Environmental Studies Program: Ongoing Study

Title	A Database and Acoustic Reference Catalog of Marine Fish Sounds—Atlantic Pilot (AT-20-06)
Administered by	Office of Renewable Energy Programs
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Procurement Type(s)	Cooperative Agreement
Conducting Organization(s)	Cornell University
Total BOEM Cost	$ 300,000
Performance Period	FY 2021–2023
Final Report Due	February, 2024
Date Revised	August 4, 2023
PICOC Summary	
Problem	This study addresses the problem of not understanding which acoustically active fish are present in passive acoustic monitoring datasets.
Intervention	This study would develop an acoustic catalog of fish sound to be used in analyzing passive acoustic data.
Comparison	NA
Outcome	The outcome will be a better understanding of passive acoustic monitoring data.
Context	BOEM currently collects passive acoustic data for a variety of research and monitoring needs. Unfortunately, the data is only used for detecting a few species of marine mammals when it could be used for detecting the presence of sound-producing fish as well.

BOEM Information Need(s): BOEM needs to understand potential impacts to fish and fisheries from offshore wind construction. One means of accomplishing this is through passive acoustic recordings, which can monitor for the presence and seasonal patterns of soniferous fishes. In order to do so, a library of fish sounds is required – this will allow for analysis of existing (and future) passive acoustic recordings. In addition, fish-specific acoustic detectors can be used to scan long-term recordings and will provide important information about key habitat areas via a non-invasive means. This information in turn will aid in environmental impact during industry activities attempting to maintain National Environmental Policy Act (NEPA) and Magnuson-Stevens Fishery Management Conservation and Management Act compliance.

Background: Ocean passive acoustic recording has primarily focused on marine mammals, due to their broadly protected status. Acoustic recordings have been demonstrated to be effective for acoustically monitoring fish populations as well. However, those species of fish that have been identified to produce sounds have not been well documented, and on many long-term marine acoustic recordings, many sounds are recorded that are likely produced by fishes, but the species identity is unclear. As many as 50–70% of the fish species along the U.S. Atlantic coast are potentially capable of producing sounds, but only a small number have been well-described. Fish sounds that emerge during these recordings create

clutter when trying to identify marine mammal sounds, but this "clutter" actually contains important information. However, the lack of species-specific description of these sounds limits their utility in terms of understanding the biology of fish populations, as well accounting for their occurrence in whale surveys.

Many fish species produce species-specific acoustic calls in courtship and aggression that are strongly tied to seasonal patterns of movement and reproduction. The ability to remotely monitor changes in their normal behaviors allows them to serve as bioindicators of anthropogenic impacts and environmental changes. Understanding (1) which species of fishes are producing sounds and (2) the time of year that they vocalize, allows for passive recording of fish bioacoustics to serve as a mechanism to detect changes in nearshore marine ecosystems. Fish acoustic behavior may be affected by anthropogenic noise, including seismic air guns, pile-driving, and ship traffic. For example, the frequency range of ship propeller noise overlaps with the fundamental frequency component of many fish sounds, creating a masking effect of fish calls. Once a baseline pattern of fish calling is established, effects of increased anthropogenic activity on fish behavior may be more accurately evaluated.

Much of the foundational work in understanding the sounds produced by fishes was published in 1970 by Marie Poland Fish and William H. Mowbray in *Sounds of Western North Atlantic Fishes*. Despite being over 40 years old, and the sounds recorded under laboratory conditions on analog equipment, this work is still largely the key reference in the field of fish acoustics. An updated, publicly available compendium of fish sounds would allow the research and regulatory communities to examine the dynamics of fish acoustic behaviors, and in turn, improve information about their populations across broad spatial scales. A group of federal stakeholders and fish bioacoustics experts will be convened to identify a list of priority species. Sounds from these species will be described in a publicly accessible database and will be made freely available as an online multi-media reference FishBase, a widely used fish identification tool. Automatic detectors for common species' calls will be created and tested using previously recorded passive acoustic data.

Our goal is to develop this approach along the U.S. Atlantic coast, given the known species occurrence, previous acoustic work, and energy development potential, but similar approaches could also be applied to other parts of the outer continental shelf.

Objectives:

1. Convene technical and stakeholder working groups to synthesize the current state of knowledge in the field and identify user needs within the scientific and regulatory communities.

2. Synthesize all known and described sound produced by marine and estuarine fishes found within the U.S. Atlantic EEZ (including both federal and state waters).

3. Deposit validated examples of fish sounds and appropriate metadata into a dedicated portal with linked with FishBase to serve as a permanent, publicly available collection of fish sounds to use for reference, research, education and outreach.

4. Compile the list of soniferous taxa into a summary database that is searchable by species, family, and Atlantic EEZ region.

Methods: A team of fish sound experts will be assembled to query the research community for which species have been recorded, and a list of acoustically active Atlantic fish species would be identified. Automatic detection algorithms will be developed for these species and will be tested against a human analyst using existing long-term passive acoustic recordings from a previous BOEM project. A

searchable, relational database with a web-based graphical user interface will be developed to describe the behavioral context of sounds recorded, environmental conditions, etc. Recordings of fish sounds will be linked within [FishBase](#), a widely used fish identification tool. If additional recordings from new species are needed, these will be collected as an add-on to other research projects.

Specific Research Question(s): This study will allow for a deeper evaluation of existing passive acoustic datasets and fine tune acoustic detectors so that specific fish or fish groups can be passively monitored during offshore wind construction and operation.

Current Status: A kick-off meeting was held on February 16, 2021. A [paper](#) was published in Frontiers in Ecology and Evolution calling for a global library of underwater biological sounds. Vocalizations from Atlantic Sturgeon have been recorded. A list of all marine fishes in the U.S. EEZ has been compiled and the table with soniferous species is nearly complete. The team has started to train automated detection models for focal fish species to demonstrate scalability.

Publications Completed: None

Affiliated WWW Sites: None

References:

Fish MP, Mowbray WH. 1970. *Sounds of the Western North Atlantic Fishes*. The Johns Hopkins Press, Baltimore.

Lobel PS, Kaatz IM, Rice AN. 2010. Acoustical behavior of coral reef fishes. In Cole KS. Editor. Reproduction and Sexuality in Marine Fishes: Evolutionary Patterns & Innovations. Elsevier Academic Press, San Diego. 307-386.