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Michael Payne March 3, 2010
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Re: US Navy request for a Letter of Authorization for the incidental harassment of marine mammals in the Gulf of Alaska Temporary Maritime Activities Area

Dear Mr. Payne

We have some significant concerns about the Navy Request for Letter of Authorization (LOA Request) for the incidental harassment of marine mammals in the Gulf of Alaska Temporary Maritime Activities Area (GOA-TMAA). While at over 400 pages long the document is comprehensive, its length does not make up for the dearth of information that the LOA Request is based upon.

We have already commented on this extensively in our comments to the earlier Draft Environmental Impact Statement (DEIS) for the GOA-TMAA – which is also a very wordy but very sparsely substantiated document. Our DEIS comments are enclosed with this letter.

I have outlined some of our systematic concerns herein, but the overarching premise that comprehensive impact models required for a LOA of this breadth are not adequately addressed by the US Navy's assessment of marine mammal population counts. And while there may be some statistical manipulations that would produce debatable population estimates from only ten days of transects across a 42,000 sq. mile area,[1] there are not credible statistical manipulations that can reconcile transects that occurred in April to represent populations over the summer months of May through October when the proposed exercises will be occurring. The summer months are the feeding months in the GOA for the Eastern Pacific Gray whale (*Eschrichtius robustus*), the Northern Pacific Humpback whale (*Megaptera noveangliae*) and male Pacific sperm whales (*Physeter*

[1] Rone, B. K, A.B. Douglas, P. Clapham, A. Martinez, L. J. Morse, A. N. Zerbini and J. Calambokidis. 2009. Final Report for the April 2009 Gulf of Alaska Line-Transect Survey (GOALS) in the Navy Training Exercise Area.

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macrocephalus). While this fact is mentioned in the LOA Request there are no accommodations in the models to account for this temporal disparity, and in fact the inadequacy of the summer estimates is even discussed in the transect report.[2]

This significant shortcoming alone should call for a denial of the LOA Request. But we also have systematic problems with the exposure models.

One of our dominant systematic concerns is that a preponderance of audiometrics for marine mammals are derived from laboratory test signals that have very little correlation to the exposure signals of concern – particularly the various acoustic communication and ranging sonar signals.

This situation is exacerbated by the presentation of exposure noises in the LOA Request Appendix Section B.1.1 "Acoustic Sound Sources" section wherein the various acoustic systems were generally described and qualified in terms of either being "broadband" for explosions or "narrow band" for sonar signals. Narrow band signals are further classified by their frequency bands (Low, Mid, and High frequency).

While these classifications do indicate something about the signal characteristics, they are by no means conclusive in terms of impacts. For example under this same classification system both Mozart and Def Leppard could be classified as "broadband" sources and Miles Davis' trumpet and an industrial fire siren could both be classified as "narrow band, mid range" signals. The aesthetic distinctions are not merely anthropomorphic; rather there are quantitative differences in the statistical distribution of harmonics, impulse, and frequencies of these signals over time which correlates to physiological impacts.[3] Quite simply stated; an alarm signal is alarming because of how it sounds, not because we have learned to be alarmed when we here it. This is the case for humans as well as marine mammals.[4] The thresholds of MMPA "Level A" and "Level B" harassments in the LOA Request do not take these facts into account. The threshold shift levels in marine mammals are correlated to exposure level alone, which we find extremely reductionist and not consistent with what is known about biological responses to various types of noise exposures.

This is equally the case with sonar signals as it is with explosives. The types of explosives are also not integrated into the metric. Rise times of explosives have a significant bearing on mortality.[5] Different explosives have varying impulse rise times[6] so without knowing

[2] Ibid. p.19-20. Equipment shortcomings and poor weather conditions are also indicated in this discussion, compromising accurate population estimates of Sei and Blue whales.

[3] Roger P. Hamernik and Wei Qiu "Energy-independent factors influencing noise-induced hearing loss in the chinchilla model" J. Acoust. Soc. Am. 110 (6), December 2001

[4] R.L. Kastelein, H.T. Rippe "The effects of acoustic alarms on harbor porpoises (*Phocoena phocoena*) behavior in a floating pen." 2000 Marine Mammal Science v. 16:1 p46-64.

[5] Stocker, M "Examination and evaluation of the effects of fast rise-time signals on aquatic animals" J. Acoust. Soc. Am. 120, 3267 (2006)

which explosives are being proposed in the LOA Request, the entire discussion about exposures to explosives is rendered meaningless.

To punctuate this point, the exposure thresholds relative to explosives are established in the LOA Request cite Finneran and Schlundt [7] who used pure tone signals to establish Temporary Threshold Shift (TTS) levels. Pure tone signals do not correlate with the "broadband" classification of explosions outlined in the LOA Request. If the "broadband" distinction is to be made for the purpose of the LOA Request, it should be adhered to otherwise the distinction merely confuses the argument.

This speciousness of the explosives argument is further illustrated in Table B-2 "Explosives Level Thresholds" where "Eardrum Rupture" is classified as a "Level A" harassment. It should be known by the authors of the LOA Request that cetaceans do not have "ear drums." This uninformed conjecture renders this metric table entirely useless for cetaceans and questionable for pinnipeds (that have physiological adaptations for extreme pressure gradients associated with deep diving).

There are also many questionable assumptions made in the LOA Request regarding the actual levels of Temporary Threshold Shift (TTS) and Permanent Threshold Shift (PTS) in marine mammals. PTS levels for marine mammals are unknown. This is because we have not intentionally subjected marine mammals to PTS levels (for compassionate reasons). I will review the PTS assumptions below, but the foundation of the PTS assumptions used in the LOA Request are made from data derived from TTS studies. These studies have all been done on test-habituated animals, and in many cases these animals are quite old. Additionally, these studies include a number of assumptions that belie the actual data. Most of the studies used in the LOA Request such as Finneran, Carder et al. (JASA 2005)[8] used mature (18 - 20 years) or old (38 - 40 years) animals that have been systematically exposed to noise studies for many years. The subjects have lived in a busy environment full of anthropogenic noise, so it is highly likely that they have been habituated to the test environment. It is clear that these animals do not represent wild marine animals across a broader – and mostly younger – age range, in their own environment.

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[6] Fry, Donald H 1953 "Observations on the effect of black powder explosions on fish life." Calif. Fish and Game v.39:2

[7] Finneran, J.J., and C.E. Schlundt. 2004. Effects of intense pure tones on the behavior of trained odontocetes. Space and Naval Warfare Systems Center, San Diego, Technical Document. September

[8] James Finneran, Donald Carder, Carolyn Schlundt, Sam Ridgeway "Temporary threshold shift in bottlenose dolphins (*Tursiops Truncatus*) exposed to mid frequency tones." October 2005 J. Acoust. Soc. Am. 118(4) p.2696

Kastelein and Rippe studies of younger animals (harbor porpoise *Phocena phocena*) with more appropriate test signals yielded significantly different results.[9] These animals demonstrated an aversion to more complex signals in the frequency range of the proposed sonars and at 130dB re: 1µPa@1m. (Animals used in this study had been recently taken into captivity and approximately 3 years old.) While the signals used in this study were specifically designed to repel net-predatory marine mammals, the signals are more similar in form to many communication sonars than to the sinusoidal waves or band limited pink noise used in the LOA Request citations.

Another study by Verboom and Kastelein indicates that more complex signals induce a discomfort threshold level for younger, less habituated marine mammals (*P. phocena* and harbor seal *Phoca vitulina*) at or below 133dB re:1µPa@1m.[10] This study extrapolates a TTS level for these animals at 150 dB(*w*) re:1µPa@1m for the harbor seal, and 137dB(*w*) re:1µPa@1m for the harbor porpoise. The paper also goes on to suggest that hearing injury – PTS, will occur in the Harbor porpoise and Harbor seal at 180dB and 190dB respectively – not the 215 dB and 224+ dB (respectively) represented in the LOA Request.

Like the estimated PTS levels used in the LOA Request, the TTS figures from the Verboom and Kastelein (2005) study are extrapolations – extrapolating results from behavioral noise-testing of young, healthy marine mammals against known human auditory responses. The disparity between the TTS figures used by Verboom and Kastelein and the figures used in the LOA Request indicate a high degree of scientific uncertainty in the models and extrapolation methods used in both sets of assumptions. We aare more inclined to accept the Verboom Kastelein numbers for three reasons:
1) they were not cited or crafted under the rubric of justifying a proposed program;
2) their studies were not funded by an agency whose desired actions would be limited by more precautionary results,[11] and 3) they are inherently more precautionary, in that they examine the thresholds of behavioral response, not the upper limits of physiological response.

Model inaccuracies due to habituation in the instance of this study is compounded by the likelihood that these animals may employ biological protections to prepare them for their tests – protections akin to the "wincing" that visual animals use to protect their eyes from

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[9] R.A, Kastelien, H.T. Rippe " The Effects of Acoustical Alarms on the Behavior of Harbor Porpoises (*Phocena phocena*) in a floating pen" Marine Mammal Science 16(1) p. 46 – 64. January 2000

[10] W.C. Verboom and R.A. Kastelein. "Some examples of marine mammal 'discomfort thresholds' in relation to man-made noise." June 22, 2005. Proceedings from the 2005 Undersea Defense Technology conference 2005, Sponsored by TNO, P.O. Box 96864, 2509 JG The Hague, The Netherlands.

[11] Hal Whitehead and Linda Weilgart "Science and the management of underwater noise: Information gaps and polluter power**."** J. Acoust. Soc. Am., Vol. 110, No. 5, Pt. 2, November 2001 142nd Meeting: Acoustical Society of America.

damage. Terrestrial animals have a mechanism, like "wincing" in their middle ears that protect them from damaging sounds. This mechanism is a tightening of the tensor tympani muscles around the middle ear ossicles, protecting the hearing organ from physical damage.[12] While this mechanism is fast acting in response to "surprise" stimulus, once terrestrial animals are habituated to expect loud noise, the system is activated by the expectation. In humans the mechanism kicks in when noise levels reach 75dB SL (re: 20µPa) – about 10dB SL below where OSHA guidelines for TTS-level noise exposures occur in humans, and about 50dB SL below where PTS occurs

The middle ear structure of marine mammals differs significantly from the middle ears of terrestrial animals. We are just learning about how environmental sounds are conveyed into the odontocetes' inner ears. This mechanism includes the lipid channels in their lower jaws,[13] (rather than the erroneous "ear drums" stated in Appendix B of the LOA Request) and the mobility of the bulla (the bone envelope that houses the cochlea and semicircular canals). While this mechanism does include the same middle ear ossicles of terrestrial mammals, these bones in cetaceans can be rigidly attached to each other and connected differently (by way of ligaments) to an internal tympanic membrane.[14] While the ears of the odontocetes or mysticetes do not have the same tensor tympani found in terrestrial mammals, it is not unlikely that these hearing specialist animals would have an analogous system to protect their inner ears from periodic or occasional sound levels that would otherwise damage their organs of hearing.[15] If this assumption is correct, then the "sound test" habituated dolphins would obviously yield much higher thresholds for TTS than their wild, un-habituated counterparts – given that they will always "prepare" for acoustical assaults when asked to perform in a given testing situation.

But even assuming that the legacy of TTS testing done on these test-habituated animals does accurately reflect the TTS levels for all wild, un-habituated animals, the data used to establish an "appropriate" TTS levels all show onset of TTS occurring between 185dB and 190dB (re: 1µPa2-s). These assumptions are justified in the LOA Request by citations from Finneran et. al (JASA 2005)[16] and Nachtigall (JASA 2003)[17] In the LOA

[12] Pierre Buser and Michel Imbert "Audition" 1992. MIT Press. p. 110 - 112.
[13] Heather Koopman, Suzanne Budge, Darlene Ketten, Sara Iverson "The Influence of Phylogeny, Ontogeny and Topography on the Lipid Composition of the Mandibular Fats of Toothed Whales: Implications for Hearing" 2003 Paper delivered at the Environmental Consequences of Underwater Sound conference, May 2003.
[14] G.N. Solntseva, "The auditory organ of mammals"1995 p. 455 in "Sensory Systems of Aquatic Mammals' R.A. Kastelein, J.A. Thomas and P.E. Nachtigall eds. De Spil press.
[15] This system might involve thermo-regulating the viscosity, and thus the acoustical compliance of the lipids through regulating blood circulation around the organs – thereby attenuating or accentuating acoustical transfer through the organ as needed.
[16] James Finneran, Donald Carder, Carolyn Schlundt, Sam Ridgeway "Temporary threshold shift in bottlenose dolphins (*Tursiops Truncatus*) exposed to mid frequency tones." October 2005 J. Acoust. Soc. Am. 118(4) p.2696
[17] Nachtigall, P.E., J.L. Pawloski, and W.W.L. Au. 2003. Temporary threshold shift and recovery following

Request the TTS levels simply established at 195dB.[18] This elevated level is a "statistical mean" to justify raising the TTS level to 195dB[19] established in the earlier Gulf of Alaska Temporary Maritime Training Area Draft Environmental Impacts Statement (GOA-DEIS) with the statement: "Use of the minimum value would overestimate the amount of incidental harassment because many animals counted would not have experienced onset TTS."[20] In evaluating the citations used in making this assumption it appears that the GOA DEIS took a "statistical mean" from the citations. This is simply not acceptable practice and should not be used without excavating the originating papers and justifying the use of the actual numbers – or else choosing some other arbitrary level such as lower thresholds indicated in the variance bars.

This highlights one of my key concerns in using TTS as an 'acceptable threshold;' why do harassed animals need to experience onset of TTS? While it may be important to find the absolute value for onset of TTS in our model animal, the purpose here is to avoid harassing animals, not derive "statistical precision" on the exposure levels that will always produce TTS in 50% of the cases in test-habituated animals. For this reason the data should be used as found and as presented in the originating papers; that onset of TTS occurs in test-habituated animals at 185dB (re: $1\mu Pa^2$-s).

Regarding the estimation of PTS onset relative to TTS levels used in the LOA Request[21] I find these data troubling as well. The linear regressions adapted from the W.D. Ward et al papers[22] (incorrectly cited and not presented in the LOA Request) were all taken from human subjects – highly visually adapted terrestrial mammals. Ward's research indicates a threshold of PTS by examining the maximum recoverable TTS in human and finds that humans can recover from a TTS of 50dB without permanently damaging their hearing.

The cat is also a highly visually adapted terrestrial animal, though it is more dependent on aurality than humans.[23] One correlation can be deduced here is that animals that are more dependent on sound cues are less able to recover from extreme TTS. Thus if there is a 10 dB disparity in recovery levels between humans (50dB TTS) and cats (40dB TTS), it might easily follow that cetaceans who rely almost exclusively on acoustical cues would be even less likely to recover from extreme TTS and may indicate a PTS threshold at

noise exposure in the Atlantic bottlenose dolphin (*Tursiops truncatus*). 113:3425-3429.

[18] GOA LOA Table B-1 "Non-Explosive Sound Source Threshold Levels"

[19] Gulf of Alaska Temporary Maritime Training Area Draft Environmental Impacts Statement (GOA-DEIS) Section 3.8-87

[20] Ibid. Section 3.8-92

[21] GOA LOA Request p.B-2

[22] e.g.: Ward, W.D. "Recovery from high values of temporary threshold shift." JASA 1960. Vol. 32:497–500.

[23] Ralph E. Beitel "Acoustic pursuit of invisible moving targets by cats" JASA – 1996. Vol.105(6) p.3449 This paper indicates that cats will follow acoustic cues without needing to visually identify the cue, unlike humans, who will use an auditory cue to help localize a source of noise which they will then "look for."

TTS level of 30dB. If we use this assumption, the onset of PTS in cetaceans may only be 15dB above the onset of TTS.[24]

Given the forgoing, we might determine from the data presented in the LOA Request that if the onset of TTS occurs at 185dB re: 1μPa^2-s then the onset of PTS could then be as low as 200dB re:1μPa^2-s (taking the above assumption about recoverable TTS levels in highly acoustically-adapted animals). While these revised numbers are "lower" than the proposed thresholds of TTS and PTS (broadly suggested for all marine mammals), they are based on assumptions that are still of questionable validity, inasmuch as they are based on extrapolated models that meld terrestrial, highly visual animals with old, test-weary odontocetes. I feel that this methodology provides a poor stand-in for a diverse variety of wild marine mammals, in their own habitat, being subjected to extreme levels of noise that they are not biologically adapted to or trained to expect. Thus precaution would revise all of these assumed thresholds downward.

Regarding the derivation of data for mysticetes; frequency threshold sensitivity has not been established for any baleen whale species. Thus, using exclusively what we know about odontocetes as a model for all mysticetes does not serve the scientific rigor demanded by a proposal of the magnitude and scope of the GOA TMAA. If we are to make assumptions about a particular order of animals, we need to consider all available data on that subject order and infer from that what we can for guidance.

If we take the gray whale avoidance thresholds from Buck and Tyack, (2003)[25] and the song-length alterations of humpback whales indicated in Fristrup, Hatch and Clark, (2003)[26] we find behavioral responses that occur when the receive levels (RL) are between 130dB and 150dB respectively. If we extrapolate the TTS levels using the threshold models from Verboom and Kastelein, (2005)[27] (extrapolating threshold assumptions from human thresholds) the TTS thresholds in some baleen whales could be as low as 160dB re:1μPa and the PTS thresholds could be 205dB re:1μPa, depending on the duration, wave shape and crest factor of the signals. While these data do not give us an "absolute sensitivity model" for all mysticetes, the data represents actual responses

[24] Using the same extrapolation and linear regression found in the DEIS and using 30dB TTS as the maximum recoverable TTS level: There is a 24 dB TS difference between onset-TTS (6 dB) and onset-PTS (30 dB).The additional exposure above onset-TTS that is required to reach PTS is therefore 24 dB divided by 1.6 dB/dB, or 15dB.

[25] John R. Buck, Peter L. Tyack "An avoidance behavior model for migrating whale populations" The Journal of the Acoustical Society of America. April 2003. Volume 113, Issue 4, p. 2326 wherein gray whale avoidance threshold of 135dB re: 1μPa was established.

[26] Kurt M. Fristrup, Leila T. Hatch and Christopher W. Clark "Variation in humpback whale (*Megaptera novaeangliae*) song length in relation to low-frequency sound broadcasts." June 2003. J. Acoust. Soc. Am. 113 (6).

[27] cf. Verboom and Kastelein, 2005 (fn. 10 above.)

from these animals, rather than inferring 'data' from a similar, but distinctly different order of cetaceans.

In section "B-5: Risk Function: Theoretical and Practical Implementation"[28] the model basis is acceptable, but there are three assumptions not clarified which continues on the theme of how different variables are used in the LOA Request for different species of marine mammals, and different orders of cetaceans.

This involves the use of the "Feller" risk function for all modeled marine mammals (except for the Harbor porpoise). The derivations of the "steepness factors" (A=10 for pinnipeds and odontocetes, A=8 for mysticetes) and the use of 'heavyside' step function exclusively for the harbor porpoise. Without an explanation these variables seem arbitrary. Is the slope variable for mysticetes chosen because we don't know what it is, and the choice of the heavyside step function chosen for the harbor porpoise because we do know? (from Kastelein)

The oceanographic exposure model and software explained in the Risk Function section seems like a useful tool to determine acoustical energy densities surrounding a sound source relative to predetermined exposure thresholds, but the factor that is missing from this model – aside from the overarching fact that the estimates of population densities are severely lacking – is the simple fact that the entire TMAA is used for population density exposure risks, yielding statistical models of fractional animals (such as .0003 Sperm whales/km. in the entire TMAA). While we understand the utility of fractional animals to represent the probability of interactions within a prescribed data set, there is no such thing as a .0003 Sperm whale, and if these statistics are to be utilized, the range of the dataset needs to clearly represent the range of the impact.

The exercises are occurring in a limited exposure area <u>within</u> the 43,000 sq. mile area. A more accurate model would involve running the model over a specific area from which actual transects were taken, take the actual animal counts from that area and assess the exposure risk relative to the calculated population density in the exposure area. Taking the entire TMAA as the risk area to "dilute" the exposed population is a statistical sleight-of-hand that does not clearly represent exposure risks to individual or populations of animals.

This attempted dilution of risks is also a concern in the dumping of 10,000 lbs. toxic chemicals into the TMAA yearly – a harassment problem that is entirely excluded from the LOA Request. While the "harassment" conventions are typically applied within a narrowly defined time span of instantaneous to 24 hours, the chemicals being dumped are toxic. Some are known endocrine disrupters, and we know that marine mammals being at the upper trophic levels are subject to bio-accumulation of these toxics over longer time frames.

[28] GOA-LOA Request p. B-26

Taking the definitions of harassment from MMPA Subsection 101(a)(5)(D) amended by National Defense Authorization Act of 2004 (NDAA) (Public Law 108-136) as it applies to a military readiness activity to read as follows:

> (i) *any act that injures or has the significant potential to injure a marine mammal or marine mammal stock in the wild [Level A Harassment]; or*
>
> (ii) *any act that disturbs or is likely to disturb a marine mammal or marine mammal stock in the wild by causing disruption of natural behavioral patterns, including, but not limited to, migration, surfacing, nursing, breeding, feeding, or sheltering, to a point where such behavioral patterns are abandoned or significantly altered [Level B Harassment].*

It is unclear to us how the dumping of 10,000 lbs of toxic materials into an otherwise pristine environment is not considered MMPA Level A Harassment when we know that these chemicals will eventually end up poisoning and compromising long term population fitness of the exposed marine mammals.

While the focus of all of the proposed assaults on the GOA marine mammal populations happens over limited time scales, and over what we perceive as a large geographical area, cetaceans have been adapted to their environment over 30 million years. The extreme and persistent disruptions that the GOA TMAA training area within a relatively short time frame – whether from acoustical, explosive, or chemical assaults would significantly alter and compromise the habitat throughout the duration of the exercises and for hundreds of years to come.

Based on all of the foregoing arguments we advise that the US Navy request for a Letter of Authorization for Incidental Harassment of Marine Mammals in the Gulf of Alaska Temporary Maritime Activities Area be denied.

Please include these comments into the administrative record on this matter.

We welcome an opportunity to discuss our findings in further detail with you at any time.

Sincerely,

Michael Stocker

Michael Stocker
Director