Environmental Studies Program: Ongoing Study

Study Area(s): All

Administered By: National

Title: Propagation Characteristics of High-Frequency Sounds Emitted During High-Resolution Geophysical Surveys: Open Water Testing – Operations (NSL #NT-14-03b)

BOEM Information Need(s) to be Addressed: Improved understanding of the operational and propagation characteristics of high-frequency sound sources is crucial to predict or assess the potential behavioral response of marine species and determine appropriate mitigation, as required under the National Environmental Policy Act (NEPA), the Marine Mammal Protection Act (MMPA) and the Endangered Species Act (ESA). Currently, limited observations are available on the underwater propagation of the high frequency sound generated from sources other than air guns (e.g., boomers, sparkers, chirpers, side-scan sonar, and single, swath, and multi-beam bathymetry).

Total BOEM Cost: $599,905 **Period of Performance:** FY 2015–2018

Conducting Organization(s): CSA Ocean Sciences, Inc.

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Description:

Background: Marine geophysical data is critical for industry and BOEM to make informed leasing decisions. High frequency marine acoustic sources are commonly used and required during infrastructure siting, geological or environmental characterization, and shallow hazard or archaeological cultural surveys. The acoustic sources currently in use include boomers; sparkers; sub-bottom (chirp or other) profilers; side-scan sonar; and single, swath, and multi-beam bathymetric fathometers. The marine source acoustic source levels generally range from 170 to 240 dB re 1 µPa @1 m (peak-to-peak), and operate in the < 300 Hz to several hundred KHz range.

Many of these high resolution geophysical systems characteristics may be capable of affect marine life (e.g., marine mammals, sea turtles, and fish). The potential for impacts range from physical injury to behavior changes, and are highly dependent on the species' hearing bandwidth and integration time along with the source characteristics and the local acoustic propagation effects.

Currently, limited calibrated or in-field source characterization data exists for these sources, other than that provided by the manufacturer. Additionally, there is a dearth *in situ* measurements of these systems. Specifically, the sound fields produced by the interaction of these sources with the local propagation characteristics are poorly understood, and shallow to intermediate water depths (e.g., 10 to <70 m) further

exacerbate the issue. In the shallow water areas where these system frequently operate, the propagation may be severely complicated by bathymetric interaction, variable sediment composition, shallow water processes (i.e., breaking waves), and mesoscale oceanographic properties. Numerical models currently used to predict propagation and transmission loss also need to be validated to not only more accurately represent these important physical processes, but also to provide a referable document that can be used to assure BOEM, NMFS and the public, of the efficacy of impact modeling of these types of sources in shallow water for the environmental compliance processes.

Objectives: BOEM's overall objective is to ensure that reliable and scientifically repeatable data is available to characterize the variety of high frequency acoustic sources typically used for geophysical surveys and to ensure that the acoustic propagation and impact models that these inputs reliable predict the sound field these systems produce. In this way, this predictive capability can be used throughout the environmental compliance process from assessing potential impacts to analyzing the effectiveness of various mitigation approaches.

The specific objective of this study is to: capture the acoustic sound fields of the actual representative sources (e.g., boomers; sparkers; chirp seismic; side-scan sonar; single, swath, and multi-beam bathymetric sonars) in a few selected shallow water environments, whose important parameters (bathymetry, sediment type and depths, sound velocity profiles, etc.) have been measured and quantified as well as current technology allows for routine sonar operations. The sound fields for each of these systems/sources will be measured in sufficient detail to capture its overall *in situ* characteristic (e.g., maximum source level, frequency spectrums, beam patterns, and acoustic multipath structure).

Methods: As a minimum, the measurements will be designed and executed to capture the three dimensional sound field for each system/source in the following minimum requirements:

- Three (3) nominal operational water depths, 10, 30 and ~100 m (or as deep as is operationally possible),
- Two (2) sediments types should be sampled (*i.e.*, be the predominant type in a given site), nominally, sand and mud,
- All pertinent and necessary meteorological and environmental acoustic (EVA) data needs to be collected,
- Record the location in all three dimensions of all source and receiver positions,
- Record the pertinent all ship self-noise data (this may be replaced or supplemented by previous, but recent measurements of this data),
- Utilize the results of Phase 1 in the planning of this measurement, and
- Ensure that sufficient quantity and quality of data is collected to support modeling effort in Phase 3.

The data collected and quantified in this project will need to be of sufficient quality to feed directly into the final separate but associated project: the acoustic modeling effort

which will examine how this data and current acoustic propagation and prediction models compare to the measured data and can be improved.

Current Status: The at-sea data collection phase of this project was completed in July 2016, and the analysis of the collected data is in progress. To date, all of the data has been:

1) transferred from the original recording systems,
2) synchronized and stamped with a corrected time,
3) localized in three dimensions throughout its recording period,
4) calibrated with corrected acoustic received levels, and
5) integrated with the calibrated source signals and positions in order to derive bearings and ranges between the source and each receiver.

The final steps of synthesizing all of this data into:

1) projected sound fields for each source and
2) estimated transmission loss or propagation estimates for the five locations where the testing occurred

is ongoing and expected to be completed in draft form within the month. Draft versions of those portions of the report that describe the experiment, the acoustics and support systems and the analysis methodology have already been drafted and reviewed.

Final Report Due: November 7, 2017

Publications Completed: T.B.D.

Affiliated WWW Sites: T.B.D.

Revised Date: July 6, 2017