

January 13, 2003

MEMORANDUM

TO: Alan Ehrlich

FROM: Arthur N. Popper

RE: Comments on Department of Fisheries and Oceans Comments on Draft ToR

The comments provided by DFO are well done, but I would like to make a few additional suggestions and thoughts.

1. **Page 7, Section 4.5 Alternatives:** I have some concern that the large airgun might also impact animals in different ways than the smaller airguns and have no idea if the fish experiments or the sound measurements done in 2002 included all of the airguns or only certain sizes. As data are requested for the EA, it should be stipulated that information is specifically requested regarding the size airgun to be used in 2003, along with any additional data on the smaller airguns. It is conceivable that it would be possible to extrapolate effects from smaller to larger airguns, but it would be important to see data that indicates that this would be valid.
2. **Page 7, Section 4.8 Noise:** I am somewhat concerned about asking for noise thresholds for all stages of fish species encountered. While this would be exceedingly useful, I think that DFO is asking the impossible. Considering there are only hearing data on perhaps 100 species of fish (if that many), and that there are probably few data on fishes in the MacKenzie River (I don't recall most of the species there, but I am pretty confident that I am comment on this), how can DFO expect WGO to get these data. There are also very few data in the literature on thresholds of different life stages of fish. (I think there are about three semi-relevant papers on this, and one of them is mine and it won't be out until March. Moreover, that study is on a species that has no relevance to the MacKenzie River).

Related to this is the actual question that DFO is asking. They are asking for "noise thresholds." These are highly specialized and would vary depending upon the bandwidth of the noise used in tests. There are almost no data on this for fish (or any species). What I think DFO wants are the bandwidth (range) of frequencies that the fish hear and the thresholds (the lowest sound level) that the fish can detect at each frequency within this bandwidth. Or they may want something like third-octave thresholds, but such data are generally not available and it would take many months (if not a year or two) to make such measurements.

I would argue that I can "predict" general hearing thresholds and bandwidth for many of the MacKenzie fish. Having some idea of what the fish can hear is highly relevant since it may be predictive of when noise damage (temporary or permanent) will show up in fish (this is based on work we are currently doing in my lab). But, I would

argue (on behalf of WGO) that the specific question asked by DFO is not reasonable. Instead, DFO should ask for general hearing information (bandwidth and thresholds) on MacKenzie River fish or related species for which data are available in the literature.

I am not sure what DFO means in their second bullet.

Finally, the questions asked by the Review Staff in this section is relevant to the comments on Section 4.5, and this information should be provided specifically for the airgun arrays proposed for 2003 (as DFO discusses in their comments on Section 4.5).

3. Page 8, Section 4.9 *Aquatic Resources*:

I would suggest the following with regard to the 2002 studies. At the same time, these may be too detailed and parts of them may be suggested in the directions to WGO in this section.

- a) Effects of the sound on anatomy and physiology of fish that were exposed to airguns. I recall that WGO was doing cage work, and I would hope they have information on the short and long-term effects of the airguns on the behavior, the ear (and perhaps lateral line), swim bladder, and perhaps other stress indicators. Perhaps the way the questions are worded here WGO will provide such data if they have it. If not, then I would suggest you need to require this information since it is critical to any understanding of the impact of the airguns on fish.
- b) Long-term impact of the sounds over days, weeks, and months. The assumption I am making is that the impact may not show up right away (e.g., vis a vis the ear, stress, or hearing capabilities) and this could mean that the survival of animals will be decreased days or weeks after the airgun array has gone by. My rationale for this question is based upon the paper I sent you recently by McCauley et al. that will appear in the *Journal of the Acoustical Society of America* this month. It took quite a while for any effects of a small airgun to show up in our experimental animals, and if WGO only looked at animals within a few hours of exposure, I would question the relevance of their results on the impact on fish. Moreover, work done in my lab in 1996 (Hastings et al. 1996) showed that examination of the ear in animals immediately after exposure to intense sounds showed no impact of the sounds, but if the animals were allowed to survive for about 96 hours post exposure, significant damage showed up.

The proposed addition by DFO is quite good and I would encourage its use. The only change, and this depends upon your definition of "life stages" is to add "...all life stages of fish species, *including eggs and larvae*, that are likely..."

4. **Page 8, Section 4.9 *Aquatic Resources*:** The bullets in general should be asking for short and long term effects on the physiology and behavior of the fish impinged (bullet 3). In the 4th bullet, I would suggest that "...to prevent mortality..." be modified to read "...to prevent *immediate and long-term* mortality..." since, as I point out in my comment (a) above, the effects may not be seen right away. I like the change suggested by DFO and my suggested change fits well with their modification.

5. **Page 8, Section 4.9 *Aquatic Resources*:** I concur strongly with the addition of invertebrates to this section. I don't know if WGO looked at invertebrate impact, and the data in the literature on this is limited to one quite old paper. But if invertebrates are ecologically and/or economically important in the MacKenzie this is certainly worth adding and thinking about.

I note that the fourth bullet in this section calls for the details of ramping up procedures. I have some concerns about this as a method. The logic behind ramp up, as I understand it, is based upon the potential impact of seismic and other devices on marine mammals. The assumption is that these fast moving animals can escape the area of the loudest noises. However, there is only limited evidence that ramp up actually works. More importantly, there have not been, to my knowledge, any studies to determine if ramping up will work with fish. Adding to the problem is how fish respond to a fear-invoking stimulus. While some fish will try to escape a freight stimulus, the normal fear response of other species is to freeze and stay in one area. Thus, ramping up may do absolutely nothing to such species. In addition, even fish that respond by trying to swim away may not move fast enough to avoid the louder sounds. Thus, without real data on the usefulness of ramping up, I am not sure that its use has any real value in protecting fish or other wild life. Its value sounds logical, but whether it really has value has yet to be tested in my view.