

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

Ecological Acoustic Recorder (EAR) 23-February-2007 to 07-February-2008

Level 1 Analysis of Passive Acoustic Observations¹

(Revised 11-February-2010)

Synopsis

This document provides a level 1 analysis of the data obtained from ecological acoustic recorder (EAR) unit 9300238B006 deployed at Fagatele Bay on the south side of Tutuila from February 23rd 2007 to February 7th 2008. The EAR unit recorded acoustic data from February 23rd 2007 to July 14th 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.

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 9300238B006 deployed at Fagatele Bay on the south side of Tutuila Island, American Samoa from February 23rd 2007 to February 7th 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

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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

Following the recovery of EAR 9300237B005, EAR unit 9300238B006 was deployed at the same site (FBAY) on the south side of Tutuila in the Fagatele Bay National Marine Sanctuary (Figures 2 and 3) on February 23rd, 2007. The unit was deployed at a depth of 16.7 meters. When EAR unit 9300238B006 was recovered on February 7th 2008, it was replaced with EAR unit 9300235B004. The level 1 report for EAR 9300237B005, which was deployed from August 8th 2006 to February 23rd 2007 at the FBAY site, is available as PIFSC Internal Report IR-09-016. (Note that Report IR-09-016 erroneously identifies EAR 9300235B004 as being deployed immediately following the recovery of EAR 9300237B005.)

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).

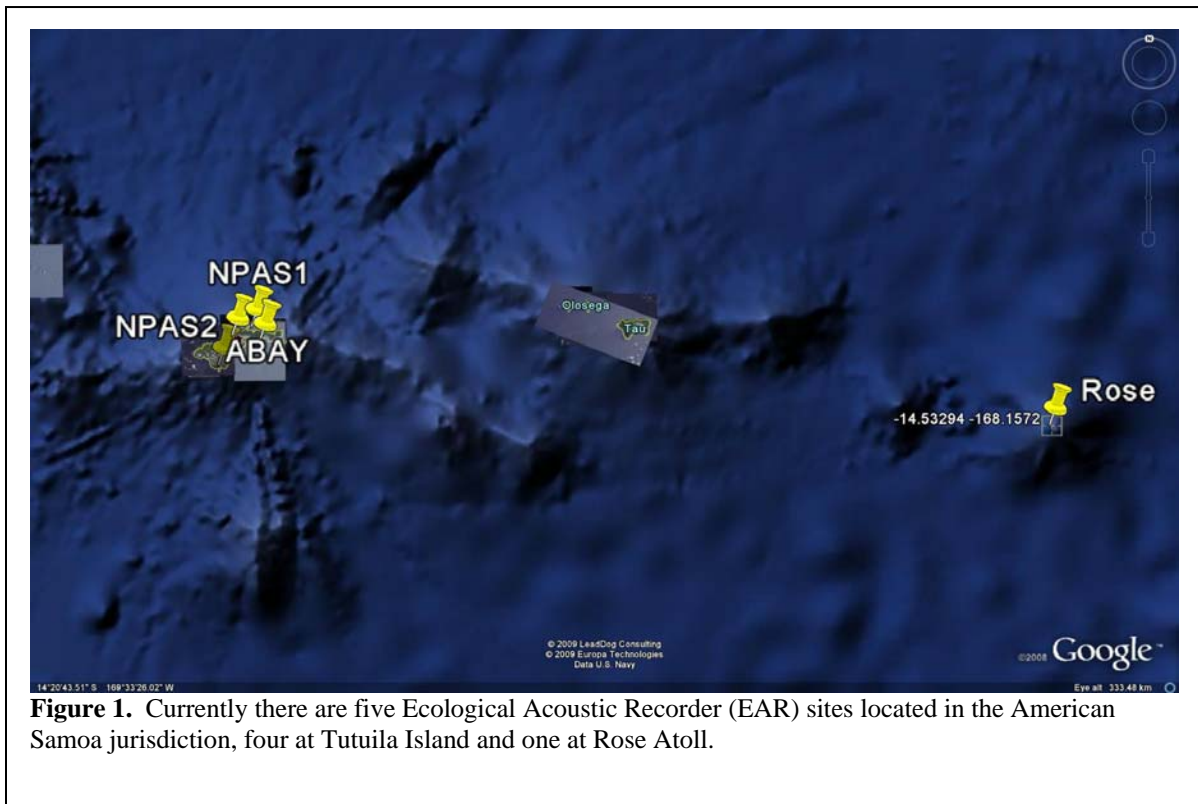


Figure 1. Currently there are five Ecological Acoustic Recorder (EAR) sites located in the American Samoa jurisdiction, four at Tutuila Island and one at Rose Atoll.

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 located between CRED Rapid Ecological Assessment (REA) sites TUT-22 and TUT-67. Coral cover of 41.2% has been observed at site TUT-22, there are nineteen coral genera, a large abundance of macroalgae, and low abundance of macroinvertebrates. REA site TUT-67 has high coral cover with medium reef complexity. Acanthurids commonly known as surgeonfishes were most common, though in general this site was surprisingly depauperate of large fish (2008, HI-08-02).

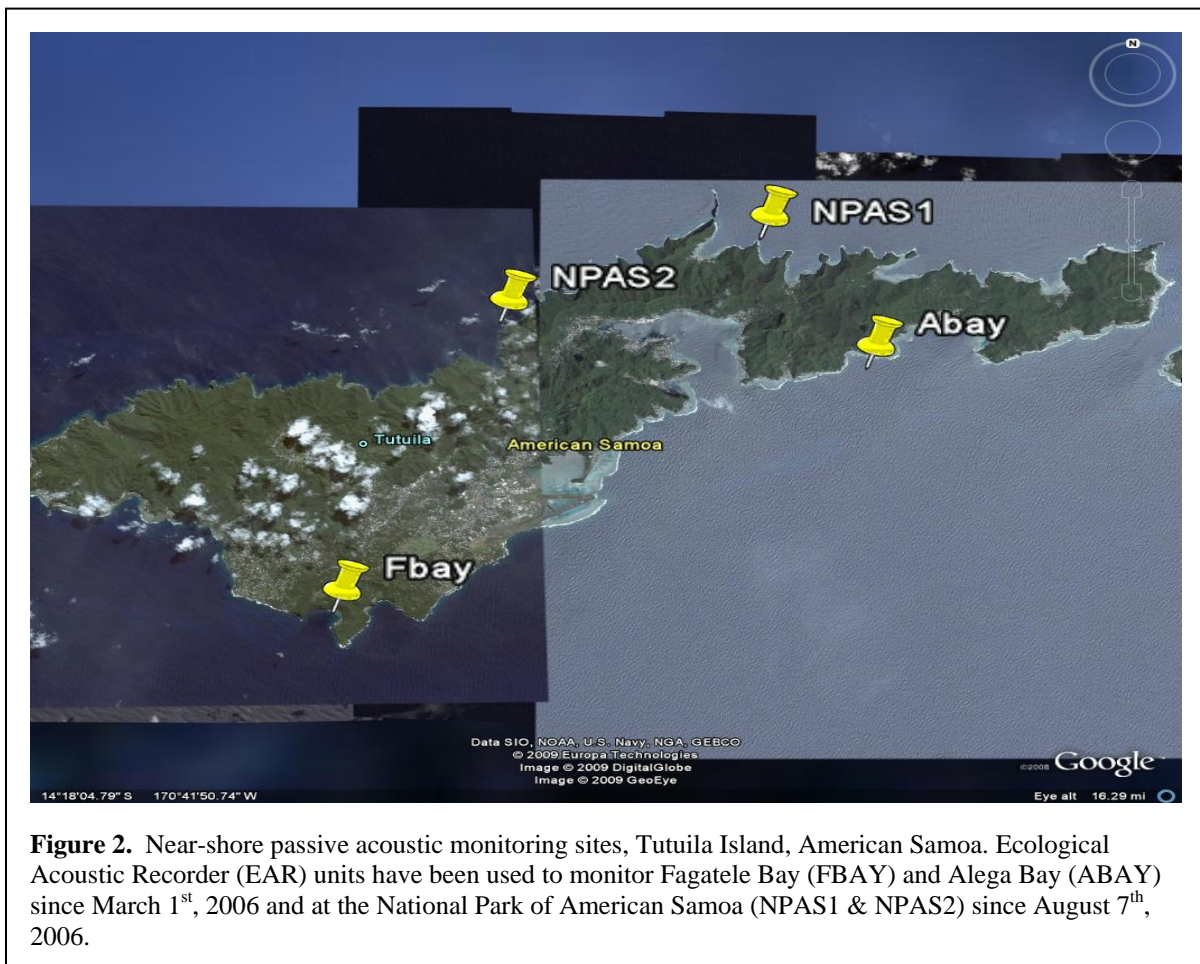


Figure 2. Near-shore passive acoustic monitoring sites, Tutuila Island, American Samoa. Ecological Acoustic Recorder (EAR) units have been used to monitor Fagatele Bay (FBAY) and Alega Bay (ABAY) since March 1st, 2006 and at the National Park of American Samoa (NPAS1 & NPAS2) since August 7th, 2006.

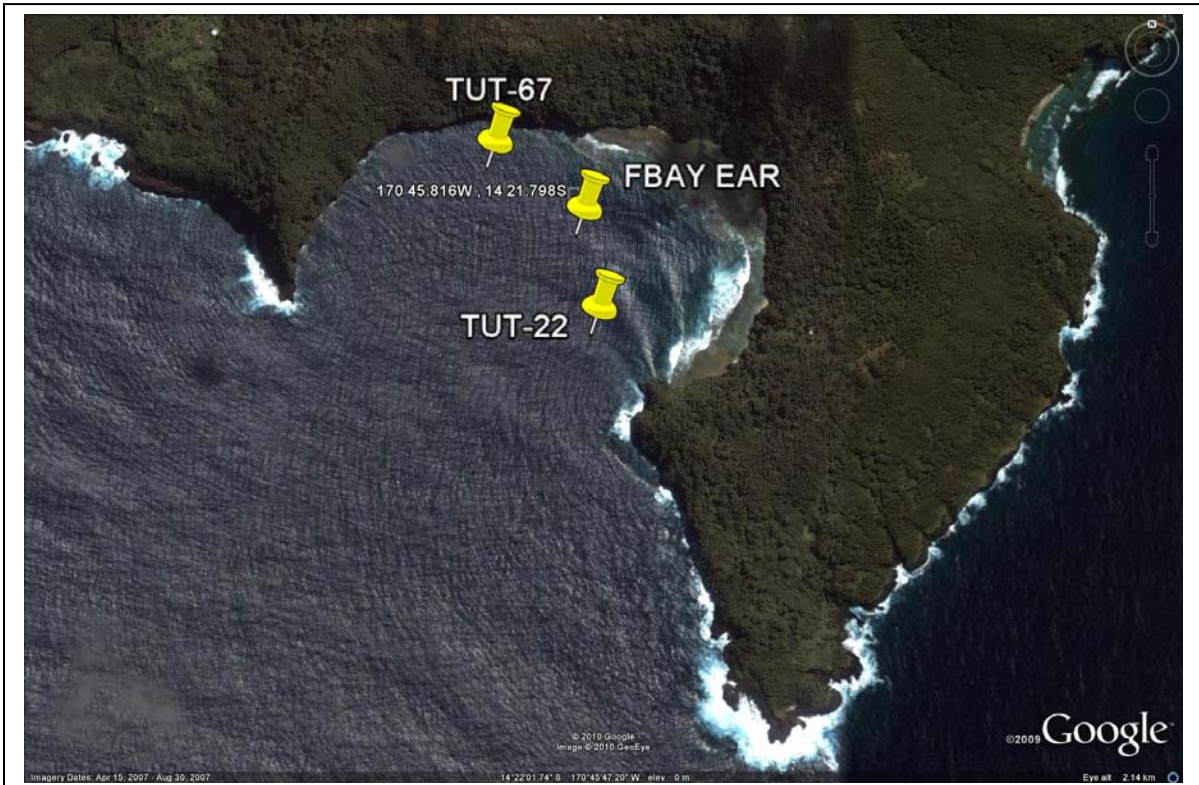


Figure 3. EAR monitoring site FBAY is located in the Fagatele Bay National Marine Sanctuary on the south side of Tutuila Island. Rapid Ecological Assessment (REA) sites TUT-22 and TUT-67 are also located in the bay.

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.

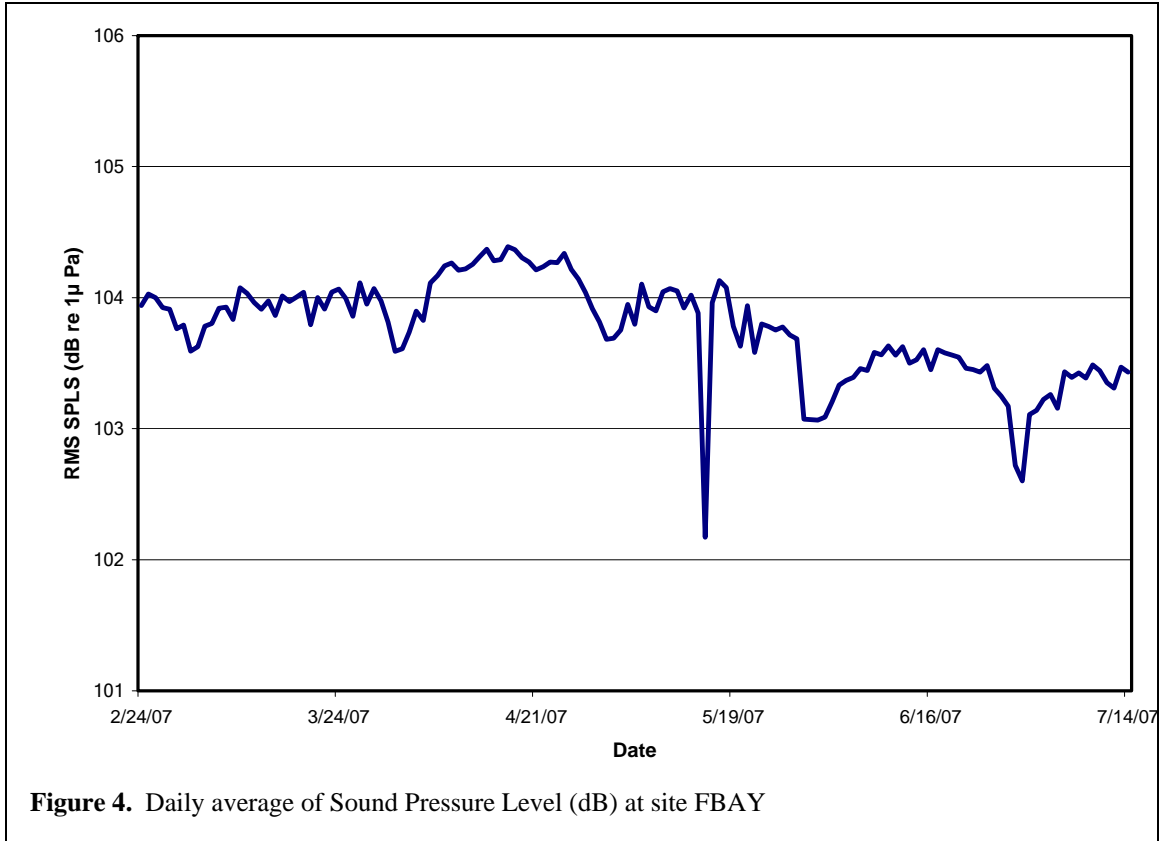
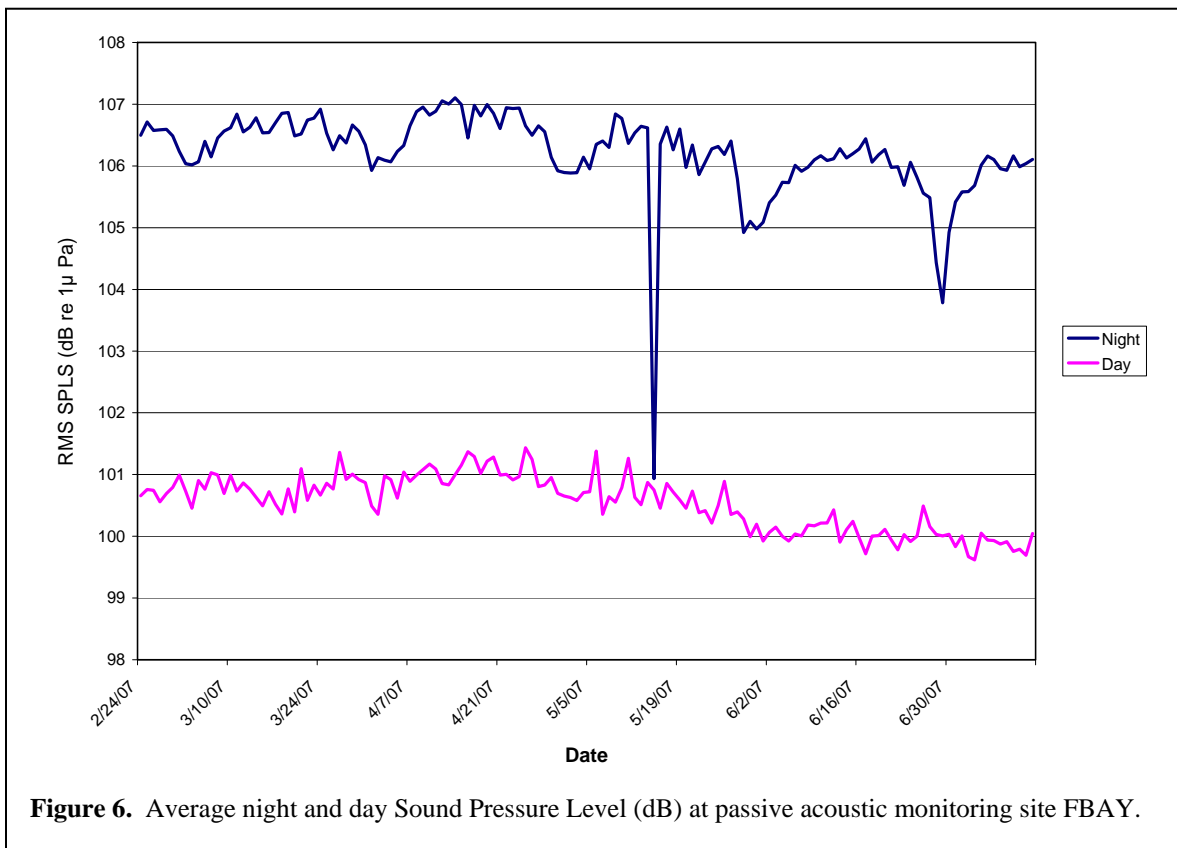
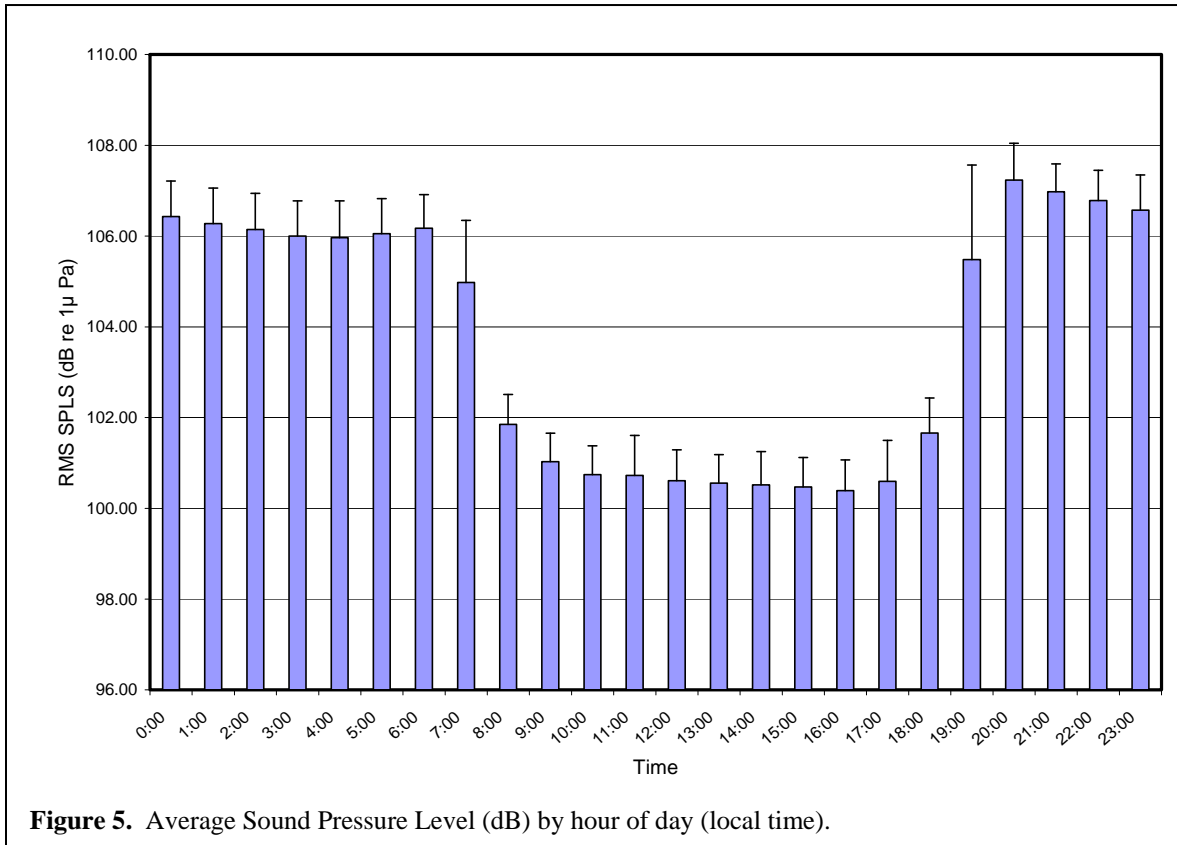
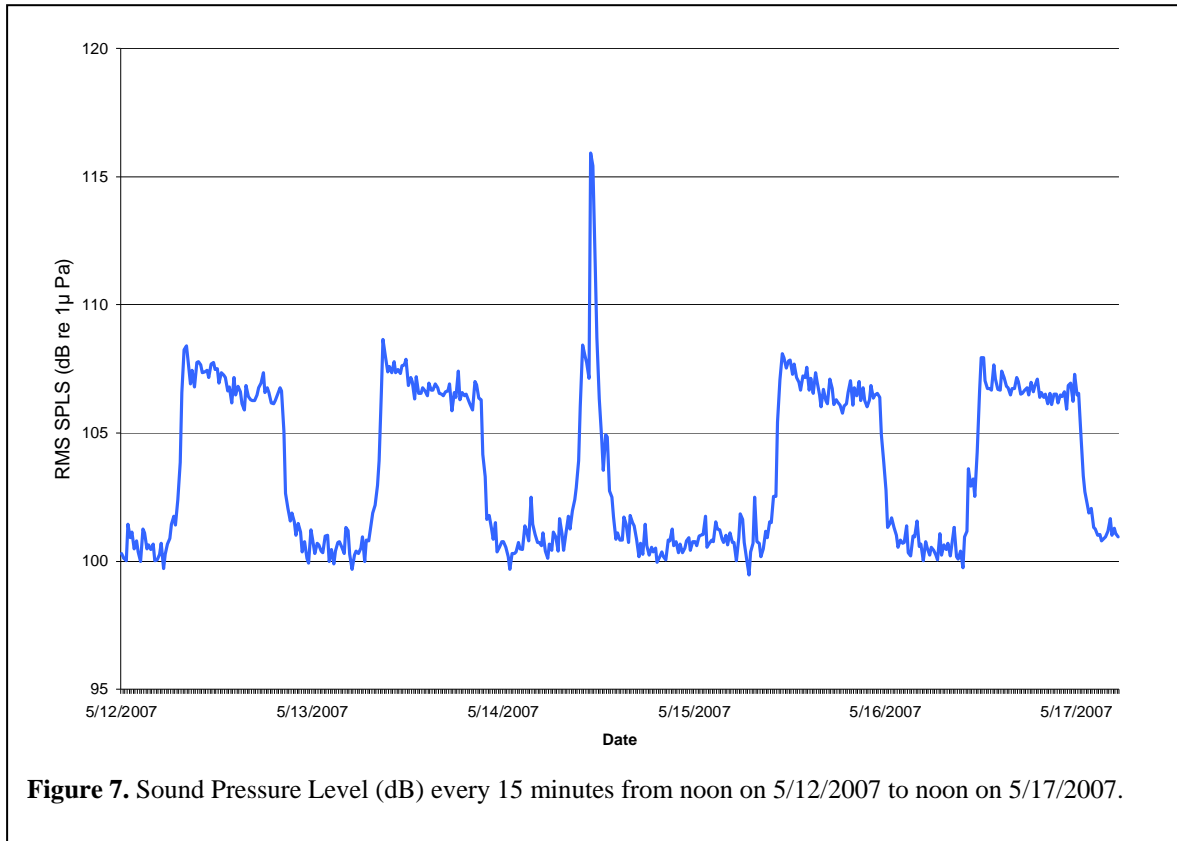


Figure 4. Daily average of Sound Pressure Level (dB) at site FBAY

The acoustic energy record obtained from periodic duty-cycle recordings shows strong diel variability (Figure 5). Nighttime Root Mean Square (RMS) Sound Pressure Levels (SPL) are typically 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 6). In addition to typical variations of SPL by day and night, there is evidence of periodic variability on the scale of several weeks (Figure 4). The major source of observed ambient acoustic energy is 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 upward spikes in ambient acoustic energy levels represent episodic events involving one or more of these sound sources.

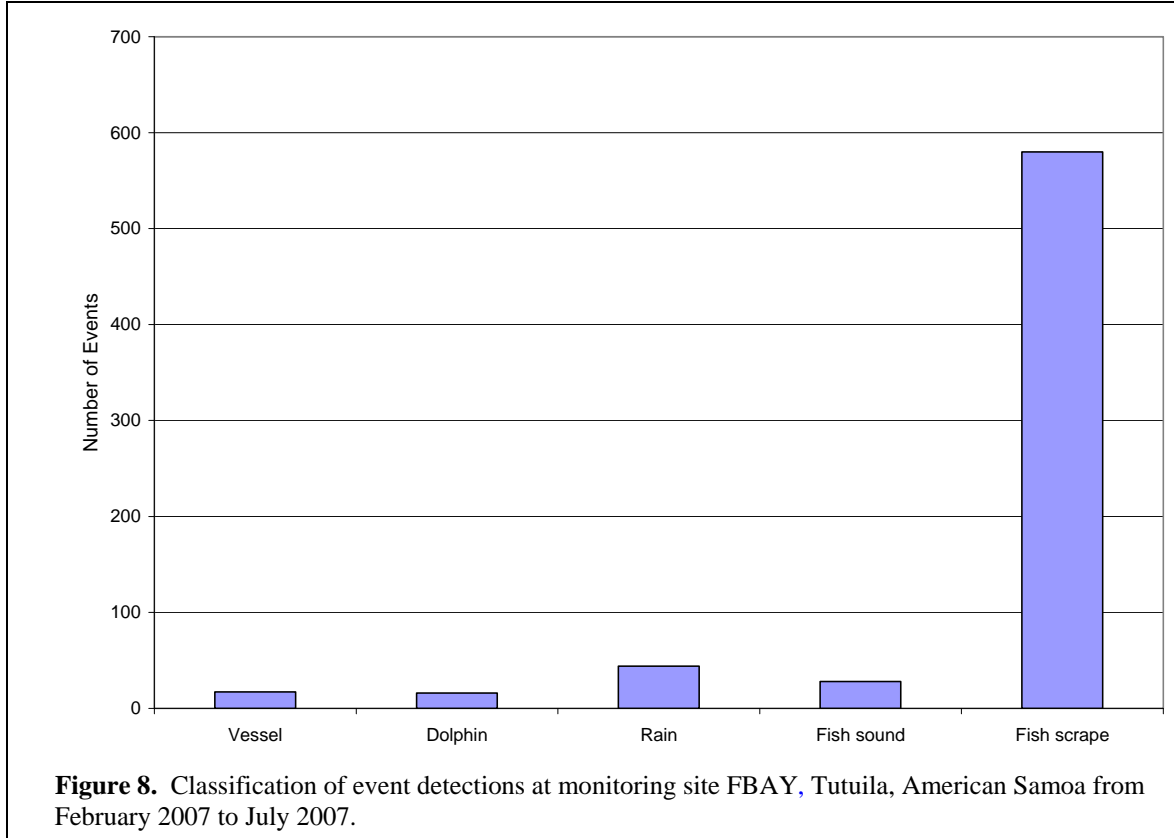


An unusual appearance of a downward spike in the long-term ambient acoustic levels (Figure 4) was caused by a temporary perturbation to the diel cycle (Figure 7). Based on the acoustic records, it appears that heavy precipitation caused an initial rise in the sound pressure level that was quickly followed by a drastic decline in nighttime snapping shrimp acoustic activity on May 15th (Figure 7). Normal ambient levels returned the following night. Heavy precipitation and storm events have been previously linked to temporary perturbations to the diel cycle of snapping shrimp at Kure (McCoy et al., 2009) and Pearl and Hermes atoll in the Northwestern Hawaiian Islands.



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 8 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 9) and by month of year (Figure 10). 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.

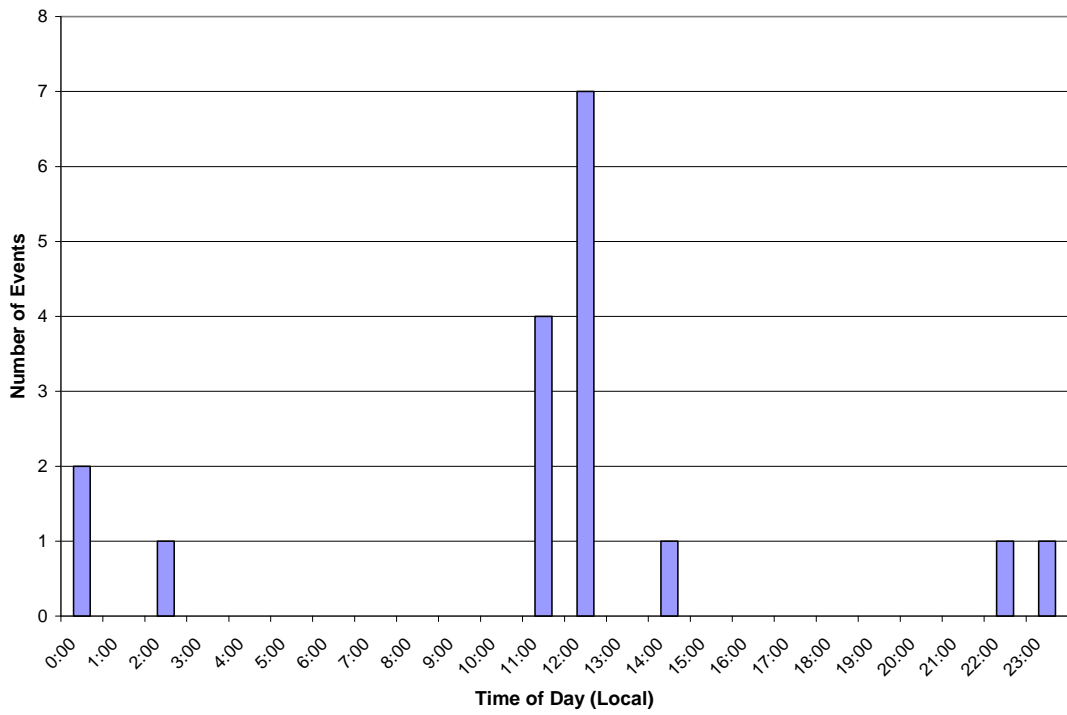


Figure 9. Vessel events classified by time of day (local time).

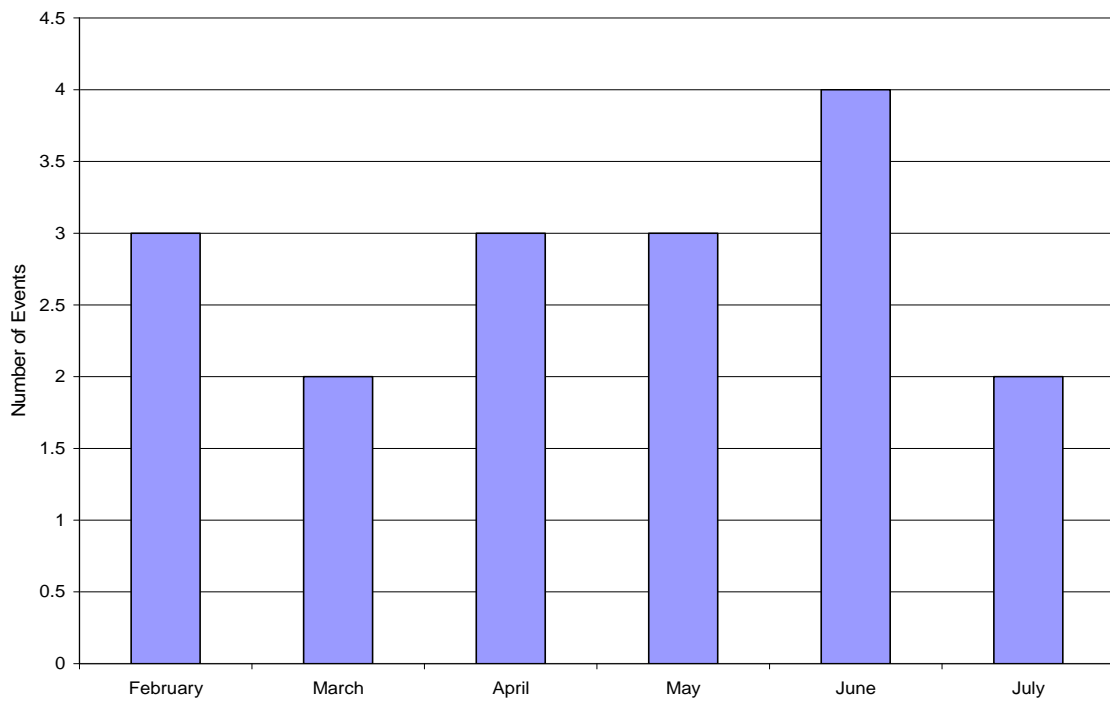


Figure 10. Vessel events classified per month.

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

Vessel Event			
UTC		Local	
Date	Time	Date	Time
2/23/2007	23:06	2/23/2007	12:06
2/23/2007	23:08	2/23/2007	12:08
2/23/2007	23:32	2/23/2007	12:32
3/20/2007	22:43	3/20/2007	11:43
3/20/2007	22:48	3/20/2007	11:48
4/6/2007	22:10	4/6/2007	11:10
4/6/2007	22:18	4/6/2007	11:18
4/6/2007	23:55	4/6/2007	12:55
5/4/2007	9:42	5/3/2007	22:42
5/4/2007	11:21	5/4/2007	0:21
5/26/2007	23:21	5/26/2007	12:21
6/5/2007	23:08	6/5/2007	12:08
6/14/2007	13:48	6/14/2007	2:48
6/15/2007	23:20	6/15/2007	12:20
6/29/2007	10:48	6/28/2007	23:48
7/4/2007	1:52	7/3/2007	14:52
7/13/2007	11:28	7/13/2007	0:28

Discussion:

The EAR unit was deployed February 23rd 2007 and recovered on February 7th 2008. The unit recorded acoustic data from February 23rd 2007 to July 14th 2007. During that period of time, 17 event detections were triggered by vessel engine noise between February and July (Figure 10). 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 twelve distinct vessel ‘events’. Seven of these were during daylight hours and five were during the night. One of these ‘events’, documented by three individual event detection recordings on February 23, 2007, was generated by the small boat used during the deployment of the EAR unit. 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 five month record.

The dominant sounds that triggered event detection on EAR unit 9300238B006 were fish scrapes, with 580 recorded events. During the deployment period, a general peak in ambient acoustic levels was observed for the month of April, followed by a steady decline through the end of the recording period in July. This suggests some degree of seasonal variability in ambient acoustic levels. 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:

Craig P. 2005. Natural History Guide to American Samoa. 2nd Edition. 2005.
<http://www.nps.gov/npsa/naturescience/upload/2nded05A.pdf>

McCoy, K., Fisher-Pool, P., Lammers, M., Wong, K., (2009) Northwestern Hawaiian Islands Passive Acoustic Monitoring Site KUR (Kure Atoll, NWHI) Ecological Acoustic Recorder (EAR) 19-September-2006 to 29-September 2008 Level 1 Analysis of Passive Acoustic Observations. Pacific Islands Fisheries Science Center Internal Report IR-09-017. Issued 5 May 2009.

National Park Service. National Park of American Samoa. 2008. Lease Agreement between landowners of American Samoa and the American Samoa Government, 9 September 1993. <http://www.nps.gov/npsa/parkmgmt/lawsandpolicies.htm>.

National Park Service. National Park of American Samoa. 2004.
<http://www.nps.gov/archive/npsa/location.htm>

Pacific Islands Fisheries Science Center, 2008. */Hi'ialakai/* Cruise Report HI-08-02.

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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