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February 18, 2020

NOAA Section 515 Officer
NOAA Executive Secretariat
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14th and Constitution Avenue, N.W.
Washington, D.C. 20230

Mr. Zachary G. Goldstein
Chief Information Officer, United States Department of Commerce
14th Street and Constitution Avenue, NW
Room 5029B
Washington, DC 20230

Re: Request to Correct Information pursuant to Section 515 of the Information Quality Act, Public Law 106-554 – (1) NMFS's Record of Decision adopting Final Programmatic Environmental Impact Statement for Issuance of Incidental Take Authorizations associated with geological and geophysical activities that may be conducted throughout Mid- and South Atlantic Outer Continental Shelf Planning Areas, and (2) NMFS Environmental Assessment dated November 2018

Dear Mr. Goldstein and Section 515 Officer:

The National Ocean Industries Association ("NOIA"), IAGC, Offshore Operators Committee ("OOC"), and Louisiana Mid-Continent Oil and Gas Association ("LMOGA") hereby submit this request to correct information pursuant to Section 515 of the Information Quality Act, Public Law 106-554 (codified at 44 U.S.C. § 3504(d)(1) and § 3516), as implemented through the National Oceanic and Atmospheric Administration's ("NOAA") Information Quality Guidelines[1] and the Office of Management and Budget's ("OMB") Guidelines for Ensuring and Maximizing the Quality, Objectivity, Utility and Integrity of Information Disseminated by Federal Agencies.[2] This request pertains to final agency documents in which the National Marine Fisheries Service ("NMFS") published results of a statistical probability model that contains a fundamental mathematical error in its methodology. This request is submitted without prejudice to any of our members who may have differing or opposing views. As set forth below, numerous commenters, including the Bureau of Ocean Energy Management ("BOEM") within the Department of the Interior, have informed NMFS of this basic math error. BOEM has informed NMFS that this math error causes "exponential," "unrealistic" overestimates of "take" of marine mammals under the Marine Mammal Protection Act ("MMPA")[3] attributable to offshore geological and geophysical ("G&G") seismic surveys in the oil and gas industry.

NMFS's model adds substantial conservative margins to individual, independent inputs *and then multiplies them together*, causing *exponential* overestimates. Instead of calculating the "best" available scientific estimate of the number of predicted marine mammal takes, as required by both the MMPA and Information Quality Act, and then adding a conservative margin to the estimate, NMFS's modeling, by multiplying the conservative margins at each and every stage, produces orders of magnitude more predicted takes than a best estimate would ever predict.

This Request for Correction is based on NMFS's application of the model in the following documents: (1) NMFS's February 23, 2018 Record of Decision ("ROD") for issuance of incidental take authorizations of marine mammals associated with G&G activities in the Atlantic

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[1] NOAA Office of the Chief Information Officer & High Performance Computing and Communications, *NOAA Information Quality Guidelines* (Oct. 30, 2014) https://www.cio.noaa.gov/services_programs/IQ_Guidelines_103014.html ("*NOAA Information Quality Act Guidelines*").

[2] 67 Fed. Reg. 8,452-8,460 (Feb. 22, 2002). OMB expanded its guidelines in a memorandum issued on April 24, 2019 (https://www.whitehouse.gov/wp-content/uploads/2019/04/M-19-15.pdf).

[3] 16 U.S.C. § 1371(a)(5)(D).

Ocean;[4] and (2) NMFS's November 2018 Environmental Assessment analyzing specific incidental harassment authorizations issued pursuant to the 2018 ROD.[5] BOEM also used the model in the Final Programmatic Environmental Impact Statement ("PEIS") for the Atlantic Outer Continental Shelf ("OCS") Proposed Geological and Geophysical Activities in the Mid-Atlantic and South Atlantic Areas[6] which NMFS made a determination "to adopt" in its ROD.[7]

NMFS's repeated use of this model has produced grossly inaccurate take estimates, in direct violation of the objectivity standard of the Information Quality Act, OMB guidance[8] and NOAA's implementing guidelines. Accordingly, NOIA, IAGC, OOC, and LMOGA request NOAA to (a) determine within 60 calendar days of receipt of this letter[9] that the statistical model adopted in the *NMFS 2018 ROD* and *NMFS 2018 Environmental Assessment* (and described in detail in the *2014 PEIS* adopted by NMFS) does not meet the requirements of the Information Quality Act; and (b) initiate corrective measures, including correcting the model and published

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[4] NMFS, *Record of Decision Adoption of the Bureau of Ocean Energy Management's Final Environmental Impact Statement for Issuance of Incidental Take Authorizations Associated with Geological and Geophysical Activities that may be conducted in Various Locations throughout the Bureau's Mid-and South Atlantic Ocean Outer Continental Shelf Planning Areas* (Feb. 23, 2018) (https://www.fisheries.noaa.gov/action/incidental-take-authorization-oil-and-gas-industry-geophysical-survey-activity-atlantic) (hereinafter "*NMFS 2018 ROD*").

[5] NMFS, *Environmental Assessment Issuance of Five Incidental Harassment Authorizations to Take Marine Mammals Incidental to Geophysical Surveys in the Atlantic Ocean* (Nov. 2018) (https://www.fisheries.noaa.gov/action/incidental-take-authorization-oil-and-gas-industry-geophysical-survey-activity-atlantic) (hereinafter "*NMFS 2018 Environmental Assessment*"); *see also id.* at 6, 11 ("NOAA served as a cooperating agency during the development of this PEIS, and after independently reviewing the Final PEIS, determined it was adequate and properly addressed comments and concerns raised by NOAA as a cooperating agency. The Final PEIS also addressed NOAA's required components for adoption, as it meets relevant requirements under the CEQ regulations and NOAA policy and procedures. Subsequently, in accordance with 40 CFR 1506.3 and 1505.2, NMFS adopted BOEM's 2014 Final PEIS and issued a separate Record of Decision (ROD) with the intent to use BOEM's programmatic analysis as the basis for tiering when reviewing ITA requests and potentially issuing ITAs under the MMPA, on a case-by-case basis, as appropriate.").

[6] BOEM, *Atlantic OCS Proposed Geological and Geophysical Activities Mid-Atlantic and South Atlantic Planning Areas Final Programmatic Environmental Impact Statement*, February 2014 at pp. 4-58 -- 4-60 and Appendices D and E (https://www.boem.gov/sites/default/files/oil-and-gas-energy-program/GOMR/BOEM-2014-001-v1.pdf and https://www.boem.gov/sites/default/files/oil-and-gas-energy-program/GOMR/BOEM-2014-001-v3.pdf), 79 Fed. Reg. 13,074 (Notice of Availability) (hereinafter "*2014 Atlantic PEIS*").

[7] *See NMFS 2018 ROD* at pp. 1, 3, 4 ("This document addresses the National Marine Fisheries Service's (NMFS) determination to adopt the Bureau of Ocean Energy Management's (BOEM) Final Programmatic Environmental Impact Statement (PEIS) for proposed Geological and Geophysical (G&G) activities in the Mid-and South Atlantic Outer Continental Shelf (OCS) Planning Area pursuant to 40 CFR § 1506.3.").

[8] *See* n.2 *infra*.

[9] *NOAA Information Quality Act Guidelines* at Part III, C.3 ("The head of the responsible office will communicate his/her initial decision or the status of the request to the requester, usually within 60 calendar days after it is received by the NOAA Section 515 Officer."); *see also* OMB, *Improving Implementation of the Information Quality Act, M-19-15*, at 10 (April 24, 2019) ("Revised procedures should, at minimum, provide that agencies will not take more than 120 days to respond to a [Request for Correction] …").

outputs described below in light of the methodological error described in this Request for Correction so that the model provides take estimates based on the best data reasonably available.

1. The Erroneous Model and Its Outputs Are "Information" and "Influential Scientific . . . or Statistical Information" Disseminated by NMFS Under NOAA's Information Quality Act Guidelines

As a threshold matter, NMFS's model for estimating takes, and its published outputs, clearly qualify as "Information" and, more specifically, as "influential scientific . . . or statistical information" and "highly influential scientific assessment," and thus fit squarely within the purview of the Information Quality Act. NMFS's model and its outputs have also been "disseminated."

a. Influential Scientific Information

The applicable definitions of "Information" and "Scientific information" expressly mention "model[s]" and data in "numerical" form.[10] That alone subjects NMFS's model to the requirements of the Information Quality Act. In addition, the *NOAA Information Quality Act Guidelines* specifically list "model outputs" as one example of "Synthesized Products," defining "Synthesized Products" as "those that have been developed through analysis of original data. This includes analysis through statistical methods; model interpolations, extrapolations, and simulations; and combinations of multiple sets of original data."[11] In other words, NMFS's "unrealistic" overestimates of exposure numbers resulting from a statistical method that erroneously multiplies conservative margins are also subject to review as a Synthesized Product.

The NMFS model further qualifies as both "influential scientific … or statistical information" and "highly influential scientific assessment" information, thereby triggering *heightened* scrutiny under the Information Quality Act. "Influential scientific information" is defined as "scientific information the agency reasonably can determine will have or does have a clear and substantial impact on important public policies or private sector decisions."[12] NMFS's erroneous model for calculating predicted takes has a significant impact on energy policies and private sector activities. As BOEM has noted, "G&G surveys are conducted to: (1) obtain data for oil and gas (O&G) exploration and production, (2) aid in siting offshore (i.e., O&G, renewable energy) structures, and (3) locate marine mineral resources. . . . Such data are also used to ensure the proper use and conservation of Outer Continental Shelf (OCS) energy resources and the receipt

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[10] *NOAA Information Quality Act Guidelines* at Part I defining "Information" as "any communication or representation of knowledge such as facts or data, in any medium or form, including textual, *numerical*, graphic, cartographic, narrative, or audiovisual forms" (emphasis added) and "Scientific Information" as "actual inputs, data, *models*, analyses, technical information, or scientific assessments based on the behavioral and social sciences, public health and medical sciences, life and earth sciences, engineering, or physical sciences. This includes any communication or representation of knowledge such as facts or data, in any medium or form, including textual, *numerical*, graphic, cartographic, narrative or audiovisual forms that involves a field identified in the preceding sentence." (emphasis added).
[11] *Id.*
[12] *Id.* at Part I, Part II under "Objectivity" heading, and Appendix.

of fair market value for the leasing of public lands."[13] For these reasons, the Administration's stated emphasis of maintaining energy independence and a global leadership position in energy development cannot succeed without G&G surveys.[14] And the private sector's ability to act in furtherance of these energy policies will be hampered if flawed calculations prevent the creation of a proper regulatory framework for permitting G&G surveys within the scope of the MMPA. The model is therefore "influential" within the meaning of the *NOAA Information Quality Act Guidelines*.[15]

Moreover, the model also qualifies as "highly influential scientific assessment" information. "Highly influential scientific assessment"[16] means:

> influential scientific information that the agency or the Administrator of the Office of Information and Regulatory Affairs in the Office of Management and Budget determines to be a scientific assessment that: (i) could have a potential impact of more than $ 500 million in any year, or (ii) is novel, controversial, or precedent-setting or has significant interagency interest.[17]

As detailed below, the erroneous model generated significant interagency interest involving at least BOEM, NOAA and the Bureau of Safety and Environmental Enforcement ("BSEE"), with BOEM raising significant concerns with NMFS's modeling. These concerns are significant, as the exponentially inflated take estimates in NMFS's model could result in fewer permits for seismic surveys and therefore ultimately reduce energy exploration activities.

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[13] BOEM, *Fact Sheet, Geological and Geophysical Surveys* (undated) https://www.boem.gov/sites/default/files/about-boem/BOEM-Regions/Atlantic-Region/GandG-Overview.pdf. *See also NMFS 2018 ROD* at 2 ("G&G surveys provide information for government and industry to evaluate the potential for offshore oil, gas, or methane hydrate resources, locate marine mineral resources, site renewable energy structures, identify geologic hazards, and other uses.").

[14] *See* E.O. 13783, 82 Fed. Reg. 16,093 (March 31, 2017); E.O. 13795, 82 Fed. Reg. 20,815 (May 3, 2017); *see also* Outer Continental Shelf Lands Act ("OCSLA") which calls for the expeditious and orderly development of the OCS (43 U.S.C. §§ 1332(3) (declaring it to be a policy of the United States that "the outer Continental Shelf is a vital national resource reserve held by the Federal Government for the public, which should be made available for expeditious and orderly development, subject to environmental safeguards, in a manner which is consistent with the maintenance of competition and other national needs;…"), 1802(1) (clarifying that Congress enacted OCSLA to "establish policies and procedures for managing the oil and natural gas resources of the Outer Continental Shelf which are intended to result in expedited exploration and development of the Outer Continental Shelf in order to achieve national economic and energy policy goals, assure national security, reduce dependence on foreign sources, and maintain a favorable balance of payments in world trade").

[15] *NOAA Information Quality Act Guidelines* at Part I defining "Influential information" as "information the agency reasonably can determine will have or does have a clear and substantial impact on important public policies or private sector decisions."

[16] *Id.* ("Scientific assessment means an evaluation of a body of scientific or technical knowledge, which typically synthesizes multiple factual inputs, data, models, assumptions, and/or applies best professional judgment to bridge uncertainties in the available information. These assessments include, but are not limited to, state-of-science reports; technology assessments; weight-of-evidence analyses; meta-analyses; health, safety, or ecological risk assessments; toxicological characterizations of substances; integrated assessment models; hazard determinations; or exposure assessments.").[17] *Id.* at Part I and Appendix.

[17] *Id.* at Part I and Appendix.

Moreover, following its use in the Atlantic, NMFS has sought to employ a similarly flawed model for estimating marine mammal takes in other regions. For example, NMFS participated in a Final PEIS for the Gulf of Mexico OCS Proposed G&G Activities in the Western, Central and Eastern Planning Areas which incorporates the same flawed statistical methodology as the *NMFS 2018 ROD* and *2018 Environmental Assessment* for the Atlantic region.[18] In addition, NMFS has indicated that it plans to adopt this flawed modeling methodology in conjunction with issuing final incidental take regulations for the Gulf.[19] NMFS's stated reliance on this same flawed methodology in the Gulf of Mexico—a major source of offshore oil and gas production in the U.S.—further underscores that the model qualifies as "highly influential."

b. Information Disseminated by NMFS

As noted above, NMFS's model was adopted in the *NMFS 2018 ROD* (which also adopted the *2014 Atlantic PEIS*) and relied upon in *NMFS 2018 Environmental Assessment* which lists the agency's estimated take numbers based on the erroneous model. NMFS has thus disseminated the model and its outputs and relied upon erroneous take estimates resulting from a fundamental methodological error—the basis of this Request for Correction.

2. NOIA, IAGC, OOC, LMOGA, and Their Members Are Adversely "Affected" by the Inaccurate Model Disseminated by NMFS

The *NOAA Information Quality Act Guidelines* define an "affected person" as an entity "that uses, benefits from, or is harmed by the disseminated information at issue."[20] NOIA, IAGC, OOC, and LMOGA, as well as their respective members, fit within this category of "affected persons."

NOIA is a national trade association representing all segments of the offshore industry with an interest in the exploration and production of both traditional and renewable energy resources. NOIA's members include multiple producers of crude oil and natural gas that have made significant investments into leases in deepwater areas of the OCS. Its members extensively use G&G surveys and are directly impacted by the flawed methodology in NMFS's model at issue here.

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[18] NMFS acted as a cooperating agency in developing the 2017 Final PEIS for the Gulf of Mexico ("*2017 GOM PEIS*"), and NMFS has since expressed its intent to adopt the 2017 GOM PEIS analysis. 83 Fed. Reg. 29,212, at 29,213 ("NMFS participated in development of the PEIS as a cooperating agency and believes it is appropriate to adopt the analysis in order to assess the impacts to the human environment of issuance of the subject ITR and any subsequent LOAs. Information in the petition, BOEM's PEIS, and this document collectively provide the environmental information related to proposed issuance of this ITR for public review and comment.").

[19] *Id.; see also* Taking and Importing Marine Mammals: Taking Marine Mammals Incidental to Geophysical Surveys Related to Oil and Gas Activities in the Gulf of Mexico (RIN: 0648-BB38); *2017 GOM PEIS* at 1-22 (https://www.boem.gov/sites/default/files/environmental-stewardship/Environmental-Assessment/NEPA/BOEM-2017-051-v1.pdf), 82 Fed. Reg. 36,418 (Notice of Availability) ("BOEM has clarified language in this Programmatic EIS to more consistently refer to modeled and quantified "exposures" to certain sound levels for analyzing impacts. The determination of what qualifies as an individual 'take,' which has a specific legal meaning under the ESA and MMPA, will ultimately be determined by NOAA through its MMPA Incidental Take Authorization development process . . . ").

[20] *NOAA Information Quality Act Guidel*ines at Part III.A.4.

Founded in 1971, the IAGC is the global trade association for the geophysical and exploration industry, the cornerstone of the energy industry. With more than 80 member companies in 50 countries, IAGC membership includes onshore and offshore survey operators and acquisition companies, data and processing providers, exploration and production companies, equipment and software manufacturers, industry suppliers and service providers, including those with interests in G&G surveys in the Atlantic that are also directly affected by the erroneous information at issue in this request. The IAGC focuses on advancing the geophysical and exploration industry's freedom to operate. The IAGC engages governments and stakeholders worldwide on issues central to geophysical operations and exploration access, including prioritizing timely, accessible G&G survey data acquisition throughout the life of the asset; providing predictability and competition; promoting regulatory and fiscal certainty and promulgating science-based regulations.

The OOC is an offshore oil and natural gas trade association that serves as a technical advocate for companies operating on the U.S. OCS. Founded in 1948, the OOC has evolved into the principal technical representative regarding regulation of offshore oil and natural gas exploration, development, and producing operations. The OOC's member companies are responsible for over 90% of the oil and natural gas production from the GOM.

LMOGA, founded in 1923, is a trade association representing all sectors of the oil and gas industry, including exploration and production, refining, transportation, marketing, and mid-stream companies as well as other firms in the fields of law, engineering, environment, financing, and government relations.

As noted above, G&G surveys are critical to the industry's continued exploration and development of oil and natural gas resources in the OCS. NOIA's, IAGC's, OOC's, and LMOGA's members' interests in these activities are jeopardized by NMFS's flawed modeling. Indeed, the exponentially inflated exposure estimates in NMFS's model could, among other things, significantly reduce the permitted scope of G&G surveying in the OCS, thereby unreasonably constraining exploration and development in the OCS, including in the Atlantic OCS. Unless corrected, NOIA, IAGC, OOC, LMOGA, and their respective members will therefore be greatly harmed by the effects of the flawed statistical model.

3. Overview of Relevant Information Quality Act Guidelines

One of the core requirements of the Information Quality Act and its implementing guidelines is "objectivity,"[21] which "ensures that information is accurate, reliable and unbiased." For "Synthesized Products," such as the model outputs at issue here, objectivity is achieved by "using data of known quality, applying sound analytical techniques, and reviewing the products or processes used to create them before dissemination."[22] Information that qualifies as "influential scientific . . . or statistical information" is held to a higher standard of objectivity,[23] and an even

[21] *Id.* at Part II ("Information quality is composed of three elements: utility, integrity and objectivity.").
[22] *Id.* at Part II.B.
[23] OMB, Improving Implementation of the Information Quality Act, M-19-15, at 3 (April 24, 2019) ("The touchstone is 'fitness for purpose'; information destined for a higher-impact purpose must be held to higher standards of quality. The *Guidelines* characterize a subset of agency information as '*influential scientific, financial, or statistical information' that is held to higher quality standards.*" (emphasis in original)); *see*

higher quality standard applies to "highly influential scientific assessment."[24] As discussed under Section 1.a. above and further below, these heightened standards apply to NMFS's statistical modeling at issue here.

NOAA's IQA guidelines further require that NMFS apply "best available science" and make "full utilization of the best scientific information available."[25] Similarly, a parallel statute, the Foundations for Evidence-Based Policymaking Act of 2018 (Public Law No. 115-435), focuses on data used for "making estimates," including "methods" used in "models." This 2018 law, according to OMB guidance, creates a "new paradigm by calling on agencies to significantly rethink how they currently plan and organize evidence-building . . . functions."[26]

4. NMFS Fails to Comply with Its IQA Guidelines by Adopting a Statistical Model that Suffers from a Basic Math Error and Other Flaws

As described below, NMFS's statistical methodology for estimating takes violates the "objectivity" and best-data-reasonably-available standards required by the Information Quality Act. Although NMFS's model is technical, the fundamental error is quite simple to identify and fix. NMFS should remove the extra margins added to independent variables derived from best available data before they are multiplied, and then, as needed, add a conservative margin to the end result after the variables are multiplied.

The attached report aptly describes the fundamental flaw with this statistical methodology when NMFS sought to employ the same faulty approach in the Gulf:

> Selection of conservative values in multiple steps of the model leads to an outcome that is not an average of the precautionary assumptions, or even an addition of uncertainty, but a multiplication of each uncertainty by the uncertainty in the other steps. Simply put, doubling the expected value for four different parts of the model does not double the outcome, nor does it result in a 2+2+2+2=8-fold increase in the predicted outcome. Instead the effect of multiple precautions is multiplicative, and the outcome is 2x2x2x2=16-fold more than if the model was run with 'most-likely' values like averages. [27]

BOEM explained in its 2014 PEIS later adopted by NMFS that NMFS's model uses overly conservative assumptions for various model inputs, including, for example, conservative

also NOAA Information Quality Act Guidelines at Part II ("Quality will be ensured and established at levels appropriate to the nature and timeliness of the information to be disseminated.").

[24] *Id.*

[25] *NOAA Information Quality Act Guidelines* at Part II.

[26] https://www.whitehouse.gov/wp-content/uploads/2019/07/M-19-23.pdf.

[27] *See Gisiner Report* at p. 1.

assumptions made for acoustic source modeling,[28] acoustic propagation modeling,[29] animal density and others.[30] These conservative margins are then *multiplied at each stage of the model*, resulting in grossly inflated take estimates because "each of the inputs into the models is purposely developed to be conservative and conservative assumptions accumulate throughout the analysis."[31] This approach ignores an elementary scientific principle of predictive modeling:

> Conservatism due to uncertainty about the values entered into the model must properly be handled separately, after modeling to most likely outcome, as is widely demonstrated and well-known for a variety of similar risk models such as weather models, economic models, and medical diagnostic and treatment models.[32]

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[28] *2014 Atlantic PEIS* at E-64 ("However, this selection necessitated that the representative source conservatively represented sources that were often 10 or more decibel lower in power. In addition, it was assumed that the modeled array was always at maximum power and that all air-guns were fully operational for fully completed survey scenarios. Similarly, for the mineral resources survey, the most conservative parameters for source level, signal repetition rate, pulse lengths, etc. were assumed."); *compare* International Association of Geophysical Contractors' ("IAGC"), the American Petroleum Institute's ("API"), NOIA's, and OOC's (together "Associations") Nov. 29, 2016 comments to BOEM Environmental Impact Statements regarding the Gulf of Mexico at Attachment A, R. Gisiner, Synopsis of Precautionary Assumptions (hereinafter "*Gisiner Report*") (https://www.regulations.gov/document?D=BOEM-2016-0068-1026) (attached hereto as **Exhibit 1**) at pp. 2, 3-5 ("The 33-37% difference in the size of the two arrays translates into an increase of some 45-50 % (roughly) in the area exposed and therefore the number of animals taken.").

[29] *2014 Atlantic PEIS* at 4-59 and E-64 ("This generally tends to underestimate the transmission loss and therefore overestimate the received levels at all ranges to some degree. Actual in situ propagation therefore typically displays much more fading and disruption of the signal, especially for signals shorter than 1 s (i.e., airguns)."); *compare Gisiner Report* (Ex. 1) at p. 5 ("The modeling of sources of variance yielded a 10 decibel difference in sound transmission between an average sound speed profile in the water and the extreme case used in the model (10 decibels is an order of magnitude or ten times the average). Use of hard or median properties for the seafloor added another 4 dB over the most likely outcome, with most of the Gulf being covered with soft sediment that is a poor reflector of sound). Use of a flat sea surface instead of a rough sea surface adds another 2 dB minimum, resulting in a conservative value of overestimated propagation of 16 decibels or 60 times (!) the amount of energy propagated than would be expected on average.").

[30] *2014 Atlantic PEIS* at 4-60 and E-64 ("Marine mammal density values are typically very conservative. As a simple check of their conservatism, a calculation consisting of multiplying each density value by the area that it covers and then summing these values results in total population values that greatly exceed those identified in the Marine Mammal Stock Assessment reports."); *compare Gisiner Report* (Ex. 1) at pp. 2 and 6 ("NMFS's Stock Assessment Reports … and Duke Model differ on average by a factor of 2." "But overall, the use of the Duke model creates an increase in predicted abundance that is about double the official NMFS abundance numbers in the SARs.").

[31] BOEM, *Record of Decision Atlantic OCS Proposed Geological and Geophysical Activities Mid-Atlantic and South Atlantic Planning Areas, Final Programmatic Environmental Impact Statement* (July 2014) (https://www.boem.gov/sites/default/files/oil-and-gas-energy-program/GOMR/Record-of-Decision-Atlantic-G-G.pdf) (hereinafter "*BOEM 2014 ROD*").

[32] *See* Associations' Aug. 21, 2018 comments to proposed Incidental Take Regulations for the Gulf of Mexico at p. 42 (citing Slingo and Palmer, *Uncertainty in weather and climate prediction*, Phil. Trans. R. Soc. A(2011) 369: 4751-4767) (https://www.regulations.gov/document?D=NOAA-NMFS-2018-0043-0015).

Because the conservative margins are multiplied, the exponential effect yields orders of magnitude more animal takes under the MMPA than a best scientific estimate would ever produce. In other words, the math error caused by using conservative assumptions at each iterative stage of the model produces inflated take numbers that are untethered from realistic estimates.

The net result is that NMFS dramatically overestimated takes based on this flawed mathematical method that was used in the agency's 2018 ROD and 2018 Environmental Assessment. To take one example, NMFS adopted take numbers reported in BOEM's PEIS and incorporated them in its determination of authorized takes in the Environmental Assessment. Information from the Environment Assessment[33] copied below shows exponentially overstated take numbers due to the model expressly "adopt[ed]" by NMFS:

Table 10. NMFS Authorized Take Versus BOEM PEIS Estimated Exposures

Common name	Level A Takes: NMFS Authorized[1]	Level A: BOEM Estimated Exposures[2]	Level B Takes: NMFS Authorized	Level B Takes: BOEM Estimated Exposures[3]
North Atlantic right whale	0	0	19	954
Humpback whale	10	17	134	3,817
Minke whale	12	0	694	206
Bryde's whale	0	4	10	1,304
Sei whale	0	1	10	1,317
Fin whale	12	0	1,888	3,015
Blue whale	0	5	5	1,429
Sperm whale	0	977	7,524	95,708
Kogia spp.[5]	15	107	2,176	10,464
Beaked whales[6]	0	761	23,324	74,554
Northern bottlenose whale	0	1	20	90
Rough-toothed dolphin	0	89	819	8,763
Bottlenose dolphin	0	42,535	90,795	4,168,872
Clymene dolphin	0	1,406	11,891	137,795
Atlantic spotted dolphin	0	20,587	75,576	173,663
Pantropical spotted dolphin	0	3,044	4,821	298,327
Spinner dolphin	0	13	455	1,296
Striped dolphin	0	13,622	43,897	1,335,139
Common dolphin	0	22,747	85,817	2,229,473
Fraser's dolphin	0	1	1,020	126
Atlantic white-sided dolphin	0	31	240	3,075
Risso's dolphin	0	11,329	6,162	1,110,342
Melon-headed whale	0	17	250	1,664
Pygmy killer whale	0	15	30	1,458
False killer whale	0	19	140	1,874
Killer whale	0	13	35	1,252
Pilot whales[7]	0	18,989	17,338	1,861,079
Harbor porpoise	20	47	874	4,559

In addition to the math error, there are other flaws that permeate NFMS's methodology in the model. All permits issued by BOEM for G&G activities require use of numerous mitigation measures to minimize potential impacts on marine mammals, including use of lower-sound

[33] *NMFS 2018 Environmental Assessment* at pp. 72-73.

emissions during a lengthy ramp-up period to cause marine mammals to disperse; use of independent observers on G&G vessels who prevent start-up or require immediate shut-down of activities if a marine mammal is detected; use of passive acoustic monitoring at times of reduced visibility to prevent start-up or require shut-down if a marine mammal is detected; and geographic and seasonal restrictions on G&G activities when marine mammal abundance is higher.[34] Yet, no mitigation measures are accounted for in the model, and no consideration is given to averting behavior by the animals themselves.[35] Ignoring such mitigation omits best evidence reasonably available.

These concerns have repeatedly been pointed out to NMFS. BOEM stated in connection with the 2014 PEIS: "Furthermore, the take estimates are based on acoustic and impact models that are by design conservative, which results in an over-estimate of take. Each of the inputs into the models is purposely developed to be conservative, ***and conservative assumptions accumulate throughout the analysis***."[36] And, as noted below, NOIA, IAGC, OOC and other oil and gas industry associations have repeatedly shared their concerns with NMFS about the overly conservative nature of the NMFS' model.

BOEM further informed NMFS that application of the same methodology in the Gulf of Mexico, for example, creates "unrealistically high," "exponentially increase[d]" take numbers, while also failing to account for mitigation measures being employed in the Gulf:

- "The existing modeling largely does not account for uncertainty in the data inputs and also selects highly conservative data inputs. *This bias often produces* ***unrealistically high*** *exposure numbers and 'takes' that* ***exponentially increase uncertainty throughout each step of the modeling.*** The modeling does not incorporate mitigation or risk reduction measures designed to limit exposure. The *modeling is an overestimate and should be viewed with that understanding*."[37]

- "Using the model estimates most often requires accepting a worst-case scenario, which ultimately *overestimates the numbers* of 'take' under the MMPA by equating those numbers with the exposures identified in the modeling ***rather than real world conditions***."[38]

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[34] 83 Fed. Reg. at 63,345-51 (Dec. 7, 2018).
[35] 83 Fed. Reg. at 29,258, 29,260 (June 22, 2018); *2017 GOM PEIS* at 1-18 ("none of the relevant mitigations examined in this Programmatic EIS were included in the impact modeling"); *2014 Atlantic PEIS* at 4-60 ("The calculations included here do not include most mitigation effect that would reduce the potential for take.").
[36] *BOEM 2014 ROD* at 12 (emphasis added); *see also 2014 Atlantic PEIS* at E-65 ("… it is important to now that these numbers represent highly conservative estimates of mostly unmitigated potential take. They should not be considered as expected levels of actual take. This is largely given the many minor conservative assumptions that ultimately result in an overestimation of potential impacts."); *see also* IAGC's, API's, and NOIA's July 21, 2017 comments to proposed NMFS Incidental Take Authorizations for the Atlantic at pp. 19-20 (https://www.fisheries.noaa.gov/action/incidental-take-authorization-oil-and-gas-industry-geophysical-survey-activity-atlantic).
[37] BOEM, *Draft Programmatic Environmental Impact Statement,* 81 Fed. Reg. 67,380 (Sept. 30, 2016), https://www.boem.gov/GOM-G-G-PEIS/, at 4-47 (emphasis added).
[38] *Id.* at 1-20 (emphasis added).

- "Without a rigorous methodology to do this interpretation, BOEM and other agencies must move forward with an overly conservative scenario equating the number of exposures to the number of 'takes' under the MMPA and ESA. This often produces ***unrealistically high exposure/take numbers***. *In this instance, the exposure/take numbers were also modeled without the application of mitigation measures,* ***adding to the unrealistically high exposure/take numbers***."[39]

Notably, NMFS does not dispute the crux of the error—that it added conservative margins to individual elements in its model, which are then multiplied.[40] In response to comments pointing to the errors in the model, NMFS responded that "[a]lthough it may be correct that conservativeness accumulates throughout the analysis, the Associations do not adequately describe the nature of conservativeness associated with model inputs or to what degree (either quantitatively or qualitatively) such conservativeness 'accumulates'."[41] But, as shown for example in the attached report,[42] industry stakeholders have described, both *quantitatively* and *qualitatively,* how the formula improperly multiplies the conservative estimations included in each element of the model inputs.[43]

Commenters on the model and its output in the documents at issue in this Request pointed out that:

- "We also emphasize that NMFS's negligible impact determinations are based upon ***highly conservative, and, in some instances, unrealistic, assumptions*** about the potential effects of the proposed surveys. For example, as addressed in more detail in Section III.D below, NMFS's estimates of the numbers of potential takes by the proposed surveys are grossly inflated as a result of overly conservative modeling assumptions."[44]
- "NMFS ***substantially overestimates*** the number of incidental takes predicted to result from the Proposed IHAs."[45]
- "NMFS's incidental take estimates for the Proposed IHAs are premised, in substantial part, upon the exposure modeling performed by BOEM in the [2014] PEIS. NMFS's reliance on the PEIS ***exposure modeling results in incidental take estimates far greater than the number of takes that can realistically occur based***

[39] *Id.* at 1-21 (emphasis added).
[40] 83 Fed. Reg. 29,212 at 29,259.
[41] 83 Fed. Reg. 63,268 at 63,292.
[42] *See Gisiner Report* (Ex. 1).
[43] *See, e.g.,* IAGC's, API's, and NOIA's July 21, 2017 comments to proposed NMFS Incidental Take Authorization for the Atlantic at p. 19 (https://www.fisheries.noaa.gov/action/incidental-take-authorization-oil-and-gas-industry-geophysical-survey-activity-atlantic); IAGC's API's, NOIA's, and the Offshore Operators Committee's ("OOC") (together "Associations") Aug. 21, 2018 comments to proposed Incidental Take Regulations for the Gulf of Mexico at p. 42 (https://www.regulations.gov/document?D=NOAA-NMFS-2018-0043-0015); *Gisiner Report* at pp. 3-8.
[44] IAGC's, API's, and NOIA's July 21, 2017 comments to proposed NMFS Incidental Take Authorization for the Atlantic at p. 18 (emphasis added).
[45] *Id.* at p. 19 (emphasis added).

on past observations and data because the PEIS analysis is premised upon biased modeling that is ***intentionally designed to overestimate take***."[46]

- The model describes a "***worst-case hypothetical*** scenario."[47]
- "The gist of the agencies' errors is that the PEIS, and therefore of NMFS's take analysis, is based upon a modeling exercise that uses a multiplicative series of conservatively biased assumptions for all uncertain parameter inputs. These assumptions ***lead to accumulating bias*** as the cumulative conservative assumptions add up to increasingly unlikely statistical probabilities that are ***not representative of real-world conditions***. Consequently, the results quickly become little more than ***improbable worst case scenarios*—**not fair simulations or representations of likely effects."[48]

NMFS rejected such comments and declared in the ROD that the "2014 Final PEIS adequately addresses, on a programmatic level, the potential direct, indirect, and cumulative impacts to marine mammals and their habitat resulting from the use of active acoustic sources deployed during G&G surveys and properly addresses NOAA's comments and input."[49]

5. The Inaccurate Model and Its Published Results Should Be Corrected

In light of the above-discussed inaccuracies in the model and outputs, NOIA, IAGC, OOC, and LMOGA ask NOAA:

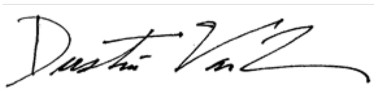
(a) to determine within 60 calendar days of receipt of this letter that the statistical model adopted in the *NMFS 2018 ROD* and *NMFS 2018 Environmental Assessment* does not meet the requirements of the Information Quality Act, and

(b) to initiate corrective measures including: (i) withdrawal of the model and the exponentially inflated take numbers that result from the model, and (ii) development of a model using the best data reasonably available to ensure there is confidence in the quality of the information disseminated.

Please feel free to contact us at the phone numbers or email addresses included in the heading of this letter if you have any questions regarding this Request for Correction.

Sincerely,

[46] *Id.* (emphasis added).
[47] *Id.* at p. 20 (emphasis added).
[48] *Id.*
[49] *NMFS 2018 ROD* at 9.



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SYNOPSIS OF PRECAUTIONARY ASSUMPTIONS

GULF OF MEXICO DPEIS

Bob Gisiner, IAGC

BACKGROUND

The BOEM Gulf of Mexico DPEIS is structurally very similar to most recent NEPA analyses for environmental risk from manmade sound in the marine environment. The interaction of the source, the propagation of the sound from source to animals, and the resulting sound exposures interact to produce a calculated estimate of effect, usually stated as MMPA Level A and Level B "takes", since the MMPA requires that the impact of an activity be quantified in those terms (NEPA and ESA do not have such strictly numerical requirements for estimating impact).

Historically and in this EIS, each element of the model is assessed relative to the available information and a value is selected that is considered sufficiently conservative or precautionary, given uncertainties about the scientific data or about natural variability in factors such as animal distribution, location and movement of the sound source or the sound propagating properties of the water column. Selection of conservative values in multiple steps of the model leads to an outcome that is not an average of the precautionary assumptions, or even an addition of uncertainty, but multiplication of each uncertainty by the uncertainty in the other steps. Simply put, doubling the expected value for four different parts of the model does not double the outcome, nor does it result in a 2+2+2+2 = 8-fold increase in the predicted outcome. Instead the effect of multiple precautions is multiplicative, and the outcome is 2x2x2x2 = 16-fold more than if the model was run with 'most likely' values like averages. Doubling all values out of precaution therefore does not predict an outcome of 200 takes when 100 was the most likely expected outcome, but instead produces an outcome of 1,600 takes.

As we will see from the following quick-look at the GOM DPEIS, there are many more variables in the model than the simple four variable example described above. And the levels of precaution are not simple doubling of expected values, but multiples that may range from addition of some percentage (less than doubling) to increases that are orders of magnitude greater than the "most reasonable" value (orders of magnitude are multiples of ten, such as 10, 100, 1000, etc.). The downstream consequences are also more complicated than the simple two times two example above, with some variables interacting in other than simple multiplicative ways.

For example, use of an 8000 cubic inch sound source rather than the mean or median of sizes actually used (5,600-5,100 cubic inches) would appear to only create a difference of about 30-37%, but that

ATTACHMENT A

difference in size produces a difference in source sound level of 3-6 decibels, depending also on the number of elements in the source array. The difference in source level needs to get translated into a difference in the area covered by the sound from the two different sources, because that will change how many animals are within the two respective areas, all other factors being equal. The 33-37% difference in the size of the two arrays translates into an increase of some 45-50% (roughly) in the area exposed and therefore the number of animals taken. That is, if one uses an 8000 cubic inch array as the precautionary standard and that results in a take estimate of 150 individuals, then use of the more likely mean value of 5,600 cubic inches will result in a take of 100 individuals. Needless to say, this is a pretty large downstream consequence from alteration of a single value by what might superficially look like a pretty small amount. As we will see, factoring in the other parts of the model where similar conservative assumptions are exercised results in a prediction of takes that is millions, possibly billions, of times greater than the outcome predicted by using most likely outcomes only.

[for ease of locating information, references to the DPEIS are to the .pdf file page number, not the page numbers on the document itself]

SUMMARY OF PRECAUTIONARY ASSUMPTIONS IN THE BOEM DPEIS

This list includes only the most obvious and clearly unsupported precautionary assumptions of the model:

- Source
    - Extreme array size and number of elements increases exposures by 1.5 to 2 times.
    - Six additional precautionary assumptions were not analyzed.
- Propagation
    - Conservative or simplifying assumptions about the propagating environment add 10-16 dB minimum to the propagated sound.
    - Combined with the precautionary source assumptions, this results in a 90-120 time increase in estimated takes, all other variables being equal.
    - Six additional precautionary assumptions were not analyzed.
- Animal Abundance, Density and Movements
    - NMFS's Stock Assessment Reports ("SARs") and Duke Model differ on average by a factor of 2. A minimum compromise for uncertainty would be to reduce abundance and density estimates by 25% to 1.5 times SAR.
    - Three specific groups showed even more extreme differences, but were not separated in this simple analysis: expansion of Bryde's whale habitat leading to more takes; large increases in numbers of deep divers (beaked whales, sperm whales, Kogia); extremely large increases in pelagic dolphin numbers (over 80 times for two species)
    - Five additional precautionary assumptions were not analyzed.
- Threshold Criteria
    - Level A calculations from SPLrms and SEL used precautionary assumptions that overestimated take by 10-1,000 times. SPLpeak takes were overestimated at least twofold by using 6 dB instead of 15 dB to derive PTS from TTS.

- Level B calculations make generous assumptions about the likelihood of response and assume all exposures that exceed threshold are biologically significant, over-estimated biological consequence by at least 1,000 to more than 100,000 times.
    - No allowance for reduced Level A due to behavioral avoidance of the source (reductions of Level A up to 85%).
    - No allowance for hearing recovery between pulses (likely reduction of cumulative SEL from a continuous pulse train of 50% or more); no allowance for hearing recovery between passes separated by hours or days (fewer than 1% of successive passes, those within 8 hours or less, will accumulate and trigger Level A criteria).
    - Four additional contributors to precautionary over-estimation were not analyzed, including application of weighting functions to impulse SPL metrics.
- Mitigation
    - No reduction in take was allocated for mitigation. While setting a specific value for mitigation may be difficult, it clearly is not zero and therefore some reduction of takes due to mitigation should be factored into the model.
    - Reductions from multiple proposed mitigations were not estimated.
        - Vessel separation and dolphin shutdowns modeled, with questionable effectiveness
        - Increased time/area closures and 10-25% effort reductions were not estimated.
- Total Multiplicative Precautions (short list)
    - [Source+Propagation (90-120x)] x [abundance (2x)] x [conservative threshold criteria (100-10,000x)]x [no recovery factor (10-100x)] x [no allowance for aversion (6.7 x Level A)] x [no mitigation (1.1 – 2x)] =
    - **1.3 million to 3.2 billion** more takes than the number that would be produced by using average or most likely values for all variables.

RECOMMENDATION

Re-calculate takes using average or most-likely values, quantify and report the overall level of uncertainty in the modeling results, and add an agreeable level of precaution to the final results, not the individual elements.

- Maybe double is reasonable?
- A statistical measure of extreme confidence like 3 sigma still covers 99.7% of all possible outcomes (370 times the central value) and is not nearly so unreasonable as the present model
- It seems unlikely that 1 million to 3 billion times the most likely outcome, which covers 99.9999% or more of all possible outcomes, is a reasonable level of 'precaution'.

PRECAUTIONARY ASSUMPTIONS

<u>The Sound Source</u>.

As discussed above, BOEM treats all geophysical surveys as if they were all conducted with the largest arrays in use. The nominal value of 8000 cubic inches is an approximation of the maximum array size currently used in the Gulf, typically 7900 to 8500 cubic inches. Based on a quick survey of IAGC members over the past decade, a little less than one third of all surveys use arrays of that size. The other two-thirds of surveys in the GOM use arrays that range in size from 6000-2000 cubic inches, for a mean array size of 5600 cubic inches. Since the different sizes are not distributed normally around that mean value (i.e. not a smooth bell shaped distribution), some other value of central tendency, like the median (5100 cubic inches) might be deemed a more appropriate central value. But in any case, using 8000 cubic inch sources for all modeled surveys greatly overestimates actual use.

The source level of a compressed air array increases as the cube root of its volume, all else being equal, so a difference of 8000 and 5600 cubic inches might seem trivial. But we have seen that it is not trivial in terms of the outcome of concern; the number of animals exposed, because of the resulting expansion of the acoustic 'footprint' of the array and the number of animals likely to be found within that footprint.

Furthermore, the modeled array is not only extreme in the total volume modeled, but also in the number of elements within the array. A typical large array of 8000 cubic inches might include 48 elements and sometimes as many as 60, but the BOEM DPEIS used 72 elements. Why is this important? Because array source level may only increase trivially with total volume, but it is directly proportional to the number of elements. An array with 72 elements has double the amplitude of an array of 36 elements; volume and air pressure being equal.

Therefore the combination of using an array at the extreme upper end of normally used array sizes, coupled with a number of elements in that array which also greatly exceeds the average, can by itself produce estimates of takes that are 1.5 to over 2 times as large as would be predicted by using the normal range of array sizes and numbers of elements actually in use. Based on this variable alone one would be justified in taking the final model predictions and halving them. But there are many more conservative assumptions in the model.

Also potentially capable of altering the model outcome, but not addressed in this quick analysis, are:

- The number of source vessels. When multiple source vessels are used they are used at intervals that are similar to a single source. The total acoustic energy is therefore not increased over using a single source operated at the same inter-pulse intervals, but the total area ensonified is slightly increased, depending on the spatial separation of the vessels. This may be compensated by the fact that each vessel is only producing sound every 60 seconds instead of every 15 seconds for a single source vessel). In the BOEM DPEIS, the maximum number of source vessels, four, is used for all surveys that might use multiple sources, even though many of those surveys, such as NAZ, WAZ and coil surveys, might more often use only one or two sources, and rarely use as many as four source vessels.
- Longitudinal tracks were only used during modeling on the slope region of the Gulf, which has the potential to alter sound fields and estimated takes relative to using both lateral and longitudinal tracks typical of most surveys.
- The choice of depth at which the array was towed was set at 8 meters, but other tow depths are common (6 meters is considered the default 'standard') and the choice of tow depth affects the frequency structure and propagation of the resulting sound field.
- The choice of pulse intervals typically varies from 10 to 20 seconds, with the DPEIS selection of 15 seconds being fairly typical. A four source survey would result in each source operating at 60 second intervals.

- Durations of surveys were not clear. On page 3-23 a nominal survey duration of 10.5 months was applied to all surveys, but elsewhere in the document, e.g. D-177, the survey durations varied.
- Survey areas, line separations, and other parameters on page D-177 appear to be in the same conservative direction as the array size and element count; suggesting that line spacing and area covered by a modeled 2D, 3D, WAZ or other survey may be greater than average and thus produce elevated sound exposures and take estimates.

Sound Propagation.

BOEM is to be commended for having run some preliminary models (Phase I modeling in Appendix D) to quantify some of the consequences of using simplifying or conservative assumptions (e.g. see pages D-100; D-106; D-113; D-122). Therefore we can assign some quantities to what is otherwise a very complicated variable, the day-to-day fluctuations in wind, temperature, currents, and other factors that affect sound propagation through the water between the sound source and the animals of concern.

The modeling of sources of variance yielded a 10 decibel difference in sound transmission between an average sound speed profile in the water and the extreme case used in the model (10 decibels is an order of magnitude or ten times the average). Use of hard or median properties for the seafloor added another 4 dB over the most likely outcome, with most of the Gulf being covered with soft sediment that is a poor reflector of sound). Use of a flat sea surface instead of a rough sea surface adds another 2 dB minimum, resulting in a conservative value of over-estimated propagation of 16 decibels or 60 times (!) the amount of energy propagated than would be expected on average. Add this to the conservatism we saw for the source itself, and we already have an ensonified area and number of animals ensonified that would be 90 to 120 times the reasonably expected exposures. A "best reasonable estimate" of 100 would become an estimate of 9,000 to 12,000 from these two precautionary measures alone.

Also potentially capable of altering the model outcome, but not addressed in this quick analysis, are:

- A single uniform propagation regime is used for the entire deepwater zone (Zone 7). Assumptions of flat bottom and maximum depth are not met in all cases and propagation is therefore subject to additional over-estimation factors in the deep water region.
- Survey days and survey effort appear to have been evenly distributed across the area and seasons, although this is likely not the case for actual survey effort. Theoretically this might average out, but it is also possible that fewer actual survey days in winter, when propagation conditions are best, will lead to actual surveys producing fewer takes than the model estimated by using equal division across winter and summer.
- SPLrms for longer range propagation is derived from the SEL values produced by the model. As JASCO acknowledges (D-49), modeled SEL at range tends to over-predict SPLrms as the signal is spread over time. Time resolution of the model also hinders accurate modeling of SPLrms based on proper analytic units such as rms.90 (average sound pressure over the time than encompasses 90% of the total pulse energy).
- Single frequency long range propagation modeling leads to increased errors in pulse properties with range. For modeling purposes a single frequency at the center of each 1/3 octave band is treated as 'representative' of all the sound energy within that frequency band. In practice, selection of a non-representative frequency (e.g. located at a ghost notch or filtered by

propagating environment) can lead to errors in weighted SEL values needed for determining effects thresholds.

- Use of "maximum over depth" in some model estimates of take creates a worst-case scenario where all individuals are assumed to be at the depth of highest sound exposure all the time. It is not clear in what context JASCO used maximum over depth as a simplifying step in modeling, but it will always greatly over-estimate takes when used.(D-296)
- Ranges to effect for mitigation monitoring and shutdown (but not for take estimation?) were calculated from unweighted values, whereas hearing frequency weighting needs to be applied to SEL threshold values (JASCO also seems to have applied weighting to SPLrms data, which may also be inappropriate – see section on Threshold Criteria, below).

Animal Abundance, Density and Movements.

This is a complex set of variables, with precautionary assumptions literally varying for each of the species modeled. But overall, the use of the Duke model creates an increase in predicted abundance that is about double the official NMFS abundance numbers in the SARs. Some additional modifications in the use of those data by JASCO add to the conservatism (over-prediction) by a fractional amount, in most cases.

The Duke model is a novel approach to forecasting animal distribution and density from historical correlations with readily available environmental data, typically not the true environmental predictors like prey patches or features like fronts, currents and eddies that are less easy to predict or track. As such, there are some things that the Duke model likely does better than the SARs, such as predicting average abundance of pelagic dolphins that move in and out of the US EEZ from one survey to the next, leading to large sampling variability. However, other similar models for the US west coast, for the UK, and for global oceans, have shown some extreme misses in their predictions, an expected outcome for models in the early stages of development for species that are infrequently counted and whose habits are still poorly understood relative to land animals for example. Too great dependence on a single very new model like the Duke model can therefore be expected to result in some improvements on the SAR or US Navy NODES data resources, but is also likely to produce some extreme "misses". Species with wide disparities between historical data and Duke model predictions include Atlantic spotted dolphins (from no historic estimates in SAR, to over 45,000 animals predicted by the Duke model, making them the third most abundant species in the Gulf, virtually overnight. Duke predictions of Clymene dolphin abundance are about 85 times higher than the SAR figures, Kogia numbers are increased by a factor of 12, rough-toothed dolphins by a factor of 8 and killer whales by a factor of more than 7. These are radical changes to our understanding of marine mammal abundance in the Gulf that require more than blind acceptance of a new model simply because it is generally "better" than the SARs (D-65).

Some of the animal abundance and distribution modeling may be unfamiliar and counter-intuitive to the average reader. The model in the BOEM DPEIS uses electronic representations of individual animals, or 'animats', to construct time series of exposure for a realistic number of animals, 'behaving' in realistic ways, so that the animats move about and dive at realistic speeds and distances relative to the sound source, which is also moving. As might be expected, capturing the complexities of animal behavior and all of the other variability of the sound source and the propagating ocean is impossible, so certain statistical techniques are used to smooth out some of the variability in outcome that can occur just from sampling errors alone. These techniques, such as over-populating the sound field with hundreds or thousands of times more animats than animals (and then reducing the result proportionally to the actual population) do not affect the outcome but do reduce the likelihood of random extreme variation in outcomes. Monte Carlo methods, or running the same simulation over and over hundreds or thousands of times also helps smooth out the distribution of outcomes. Because the animats are seeded randomly for each model run and because they run independently according to user-specified rules, no single model run will produce the same result (as in real life) and so the model must be run many, many times in order to arrive at a statistical average. This process, which is widely accepted as statistically legitimate and even necessary to producing realistic model outcomes, should not be confused with the selection of variables to put into the animat models and Monte Carlo simulations: those variables, like the source and propagating environment variables, can and do produce biases in the outcome, as will be discussed in detail below.

Animal survey data for the Gulf of Mexico is sparse overall, and therefore statistically weak. Various techniques have been applied to the data to generate estimates of population abundance, density and distribution. The official NMFS Stock Assessment Reports (SAR) are an official estimate by NMFS of the best estimate of population abundance in a region, but they do not offer information about animal distribution, forcing the user to either evenly distribute the animals even across the habitat, even though it is known the animals do not use all of the habitat equally. Alternatively, the modeler can generate 'expert' assumptions about how the animals use the habitat, but those assumptions can create unrealistic estimates of take if the assumptions are not good. For example, JASCO placed all sperm whale animats in water depths greater than 1000 meters because sperm whales are deep divers that tend to occupy deep water. However, a look at the data show that many, if not most, sightings of sperm whales occur in water depths of 400-800 meters, and this is largely confirmed by tagged whale data from the BOEM SWSS research project.

Alternative to applying a population estimate for the entire Gulf evenly or selectively across the Gulf is to use habitat features correlated with animal sightings to predict where animals are most likely to be seen based on 'suitability' of habitat. The statistical aspect of this process is quite well worked out as in the Duke University model applied in the BOEM DPEIS, but there are still 'human-in-the-loop' decisions that can affect model outcome. Something like the Duke model is therefore a "work in progress" in which model predictions may be more or less accurate, depending on the habitat variables available to the modeler and whether they are in fact strongly predictive of where animals will in fact be. A few "warning flags" about the novel predictions by the Duke model are:

- The distribution of Bryde's whales across the entire GOM shelf edge by the inclusion of "unidentified baleen whale" data as Bryde's whale data. Actual observations suggest that the Bryde's whales are confined to a relatively small area of habitat around DeSoto Canyon in the Eastern Planning Area (EPA), and in fact this site has been selected as a special mitigation zone. But the Duke model "places" Bryde's whales across large swaths of area where they have never been seen, greatly elevating the predicted takes in the WPA and CPA by what are probably orders of magnitude (hundreds or even thousands of modeled takes not supported by the real data).
- Several species for which there are low sighting data produced low likelihoods of occurrence across vast areas of the Gulf in the Duke model, which were further simplified to even probabilities across entire modeling zones: false killer whales, killer whales and several other species are therefore equally likely of being taken wherever surveys occur, when in reality there

are probably higher and lower areas of likelihood. It is hard to predict how the "fuzzy" predictions of the Duke model, and the modifications of the JASCO model affect take outcomes but generally speaking, these species tend to have predicted abundances derived from Duke density models that are among the highest deviations of the Duke model from SARs (e.g. 6 times SAR for killer whale, 14 times SAR for pygmy killer whale).

- Deep divers that are seldom seen during visual surveys were subjected to some assumptions about sightability that greatly elevated predicted abundance and greatly expanded habitat occurrence over the SARs; 12 times the SAR for Kogia and about 8 times the abundance for beaked whales (based on Cuvier's beaked whale modeling). This radical departure from historical estimates of abundance is somewhat consistent with comparisons elsewhere (Atlantic, California, Bahamas, eastern north Atlantic sites), but on the high side. It is also higher than predictions by passive acoustic surveys and modeling by Hildebrand, Moretti, and others. Just how "precautionary" the Duke model is for these species is hard to estimate at this time, but it is fairly clear that the Duke model is over-predicting deep diver abundance and distribution leading to excessive estimates of takes.

Additional aspects of animal distribution and movements information that may lead to over-prediction of takes include:

- Assumptions used to deal with the large number of modeling cells that yield zero abundance and zero takes can lead to over-prediction of takes. JASCO notes that the outcomes that yielded a probability of Level A take greater than one (1) was less than 0.2% (i.e., only 2 out of a thousand model results yielded a take of 1 or more animals)(D-123, D-129). The average number of Level A takes was 0.0195 or about 2 per 100, the result of a very small number of model outcomes that yielded more than one Level A take.
- The 3MB model used to set swimming and dive parameters for the animals rely on limited data, quite often from related species studied at different locations than the Gulf. It is therefore hard to predict whether the overall effect of the values entered into the 3MB model resulted in over-prediction of takes or under-prediction, but the most likely outcome is that the values used were conservative, precautionary values that added to the over-prediction of takes.
- The modelers assumed that the animals did not undergo long-term, large-scale movements. Certainly it is widely assumed that animals do not migrate in and out of the Gulf in great numbers, although sperm whales, a variety of baleen whales, and probably many other species do move between the Gulf and Atlantic or Caribbean. But the currently available data do not offer enough information, especially for winter months, to determine whether other species exhibit moderate north-south or east-west movements with the seasons similar to the inshore-offshore movements of estuarine bottlenose dolphins in the late winter and spring, or during other seasons. It is well known that large numbers of animals may travel from east to west, tracking the warm core rings spun off by the Loop Current, but this phenomenon is not sufficiently documented to inform the model.
- JASCO modeled the effect of group size on outcome. They did not see a significant difference in average outcome from using single, ungrouped animats, although they did note that obtaining the same outcome regardless of group size means that there will be more zero-take model runs as group size increases (D-135; D-174).

- As animats move over time, and if animats are removed once they exceed a take threshold, then the probability of take will decline over time as there are fewer and fewer animats in the field. JASCO used a common technique for keeping the number of animats constant and thus keeping probability of take constant over time by introducing new animats on the opposite side from which an animat had just left (D-49; D-82; D201). It is also not clear if and how animals were removed or replaced once taken. This is especially important where animats were left in the field to accumulate SEL for days or weeks. There are other nuance to re-seeding the sound fields that can result in skewed results, but a full treatment is beyond the scope of this short review.

Take (Acoustic Risk) Thresholds.

Both Level A and Level B thresholds range from more than 100 times higher than best scientific evidence to over 100,000 times higher. There are multiple conservative assumptions that produce this extraordinary outcome: the assumption that exposure equals take, the conservative linkage of permanent hearing decrements to temporary hearing decrements, assumptions about the accumulation of hearing effects over time without recovery between exposures, and assumptions about how many of these exposures actually have any meaningful biological consequences.

The MMPA defines "harassment" with reference to two categories: Level A harassment (potential to "injure") and Level B harassment (potential to "disturb"). NMFS applies acoustic thresholds to estimate the amount of harassment for each category that may result from an activity. The acoustic thresholds are often mistakenly assumed to mean that an injury or mortality will occur, with 100% of the exposed animals being injured or killed, or that 100% of exposures at behavioral thresholds will cause behavioral change and that the consequences of the change are a significant and meaningful loss of food, energy, or some other key biological function. In fact, both thresholds imply a probability of there being an effect upon exposure. BOEM was quite emphatic in stating that exposure does not equal take, but the model still treats any exposure that exceeds threshold as a take. This is the first of many features within the Acoustic Risk Threshold part of the model that lead to large over-estimates of take.

Additionally, the DPEIS is not always clear when and how animals are removed from the model to prevent multiple takes of the same individual (e.g., being counted as a Level B take and then exceeding Level A criteria and also being counted as a Level A take). Removals need to be handled carefully to prevent gradual reductions of model 'animats' in the sound field as "taken" animats are removed.

The most recent threshold criteria for Level A takes are based on empirical data for the threshold at which a temporary decrease in hearing sensitivity (TTS) occurs across a narrow frequency range of hearing (NMFS, 2016; Finneran, 2015). BOEM also variously cites NMFS 1995; Southall et al 2007; Finneran and Jenkins, 2012: it is not yet clear which criteria they plan to use in the Final EIS, making analysis of the DPEIS difficult. JASCO in Appendix D modeled the 1995 threshold

The simplest Level A threshold, long since superseded by scientific data but still in use by NMFS, is 180 dB SPLrms (root mean squared – an average over some specified time period, and since it is an average of a logarithmic scale, dB, a square root of the mean of summed square values is required rather than a simple average). Despite being outdated by more than 20 years, BOEM still modeled takes using this hyper-precautionary threshold. This provides a threshold that is some 10 to 1,000 times more precautionary than the current best data derived from TTS thresholds for both impulse and tonal sources; the peak SPL or the summed sound energy over time (SEL), although we shall see later in this section that the SEL has also been subjected to additional conservative assumptions that render it some 10-1,000 times more conservative than SPLpeak. The values of 10 to 1000 times are based on SPLpeak thresholds of 230-200 dB SPLpeak, and an estimate of 180 dB SPL rms being comparable to 190 dB SPL peak (200 dB is ten times 190 dB and 2230 dB is one thousand times 190 dB on the same scale, in this case SPLpeak).

Permanent Threshold Shift (PTS) is not tested directly, and is assumed to occur at a level above TTS consistent with marine mammal TTS data and human/lab animal data. PTS, as for TTS, is not a threshold for deafness or major loss of hearing, but for a small decrement of hearing sensitivity within a narrow frequency range, a 'hearing notch'. This is a liberal interpretation of "injury", since the original sense of the term in MMPA was intended for animals that lost eyes, limbs, or suffered broken bones and spinal injuries during interactions with fisheries or due to being struck by ships, shot at, or otherwise seriously injured.

The criterion is rendered even more conservative by the use of a 15 decibel difference between TTS and PTS when the data from other species, including humans, indicates PTS onset at 20-40 dB above TTS threshold. Since even this conservative addition of only 15 dB to TTS produces thresholds of PTS above the source level of the sound source, Southall et al (2007) and subsequent criteria (NMFS 2016) have arbitrarily set the SPL peak metric for PTS at a mere 6 dB above TTS threshold, or almost ten times lower (and therefore productive of ten times as many exposures and takes).

The best predictor of TTS and therefore PTS, at least for tonal sounds, is SEL, a product of both signal intensity (not amplitude) and duration. It is not clear how well this relationship holds up for an impulse signal like compressed air (CA) sources, so relationships for tonal signals are applied to impulse thresholds. SEL is referenced to a time duration, typically one second, but for sounds less than 1 second long, like impulse sounds, SEL does not always hold up.

Furthermore, models like the BOEM DPEIS treat multiple exposures separated by many seconds or even hours or days, as if the sound exposure had been continuous. Near the source a geophysical survey produced 0.1 s of sound every 10-20 seconds, expressed as a "duty cycle" of approximately 1-2%. Further from the source the energy in the impulse may spread in time, increasing the duty cycle, but at ranges meaningful for Level A determination, the duty cycle remains below 10%, meaning that 90% of the time the ear is capable of recovering from some of the induced fatigue or threshold shift. Early TTS studies noted that the animals recovered from low levels of TTS within seconds or minutes, and subsequent ongoing studies are consistent, suggesting that it make take considerably more intermittent exposures to produce TTS or PTS than would be predicted by simply adding up multiple pulses as if they all occurred in succession without any time for recovery (In other words 12 pulses of 0.1 second duration each are treated as a continuous 1.2 second pulse and not what they are, which 1.2 seconds of sound within ten 15 second intervals or 150 seconds of ambient sound only).

The case for some sort of recovery function is even stronger for intermittent passes of an array that may be separated by 4, 8, 16 or more hours, in which case hearing is likely fully recovered and no accumulation of SEL should be carried forward. NMFS has traditionally carried SEL forward for 24 hours, a scientifically unwarranted precaution that leads to over-estimations of take by another 10-100 times, if not more. The current modeling exercise suggests in places that SEL accumulation was carried forward even further for weeks or even months. Appendix K offers annual summations of SEL and a similar cumulative sound metric, Leq, for an entire year. This is not scientifically justified and leads to overestimates of takes by tens or even hundreds of thousands of takes, both Level A and Level B.

Because we do not have a specific recovery function to offer yet, BOEM has not included ANY recovery in their model, whereas a model consistent with best available science should include at the very least a recovery function consistent with human and other mammalian hearing. Absence of a recovery function is likely adding another 10 to 100 fold over-estimation to Level A take.

Thresholds for Level B take have been difficult to derive, although more and more publications have offered data and a proposed threshold function: most of these papers are not cited or reviewed in the EIS, or in the reference used by the Phase II model (Appendix D), which is an unpublished contract report to a California utility company (Wood et al 2012). Wood et al (2012) also presents a potential conflict of interest, since the author of Appendix H (Brandon Southall) is also a co-author of the Wood et al (2012) report. The industry is sponsoring a review of the behavioral effects literature, but that review will not be published in time to inform the current PEIS.

In any case, the Wood et al recommendation was a step function of increasing behavioral response at increasing exposure levels, and in this respect Wood et al (2012) is similar to other Level B risk assessments like the US Navy Programmatic EISs (2009; 2014, draft 2017). All recognize that out of a given group of animals, a few will respond at low levels, with increasing recruitment up to an exposure level that approaches thresholds for TTS and PTS. BOEM also applied the outdated NMFS 1995 Level B threshold of 160 dB SPLrms.

The outcome of applying any of these thresholds is the generation of tens of thousands to millions of Level B takes in which the vast majority of "takes" are transitory disturbances that last hours or a day or two and have no impact at all on foraging success, breeding success, growth, health or any other biologically meaningful metric. The hypothetical possibility that cessation of feeding for a day or movement a few miles from the source, or a change in vocal behavior "might" lead to biologically meaningful consequences means that the model calculations are treated as "takes" under MMPA even though all acknowledge that exposures don't equal takes and takes do not equal meaningful effects. The development of the PCOD model, and population of that model with data, confirm that behavioral disturbance from sound needs to be reduced to a "biologically significant" number that is a fraction of the counted exposures; anywhere from a conservative 1% to a more realistic 0.001% or less. In other words, estimates of thousand to millions of takes in the model are like to result in fewer than 1 to 1000 takes with actual biological consequences. These numbers, spread across large areas like the Gulf and multiple species are mathematically too low to result in a population level consequence from Level B takes (e.g. elevation of baseline mortality, decrease in baseline fecundity). This is consistent with history, where more than five decades of regular geophysical survey effort all over the globe has not generated any evidence that observed behavioral responses to the sound has any biological consequence.

Calculation of grossly inflated Level B take numbers in the GOM DPEIS is not consistent with current best information, and greatly over-estimates the consequences for the stocks of marine mammals being managed.

Finally, behavioral aversion was not applied to this model, even though a preliminary Phase I model showed that even small amounts of aversive greatly affected both Level A and Level B takes. If behavioral aversion is a trigger for Level B take then it cannot subsequently be omitted from modeling of Level A takes, since the low level exposures that trigger aversion will reduce the likelihood of higher levels of exposure.

Additional aspects of threshold assessment that may lead to over-prediction of takes include:

- Conservative thresholds for low frequency whales. Current conservative thresholds for whales increase the estimated Level A and Level B takes for these species by some 4 to 10 times over best available science predictions. Arguments for unreasonable precaution in the face of uncertainty are not consistent with mammalian auditory biology in general.
- JASCO applied novel uses of weighting functions, using outdated M1 weighting functions from Southall et al (2007) on SPL thresholds, where weighting functions should not be applied.
- Kogia are considered to have the same hearing thresholds as porpoises, even though they are unrelated and the evidence for high sensitive is based largely on data about Kogia vocal behavior and some inconsistent evoked potential audiometry.
- Modifications to beaked whale Level B thresholds unique to this EIS are applied without justification other than precaution.

Mitigation.

BOEM allowed no reduction in the estimated take for mitigation. This is a highly over-conservative assumption, justified by the relatively little data available on mitigation effectiveness, together with the likely variability in mitigation effectiveness between mitigation service providers, types of marine species present, monitoring conditions and other variables. Some analysis on page D-151 suggests ranges of observer mitigation effectiveness from near zero to over 70%. One cannot require mitigation and at the same time treat it as if it provides no reduction in takes. BOEM needs to come up with some metric for the benefits from required mitigation.A variety of other possible mitigations have been proposed in the GOM DPEIS, ranging from alternative source technologies and active acoustic mitigation to time/area closures, vessel separation schemes, and reduced quantities of geophysical survey effort of 10-25%. At least two of the suggested mitigation measures, vessel separation (Table ES-1; page 1-10; page 2-10; B-32; page 2-38; and D-162-163) and shutdowns for dolphins approaching vessels or bowriding (p. 2-24) offer the possibility of actually increasing takes through expansion of ensonified areas (vessel separation), or extremely high increases in shutdowns with associated prolongation of survey effort (and sound exposure) to achieve survey completion (an estimated 35-40% increase).