

**American Samoa  
Passive Acoustic Monitoring Site NPAS1  
North Tutuila Island**

**Ecological Acoustic Recorder (EAR) 19-July-2006 to 29-September-2006**

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

**Synopsis**

This document provides a level 1 analysis on the data obtained from ecological acoustic recorder (EAR) unit 9300238B06 deployed on the north side of Tutuila Island, American Samoa from July 19<sup>th</sup> 2006 to September 29<sup>th</sup> 2006. The unit recorded data from August 2006 to September 2006. The site is within the National Park of American Samoa (NPAS). This initial report contains background information about the site, time-series of total acoustic energy, analyses of event-triggered recordings, and a complete metadata record for the dataset.

**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 the engine noise from passing vessels or any other high amplitude sounds.

This level 1 report is the product of an initial analysis of the EAR dataset from EAR unit 9300238B06 deployed on the north side of Tutuila Island in American Samoa from July 19<sup>th</sup> 2006 to September 29<sup>th</sup> 2006. The unit recorded data from August 2006 to September 2006. This unit was recovered after only one month of operations due to a suspected software problem. 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

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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 archipelago scale. It is anticipated that level 4 reports will take the form of manuscripts for publication in peer-reviewed scientific journals.

### **Deployment site**

EAR unit 9300238-06 was deployed on the north side of Tutuila Island at the National Park of American Samoa (Figure 1). This unit was placed at a depth of 13.1 meters (43 ft.). Immediately after recovery, a replacement EAR was deployed in the same location to continue the passive acoustic monitoring of this site. Previously, an EAR was deployed at this site from February to July of 2006.

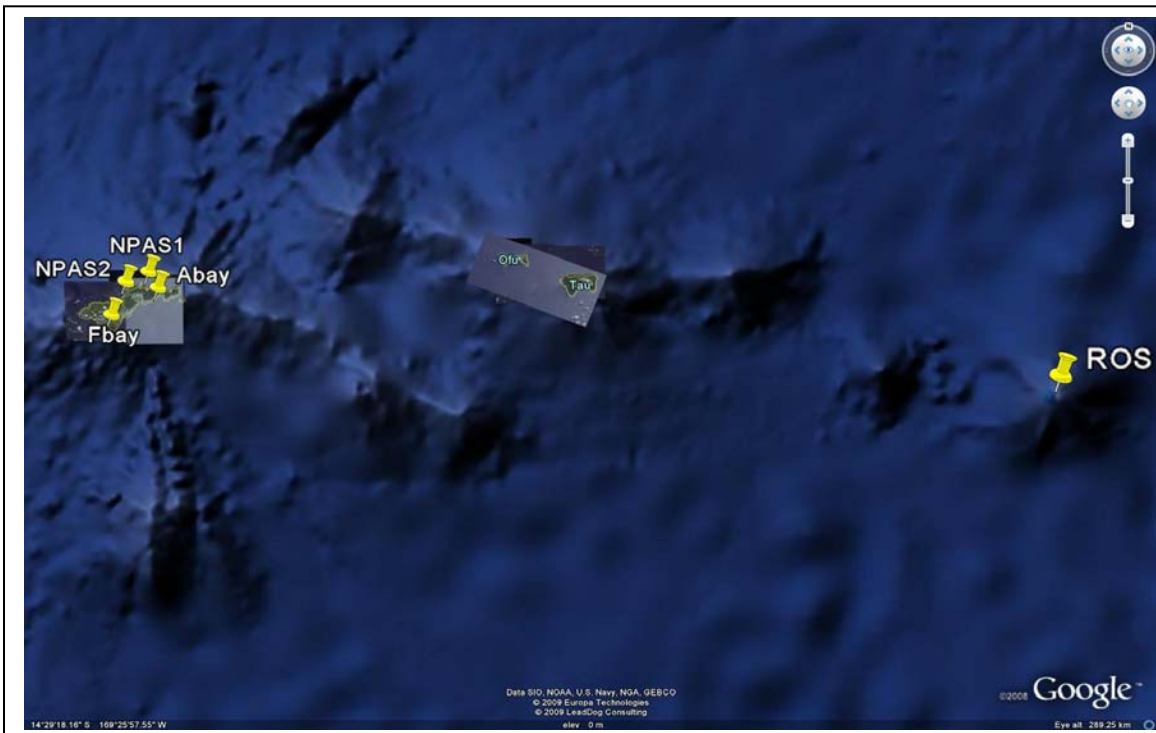
Four passive acoustic monitoring sites (NPAS1, NPAS2, Abay and Fbay) are currently maintained off of Tutuila Island (Figure 1). The other sites are at Fagatele Bay on the south side of Tutuila, Alega Bay, on the south east side of the island, and at another site in the National Park of American Samoa, west of the unit at NPAS1. Another EAR site has been established at Rose Atoll, about 160 miles west of Tutuila Island (Figure 2).

Site NPAS1 is within the American Samoa National Park. Some lands and waters from the islands of Ta'u, Ofu, Olosega, and Tutuila were leased to the National Parks System with intentions of creating the American Samoa National Park. The main goal of the park is the conservation of wildlife, natural and cultural resources of American Samoa. Undeveloped and remote, it consists of three parks on four islands. The park encompasses tropical rainforest, remote forests, streams, rugged coastline, reef and beaches (National Park Service, 2008).

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).



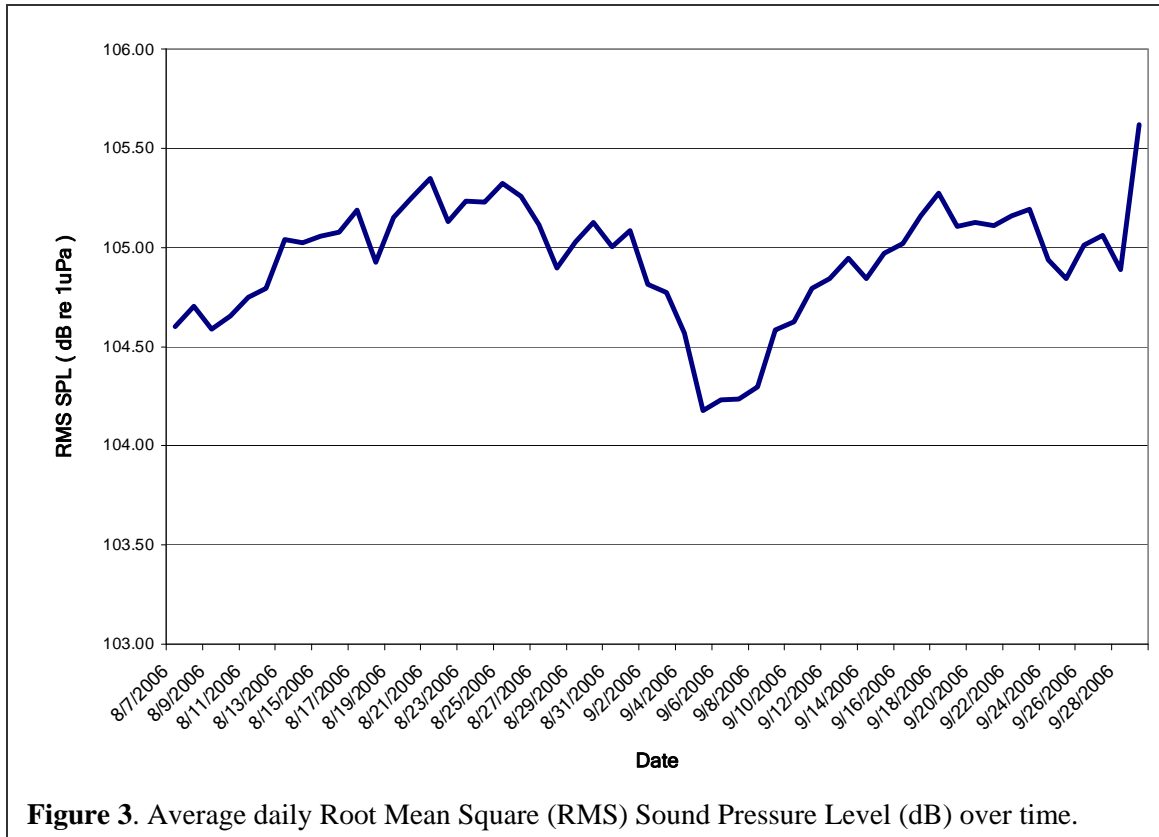
**Figure 1.** Passive acoustic monitoring sites for EAR units of Tutuila island, American Samoa. EAR unit 9300238B06 at NPAS1 was replaced by EAR unit 9300286B14.



**Figure 2.** EAR sites in American Samoa.

### **Total acoustic energy**

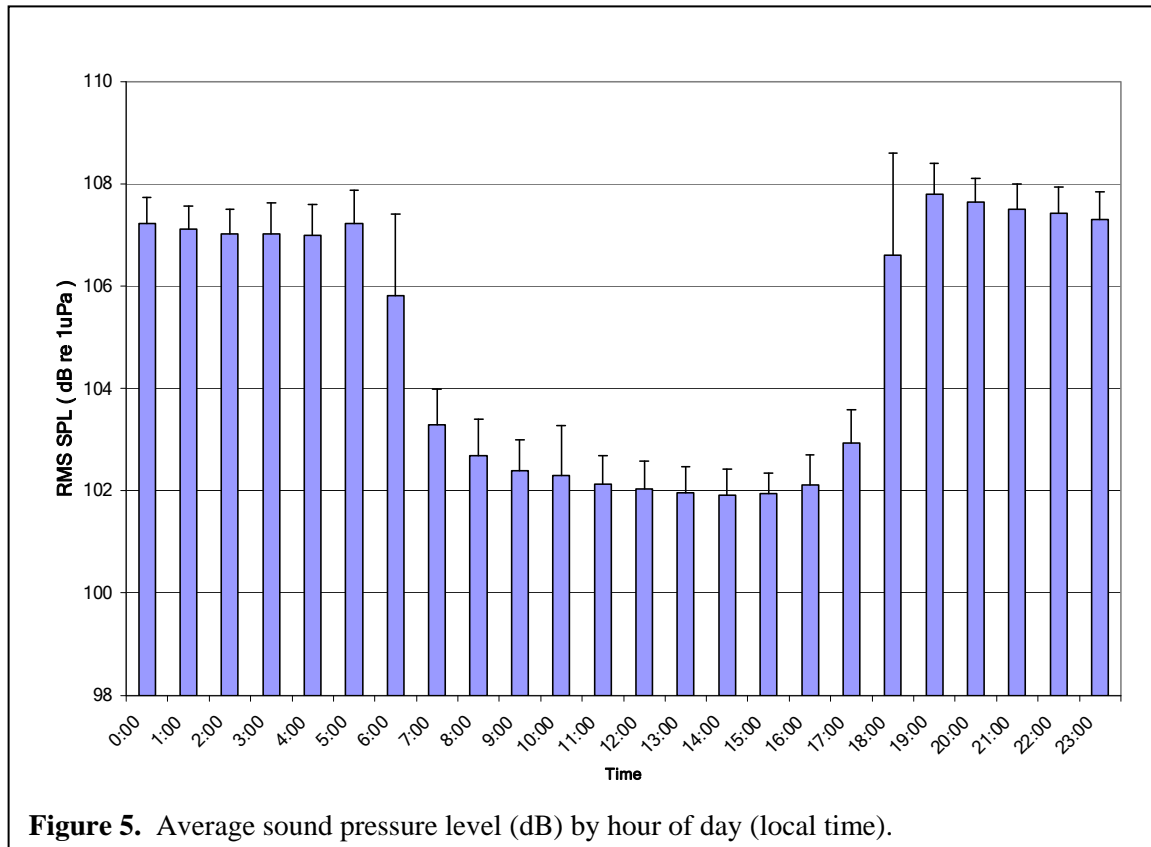
A time series of Total Acoustic Energy provides a synoptic view of the major trends and variability of the acoustic activity at this site (Figure 3).



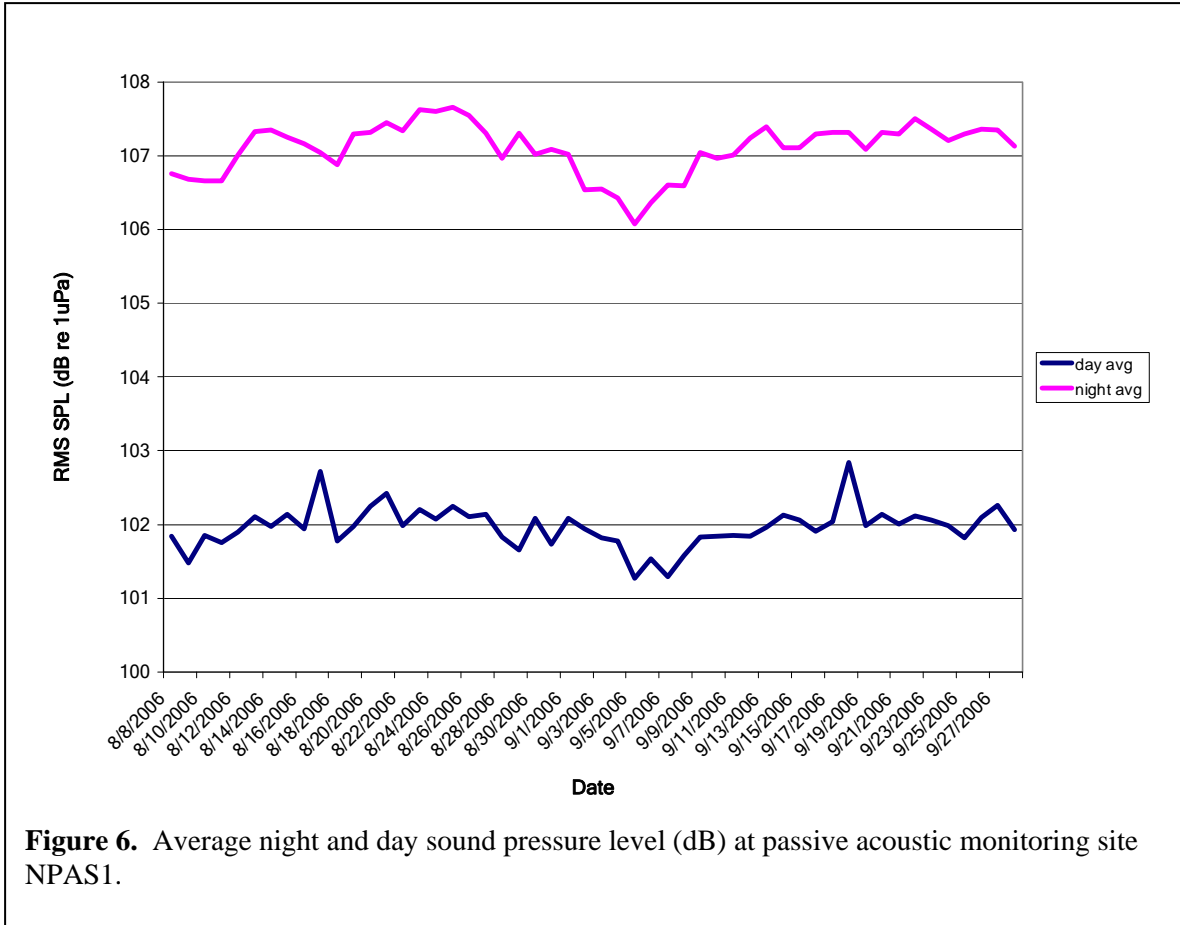
**Figure 3.** Average daily Root Mean Square (RMS) Sound Pressure Level (dB) over time.

There is evidence of periodic variability on the scale of several weeks. The sound pressure level is lower at the beginning of August and increases towards the end of the month before decreasing again at the beginning of September. The major source of ambient acoustic energy is from snapping shrimps, so the periodic variability can be attributed to changes in their activity levels. Snapping shrimp activity at other locations is known to be influenced by the lunar cycle, which is likely also the source of variability here. 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.

The acoustic energy averaged hourly, as obtained from duty-cycled (periodic) recordings, shows strong diel variability (Figure 5).



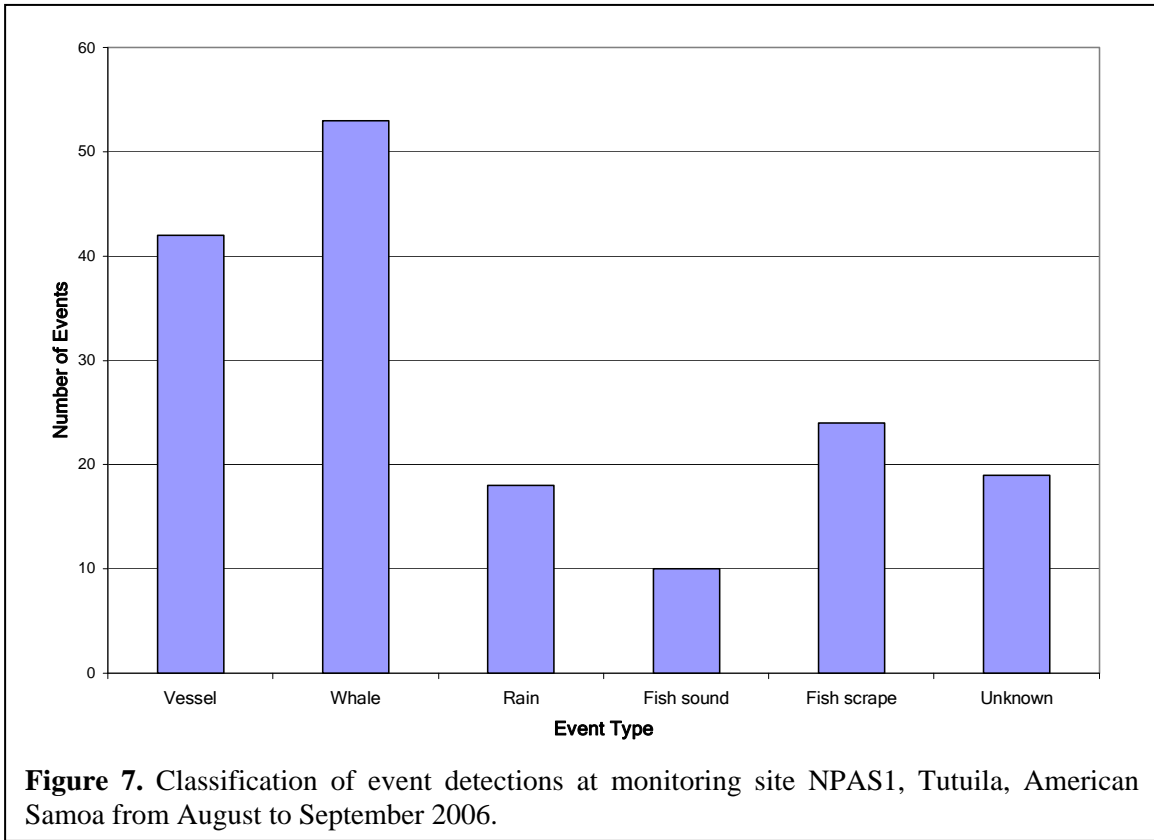
Nighttime Root Mean Square (RMS) Sound Pressure Levels (SPL) are 4-5 dB higher at night than during the day, where nighttime is defined as the four hour period from midnight to 4 AM and daytime is defined as the four hour period from noon to 4 PM (Figure 6). Once again, the major source of ambient acoustic energy is from snapping shrimps, so the diel variability can be attributed to changes in their activity levels.



**Figure 6.** Average night and day sound pressure level (dB) at passive acoustic monitoring site NPAS1.

### **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 the site NPAS1 of northern Tutuila Island from August to September 2006.



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

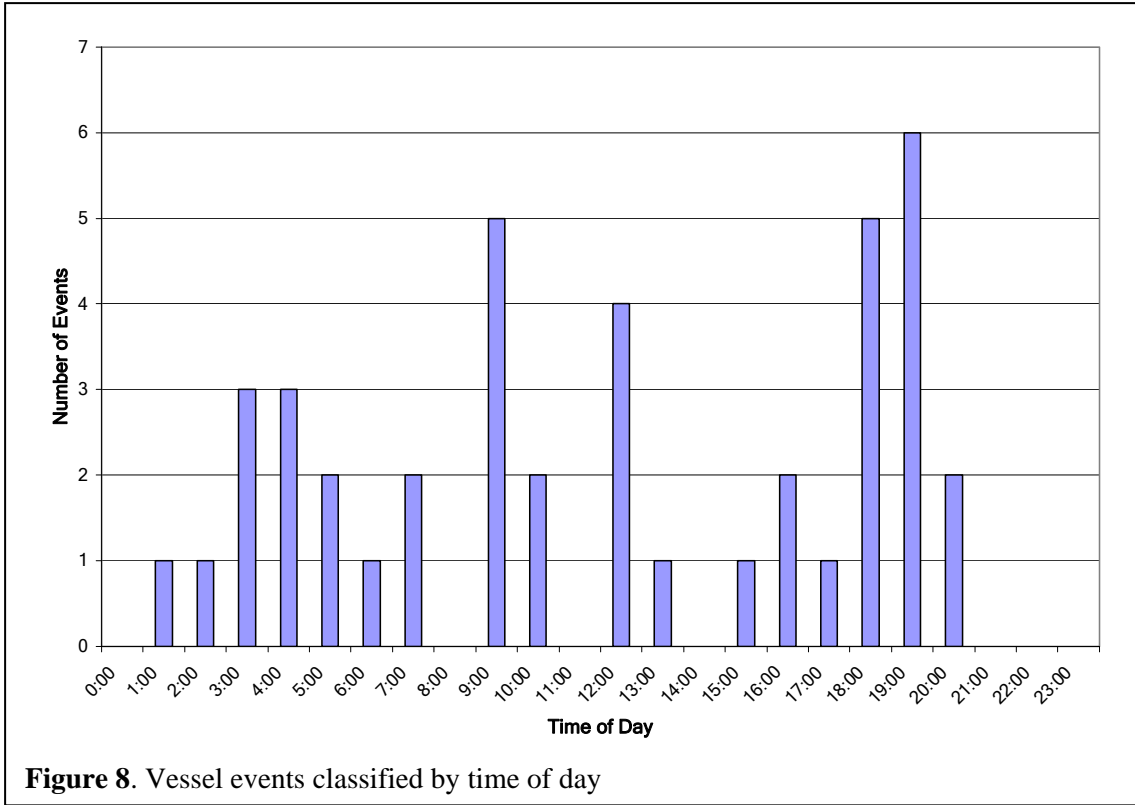




Table 1. UTC and local date and time of vessel events at site NPAS1 (National Park of American Samoa). Due to the software glitch, exact times were not recorded. Each vessel event happened within 15 minutes of the time noted in the table.

<b>Vessel Event</b>		
<b>Date/Time - UTC</b>	<b>Date/Time - Local</b>	<b>File</b>
8/8/2006 2:15	8/7/2006 15:15	00000014.BIN
8/8/2006 18:45	8/8/2006 7:45	00000081.BIN
8/11/2006 23:15	8/11/2006 12:15	00000397.BIN
8/11/2006 23:30	8/11/2006 12:30	00000399.BIN
8/12/2006 16:30	8/12/2006 5:30	00000469.BIN
8/12/2006 16:45	8/12/2006 5:45	00000472.BIN
8/17/2006 0:45	8/16/2006 13:45	00000892.BIN
8/18/2006 5:00	8/17/2006 18:00	00001010.BIN
8/18/2006 5:15	8/17/2006 18:15	00001012.BIN
8/19/2006 6:00	8/18/2006 19:00	00001112.BIN
8/19/2006 12:15	8/19/2006 1:15	00001139.BIN
8/23/2006 5:45	8/22/2006 18:45	00001498.BIN
8/23/2006 14:00	8/23/2006 3:00	00001532.BIN
8/24/2006 6:00	8/24/2006 19:00	00001694.BIN
8/26/2006 6:45	8/25/2006 19:45	00001797.BIN
8/26/2006 15:15	8/26/2006 4:15	00001832.BIN
8/27/2006 3:30	8/26/2006 16:30	00001884.BIN
8/27/2006 3:45	8/26/2006 16:45	00001886.BIN
8/27/2006 7:15	8/26/2006 20:15	00001901.BIN
8/27/2006 13:30	8/27/2006 2:30	00001927.BIN
8/31/2006 7:15	8/30/2006 20:15	00002291.BIN
9/1/2006 6:00	8/31/2006 19:00	00002384.BIN
9/1/2006 15:00	9/1/2006 4:00	00002421.BIN
9/2/2006 4:45	9/1/2006 17:45	00002477.BIN
9/2/2006 5:00	9/1/2006 18:00	00002479.BIN
9/4/2006 18:00	9/4/2006 7:00	00002727.BIN
9/4/2006 23:30	9/4/2006 12:30	00002751.BIN
9/7/2006 6:00	9/6/2006 19:00	00002974.BIN
9/7/2006 15:30	9/7/2006 4:30	00003013.BIN
9/15/2006 5:30	9/14/2006 18:30	00003787.BIN
9/15/2006 14:15	9/15/2006 3:15	00003823.BIN
9/16/2006 23:15	9/16/2006 12:15	00003959.BIN
9/17/2006 6:15	9/16/2006 19:15	00003988.BIN
9/17/2006 14:00	9/17/2006 3:00	00004021.BIN
9/19/2006 21:30	9/19/2006 10:30	00004245.BIN
9/22/2006 17:45	9/22/2006 6:45	00004522.BIN
9/23/2006 21:45	9/23/2006 10:45	00004638.BIN
9/29/2006 20:30	9/29/2006 9:30	00005236.BIN
9/29/2006 20:30	9/29/2006 9:30	00005237.BIN
9/29/2006 20:30	9/29/2006 9:30	00005238.BIN
9/29/2006 20:45	9/29/2006 9:45	00005241.BIN
9/29/2006 20:45	9/29/2006 9:45	00005242.BIN

**Discussion:**

The EAR unit was deployed on July 19<sup>th</sup> of 2006 and recovered on September 29<sup>th</sup> of 2006. The unit recorded acoustic data from August 7<sup>th</sup> to September 29<sup>th</sup> 2006. The period of data collection was short 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.

The dominant sounds that triggered the event detection on EAR unit 9300238-06 were whale signals, with 53 events. The frequency of whale signals indicates a fair amount of whale activity in the area. This is most likely due to the migrating humpback whales that feed in Antarctica in the summer months, and make their way north to warmer waters for the winter months. They are seasonally present in American Samoa from August-October (Craig, 2005).

During the deployment period, there were 42 recorded events of vessels in the vicinity of the monitoring site. Vessel events were high at 9 AM and 12 PM and peaked between 6 and 7 PM (Figure 8). Of note is that 45% of vessel detections were made during the hours following sunset and prior to sunrise. This suggests a substantial amount of nighttime vessel traffic in the area during the monitoring period. Table 1 shows that several of these events were likely triggered by the same vessel, as they were recorded within a short time period.

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 can provide baseline information on the presence and activity levels of acoustically active marine fauna and the frequency and intensity of human activities as revealed by vessel traffic.

**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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