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Naval Facilities Engineering Command Northwest
Attn: Mrs. Amy Burt, Gulf of Alaska EIS/OEIS Project Manager
1101 Tautog Circle, Suite 203
Silverdale, WA 98315-1101

Re: 5090 Ser. N01CE1/1333 Comments on the Gulf of Alaska Navy Training Activities Environmental Impact Statement/Overseas Environmental Impact Statement

January 21, 2010

Cc: Dr. Jane Lubchenco, Director, NOAA
Nancy Sutley, Chair, Whitehouse Council on Environmental Quality
Hon. Barbara Boxer, US Senate, Chair of Environment and Public Works.
P. Michael Payne, Chief, Marine Mammal Div. NMFS - OPR

Dear Mrs. Burt,

We have taken the opportunity to review the Draft Environmental Impact Statement for the Gulf of Alaska Navy Training Activities (GOA-DEIS) Temporary Marine Activities Area (TMAA). While the document reflects much work and a comprehensive exploration into the possible impacts of the proposed additional uses of the GOA as required by the National Environmental Policy Act (NEPA), we believe that the GOA-DEIS leaves much to be desired if it is to be considered a guiding document for environmental stewardship.

This observation is made in particular light of the fact that despite our assumptions about the boundless ability of the ocean to absorb the assaults of human enterprise we are rapidly finding that the ocean is in very poor shape. This is a consequence of reckless resource extraction (which is not under the Navy's purview) and relentless dumping and pollution (which is). The fact is that in many of the more extreme cases, ocean environmental degradation has been a significant product of the militarization of ocean habitats.

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We are seeing that the long term accumulation of toxics and “inert” trash is causing global scale problems with impacts on all marine biota. We are seeing the gradual and slow release of chemicals bio-accumulating and bio-concentrating throughout the entire food chain – including in humans, who consume the products of the ocean at the highest trophic levels.

Bio-accumulation and concentration of toxics had not been part of the models used when decisions were made to use the ocean as a chemical toilet. But now we know better. We also know that some chemicals once thought of as benign are having profound effects on biological function such as compromised reproductive health, mutation, carcinomas, and neurological damage in “parts per trillion” concentrations. Knowing this, it is unconscionable to continue to treat the ocean as a toxic waste dump.

While many of the toxic substances in the ocean are a product of civilian dumping and unintentional runoff from terrestrial as well as marine sources, a preponderance of terrestrial Superfund sites are due to reckless military hubris. There is no indication that the Navy has been any different in their stewardship of the sea. This is substantiated in our comments to the GOA-DEIS herein.

The GOA-DEIS largely concerns the addition of Anti-Submarine Warfare (ASW) activities currently not included in the existing training range and operations. As such the proposed operations will be introducing an acoustical systems component to the training range. This includes both the introduction of acoustical energy into the environment, as well as chemicals and other pollution from expendable materials, acoustical systems, and associated equipment. It also includes an extra component of underwater explosives – used for acoustical signals as well as for weapons ordnance.

I am limiting our comments to impacts on fish and marine mammals; and while the main focus of Ocean Conservation Research is the bio-acoustic impacts of human generated noise on the marine environment, I also include our concerns for chemical pollution in the training area. The models and assumptions used in the GOA-DEIS for chemical and toxics “mitigation” serve as a philosophical as well as a systematic model for noise pollution inasmuch as that while the jurisdiction and management of the training range fits within prescribed borders, acoustical energy and chemical pollutants, and their impacts on marine life and environment that would result from the proposed exercises are not so tidily constrained.

Symptomatic of this is that while the dumping of expended materials under “Alternative 1” and Alternative 2” is not increased within US territorial waters (which are subject to

NEPA and other US environmental laws), there are substantial increases of expendables dumped in non-US Territorial waters (which are not subject to US environmental laws). This situation clearly illustrates the effectiveness of NEPA in protecting US territorial waters, but is also shows the "avoidance relationship" that the US Navy has for NEPA and by extension other US environmental laws.

The overarching problem here is that while the jurisdictional boundaries of US environmental laws are clearly defined at 12 nm from the US Coast, energy and chemical pollutants and other destructive practices in the ocean are not subject to those boundaries. Animals impacted by reckless dumping practices, marine mammal acoustical "takes," damage to fish and fisheries food-stock (and habitat) are all trans-boundary problems in the ocean. And just because an animal or habitat is outside of US jurisdiction, it does not mean that the damage is any less grave than damage that occurs within US territorial waters.

The boundaries of our Federal laws are practically established as a consequence of the likelihood of enforcement, not as an expression of diminished impacts. If the US Navy is to uphold laws which express the priorities of the American People, the impact categories outlined in the various tables and "Environmental Consequences" statements in the GOA-DEIS[1] belie the Navy's stated concern to be "stewards of the sea."

It is within the context of the US Navy's responsible stewardship of the ocean – along with the understanding that the ocean is in terrible shape – that I submit the following comments and concerns for the proposed activities in the Gulf of Alaska Warfare Training Range.

Our overarching recommendation is the "No Action Alternative" and to not include ASW training exercises proposed in either Alternative 1 or Alternative 2 in the Gulf of Alaska Temporary Marine Activities Area (TMAA) for the following summary reasons:

- It is becoming increasingly and shockingly clear, the ocean is in precarious shape due to continuous and expanding insults of human enterprise and adventure. This must figure into all of our deliberations and practices that compromise ocean habitat.
- Of all ocean areas within US Territorial reach, the Gulf of Alaska is one of the least assaulted areas and should remain so.

[1] The jurisdictional distinction is made throughout the GOA-DEIS as to whether the impact standards – and thus mitigation thresholds, adhere to NEPA (inside 12 nm) or Executive Order [EO] 12114 (outside of US Territorial waters).

- The US Navy has recently expanded Anti-submarine Warfare training areas in Atlantic (USWTR), the Northwest Warfare Training Range Complex, Hawaii Range Complex, and the Southern California Warfare Training Range Complex. Adding the Gulf of Alaska is not justified by any scarcity of other training areas.
- The chemical, toxic and "inert" pollution models used in the GOA-DEIS are over-simplistic and do not take into account current state of knowledge about accumulation and concentrations of chemical, toxic, and "inert" pollutant behavior throughout the entire ocean, and up and down the entire food chain – including humans.
- Insufficient data provided on the sonar characteristics and source levels so the assessments of the potential impacts presented in the DEIS are incomplete.
- The bio-acoustic impact models used in the GOA-DEIS are over-simplistic and do not represent wild animal impacts or behaviors and do not account for the agonistic qualities and characteristics of the various signals that would be introduced into the environment.
- Mid and high frequency sonar acoustic impact data on fish is lacking and does not justify the DEIS conclusion that impacts are "negligible or non-existent."
- The mortality "risk continuum" for fish due to explosives is inadequate and suspiciously biased to appear much more benign than it is.
- The conclusion in the DEIS section on fish admits that very little is known about the impacts of sonar on fish – which contradicts the summary table statement that "sonar used in Navy exercises would result in minimal harm to fish or EFH."
- The exposure risk models of marine mammals appear to contain many examples of "statistical manipulations of convenience" which erodes both the credibility of the models and the integrity of the entire GOA-DEIS.
- The model of bio-acoustic impact of explosives on marine mammals is over simplistic. It models the animals as "linear input devices" and does not account for synergistic effects of stress on the animal or the destruction of habitat and food sources.
- The issuance of the DEIS over the winter holidays – truncating the available comment period is cause for suspicions that the Navy is disingenuous about seeking public input on this cumbersome, comprehensive, but nonetheless inadequate document. This established a justifiable foundation of mistrust as we evaluated the document.

We have substantiated these assertions below. Given the limited time that was available for review we had to focus on the more obvious concerns. If we actually had the full 45 days required by NEPA not interrupted by holidays and obligatory year-end activities our comments would be much more comprehensive and informative. Nonetheless we were able to provide the forgoing, which more than adequately substantiates our recommendation that the "No Action Alterative" is the preferred alternative for the GOA-DEIS.

“Expended Materials”

While Ocean Conservation Research is focused on understanding and finding solutions to the impacts of human generated noise on marine life, we are compelled to comment on the chemical, toxics, and “inert” pollution from expended materials in the proposed DEIS. This is because, as indicated above, this dumping of chemicals in the ocean needs to be curtailed. The US Navy’s continued disregard for the mounting biological evidence that chemicals are seriously impacting the global ocean is indicative of a larger hubris that plagues the entire GOA-DEIS.

This hubris is characteristically represented in the following comment from the Executive Summary section Table ES 3.1:

> “Outside of U.S. territory, air pollutant emissions would increase substantially, mainly from increased surface vessel and aircraft activities. • SINKEX would generate a substantial portion of the air pollutants that would be emitted under Alternative 2. • Although Alternative 2 would increase emissions of air pollutants over the No Action Alternative, emissions outside of U.S. territorial seas would not cause an air quality standard to be exceeded”

Believing that air pollution (in this case) or marine pollution respects US Territorial boundaries is particularly short sighted in light of what we know about air and ocean circulation patterns; especially in the GOA and arctic waters.

Also in Table ES-3: Summary of Effects: “Expended materials under Alternative 2 would not have a substantial effect on the marine environment.” The phrase “substantial effect” needs to be more clearly defined, because the numbers and weights of materials expended annually (under preferred Alternative 2) provided in Table 3.2-18 and Table 3.2-19 indicate 10,000 lbs. of hazardous materials per year. Without even evaluating the toxicity of the specific materials, 10,000 lbs. per year is not insignificant.

Our current state of knowledge about the impacts of hazardous substances on marine life, and the effects of bio-concentration as hazardous materials move up the trophic levels do not constitute an inconsequential impact. Hazardous materials are not static; they are hazardous because they are dynamic. And just because a deposit of hazardous materials might be statistically hard to detect, we can assume that over time the accumulation of these materials in the environment will have negative impacts on marine life.

Additionally, framing the hazard in long time frames does not decrease the impacts. For example on page 3.2-12 we find "In instances where seawater corrodes the sonobuoy, that corrosion takes at least 40 years."

What will happen after 40 years? Will the ocean be somehow immune to the effects? And on page 3.2-23 "Most of these materials are relatively inert in the marine environment, and will degrade slowly." What does "relatively inert" mean?

Throughout the "Expended Materials" section we find the repeated use of the phrase "quickly dispersed by (or diluted by) ocean and tidal currents" troubling. It seems that the US Navy assumption is that once dispersed outside of the training range that the substances are no longer a problem. But we have found that chaff, plastics, and drifting chemical pollutants are a significant and growing global environmental problem because ocean currents end up pulling them into oceanic gyres where they end up in dangerous concentrations, polluting the food supply from the lowest trophic levels on up. While much of this has been accidental or incidental to global consumption, the US Navy deliberately adding to this mess – particularly with known military toxins is unconscionable.

Acoustic Impacts

While we know that the ocean is largely an acoustic environment, the understanding about role of acoustics across the vast array of marine animals is rudimentary at best. In some cases we have not been able to procure evidence that our noises have any impact at all, and in other cases we are baffled by the extreme impacts that human generated noise has wrought on marine life.

As we roll back the frontiers of our ignorance it will be wise to assume precaution. This would mandate that we gather as much evidence as possible and populate our models with the most accurate, concise, and up-to-date data as possible.

We are concerned about the impacts of the noise generated in the training range on marine animals both inside and outside of the training range. This includes impacts on migratory and resident marine mammals as well as migratory and resident fish - particularly fish with a high commercial value, including but not limited to salmon, halibut, herring, haddock, Pollack, and crab, the consequent impacts on the commercial fishery, and the consequent impacts on links in the regional food chain.

Noises of concern are the noises from explosive ordinance, mid-frequency sonar, sonar jamming signals, communication and surveillance sonar, and mechanical noises associated with warfare exercises such as engine noise, propeller cavitation, and through-hull transmitted mechanical noise.

One of our dominant systematic concerns expressed throughout this document is that a preponderance of audiometrics for fish and 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 sonar signals.

This situation is exacerbated by the presentation of sonar systems in the DEIS Appendix H "Acoustic Systems Descriptions" section wherein the various acoustic systems were generally described and qualified in terms of their frequency bands (Low, Mid, and High frequency) but source levels were not provided, and in most cases there was no indication of signal qualities (e.g.: short "pings" or longer data-streams). Both exposure levels and signal qualities have bearing on the biological impacts so a complete assessment of the potential impacts presented in the DEIS are incomplete.

This is also the case with the Portable Undersea Training Range (PUTR) (section H.1.9) in terms of transponder frequencies, source levels, and signal characteristics.

Without knowing more about the signal characteristics of these devices it is impossible to derive and accurate impact model; to determine how different these signals are from the audiometric signals used to establish auditory thresholds in subject animals, or determine if there are acoustical characteristics of these signals that may be of greater concern than just their amplitude.

Seminal to this discussion is the assumption that all hearing animals have a need to discriminate pitch. While mammals, including marine mammals, have organs of pitch discrimination (the cochlea) it is not clear that any other animal family has a need to discriminate pitch. It is likely that other animals have acoustical perceptions tailored to their specific habitat priorities that do not include pitch discrimination.

Almost without exception, all audiograms taken of marine animals are a comparison of frequency and amplitude sensitivities. It is possible that in lieu of pitch and level perceptions, that many fish (or other marine animals) could be sensitive to other characteristics of acoustical energy; that in place of level or time-of arrival differences between sound receptors, these animals can distinguish phase differences between 'particle' and 'pressure gradient' acoustical energy. In this context, time-domain cues across these physical characteristics of acoustical energy are much more important than frequency or amplitude cues.

This could cut both ways in regards to the acceptable noise levels for fish in the subject environment: Up to the point where the acoustical mechanics of the noise in the environment and the acoustical compliance of the organism are in conflict with the noise levels, a particular fish may not even perceive the noise. This would explain why fish residing in extremely turbulent settings (like corvina or surf perch) can endure extreme, noise-saturated acoustical settings and still respond to subtle acoustical stimulus in their environment.[2] This could mean that very loud but distant noise sources might have much less impact on an animal than quieter but closer noises.

This is germane to the DEIS because the preponderance of audiograms and threshold shift procedures used to determine the acoustical sensitivities of fish in the cited studies[3] used either sinusoidal signals or band limited 'pink' noise[4]. While this statement doesn't answer many questions in regard to the impacts of the noise generated by the proposed TMAA project on various fish exposed to the noises of the program, it highlights the fact that the assumptions used to frame the impact models do not reflect the actual acoustical situation proposed in the program. This is particularly evident in the fact that some of the proposed acoustical signals will not be sinusoidal, rather some signals will include fast rise times and high "crest factors"[5] which are significantly different from sinusoidal signals.

This shortcoming can only be addressed by doing systematic testing on various fish using signals and levels that more closely match the signals proposed for the TMAA, especially the mid frequency communication sonars that overlap the known audiological response of the subject fish and contain either rich harmonic content, fast rise times, and crest factors at or above unity.

Using the actual sonar signals to determine acoustical thresholds would also clarify the impacts of the proposed signals on other marine biota, where again the preponderance of audiological or physiological impact data are taken from sinusoidal or 'pink noise' sources.

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[2] J. Engelmann, W. Hanke, J. Mogdans & H. Bleckmann "Neurobiology: Hydrodynamic stimuli and the fish lateral line" 2000 Nature 408, p.51-52

[3] The GOA-DEIS cites Scholik and Yan, 2002 and Wysocki and Ladich, 2005. These studies also evaluate three fresh water species: The goldfish (*Carassius auratus*) and the Rafael catfish *Platydoras costatus*) both live in still, turbid waters, (thus their particular acoustical adaptations), and the sunfish (*Lepomis gibbosus*), a clear water inhabitant. These animals are not good models for open ocean fish that live in a completely different acoustic habitat.

[4] Band limited "Pink Noise" is typically derived from Fourier Transfer derived Gaussian noise constructed from sine waves without any coherent time-domain component.

[5] Crest factor is the ration of peak to RMS value of a signal. Pure sinusoidal waves have a crest factor of .707; pure "square waves have a crest factor of 1; repetitive impulse sounds have a crest factor greater than 1.

Marine invertebrates have mechanoreceptors that are adapted to the sinusoidal motions of their environment. Sometimes these motions are relatively energetic (such as the acoustical energy generated by heavy currents and wave motions), so these animals may not be as affected by extreme sinusoidal energy. On the other hand, fast rise times or high crest factors used in some acoustical communication signals may exceed the acoustical compliance of the organism and damage it. These types of signals need to be explored with various marine invertebrates and plankton prior to excluding all of these animals from consideration of acoustic impacts in the GOA-DEIS.

Acoustic Impacts: Fish

In chapter 3.6 on fish, and most notably under section 3.6.2.2 Assessment Framework it is stated repeatedly that there are many data gaps in the literature on the impacts of noise on fish. The remark that "it is hard to extrapolate between species or conditions" is abundantly found throughout this section, substantiating the general position that there is a high level of uncertainty in the known impacts of noise on fish.

But the absence of data does not mean the absence of harm, and precautionary practices would dictate that some known statistical mean of harm would be used to set mitigation thresholds. What is done throughout this section ambiguates the probable impacts with biased metrics. For example the correlation of impulse impact mortality relative to body mass and charge size taken from Young's equations[6] were extrapolated into tables 3.6-4: "Range of Effects for at-Sea Explosions" and table 3.6-5: "Estimated Fish-Effects Ranges for Explosive Bombs" to indicate the distance at which 10% mortality would occur (also noted as "90% survival" in the DEIS.)[7]

This metric ambiguates the perspective that fish at or *outside* of the specified range have a 10% or greater survival rate. There is a mortality continuum from 10% - 100% mortality *inside* that range. So while for example only 10% of the fish greater than 30 lbs will be killed at 578 feet by a 500 lb. bomb, it is highly likely that the death rate will be significantly higher for smaller fish with the mortality continuum scaling down to only 10% at 1289 feet and beyond

[6] Young, G.A.. 1991. Concise methods for predicting the effects of underwater explosions on marine life. Naval Surface Warfare Center, Dahlgren, Virginia.
[7] GOA-DEIS 3.6-31

The Young paper also only states short term or instant mortality. It does not evaluate intermediate and long term damage to the animals and their biological function that will kill them within days or weeks from the assault.[8]

The type of explosive is also not integrated into the metric. Rise times of explosives have a significant bearing on mortality.[9] Different explosives have varying impulse rise times[10] so without knowing what was used in the literature and what explosives are proposed in the GOA-DEIS this entire section along with the extrapolated metrics are meaningless.

The conclusion on the impacts of sonar on fish found in the DEIS on page 3.6-43 tidily sums it up: "the effects of sound on fish are largely unknown…There is a dearth of empirical information on the effects of exposure to sound, let alone sonar, for the vast majority of fish."

Given this admission (strengthened by the remaining text in the paragraph), the conclusion in table 3.6.10 "Because only a few species of fish may be able to hear the relatively higher frequencies of mid-frequency sonar, sonar used in Navy exercises would result in minimal harm to fish or EFH" contradicts the conclusion that 'we know nothing.' Either we know nothing, or we know that no harm will come from sonar exposure. Not both. Given that "we know nothing" supersedes the assumption that no harm will come from exposure, the former statement prevails.

We also do know that there are many fish that do hear well in the ranges covered by Mid-frequency and High frequency sonar[11] although currently there are no published exposure tests on these animals using MF and HF sonars. The auditory bandwidth sensitivity of these fish was probably a consequence of evolutionary pressure to hear the sounds of their main predators, the odontocetes – indicating that other odontocete prey may as well perceive and thus be impacted by Mid or High Frequency sonars.

An important element of certainty is missing from our understanding of fish responses to MF and HF sonar signals. The Popper 2008[12] report frequently cited in the DEIS refers to

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[8] McCauley et al., High Intensity Anthropogenic Sound Damages Fish Ears, J. Acoust. Soc. Am. 113 (2003).

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

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

[11] Mann, D.A., D.M. Higgs, W.N. Tavolga, M.J. Souza, and A.N. Popper. 2001. "Ultrasound detection by clupeiform fishes." The Journal of the Acoustical Society of America 109: 3048-3054.

[12] Popper, A.N. 2008. Effects of Mid- and High-Frequency Sonars on Fish. Naval Undersea Warfare Center Division. Newport, Rhode Island. Contract N66604-07M-6056

contract studies on the impacts of MF and HF sonars on fish, but the paper is only used to cite known and published data about fish hearing. The impact data is not cited and the paper is a US Navy contract paper and has not been published in peer reviewed journals.

So what we are left with is data derived from audiograms taken of marine animals are a comparison of frequency and amplitude sensitivities using sinusoidal derived signals.[13] It is possible that in lieu of pitch and level perceptions, that many fish (or other marine animals) could be sensitive to other characteristics of acoustical energy; that in place of level or time-of arrival differences between sound receptors, these animals can distinguish phase differences between 'particle' and 'pressure gradient' acoustical energy. In this context, time-domain cues across these physical characteristics of acoustical energy are much more important than frequency or amplitude cues.

While this statement doesn't answer many questions in regard to the impacts of the noise generated by the proposed GOA training range operations on various fish exposed to the noises of the operations, it highlights the fact along with the "dearth of empirical information on the effects of exposure to sound, let alone sonar,"[14] that fish will be exposed to signals for which we have even less data and will include signals with fast rise times and high "crest factors"[15] which are significantly different from sinusoidal signals.

This shortcoming can only be addressed by doing systematic testing on various fish using signals and levels that more closely match the signals currently being used or developed for modern ASW operations, especially the mid frequency communication sonars that overlap the known audiological response of the subject fish and contain either rich harmonic content, fast rise times, and crest factors at or above unity.

Using the actual sonar signals to determine acoustical thresholds would also clarify the impacts of the proposed signals on other marine biota, where again the preponderance of audiological or physiological impact data are taken from sinusoidal or 'pink noise' sources. Marine invertebrates have mechanoreceptors that are adapted to the sinusoidal motions of their environment. Sometimes these motions are relatively energetic (such as the acoustical energy generated by heavy currents and wave motions), so these animals may not be as affected by extreme sinusoidal energy. On the other hand, fast rise times or high crest factors used in some acoustical communication signals may exceed the

[13] Most audiograms either use single frequency sinusoid signals or band limited "Pink Noise" which is typically derived from Fourier Transfer derived Gaussian noise constructed from sine waves without any coherent time-domain component. These signals are very unlike mid-frequency sonar signals.
[14] GOA-DEIS 3.6-43
[15] Crest factor is the ration of peak to RMS value of a signal. Pure sinusoidal waves have a crest factor of .707; pure "square waves have a crest factor of 1; repetitive impulse sounds have a crest factor greater than 1.

acoustical compliance of the organism and damage it. These types of signals need to be explored with various marine invertebrates and plankton prior to concluding that they are not impacted by loud, fast rise-time, high crest-factor sonar signals.

But in the absence of evidence clearly indicating harm, the GOA-DEIS takes the "let's see if anything floats up to the surface" approach – which has left our ocean in such bad shape already.

Acoustic Impacts: Marine Mammals

While the modeling of the impacts of acoustical exposure in section 3.8.7.2 "Acoustic Effects: Assessing Marine Mammal Responses to Sound" is extensive, detailed, and comprehensive, given the other quirky statistical models found throughout the entire GOS-DEIS (and the predictable history of biased mathematical and statistical models in prior Navy DEIS documents), frankly I worry when the Navy's statistical modelers are given so much text space to synthesize decades of scientific study into their own home-spun complex risk-continuum.

Symptoms of this are ambiguously presented in the opening gambit on Table 3.8-1[16] wherein the density of given species of concern are presented in a density metric of animals per km^2. While I understand the statistical value of having a distribution number that represents the probability of interactions within a prescribed data set, the fact of the matter is that there is no such thing as ".0019" of a Humpback whale, or even a ".1892 of a Dall's porpoise." And once the statistical arguments get to this point they are in their third derivation which indicates that they are being set up for a statistical model of convenience.

While we did review the models that use these metrics in Appendix D and at face value they appear to be based on reasonable assumptions, given some of the other biased and quirky models used in the Fish Impacts section we would need to run these models in a few scenarios to assure that they do yield cogent and credible results. For example the setting the cutoff extent of the integral to 120dB seems to be based on either excluding the harbor porpoise form the marine mammal response data set or modifying the harbor porpoise risk function to a "heaviside step function"[17] smells suspiciously like manipulations of statistical convenience.

Unfortunately given the truncated comment period on the GOA-DEIS due to the issuance of this over the traditional winter holidays we did not have as much time as would be required to review the entire architecture of the US Navy statistical arguments justifying their particular models. Suffice it to say that in addition to the forgoing comments, we suspect that there are clever manipulations afoot.

[16] GOA-DEIS section 3.8-2 through 4.
[17] GOA-DEIS Appendix D-31, also Section 3.8-101

Of course none of these characterizations require a response under NEPA, but the following criticisms substantiate these claims.

There are many questionable assumptions made in the GOA-DEIS regarding the actual levels of Temporary Threshold Shift (TTS) and Permanent Threshold Shift (PTS) in marine mammals. As inferred in the DEIS, PTS levels are on marine mammals are derived numerically and not actually known. 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 DEIS are made from data derived from TTS studies. Furthermore, these studies have all been done on test-habituated animals, and in many cases these animals are quite old. Additionally, these studies include a level of assumptions that belie the actual data. For example a study featured in the GOA-DEIS by Finneran, Carder et al. (JASA 2005)[18] 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 different species of wild marine animals across a broader – and mostly younger – age range, in their own environment.

Model inaccuracies due to habituation in the instance of this study is compounded by the fact that the test 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 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.[19] 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 odontocete's inner ears. This mechanism seems to include the lipid channels in

[18] 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
[19] Pierre Buser and Michel Imbert "Audition" 1992. MIT Press. p. 110 - 112.

their lower jaws,[20] 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 the tympanic membrane.[21] While the ears of the odontocetes or mysticetes do not have the same tensor tympani found in terrestrial mammals, it is probable 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.[22] 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: $1\mu Pa^2$-s).

In the DEIS these levels are presented on a chart that includes three different signal types;[23] impulsive signals representing distant explosions,[24] seismic airguns,[25] and tone bursts.[26]

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[20] 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.

[21] 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.

[22] 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.

[23] Not from Nachtigall et. Al. 2004 as stated in the DEIS. Additionally Chart 3.8.7 is mislabels "Existing TTS Data for Cetaceans when is should be labeled "Some TTS Data for Cetaceans." Many other peer reviewed TTS models exists that are not represented in the chart.

[24] Finneran, J.J., C.E. Schlundt, D.A. Carder, J.A. Clark, J.A. Young, J.B. Gaspin, and S.H. Ridgway. 2000. Auditory and behavioral responses of bottlenose dolphins (Tursiops truncatus) and a beluga whale (Delphinapterus leucas) to impulsive sounds resembling distant signatures of underwater explosions. Journal of the Acoustical Society of America. 108:417-431.

[25] Finneran, J.J., R. Dear, D.A. Carder, and S.H. Ridgway. 2002. Temporary shift in masked hearing thresholds in odontocetes after exposure to single underwater impulses from a seismic watergun. Journal of the Acoustical Society of America. 111:2929-2940.

[26] Schlundt, C.E., J.J. Finneran, D.A. Carder, and S.H. Ridgway. 2000. Temporary shift in masked hearing thresholds of bottlenose dolphins, Tursiops truncatus, and white whales, Delphinapterous leucas, after exposure to intense tones. Journal of the Acoustical Society of America. 107:3496-3508.

This disparity in signal types is noted in the text, but with the exception of two cases of TTS as a consequence of seismic signals (one at 185dB re: 1µPa^2-s and the other at 190dB) the chart represents TTS as a consequence of pure tone bursts. (It was in this Schlunt et.al. study that the test-habituated beluga whale subject attacked the testing apparatus before the tests were complete). You might say that this illustrates that there is a physiological as well as a behavioral difference in impacts between the various signals rather than the conclusion that there is a clear threshold at 195dB as indicated in the DEIS.

Nonetheless the chart takes a "statistical mean" to justify raising the TTS level to 195dB.[27] This elevated level is justified in part by the statement: "Use of the minimum value would overestimate the amount of incidental harassment because many animals counted would not have experienced onset TTS."[28] This highlights one of my concerns; 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 test-habituated animals. For this reason the data should be used as found and as presented; that onset of TTS occurs in test-habituated animals at 185dB (re: 1µPa^2-s).

The statement in the DEIS that "The growth and recovery of TTS are analogous to those in land mammals. This means that, as in land mammals, cetacean [TTS] depend on the amplitude, duration, frequency content, and temporal pattern of the sound exposure"[29] is correct, but the DEIS-adapted assumptions used in the following bullet points in this section to build the argument omit the critical characteristics of "frequency content, and temporal pattern," ignoring the evidence that signal characteristics have a stronger bearing on TTS thresholds than amplitude.[30]

So the fundamental argument here is that as in the fish studies, none of the tests performed on marine mammals used to substantiate the Navy's impact and mitigation models used signals that simulated the actual sonar signals proposed in the GOA ASW activities.

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[27] GOA-DEIS Section 3.8-87
[28] GOA-DEIS Section 3.8-92
[29] GOA-DEIS Section 3.8-87
[30] 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

Most papers cited for the DEIS used either sinusoidal tones or impulse noises. These signals do not elicit the same behavioral responses as more complex signals.[31] The test subjects of most papers cited for the DEIS were also older (over 30 years old), test-habituated animals that have been in captivity and used as test subjects for a large portion of their lives.[32] The captive animals are accustomed to coming into a test area for their livelihood and while they provide TTS data for their specific physiology, they are poor stand-ins for a majority of marine mammals that will be impacted by the GOA proposal.

In terms of the range of impact relative to signal amplitude, Kastelein and Rippe studied younger animals (harbor porpoise *Phocena phocena*) [33] with more appropriate test signals yielded significantly different results than the assumptions made in the GOA-DEIS. 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 were 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 closer in form to many communication sonars than to the sinusoidal waves or band limited pink noise used in the DEIS 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.[34] 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 seal and Harbor porpoise at 190dB and 180dB respectively – 50% to 500% less energy than the 195dB level that the GOA-DEIS presents as the thresholds for MMPA Level B harassment.

Like the estimated PTS levels used in the DEIS, the TTS figures from the Verboom and Kastelein (2005) study are extrapolations – extrapolating from behavioral responses to noise exposure of young, healthy marine mammals against known human auditory

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[31] R.A. Kastelien, D. Goodson, L. Lein, and D. de Haan. "The effects of acoustic alarms on Harbor Porpoise (*Phocena phocena*)" 1997 P.367-383 in A.J. Read, P.R. Wiepkema, and P.E. Nachigall eds. "The Biology of Harbor Porpoise" de Spil publishers, Woerned, The Netherlands.

[32] e.g. J. J. Finneran, C. E. Schlundt, D. A. Carder, J. A. Clark, J. A. Young, J. B. Gaspin, S. H. Ridgway Auditory and behavioral responses of bottlenose dolphins (*Tursiops truncatus*) and a beluga whale (*Delphinapterus leucas*) to impulsive sounds resembling distant signatures of underwater explosions. J. Acoustical Soc. of America. V.108(1) July 2000.

[33] 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

[34] 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.

responses. The disparity between the TTS figures used by Verboom and Kastelein and the numbers used in the DEIS indicate a high degree of scientific uncertainty in the models and extrapolation methods used in both sets of assumptions. I am 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,[35] and 3) they are inherently more precautionary, in that they examine the thresholds of behavioral response, not the upper limits of physiological response.

Regarding the estimation of PTS onset relative to TTS levels used in the DEIS,[36] I find these data troubling as well. The linear regressions adapted from the W.D. Ward et al papers[37] cited in the DEIS 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 Ward studies are "conservatively" tempered in the DEIS by incorporating a study of cats by Miller[38] that indicates that cat's threshold of PTS is at 40dB recoverable TTS.[39]

The cat is also a highly visually adapted terrestrial animal, though it is more dependent on aurality than humans.[40] One correlation can be deduced here is that animals that are more dependent of 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

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[35] 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.

[36] GOA-DEIS 3.8-88–92

[37] e.g.: Ward, W.D. "Recovery from high values of temporary threshold shift." J. Acoust. Soc/ Am., 1960. Vol. 32:497–500.

[38] Miller, J.D., C.S. Watson, and W.P. Covell. 1963. "Deafening effects of noise on the cat."Acta Oto-Laryngologica Supplement Vol. 176:1–91.

[39] The DEIS states further that "A variety of terrestrial mammal data sources point toward 40 dB as a reasonable estimate of the largest amount of TS that may be induced without PTS" though no citations are provided for this statement.

[40] 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,[41] not the "conservative" 20dB modeled in the DEIS.

Given the forgoing, we might assume from the data presented in the DEIS that the onset of TTS occurs at 185dB re: 1μPa^2-s (as shown in the DEIS without incorporating the "statistical mean" tool), and that 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 (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.

Regarding the DEIS section 3.8-92 "Criteria and Thresholds for Level B Harassment from Non-TTS:" The authors of this section state that there is no metric to determine the "annoyance" levels of non-verbal animals. I suggest that the subjective term "annoyance" be replaced with the more observable characteristic of "disturbance." Many papers on disturbance levels in marine mammals are available[42] and can be used in lieu of trying to find published papers on the subjective "annoyance levels."

The behavioral effects section 3.8-92 does mention that "…there are few observations and no controlled measurements of behavioral disruption of cetaceans caused by sound sources with frequencies, waveforms, durations, and repetition rates comparable to those employed by the tactical sonars to be used on the proposed TMAA." This statement is the first indication in the DEIS that the authors have identified that the paucity of data derived from exposing animals to actual sonar signals is a shortcoming of the analysis.

The "risk function adapted from Feller"[43] could prove to be a useful tool, but like any model, the output is only as good as the input. As such, any data using the trained and

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[41] 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.

[42] e.g.: 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. See also 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.

[43] GOA-DEIS 3.8-94

long-term habituated animals at the San Diego test facility must be categorically dismissed because the SCC animals have been treated as "biological input devices" and thus are a very poor analogy for wild animals. Surprisingly the conclusions in the DEIS reflect exactly the opposite conclusion, although some of the shortcomings are addressed (limited species range and the animals trained for TTS tests, not behavioral tests).

The data from the Haro Strait incident[44] should be tailored to reflect that the J-pod orcas were already being set upon by groups of whale-watching tour-boats (of which they must be habituated) so there is a probability that their "disturbance" thresholds would have been elevated from their non-set-upon or wild habitat state. Thus the impact risk thresholds modeled with the risk function using the Haro Strait data should be weighted down by some amount. While this is reflected in the DEIS, any weighting factor would be arbitrary.

In the absence of empirical data some model must be used. The risk function is heading in the right direction, but with the limited input sources the weighting should favor a lower threshold than what unweighted inputs from Haro Strait and SCC inputs would yield. We believe that the Nowacek data[45] is the "cleanest" of all three, but as noted in the DEIS the alerting signals do not approximate MFA Sonar signals, although the relatively low behavioral threshold for mysticetes is supported by Di Iorio and Clark[46] in seismic sparker signals.

Meanwhile excluding the fairly comprehensive and robust harbor porpoise data from the input set, or modifying the same risk function curve used in the other three inputs is arbitrary. With the paucity of data – both in terms of studies as well as species, qualified data should not be excluded from the input data set, nor should any clean data be modified to accommodate for arbitrary considerations just because the data does not fit the desired outcome of the model.

The fact is that the years of Kastelein data on harbor porpoises more accurately represent the behavioral responses of near wild animals because 1) these animals are the most recently wild captive animals, 2) the testing done on these animals is done with signals more characteristically akin to MF and HF sonar, 3) the tests are focused on behavioral responses, not operant conditioning, and 4) the testing environments have been

[44] Fromm, D. 2004. "Acoustic Modeling Results of the Haro Strait For 5 May 2003." Naval Research Laboratory Report, Office of Naval Research, 30 January 2004.
[45] Nowacek, D.P., M.P. Johnson, and P.L. Tyack. 2004. North Atlantic right whales (*Eubalaena glacialis*) ignore ships but respond to alerting stimuli. Proceedings of the Royal Society of London, Part B 271:227-231.
[46] Lucia Di Iorio and Christopher W. Clark "Exposure to seismic survey alters blue whale acoustic communication" Biol. Lett. 23 February 2010 vol. 6 no. 1 51-54

specifically designed or cited to eliminate high levels of background noise and specular reflections found in most training enclosures.

Additionally, tailoring the harbor porpoise data because they "inhabit shallow and coastal waters suggest[ing] a very low threshold level of response for both captive and wild animals"[47] flies in the face of glomming together mysticetes and odontocetes that do fit a convenient risk function. If the justification for melting together three disparate species under three disparate conditions is due to the paucity of behavioral data available, then the Tyack et. al[48] controlled exposure work on beaked whales should not have been excluded from the data set. This is particularly the case since the exposure tests were funded by the US Office of Naval Research and included beaked whales – a species of particular concern. Perhaps the Tyack results were not included because they showed behavioral responses to signal Receive Levels as low as 117 dB (re: 1 μPa)?

In section 3.8-106, Table 3.8-7a "Approximate Distance to Effects for At-Sea Explosives in the Temporary Maritime Activities Area" the metric is not stated. Are these feet or meters? Without this data the table is meaningless.

Regarding the general topic of behavioral responses to explosions, it is extremely reductionist to assume that agonistic response linearly correlates to exposure level regardless of the signal source or characteristic. The DEIS assumes that the response value of an explosion is equivalent to the response value of other impulsive but natural sounds such as thunder or calving icebergs. I don't believe that it would be too anthropomorphic to assume the analogy to human response to explosions; and that our response to explosions in our own neighborhood, or even across town would definitely be different than our response to thunder.

The clear fact is that explosions from military ordnance have the acoustical signature of things being destroyed. Regardless of the collateral damage to animals and habitat, military explosions are a product of destruction. This plays into physiological impacts and behavioral responses, but also into psychological disruption, inducing stress and anxiety, compromising biological function. The DEIS fails to bring this into the discussion.

Additionally, despite the appearances presented in the inverted impact model used to examine the impacts of explosions on fish (evaluated in this document), explosions will

[47] GOA-DEIS 3.8-101
[48] Tyack, P. et. al.. "Effects of sound on the behavior of toothed whales." J. Acoust. Soc. Am. Volume 123, Issue 5, pp. 2984-2984 (May 2008)

cause fish mortality and habitat destruction which will in turn compromise food abundance for marine mammals. To what extent is not included in the DEIS analysis.

For the foregoing reasons we advise the “No Action Alternative” be used.

In the event that the US Navy sees to dismiss the foregoing arguments, or accommodates them to their best “practicable manner” and proceeds with Action Alternative 1 or Action Alternative 2, we advise the deployment of third-party (non military) aerial and marine observers to scan coastlines and littoral waters for marine mammal stranding incidents during the exercises. The GOA is sparsely populated with very long stretches of uninhabited coastline. Should some catastrophic impacts of the TMAA operations kill or maim marine mammals causing them to strand there is a high probability that the event would go unnoticed or unreported without an active, non-biased watch.

Sincerely,

Michael Stocker
Director