Use of Acoustic Models to Assess Southern Resident Killer Whale (SRKW) Mitigation and Address Uncertainty Regarding Marine Shipping

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1. BACKGROUND

Environmental assessments are an important tool to support decision makers, providing levels of certainty regarding potential project effects and mitigation effectiveness. However, decision making can be challenging when there is uncertainty and complexity regarding potential effects and mitigation effectiveness. There is often more uncertainty in the case of large complex industrial development and assessments are particularly challenging when species at risk are involved. Modelling tools can be developed to assess effects under various project scenarios or mitigation options to help address uncertainty. Models can therefore be a valuable tool to support environmental assessments.

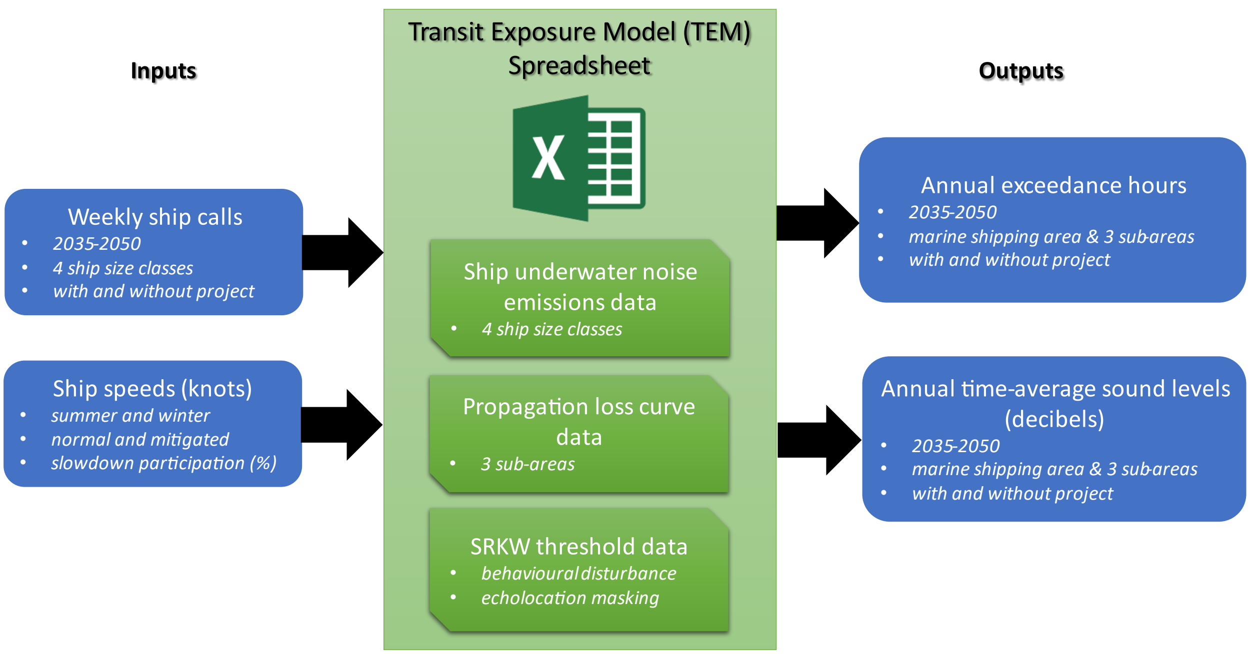
Using the case study of a proposed marine container terminal in British Columbia, Canada, we describe how an adaptable modelling tool can be used to assess potential project effects and evaluate mitigation effectiveness. The project location and adjacent waters overlap with the critical habitat of the federally endangered southern resident killer whale (SRKW; *Orcinus orca*), with a population of 75 individuals. When present, SRKW are believed to use the critical habitat near the proposed project primarily to forage and feed on salmon. As underwater noise can affect the ability of SRKW to feed and perform other life functions, the acoustic environment is considered a key feature of its critical habitat (DFO 2018). An increase in underwater noise from anthropogenic sources (such as container vessel traffic) could lead to reductions in the effectiveness of echolocation for foraging and masking of communication calls for socializing and mating (DFO 2018). As such, it is important to identify effective measures to mitigate potential project-related acoustic effects to SRKW.

For the case study, we developed an innovative approach to assess potential acoustic effects to SRKW and evaluate the effectiveness of mitigation measures for marine shipping incidental to the proposed terminal project. We built an interactive model to assess differences in underwater noise exposures from changes in container vessel traffic, evaluate mitigation effectiveness, and support follow-up monitoring and adaptive management.

2. METHODS

We developed a container vessel Transit Exposure Model (TEM) to estimate potential acoustic effects to SRKW from container vessel traffic incidental to the proposed project (Figure 1). This model is an interactive spreadsheet-based tool which estimates sound exposure levels in the critical habitat of SRKW based on an analysis of vessel source level measurements (i.e., noise emissions) and the composition of vessel classes projected to call at the terminal in the future. The TEM used data on container vessel noise emissions to estimate underwater noise exposures from different size classes of container vessels transiting in the international shipping lanes within the inland waters of the Salish Sea. The TEM was used to analyze yearly differences in underwater noise in the marine shipping area based on projections of container vessel traffic (i.e., sizes, speeds, and numbers of vessels) at the Port of Vancouver with the proposed project.

Figure 1. Flowchart diagram of Transit Exposure Model (TEM), showing process inputs, data, and outputs.



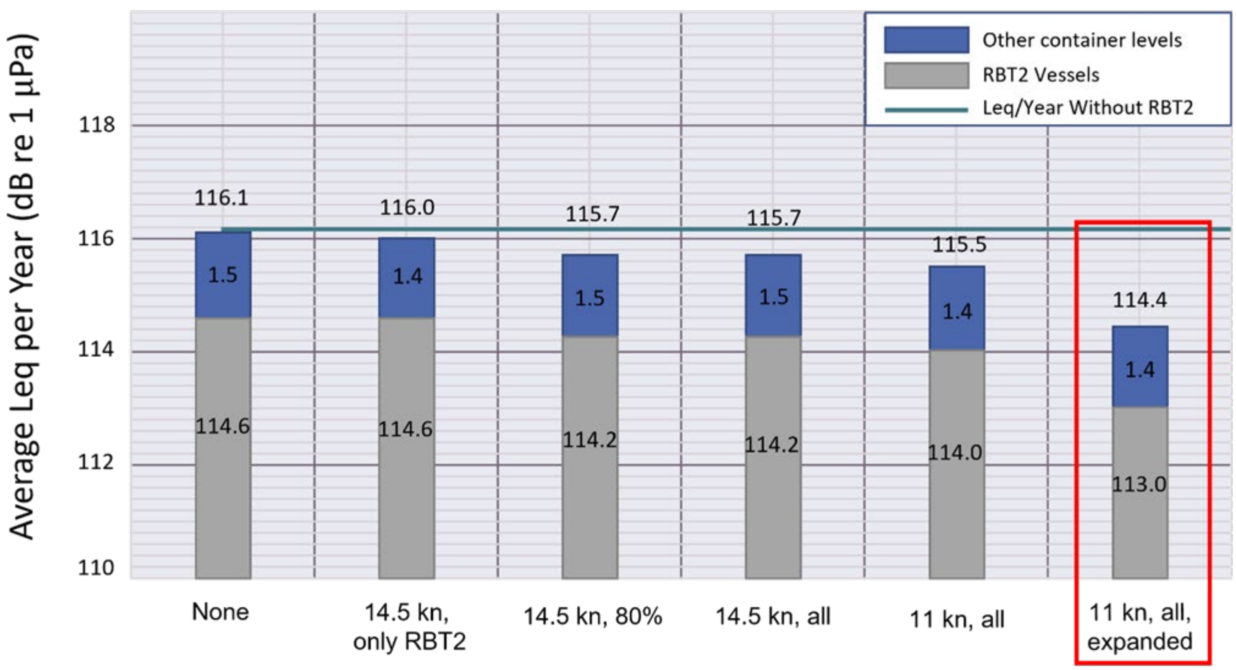
We used this tool to model accumulated yearly underwater noise exposures at key locations within SRKW critical habitat in the Salish Sea. The TEM estimated noise exposure for three sub-areas within the marine shipping area (Georgia Strait, Haro Strait, and Juan de Fuca Strait) using sound propagation loss curves. The TEM assessed noise exposure in terms of two acoustic metrics, which were selected to provide information on long-term changes in underwater noise levels and potential acoustic behavioural disturbance effects on SRKW. First, we determined yearly time-averaged underwater noise level, which reflects the long-term, time-averaged noise level received at a given location from passing container vessels over a one-year period and is directly related to the total sound exposure level over the same period. Second, we assessed annual exceedance hours above behavioural disturbance thresholds, which reflect the total time a given location could be exposed to noise above the threshold, from container vessels transiting in the marine shipping area over one year. These metrics were assessed for broadband sound pressure level (behavioural disturbance threshold of 120 dB re 1 μPa). We estimated annual differences in sound level and exceedance hours with and without the proposed project and under different mitigation scenarios. Differences are indicative of changes in the acoustic quality of SRKW habitat that would be expected if the proposed terminal is built.

The different mitigation measures evaluated slowdowns of container vessels along the marine shipping route to and from the Port of Vancouver. We focused on vessel slowdowns as the measure has been proven to be effective in reducing underwater noise within SRKW critical habitat hence potential effects to SRKW (Joy et al. 2019; MacGillivray et al. 2019; Burnham et al. 2021; VFPA 2021, 2022). The mitigation scenarios evaluated involved different container vessel slowdown speeds and spatial scales throughout the marine shipping area for six months out of the year. These mitigation scenarios included two vessel transit speed reductions (14.5 knots and 11 knots), different numbers of vessels participating (only project-bound vessels, 80% of all container vessels, or all container vessels), and various vessel slowdown areas including existing slowdown areas (Haro Strait, Boundary Pass, and Swiftsure Bank) and additional potential areas (e.g., Strait of Juan de Fuca and Strait of Georgia).

3. RESULTS AND DISCUSSION

The TEM allowed the assessment of potential project effects under various container vessel slowdown mitigation scenarios. We found that all of the slowdown scenarios would reduce broadband noise levels below expected conditions (i.e., without the project). The most effective slowdown scenario involved the slowest speed (11 knots), increased vessel participation (all vessels), and the expanded slowdown area (including additional areas of the Strait of Juan de Fuca and Strait of Georgia) (Figure 2). Overall, the slowdown mitigation measures were found to be more effective as speeds were reduced, the number of participating vessels was increased, and the area of the slowdowns was expanded. This work further supports the anticipated effectiveness of vessel slowdowns at mitigating underwater noise from marine shipping incidental to the project and highlights the availability of additional measures to mitigate effects if the predicted effect is identified to be exceeded during follow-up monitoring.

Figure 2. The effectiveness of potential mitigation measures for container vessel traffic in the marine shipping area. Measures include further reducing vessel speed and extending the area in which container vessels slow down.



In addition, the TEM is a flexible tool capable of being adapted to assess various scenarios based on new information in the future. This interactive tool provides the ability to conduct scenario testing and easily update the model based on future vessel traffic conditions and/or new mitigation scenarios, which is an asset for follow-up monitoring. The TEM could be used to assess whether unforeseen increases in project-related container vessel calls, size classes, or noise emissions increase underwater noise beyond predicted levels. The model can then be used to assess the effectiveness of potential contingency mitigation options that could be implemented if underwater noise from container vessels is higher than predicted. For example, the TEM can be used to assess the effectiveness of new mitigation options such as expanding slowdown durations beyond six months. In addition, the model can be updated over time based on source level measurements for new classes of container vessels calling at the Port of Vancouver in the future. The TEM can therefore be a useful tool to assist with monitoring of underwater noise from marine shipping to verify predictions over time and inform adaptive management.

The innovative modelling tool developed for this case study was used to assess potential changes in the acoustic quality of SRKW habitat from marine shipping incidental to the project and illustrate the potential effectiveness of slowdown mitigation scenarios at reducing underwater noise. This type of approach can play an important role in developing and updating assessment methods and mitigation measures based on new information. As such, modelling tools that can be adapted to reflect various conditions can be valuable for supporting decision making by quantifying effects and evaluating mitigation effectiveness under different scenarios. This case study illustrates the value of adaptable modelling tools for environmental assessments, follow-up monitoring, and adaptive management.

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