Woods Hole Oceanographic Institution
Biology Department
MS #34, Redfield 1-32
46 Water St.
Woods Hole MA 02543-1049
ph: 508-289-3482
fax: 508-457-2134
pmiller@whoi.edu

May 31, 2001

Ms. Donna Wieting
Chief, Marine Mammal Conservation Division
Office of Protected Resources
National Marine Fisheries Service
Silver Spring, MD 20910-3226 USA

Dear Ms Wieting,

Thank you very much for the opportunity to comment on the proposed rule by NMFS to allow the US Navy to operate the LFA sonar system as described in the FEIS. Also, thank you for extending the deadline for comment submission. I have carefully reviewed the FEIS presented by the Department of the Navy and give my comments below.

I have studied the behavior of marine mammals since 1988, and in 2000 I received a PhD from the MIT/WHOI Joint Program in Biological Oceanography for which I completed a dissertation on the design and use of communication signals in killer whales. In addition to my thesis work, I have participated in several studies of the effects of noise on marine mammals, including the marine mammal monitoring component to the Haro Strait Frontal Dynamics Experiment with results presented in a NMFS report and a conference presentation to the Society for Conservation Biology in Victoria, BC. I also directly participated in phases I and III of the LFA SRP, and was lead author on a publication in Nature on the effect of LFA sonar on the singing behavior of humpback whales in Hawaii. Currently I am a postdoctoral investigator with joint appointments at WHOI and MIT, and a small portion of my current activities (and funding) relates to the continuing LFA SRP. However, I was not involved in the preparation or review of the EIS.

In summary, I do not believe that NMFS is justified in its position that the planned use of LFA sonar will result in the "least practicable impact" on marine mammals. I also question the conclusion in the FEIS that the proposed activity will result in a small number of takes with a negligible impact on marine mammal stocks. Despite these rather significant failings in the plan, I do believe that the FEIS represents a significant advance in the acknowledgement of underwater noise as a potential hazard to marine organisms. There are numerous other sources of noise in the oceans that have not received the level of scrutiny that this sonar has received (i.e. ocean shipping), and I believe that NMFS is obligated under the MMPA to identify such noise sources to review their potential impact on marine mammals.

My primary concern is that the method used to convert multiple low-level exposures to "biological risk" (section 4.2.3) is inadequate and potentially grossly underestimates the true

biological risk that multiple exposures at low levels could reasonably be expected to have on marine mammals. There are two components to the method employed in the FEIS: the multiple exposure conversion (4.2.3.1) and the single-ping equivalent risk function (4.2.3.2). Both components are significantly flawed, and below I provide an analysis including an example from the SRP research itself that shows that this technique seriously underestimate the true risk to marine mammals due to behavioral disturbance. Because levels >140 dB will be received at ranges up to 200km (see appendix), the 12nm geographic mitigation is ineffective.

Multiple Exposures:

There is no scientific justification for the $5\log_{10}(N)$ rule for assessing behavioral disturbance risk of multiple exposures. Previous use of this rule was for physical injury only (pg. 4.2-22). Most documented responses to low-levels (120-130 dB) of noise entail avoidance reactions or subtle alterations in diving behavior (Richardson *et al.*, 1995). The FEIS treats such responses as non-significant, and they might be for a single exposure because the duration of the response is short. However, the cost of the avoidance continues for the duration of the effect, so the effects of multiple exposures should be additive. Given the maximum 20-day use, and transmissions every 10 minutes, a total of 2880 pings will be transmitted. Twenty days of disturbed behavior is 20x more costly than one day of disturbed behavior, and is 2880x more costly than 10 minutes of disturbed behavior. An additive effect of exposure is more appropriately modeled as $10\log_{10}(N)$, and this equation sums the total energy to which an animal is exposed.

The use of $5\log_{10}(N)$ therefore contains a hidden assumption that animals will habituate to the disturbance effect. Richardson *et al.* (1995, pg 319; 397) state that such gradual waning of responses have not been observed directly, and some animals may even be sensitized to respond more strongly to LFA if they were previously exposed at high levels. As neither habituation nor sensitization has been clearly demonstrated, NMFS has no justification for accepting the $5\log_{10}(N)$ rule and the AIM models should be re-run using $10\log_{10}(N)$. Assuming every ping is received at the same level, the $5\log_{10}(N)$ rule results treats the effect as a single ping 17.3 dB above the RL of each ping. Thus, an animal exposed to the full suite of pings at a received level of 132.7 dB is treated as if it received a single ping at 150 dB, with a 2.5% risk of significant change in biologically important behavior. Using the $10\log_{10}(N)$ rule, this would be treated as a single ping at 167.3 dB with a roughly 40% chance of significant change in biologically important behavior. The difference is considerable, and I believe the results would more accurately reflect our understanding of the cumulative effects of disturbance reactions.

Biological Risk

The single-ping equivalent risk function is an attempt to calculate the percentage of animals with a "significant change in biologically important behavior". I agree that this approach is preferable to modeling response as a step function (0% risk at 119 dB and 100% risk at 120 dB). However, I do not believe the curve used in the model runs reflects any documented knowledge of disturbance effects. We know from multiple studies that the behavior of animals is commonly affected at levels below 150 dB, so the risk function score of 2.5% (or less) is an attempt to define "harassment" under the MMPA as something more than just a change in behavior.

There are two parts to what is actually happening in nature: a certain percentage of animals are observed to change their behavior, and a certain percentage of those changes are a "significant

change in biologically important behavior". What is a significant change? The model implicitly defines significant as those costs incurred by the worst-affected percentage of animals under the curve. So, since 50% of migrating animals are likely to alter their migration behavior to avoid levels >141 dB (from phase II results), then the model assumes that less than 5% of those animals will be "harassed" (50% x 5% = 2.5%). Yet, when LFA sonar is used in an operational fashion, the 140 dB contour will be over 100km from the sonar, reasonably suggesting that animals may move large distances to avoid exposure to those levels or alternatively suffer stress from being force to be exposed to the high levels. Why should NMFS concur that only 5% of such animals are "harassed" under the MMPA? I believe scientific evidence suggests the true percentage could be significantly higher than this figure.

I do not believe the scientific data from the SRP justifies the Navy's statements that levels below 150dB are less than 2.5% likely to lead to a "significant change in biologically important behavior". I refered above to the documented avoidance responses of gray whales, for which the FIES under-represents risk of "harassment". The only study from the SRP published in a peer-review journal (on which I was first author) to date documented significant changes in singing behavior of Hawaiian humpbacks (Miller *et al.*, 2000). Roughly a quarter of the animals stopped singing in response to the sonar, while the singers that persisted through the sonar altered their songs by lengthening them an average of 30%. Further analysis of this data has shown that the singers made other detailed changes to their song by switching phrase types overlapping the sonar transmissions. What our study showed was that important behavior was altered during exposure at levels as low as 130 dB. While the changes to song may reflect an attempt to compensate for interference from the sonar, it is most likely that such an ability adapted in response to noise from other competing singers, so it is doubtful that compensation for the sonar is effective.

The FEIS interpreted these results as a minor, non-significant change. I strongly disagree. Because song is related to mating behavior, ANY change is likely to be significant to the limited gene pool of this endangered species. That singers altered their songs is rather clear evidence that they interpreted the sonar as interfering with their signals. If their compensation mechanisms are effective, use of LFA for 20 days within 100 nm of humpback breeding grounds, can reasonably be predicted to reduce the gene pool by as much as a quarter of the males (those that stop singing). While some singers who stopped singing during the SRP did resume after some time, the effect is likely to be stronger during a continuous 20-day transmission cycle. If the compensation mechanisms are ineffective (which seems likely) the effect will be even larger. Therefore, the value of 2.5% below 150 dB considerably underestimates the risk to these animals due repeated exposure of the LFA sonar.

Least Practicable Impact

Under the current FEIS, there is nothing restricting the Navy from deploying the LFA sonar close enough to any humpback breeding ground that they will be exposed to 20 days of sonar at received levels at or above 140 dB. A large number of marine mammals in biologically important areas which will receive ensonification at levels (RL) ranging from 120-180 dB re 1μPa due to LFA activities, and the long period of time over which those animals will exposed to sounds at those levels. The FEIS does restrict LFA activity in a few biologically important areas, but many other known areas with important biological activities are not excluded. Many of these important areas are in coastal waters, but the FEIS allows LFA to operate within 23 km from shore. Thus, for example, under the current plan the LFA sonar could operate for 20 days at a range of 23 km of the

coast of Hawaii during the humpback breeding season. Assuming the source boat moves from 23 to as much as 200 km from the coast, humpbacks on the breeding grounds would be exposed continuously for 20 days to levels of 140 dB or higher.

Given the analysis above, the FEIS greatly underestimates the number of marine mammals that will be harassed due to multiple exposures at low levels. Also, in sensitive areas like humpback breeding areas, as much as 25% of the population could reasonably be affected in a critical manner (which is beyond simple harassment), under permitted LFA activities in the FEIS. I do not believe that this plan represents a legitimate attempt to minimize harm due to testing of the LFA sonar system. The distance from breeding areas of humpbacks should be at least 200km during periods during the breeding season. NMFS should also identify other biologically important areas and determine distances that LFA should be allowed to operate to keep received levels below 130-140 dB.

I believe the structure of the FEIS where parties can petition to add "biologically relevant areas" to the operating plan is insufficient to address this issue. First, that plan only requires the Navy to operate as little as 23 km from the breeding area, which results in exposure levels well exceeding 130-140 dB. Also, the addition of new areas appears to be contingent on NMFA and Navy approval. It seems doubtful that the Navy would agree to further restrictions of its system. It must be required to so in advance. NMFS is charged with enforcing the Marine Mammal Act, and can justifiably add restrictions that reduce the harm of the LFA sonar activities.

Sincerely yours,

Patrick J. O. Miller

Patrick J. O. Miller, PhD
Postdoctoral Investigator, Woods Hole Oceanographic Institution
Postdoctoral Associate, Massachusetts Institute of Technology

REFERENCES:

Miller, P. J. O., Biassoni, N., Samuel, A. and Tyack, P. L. (2000). Whale songs lengthen in response to sonar. Nature, 405, 903.

Richardson, W. J., Greene, C. R. Jr., Malme, C. I., & Thomson, D. H. (1995). Marine Mammals and Noise. New York: Academic Press.

APPENDIX: Predicted Received Level in Biologically Important Areas

The FEIS states that the source level of a single projector is 215dB and that 18 sources are used in an array. When the 18 sources add coherently in the far field, the signal is thereby amplified by 18x or roughly 25 dB. Thus, for long-range predictions, a source level of 240 dB is a reasonable

estimate. As detailed in the FEIS, sound transmission loss (TL) is complicated and depends critically on oceanographic features and bottom topography so it is difficult to accurately predict received level versus range for all environments. To make my point, I will use assume spherical spreading loss of $20\log_{10}$(range). This equation underestimates TL over long ranges in the open ocean (Urick), but may overestimate TL when bottom topography slopes to shallower water. This simple estimate of received level versus a few ranges is:

Range (km)	RL (dB)
23	160
200	140
1000	120

These estimates fairly closely match those obtainable from figs. 4.2-4,5 in the FEIS.