

**American Samoa
Passive Acoustic Monitoring Site FBAY
Fagatele Bay, Tutuila Island**

Ecological Acoustic Recorder (EAR) 08-August-2006 to 23-February-2007

Level 1 Analysis of Passive Acoustic Observations¹

(Revised 30-April-2009)

Synopsis

This document provides a level 1 analysis of the data obtained from ecological acoustic recorder (EAR) unit 9300237B05 deployed at Fagatele Bay on the south side of Tutuila from August 08th 2006 to February 23rd 2007. The EAR unit recorded acoustic data from August 9th 2006 to February 23rd 2007. This initial report contains background information about the site, time-series of total acoustic energy, and analyses of event-triggered recordings. A complete metadata record for the dataset is available upon request. (See Contact Information.)

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 9300237B05 deployed at Fagatele Bay on the south side of Tutuila Island, American Samoa from August 8th 2006 to February 23rd 2007. 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

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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 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 9300237B05 (FBAY) was deployed at Fagatele Bay on the south side of Tutuila in the Fagatele Bay National Marine Sanctuary (Figures 2 and 3). The unit was deployed at a depth of 16.7 meters. When EAR unit 9300237B05 was recovered on February 23rd 2007, it was replaced with EAR unit 9300235B04.

Four passive acoustic monitoring sites (ABAY, FBAY, NPAS1, and NPAS2) are currently maintained in the near-shore regions of Tutuila Island (Figure 2). Two monitoring sites (NPAS1, NPAS2) are within the American Samoa National Park. The park ranges in scenery from tropical rainforest, remote forests, streams, rugged coastline, reef and beaches (National Park Service, 2008). The fourth Tutuila monitoring site (ABAY) is located in Alega Bay. A fifth EAR site has been established at Rose Atoll which is located, about 160 miles west of Tutuila Island (Figure 1).

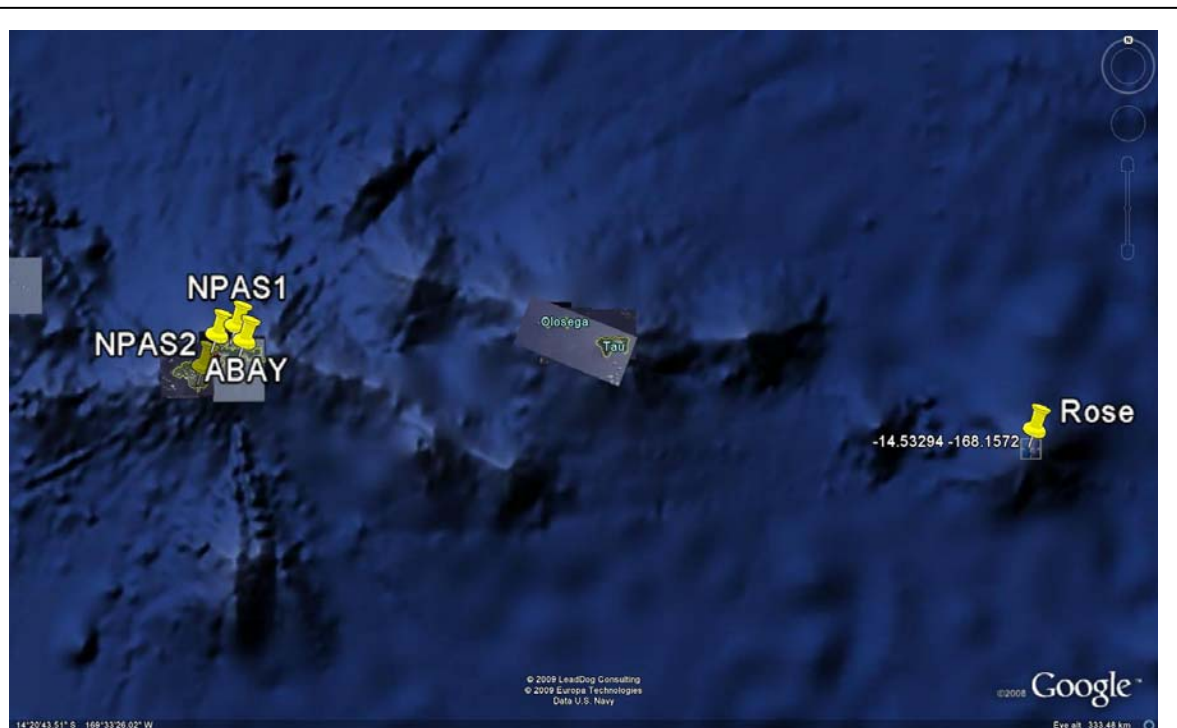


Figure 1. Currently there are five Ecological Acoustic Recorder (EAR) sites located in American Samoa and Rose Atoll.

American Samoa is the only US Territory south of the equator and is located east of the International Date Line in the Pacific Ocean (National Park Service, 2004). The total land area of American Samoa is 76.1 square miles (197.1 km²), it includes five volcanic islands (Tutuila, Aunu'u, Ofu, Olosega, Ta'u) and two remote atolls (Rose, Swains) (Craig, 2005).

The FBAY site is co-located at CRED Rapid Ecological Assessment (REA) site TUT-22. Coral cover of 41.2% has been observed at this site. The site has nineteen coral genera, a large abundances of macroalgae, and low abundances of macroinvertebrates (2008, HI-08-02).

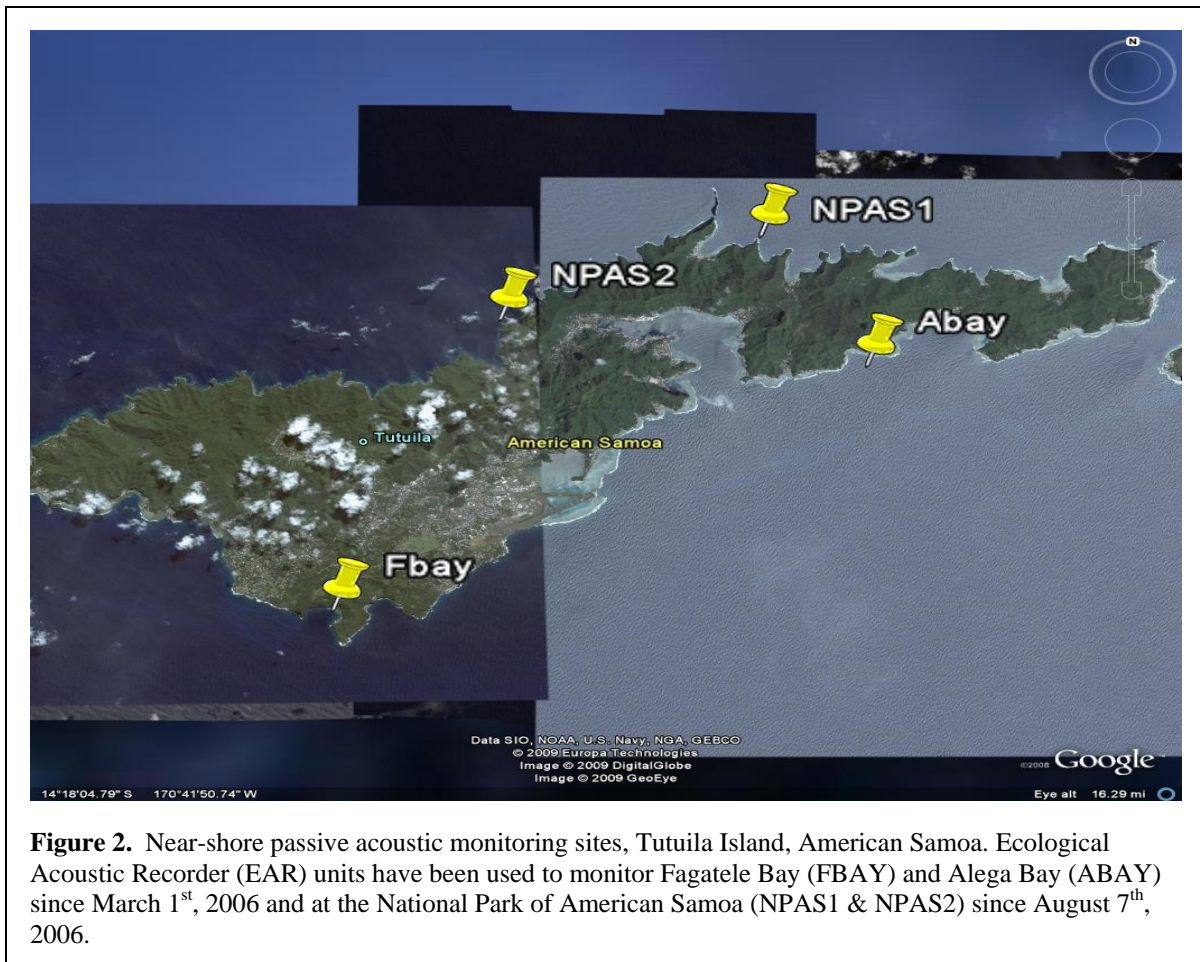


Figure 2. Near-shore passive acoustic monitoring sites, Tutuila Island, American Samoa. Ecological Acoustic Recorder (EAR) units have been used to monitor Fagatele Bay (FBAY) and Alega Bay (ABAY) since March 1st, 2006 and at the National Park of American Samoa (NPAS1 & NPAS2) since August 7th, 2006.

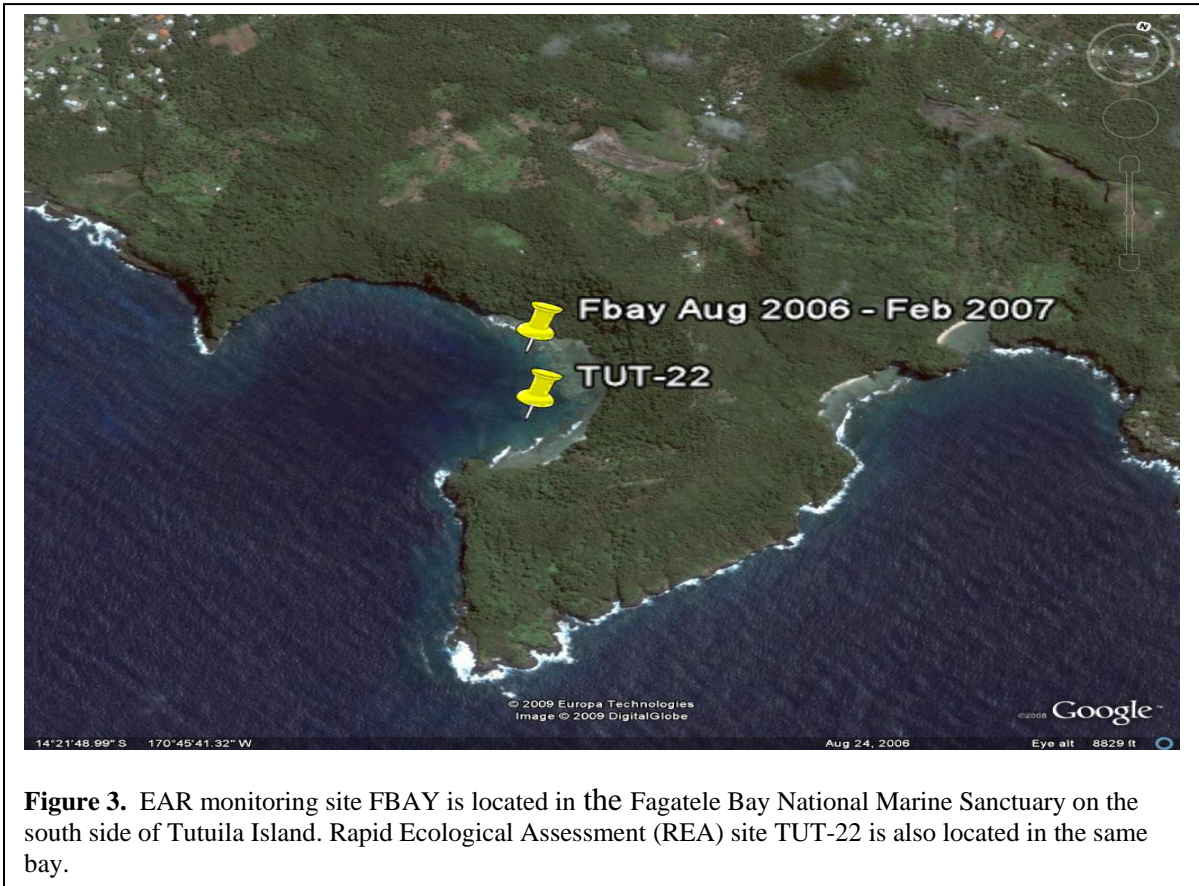


Figure 3. EAR monitoring site FBAY is located in the Fagatele Bay National Marine Sanctuary on the south side of Tutuila Island. Rapid Ecological Assessment (REA) site TUT-22 is also located in the same bay.

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.

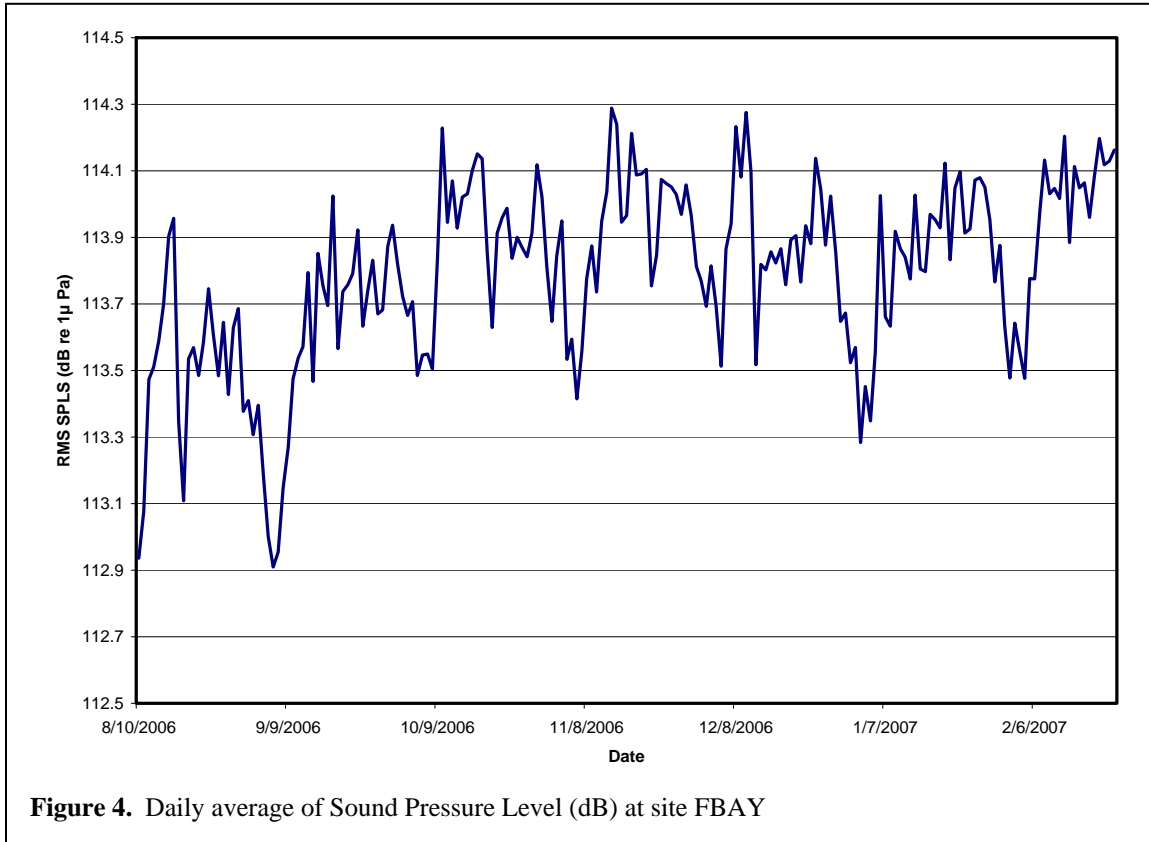


Figure 4. Daily average of Sound Pressure Level (dB) at site FBAY

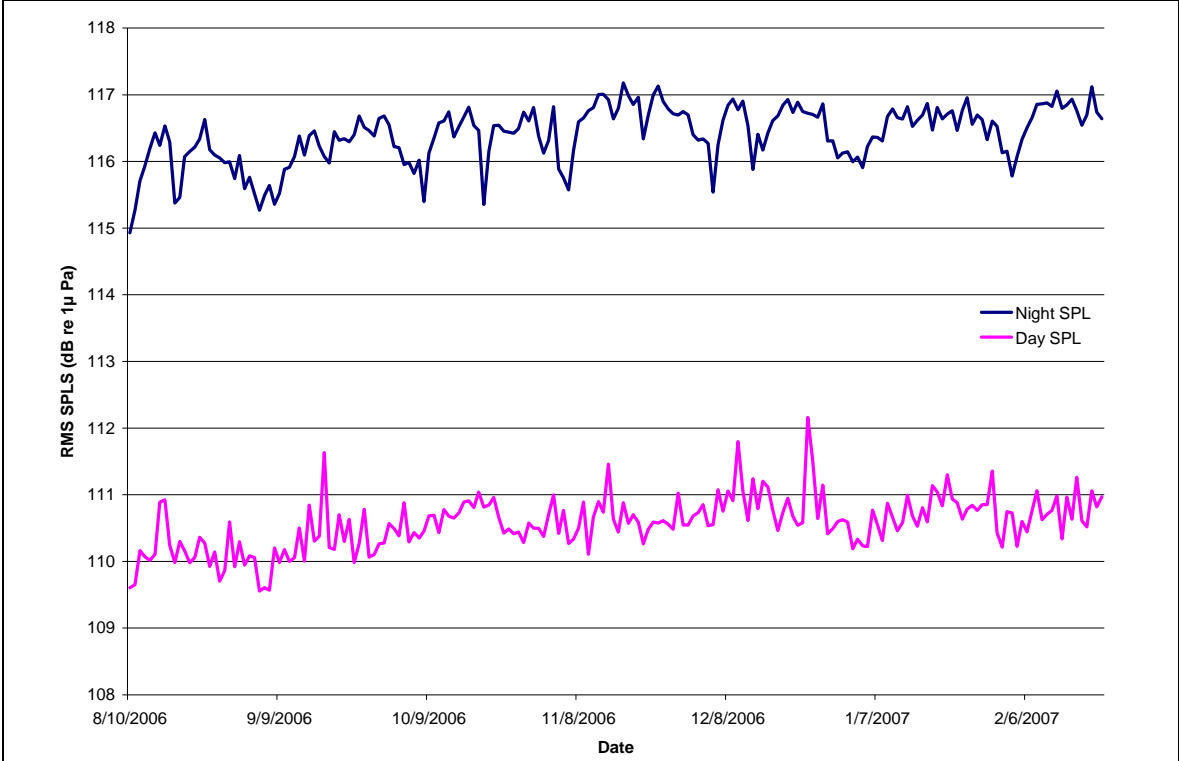


Figure 5. Average night and day Sound Pressure Level (dB) at passive acoustic monitoring site FBAY.

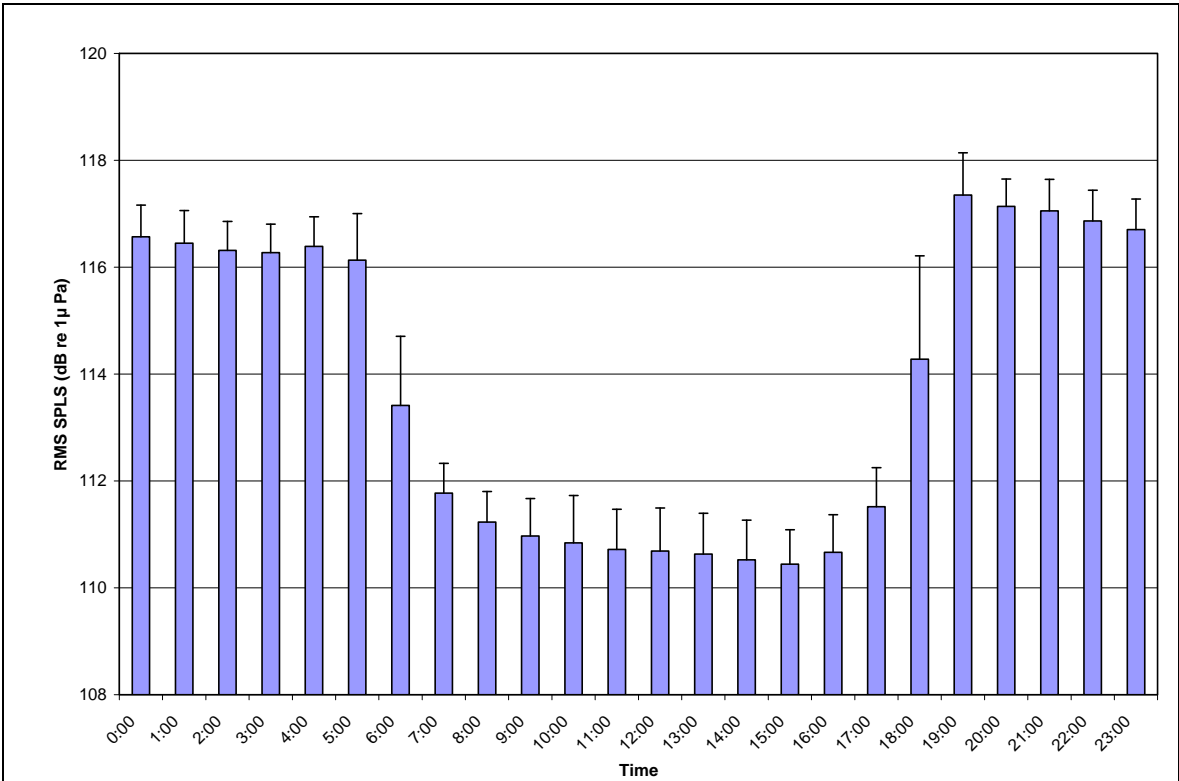
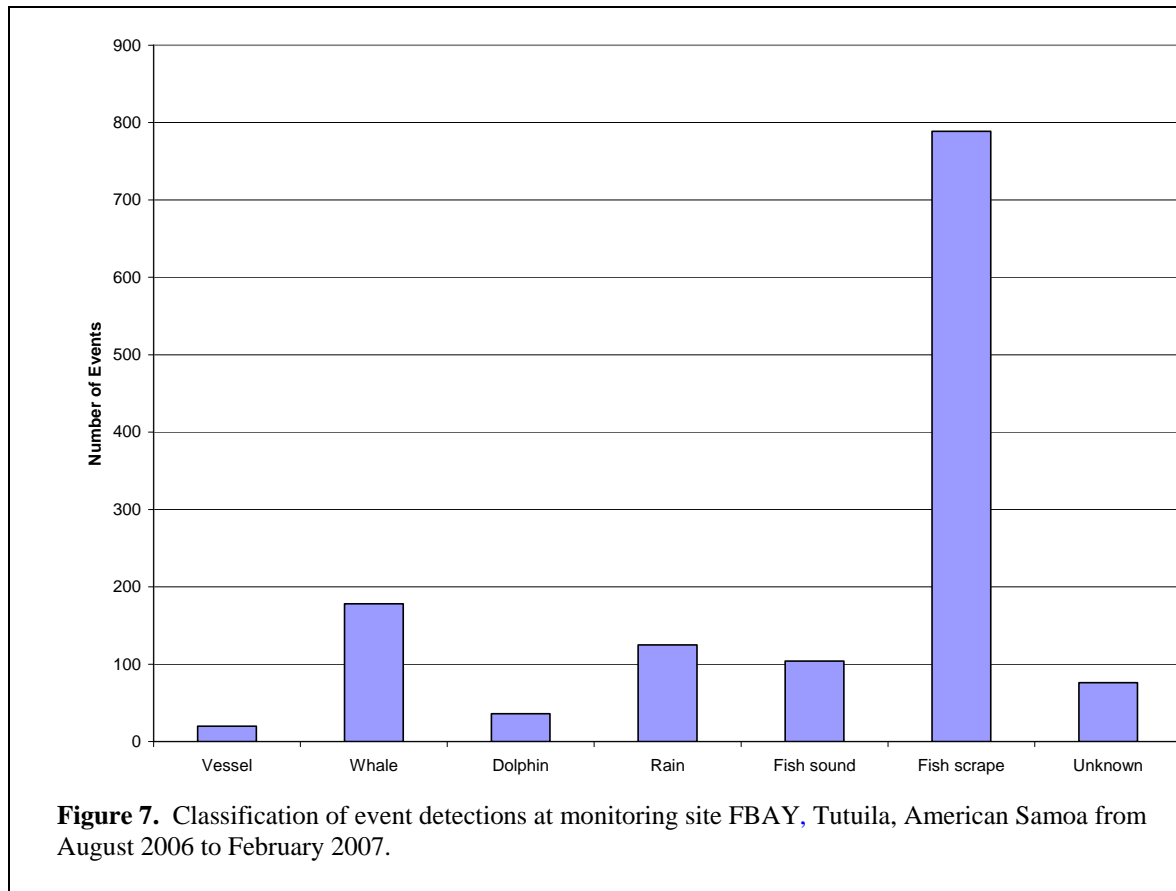


Figure 6. Average Sound Pressure Level (dB) by hour of day (local time).

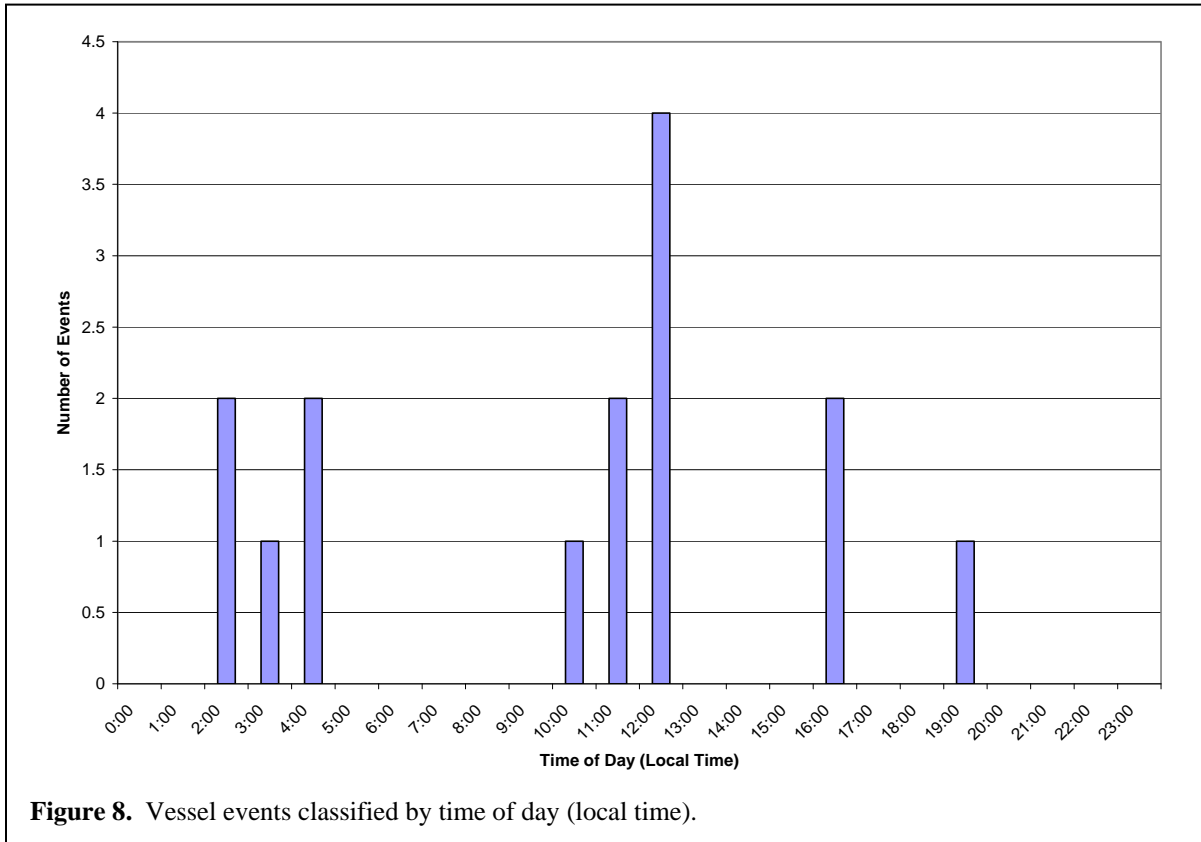
The acoustic energy record, as obtained from the periodic duty-cycle recordings made by the EAR, shows strong diel variability (Figure 6). Nighttime Root Mean Square (RMS) Sound Pressure Levels (SPL) are 5-6 dB higher than during the day, where nighttime is defined as the four hour period from midnight 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 increasing ambient acoustic levels over the course of the deployment from August to February 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, whales, 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.



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.



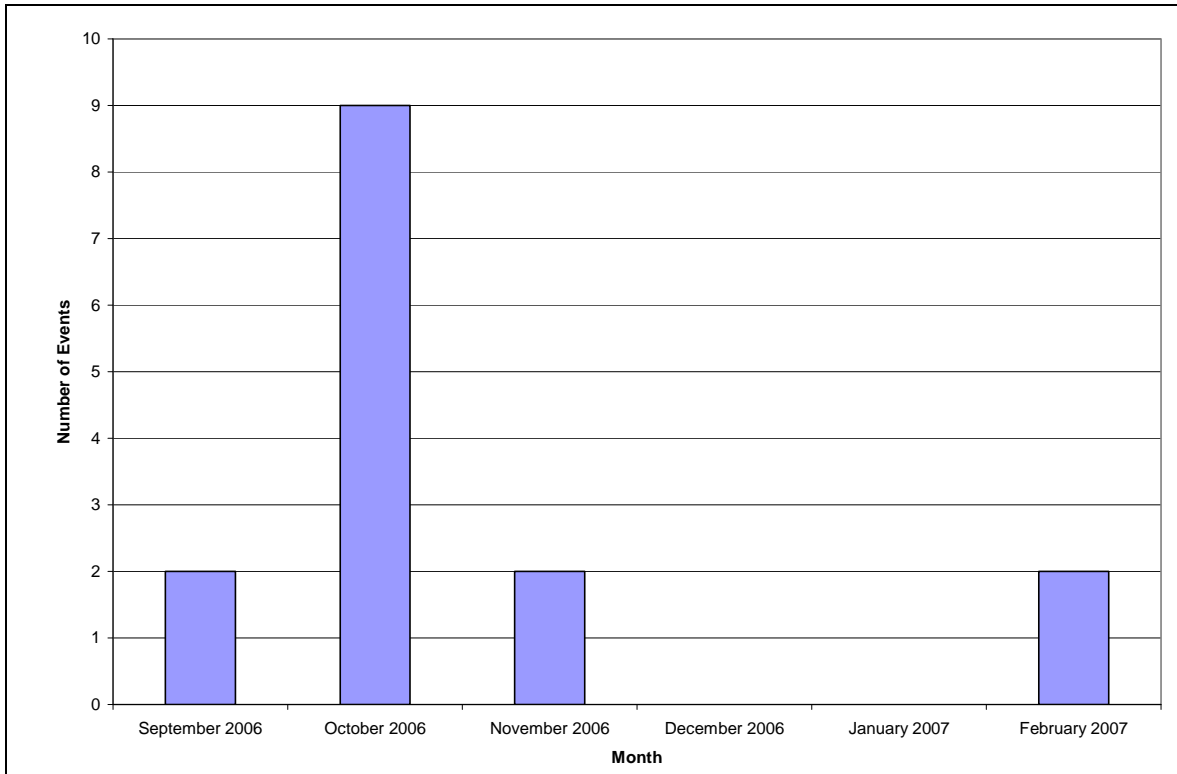


Figure 9. Vessel events classified per month.

Table 1. UTC and local date and time of vessel events at site FBAY, (Tutuila, American Samoa) from August 2006 to February 2007.

Vessel Event			
UTC		Local	
Date	Time	Date	Time
9/30/2006	15:05	9/30/2006	4:05
9/30/2006	15:15	9/30/2006	4:15
10/1/2006	21:20	10/1/2006	10:20
10/4/2007	6:15	10/3/2007	19:15
10/4/2006	23:09	10/4/2006	12:09
10/4/2006	23:12	10/4/2006	12:12
10/4/2006	23:13	10/4/2006	12:13
10/4/2006	23:49	10/4/2006	12:49
10/6/2006	13:47	10/6/2006	2:47
10/7/2006	13:57	10/7/2006	2:57
10/7/2006	14:06	10/7/2006	3:06
11/21/2006	3:25	11/20/2006	16:25
11/21/2006	3:27	11/20/2006	16:27
2/9/2007	22:01	2/9/2007	11:01
2/9/2007	22:11	2/9/2007	11:11

Discussion:

The EAR unit was deployed on August 08th of 2006 and recovered on February 23rd 2007. The unit recorded acoustic data from August 09th of 2006 to February 23rd 2007. During that period of time, 15 event detections were triggered by vessel engine noise between September and November (Figure 9). Examining the time stamp for each event, it is apparent that several occurred within minutes of each other (Table 1). This indicates that the same vessel caused multiple events to be triggered. An examination of Table 1 suggests that there were nine distinct vessel 'events'. Five of these were during daylight hours and four were during the night. Continuous monitoring of the site will provide a more comprehensive assessment and may elucidate seasonal patterns of vessel activity that are not evident in this seven month record. The dominant sounds that triggered event detection on EAR unit 9300237B05 were fish scrapes, with 789 recorded events. A general trend of increasing ambient acoustic levels over the course of the deployment is evident, suggesting some degree of seasonal variability. This variability is similar to that observed at other locations throughout the Pacific and is likely correlated with changing water temperatures. A subsequent report will examine this relationship in more detail. With the replacement EAR unit currently deployed, we will continue to monitor this seasonal variability to better understand the yearly cycle.

References:

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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>

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