

# Discovering patterns of biological and anthropogenic activity at National Park of American Samoa using underwater acoustical monitoring

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## Objectives

- What are the acoustical conditions of the National Park of American Samoa's marine environment?
- What are the sources of biological sounds?
- What are the sources of human-associated noise?
- What are the patterns of presence of biological sounds and human-associated noise?

## Introduction

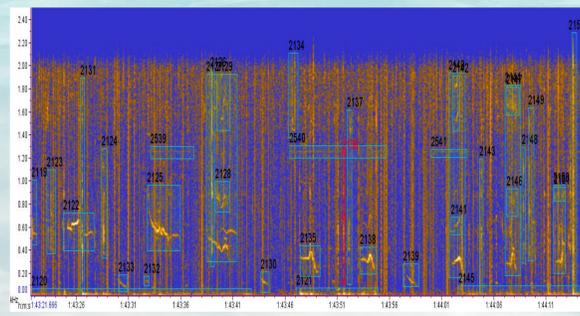
- The acoustical environment of a place can tell us a lot about the health of an ecosystem.
- Acoustical monitoring is a non-invasive and effective method of characterizing both terrestrial and marine ecosystems.
- Acoustical monitoring can provide insight into the presence and occurrence of species living or migrating through a region, ecological processes, and levels of human activity.
- Long-term acoustical monitoring can provide important insight into changes to ecosystems, as well as provide guidance for management decisions.
- National Park of American Samoa is part of the first large-scale effort to monitor long-term trends of underwater acoustical environments across U.S. waters.

## Methods

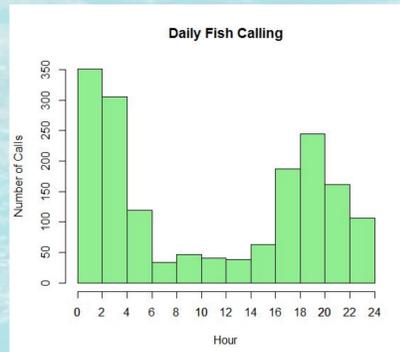


**Figure 1:** Park staff deployed an underwater microphone, or hydrophone, which recorded the underwater acoustical environment 33m below the surface for one entire year, beginning in June 2015. For our study, we analyzed a representative subsample of these data to help build our understanding of the acoustical environment.

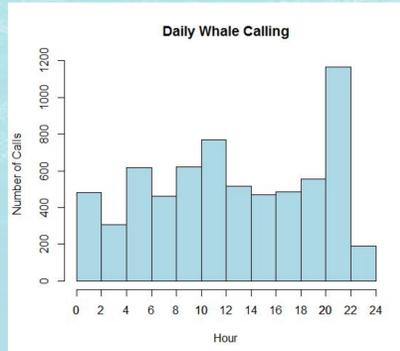
**Figure 2:** The presence of biological sounds and human-associated noise in our subsamples were viewed on spectrograms and then logged using the acoustical analysis software 'Raven'. For spectrograms, the x-axis represents time and the y-axis represents frequency or pitch. Finally, brighter colors represent louder acoustic events.



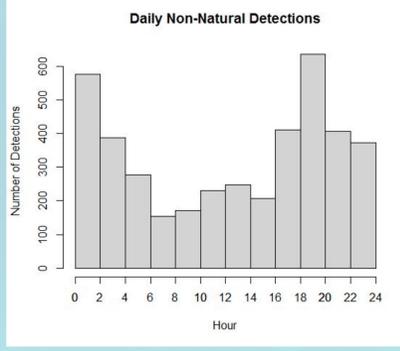
## Results



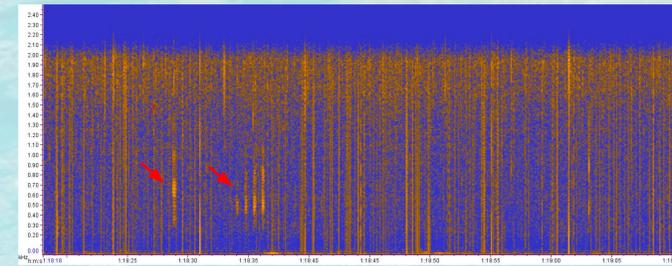
**Figure 3:** Fish vocalizations (n=1696) peak during the early morning and dusk, with a lull during the middle of the day.



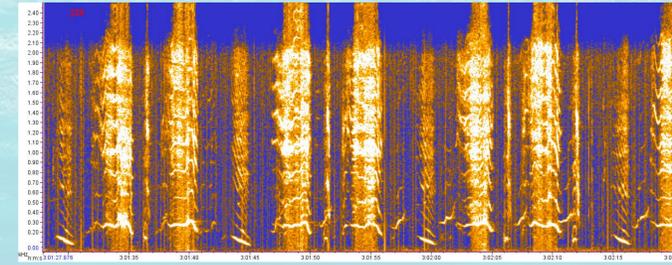
**Figure 4:** Whale vocalizations (n=6644) don't exhibit any particular day pattern of presence throughout the day.



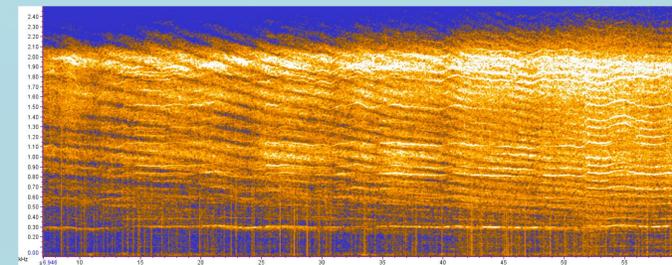
**Figure 5:** Human-associated noise (n=4078) peaked during the middle of the night and during evening hours, with a lull in the middle of the day.



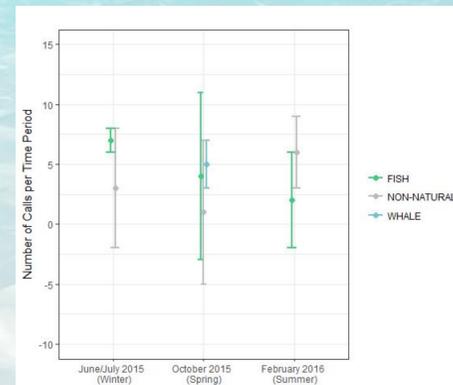
**Figure 7:** Spectrogram depicting the presence of fish calls as indicated by the red arrows. The remaining yellow vertical lines are the snapping sounds made by snapping shrimp.



**Figure 8:** Spectrogram depicting the presence of whale vocalizations recorded in October 2015. During this month, we detected a total of 6644 whale vocalizations, but none in the other months analyzed, clearly indicating an active time period for whales in the park.



**Figure 9:** Spectrogram depicting the presence of a motorized boat passing within the vicinity of the hydrophone. The broadband nature of boat noise has the potential to cover up or mask many biological sounds, potentially disrupting animal communication.



**Figure 6:** Whale vocalizations were only seen during the Spring in the waters of National Park of American Samoa. Yearly patterns for fish vocalizations and non-natural noise are not evident, but further investigation using a larger subsample of the acoustical data might better bring into focus any patterns which may exist.

## Conclusions

- This work is helping to establish a baseline understanding of the marine acoustical environment of the National Park of American Samoa.
- This initial study will inform subsequent studies further examining acoustical data collected within the park.
- Resulting findings will support management decisions intended to aid species that use acoustic communication.
- Extracted sound clips may be used for park interpretation in order to raise visitor awareness about natural sounds and noise pollution in the park, as well as how they interact to affect marine ecosystems.

## Acknowledgements

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**Figure 10:** The red star depicts the monitoring location where acoustical data were collected in the National Park of American Samoa. Inset map places the park in a global context.