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December 21, 2005
Re: Comments on the Draft Overseas Environmental Impact Statement/Environmental Impact Statement for the Undersea Warfare Training Range
(70 Federal Register 62101-62103)

Dear Mr. Jenkins,

I have taken some time to review the DOEIS/EIS for the proposed Undersea Warfare Training Range (USWTR). It is a comprehensive document and reflects much work and deliberation on the part of the preparers. Thank you for granting an extension on the public comment period on this document. This added time has allowed me to be a bit more thorough in my review and comments.

There are many challenges in assembling an EIS of this breadth, particularly when dealing with an environment as vast and unknown as the ocean. The paucity of knowledge on the biology, behaviors and natural history of ocean animals causes us to speculate and make many assumptions about the impacts that our enterprises will have on the subject environment and the resident biota. Nonetheless, if we want to succeed in our ocean enterprises we need to move ahead based on these assumptions; because if it was the human predilection to 'know everything' about our actions prior to moving ahead, I am sure that we would still be dragging our knuckles around in Olduvai Gorge looking for food.

Fortunately we have moved on from our ancestral roots and accumulated a body of experience which we can bring to bear on our continuing assumptions. But our assumptions are still just speculations – based on inquiries that support our own ideas about progress. In an enterprise of the magnitude, importance and consequence of the Undersea Warfare Training Range, we really need to evaluate the foundation of the assumptions that are used to justify the project. It is here where disparate perspectives and priorities need to be considered and deliberated, otherwise the project may fail in some important measure.

I am not a military strategist, but I do know that any great nation needs a prepared, defensive military; thus I do not refute the need for a training range. I am an acoustician, working in bio-acoustics and applied physics. And while I know that there are alternatives to many of the technologies included in the USWTR, it is not the purpose of this letter to discuss these alternatives, rather it is my purpose to evaluate some of the assumptions that frame the "safe" use of our existing technologies in a complex animal habitat. (I will also be largely focusing my comments on the marine bio-acoustic environment, as I am not qualified to comment on socio-economic, cultural or terrestrial impacts of the proposed project.)

In this context, perhaps my deepest concern with the DEIS as a whole is the assumption that "Temporary Threshold Shift" (TTS) is an acceptable benchmark of safety for marine organisms. While it is true that by definition TTS is a recoverable condition, the animals subject to this harassment are not just biological machines that predictably respond and reliably recover from calibrated stimulus, rather they are organisms that rely on a healthy, predictable habitat to thrive. The assumption that a 50% behavioral response is an acceptable threshold[1] for maintaining a healthy ecosystem is questionable; it is based on the assumption that any "take" from a specific stimulus is only a brief moment from which an organism can recover unchanged. It does not account for the effects of repeated and chronic "takes" in an ecosystem subjected to continuous or periodic, multiple-source, and overlapping "takes," and other known, but unaccounted for ecosystem stress factors. Thus the use of an "acceptable level of TTS," up to the threshold of PTS being within the Marine Mammal Protection Act "Level B" harassment definitions is a bit of a reach and should not be the standard used in the EIS.

While TTS is a "recoverable" condition, it is nonetheless a symptom of physiological damage. It is like a contusion from blunt physical impact. While the contusion is also recoverable, it is still painful. A light contusion may not reveal tissue damage, and even while it may leave no lasting evidence in the tissues, it will cause "disruption of natural behavior patterns…[potentially up] to a point where such behavioral patterns are abandoned or significantly altered."[2] So TTS is physical damage. When an animal is traumatized by a painful incident, it is likely to evade circumstances similar to the conditions that caused the trauma. In this context I believe that the onset of TTS is actually where the definition of MMPA "Level A" harassment criteria sets in, not at the higher point where physical damage is not recoverable.

[1] USWTR DEIS document, Section 4.3.4.2.
[2] The threshold between MMPA "Level A" and "Level B" harassment is the threshold between behavioral disruption and physical damage,

I will comment in more detail on the systemology behind my concerns below, but I believe that as a whole, we need to consider the synergistic effects of the proposed project as a 'transformation of the habitat' rather than considering the project as a set of specific incidents that have tidy "recovery metrics" written into their implementation.

My concern for the 'transformation of the habitat' is clearly illustrated in the DEIS discussion about "expendables" dropped to the seafloor.[3] The discarded sonobuoys are emblematic of this framing: According to the DEIS, close to 8,000 of the sonobuoys will drop to the sea floor each year. In the DEIS discussion, an individual sonobuoy's contribution of lead to its immediate surroundings are justified through a model of limited dimensions. The arguments seem reasonable while looking through the narrow window of the DEIS model, but the environmental impact will prove different over time. By discarding all of these sonobuoys, somewhere between 6,000 – 7,000 pounds of lead will be deposited into the sea each year. This will be joined by copper, lithium, arsenic, capacitor electrolytes and other corroding heavy metals contained in the sonobuoys that will accumulate over the years. Using a "USEPA 1 hour exposure criteria" (using fresh water corrosion rates) [4] to justify the accumulation of all of these heavy metals over time is characteristic of the type of limited "exposure risk" assumptions used throughout the DEIS – including the assumptions used for bio-acoustic risks. Establishing the viability and safety of the entire project using these isolated sets of narrow evaluation windows does not bode well for a successful enterprise.

Of course the counter argument to this is that the sea is very large, and it can absorb these relatively tiny assaults. But over the recent years we are finding that the sea isn't as large as we thought, and that the impacts of human endeavors are seriously compromising the habitat and biota.[5]

The USWTR DEIS section 4.1.1.3 assures us that it would take 2 million years at the proposed rate to cover the sea floor of the proposed training range with expended sonobuoys. This is a specious metric, as it does not reflect the objective of the program. This metric also reveals other numerical shortcomings of the DEIS model.

First, it us unlikely that the distribution of discarded sonobuoys will be evenly distributed across the entire extents of the range; it is more likely that the center of the range will be subject to high concentrations of sonobuoys, and the perimeters will likely have none. This distribution should be reflected in the toxicity concentration metrics, and

[3] *Ibid*. Section 4.1.2.3
[4] In the DEIS model, freshwater solubility constants were used which do not accurately represent the corrosion rates in salt water, which are considerably higher.
[5] An Ocean Blueprint for the 21st Century" Final Report of the U.S. Commission on Ocean Policy. Washington, D.C., 2004 ISBN#0–9759462–0–X

not obfuscated by the concept of the physical dimensions of the sonobuoys covering the entire extents of the range, which is a useless statistic.

Second, the toxicity metric proposed in Section 4.1.2.3, including the "freshwater solubility constants.' The environment is salt water, so saltwater solubility constants should be used. But even using the proposed "freshwater solubility constants " it would only take 20 years accumulation at the proposed discard rate for the area to exceed current EPA "1 hour limit" sited in the DEIS. The prospect of covering the floor with expended toxins without considering the toxic impacts exhibits a lack of perspective on the part of the DEIS preparers. It is just this type of limited modeling used in the DEIS that continues to justify the damaging practices that have so compromised the health of the ocean.

Another overarching concern I have is the blanket exclusion of all fish and invertebrates from consideration in terms of acoustic impacts. While the OBIS[6] has cataloged some 40,000 species of marine animals, and some 190,000 sea animals are known to science,[7] the current estimate is that there are some 2.3 million marine animals extant, and of the ~50,000 species of fish, we have audiograms on less than 100 individual species.[8] We have perhaps only a dozen audiograms on invertebrates. This situation suggests that we have much to learn about sound perception of marine animals.

Meanwhile, the executive summary Section 5.3, states that there is "no information available that suggests that exposure to non-impulsive acoustic sources results in fish mortality." While the absence of information does not imply an absence of harm, what particularly concerns me is the continuing comment in this section that "…While experiments have shown that exposure to loud sound can result in significant threshold shifts in certain fish that are classified as hearing specialists … these threshold shifts are temporary and it is not evident that they lead to any long term behavioral disruptions in fish that are biologically significant."[9]

Again, the absence of evidence does not imply an absence of harm. Lacking any thorough studies on the intermediate or long term effects of threshold shifts on fish populations repeatedly exposed to active sonar signals, it is reckless to assume that disruptions would not be biologically significant.

The assumptions used in the DEIS to exclude fish and invertebrates are quite sweeping, and while they may seem plausible in the context of human experience and

[6] Ocean Biogoegraphical Information Systems http://iobis.org

[7] "Sidelines" feature in Nature Dec. 15, 2005 V. P. OBIA

[8] National Research Council Ocean Studies Board " Ocean Noise and Marine Mammals" 2003 p.87 National Academies Press.

[9] USWTR DEIS section ES 5.3 "Acoustic Effects" p.S9

human priorities, they may not reflect the priorities and "experience" of the subject organism.

There are a few simple examples of how human priority framing misses the biological responses of these animals: There is a common, but erroneous assumption that fish subjected to a threatening noise will swim away from the threat to escape it. While migratory fish may evade threats by swimming away, many fish, especially sedentary fish, will "entrench" into their safe zone when threatened and thus prolong their exposure to potentially damaging stimulus. An example of "entrenchment" behavior is used in the DEIS[10] regarding salmon exposed to 5 – 10 Hz noise. These animals retreated to deeper waters, even while the deeper waters they retreated into "was near the sound source." (DEIS p.3.3-4) Of course due to the wavelength of 5 - 10 Hz tones (1000' – 500') in water, the location of the noise source *in situ* would not be evident to the salmon, so they just went deeper to a known 'safer' area.

Fish respond to threats in ways not clearly understood by humans. The classic "fight or flight" response we expect from terrestrial animals is not necessarily consistent across all vertebrates, so while mammals and birds will prepare for action when threatened by increasing their blood flow – through increasing their hear rate, the heart rates of many fish will decrease when they are threatened.[11] While we don't have a clear grasp on the purpose of this response, it may have to do with their need to 'become acoustically invisible' when threatened by predation. (A racing, high blood-pressure heart will convey significantly more acoustic energy into the aqueous surroundings than will a "still" heart.)

These differences in biological responses betray some of our assumptions about animal threat-response and behavior. 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

[10] (Section 3.3.1.2. citing Knudsen, 1994 – not listed in the reference section.)
[11] e.g.: Nestler, J. M., Ploskey, G. R., Pickens, J., Menezes, J., and Schilt, C. "Responses of blueback herring to high-frequency sound and implications for reducing entrainment at hydropower dams." 1992 North American Journal of Fish Management. V.12. p.667-683

'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.[12]

This is germane to the DEIS because the audiograms and threshold shift procedures used to determine the acoustical sensitivities of fish in the cited studies[13] that justify their exclusion from consideration used either sinusoidal signals or band limited 'pink' noise[14]. While this statement doesn't answer many questions in regard to the impacts of the noise generated by the proposed USWTR project on various fish exposed to the noises of the program, it highlights the fact that the assumptions used to frame their exclusion 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"[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 proposed for the USWTR, 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'

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

[13] The DEIS cites Scholik and Yan, 2002 and Wysocki and Laddich, 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.

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

[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.

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 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 in the DEIS.

There are also many questionable assumptions made in the DEIS regarding the actual levels of Temporary Threshold Shift (TTS) and Permanent Threshold Shift (PTS) in marine mammals. As stated in the DEIS, PTS levels are on 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 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. A recent study by Finneran, Carder et al. (JASA 2005)[16] 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. One of the assumptions is that they do.

Model inaccuracies due to habituation in the instance of this study is compounded by the fact 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 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.[17] 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.

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

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 seems to include the lipid channels in their lower jaws,[18] 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.[19] 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.[20] 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. Surprisingly, the DEIS addresses this "habituation issue" with exactly the opposite conclusion – that "…it is also possible that prior experiences and resultant expectations may have made some trained subjects less tolerant of the sound exposures." (DEIS Section 4.3.4 p. 4.3-22)

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), with some examples of TTS occurring at higher levels. In the DEIS these levels are averaged in a "statistical mean" to justify raising the TTS level to 195dB.[21] 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." 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

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[18] 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.

[19] 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.

[20] 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.

[21] USWTR Section 4.3.3.1

should be used as found and as presented; that onset of TTS occurs in test-habituated animals at 185dB (re: 1μPa^2-s).

As in the fish studies, none of the tests performed on marine mammals used signals that simulated the actual sonar signals proposed for the USWTR project. 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.[22] 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.[23] These 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 USWTR operation.

Kastelein and Rippe studied younger animals (harbor porpoise *Phocena phocena*) with more appropriate test signals yielded significantly different results.[24] And while the Harbor porpoise will not be subject to the more southern extents of the proposed USWTR ranges, 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.[25] 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.

Like the estimated PTS levels used in the DEIS, the TTS figures from the Verboom and Kastelein (2005) study are extrapolations – extrapolating results from behavioral

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[22] 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.

[23] 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.

[24] 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

[25] 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.

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 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,[26] 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 (Section 4.3.3.2); I find these data troubling as well. The linear regressions adapted from the W.D. Ward et al papers[27] 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[28] that indicates that cat's threshold of PTS is at 40dB recoverable TTS.[29]

The cat is also a highly visually adapted terrestrial animal, though it is more dependent on aurality than humans.[30] 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 TTS level of 30dB. If we use this assumption, the onset of PTS in cetaceans may only be 15dB above the onset of TTS.[31]

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[26] 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.

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

[28] 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.

[29] 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.

[30] 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."

[31] 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

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 I 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 chapter 4.3.4 on behavioral effects: The authors of this chapter 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[32] and can be used in lieu of trying to find published papers on the subjective "annoyance levels."

This behavioral effects chapter (4.3.4) 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 USWTR." 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 liability.

Because "(a)t the present time there is no consensus in the scientific community on how to account for behavioral effects on marine mammals exposed to continuous-type sounds" the "OEIS/EIS uses behavioral observations of trained cetaceans exposed to intense underwater sound under controlled circumstances to develop a criterion and threshold for behavioral effects of sound."[33] These (same) animals are again all over 30

(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.

[32] 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.

[33] DEIS (p.4.3-22)

years old and habituated to training routines.[34] The DEIS states that these tests are most appropriate because these animals are typical of animals found in the proposed areas and exposed to “controlled, tonal sound exposures within the tactical sonar frequency range.” The argument remains the same for these same animals as for when they were used in TTS testing above; they are older, test-habituated animals that have lived a large portion of their lives performing tests for a living – and they are not exposed to actual sonar-type signals. Furthermore, the behavioral tests cited here are observations of incidental responses to stimulus and do not incorporate any long term synergistic effects of continued, repeated exposures to loud sonars.

While the synergistic effect is somewhat addressed in the DEIS Section 4.3.4.3. “Likelihood of Prolonged Exposure” this consideration is only in terms of actual exposures from specific incidents. This does not account for the synergistic effect of animals that end up avoiding familiar but compromised habitat (displacement) or the effect of the compromised habitat on the subject animals if they chose to (or must) remain in the compromised habitat. An ocean habitat subjected to 161 six-hour events per year does not leave a calm, natural habitat in tact once each six hour exercise is terminated, rather it significantly modifies the habitat to include a high degree of acoustic activity throughout the year (44% of the days in a year).

In terms of other behavioral impacts of the proposed program, the DEIS also uses a “50% point” behavioral threshold “at which a significant alteration of a statistically normal behavior pattern occurs.”[35] There are two reservations that arise from this metric. First, trained animals’ reluctance of to perform in a controlled setting where the expectations of reward are the only performance incentive are not a good metric for the behavior of wild populations that are free to avoid compromised habitat – and thus may be displaced over time. Secondly, the statistical use of the “50% point” for an “all or nothing” response belies the fact that the trained animals avoid trained behaviors 10% of the time at 170dB. This indicates that there is also a ‘tolerance threshold’ unique to trained animals where they will avoid disturbing noise at a much lower level than the proposed 190dB, but also will tolerate a known and familiar stimulus regime because this is their ‘livelihood.’

If the objective is to avoid displacing or compromising natural behaviors of wild animals, using the cited tests would indicate that the threshold for behavioral alteration is 170dB, not 190dB. This level is still significantly higher than disturbance levels indicated

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[34] 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.” J. Acoust. Soc. of Am. 107(6), 3496-3508. Also see: Finneran, Shluntd 2005 above.
[35] DEIS 4.3.4.2 p. 4.3-26

in tests done with "fresher" animals using sonar-like signals more akin to the signals used in the proposed USWTR program. The Verboom and Kastelein (1997) study indicates harbor porpoise avoidance behavior at 133dB, [36] and the Buck and Tyack (2003) study indicates a gray whale avoidance behavior (to Low Frequency Active Sonar (LFAS) signals) at 135dB.[37] These studies more accurately reflect the true conditions of the proposed USWTR and should be incorporated into the EIS.

Regarding the derivation of data for other species: The DEIS Section 4.3.5.1 states that there the "absolute [frequency threshold] sensitivity has not been modeled for any baleen whale species." While this is true, it is also true (evident from the forgoing) that there are no absolute sensitivity models for any odontocetes either. 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 USWTR. 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)[38] and the song-length alterations of humpback whales indicated in Fristrup, Hatch and Clark, (2003)[39] we find behavioral responses that occur when the receive levels (RL) are between 130dB and 150dB. If we extrapolate the TTS levels using the threshold models from Verboom and Kastelein, (2005)[40] (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 from these animals, rather than inferring 'data' from a similar, but distinctly different order of cetaceans.

Regarding the "Long Term Effects" addressed in the DEIS Section 4.3.6.3; I find much of this section troubling. The opening assumption is that the "non-injurious sound exposure levels (SELs) predicted to cause TTS or temporary behavioral disruptions qualify as Level B harassment." The paragraph goes on to state that it is "highly unlikely that all behavioral disruptions or instances of TTS will result in long term impacts."

These two assumptions that both require deeper scrutiny. The first is that the impacts to all animals in the subject area will all be at or below the MMPA "Level B"

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[36] cf.: Verboom and Kastelein, 1997 above.
[37] cf: Buck and Tyack, 2003 above.
[38] Ibid.
[39] 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).
[40] cf. Verboom and Kastelein, 2005 above.

harassment criteria. As indicated above, onset of TTS is really the threshold of MMPA "Level A" harassment, particularly when intermediate and long term effects are taken into account. This brings up the second assumption that the harassment (regardless of MMPA criteria) is "highly unlikely" to have any long term impacts.

That the preparers of the DEIS use the "Level B" argument to substantiate the claim that the noise will have no long term impact springs out of a circular argument that does not square with the obvious: The USWTR will significantly transform and alter the habitat of the proposed site. This will have intermediate and long term impacts on the resident biota. What the EIS process is attempting to determine is whether the compromises to the habitat are such that they will incur serious non-recoverable damage on that biota. The "highly unlikely" comment is an editorial comment, not borne out by scientific inquiry or methodology.

Furthermore, this editorial position is 'substantiated' by the bulleted claim that "There is no established scientific correlation between mid-frequency sonar use and long-term abandonment or significant alteration of behavioral patterns in marine mammals." This is yet another instance in the DEIS where the absence of information does not indicate an absence of harm. If this bulleted comment is to be included in the DEIS, it should be substantiated by a study demonstrating that chronic, long term use of mid-frequency sonars do not have any negative impact on the habitat. Lacking this information, and in the face of the evidence of damage incurred by mid-frequency sonars,[41] precautionary practices would infer that chronic use of mid-frequency sonars will have negative intermediate and long term effects on the habitat.

The second bulleted point under this section is a speculation that can be argued in any way; either the subject animals will or will not be exposed to repeated or prolonged exposures. While the limited reach of the mid-frequency sonars might in turn limit the "disturbance reach" of the signals, the high platform speeds will increase the range of disturbance incidents.

The final bullet point is perhaps the most troubling of this section, inasmuch as it indicates an observation program and infers monitoring and mitigation measures, but the mitigation Chapter 6 only speaks about monitoring and does not include provisions for what actions will be taken if "long term changes in habitat use or behavior" are noticed. I suppose at the point where long term changes are observed, "the horses will be out of the barn" and we can only 'notice' as the habitat falls apart – it being at that point far too costly to pull up the infrastructure of the USWTR and relocated it, or employ an array of more benign technologies. Hopefully by being precautionary and scientifically rigorous

[41] e.g.: Bahamas Cuvier beaked whale strandings, 2000; The Canary Island Beaked whale strandings, 2002 ad 2004; Haro Strait/USS Shoup Incedent, 2003; Hanalei Bay Melon headed whale incident 2004 .

in this “proposal and development” stage of the USWTR project, we can avoid this costly and unfortunate scenario.

Sincerely,

Michael Stocker
Science Advisor,
Seaflow Inc.

Recommendations:

Based on the forgoing arguments, the following recommendations should be included in the USWTR EIS:

1) The toxicity model examining the impacts of discarding sonobuoys into the ocean should model the concentrations of the sonobuoys and the resulting release of toxins into the environment using the distributions of the discarded sonobuoys as a true product of where the sonobuoys are likely to land, not as a product of the concentration of the discarded sonobuoys across the entire area of the range.
2) The toxicity model examining the impacts of the discarded sonobuoys should evaluate other toxins contained in the sonobuoys, not just lead.
3) The toxicity model examining the impacts of the discarded sonobuoys should use saltwater solubility rates, not freshwater rates.
4) Fish and marine invertebrates should not be systematically excluded from the EIS until threshold tests using actual sonar signals on these organisms are evaluated.
5) Until intermediate and long term studies on the effects of TTS on fish are done, it should not be assumed that there are no intermediate and long term effects of loud noises and TTS on these animals.
6) Threshold evaluations for marine mammals should use studies that employ complex, sonar-like signals.
7) Temporary threshold shifts in marine mammals should not be considered a “safe and acceptable exposure level,” rather TTS in a subject should be the considered the threshold for MMPA “Level A” harassment.
8) Temporary threshold shifts in any subject animal should not be considered a “safe and acceptable exposure level.”
9) MMPA “Level B” harassment should begin at the threshold of behavioral disturbance and end just below TTS.
10) Threshold testing on old, test-habituated animals should be given much less weight than threshold testing on younger, less habituated animals.
11) Existing avoidance behavior and behavioral response studies on mysticetes should be included in the DEIS.

12)
13) Wherever possible, the use of terrestrial animals to establish physiological thresholds in marine animals should be avoided. If terrestrial animal models are used, they should be used with the caveat that the terrestrial and marine environments differ significantly, and so too the biological adaptations of the resident biota to their respective environments.