

Acoustics in the Cetaceans' Environment: A Multimedia Educational Package

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LONG-TERM GOALS

Our project, working title "Sea of Sound," is an education program about marine acoustics, especially as applies to marine mammals, natural and anthropogenic sound. The majority of the public perceives the undersea realm to be a largely silent world. While many people are aware that whales produce haunting songs or cacophonous clicks and whistles, most don't know the extent to which marine mammals use sounds to communicate, survey their environment, and find food. More surprising to many is that the sea is alive with sounds of all kinds, from bubbles in breaking waves and rumbling undersea volcanoes, to croaking fish, snapping shrimp, and rasping mollusks. The general public has a poor understanding of how the behavior of sound in marine environments compares with our terrestrial world. They also know little about the critical role sound plays in marine research and marine mammal conservation. While there is increasing public concern over rising levels of anthropogenic noise in the marine environment, there is a lack of comprehensive, broadly disseminated information about sound in the sea. This makes it difficult for the public to make informed decisions about sound-related marine issues. This education project aims to create and disseminate accurate information about sound in the sea, and to engage a broad cross section of Americans in the science of sound in the oceans.

OBJECTIVES

Now in our third year, we have accomplished the major objectives of our phase one proposal. We are seeking renewal funding to bring the educational materials we've collected to the public through synergistic channels that will reach many millions of people with the science of sound in the oceans. Specifically, our goals for deliverables include documentary programming for broadcast television, formal science curricula for middle and elementary school students, multiple Internet projects with private and public partners in ocean education, and the integration of all of these materials.

APPROACH AND WORK PLAN

We have completed the Pre-production and Production of the first two years (see work complete below) and much of our work plan for this year is contingent upon available funding.

Curricular Development

Working with the Lawrence Hall of Science, we will create innovative curricular materials that will be integrated into existing, broadly adopted programs. This year's efforts will identify the key principles for the lessons, map national and state standards to the principles, begin development of the lesson materials, pilot test lessons and exercises in classrooms, and develop a first complete draft of the

lessons. This effort will be led by the Lawrence Hall of Science team, with extensive participation from the team's other members and scientific advisors.

Documentary Programming for Broadcast

Working with our partners at National Geographic, we are pursuing a number of broadcast venues and audiences. The first is to create a series about biological sound in the ocean, to be aired on the PBS program, "National Geographic: Wild Chronicles." This series of short articles is in post-production now, and would air later this year. We are also pursuing the creation of a National Geographic Special for PBS on the Science of Sound in the Oceans. This is contingent on pending funding and the approval of PBS. We are optimistic about this possibility, and are working now on script, story, and computer graphics for the program. All post-production work will be done both at our Cornell facilities and at National Geographic's studios in Washington D.C. Stories and scripts will all be developed in collaboration with National Geographic, but all program materials will be vetted by our scientific advisors.

Production of Media for Online Venues

Working with a variety of partners, we will build a web of synergy around the curricular and programming development. To do this we will repurpose programming produced with National Geographic, as well as create new web-only short format media for three important educational and marine websites—the University of Rhode Island's "Discovery of Sound in the Sea" (DOSITS), the National Marine Sanctuary Program (NMSP), and the Apple Learning Interchange (ALI)

Staff: Cornell's David O. Brown is principle camera, and editor on the project as well as co-writer and co-producer with the PI, Marc Dantzker. Dantzker is also the project coordinator and principle sound recordist. Ian Fein recently joined the project as production assistant and assistant audio engineer. Dan Maas of Maas Digital is charged with data visualizations. The Lawrence Hall of Science and the University of California, Berkeley, has joined our team as our curricular development partner. We are now working with the National Geographic Society and their Missions Programming division to develop broadcast television materials. Additional Web partners include University of Rhode Island, Discovery of Sound in the Sea (DOSITS), NOAA National Marine Sanctuaries Program, and Apple Computers, Apple Learning Interchange.

WORK COMPLETED

In 2004 we proposed a two-phased project, with four tasks that were to be completed in Phase one. Phase one; covered by the original 2004 NOPP award ends February 28th, 2007 and we can report great success on all fronts. The four primary tasks for Phase one were 1) Field content acquisition, 2) Archival of materials in the Macaulay Library, enabling public access, 3) the creation of scientific illustrations and data visualizations for use in education materials, and 4) the production of documentary program materials to be used in education efforts. Additionally, we were to have laid the groundwork for Phase two tasks of curricular development, DVD creation, and other deliverables. \

Field content Acquisition

We planned and executed our targeted fieldwork so as to efficiently collect the materials we need to convey the core principles of our educational media products in a cohesive and engaging way. Over 18 months, we worked in five locations; Baffin Island in the Canadian Arctic, the Cape Cod/Stellwagen Bank region of the Lower Gulf of Maine, the Houston Shipping Channel and Flower Gardens areas of the Texas Gulf Coast, the Southwest Maui region of the Hawaiian Humpback Whale

National Marine Sanctuary and the Kona Coast of the Big Island of Hawaii. This fieldwork was conducted in collaboration with six distinct research teams and cruises, as well as with the ONR-supported winter bioacoustics course.

We recorded nearly 60 hours of High Definition (HD) video content and over 30 hours of high-resolution (96kHz/24bit) stereo sound. We modified our professional underwater camera systems to capture high-quality synchronous stereo sound. A documentary team has not, to our knowledge, achieved this quality of synchronous sound recording. For additional high-resolution audio, we developed an underwater broadcast-sound quality recording system. Unlike the various existing sound recording devices designed for research, our autonomous sound recording system was designed to put sound quality first. We planned a custom underwater housing for broadcast-quality recording equipment that we paired with high-quality stereo hydrophones and underwater headphones. We deployed the system with its hydrophones in myriad situations—stuck in rock crevices, pounded in surf zones, or floating in the water column—then checked sound quality aurally and manually adjusted gain levels to maximally utilize the dynamic range of the recording system. Both recording methods allowed us to capture recordings that are uniquely engaging and representative of the world of ocean sound.

Figures 1, 2, and 3 demonstrate respectively some of the ocean science and education efforts, soniferous animals, as well as the important sources of anthropogenic sound. This selection of images reflects a very small fraction of the materials we have gathered. In addition to these recordings we also licensed stock materials.

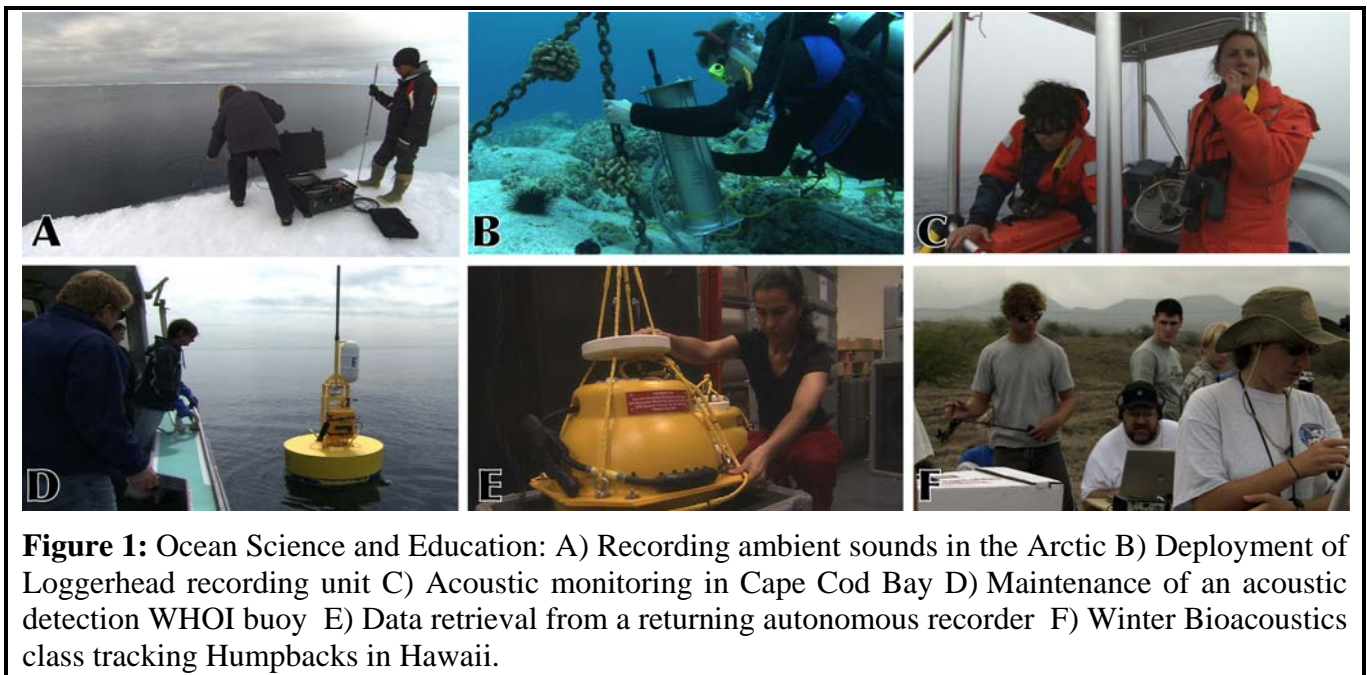


Figure 1: Ocean Science and Education: A) Recording ambient sounds in the Arctic B) Deployment of Loggerhead recording unit C) Acoustic monitoring in Cape Cod Bay D) Maintenance of an acoustic detection WHOI buoy E) Data retrieval from a returning autonomous recorder F) Winter Bioacoustics class tracking Humpbacks in Hawaii.

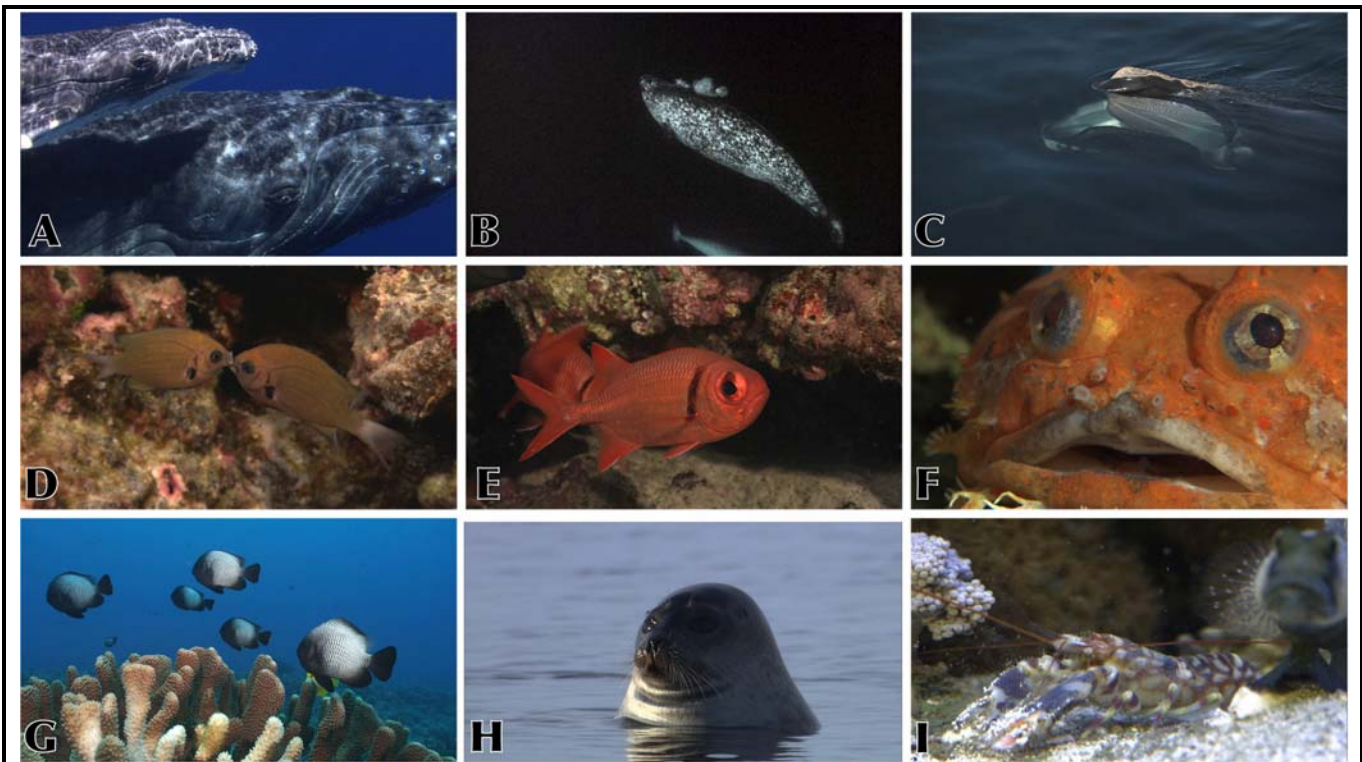


Figure 2: A selection of the species that we recorded for *Sea of Sound* A) Humpback Whale, *Megaptera novaeangliae* B) Narwhal, *Monodon monoceros* C) North Atlantic Right Whale, *Eubalaena glacialis* D) Chocolate-dipped Chromis, *Chromis hanui* E) Big-eye Squirrelfish, *Myripristis jacobus* F) Atlantic croaker, *Micropogonias undulatus* G) Hawaiian Dascyllus, *Dascyllus albisella* H) Ring Seal, *Phoca hispida* I) Snapping shrimp, *Alpheus sp.*

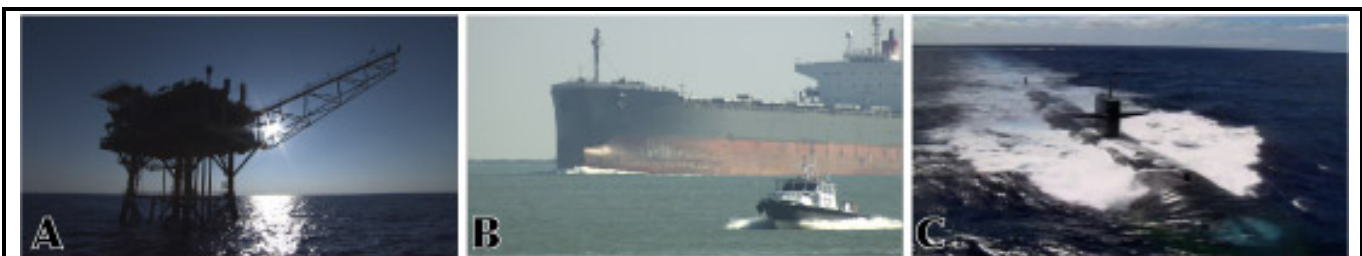


Figure 3: Important Anthropogenic Sound Sources: A) Energy infrastructure. We were unable to gain access on to commercial seismic survey vessels, but we can illustrate the industry with images like this and seismic survey techniques with graphics B) Shipping in the Houston Ship Channel and Port of Houston C) Unable to film navy vessels ourselves, we've acquired quality stock materials, such as this, from public archives.

Archival of Recordings for Public Access

All recordings, audio and video, are archived in the Macaulay Library and made available for public use. Public access is now possible through the National Science Digital Library system and at the Library's own website <http://www.birds.cornell.edu/macaulaylibrary>. The online collection is user-friendly and free. It has also has a remarkable tool that allows users to visualize sounds with spectrograms, waveforms, and spectra as they play from the website. Even the sound in the videos can be visualized in this way.

All recordings have been duplicated and logged into the Macaulay Library. As of early December, roughly 60% of the video recordings made for *Sea of Sound* are available through the website. By the end of the Phase one period, all usable video will be available online. There is a large marine audio archival effort in the Library, and our position in the queue has our recordings appearing online throughout the next calendar year.

There is very little if any HD footage of most of the animals that we recorded. That which has been recorded is locked up in corporate collections. Making these materials publicly accessible and available is a major contribution to the marine—as well as the larger—community.

Scientific Illustrations and Visualizations

Our Visualizations partner is Maas Digital, most well known for their Emmy-nominated work animating the Mars Rover missions. Their approach to *Sea of Sound* has been committed, detailed, and focused on scientific accuracy, as was their Mars work for NASA/JPL, NOVA, and IMAX. Maas began work with us earlier this year and will complete three or four sequences before the end of Phase one. We will be showing the transition from the world of light to the world of sound. And, as suggested repeatedly by our scientific advisors, we will be illustrating the sonic sense of *Odontocetes* as far more than just a prey detection mechanism.

We are in the early stages of a visualization of long distance communication in Blue Whales. Maas Digital is also working with Anna Nousek and Douglas Nowacek on a 3D model of a North Atlantic Right Whale that we will use in a visualization of the masking noise from shipping.

The visualizations created by Maas Digital will be used in both the GEMS/MARE curriculum and the extended documentary production with National Geographic.

Documentary Program Materials for Incorporation into Education Materials

As part of Phase one, pending the finalization of contracts with National Geographic, we will complete our first set of documentary programs. These will be a series of 6-8 minute short films created especially for National Geographic's *Wild Chronicles*, a weekly half-hour series broadcast on PBS. Following broadcast, the shows are disseminated free of charge via video podcasts from MSN as well as iTunes. Together we can expect nearly two million viewers for each episode. The "time-release" nature of this series will give more people the opportunity to encounter the series, and give regular viewers and podcast subscribers a weekly dose of marine sounds. This first series will focus on animals that make and use ocean sound.

These short episodes are ideal for use with the GEMS/MARE guides and will be used in that development process. Also, we will be aggregating the video podcasts into an Apple Learning Interchange website as they air, giving teachers an easy way to follow the subject and find the media materials. This is the first step in our partnership with NGS. Working with NGS on projects, we will create content that addresses more of the physics, science, and human impacts over the next 12 months of this renewal. Our current plan with NGS is to produce roughly 2 hours of PBS programming about marine sound and sound-related issues.

RESULTS

See descriptions above under work completed.

IMPACT AND APPLICATIONS

Science Education and Communication

This project will answer the need for comprehensive, top-quality science education and outreach materials telling the story of sound in the sea. The result will be a more informed public, better able to understand the science of sound in the ocean and the role people play in managing healthy oceans for all species.

TRANSITIONS

Economic Development

The Cornell Lab of Ornithology's media archive is a major resource of sound and video recordings for public and commercial media, museums, zoos and aquaria, producers of products reproducing animal sounds, wildlife identification devices, CD and DVD nature productions, sound effects for the movie industry, and more. The recordings from this project are available to the public as part of this archive, known as the Macaulay Library.

Science Education and Communication

Our recordings (audio and video) are placed into Cornell's Macaulay Library, one of the world's primary resources for recordings of animals. Thus the materials are available for wide use by scientists, teachers, and students. The curricula we are developing with the Lawrence Hall of Science will be integrated into their successful GEMS/MARE education series and programs.

RELATED PROJECTS

The Lab's Macaulay Library has a concurrent grant from the NSF-funded National Science Digital Library program to maintain an NSDL portal and web pages that will maximize access and utilization of the animal sound and video collections for education at all levels. The materials collected in this project are available through this portal. The Library has a second NOPP grant that is funding the development of online tools for sound annotation and feature extraction. Sounds recorded for this project will be included in the Library on which these tools will be used. ONR is supporting the archival of the last half-century's accumulated field recordings of marine animals at the Macaulay Library.