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Mr. Gary D. Goeke, Chief, April 30, 2014
Regional Assessment Section,
Office of Environment (MS 5410),
Bureau of Ocean Energy Management,
Gulf of Mexico OCS Region,
1201 Elmwood Park Boulevard,
New Orleans,
Louisiana 70123–2394

Cc: Jill Lewandowski, USDOI

Re: Comments on the Final PEIS for Atlantic G&G Activities

Dear Mr. Goeke,

We appreciate this opportunity to submit our comments on the Final Programmatic Environmental Impact Statement on the Atlantic OCS Proposed Geological and Geophysical Activities (hereinafter Atlantic G&G PEIS). In this document we will comment on how and if our original comments on the 2012 Draft Environmental Impact Statement were addressed, and to the extent that we can, comment on the changes made in the document reflecting the comments of the public and industry.

As in our original comments we will attempt to be thorough and informative in our review. We will also be focusing the bulk of our comments on the acoustical impacts of the proposed actions because this is our area of expertise.

In our conversations with colleagues about this "final" PEIS the fact continuously arises that Draft EIS on acoustical guidelines was recently submitted by NOAA for public review[1] (hereinafter "NOAA Acoustical Guidelines"). While these guidelines represent an incremental improvement over previous noise exposure guidelines, we found them lacking due to the paucity of data establishing auditory thresholds across marine mammal species, and with the submission of new data which puts the whole concept of "Temporary Threshold Shift" into question.[2, 3] (We have attached our critique of the guidelines to this letter.)

[1] 78 Fed. Reg. 78822 "Draft Guidance for Assessing the Effects of Anthropogenic Sound on 13 Marine Mammals" (Dec. 27, 2013)
[2] Kujawa, S.G., and M.C. Liberman. 2009. Adding insult to injury: Cochlear nerve degeneration after "temporary" noise-induced hearing loss. The Journal of Neuroscience 29:14077-2
[3] Lin, H.W., A.C. Furman, S.G. Kujawa, and M.C. Liberman. 2011. Primary neural degeneration in the guinea pig cochlea after reversible noise-induced threshold shift. Journal of the Association for Research in Otolaryngology 12:605-616.

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Given that the Atlantic G&G PEIS depends on the most up-to-date scientific information it stands to reason that a final decision on the plan cannot be issued until the noise guidelines are amended, approved, and used as guidelines for the Atlantic G&G PEIS.

It appears that BOEM had anticipated this, and why what is known as "Southall 2007" [4] was cited so extensively in the Atlantic G&G Draft PEIS. So while using the Southall guidelines in parallel with the legacy guidelines presaged the issuance and review of the NOAA Acoustical Guidelines, we believe that there are too many shortcomings in the acoustical guidelines to even approximate impacts indicated in the literature which has been published since the Southall 2007 paper. (e.g. Roland et.al.[5], 2012 and Costellote et.al 2012 [6])

So while we will put effort into our review, we believe in the end that a final "Final PEIS" will need another review using a revised set of acoustical guidelines.

From an editorial perspective it is clear that "Alternative B, the preferred action" is a paean to the fossil fuel industry. One of the deepest concerns of conservationists about the Atlantic G&G plan is that choosing the wrong alternative will be a tacit gateway for fossil fuel development on the Eastern Seaboard. In light of all we know about the severe impacts of fossil fuel on global climate, and the risks that fossil fuel extraction – particularly deepwater exploration and production on local and regional marine habitat, continuing to subsidize the hydrocarbon industry with the opportunities cleared by Alternative B is reckless and irresponsible.

Political, social, economic, and environmental threats posed by higher-energy climate conditions, sea level rise, and dependence on politically volatile non-renewable fossil fuel have been well detailed. Continuing to place the future of our civilization in the hands of private global energy interests is the epitome of madness. For these reasons alone it should be clear that the only realistic alternative would be Alternative C – the no action alternative which promotes the development of offshore wind and tidal energy resources. Choosing this alternative will send a clear message to the world that the US government is finally taking a stand on the climate disaster that is currently and rapidly unfolding.

Regarding some of the specific aspects of BOEM responses to our 2012 comments to the Draft PEIS,[7] we appreciate the time that went into reviewing and in a number of cases revising the "Final" PEIS in response to many of our (collective) concerns, although there remain some issues that we either did not express clearly enough, or the issue was not

[4] Southall, B.L., A.E. Bowles, W.T. Ellison, J.J. Finneran, R.L. Gentry, C.R. Greene Jr., D. Kastak, D.R. Ketten, J.H. Miller, P.E. Nachtigall, W.J. Richardson, J.A. Thomas, and P.L. Tyack. 2007. Marine mammal noise exposure criteria: Initial scientific recommendations. Aquatic Mammals 33(4):411-521.

[5] Rosalind M. Rolland, Susan E. Parks, Kathleen E. Hunt, Manuel Castellote, Peter J. Corkeron, Douglas P. Nowacek, Samuel K. Wasser and Scott D. Kraus. 2012 "Evidence that ship noise increases stress in right whales" Proc. R. Soc. B

[6] Manuel Castellote, Christopher W. Clark, Marc O. Lammers 2012 "Acoustic and behavioural changes by fin whales (*Balaenoptera physalus*)in response to shipping and airgun noise" Biological Conservation 147 (2012) 115–122

[7] Found in BOEM-2014-001-v3 Table 6: NGO-E-4 comments 0.01 through 0.31

resolved due to established regulatory guidelines – some of which we believe are regulatory shortcomings.

In response to our comment NGO-E-4-0.07 about hearing damage in fish, we believe that there is still too little known about fish hearing to make the broad assumption that "fishes are not likely to ever become permanently deaf."[8] We dismissed the Smith 2006 paper because the study was on goldfish – not representative of marine fish, and while Lombarte and Popper, (1994)[9] indicate high densities of hair cells in the saccule, there is no clear correlation that these high densities result in increased (or even what humans might consider "good") hearing sensitivity. While Mann et.al., (2009) do correlate increased hearing sensitivity in other gadiformes[10] correlated with age (or size of the saccular otolith and associated sensory epithelia of the inner ear) the effect of the increase in saccule size and number of hair cells does not clearly point to the same relationship between between quantity of hair cells to hearing acuity (or hearing damage) found in humans and other terrestrial vertebrates. Thus I would not rely on hair cell density, or even "self repair" to be a proxy for hearing health or acuity.

Furthermore McCauley et al., (2003)[11] does not indicate hair cell repair as indicated in the Atlantic G&G PEIS section 4.2.5.1.4; rather the paper indicated intermediate and long-term damage through "blebbing" and holes developing in the sensory epithelia. The paper also included the statement that "impact of exposure on ultimate survival of the fish is not clear. Fishes with impaired hearing or vestibular senses would have reduced fitness, potentially leaving them vulnerable to predators." This is an important factor that the Atlantic G&G PEIS continues to overlook – whether it is in fish or in marine mammals: That when animal's sensory systems are compromised they become less fit. Even if the compromise is "temporary," the animals will become more subject to predation, less capable of locating food, navigating, and sensing its surrounding for any survival purpose. McCauley et al., (2003) noted serious physiological compromise after 58 days. This is a long time to not hear well. And the very cage that prevented the fish from dispersing (used as a dismissive argument in the PEIS) may have also protected them from predation. (There was no later histologies performed on these subjects tracking degradation or recovery.)

Regarding the comment about caged fish not being able to escape from the noise; sedentary fish will not necessarily disperse when under assault, but may be predisposed to diving down and "sheltering in place."[12] This response is likely an adaptation to escape predation rather than to escape noise. In McCauley 2000 squid swam closer to the surface when exposed to noise where low frequency noise levels would be attenuated by the

[8] Atlantic G&G PEIS section 4.2.5.1.4

[9] Lombarte, A. and A.N. Popper. 1994. Quantitative analyses of postembryonic hair cell addition in the otolithic endorgans of the inner ear of the European hake, (*Merluccius merluccius*). Journal of Comparative Neurology 345:419-428

[10] David A. Mann, Christopher D. Wilson, Jiakun Song & Arthur N. Popper . 2009 "Hearing Sensitivity of the Walleye Pollock" Transactions of the American Fisheries Society Volume 138, Issue 5, pp 1000-1008

[11] McCauley, R. D., Fewtrell, J, and Popper, A. N. (2003). High intensity anthropogenic sound damages fish ears. J. Acoust. Soc. Am., 113:638-642

[12] Lise Doksæter, Nils Olav Handegard, and Olav Rune Godø, Petter H. Kvadsheim and Nina Nordlund. 2011 "Behavior of captive herring exposed to naval sonar transmissions (1.0–1.6kHz) throughout a yearly cycle." Acoust. Soc. Am. V.131:2

Lloyd mirror effect.[13] If the caged fish attempted to escape the noise they may have sensed the quieter boundary area near the surface and sheltered there. This provides an additional perspective on the cage issue from McCauley et. al., (2003) which also casts a shadow (or sheds light) on the BOEM response to our comment NGO-E-4-0.08, so our comments still stands, paraphrased in this and the previous paragraph. So the phrase "No mortality or injury is expected because there has been no observation of direct physical injury or death to fishes from airguns" should be pulled from the Atlantic G&G PEIS Summary page xviii

There is an ongoing assumption that fish will successfully disperse from areas they find unsuitable, represented in the BOEM comment "…adult fish exposed to elevated sound levels would be able to leave the area most severely impacted by the survey noise" made in the section 4.2.5.1. "Summary of Fish and Invertebrate Hearing Capabilities." This statement is pure speculation and is not consistent with what we know about sedentary and non-migratory fish. This assumption should not be used as a mitigation strategy and should be pulled from the EIS.

The fact stated in section 4.2.5.1.4 that "there is no evidence in fishes for permanent hearing loss" can also as factually be rephrased to "there is no evidence in fishes that permanent hearing loss does not occur." To substantiate this point; fish deafened "temporarily" in lab settings would typically be dissected to perform a histology of the inner ear. Deaf fish in their native habitat would likely be eaten – leaving no evidence of their hearing impairment.

As we have indicated in our 2012 comments, an absence of evidence does not indicate an absence of harm, and given the overwhelming evidence that human enterprise is significantly compromising marine habitat it becomes incumbent upon us to apply the precautionary principal when there is an absence of evidence of possible harm from habitat compromise.[14]

We also continue to stand behind our comments that "The DEIS treats invertebrates very lightly - almost dismissively" because we find the following summary statement in Appendix D:

> "At present very little is known about the response to invertebrates to sound exposure and it is not possible to specify levels of sound exposure that are safe for invertebrates. There are few, if any, data suggesting that exposure to seismic airguns produce immediate mortality for invertebrates. A more important issue for invertebrates is likely to be the induction of sub-lethal effects that may impact life functions without causing death."

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[13] McCauley, R.D., J. Fewtrell, A.J. Duncan, C. Jenner, M.-N. Jenner, J.D. Penrose, R.I.T. Prince, A. Adhitya, J. Murdoch, and K. McCabe. 2000. Marine seismic surveys: Analysis of airgun signals and effects of air gun exposure on humpback whales, sea turtles, fishes and squid. Report from Centre for Marine Science and Technology, Curtin University, Perth, Western Australia, for Australian Petroleum Production Association, Sydney, NSW.

[14] "Precautionary Tools for Reshaping Environmental Policy" MIT Press 2005 Edited by Nancy Myers and Carolyn Raffensperger

This is the convener's synthesis of Dr. Jerry Payne's presentation to the "Effects of Noise on Fish, Fisheries, and Invertebrates in the U.S. Atlantic and Arctic from Energy Industry Sound" workshop cited in the PEIS as Normandeau (2012) [15] This comment was found in the "Gap Analysis" section of the report – which substantiates the fact that there is little known about the impacts of seismic impulses, or any other noise on marine invertebrates.

It is important to establish here that while marine invertebrates are not specifically protected under an agency such as the Marine Mammal Commission (MMC), and that any regulatory oversight on the general health of any given species falls under the Department of Commerce (DOC)[16] which predicates regulatory guidelines on the commercial importance of the species. Thus abalone, clams, and lobsters are regulated, but sea pens and zooplankton are not. Because these "lesser creatures" do not have a "front line" regulatory status, there is little incentive to understand their natural history (no funding for research). As a consequence we know very little about the impacts of chemical pollution, over-harvesting, or industrial noise on these building-block species - and do not have a regulatory framework or mitigation guidelines to protect them.[17]

But many species that are protected under the DOC depend on these unregulated and unprotected species. If we use the "no evidence of harm" argument to justify disrupting their habitat we are setting a bad precedent of opening a gateway for potential habitat disruption that will have impacts on species of concern which are protected under our regulatory regimes.

Regarding the use of Appendix J for any guidance on impact s on fish, it appears as though Dr. Popper arrives at similar conclusion that we have; that with all of the uncertainty it is hard to predict, especially in broad terms, what impact noises will have on fish. Representative of some of his comments:

> "The data obtained to date on effects of sound on fishes are very limited both in terms of the number of well-controlled studies and in the number of species tested. Moreover, there are significant limits in the range of data available for any particular type of sound source."
>
> "Because of the limited ways in which behavior of fishes in these studies were "observed" (often by doing catch rates, which tell nothing about how fishes really react to a sound), there really are no data on the most critical questions regarding behavior."
>
> "Long-term rises in sound level are not likely to result in death or physiological effects (though it is possible that there may be long-term changes in stress levels

[15] Normandeau Associates, Inc. 2012. "Effects of noise on fish, fisheries, and invertebrates in the U.S. Atlantic and Arctic from energy industry sound-generating activities." A literature synthesis for the U.S. Dept. of the Interior, Bureau of Ocean Energy Management.

[16] National Oceanographic and Atmospheric Administration (NOAA) over National Marine Fisheries Service (NMFS) are under the Department of Commerce.

[17] In Normandeau 2012 Dr. Payne states "These laboratory studies should focus on deriving dose-response relationships, including those for chronic sound exposure, for both commercially important species as well as keystone zooplankton species such as *Calanus*".

and immune response), but they could also produce hearing impairment, masking, and/or behavioral effects"

"There are very few data documenting effects of any intense sound source on eggs and larvae in the open ocean. Far more data are needed before any preliminary conclusions can be reached on the effects of sound on eggs and larvae, and studies need to include, in addition to mortality, effects on growth and body tissues."

Using Dr. Popper's synthesis of existing literature, and citing his expressed need for more data, we submit that the Atlantic Seaboard should not be used as a makeshift lab for studies on the impacts of anthropogenic noise on fish and invertebrates.

Regarding BOEM response to our propagation models (NGO-E-4-0.10) we found that the models used in Appendix D were even more simplistic than our models – reverting back to either spherical or cylindrical spreading. We stand by our comments:

One assumption [made in the Atlantic G&G PEIS, Appendix D is that sound will propagate in a hemispherical pattern away from the source until the acoustical energy encounters a boundary. The 'broad brush' attenuation formula for this is: $20\log_{10}(r_1/r_2)$ where r_1 is the reference distance (usually 1 meter) and r_2 is the subject distance for evaluation.

Once the energy hits the seafloor the energy tends to spread in a cylindrical pattern wherein the attenuation formula is $10\log_{10}(r_1/r_2)$. Because the first boundary encountered is the seafloor, the sound levels at a distance within the depth of the ocean directly beneath the source will be more in line with attenuation at 20dB $\log_{10}$ of r. Far field will be more in line with $10\log_{10} r$. But there is some continuum between these attenuation conditions, so depending on the distance between the receiver and the source the attenuation factor may be closer to 17 in the "nearish field" and 13 in the far field.

Additionally, while it is not mentioned anywhere in the DEIS there is a secondary transmission path in the "mixed layer" above the marine thermocline that behaves as a "surface duct." While the propagation in this transmission path is dependent on the wavelength of the source, the angle of incidence, the depth of the mixed layer, and the surface conditions, the attenuation characteristics are more in consistent with the cylindrical model of $10\log_{10} r$. (see Urick 1983)[18]

Transmission in the surface duct, along with the far-field cylindrical propagation highlights concerns in the "nearish" field pertaining to both required "exclusion zones" and the efficacy of marine mammal observers (MMO). It is already impractical to expect MMOs to effectively spot marine mammals at distances over 1000 meters in calm seas during the day. In these conditions a large airgun array with a source level of 229 dB re:1µPa @ 1m[(FN.19)] would require 10km to attenuate to 180dB re:1µPa exposure level.

[18] Urick, R. J. 1983. Principles of Underwater Sound. (3rd Edition). McGraw-Hill Book Company, New York, NY. Chapter 6

[19] 235 dB (from Appendix D Table-22) – 6dB to accommodate for directionality of the array.

$$229\text{dB} - 180\text{dB} = 41\text{dB} \rightarrow 10\log_{10}(1/13000) = -41\text{dB}$$

MMO effectiveness over these ranges is not just impractical, it is improbable. So it is clear that in most situations a large capacity survey cannot avoid subjecting any marine mammal within 10km to Level A harassment exposures from either the surface ducting or the cylindrical propagation of acoustical energy.

If you add the "second hit" from the reflected sound off of the sea bottom, and the direct noise from the hemispherical propagation, the receiver is hit with at least three distinct wave fronts from multi-path sources (all three transmission paths have differing geometrical lengths as well as different transmission speeds due to temperature, pressure, and salinity factors). These three paths need to be integrated into the Sound Exposure Level (SEL) metric in the near-to-intermediate field.

Additionally, due to the various transmission artifacts there may be situations in the far field in which the noise from the surveys are not heard as distinct pulses, but as a continuous noise due to reverberation and multipath effects.[20,21,22,23] Because the noise would be continuous it should be mitigated under the 120dB "continuous noise" exposure threshold, particularly since the surveys will likely be occurring around the clock anyway.

These considerations preclude the use of large capacity seismic surveys if Level A harassment conditions are to be avoided.

Regarding the mitigation strategy of separating the survey vessels by more than 40 km: While the model was not clearly articulated it appears that the DEIS used the hemispherical attenuation factor of $20\log_{10} r$ to derive the 40km "mitigation" strategy.

A more accurate model for this setting is to determine what the exposure level would be at the midpoint (20km) between the two survey vessels. We assume that a source level of 235 dB (convergence in the far field is not influenced by the directivity of the array).

Using the hemispherical propagation model:

$$20\log_{10}(1/20000) = 86\text{dB} \rightarrow 235\text{dB} - 86\text{dB} = 149\text{dB re:}1\mu\text{Pa}$$

Each survey would contribute 149dB to the system, which at the mid-point between them would yield 152dB (adding two equal sound levels increases the overall level by 3dB). But as we know, far field propagation is not hemispherical, rather it is more cylindrical. Using exclusively the cylindrical model:

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[20] Guerra, M., Thode, A.M., Blackwell, S.B., Macrander, A.M. (2011) "Quantifying seismic survey reverberation off the Alaskan North Slope., J. Acoustical Society of America 130:5 3046-3058

[21] Nieukirk, S.L., Mellinger, D.K., Moore, S.E., Klinck, K., Dziak, R.P., Goslin, J. (2012) "Sounds from airguns and fin whales recorded in the mid-Atlantic Ocean, 1999-2009, J. Acoustical Society of America 131:1102- 1112

[22] Nieukirk, S.L., Stafford, K.M., Mellinger, D.K., Dziak, R.P., and Fox, C.G.(2004)"Low-frequency whale and seismic airgun sounds recorded in the mid-Atlantic Ocean" J. Acoustical Society of America 115: 1832-1843

[23] Roth, E.H., Hildebrand, J.A., Wiggins, S.M., and Ross, D. (2012). "Underwater ambient noise on the Chukchi Sea continental slope" J. Acoustical Society of America 131:104-110

$$10\log_{10}(1/20000) = 43dB \rightarrow 235dB - 43dB = 192dB \text{ re:}1\mu Pa$$

Each survey would contribute 192dB to the system, which at the mid-point between them would combine to add +3dB yielding 195dB – well above the 180dB exclusion zone. (These levels would also be significantly beyond the visual reach of MMOs.)

Of course the attenuation factor is somewhere between these two models, but this − like the surface ducting transmission path, is not accounted for in the DEIS. Additionally, while convergence zones as an artifact of propagation are mentioned in Appendix D, there is no evidence that this propagation characteristic is used in calculating exposure levels in marine mammals that are well beyond the visual reach of Marine Mammal Observers or even the acoustical reach of passive acoustic monitors.

Regarding BOEM response to our comment NGO-E-4-0.15 on fuel spills. We appreciate that the DEIS text has been revised to not include speculative text about marine mammal "avoidance behavior" of toxic oil spills it nonetheless continues to treat fuel oil spills lightly – speculating that "lighter, volatile components of the fuel would evaporate to the atmosphere almost completely in a few days. Evaporation rate may increase as the oil spreads because of the increased surface area of the slick. Rougher seas, high wind speeds, and high temperatures also tend to increase the rate of evaporation and the proportion of oil lost by this process" citing an American Petroleum Industry (1999) document which all seems rather innocuous. But it is a well-known practice that once ships are beyond the regulatory reach of the coastal states that they burn filthier and much thicker bunker fuel.

If I were writing this section I would balance the "lighter" fuel impacts discussion with an equally weighted comment on bunker fuel – and perhaps not cite a document published by one of the leading US petroleum industry propaganda organizations.[24]

We know from aerial photographs of dolphins and whales surfacing through oil slicks, and dramatically increased mortality rates of marine mammals in the Gulf of Mexico as a consequence of the 2010 BP-Macondo rig blowout, treating any fossil fuel spill lightly both flies in the face of the facts, and ignores the high probability of oil spills occurring, and marine mammal habitat compromise resulting from spills of any size. And while the scope of the Atlantic G&G PEIS does not cover Oil and Gas Exploration and Production (E&P) (as we have indicated above) if the wrong action alternative is selected this PEIS will serve as a gateway for Oil and Gas E&P – dramatically increasing the probability of both catastrophic as well as chronic oil spills – and the toxic compromise of protected species.

Regarding our comments NGO-E-4-0.18 on considering the increased impacts of a complex array of simultaneous signals: BOEM response that "The complexity of the integrated sound field or "soundscape" referred to in this comment is not feasible or

[24] It is ironic that BOEM response to our comment includes the statement "However, BOEM and NOAA cite the best available information available" e.g.: American Petroleum Institute. 1999. "Fate of spilled oil in marine waters: Where does it go? What does it do? How do dispersants affect it?" API Publication No. 4691. 57 pp.

appropriate to model in a programmatic document since there are so many different possibilities of equipment combinations to be used for various surveys" misses our point that while the DEIS and PEIS evaluate each noise as an autonomous event, these noises are often concurrent with other noises, all of which contribute to a "soundscape." It would be difficult (and not particularly helpful) to characterize each possible assemblage of equipment to their unique contribution to the soundscape. But it is important to state that no survey will have any particular noise from which the exposure impacts will supersede others (if louder) or will be negated by louder noises if quieter. Rather the entire compliment of noise will contribute to the overall impact.

There is currently no metric for the behavioral impacts of complex soundfields composed of multiple antagonistic noises, but it stands to reason (as in the "common sense"[25] approach to "ramp-up" as a mitigation practice stands to reason) that a juggernaut of banging, screeching, chirping, thrashing, and jangling noises from a moving soundsource will induce higher stress in exposed animals than a single banging, or screeching, or chirping noise from the same moving source. The call here is not to deconstruct and model each scenario considering a full complement of equipment; rather it is to state that the impacts complex soundfields need to be considered in their own complexity – with the understanding that additional complexity increases the uncertainty of any anticipated behavioral responses - tending toward higher impact, rather than a lower impact that would be derived from simple cumulative impact metrics.

If simple metrics are to be used for complex soundfields, then all of the noises running simultaneously – including any vessel propulsion system - would qualify as a continuous sound source and be subject to the 160dB mitigation criteria. We understand from BOEM response to our comment NGO-E-4-0.24 that vessel propulsion noise is not currently regulated by BOEM. We are not sure how this exclusion became set in (or was omitted from) the regulations, but given that the vessels under consideration in the PEIS are soundsource platforms with large compliments of acoustical stimulus, communication, and control signals, it might be time to look at the entire soundfield generated by these acoustical platforms in a regulatory context (as indicated above).

Additionally thruster-stabilized drilling platforms that would be used in COST well drilling are not technically "vessels underway;" rather they are stationary noise sources being used for activities that are under BOEM purview and should be regulated as such. This foregoing comment also applies to BOEM response to our comment NGO-E-4-0.25. Thruster-stabilized operating platforms are increasingly becoming a feature in offshore operations and we appreciate that "BOEM will consider the acoustic effects from these activities in site/permit-specific evaluations of individual survey applications," and that "Text has been added to the section to note noise attenuation conditions, approximate radial distance, and the fact that BOEM will evaluate project-specific noise sources, as necessary."

Regarding BOEM response to our comment NGO-E-4-0.29 that "Prohibiting all survey operations at night is not feasible based on the operational requirements for broad scale surveys that may require months of 24 hour days to complete" precisely illustrates our

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[25] See BOEM response to our comment NGO E-4-0.06

point. If it is not feasible to shut down operations at night when opportunities for preventing impacts are reduced, then operations should not continue at all.

This entire Environmental Impact Statement exercise is not designed to drop regulations when it is not convenient to adhere to them, it is designed to safeguard marine protected species and marine habitat from undue impacts. This is particularly the case during the night – a time when our already limited knowledge of marine mammal behavior is at its lowest. To blithely exempt seismic operations from established mitigation procedures because "it is not feasible" is a nadir of hubristic thinking.

Seismic surveys are an integral part of the entire offshore fossil fuel industry. This industry is incredibly profitable (as any pension fund manager will concur). One reason it is so profitable is that the industry has been able to externalize their costs – often by way of not paying for the damage their operations exact on the environment. Seismic surveys are very expensive, but this is the cost of doing business. If it is more costly to shut down an operation when it is not able to adhere to the law, then that cost of shutting down will need to be assumed into the cost of doing business – not foisted on marine animals that otherwise do not benefit in any way from the suppositions that inflicting "limited damage" to their populations is somehow "OK."

All of our other forgoing comments aside, the BOEM statement about the 'infeasibility of shutting down seismic surveys at night' is really all that is needed to rule out both Action Alternatives A or B. But to summarize the other shortcomings of the Atlantic G&G PEIS:

1) The PEIS should be reevaluated in the context of the most up-to-date NOAA Acoustic Guidelines. These guidelines have just recently been reviewed by the public and stakeholders whose comments will need to be addressed in what will become the final NOAA Acoustic Guidelines. As we found many shortcomings with the guidelines we don't expect the final guidelines to align with the comparisons made in the Atlantic G&G PEIS referencing Southall 2007.[26]
2) Not enough is known about fish hearing to make the broad assumption that the proposed action alternatives will not either damage physically, or disrupt behaviorally commercially or biologically important fish.
3) No enough is known about fish hearing to assume that any temporary damage or displacement will not adversely impact individual fishes, or the fitness of any fish species populations.
4) BOEM statements in 4.2.5.1. "Summary of Fish and Invertebrate Hearing Capabilities" about fish dispersing from a survey area is speculative and should not be implied as a mitigation strategy.
5) The statement in section 4.2.5.1.4 that "there is no evidence in fishes for permanent hearing loss" can also as factually be rephrased to "there is no evidence in fishes that permanent hearing loss does not occur." This is one of many places in the PEIS where statements about the absence of evidence does not perfect the argument for the absence of harm.[27]

[26] "Draft Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammals" OCR Comments (attached to this document).
[27] See Colin Macilwain (2014) "Beware of backroom deals in the name of 'science'" Nature v.508:7496 on "lack on evidence" being used to substantiate industry arguments of "no harm."

6) Very little is known about impacts of seismic and other survey signals on marine invertebrates. This dearth on knowledge should not be a reason for proceeding under the assumption that there will be no harm to species that - while not protected, may nonetheless be important elements in the trophic fabric of animals that are protected.
7) Our current state of knowledge about fish and invertebrate responses to chemical, electromagnetic, seismic survey, and other survey signals is very sketchy. The proposed action alternatives should not be used to find out "the hard way" what fish and invertebrates can endure.
8) Propagation models used in the PEIS Appendix D remain simplistic, only considering cylindrical and hemispherical spreading and only mentioning, but not modeling surface ducting,[28] leaving propagation models used in calculating exclusion zones only speculative.
9) While 'convergence zones' are mentioned in the PEIS there no evidence that this propagation characteristic is used in calculating exposure levels in marine mammals that are well beyond the visual reach of Marine Mammal Observers or even the acoustical reach of passive acoustic monitors.
10) PEIS Sections 2.1.3.2 and 4.2.2.3 discussion on fuel oil spills should be expanded to include a realistic discussion about fuels that will be used, not just lighter, more volatile, and faster dispersing fuels.
11) Because survey platforms are increasingly being fitted with various acoustical signal generators, the produced soundfield impacts should be considered in its entirety, not as a composite of individual signals.
12) Because the complex soundfields produced by survey vessels are a product of many overlapping sounds, the resulting soundfield should be considered as continuous and subject to the 160dB (re:1µPa) mitigation threshold and exclusion zone guidelines.
13) Thruster-stabilized drilling platforms that used in COST well drilling are not "vessels underway;" rather they are stationary noise sources being used for activities that are under BOEM purview and should be regulated as such.
14) Finally, precluding regulatory constraints on seismic survey vessels at night because "it is not feasible" is the strongest argument for prohibiting their implementation. Laws and guidelines – regardless of how simplistic, incomplete, or inconvenient are nonetheless a product of many years of research and deliberation by many dedicated, thoughtful, and informed people. Dismissing them for the sake of expediency is both unlawful and sets a dangerous precedent.

Even if BOEM satisfactorily addresses our above concerns we still believe that Action Alternatives A and B should be disallowed. Unfortunately it seems almost a foregone conclusion that Atlantic Geophysical and Geological plan will include the seismic survey regulatory framework necessary to advance oil and gas exploration and production on the Eastern Seaboard. And this would be a shame, because we know without question that the global environmental consequences of promoting a fossil fuel-based economy are killing the planet – by way of atmospheric CO_2 as well as all of the chemical and materials products of that industry which are poisoning our water, and littering the ocean and terrestrial landscapes with "cheap" and thus disposable plastic products.

[28] See: Ivan Tolstoy "Ocean Acoustics: Theory and Experiment in Underwater Sound" p. 181-185 American Institute of Physics.

If we are to assure an acceptable life quality in the future for ourselves as well as our future generations this must stop.

But it is clear that despite over 30 years of discussing the deleterious impacts of fossil fuel on the global environment we cannot muster the political will to have the industry account for the costs of exploration, production, and use of their products – rather we continue to find ways to subsidize the industry by exempting them from environmental laws, making provisional allowances for "take authorizations," suggesting that damaging our environment is acceptable and necessary for "our national security," and even sending our youth out to secure fossil fuel resources in foreign countries – many losing their lives and killing others to do so. This is madness.

But herein lies an opportunity: While we have not, and likely will not find the political will to change our global energy strategy (and hopefully save the planet), we do have the regulatory framework to shift our global energy priorities from fossil fuel over to wind, tidal, wave, and solar power. Making the right decision on the Atlantic G&G PEIS could be a watershed toward turning the fossil fuel juggernaut around.

Due to the foregoing arguments, Action Alternatives A and B should be disallowed. The "No Action Alternative C" should be the preferred action.

Thank you for this opportunity to review and comment on the proposed actions.

Sincerely,

Michael Stocker
Director

Appendix

OCR Comments on NOAA Acoustical Guidelines

February 26, 2014

Chief, Marine Mammal and Sea Turtle Conservation Division,
Office of Protected Resources,
National Marine Fisheries Service,
1315 East-West Highway,
Silver Spring,
MD 20910-3226

Re: Draft Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammals

To Whom it May Concern;

It is clear that much work and consideration has been put into the "Draft Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammals" (hereinafter "Draft Guidance document"), gathering together and including many of the studies that have been executed, reviewed, and published over the past decade. The guidelines represent a significant improvement over the broad-brush threshold guidelines that have been used to date and as such should more accurately represent potential noise induced physiological impacts of noise exposures on marine mammals. The preparers should be applauded for their work.

I am also encouraged that the Draft Guidance document has provisions for updating the thresholds as new data become known, reflecting the best available science.[29] It is important in this context to assure that all of the best available science is considered when updating the guidelines.

Even with all of the work that has been put into achieving a greater understanding of marine mammal acoustical sensory systems, there remains many shortcomings in what we know, how we frame our inquiries, and our assumptions about the impacts of noise on these animals. Our concerns are outlined in the following body of this letter.

The paucity of data:

Establishing Temporary Threshold Shift exposure levels the document relies heavily on so few subjects, and many tests on these few animals from the SPAWARS studies.[30] This dependence is also woven into the fabric of the main reference studies used to substantiate the Draft Guidance document (Finneran and Jenkins; 2012 and Southall et. al. 2007) wherein the mature (13 – 20 y.o.) to old (35 – 40 y.o.) animals are used to examine auditory performance. The Draft Guidance document also relies heavily on the University of Hawaii studies of the hearing responses of one captive born Atlantic bottlenose dolphin. (Mooney et.al. 2009, Nachtigall et. al. 2003, 2004)

[29] Draft Guidance document section IV
[30] Finneran, J.J. 2011; Finneran and Schlundt 2009; Finneran and Schlundt 2010; Finneran and Schlundt 2011; Finneran and Schlundt 2013; Finneran et.al. 2000; Finneran et.al. 2002; Finneran et.al. 2005; Finneran et.al. 2007; Finneran et.al. 2010a; Finneran et.al. 2010b

All of the SPARWAR subjects and the University of Hawaii subject have been systematically exposed to noise studies for many years. The dolphin and beluga whale subjects of these studies have lived in a busy environment full of anthropogenic noise, and continuously exposed to noise testing, so it is highly likely that they have been habituated to the test environment. It is clear that these animals do not represent approximately 125 different species of wild marine cetaceans in their own environment.

This paucity of data from a limited number of subjects discussed in the Draft Guidance document text,[31] but because there are so many ingrown layers of these references through Finneran and Jenkins 2012, and Southall et. all. 2007, and that these studies are used to conjecture the hearing performance of "Low Frequency" cetaceans, are all facts that should be clearly established as significant caveats in interpreting the guidelines. These interpretations should be founded on the precautionary principal that lacking data to prove otherwise, an assumption of harm should direct actions with unknown impacts.[32]

For the record, all cetacean TTS models – including the models for the "Low Frequency cetaceans are based on six bottlenose dolphins (five from SPAWAR, one from Univ. of Hawaii) three belugas (two from SPAWAR, one from Popov et. al. 2011b) two harbor porpoises (one from Kastelein et. al. 2012a, and one from Lucke et. al. 2009) and two Yangtze finless porpoises (Popov et.al. 2011a). Additionally all pinniped thresholds are derived from only four individual animals, two California sea lions (aged between 12 and 21 years), three harbor seals (one from Long Marine Lab, the other two from SEAMARCO), and a northern elephant seal (Kastak et.al 1999, Kastak et.al.2005). The California sea lions were mature to old, aged 12 - 21 years in the two cited studies,[33] the domesticated harbor seal (named "Sprouts") from Long Marine Lab had been inadvertently exposed to damaging airborne construction noise at four years of age [34] which may have had long term impacts on its hearing sensitivities,[35] the two harbor seals from SEAMARCO were captive bred, and a young (4 – 7 years) elephant seal whose provenance was not articulated in the citations.

All data are taken from captive animals:

All of these animals – cetaceans and pinnepeds, are captive so we can assume a few things about them: With the exception of the captive bred harbor seals from SEAMARCO, they were likely rescued and thus either suffered some trauma or were not as fit as their wild kin. Additionally their captive habitat is not fraught with predation, nor are they taxed with the necessity of locating their own food supplies, so it is possible that these animals are less alert due their provenance and to habituating to these less stimulating (sensory-deprived relative to their natural habitat) circumstances. Although it is not surprising that the

[31] Section 1.1 directly under the introductory paragraph of the Draft Guidance document.
[32] "Precautionary Tools for Reshaping Environmental Policy" MIT Press 2005 Edited by Nancy Myers and Carolyn Raffensperger
[33] Schusterman, Ronald J., Brandon Southall, David Kastak and Colleen Reichmuth Kastak "Age-related hearing loss in sea lions and their scientists" J. Acoust. Soc. Am. 111, 2342 (2002)
[34] Kastak, David and Ronald J. Schusterman (1996) "Temporary threshold shift in a harbor seal (*Phoca vitulina*) J. Acoust. Soc. Am. 100 (3)
[35] Lin, H.W., A.C. Furman, S.G. Kujawa, and M.C. Liberman. 2011. Primary neural degeneration in the guinea pig cochlea after reversible noise-induced threshold shift. Journal of the Association for Research in Otolaryngology 12:605-616

captive bred harbor seals had significantly lower auditory thresholds[36] and lower onset of TTS[37] than the Long Marine Lab harbor seal given their “cushy” captive life and not having been acoustically traumatized and an early age.

It should also be noted that the three species of pinnipeds are species that are commonly found in coastal mid-latitudes in close proximity to high concentrations of human activity. It would be hard to determine how this proximity to what is now noisy habitat is reflected in their physiology as opposed to the polar seals. We know behaviorally that the polar seals are extremely songful, which is not found in the harbor seal, the elephant seal, or the California sea lion. It would stand to reason that the polar seals have different, if not more complex acoustical adaptations than the two captive phocid species.

Natural protective hearing mechanisms are not included in the threshold model:

Model inaccuracies due to habituation to captivity may be 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. While this mechanism is fast acting in response to unexpected 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)[38] – 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 learning about how environmental sounds are conveyed into the odontocete’s inner ears. This mechanism seems to include the lipid channels in their lower jaws,[39] 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.[40] 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

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[36] Kastelein,Ronald A., Paul J. Wensveen1, Lean Hoek, Willem C. Verboom and John M. Terhune. (2009) “Underwater detection of tonal signals between 0.125 and 100kHz by harbor seals (*Phoca vitulina*)” J. Acoust. Soc. Am. 125, 1222

[37] Kastelein, R.A., R. Gransier, L. Hoek, A. Macleod, and J.M. Terhune. (2012b). Hearing threshold shifts and recovery in harbor seals (Phocina vitulina) after octave-band noise exposure at 4 kHz. Journal of the Acoustical Society of America 132:2745-2761

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

[39] 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.

[40] 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.

periodic or occasional sound levels that would otherwise damage their organs of hearing.[41] In fact it stands to reason that echolocating odontocetes would necessarily have some form of "automatic gain control" (AGC) because they need to discriminate bio-sonar return signals much quieter than their outgoing signal. If they did not have some form of AGC their own outgoing signal might induce a temporary threshold shift that would defeat their receiving sensitivity, given that outgoing clicks of *tursiops* can be as loud as $227dB_{(peak)}$ re: 1µPa[42] and TTS for continuous signals in MF cetaceans is $224dB_{(peak)}$. If this assumption is correct, then the "sound test" habituated odontocetes [43] 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.[44]

Lab data are derived from signals that are not representative of exposure signals:

In terms of the range of impact relative to signal amplitude, Kastelein and Rippe (2000) studied younger animals (harbor porpoise *Phocena phocena*) [45] with more appropriate test signals yielded significantly different results than what was found in the much older, test-habituated subjects. 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 the Kastelein and Rippe study had been recently taken into captivity and approximately three years old at the time of the study.)

It should also be noted that all non-impulsive signals used in the citations upon which the thresholds are established are sinusoids or sinusoidal-derived band-limited 'pink' noise.[46] While these signals do lend consistency to audiometric testing, they do not necessarily reflect the characteristic signals being introduced into the sea. We are particularly concerned with the exponential proliferation of acoustical communication signals being used in underwater multimodal communication networks for control and monitoring of autonomous and remotely operated equipment for resources extraction, scientific research, and industrial exploration.

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[41] 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.

[42] Aroyan JL, McDonald MA, Webb SC, Hildebrand JA, Clark D, Laitman JT, Reidenberg JS (2000) "Acoustic Models of Sound Production and Propagation." In: Au WWL, Popper AN, Fay RR (eds), *Hearing by Whales and Dolphins.* New York: Springer-Verlag, pp. 409-469.

[43] 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.

[44] Nachtigall, Paul E., and Alexander Ya. Supin (2013) "False killer whale reduces its hearing sensitivity when a loud sound is preceded by a warning" J. Exp. Biology 216, 3062-3070

[45] 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

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

These communication signals include characteristically rapid rise-times either in set frequencies such as square waves or other high "crest factor"[47] signals which are not sinusoidal, or they include signals that are rapid rise time in frequency switching of sinusoids such as "Frequency Shift Key" (FSK) and spread spectrum frequency hopping schemes such as Orthogonal Frequency-Division Multiplexing (OFDM), Trellis Coded Modulation (TCM), and Time Domain Multiplexing (TDM). Many of these schemes, when used in short to intermediate distance acoustic communication technologies (1km – 10km) operate in the 10kHz – 100kHz ranges that overlap all of the marine mammal hearing groups. Furthermore due to the need for well-defined leading edges required for reliable state-change detection, the signals read more like impulsive signals and are characterized by high kurtosis in amplitude and frequency variability over time.

Kurtosis (β) describes the shape of a probability distribution on an x-y graph. It is equated with the "peakedness" of the curve as a product of the distribution of observed data around the mean:

$$\beta = \frac{1}{N}\sum_{\infty}^{N}\left(\frac{X_i - \overline{X}}{S}\right)^4$$

Where:

> N = the number of elements in the distribution.
> S = Standard deviation
> X= are the discreet peaks in data stream (for sound, the pressure/time waveform) over some interval of time.

Kurtosis then is an expression weather the data are peaked or flat relative to a Gaussian distribution. This matters because noise impacts from high kurtosis signals induce significantly higher hearing losses than exposures from sinusoidal signals[48] and is associated with "unpleasantness" or aggravating characteristics of sound.[49] This characteristic is only taken into consideration in Draft Guidance document relative to impulsive sounds and the Equal Energy Hypothesis (EEH) (Danielson et al. 1991; Hamernik et al. 2003; Henderson and Hamernik 1986; Henderson et al. 1991).

Unfortunately there is a dearth of data on the physiological impacts of high kurtosis continuous signals or tone bursts on hearing systems, but avoidance behavior which is a proxy for self-protection is clearly influenced by sound quality characterized by high kurtosis signals.[50,51]

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[47] 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.

[48] Hamernik, R. P., Qiu, W., and Davis, B. (2003). "The effects of the amplitude distribution of equal energy exposures on noise-induced hearing loss: "The kurtosis metric," J. Acoust. Soc. Am. 114, 386–395

[49] Sukhbinder Kumar, Helen M. Forster, Peter Bailey, Timothy D. Griffiths (2008) "Mapping unpleasantness of sounds to their auditory representation" J. Acoust. Soc. Am. 124: 6

[50] 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.

The Verboom and Kastelein (2005) 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[52] for the harbor porpoise. These levels are significantly lower than the TTS levels of 160dB SEL_{CUM} for HF Cetaceans and 183dB SEL_{CUM} for Phocids suggested in Draft Guidance document Table 6. The paper also goes on to suggest that hearing injury – PTS, will occur in the Harbor seal at 190dB – Less than half the energy of the 197dB level found in Draft Guidance document Table 6. While this is just one paper, it evaluates various responses to different sounds and is one of the earlier papers to suggest segregating species into their various hearing function groups. As such the paper should be included and brought into consideration in the Draft Guidance document.

The foregoing also suggests that noise exposure guidelines should include a metric for sound quality, not just instantaneous, periotic, or cumulative exposure amplitude as suggested in the Draft Guidance document table 6b. We need a metric that expresses actual signal quality, not merely exposure profile. And while we do not have enough data to derive a precise "quality" metric, we do have enough information to know that not all signals inflict equal impact and that if signals are anything other than sinusoidal-derived continuous signals or tone bursts that the exposure should be reviewed on a case-basis (as provided for in Draft Guidance document section 2.3 "TTS and PTS Onset Acoustic Threshold Levels.")

For example: when digital communication signal exposures are subject to impact assessment, the thresholds should be established using data from Kastelein et.al (2005) and Kastelein et.al (2006) where actual communication signals were used. In these studies it was found that discomfort thresholds in Harbor porpoise were at 103 – 104 dB for Direct Sequence Spread Spectrum signals, and 111 – 112 dB for Modulated Frequency Shift Key signals (all re: 1µPa, frequency range: 6.3kHz – 18kHz). In a similar study with Harbor seals it was found that the discomfort thresholds were all around 107 (dB re: 1µPa) for all communication signal types.[53]

While "discomfort thresholds," are not a defined term in the Draft Guidance document, they are indicative of pain and avoidance behavior well below the TTS levels suggested in the Draft Guidance document. Kastelein et.al were not measuring TTS in these studies, but there is a probable correlation between avoidance behavior and physiologically damaging (TTS inducing) sound types (not just sound levels).

It is noted in the Draft Guidance document that there are no data on PTS in marine mammals, but the estimated PTS levels used in the DEIS, like the PTS 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 and terrestrial mammal auditory responses. The disparity between the TTS

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[51] 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.

[52] "dB(*w*) re: 1µPa@1m" is not a standard metric but was an attempt by the authors to weight broadband noise for the inverse shape of the relevant audiogram. Not equal energy but equal perceived loudness for the subject, so direct comparison to dB SEL_{CUM} is not precise, but approximate (time dimension notwithstanding).

[53] Kastelein et.al. (2006) Continuously varying frequency sound, Direct Sequence Spread Spectrum, frequency sweep, and Modulated Frequency Shift Key signals.

figures used by Verboom and Kastelein (2005) 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 and Kastelein (2005) data because they are inherently more precautionary in that they examine the thresholds of behavioral response, not the upper limits of physiological response.

PTS Thresholds based on terrestrial and hearing generalist species:

Regarding the estimation of PTS onset relative to TTS levels used in the DEIS, I find the statement that TTS extrapolation for PTS onset "based on data from humans and terrestrial mammals"[54] a bit troubling. Firstly because beyond this cursory statement there is no explanation of the way the relationship was derived. Due to its historic use throughout the NMFS DEIS's over the years[55] I presume they are linear regressions adapted from the W.D. Ward et. al. (1960) papers [56] (also cited in the Draft Guidance document). Ward's data 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 legacy DEIS's (see ref. 19) by incorporating a study of cats by Miller et.al. (1963)[57] that indicates that cat's threshold of PTS is at 40dB recoverable TTS.[58]

The cat is also a highly visually adapted terrestrial animal, though it is more dependent on aurality than humans.[59] One correlation that 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 difference on onset of TTS and PTS) and cats (40dB difference on onset of TTS and PTS), it might reasonably follow that cetaceans who rely almost exclusively on acoustical cues would be even less likely to recover from extreme TTS. While we don't know what these differences are between these onset thresholds, it is appropriate to bear in mind that this framing again calls in the precautionary principal; inasmuch as we should assume harm where data does not exist.

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54 Draft Guidance document section 2.3.4 "Development of TTS and PTS Onset Acoustic Threshold Levels" item #6

55 e.g. "Gulf of Alaska Navy Training Activities Preliminary Final Environmental Impact Statement/ Overseas Environmental Impact Statement." March 2011. Section 3.8-88–92 "Relationship between TTS and PTS, and "Overseas Environmental Impact Statement/Environmental Impact Statement. Undersea Warfare Training Range." October 2005. 4.3.3.2 Relationship Between TTS and PTS

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

57 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.

58 The Gulf of Alaska 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 to substantiate this statement. The Undersea Warfare Training Range DEIS cites Kryter et al. (1966) stated: "A TTS that approaches or exceeds 40 dB can be taken as a signal that danger to hearing is imminent." Then the DEIS speculates: "These data indicate that TSs up to 40 to 50 dB may be induced without PTS, and that 40 dB is a reasonable upper limit for TS to prevent PTS."

59 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 the source."

The threshold difference between TTS and PTS vary in the Draft Guidance document tables, depending on whether the exposures are weighted or un-weighted, which demonstrate a more thorough evaluation of the literature than what had been used in the legacy guidelines. In the threshold tables the level difference between onset of TTS and onset of PTS thresholds are 15dB for impulsive noise exposure, and 20dB for non-impulsive noise exposure (14dB for the pinnepeds) in all frequency classes of animals.

While we appreciate that the extrapolations used to derive onset of PTS from onset of TTS are much more conservative than what has been used in the legacy guidelines, 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 (mostly) old, test-weary odontocetes. I feel that these assumptions provide 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.

Current data on long-term neural damage from "TTS" not included in the DEIS:

Additionally, while the Draft Guidance document does allude to the Kujawa and Liberman (2009) [60] and Lin et. al. (2011)[61] findings to the that "temporary" threshold shift is a predictor of a longer-term permanent damage to the inner hair cell ganglion, these findings are "soft-pedaled" in the document for wont of more data.[62] This position flies in the face of the precautionary principal – particularly in light of the knowledge that TTS is NOT "temporary" and thus TTS is a "Level A take" We should be confident that there is true recoverability of compromised hearing which does not cause long-term synaptic damage before we abuse these animals − to later find that the abuse causes irreversible harm. I suspect than once any of the SPAWARS subjects dies, a histology of their auditory nervous system will tell us volumes about the TTS and PTS assumptions that have been made using these animals.

SEL_{CUM} accumulation period modeled for convenience but not substantiated by the literature:

Regarding setting the baseline for the SEL_{CUM} metric (Draft Guidance document 2.3.1.1 Recommended Baseline Accumulation Period), while helpful for modeling simplification, we find this whole section troubling. Using a 24 hour accumulation window is only a convenience which only has meaning in terms of how we set our watches; exposed animals do not "clear the stack" after 24 hours and start anew. Accumulation of sound form the purposes of SEL_{CUM} should continue as long as the sound continues. This is particularly germane as the noises we are using in the ocean are increasingly becoming continuous – from the "around the clock" seismic surveys, to the increasing array of autonomous vehicles and stationary equipment, to the continuously operating communication and navigation beacons.

[60] Kujawa, S.G., and M.C. Liberman. 2009. Adding insult to injury: Cochlear nerve degeneration after "temporary" noise-induced hearing loss. The Journal of Neuroscience 29:14077-2

[61] Lin, H.W., A.C. Furman, S.G. Kujawa, and M.C. Liberman. 2011. Primary neural degeneration in the guinea pig cochlea after reversible noise-induced threshold shift. Journal of the Association for Research in Otolaryngology 12:605-616.

[62] Draft Guidance document section 3.2.1 Temporary Threshold Shift Acoustic Threshold Levels: "It is not known whether smaller levels of TTS would lead to similar changes. NOAA acknowledges the complexity of noise exposure on the nervous system, and will re-examine this issue as more data become available."

“Avoidance behavior” used as an exposure mitigation strategy:

We also find it troubling that this section is loosely hinged on the idea of “avoidance behavior” being a mitigating factor in the exposure. With the understanding that the Draft Guidance document is specifically about MMPA “Level A Takes” and not behavioral impacts Castellote et.al. (2010) notes that seismic survey noise disrupted an entire migration season of fin whales. In this case the avoidance behavior was at cause for a loss of entire breeding year (which is not strictly physical damage to the organism but does have a profound bearing on survival). That this “avoidance behavior” occurred at hundreds of kilometers from the airgun source points to a fallacy in the assumption that animals can escape the impacts of noise by moving out of the noise field. It may be that case that animals would avoid the most direct physiological impacts of noise by moving away from the source, although this is not always the case as commonly seen in dolphins that gambol in the bow waves of ships and in the “diner bell” effect of net predator pinnipeds[63] that for one reason or another have elected not to avoid noise exposure. Thus “avoidance behavior” cannot be relied upon as a mitigation strategy and should not be incorporated into any exposure models.

This brings forth a larger concern about framing. It is well known that behavioral responses to any stimulus are dependent on situations and circumstances; courting animals will be less disturbed by alien noises than resting animals; net predator animals will even be attracted to noises designed to harass them if they know that food is available for the mere cost of their suffering.[cit.35] Regulators like clear guidelines, but by viewing all animals mechanistically we are assuming that all animals will predictably respond, or be impacted similarly. Segregating animals into frequency groups is an improvement – expressing our deeper understanding of marine mammal bioacoustics derived over the past decade of research, but given the paucity of quality data the guidelines remain a very blunt gauge to measure our impacts on the marine acoustic habitat.

In summary, while we find the Draft Guidance document a significant improvement over the previous guidelines and we welcome its final implementation, as it is currently written there remain many shortcomings. We are pleased that the document includes provisions and a schedule for revising as more data become available, because it is clear that much data is lacking and significant revisions will be required.

The following points have been detailed in the foregoing review:

- Where data are lacking, assume harm until the data clearly indicates otherwise.
- All models for TTS depend on very few animals and thus are incomplete.
- The animals from which the TTS data are derived are captive and test-regime habituated and thus are a poor proxy for their wild counterparts.
- The four species of captive odontocetes are a data-poor approximation of the 125+ species of all cetaceans.
- The two species of phocids found in the Draft Guidance document are commonly found in close proximity to human population centers and are not good stand-ins for Arctic and Antarctic seals.

[63] Jefferson, T. A. and B. E. Curry, 1996, “Acoustic methods of reducing or eliminating marine mammal-fishery interactions: do they work?” Ocean and Coastal Management 31:41–70

- Captive animal's provenance further segregates them from wild animals due to their differing survival tactics relative to food provision and predator awareness.
- Signals used in auditory test regimes are not representative of typical exposure signals found in the field and this are inadequate models for actual exposure impacts.
- Where there is a disparity in TTS onset thresholds, the lower thresholds should be used, not cast out as "outliers." (Draft Guidance document App. B Section 2.2 III)
- Currently there is no metric to express various sound qualities that do have bearing on impacts (e.g. rise time, kurtosis).
- Extrapolating PTS from TTS by way of terrestrial, visually dominant animals (from Ward et.al. 1960 and Miller e.al. 1963) requires a deeper discussion and a precautionary approach.
- Findings by Kujawa and Liberman (2009) and Lin et.al. (2011) indicate that TTS is <u>not</u> temporary, but is an injury and should be classified as a MMPA "Level A Take." This data has been excluded from the Draft Guidance document because there are no equivalent data on marine mammals and lower TTS levels. It should be included.
- SEL_{CUM} accumulation period should not "dump and reset" after 24 hours (for complex models) or integrate over 1 hour (for simple models); rather accumulation should continue for the entire duration of the exposure.
- Avoidance behavior of an exposed animal should not be incorporated into any mitigation model.

There is a larger philosophical discussion here that while our focus on regulatory thresholds does drive the very reason we are engaged in this exercise, in attempting to find clear numeric guidance we sometimes lose track of our relationship with our mutually inhabited marine (and terrestrial) habitats. The noise exposure guidelines we have in place for our own neighborhoods are not based on physiological damage to our neighbor; rather they are based on annoyance. Our neighbor's "ability to recover their hearing sensitivity" from acoustical assault is not an acceptable threshold for our less-than-neighborly noise-making behavior. So why should we believe it is acceptable to expose clearly sentient marine animals to noises that compromise their sensory systems?

This is not just sentimentality, because as we understand the interdependence of all life on our planet it is becoming increasingly clear that as we compromise the habitats of other life forms on the planet we are also compromising our own habitat, and that without a healthy and robust natural environment no amount of money or oil will improve the quality of our own civilization or our engagement with the natural world upon which we depend.

Sincerely,

Michael Stocker
Director
Ocean Conservation Research

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