ASSESSMENT AND INTERPRETATION OF INFORMATION ON UNDERWATER NOISE PROVIDED FOR THE MARINE TERMINAL CONSTRUCTION PROJECT IN PORT-DANIEL-GASCONS, IN CHALEUR BAY, QC

Context

In July 2014, Fisheries and Oceans Canada (DFO) issued an authorization under the *Fisheries Act* for a marine terminal construction project in Port-Daniel–Gascons by McInnis Cement Inc. The conditions included in the authorization dictate that whales must be monitored during pile driving operations and that operations must stop if whales are spotted within a determined radius. The authorization also allows for the possibility of changes to the conditions associated with whale monitoring. A request to make changes must nonetheless be accompanied by supporting documentation regarding the level of noise generated by the work, and obtain DFO approval.

On September 10, 2014, the proponent submitted a technical note on measurements of the underwater noise generated by pile driving operations and requested that the monitoring radius be revised as a result.

This Science Response is the result of a request submitted by the Regional Ecosystem Management Branch (REMB) to the DFO Regional Science Branch (RSB) to validate the results presented and methods used by the proponent to measure the underwater noise associated with pile driving operations in the port construction project in Port-Daniel–Gascons in Chaleur Bay, QC. These measurements are intended to determine the size of the whale monitoring area during the work, where noise levels exceed 120 dB re 1µPa (broadband SPL_{rms} level).

More specifically, the REMB would like to know if the methods used and the results submitted can help determine with reasonable certainty:

1) Noise reduction in the area (i.e. model of losses by sound transmission);
2) Noise levels at the source during pile driving operations, particularly while rocks are drilled and piles are screwed in, expressed in the relevant metrics to determine potential disturbances to aquatic wildlife;
3) If applicable, the faults and other necessary information to establish the two points above.

The REMB requires a prompt response to the items stated above so that it can reply to the proponent's request to reduce the cetacean monitoring area during pile drilling operations.

This Science Response Report results from the Science Response Process of October 2014 on the Assessment and interpretation of information on underwater noise provided for the marine terminal construction project in Port-Daniel–Gascons, in Chaleur Bay, QC.

Background

The documents provided for this review are a) the request dated September 25, 2014 and submitted by the REMB to the RSB, b) the proponent's report dated September 10, 2014 and submitted to the REMB[1] and c) an email from the proponent to the REMB dated September 16, 2014 at 2:43 p.m. that answers questions from the REMB regarding this report.

In brief, the proponent's report gives an account of the results of the acoustic measurements taken in July, August and September in Port-Daniel Bay, in Chaleur Bay, in accordance with the following two protocols:

i. In July, to measure transmission losses, sounds were emitted through a projector placed at shallow depths (~ 2 m) near the shore and their levels were measured at various distances along three 4-km radial transects by a hydrophone connected to a recording system and suspended between 5 and 10 m from the surface.
ii. In August and September, for noise measurement associated with drilling and screwing in piles with or without an air bubble curtain, the same hydrophone and recording system were used to make recordings at distances of 25 to 1000 m from the pile being driven.

The report discusses difficulties associated with taking acoustic measurements, noise interference from other sources, and bubble curtain deficiencies that limited the quality and quantity of the measurements.

Analysis and Response

Noise attenuation in the area is it known with reasonable certainty?

The review of the results presented requires a negative answer. The proponent's report forecasts average transmission losses at 100, 500 and 1000 m from the source. Yet no sound measurements were taken less than 700 m from the source for two of the three radial transects considered. Measurements at a short distance from the source are crucial to consolidating any transmission loss models because losses are most substantial at these distances and have a great impact on the model's shape. This first gap leads to deeming transmission loss models perpendicular to the shore and toward the southeast highly uncertain and overall predictions invalid.

In addition, the very high variability of the estimates of transmission loss levels at various distances from the sound projector along the 3 radial transects leads to the conclusion that there is no general model for estimating transmission losses with reasonable accuracy. For the same distance from the source, this variability can reach 40 dB (a factor of 10^4), which is huge. Despite this variability, the proponent suggests a model based on these measurements, but it is marred by a very high degree of uncertainty that is not taken into account in the report's findings. The variability observed is basically due to the bathymetric variability, the nature of the floor, obstacles, large stones, suspended particulate, etc. No other factors are brought up to attempt to explain this great variability in the measurements taken.

[1] "Measurement of underwater noise caused by pile driving" WSP, Technical note Project 121-20440-00. September 10, 2014.

Can the sound level at the source of the drilling and screwing-in of the piles be predicted with reasonable certainty?

This sound level is estimated by measuring the noise at various distances and adding losses caused by transmission. As this last point is not deemed valid, neither is the sound level at the source. Consequently, the Regional Science Branch's answer to this question is also no.

According to the methodology presented, measurements were taken between 25 and 1000 m from the source, but the report does not mention any of these results; it provides in an appendix only a few "typical" examples of measurements taken. The report notes that it was difficult to isolate the noise caused by pile driving, the result of which was "no clear noise reduction trends based on distance could be established at this stage because greater sound pressure was sometimes measured at a greater distance from the source." Nonetheless, and despite the great variability in the measurements that is mentioned above and the inconsistencies noted in them by the proponent, the report presents source estimates that are accurate to 2 decimal places, but with no confidence interval.

In addition, examples of measurements provided by the proponent in Appendix 3 of the document submitted raise several questions about how they were taken from the data collected and about their representativeness with respect to the target objectives.

Required information for measuring noise attenuation and level at the source:

This question of identification of faults and missing information is partly answered in the first question above. It is not DFO's role to describe the exact protocols to follow to estimate the acoustic quantities sought because there are several ways of doing this and they can be implemented by relying on specialized expertise and abundant underwater acoustics scientific and methodological literature. However, in all cases, the protocol used must be rigorous and able to properly support a critical review.

This is not the case here for the points raised above, especially the approach used to measure transmission losses with a sound projector deployed on shallow floors and to measure sound levels solely near the surface along 4-km radial transects in three directions. These measurements yielded results tinged with great uncertainty whose potential sources must be explained. This uncertainty should be taken into account in the conclusions. In particular, the report has to include reasonable proof that the following points were correctly considered, assessed and taken into account:

- The sound projector's directivity pattern at different acoustic frequencies used to estimate transmission losses;
- The biases that may result in measurements taken only near the surface (between 5 and 10 m in an area where the floor is inclined and the depth reaches 40 m) because of the complex three-dimensional acoustic propagation pattern at different frequencies along the 4-km radial transects resulting from the sound speed profile of a typical summer noise favouring propagation toward the floor and from the inconsistent nature of the floor and the bathymetry, both for measuring and estimating sound levels;
- The hydrophone's and its recording system's sensitivity with regard to acoustic frequency (RS curve) verified by measurements to estimate sound levels;
- Noises interfering with measurements were correctly filtered in the sound level estimates;

- The representativeness of the choice of measurement sequences not based on an unbiased statistical protocol, the very short duration (10 s), and the absence of repetition of measures for estimating unbiased sound levels;
- The uncertainty of the measurements and the models is taken into account in the results and conclusions.

Lastly, a lack of rigour and details in the units presented for the various acoustic measurements and graph axes, as well as the erroneous use of the peak pressure level (as asked about by the REMB in its discussions with the proponent) that is not the peak level taken on a spectrogram (in Hz or third octave or other bands), as presented by the proponent. It is also not clear how the sound pressure level (SPL) averages (in dB re $1\mu Pa_{rms}$) were calculated; if they were based on the data in linear units and converted into dB as they should have been. Some do not in any way seem related to the associated graph (e.g. for the case of 300 m without a bubble wall on September 4 where a value of 106.48 is given, whereas the graph presents levels around 30 dB higher). It is also not clear whether the spectrograms presented, which seem to be raw releases of acquisition software, are in 1 Hz band or another frequency band.

In brief, more thorough work and a more detailed, more extensive report are required to answer this question about distance from the source where the noise level measured becomes lower than 120 dB (SPL in dB re $1\mu Pa_{rms}$) with the required expertise and scientific rigour.

Conclusions

The review of the results presented by the proponent does not lead to a conclusion, with reasonable certainty, that noise in the area where the work is being done has been mitigated. The gaps raised in the analysis lead to a conclusion that the transmission loss models are highly uncertain and the overall predictions invalid. The very high variability of the estimates of transmission loss levels at various distances from the sound projector along the radial transects leads to the conclusion that there is no general model for estimating transmission losses with reasonable accuracy.

The information presented also does not allow prediction, with reasonable certainty, of the sound level at the source of the drilling and screwing-in of the piles that is estimated by measuring the noise at various distances and adding losses caused by transmission. As this last point is not deemed valid, neither is the sound level at the source

In brief, more thorough work and a more detailed, more extensive report are required to answer this question about the distance from the source where the noise level measured becomes lower than 120 dB (SPL in dB re $1\mu Pa_{rms}$) with the required expertise and scientific rigour.

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