Comments on the
Eastern Newfoundland Regional Assessment

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Summary
There is very poor referencing throughout, using unpublished, outdated, or not the best, most appropriate references. Many important references are missing. One very biased oil industry newsletter is used as a reference which has no business in a scientific review. Repeated use is made of phrases similar to "there is no evidence of", or "effects are temporary and over small areas", yet often no studies exist to back up these claims. If you don't adequately look, you cannot find. And if the studies are not long-term nor over large areas, we have no way of knowing what the spatial and temporal extent of the impacts might be. Sometimes outright false or disingenuous statements are made, such as claiming seismic surveys don't cause outright mortality in marine mammals or in fish or shellfish, so that known plankton and squid mortalities can be excluded. However, even there, a study showing a five-fold increase in scallop mortality is ignored. Even when the appropriate literature is referenced, the most important result is not mentioned. Appropriate caveats to results of no apparent impact are not made. Mitigation measures such as ramp up are assumed to be effective, even when meager supporting evidence exists. There is no treatment of the limitations and problems with ramp up. Avoidance and displacement are also not fully appreciated as impacts in themselves, with associated time and energy costs. Sound exposure thresholds are very problematic and inaccurate, especially in cetaceans and especially in the great whales for which no audiograms exist. Any one human-caused threat, such as noise, is hard to link to a particular population-level decline, especially in the ocean, which is not a controlled laboratory. It is not necessarily true that seismic pulses are discontinuous in nature, as over larger ranges they can blend together and raise the background noise floor by two orders of magnitude or more, with no quiet intervals between the seismic shots. Sometimes no obvious behavioral reaction to noise is implied to mean there is no effect, which can certainly not be assumed. Overall, this document appears sloppy, inadequately researched, and biased.

I have concentrated mostly on seismic airgun noise here, but a large literature exists on the impacts of ship and boat noise on marine mammals, fish, and invertebrates. In the case of some fish species, boat noise in linked to fewer eggs, so a clear impact on reproduction exists.

For the source levels of seismic airgun surveys, Hildebrand (2009) gives a source level of 260 dB, not 220-255 dB, and I've seen references that go as high as 263 dB. Hildebrand (2009) is a much better reference than those used.

Module 7: Marine Fish and Fish Habitat
There is mention in the document of temporary avoidance of areas due to noise but without long-term studies, there is no way of knowing whether fish only temporarily avoid noisy areas rather than stay away for long time periods.

The claim in the document that there is no direct evidence of mortality on fish or shellfish due to seismic surveys in the field is untrue. Mortality rates were five times higher in exposed scallops than controls even 4 mos. after the seismic survey was finished (Day et al. 2017). Even though the following would not fall under "fish or shellfish", they are relevant. There was a 2-3 fold increase in dead zooplankton after a single airgun passed, compared to controls (McCauley et al. 2017). During two separate strandings in 2001 and 2003, five and four giant squid, respectively, fatally mass stranded together with seismic surveys, showing extensive organ damage (Guerra et al. 2011a).

Gausland (2003) is an especially poor reference as an oil industry newsletter. I, together with other scientists, have read this article and found its statistics highly flawed and very biased. This reference surely does not belong in a scientific review.

In referring to McCauley et al. 2017, there needs to be a clear statement that the study DID show clear evidence of higher zooplankton mortality due to seismic noise (2-3-fold increase in mortality), not "where seismic sound causes significant mortality".

McCauley et al. 2003 mainly has to do with showing severe damage to fish ears from seismic surveys with no evidence of recovery after 58 days. This should be mentioned.

When citing Payne et al. (2008) the document should have mentioned that lobster increased feeding several weeks after being exposed to airguns in the laboratory.

In the Streever et al. (2016) study, there is no mention of the main results, namely that there were significant changes in catch rates (both higher and lower) with seismic surveys, showing measurable displacement of fish.

The Wardle et al. (2001) study involved two individual fish with territories, so it would be hard to chase fish away from their home territory. Moreover, the airguns were not approaching, giving the animals no direction cues on how to escape. Fish populations associated with underwater structures like these are also more apt to be stationary and less likely to disperse due to airguns. All these caveats to the results should have been mentioned.

References that should have been included, in addition to those mentioned above:
Day et al. (2019) found that lobsters showed impaired righting and significant damage to the statocyst which persisted up to 365 days post-seismic airgun exposure and, against all expectation, did not improved following moulting. This damage to lobsters' reflexes puts them at much greater risk of predation.

Day et al. (2017) demonstrated that seismic airgun noise substantially disrupted behavioral patterns and reflex responses in scallops, caused them to be immunocompromised, and caused impacts to their physiology and biochemistry, including imbalances in their electrolytes.

Fitzgibbon et al. (2017) found seismic airgun noise decreased hemocyte count 23-60% in lobsters up to 4 mos. post-exposure, suggesting a chronic reduction of immune competency and impairment of nutritional condition.

Aguilar de Soto et al. (2013) discovered that scallop larvae in tanks subjected to recordings of seismic airgun pulses showed significant developmental delays and 46% developed body malformations compared to controls.

Pearson et al. (1992) found subtle behavioral changes could occur at exposures as low as 161 dB in captive rockfish in the field. Blue rockfish milled tightly during airgun shots, black rockfish collapsed to the bottom, and other rockfish species became motionless.

Paxton et al. (2017) analyzed fish abundance at a temperate reef before and during a seismic survey. During the seismic survey, reef fish abundance declined by 78% in the evening when fish habitat use was normally highest. The entire community appeared to respond. Fish losing opportunities to aggregate can affect their foraging, mating and other vital functions (Paxton et al. 2017).

Santulli et al. (1999) found a biochemical stress response in caged European sea bass when a seismic survey passed by at distances from 180 m to 6,500 m.

Module 8: Marine and Migratory Birds

The Pichegru et al. 2017 study states: "Penguins showed a strong avoidance of their preferred foraging areas during seismic activities, foraging significantly further from the survey vessel when in operation, while increasing their overall foraging effort. The birds reverted to normal behaviour when the operation ceased, although longer-term repercussions on hearing capacities cannot be precluded." and "Penguins foraging <100 km from active seismic operations showed a clear change of foraging direction during seismic periods, increasing their distance between their feeding area and the location of the seismic vessel". I would not characterize that as no evidence of direct adverse effects, though of course, as is almost always the case in field studies, there is no way of knowing whether the effect was primarily on the prey and indirectly on the penguins. Either way, it is an important impact.

To conclude ramp-up mitigation would immediately and totally solve this impact is incorrect. Firstly, ramp-up doesn't necessarily cause animals to avoid loud noise in time, as that depends on whether animals can discern which way to move to lessen noise exposure (sound fields can be complex) and whether they can move fast enough to escape, suffering meaningfully less exposure. Secondly, even if they can lessen their noise exposure, it is still an impact, as they are being displaced from their preferred foraging area, and there are time and energetic costs to having to move away and return again (if they even return). That is, there is a cost either way (staying and suffering impacts from greater noise exposure or moving away and suffering the costs of displacement). Moreover, some animals may even be attracted to the ramp up through curiosity and then, when close, be exposed to the full noise without time to escape.

Module 9: Marine Mammals and Sea Turtles

Regarding the emphasis on received levels, Gomez et al. (2016) found that more severe behavioural responses were not consistently associated with higher received levels and vice versa, so context and other factors (whether the sound is approaching or not) are also important, not solely received level and proximity to the animal.

TTS can last a week or more during which vital activities, such as feeding and mating, are compromised.

Yes, drill rig noise has more energy in the low frequencies, but the noise extends to 10 kHz. The 1-10 kHz is a frequency band that is used by many marine mammals.

Sound exposure thresholds for marine mammals, especially for the great whales, should be viewed with caution as practically all the audiograms of the great whales are only estimated from ear morphology and some sound exposure thresholds are based on only a handful of individuals. Sound sensitivity varies greatly between individuals and their age, in addition to context, sex, prior exposure, etc.

To state that “there is no evidence that seismic programs can cause serious injury, death, or stranding of marine mammals or sea turtles” is false and uses very inadequate unpublished references. Hildebrand (2005) gives a very convincing account of a fatal stranding of two individual Cuvier's beaked whales which was tied very closely in space and time to an academic seismic survey in the Gulf of California.

A pantropical spotted dolphin suffered rigidity and postural instability progressing to a catatonic-like state and probable drowning within 600 m of a 3D seismic survey firing at full power (Gray & Van Waerebeek 2011). The authors explained the initial aberrant behavior by a possible attempt by the dolphin to shield its sensitive rostrum and hearing structures from the intense acoustic energy of the airguns, by lifting its head above the water's surface. They believed the seismic survey could have caused this observed behavior, presumably resulting from severe acoustic distress and even injury. Other explanations were examined and considered less likely (Gray & Van Waerebeek 2011). It may be of significance that Weir (2008) found the closely related Atlantic spotted dolphin to be the species “with the most marked overt response” to airgun noise of the three cetacean species examined.

With any claim of "no evidence that seismic programs can cause serious injury, death, or stranding of marine mammals or sea turtles", there must be some measure of how closely this is actually examined, else the statement is meaningless. If you don't look, you can't find. Even if impacts in cetaceans in the wild are fatal, only 2% of all cetacean carcasses are detected, on average (Williams et al. 2011). The authors state that for cryptic mortality events such as acoustic trauma, analytical methods are necessary to take into consideration the small percentage of carcasses that will be recovered.

If longer-term studies are not carried out, it cannot be assumed that these behavioral reactions are only short-term. Any one human-caused threat is hard to link to a particular population-level decline, especially in the ocean, which is not a controlled laboratory. However, when seismic surveys cause declines in vocalizations which are used for mating, avoidance of hazards, orientation, or group contact, it is very plausible that vital rates will be affected. This is also the case with avoidance behavior, which displaces animals from prime and preferred habitat, and costs time and energy to travel away and return (if they even do after the area is exposed to noise).

The decrease in buzzes, which are associated mostly with feeding, in harbor porpoise exposed to seismic noise can have a serious effect on their energy budgets. This is not explained in the document.

It is not really true that seismic pulses are discontinuous in nature, at least not in many situations, as often over longer ranges there is considerable reverberation and multipaths occur that cause the airgun shots to be "smeared together" over time, raising the whole background noise floor 100-fold with no gaps or silence between shots (Clark & Gagnon 2006; Guerra et al. 2011b).

Sea turtles are very hard to detect at sea, especially over longer ranges.

No obvious behavioral reaction to explosives is not to be equated with no effect! Explosives kill marine life, even marine mammals, so it is disingenuous to not explicitly state that. Dead humpback whales (most likely killed by the blasts) with severely damaged ear bones were recovered around the blasting that the Todd et al. 1996 study mentions. Moreover, even though there was no obvious behavioral reaction, the humpback whales that did survive the blasting, blundered into fishing gear at a much higher rate than is typical, and only around the area of the blasting (Todd et al. 1996). Moreover, these individuals were atypically adult rather than juveniles, that more commonly are entrapped (adults learn to avoid nets).

There is no mention of Farmer et al. (2018) who modelled the behavioral disturbance of sperm whales from seismic surveys. All simulations suggested significant reductions in the fitness of reproductive females due to persistent disturbances to foraging behaviors, causing a possible 4.4% of the stock to reach terminal starvation.

Newer references should be included under the section on masking and communication space reduction such as Clark et al. 2009, Cholewiak et al. 2018, Putland et al. 2017, Hatch et al. 2012, even though some of these are mentioned elsewhere in this module.

There is no mention that the number of humpback whale singers significantly decreased with increasing received level of seismic survey shots, suggesting that the breeding display of humpback whales is disrupted by seismic survey activity off Angola (Cerchio et al. 2014).

Module 12: Fisheries and other Ocean Uses
Add Løkkeborg (1991), Skalski et al. (1992), Hassel et al. (2004) for decreased catch rates.

Pronouncements are made in the document that seismic surveys have no significant effect on stock recruitment, yet I do not believe this has been adequately studied to back up such a claim. Also, the document states that the spatial and temporal effects on catchability of fish were limited, yet studies have not been long-term enough nor over large areas, so these conclusions are not valid.

Again, Gausland (2003) is an especially poor reference in an oil industry newsletter. I, together with other scientists, have read this article and found its statistics highly flawed and very biased. This reference surely does not belong in a scientific review.

References cited in this report and that should be included in a more thorough literature review *

**with the exception of those already listed in the Regional Assessment*

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