that there is a high potential for behavioural effects within 10s and 100s of metres from the drilling sound source, a moderate potential for behavioural effects within 1000s of metres from the source.

Underwater noise impact during Operation: operational tidal turbines

The worst-case parameters for tidal turbine build out and design is detailed in Subacoustech (2020).

Subacoustech (2020) modelled the source level (unweighted; RMS) of both a small and large tidal turbine. For the small turbine layout, the source level was 155.7 dB re 1 µPa @ 1 m, and for the large turbine layout, the source level was 161.2 dB re 1 µPa @ 1 m.

Popper *et al.* (2014) did not directly assess the thresholds associated with operational tidal turbine noise, therefore the thresholds for a source of continuous noise, shipping, have been used. The sound levels at which different effects may be seen in fish where the swim bladder is involved in the hearing (the worst-case scenario) are as follows (Popper *et al.,* 2014[1]):

- Mortality and potential mortal injury: near, intermediate and far (low);
- Recoverable injury: 170 dB rms for 48 h;
- TTS: 158 dB rms for 12 h;
- Behaviour and masking changes: High (near), Moderate (intermediate), Low (far).

Popper *et al.* (2014) state that "*There is no direct evidence of mortality or potential mortal injury to fish from ship noise*", as evidence by the assessment of 'low' risk for all distances, therefore it is considered that the risk of mortality from underwater noise of operational tidal turbines can be excluded. The modelled source levels of operational tidal turbine are also below the threshold for recoverable injury, which has been derived from 48 hours of continuous exposure, which is an unrealistic scenario given the mobility of fish and potential to move away from any noise source.

The threshold for TTS is marginally exceeded by the large turbine layout of the MDZ, though not the small turbine layout. Though there is potential for fish species to experience TTS, this is only applicable to an individual fish that remained within the vicinity (<20 m, the maximum distance of a noise level of 150 dB) of the operational turbine for a period of 12 hours. Given the mobility of fish species and therefore the potential to move away from noise sources, particularly those that could be perceived as having an adverse effect on the individual, it is considered highly unlikely that any fish would experience TTS as a result of operational noise from the tidal turbines at the MDZ.

Following the qualitative descriptions of Popper *et al.* (2014), it can be inferred that there is a high potential for behavioural effects within 10s of metres from the operational turbine sound source, a moderate potential within 100s of metres, and a low potential within 1000s of metres.

<u>Underwater noise impact during Operation: acoustic deterrent devices (ADDs)</u>

As indicated by Subacoustech (2020), ADDs are being considered for each tidal turbine location, in order to deter marine mammals from the operational rotors. The worst-case option for ADDs is the Lofitech Seal Scarer, which has been used here.

Based on the noise modelling by Subacoustech (2020), the unweighted source level (RMS) of the ADD is 182.7 dB re 1 µPa @ 1 m.

Popper *et al.* (2014) did not directly assess the thresholds associated with ADD. ADDs are considered a sound of impulsive noise as opposed to continuous noise, therefore the thresholds for another impulsive activity, piling, have been used. The sound levels at which different effects may be seen in fish where the swim bladder is involved in the hearing (the worst-case scenario) are as follows (Popper *et al.,* 2014):

- Mortality and potential mortal injury: >207 dB peak;

[1] Note that Popper *et al.* (2014) only provided quantitative thresholds for hearing specialist fish; for all other fish groups, including eggs and larvae, the thresholds presented were the qualitative thresholds as there is a lack of evidence on qualitative thresholds.

- Recoverable injury: >207 dB peak;
- TTS: 186 dB SEL_{cum};
- Behaviour and masking changes: High (near and intermediate distances), Moderate (far).

It is apparent that the peak source levels produced during ADD usage will not exceed the threshold for injury in the most sensitive of the fish hearing groups, and therefore by extension any of the fish hearing groups, include eggs and larvae.

The effects of cumulative noise from ADD operations on fish groups were not investigated by Subacoustech (2020). ADDs such as the Lofitech Seal Scarer produce tones between 15-18 kHz. Most fish species that are not hearing specialists are only sensitive to lower frequencies and such tones from an ADD would fall outside of their hearing range. The exception is hearing specialists such as fish in clupeid family such as Atlantic herring, which have been recently shown to detect high-frequency broadband sounds from 1->20 kHz. In this respect, hearing specialist fish can be considered as having a hearing range that would not be more sensitive to ADDs than phocid carnivores in water (PCW) (which have a frequency of best hearing of 8.6 kHz, maximum hearing cut off of 60 kHz; Southall *et al.,* 2019). The SEL_{cum} threshold for PCW is 181 dB for TTS, which is also more conservative than the SEL_{cum} limit for hearing specialist fish, therefore this is considered suitably precautionary for assessment. Based on the results of Subacoustech (2020), SEL_{cum} noise level thresholds that could lead to TTS would only occur at a maximum of 10 m from the ADD. It can therefore be concluded that a distance of 10 m would also be the worst-case distance at which fish hearing specialists could experience TTS. The range of injury effects is therefore limited to the immediate vicinity around the ADD.

Following the qualitative descriptions of Popper *et al.* (2014), it can be inferred that there is a high potential for behavioural effects within 10s and 100s of metres from the ADD sound source, and a moderate potential for behavioural effects within 1000s of metres from the source. It is noted that there is a significant amount of uncertainty around the potential behavioural responses of fish species to the noise source, at what source or received levels such responses may be observed, the influence of other factors on an individual response, and any population consequence.

REFERENCES

Popper, A.N., & Hawkins, A.D. (2019). *An overview of fish bioacoustics and the impacts of anthropogenic sounds on fishes*. Journal of Fish Biology, Volume 94, Issue 5, May 2019.

Subacoustech (2020). Underwater Noise Modelling Report. Produced for Menter Môn Morlais Limited. Document No. MOR/RHDHV/DOC/0116.