

**Study Title:** Identify Information Needs and Data Gaps on the Effects to Fish, Fisheries and Invertebrates in the U.S. Atlantic and Arctic from Sound-Generating Activities by the Energy Industry

**Report Title:** Effects of Noise on Fish, Fisheries, and Invertebrates in the U.S. Atlantic and Arctic from Energy Industry Sound-Generating Activities

CONTACT NUMBER: M11PC00031

SPONSORING OCS REGION: Headquarters

APPLICABLE PLANNING AREAS: Alaska (Beaufort Sea, Chukchi Sea, Hope Basin), Atlantic (North, Mid, South)

COMPLETION DATE OF REPORT: December 2012

COST BY FISCAL YEAR: FY 2011: \$351,781

CUMULATIVE PROJECT COSTS: \$ 351,781

PROJECT MANAGER: Ann Pembroke

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**KEY WORDS:** underwater sound, underwater noise, seismic exploration, pile driving, marine minerals extraction, dredging, offshore wind, impacts to fish, impacts to fisheries, impacts to invertebrates, sound detection

**BACKGROUND:** Sound from man-made sources has been increasing in the world's oceans. BOEM's missions all include one or more activities (e.g., seismic exploration, pile driving, drilling, dredging, and vessel traffic) that introduce sound into the marine environment. BOEM is responsible for evaluating the effects of these noise sources on biota. While advances have been made in understanding the effects on marine mammals, the sheer taxonomic and environmental diversity of fishes and invertebrates has made the task of understanding the effects on these species a much more onerous task. Much remains to be learned about the hearing or sound-producing capabilities of fishes and invertebrates, let alone how they respond to, and are potentially affected by, man-made sounds.

**OBJECTIVES:** This project encompasses three components: a literature synthesis, a workshop, and an analysis of information needed to improve BOEM's understanding of the issues and enhance BOEM's ability to make environmentally sound management decisions. There were three primary study objectives:

- Compilation of the recent information on the effects on underwater sounds on fish, fisheries, and invertebrates to aid in identifying issues that need further investigation and to inform workshop participants prior to the workshop;

- Convening a group of experts to discuss the state of knowledge on this topic at a workshop that includes oral presentations and discussion groups on critical issues; and,
- Evaluation of the information needs and data gaps that arose through the literature synthesis and the workshop to identify those that are achievable, have the most relevance to BOEM, and have the greatest potential to advance an understanding of the impact issues in the reasonable future.

**DESCRIPTION:** A comprehensive literature survey was conducted on the effects of noise from man-made sources on fish, fisheries, and invertebrates. The synthesis included background information on the fisheries and ESA-listed species in the two geographic areas of interest so that analysis of the issues could focus on species relevant to BOEM's interests. Further background information on the background levels of sound in the sea, biological sound production and hearing capabilities, and man-made sources of underwater sound were included. The synthesis summarized the available literature on the various effects from sound exposure that have been documented, ranging from behavioral responses to injury or death.

A workshop that included 24 oral presentations and six breakout group discussions on four major topic areas (purpose of the workshop; priority habitats, species, and fisheries; sources and sound exposure; and effects of sound on fishes and invertebrates) was convened in March 2012. The oral presentations were designed to set the stage for breakout group discussions the goals of which were to identify the most important information needed to resolve questions of how fish, fisheries, and invertebrates are affected by man-made sounds in the marine environment.

The workshop report has two major components: a summary of the workshop and an analysis of the information needs and data gaps that were identified throughout the project. The report discusses all of the needs and gaps and then narrows them down to those that are likely to provide the most direct path to improving BOEM's ability to analyze the impacts arising from sound-generating activities in BOEM's missions.

**STUDY PRODUCTS:** Normandeau Associates, Inc. 2012. Effects of Noise on Fish, Fisheries, and Invertebrates in the U.S. Atlantic and Arctic from Energy Industry Sound-Generating Activities. A Literature Synthesis. U.S. Department of the Interior, Bureau of Ocean Energy Management. Contract # M11PC00031. 135 pp.

Normandeau Associates Inc. 2012. Effects of Noise on Fish, Fisheries, and Invertebrates in the U.S. Atlantic and Arctic from Energy Industry Sound-Generating Activities. Workshop Report. U.S. Department of the Interior, Bureau of Ocean Energy Management. 72 pp. + appendices