Remote Monitoring of Dolphins and Whales in the High Naval Activity Areas in Hawaiian Waters

Whitlow W. L. Au
Marine Mammal Research Program
Hawaii Institute of Marine Biology
phone: (808) 247-5026 fax: (808) 247-5831 email: wau@hawaii.edu

Award Number: N000140810903

LONG-TERM GOALS

The axiom that knowledge is power applies directly to the problems experienced by the U.S. Navy in encountering dolphins and whales. These encounters can be avoided if more knowledge and understanding of the behavior, distribution, and movements of these animals. Simply stated, if the Navy had more knowledge of the **what**, **where**, **when** and **why** of marine mammals in a given body of water, encounters between Naval vessels and marine mammals could be reduced or avoided all together. The ocean is large and the chances of avoiding any interaction with any sizable group of marine mammals are probably much greater than the probability of encountering marine mammals. However, the cost of negative encounters is disproportionately high in terms of negative publicity and law suits so it would be prudent to take steps to increase the odds against any encounters. Therefore, basic information on the biology, natural history, and behavior of cetaceans that frequent waters of high Navy activity are needed to understand ways to avoid encounters. A robust database of this information currently does not exist. There is a higher probability of Naval encounters with marine mammals in Hawaiian waters than in most other regions of the world because of the large number of cetacean species that inhabit or frequent these waters. Approximately 16-20 species of cetaceans can be found in Hawaiian waters. This is a large number of species for such a small geographic area. Knowing **what** animals are present in a given body of water is important because different species utilize their habitat in different ways. Therefore, it is important to understand the distribution, abundance and movement of dolphins and whales over the day-night cycles and seasonal periods.

OBJECTIVES

The objective of this study is to map the distribution and abundance of whales and dolphins in selected regions of Hawaiian waters. The waters surrounding the islands of Kauai and Oahu, where most Naval activities occur, will be the focus of this study. The Pacific Missile Range is in the waters of Kauai and the Pearl Harbor Naval Base is the home of the U.S. Pacific Fleet.

APPROACH

During the first year, five relatively low-cost autonomous, remote acoustic recorder denoted as the **EAR** (Ecological Acoustic Recorder) will be deployed around the island of Kaui and five more EARs will be moored around Oahu, to simultaneously monitor for the presence of dolphins and whales. In

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE **2009**	2. REPORT TYPE	3. DATES COVERED **00-00-2009 to 00-00-2009**
4. TITLE AND SUBTITLE **Remote Monitoring Of Dolphins And Whales In The High Naval Activity Areas In Hawaiian Waters**		5a. CONTRACT NUMBER 5b. GRANT NUMBER 5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)		5d. PROJECT NUMBER 5e. TASK NUMBER 5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Hawaii Institute of Marine Biology,Marine Mammal Research Program,Kane'ohe,HI,96744**		8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)		10. SPONSOR/MONITOR'S ACRONYM(S) 11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT
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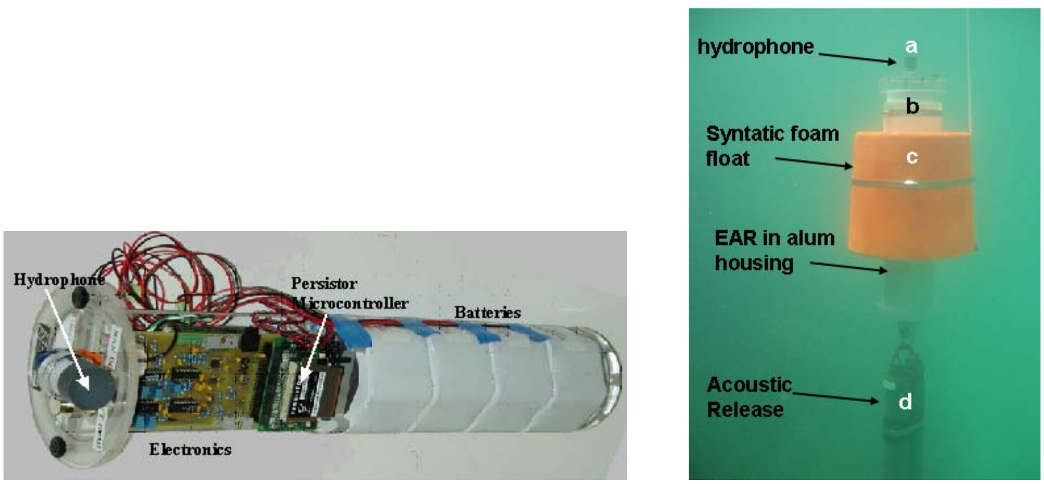
15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**Same as Report (SAR)**	**5**	

the second year, the locations of the EARs will be relocated and deployed in "hot spots" as determined by prior EAR deployment during the first year.

The EAR, jointly developed by the Hawaii Institute of Marine Biology (HIMB) and the Coral Reef Ecological Division of NOAA's Pacific Islands Fisheries Science Center has a maximum sampling rate of 64 kHz with a hydrophone that is functional up to 40 kHz and records data to a 160 Gbyte laptop recorder. It has a recording bandwidth of 30 kHz and can be deployed to depths of up to 500 m. The EAR is controlled with a Persistor Instrument CF2 microcontroller. Its deployment life is determined by the programmable recording duty cycle and the number of battery packs included, but typical deployment durations range between 3-12 months. At its maximum sampling rate, it is capable of recording the calls of all cetacean species found in Hawaiian waters, including beaked whales. A pictorial description of the interior electronics and power supply is shown in Figure 1a along with a picture of a deployed EAR on an acoustic release device in Figure 1b. A map of potential deployment sites around the islands of Kauai



(a) (b)

Figure 1. (a) The internal parts of the EAR with the electronics, Persistor microcontroller and the battery pack, (b) EAR in deep mooring configuration showing an acoustic release, EAR in an aluminum housing and a syntactic foam collar.

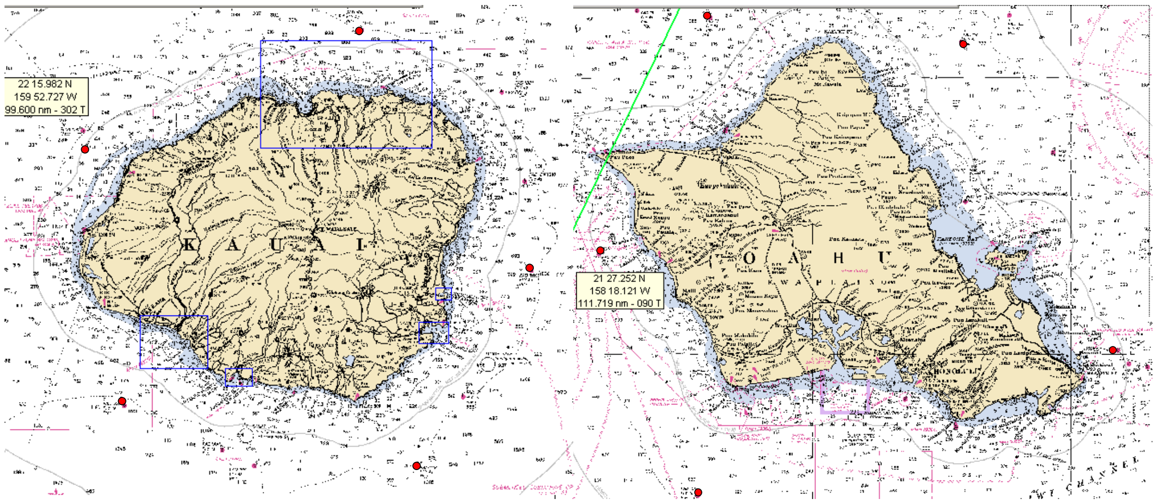


Figure 2. The potential locations around the islands of Kauai and Oahu where EARs (red dots) operating simultaneously will be deployed during the first year.

WORK COMPLETED

Five EARs were deployed around the island of Kauai and five around the island of Oahu in February at the general locations shown in Figure 2. The units around Kauai were deployed at a depth of approximately 800m and the units around Oahu were deployed at shallower depths, with four units at depths between 114 m and 170 m and one unit at 576 m. Each unit was programmed to turn on and collect data for 30 sec every 5 minutes. In May, the units were retrieved and redeployed after a swap-out of the laptop disk holding the acoustic data and a swap-out of the battery packs. The data from Kauai are being analyzed for beaked whale echolocation signals while the data although a brief preview of the data indicate the detection of humpback whale songs and dolphin whistles. Echolocation signals have been detected at all five sites at different times and the data is currently being organized so that a coherent description of echolocation activities can be presented in terms of the monthly and diurnal occurrence. An example of a click train from one of the Kauai EARs is shown in Figure 3 for a 30 s time window. The maximum sound pressure level for this click train was 136 dB re 1 μPa. Hundred of click train similar to this examples have been detected.

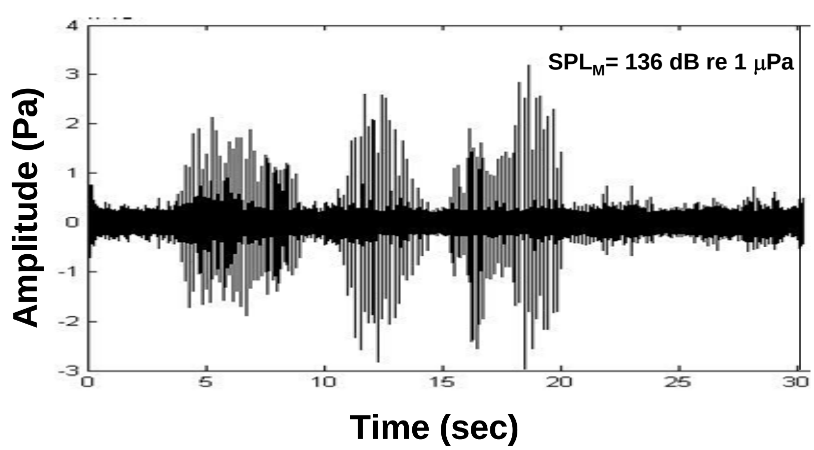


Figure 3. Example of an echolocation click train recorded by one of the EARs off Kauai.

Although the Kauai data has undergone one level of data analysis, the results are not in a form that can be presented in an organized manner at this time. We hope to have the number of clicks detected in each hour and have the results displayed as a function of days in each month to examine monthly and seasonal variations at each location and also as a function of time in a day to examine diurnal variations at each location.

The Oahu is being analyzed primarily for dolphin whistles at this time, although humpback whale songs and echolocation signals have also been detected. Examples of the various detections indicated on two spectrograms are shown in Figure 4. Three of the Oahu data disk have been reduced, however the results are not in a form that can be presented in an organized manner at this time.

IMPACT/APPLICATIONS

Potential future impact for Science and/or Systems Applications is gaining knowledge of how dolphins and whales utilize the waters surrounding Kauai and Oahu, two areas of high Naval activities and from that knowledge, operations can be planned that would maximize the probability of avoiding marine mammals. Successful results and methods used in this project could also be applied to other areas of high Naval activities.

RELATED PROJECTS

None

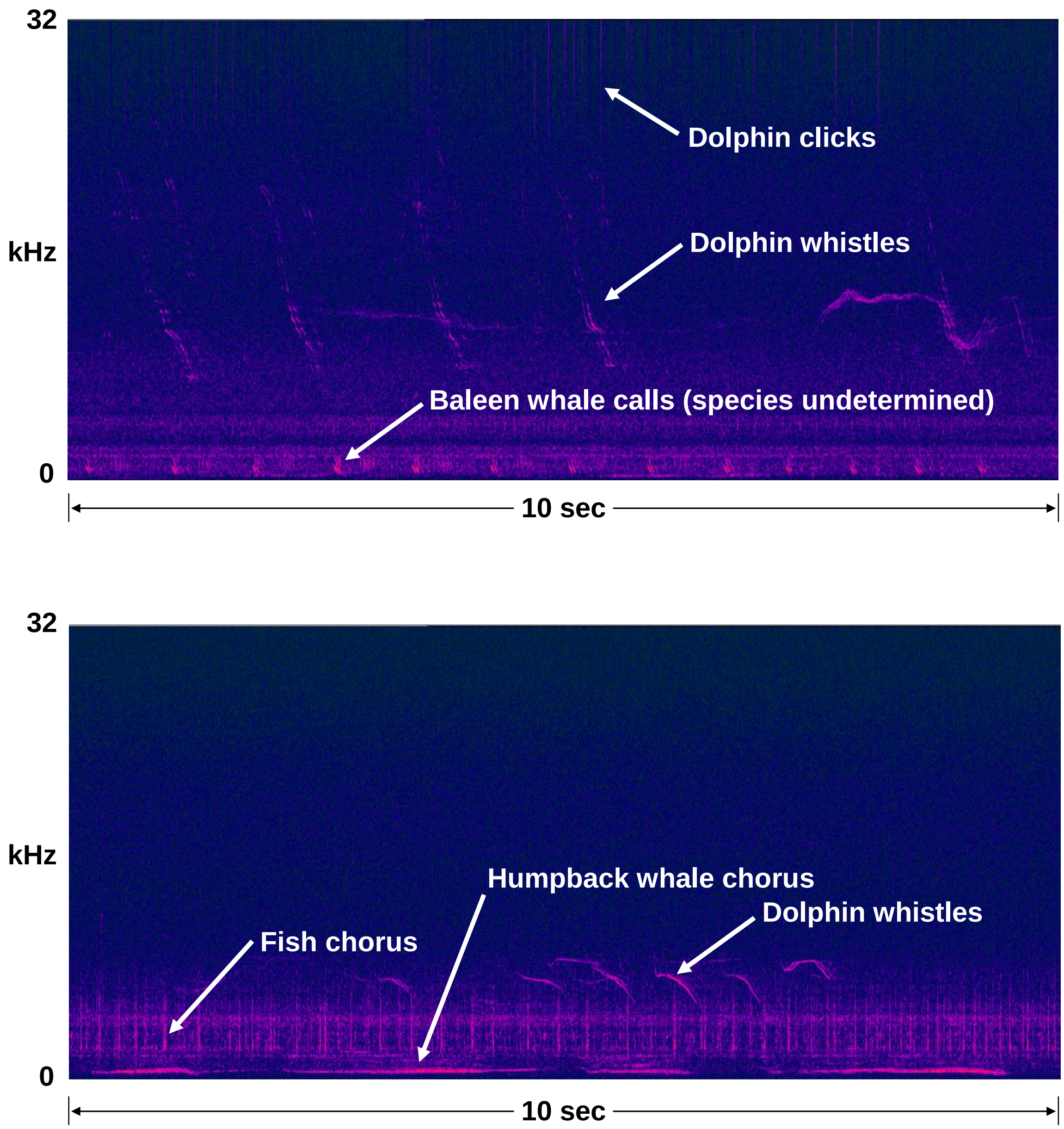


Figure 4. Examples of two spectrograms showing the detection of dolphin whistles, humpback whale songs and fish chorusing sounds.