

OCEAN CONSERVATION RESEARCH



Science and technology serving the sea

Jolie Harrison, Chief,
Permits and Conservation Division,
Office of Protected Resources,
National Marine Fisheries Service.
1315 East-West Highway, Silver Spring, MD 20910

June 19, 2017

Re: Atlantic Geophysical IHA requests

Dear Ms. Harrison,

I am among many who are chagrined that we are again having to review proposals for the Atlantic Geophysical Surveys (hereinafter Atlantic G&G). But we are grateful to be given the opportunity to comment on the five proposed Incidental Harassment Authorization requests submitted to NMFS pursuant to the Atlantic G&G Programmatic Environmental Impact Statement (PEIS). Due to the limited time we have for the reviews we will not be excavating each of the Incidental Harassment Authorizations (IHAs) for specific concerns; rather we will be assessing the larger prospect of the Atlantic G&G with a focus on systematic and cumulative impacts of surveys on marine ecosystems and the animals that live in them.

While it is not the remit of this NMFS review request, as a matter of political housekeeping; it should be amply clear to the Administration that the citizens of this nation are not interested in the future that the fossil fuel industry and their proponents in Congress and the Whitehouse are offering.¹ In fact it seems that the only people interested in offshore fossil fuel development are the very companies who will profit from the proposal,² and the governmental representatives who they sponsor. It forces one to ask: What is it about representative democracy do these guys not get?

We commented to BOEM on the original Atlantic G&G plan in 2012³ (see Appendix B). While many of our comments were noted and addressed to some degree, we were taken

¹ As of June 2017 regional opposition to seismic surveys include 125 municipalities, 1200 elected officials, 41,000 business, and 500,200 fishing families.

http://usa.oceana.org/sites/default/files/4046/final_opposition_map_4_17-01.png

² In the 720 pages of public comments on the Atlantic Geophysical and Geological Survey Five-year plan, only one letter – a 100 page screed jointly authored by industry trade organizations International Association of Geophysical Contractors, American Petroleum Institute, and the National Ocean Industry Association support the surveys.

³ 77 Fed. Reg. 19321 and BOEM OCS EIS/EA - BOEM 2012-005

aback that the PEIS released in 2014⁴ after the 2012 round of public comments was even more disruptive than the original plan. We then commented on the 2014 plan (see Appendix A) and have found that while our comments are in the record, we have found no evidence that the Final EIS was modified in response to any of our concerns.

What I find exceptionally annoying about this entire gambit is that by only including the public comments in the record and not addressing them, BOEM has demonstrated that the February 2014 public comment period for the Atlantic G&G PEIS was merely a bureaucratic exercise. It is an insult to the public and the many conservation organizations that spent considerable time and energy reviewing and commenting on the PEIS, which clearly BOEM did not take the time to review. I would ask that NMFS review our 2014 comments (Appendix A) before issuing the IHAs and assure us that our concerns expressed in that review – along with issues and concerns brought up herein are properly addressed.

BOEM continues to operate under the “half-truth” of a statement that BOEM “Chief Environmental Officer” William Brown made in a BOEM “Science Notes” article⁵ that “To date, there has been no documented scientific evidence of noise from air guns used in geological and geophysical seismic activities adversely affecting marine animal populations.” This is a “half-truth” because to date there have been no studies of marine animal population impacts from seismic surveys. No studies, no evidence.

There is absolutely no question that seismic surveys are disruptive to marine life. There are many published accounts of migratory disruptions,^{6,7,8} communication disruptions,^{9,10} population displacement^{11,12} feeding disruptions,¹³ metabolic and hearing

⁴ 79 Fed. Reg. 13074 and BOEM OCS EIS/EA - BOEM 2014-001

⁵ Aug. 22, 2014 BOEM *Science Notes* article “The Science Behind the Decision”

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

⁷ Richardson, W.J., G.W. Miller, and C.R. Greene Jr., “Displacement of migrating bowhead whales by sounds from seismic surveys in shallow waters of the Beaufort Sea.” *Journal of the Acoustical Society of America* 106:2281 (1999)

⁸ Castellote, M. Clark, C.W., Lammers M.O. “Potential negative effects in the reproduction and survival on fin whales (*Balaenoptera physalus*) by shipping and airgun noise.” *International Whaling Commission report SC/62/E3* - 2010

⁹ Di Iorio, L., and C. W.Clark, “Exposure to seismic survey alters blue whale acoustic communication.” *Biology Letters*, doi:10.1098/rsbl.2009.0651 (2009)

¹⁰ Blackwell, S.B., et al., “Effects of airgun sounds on bowhead whale calling rates in the Alaskan Beaufort Sea” *Marine Mammal Science*, DOI: 10.1111/mms.12001 (2013)

¹¹ Parente, C.L., J.P. Araújo, and M.E. Araújo, “Diversity of cetaceans as a tool in monitoring environmental impacts of seismic surveys,” *Biota Neotropical*, 7 (1): 49-55 (2007)

¹² Weller, D.W., et al., “Influence of seismic surveys on western gray whales off Sakhalin Island, Russia in 2001.” Paper No. SC/54/BRG14 presented to the International Whaling Commission Scientific Committee (2002)

compromise,^{14,15} and even seismic survey associated strandings of marine mammals.¹⁶ Additionally there is evidence of increased metabolic stress due to anthropogenic (shipping) noise that would compromise health and breeding success.¹⁷ There is no reason to believe that seismic survey noise would be any less stressful to marine life.

And this is just the literature on the impacts of seismic surveys on marine mammals. There is also ample evidence of negative impacts on fisheries and catch rates^{18,19} habitat displacement,²⁰ and at least at close range, physiological impacts on fish.²¹ And while invertebrates don't figure into the concerns of the Incidental Harassment Authorizations, as they are part of the food chain, any compromise to vitality of squid^{22,23} (for example) will certainly impact fisheries as well as compromise the major food stock for many odontocetes. I suspect the lack of more published data of impacts of seismic surveys on fish and fisheries is more due to lack of funding for these studies rather than an absence of harm; nonetheless there is ample anecdotal evidence of fisheries compromise due to seismic surveys. And while anecdotal evidence is by definition not verified by a peer review process, they should be sound enough to call on precaution to protect our fisheries rather than to dismiss the accounts for expediency sake.

¹³ Frances C. Robertson, William R. Koski, Tannis A. Thomas, W. John Richardson, Bernd Würsig, Andrew W. Trites “Seismic operations have variable effects on dive-cycle behavior of bowhead whales in the Beaufort Sea” *Endangered Species Res.* Vol. 21: 143–160, 2013

¹⁴ Gray, H. and K. Van Waerebeek, “Postural instability and akinesia in a pantropical spotted dolphin, *Stenella attenuata*, in proximity to operating airguns of a geophysical seismic vessel.” *Journal for Nature Conservation*; 19:363-367.(2011)

¹⁵ Mann, D., et al., “Hearing loss in stranded odontocete dolphins and whales.” *PLoS ONE*, 5(11): (2010).

¹⁶ Hildebrand, J.A., “Impacts of anthropogenic sound” in *Marine mammal research: conservation beyond crisis*. The Johns Hopkins University Press, Baltimore, Maryland, pp. 101-124 (2005)

¹⁷ 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*

¹⁸ Engås, A. S. Løkkeborg, E. Ona, and A.V. Soldal. 1996.” Effects of seismic shooting on local abundance and catch rates of cod (*Gadus morhua*) and haddock (*Melanogrammus aeglefinus*)”. *Can. J. Fish. Aquat. Sci.* 53:2238-2249.

¹⁹ Løkkeborg, S. and A.V. Soldal. 1993. The influence of seismic exploration with airguns on cod (*Gadus morhua*) behaviour and catch rates. *ICES mar. Sci. Symp.*, 196:62-67.

²⁰ Paxton. A.B., J.C. Taylor, D.P. Nowacek, J. Dale, E. Cole, C.M. Voss, and C.H. Peterson. 2017. Seismic survey noise disrupted fish use of a temperate reef. *Marine Policy* 78: 68-73. DOI: [10.1016/j.marpol.2016.12.017](https://doi.org/10.1016/j.marpol.2016.12.017).

²¹ McCauley, R. D., Fewtrell, J. & Popper, A. N. (2003). “High intensity anthropogenic sound damages fish ears.” *Journal of the Acoustical Society of America* 113, 638–642

²² Michel André, Marta Solé, Marc Lenoir, Mercè Durfort, Carme Quero, Alex Mas, Antoni Lombarte, Mike van der Schaar, Manel López-Bejar, Maria Morell, Serge Zaugg, and Ludwig Houégnigan (2011) “Low-frequency sounds induce acoustic trauma in cephalopods” *Front Ecol. Environ.* 2011; doi:10.1890/100124

²³ A. Guerra, A.F. González and F. Rocha (2004) “A review of the records of giant squid in the north-eastern Atlantic and severe injuries in *Architeuthis dux* stranded after acoustic explorations” *International Council for the Exploration of the Sea* CC:29

This argument substantiates the need for blanket precaution in the authorization of any individual Incidental Harassment Authorizations built on the legacy exposure thresholds. But since these IHA requests were written before the recently adopted Acoustical Guidelines²⁴, but are being issued after the adoption of the Acoustical Guidelines, the most current guidelines need to be employed.

The fact that a large number of surveys will occur over a limited period of time – and perhaps concurrently, there is absolutely no accounting for cumulative impacts in any of the individual IHAs. There is also no accounting for concurrent exposures due to concurrent (and duplicative) survey efforts. These are glaring omissions that need to be addressed as a whole by NMFS before proceeding with the authorizations.²⁵

It also appears that the propagation modeling used in all IHAs use an accurate but incomplete model based on the propagation of a single airgun pulse released into a modeled environment.²⁶ While this model can predict with reasonable accuracy the noise exposure from a single airgun pulse, airgun surveys use a continuous run of pulses. In the near field this results in an exposure to a series of pulses, and would be subject to Level A 180dB (re1uPa), and Level B 160dB (re1uPa) regulatory guidelines for impulsive noise exposures. And in the far field the noise from the surveys are not heard as distinct pulses, but as a continuous noise due to reverberation and multipath effects.^{27,28,29,30,31} Because the far-field noise would be continuous it should be mitigated under the Level B 120dB “continuous noise” exposure threshold,³² particularly since the surveys will likely be occurring around the clock anyway.

²⁴ NOAA 2016 “Draft Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammals”

²⁵ In an NGO meeting with NMFS Chief Eileen Sobeck we pointed out this regulatory shortcoming, to which she responded that NMFS had no mechanism in place for assessing impacts from concurrent exposures *and did not want to develop one*.

²⁶ JASCO “Marine Operations Noise Model” taken from BOEM 2014 Atlantic G&G Appendix H

²⁷ 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

²⁸ Nieuwkirk, 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

²⁹ Nieuwkirk, 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

³⁰ 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

³¹ Bruce Martin, Marie -Noel Matthews, Jeff MacDonald, Koen Broker “Characteristics of seismic pulses and the ambient Characteristics of seismic pulses and the ambient soundscape in Baffin Bay and Melville Bay, West Greenland, measured during the 2012 – 2014 Shell seismic programs” In review

³² Interim Sound Threshold Guidance. See:

http://www.westcoast.fisheries.noaa.gov/protected_species/marine_mammals/threshold_guidance.html

Additionally, while it is not mentioned anywhere in the Atlantic G&G PEIS or in any of the IHAs, 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)³³ This transmission path would be particularly germane to North Atlantic Right Whales as they are surface-feeding whales.

Cylindrical propagation of surface ducted noise also puts in question the efficacy of mandated marine mammal observers (MMOs). It is already impractical to expect MMOs to effectively spot marine mammals at the specified distances over 1000 meters in calm seas during the day. Using the surface duct model, a large airgun array with a source level of 229 dB re:1μPa @ 1m^(FN.34) would require 13km to attenuate to Level A 180dB re:1μPa exposure level.

$$229\text{dB} - 180\text{dB} = 49\text{dB} \rightarrow 10\log_{10} (1\text{m}/13\text{km}) = -41\text{dB}$$

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 13km to Level A harassment exposures from either the surface ducting alone, precluding the use of large capacity seismic surveys if Level A harassment conditions are to be avoided.

While none of the individual IHAs refer to concurrent survey taking place (and NMFS has no mechanism for concurrent exposures)³⁵, the Atlantic G&G PEIS does and suggests the mitigation of separating the survey vessels by more than 40 km. While the model was not clearly articulated in the PEIS, it appears that the hemispherical attenuation factor of $20\log_{10} r$ was used 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:

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

³³ Urick, R. J. 1983. Principles of Underwater Sound. (3rd Edition). McGraw-Hill Book Company, New York, NY. Chapter 6

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

³⁵ See FN.25

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:

$$10\log_{10}(1/20\text{km}) = 43\text{dB} \rightarrow 235\text{dB} - 43\text{dB} = 192\text{dB re: } 1\mu\text{Pa}$$

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 PEIS or in any of the IHAs. Additionally, while convergence zones as an artifact of propagation are mentioned in Appendix D of the PEIS, 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.

On top of this, 20km mid-point would in most cases be moving the exposure subject into the far field – where individual airgun pulses are scattered across time by multi-path reflections and reverberations³⁶ (exacerbated by the multiple noise sources of two or more concurrent, non-synchronized surveys). The continuous noise field from this configuration would demand adherence to the Level B 120dB re 1μPa continuous noise threshold – well below the modeled exposure above of somewhere between 149dB and 192dB.

Finally, while none of the IHAs mention any ancillary noise sources, such as side-scan or multi-beam bottom-profiling sonars, it is common that these technologies are deployed along with seismic airgun survey operations. These technologies have been associated with marine mammal strandings.³⁷ If these technologies are to be included in any of the survey operations, their noise also needs to be included in the take estimations.

³⁶ Bruce Martin, Marie -Noel Matthews, Jeff MacDonald, Koen Broker “Characteristics of seismic pulses and the ambient Characteristics of seismic pulses and the ambient soundscape in Baffin Bay and Melville Bay, West Greenland, measured during the 2012 – 2014 Shell seismic programs” In review

³⁷ Southall, B.L., Rowles, T., Gulland, F., Baird, R.W., and Jepson, P.D. 2013. Final report on the Independent Scientific Review Panel investigating the potential contributing factors to a 2008 mass stranding of melon-headed whales (*Peponocephala electra*) in Antsohihy, Madagascar

Summary

- Issues and concerns submitted by OCR to the 2014 Atlantic G&G PEIS need to be addressed in the review of the proposed IHAs (See Appendix A)
- IHA take estimations need to be reconciled to the NMFS 2016 Acoustical Guidelines
- Cumulative impacts need to be accounted for in the assessment of all IHAs as a complete set of activities, not just individual operations.
- Impacts of concurrent exposures need to be accounted for in the assessment of all IHAs as a complete set of activities, not just individual operations.
- Exposure metrics in the IHAs need to include sound-field modeling over time and in the far field in consideration of multi-path echoes and reverberation, not just Sound Exposure Level estimation based on a single-shot airgun pulse.
- Concurrent operations need to be modeled as one event and the sources need to be separated far enough to assure that the noise field (continuous due to reverberation and multipath transmission) do not exceed the 120dB re:1uPa exposure threshold.
- Noise transmission/propagation by way of surface ducting needs to be included in the exposure models.
- While Marine Mammal Observers are mandated to scan a 1000-meter horizon for marine mammals, the regulatory thresholds (both Level A and Level B impulse) extend farther over the horizon than the MMOs are able to see, compromising their efficacy. This needs to be addressed in mitigation and setback measures.
- Concurrent survey operations would need to be displaced enough so that the summed sound-field does not exceed the Level B 120dB continuous noise threshold (due to combined reverberant noise in the far field between concurrent operations).
- Any side-scan or multi-beam bottom-profiling sonars need to be included in the IHAs along with their respective estimated takes.

Given the above arguments and shortcomings to the Incidental Harassment Authorization requests, we recommend that they all be denied.

We appreciate this opportunity to comment on this critical issue.

Sincerely,

A handwritten signature in black ink that reads "Michael Stocker". The signature is written in a cursive, flowing style.

Michael Stocker
Director

APPENDIX A

Ocean Conservation Research comments to The Atlantic Geophysical and
Geological Programmatic Environmental Impact Statement
April 30, 2014

OCEAN CONSERVATION RESEARCH



Science and technology serving the sea

Mr. Gary D. Goeke, Chief,
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

April 30, 2014

Cc: Jill Lewandowski, USDO

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 review¹ (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.

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 Castellote et.al 2012⁶)

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 gadiformes¹⁰ 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 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.”

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 impacts 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 $20\text{dB } \log_{10}$ 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:1 μ Pa @ 1m^(FN.19) would require 10km to attenuate to 180dB re:1 μ Pa 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.

$$229\text{dB} - 180\text{dB} = 49\text{dB} \rightarrow 10\log_{10} (1/13000) = -41\text{dB}$$

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:

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 Nieu Kirk, 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 Nieu Kirk, 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

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

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

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 CO₂ 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,

A handwritten signature in black ink that reads "Michael Stocker". The signature is written in a cursive, flowing style with a long horizontal stroke at the end.

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. al. 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 age³⁴ 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 pinnipeds, 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 thresholds³⁶ and lower onset of TTS³⁷ 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

³⁶ Kastelein, Ronald A., Paul J. Wensveen, 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: 1μPa⁴² and TTS for continuous signals in MF cetaceans is 224dB_(peak). If this assumption is correct, then the “sound test” habituated odontocetes⁴³ 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.

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:

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

Where:

N = the number of elements in the distribution.

S = Standard deviation

X_i = are the discrete peaks in data stream (for sound, the pressure/time waveform) over some interval of time.

Kurtosis then is an expression whether 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 signals⁴⁸ 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}

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@1m⁵² 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, periodic, 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

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 years⁵⁵ I presume they are linear regressions adapted from the W.D. Ward et. al. (1960) papers⁵⁶ (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.

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-wearied 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 want 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 that 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 for 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 pinnipeds⁶³ 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 not 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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APPENDIX B

Ocean Conservation Research comments to The Atlantic Geophysical and
Geological Programmatic Environmental Impact Statement
June 14, 2012

OCEAN CONSERVATION RESEARCH



Science and technology serving the sea

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June 14, 2012

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

Dear Mr. Goeke,

We welcome the opportunity to review and comment on the Draft Environmental Impact Statement on the Atlantic OCS Proposed Geological and Geophysical Activities (hereinafter DEIS). We will attempt to be thorough and informative in our review comments. 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.

While the document reflects much work and a comprehensive exploration into the possible impacts of the proposed activities as required by the National Environmental Policy Act (NEPA), we believe that the DEIS leaves much to be desired if it is to be considered a guiding document for environmental stewardship.

This observation is made in particular light of the fact that despite our assumptions about the boundless ability of the ocean to absorb the assaults of human enterprise we are rapidly finding that the ocean is in very poor shape. This is a consequence of reckless resource extraction and relentless dumping and pollution. The fact is that in many of the more extreme cases ocean environmental degradation has been a significant byproduct industrial practices – particularly the practices of the petroleum exploration and extraction industry.

It was due to the extents of environmental degradation due to reckless and unregulated industrial practices that in the early 1980's a moratorium was placed on exploration and extraction on the US Outer Continental Shelf (OCS). It was clear at that time that the coastal resources for commercial and recreational fishing, and the socio-economic value of clean and vibrant coastal environments were far too valuable to put at risk to the dangers of the fossil fuel extraction and production chain.

This moratorium remained in place until 2008 when the original bill requiring annual reinstatement expired. It was the assumption that technologies and techniques had

improved that would diminish the likelihood of catastrophic events the likes of which ushered in the 1980's moratoriums in the first place.

Unfortunately as we found in April 2010, the technologies are still dangerous and unpredictable. The full extent of the damages in the Deepwater-Horizon-Macondo well disaster is still unknown, and likely to continue to unfold well into the future. It is also clear that while technologies have advanced significantly in the past 27 years since the initial moratorium (and the reason that legacy OCS surveys are no longer suitable), the task has also become more complex as the reach of exploration sinks down into ever-deeper waters, and ever deeper hydrocarbon deposits.

This has left us with a technology bank that while impressive, is definitely not up to the task. I substantiate this statement by referring to the recently out-of-control gas well in the North Atlantic (Total-Elgin gas leak) and the ongoing leaks, spills, and blowouts that have continued to plague the ocean from Timor, to Nigeria, to Brazil, to the Gulf of Mexico just in this last year. And while the "Atlantic Geological and Geophysical Activities DEIS" is not specifically about deepwater extraction operations, it pre-supposes fossil fuel extraction and production.

Unfortunately that despite the ongoing global problems associated with offshore hydrocarbon exploration and extraction that we are not learning that the cost of powering our global economy with fossil fuel is becoming increasingly expensive. These costs are not just "borne at the pump;" rather they are heavily distributed into the environment at the cost of nature's bounty and the compromised quality of our own lives.

It is also clear from how the three alternatives are presented in the DEIS that Alternative A or B are assumed to be not just the preferred alternatives, but the likely ones as well. This is obviated by the many reinforcing assumptions made to "pave the way" for the proposed Geological and Geophysical activities, but also in the quaint convention used of highlighting the word "**negligible**" throughout the document. This highlighted word shows up some 956 times in just 550 pages. (The highlighted word "**minor**" shows up 513 times in the document, "**moderate**" only 131 times.) While this observation is only a casual metric, it does appear to reveal a bias in the drafting of the DEIS.

The words "**negligible**," "**minor**," and "**moderate**" indicate value judgments which while they are sometimes backed up through more detailed discussions in Vol. 1 Chapter 4 using citations, these citations do not track consistently and clearly back to the summary impact assessments. We feel that any assessment in the DEIS should be directly backed up with either peer reviewed literature or some other qualified accountability.

We are also concerned about the arbitrary use of impact conventions when evaluating an action for its "Level A" or "Level B" threshold. The current standard is used by National Marine Fisheries Service (NMFS) under the Marine Mammal Protection Act (MMPA). It is a blunt metric and could use some refinement, but it is the standard. Using it in parallel selectively substituting it with the "Southall Criteria"¹ is confusing and inconsistent,

¹ 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.

particularly since the “Southall Criteria” is only an initial scientific recommendation and has not yet gone through an EIS review as would be required under the National Environmental Policy Act (NEPA) to be used as a guiding document for this DEIS.

And while I believe that the “Southall Criteria” will eventually represent a significant improvement to the current impact threshold assessment process. The motivation behind using one or the other is particularly confusing when there is such a disparity between the results. The table below highlights a few examples of these disparities from Section 4.2.2.2.2 page 4.52- 4.53 referring to “Level A” harassment.

Species	Southall 2007 Criteria (Quoted in the DEIS) ²	NMFS “180 dB” criteria (Not quoted in DEIS) ³
Risso’s Dolphin	8 - 731	444 - 3180
Striped Dolphin	86 - 1020	495 – 2038
Atlantic Spotted Dolphin	154 – 1496	640 - 3180
Bottlenose Dolphin	3 - 39	1314 - 11748

Table 1: Disparity between estimated “Level A” takes between the Southall 2007 (Table 4-9 in the DEIS) and the 180 dB “historic” criteria (table 4-10 in the DEIS).

The reason for choosing one standard over the other is not clear in the arguments, but the numbers in Table 1 suggest that the lower estimation of the “Level A” takes were used in the DEIS, which would seem to infer a “cherry picking” to derive a desired outcome. We suggest that historic NMFS standards be consistently used throughout the DEIS until that time when the Southall Criteria is complete and has gone through public review as required by the National Environmental Policy Act (NEPA).

Another conceit appears occasionally throughout the DEIS that “marine mammals within the AOI are familiar with vessel noises, so the effects of vessel noises are expected to be **negligible to minor.**”⁴

Firstly, forced habituation is not a mitigation strategy. Additionally, “habituation” is a faulty assumption because there is no evidence that marine mammals (or fish for that matter) habituate to broad-band noise that would potentially mask biologically significant signals. In fact it has recently been determined that chronic shipping noise induces stress in bowhead whales,⁵ so the assumption that animals habituate to vessel noise is patently false and should to be removed from both the marine mammal as well as the fisheries sections of the DEIS until proven to be true.

² From DEIS Vol. 2., Table 4-9 “Annual Level A Take Estimates from Seismic Airgun Sources Using Southall et al. (2007) Criteria for Marine Mammal Species during the Project Period (2012-2020)”

³ From DEIS Vol. 2., Table 4-10 “Annual Level A Takes Estimates from Seismic Airgun Sources Using 180-dB Criteria for Marine Mammal Species during the Project Period (2012-2020)”

⁴ This “presumption” or “assumption” appears in Vol. 1 Summary p.xv, Ch. 2 pages 15, 31, and 40, Ch. 4 page 58 and 255.

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 doi:10.1098/rspb.2011.2429

Rolland et. al.(2012)⁶ points to another serious shortcoming in the entire DEIS; While there are sections throughout the document addressing “Cumulative” impacts of the activities, these are considered as “incremental” impacts⁷ rather than synergistic impacts.

Biological systems are not adding machines; they have operating ranges that can be stable in the center of their range, but as the systems approach the extents of their range they become unstable and subject to amplification of synergistic inputs. Subjecting entire ecosystems to a chronic assault such as noise, physical disruption, or chemical pollution will at some point cause an irrecoverable instability that will crash the system.

In this context the DEIS fails to address anything but the immediate or concurrent impacts of an assault, assuming that once the assault has “moved on” or ceased that it no longer has a measurable impact. While our ability to account for synergistic impacts is rudimentary at best, precaution and empirical evidence would dictate that we factor in synergistic impacts even while we don’t entirely understand them.

Furthermore, while we may be arguable that “Level B” behavioral adaptations to proposed activities would be disruptive but recoverable, there is absolutely no justification for biological damage indicated in a “Level A” harassment. Even short term “recoverable” assaults such as temporary threshold shift (TTS) are barbaric. NMFS issuing “Incidental Harassment Authorizations” or “Take Permits” for “Level A” harassment is the apex of institutional hubris. If someone were to apply to the Department of Health and Human Services for a permit to yell in someone’s ear, or spill diesel fuel in their salad they would be watched cautiously and put on some “security risk list.” So why are institutions encouraged to apply for permission to damage animals? It is patently unethical to damage an animal unless you are going to eat it, or it is going to eat you.

While the forgoing opinions do not have a structural procedure within NEPA to address, they substantiate a systematic shortcoming in this process which is continuously echoed throughout the DEIS: What is the overall impact of 956 “**negligible**” impacts on top of 513 “**minor**” impacts, added to 131 “**moderate**” impacts?

Specific oversights and shortcomings in the DEIS

While it is the purpose of the DEIS to model and address the entire foreseen impacts of the proposed actions, given the complexity of the subject environment and the challenges of introducing complicated technologies and procedures into it, understanding the possible range of impacts is speculative at best. There is no way that comprehensive foreknowledge can be formed with the limited data available.

This situation is addressed to some extent in the DEIS with “When an agency is evaluating reasonably foreseeable significant adverse effects on the environment in an EIS and there is incomplete or unavailable information, the agency reports that such information is lacking...the agency is required to report what relevant information is

⁶ Ibid.

⁷ DEIS 2.4.1

incomplete and why it is unavailable... Complex environmental evaluations are always to some degree a documentation exercise in the face of imperfect information.⁸”

To this I would add that environmental evaluations are also a studied speculation fed by available, but necessarily incomplete data. This speculation “fills in the gaps” – of which there are many in the field of marine biology, with assumptions – of which there are many in this DEIS. The aforementioned assumption about “habituation” is clearly an incorrect assumption.

Another assumption that is also found in the DEIS is the assumption that “ramp-up” or “soft start” of seismic surveys are effective mitigation strategies. In fact Jochens et. al. (2008)⁹ indicates that there was no avoidance behavior with ramp up in sperm whales. This could be due to a number of factors; one possibility being that animals familiar with the seismic survey pulses did not find suitable respite in swimming away from the source so they just waited it out. This hypothesis would be supported by the observation in the study that a whale lingered at the surface throughout the exposure, and then sounded immediately after the last pulse.

Another possibility is that the subjects of Jochens et.al controlled exposure experiments had already been so deeply exposed to airgun blasts that their hearing was already significantly compromised and did not find much reason to avoid airguns (particularly since the study exposures were so carefully controlled to not exceed Level B harassment thresholds).

It may be that some highly mobile and migratory animals would avoid airgun surveys, but animals that exhibit strong site-fidelity such as the sperm whales or sedentary fish would likely not depart from their legacy hunting grounds, or in the case of the fish “shelter in place” rather than seek refuge in unknown areas. Engås et al. (1996)¹⁰ and Løkkeborg and Sodal (1993)¹¹ showed decreased catch rates of fish following seismic surveys, but the fishing technique in the study was long-lining, requiring some action on the part of the fish, so whether the fish left the area or were not feeding due to physiological compromise remains ambiguous.

Thus the assumption that “ramping up” and “soft starts” constitute an effective mitigation should be withdrawn from the DEIS until proven otherwise.

The comment on page xviii in the summary, and in section 2.1.3.5, and 4.2.5.1.4 that “there is no permanent damage in fish ears” is incorrect and based on outdated literature.¹² The citation from Smith et. al. (2006)¹³ is work done on a goldfish, a

⁸ DEIS section 4.1.4.1

⁹ Jochens et.al. 2008 “Sperm Whale Seismic Study in the Gulf of Mexico” Minerals Management Service contract.

¹⁰Engås, A. S. Løkkeborg, E. Ona, and A.V. Soldal. 1996.” Effects of seismic shooting on local abundance and catch rates of cod (*Gadus morhua*) and haddock (*Melanogrammus aeglefinus*)”. Can. J. Fish. Aquat. Sci. 53:2238-2249.

¹¹ Løkkeborg, S. and A.V. Soldal. 1993. The influence of seismic exploration with airguns on cod (*Gadus morhua*) behaviour and catch rates. ICES mar. Sci. Symp., 196:62-67.

¹² McCauley, R. D., Fewtrell, J. & Popper, A. N. (2003). High intensity anthropogenic sound damages fish ears. Journal of the Acoustical Society of America 113, 638–642.

¹³ Smith, M.E., A.B. Coffin, D.L. Miller, and A.N. Popper. 2006. Anatomical and functional recovery of

freshwater air-breathing fish that resides in turbid environments. The goldfish has been categorized as a “hearing specialist” due to adaptations that are specific to their environment which have no analogies in open ocean fish. So the comment about “fish not suffering lasting hearing damage” and the associated assumptions should be removed from the DEIS.

There is also the phrase “No mortality or injury is expected in any case because there has been no observation of direct physical injury or death to fishes from airguns” found in the fisheries impacts sections of the DEIS. This phrase is only partially correct, as there is evidence of physical injury of fishes from airguns in McCauley et. al. 2003¹⁴. And while there may be no direct evidence of fish mortality from airguns, if fish sensory systems are compromised by seismic surveys it may lead to intermediate or long term impacts that are not evident immediately after a survey. In this case an absence of evidence does not indicate an absence of harm. Engås et. al 1996 does indicate damage to caged fish, but sedentary fish, while not caged would not necessarily attempt to leave their habitat to escape a pervasive noise, particularly since the pressure-gradient wavelengths are too long for localization, and the particle motion vectors in the far field would be ambiguous and not provide benthic and demersal (and often sedentary) species cues or incentives to leave familiar habitats.

The DEIS treats invertebrates very lightly – almost dismissively. In section 2.1.3.1 the comment is made that “...limited available data assessing physiological effects or biochemical responses of marine invertebrates to underwater noise indicate that serious pathological and physiological effects are unlikely.” This is clearly not the case according to André et.al (2006)¹⁵ wherein giant squid mortality was directly correlated to seismic airgun surveys. This is clearly a case where the writers of the DEIS were wrong when they assumed that in a paucity of evidence that the impacts would be “**negligible.**”

These findings, along with the prior work of Angel Guerra et.al (2004)¹⁶ should be incorporated into the DEIS section 2.1.3.1 and 4.2.1.2.2, and the assumptions revised to reflect the papers.

Also in section 4.2.1.2.2 is after citing Payne (2007)¹⁷ the comment is made that “this particular species of lobster was not present in the AOI,” thus dismissed. While this species of lobster is not present in the AOI, it stands to reason that other arthropods may suffer the same damage under similar exposures – an “assumption” on our part that holds

the goldfish (*Carassius auratus*) ear following noise exposure. Journal of Experimental Biology 209:4193-4202.

¹⁴ McCauley, R. D., Fewtrell, J. & Popper, A. N. (2003). High intensity anthropogenic sound damages fish ears. Journal of the Acoustical Society of America 113, 638–642

¹⁵ Michel André, Marta Solé, Marc Lenoir, Mercè Durfort, Carme Quero, Alex Mas, Antoni Lombarte, Mike van der Schaar, Manel López-Bejar, Maria Morell, Serge Zaugg, and Ludwig Houégnigan (2011) “Low-frequency sounds induce acoustic trauma in cephalopods” Front Ecol. Environ. 2011; doi:10.1890/100124

¹⁶ A. Guerra, A.F. González and F. Rocha (2004) A review of the records of giant squid in the north-eastern Atlantic and severe injuries in *Architeuthis dux* stranded after acoustic explorations” International Council for the Exploration of the Sea CC:29

¹⁷ Payne, J.F., C.A. Andrews, L.L. Fancey, A.L. Cook, and J.R. Christian. 2007. Pilot study on the effects of seismic air gun noise on lobster (*Homarus americanus*). Canadian Technical Report of Fisheries and Aquatic Sciences 2712. 46 pp.

much more water than the blanket use of goldfish hearing as a proxy for all marine teleost fishes found in the DEIS.

Also found in section 4.2.1.2.2 and consistent with worrying convention in the DEIS to conflate an absence of data with an absence of harm is the comment that “The BOEM has determined that incomplete or unavailable data or information on the physiological effects or biochemical response of marine invertebrates in the AOI that results from acoustic noise is not relevant to reasonably foreseeable significant adverse impacts or essential to a reasoned choice among the alternatives.”

This phrase and the assumptions that it substantiates should be pulled from the DEIS as it is only an opinion and not substantiated by the literature.

Some comments on modeling

Sound propagation and noise attenuation in the ocean is a complex topic. Almost any marine setting will exhibit propagation characteristics that defy our ability to model. This may obviate a need for ongoing monitoring during any potentially noisy operation as a matter of course. In lieu of comprehensive regional and temporal sound propagation models to feed with data we must rely on some stock, simple assumptions. Some simple assumptions are used in the DEIS, but given the scope of the proposed actions both in spatial and temporal terms, the simple models used in the DEIS fail to capture the extents of the impacts.

One assumption 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 $20\text{dB } \log_{10}$ 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

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

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:1 μ Pa @ 1m^(FN.19) would require 10km to attenuate to 180dB re:1 μ Pa exposure level.

$$229\text{dB} - 180\text{dB} = 49\text{dB} \rightarrow 10\log_{10} (1/13000) = -41\text{dB}$$

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.^{2021,22,23} 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).

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

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 Niekirk, 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 Niekirk, 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

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:

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

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.

Section comments on Alternatives:

In Section 2.1.3.1 (associated with chapter 4.2.1) evaluating the impacts of Alternative A, the statement is made regarding the lack of pressure gradient sensors in most marine invertebrates. It is known that many invertebrates have particle motion sensing systems. It is also mentioned that there is limited data on the vulnerability of these sensing systems to mechanical damage, and with this lack of data the writers of the DEIS assume therefore that marine invertebrates are “unlikely” to suffer physiological or pathological impacts from noise exposure.

Unfortunately most of the data we do have on the impacts of large vector particle motion on marine invertebrates is limited to intertidal animals and coastal animals such as lobster, shrimp, clams, scallops, and octopus which would have evolved sensory systems adapted to coastal turbulence and crashing waves and thus not necessarily vulnerable to high amplitude, coherent-vector particle motion. But there has been a correlation to squid mortality and damage associated with seismic airgun surveys, so the blanket assumption that damage to marine invertebrates “is expected to be **negligible**” is an assumption that is not supported by the range of evidence²⁴ (see also ref. 15, 16, and 17 above).

In Section 2.1.3.2 (associated with chapter 4.2.2) regarding the impacts of boomer, chirp, and sub-bottom profilers, and multi-beam depth sounders, the statement is made that “some of [these] are expected to be beyond the functional hearing range of marine mammals or would be detectable only at very close range.” With the exception of the multi-beam depth sounders, these other sources would be detectable by odontocetes and should be evaluated for impacts.

²⁴ R.D. McCauley, 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— a study of environmental implications” The Australian Petroleum Production & Exploration Association Journal p.692-708

Also in Section 2.1.3.2 the Level B impacts of vessel noise is discounted by the fact that Level B impacts from seismic surveys and other active noise sources have been accounted for. While numerically the exposure levels may have been accommodated in the Level B exposure criteria, this is an over-simplification of the response of animals to increasingly complex noises. It is likely that a fully operating seismic survey with system calibration signals, sea-floor profilers, and various other noises added to the sum of the noises of the vessel would have a more pronounced behavioral impact than the simple exposure impact of each of the sounds separately. It would stand to reason that a complex and varying sound field would have greater impacts than the impacts of just sound type at a specific amplitude – even if each one of them was at or below the Level B harassment threshold. Response to sound quality rather than level alone is substantiated in Frankel and Clark (1998).²⁵ (This argument appears in section 4.2.2.2 p.4-58 under Vessel Noise Evaluation as well.)

A more accurate (but equally simplistic) model would treat each noise source that exceeded the Level B harassment threshold as a separate Level B harassment.

While it is not entirely within the range of our acoustical impacts evaluation, under the same section 2.1.3.2 regarding accidental oil spills that “marine mammals would be expected to avoid areas of heavy fuel sheen” and thus the impacts would be “**negligible to minor.**”²⁶ Avoidance behavior of oil-sheen waters has not been confirmed and would not necessarily be an evolutionary adaptation. The fact is that there are many compelling photographs and accounts of dolphins and whales surfacing through oil sheens during the BP oil disaster of 2010.²⁷ Additionally since the BP disaster the number of dead cetaceans washing ashore has increased significantly with evidence of hydrocarbon poisoning in their systems.²⁸ The “avoidance behavior” assumption should be pulled from the DEIS along with the assumptions that the comment substantiates.

Chapter 4 Description and Analysis comments

Where not previously addressed in these comments, the following comments are in consideration of Chapter 4 statements and evaluations.

In Section 4.2.2.2.2 “Evaluation” (p.4-52) the comment is made referencing Au and Hastings (2008)²⁹ that mammalian ears “behaves like an integrator with an integrator time constant,” which in the paper is determined to be 100ms, and through this mechanism a 10ms pulse integrated over 100ms represents a 10dB decrease in exposure (presumably impacts). While this does mathematically work into the “Sound Exposure

²⁵ Frankel, A.S. and C. W. Clark. 1998. Results of low-frequency playback of M-sequence noise to humpback whales, *Megaptera novaeangliae*, in Hawaii. Canadian Journal of Zoology 1998:521-535.

²⁶ DEIS p. 2-16

²⁷ See the photos by John Wathan <http://www.docudharma.com/diary/21948/wathen-bp-slick-covers-dolphins-whales-video-text>

²⁸ Leigh Coleman “Baby dolphin deaths rise along Gulf Coast” Reuters Feb. 23, 2011

²⁹ Au, W.L. and M.C. Hastings. 2008. Hearing in marine animals. In: Principles of marine bioacoustics. New York: Springer-Verlag.

level” metric³⁰ this metric is for physiological impacts only, there is no evidence of decreased stress from repetitive exposures of "short duration shocks" over longer pulses.

In the same section, p.4-53 “Level A Incidental Take Estimates” are referenced to Tables 4-9 and 4-10. These tables variously refer to either the “Southall criteria” or the “180dB criteria.” The reason for choosing one over the other standard is not clear here, except that the “Southall Criteria” numbers are all significantly smaller. As mention before, the Southall Criteria should not be used until complete and approved through NEPA review.

In this same paragraph regarding the use of “other equipment, including sub-bottom profilers, side-scan sonars, and depth sounders” concurrently with airguns would have no additional impacts because “airguns represent the highest energy source” this “it is reasonable to assume that there would be no additional take from the electromechanical sources operating concurrently.”

As indicated above it is a faulty assumption based on noise level exposure alone - we can assume that like humans, other animals respond negatively to the complexity of any agonistic signal. For example a racing engine may not in-and-of-itself be too alarming, but if it is accompanied by the noise of grinding metal, or a the beeping of an alarm - even if the noises do not measurably add to the overall noise level, they will induce very different impacts on the nervous system.

Additionally, the noises of the other electromechanical systems are operating across different frequency bands which would not necessarily be masked by the low frequency noise of airguns. Concurrent noise sources are not a set of individual exposures, rather they all contribute to an entire soundscape. These “holo-phonic” impacts will be far greater than individual sound sources or even the sum of concurrent sound sources. In this context a survey operation with two or more boats and an array of profilers and multi-beam sonars should be evaluated across the entire noise spectrum, and over the entire time of the operation. In this context many of these surveys would qualify as “continuous noise sources, and thus subject to the 120dB mitigation criteria.

In the “Conclusion” section the airgun evaluation it is stated from Tables 4-10 and 4-11 that “Incidental take calculations presented in for seismic airgun survey-related noise may be “conservative” because the exposure evaluations “do not consider functional hearing sensitivity ranges for the various species and so assume that all of the species are equally sensitive to received sound frequencies and levels.”

While it is true that various animals have adapted to their own acoustical niches, we must assume that these animals reside in a complete bio-acoustic habitat with other animals and that the receivers are not just individual subjects in a test environment.

It would actually be more realistic to state that the auditory thresholds of odontocetes have been determined by way of captive animals that have been habituated (trained) to respond to operant conditioning and to cooperate with Audio Evoked Potential auditory

³⁰ Hastings MC, Popper AN (2005). Effects of Sound on Fish. California Department of Transportation Contract 43A0139, Task Order 1. Available from URL: http://www.dot.ca.gov/hq/env/bio/files/Effects_of_Sound_on_Fish23Aug05.pdf

testing. These individual animals only approximate the hearing responses of wild animals which often respond as a group to sound stimulus and are adapted to be more responsive to environmental sounds.

Additionally the auditory responses of mysticetes have only been approximated by way of anatomical studies of dead animals and modeled from other vertebrate hearing and thus the auditory threshold models do not clearly represent the entire auditory response capabilities of living baleen whales residing in their natural habitat.

In the same section p.4-55 it is insinuated that animals with differing hearing priorities would have the chance to evade a slow-moving seismic operation to “avoid exposure to injurious sound levels.” What is not taken into consideration is the likelihood that most animals are in a particular area because they need to be there – for feeding, community coherence, family bonding, and breeding opportunities. Forced relocation due to exposure to agonistic stimulus undoubtedly increases stress, compromising metabolic, social, and immune system functions.

On p.4.56 referring to the “non-airgun HRG surveys” impacts conclusion section, the statement is made that “Level A take estimates that were calculated utilizing only the 180-dB criterion do not consider functional hearing sensitivity ranges for the various species and so assume that all of the species are equally sensitive to received sound frequencies and levels.”

This statement appears to be a specious attempt to soft-pedal exposure impacts. The decision to use the “180 dB Criteria” as a mitigation threshold is an accepted, historical standard predicated on known auditory thresholds found in captive animals. It was chosen as a mitigation threshold after long deliberation. Deconstruction of this standard for the purpose of this DEIS is inappropriate.

In the same paragraph: “assuming selective avoidance of the sound source by individual animals and operations within an open ocean environment” is implied as a mitigation strategy. This is not a mitigation strategy; rather it is why mitigation strategies are required. This statement should be pulled from the DEIS along with the assumptions it purportedly substantiates.

In the evaluation of noise impacts from “Vessels and Equipment Noise” p.4-57 that “broadband source levels for most small ships (a category that would include seismic survey vessels and support vessels for drilling of COST wells or shallow test wells) are anticipated to be in the range of 170-180 dB re 1 μ Pa at 1 m and source levels for smaller boats (a category that would include survey vessels for renewable energy and marine minerals sites) are in the range of 150-170 dB re 1 μ Pa at 1 m (Richardson et al., 1995).” As these operations are continuous and not periodic or pulse noises the mitigation threshold would be 120dB re: 1 μ Pa, so the exclusion zone in the loudest instance would be:

$$180\text{dB} - 60\text{dB} = 120\text{dB}$$

$20\log_{10}(1/1000) = -60\text{dB}$ or 1000m for spherical propagation, and

$13\log_{10}(1/40000) = -60\text{dB}$ or 40km for far field propagation per our earlier argument.

Also on the same page is the statement:

“Drilling-related noises from semi-submersible platforms in deeper waters ranges in frequencies from 10 to 4,000 Hz, and therefore audible to all cetacean and pinneped species within the AOI. Drilling sound source levels from semi-submersible platforms are estimated at 154 dB re 1 μ Pa-m. Source levels for drillships have been reported to be as high as 191 dB re 1 μ Pa during drilling. It is expected that marine mammals would detect drilling-related noises within a radius of audibility.”

This statement needs to be clarified: Semi-submersible platforms are stabilized by way of thrusters, which have not been characterized in the literature, nonetheless with a source level of 191dB and due to the continuous characteristic of the noise will need to be mitigated at the 120dB exclusion zone, not just “within a radius of audibility.”

Given: 191dB – 69dB = 120dB

$20\log_{10}(1/2850) = -69\text{dB}$ or 2.85km for spherical propagation, and

$13\log_{10}(1/200000) = -69\text{dB}$ or 200km for far field propagation per our earlier argument

Of course this is a simple model and does not account for frequency-dependent sound absorption over distance, but is also does not account for surface channel propagation or effects of multipath propagation over distance. The appropriate use of the 120dB mitigation threshold would preclude the use of semi-submersible platforms in the Area of Interest for exploratory drilling, and in the future for extraction and production.

Summary and Conclusion

While BOEM, and their legacy agencies MMS under the Department of the Interior have not been known to be precautionary, the Atlantic Geological and Geophysical DEIS appears to over-extend hospitality to industry by systematically failing to address many impacts that will occur if either Alternative A or Alternative B is approved.

From the foregoing discussion the following corrections and recommendations should be included in the Atlantic Geological and Geophysical DEIS:

1. NMFS –MMPA Level A and level B criteria should be used exclusively throughout the DEIS. The “Southall Criteria” should not be used until it is complete and has gone through NEPA review.
2. The words “**negligible**” and “**minor**” in the DEIS should be always traceable to peer reviewed papers that substantiate the particulars of the specific evaluation.
3. All references to “habituation” should be removed from the DEIS, especially where it is inferred as a mitigation strategy because it is not supported by the literature.
4. All references to “Ramp-up” and “Soft Start” being used as a mitigation strategy should be either pulled from the DEIS, or included with the caveat that there is no evidence that these techniques are effective (until proven otherwise).

5. All references to fish not being subject to permanent hearing damage should be removed from the DEIS along with the consequent assumptions associated with the comment because it is not supported by the literature.
6. References to acoustical impacts on marine invertebrates – particularly squid, should be updated and included in the EIS to reflect current state of understanding.^{31,32,33,34,35}
7. Sound propagation models should include provisions for surface duct transmission paths in seismic surveys, and thruster-stabilized platform and drill-ship operations.
8. Sound propagation models of seismic surveys should account for reverberation and multipath effects in the far field. If the far field noise artifacts are not distinguishable as discrete pulses then the noise criteria should fall under the 120dB mitigation threshold for continuous noise.
9. Exposure to the same seismic signal that arrives at the receiver as multiple signals due to time domain differences in direct, reflected, surface, and SOFAR ducting should be considered separately and figured into the overall Sound Exposure Level (SEL) metric.
10. Complex noise exposures should be integrated as a complete sound field over time rather than taken as a set of discrete noise sources. As such most seismic surveys would be considered “continuous noise sources” in the far field and should be subject to the 120 dB Continuous Noise mitigation criteria.
11. Expecting MMOs to effectively find marine mammals at night or in exclusion zones greater than 1000 meters is impractical even in calm sea states. Seismic survey operations should be limited to times and conditions in which MMOs can actually locate marine mammals within the prescribed exposure-dependent “exclusion zone”.
12. Boomers, chirp, and sub-bottom profilers, should be more closely scrutinized in terms of their respective impacts on odontocetes.
13. Suggesting an animal’s “selective avoidance” be used as a mitigation strategy is circular reasoning and fails to address the purpose of the DEIS. Comments to this effect found throughout the DEIS should be pulled from the document.
14. Under any airgun operation the noise propagation models used in the Final EIS should be verified in the field with acoustical monitoring both in the near and far fields until there is confidence that the EIS models represent the actual noise propagation in the field.

³¹ Michel André, Marta Solé, Marc Lenoir, Mercè Durfort, Carme Quero, Alex Mas, Antoni Lombarte, Mike van der Schaar, Manel López-Bejar, Maria Morell, Serge Zaugg, and Ludwig Houégnigan (2011) “Low-frequency sounds induce acoustic trauma in cephalopods” *Front Ecol Environ* 2011; doi:10.1890/100124

³² T. Aran Mooney, Roger T. Hanlon, Jakob Christensen-Dalsgaard, Peter T. Madsen, Darlene R. Ketten and Paul E. Nachtigall” Sound detection by the longfin squid (*Loligo pealeii*) studied with auditory evoked potentials: sensitivity to low-frequency particle motion and not pressure *J Exp Biol* 2010 213:3748-3759.

³³ R.D. McCauley, 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— a study of environmental implications” *The Australian Petroleum Production & Exploration Association Journal* p.692-708

³⁴ A. Guerra*, A.F. González and F. Rocha (2004) A review of the records of giant squid in the north-eastern Atlantic and severe injuries in *Architeuthis dux* stranded after acoustic explorations” *International Council for the Exploration of the Sea* CC:29

³⁵ Payne, J.F., C.A. Andrews, L.L. Fancy, A.L. Cook, and J.R. Christian. 2007. Pilot study on the effects of seismic air gun noise on lobster (*Homarus americanus*). *Canadian Technical Report of Fisheries and Aquatic Sciences* 2712. 46 pp.

15. Semi-submersible drilling platforms and thruster stabilized drilling ships need to be evaluated for noise contribution while in operation and due to the continuous noise characteristic of their thrusters, and need to be mitigated at the 120dB re 1 μ Pa exclusion criteria.

It appears from the forgoing that neither Alternative A nor Alternative B will meet safe exposure criteria established under the Marina Mammal Protection act, and will cause significant habitat and wildlife damage. This should be avoided. Waiving the extents of the damages with “take authorizations” and “harassment permits” is a short-sighted hubristic strategy that does not take into consideration our own species dependence on healthy, productive marine habitats.

It is increasingly clear that the costs of promoting fossil fuel exploration and production is becoming prohibitively high. The good news in this is that consideration of the true costs of hydrocarbon exploration, extraction, production, and consumption will give our economic society greater incentives to conserve the fossil fuel that we can extract without the extreme collateral damage, and to develop energy alternatives that are regenerative and less damaging to our own habitat.

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

Sincerely,

A handwritten signature in black ink, appearing to read "Michael Stocker", with a long horizontal flourish extending to the right.

Michael Stocker
Director