

NEAR-Lab

*Northwest Electromagnetics &
Acoustics Research*

Conservation Technology Initiative (CTI)

— Acoustic Data Collection in Hawaii Marine Protected Areas

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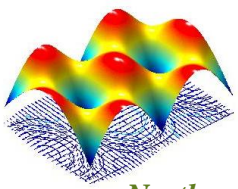
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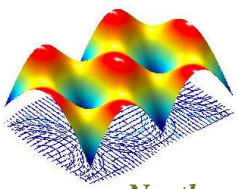




- **Goal: Harvest cutting-edge technology for use in conservation applications**
 - **Establish a connection between university research and conservation organizations**
 - **Establish cross-disciplinary research and educational pathways for faculty, students, practitioners**
- **Structure**
 - **Joint collaboration/funding between Portland State University and The Nature Conservancy**
 - **Five year effort starting in 2008**

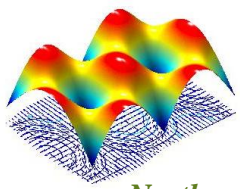
Current Stage:

Introduce sensing technology and signal processing tools to monitor Marine Protected Areas (MPA's). Focus on the detection/Localization of motorized vessels.



- **Why passive?**
 - **Non-invasive** (effect of active sonar unknown – disruptive?)
 - **Low power**, has the potential for persistent wide area coverage
 - Autonomous sensors give **24/7 coverage** (e.g. night-time sensing) with additional sensing, such as temperature
- **Passive acoustics**
 - Evidence for increasing ocean noise levels “global noising”, but no long-term quantitative measurements
 - Documented effect of man-made noise
 - Fish and biologies themselves generate noise at measurable levels through various mechanisms (tail slap, snapping, etc.)
 - Presence, activity, and species classification may be possible
 - **Vessel and human intrusion in protected areas may be detected**





Hawaii Data Collection Overview

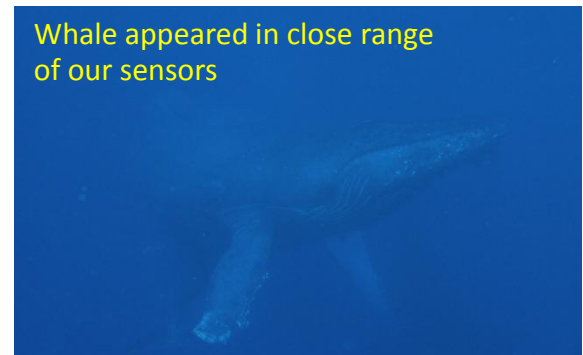
A Resource at Risk!

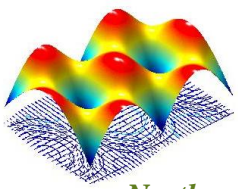


- Over 400 species of inshore and reef fishes inhabit Hawaii's coastal waters.
- The state's growing population has an adverse effect on nearshore fish populations. MPA's were created to provide fish and other aquatic life with areas to grow and reproduce.
- With limited park rangers and no clear boundary marker, it has been very difficult to reinforce the regulations.

The NEAR-Lab collaborated with TNC Hawaii to establish a link between maritime sensing techniques and the monitoring of MPA's.

- Using four of the latest Soren 3.0 sensors, 126 hours of data were collected at three locations in the Main Hawaiian Islands.
- Sensors were arranged in triangular patterns to enable localization and tracking abilities.
- Detected night-time vessel activities near the MPA boundary. Localization of these vessels is a topic for further investigation.
- Collected plenty of humpback whale noise near Ahihi-Kinau, Maui. Local TNC marine coordinator suggested counting the ratio of whales inside/outside the protected boundary as a future research topic. This will benefit TNC for evaluating the efficiency of MPA.





Equipment Overview

– Underwater Acoustic Sensors

1. Soren Sensor 3.0

Height - 50"

Diameter - 5"

2. Hydrophone

Hi-Tech HTI-9WB

160dB sensitivity

Sampling Freq – 44.1kHz

External Plug

Sensor Power on/off

External Read/Write

3. Processor Board

Gumstix Verdex XM4

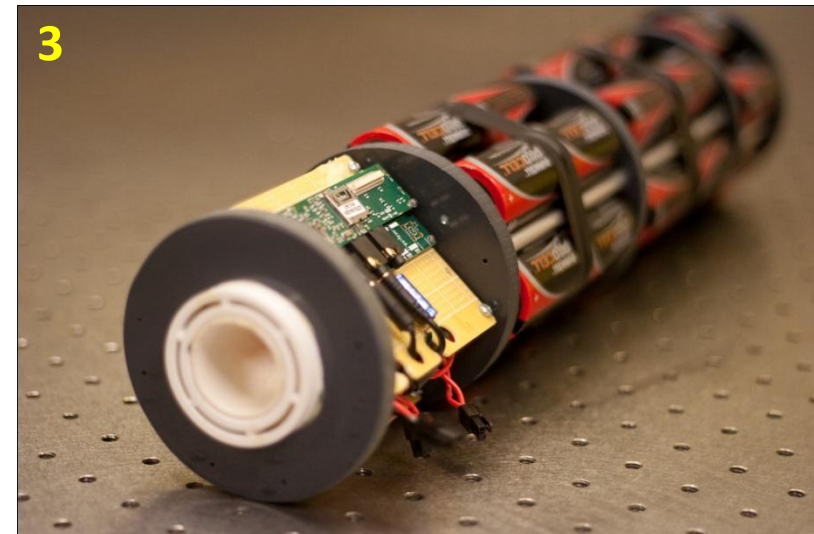
Memory

Thumb drive – 64 GB

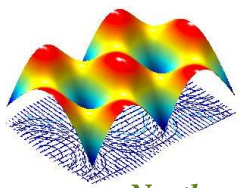
Records data for 4 days

Batteries

Last approximately 3 weeks



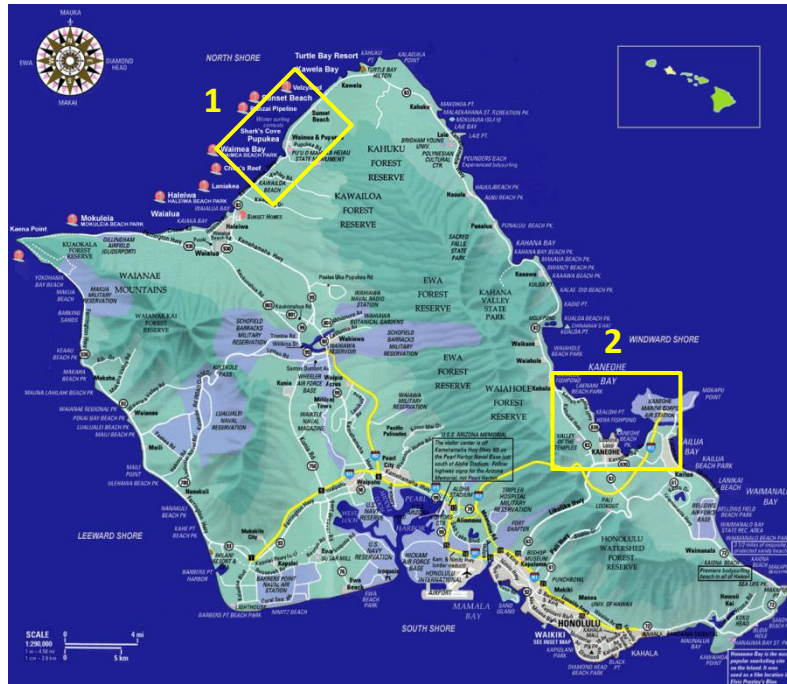
Entirely Passive
Do Not Cause Any Negative
Environmental Impact



Data Collection in Hawaii, MAR 2010

Detection of Motorized Vessels in Marine Protected Areas (MPA) — Research Subjects:

- (1) Development of Vessel Detection & Identification Algorithms
- (2) Testing of Localization & Tracking Methods



Oahu Deployment

1. Pupukea MPA (3/29)
2. Kaneohe Bay, Coconut Island (3/10)

X's: Mark the locations where the sensor was deployed (Used 1 sensor only)

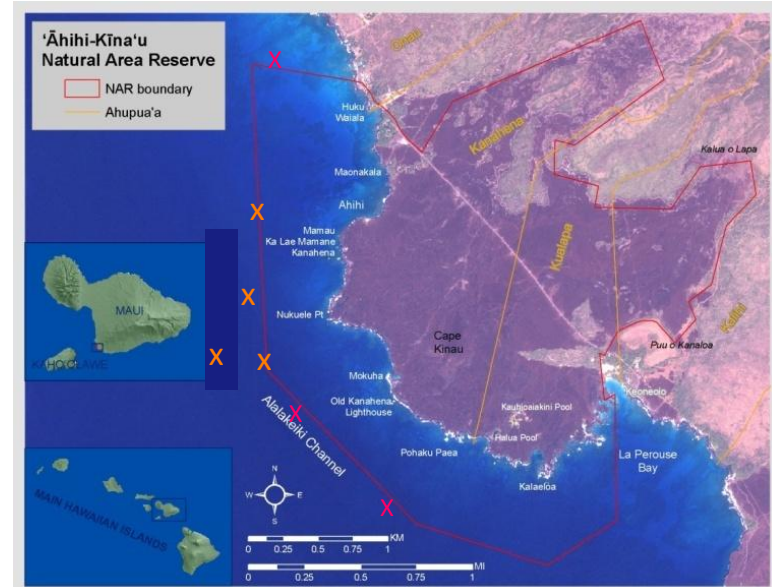


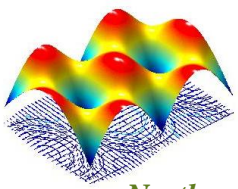
Maui Deployment – Ahihi-Kinau MPA

- 3/17 24 hrs deployment with 4 sensors
- 3/18 96 hrs deployment with 3 sensors
- 3/22 Sensor retrieval

X's: Mark the locations where sensors were deployed on Day 1

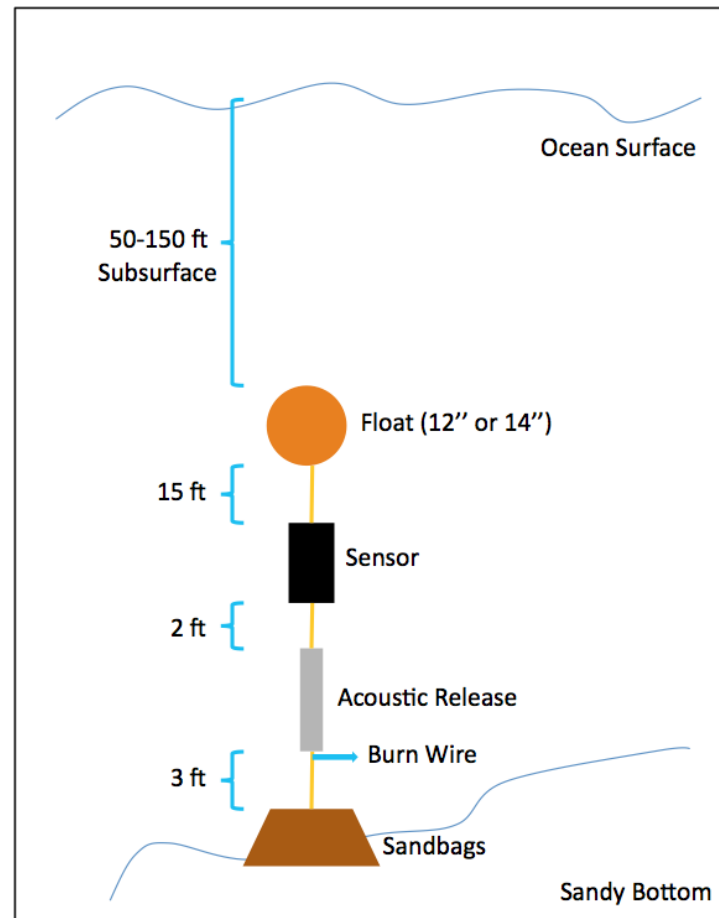
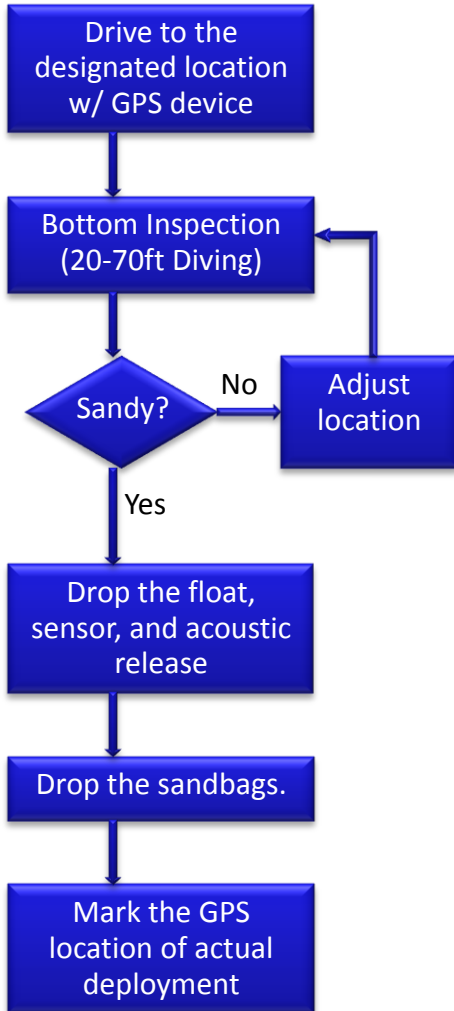
X's: Deployment locations on Day 2



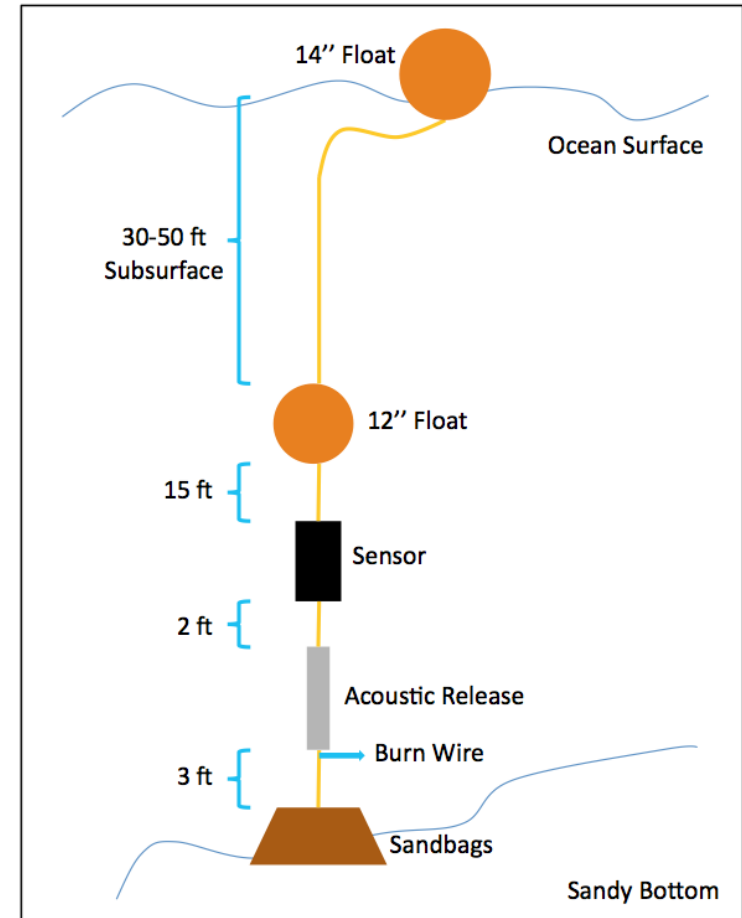


Deployment Strategy

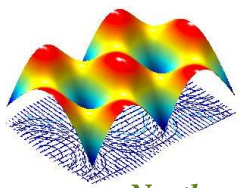
A dive team was sent prior to every deployment for site inspection.
Desired bottom type: sandy without any live coral heads.



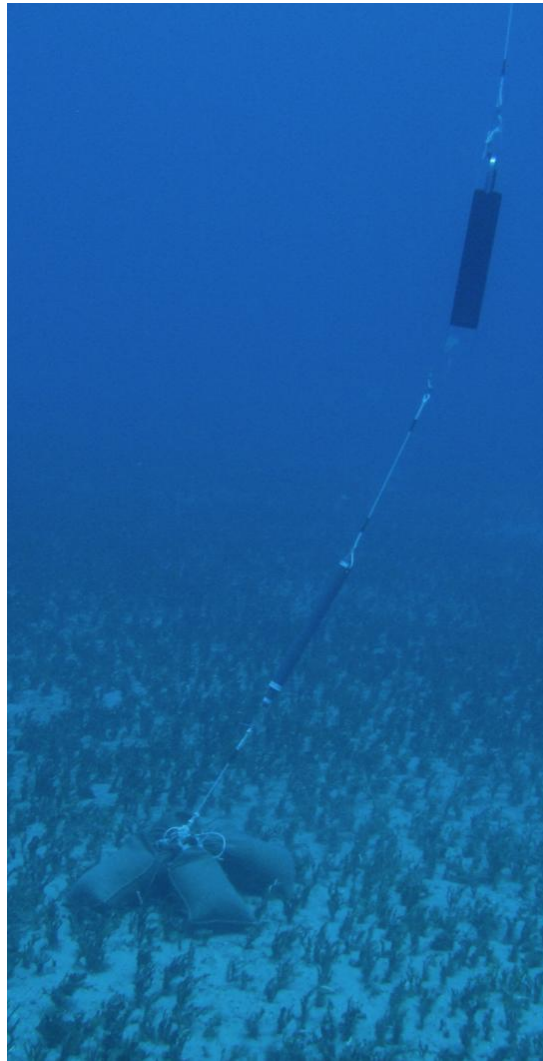
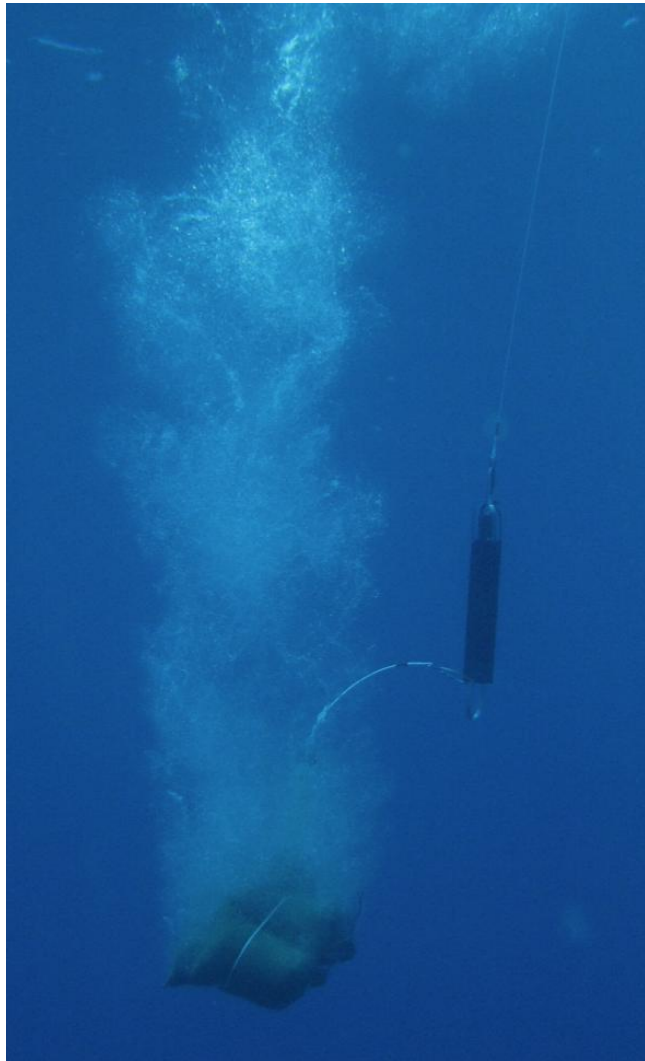
Long Term (Overnight)



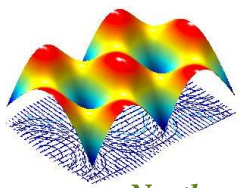
Short Term (Less than 3 hrs)



Deployment Photos



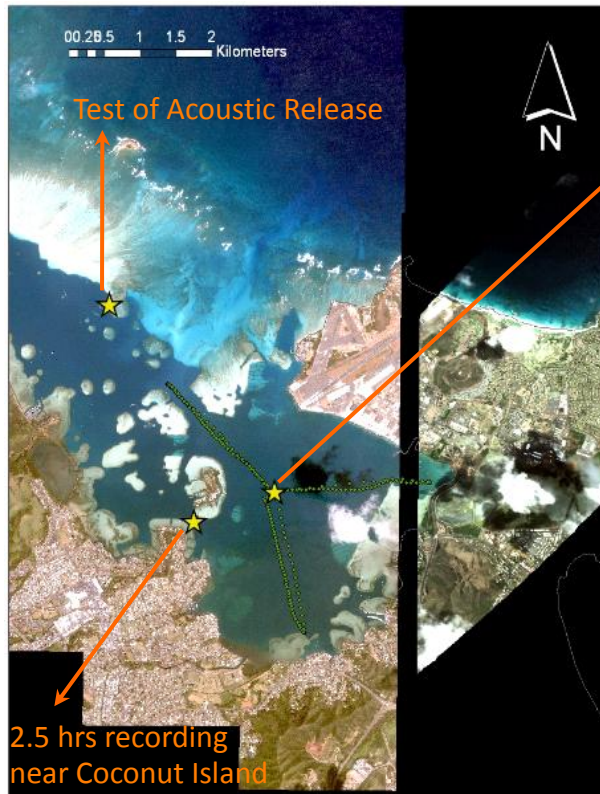
Photos were taken by Zachary Caldwell and Kydd Pollock when they dived in Ahihi-Kinau to secure the equipment at sandy areas. (3/17/10)



Kaneohe Bay & Coconut Island, Oahu



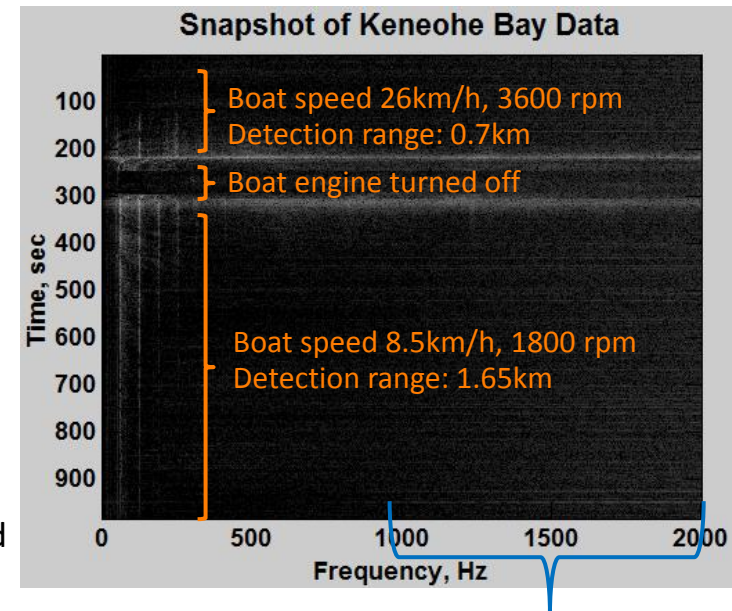
- Weather Condition – wind 15mph, water current slight above 1 knot, cloudy with passing shower.
- Duration of recording – 4 hrs 58 min, HST 10:56am to 3:54pm
- Crew
 - Captain/Diver – Eric Conklin (TNC Honolulu)
 - Engineer – Helen H. Ou (NEAR-Lab), Chris Layman (UH), Tyler H. Wai (UH)

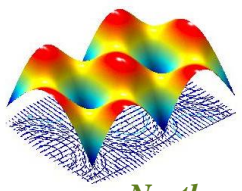


Detection Range Test:

1. Deploy the sensor at a relatively open location
2. Let the boat drive away from sensor at a constant 1800 rpm until it reached 2km distance
3. Restart the boat engine and turn around, drive towards sensor at 3600 rpm until it reached the sensor location

- ★ Location where sensor was deployed
- Boat track





Crew Photos



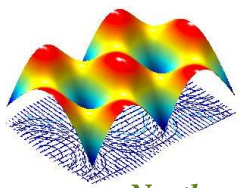
Left to right: Tyler, Helen, and Eric



Eric keeping the boat at constant rpm during the detection range test



Chris and Tyler preparing the anchor



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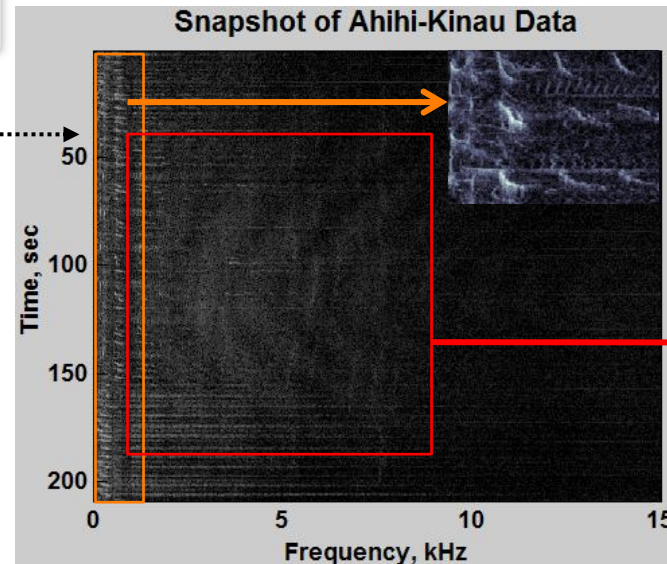
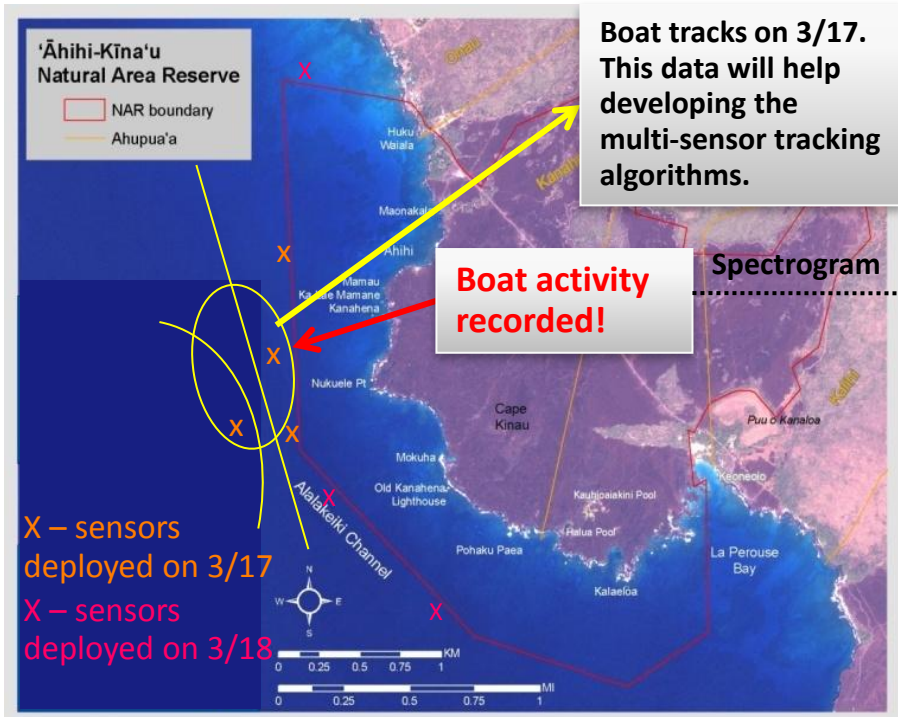
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Ahihi-Kinau, Maui (3/17-3/18)

Boat: Discovery 246
power yacht (rental)

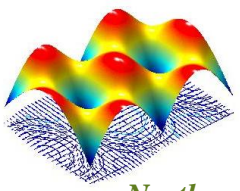


- Weather Condition – 3/17 wind 5-10 knots, sunny; 3/18 wind 15-25 knots, gusts 30-40 knots, sunny
- Duration of recording – 22 hrs 48 min, HST 11:17am (3/17) to 10:05am (3/18)
- Crew
 - Diver – Zachary Caldwell & Kydd Pollock (TNC Honolulu)
 - Engineer – Helen H. Ou & Eric Sorensen (NEAR-Lab)



Low-frequency whale sound

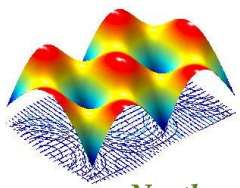
Boat detected using one of the sensors deployed near the MPA boundary. Recorded around 8:00pm, 3/17



Crew Members



Left to right: Zachary, Eric, Kydd, and Helen



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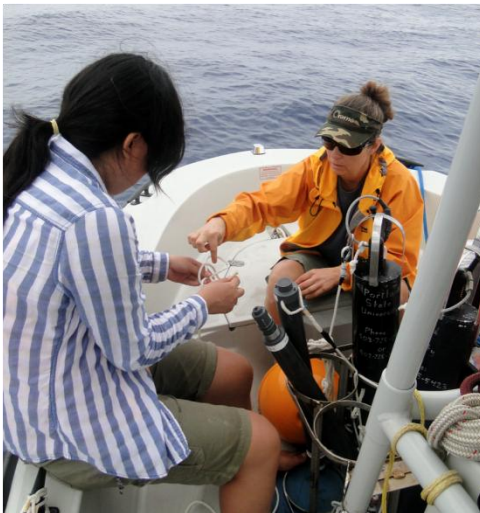
Ahihi-Kinau, Maui (3/22)

Boat: 18'
Boston whaler
(DAR Maui)



Left to right: Emily, Helen, and Eric

Emily teaching
Helen how to
tie a knot



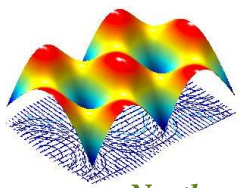
- Sensors deployed on 3/18 were retrieved on 3/22.
- Duration of recording – 95 hrs 21 min, HST 11:39am (3/18) to 11:00am (3/22)
- Crew
 - Captain – Skippy Hau (DAR Maui)
 - Diver – Emily J. Fielding (TNC Maui)
 - Engineer – Helen H. Ou & Eric Sorensen (NEAR-Lab)



Left to right: Skippy,
Helen, and Eric

The float popped up to
surface 1-5 minutes after
the release command
was sent from boat.





Pupukea, Oahu (3/29)



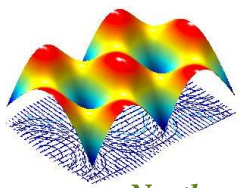
During March and April season, this is where most poaching would happen.



Helen Ou and Eric Conklin met with the Pupukea Community Group on 3/9. Helen presented the deployment plan and collected valuable suggestions from them on site selection.



- Weather Condition – wind 20-25 knots, wave 8-10ft, rainy.
- Duration of recording – 1 hr 55 min, HST 10:04am to 11:59pm
- Boat – 18' rigid-hull inflatable (TNC Honolulu)
- Crew
 - Captain – Russell Amimoto (TNC Honolulu)
 - Diver – Zachary Caldwell (TNC Honolulu), Brett Schumacher (DAR Honolulu)
 - Engineer – Helen H. Ou (NEAR-Lab)



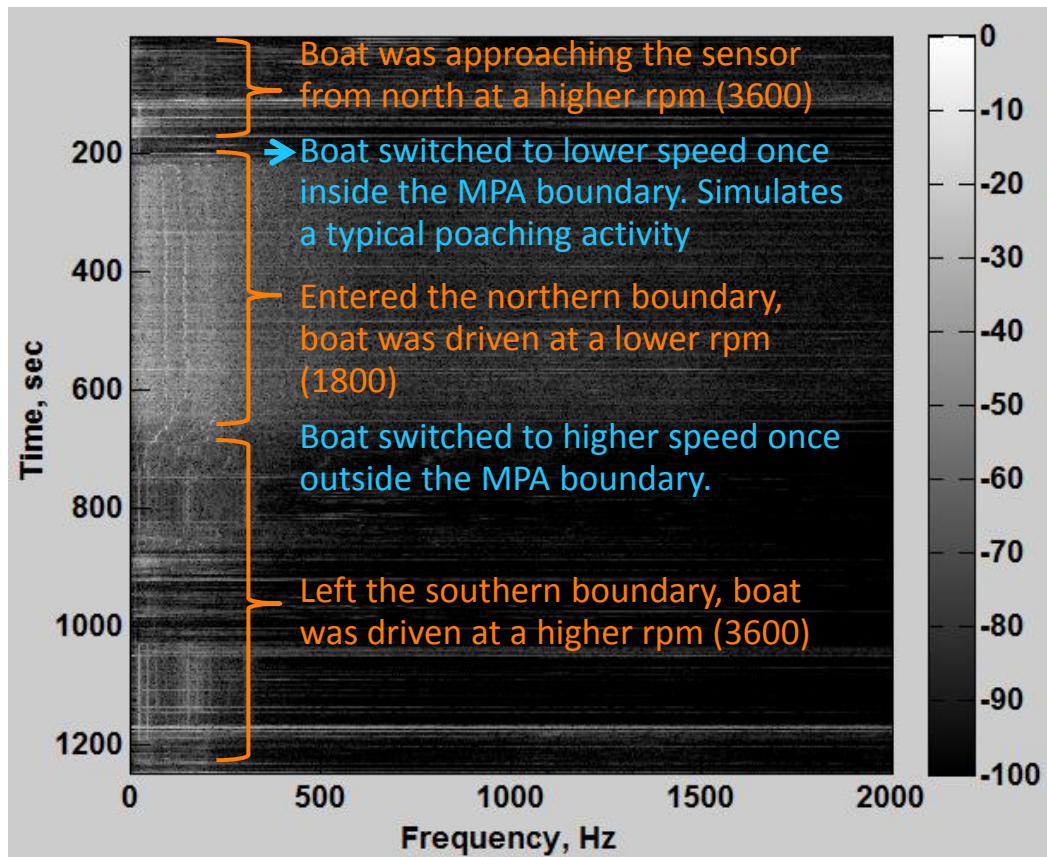
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Pupukea, Oahu (3/29)

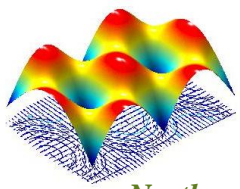
Detection Range Test in Pupukea:

1. Boat was approaching the sensor in a straight line along the MPA boundary from 3km distance (north to south).
2. Boat speed was 24km/h (3600 rpm) outside the north boundary, and switched to 16.7km/h (1800 rpm) inside the north boundary.
3. Boat speed switched again to 24km/h (3600 rpm) when the boat reached the south boundary.



Conclusion:

At 1800 rpm and 16.7km/h speed, ONE Soren 3.0 sensor is sufficient to cover the entire Pupukea MPA boundary for the detection of poaching activities.



Crew Photos



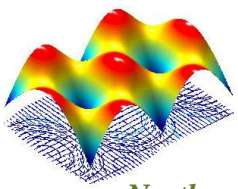
Left to right: Helen, Russell, and Brett



Brett preparing the sensor for deployment

Zachary checking the underwater camera before site inspection





Acknowledgements

- The NEAR-Lab would like to acknowledge the support of the Nature Conservancy in Hawaii, the Hawaii State Division of Aquatic Resources, and the University of Hawaii at Manoa on this project. Especially the efforts of following persons:
 - Eric Conklin, *Marine Science Advisor*, TNC Honolulu
 - Zachary Caldwell, *Diving Safety Officer/Monitoring Program Coordinator*, TNC Honolulu
 - Kydd Pollock, *Science Specialist*, TNC Honolulu
 - Russell Amimoto, *Assistant Marine Coordinator*, TNC Honolulu
 - Emily Fielding, *Maui Marine Coordinator*, TNC Maui
 - Alton Miyasaka, *Aquatic Biologist*, DAR Honolulu
 - Brett Schumacher, *Aquatic Biologist*, DAR Honolulu
 - Skippy Hau, *Aquatic Biologist*, DAR Maui
 - John Allen, *Associate Professor of Mechanical Engineering Department*, UH Manoa
 - Chris Layman, *Post Doctoral Researcher*, UH Manoa
 - Tyler Wai, *Mechanical Engineering Student*, UH Manoa

