NATURAL RESOURCES DEFENSE COUNCIL

By Overnight Mail

January 13, 2005

Mr. Keith Jenkins
Naval Facilities Engineering Command Atlantic (Code EV21KJ)
6506 Hampton Boulevard
Norfolk, VA 23508

Re: Draft Overseas Environmental Impact Statement/ Environmental Impact Statement for the Undersea Warfare Training Range

Dear Mr. Jenkins:

On behalf of the Natural Resources Defense Council ("NRDC") and our more than 650,000 members, over 70,000 of whom reside in potentially affected states, we are writing to submit comments on the Navy's Draft Overseas Environmental Impact Statement / Environmental Impact Statement ("DEIS") for a proposed Undersea Warfare Training Range. See 70 Fed. Reg. 62102 (Oct. 28, 2005).[1] For the reasons discussed in detail below, we believe that the DEIS not only fails to meet the environmental review standards prescribed by the National Environmental Policy Act ("NEPA"), 42 U.S.C. 4321 et seq., but fails to an extent that cannot be remedied through the issuance of a final EIS. Accordingly, if the Navy intends to pursue this project, we believe that the document must be thoroughly revised and reissued as a draft for further public review and comment.

The proposed Undersea Warfare Training Range ("USWTR") poses significant risks to wildlife and coastal resources without economic or environmental benefit to local communities. The preferred site for the project lies off the coast of North Carolina, south of Cape Hatteras, with alternatives proposed for the coasts of northern Virginia and Florida. Whatever area is selected would become the Atlantic hub for Navy training with high-intensity active sonar—a technology whose deadly impacts on marine life have in recent years been the subject of widespread scientific recognition and public concern. Of the more than 160 training exercises slated for the range each year, many would employ the same hull-mounted sonar systems that have been implicated in mass mortalities of

[1] NRDC is aware that comments are being submitted independently by a substantial number of government agencies, individual scientists, environmental organizations, and the public. The comments that follow do not constitute a waiver of any factual or legal issue raised by any of these organizations or individuals and not specifically discussed herein.

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whales around the globe. And those systems would be joined by submarine sonars, helicopter dipping sonars, active sonobuoys, range pingers, torpedo sonars, and a gamut of other sources of intense underwater sound.

It is undisputed that sound is a fundamental element of the marine environment. Whales, fish, and other wildlife depend on it for breeding, feeding, navigating, and avoiding predators—in short, for their survival—and it is no exaggeration to say that the Navy's training range would dramatically degrade the acoustic environment along the North Carolina coast. The project also stands to affect fisheries, to damage coral and hard-bottom habitat, and to release a variety of hazardous materials into coastal waters. Under these circumstances, the siting of USWTR must be undertaken with particular care, dictated not by assertions of convenience but by a recognition that protection of the marine environment and safeguarding of our national defense are mutually dependent national interests that can and must be achieved through compliance with our federal environmental laws.

To that end, Congress has dictated through NEPA that, in undertaking such a project, the Navy must employ rigorous standards of environmental review, including a fair and objective description of potential impacts of the range, a comprehensive analysis of all reasonable alternatives, and a thorough delineation of measures to mitigate harm. Unfortunately, the draft EIS released by the Navy falls far short of these standards. Indeed, it provides an analysis that on almost every crucial point is disconnected from the relevant science, in a way that consistently tends to understate or overlook impacts and, consequently, to rationalize the Navy's preferred alternative. To cite just a few examples:

- The Navy throws out nearly the entire literature on acoustic impacts on marine mammals and other marine species, in support of standards that are dramatically less protective than any previously applied by either the Navy or the agency with regulatory authority over most species of marine mammals, the National Marine Fisheries Service ("NMFS").

- It discounts most of the peer-reviewed science that has emerged linking naval sonar both with marine mammal strandings and with the injury of whales at sea.

- It fails even to mention the mass mortality of 34 whales of three species off the North Carolina coast in January 2005—an event that occurred in the shadow of a naval sonar exercise in virtually the identical location now proposed by the Navy for its acoustic training range.

- It uses modeling techniques that fail to map the sound field beyond a very short distance of a sound source (1 kilometer) and that do not account for impacts from long-term operation of the range.

- It ignores most of the scientific literature demonstrating the impacts of ocean noise on fish and commercial fisheries, and understates the project's potential impacts on fragile bottom habitat.

- It fails to acknowledge risks posed to a wide range of marine species, including one of the most endangered species of whales on Earth—the Northern right whale—whose migration path parallels the eastern seaboard of North Carolina.

The picture that the Navy paints with such an analysis belies common sense. Although mass mortalities of whales have resulted from the single transit of a sonar ship, the DEIS concludes that no marine mammals would die or even abandon their habitat during the USWTR's many years of operation. Although intense sound can cover hundreds of square miles of ocean, the DEIS concludes that no wildlife or resources would be affected outside the range itself. And, although ocean noise has been shown to reduce catch rates of various species of fish, the DEIS concludes that none of the area's offshore fisheries would suffer. If one is to believe the DEIS—and ignore the overwhelming weight of scientific evidence—then the year-round course of high-intensity acoustic activities contemplated by the Navy would unfold day after day, decade after decade, without <u>any</u> significant environmental effect.

Nor is the Navy's analysis of alternatives any more credible. For a long-term project like the USWTR, there is no step more crucial to reducing impacts than careful siting, avoiding concentrations of vulnerable and endangered species and high abundances of marine life to the greatest extent possible. Yet it is clear that the Navy did not factor the environment into its siting decision until long after the candidate and preferred sites were chosen. And the Navy fails to consider a variety of other options, some employed by other navies, that would reduce the impacts of its range. What the Navy presents instead is an analysis so narrowly defined—and so predominated by factors of operational convenience—that the marine environment and those who depend on it are left out of the equation altogether. Stated more generally, the Navy's DEIS is a classic <u>post hoc</u> rationalization for a decision unlawfully made <u>before</u> environmental impacts and reasonable alternatives were considered.

The DEIS is fatally flawed by its inconsistency with the weight of scientific evidence and with the standards of environmental review embodied in NEPA. As a matter of science, it lacks objectivity; as a matter of law, it is insupportable. If the Navy does not substantially alter its approach, it will necessitate opposition both to protect the species and habitat immediately affected by the proposed range and to prevent a regulatory precedent that, in future proceedings, will undermine administrative standards and the science on which their validity and credibility depend.

Under these circumstances, merely revising the draft into a final EIS is not sufficient, because the pervasive flaws and omissions in the DEIS have effectively deprived federal and state agencies, the scientific community, and the general public of their statutory right to an objective description of the proposed project and a meaningful opportunity to comment on it. We therefore strongly urge the Navy to <u>withdraw its DEIS and to reissue it for public comment</u> after the document has been revised and rewritten consistent with

federal law. We also urge the Navy to make available to the public the data and modeling on which its analysis is based.

I. BACKGROUND

A. Impacts of High-Intensity Sonar

Scientists agree, and the publicly available scientific literature confirms, that the intense sound generated by military active sonar can induce a range of adverse effects in whales and other species, from significant behavioral changes to stranding and death. By far the most widely-reported and dramatic of these effects are the mass strandings of beaked whales and other marine mammals that have been associated with military sonar use. Associated strandings have occurred in Greece, during the trial of a NATO sonar system; on the islands of Madeira and Porto Santo, during a NATO event involving subs and surface ships; in the U.S. Virgin Islands, during a training exercise for Navy battle groups; in the Bahamas, the Canaries, Japan, Hawaii, Alaska, and other spots around the world.[2] On several occasions, bodies have been recovered in time to give evidence of acoustic trauma. In a 2004 symposium at the International Whaling Commission, more than 100 whale biologists concluded that the association between sonar and beaked whale deaths "is very convincing and appears overwhelming."[3] In the United States, an expert report commissioned by the Navy said much the same thing.[4]

Mass mortalities, though an obvious focus of much reporting and concern, are likely only the tip of the iceberg of sonar's harmful effects. Marine mammals are believed to depend on sound to navigate, find food, locate mates, avoid predators, and communicate with each other. Flooding their habitat with man-made, high-intensity noise interferes with these and other functions. In addition to strandings and non-auditory injuries, the harmful effects of high-intensity sonar include:

- temporary or permanent loss of hearing, which impairs an animal's ability to communicate, avoid predators, and detect and capture prey;
- avoidance behavior, which can lead to abandonment of habitat or migratory pathways;
- disruption of biologically important behaviors such as mating, feeding, nursing, or migration, or loss of efficiency in conducting those behaviors;

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[2] A summary of the strandings record appears below at section II(B)(2)(a) ("Strandings and Mortalities Associated with Mid-Frequency Sonar").

[3] International Whaling Commission, 2004 Report of the Scientific Committee, Annex K at § 6.4 (2004).

[4] H. Levine, Active Sonar Waveform 1 (2004) (JASON Group Rep. JSR-03-200) (describing evidence of sonar causation as "completely convincing"). The strandings record is further described infra at section II(B)(2)(a).

- aggressive (or agonistic) behavior, which can result in injury;
- masking of biologically meaningful sounds, such as the call of predators or potential mates;
- chronic stress, which can compromise viability, suppress the immune system, and lower the rate of reproduction;
- habituation, causing animals to remain near damaging levels of sound, or sensitization, exacerbating other behavioral effects; and
- declines in the availability and viability of prey species, such as fish and shrimp.

Over the past 20 years, a substantial literature has emerged documenting the range of effects of ocean noise on marine mammals.[5]

Marine mammals are not the only species affected by undersea noise. Impacts on fish are of increasing concern due to several recent studies demonstrating hearing loss and widespread behavioral disruption in commercial species of fish and to reports, both experimental and anecdotal, of catch rates plummeting in the vicinity of noise sources.[6] Sea turtles, most of which are considered threatened or endangered under federal law, have been shown to engage in escape behavior and to experience heightened stress in response to noise.[7] And noise has been shown in several cases to kill, disable, or disrupt the behavior of invertebrates, many of which possess ear-like structures or other sensory mechanisms that could leave them vulnerable.[8] It is clear that intense sources of noise are capable of affecting a wide class of ocean life.

B. The Proposed Range

The proposed Undersea Warfare Training Range would be the site of intensive, year-round exercises employing active sonar and other active acoustic sources. It would effectively transform the waters off the North Carolina coast into one of the nation's epicenters of sonar use. The Navy envisions an area of about 500 square nautical miles laced with a network of undersea cables and up to 300 "acoustic transducer devices," which are four-foot domes capable of both transmitting and receiving sounds. DEIS at 2-3 and Fig. 2-1. About 161 individual training exercises are proposed to occur on the

[5] For a review of research on behavioral and auditory impacts of undersea noise, see, e.g., W.J. Richardson, C.R. Greene, Jr., C.I. Malme, and D.H. Thomson, Marine Mammals and Noise (1995); National Research Council, Ocean Noise and Marine Mammals (2003); and P. Tyack, Behavioral Impacts of Sound on Marine Mammals, Presentation to the U.S. Marine Mammal Commission Advisory Committee on Acoustic Impacts on Marine Mammals (February 4, 2004); Whale and Dolphin Conservation Society, Oceans of Noise (2004).

[6] See the discussion below, at section II(C) of "Impacts on Fish and Fisheries."

[7] See below at section II(G)(3) ("Species Excluded from Risk Analysis").

[8] See below at section II(G)(4) ("Species Excluded from Risk Analysis").

range each year, scheduled without apparent interruption throughout the seasons, and sometimes with more than one exercise occurring at a time. DEIS at 2-11 to 2-12.

A battery of acoustic sources would be used in these exercises, deployed from surface ships, submarines, aircraft, training targets, and range sources. DEIS at 2-13. Among the high-intensity active sonars to be employed are the two systems that caused 16 whales to strand in the Bahamas in 2000, following a Navy exercise, and are believed to have been involved in several other mass mortalities.[9] Those two systems, known as SQS-53 and SQS-56, would emit sound on the proposed range at nominal source levels, respectively, of 235 dB and 225 dB re 1 μPa. DEIS at 2-13. These source levels, which equal or approach the levels used by the Navy in the Bahamas stranding event, are millions of times more intense than the maximum levels to which those stranded whales are believed to have been exposed.[10] But acoustics are not the only source of impacts. Construction and operation of the range will damage bottom habitat, release hazardous materials into the coastal environment, cause entanglements and ship collisions with marine wildlife, and potentially impact sea turtle hatchlings on shore.[11]

II. THE NAVY'S COMPLIANCE WITH THE NATIONAL ENVIRONMENTAL POLICY ACT

Enacted by Congress in 1969, NEPA establishes a national policy to "encourage productive and enjoyable harmony between man and his environment" and "promote efforts which will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of man." 42 U.S.C. § 4321. In order to achieve its broad goals, NEPA mandates that "to the fullest extent possible" the "policies, regulations, and public laws of the United States shall be interpreted and administered in accordance with [NEPA]." 42 U.S.C. § 4332. As the Supreme Court explained,

> NEPA's instruction that all federal agencies comply with the impact statement requirement – and with all the requirements of § 102 – "to the fullest extent possible" [cit. omit.] is neither accidental nor hyperbolic. Rather the phrase is a deliberate command that the duty NEPA imposes upon the agencies to consider environmental factors not be shunted aside in the bureaucratic shuffle.

Flint Ridge Development Co. v. Scenic Rivers Ass'n, 426 U.S. 776, 787 (1976).

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[9] Department of Commerce & Secretary of the Navy, Joint Interim Report: Bahamas Marine Mammal Stranding Event of 15-16 March 2000 at iii, 16, 23 (2001).

[10] Id. at 24, 26; International Whaling Commission, 2004 Report of the Scientific Committee, Annex K at § 6.3.

[11] See discussion at sections II(B)(4) ("Other Impacts on Marine Mammals") and II(D) ("Other Impacts on Marine Wildlife").

Central to NEPA is its requirement that, before any federal action that "may significantly degrade some human environmental factor" can be undertaken, agencies must prepare an environmental impact statement. Steamboaters v. F.E.R.C., 759 F.2d 1382, 1392 (9th Cir. 1985) (emphasis in original). The fundamental purpose of an EIS is to force the decision-maker to take a "hard look" at a particular action – at the agency's need for it, at the environmental consequences it will have, and at more environmentally benign alternatives that may substitute for it – before the decision to proceed is made. 40 C.F.R. §§ 1500.1(b), 1502.1; Baltimore Gas & Electric v. NRDC, 462 U.S. 87, 97 (1983). The law is clear that the EIS must be a pre-decisional, objective, rigorous, and neutral document, not a work of advocacy to justify an outcome that has been foreordained.

In nearly every respect, the Navy's DEIS fails to meet the high standards of rigor and objectivity established under NEPA.

A. Statement of Purpose and Need

It is a fundamental requirement of NEPA that agencies preparing an EIS specify their project's "purpose and need." 40 C.F.R. § 1502.13. Not any statement of purpose and need will suffice: "An agency cannot define its objectives in unreasonably narrow terms" so as to exclude consideration of reasonable alternatives. City of Carmel-by-the-Sea v. United States Dep't of Transp., 123 F.3d 1142, 1155 (9th Cir. 1997) (citing Citizens Against Burlington, Inc. v. Busey, 938 F.2d 190, 196 (D.C. Cir. 1991)). Instead, the statement must reflect the agency's core aim without foreclosing reasonable alternatives. Id.

Here, the core aim of the Navy appears to be to train its Atlantic Fleet forces in anti-submarine warfare (i.e., to detect submarines using sonar and to destroy them), with a focus on training for shallow-water combat. Yet the Navy has put forth a statement of purpose too narrow to support an analysis of all reasonable alternatives to achieve this core aim. It states as its purpose "to enable the US Navy to train effectively in a shallow water environment (encompassing 37 to 274 meters [m], or 120 to 900 feet [ft], in depth) at a suitable location for Atlantic Fleet units." DEIS at 1-1. This statement presupposes, and therefore unreasonably removes from meaningful discussion and consideration, at least two key characteristics of the final project.

First, the Navy's purpose statement assumes that all required training must occur in open water, as opposed to using other methods such as simulators. One consequence of this assumption, as discussed below in the section on "Alternatives," is a cursory analysis of the use of simulators as an alternative to the proposed open-water range or to at least some of the exercises that would be conducted there. See DEIS 2-3. The use of simulators for at least some portion of the planned training is a reasonable alternative to the conduct of all 161 exercises in open water, and the Navy's statement of purpose cannot foreclose discussion of this alternative by employing an overly narrow definition of the project. The basic aim of the Navy is to train its forces, not to construct an open-

water sonar range, and by obscuring this aim the DEIS unlawfully marginalizes reasonable alternatives.

Second, the Navy's purpose statement takes as a given the specific water depths required for its open-water training range, namely 37 to 274 meters. This is a crucial assumption, because the choice of water depths drives, in part, the Navy's screening of locations for the range. DEIS at 2-15 to 16. Yet, because this choice is embedded within the purpose of the project itself, the DEIS never questions it and, just as importantly, never considers alternatives to this particular range of depths, though many such alternatives are likely to be reasonable. For example, the DEIS never asks whether small changes in the proposed water depths would reduce the environmental impacts of the range without unduly compromising required training. "The existence of a viable but unexamined alternative renders an environmental impact statement inadequate," Idaho Conservation League v. Mumma, 956 F.2d 1508, 1519 (9th Cir. 1992), and an EIS errs when it accepts "as a given" parameters that it should have studied and weighed. Simmons v. U.S. Army Corps of Eng'rs, 120 F.3d 664, 667 (7th Cir. 1997).

To correct these deficiencies, the Navy should consider a statement of purpose that would allow meaningful review of all reasonable alternatives and mitigation measures to achieve its core purpose of ASW training for the Atlantic Fleet. Such a statement might read as follows: "To enable the US Navy Atlantic Fleet units to train effectively for anti-submarine warfare." We urge the Navy to adopt a statement of purpose along these lines and to consider all reasonable alternatives that might achieve this broadened purpose, as discussed further below in the section on "Alternatives Analysis."

B. Impacts on Marine Mammals

Fundamental to satisfying NEPA's requirement of fair and objective review, agencies must ensure the "professional integrity, including scientific integrity," of the discussions and analyses that appear in environmental impact statements. 40 C.F.R. § 1502.24. To this end, they must make every attempt to obtain and disclose data necessary to their analysis. The simple assertion that "no information exists" will not suffice; unless the costs of obtaining the information are exorbitant, NEPA requires that it be obtained. See 40 C.F.R. § 1502.22(a). Agencies are further required to identify their methodologies, indicate when necessary information is incomplete or unavailable, acknowledge scientific disagreement and data gaps, and evaluate indeterminate adverse impacts based upon approaches or methods "generally accepted in the scientific community." 40 C.F.R. §§ 1502.22(2), (4), 1502.24. Such requirements become acutely important in cases where, as here, so much about a program's impacts depend on newly emerging science.

In this case, the Navy's assessment of impacts on marine mammals is consistently undermined by its failure to meet these fundamental responsibilities of scientific integrity, methodology, investigation, and disclosure. The document excludes a great deal of relevant information adverse to the Navy's interests, uses approaches and

methods that would not be acceptable to the scientific community, and ignores whole categories of impacts. In short, it leaves the public with an analysis of environmental harm—behavioral, auditory, and physiological—that is at odds with established scientific authority and practice.

1. Thresholds of Injury, Hearing Loss, and Significant Behavioral Change

At the core of the Navy's assessment of acoustic impacts on the training range are the thresholds it has established for physical injury, hearing loss, and significant behavioral harassment, the levels above which meaningful effects on marine mammals are found to occur. DEIS at 4.3-11 to 12. Previous environmental reviews of non-impulsive sources of sound have generally calibrated these thresholds to sound pressure levels, or SPLs, the amount of pressure received by a marine animal at a discrete moment in time, usually the duration of a sound wave. For the USWTR, however, the Navy has used a somewhat different measurement: energy flux density level, or "EL," which integrates the amount of energy flowing through an area over time. DEIS at 4.3-12. In theory, the use of ELs (at least as a supplement to sound-pressure levels) has merit: they can account for the duration of an acoustic insult—an essential consideration for activities like sonar exercises that threaten to expose animals to underwater sound repeatedly. But there are gross problems with their application here.

a. Injury Threshold

The Navy fixes its highest threshold of 215 dB re 1 μPa^{2}•s—which it considers the ground floor for physical injury—on the amount of energy necessary to induce permanent hearing loss (or "threshold shift") in marine mammals. Beneath this decision lies an assumption that the tissues of the ear are "the most susceptible to the physiological effects of sound" (DEIS at 4.3-8), and, indeed, a few paragraphs are spent in an effort to set aside other types of injury that have been identified or observed. Unfortunately, the Navy's position is inconsistent with the scientific literature and with the legal standard of review.

First, the DEIS disregards data gained from actual whale mortalities. The best available scientific evidence, as reported by the IWC's Scientific Committee, indicates that the whales beached in the Bahamas stranding were exposed to no more than 160-65 dB re 1 µPa of mid-frequency sonar for 30 seconds.[12] A further modeling effort, undertaken in part by the Office of Naval Research, suggests that the mean exposure level of beaked whales, given their likely distribution in the Bahamas' Providence Channels, was lower than 140 dB re 1 µPa.[13] (In another

[12] International Whaling Commission, 2004 Report of the Scientific Committee, Annex K at § 6.3.

[13] J. Hildebrand, K. Balcomb, and R. Gisiner, Modeling the Bahamas Beaked Whale Stranding of March 2000 (2004) (presentation given at the third plenary meeting of the U.S. Marine Mammal Commission Advisory Committee on Acoustic Impacts on Marine Mammals, 29 July 2004).

context, where it wishes to dismiss evidence of impacts to hearing at lower levels than its standard allows, the Navy refers to the statistical mean as "'the best unbiased estimator.'" DEIS at 4.3-21.) Factoring in duration, then, evidence of actual sonar-related mortalities would compel an EL no greater than 174 dB re 1 μPa^{2}•s, at least for beaked whales. Such a level would not be precautionary and is likely to underestimate injury and death, but it would at least have the semblance of responding to the existing data.[14]

Second, the DEIS fails to take proper account of published research on bubble growth in marine mammals, which separately indicates the potential for injury and death at levels far lower than the Navy proposes. According to a series of published, peer-reviewed articles (based both on accepted theoretical methods and on experimental research), gas bubbles could be activated in supersaturated marine mammal tissue on brief exposure to sounds of 150 dB (RMS) re 1 µPa or lower and then grow significantly, causing injury, as the animal rises toward the surface.[15] That work is supported by a number of other studies, also published in leading, peer-reviewed journals, demonstrating through anatomical evidence that in vivo bubble growth can occur in a variety of marine mammal species, from sperm whales to beaked whales to Risso's dolphins.[16] And this is not even to mention the investigation of the 2002 Canary Islands strandings, whose findings concerning fat and gas emboli were recently published at length in another major journal.[17] The DEIS argues, in its avoidance of the issue, that the evidence supporting bubble growth "is debatable" (DEIS at 4.3-32); but this characterization simply elides the numerous published, peer-reviewed papers—in dive behavior, veterinary pathology, and molecular biology—that support it, and disregards the recognition bubble growth has received from expert panels, such as

[14] The Navy claims that similar mortalities could not occur on any of the proposed USWTR sites because they do not offer the characteristics seen in the Bahamas. This specious argument will be addressed below in the discussion of "Strandings" (section II(B)(2)).

[15] D.S. Houser, R. Howard, and S. Ridgway, Can Diving-Induced Tissue Nitrogen Supersaturation Increase the Chance of Acoustically Driven Bubble Growth in Marine Mammals? 213 Journal of Theoretical Biology 183, 190 (2001); L.A. Crum, M.R. Bailey, J. Guan, P.R. Hilmo, S.G. Kargl, T.J. Matula, and O.A. Sapozhnikov, Monitoring Bubble Growth in Supersaturated Blood and Tissue ex vivo and the Relevance to Marine Mammal Bioeffects, 6(3) Acoustics Research Letters Online 214 (2005) See also J.R. Potter, A Possible Mechanism for Acoustic Triggering of Decompression Sickness Symptoms in Deep-Diving Marine Mammals (paper presented at the IEEE International Symposium on Underwater Technology 2004, Taipei, Taiwan, April 2004).

[16] M.J. Moore and G.A. Early, Cumulative Sperm Whale Bone Damage and the Bends, 306 Science 2215 (2004); P.D. Jepson, R. Deaville, I.A.P. Patterson, A.M. Pocknell, H.M. Ross, J.R. Baker, F.E. Howie, R.J. Reid, A. Colloff, and A.A. Cunningham, Acute and Chronic Gas Bubble Lesions in Cetaceans Stranded in the United Kingdom, 42 Veterinary Pathology 291 (2005).

[17] A. Fernández, J.F. Edwards, F. Rodríguez, A. Espinosa de los Monteros, P. Herráez, P. Castro, J.R. Jaber, V. Martín, & M. Arbelo, 'Gas and Fat Embolic Syndrome' Involving a Mass Stranding of Beaked Whales (Family Ziphiidae) Exposed to Anthropogenic Sonar Signals, 42 Veterinary Pathology 446 (2005).

the one convened last year by the Marine Mammal Commission to review sonar-related strandings.[18]

In any case, the law requires agencies to evaluate all "reasonably foreseeable" impacts, which, by definition, includes "impacts which have catastrophic consequences, even if their probability of occurrence is low, provided that the analysis of the impacts is supported by credible scientific evidence, is not based on pure conjecture, and is within the rule of reason." 42 C.F.R. § 1502.22. The scientific literature supporting bubble growth rises far above this standard, and the Navy's failure to incorporate it into its impact model is arbitrary and capricious.

Third, the Navy's threshold is called into question by a white paper generated and heavily relied on by the Navy in its environmental review of SURTASS LFA. That paper summarized the results of tests on small terrestrial mammals that had been submerged just beneath the water surface and exposed to low-frequency sound. According to those tests, resonance damage could occur on exposure to 5 minutes of sound of 180 dB re 1 μPa (or approximately 205 dB re 1 μPa^{2}•s), and the "onset" of transluminal damage and tissue shearing at 190 dB re 1 μPa (duration is not indicated).[19] It was on this basis that the Navy established a 180 dB sound-pressure threshold for injury for the LFA system. The DEIS gives no consideration as to whether mid-frequency sound might produce the same results, and no indication why it is not therefore, on this basis alone, setting the EL at 190 dB re 1 μPa^{2}•s or below. Cf. DEIS at 4.3-20 to 21.[20]

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[18] T.M. Cox, T.J. Ragen, A.J. Read, E. Vos, R.W. Baird, K. Balcomb, J. Barlow, J. Caldwell, T. Cranford, L. Crum, A. D'Amico, G. D'Spain, A. Fernández, J. Finneran, R. Gentry, W. Gerth, F. Gulland, J. Hildebrand, D. Houser, T. Hullar, P.D. Jepson, D. Ketten, C.D. MacLeod, P. Miller, S. Moore, D. Mountain, D. Palka, P. Ponganis, S. Rommel, T. Rowles, B. Taylor, P. Tyack, D. Wartzok, R. Gisiner, J. Mead, & L. Benner, Report of a Workshop to Understand the Impacts of Anthropogenic Sound on Beaked Whales 2 (in press) (noting particular plausibility of gas-bubble disease as one of 2 major findings of workshop).

[19] E. Cudahy and W.T. Ellison, A Review of the Potential for in vivo Tissue Damage by Exposure to Underwater Sound (2002) (forwarded to Chief of Naval Operations by Naval Submarine Medical Research Laboratory on Mar. 12, 2002).

[20] The Navy argues that there is no need to consider resonance effects since an expert group, convened in 2002 by NMFS, rules out resonance effects as a cause of the Bahamas stranding. DEIS at 4.3-32. In fact, that group did not rule out resonance, though it considered lung resonance in particular less promising than other pathologies such as bubble growth, and, in fact, called for further research on the subject—particularly on structures other than the lungs, which was the only structure it considered. NMFS, Report of the Workshop on Acoustic Resonance as a Source of Tissue Trauma in Cetaceans (2002). Meanwhile, an expert group convened more recently, by the Marine Mammal Commission, concluded that resonance remained a potential cause and made similar recommendations for further research. Cox et al., Report of a Workshop to Understand the Impacts of Anthropogenic Sound at 13, 22-23. Under NEPA, damage from resonance is a "reasonably foreseeable" impact that must be considered in the Navy's environmental review. 42 C.F.R. § 1502.22.

Fourth, the numbers do not reflect other non-auditory physiological impacts, as from stress and from chronic exposure during development, which are discussed further among "Other Impacts on Marine Mammals" (below).

Fifth, the Navy's exclusive reliance on energy flux density as its unit of analysis does not take other potentially relevant acoustic characteristics into account. For example, an expert group commissioned by the Office of Naval Research in 2003 to provide recommendations on mitigation suggested that peak power may matter more to beaked whale mortalities than integrated energy.[21] Reflecting this uncertainty, the Navy should establish a dual threshold for marine mammal injury.

Sixth, the Navy's calculation of permanent threshold shift (which it equates to the onset on injury) may be based on an improper model. A recent study of threshold shift in pinnipeds found that the amount of hearing loss an animal experiences does not increase linearly with the energy it receives. As the energy intensifies, its rate of hearing loss increases, to such a degree that projections of permanent threshold shift according to traditional, linear models are likely to result in underestimates of harm.[22] Given the uncertainties presented by this study, the Navy should lower its estimate of auditory injury.

b. Hearing Loss Threshold

The DEIS sets its threshold for temporary hearing loss, or "threshold shift" ("TTS"), at 195 dB re 1 $\mu Pa^2 \bullet s$. DEIS at 4.3-18. It bases this threshold on a synthesis of studies on two species of cetaceans, bottlenose dolphins and beluga whales, conducted by the Navy's SPAWAR laboratory in San Diego and by researchers at the University of Hawaii. DEIS at 4.3-12 to 15.

First, the Navy's extrapolation of data from bottlenose dolphins and belugas to all cetaceans is not justifiable. Given the close association between acoustic sensitivity and threshold shift, such an approach must presumes that belugas and bottlenose dolphins have the best hearing sensitivity in the mid-frequencies of any cetacean. Yet, as noted below at subsection (c) ("Threshold for Significant Behavioral Change"), harbor porpoises and orcas are more sensitive over part of the mid-frequency range than are the two species in the SPAWAR and Hawaii studies.[23] Furthermore, the animals in the studies may not represent the full range of variation even within their own species, particularly given their age and situation (the SPAWAR animals, for example, are housed in a noisy bay).

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[21] Levine, Active Sonar Waveform at 27.

[22] D. Kastak, B.L. Southall, R.J. Schusterman, C.R. Kastak, Underwater Temporary Threshold Shift in Pinnipeds: Effects of Noise Level and Duration, 118 Journal of the Acoustical Society of America 3154, 3161 (2005).

[23] Richardson et al., Marine Mammals and Noise at 209.

Second, the Navy doesn't consider pinniped data because they are said not to normally occur within the range—a serious omission given that a few species are found around the sites that the Navy has proposed.[24]

Third, the small size of the data set generated by the studies leads the Navy to some arbitrary interpretations. For example, the Navy effectively excludes the results of one study that found threshold shift originating in a bottlenose dolphin at 190 re 1 $\mu Pa^{2\bullet}s$, which is a full 5 dB re 1 $\mu Pa^{2\bullet}s$ below its proposed standard. DEIS at 4.3-12 to 13. The basis for this exclusion is the equal energy hypothesis: if you assume that the threshold for hearing loss decreases by a constant amount as the duration of a sound increases, you can fit a straight line connecting the data points that the studies have produced. Yet where the line falls can remain somewhat arbitrary given the small number of points on the chart. In this case, the Navy relied for its line-drawing on a single data point, from a single subject, lying at a distance from the main data cluster (Nachtigall et al. 2003b); alternatively, it might have dropped the line about 5 dB lower, which would have brought it closer to a second cluster, made of multiple data points from multiple subjects. See DEIS at Fig. 4.3-5. That choice would have fit the data just as well (perhaps better) and would have had the advantage of being marginally more conservative—yet there is no justification in the Navy's DEIS for the choice it made. The Navy's assumption of a 195 re 1 $\mu Pa^{2\bullet}s$ threshold is arbitrary.

c. Threshold for Significant Behavioral Change

The DEIS sets its threshold for behavioral harassment, the point at which significant behavioral change would occur, at 190 dB re 1 $\mu Pa^{2\bullet}s$, just 5 dB (EL) below the onset of TTS. DEIS at 4.3-25. This level, which runs a full 30 dB re 1 μPa (at 1s) higher than anything seen before in environmental permitting and review, is based on a remarkably partial and idiosyncratic reading of the available literature.[25] In sum, the DEIS eschews the rather extensive literature that has emerged on the behavioral impacts of sound on marine mammals in the wild (and that NMFS and other agencies have relied on in the past), choosing instead to base its standard on two reports of behavioral disruption in captive Navy test subjects during auditory testing. DEIS at 4.3-22. This procedure is completely arbitrary.

[24] See below at section II(G) ("Species Excluded from Risk Analysis").

[25] NMFS, for example, routinely uses levels no greater than 160 dB (RMS) re 1 μPa as its threshold for behavioral harassment in non-impulsive acoustic permitting decisions. A brief history of the development of the standard can be found in M. Jasny, Sounding the Depths II: The Rising Toll of Sonar, Shipping, and Industrial Ocean Noise on Marine Life 43-45 (2005) (citing Federal Register notices and other primary sources).

First, the Navy disregards a substantial body of research on wild animals (and some research on other experimental animals as well) to use a small set of captive animals in their stead. Marine mammal scientists have long recognized the deficiencies of using captive subjects in behavioral experiments, and to blindly rely on this material, to the exclusion of copious data on animals in the wild, is not supportable by any standard of scientific inquiry. Cf. 42 C.F.R. § 1502.22. The problem is exacerbated further by the fact that the subjects in question, roughly two belugas and five bottlenose dolphins, are highly trained animals that have been working in the Navy's research program in the SPAWAR complex for years.[26] Indeed, the disruptions observed by Navy scientists, which included pronounced, aggressive behavior ("attacking" the source) and avoidance of feeding areas associated with the exposure, occurred during a research protocol that the animals had been rigorously instructed to complete.[27] These observations, while not irrelevant, are profoundly limited even for the species concerned and the particular effects observed.

The DEIS justifies its exclusive reliance on this material, and the possibility that trained Navy animals might tolerate higher levels of sound than some animals in the field, by suggesting that the "threshold for effect" implicit in these studies is "conservative" compared to the regulatory definition of behavioral harassment under the Marine Mammal Protection Act. 42 C.F.R. 4.3-22. But the idea that such an evidentiary threshold is inherently conservative, as though the responses described in the SPAWAR studies were the equivalent of a sea lion turning its head toward a sound source, is directly and explicitly challenged in the scientific literature. In a separate, published study, researchers called attention to the potential biological significance of the observations that the Navy scientists made, noting, for example, that avoidance of feeding areas associated with loud sounds can have "dramatic fitness effects" on animals in the wild.[28] In other words, such reactions projected onto wild animals are potentially of considerable biological significance. Nor does the regulatory history of harassment that the Navy cites (DEIS at 4.3-6) suggest that its approach is conservative. NMFS, which, as the Navy observes (id.), has been reviewing permits under a "significance" standard for several years, has adopted a far lower threshold for short-term, acoustic

[26] See, e.g., S.H. Ridgway, D.A. Carder, R.R. Smith, T. Kamolnick, C.E. Schlundt, and W.R. Elsberry, Behavioral Responses and Temporary Shift in Masked Hearing Threshold of Bottlenose Dolphins, Tursiops truncates, to 1-Second Tones of 141 to 201 dB re 1 µPa (1997) (SPAWAR Tech. Rep. 1751, Rev. 1).

[27] C.E. Schlundt, J.J. Finneran, D.A. Carder, and S.H. Ridgway, Temporary Shift in Masked Hearing Thresholds of Bottlenose Dolphins, Tursiops truncates, and White Whales, Delphinapterus leucas, after Exposure to Intense Tones, 107 Journal of the Acoustical Society of America 3496, 3504 (2000).

[28] D. Kastak, R.J. Schusterman, B.L. Southall, and C.J. Reichmuth, Underwater Temporary Threshold Shift Induced by Octave-Band Noise in Three Species of Pinniped, 106 Journal of the Acoustical Society of America 1142, 1146 (1999). The authors observed similar responses in their own trained subjects. Id.

disruptions of behavior.[29] In evaluating the potential for behavioral impacts, NMFS routinely considers a far wider body of research—which the Navy must do as well.

Second, in relying exclusively on SPAWAR data to set a single behavioral threshold for all marine mammals, the Navy extrapolates from two species to all other species of cetacean—a move that, for behavioral impacts, is scientifically baseless. There is no reason to believe that these two species, among the more than 120 species of marine mammals, happen to be the most sensitive to underwater sound; indeed, the scientific record clearly establishes that a number of other species are acutely sensitive to far lower levels of noise. Harbor porpoises have been reported to avoid a broad range of sounds—low-frequency (airgun pulses), mid-frequency (sonar transmissions), and high-frequency (acoustic harassment devices)—at very low sound-pressure levels (between 100 and 140 dB re 1 μPa);[30] orcas were found to have broken off their feeding and otherwise to have engaged in completely abnormal behavior on exposure to mid-frequency sonar signals of 169.1 to 187.4 re 1 μPa^{2}•s (with most received pings below 160 dB re 1 μPa);[31] right whales have responded to mid- and low-

[29] NMFS has been applying a "significance" standard (which it has defined administratively as "a significant disruption in an animal's normal pattern of biological traits or behavior") since at least early 2001. See, e.g., 66 Fed. Reg. 9291 (Feb. 7, 2001). The threshold it has generally used for significant behavioral change is no greater than 160 dB (RMS) re 1 μPa (for any duration of exposure). In the case of LFA, discussed infra in this section, it established a progressive threshold, such that a small percentage of all marine mammals exposed to 119 dB re 1 μPa, and 50% exposed to 165 dB re 1 μPa, would be considered harassed. These numbers are controversial—many in the scientific community have argued, and the scientific literature plainly indicates, that for some species and sources of noise they are too high—but NMFS' history of applying the harassment standard argues against the Navy's exclusive use of the SPAWAR data, not for it.

[30] See, e.g., R.A. Kastelein, H.T. Rippe, N. Vaughan, N.M. Schooneman, W.C. Verboom, and D. de Haan, The Effects of Acoustic Alarms on the Behavior of Harbor Porpoises in a Floating Pen, 16 Marine Mammal Science 46 (2000); P.F. Olesiuk, L.M. Nichol, M.J. Sowden, and J.K.B. Ford, Effect of the Sound Generated by an Acoustic Harassment Device on the Relative Abundance of Harbor Porpoises in Retreat Passage, British Columbia, 18 Marine Mammal Science 843 (2002); J. Calambokidis, D.E. Bain, and S.D. Osmek, Marine Mammal Research and Mitigation in Conjunction with Air Gun Operation for the USGS 'SHIPS' Seismic Surveys in 1998 (1998) (report to Minerals Management Service); NMFS, Assessment of Acoustic Exposures on Marine Mammals in Conjunction with USS Shoup Active Sonar Transmissions in the Eastern Strait of Juan de Fuca and Haro Strait, Washington, 5 May 2003 at 10 (2005).

[31] NMFS, Assessment of Acoustic Exposures at 6. The Navy's report on the Haro Strait incident, which it published independent of NMFS, dismisses the evidence of behavioral disruption of orcas, harbor porpoises, and minke whales as "biologically insignificant." Navy, Report on the Results of the Inquiry into Allegations of Marine Mammal Impacts Surrounding the Use of Active Sonar by USS Shoup (DDG 86) in the Haro Strait on or about 5 May 2003 at 12 (2004). But any reliance on that report would be misplaced. The Navy provides no factual support for its position, choosing simply to cite the general opinion of several of its scientists, who, unlike the three field biologists on the scene who independently testified to NMFS about the significance of the whales' reactions, have little special experience with the affected species and populations, were not themselves present at the event, and do not ordinarily study marine mammals in the wild. Id. It is worth noting that NMFS did not adopt the Navy's position. All of the information and testimony to which the Navy had access in preparing its report, including any

frequency alarm signals, surfacing dramatically and breaking off feeding, at levels of 133 to 148 dB re 1 μPa;[32] and beaked whales, as noted, have actually died on exposure to mid-frequency sonar at levels likely to have been orders of magnitude lower than what the Navy has proposed for "non-injurious harassment."[33] And these are only a few of the relevant examples. That the Navy would eschew all of the extant data on behavioral impacts (even in cases where received levels were reasonably calculated), and pluck out this particular set of laboratory observations—with its mere two species, its narrow set of examined behaviors (excluding, e.g., changes in vocalization and dive patterns), and its small number of captive animals in a laboratory environment—is the definition of arbitrary and capricious.[34]

Third, in evaluating its SPAWAR data, the Navy improperly discounts all responses below the arithmetic mean. According to the Navy, the 190 dB re 1 μPa^{2}•s threshold should prevail because, at that point, animals exposed to the signal experienced significant behavioral change 50% of the time (DEIS at 4.3-26); yet some of the animals in the Navy's study exhibited the same disruptions in behavior at lower levels, some as low as 160 dB re 1 μPa^{2}•s. DEIS at 4.3-24. The Navy argues that taking the mean value "to estimate a single numeric 'all-or-nothing' threshold" is accepted practice in psychoacoustics (DEIS at 4.3-26)—but it is important to understand the context in which that practice operates. As a review of the articles cited by the Navy suggests, acousticians use the mean in describing the acoustic sensitivity of a single subject; it does not make sense as a method if your goal is predictive and you are attempting to conservatively assess impacts on a larger, non-particularized group of animals, or if you are combining data from multiple subjects, or if your approach does not depend on the voluntary detection of a signal.[35] Indeed, the approach taken by the Navy here is plainly inconsistent with the behavioral risk function that it vaunted, in its final EIS for

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correspondence it had with NMFS, is directly relevant to the present environmental review, and we hereby incorporate it by reference into the administrative record.

[32] See D.P. Nowacek, M.P. Johnson, and P.L. Tyack, North Atlantic Right Whales (Eubalaena glacialis) Ignore Ships but Respond to Alerting Stimuli, 271 Proceedings of the Royal Society of London, Part B: Biological Sciences 227 (2004).

[33] See above in this subsection and below at section II(B)(2)(a) ("Summary of Strandings Data").

[34] The DEIS touts the similarity between the some of the sounds used in the SPAWAR studies and mid-frequency sonar signals (DEIS at 4.3-26), but the basis for comparison is not entirely clear. While the SPAWAR source did indeed operate in the mid-frequencies, the sound field it generated surely differs from the ones animals would encounter in the wild, and the smooth, sinusoidal waves it produced surely differ in form from the waves produced by some sonar systems.

[35] The mean is a method of obtaining accuracy in hearing tests (of individual subjects) that depend on voluntary signal detection, where false positives are possible. See P. Nachtigall, D.W. Lemonds, and H.L. Roitblat, Psychoacoustic Studies of Dolphin and Whale Hearing, in W.W.L. Au, A.N. Popper, and R.r. Fay, Hearing by Dolphins and Whales 330, 333 (2000). Those conditions are not present here.

the SURTASS LFA system, as a great scientific improvement over previous all-or-nothing standards.[36]

We would further note that any risk function based in part on the SPAWAR data would have to take a more conservative approach than the function already outlined (but not used) in the DEIS (4.3-24). This is due not only to the need for conservatism in working with trained animals, which the Navy itself recognizes (DEIS at 4.3-22), and to the other extrapolations described above, but also to the social ecology of some marine mammal species. For species that travel in tight-knit groups, an effect on certain individuals can adversely influence the behavior of the whole. (Pilot whales, for example, are prone to mass strand for precisely this reason.) Should those individuals fall on the more sensitive end of the spectrum, the entire group or pod can suffer significant harm at levels below what the Navy would take as the mean. In developing any behavioral risk function, the Navy must take account of such potential indirect effects. 42 C.F.R. § 1502.16(b).

Fourth, the Navy's exclusive reliance on ELs in setting a behavioral threshold is misplaced. Energy flux density standards were originally developed for use in audiology; when applied to behavior, a context in which sensitization and habituation can occur and in which impacts may not scale linearly over time, their value is substantially limited. It is therefore appropriate for the Navy to set dual thresholds for behavioral effects, one based on ELs and one based on sound pressure levels (SPLs). Indeed, that is what has been recommended for NMFS' own acoustic criteria.[37] For the Navy to do otherwise would be arbitrary and capricious.

Fifth, the Navy's threshold is applied in such a way as to preclude any assessment of long-term behavioral impacts on marine mammals, which might be expected to occur after weeks, months, and indeed years of acoustic activities on the range. The Navy justifies this omission by offering, in its place, the "conservative" approach to assessing behavioral impacts that we have already discussed above. DEIS at 4.3-33. Under that approach, the short-term behavioral changes observed in the SPAWAR pool, which are the sole basis for the Navy's behavioral threshold, are considered biologically significant. DEIS at 4.3-6, 4.3-25 to 26. But there are at least two glaring problems with the Navy's approach.

To begin with, the threshold that the Navy actually establishes with its SPAWAR data is not in the least "conservative." It runs counter to NMFS' practice in

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[36] See Navy, Final Overseas Environmental Impact Statement and Environmental Impact Statement for Surveillance Towed Array Sensor System Low Frequency Active (SURTASS LFA) Sonar ES-18 (2001).

[37] B. Southall, NMFS, Noise Exposure Criteria: Structure of the Matrix at sl. 5 (2004) (presentation given by NMFS' Acoustic Criteria Panel at the Third Plenary of the Marine Mammal Commission Advisory Committee on Acoustic Impacts on Marine Mammals, San Francisco, Cal., 28-30 Apr. 2004).

interpreting "biological significance," disregards 49 percent of all takes that even the Navy predicts would occur, and arbitrarily throws out nearly the entire literature on acoustic impacts on marine mammals in favor of one study conducted on a small number of trained animals.[38] Furthermore, it ignores evidence of significant behavioral change, as from habitat abandonment, occurring at exposure levels far below the number given here.[39] Since the Navy's threshold is not conservative, it has no basis for avoiding analysis of long-term impacts.[40]

In the second place, the Navy's approach does not fully account for the problem of repetition: the way that apparently insignificant impacts, such as subtle changes in dive times or vocalization patterns, can become significant if experienced repeatedly or over time.[41] The level at which such subtle changes occur could fall well below the Navy's "significance" threshold of 190 dB re 1 μPa^{2}•s. For most species, the literature points to levels south of 150 dB re 1 μPa and, in some cases, of 120 dB re 1μPa, for only a few seconds or minutes of exposure.[42] All this suggests that the Navy's threshold for behavioral disruptions must be revisited;

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[38] See the discussion of the threshold's "conservatism" earlier in this section.

[39] See, e.g., A.B. Morton and H.K. Symonds, Displacement of Orcinus orca by High Amplitude Sound in British Columbia, Canada, 59 ICES Journal of Marine Science 71 (2001); D.W. Weller, Y.V. Ivashchenko, G.A. Tsidulko, A.M. Burdin, & R.L. Brownell, Jr., Influence of Seismic Surveys on Western Grey Whales off Sakhalin Island, Russia in 2001 (2002) (IWC Doc. SC/54/BRG14). The Navy claims there is "no established scientific correlation between mid-frequency sonar use and long-term abandonment or significant alteration of behavioral patterns in marine mammals." DEIS at 4.3-33. But its reasoning here depends less on science than it does on semantics. That no "established scientific correlation" exists between mid-frequency sonar and habitat abandonment, for example, proves very little since the issue has not been studied. Yet habitat abandonment has been attributed to a variety of sound sources, from shipping to high-energy seismic surveys to acoustic harassment devices, and there is no reason to believe that mid-frequency sonar use would not produce analogous results in certain species. See id.; M.L. Jones, S.L. Swartz, and M. Dahlheim, Census of Gray Whale Abundance in San Ignacio Lagoon: A Follow-up Study in Response to Low Whale Counts Recorded During an Acoustic Playback Study of Noise-Effects on Gray Whales (1994) (Marine Mammal Commission No. MM2911023-0); P.J. Bryant, C.M. Lafferty, & S.K. Lafferty, Reoccupation of Laguna Guerrero Negro Baja California, Mexico, by Gray Whales, in M.L. Jones, S.L. Swartz, and S. Leatherwood, The Gray Whale: Eschrictius robustus 375-386 (1984); Richardson et al., Marine Mammals and Noise at 267. The Navy's disregard of the Haro Strait incident and of the numerous mass strandings that have been linked to mid-frequency sonar, all of which involve, in one way or another, a significant behavioral impact, is based on a similar parsing of words.

[40] Elsewhere in the DEIS, the Navy uses the supposed conservatism of its approach to justify its exclusive reliance on trained subject data. DEIS at 4.3-22. Even if its approach were conservative, it is hard to see how the same adjustment could reasonably compensate for both of these uncertainties.

[41] The importance of this problem for marine mammal conservation is reflected in a recent NRC report, which calls for models that, inter alia, translate such subtle changes into disruptions in key activities like feeding and breeding that are significant for individual animals. National Research Council. Marine Mammal Populations and Ocean Noise: Determining When Noise Causes Biologically Significant Effects 35-68 (2005).

[42] Aside from the studies on harbor porpoises, right whales, and other species cited elsewhere in this subsection, see, e.g., Richardson et al., Marine Mammals and Noise at 231-324.

even more than this, however, it underscores the failure of the DEIS to take its own "energy flux density" approach seriously. As will be discussed at greater length in the section on "Modeling," the Navy does not map the sound field created by its high-intensity sound sources beyond about 180 dB re 1μPa. DEIS at 4.3-27 to 28, 40. If it did, and if it modeled exercises on a cumulative basis instead of treating each kilometer of ship movement as a discrete and independent event, it would almost certainly find that a far greater number of animals would come within the "harassment" zone.

For all these reasons, the thresholds of injury, hearing loss, and significant behavioral change utilized by the Navy in this DEIS are fundamentally inconsistent with the scientific literature on acoustic impacts, and, indeed, with marine mammal science in general, and, if adopted in a Record of Decision, would violate NEPA.

2. Strandings and Mortalities Associated with Mid-Frequency Sonar

a. Summary of Strandings Data

Over the last five years, the association between military active sonar and whale mortalities has become a subject of considerable scientific interest and concern. That interest is reflected in the publication of numerous papers in peer-reviewed journals, in reports by inter-governmental bodies such as the IWC's Scientific Committee, and in evidence compiled from a growing number of mortalities associated with sonar.

In March 2000, for example, sixteen whales from at least three species—including two minke whales—stranded over 150 miles of shoreline along the northern channels of the Bahamas. The beachings occurred within 24 hours of Navy ships using mid-frequency sonar (AN/SQS-53C and AN/SQS-56) in those same channels.[43] Post-mortem examinations found, in all whales examined, hemorrhaging in and around the ears and other tissues related to sound conduction or production, such as the larynx and auditory fats, some of which was debilitative and potentially severe.[44] It is now accepted that these mortalities were caused, through an unknown mechanism, by the Navy's use of mid-frequency sonar.

The Bahamas event is one of numerous strandings coincident with military activities and active sonar that have now been documented:

[43] Commerce and Navy, Joint Interim Report at iii, 16.

[44] Id.

(1) In January 2005, 34 whales of three species beached along the Outer Banks of North Carolina as the Navy conducted exercises offshore. An investigation into this stranding event is still pending.[45]

(2) In July 2004, four dead beaked whales were found around the coasts of the Canary Islands, within one week of an NATO exercise. The exercise, Majestic Eagle 2004, was conducted approximately 100 kilometers north of the Canaries. Although the three whale bodies that were necropsied were too decomposed to allow detection of gas embolisms (see below), systematic fat embolisms were found in these animals.[46] The probability that the whales died at sea is extremely high.[47]

(3) Also in July 2004, a pod of melon-headed whales exhibited extraordinary behavior just off Kaua'i, Hawai'i, within range of Japanese and U.S. Navy ships participating in the biennial Rim of the Pacific (RIMPAC) tactical naval exercises there.[48] Two hundred of the normally deep-water whales crowded into shallow waters very near shore, an event that apparently had never before been seen in Kaua'i. According to a biologist observer associated with NMFS, the pod appeared stressed, and, in the ensuing chaos, one juvenile member of the pod stranded and died. After learning of this unusual whale behavior, the Navy temporarily restricted its active sonar operations in the area.[49]

(4) In June 2004, six beaked whales were found stranded along the Gulf of Alaska, on the state's southern coast. The strandings coincided with a U.S. naval exercise called Northern Edge.[50]

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[45] For further discussion of this event, see below at subsection (c) ("North Carolina Strandings (January 2005)").

[46] A. Espinosa, M. Arbelo, P. Castro, V. Martín, T. Gallardo, and A. Fernández, New Beaked Whale Mass Stranding in Canary Islands Associated with Naval Military Exercises (Majestic Eagle 2004) (2005) (poster presented at the European Cetaecan Society Conference, La Rochelle, France, April 2005); A. Fernández, M. Méndez, E. Sierra, A. Godinho, P. Herráez, A. Espinosa de los Monteros, F. Rodríguez, F., and M. Arbelo, M., New Gas and Fat Embolic Pathology in Beaked Whales Stranded in the Canary Islands (2005) (poster presented at the European Cetaecan Society Conference, La Rochelle, France, April 2005).

[47] Id.

[48] Navy, Update on Melon-Headed Whales Stranded in Hawaii (2004) (presentation given at the Third Plenary of the Marine Mammal Commission Advisory Committee on Acoustic Impacts on Marine Mammals, San Francisco, 29 July 2004).

[49] This account incorporates details as reported by Jan TenBruggencate in Whale Dies After Pod Returns to Sea, Honolulu Advertiser, July 7, 2004. See also Marc Kaufman, Whales' Plight Revives Sonar Theory, Washington Post, July 11, 2004 at A1 (detailing incident).

[50] S.E. Moore and K.M. Stafford, Habitat Modeling, Ambient Noise Budgets, and Acoustic Detection of Cetaceans in the North Pacific and Gulf of Alaska sl. 27-28 (2005) (presentation given at ECOUS 2005, Office of Naval Research, 16-18 Mar. 2005).

(5) In May 2003, the U.S. Navy vessel USS Shoup was conducting a mid-frequency sonar exercise while passing through Haro Strait, off the coast of Washington. According to one contemporaneous account, "[d]ozens of porpoises and killer whales seemed to stampede all at once . . . in response to a loud electronic noise echoing through" the Strait.[51] Several field biologists present at the scene reported observing a pod of endangered orcas bunching near shore and engaging in very abnormal behavior consistent with avoidance, a minke whale "porpoising" away from the sonar ship, and harbor porpoises fleeing the vessel in large numbers.[52] Eleven harbor porpoises—an abnormally high number given the average stranding rate of six per year—were found beached in the area of the exercise.[53]

(6) In September 2002, at least fourteen beaked whales from three different species stranded in the Canary Islands. Four additional beaked whales stranded over the next several days.[54] The strandings occurred while a Spanish-led naval exercise that included U.S. Navy vessels and at least one ship equipped with mid-frequency sonar was conducting anti-submarine warfare exercises in the vicinity.[55] The subsequent investigation, as reported in the journals Nature and Veterinary Pathology, revealed a variety of traumas, including emboli and lesions suggestive of decompression sickness.[56]

(7) In May 2000, four beaked whales stranded on the beaches of Madeira while several NATO ships were conducting an exercise near shore. Scientists investigating the stranding found that the whales' injuries—including "blood in and around the eyes, kidney lesions, pleural hemorrhage"—and the pattern

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[51] Christopher Dunagan, Navy Sonar Incident Alarms Experts, Bremerton Sun, May 8, 2003.

[52] NMFS, Assessment of Acoustic Exposures at 6, 9.

[53] NMFS, Preliminary Report: Multidisciplinary Investigation of Harbor Porpoises (Phocoena phocoena) Stranded in Washington State from 2 May – 2 June 2003 Coinciding with the Mid-Range Sonar Exercises of the USS Shoup 53-55 (2004) (conclusions unchanged in final report). Unfortunately, according to the report, freezer artifacts and other problems incidental to the preservation of tissue samples made the cause of death in most specimens difficult to determine; but the role of acoustic trauma could not be ruled out. Id.

[54] Vidal Martin et al., Mass Strandings of Beaked Whales in the Canary Islands, in Proceedings of the Workshop on Active Sonar and Cetaceans 33 (P.G.H. Evans & L.A. Miller eds., 2004); Fernández et al., 'Gas and Fat Embolic Syndrome', 42 Veterinary Pathology at 446-57.

[55] Fernández et al., 'Gas and Fat Embolic Syndrome', 42 Veterinary Pathology at 446; K.R. Weiss, Whale Deaths Linked to Navy Sonar Tests, L.A. Times, Oct. 1, 2002, at A3.

[56] Fernández et al., 'Gas and Fat Embolic Syndrome', 42 Veterinary Pathology at 446-57; Jepson et al., Gas-Bubble Lesions, 425 Nature at 575-76.

of their stranding suggest "that a similar pressure event [*i.e.*, similar to that at work in the Bahamas] precipitated or contributed to strandings in both sites."[57]

(8) In October 1999, four beaked whales stranded in the U.S. Virgin Islands as the Navy began an offshore exercise. A wildlife official from the Islands reported the presence of "loud naval sonar."[58] When NMFS asked the Navy for more information about its exercise, the Department's response was to end the consultation that it had begun for the exercise under the Endangered Species Act.[59]

(9) In January 1998, according to a NMFS biologist, a beaked whale "stranded suspiciously" at Vieques as naval exercises were set to commence offshore.[60] Another beaked whale stranded in the same area and under similar circumstances in May 2000.[61]

(10) In 1996, twelve Cuvier's beaked whales stranded along 35 kilometers on the west coast of Greece. The strandings were correlated, by an analysis published in Nature, with the test of a low- and mid-frequency active sonar system operated by NATO.[62] A subsequent NATO investigation found the strandings to be closely timed with the movements of the sonar vessel, and ruled out all other physical environmental factors as a cause.[63] The following year saw nine additional Cuvier's beaked whales strand off Greece, again coinciding with naval activity.[64]

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[57] D.R. Ketten, Beaked Whale Necropsy Findings 22 (2002) (paper submitted to NMFS); L. Freitas, The Stranding of Three Cuvier's Beaked Whales Ziphius Cavirostris in Madeira Archipelago—May 2000, in P.G.H. Evans and L.A. Miller, Proceedings of the Workshop on Active Sonar and Cetaceans 28-32 (2004).

[58] Personal communication of Dr. David Nellis, U.S. Virgin Island Department of Fish and Game, to Eric Hawk, NMFS (Oct. 1999); personal communication from Ken Hollingshead, NMFS, to John Mayer, Marine Acoustics Inc. (March 19, 2002).

[59] Letter from William T. Hogarth, Regional Administrator, NMFS Southeast Regional Office, to RADM J. Kevin Moran, Navy Region Southeast (undated); personal communication from Ken Hollingshead, NMFS, to John Mayer, Marine Acoustics Inc. (March 19, 2002).

[60] Personal communication from Eric Hawk, NMFS, to Ken Hollingshead, NMFS (Feb. 12, 2002).

[61] Id.

[62] A. Frantzis, Does Acoustic Testing Strand Whales? 392 Nature 29 (1998).

[63] See SACLANT Undersea Research Center, Summary Record, La Spezia, Italy, 15-17 June 1998, SACLANTCEN Bioacoustics Panel, SACLANTCEN M-133 (1998).

[64] Id.; A. Frantzis, The First Mass Stranding That Was Associated with the Use of Active Sonar (Kyparissiakos Gulf, Greece, 1996), in P.G.H. Evans and L.A. Miller, Proceedings of the Workshop on Active Sonar and Cetaceans 14-20 (2004).

(11) Between 1985 and 1989, at least three separate mass strandings of beaked whales occurred in the Canary Islands, as reported in Nature.[65] Thirteen beaked whales of two species were killed in the February 1985 strandings, six whales of three species stranded in November 1988, and some twenty-four whales of three species stranded in October 1989—all while naval vessels were conducting exercises off shore.[66] An additional stranding of Cuvier's beaked whales, also coinciding with a naval exercise, occurred in 1991.[67] It was reported that mass live strandings occurred each time exercises took place in the area.[68]

Some preliminary observations can be drawn from these incidents. For example, beaked whales, a group of deep-water species that are seldom seen and may in some cases be extremely rare, seem to be particularly vulnerable to the effects of active sonar. A 2000 review undertaken by the Smithsonian Institution, and reported and expanded by the IWC's Scientific Committee and other bodies, supports this conclusion, finding that every mass stranding on record involving multiple species of beaked whales has occurred with naval activities in the vicinity.[69] Indeed, it is not even certain that some beaked whales naturally strand in numbers.

But the full magnitude of sonar's effects on these species—or on other marine mammals—is not known. First, most of the world lacks networks to identify and investigate stranding events, particularly those that involve individual animals spread out over long stretches of coastline, and therefore the mortalities that have been identified thus far are likely to represent only a subset of a substantially larger problem. For example, most Cuvier's beaked whale casualties (according to NMFS) are bound to go undocumented because of the remote siting of sonar exercises and the small chance that a dead or injured animal would actually strand.[70]

Second, until recently, no one knew to look for a potential link between stranding events and nearby naval exercises. Now that such a link is strongly suspected, stranding incidents related to naval exercises are more likely to be recognized as

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[65] M. Simmonds and L.F. Lopez-Jurado, Whales and the Military, 337 Nature 448 (1991).

[66] Id.

[67] V. Martín, A. Servidio, and S. Garcia, Mass Strandings of Beaked Whales in the Canary Islands, in P.G.H. Evans and L.A. Miller, Proceedings of the Workshop on Active Sonar and Cetaceans 33-36 (2004).

[68] Simmonds and Lopez-Jurado, Whales and the Military, 337 Nature at 448.

[69] Marine Mammal Program of the National Museum of Natural History, Historical Mass Mortalities of Ziphiids 2-4 (Apr. 6, 2000); see also 2 J. Cetacean Res. & Mgmt., Supp., Annex J at § 13.8 (2000) (report of the IWC Scientific Committee, Standing Working Group on Environmental Concerns).

[70] J.V. Carretta, K.A. Forney, M.M. Muto, J. Barlow, J. Baker, and M. Lowry, U.S. Pacific Marine Mammal Stock Assessments: 2003 at 147 (2004).

such. This has been borne out by a recent re-examination of records of old strandings conducted by several prominent biologists. As reported by the Scientific Committee of the International Whaling Commission, the re-examination showed a concentration of mass beaked whale strandings along the Japanese coast near Yokosuka, one of the primary bases for U.S. naval activity in the western Pacific, with ten mass strandings reported since the late 1950s; an additional 64 beaked whales were reported to have stranded individually. By comparison, only two other possible mass strandings of beaked whales are known to have occurred over the rest of the entire Pacific coast of Japan. The authors concluded that a relationship between mass strandings and naval acoustics was "strongly suggest[ed]" by this record.[71]

Furthermore, although the physical process linking sonar to strandings is not perfectly understood, the record indicates that debilitating, possibly lethal injuries are occurring in whales exposed to sonar at sea—only some of which may then strand. As first reported in the journal *Nature*, animals that came ashore during sonar exercises off the Canary Islands, in September 2002, had developed large emboli in their organ tissue and suffered from symptoms resembling those of severe decompression sickness, or "the bends."[72] It has been proposed that the panic led them to surface too rapidly or because it pushed them to dive before they could eliminate the nitrogen accumulated on previous descents, or because the sound itself precipitated the growth of nitrogen bubbles in the blood, which expanded to devastating effect. This finding has since been supported by follow-on papers, by published work in other fields, and by expert reviews.[73] In any case, the evidence is considered "compelling" that acoustic trauma, or injuries resulting from behavioral responses, has in some way led to the deaths of many of these animals.[74]

That beaked whales are suffering injury in larger numbers than are turning up on shore would be consistent with one of the most disturbing findings from the

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[71] R.L. Brownell, Jr., T. Yamada, J.G. Mead, and A.L. van Helden, Mass Strandings of Cuvier's Beaked Whales in Japan: U.S. Naval Acoustic Link (2004) (IWC Doc. SC/56/E37). As in the case of many of the other incidents discussed above, most of the animals involved in these incidents over the years were observed to have stranded live.

[72] See P.D. Jepson, M. Arbelo, R. Deaville, I.A.P. Patterson, P. Castro, J.R. Baker, E. Degollada, H.M. Ross, P. Herráez, A.M. Pocknell, F. Rodríguez, F.E. Howie, A. Espinosa, R.J. Reid, J.R. Jaber, V. Martín, A.A. Cunningham, A. Fernández, Gas-Bubble Lesions in Stranded Cetaceans, 425 Nature 575-576 (2003); Fernández et al., 'Gas and Fat Embolic Syndrome', 42 Veterinary Pathology at 415.

[73] Cox et al., Report of a Workshop to Understand the Impacts of Anthropogenic Sound at 15-21, 23. For additional papers, see also the studies referenced at section II(B)(1)(a) ("Injury Threshold").

[74] P.G.H. Evans and L.A. Miller, Concluding Remarks, in Proceedings of the Workshop on Active Sonar and Cetaceans 74 (2004); see also Cox et al., Report of a Workshop to Understand the Impacts of Anthropogenic Sound at 2. Of course it would be a mistake to assume that an animal must suffer bends-like injury or some other sort of acoustic trauma in order to strand. Some may die simply because the noise disorients them, for instance. See, e.g., NMFS, Assessment of Acoustic Exposures at 9-10.

Bahamas, the only stranding event for which baseline survey data are available. Since the Navy passed through in March 2000, the cohort of Cuvier's beaked whales that had been photo-identified and recorded for years has virtually disappeared, leading researchers to conclude that nearly all of the animals died of physical injury or, at the very least, were driven to permanently abandon their habitat.[75] Five years later, the species is slowly returning but sightings are still far below what they had been.[76] Although not much is known about beaked whale ecology, the latest research suggests that some Cuvier's whales might aggregate in small populations, taking up residence along the continental shelf.[77] Under the right conditions, even the transient sweep of a sonar vessel or other source could devastate a local population.[78] In the Bahamas, that is precisely what appears to have happened.

It should be noted that beaked whales are not the only species vulnerable to these severe effects. As the IWC's Scientific Committee has noted, a variety of other cetaceans have shown signs of stranding or significant distress in response to active sonar use.[79] Some species, such as minke whales (Bahamas 2000) and pygmy sperm whales (Canary Islands 1988), are known to have stranded concurrent with beaked whales in two of the events described above; others, such as long-finned pilot whales and dwarf sperm whales (North Carolina 2005), melon-headed whales (Hawaii 2004), and harbor porpoises (Haro Strait 2003), appear to have stranded in sonar-associated events that did not involve beaked whales at all. It is not known which other species are most vulnerable to these effects, but concern has been raised about deep-diving whales in particular since these animals, in theory, would stand at greatest risk of injury from bubble growth.[80] Some recent anatomical studies of sperm whales and other species

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[75] Personal communication with Ken Balcomb, Center for Whale Research, June 2005; K.C. Balcomb and D.E. Claridge, A Mass Stranding of Cetaceans Caused by Naval Sonar in the Bahamas, 8(2) Bahamas Journal of Science 1 (2001).

[76] Personal communication with Ken Balcomb, Center for Whale Research, June 2005; International Whaling Commission, 2004 Report of the Scientific Committee, Annex K at § 6.3; Balcomb and Claridge, A Mass Stranding of Cetaceans.

[77] T. Wimmer and H. Whitehead, Movements and Distribution of Northern Bottlenose Whales, Hyperoodon ampullatus, on the Scotian Slope and in Adjacent Waters, 82 Canadian Journal of Zoology 1782 (2004); M.L. Dalebout, K.M. Robertson, A. Frantzis, D. Engelhaupt, A.A. Mignucci-Giannoni, R.J. Rosario-Delestre, and C. Scott Baker, Worldwide Structure of mtDNA Diversity among Cuvier's Beaked Whales (Ziphius cavirostris): Implications for Threatened Populations, 11 Molecular Ecology 3353 (2005).

[78] See, e.g., Letter from Hal Whitehead, Dalhousie University, to Donna Wieting, NMFS (May 2001), p. 2 (comments submitted to NMFS concerning its environmental review of the Navy's SURTASS LFA system); see also Dalebout et al., Worldwide Structure at 3354.

[79] International Whaling Commission, 2004 Report of the Scientific Committee, Annex K at § 6.3.

[80] D.S. Houser, R. Howard, and S. Ridgway, Can Diving-Induced Tissue Nitrogen Supersaturation, 213 Journal of Theoretical Biology at 183; J.R. Potter, A Possible Mechanism for Acoustic Triggering of Decompression Sickness Symptoms; L.A. Crum, M.R. Bailey, J. Guan, P.R. Hilmo, S.G. Kargl, T.J. Matula, and O.A. Sapozhnikov, Monitoring Bubble Growth, 6(3) Acoustics Research Letters Online at 214.

indicate that *in vivo* bubble formation is indeed possible in cetaceans other than beaked whales.[81]

b. The DEIS' Analysis

In this light, the Navy's assessment of the risk of marine mammal injury and mortality is astonishingly poor. While some relevant papers appear in the bibliography, overall its analysis proceeds as though little has happened since 2000, when the Bahamas stranding accelerated research in the field. Among the most significant errors:

(1) The Navy fails to account for the possibility—indeed, the very strong likelihood—that sonar can injure whales at sea at considerable distances from the source. DEIS at 4.3-57. Its position here is consequential. In dismissing the issue, the Navy avoids the task of setting thresholds for hemorrhaging, lesions, embolisms, and other damage reported in sonar-afflicted whales, and ultimately of admitting that any serious or potentially lethal injury may occur on the range. It justifies this failure by appealing to scientific uncertainty, suggesting that, in the Bahamas, Canaries, and other cases for which physical evidence has been obtained, one cannot discern which came first, the strandings or the injuries. Since it is uncertain whether the dead animals were "directly injured by sound (a physiological effect) prior to stranding or whether a behavioral response to sound occurred that ultimately caused the beaked whales to strand and be injured," the Navy feels no need to incorporate the potential for seaborne injury into its analysis. DEIS at 4.3-30.[82]

Even if the science on sonar-related trauma had not advanced beyond March 2000, and no additional physical evidence had come to light, the mere fact that injury at sea is a "reasonably foreseeable" possibility (as the Navy's own description suggests, id.) should compel the agency to take account of it. 42 C.F.R. § 1502.22(b). But the state of the evidence far outstrips the regulatory threshold. As discussed above at section II(B)(1)(a), a considerable amount of published evidence supports the view that at least some of the whales killed by mid-frequency sonar were injured, and injured severely, through a pathology involving the growth of bubbles in organ tissue—a pathology that would affect diving animals.[83] And the circumstances behind some mortality

[81] Jepson et al., Gas-Bubble Lesions, 425 Nature at 575; Moore and Early, Cumulative Sperm Whale Bone Damage, 306 Science at 2215; Jepson et al., Acute and Chronic Gas Bubble Lesions, 42 Veterinary Pathology at 291.

[82] Remarkably, the Navy's description of alternative mechanisms leaves out a third possibility that has been widely noted in the literature: i.e., that some of the observed injuries are a result of behavioral changes, such as rapid surfacing or premature diving, that sonar could induce in whales at sea. This mechanism of injury would also result in injury apart from strandings.

[83] See supra at section II(D)(1)(a). As noted above, a number of papers on allied issues have also been published in support of the bubble-growth theory.

events, such as the September 2002 Canary Islands strandings (in which three injured whale were recovered from the water rather than from the beach) and the July 2004 Canary Islands mortalities (in which all four dead whales were recovered at sea and were extremely unlikely to have stranded and refloated), provide additional support for the conclusion that significant injury occurred at sea.[84]

Finally—and regardless of any uncertainty that may exist about the precise mechanism of injury at work in the Canaries and elsewhere—stranding simply does not account for some of the injuries (such as subarachnoid hemorrhage and gas emboli) that have been observed. Such was the conclusion of a thirty-member expert panel convened by the Marine Mammal Commission last year and involving several Navy scientists.[85] To properly evaluate the potential impacts of its range, the Navy must assume that injuries similar to those seen in the Bahamas, the Canaries, and other events may occur in whales at sea. To do otherwise is to arbitrarily disregard the preponderance of the evidence in this field.

(2) The Navy dismisses the possibility that strandings could occur at the particular sites it has chosen, but its rationale for doing so seems to change from section to section of the DEIS. In one place, it argues that its sites are unlikely candidates because of the somewhat greater distance between likely beaked whale habitat and shelf water than appears to have characterized certain other mass stranding events (DEIS at 3.2-31); in another it claims it would minimize risk by avoiding the operational conditions and environmental characteristics ("a strong surface duct, unusual underwater bathymetry, a constricted channel with limited egress") present in one particular event, the March 2000 mass stranding of whales in the Bahamas (DEIS at 4.3-30). The fundamental problem with both of these rationales is that they assume an animal must strand to be injured; but they are defective on their own terms as well.

First, the Navy has no basis on which to claim that shoal waters near the proposed sites occur too far from beaked whale habitat (roughly 50nm in the case of North Carolina) for strandings to occur. For the vast majority of suspect strandings, ship-track and habitat analyses have not been performed (although they have repeatedly been called for), making it impossible to say in

[84] Fernández et al., 'Gas and Fat Embolic Syndrome', 42 Veterinary Pathology at 446-457 (2002 strandings); A. Espinosa et al., New Beaked Whale Mass Stranding in Canary Islands (2004 mortalities).

[85] Cox et al., Report of a Workshop to Understand the Effects of Anthropogenic Sound at 14-15. Indeed, the panel goes on to state that the "array of pathologies" from the 2000 Bahamas and 2002 Canary Islands strandings alone suggests injuries "in addition to the physical effects typical of stranding itself." Id.

most cases where naval vessels and beaked whale habitat were located.[86] From the few events that have been modeled, the 2000 Bahamas event and, to a lesser extent, the 1996 incident in Greece, it is evident that mid-frequency sonar arrays can induce strandings from tens of miles offshore and are likely to affect animals at tens of miles' distance.[87] Given the Navy's conclusion that beaked whales will occur throughout the proposed sites, and given the generally unpredictable nature of beaked whale distribution off the eastern seaboard, the broad claim that strandings of those species will not occur is insupportable.

Second, the Navy places undue reliance on the list of "contributory factors" it associates with the 2000 event in the Bahamas. In the first place, the three sites that the Navy has proposed do not, in fact, avoid all of the environmental characteristics noted in the government's report. Beaked whales would be present in and around all three sites (DEIS at 3.2-29 to 30, 3.2-40 to 41, 3.2-49 to 50), as in the Bahamas, and the sort of surface ducting that developed off the islands in March 2000 can certainly occur there as well. Moreover, the general significance of those factors has been outstripped by events. There is no indication that a surface duct occurred during the subsequent strandings in the Canary Islands or, indeed, during any of the beaked whale mortalities later reported by the IWC's Scientific Committee and others as being associated with sonar; and few other stranding incidents have involved sonar ships passing through a narrow channel with limited egress.[88] We do not doubt that certain factors, such as the use of sonar in channels, can increase the risk of harm; but it is abundantly evident from the literature that has emerged since the government's Bahamas report appeared in 2001 that strandings may well occur in their absence.[89]

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[86] For a partial list of Cuvier's beaked whale strandings associated with naval exercises, along with others for which an association has neither been confirmed nor denied, see, e.g., International Whaling Commission, 2004 Report of the Scientific Committee, Annex K at Tab. 1. See also Brownell et al., Mass Strandings of Cuvier's Beaked Whales in Japan at Tab. 1; Jasny, Sounding the Depths II at Tab. 1-3 (including references to primary texts).

[87] Commerce and Navy, Joint Interim Report at 7-11; SACLANT Undersea Research Centre, Summary Record SACLANTCEN Bioacoustics Panel, La Spezia, Italy, 15-17 June 1998 at 2-6, 2-35 to 36 (1998).

[88] See, e.g., Fernández et al., 'Gas and Fat Embolic Syndrome', 42 Veterinary Pathology at 446-457; International Whaling Commission, 2004 Report of the Scientific Committee, Annex K at Tab. 1.

[89] In addition, the Navy claims to avoid "operational characteristics most likely to have contributed to the Bahamas stranding." DEIS at 4.3-30. Although the discussion that follows is somewhat murky, we assume the Navy has two such characteristics in mind: (1) the use of only 1-2 surface ships in the various exercises planned for the range (as opposed to the use of 4 surface ships in the Bahamas) and (2) the operation of the SQS-53C system at nominal source levels of 235 dB re 1 μPa^{2}•s (as opposed to the Bahamas operation of one 53C system at levels approaching 245 dB re 1 μPa^{2}•s). But the significance of these factors in the Bahamas event—not to mention the other sonar-related strandings—is questionable. The Bahamas strandings did involve more than two surface ships, but they transited the Providence Channels at spatial and temporal intervals (and did not include some of the other sources that the Navy plans to use on the USWTR range); the 1996 Greek strandings, furthermore, involved only a single sonar

(3) The Navy sets an impact threshold for beaked whales that is substantially higher than the available evidence can justify. DEIS at 4.3-31.[90] As discussed above, data and analysis from the Bahamas strandings support a threshold for lethal injury no greater than 174 dB re 1 μPa^{2}•s, and a conservative approach would dictate a number considerably lower than that.[91]

(4) The Navy has failed to consider most of the mass beaked whale strandings that have been identified for their association, or possible association, with sonar. See DEIS at 3.2-30 to 31, 4.3-30 to 31, 8-1 to 44. Indeed, the only incidents that the authors appear to acknowledge are the 2000 strandings in the Bahamas, the 2002 strandings in the Canaries, and the 1996 strandings off Greece (DEIS at 3.2-30 to 31), though they also make a fleeting reference to the 2000 strandings off Madiera (DEIS at 3.2-40, 49). Yet the list reported by the IWC's Scientific Committee and other expert bodies is far broader than the Navy's review would suggest, and should be included and considered in the final document.[92]

(5) The Navy improperly restricts its analysis of strandings and related injuries to beaked whales and does not consider the potential for similar impacts on other species. See DEIS at 3.2-30 to 31, 4.3-30 to 31, 4.3-31 to 32. For example, it does not give special consideration to minke whales, even though two minkes stranded in the Bahamas event, another died in the 2005 North Carolina incident still under investigation, and at least one was observed to engage in dramatic "porpoising" behavior in reaction to sonar use

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vessel. Commerce and Navy, Joint Interim Report at 25; SACLANT Undersea Research Centre, Summary Record SACLANTCEN Bioacoustics Panel at 2-6, 2-30. And systems operating at 235 dB re 1 μPa^{2}•s in the Bahamas still managed to produce over 160 dB re 1 µPa of sound tens of miles away. Commerce and Navy, Joint Interim Report at 34. Again, this is not to say that taking such steps as source reduction would fail to decrease the risk of harm—only that the specific operational regime proposed by the Navy for the USWTR range would not avoid the types of severe impacts we know have occurred.

[90] The Navy claims it is impossible to set "meaningful impact thresholds" for beaked whales given that the precise causes of injury and stranding are unknown. DEIS at 4.3-31. Yet the 190 dB re 1 μPa^{2}•s standard it has set—in complete disregard of the available evidence—is in fact an impact threshold.

[91] See supra at section II(B)(1)(a) ("Injury Threshold").

[92] See, e.g., International Whaling Commission, 2004 Report of the Scientific Committee, Annex K at Tab. 1; Brownell et al., Mass Strandings of Cuvier's Beaked Whales in Japan at Tab. 1; J. Hildebrand, Impacts of Anthropogenic Sound on Cetaceans Tab. 5 (2004) (IWC Doc. SC/56/E13); B. Taylor, J. Barlow, R. Pitman, L. Balance, T. Klinger, D. DeMaster, J. Hildebrand, J. Urban, D. Palacios, and J. Mead, A Call for Research to Assess Risk of Acoustic Impact on Beaked Whale Populations Tab. 1 (2004) (IWC Doc. SC/56/E36). See also the studies on individual strandings referenced in this section; and Jasny, Sounding the Depths II at Tab. 1-3.

in Haro Strait, Washington.[93] Nor does it properly consider harbor porpoises, which stranded at Haro Strait;[94] or pygmy sperm whales, which stranded along with two species of beaked whales during naval exercises off the Canary Islands in November 1988;[95] or pilot whales and dwarf sperm whales, which stranded in the 2005 North Carolina incident;[96] or sperm whales and other deep-diving cetaceans, despite anatomical evidence of their susceptibility to bubble lesions and the concern raised by numbers of scientists that these animals stand at greatest risk of damage from bubble growth.[97] The potential for serious injury of these species is "reasonably foreseeable" and must be considered in the Navy's evaluation of impacts. 42 C.F.R. § 1502.22.

c. North Carolina Strandings (January 2005)

Early last year, on the 15th and 16th of January, thirty-seven whales of three different species (pilot whales, dwarf sperm whales, and one minke whale) beached themselves along the Outer Banks of North Carolina after the Navy used mid-frequency sonar at some unspecified distance offshore. Multi-species mass strandings are extraordinary events, and the North Carolina incident was widely reported in the local and national media, which remarked upon its obvious relevance to the Navy's local plans.[98] NMFS, in partnership with three of the state's universities, has since embarked on a full-scale investigation of the event, conducting necropsies, histopathologies, and other forensic work on many of the dead whales. NMFS expects that a report will issue early this year, after the

[93] Commerce and Navy, Joint Interim Report at 1, 15-16 (Bahamas); M. Kaufman, "Whale Stranding in N.C. Followed Navy Sonar Use," Washington Post, Jan. 28, 2005, Sec. A (North Carolina); NMFS, Assessment of Acoustic Exposures at 9 (Washington).

[94] In dismissing the connection to harbor porpoises, the Navy argues that necropsies of animals stranded in association with sonar use in Haro Strait "found no evidence of acoustic trauma." DEIS at 3.2-45. This statement is misleading. In fact, the NMFS investigation was inconclusive given the poor condition of the bodies and the failure to adequately preserve them for tissue analysis. NMFS, Preliminary Report: Multidisciplinary Investigation of Harbor Porpoises at 53-55 (conclusions unchanged in final report). In any case, as NMFS indicated in a further assessment, it is possible that behavioral reactions, rather than acoustic trauma, were responsible for the strandings. NMFS, Assessment of Acoustic Exposures at 10.

[95] V. Martín et al., Mass Strandings of Beaked Whales in the Canary Islands at 35.

[96] M. Kaufman, "Whale Stranding in N.C. Followed Navy Sonar Use," Washington Post, Jan. 28, 2005, Sec. A.

[97] Moore and Early, Cumulative Sperm Whale Bone Damage, 306 Science at 2215; Jepson et al., Gas-Bubble Lesions, 425 Nature at 575; D.S. Houser, Can Diving-Induced Tissue Nitrogen Supersaturation, 213 Journal of Theoretical Biology at 183; J.R. Potter, A Possible Mechanism for Acoustic Triggering of Decompression Sickness Symptoms; International Whaling Commission, 2004 Report of the Scientific Committee, Annex K at § 6.3.

[98] See, e.g., M. Kaufman, "Whale Stranding in N.C. Followed Navy Sonar Use," Washington Post, Jan. 28, 2005, Sec. A; Kate Wiltrout, "Navy Sonar under Scrutiny," Virginian-Pilot, May 3, 2005, Sec. A.

Navy's deadline for public comment expires. Nowhere in the DEIS does the Navy even mention—let alone analyze—this event.

The investigation could have enormous significance for the Navy's environmental analysis of the USWTR range. If it does provide evidence implicating mid-frequency sonar in the strandings—or suggesting that sonar may have been the cause—it would undermine a number of assumptions on which the Navy's draft analysis is based. First, it would directly contradict the Navy's claim (DEIS at 3.2-31) that strandings and mortalities would not occur at the North Carolina site, and challenge the basis of the Navy's conclusion (DEIS at 3.2-40, 49-50) that the additional proposed sites in Virginia and Florida are also safe. Second, it would demonstrate that the range of species vulnerable to strandings is broader than the Navy's analysis suggests. In its analysis, the Navy assumes that any mortalities would be limited to beaked whales, a family of rarely-seen, deep-diving species whose unusual mass strandings over miles of coast first alerted scientists to the association between active sonar and whale deaths (id.); yet the North Carolina event involved a completely different set of species. If the investigation provides additional evidence to suggest that other species may be susceptible to similar impacts, then the project's risk to marine mammals enlarges considerably.

The record before the Navy is clearly inadequate and incomplete without both the NMFS report and the data produced in the agency's investigation of this stranding event. Any final review that excludes them would surely fail to satisfy NEPA's demand of scientific integrity; but even if the Navy references the event in its final EIS, it will have already damaged this public process. In prematurely closing its comment period prior to the release of NMFS' report and data, the Navy is effectively denying the public and scientific community an opportunity for informed participation on a core factual issue. 42 C.F.R. §§ 1502.9(a), 1503.1(a); see also, e.g., The Lands Council v. Powell, 395 F.3d 1019, 1027 (9th Cir. 2005) (citing informed public comment as one of the purposes of NEPA).[99] The problem is only exacerbated should the Navy rely on its own report on the stranding event. See Idaho Farm Bureau Federation v. Babbitt, 58 F.3d 1392 (9th Cir. 1995) (requiring reopening of public comment after agency relied critically on own undisclosed report in listing decision under the Endangered Species Act). We would again urge that the Navy withdraw the DEIS or extend its comment period accordingly. 42 C.F.R. § 1502.9(a).

[99] NRDC notified the Navy of these problems and requested an appropriate deadline extension in early November, one-and-one-half months before the close of the comment period. See Letter from Joel R. Reynolds, Senior Attorney, NRDC, to Keith Jenkins, Naval Facilities Engineering Command Atlantic, Navy (Nov. 9, 2005). In response to our request, and to extension requests submitted by Congressional offices, government agencies, and private citizens, the Navy extended the deadline by approximately one month, but the timing still will not allow for meaningful public comment on the January 2005 event. We hereby incorporate by reference our Nov. 9 letter as well as all of the other extension requests, many of which explicitly cited the stranding.

3. Modeling of Acoustic Impacts

The Navy bases its calculation of marine mammal impacts on a series of models. Its CASS/GRAB model determines received levels of sound within a limited distance of a sonar array; its MATLAB model converts those received levels into energy levels; its MMEM model translates the Navy's energy levels into a graph of where marine mammal "take" will occur; and its Take Estimation Model model calculates the number of animals (and therefore the number of "takes") within the area of harm. DEIS at Fig. 4.3-8. In other words, the four models estimate the amount of energy received at each point (or "cell") within the immediate area of an exercise and then estimate the number of animals that would therefore suffer injury or disruption.

It is difficult to fully gauge the accuracy and rigor of these models with the paucity of information that the DEIS provides. They have not previously been used in the Navy's environmental reviews of acoustic activities, or at least not in those that have been opened to public comment, and, as a group, they appear to differ significantly from other systems, like AIM, that are used in other contexts to model impacts from both mid-frequency and low-frequency sonar.[100] Given the importance of these models to the Navy's analysis, they must be available to the public.[101] But even from the limited description in the DEIS, it is clear that they are deeply flawed. They leave out most of the sound field, avoid any calculation of cumulative effects, and ignore the potential for long-term impacts on local populations. Among the most significant errors:

a. First and foremost, as discussed above, the thresholds established for injury, hearing loss, and significant behavioral change are grossly inconsistent with the available data and are based, in part, on assumptions not acceptable within the field.[102] Since the Navy's entire analysis (including its propagation modeling) depends on these thresholds, its entire analysis is in error.

b. It appears from the Navy's description (DEIS at 4.3-38 to 40) that some relevant environmental factors—factors that may enhance propagation of the sonar signal—have not been incorporated into its analysis.

First, the DEIS does not properly account for reverberation (or "reflection") of the signal off the seabed, a potential problem given the relatively shallow topography of the training range and the presence of hard bottom at all three proposed sites. It has been shown in other contexts that reverberation can dramatically prolong

[100] See, e.g., Navy, Final Overseas Environmental Impact Statement and Environmental Impact Statement for SURTASS LFA at 4.2-31 to 38 (includes modeling for beaked whales and right whales in Onslow Bay); Hildebrand et al., Modeling the Bahamas Beaked Whale Stranding.

[101] See discussion below at section II(J) ("Project Description and Meaningful Public Disclosure").

[102] See discussion above at section II(B)(1) ("Thresholds of Injury, Hearing Loss, and Significant Behavioral Change").

the mid-frequency sonar signal, effectively boosting its duty cycle and raising the energy levels experienced by animals in the area. During the Haro Strait incident, for example, the 1- to 2-second "ping" emitted by a transiting ship became at times a 19-second transmission, which, repeated every 28 seconds, significantly increased the energy and duration of the signals received by local animals, including an endangered population of orcas.[103] How the Navy addresses this problem in its USWTR modeling is not obvious. To the extent that it has considered reverberation at all, it appears to have overlooked the potential impact of a prolonged signal on marine mammal behavior;[104] nor has it factored reverberation into its estimates of duty cycles (DEIS at 4.3-43); nor is it evident how energy levels were calculated in the greater portion of the Navy's proposed sites, where the sea bottom has not yet been mapped.[105]

Second, the Navy's analysis of the Bahamas stranding, which (wrongly) states that many of the "environmental characteristics" present during the Bahamas mass stranding incident of 2000 would not occur on the training range, suggests that the Navy has discounted the potential for surface ducting: the channeling of sounds in the upper reaches of the water column. Surface ducting can occur in temperate latitudes, particularly under cloudy, windy conditions; and, as in the Bahamas, it could send noise from hull-mounted sonars further than the Navy's propagation analysis might otherwise indicate.[106] The Navy must account for the possibility of surface ducting if it has not already done so.

c. The Navy truncates its propagation analysis in such a way that most of the sound field generated by the range simply disappears from view. Under the CASS/GRAB model, the environmental footprint of even the most powerful mid-frequency signals extends only 1 km from the source; beyond this point, the sound field is not even mapped. DEIS at 4.3-40. The result is that the field shrinks to a small portion of its actual size, not much larger than a point at the center of a moving circle, and exposures of marine life to sound below about 180 dB re 1

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[103] NMFS, Assessment of Acoustic Exposures at 3, 8-9.

[104] Judging from Fig. 4.3-9, it would appear that all energy arriving at a particular point is summed (under the CASS/GRAB model) as though it lasted merely for the duration of the sonar transmission. This suggests that the Navy may have (to some extent) considered surface and bottom reflection in calculating total received energy levels, but that it did not consider the environmental consequences of a prolonged signal. It should go without saying that a sound occupying 30 seconds of every minute may have a greater impact on species behavior than one lasting 2-4 seconds, to a degree that is not necessarily represented by the differences in energy they convey. See the discussion above at section II(B)(1)(c) ("Threshold for Significant Behavioral Change").

[105] See DEIS at Figs. 3.2-1 and 3.2-2. A conservative approach would assume that significant reverberation would occur wherever field data suggesting the opposite was lacking. It is also worth noting that the sea-bottom map used by the Navy for its preferred site off North Carolina is out of date.

[106] 67 Fed. Reg. 46714 (conditions for surface ducting); Commerce and Navy, Joint Interim Report at (surface ducting during the 2000 mass stranding).

μPa are entirely disregarded. What the authors attempt here is inconsistent with every other effort that, to our knowledge, has been made by regulators, scientists, and others to determine acoustic impacts on marine mammals. Even the Navy, in its EIS for the Navy's SURTASS LFA system, models the entire sound field (down at least to 119 dB re 1 μPa) for each sample site.[107] It is also completely inconsistent with the literature on ocean noise, as discussed above, which indicates that significant impacts can occur at levels received well outside the Navy's cut-off range. The result is a model that provides no basis for assessment of chronic effects or of effects on wildlife and fisheries that may occur outside the training range itself.

d. The Navy excludes from its analysis any system whose source level does not exceed 205 dB re 1 μPa. DEIS at 4.3-33. It therefore does not perform even a propagation analysis for several mid-frequency sources, such as DICASS sonobuoys, that are to be used extensively in the range. DEIS at 4.3-34. The Navy's rationale turns upon its thresholds: it claims that the noise from these systems would exceed its "Level B" threshold only at very short distances that would not easily be breached. But this argument does not account for the cumulative effects that the various sources, adding to one another and to still more powerful sources, may have.[108] Nor does it explain the extensive literature that has emerged on the various impacts of commercial shipping (190 dB re 1 μPa) , acoustic harassment devices (185-95 re 1 μPa), and other producers of ocean noise whose source levels fall well below the Navy's minimum.[109] Indeed, as with the Navy's truncation of the sound field, its omission of sources only serves to underscore the inconsistency of its acoustic thresholds with the prevailing science.

e. The Navy fails to fully consider the consequences of using multiple sources, such as dipping sonar and ship-based sonar, in the same exercise. It appears simply to sum whatever sound is received within each "cell" of ocean—a method that may help determine cumulative energy levels but that says little about the synergistic impacts that a complex sound field might incur. The "Group SAILEX" exercise, denominated "Scenario 4" in the DEIS, would involve two surface ships, two helicopters, one or two hull-mounted sonar systems, one or two dipping sonars, active sonobuoys, range pingers, torpedo sonar, fathometers, underwater communication devices, acoustic countermeasures, target simulators,

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[107] Navy, Final Overseas Environmental Impact Statement and Environmental Impact Statement for SURTASS LFA at 4.2-24, 4.2-39.

[108] Notably, the Navy excludes these sources on the basis of their sound pressure levels and does not consider how they may add to total received Energy Levels, which are otherwise the Navy's units of analysis. See DEIS at 4.3-33.

[109] For discussion of this research and expression of concern about shipping noise and other sources, see, e.g., National Research Council, Ocean Noise and Marine Mammals (2003).

and XBTs. DEIS at 2-6. The potential synergistic impacts of all of these sources acting in rough proximity must be evaluated.

f. The Navy makes a number of errors in calculating marine mammal densities—a significant problem given the importance of accurate and representative density numbers for the calculation of species "take." See DEIS at 4.3-43. Most of these errors arise out of the Navy's distribution and abundance analysis and are discussed below in the section on "Distribution and Abundance on Marine Species" (section II(F)). But the model suffers in other ways as well. For example, it appears to assume that individuals are evenly distributed over shallow-water and deep-water areas, which fails to capture how species that travel in pods or in other social units actually travel.

g. The Navy effectively "segments" its calculation of marine mammal takes: that is, it divides its analysis in such a way that cumulative impacts from the project go unassessed. DEIS at 4.3-27 to 28. Here as elsewhere, the Navy's description of its method is somewhat obscure, but it appears to calculate marine mammal impacts by (a) determining the acoustic "footprint" of a sonar system, based on a single 1-kilometer run; (b) calculating the portion of the footprint that receives more noise than the Navy's impact threshold will allow; (c) multiplying the area of impact by the density of marine mammals in the area, yielding what the Navy calls a "harassment rate"; and (d) multiplying the harassment rate by the number of kilometers the source will cover in a season or year. DEIS at 4.3-41 to 42. Buried in this reductive formula are a number of unrealistic assumptions. Most crucially, the Navy seems to assume that every whale encountered during an exercise (or during several exercises) is essentially a new whale and that animals will never be encountered twice. As a result, it gives absolutely no consideration to cumulative impacts on animals that, out of strong habitat preference, may remain within a year-round, active naval training range.

h. The Navy fails to meaningfully evaluate long-term impacts on local wildlife populations. Ecological factors are discounted on the grounds that "an ecological impact may not be observable over short periods of observation." DEIS at 4.3-4. Yet, as discussed above with regard to the Navy's "Threshold for Significant Behavioral Change," subtle alterations in behavior at low levels of exposure may, over time, significantly affect an animal's ecology, its "normal pattern" of biological traits or behavior. The standard employed by NMFS to evaluate harassment explicitly takes account of such changes (see, e.g., 67 Fed. Reg. 46763), and the Navy must model for such effects in its environmental review of the range.

Finally, it must be noted that the consequences of these modeling errors are cumulative. The unjustifiably high impact thresholds, the truncated map of the sound field, the omission of sound sources, the segmentation of analysis—all of these assumptions combine in ways that put additional strain on the credibility of the

Navy's analysis and lead to the counter-intuitive results that we described in our introduction. The Navy must make substantial changes if its modeling is to meet the "scientific integrity" standard prescribed by NEPA. 42 C.F.R. § 1502.24.

4. Other Impacts on Marine Mammals

The USWTR is a complex project whose impacts on marine mammals are not limited to the overt physiological and behavioral effects of ocean noise. Unfortunately, the Navy's analysis of most of these other impacts is inadequate.

a. The Navy improperly discounts the risk of ship collisions with large cetaceans. Under the same procedures laid out in the USWTR mitigation plan, which have been required by the Navy for years, right whales and other large cetaceans have been struck and killed by Navy vessels. For example, a pregnant right whale was mortally injured off the Virginia coast in November 2004 by a Navy ship that was reportedly following protocol.[110] The risk of ship collision in this case is only exacerbated by the use of active acoustics. Right whales have been shown to engage in dramatic surfacing behavior, increasing their vulnerability to ship strikes, on exposure to mid-frequency alarms above 133 dB re 1 μPa—a level of sound that can occur many tens of miles away from the sonar systems slated for the range.[111] Thus the Navy's claim that collisions would not occur is insupportable. The Navy must accurately represent the risk, especially for the critically endangered Northern right whale, for which even a single strike can have a significant adverse impact on species survival and reproduction. 70 Fed. Reg. 36121 (conclusion of NMFS).

b. As the Navy observes, a number of features of the USWTR pose a risk of marine mammal (and sea turtle) entanglement. DEIS at 4.2-9 to 11. The Navy fails to analyze the risk of entanglement with the interconnect cables that run between the range's numerous acoustic nodes. At the North Carolina site these cables would be entirely exposed; in Virginia and Florida, they would be buried in shallow depths but not in deeper water. DEIS at 2-23, 24, 25. Movement of the Navy's transducers along the sea floor could cause slack in the unburied cable, creating the potential for entanglement of bottom-feeding baleen whales, much like lobster-pot lines, whose risk to baleen whales are acknowledged. Similarly, these species could stand at greater risk of entanglement with control wire, parachutes, and other objects that settle at the bottom after use. See DEIS at 4.2-9 to 11. The Navy must evaluate the potential for harm.

[110] C. Morello, "Whale's Death Brings Calls for Sea Speed Limits," Washington Post, Dec. 5, 2005.

[111] Nowacek et al., North Atlantic Right Whales, 271 Proceedings of the Royal Society of London, Part B: Biological Sciences at 227.

c. In the course of its activities, the Navy would release a host of toxic chemicals into the marine environment—hydrogen cyanide, lead and other heavy metals, bioactive compounds, and others—that could pose a threat to local wildlife over the life of the range. Nonetheless, the DEIS generally fails to consider the cumulative, long-term impacts of these toxins, restricting itself instead to the effects of single releases or, in the case of lead, to the effects of biomagnification (rather than bioaccumulation); at no time does it consider the cumulative and synergistic impacts of all of the chemicals the Navy proposes or risks sending into the local environment. DEIS at 4.1-5 to 16. Careful study is needed into the way they might disperse and circulate within the region, but the DEIS generally does not look beyond the initial dispersal of chemicals into the water column. See, e.g., DEIS at 4.1-10. The Navy's analysis of hazardous materials is therefore incomplete.

d. The Navy fails to assess the impact of stress on marine mammals, a serious problem for animals exposed even to moderate levels of sound for extended periods.[112] As the Navy observes, it is "important to recognize" that stress from ocean noise may weaken a cetacean's immune system, making it "more vulnerable to parasites and diseases that normally would not be fatal"; may over time "cause damage to the heart muscle and vasculature"; and may hinder reproduction or cause malformations and other defects in the young. DEIS at 4.8-5 to 6 (citing several studies).[113] And one might add, following studies on terrestrial mammals, that chronic noise can interfere with brain development, increase the risk of myocardial infarctions, and depress reproductive rates—all at moderate levels of exposure, well below the Navy's absolute thresholds of harm.[114] Yet despite acknowledging the potential for stress in marine mammals and the significant consequences that can flow from it (particularly from the long-term activities contemplated for the range), the DEIS provides no analysis of its impacts, as NEPA requires. 42 C.F.R. § 1502.22.

e. Finally, the Navy's analysis cannot be limited only to the USWTR's direct effects, i.e., effects that occur at the same time and place as the various new activities that would be authorized. See id. § 1508.8(a). It must also take into

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[112] See National Research Council, Ocean Noise and Marine Mammals.

[113] Some additional evidence relevant to the problem of stress in marine mammals is summarized in T.A. Romano, M.J. Keogh, C. Kelly, P. Feng, L. Berk, C.E. Schlundt, D.A. Carder, and J.J. Finneran, Anthropogenic Sound and Marine Mammal Health: Measures of the Nervous and Immune Systems Before and After Intense Sound Exposure, 61 Canadian Journal of Fisheries and Aquatic Sciences 1124, 1130-31 (2004).

[114] See, e.g., E.F. Chang and M.M. Merzenich, Environmental Noise Retards Auditory Cortical Development, 300 Science 498 (2003) (rats); S.N. Willich, K. Wegscheider, M. Stallmann, and T. Keil, Noise Burden and the Risk of Myocardial Infarction, European Heart Journal (2005) (Nov. 24, 2005) (humans); F.H. Harrington and A.M. Veitch, Calving Success of Woodland Caribou Exposed to Low-Level Jet Fighter Overflights, 45 Arctic vol. 213 (1992) (caribou).

account the expansion's indirect effects, which, though reasonably foreseeable, may occur later in time or at a farther remove. See id. § 1508.8(b). This requirement is particularly critical in the present case given the potential of sonar exercises to cause significant long-term impacts not clearly observable in the short or immediate term (a serious problem, as the National Research Council has observed).[115] Thus, for example, the Navy must not only evaluate the potential for hearing loss in marine mammals but also the potential for indirect effects—loss of breeding, vulnerability to predators, and so on—that might arise from that hearing loss. 42 C.F.R. § 1502.16(b).

C. Impacts on Fish and Fisheries

1. Acoustic Impacts on Fish

Though the architecture of their ears may differ, fish are equipped, like all vertebrates, with thousands of sensory hair cells that vibrate with sound; and a number of specialized organs like the abdominal sac, called a "swim bladder," that some species possess can boost hearing. Fish use sound in many of the ways that marine mammals do: to communicate, defend territory, avoid predators, and, in some cases, locate prey.[116]

One series of recent studies showed that passing airguns can severely damage the hair cells of fish (the organs at the root of audition) either by literally ripping them from their base in the ear or by causing them to "explode."[117] Fish, unlike mammals, are thought to regenerate hair cells, but the pink snapper in those studies did not appear to recover within approximately two months after exposure, leading researchers to conclude that the damage was permanent.[118] It is not clear which elements of the sound wave contributed to the injury, or whether repetitive exposures at low amplitudes or a few exposures at higher pressures, or both, were responsible.[119] As with marine mammals, sound has also been shown to induce temporary hearing loss. Even at fairly moderate levels, noise from outboard motor engines is capable of temporarily deafening some species of fish, and other sounds have been shown to affect the short-term hearing of a number of other species, including sunfish and

[115] "Even transient behavioral changes have the potential to separate mother-offspring pairs and lead to death of the young, although it has been difficult to confirm the death of the young." National Research Council, Ocean Noise and Marine Mammals at 96.

[116] See, e.g., A.N. Popper, Effects of Anthropogenic Sounds on Fishes, 28(10) Fisheries 26-27 (2003); M.C. Hastings & A.N. Popper, Effects of Sound on Fish 19 (2005) (Report to the California Department of Transportation, Contract No. 43A0139), p., 19; D.A. Croll, Marine Vertebrates and Low Frequency Sound—Technical Report for LFA EIS 1-90 (1999).

[117] R. McCauley, J. Fewtrell, and A.N. Popper, High Intensity Anthropogenic Sound Damages Fish Ears, 113 Journal of the Acoustical Society of America 640 (2003).

[118] Id. at 641 (some fish in the experimental group sacrificed and examined 58 days after exposure).

[119] Id.

tilapia.[120] For any fish that is dependent on sound for predator avoidance and other key functions, even a temporary loss of hearing (let alone the virtually permanent damage seen in snapper) will substantially diminish its chance of survival.[121]

Nor is hearing loss the only effect that ocean noise can have on fish. For years, fisheries in various parts of the world have complained about declines in their catch after intense acoustic activities (including naval exercises) moved into the area, suggesting that noise is seriously altering the behavior of some commercial species.[122] A group of Norwegian scientists attempted to document these declines in a Barents Sea fishery and found that catch rates of haddock and cod (the latter known for its particular sensitivity to low-frequency sound) plummeted in the vicinity of an airgun survey across a 1600-square-mile area, an area three times the size of the proposed USWTR range and larger than the state of Rhode Island; in another experiment, catch rates of rockfish were similarly shown to decline.[123] Drops in catch rates in these experiments range from 40 to 80 percent.[124] A variety of other species, herring, zebrafish, pink snapper, and juvenile Atlantic salmon, have been observed to react to various noise sources with acute alarm.[125]

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[120] A.R. Scholik and H.Y. Yan, Effects of Boat Engine Noise on the Auditory Sensitivity of the Fathead Minnow, Pimephales promelas, 63 Environmental Biology of Fishes 203-09 (2002); A.R. Scholik and H.Y. Yan, The Effects of Noise on the Auditory Sensitivity of the Bluegill Sunfish, Lepomis macrochirus, 133 Comparative Biochemisty and Physiology Part A at 43-52 (2002); M.E. Smith, A.S. Kane, & A.N. Popper, Noise-Induced Stress Response and Hearing Loss in Goldfish (Carassius auratus), 207 Journal of Experimental Biology 427-35 (2003); Popper, Effects of Anthropogenic Sounds at 28.

[121] See Popper, Effects of Anthropogenic Sounds at 29; McCauley et al., High Intensity Anthropogenic Sound Damages Fish Ears, at 641.

[122] See "'Noisy' Royal Navy Sonar Blamed for Falling Catches," Western Morning News, Apr. 22, 2002 (sonar off the U.K.); Percy J. Hayne, President of Gulf Nova Scotia Fleet Planning Board, "Coexistence of the Fishery & Petroleum Industries," www.elements.nb.ca/theme/fuels/percy/hayne.htm (accessed May 15, 2005) (airguns off Cape Breton); 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, Marine Seismic Surveys: Analysis and Propagation of Air-Gun Signals, and Effects of Air-Gun Exposure on Humpback Whales, Sea Turtles, Fishes, and Squid 185 (2000) (airguns in general).

[123] A. Engås, S. Løkkeborg, E. Ona, and A.V. Soldal, Effects of Seismic Shooting on Local Abundance and Catch Rates of Cod (Gadus morhua) and Haddock (Melanogrammus aeglefinus), 53 Canadian Journal of Fisheries and Aquatic Sciences 2238-49 (1996); J.R. Skalski, W.H. Pearson, and C.I. Malme, Effects of Sound from a Geophysical Survey Device on Catch-Per-Unit-Effort in a Hook-and-Line Fishery for Rockfish (Sebastes spp.), 49 Canadian Journal of Fisheries and Aquatic Sciences 1357-65 (1992). See also S. Løkkeborg and A.V. Soldal, The Influence of Seismic Exploration with Airguns on Cod (Gadus morhua) Behaviour and Catch Rates, 196 ICES Marine Science Symposium 62-67 (1993).

[124] Id.

[125] See J.H.S. Blaxter and R.S. Batty, The Development of Startle Responses in Herring Larvae, 65 Journal of the Marine Biological Association of the U.K. 737-50 (1985); F.R. Knudsen, P.S. Enger, and O. Sand, Awareness Reactions and Avoidance Responses to Sound in Juvenile Atlantic Salmon, Salmo salar L., 40 Journal of Fish Biology 523-34 (1992); McCauley et al., Marine Seismic Surveys at 126-61.

Equally troubling are the high mortalities from noise exposure seen in developmental stages of fish. A number of studies, including one on non-impulsive noise, show that intense sound can kill eggs, larvae, and fry outright or retard their growth in ways that may hinder their survival later.[126] Increased mortality for fish eggs has been shown to occur at distances of 5 miles from an airgun source; mortality rates approaching 50 percent affected yolksac larvae at distances of 2 to 3 miles.[127] Also, larvae in at least some species are known to use sound in selecting and orienting toward settlement sites.[128] Acoustic disruption at that stage of development could have significant consequences.[129]

2. The DEIS' Analysis

Despite the emerging record on acoustic harm to fish, and despite the importance of the proposed USWTR sites to commercial and recreational fisheries in the southeastern United States, the Navy dismisses the potential for significant impacts on fish and fisheries. DEIS at 4.3-76. It also discounts the impact its range would have on hard-bottom habitat, on which many species depend. DEIS at 4.2-5. But it provides little analysis to support its conclusions.

a. Very little of the scientific literature on acoustic impacts on fish, summarized above, is referenced in the DEIS. Instead, the Navy's analysis is qualitative and cursory, containing no reference to the literature on hearing damage, mortality, and large-scale behavioral change, and no mention of the effect of noise on catch rates. See DEIS at 4.2-4 to 4.2-7, 4.3-76 to 77, 4.4-1.

The DEIS offers three reasons for its conclusion that significant impacts will not occur. First, it claims there is no evidence linking non-impulsive sound to mortalities in fish. DEIS at 4.3-76. The statement is untrue, as a few studies have been made of mortality in adults and in eggs and larvae;[130] but even if no such

[126] See, e.g., C. Booman, J. Dalen, H. Leivestad, A. Levsen, T. van der Meeren, and K. Toklum, Effecter av luftkanonskyting på egg, larver og yngel (Effects from Airgun Shooting on Eggs, Larvae, and Fry), 3 Fisken og Havet 1-83 (1996) (Norwegian with English summary); J. Dalen and G.M. Knutsen, Scaring Effects on Fish and Harmful Effects on Eggs, Larvae and Fry by Offshore Seismic Explorations, in H.M. Merklinger, Progress in Underwater Acoustics 93-102 (1987); A. Banner and M. Hyatt, Effects of Noise on Eggs and Larvae of Two Estuarine Fishes, 1 Transactions of the American Fisheries Society 134-36 (1973); L.P. Kostyuchenko, Effect of Elastic Waves Generated in Marine Seismic Prospecting on Fish Eggs on the Black Sea, 9 Hydrobiology Journal 45-48 (1973).

[127] Booman et al., Effecter av luftkanonskyting på egg, larver og yngel at 1-83.

[128] S.D. Simpson, M. Meekan, J. Montgomery, R. McCauley, R., and A. Jeffs, Homeward Sound, 308 Science 221 (2005).

[129] Popper, Effects of Anthropogenic Sounds at 27.

[130] See, e.g., A. Banner and M. Hyatt, Effects of Noise on Eggs and Larvae of Two Estuarine Fishes, 1 Transactions of the American Fisheries Society 134-36 (1973); A.W.H. Turnpenny, K.P. Thatcher, and J.R. Nedwell, The Effects on Fish and Other Marine Animals of High-Level Underwater Sound (1994).

evidence existed, it is not unreasonable based on the broader literature cited above to suppose that non-impulsive sounds might have lethal impacts as well. 42 C.F.R. § 1502.22. Second, the DEIS claims that hearing loss would not have significant biological consequences for fish because, while the threshold shift in certain fish may be substantial, it would only be temporary. DEIS at 4.3-76.[131] In fact, at least one study demonstrates the permanent damage that noise can have on the sensory cells of fish ears—an especially important finding given the importance of snapper, the study's subject, to commercial and recreational fishing around the Navy's preferred site.[132] In any event, it has been noted that even temporary hearing loss could significantly affect a fish's survival.[133]

Third, while admitting that mid-frequency noise can alter behavior, the DEIS argues that fish are less responsive to mid-frequency than to low- and high-frequency sounds. DEIS at 4.3-77. For this proposition, it improperly relies entirely on two studies on acoustic deterrent devices, otherwise known as "pingers": a technology used in some American fisheries to ward harbor porpoises and certain other marine mammals away from gillnets. Id. Not only do the deterrents featured in the two papers differ enormously from the Navy's mid-frequency tactical sonar, presenting a very different wave form and operating at a source level literally billions of times less intense (130 dB versus 235 dB re 1 μPa); but, in at least one of the studies, it actually altered the behavior of the fish, drawing them into the gillnet for reasons that are not explored.[134] Of course, it is more parsimonious to assume that mid-frequency sound can induce similar kinds of behavioral change.

The Navy must rigorously analyze the potential for behavioral, auditory, and physiological impacts on fish, including the potential for population-level effects, using models of fish distribution and population structure and conservatively estimating areas of impact from the available literature. 42 C.F.R. § 1502.22.

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[131] The DEIS observes that sound can cause hearing loss in hearing specialists, but not in hearing generalists. DEIS at 4.3-76. While it is true that the few hearing generalists studied thus far experienced relatively little threshold shift, they did experience some. M.E. Smith, A.S. Kane, and A.N. Popper, Acoustical Stress and Hearing Sensitivity in Fishes: Does the Linear Threshold Shift Hypothesis Hold Water? 207 Journal of Experimental Biology 3591-3602 (2004). In any case, it is important to recognize that most of the impact studies cited above in subsection (a) ("Acoustic Impacts on Fish") were performed on hearing generalists.

[132] Memorandum on U.S. Navy Undersea Warfare Training Range, EA No. 06-0146, from Fritz Rhode, North Carolina Division of Marine Fisheries, to Melba McGee, Office of Legislative and Intergovernmental Affairs, North Carolina Department of Environmental Resources 3 (Dec. 2005).

[133] Popper, Effects of Anthropogenic Sounds at 29.

[134] B.M. Culik, S. Koschinski, N. Tregenza, and G.M. Ellis, Reactions of Harbor Porpoises Phocoena phocoena and Herring Clupea harengus to Acoustic Alarms, 211 Marine Ecology Progress Series 255, 258 (2001).

b. The Navy does not adequately assess the potential for damage to fragile hard bottom habitat. In the first place, it seems to grossly underestimate the extent of hard bottom that lies beneath its preferred site, relying on an outdated survey that may undercount hard blocks by a factor of three, and wrongly assuming that live-bottom areas such as reefs are small and isolate.[135] Second, in assessing damage, the Navy appears to consider only the 4-centimeter-wide furrow made in the seabed to bury its trunk cable (DEIS at 4.2-5); it does not, however, evaluate the reasonably foreseeable impacts of construction and installation, or of the transducers and interconnect cables as they lie on the seafloor and move with the waves, or of the release of debris, or of the toxic biocide or other form of maintenance that presumably would be used to preserve the Navy's hardware. The analysis must be revised.

c. Having concluded—without basis—that the USWTR would have no significant impact on fish and fish habitat, the Navy dismisses the notion that fisheries in the area would suffer economic loss. DEIS at 4.4-1 to 5. Its conclusion lies at odds with the North Carolina Department of Marine Fisheries, which, in expressing its concern about the USWTR's potential impacts, has observed that "[f]urther disruption of [offshore] fishing activities for non-fisheries reasons would likely have severe economic impacts."[136] According to the Department of Marine Fisheries, the Navy has underestimated the number of offshore hotspots, the number and value of landings, and the fishing effort in the area of Onslow Bay, its preferred site.[137] All of this underscores the need for a more serious and informed analysis than the DEIS currently provides. The Navy must assess the economic consequences of reduced catch rates on the area's commercial and recreational fisheries.

D. Other Impacts on Marine Wildlife

The USWTR poses risks to marine wildlife beyond ocean noise: entanglement in cables and detritus, collisions with ships, bioaccumulation of toxins, degradation of live-bottom habitat, depletion of prey species, and the like. Indeed, many of the same concerns that apply to marine mammals (and are discussed above at section II(B)(4)) apply to fish, sea turtles, and other biota as well. Some risks, however, may concern only certain species. For example, electric cables along the beach could disorient sea turtle hatchlings, which rely on a proper magnetic field to orient themselves correctly.[138] The Navy must evaluate impacts and propose mitigation for each category of harm. 42 C.F.R. §§ 1502.14, 1502.16.

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[135] Memorandum from Fritz Rhode to Melba McGee at 1-2.

[136] Id. at 3.

[137] Id. at 2-3.

[138] W.P. Irwin and K.J. Lowmann, Magnet-Induced Disorientation in Hatchling Loggerhead Sea Turtles, 206 Journal of Experimental Biology 497-501 (2003).

E. Cumulative Impacts

In order to satisfy NEPA, an EIS must include a "full and fair discussion of significant environmental impacts." 40 C.F.R. § 1502.1. It is not enough, for purposes of this discussion, to consider the proposed action in isolation, divorced from other public and private activities that impinge on the same resource; rather, it is incumbent on the Navy to assess cumulative impacts as well, including the "impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future significant actions." Id. § 1508.7. Thus, for example, it will be necessary to consider the impacts of the proposed range alongside those of existing naval activities in the region, including the operations areas and complexes in which the range would reside (see also infra at (H)), as well as those of industrial and commercial activities such as fishing, shipping, and geophysical research.[139]

As it stands, the Navy does not consider cumulative impacts for any species other than marine mammals; and, as for marine mammals, it does little more than identify, in a summary way, some of the leading threats they face globally. DEIS at 4.8-1 to 6. It does not attempt to examine any specific marine mammal population affected by the training range, so that, for example, one cannot ascertain what the combined effects of USWTR activities, ship-strikes, and fishing entanglements on the Northern right whale might be; nor does it imagine for a moment that USWTR activities might work synergistically with other threats to affect them.[140] For individual types of naval exercises, including those covered by the DEIS, the Navy offers only the bromide that mitigation will preclude any significant or long-term impacts on marine mammals and the marine environment. DEIS at 4.8-4 to 4.8-6. Not only is this statement factually insupportable (at least with regard to the USWTR itself) given the lack of any population analysis or quantitative assessment of long-term effects in the DEIS—but it misapprehends the definition of "cumulative impact," which, according to NEPA's regulations, "can result from individually minor but collectively significant actions taking place over a period of time." 42 C.F.R. § 1508.7. It cannot be reconciled, for example, with the Navy's own account of the long-term effects of stress (cited above at section II(B)(4)(d)), a reasonably foreseeable impact that does not otherwise receive attention in the document.

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[139] In the 2005 Energy Policy Act, Congress mandated that the Minerals Management Service conduct an offshore inventory for oil and gas throughout the entire outer continental shelf of the United States, a process that could well extend high-energy seismic exploration to the east coast and to waters within or near the USWTR range. Energy Policy Act of 2005, Pub. L. No. 109-58, §357, 119 Stat. 594, 720. The Navy must evaluate the cumulative impacts stemming from this additional acoustic activity.

[140] For example, as discussed above, exposure to some manmade sounds may increase the risk of ship-strikes of the critically endangered right whale. See Nowacek et al., Right Whales Ignore Ships, 271 Proceedings of the Royal Society of London, Part B: Biological Sciences at 227.

In short, the Navy must (a) consider cumulative impacts on species other than marine mammals, such as fish and sea turtles, (b) evaluate the potential for cumulative impacts on populations that would occur on and near the range, (c) assess the potential for synergistic adverse effects, as from noise in combination with ship-strikes,[141] (d) properly assess the long-term cumulative impacts of the activities actually covered by the DEIS (see above at section II(B)(3)), and (e), even if (contrary to reason) the Navy finds that the long-term impacts of the range itself are likely to be small, consider whether individual naval exercises and other activities could combine with the USWTR's impacts to produce a significant effect.

F. Distribution and Abundance of Marine Mammals

A core element of the DEIS is its assessment of the distribution and abundance of marine mammal species at each of its proposed sites. Careful assessment is essential not only for meeting the Navy's responsibility, under NEPA, to objectively describe the environment affected by the range, but also for evaluating the USWTR's impacts on marine wildlife and for conducting an analysis of alternatives. But the treatment of distribution and abundance in the DEIS is flawed in several respects.

1. General Methodology

As with its impact analysis, the Navy appears to disregard a substantial amount of relevant material largely in favor of a few internal reports. DEIS at 3.3-7. The extent to which those reports rely on the primary literature is not clear. In general, however, the accounts of individual species set forth in the DEIS omit relevant sources and contain a substantial amount of outdated information. See DEIS at 3.2-23 to 53. For example, the authors do not seem to use the most recent NMFS stock assessments (a standard reference) or many of the relevant databases maintained by private institutions (such as the New England Aquarium) in estimating species density. Id. And in assessing species distribution, the Navy appears to rely primarily on data from CeTAP (Cetacean and Turtle Assessment Program) surveys, which are more than 20

[141] The 2004 Report of the IWC's Scientific Committee emphasizes the importance of evaluating the synergistic impacts of ocean noise and other stressors, such as toxins. IWC, 2004 Report of the IWC Scientific Committee, Annex K at § 6.4 and App. 2 (noting studies of terrestrial animals that demonstrate significant adverse synergistic effects).

years old. DEIS at 3.3-8 to 9. Given NMFS' bias against distribution and abundance data older than 8 years, it is all the more essential for the DEIS to take more recent information into account.[142]

It is not clear from the DEIS whether the Navy has undertaken any original surveys within the sites it has proposed, particularly for ESA-listed species such as the right whale and sperm whale and for especially vulnerable species such as beaked whales. Certainly the Navy's long-term investment in the range makes accuracy in this matter crucial. Indeed, NEPA requires the agency to obtain such information for the EIS, given that the costs of obtaining it are not exorbitant (relative to the costs of the USWTR) and the means of obtaining it are known. 42 C.F.R. § 1502.22(a). Meanwhile, the Navy should release its internal distribution and abundance reports to the public, for further review.[143]

2. Species Accounts

The Navy's accounts of individual species reflect the flaws in methodology described above. Among the species whose estimates must be revised:

a. Northern Right Whales

The Navy concludes that right whales will rarely if ever occur within the offshore areas proposed for the USWTR (e.g., DEIS at 3.2-23 to 24), but such a statement is based on little empirical evidence. In fact, little effort has been made to survey right whales outside their critical habitat, particularly in the southeastern United States, and what evidence is available suggests a different story. Right whales have been sighted well offshore, as far as 140 miles in one study, and tagged whales have been found to range more frequently offshore than the sightings record would indicated.[144] There are numerous reports in the scientific literature and in the popular press of right whales ranging into unusual areas, including the

[142] P. Wade and R. Angliss, Report of the GAMMS Workshop (1997) (NOAA Tech. Memo NMFS-OPR-12).

[143] It should also be noted that the Navy provides no detailed information on the factors it used for dive-time correction, making public comment on this point impossible. DEIS at 3.3-8. Using conservative correction factors is particularly vital for calculating abundances of deep-diving animals such as beaked whales and sperm whales, which are among the species most vulnerable to the impacts of high-intensity active sonar. Analogously, it is not clear how the Navy compensates in its analysis for lack of offshore survey effort outside the summer months.

[144] A. Knowlton, J. Beaudin-Ring, and B. Russell, Right Whale Sightings and Survey Effort in the mid-Atlantic Region: Migratory Corridor, Time Frame and Proximity to Ports (2002) (report submitted to the NMFS Ship Strike Working Group); R. Kenney, C. Mayo, and H. Winn, Migration and Foraging Strategies at Various Spatial Scales in North Atlantic Right Whales: A Review of Hypotheses, 2 Journal of Cetacean Research and Management: Special Issue 251 (2001); B. Mate, S. Nieukirk, and S. Kraus, Satellite Monitored Movements of the North Atlantic Right Whale, 61 Journal of Wildlife Management 1393 (1997).

Carolina coast, at unusual times of year.[145] Given their sightings well offshore in the mid-Atlantic, the preference of some migrating whales for shelf and bank edges, and the rapid travel times of some individuals along the eastern seaboard, it is reasonable to assume that some right whales keep offshore in traveling between the southeast and their feeding grounds in the north.[146] Indeed, it has been noted that one of the whales' routes may lie along the shelf break, which runs through the North Carolina operations area.[147]

The Northern right whale is a critically endangered species that numerous parties, including the Navy itself, have worked to save from extinction. It is incumbent on the Navy to take a conservative approach in evaluating potential impacts on the species from the USWTR project.

b. Marine Mammals Not Expected to Occur at the North Carolina Site

In its treatment of Site A (North Carolina), the Navy virtually excludes a number of species from risk analysis on the basis of an incomplete review of the existing data.[148] For example, it improperly excludes: sei whales, which the North Carolina Department of Transportation, U.S. Fish and Wildlife Service, and NMFS have all concluded occurs off the coast of North Carolina;[149] pygmy killer whales, which, according to NMFS, has been sighted just east of Cape Hatteras;[150] melon-headed whales, which NMFS sighted just east of Cape

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[145] See, e.g., A. Jensen and G. Silber, Large Whale Ship Strike Database (2003) (NOAA Tech. Memo NMFS-OPR-25). Just yesterday (12 January 2006), a right whale was reported 60 miles off Cape Lookout, North Carolina—well within the Cherry Point operations area. NOAA, "Northeast U.S. Right Whale Sighting Advisory System (SAS)," rwhalesightings.nefsc.noaa.gov (accessed 12 Jan. 2005).

[146] Kenney et al., Migration and Foraging Strategies, 2 Journal of Cetacean Research and Management at 251; Mate et al., Satellite Monitored Movements, 61 Journal of Wildlife Management at 1393.

[147] Kenney et al., Migration and Foraging Strategies, 2 Journal of Cetacean Research and Management at 251.

[148] Our comments in this subsection focus on the North Carolina site, since this is the one preferred by the Navy; however, many of the same comments are applicable to species at the Navy's two alternatives sites as well.

[149] See North Carolina Department of Transportation, "Geographic Information Systems," www.ncdot.org/it/gis/facts.html (accessed 11 Jan. 2005); U.S. Fish and Wildlife Service, "Endangered and Threatened Mammals in North Carolina," nc-es.fws.gov/mammal/mammal.html (accessed 11 Jan. 2005); NMFS Southeast Regional Office, Biological Opinion: The Continued Hopper Dredging of Channels and Borrow Areas in the Southeastern United States.5 (1997). By contrast, NMFS considers the CeTAP data for sei whales on which the Navy relies to be outdated. G.T. Waring, R.M. Pace, J.M. Quintal, C.P. Fairfield, and K. Maze-Foley, U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments—2003 at 28 (2004) (NMFS-NE-182).

[150] Waring et al., U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments—2003 at 46. The DEIS itself acknowledges strandings and sightings that have occurred in the vicinity of the proposed range. DEIS at 3.2-35.

Hatteras on its 1999 and 2002 surveys;[151] Fraser's dolphins, which NMFS sighted east of Cape Hatteras in 1999;[152] and striped dolphins, which are reported by NMFS to occur south to Jamaica and which, like right whales, have been sighted near warm core rings in the Gulf Stream.[153] Since most of these species tend to keep offshore where survey effort is relatively low, a conservative approach to determining their distribution is essential.

There are a number of other species, moreover, that the Navy improperly concludes would occur only at certain times of year. For example, it states that fin whales would not appear outside the winter months, despite their occurrence in other seasons less than 70 kilometers from the border of the proposed site and their known capacity for ranging widely;[154] and it holds, based on NMFS surveys, that clymene dolphins would appear only in summer, ignoring the fact that survey data are unavailable for any other months and that the species is considered common.[155] Finally, the Navy assumes that humpback whales in the vicinity of the North Carolina site would "undoubtedly be migrating animals" and that any humpbacks feeding in the area would keep well inshore. DEIS at 4.3-45. In fact, none of the studies cited for these propositions conducted surveys beyond a few miles from shore; on the contrary, one study even suggests that some juveniles are overwintering in the area, presenting a risk of offshore movement that the Navy must assess.[156]

c. Marine Mammal Stocks

In general, information on the size and structure of marine mammal populations is meager. Populations are frequently defined in terms of geography, not biology, meaning, for example, that some species off the southeast coast of the United States are not broken down into smaller, local units but are treated collectively by NMFS as part of one broad northwest Atlantic stock. Of course the Navy is

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[151] Waring et al., U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments—2003 at 48. NMFS noted that "the paucity of sightings [of melon-headed whales] is probably due to naturally low abundance compared to other cetacean species." Id.

[152] Id. at 84. As with melon-headed whales, NMFS noted that "the paucity of sightings [of melon-headed whales] is probably due to naturally low abundance compared to other cetacean species." Id.

[153] G.T. Waring, C.P. Fairfield, C.M. Rusham, and M. Sano, Cetaceans Associated with Gulf Stream Features off the Northeastern USA Shelf (1992) (ICES C.M. 1992/N:12 Marine Mammals Committee, Ref. C). The potential development of warm core rings in the vicinity of the proposed range—and the consequences for marine mammal distribution—should be assessed in the EIS.

[154] Waring et al., U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments—2003 at 24.

[155] Id. at 82.

[156] W.M. Swingle, S.G. Barco, T.D. Pitchford, W.A. McLellan, and D.A. Pabst, Appearance of Juvenile Humpback Whales Feeding in the Nearshore Waters of Virginia, 9 Marine Mammal Science 309 (1993); D.N. Wiley, T.D. Pitchford, and D.P. Gannon, Stranding and Mortality of Humpback Whales, Megaptera novaeangliae, in the Mid-Atlantic and Southeast United States, 1985-1992, 93 Fishery Bulletin 196 (1995).

required to identify uncertainties about populations in the area, to obtain relevant data except where infeasible, and to evaluate population size and structure in light of the incomplete information. 42 C.F.R. § 1502.22. For at least one species, however, it is clear that relevant data have been omitted from the Navy's analysis. NMFS currently manages bottlenose dolphins off the southeast coast of the United States as a group of stocks with overlapping distributions. For example, at least three management units off North Carolina could fall within the vicinity of the proposed range.[157] The Navy must calculate the potential for impacts on each of these discrete ecotypes.

G. Species Excluded from Risk Analysis

Under NEPA, the Navy is responsible for assessing and mitigating the reasonably foreseeable impacts of its project on marine species. 42 C.F.R. § 1502.22. For some species, however, including several that are listed under the Endangered Species Act, it does not engage in any such analysis; rather, it improperly screens them from evaluation at the outset, so that their exposure to potentially harmful levels of sound (and to some other stressors as well) goes unmodeled. Yet, in each of the following cases, the Navy's rationale for excluding them does not stand up against the scientific record.

1. Pinnipeds are excluded on the grounds that the four species known to the northwest Atlantic, gray, harbor, harp, and hooded seals, occur well north of Virginia and thus would not find themselves near any of the three proposed sites. DEIS at 3.3-5. In fact, according to NMFS' most recent stock assessments, the harbor seal is occasionally distributed in the Carolinas and can occur as far south as Florida; the harp seal, although concentrated further north, has stranded as far south as North Carolina; and the hooded seal, which tends to range farther and into deeper water than some other pinnipeds, has increasingly been seen between Maine and Florida, indicating perhaps a shift in seasonal distribution or an expansion southward of the species' primary range.[158] Under these circumstances, an assessment of environmental impacts on pinnipeds is required.

2. Manatees are generally excluded from analysis because they tend to occupy shallow inshore and near-shore habitat and thus would "lie outside the operational range of the USWTR." DEIS at 3.3-5. Consideration is given only to the impacts of cable installation, which, depending on the choice of site, could occur precisely in the seagrass habitat that manatees prefer. DEIS at 4.6-11. Yet the Navy is obliged to consider impacts from other project activities, such as increased vessel traffic, that could take place in manatee habitat. And it must evaluate the potential for acoustic impacts given that manatees are occasionally sighted offshore and that sound from

[157] See Waring et al., U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments—2003 at 86. In this respect, the Navy's reliance on a 1990 study is outdated.

[158] Id. at 103, 118, 121, 123.

intense mid-frequency sources can travel considerable distances underwater.[159] To this end, at the very least, a propagation analysis should be performed—and disclosed—indicating levels of sound that might be received in the manatee's near-shore habitat under a variety of assumed conditions, such as surface ducting, and topographies.[160] The manatee, like the right whale, is a badly imperiled species. According to NMFS, the U.S. Fish and Wildlife Service has "consistently concluded in Section 7 Biological Opinions, pursuant to the Endangered Species Act, that the take of a single manatee would "jeopardize the continued existence" of the species."[161] For the Navy to shirk its analysis of the species before embarking on a project with the potential for significant, long-term impacts, let alone a single "take," is not justifiable.

3. Sea turtles are excluded from further analysis of acoustic impacts on the grounds that their best hearing range appears to occur below 1 kHz. DEIS at 3.3-4 to 5. But having their best acoustic sensitivity in this range does not mean that sea turtles are oblivious to noise at higher frequencies. Juvenile loggerheads, for example, have their best sensitivity at frequencies all the way up to 1 kHz, suggesting that they continue to detect sounds at higher levels, including potentially the lower end of the intense mid-frequency sources intended for the range.[162] Furthermore, they have been shown to engage in startle and escape behavior—behavior that may involve diving and surfacing—and to experience heightened stress in response to vessel noise, which receives no discussion (neither for sea turtles nor for any other species) in the DEIS.[163] Given these findings, and given that all of the sea turtles on the proposed sites belong to endangered or threatened populations, a more rigorous analysis of potential impacts is necessary.[164]

4. The DEIS excludes invertebrates from further analysis because, according to the Navy, they lack organs and tissues whose acoustic impedance differs significantly from water (and therefore, presumably, would not be susceptible to injury) and because no data are available showing acoustic capabilities in these species above 1

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[159] See, e.g., Commerce and Navy, Joint Interim Report at 34, 36 (showing propagation of mid-frequency sonar above 160 dB in near-shore environment).

[160] As noted above at section II(B)(3)(c), the Navy has not considered the propagation of its signal beyond 1 km from a source.

[161] Waring et al., U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments—2003 at 280.

[162] S.M. Bartol, J.A. Musick, and M. Lenhardt, Auditory Evoked Potentials of the Loggerhead Sea Turtle (Caretta caretta), 99 Copeia 836 (1999).

[163] National Research Council, The Decline of Sea Turtles: Causes and Prevention (1990).

[164] According to the North Carolina Wildlife Resources Commission, the Navy has significantly underestimated the importance of Onslow Bay, particularly for post-nesting turtles. Memorandum from Steven H. Everhart, Southeastern Permit Coordinator, North Carolina Wildlife Resources Commission, to Melba McGee, Office of Legislative and Intergovernmental Affairs, North Carolina Department of Environmental Resources 3-4 (Dec. 12, 2005) (citing several sources).

kHz. DEIS at 3.2-2 to 3. Both claims rest on summary argument that ignores the available record, which, to the contrary, suggests that invertebrates are vulnerable to impacts from acoustic sources. The fact is that marine mammal echolocation has been shown to directly injure invertebrates, raising the question of whether lower-frequency sources can do the same.[165] And the sweeping conclusion in the DEIS that invertebrates are insensitive to noise in the mid-frequencies is baseless. An audiogram is available for only one invertebrate species (the American lobster), which indeed shows relative insensitivity to sounds above several hundred Hertz;[166] but to argue, on this account, that other invertebrates cannot detect mid-frequency sound is rather like claiming that humans cannot not hear well above 10kHz because salmon, another vertebrate species, cannot.

It has recently been observed that many species of invertebrates possess mechanosensors that bear resemblance to vertebrate ears, making it "important to examine the effect of anthropogenic sounds on a wider range of marine fauna."[167] Impacts have already been observed in a number of species: giant squid, which twice now have stranded in numbers in the vicinity of airgun surveys; brown shrimp, whose growth and reproduction were retarded from being raised in a noisy environment; and snow crabs, which, in some preliminary research, showed signs of ovary and liver damage on exposure to airgun noise.[168] The proper approach under NEPA is to acknowledge the lack of necessary data and to either obtain it (if the cost of doing so is not exorbitant) or to conduct a risk assessment based on methods generally accepted by the scientific community. 42 C.F.R. § 1502.22.

5. Seabirds are dismissed from further analysis for reasons that do not bear up to any serious scrutiny. First, the Navy argues, seabirds are excludable because there is no evidence that the species use sound underwater (DEIS at 3.3-6); yet this consideration has no bearing on whether injury, temporary hearing loss, or some types of behavioral disruptions would occur. Second, they are excluded because, in theory, they could "rapidly disperse" to other areas if disturbed (id.); yet the birds'

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[165] See K. Norris and B. Møhl, Can Odontocetes Debilitate Prey with Sound? 122 The American Naturalist 85 (1983).

[166] G.C. Offutt, Acoustic Stimulus Perception by the American Lobster, Homarus americanus (Decapoda), 26 Experientia 1276 (1970).

[167] A.N. Popper, Effects of Anthropogenic Sounds on Fishes, 28(10) Fisheries 24, 30 (Oct. 2003).

[168] A. Guerra, A.F. Gonzalez and F. Rocha, A Review of Records of Giant Squid in the North-Eastern Atlantic and Severe Injuries in Architeuthis dux Stranded after Acoustic Exploration (2004) (paper presented to the Annual Science Conference of the International Council for the Exploration of the Sea, Vigo, Spain, 22-25 Sept. 2004) (giant squid); J.P. Lagardère, Effect of Noise on Growth and Reproduction of Crangon crangon in Rearing Tanks, 71 Marine Biology 177 (1982) (brown shrimp); Fisheries and Oceans Canada, Potential Impacts of Seismic Energy on Snow Crab (2004) (Maritime Provinces Regional Habitat Status Report 2004/Draft) (snow crab). See also R.D. McCauley, J. Fewtrell, A.J. Duncan, C. Jenner, M.-N. Jenner, J.D. Penrose, R.I.T. Prince, A. Adhitya, J. Murdoch, & K. McCabe, Marine Seismic Surveys: Analysis and Propagation of Air-Gun Signals, and Effects of Air-Gun Exposure on Humpback Whales, Sea Turtles, Fishes, and Squid 185 (2000) (squid)

> ability to flee does not eliminate the risk of injury and hearing loss, and their abandonment of a feeding area would itself constitute an acoustic impact, the significance of which would depend in part on the duration and degree of displacement. Seabirds occur at the three proposed sites, dive underwater (in some cases to depths of hundreds of feet), and are sensitive to same frequencies used by the Navy's acoustic sources. They must receive further analysis in the EIS, both for the direct impacts they may suffer on exposure to the Navy's sources and for the impacts they may incur indirectly through depletion of prey species and hard bottom habitat. 42 C.F.R. § 1502.16(a), (b).[169]

Without further consideration of these species, the Navy's review is incomplete.

H. Alternatives Analysis

At bottom, an EIS must "inform decision-makers and the public of the reasonable alternatives which would avoid or minimize adverse impacts or enhance the quality of the human environment." 40 C.F.R. § 1502.1. This requirement has been described in regulation as "the heart of the environmental impact statement." Id. § 1502.14. The agency must therefore "[r]igorously explore and objectively evaluate all reasonable alternatives, and for alternatives which were eliminated from detailed study, briefly discuss the reasons for their having been eliminated." Id. § 1502.14(a). Consideration of alternatives is required by (and must conform to the independent terms of) both sections 102(2)(C) and 102(2)(E) of NEPA.

Here, the DEIS presents four alternatives for full review: three alternative locations for the range (the preferred site off North Carolina, a site off Virginia, and a site off northern Florida) and the no-action alternative. DEIS at 2-1. There are at least two broad problems, however, with its approach.

1. Identification of alternative sites

> The Navy's methodology for identifying alternative locations for the range was flawed in ways that resulted in the omission of reasonable sites from its analysis. As the DEIS makes clear, the Navy's first step in its three-step site selection process—namely, the identification of areas that would meet the operational requirements of the East Coast Fleet commands with respect to geographic area and water depths—resulted in a very broad array of choices along the East Coast and in the Gulf of Mexico. These choices included the Gulf of Maine; an offshore area stretching from

[169] Notably, the Navy's list of coastal and offshore seabirds around the North Carolina site is incomplete and omits a number of species, such as the northern gannet, common loon, red-throated loon, horned grebe, and Bermuda petrel (the last an endangered species), that would occur in the vicinity of the range. Memorandum from Steven H. Everhart to Melba McGee at 2 (citing various sources). Given these gaps in the Navy's synthesis of the distributional literature, we expect that similar errors have been made in connection with the proposed Florida and Virginia sites.

New Jersey to the Chesapeake Bay; an offshore area stretching along almost the entire Southeastern coast from North Carolina to Cape Canaveral, Florida; and an area of the Gulf of Mexico stretching from Louisiana to Florida. DEIS at 2-15 to 2-16.[170]

But the DEIS tells the public very little about why most of these areas were eliminated from further consideration. For example, in eliminating the Gulf of Mexico site, the DEIS states only that it is not "proximate" to existing Fleet homeports and would result in "lengthy" transit times, without defining or quantifying these terms. DEIS at 2-16. The DEIS excludes other sites for reasons that are even less defined, *e.g.*, by stating that "[i]n each region a candidate site or sites were identified. These sites were iteratively determined through consideration of one or more of the factors outlined below [where the reference to "factors outlined" is unclear]." DEIS at 2-17.

What information the DEIS does include indicates that factors of convenience dominated the decision about which candidate sites to pursue as NEPA alternatives. In explaining how it whittled the many operationally appropriate areas down to five small candidate sites for analysis, the DEIS states that "[p]rogram cost considerations were important factors in the analysis, as such costs would clearly be minimized by selecting a site that was both as close to shore as possible and in proximity to a secure federal facility." DEIS at 2-17. In choosing its three final alternatives from among these five coastal sites, the Navy weighed factors such as proximity to airfields and shore property "free of acquisition costs." DEIS at 2-19 to 2-20. From among these three final alternatives, the North Carolina site was selected as the Navy's preferred alternative because of airfield proximity, good weather, convenient shore landing site, and proximity to Navy fleet areas. DEIS at 2-22. <u>At no point in the site selection process described in the DEIS were impacts to marine resources considered</u>. DEIS at 2-15 to 2-22.

Not all of the factors of convenience and cost cited in the DEIS seem crucial enough to justify their wholesale dictation of location for the range. The DEIS makes clear, for example, that specialized recovery boats or, in their absence, surface combatants are the vessels immediately engaged in on-water recovery operations. Under these circumstances, siting of the USWTR within easy range of helicopters for on- and off-loading might work to the convenience of the Navy but is not necessary.[171] The same is true of the Navy's third rubric, that the range be located near a landing site currently owned by the federal government. DEIS at 2-19 to 2-20.

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[170] Given the presence of shelf land along the eastern seaboard, it is not clear why additional areas would not also meet the Navy's bathymetric criterion.

[171] Tellingly, airfield proximity was not included along with homeport proximity as a constraining factor in the initial screening for candidate sites. DEIS at 2-15.

More importantly, factors of mere convenience and cost alone cannot dictate an agency's choice of alternatives to evaluate in an EIS. An agency must discuss all reasonable alternatives—those that will accomplish the purpose and need of the agency and are practical and feasible—not simply those it finds most convenient. 40 C.F.R. § 1502.14. "The primary purpose of the impact statement is to compel federal agencies to give serious weight to environmental factors in making discretionary choices." I-291 Why? Ass'n v. Burns, 372 F.Supp. 233, 247 (D.Conn. 1974). If an agency is permitted to consider and compare the environmental impacts of its proposed action with only other, equally convenient alternatives—and permitted to omit from such analysis any alternatives that are less convenient, no matter that they might result in significant environmental benefits—this purpose would be thwarted.

In this case, for example, posit the existence of a location for the sonar range that meets the operational requirements of the Atlantic Fleet with respect to geography and bathymetry, according to the Navy's own analysis. Then assume that the location would be vastly safer for marine life than the three action alternatives presented in the DEIS, perhaps because marine life is less abundant there.[172] Under the analysis used by the Navy to select its three action alternatives, such a location could easily have been omitted simply because it was slightly further from convenient airfields or would require a marginally more expensive transit from the shore. Such a result is not permissible under NEPA; indeed, NEPA's EIS requirement is aimed precisely at ensuring that policy-makers and the public are aware of such potential trade-offs and environmental benefits before discretionary decisions are made. Trout Unlimited v. Morton, 509 F.2d 1276, 1282 (9th Cir. 1974).

Carefully siting the range to avoid concentrations of vulnerable and endangered species and high abundances of marine life is the most critical step the Navy can take in reducing the environmental impacts of this range. Because the Navy has failed to undertake an alternatives analysis that allows it to make an informed siting choice, the DEIS is inadequate and must be withdrawn.

2. Other reasonable alternatives

Even aside from the omission of reasonable alternative locations, the DEIS fails to consider any alternatives beyond alternative sites. While the question of proper siting is crucial, it is not the only factor that must be considered in identifying other, less harmful ways to fulfill the Navy's purpose. Indeed, it appears that many reasonable alternatives are missing from the Navy's analysis that might fulfill that purpose while reducing harm to marine life and coastal resources. For example:

[172] The DEIS recognizes, for example, that beaked whales are not consistently distributed along the Atlantic slope. DEIS at 3.2-40. This fact suggests that beaked whales, which are the type of whale perhaps most vulnerable to harm from mid-frequency sonar, might be avoided through proper siting. But the Navy has taken no account of such facts in choosing its three action alternatives.

a. The DEIS fails to analyze meaningfully whether a mix of simulators and at-sea exercises would accomplish its aims. Instead, it rules out the use of simulators by stating, in a cursory three sentences, that they do not obviate the need for realistic training. DEIS at 2-3. But its summary treatment of this issue does not sufficiently justify the precise number of exercises that have been proposed: that is, 161 exercises per year, as opposed to 120 or 80. Alternatives that combine greater use of simulators with fewer open-water exercises should have been analyzed, not dismissed out of hand.[173]

b. The DEIS fails entirely to consider seasonal restrictions on the use of the range. Instead, all three action alternatives propose year-round use of high-intensity sonar, "with events evenly distributed across all four seasons" and without regard to seasonal variations in marine mammal and fish abundance. DEIS at 2-11. This is true despite the well-documented seasonal migration of one of the most endangered whale species, the North Atlantic right whale, along the Virginia and North Carolina sites, and despite the proximity of the Florida site to the species' winter calving ground. Studies have shown that right whales engage in dramatic surfacing behavior—increasing their exposure to ship strikes—in response to mid-frequency and low-frequency signals, and that great whales may abandon their own calving or breeding grounds when various types of manmade noise begin to occupy the area.[174] Yet the DEIS fails even to consider the feasibility of avoiding these seasonal migrations, or any other seasonal variation in marine life abundance. This omission is plainly unacceptable.

c. The DEIS fails to include a range of mitigation measures among its alternatives. Many such measures are employed by other countries in their sonar exercises and even by the U.S. Navy in other contexts, as discussed below at section II(I); and there are many others that should be considered. Such measures are reasonable means of reducing harm to marine life and other resources on the proposed range, and their omission from the alternatives analysis renders that analysis inadequate.[175]

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[173] As discussed above, the fact that the Navy has crafted its Purpose and Needs statement so as to preclude serious consideration of the use of simulators does not relieve the Navy of the obligation to consider this alternative; indeed, the law is precisely to the contrary. The exclusion of reasonable alternatives such as this one from the scope of the Navy's Purpose and Needs statement renders that statement inadequate. See supra at II(A) and City of Carmel-by-the-Sea v. United States Dep't of Transp., 123 F.3d 1142, 1155 (9th Cir. 1997).

[174] See, e.g., Nowacek et al., North Atlantic Right Whales, 271 Proceedings of the Royal Society of London, Series B: Biological Sciences at 227-31 (right whales); Weller et al., Influence of Seismic Surveys; Jones et al., Census of Gray Whale Abundance in San Ignacio Lagoon; Bryant et al., Reoccupation of Laguna Guerrero Negro at 375-386; Richardson et al., Marine Mammals and Noise at 267.

[175] In this respect, the DEIS stands in contrast to a draft EIS recently published by the Navy analyzing the use of another type of high-intensity active sonar known as SURTASS LFA (or LFA). See Navy, Draft Supplemental Environmental Impact Statement for SURTASS LFA Sonar (2005). That Draft EIS analyzes five alternatives and includes, within those alternatives, consideration of a variety of mitigation measures for the use of LFA sonar, including seasonal variations, visual monitoring for marine mammals and sea

In sum, the DEIS shortchanges or omits from its analysis reasonable alternatives—with regard to both the siting of the range and other operational choice—that might achieve the Navy's core aim of training its Atlantic Fleet forces in the use of sonar while minimizing environmental harm. These omissions are all the more unreasonable given the long period during which the Navy has worked on this DEIS, which appears to have been in process for nine years. See 61 Fed. Reg. 22028 (May 13, 1996) (notice of intent to prepare DEIS). For these reasons, we urge the Navy to withdraw its DEIS or to issue a supplemental EIS that adequately informs the public of all reasonable alternatives that would reduce adverse impacts to whales, fish, and other resources. 40 C.F.R. § 1502.1.

I. Mitigation Measures

To comply with NEPA, an agency must discuss measures designed to mitigate its project's impact on the environment. See 42 C.F.R. § 1502.14(f). There is a large and growing set of options for the mitigation of noise impacts to marine mammals and other marine life, some of which have been imposed by navies—and by the Navy itself, in other contexts—to limit harm from high-intensity sonar exercises. Yet here the Navy does little more than set forth a cribbed set of measures, falling short even of what other navies have implemented for transient exercises and providing no discussion on a variety of other options. Instead, it seems to take the position that by applying for an MMPA Letter of Authorization from NMFS for its activities on the range, it will satisfy its duties with respect to the protection of marine mammals. But deferral to NMFS does not satisfy the Navy's independent duty under NEPA to consider mitigation.

The mitigation for acoustic impacts proposed by the Navy boils down to the following: (1) Visual monitoring for marine mammals by non-dedicated Navy personnel (i.e., personnel with other responsibilities as well) prior to and during exercises; (2) reduction of active sonar power levels by 6 dB re 1 μPa when whales or dolphins are detected within 320 meters of the sonar source, with normal operations resuming as soon as Navy personnel assess that the marine mammal has left this 320 meter zone; and (3) for sonar dipping helicopters only, the cessation of active sonar use when sea turtles or marine mammals are detected within 200 yards of the source. DEIS at 6-2 to 6-3. In addition, the DEIS considers but rejects, in a one-page discussion, the use of ramp-up, third-party visual observers, and acoustic monitoring using the range's network of acoustic nodes. DEIS at 6-4 to 6-5.

This mitigation scheme, which places all of its faith in visual monitoring, disregards the best available science on the significant limits of that technique. Even under ideal conditions, only about 33 percent of right whales already known to occupy an area would be detected visually; only 11 percent of right whales would be detected more than a mile-

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turtles, passive acoustic monitoring for marine mammals, active acoustic monitoring, and shutdown procedures. Id. at 2-10 to 2-14.

and-a-half from the platform.[176] Moreover, the species perhaps most vulnerable to acoustical injuries, beaked whales, are among the most difficult to detect because of their small size and diving behavior. It has been estimated that in anything stronger than a light breeze, only one in fifty beaked whales surfacing in the direct track line of a ship would be sighted.[177] These limits adhere even when the observers are marine biologists assigned only to the task of wildlife monitoring. Sighting rates will only decrease with non-biologist observers whose attention is divided between several mission tasks, as the Navy proposes. The Navy's reliance on visual observation as the sole mainstay of its acoustical mitigation plan is therefore profoundly misplaced.

The mitigation analysis ignores or improperly discounts an array of options that have been considered and imposed by other active sonar users, including seasonal restrictions on operations;[178] shutdown procedures when whales enter the safety zone (rather than the mere power down by 6 dB that the Navy has proposed); the employment of a safety zone far more protective than the 320 meters proposed by the Navy; passive acoustic monitoring for whales; aerial and small-boat surveys for marine mammals; monitoring and shutdown procedures for large schools of fish; and many others.

The NATO Undersea Research Centre (NURC), for example, requires the following measures for the protection of marine mammals during active sonar use:

- Sonar test sites be selected only after an environmental assessment has considered known marine mammal habitat and predicted noise propagation;
- Sonar test sites be selected based on the findings of that environmental assessment and so as to avoid enclosed areas and coastal areas with complex, steep sea bed topography;
- Once a site is chosen, tracks be planned to provide mammal escape routes and avoidance of embayment;
- Trained lookouts, passive acoustic monitoring systems, and, when available, aircraft/helicopters be used to ensure the area is clear of marine mammals before energizing the sound source and during operations;
- Sound sources be "ramped up" gradually from 150 dB re 1 μPa at 1 meter, or from lowest possible setting if higher than that;
- Sound sources be kept as low as possible consistent with mission demands;

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[176] J.W.W. Hain, S.L. Ellis, R.D. Kenney, and C.K. Slay, Sightability of Right Whales in Coastal Waters of the Southeastern United States with Implications for the Aerial Monitoring Program, in G.W. Garner, S.C. Amstrup, J.L. Laake, B.F.J. Manley, L.L. McDonald, and D.G. Robertson, Marine Mammal Survey and Assessment Methods 191 (1999). Right whales are among the easiest marine mammals to detect.

[177] J. Barlow and R. Gisiner, Mitigation and Monitoring of Beaked Whales During Acoustic Events, Journal of Cetacean Research and Management (in press) (number cited is based on draft text).

[178] Clearly some seasons are more problematic than others at certain sites for certain species of concern. Off North Carolina, for example, the winter months come with a greater abundance of several species considered vulnerable by the Navy, including humpback whales and right whales.

- Operations be suspended if marine mammals enter the safety zone or, in the case of endangered species or Cuvier's beaked whales, enter within twice the safety zone, which for large whales is defined to be the area ensonified to 160 dB re 1 μPa at 1 meter;
- All sightings and acoustic identifications recorded be reported to NATO on a standard sighting report form; and
- A marine mammal incident action team be ready to respond quickly and appropriately to potential incidents of injury. [179]

These measures, according to NURC, "represent the minimum precautions that must be observed" to address risks to marine mammals from sonar.[180]

The Australian Navy also goes much further than the Navy in its training protocols and, in doing so, demonstrates the practicability of these methods. When training with one of the same active sonar systems planned for use on the proposed range, SQS-56, Australia requires seasonal and geographic restrictions on the use of the system at its highest power levels; use of lower power levels in conditions that may produce surface ducting and within certain geographic conditions such as shallow marine embayments; pre-operational and operational monitoring of a much larger safety zone (4000 yards) than the Navy considers; and mandatory shut-down of sonar transmissions if a whale is sighted within that safety zone.[181]

Remarkably, these mitigation procedures were devised for transient exercises, not for exercises in an established installation, where both the opportunities for mitigation and the risk of environmental harm are greater. The only Navy proposal that addresses the problem of long-term risk is its "conservation measures," essentially a wildlife survey program, which, important as it may be, has no explicit charge for reducing the USWTR's environmental damage. DEIS at 6-5. The Navy must consider mitigation options that get at this problem. For example, it must thoroughly assess the options for real-time passive acoustic monitoring on the range, and review operational restrictions that would apply if certain restrictions are met.[182] Furthermore, it must consider research and development of engineering solutions as a long-term mitigation measure. In Europe, the Norwegian and Dutch navies have begun to experiment with the characteristics of their mid-frequency systems, endeavoring to find an alternative that would prove less

[179] See NURC, NATO URC Human Diver and Marine Mammal Risk Mitigation Rules, Staff Instruction 77 at § 4-6 and Ann. B (May 10, 2004).

[180] Id. at § 3.

[181] See Royal Australian Navy "Maritime Exercise Areas Environmental Management Plan," Procedure S-1 (June 9, 2004).

[182] Passive acoustic monitoring is required of seismic survey vessels in some waters off the United Kingdom and of the U.S. Navy's in operating its SURTASS LFA system. Joint Nature Conservation Committee, Guidelines for Minimising Acoustic Disturbance to Marine Mammals from Seismic Surveys § 4.1 (2004); Navy, Overseas Environmental Impact Statement and Environmental Impact Statement (SURTASS LFA) at 2-14 to 2-21.

hazardous to beaked whales.[183] In the United States, an expert panel, commissioned by the Office of Naval Research, advised the Navy to explore the use of complex waveforms that would retain Doppler sensitivity but produce lower peak amplitudes.[184] And it is our understanding that a number of engineering solutions are currently being exhibited on the technology market. Long-term environmental planning is an important element of the Defense Department's operations on land. The fact that the USWTR would be located off the coast does not make long-term mitigation any less critical.

The mitigation measures offered by the Navy to address other environmental risks, such as the risk of ship strikes, fare no better. For protection of right whales, the Navy relies on ship-strike measures that it has adopted for near-shore areas of the mid-Atlantic; but, as noted above at section II(B)(4)(a) ("Other Impacts on Marine Mammals"), there is a good deal of controversy over the efficacy of these rules. And the proposed measures appear to take no account of the additional risk posed by the use of active acoustics, since right whales have been shown to engage in dramatic surfacing behavior, increasing their vulnerability to ship strikes.[185] It should also be noted that the shore-to-range transits contemplated by the Navy (DEIS at 4.2-13) would run perpendicular to any near-shore migration, posing a further risk of collision.

The Navy's proposal for protecting endangered sea turtles from landside construction is likewise lacking. Though admitting that the endangered turtles nest seasonally on the beach where construction is planned, DEIS at 6-8, the Navy does not consider avoiding the nesting season but instead simply assures the public that construction will occur during the day, in the presence of someone "knowledgeable in sea turtle nesting," and with workers who have been told that harming endangered species is against the law. Id. The DEIS's conclusion that these spare measures "would eliminate the potential for adverse effects on sea turtles" is not reasonable. Furthermore, no mitigation is considered, let alone offered, for a variety of impacts that the system may have on the local environment: the damage to hard-bottom habitat from cable construction and from operation of the range; the potential for magnetic disruption of post-nesting sea turtles; the discharge of hazardous materials into the sea. See DEIS at 6-1 to 6-9. The Navy must address these issues in any final document.

Finally, we are disappointed by the Navy's proposal to begin a baseline analysis of marine mammal abundance at the proposed North Carolina site in the fall of 2005. DEIS at 6-6. As discussed elsewhere in this letter, proper siting to avoid significant marine mammal populations is the most important step the Navy can take to reduce harm to marine life from the proposed range. Yet the Navy has apparently selected its preferred

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[183] J.J. Lok, Green Issues Loom Larger in Future Blue-Water Active Sonar Operations, Jane's International Defense Review 44-47 (Aug. 2004).

[184] Levine, Active Sonar Waveform at 27.

[185] Nowacek et al., North Atlantic Right Whales, 271 Proceedings of the Royal Society of London, Part B: Biological Sciences at 227.

site based on a calculus dominated by factors of convenience, without putting significant effort into finding a site where fewer marine mammals and other species will be harmed. See infra at § II.H.1. This DEIS has been in the works since 1996, and the abundance studies now being proposed could and should have been done long before, not after, site selection in order to assure a choice that satisfies both the Navy's need for training and proper protection of our marine resources. Looking for marine mammals only after the Navy has decided upon its preferred site upends the goals of NEPA and shows, once again, the nature of this document as a post hoc rationalization of a choice already made.

J. Project Description and Meaningful Public Disclosure

Disclosure of the specific activities contemplated by the Navy is essential if the EIS process is to be a meaningful one. See, e.g., LaFlamme v. F.E.R.C., 852 F.2d 389, 398 (9th Cir. 1988) (noting that NEPA's goal is to facilitate "widespread discussion and consideration of the environmental risks and remedies associated with [a proposed action]").

With regard to noise-producing activities, for example, the Navy must describe source levels, frequency ranges, duty cycles, and other technical parameters relevant to determining potential impacts on marine life. The DEIS provides some of this information, indicating, for example, the nominal source levels of SQS-53 and SQS-56 sonar, which are deployed from surface ships. DEIS at 2-13. But it fails to disclose any information about helicopter dipping sonar (the ALFS system) or the submarine-based sonars that would be used on the range (the BQQ-5 and BQQ-10 systems); and, even with respect to the two hull-mounted systems, refrains from giving any indication of platform speed, pulse length, repetition rate, beam widths, or operating depths—that is, most of the data that the Navy presumably used in modeling acoustic impacts. DEIS at 4.3-36. Without this information, the EIS process will be a charade, with the public guessing at the nature of the activities proposed for their own backyard.

Just as important, the Navy has not released or offered to release any of the modeling systems (CASS/GRAB, MATLAB, MMEM, or the Take Estimation Model) it used to calculate acoustic harassment and injury.[186] These models must be made available to the public, including the independent scientific community, for public comment to be meaningful under NEPA and the Administrative Procedure Act. 42 C.F.R. §§ 1502.9(a), 1503.1(a) (NEPA); 5 U.S.C. § 706(2)(D) (APA). And guidelines adopted under the Data (or Information) Quality Act also require their disclosure. The Office of Management and Budget's guidelines require agencies to provide a "high degree of transparency" precisely "to facilitate reproducibility of such information by qualified third parties" (67 Fed. Reg. 8452, 8460 (Feb. 22, 2002)); and the Defense Department's own data quality

[186] As noted above in section II(F) ("Distribution and Abundance of Marine Mammals"), the internal reports that the Navy relies on almost exclusively in determining species distribution and abundance must be released as well.

guidelines mandate that "influential" scientific material be made reproducible as well.[187] We encourage the Navy to contact us immediately to discuss how to make this critical information available.

K. Scope of Review

The Navy intends to conduct its environmental analysis for the "extraterritorial" portion of the USWTR project, that part which lies outside U.S. territorial waters, under the authority of Executive Order 12114 rather than under NEPA. DEIS at 2-1. Not only is this position on the scope of review inconsistent with the statute (see, e.g., Environmental Defense Fund v. Massey, 968 F.2d 528 (D.C. Cir. 1994) and NRDC v. Navy, No. CV-01-07781, 2002 WL 32095131 at *9-12 (C.D. Cal. Sept. 19, 2002)), but, insofar as it represents a broader policy, it suggests that current operations may likewise be out of compliance. The greater part of the existing VACAPES, Cherry Point, and Jacksonville operations areas are sited beyond the 12nm territorial boundary, within the U.S. Exclusive Economic Zone. See DEIS at Figs. 9, 10, 12. If, as we expect, activities currently taking place within these operations areas, and within the still larger complexes that contain them, have not received their due analysis in a prior environmental impact statement, then the Navy is operating in ongoing violation of NEPA. We therefore would strongly encourage the Navy, for the sake of environmental compliance, to assume a baseline of zero activity on the operations areas and complexes and to conduct an impact assessment and alternatives analysis that address both current and proposed operations there.

L. Compliance with Other Applicable Laws

The Navy has stated its intention to apply for an Incidental Harassment Authorization under the Marine Mammal Protection Act (DEIS at 1-16 to 17). NRDC will submit comments regarding the Navy's application to NMFS under the MMPA at the appropriate time. But other statutes and conventions also apply to the Navy's proposal and include:

1. The Endangered Species Act, 16 U.S.C. § 1531 et seq., which requires the Navy to enter into formal consultation with NMFS or the U.S. Fish and Wildlife Service, and receive a legally valid Incidental Take Permit, prior to its "take" of any endangered or threatened marine mammals or other species, including fish, sea turtles, and birds, or its "adverse modification" of critical habitat. See, e.g.,

[187] Navy, Ensuring the Quality of Information Disseminated to the Public by the Department of Defense: Policy and Procedural Guidance § 3.2.3.1 (Feb. 10, 2003). The Defense Department defines "influential" to mean "that the Component can reasonably determine that dissemination of the information will have or does have clear and substantial impact on important public policies or important private sector decisions"—which is clearly the case here, in the Navy's first NEPA review of mid-frequency sonar exercises. See Ensuring the Quality of Information Disseminated to the Public by the Department of Defense: Definitions § 3 (Feb. 10, 2003).

1536(a)(2); Romero-Barcelo v. Brown, 643 F.2d 835 (1st Cir. 1981), rev'd on other grounds, Weinberger v. Romero-Carcelo, 456 U.S. 304, 313 (1982). While the Navy has indicated it will consult with the National Marine Fisheries Service over two marine mammal species, humpback whales and sperm whales, it appears to exclude others—including, remarkably, the critically endangered Northern right whale—that may also be affected by its proposal. See DEIS at 4.3-45.

2. The Coastal Zone Management Act, and in particular its federal consistency requirements, 16 U.S.C. § 1456(c)(1)(A), which mandate that activities that affect the natural resources of the coastal zone—whether they are located "within or outside the coastal zone"—be carried out "in a manner which is consistent to the maximum extent practicable with the enforceable policies of approved State management programs." The Navy has prepared consistency determinations (see below at section II(M)) but has not indicated its intent to apply to the relevant state coastal agency (or agencies) for review.

3. The Magnuson-Stevens Fisheries Conservation and Management Act, 16 U.S.C. § 1801 et seq. ("MSA"), which requires federal agencies to "consult with the Secretary [of Commerce] with respect to any action authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken" that "may adversely affect any essential fish habitat" identified under that Act. 16 U.S.C. § 1855 (b)(2). In turn, the MSA defines essential fish habitat as "those waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity." 16 U.S.C. § 1802 (10). All three of the proposed sites encompass essential fish habitat, as identified by the South Atlantic Fisheries Management Council, the Mid-Atlantic Fisheries Management Council, and NMFS. See DEIS at 3.2-7 to 3.2-10. As discussed at length above (section II(C)), the activities proposed for the range have the significant potential to adversely affect both the waters and the hard bottom substrate on which fish in these areas depend. Yet the Navy improperly defines essential fish habitat to exclude acoustic degradation (DEIS at 4.2-4 to 4.2-7), and has not said it would consult with the Secretary of Commerce even over impacts to substrate. DEIS at 1-18. Under the MSA, a thorough consultation is required.

4. The Migratory Bird Treaty Act, 16 U.S.C. § 703 et seq. ("MBTA"), which makes it illegal for any person, including any agency of the Federal government, "by any means or in any manner, to pursue, hunt, take, capture, [or] kill" any migratory birds except as permitted by regulation. 16 U.S.C. § 703. After the District Court for the D.C. Circuit held that naval training exercises that incidentally take migratory birds without a permit violate the MBTA, see Center for Biological Diversity v. Pirie, 191 F. Supp. 2d 161 (D.D.C. 2002) (later vacated as moot), Congress exempted some military readiness activities from the MBTA but also placed a duty on the Defense Department to minimize harms to seabirds. Under the new law, the Secretary of Defense, "shall, in consultation with the Secretary of the Interior, identify measures--(1) to minimize and mitigate, to the extent practicable, any adverse impacts of

authorized military readiness activities on affected species of migratory birds; and (2) to monitor the impacts of such military readiness activities on affected species of migratory birds." Pub.L. 107-314, § 315 (Dec. 2, 2002). As the Navy acknowledges, all three of the proposed sites "lie within the Atlantic Flyway, a major migration route along the east coast of the U.S." that receives "large numbers of birds" during the fall and spring seasons. DEIS at 3.2-55. All three of the proposed landfall sites also provide or may provide suitable habitat for migratory birds. DEIS at 3.6-6, 3.6-11, and 3.6-16. The Navy must therefore consult with the Secretary of the Interior regarding measures to minimize and monitor the effects of the proposed range on migratory birds, as required.

5. The Marine Protection, Research and Sanctuaries Act, 33 U.S.C. § 1401 et seq., which has as its purpose to "prevent or strictly limit the dumping into ocean waters of any material that would adversely affect human health, welfare, or amenities, or the marine environment, ecological systems, or economic potentialities." 33 U.S.C. § 1401(b). The Act prohibits all persons, including Federal agencies, from dumping materials into ocean waters, except as authorized by the Environmental Protection Agency. 33 U.S.C. §§ 1411, 1412(a). The Navy has not indicated its intent to seek a permit under the statute. DEIS at 1-15 to 18.

6. Executive Order 13158, which sets forth protections for marine protected areas ("MPAs") nationwide. The Executive Order defines MPAs broadly to include "any area of the marine environment that has been reserved by Federal, State, territorial, tribal, or local laws or regulations to provide lasting protection for part or all of the natural and cultural resources therein." E.O. 13158 (May 26, 2000). It then requires that "[e]ach Federal agency whose actions affect the natural or cultural resources that are protected by an MPA shall identify such actions," and that, "[t]o the extent permitted by law and to the maximum extent practicable, each Federal agency, in taking such actions, shall avoid harm to the natural and cultural resources that are protected by an MPA." Id. The Navy must therefore consider and, to the maximum extent practicable, must avoid harm to the resources of all federally- and state-designated marine protected areas potentially affected by activities taking place on its proposed range. For example, these areas include but are not limited to the following: the Monitor National Marine Sanctuary, the Southeast Right Whale Critical Habitat (50 C.F.R. § 226.203(c)), the East Florida Coast Closed Area (50 C.F.R. § 653.21(c)(2)), and the North Carolina Sea Turtle Sanctuary in Onslow Bay (see below).

Construction and operation of the USWTR cannot legally be undertaken absent compliance with these laws.

M. Conflicts with Federal, State, and Local Land-Use Planning

NEPA requires agencies to assess possible conflicts that their projects might have with the objectives of federal, regional, state, and local land-use plans, policies, and controls. 40 C.F.R. § 1502.16(c). Unfortunately, in conducting its assessment, the Navy has taken an unjustifiably narrow approach that fails the Act's requirement. The Navy argues that antisubmarine warfare exercises would not impact state and local resources because the state coastal zone, as defined in the Coastal Zone Management Act, does not extend beyond 3 nautical miles from shore. DEIS at D-3, E-3, F-2 to 3. But this approach, like much of the rest of the Navy's DEIS, seems predicated on the strange assumption that the range is self-contained and that neither species nor pollutants can escape it. It fails to account for (1) the movement of migratory species such as sea turtles, (2) the impacts that USWTR might have on coastal wildlife populations (such as those of many marine mammal species) whose habitat extends further than 3 nautical miles from shore, and (3) the propagation of noise beyond the bounds of the range. Activities taking place on the USWTR may well affect resources in the coastal zone and within other state and local jurisdictions, such as the North Carolina Sea Turtle Sanctuary, in conflict with the purpose and intent of those areas.[188] The consistency of USWTR with these land-use policies must receive more thorough consideration in the Navy's EIS.

N. Alternatives Analysis Under Section 102(2)(E) of NEPA

Above and beyond the EIS requirement, NEPA directs agencies to "study, develop, and describe appropriate alternatives" to any project that presents "unresolved conflicts concerning alternative uses of available resources." 42 U.S.C. § 4332(2)(E). Courts have concluded that this duty is "both independent of, and broader than, the EIS requirement." Bob Marshall Alliance v. Hodel, 852 F.2d 1223, 1229 (9th Cir. 1988), cert. denied, 109 S.Ct. 1340 (1989). Because its offshore range proposal presents "unresolved conflicts" about the proper use of "available resources," the Navy must explicitly address its separate and independent obligations under section 4332(2)(E).

III. CONCLUSION

For the reasons set forth above, we urge the Navy to withdraw its DEIS on the Undersea Warfare Training Range, and to revise the document, as discussed above, prior to its recirculation for public comment. In particular, we call on the Navy immediately to undertake a thorough assessment of a broader range of alternatives, to ensure that its

[188] The state legislature of North Carolina established the nation's first sea turtle sanctuary, off Onslow Beach, Brown's Island, and Bear Island, in 1980. Unfortunately, the Navy's analysis of impacts on the sanctuary, which falls within the impact area, is limited to the turtles' interaction with the Navy's trunk cable and does not include impacts from training exercises, construction or cable-laying activity, or increased ship traffic. See DEIS at 4.2-8.

decision on whether to proceed with the project—and, if so, under what conditions—will result in the least practicable adverse impact on marine species.

Very truly yours,

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