

MOCHA - Multi-Study Ocean Acoustics Human Effects Analysis

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LONG-TERM GOALS

The long-term goal is to substantially enhance our quantitative understanding of the response of marine mammals to navy sonar and other acoustic stimuli, by maximizing the information gain from Behavioural Response Studies (BRSs). We aim to develop and implement innovative methods for the analysis of BRS data, and to complement and enhance analyses already taking place as part of each current Navy-funded BRS project. We aim for synergies by looking at the studies in combination.

OBJECTIVES

The overall objective of this project is to develop and implement innovative statistical methodologies for the analysis of behavioral response study data. Our focus is on studies estimating the response to mid-frequency active sonar, but the methods developed will be widely applicable. We aim to maximize the inferences that can be drawn from current and ongoing studies as well as to provide advice on future studies. Advances will be made in close collaboration with those involved in existing BRS projects, using a working group format. This approach enables us to complement and enhance the analytical work already being undertaken, as well as to be flexible and incorporate new ideas as they arise in working group sessions.

The project has four specific objectives:

1. Improve methods for combining diverse behavioral measures into metrics of behavioral response. Consideration will be given to obtaining metrics that can be linked to biological consequences. We will consider the strengths and limitations of the various possible behavioral measures, and provide recommendations on appropriate behavioral measures and metrics for future studies.
2. Improve methods for estimating dose-response functions for individual studies. This involves both developing and applying cutting-edge statistical methods, as well as considering what contextual variables in addition to acoustic dose can be incorporated into the analysis. The output will be improved estimates of response curves (with uncertainty) for each study.

3. Combine information across studies and species (“meta-analysis”), making use of expert biological opinion, to make predictions about taxa and contexts not yet studied. Differences in methods/protocols between studies will need to be accounted for. A component of this objective is to quantify the similarity/dissimilarity between species, placed into functional groups.
4. Based on the above, determine where major uncertainties still lie, and hence suggest where future experimental effort might be applied most fruitfully (through sensitivity analyses).

APPROACH

We have formed a working group, supported by two full-time post-doctoral researchers, to develop and implement innovative methods for the analysis of the results from BRSs. The working group is composed of the chief scientists of existing BRS projects (Sirena sonar trials on sperm whales, Bahamas BRS, SOCAL BRS, Norwegian 3S and 3S2, Cape Hatteras EK60 experiments and Cape Hatteras and Hawaiian killer whale BRS), together with other scientists working on BRS issues and statisticians who have expertise in the analysis of biological data of this kind. A smaller steering committee, comprising the PIs on this project and the BRS PIs, is providing overall direction.

Over the course of the project we will hold a series of workshops that will be attended by the working group, steering group and project post-doctoral researchers. Each workshop will focus on a functional/taxonomic group of marine mammals (deep divers, pilot whales, baleen whales, other odontocetes). We have chosen these focal groups and in this order for a number of reasons, as follows. We have begun with deep divers (beaked whales and sperm whales) because this group contains species of concern, there are data for these species across multiple BRS projects and the metrics measured are fairly well defined and the social complexities are minimized. We are now beginning to focus on pilot whales for which there is data from most BRSs but focusing on this species will provide an opportunity to investigate the additional complexities associated with a social species whose vocal behavior is poorly understood. The 3rd and 4th workshops will focus on baleen whales and other odontocetes respectively – one motivation for focusing on these groups later in the project is because data collection is ongoing and we anticipate additional data being obtained for these groups particularly over the first year of the project (2012).

Two post-doctoral researchers (Stacy DeRuiter and Dina Sadykova) will conduct the majority of the research and model development over the course of the project under the supervision of Harris and Thomas, with frequent inputs from other project partners as required.

In the periods between workshops, small sub-sets of the working group will participate in technical groups to advance particular aspects of the project in parallel with the main effort. These will be formed as necessary and will hold regular (at least one per month) conference calls to discuss technical aspects of the project. This format of separating conference call meetings into small technical meetings and larger progress meetings has worked very well within other projects coordinated by the PIs (such as the NOPP-facilitated DECAF project and the ONR-funded LATTE project).

WORK COMPLETED

The project officially started in April 2012; however to take advantage of a number of the working group being present in the UK in February 2012 we held the first working group meeting early. In addition we took the opportunity to present the project to the participants in the BRS workshop held on

26th November 2011 at the Biennial Society for Marine Mammalogy conference in Tampa, Florida, and discuss the project plan with the working group at a smaller workshop following the BRS workshop. This greatly facilitated project start-up.

The first working group meeting took place in St Andrews, UK between the 15th and 16th February 2012. This was the start-up meeting of the project and so involved all parties and included an overview of each BRS project, focussing particularly on the protocols used and metrics measured, and discussion of how to integrate data and results across projects. One important outcome of this meeting was the setting up of a number of technical groups who will advance particular aspects of the project in parallel with the main effort. The report of the first working group meeting can be found at <http://www.creem.st-and.ac.uk/mocha/project-outputs>

The second working group meeting took place in St Andrews, UK between the 19th and 21st September 2012. The aim of this workshop was to focus on deep-divers (beaked whales and sperm whales). In the months prior to this deep-diver workshop the MOCHA project team focused on combining the data available from different BRS projects on beaked and sperm whales, and developing methods that can be applied across species. In order to combine data we had to make sure the metrics measured were consistent across species, which required some exploratory analysis of the data. Methods developed included change-point analysis on time-series data, identifying if exposed dives differed from baseline dives and preliminary dose-response relationships. During the workshop these analyses were discussed with the working group and ways to move forward were decided so that the analysis could be completed before the next workshop.

A database summarizing each exposure used in the MOCHA project has also been developed and the aim is to populate it for each exposure across the BRSs.

A dedicated project website has been set-up to enhance communication within the project and to allow dissemination of progress to a wider audience (<http://www.creem.st-and.ac.uk/mocha/>).

RESULTS

No concrete results as yet.

IMPACT/APPLICATIONS

This project aims to significantly enhance the Controlled Exposure Experiments component of the Marine Mammals and Biology Program, and it will also address broader commitments of the Navy for environmental compliance. As part of rule making under the US Marine Mammal Protection Act, the Navy has committed to an Integrated Comprehensive Monitoring Program with the following objectives: monitor and assess the effects of Navy activities on protected marine species; ensure that data collected at multiple locations is collected in a manner that allows comparison between and among different geographic locations; assess the efficacy and practicality of the monitoring and mitigation techniques; add to the overall knowledge base of protected marine species and the effects of Navy activities on these species (Stone 2009). As part of its environmental compliance, the Navy must attempt to quantify the effect of sonar operations on marine mammals in all of its operating areas. This requires methods to estimate the relationship between acoustic dosage and other factors with behavioral responses. Here we propose to develop a framework to pool data across studies and areas to develop more systematic models to quantify these effects.

The focus of this research will be BRSs that have been funded by the US Navy and SERDP. We hope to maximize the gain from each BRS by combining the expertise, knowledge and data from these studies. All BRS studies collected some baseline and control data, but we also propose to include as much baseline data from other studies as will strengthen the development of our models. In addition, we hope to include other BRS studies, such as those looking at effects of seismic activities, as these are likely to have similar exposure protocols and data analysis issues but this will require additional resources.

RELATED PROJECTS

Data to be analysed in the MOCHA project comes from a number of BRS projects that have focussed on different geographic areas and species. Below is a list of the projects providing data and links to websites with further information on each project, where available. More information about each project can be found in links listed at <http://www.creem.st-and.ac.uk/mocha/links>

- Sirena sonar trials on sperm whales
- BRS Bahamas (AUTEK): <http://www.nmfs.noaa.gov/pr/acoustics/behavior.htm>
- SOCAL BRS: <http://sea-inc.net/socal-brs/>
- 3S: <http://soi.st-andrews.ac.uk/documents/424.pdf>
- 3S2: <http://www.ffi.no/no/Rapporter/11-01289.pdf>
- Cape Hatteras: <http://www.serdp.org/Program-Areas/Resource-Conservation-and-Climate-Change/Natural-Resources/Living-Marine-Resources-Ecology-and-Management/RC-2154/RC-2154>

Other related research projects are:

- LATTE - This three year project is developing and implementing statistical models that integrate passive acoustic monitoring data and animal-borne tag data to estimate the effect of Mid Frequency Active (MFA) sonar on beaked whales at AUTEK.
- M3R program – This is the passive acoustics monitoring algorithms and tools development program at NUWC that has facilitated much of the data processing work used in the current project.
- PCADs – This project aims to operationalize the Population Consequences of Acoustic Disturbance framework, focusing (currently) on four case study species, including beaked whales at AUTEK.

REFERENCES

Stone VF (2009) United States Navy Integrated Comprehensive Monitoring Program. Available at http://www.nmfs.noaa.gov/pr/pdfs/permits/socal_hrc_icmp.pdf

PUBLICATIONS

1st MOCHA Working Group Meeting Report, 2012 (Technical Report)