An Integrated ESME (Effects of Sound on the Marine Environment) Workbench

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The Naval Research Laboratory has developed a workbench that integrates software modules developed by different researchers in the US Navy's R&D program.

The Influence of Bottom Properties on the Acoustic Environment in Shallow Water

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Many sources of man-made sound exist on the continental shelf, in bays and inlets, and in sounds and estuaries. In addition, these same waters are the habitats for a number of marine animals. The Effects of Sound on the Marine Environment (ESME) project is building a tool for predicting the impact of these sound sources on animals. The properties of the seafloor can significantly affect the propagation of sound, especially in shallow waters, and thus affect the impact of the sound. Lower frequencies can penetrate many meters in the sediment and suffer increased loss. However, the transmission loss between a source and receiver in the water column can be reduced by the reflections off the seafloor. The competing propagation features (absorption in the bottom versus reflection) are influenced by acoustic properties of the sub-bottom structure. Our long-term objective is to establish a database of bottom properties including sediment compressional wave speed, shear wave speed, attenuation, and density as a function of depth and location. Using this we propose to provide the best sediment model for any region with estimates of model uncertainty. These data would be appropriate for incorporation in state-of-the-art propagation models for acoustic effects prediction on the marine environment. Sediment models suitable for the Southern California Bight (SOCAL) region and the Middle Atlantic Bight (MAB) region were developed. These sediment models were developed based on core data, sediment maps, sediment type information, etc. from published literature and were successfully integrated into the ESME module. Present efforts are focused on incorporating additional information from geological models, river discharge models, etc. into these sediment models.

Evaluating Oceanographic Fields and Processes In ESME: Two Test Cases

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Hydrographic fields generated by NRL-Stennis MODAS (Modular Ocean Data Assimilation System) are compared to synoptic sections and feature models for two test cases: a deep water southern California site and a shallow water New England site. There is god agreement between data sets for the deep water case. In the shallow water case, in the vicinity of he shelfbreak front, the MODAS fields capture the stratification well but not the horizontal gradients. A new climatology for New England demonstrates how areas of high variability can be identified from historical data. Acoustic effects of the frontal variability, including internal wave variability,

will be summarized from high-resolution observations collected as part of the Shelfbreak PRIMER experiment. Modeling results of the effects of internal solitary waves on acoustic propagation will be presented. Future directions will be briefly outlined.

Advanced Acoustic Modeling Tools for Marine Mammal Risk Assessment

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Understanding how sound impacts marine mammals depends on our ability to model sound propagation in the ocean. Reliably predicting the acoustic field requires modeling in three dimensions and correctly incorporating transmitted waveforms (e.g. frequency band, beam-patterns and power). To determine potential risk areas over large areas, the sound intensity is modeled using a coupled normal mode approach. The normal-mode model is particularly attractive for this application because it can be divided into a lengthy pre-computation stage (to calculate the local normal modes) and an extremely rapid final stage in which the modes are combined to calculate acoustic levels. In the latter stage one can dynamically move sources (ships) and receivers (marine mammals) through the environment to do extensive simulations of acoustic impact under a variety of conditions. While modeling sound intensity is useful to rapidly assess risk areas, other factors such as exposure time and source waveform may be equally important. Using a ray/beam model the received acoustic time-series from narrow or broad-band sources can be simulated. The resulting field can include receiver motion (typical for diving marine mammals) and source waveforms. In this paper, the acoustic modeling tools developed for marine mammal risk assessment will be presented.

A Database for the Study of Marine Mammal Behavior: A Tool to Define their Critical Habitat

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We have compiled a bibliography that contains 448 references related to diving behavior or movement patterns of marine mammals. This bibliography includes references from books, peer-reviewed articles, and technical reports up to October 2002. A relational database was created that contains metadata (e.g. animal species, numbers, locations, etc.) and summarized statistics on diving behavior and movement patterns. Currently, the database includes 1815 entries and is compiled in Microsoft Access 2000. Pinniped species overwhelmingly make up the majority of animals that have been studied and most species are from high latitudes. Although the database contains a wealth of information, its usefullness would be significantly enhanced if the original individual post-processed data files were made available. To this end, we hosted a workshop in December 2001 that brought together leaders in the field who study diving behavior of marine mammals. The central goal of the workshop was to explore ways to create common standards for how data on diving behavior and movement patterns are reported in publications and to initiate the development of creating a common access archive for storing raw published and unpublished data.

A Marine Mammal Movement and Behavior (3MB) Program

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Prediction of the degree and impact of anthropogenic acoustic exposure on marine mammals requires simulation of marine mammal movement and behavior in concert with sound propagation modeling. Considerable variation in behavior, diving and rate of horizontal travel exist between different species of marine mammals and may vary within a species by season and location. A flexible model framework (3MB) has been designed allowing species-specific movements and behaviors to be simulated based upon available information for a given species. Accurate simulation of behavior and movement can be parameterized via vector models when information on movement and behavior is detailed. Where information is lacking, alternative continuous distribution models are provided for approximations of behavior and movement. The full complement of vector and continuous distribution models makes up a species definition that is used to control multiple animats within a single simulation. Animats can also be programmed to aversively respond to acoustic exposure given a user-defined exposure threshold. Individual animats record behavior, movement (vertical and horizontal), and the acoustic exposure record for post-simulation analysis. The 3MB program provides a flexible capability to model the spectrum of marine mammal species for which acoustic exposure scenarios may be required.

A TTS-Based Damage Risk Model for Marine Mammals

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The ONR Effects of Sound on the Marine Environment (ESME) program is a multidisciplinary effort to integrate ocean acoustics and marine mammalogy in a modeling architecture that simulates the exposure to and effects of underwater sound on marine mammals. ESME includes components for ocean acoustic tomography, sound propagation, sound source characteristics, and models for marine mammal auditory sensitivity, temporary threshold shift (TTS), and movement. This paper describes the operation of the ESME TTS module. The computational model is based upon existing marine mammal TTS data. Existing data (obtained using behavioral response paradigms and evoked potential recordings) consist of sound exposures sufficient to cause TTS in trained marine mammals exposed to tonal signals at various frequencies, broadband noise, and impulsive sounds. The TTS module uses a simple "lookup table" approach to compare predicted sound exposures to those that induced TTS in experimental subjects. Input to the TTS module consists of the subject species and received sound pressure as a function of time. The module output indicates if a TTS is predicted to occur.

Models of Whale Auditory Function

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In order to be able to predict the impact of man-made sounds on marine mammals we have developed a model of the peripheral auditory system that can be used to simulate any mammalian species through the use of appropriate parameters. A key component of this model is the middle ear transfer function (the ratio of sound pressure inside the cochlea to the pressure outside the head). Biomechancal models suggest that this transfer function is largely dependent on two impedances, the stiffness of the middle ear ossicular chain and the cochlear input impedance. The cochlear input impedance can be computed if the dimensions of the cochlear fluid spaces and the compliance of the basilar membrane are known. Simulations of several common terrestrial species where dimensions and stiffness are known have been used to verify this approach. To estimate middle ear stiffness and basilar membrane compliance in cetaceans, we have developed techniques to measure these quantities in ears harvested from stranded animals. The details of the methodology as well as preliminary results from both the theoretical and experimental studies will be presented.

HLA-based ESME: A Distributed Solution

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The Naval Research Laboratory has developed a workbench that integrates software modules developed by researchers in the US Navy's R&D program, "Effects of Sound on the Marine Environment" (ESME). We are parallelizing the calculation of acoustic transmission loss for the three dimensional ocean model, a computationally intensive task invoked by the ESME workbench, and one well suited for a distributed solution. This simulation will be compliant with the Defense Modeling and Simulation Office's (DMSO) High Level Architecture (HLA), the DoD-advocated methodology for building distributed simulations. This approach is advantageous since this makes the simulation executable on a network of inexpensive PCs.

There are several issues that require study in distributing this problem. First, is the handling of the large data sets used to calculate ocean acoustic propagation, such as sea floor properties, bathymetric data, etc. Second, is the collection of the analysis products created by a distributed system and their presentation to a workbench user. Third, is the conversion of the workbench architecture to the HLA framework, in a manner that is extensible for multiple problem domains.

This paper describes the current state of this software development effort and discusses extensions to this distributed methodology that will improve complex ESME-based analysis.

Oil and Gas Industry Sounds and Their Effects on Marine Life: What We Know, What We Believe and What Remains to be Determined

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Recognizing the emergence of global concern for marine mammals and the effects sounds from oil and gas exploration and production operations may have on their health and well being, OGP and IAGC, the two international trade associations whose members are most directly affected by this issue, are acting. Their first effort will be a technical paper that will characterize those sounds, discuss their underwater propagation and summarize the body of knowledge relative to any impact they may have on marine life. It will also state the industry's understanding of the science associated with sound in water, apply it to the sound emitted by the industry and then detail the types of operations the industry undertakes (e.g. seismic surveys). This effort will produce a second paper – a position paper – that draws on the technical document to summarize the industry's conclusions drawn from the technical paper, and maps out the research path forward as well as a suggested path for seismic mitigation measures. This paper, which is well along in its development, will be the primary topic of this discussion. The authors will also touch on the global state of this issue and what the industry is doing about it.

The Strategic Environmental Research and Development Program

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The Strategic Environmental Research and Development Program (SERDP) is the Department of Defense's (DoD) corporate environmental research and development (R&D) program, planned and executed in full partnership with the Department of Energy (DOE), and the Environmental Protection Agency (EPA), with participation by numerous other Federal and non-Federal organizations. Within its broad areas of interest, the Program focuses on Cleanup, Compliance, Conservation, Pollution Prevention, and UXO technologies.

SERDP has collaborated with the Navy to address concerns about marine mammals, their activities and their habitats for over ten years. It is presently funding work on marine mammal monitoring. In the future SERDP will continue to collaborate with the Navy in a variety of areas. The project funding process will be addressed in the presentation.

Immunologic Evaluation of Short-term Capture-Associated Stress in Free-Ranging Bottlenose Dolphins *(Tursiops Truncatus)* in Sarasota Bay

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This immunologic study was part of a larger program directed at defining potential associations between environmental contaminants and the health of the free-ranging bottlenose dolphin (*Tursiops truncatus*) population in Sarasota Bay, Florida. The immunologic effects of the short-term capture-associated stress were assessed in 26 dolphins; a wide range in animal age was represented. Blood samples were obtained immediately after capture and then again just prior to release; the time from the 1st to 2nd bleed ranged from 1.3 to 3.3 hours. The immune system is extremely sensitive to perturbation and, as such, is an excellent measure of animal health, including presence of stress. The immune panel data applied to the paired dolphin blood samples included the following: a) a complete blood cell count (CBC), b) flow cytometry analysis of lymphocyte subpopulations including total T lymphocytes (express CD2), naïve versus memory T lymphocytes (differential expression of CD45R on CD2-expressing lymphocytes), and B lymphocytes (expression of CD21 and CD19), c) leukocyte surface density of adhesion proteins using analytical flow cytometry, d) clinical chemistries, e) fibrinogen, f) serum cortisol, g) systemic levels of the acute phase protein interleukin-6 (IL-6), and h) lymphocyte function by mitogen-induced proliferative response (blastogenesis assay). Taken together, such data are useful in determining the presence of immune system dysfunction, leukocyte abnormalities and/or infectious disease/inflammation. While individual animal variability probably masked some capture-associated immunologic changes, certain perturbations were easily identifiable. Relative to the 1st bleed, total white blood cell counts were decreased at the 2nd bleed. This reduction was due to a decrease in eosinophils (23 of 26 animals) and neutrophils (18 of 26 animals). A dramatic decrease in the apparent cell-surface density of CD19 on B lymphocytes was recorded. Relative to analysis of serum, elevated levels of cortisol and glucose were very obvious at the 2nd bleed.

Investigation of the Effects of Anthropogenic Sound on Marine Mammal Health

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We have initiated investigations to help determine the effects of underwater sound on marine mammal health. These studies were carried out in conjunction with a US Navy Marine Mammal Program effort to determine underwater hearing thresholds before and after exposure to single underwater impulsive sounds (up to 200 kPa) and before and after exposure to tones (simulated sonar pings) (up to 201 dB re 1 Pa) in a white whale (*Delphinapterus leucas*) and a bottlenose dolphin (*Tursiops truncatus*). Blood samples were obtained before and after

sound exposures to measure catecholamines, hormones, lymphoid cell subsets, serum chemistry and hematology constituents and complete blood cell counts. Mean norepinephrine, epinephrine and dopamine levels significantly increased after high-level sound exposures compared to low-level sound exposures or controls (P-values = 0.003, 0.006, 0.020) for the white whale. Furthermore, all three catecholamine levels increased with increasing sound levels (P-values = 0.021, 0.012, 0.021). Mean Cell Volume and alkaline phosphatase decreased over the experimental period (P-value = 0.004, 0.000), while gamma glutamyltransferase increased over the experimental period (P-value = 0.000). Significant neural-immune measurements for the dolphin after exposure to impulsive sounds included an increase in aldosterone (P-value=0.000) and a decrease in monocytes (P-value = 0.015). No significant differences were observed after exposures to simulated sonar pings. These studies are the first attempt to investigate anthropogenic sound as a ``stressor`` and potential impacts on marine mammal health.

Marine Mammal Strandings in Australia and a Proposed National Stranding Pathology Program

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Popular concern regarding the potential for impact of high power active sonar on whales has resulted from the concurrence of some strandings with Defence sonar operations, when little direct evidence of a causal link is apparent. Few studies of stranded marine mammals include comparisons with events occurring in locations remote from human interference.
Australia possesses a large coastline upon which marine mammals of a wide range of species, including beaked whales, strand at regular intervals. These strandings occur despite a relatively sparse human population and a geographical location remote from major industrial regions of the world. Much of the Australian coastline is comparatively free of shipping and naval activity, and in some areas man-made noise is negligible. Australia therefore provides a unique opportunity to examine stranded whales in an environment largely free of anthropogenic noise.

This paper will describe the pattern of historical Australian marine mammal strandings with reference to commercial shipping routes, seismic survey and naval activity. A proposal for a national database on stranding events is discussed, together with proposed standardisation of pathological and histological sampling. It is hoped that this work can be coordinated with studies elsewhere and perhaps serve as a control for some overseas investigations.

SURTASS LFA Environmental Compliance Experience

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In executing the ASW mission, sonar is the key to survival for U.S. ships and sailors and marines that man them. SURTASS LFA sonar enables the Navy to meet the clearly defined, real-world national security need for improved ASW capability by allowing Navy Fleet units to reliably detect quieter and harder-to-find submarines at long range, before they get within effective weapons range. The Navy understands there are significant concerns regarding the use of SURTASS LFA. While no real-world military action is risk-free, the environmental issues have been thoroughly examined over the

past six years through comprehensive and unprecedented research programs and a detailed risk-based analysis process under the National Environmental Policy Act, Marine Mammal Protection Act, and Endangered Species Act. SURTASS LFA is the first operational Navy system to undergo this rigorous environmental compliance process and verifies the Navy`s commitment to its stewardship of the seas. The outcome of this painstaking process was that the Navy and the National Marine Fisheries Service have determined that the safe and effective use of SURTASS LFA is possible through geographical restrictions and monitoring mitigation, such that the marine environment and the humans that use it are protected to the maximum extent practicable.

Passive Acoustic Monitoring for US Navy Ship Shock Trials

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Each new class of navy ships must be shock tested to assess survivability of the ship`s hull and the capability of the ship to protect the crew after a near miss from an underwater explosion. During the recent shock test for USS Winston S. Churchill, an extensive mitigation plan was deployed to minimize the effect of the test on marine animals. During the post detonation surveys no dead or injured marine animals were found.

A component of the mitigation plan was the use of a passive directional acoustic monitoring system to detect and track vocalizing whales within the mitigation zone. During the execution of the shock test, no large whales were detected by the system.

The shock test was planned for a time of year when whales were least likely to be seen. The cost of deploying the monitoring system was a million dollars. The case can be made for eliminating the use of passive acoustic monitoring when environmental planning determines a very low probability of any system detections during the test.

Minimising the Risk to Marine Mammals from Active Sonar Transmissions - A Royal Navy Perspective

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The Royal Navy (RN) deploys active sonar systems to maintain its defence capabilities, which requires deployment of active sonar systems in research and procurement acceptance trials, and in training and exercises. The RN is also required to demonstrate that it is a responsible user of the environment.

Deployment of active sources must take into account national and international legislation to minimise the potential effects of acoustic energy on the maritime environment. There is a particular concern with marine mammals, highlighted by recent mass whale strandings.

The potential environmental impacts are mitigated using risk management and risk reduction methods. To achieve this an Environmental Impact Assessment (EIA) is conducted and Risk Mitigation Measures (RMM) determined. The EIA characterises the oceanographic, acoustic and biological environments, and for the latter is critically dependent upon the distribution, abundance and behaviour of marine mammals. Implementing RMM requires a marine mammal detection capability and the RN is committed to

researching improved passive acoustic and non-acoustic detection techniques.

The EIA and RMM have identified gaps in the science and research and this paper will report on future work to prioritise and address these gaps.

Navy Operations and Marine Mammal Compliance

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The Navy is proud of its record as a good steward of the environment, and leads the world in research into Marine Mammal Compliance issues. What are the challenges that the Navy faces in operating within the realm of marine mammal environmental regulations? How is marine mammal and acoustic science used to develop Navy mitigation and policy? This brief will present an overview of Navy operations, planning, and policy considerations that drive the need for marine mammal acoustic research.

Learning from the LFA Fiasco: Whither the Credibility of Marine Mammal Bioacoustics?

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Despite a costly, lengthy LFAS research program, fundamental questions over the impact of sonar on cetaceans remain unanswered, while the Dr. to regulatory approval has provoked a public backlash via their NGO mouthpieces resulting in a legal stalemate. This entrenchment, not entirely unforeseen, serves neither the Navy, the public, nor the whales, and undermines the credibility of marine mammal bioacoustics in general. The most fundamental problem with the current situation is that the science is simply not credible in the public domain because it has been seriously undermined by a perceived conflict of interest, while dead whales continue to wash up on the beach. Until that conflict of interest is removed the problem will persist. The ONR should step back from funding research directly and instead contribute funds to an independent research committee. Additionally, if science is to be an effective regulatory tool, it must include the entire scientific process. Effective science demands rigorous peer-review, and that we admit what we don`t know: All parties need to acknowledge the limits of science when dealing with such unknowns. Science may eventually answer outstanding LFAS questions - but it will take decades, and be wasted if the credibility issue is resolved.

Must All Future CEE Research on Noise Impacts be Constrained by Legal Challenges?

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Successful legal challenges to Controlled Exposure Experiments and other research using noise are becoming routine. The challenges come from the "environmental community", acting on a moral concern that the science will do harm, and the legal concern that the intent of the Marine Mammal Protection Act is being stretched. The environmental consequences of underwater sound cannot be addressed without appropriate science. Fundamental questions about the consequences of noise remain unanswered, but judges are preemptively deciding the validity of scientific research projects and their permits. Successful or not, legal challenges delay or halt projects, close operational windows, increase costs, and idle valuable people and resources. Opportunities for data are lost, forcing managers and policy makers faced with deadlines to continue to act on educated guesswork. The legal challenges may include research protocols, but are usually directed at perceived inadequacies in the permitting process. Attempts by the scientific community to prevent conflict by addressing these concerns are rare. An increasing lack of understanding, respect and communication from all sides is fueling the conflict. Case studies will illustrate the perceptions causing these challenges, along with suggested solutions that may allow appropriate science to continue without the added, potentially fatal burden of legal challenges.

Research and Regulation: Modifying the Research Agenda to Improve Environmental Compliance

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Stakeholders on all sides of the ocean noise debate have offered criticism of the current regulatory process. From an environmentalist perspective, the current system fails to capture the range of industrial, commercial, and military activities that contribute to the noise budget, tolerates commitment of substantial resources to programs well in advance of review, and creates inefficiencies of scale that deplete agency resources. A necessary part of any solution is to modify the research agenda, both to address these problems and to better facilitate agency and industry compliance with federal and state environmental law. By gearing research toward meeting the requirements of alternatives analysis under the National Environmental Policy Act (NEPA) and toward satisfying the mitigation and monitoring provisions of NEPA, the Marine Mammal Protection Act, and the Endangered Species Act, it should be possible to improve the compliance process for stakeholders.

Seismic and Sperm Whales: The MMS Experience

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The increase in anthropogenic noise in the oceans and concerns that this will have negative effects on marine mammals and other marine life have led to an increase in public scrutiny of government, industry, and scientific research activities. Though much of the increase in noise is attributed to vessel traffic, Navy [military] activities and oil and gas industry activities have also been accused of contributing to the problem. In the Gulf of Mexico, industry operations, including seismic exploration, explosive structure removals, and drilling operations, constitute the primary concern for the Minerals Management Service (MMS) with regards to noise in the marine environment.

The Sperm Whale Acoustic Monitoring Program (SWAMP, 2000-2001) and the Sperm Whale Seismic Study (SWSS, 2002-present) are research programs funded by MMS in cooperation with the Office of Naval Research (ONR), the National Oceanic and Atmospheric Administration, the National Science Foundation (NSF), academic institutions, and the oil and gas industry to investigate the effects of industry-generated noise on sperm whales. Collectively, SWAMP and SWSS have tested and established scientific methods to investigate underwater acoustic effects on sperm whales. For example, digital tags for short-term effects studies, satellite-radio tags for long-term distribution, visual and passive acoustic tracking of animals, and genetic analyses have all been successful components of both SWAMP and SWSS. SWSS has expanded upon the highly successful SWAMP by conducting the first controlled exposure experiment (CEE) involving sperm whales and an airgun array in 2002. The basic SWSS objectives are to understand "normal" sperm whale behavior, characterize industry noise (specifically, airguns), and then determine if airguns alter sperm whale behavior in any detectable way. In addition, SWSS addresses habitat use issues and may provide useful spin-off technology for mitigation monitoring.

The results from SWAMP and SWSS should be critical in preparing National Environmental Policy Act (NEPA) documents, in petitioning for rulemaking under the Marine Mammal Protection Act (MMPA), in the Endangered Species Act (ESA) consultation process, and other regulatory decision-making purposes. However, research and regulatory timelines and processes are not always in sync. It is imperative that new research results are incorporated into the regulatory process in a timely and responsive manner.

Canadian Sonar R&D Environmental Risk Management

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Defence Research and Development Canada (DRDC) has embarked on an exploratory development of new sonar technology: the Towed Integrated Active Passive Sonar (TIAPS). The TIAPS Technology Demonstrator will demonstrate basic sonar capability and will serve as a testbed for concept development. In meeting this goal, a series of experimental trials is underway, ending in Fall 2003. Since the transmission of acoustic energy is required during each of these sea trials, the potential for an adverse effect on marine fauna exists. This presentation discusses the environmental impact risk management carried out for the series of sea trials associated with the project.

Minerals Management Service Regulatory Responsibilities and Application of Acoustic Monitoring Risk Assessment, and Mitigation

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The Minerals Management Service (MMS) is a Bureau in the U.S. Department of the Interior whose mission is: to manage the mineral resources on the Nation`s Outer Continental Shelf (OCS) in an environmentally sound and safe manner; and to collect, verify, and distribute mineral revenues generated from Federal (onshore and offshore) leases. The agency collects, accounts for and disburses more than $5 billion per year in revenues from federal offshore mineral leases and onshore minerals leases on federal and Indian lands. The federal OCS has more than 8,000 active leases on 42 million acres and contributes 30% of total domestic oil production and 23% of total domestic natural gas production. The MMS must conduct rigorous environmental assessments of the likely effects of OCS activities on the marine, coastal, cultural, and human environments. This entails preparing Environmental Impact Statements or other environmental analyses to comply with our responsibilities Endangered Species Act, Marine Mammal Protection Act and the Magnuson Stevens Fishery Conservation and Management Act. The MMS must review and approve industry exploration and development plans before any operations commerce; and monitor all pre-lease and post lease operations to ensure that industry is in compliance with the OCS Lands Act and various environmental laws. Source of noise from routine operations include seismic surveys, drilling and production activities, vessels and aircraft traffic, and offshore structure removals.

Marine Mammal Commission Review of the Effects of Anthropogenic Sound on Marine Mammals

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In recent years, the potential effects of noise on marine mammals and their populations have gained attention. In part, this attention is the result of several beaked whale stranding events concurrent with military exercises and seismic studies, Navy plans to deploy its LFA SURTASS sonar system, and a series of lawsuits regarding Marine Mammal Protection Act permits and letters of authorization for activities using sound sources. In its Fiscal Year 2003 appropriations bill, and the US Congress directed the Marine Mammal Commission "....to fund an international conference, or series of conferences, to share findings, survey acoustic "threats" to marine mammals and develop means of reducing those threats while maintaining the oceans as a global highway of international commerce." In response to this directive, the Commission has conducted a series of meetings and interviews with parties involved with this issue, including representatives of federal agencies (e.g., National Marine Fisheries Service, Navy, Minerals Management Service, Coast Guard, and National Science Foundation), non-governmental organizations, researchers, Congressional committees, and the National Academy of Science's Ocean Studies Board. This talk will describe the status of efforts to meet the directive of Congress and plans for a series of related meetings and workshops.