

**American Samoa**  
**Passive Acoustic Monitoring Site NPAS2 (Tutuila Island, North Shore)**

**Ecological Acoustic Recorder (EAR)**  
**21-September-2006 to 13-April-2007**

**Level 1 Analysis of Passive Acoustic Observations<sup>1</sup>**

**Synopsis**

This document provides a level 1 analysis of the data obtained from ecological acoustic recorder (EAR) unit 9300287B015 deployed on the north shore of Tutuila Island, American Samoa from September 21<sup>st</sup> 2006 to April 13<sup>th</sup> 2007. The unit recorded data for the duration of its deployment. The site is within the National Park of American Samoa. 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 also available.

**Background**

Monitoring the changing status of coral reef environments and their 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 monitoring biological and anthropogenic sounds, CRED investigates and monitors the presence and activity of sound-producing marine life and humans. The EAR can be left in place unattended for up to a year at a time and is 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 9300287B015 deployed on the northern shore of Tutuila Island, American Samoa from September 21<sup>st</sup> 2006 to April 13<sup>th</sup> 2007. The unit recorded data from September 21<sup>st</sup> 2006 to April 21<sup>st</sup> 2007. This report 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 temporal variability in occurrence of these sounds will be presented in summary tables and graphic products and discussed. A final, level 4 report is an integrative report comparing data from multiple years and multiple EAR monitoring sites at an island or archipelagic scale. It is anticipated that level 4 reports will take the form of manuscripts for publication in peer-reviewed scientific journals.

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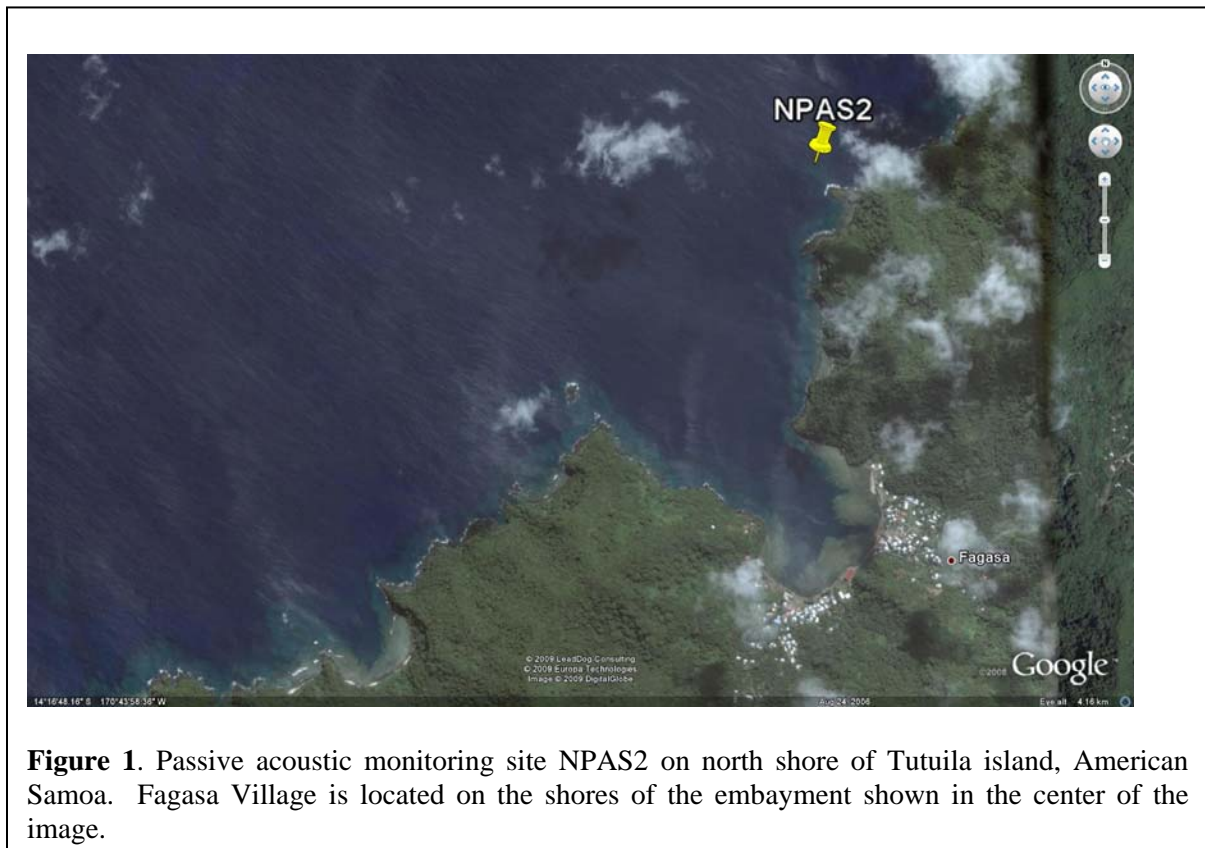
<sup>1</sup> PIFSC Internal Report IR-09-037  
Issued 18 November 2009

## **Deployment site**

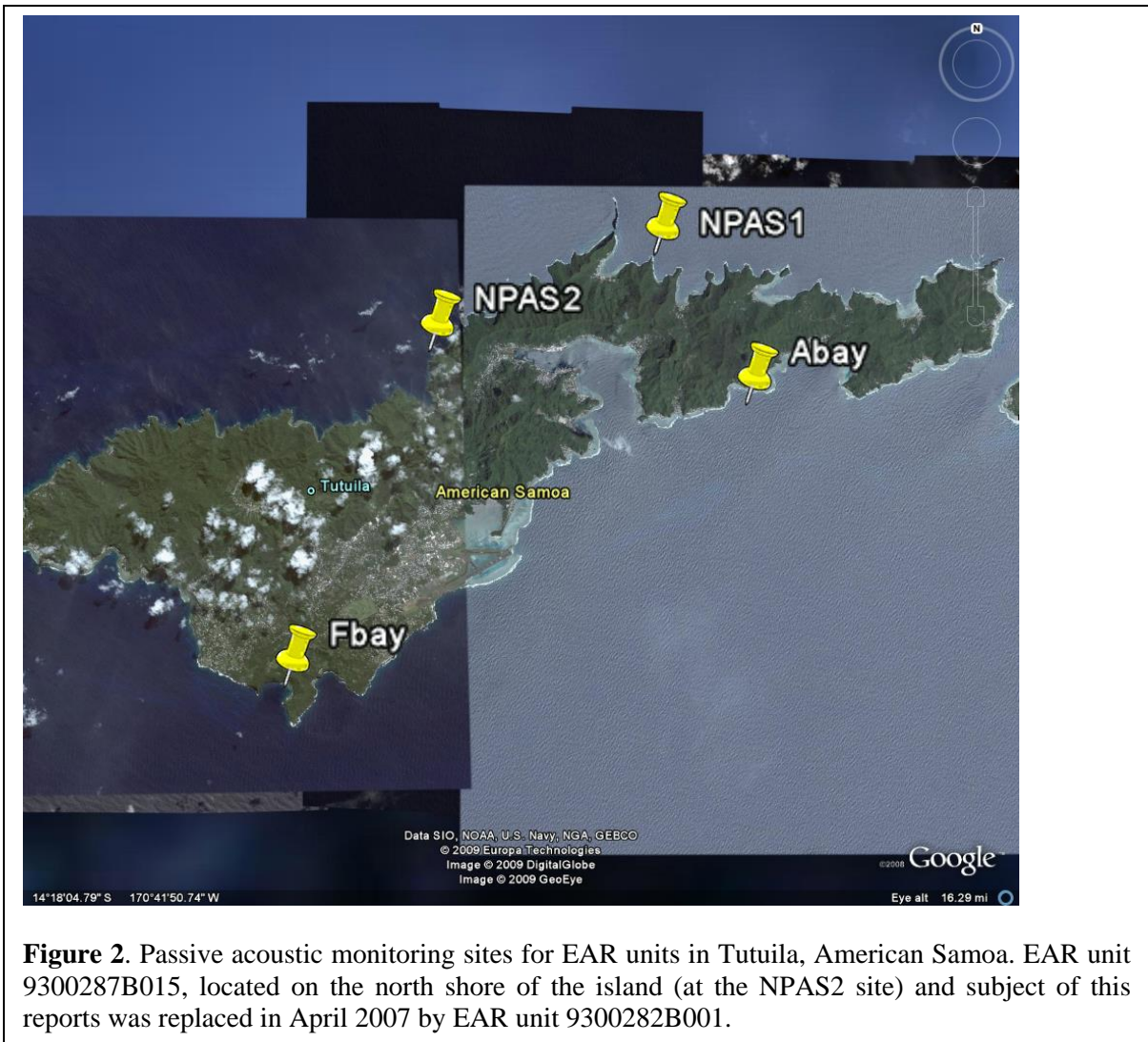
American Samoa is the only US Territory south of the equator and is located east of the International Date Line in the Pacific Ocean (National Park Service, 2004). The total land area of American Samoa is 76.1 square miles (197.1 km<sup>2</sup>), it includes five volcanic islands (Tutuila, Aunu'u, Ofu, Olosega, Ta'u) and two remote atolls (Rose, Swains) (Craig, 2005).

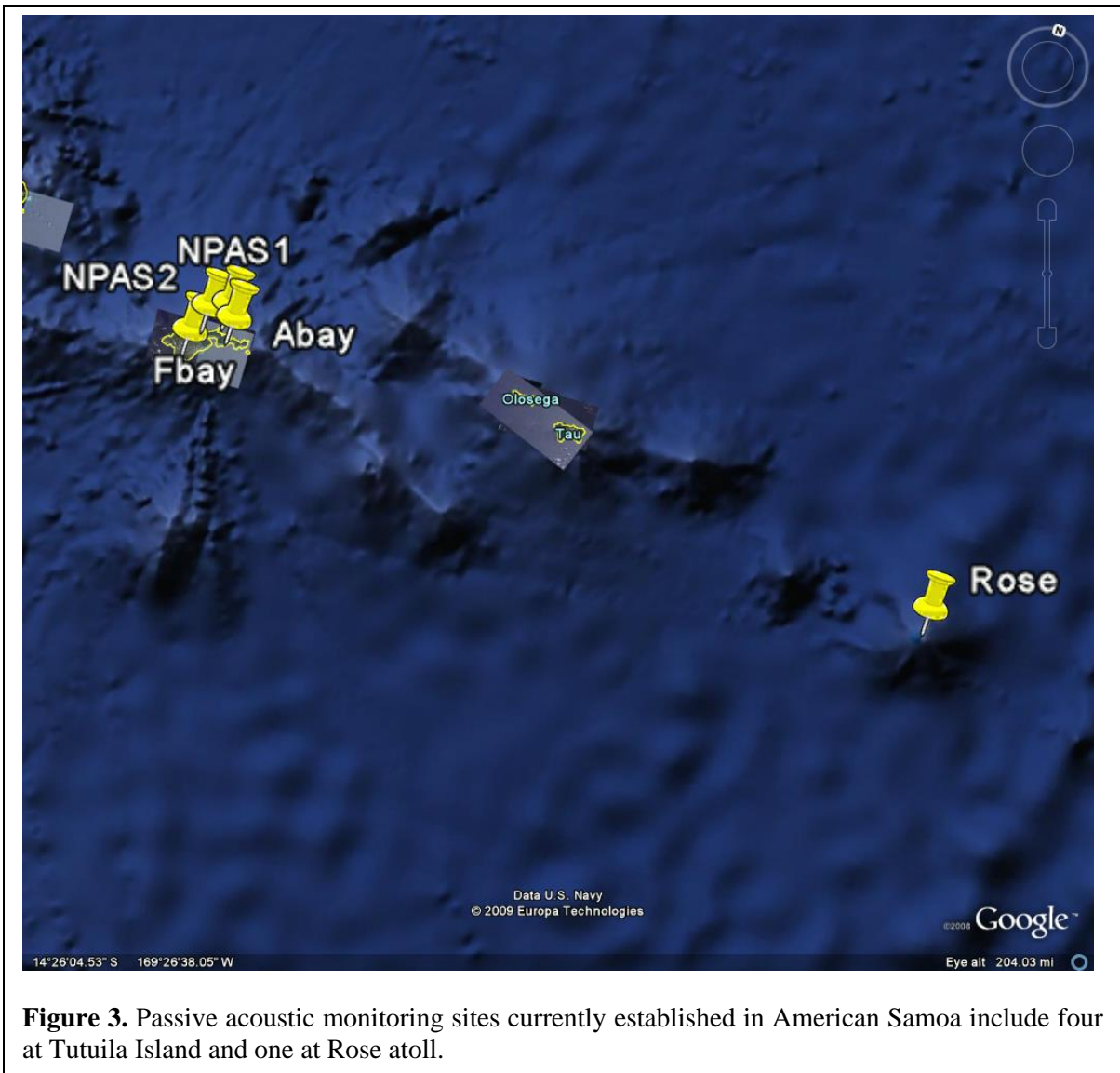
EAR unit 9300287B015 was deployed on the north Shore of Tutuila Island at the National Park of American Samoa from September 2006 to April 2007 (Figure 1). It was deployed at a depth of 16.7 meters (54.8 ft). Upon recovery, replacement EAR unit 9300282B001 was deployed in the same location to continue the passive acoustic monitoring of this site. Previously, an EAR was deployed at this site from July to September of 2006; this recorder encountered a software glitch and did not record any data.

The deployment site on the north Shore of Tutuila Island is one of four passive acoustic monitoring sites (NPAS1, NPAS2, ABAY and FBAY) that are currently maintained in the near-shore waters of Tutuila Island (Figure 2). Two of these sites 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). In addition to the four sites on Tutuila Island, another American Samoa EAR site is located at Rose Atoll which is about 160 miles west of Tutuila Island (Figure 3).



**Figure 1.** Passive acoustic monitoring site NPAS2 on north shore of Tutuila island, American Samoa. Fagasa Village is located on the shores of the embayment shown in the center of the image.

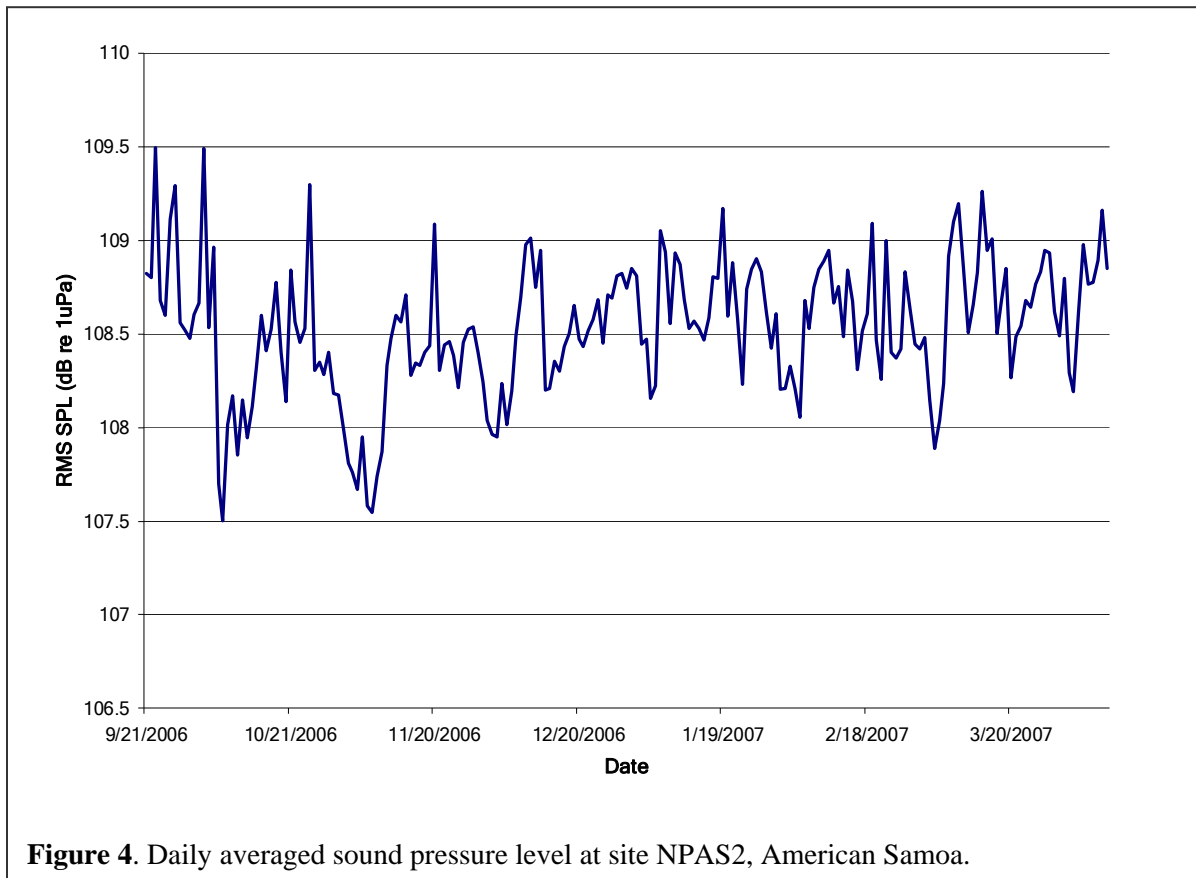




**Figure 3.** Passive acoustic monitoring sites currently established in American Samoa include four at Tutuila Island and one at Rose atoll.

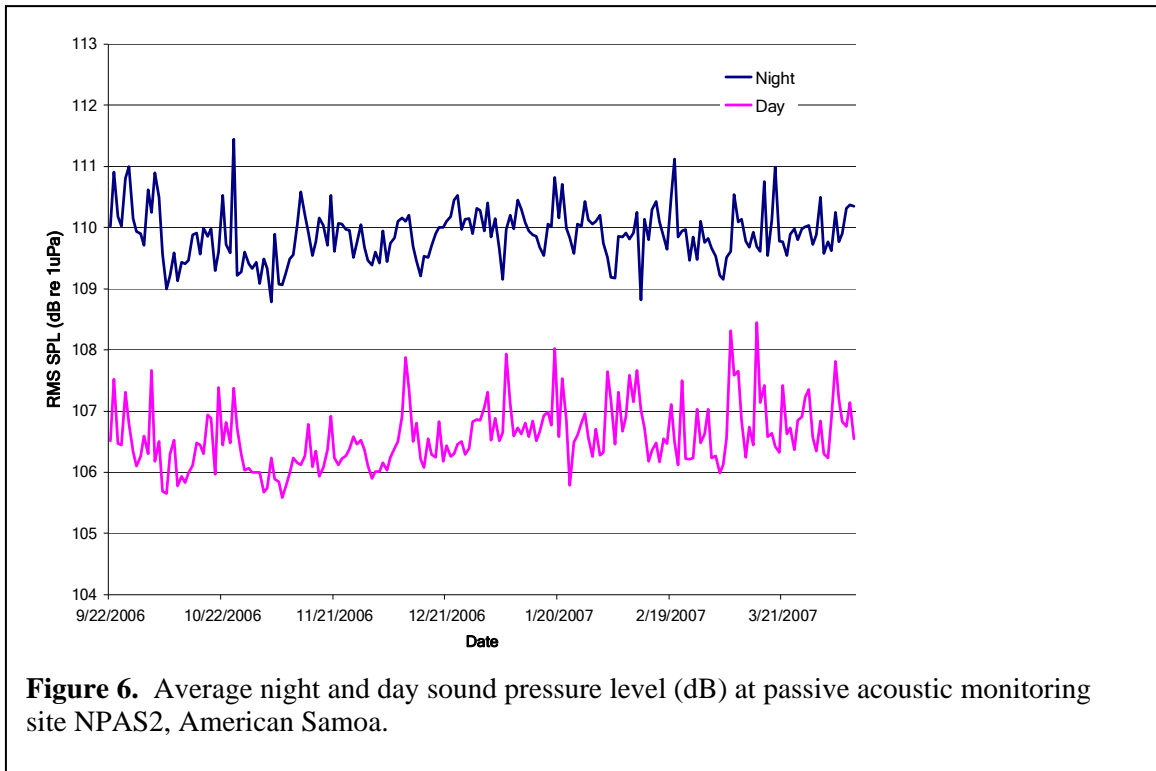
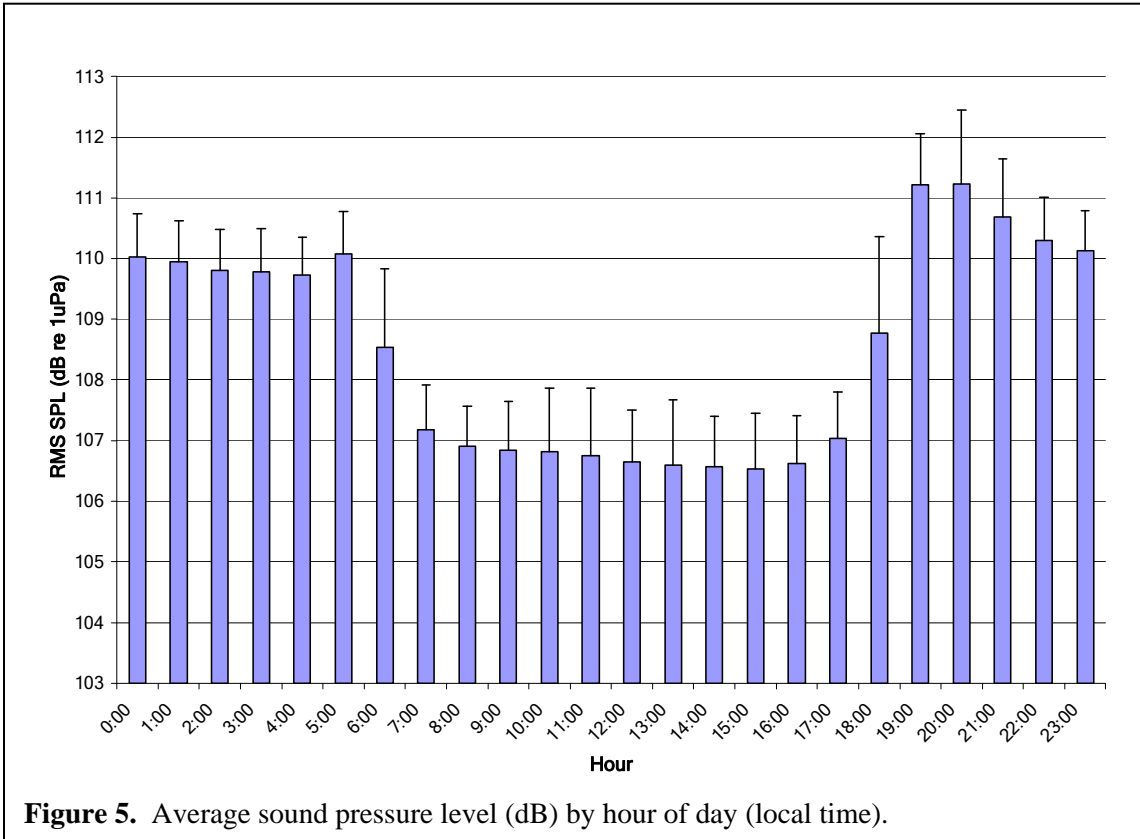
## **Total acoustic energy**

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.



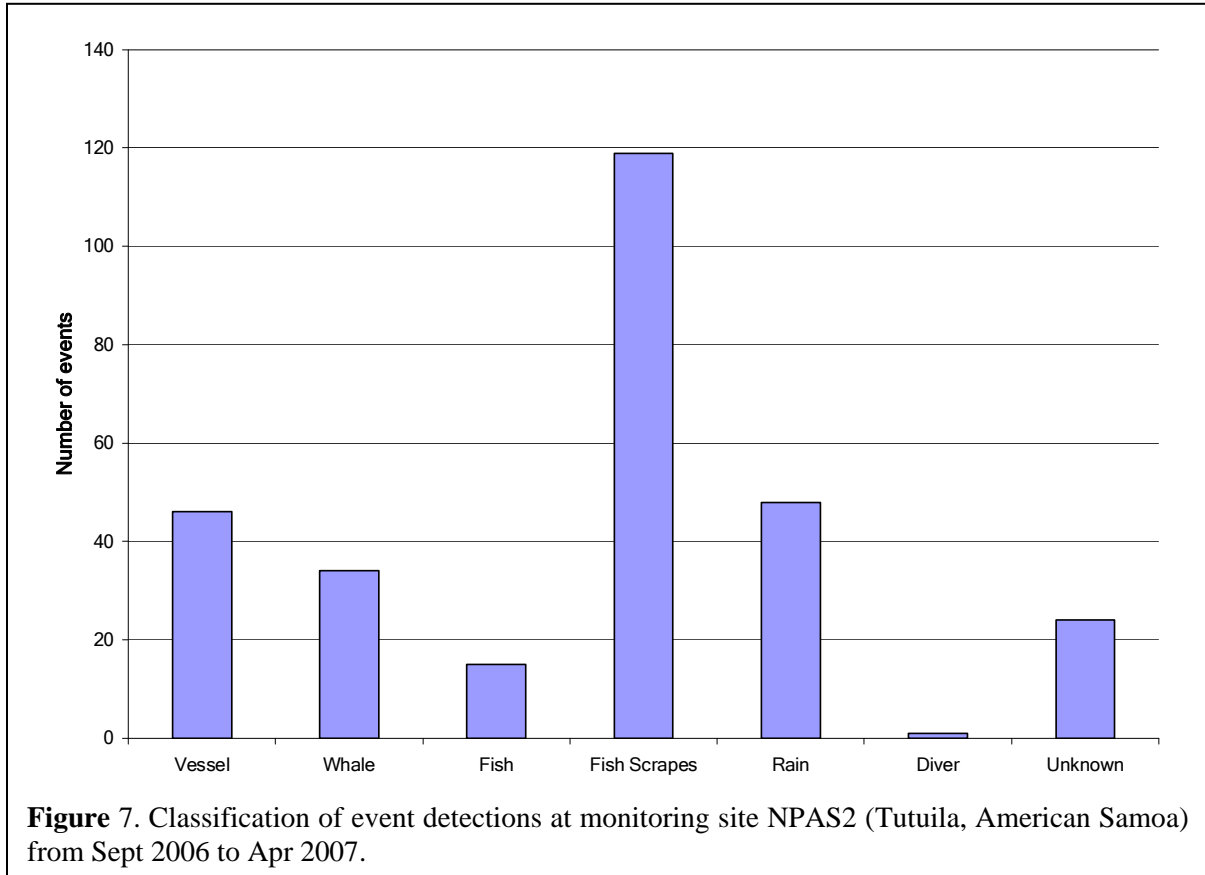
**Figure 4.** Daily averaged sound pressure level at site NPAS2, American Samoa.

The acoustic energy record, as obtained from the duty-cycle (periodic) recordings made by the EAR, shows strong diel variability (Figure 5). Nighttime Root Mean Square (RMS) Sound Pressure Levels (SPL) are 3-4 dB higher at night 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, there is evidence of periodic variability on the scale of several weeks. The major source of ambient acoustic energy is from snapping shrimps, so the diel and periodic variability can be attributed to changes in their activity levels. Further, there is little change in the overall levels over the course of the deployment, suggesting no real seasonal variability in snapping shrimp activity at this site. This contrasts with several other sites observed throughout the Pacific (including Fagatele Bay on the south side of Tutuila Island) where seasonal trends are clear. Other major contributing sources to ambient sound levels include vessel engines, whale signals, rain, and fish. Sporadic spikes in ambient acoustic energy levels represent episodic events involving one or more of these sources.

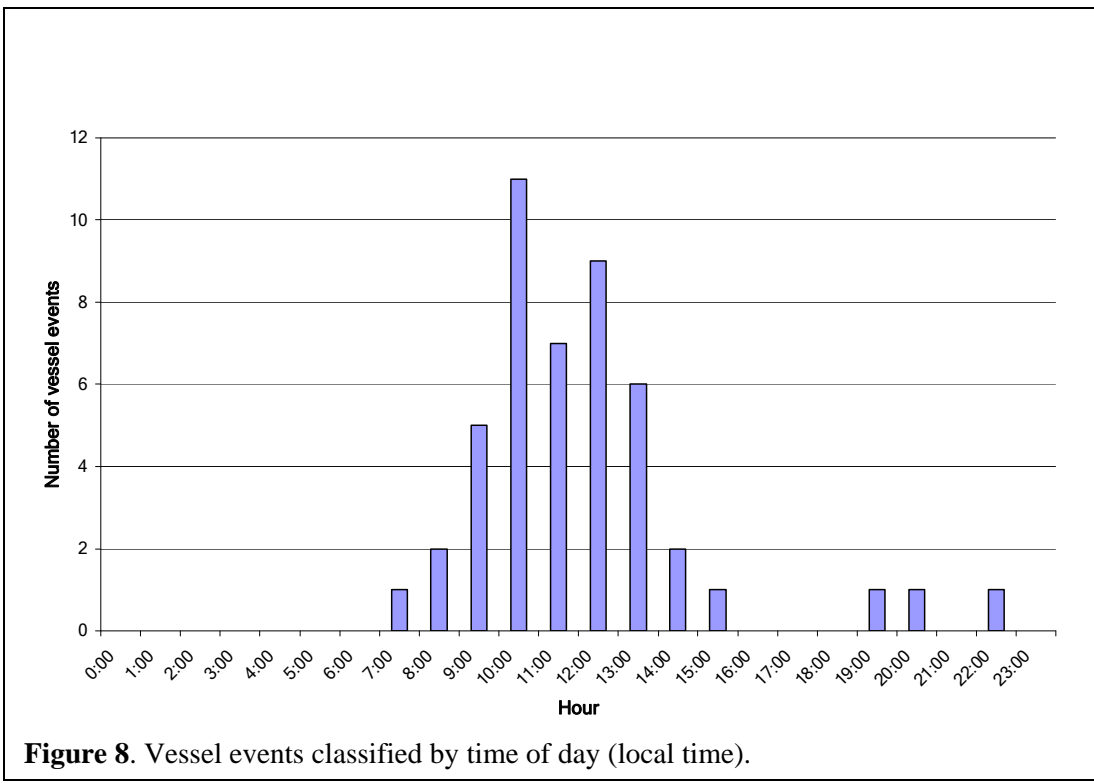


## **Analysis of event-triggered recordings**

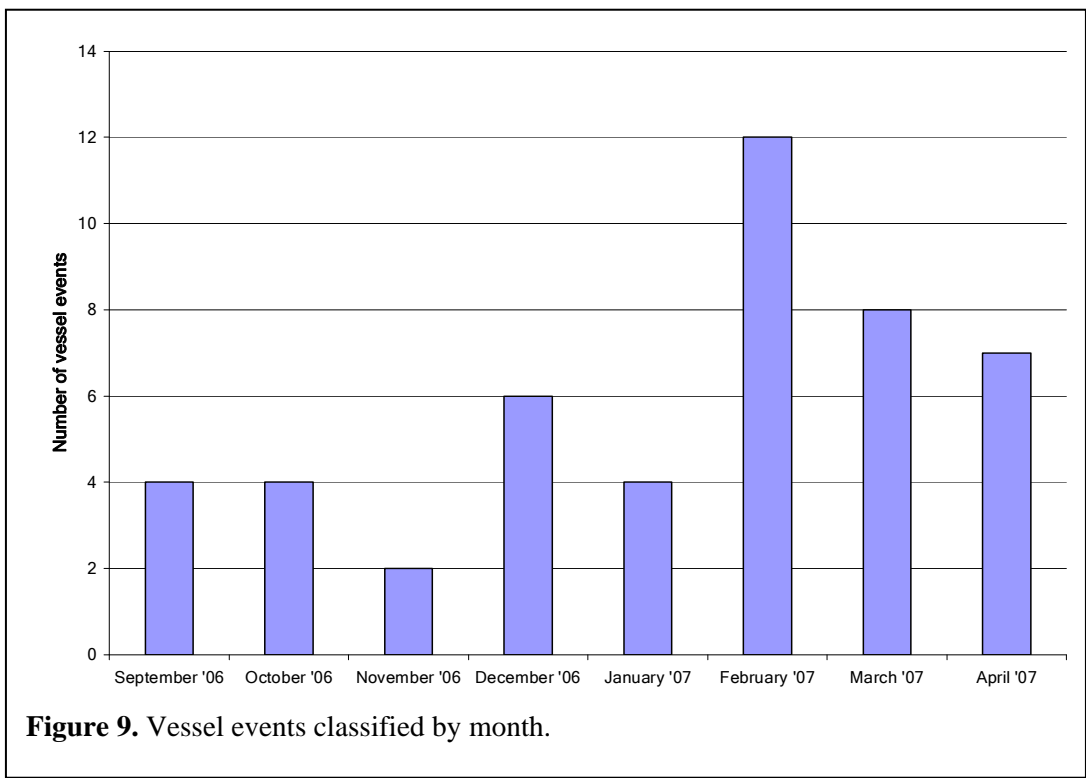
An analysis of all the event-triggered recordings provides usage patterns of motorized vessel, cetaceans, and other acoustic sources. Figure 7 shows the classification of event-triggered recordings at this site.



Each vessel event recording is linked to the time/date 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). The complete record of event triggered vessel detections is included as Table 1.



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



**Figure 9.** Vessel events classified by month.



Table 1. UTC and local date and time of vessel events at site NPAS2 (National Park of American Samoa).

<b>Vessel Event</b>	
UTC	Local
Date / Time	Date / Time
9/21/2006 22:05	9/21/2006 11:05
9/22/2006 22:04	9/22/2006 11:04
9/26/2006 19:48	9/26/2006 8:48
9/27/2006 0:51	9/26/2006 13:51
10/5/2006 21:43	10/5/2006 10:43
10/11/2006 20:02	10/11/2006 9:02
10/17/2006 18:25	10/17/2006 7:25
10/20/2006 7:51	10/19/2006 20:51
11/3/2006 21:06	11/3/2006 10:06
11/25/2006 9:20	11/24/2006 22:20
12/12/2006 23:18	12/12/2006 12:18
12/15/2006 21:30	12/15/2006 10:30
12/20/2006 21:45	12/20/2006 10:45
12/20/2006 23:47	12/20/2006 12:47
12/27/2006 6:51	12/26/2006 19:51
12/28/2006 19:44	12/28/2006 8:44
1/8/2007 23:29	1/8/2007 12:29
1/11/2007 21:02	1/11/2007 10:02
1/18/2007 20:53	1/18/2007 9:53
1/20/2007 0:28	1/19/2007 13:28
2/8/2007 23:13	2/8/2007 12:13
2/9/2007 0:43	2/8/2007 13:43
2/13/2007 22:37	2/13/2007 11:37
2/14/2007 21:08	2/14/2007 10:08
2/14/2007 22:54	2/14/2007 11:54
2/14/2007 23:25	2/14/2007 12:25
2/15/2007 1:47	2/14/2007 14:47
2/21/2007 1:58	2/20/2007 14:58
2/22/2007 0:16	2/21/2007 13:16
2/27/2007 0:13	2/26/2007 13:13
2/27/2007 23:25	2/27/2007 12:25
2/28/2007 21:14	2/28/2007 10:14
3/1/2007 21:59	3/1/2007 10:59
3/6/2007 20:01	3/6/2007 9:01
3/7/2007 21:05	3/7/2007 10:05
3/13/2007 0:09	3/12/2007 13:09
3/13/2007 23:32	3/13/2007 12:32
3/15/2007 20:23	3/15/2007 9:23
3/26/2007 21:35	3/26/2007 10:35
3/27/2007 2:49	3/26/2007 15:49

Table 1 continued.

4/1/2007 22:03	4/1/2007 11:03
4/1/2007 23:01	4/1/2007 12:01
4/3/2007 20:19	4/3/2007 9:19
4/3/2007 22:25	4/3/2007 11:25
4/3/2007 23:26	4/3/2007 12:26
4/10/2007 21:40	4/10/2007 10:40

Similar analyses, not included in this report, can be performed on the other types of events (rain, cetaceans, fish sounds, etc.)

### **Discussion:**

The EAR unit was deployed in September of 2006 and recovered on April of 2007. The unit recorded acoustic data during the entire deployment period.

During the eight-month deployment period, there were 48 recorded events of vessels in the vicinity of the monitoring site. The highest vessel activity was observed during the month of February (Figure 9). Most of the vessel activity at the site happened between 7 AM to 3 PM with peak activities at 11 AM (Figure 8). There are a few isolated incidents of vessels triggering the event detection in the evening.

The dominant sounds that triggered the event detection on EAR unit 9300287B015 were fish scrapes, with 119 events. These sounds happen when fish feed on the bio-fouling growing on the recorder.

The site at National Park of American Samoa is a marine protected area, where the managers of the park face difficulties in monitoring anthropogenic impacts to the remote insular ecosystems. The EAR provides an idea of the frequency and timing of human activities as revealed by motorized vessel presence in the area.

### **Note:**

This report is distributed to NOAA offices and resource management agencies of the local jurisdiction. Due to the potentially sensitive nature of this data and to prevent vandalism or theft of the deployed instruments, discretion is advised when re-distributing the information contained in this report.

### **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.

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**References:**

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

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

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