A Power Analysis and Recommended Study Design to Directly Detect Population-Level Consequences of Acoustic Disturbance

Jeffrey Moore
NOAA Southwest Fisheries Science Center
8901 La Jolla Shores Drive
La Jolla, CA 92037
phone: (858) 546-7161 fax: (858) 546-7003 email: jeff.e.moore@noaa.gov

David Moretti
Navy Undersea Warfare Center (NUWC)
Newport, RI
phone: (401) 832-5749 email: david.moretti@navy.mil

Award Number: N0001415IP00088 & N0001415WX01764
https://swfsc.noaa.gov/textblock.aspx?Division=PRD&id=1222&ParentMenuId=148

LONG-TERM GOALS

Provide advice to the Navy on how best to monitor health and status of beaked whale populations on and in the vicinity of the SOAR range within the Southern Californinia Bight based data from a fixed acoustic array and photo-ID program. Recommendations will be based on addressing the following question: "How do quantify potential human impacts on the health of beaked whale populations?"

OBJECTIVES

The following is a modified list of objectives from our funded research proposal:

1) Conduct power analyses individually for the mark-resight (photo ID) monitoring schemes, to compare it effectiveness at being able to detect beaked whale population trends, and suggest revisions to sampling design to improve the effectiveness
2) Use photo-ID datasets to assess and improve the reliability of different measures of abundance from the acoustic hydrophone datasets, noting that the hydrophones record activity levels, not actual abundance
3) Evaluate sampling design schemes that will enable the hydrophone-array and photo-ID data to best complement each other; i.e., describe an optimal "mix" of these data types to maximize inference about beaked whale population dynamics

APPROACH

The methodological approach is outlined in our research proposal. Briefly, analysts (led by PIs Moore and Curtis) will develop an analytical framework for estimating key population dynamics parameters (trends, abundance, survival rates, etc.) from the data being collected at SOAR (photo ID data,

collected by PIs Falcone and Schorr; and acoustic data, coordinated by PI Morretti). The analysis framework will allow for a power analysis to be conducted (i.e., to evaluate the statistical power to detected trends and estimate other parameters with desired precision, given observed sampling variances). From this, we will be able to provide advice as to which data types need to be collected (that presently are not) and what sampling sizes (i.e., levels of effort) are required to make accurate inferences about the population.

WORK COMPLETED

Investigators met for an all-day planning meeting (Aug 28, 2015) at Southwest Fisheries Science Center, La Jolla, CA. During the first part of the meeting, investigators provided detailed overviews of individual projects that are relevant (e.g., as inputs) to this collaborative project. Moore provided an overview of an analysis template for evaluating the power to detect trends within a Bayesian framework. Falcone and Schorr described their sight-resight study on the SOAR range. Moretti described the acoustic array monitoring program at SOAR. A primary purpose of this was for the project analysts to get familiar with the datasets.

The second part of meeting was devoted to brainstorming a way forward for the project analysis. At the meeting, we were able to define the overarching question for the project as: "How do quantify potential human impacts on the health of beaked whale populations?" (i.e, what is a recommended study design for doing this?). Quantifying population health requires defining appropriate metrics, and in turn, identifying whether data are being collected (at sufficient sampling levels) to quantify those metrics. For example, *some* metrics of population health (in the study area) include:

1) trends in use (e.g., of the SOAR range)
2) trends in actual abundance of animals using SOAR (which may differ from trends in use; for example abundance in the San Nicolas Basin could be stable while use of SOAR declines)
3) annual survival rates
4) productivity (e.g., reproductive success)

We will consult the PCAD project as one precedent-setting framework for defining population health and impacts thereon.

The acoustic array data from the SOAR range provide powerful inference to measure trends in use at SOAR, but this alone is insufficient to assess population health, because use patterns of the study area provide limited information about whether the population (abundance) is actually increasing, stable, or decreasing (population could be stable but just not using the SOAR area as much, or use of the SOAR area could be stable due to steady influx of immigrants while population fails to successfully reproduce). The mark-resight and satellite tag data potentially (if sample effort is sufficient) provide estimates of annual survival and actual abundance – key measures of population health -- but to determine this, we need to develop an analysis framework that integrates all the available data that exist to date (acoustic array, mark-resight, and satellite tag). The next step of our project is to do this. Analyzing the existing data will allow us to evaluate what data types are needed to obtain better (or any) estimates of key parameters for assessing population health and what level of sampling is required to do this adequate (i.e,. the power analysis).

By developing an analysis framework, applying this to existing data, and using this as the basis for conducting power analysis, we aim to address a number of specific questions:

- What kind of inferences can and cannot be obtained from the acoustic array monitoring data alone?
- How essential are the mark-resight and satellite tag data? How is the value of those data maximized? What are the minimum sampling levels/effort required for those data to provide suitable inference?
- What other data sets are needed (that are not currently collected), if any, to adequately assess population health?
- Are there other survey approaches (currently used or not) that could be useful for monitoring beaked whale population health? For example, biopsy sampling could provide data on population sex ratio and reproductive success. Visual survey data (vessel or aerial line transects) were ruled out due to the obvious ineffectiveness of this platform to detect beaked whales with suitable sample size. And so on.

The next step of the project is to develop a statistical framework to integrate the various datasets that have been collected by Morretti and Schorr/Falcone. Potential analytical ways forward were discussed at the meeting.

We maintain the overarching objective of recommending a monitoring design -- that describes necessary data types and levels of survey effort -- required to effectively assess population health for beaked whales in the Southern CA Bight.

RESULTS

There are no results obtained to date. Analyses for the project will be undertaken during FY16.

IMPACT/APPLICATIONS

Based on project outcomes, we will be able to recommend a monitoring design to maximimze effectiveness of Navy funds for monitoring population health of beaked whales and human impacts thereon.

RELATED PROJECTS

Moretti, David

- Advanced methods for passive acoustic detection, classification, and localization of marine mammals)
- A population consequence of acoustic disturbance model for Cuvier's beaked whale (Ziphius cavirostris) in southern California: Photo-id and tag data components