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Science and technology serving the sea

Mr. Gary D. Goeke, Chief, May 29, 2012
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

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

Box 559, Lagunitas, California 94938
V. 415.488.0553 F. 415.488.1725
www.OCR.org

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 standard 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” impacts[7] 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 instable 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

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[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.

[10] 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.

[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. 2003[14]. 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

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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 20dB $\log_{10}$ of r. Far field will be more in line with $10\log_{10} r$. But there is some continuum between these attenuation conditions, so depending on the distance between the receiver and the source the attenuation factor may be closer to 17 in the "nearish field" and 13 in the far field.

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

Transmission in the surface duct, along with the far-field cylindrical propagation highlights concerns in the "nearish" field pertaining to both required "exclusion zones"

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

and the efficacy of marine mammal observers (MMO). It is already impractical to expect MMOs to effectively spot marine mammals at distances over 1000 meters in calm seas during the day. In these conditions a large airgun array with a source level of 229 dB re:1μPa @ 1m[(FN.19)] would require 10km to attenuate to 180dB re:1μPa exposure level.

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

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

If you add the "second hit" from the reflected sound off of the sea bottom, and the direct noise from the hemispherical propagation, the receiver is hit with at least three distinct wave fronts from multi-path sources (all three transmission paths have differing geometrical lengths as well as different transmission speeds due to temperature, pressure, and salinity factors). These three paths need to be integrated into the Sound Exposure Level (SEL) metric in the near-to-0intermediate 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] 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 pretty much exclude 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:

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

[19] 235 dB (from Appendix D Table-22) – 6dB to accommodate for directionality of the array.
[20] Nieukirk, S.L., Mellinger, D.K., Moore, S.E., Klinck, K., Dziak, R.P., Goslin, J. (2012) "Sounds from airguns and fin whales recorded in the mid-Atlantic Ocean, 1999-2009, J. Acoustical Society of America 131:1102- 1112
[21] Nieukirk, S.L., Stafford, K.M., Mellinger, D.K., Dziak, R.P., and Fox, C.G.(2004)"Low-frequency whale and seismic airgun sounds recorded in the mid-Atlantic Ocean" J. Acoustical Society of America 115: 1832-1843
[22] 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

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 evidence [23] (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.

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

[23] 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

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).[24] (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.**"[25] 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 trough oil sheens during the the BP oil disaster of 2010.[26] Additionally since the BP disaster the number of dead cetaceans washing ashore has increased significantly with evidence of hydrocarbon poisoning in their systems.[27] 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)[28] 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 Level" metric[29] this metric is for physiological impacts only, there is no evidence of decreased stress from repetitive exposures of "short duration shocks" over longer pulses.

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[24] 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.
[25] DEIS p. 2-16
[26] See the photos by John Wathan http://www.docudharma.com/diary/21948/wathen-bp-slick-covers-dolphins-whales-video-text.
[27] Leigh Coleman "Baby dolphin deaths rise along Gulf Coast" Reuters Feb. 23, 2011
[28] Au, W.L. and M.C. Hastings. 2008. Hearing in marine animals. In: Principles of marine bioacoustics. New York: Springer-Verlag.
[29] 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

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 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 in 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 a 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 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 μPa 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 μPa 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 μPa, 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 pinniped species within the AOI. Drilling sound source levels from semi-

submersible platforms are estimated at 154 dB re 1 μPa-m. Source levels for drillships have been reported to be as high as 191 dB re 1 μPa 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

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

$13\log_{10}(1/200000) = -69$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 seem to 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.[30,31,32,33,34]
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 that 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 the120 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.
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

[30] 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

[31] 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.

[32] 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

[33] 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

[34] 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.

noise characteristic of their thrusters, and need to be mitigated at the 120dB re 1 μPa 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 expensive. 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,

Michael Stocker
Director