Commonwealth of the Northern Mariana Islands
Passive Acoustic Monitoring Site SAI2
Saipan Island, East Side

Ecological Acoustic Recorder (EAR)
20-May-2007 to 15-Aug-2008

Level 1 Analysis of Passive Acoustic Observations[1]

(Revised 25-NOV-2008)

Synopsis

This document provides a level 1 analysis of the data obtained from ecological acoustic recorder (EAR) unit 9300313-27 deployed at Puntan Halaihai on the east side of Saipan from May 2007 to August 2008. The EAR unit recorded acoustic data from June 1st 2007 to October 4th 2007. This initial report contains background information about the site, time-series of total acoustic energy, and analyses of event-triggered recordings.

Background

Monitoring the changing status of coral reef environments and associated biota is a critical management need and a considerable technological challenge, especially on reefs in remote locations. The Pacific Islands Fisheries Science Center (PIFSC) Coral Reef Ecosystem Division (CRED), in partnership with the Hawaii Institute of Marine Biology (HIMB), is using natural ambient sounds as a way to characterize the activity of marine organisms on coral reefs and in surrounding waters. By deploying a device known as the Ecological Acoustic Recorder (EAR), a cost-effective tool for recording biological and anthropogenic sounds, CRED investigates and monitors the presence and activity of sound-producing marine life and human activity. The EAR can be left in place unattended for up to two years, depending on the instrument's configuration. Passive acoustic observations are typically not compromised by bio-fouling. It records the local ambient acoustic environment on a programmed schedule and is also triggered to record by high amplitude transient events, such as engine noise from passing vessels.

This level 1 report is the product of an initial analysis of the EAR dataset from EAR unit 9300313-27 deployed at Puntan Halaihai on the east side of Saipan Island in the Commonwealth of the Northern Mariana Islands (CNMI) from May 2007 to August 2008. It includes a time series of total acoustic energy, an analysis of the event-triggered recordings, and a discussion of results. A subsequent level 2 report will include an analysis of additional concomitant variables collected in conjunction with the EAR that may include tidal phases, episodic storms, wave events, temperature, primary productivity, etc. The level 2 report will also include an analysis of cetacean vocalizations. A level 3 report will describe unique fish sounds that have been isolated during bioacoustic analysis. The level 3 report will also discuss the temporal variability in occurrence of these sounds and present summary tables and graphic products. A final level 4

[1] PIFSC Internal Report IR-08-025
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report will be an integrative study comparing data from multiple years and multiple EAR monitoring sites at island or archipelagic scales. It is anticipated that level 4 reports will take the form of manuscripts for publication in peer-reviewed scientific journals.

Deployment Site

The EAR unit 9300313-27 was deployed on the east side of Saipan at the CRED Rapid Ecological Assessment (REA) site 2 with an attached subsurface temperature recorder #3944309-3476. The EAR unit was deployed on May 20th of 2007 and recovered on August 15th 2008. Immediately after recovery, a replacement EAR was deployed in the same location to continue the passive acoustic monitoring of this site.

Two passive acoustic monitoring sites (SAI1, SAI2) are currently maintained on the east side of the island of Saipan. An EAR site is also located off the north coast of the island of Guam, which is located 197.40 km to the southwest of Saipan (Figures 1 and 2).

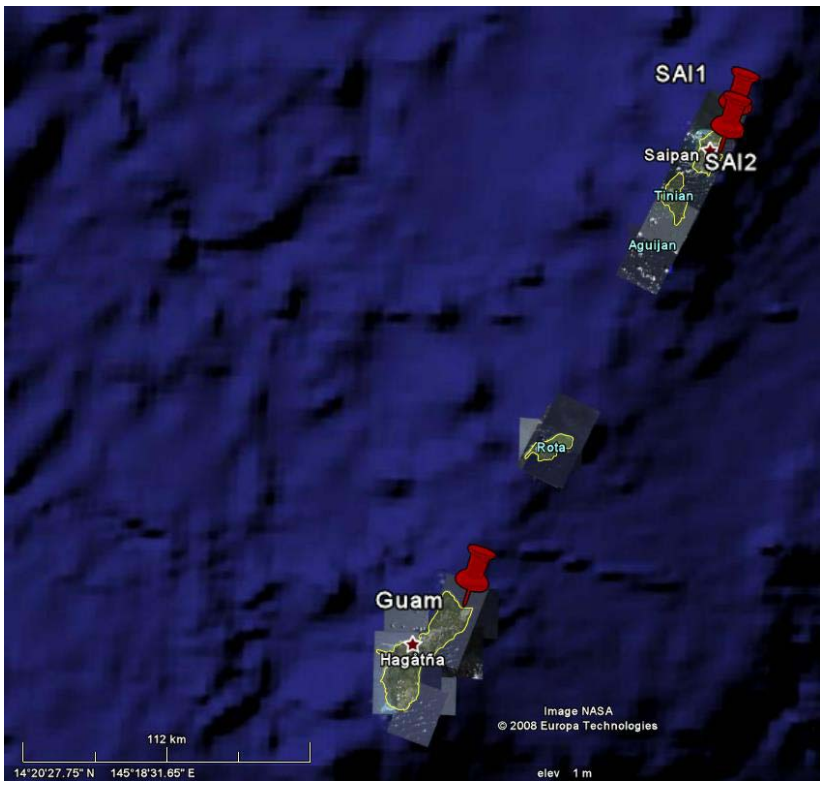

Figure 1. From 2007 through the present, two Ecological Acoustic Recorders (EARs) have been maintained off Saipan and one EAR has been maintained off Guam.

The deployment site (SAI2) is at Puntan Halaihai (Figure 3), one of five marine protected areas around the island of Saipan. Saipan is the most developed of the chain of islands of the CNMI. Besides the five marine protected areas around Saipan, there are three no-take marine conservation areas and two species-based reserves (Schroeder, 2007). Gill-netting is prohibited except for traditional events, and scuba spearfishing is banned in the CNMI.

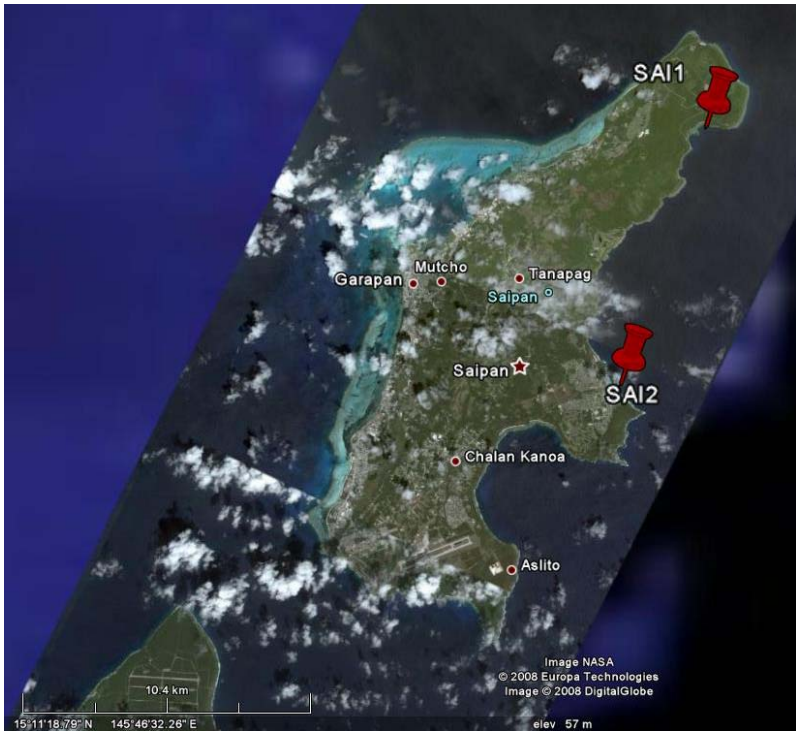

Figure 2. Two passive acoustic monitoring sites (SAI1 and SAI2) have been established on the east side of Saipan Island.

Figure 3. Passive acoustic monitoring site SAI2, which is the subject of this report, is located on the east side of Saipan Island at Puntan Halaihai.

Total acoustic energy

A time series of total acoustic energy provides a synoptic view of the major trends and variability of the acoustic activity at this site, as seen in Figure 4.

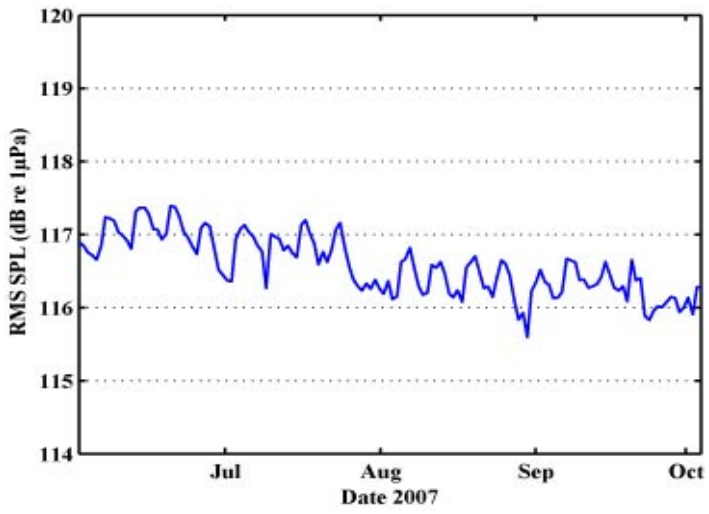

Figure 4. Daily average of sound pressure level at site SAI2**.**

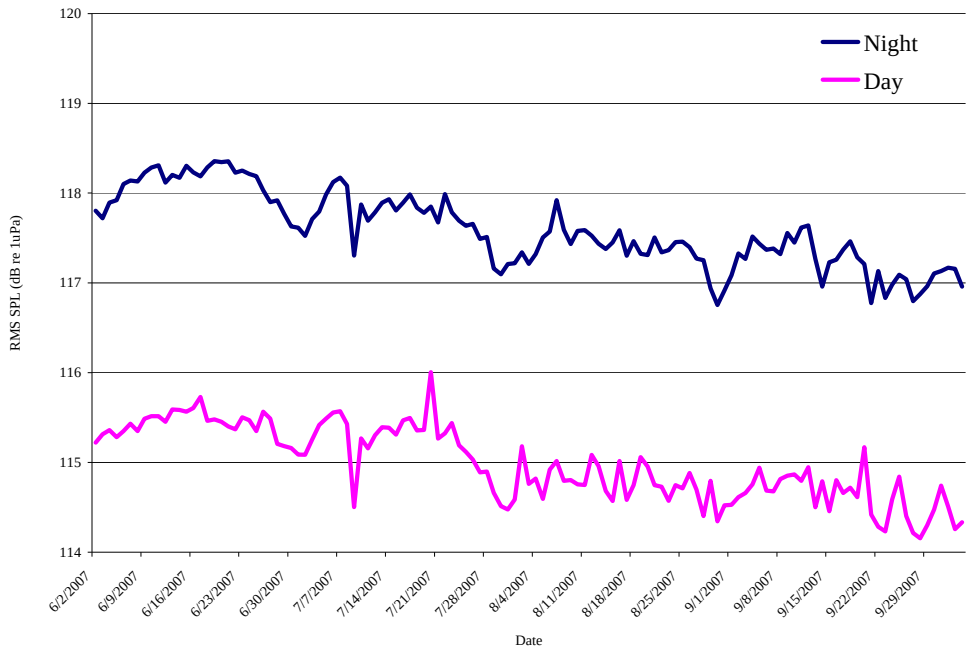

Figure 5. Average night and day Sound Pressure Level (dB) at passive acoustic monitoring site SAI2, Saipan, CNMI.

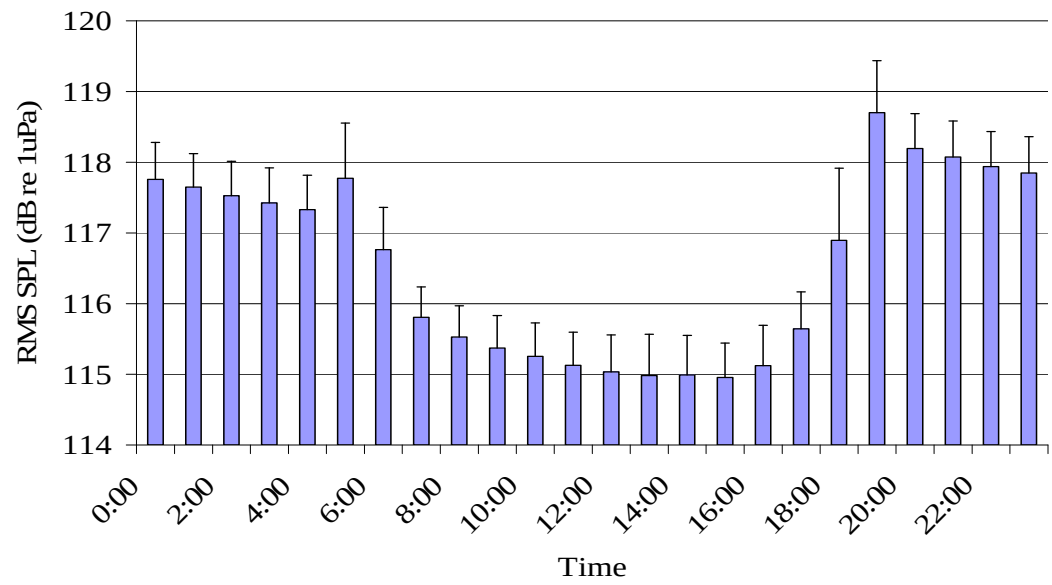

Figure 6. Average Sound Pressure Level (dB) by hour of day (local time).

The acoustic energy record, as obtained from the periodic duty-cycle recordings made by the EAR, shows strong diel variability (Figure 6). Nighttime Root Mean Square (RMS) Sound Pressure Levels (SPL) are 3-4 dB higher than during the day, where nighttime is defined as the four hour period from midnight to 4 AM and daytime is defined as the four hour period from

noon to 4 PM (Figure 5). In addition, there is evidence of periodic variability on the scale of several weeks. A general trend of decreasing ambient acoustic levels over the course of the deployment from June to October is evident, suggesting some degree of seasonal variability. The major source of observed ambient acoustic energy was from snapping shrimps, so the diel and periodic variability are attributed to changes in their activity levels. Other major contributing sound sources include vessel engines, whale, rain, and fish. Sporadic spikes in ambient acoustic energy levels represent episodic events involving one or more of these sound sources.

Analysis of event-triggered recordings

An analysis of all the event-triggered recordings provides usage patterns of motorized vessels, cetaceans, and other acoustic sources. Figure 7 shows the classification of event-triggered recordings at the site.

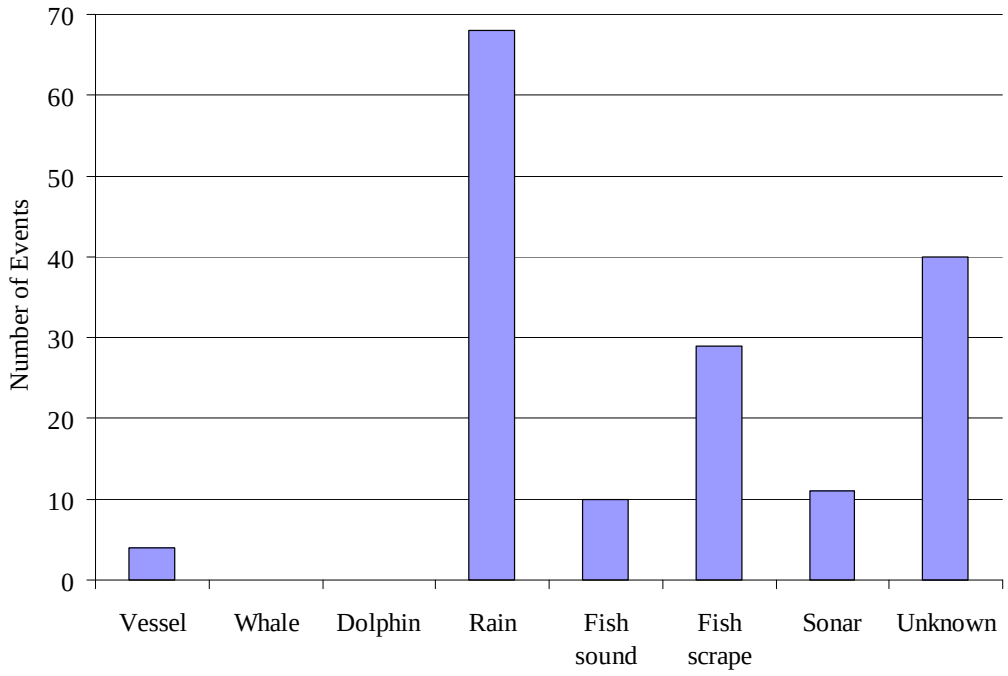

Figure 7. Classification of event detections at monitoring site SAI2, Saipan, CNMI from June 2007 to October 2007.

Each vessel event recording is linked to the date /time of the recording to generate a plot of vessel occurrences in the vicinity of the monitoring site by time of day (Figure 8) and by month of year (Figure 9). Similar analyses, not included in this report, can be performed on the other types of events (rain, cetaceans, fish sounds, etc.) The complete record of event triggered vessel detections is included as Table 1.

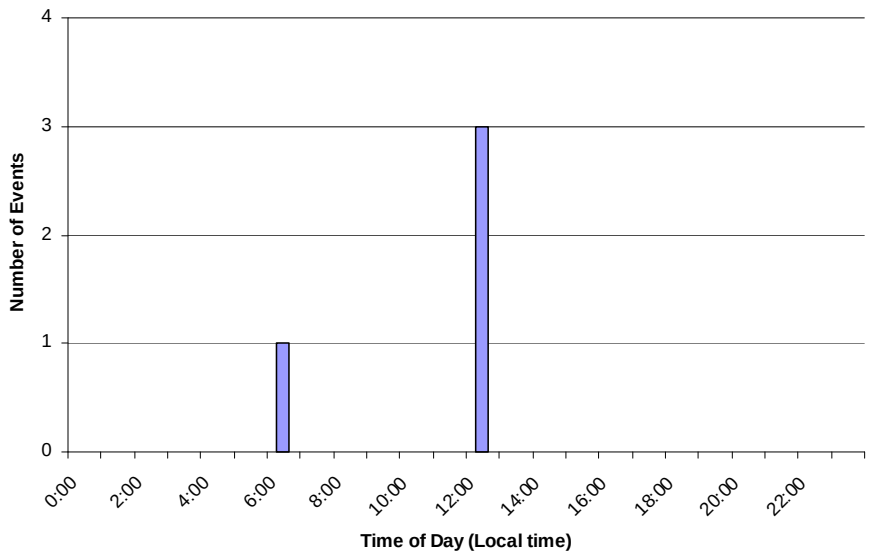

Figure 8.Vessel event classified by time of day (local time).

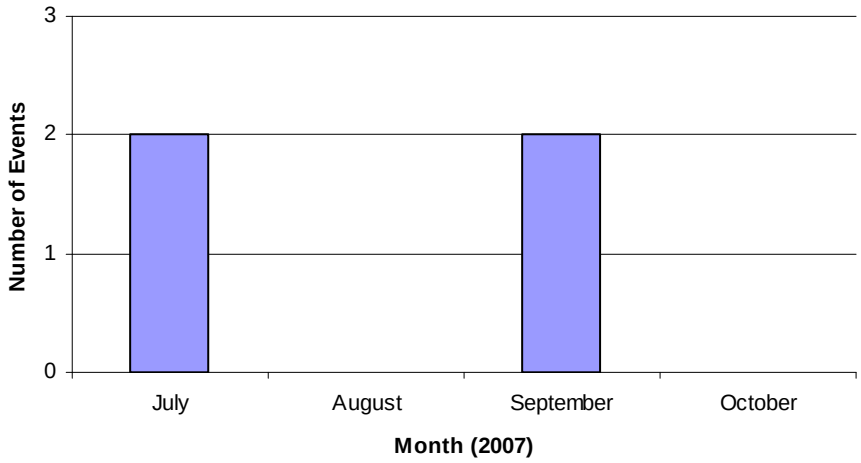

Figure 9. Vessel events classified per month. Note: detections on September 1st occurred 12 minutes apart and were probably the same vessel.

Vessel Events		
Date/Time - UTC	**Date/Time - Local**	**File**
7/19/2007 02:31	7/19/2007 12:31	00006977.BIN
7/23/2007 20:58	7/24/2007 6:58	00007672.BIN
9/1/2007 02:29	9/1/2007 12:29	00013380.BIN
9/1/2007 02:41	9/1/2007 12:41	00013383.BIN

Table 1. UTC and local date and time of vessel events at SAI2,(Saipan, CNMI) from June 2007 to October 2007.

Discussion:

The EAR unit was deployed on May 20th of 2007 and recovered on August 15th 2008. The unit recorded acoustic data from June 1st 2007 to October 4th 2007. The premature cessation of data collection was presumably due to a software error in the autonomous control program. The most recently deployed EAR has the latest software revision installed and this problem is not anticipated to re-occur.

During the fourteen-month period of deployment of the EAR, only a four month dataset was recovered. During that period of time, vessel activity was recorded in the vicinity of the monitoring site in July with two events on separate days and in September with two events during the same day (Figure 9). These initial results suggest that the site does not typically encounter much vessel activity, although continuous monitoring of the site will provide a more comprehensive assessment and may elucidate seasonal patterns of vessel activity that are not evident in the four month record.

The dominant sound that triggered event detection on EAR unit 9300313-27 was rain, with 68 recorded events.

The event detection was also triggered by what was initially labeled as an "unknown anthropogenic source" -- a high pitched metallic whistle that occurred every two to three minutes over a span of thirty-five minutes. Military sonar is the most likely source.

References:

Schroeder, R. E. 2007. */Hi'ialakai/* Cruise Report HI-07-02. */In/*: Appendix F, Saipan, p. 5. Pacific Islands Fisheries Science Center Cruise Report CR-07-011, 6 July 2007, 133 pp.

Contact Information:

The Ecological Acoustic Recorder (EAR) program is a collaborative effort of the Pacific Islands Fisheries Science Center and the Hawaii Institute of Marine Biology. For more information please visit the following URL or contact the following individuals.

http://www.pifsc.noaa.gov/cred/ear.php

Kevin B. Wong
NOAA Fisheries, Pacific Islands Fisheries Science Center
Coral Reef Ecosystem Division
1125 B Ala Moana Boulevard, Honolulu, Hawaii 96814
kevin.wong@noaa.gov

Marc O. Lammers
Hawaii Institute of Marine Biology, University of Hawaii
46-007 Lilipuna Road, Kaneohe, Hawaii 96744
lammers@hawaii.edu