Research Provisions

8. The Navy agrees to spend $14.75 million from the Navy's general research and development budget over the course of three years, from FY 2009 to FY 2011, to fund research projects relating to marine mammals within the three agreed research topic areas described in Appendix C to this agreement. Work under existing contracts or grants that has already been funded at the time this settlement agreement is executed by all parties will not be counted against the $14.75 million, but any work funded after this settlement agreement is executed by all parties that is within the three agreed research topic areas described in Appendix C will be counted against the $14.75 million. The Navy also reserves the right to fund ongoing and new contracts and grants using FY09, FY10 and/or FY11 funds for projects that may build on work accomplished before the settlement agreement is executed by all parties. Thus, task orders, delivery orders or contract modifications under existing contracts or grants that are funded after this settlement agreement is executed by all parties and that are within the three agreed research topics will be counted against the $14.75 million, including options on existing contracts or ongoing grants that are funded after the settlement agreement is executed by all parties. Contracts or grants that are within the three agreed research topics and are awarded after the settlement agreement is executed by all parties will also be counted against the $14.75 million. Consistent with Appendix C, the Navy shall provide notice to NRDC of task orders, delivery orders, or contract modifications under existing contracts or grants that are funded after this settlement agreement is executed by all parties and that are within the three agreed research topics, including options on existing contracts or ongoing grants that are funded after the settlement agreement is executed by all parties. In the event that project costs under the proposed topics do not realize $14.75 million over three fiscal years, Navy shall, subject to the availability of appropriated funds, apply fiscal year 2012 funding towards projects in the agreed upon topics to achieve $14.75 million over four fiscal years. A comprehensive description of the three research topics, their

objectives, and their cost estimates are provided in Appendix C. The cost estimates contained in Appendix C are estimates only and do not restrict the Navy's ability to allocate the $14.75 million across the three agreed research topics as the Navy deems appropriate.

9. The National Marine Fisheries Service ("NMFS") has noticed its intent to conduct marine mammal survey efforts in Hawaii by 2010. Within a reasonable amount of time after NMFS has completed these survey efforts and made the survey data available, the Navy will apply the Hawaii survey data to the Spatial Decision Support System (predictive habitat model for SOCAL, U.S. West Coast, and Eastern Tropical Pacific), and will make the results of this application available to the public. The Navy commits to completing this task within 90 days of receiving the relevant data from NMFS to the extent it is reasonably possible. To the extent it is not reasonably possible to complete this task within 90 days, the Parties will meet and confer so that the Navy may describe the circumstances delaying the completion of this task.

Navy Environmental Compliance Re: August 2005 Lett

APPENDIX C

Proposed Research Topics List
December 5, 2008

This document details the research topics, objectives under those topics, cost estimates, and projections on funding discussed by the Navy and NRDC. The following general points apply across all proposed topics:

- **Research Project Notification.** Navy will provide written, post-award notice to NRDC of the projects funded under the agreed upon research topics, with the following data elements: date of contract/grant; number of contract/grant; contractor's name; Principal Investigator's (PI's) name; title of project (work being done); amount of contract/grant; and performance period.
- **Progress Reviews.** Navy will provide NRDC with progress reviews in the form of peer-reviewed publications or annual reports on the research projects funded under the agreed upon research topics. In addition, Navy will provide an annual information brief at a mutually agreed location to NRDC on the research projects funded under this agreement with opportunity for dialog that does not infringe on selection and oversight duties of the Navy offices responsible for research.
- **Time Frame.** Navy will stress to grant applicants that obtaining and disseminating relevant results in a timely manner will be a priority. Annual reports will provide preliminary results and a section explaining how those results are relevant to management and Navy operations.
- **Availability of Appropriations:** Projects funded pursuant to the agreed upon topic list will be funded through general appropriations for Navy research, if made available by Congress, beginning in fiscal year 2009. Navy agreement to fund projects under the topic list will be subject to the availability of appropriated funds. The Navy agrees to seek sufficient funding through its budgetary process to fulfill its obligations under this agreement. Any requirement for the payment or obligation of funds by the Navy, however, shall be subject to the availability of appropriated funds, and no provision herein shall be interpreted to require obligation or payment of funds in violation of the Anti-Deficiency Act, 31 U.S.C. Section 1341.
- **Cost Estimates.** The costs provided below are the Navy's best estimates of all projected research costs for projects under each topic, and total $14.75M in expenditures over three fiscal years. In the unanticipated event that project costs under the proposed topics do not realize $14.75M over three fiscal years, Navy shall, subject to the availability of appropriated funds, apply fiscal year 2012 funding towards projects in the agreed upon topics to achieve $14.75M over four fiscal years. As represented in the parties' negotiations, the Navy will not expend future funding on redundant projects. However, the Navy reserves the right to fund ongoing and new contracts and grants using FY09, FY10 and/or FY11 funds for projects that may build on work accomplished in a previous project or projects.
- **Welfare considerations**. NRDC and co-plaintiffs recognize that invasive techniques such as biopsy and tagging can yield important information that cannot be obtained by

other means. However, the benefit of the information obtained must be weighed against the potential risk to animals, and thus invasive techniques are only to be used as part of a well-defined research program, the ultimate objective of which is to provide data that will assist the Navy in mitigating more effectively the potential effects of midfrequency sonar on marine mammals. The Navy's research efforts will continue to be part of such a well-defined research program, approved by the host institution Institutional Animal Care and Use Committee (IACUC), consistent with the approved Department of Defense Animal Use Protocol, and where applicable, covered by a scientific research permit issued pursuant to the Marine Mammal Protection Act by the National Marine Fisheries Service (NMFS) or the United States Fish and Wildlife Service (USFWS).

1) MAP KEY HABITAT PREDOMINANTLY FOR BEAKED AND OTHER WHALES IN AREAS USED FOR MFA SONAR TESTING AND TRAINING

Background

There has been recognition that atypical mass strandings of beaked and other whales may be associated with naval exercises that use mid-frequency active (MFA) sonar (Evans and England 2001, Cox et al. 2006). A variety of hypotheses have been proposed to explain the causal chain of events from sound exposure to stranding. These include hypotheses that whales may be physically affected by MFA sonar signals, MFA sonar may trigger behavioral reactions that cause beaked whales to panic and swim to shore, and then die from injuries associated with stranding, or that MFA sonar exposure may trigger a behavioral reaction in beaked whales that could injure them independent of stranding, and that either the reaction or the subsequent injury leads some of the whales to strand; the last of these is considered “a plausible pathologic mechanism” (Cox et el. 2006). It is clear that each of these different hypotheses would require very different approaches for reducing the risk to whales from MFA sonar exercises, and a fundamental understanding of the reasons behind strandings is required.

To understand the mechanisms underlying strandings and to reduce risks to whales, a number of reviews (e.g. National Research Council 2003 & 2005, MMC 2004) over the past few years have identified the need for additional research in a number of areas, including to measure the distribution and abundance of beaked whales (e.g. Evans and England 2001, Cox et al. 2006). Research into the best methods for acquiring such knowledge is important both to plaintiffs and to the Navy as it seeks to enhance its environmental assessment capabilities.

MacLeod and Mitchell (2006) list several areas in US waters as beaked whale habitat based on sightings and stranding records that include the following: 1) northeastern North America continental shelf margins (from Cape Hatteras to southern Nova Scotia and east to the start of the abyssal plain), 2) California shelf margins (from the coast west to 125ºW), 3) Hawaii 18.5-22.5ºN, 154.4-160.25ºW, and 4) Northern Gulf of Mexico (North of the US-Mexico border, east to 84.87ºW, south to the western end of Cuba, east to 81.34ºW and North to Florida).

Areas used for Navy MFA sonar testing and training overlap with the four areas likely to represent beaked whale habitat as described above; however, relatively little is known about species diversity, abundance and habitat use in these areas. The locations where Navy tests and trains with MFA sonar include the Hawaii Range Complex, the Southern California Range Complex, the Atlantic Undersea Test and Evaluation Center (AUTEC) in the Bahamas, and the Atlantic Fleet Active Sonar Training (AFAST) area.

The continental shelf off the northeastern coast of North America likely represents habitat for beaked whales based on sightings or strandings, including at least six species from three genera (MacLeod and Mitchell 2006). Previous work suggests that beaked whales are broadly distributed across the continental shelf and over the continental slope and rise, and may be particularly concentrated around Cape Hatteras and Georges Bank (CeTAP 1982, Waring et al. 1993, Waring et al. 2001) The deep waters off the California coast are also likely habitat for a diversity of beaked whales: seven species have been recorded, including Perrin's beaked whale (*Mesoplodon perrini*) which is only known from California waters at present (Dalebout et al. 2002). Density may be highest around the southern California Bight (MacLeod and Mitchell 2006). In the waters surrounding Hawaii, three species of beaked whales are known to occur: Blainville's beaked whale (*Mesoplodon densirostris*), Cuvier's beaked whale (*Ziphius cavirostris*), and Longman's beaked whale (*Indopacetus pacificus*). Although few dedicated surveys have been undertaken to determine densities, recorded sightings suggest the regular occurrence of at least the first two species around the Hawaiian Islands. Density of beaked whales may be particularly high around seamounts near the Hawaiian archipelago (Johnston et al. 2008). Although only 10 beaked whale strandings have been recorded in the Hawaiian Islands through 2005 (Maldini et al. 2005) and no mass strandings have been recorded, Faerber and Baird (submitted) suggest that the near shore bathymetry, coastal topography and demographics of the Hawaiian Islands are such that the probability of observing strandings, should they occur, is a great deal lower than for other island chains such as the Canary Islands. Finally, in the northern Gulf of Mexico, four species of beaked whales occur (Sowerby's beaked whale, Blainville's beaked whale, Gervais's beaked whale, and Cuvier's beaked whale), but little is known about abundance of these species.

In addition to the potential effects of Navy sonar operations on beaked whales, the Navy also has interest in examining the potential effects of sonar on other related species. For example, the Navy is interested in the general behavior of baleen whales in regions of possible Navy influence, primarily to establish a background to measure trends, particularly those that can be correlated with changes in the ocean environment.

Research Topic #1

- Use existing survey data[1] to estimate presence/absence, and abundance of beaked whale species in areas used for MFA sonar testing and training in proximity to the beaked whale habitat areas as described above.
- Obtain/add to environmental and oceanographic data for areas used for MFA sonar testing and training in proximity to the beaked whale habitat areas as described above.
- Develop, augment and update habitat models for beaked whale species, including species presence and abundance in areas used for MFA sonar testing and training.
- Undertake fine-scale surveys to include focal animal follows (including monitoring animal movements via satellite tagging), passive arrays, floating instrument platform (FLIP) within Southern California Offshore Range (SCORE) in order to improve habitat mapping.

[1] Emphasis should be placed on estimating density and abundance from existing survey data. The highest priority should be given to the analysis of existing survey data for the estimation of marine mammal abundance in the SOCAL Range Complex. These include the analysis of the 2005-08 CalCOFI ship surveys collected by SIO and Cascadia Research, the analysis of SWFSC at-sea pinniped sightings, the analysis of SWFSC cetacean survey data off northern Baja California, Mexico, and the analysis of the 2001-03 aerial survey data from the San Clemente range collected by SIO.

The goals of this research topic are to document species occurrence, population densities, spatial patterns and fine-scale habitat utilization by beaked whales and other species using dedicated line-transect survey and acoustic data, particularly in the deep waters in areas used for MFA sonar testing and training. Initial habitat modeling for beaked whales should be carried out (or assessed/augmented if it has already been completed for these areas) based on all available previously collected NOAA survey datasets.

Habitat modeling techniques have been described extensively for beaked whales and other cetaceans (Ferguson et al. 2006, Hamazaki 2002). For example, Generalized Linear Models (GLMs) with a logistic link function have been used to model beaked whale habitat off the northeastern coast of the US (Waring et al. 2001, Hamazaki 2002). Ecological niche factor analysis has also been used to model beaked whale habitat in the North Atlantic based on water depth, slope and orientation (MacLeod 2005). MacLeod and Zuur (2005) used generalized additive models (GAMs) to model beaked whale habitat association in the Bahamas. Variables that have been investigated in these past studies include depth, slope, distance offshore, seabed topography, sea surface temperature, salinity, chlorophyll concentration, thermocline depth, and thermocline strength. The proposed research topic should build upon these methods (GLMs, GAMs, and others) in order to model beaked whale habitat in areas used for MFA sonar testing and/or training.

ONR Estimated Costs

- FY10 - $600K

N45 Estimated Costs

- FY09 - $850K
- FY 10/11 - $1.5M

2) IMPROVING METHODS IN CETACEAN DETECTION

Background

Marine mammal calls cover the frequency range from 10 Hz – 150 kHz (Richardson et al. 1995). Mysticetes (baleen whales) generally produce low frequency sounds (10 – 2000 Hz) which are a tonal or modulated-tonal quality. Odontocete (toothed whale) sounds are divided into three general categories: echolocation clicks, burst-pulsed calls, and whistles. Echolocation clicks are broadband, impulsive sounds with typical frequencies between 5 - 150 kHz, burstpulsed calls are rapid series of broadband clicks, and whistles are frequency modulated narrowband calls that occur between 2-35 kHz.

Detection of bioacoustic sounds, classification by species, and localization (DCL) of calling animals as a function of time (tracking) are key steps in processing passive acoustic monitoring data. Recent advances in acoustic recording capabilities allow remote autonomous recordings with multiple-terabyte data storage (Wiggins and Hildebrand 2007). Manual analyses of these large datasets are prohibitive, based on time and expense. A variety of methods have been tested detecting and classifying beaked whale sounds. Many of these methods were presented at the Third International Workshop on Detection and Classification of Marine Mammals using Passive Acoustics (Boston, July 2007). These methods have variously relied on a support vector machine (Jarvis et al. 2007, Roch et al. 2007), a statistical classifier (Gillespie and Caillat 2007), the Teager-Kaiser energy operator (Kandia and Stylianou 2007, Roch et al. 2007), a noise-adaptive band-limited thresholding (Theriault and Hood 2007), matched filtering (Morrissey et al. 2007, Mellinger 2007a), and a neural network (Mellinger 2007a). Among the best of these was a support vector machine (Roch et al. 2007); the neural network also performed well. Other detection methods are being explored in the analysis of several datasets of beaked whale sounds (Mellinger and Clark 2006).

Buoyancy-driven autonomous underwater gliders provide unique platforms to support the development of real-time algorithms for marine mammal detection and classification. The current generation of gliders (Spray, Seaglider, and Slocum) are severely limited in payload and battery capabilities since they were originally designed as 2-person-deployable platforms for vertically profiling slowly-varying ocean properties such as temperature and salinity. These design parameters limit their ability to conduct marine mammal monitoring missions. Two developments improve this situation significantly. First is the development of low-power, small (in weight and volume) hardware for marine mammal passive acoustic monitoring (PAM), reducing the demands on the glider platform. Second is the expanded platform capability provided by a glider specifically designed for real-time, persistent, and passive acoustic monitoring missions. This combination of attributes ultimately will result in an operational system that provides timely information on marine mammal presence to support Naval mitigation efforts.

Determining the density and distribution of cetacean species is fundamental to understanding their basic biology, and also to monitoring and mitigating the effect of man-made impacts on their populations. Currently, the main method of achieving this is using visual line transect surveys. Another fruitful avenue of recent research has been the use of towed passive acoustic arrays either in place of a single visual platform or as a secondary observation platform. With an array of two or more hydrophones towed in a known configuration it is possible to estimate the bearing to a sound received at multiple hydrophones and, if the ship is moving fast relative to the animal, a sequence of these bearings can be used to estimate the perpendicular distance of the animal from the transect line. Fixed passive acoustic devices have enormous potential for cetacean monitoring, because they enable large amounts of data to be collected over long time periods, or potentially processed in real time for select outputs, at low to moderate cost. In areas where fixed arrays already exist, there would be very little additional expenditure required to extract and analyze the data, were suitable methods available. Where fixed arrays do not exist at an appropriate scale, but where short to medium term monitoring is required, temporary deployments of devices such as sonobuoys or various pop-up (i.e., anchored, retrievable) buoys could provide the required data.

It is an important goal to estimate absolute density using PAM data as opposed to some index of density such as received call rates, because indices often have only a weak relationship with population size (e.g., Anderson 2001 and 2003, Pollock et al. 2002). For example, if we find that the number of calls of a species of interest received per unit time are different between two areas or two seasons then this could be because of variation in calling frequency or in probability of detecting calls caused by differences in sound propagation in the water, average depth of the animals, call strength, etc. These potential sources of bias focus mainly on the application of distance sampling methods to the fixed passive acoustic scenario, which is a specific research need addressed under this research topic.

Research Topic #2

- Explore multiple avenues of detection and species classification from PAM data.
- Develop automated detection and classification of marine mammals for mobile underwater gliders.
- Develop methods for estimating the density of cetacean species from fixed passive acoustic devices. Methods should be applicable to a wide range of scenarios, including dense and sparse arrays of permanent, bottom-mounted sensors and single bottom mounted or floating sensors.
- Demonstrate the utility and generality of the density estimation methods by implementing them in a set of key test case studies to ensure their relevance to real-world applications.
- As feasible, use case studies to cross-validate passive acoustic species identification by enabling visual monitoring effort in combination with acoustic data collection.
- Utilize photo-identification and biopsy data that confirm species identification and provide information about stock structure and sex of animals (as well as reproductive status and contaminant load).
- Promote adoption of the new density estimation methods in the marine mammal research community by (a) publishing results in the peer-reviewed literature, (b) archiving data and results in publicly available electronic storehouses (e.g., the Ocean Biogeographic Information System, OBIS), (c) holding start-up and wrap-up workshops open to all interested researchers.

The principal goal of this research topic is to improve our ability to infer cetacean presence, abundance, and behavior using acoustic data. In order to accomplish this, we propose a research topic with the goal of 1) improved ability to detect, classify, and localize animals, and 2) application of distance sampling methods to determine density from fixed passive acoustic sensors. This will enable the integration of acoustic data with information from visual surveys and other sources (such as photo-identification and biopsies). Once these methods are developed researchers will be able to capitalize on existing sources of data including a number of moored recording stations already collecting acoustic data in U.S. waters, including passive acoustic sensors in military ranges such as SCORE, AUTEC and PMRF ranges, Autonomous Underwater Listening Stations (AULS), which are deployed in each of the 14 National Marine Sanctuaries, and oceanographic acoustic moorings deployed by IOOS (Integrated Ocean Observing System). As necessary, additional acoustic equipment could be deployed in order to capture information along an anthropogenic noise gradient. In addition, it will also be important to ensure that continuous oceanographic data are available for the same areas, and that as much as possible of the full acoustic bandwidth is being measured in order to detect vocalizations by any species as well as any anthropogenic noise.

In order to fulfill the primary goal of accurate species identification from passive acoustic data, it may be useful to cross-validate information from acoustic sources with visual monitoring efforts. To this end, the key case studies mentioned above could compare inferences from acoustic data to data collected using visual monitoring or focal animal follows. For these studies, visual monitoring effort could be undertaken in areas where acoustic data are being collected, focusing on areas of potential anthropogenic acoustic effects. Data from acoustic and visual monitoring efforts could then be integrated across different spatial and temporal scales in order to derive best estimates of species diversity and these data could be used to add to our understanding of factors influencing encounters that are missed acoustically but sighted, and vice versa.

ONR Estimated Costs

- PAM DCL development FY09/10 – $1.5M
- PAM with gliders FY09/10 – $4.3M

N45 Estimated Costs

- FY09 - $2M
- FY10/11 - $2.15M

3) EFFECTS OF STRESS ON MARINE MAMMALS EXPOSED TO MFA SONAR

Background

Marine mammals are exposed to a variety of anthropogenic effects that may be a source of stress, including noise, pollutants, threatening stimuli, and habitat disruption. The stress response in captive marine mammals has been shown to include cardiac (heart rate) and neuroendocrinological responses (catecholamine and cortisol concentrations) (Myksis-Olds et al. 2001, Fair and Becker 2000). Little is known, however, about long-term effects of stress on individuals and populations (Wright and Kuczaj 2007). Prolonged exposure to stress may result in effects including immune system suppression, reproductive failure, accelerated aging, and slowed growth (Wright et al. 2007). Biomedical research on human stress provides a theoretical framework that can assist in conceptualizing and ultimately measuring the cumulative effects of multiple stressors on individual animals (NRC 2005).

Recent promising advances in the marine mammal field include the detection of stress hormones such as catecholamine and glucocorticoidsteroid hormones via non-invasive means such as fecal sampling (Rolland et al. 2006), sloughed skin or collection of exhaled mucus (Hogg et al. 2005). However, research needs in this area include validation and calibration of assays, improved detection capabilities, characterization of the relationship between hormone levels and time since exposure to the stressor, and determination of the levels of variability among individuals (ie. Buchanan and Goldsmith 2004).

Heart rate is a valuable parameter to measure for addressing a number of questions in biology because it is a function of the autonomic nervous system that provides information on the individual’s behavioral state, sensory abilities, and response to stimuli (Myksis-Olds et al. 2001). However, as the technologies used to measure heart rate (e.g. those that sample blood serum) are potentially invasive, great care must be taken to weigh the research benefits against the potential risk to the welfare of animal subjects as required by the Navy and approved by the host institution Institutional Animal Care and Use Committee (IACUC), consistent with the approved Department of Defense Animal Use Protocol, and, if applicable, a scientific research permit issued pursuant to the Marine Mammal Protection Act by NOAA Fisheries or United States Fish & Wildlife Service (USF&WS). One potential physiological change in a marine mammal following exposure to noise is an acute stress response that would include an increase in heart rate. During diving, marine mammals exhibit what has been termed the ‘dive response’ that includes redistribution of blood flow and reduced heart rate. Marine mammals maintain tight active control over heart and respiration rates for regulating blood gas homeostasis while diving.

Under normal conditions the intensity of the dive response depends upon the type of dive (e.g. foraging or traveling), dive depth and the planned duration of the dive. Diving mammals demonstrate a level of active control over the intensity of the dive response and modify it according to the demands of the particular dive type. A startle reaction may cause an animal to react to threats with a general discharge of the sympathetic nervous system, priming the animal for fighting or fleeing. Introduction of a novel stressor that startles an animal during a dive could potentially result in a suite of physiological conflicts; e.g., increased heart rate instead of suppressed heart-rate, increased oxygen requirements of muscles for flight, vasodilation at depth, etc. It is hypothesized that unexpected exposures to loud noises could produce a startle response and cause a temporary lapse in active control of physiological functions. When coupled with potential rapid ascents or descents, exposures could hypothetically affect normal diving patterns (dive duration, depth) potentially making animals more susceptible to diving related traumas.

Research Topic #3

- Conduct a workshop with internationally recognized researchers to identify the state of the field in stress physiology, focusing on identifying and evaluating available or developing technologies for measuring neuroendocrinological and cardiological indicators and other biomarkers, taking into consideration non-invasive techniques. The desired outcomes from this workshop would include:
    - Examine the utility and validity of recently developed non-invasive means of measuring hormones such as catecholamine and glucocorticoidsteroid hormones via fecal sampling, sloughed skin, or collection of exhaled mucus for application in marine mammal investigations.
    - Identify key cardiological and/or neuroendocrinological indicators that have promise in investigating the effects of stress on marine mammals exposed to MFA sonar
    - Identify technological needs related to sampling cardiological and/or neuroendocrinological indicators in free-ranging marine mammals. This may include more sophisticated data logger tags that sample blood serum and cardiac parameters, and/or other biomarkers for measuring cardiological and/or neuroendocrinological indicators. In particular, workshop participants should attempt to identify available technologies that are minimally invasive.
    - Identify existing research protocols in the marine mammal field that would facilitate development and testing of devices (data logger and/or biomarkers) to measure stress response in marine mammals.

Understanding of the long-term effects of stress on marine mammal individuals and populations requires the conceptual integration of short-term stress responses, energy budgets, and life history events. Stress responses, however, are only one of several concepts that require integration of energy budgets, and life history events if population level impacts of MFA sonar are to be considered. To date, little conceptual, empirical, experimental, or field work has been conducted in this area and it is well beyond the topic of the effects of stress on marine mammals exposed to MFA sonar.

ONR Estimated costs

- FY09 - $100K
- FY10 - $750K
- FY11 - $1.00M

N45 Estimated Costs

- n/a

The Navy agrees that the central management of cetacean acoustic and survey data would be an important tool. The Navy agrees to propose the development of a data management system for marine mammal data to the Federal Interagency Coordinating Group (ICG), which is composed of agency representatives that support or conduct research on the effects of sound on marine mammals. We believe the ICG is the appropriate interagency facilitator for this project.

References cited:

Anderson, DR. 2001. The need to get the basics right in wildlife field studies. Wildlife Society Bulletin 29: 1294-1297.

Anderson, DR. 2003. Response to Engeman: index values rarely constitute reliable information. Wildlife Society Bulletin 31: 288-291.

Buchanan KL, Goldsmith AR. 2004. Noninvasive endocrine data for behavioral studies: the importance of validation. Animal Behavior. 67: 183-185.

CeTAP. 1982. A characterization of marine mammals and turtles in the mid- and north Atlantic areas of the US outer continental shelf. Report BLM/YR/TR-82/03. Bureau of Land Management, US Department of the Interior, Washington DC, USA. 538 pp.

Cox, T ., T J Ragen, A J Read, Vos, RW 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 Houserp, T Hullar, P D Jepson, D Ketten, C D Macleod, P Miller, S Moore, D C Mountain, D Palka, P Ponganis, S Rommel, T Rowles, B Taylor, P Tyack, D Wartzok, R Gisiner, J Mead, and L Benner. 2006. Understanding the impacts of anthropogenic sound on beaked whales. Journal of Cetacean Research and Management 7:177-187.

Dalebout, M., JG Mead, CS Baker, AN Baker, and AL van Helden. 2002. A new species of beaked whale *Mesoplodon perrini* sp. n. (Cetacea: Ziphiidae) discovered through phylogenetic analyses of mitochondrial DNA sequences. Marine Mammal Science 18:577-608.

Evans, D I and England, GR. 2001. Joint interim report Bahamas marine mammal stranding event of 15-16 March 2000. National Oceanic and Atmospheric Administration. 59 pp available at: http://www.nmfs.noaa.gov/prot_res/PR2/Health_and_Stranding_Response_Program/Interim_Bahamas_Report.pdf

Fair, PA and PR Becker. Review of stress in marine mammals. 2000. Journal of Aquatic Ecosystem Stress and Recovery, 7: 335-354.

Ferguson MC, Barlow J, Reilly S, Gerrodette T. 2006. Predicting Cuvier's (Ziphius cavirostris) and Mesoplodon beaked whale population density from habitat characteristics in the eastern tropical Pacific Ocean. J Cetacean Res Manage 7:287-299.

Gillespie, D., and M Caillat. 2007. Statistical classification of odontocete clicks. Presentation with abstract, Third International Workshop on Detection and Classification of Marine Mammals using Passive Acoustics, Boston, July 2007.

Hamazaki T. 2002. Spatiotemporal prediction models of cetacean habitats in the Midwestern North Atlantic Ocean (from Cape Hatteras, North Carolina, USA to Nova Scotia, Canada). Marine Mammal Science 18:920-939.

Hogg, C, Rogers, T, and Vickers, ER. 2006 Reproductive hormones are unstable in some non-invasive samples Journal of Experimental Zoology Part A – Comparative Experimental Biology 305A (2): 133-133.

Jarvis, SM, NA DiMarzio, RP Morrissey, and DJ Moretti. 2007. A novel multi-class support vector machine classifier for automated classification of beaked whales and other small odontocetes. Presentation with abstract, Third International Workshop on Detection and Classification of Marine Mammals using Passive Acoustics, Boston, July 2007.

Johnston DW, McDonald M, Polovina J, Domokos R, Wiggins S, Hildebrand J. 2008. Temporal patterns in the acoustic signals of beaked whales at Cross Seamount. Biology Letters 4:208-211.

Kandia, V, and Y Stylianou. 2007. Detection of clicks based on group delay. Presentation with abstract, Third International Workshop on Detection and Classification of Marine Mammals using Passive Acoustics, Boston, July 2007.

MacLeod, CD. 2005. Niche Partitioning, Distribution And Competition In North Atlantic Beaked Whales. Doctoral Thesis, University of Aberdeen, Aberdeen,UK.

MacLeod, CD and Zuur, AF. 2005 Habitat utilization by Blainville's beaked whales off Great Abaco, northern Bahamas, in relation to seabed topography. Marine Biology 147: 1-11.

MacLeod CD, Mitchell G. 2006. Key areas for beaked whales worldwide. JCRM 7:309-322.

Maldini DL, Mazzuca L, Atkinson S. 2005. Odontocete stranding patterns in the main Hawaiian Islands (1937-2002): how do they compare with live animal surveys? Pacific Science 59:55-67.

Marine Mammals Commission (2004) Marine Mammal Commission Beaked Whale Technical Workshop Summary - April 13-16, 2004. 13pp. http://mmc.gov/sound/beakedwhalewrkshp/pdf/bwhale_wrkshpsummary.pdf

Mellinger, DK 2007. A comparison of methods for detecting sounds of Blainville's beaked whales (*Mesoplodon densirostris*). Presentation with abstract, Third International Workshop on Detection and Classification of Marine Mammals using Passive Acoustics, Boston, July 2007.

Mellinger, DK, and CW. Clark. 2006. MobySound: A reference archive for studying automatic recognition of marine mammal sounds. Appl. Acoust. 67:1226-1242.

Morrissey, RP., DJ Moretti, NA DiMarzio, SM Jarvis, and JA Ward. 2007. A comparison of a matched filter, an energy detector, and an FFT based detector for click detection based on a data set consisting of beaked whale (*Mesoplodon densirostris*) vocalizations. Presentation with abstract, Third International Workshop on Detection and Classification of Marine Mammals using Passive Acoustics, Boston, July 2007.

Myksis-Olds, JL, RC Conner, MD Grund, Dp Nowacek, AR Solow, and PL Tyack. 2001. Cardiac response to acoustic playback experiments in the captive bottlenose dolphin (Tursiops truncates). J Comp Psych 115:227-232.

National Research Council (NRC). 2003. Ocean Noise and Marine Mammals. National Academy Press: Washington, D.C. 192 pp.

National Research Council (NRC). 2005. Marine Mammal Populations and Ocean Noise: Determining When Noise Causes Biologically Significant Effects. National Academy Press: Washington, D.C. 96 pp.

Pollock, KH, JD Nichols, TR Simons, GL Farnsworth, LL Bailey and JR Sauer. 2002. Large scale wildlife monitoring studies: statistical methods for design and analysis. Environmetrics 13:105-119.

Richardson WJ, Greene CRJ, Malme CI, Thomson DH (1995) Marine Mammals and Noise. Academic Press, San Diego

Roch, MA, MS Soldevilla, JC Burtenshaw, R Hoenigman, SM Wiggins, and JA Hildebrand. 2007. Comparison of machine learning techniques for the classification of echolocation clicks from three species of odontocetes. Presentation with abstract, Third International Workshop on Detection and Classification of Marine Mammals using Passive Acoustics, Boston, July 2007.

Rolland, RM , PK Hamilton SD Kraus, B Davenport, RM Bower and SK Wasser. 2006. Faecal sampling to study reproduction and health in North Atlantic right whales. Journal of Cetacean Research and Management. 8:121-125.

Theriault, JA, and J Hood. 2007. Acoustic cetacean detection capability performance with the workshop dataset. Presentation with abstract, Third International Workshop on Detection and Classification of Marine Mammals using Passive Acoustics, Boston, July 2007.

Waring GT, Fairfield CP, Ruhsam CM, Sano M. 1993. Sperm whales associated with Gulf Stream features off the northeastern USA shelf. Fisheries Oceanography 2:101-105.

Waring GT, Hamazaki T, Sheenan D, Wood G, Baker S. 2001. Characterization of beaked whale (Ziphiidae) and sperm whale (Physeter macrocephalus) summer habitat in shelf-edge and deeper waters off the northeast US. Marine Mammal Science 17:703-717.

Wright AJ, Kuczaj S. 2007. Noise related stress and marine mammals: an introduction. International Journal of Comparative Psychology 20:iii-viii.

Wright AJ, Aguilar Soto N, Baldin AL, Bateson M, Beale C, Clark C et al. 2007. Are marine mammals stressed by anthropogenic noise? International Journal of Comparative Psychology 20:274-316.

Wiggins, SM and Hildebrand, JA (2007). High-frequency Acoustic Recording Package (HARP) for broad-band, long-term marine mammal monitoring. In UT07 Underwater Tech. and Workshop on Scientific Use of Submarine Cables and Related Tech., pp. 551-557. Tokyo, Japan.

Additional references cited:

Barlow J, Gisiner R. 2006. Mitigating, monitoring and assessing the effects of anthropogenic sound on beaked whales. J Cetacean Res Manage 7:239-249.

Best BD, Halpin PN, Fujioka E, Read AJ, Qian SS, Hazen LJ, Schick RS. 2007. Geospatial web services within a scientific workflow: Predicting marine mammal habitats in a dynamic environment. Ecological Informatics 2:210-223.

Redfern JV, Ferguson MC, Becker EA, Hyrenbach KD, Good C, Barlow J, Kaschner K, Baumgartner MF, Forney KA, et al. 2006. Techniques for cetacean habitat modeling. Marine Ecological Progress Series 271-295.