Letter of Comment to the NEB, 3 October 2018
Re: Hearing Order MH-052-2018 and File-OF-Fac-Oil-T260-2013-03-59

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The draft list of issues for the reconsideration hearing (Appendix 2 to Board Letter of 16/09/2018) is based on unrealistic limitations. The environmental effects, particularly on trophic organisation, of Project-related marine shipping must be considered, not only for species at risk like the SRKW but also for their prey (e.g. chinook salmon) and for forage fishes, a group of species at the centre of the B.C. coastal marine food web. As well, there is increasing evidence that fishes respond negatively to shipping noise, and can change their behaviour to avoid noisy areas with possible population effects if those areas had been used for spawning and feeding.

My letter is structured as follows:

1) **B.C. coastal marine food web**
   a) Life history characteristics of forage fishes, including Pacific herring, that make them vulnerable to oil spills and other pollution
   b) Why gulping air and feeding at the surface by Pacific herring make even a "small" oil spill particularly dangerous to them

2) **The effects of shipping noise** on Pacific herring (*Clupea pallasi*).

1—B.C. coastal marine food web

a) Forage fishes are at the centre of the B.C. coastal marine food web, linking the plankton with large marine predators. Because their plankton diet renders them nutrient-rich (nutrients stored primarily as lipids), they are sought after by numerous predators: marine mammals like the SRKW population, seabirds, and larger fishes. In the Salish Sea the commonest forage fishes are Pacific herring, Pacific sand lance, and several species of smelts, including eulachon. All are relatively small, mostly silvery pelagic fishes that form immense schools, inhabit coastal waters, and (except for the anadromous eulachon) spawn in the intertidal and shallow subtidal zones. Their coastal habitat and spawning preferences, and the migration routes of some, like Pacific herring, make them particularly vulnerable to the effects of human activities in coastal waters, including shipping accidents and oil spills.

Pacific herring is the largest of our forage fishes, and in the Salish Sea it is the most abundant and available prey for a variety of predators. Salish Sea chinook take a very high percentage of Pacific herring, and are directly affected by what happens to herring populations. In the amended Fisheries Act, fish habitat includes migration routes as well as spawning and feeding areas, and Fisheries and Oceans Canada is tasked with its protection. Our largest stock of Pacific herring makes twice yearly migrations between offshore feeding grounds and inshore spawning grounds. Because their migration routes include the Strait of Juan de Fuca and Haro Strait, the herring are exposed to increasingly busy

shipping lanes. During the day, they form huge, dense, fast-moving schools that travel fast at 90-150 m depth, but around dusk they rise toward the surface, slow their movements, and spread out into "skimmers" that may be many km long and that extend from the surface down to 15-20 m depth. During the night the fish feed on plankton that also rise into surface waters at dusk. Before dawn the skimmers re-form as schools and sink again. **Because the draft of an Aframax tanker is between 13.5 and 15.5 m, during nighttime transits a tanker may come into contact with skimmers, potentially disrupting their feeding.** This is also a problem for other large vessels (container ships, bulk carriers, cruise ships), and might be significantly reduced if nighttime transits were minimized and vessel speed was reduced. For Pacific herring, minimizing nighttime transits and slowing down would be particularly important during their migrations between offshore and inshore areas.

As an additional benefit, slower speeds would reduce the amount of noise produced by cavitation at the propeller. We already know that killer whales respond negatively to noise produced by ship propellers, engines and other gear, and that slower speeds have been recommended by many authorities and are being examined by Port Metro Vancouver. This would benefit the herring as well, as their advanced hearing ability

b) Herring and salmonids appeared early in the evolution of the bony fishes. With other "early" fishes, **they share an anatomical trait, physostomy, that to the best of my knowledge has not been mentioned in any of the documents on the Trans Mountain project, but that makes them particularly vulnerable to an oil spill**.

Most fishes have a swimbladder, an organ that functions primarily as an energy-saving buoyancy control device. The amount of gases (including air) in the swimbladder controls buoyancy and must be replenished periodically. A fish does this either by bringing blood gases out of solution into the swimbladder (physoclists) or by rising to the surface to gulp air which is moved via a special duct into the swimbladder (physostomes). Both salmonids and herring are physostomes. **Pacific herring refill their swimbladders on a nightly basis (when they are feeding), and surfacing to gulp air provides a direct mechanism for contamination by a surface oil spill** (Thorne and Thomas 1990).

Those researchers also noted that the herring population decline in Prince William Sound began immediately after the Exxon Valdez oil spill, in parallel with collapses of populations of marine birds and mammals that depended on herring for critical overwinter forage. I could not find information on when chinook refill their swimbladders, but being physostomes they must surface to do so. Over the next 15 years, significant increases have been projected in the number of container ships, bulk cargo vessels, tankers, cruise ships and smaller vessels using Vancouver harbour and various terminals. Shipping lanes will become even more crowded than they are at present. **All ships carry oil as fuel**, **which can be leaked or even spilled during a collision**. The large and increasing size of commercial vessels, plus the increase in their numbers, will make shipping lanes more

crowded, increasing the chances of "accidents" and "minor" spills which are potentially lethal for both Pacific herring and possibly salmon including chinook.

2—Effects of shipping noise on fishes, particularly Pacific herring
Note: *There are far fewer reports of acoustic studies on fishes than there are on marine mammals, but it cannot be assumed that sound is less important to fishes than it is to killer whales. Rather, it is because fishes do not surface to breathe, can be distinguished as individuals very rarely, and are very difficult to follow (the research vessel itself may alter their behaviour, invalidating or at best compromising the data*).

Sound is a critical sensory modality for aquatic animals (fishes, some marine turtles and some invertebrates as well as marine mammals and seabirds) because water's properties favour its use over vision and olfaction. Visible displays require light and clear water, limiting them to daytime and relatively short distances, usually no more than about 46 m. Navigation under water by using visible features is thus limited. Olfactory signals are slow to reach recipients, fade with distance, and are best at short range. By contrast, sound is useful both day and night, travels 4.4 times faster in water than in air, and travels much farther than either visible or olfactory signals. It shows little attenuation (fading) so it retains high information value, particularly at frequencies below 1 kHz (1000 Hz), making it useful for navigation and communication over long distances.

The fish inner ear resembles that of other vertebrates studied. All fishes studied so far can hear, though the frequencies to which they are sensitive can vary. Many fishes make sounds themselves to find or advertise spawning areas, attract and keep mates, defend eggs and young, repel competitors, deter predators, and maintain social cohesion (contact calls), but even silent fishes respond to the combination of abiotic and biotic sounds that make up their "soundscape". The common goldfish is silent but has an acute sense of hearing and sound discrimination abilities very similar to that of humans and other vertebrates, and the studies on goldfish led to the realization that underwater sounds carried important information for fishes as well as for marine mammals. The ability to hear, localize and interpret sounds in their environment is being reported for more and more fishes. Hearing enhances a fish's ability to carry out critical life functions, such as navigation and migration to feeding, wintering and spawning grounds and nursery areas where it can mature, prey detection, predator avoidance, and finding mates. **The ability to hear and respond to biologically significant sounds significantly increases survival and reproduction, and thus would have been a strong selective factor in the evolution of hearing in fishes.**

Most sounds of biological importance to fishes, and to which all fishes studied so far are most sensitive, are below 1 kHz in frequency, particularly in the range 20-500 Hz.
Schwarz and Greer (1984) found Pacific herring to be capable of directional and selective responses to noises from the vessels used in the roe fishing fleet in Barkley Sound, B.C. The sounds had been taped and were played back to groups of herring in net pens. Playbacks were for a maximum of 3 min each. The responses were almost always negative,

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sometimes absent, but never positive. The largest vessels we used were only 20 m in length (drum and table seiners), moving at low speeds, and we gave each group of fish only a single trial of each playback. By contrast, shipping noise in the ocean comes mainly from vessels that are 10-15 times the length of our seiners: (container ships up to 290 m long, bulk carriers about 213 m, and Aframax tankers about 228 m). It is continuous and pervasive even in the deep ocean (no "single trials"), travels rapidly over long distances with little loss of energy, and because it comes from moving sources, it affects a large and changing area and is very difficult to avoid. **Of particular concern, shipping noise is most intense between <50 to 500 Hz, the same frequencies occupied by sounds of biological importance to fishes.** The greatest danger that shipping noise presents to fishes and other aquatic fauna is that even from great distances, it has the potential to **mask** natural sounds of biological importance to fishes. (Masking is when two sounds overlap in frequency and one "drowns out" the other because it is louder.) **Fitness and survival could be affected if the natural sounds cannot be heard and responded to appropriately, and ultimately the consequences could be felt at the population level.**
For example, noise-related avoidance of customary feeding or spawning grounds, or of migration routes, could negatively affect feeding, spawning, and predator avoidance. This possibility becomes more likely as the number of vessels using the Salish Sea and adjacent waters is predicted to increase significantly in the coming decade.

Probably the single, simplest, and most important action that will reduce shipping noise is to mandate slower vessel speeds, particularly in the commercial fleets. There must also be improvements in propeller design (to reduce cavitation) and more enforcement of maintenance standards.

On a personal note: The current business model assumes that no matter what is done to establish and run a project, growth must continue, and species living in the project area will "adapt". This assumption is ecologically incorrect; organisms cannot adapt to any change in condition (consider climate change and the difficulties it presents). Each organism has finite energy, and its efforts to withstand new conditions may leave it with insufficient energy to successfully carry out critical functions. I believe that business, and society in general must adopt a new paradigm: accommodate rather than override the needs and preferences of other species. We must share habitat and resources and not assume they are ours for the taking.

Citations

Schwarz, AL and GL Greer 1984. Responses of Pacific herring, *Clupea harengus pallasi*, to some underwater sounds. Can. J. Fish. Aquat. Sci. 41(8): 1183-1192.

Thorne, RE and GL Thomas 2009. Herring and the "Exxon Valdez" oil spill: an investigation into historical data conflicts. ICES Journal of Marine Science 65: 44-50.