Passive acoustic monitoring of cetaceans in the Hawaii Range Complex using EARs

Marc Lammers[1,2], Lisa Munger[1], Whitlow Au[2]

[1] Oceanwide Science Institute
Honolulu, HI

[2] Hawaii Institute of Marine Biology
Kaneohe, HI

OCEANWIDE SCIENCE INSTITUTE

HAWAII INSTITUTE OF MARINE BIOLOGY · COCONUT ISLAND, OAHU ·

HDR

NAVFAC Naval Facilities Engineering Command

Introduction

Background

- HIMB was contracted to deploy four EARs off Niihau & Kaula Rock between July 2011 and Feb 2013.

- The data analyses were divided between HIMB, OSI and Bio-Waves, Inc. to address 4 topic areas (Q1 – Q4):

- Q1a. What species of beaked whales (Ziphius/Mesoplodon) are in the region surrounding Niihau and Kaula Islands in the HRC?

  Q1b. Do beaked whale detection rates vary before, during, and after mid-frequency active sonar (MFAS) detections?

Introduction

Background

- Q2a. What is the seasonal occurrence of baleen whales near Niihau and Kaula Islands in HRC?

  Q2b. Do baleen whale detection rates vary before, during, and after MFAS detections?

- Q3a. What is the occurrence of sperm whales near Niihau and Kaula Islands in the HRC?

  Q3b. Do sperm whale detection rates vary before, during, and after MFAS detections?

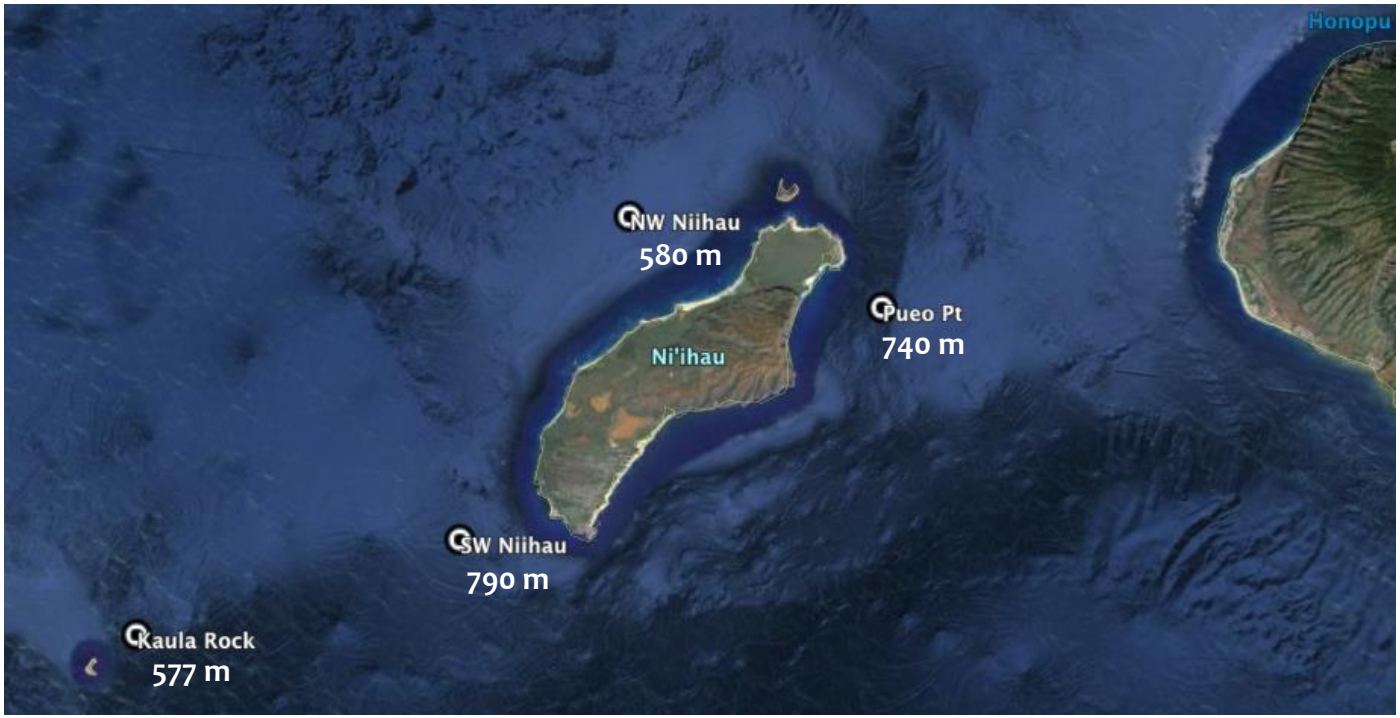
- Q4a. What species of delphinids occur near Niihau and Kaula Islands in the HRC?

  Q4b. Do delphinid detection rates vary before, during, and after MFAS detections?

Methods

Ecological Acoustic Recorder (EAR)

- Recording bandwidth= 40 kHz
- Duty cycle = 30 sec ‘on’ every 5 or 10 min (10% or 5%)
- Deployed between July 2011 and February 2013
- Refurbished approx. every 6 months



Methods

Data analysis

- HIMB tasked with establishing presence/absence of beaked whales, baleen whales and delphinids using a combination of automated (M3R & custom algorithms) and manual (e.g. LTSAs) detection methods.
- Bio-Waves tasked with delphinid species identification using ROCCA, validating the performance of automated detectors and interpretation of the M3R output.
- OSI tasked with quantifying odontocete presence, detecting MFAS on recordings, examining changes in acoustic activity around MFAS periods for various taxa, and synthesizing analysis outputs from HIMB and Bio-Waves.

Methods

Data analysis - OSI

- Manual inspections of data for the presence of MFAS, dolphin signals, sperm whale clicks and baleen whale calls one week before, during & after MFAS.
- Quantification of encounter parameters (e.g. number, duration, whistle frequency, % recordings present/absent).
- Statistical analysis of the acoustic activity of different taxonomic groups relative to periods before, during & after MFAS.

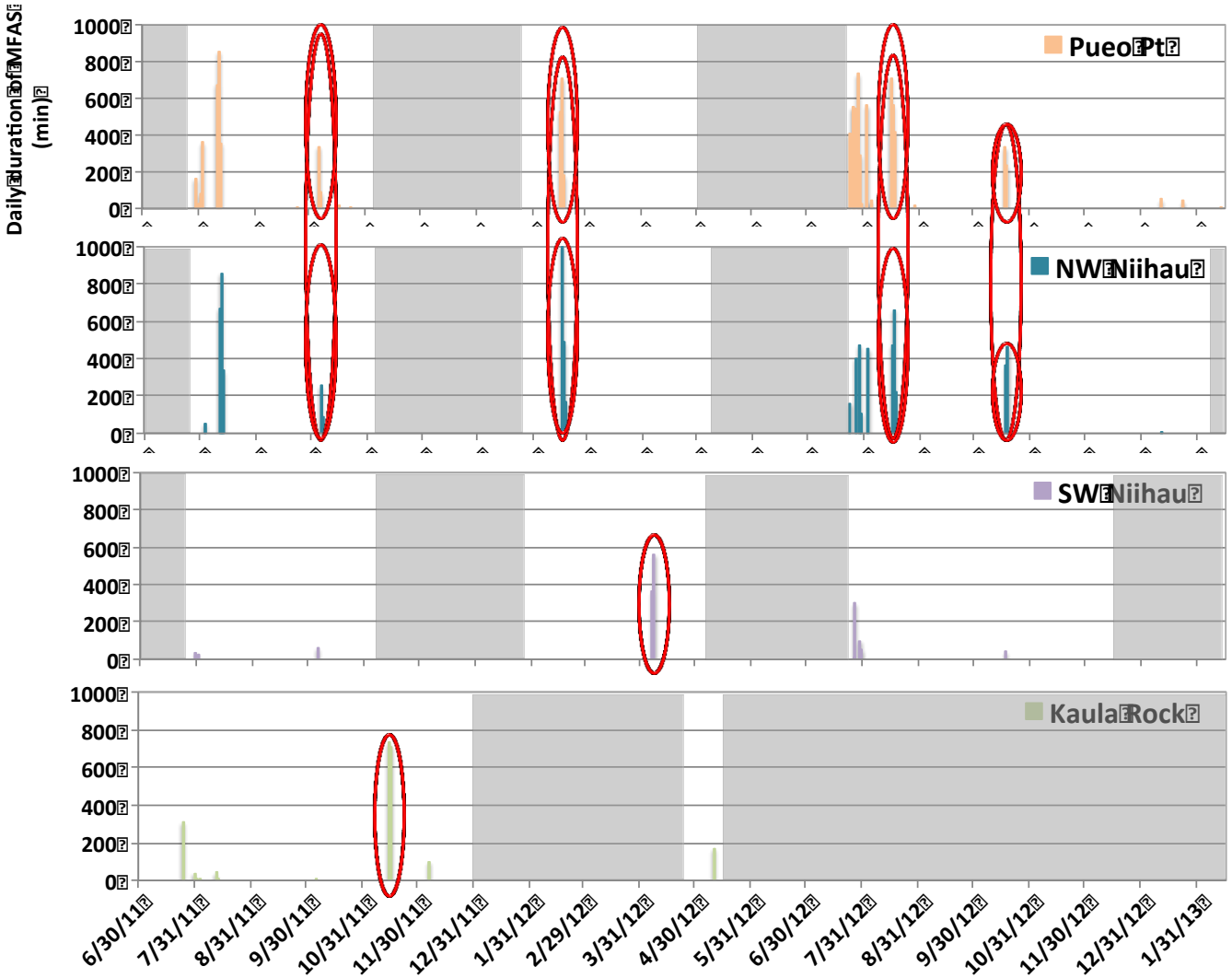
Results

Data obtained

Location	Depth	Start Recording Date	End Recording Date	Hours of Data Recorded
Pueo Pt	737	7/26/11	11/2/11	230.4
Pueo Pt	740	1/26/12	5/1/12	223.2
Pueo Pt	736	7/22/12	2/15/13	249.0
Niihau NW	526	7/26/11	11/2/11	230.4
Niihau NW	527	1/26/12	5/7/12	237.6
Niihau NW	580	7/22/12	2/8/13	241.0
Niihau SW	766	7/26/11	11/2/11	230.4
Niihau SW	790	7/22/12	12/14/12	174.0
Niihau SW	791	1/26/12	5/5/12	237.6
Kaula	538	6/30/11	12/31/11	432.0
Kaula	538	4/25/12	5/16/12	50.4
TOTAL				2536.0

Results

MFAS occurrence

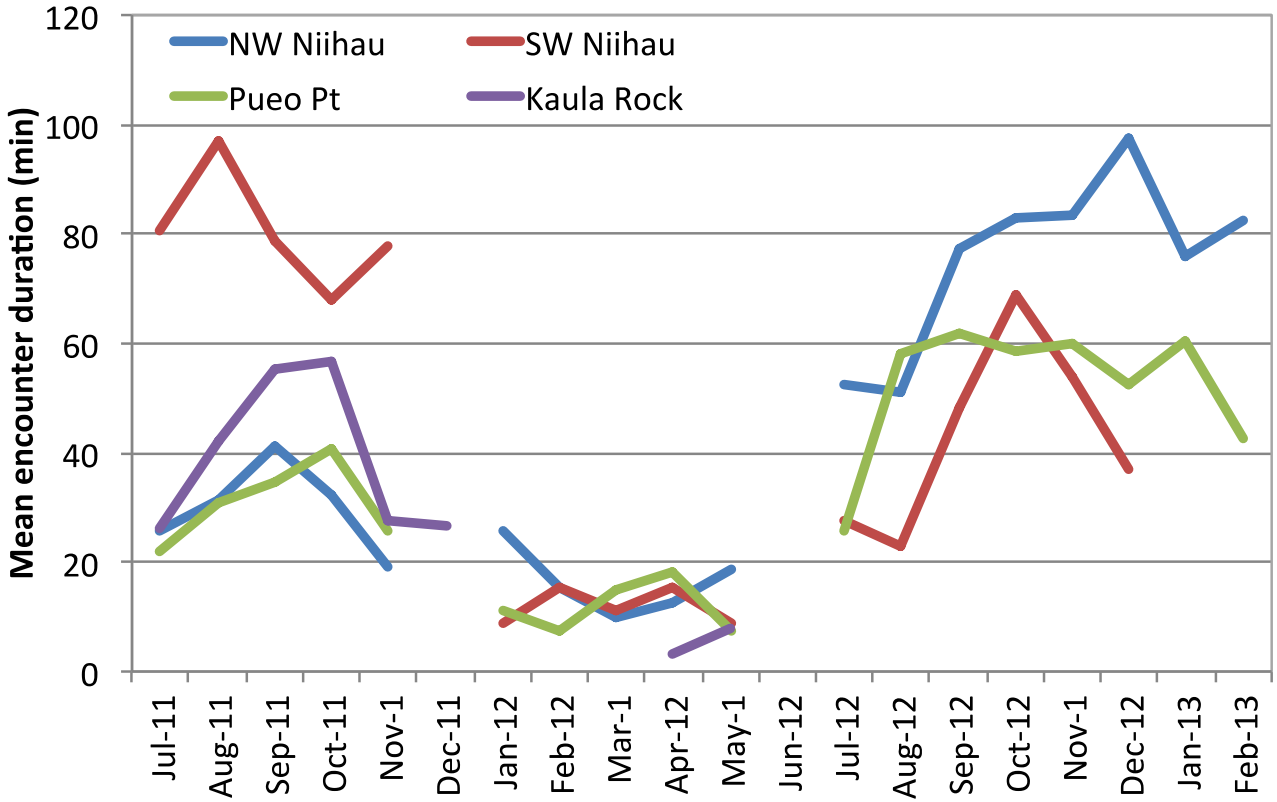


- MFAS detected on 40 days
- 11 multi-day events
- 6 multi-day events with data 1 week before & after event
- 10 MFAS exposure periods examined for effect

Results

Seasonal detection of dolphins

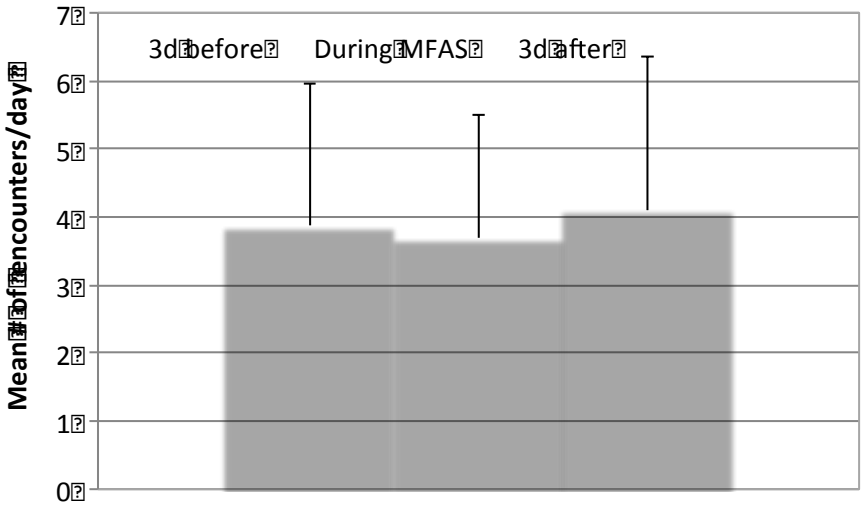
- Significantly fewer & shorter encounter durations in winter/spring vs summer/fall (Kruskall-Wallis test, $p < 0.05$)

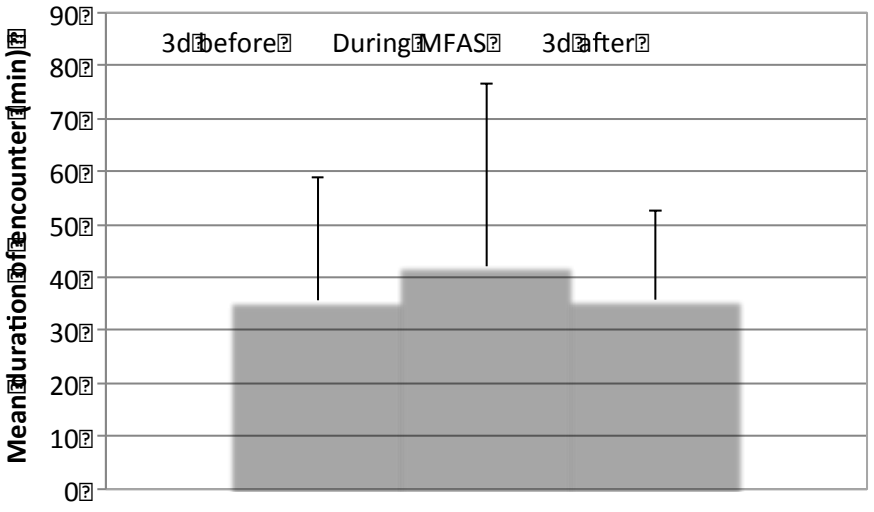


Results

Dolphin detections & MFAS

- Dolphin encounters/day & encounter duration pooled across sites & MFAS exposure periods (n = 10)





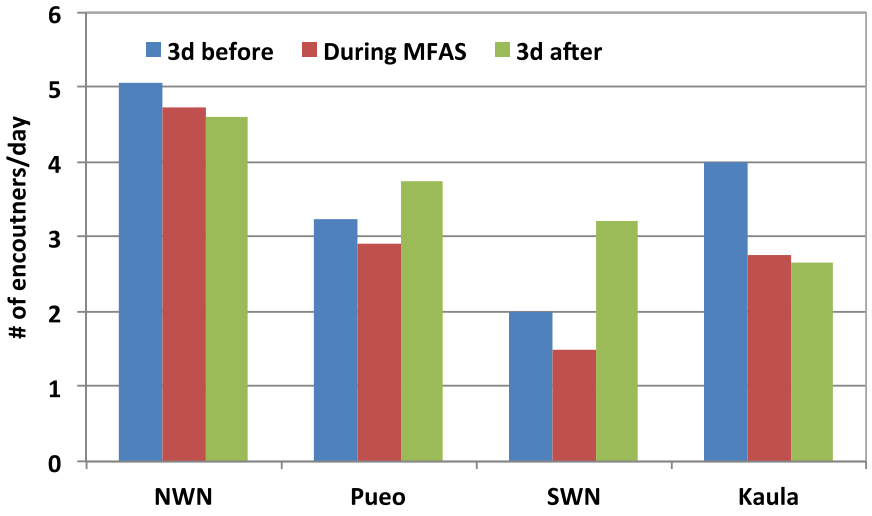
- Wilcoxon matched pairs test (3d before vs. during), n = 10, Z = 0.35, p = 0.76
- Wilcoxon matched pairs test (during vs. 3d after), n =10, Z = 0.87, p = 0.39

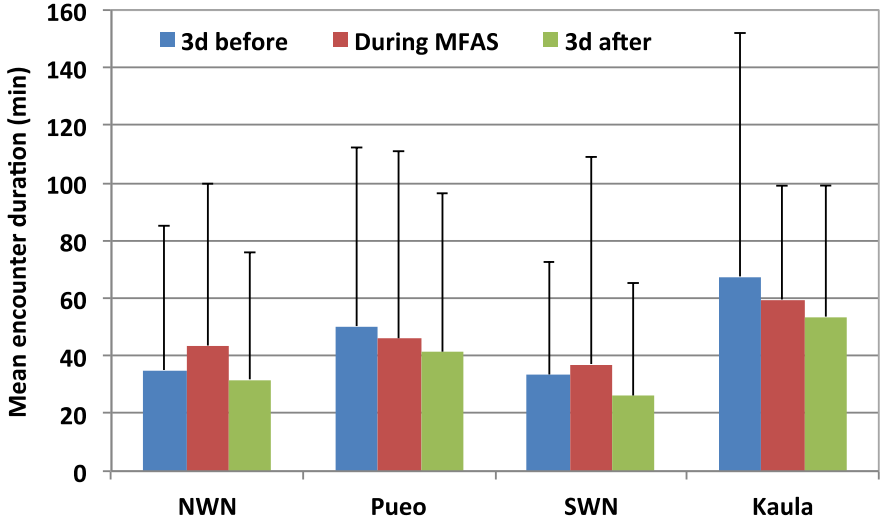
- Wilcoxon matched pairs test (3d before vs. during), n = 10, Z = 0.46, p = 0.65
- Wilcoxon matched pairs test (during vs. 3d after), n =10, Z = 0.15, p = 0.88

Results

Dolphin detections & MFAS

- Dolphin encounters/day & mean encounter duration pooled by site



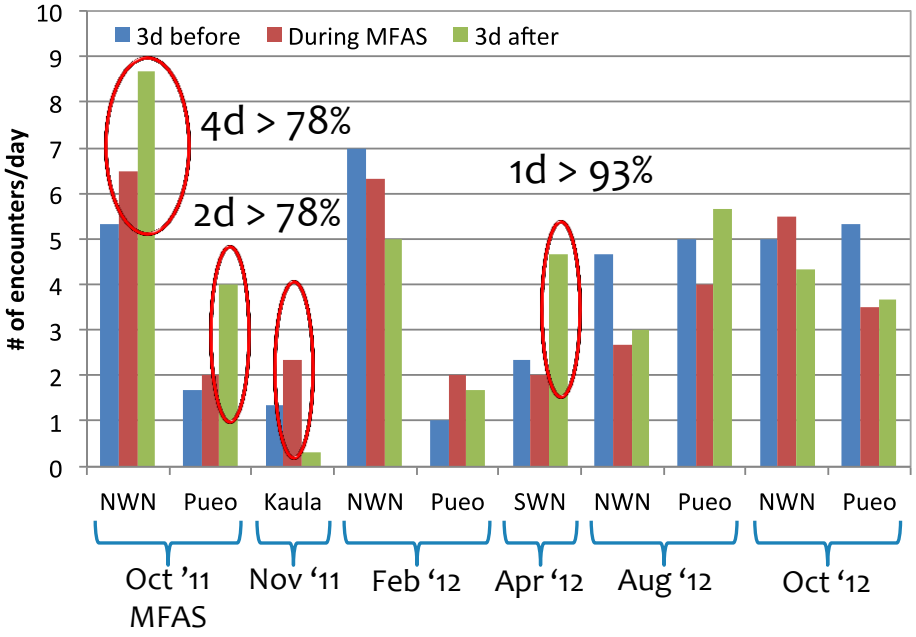


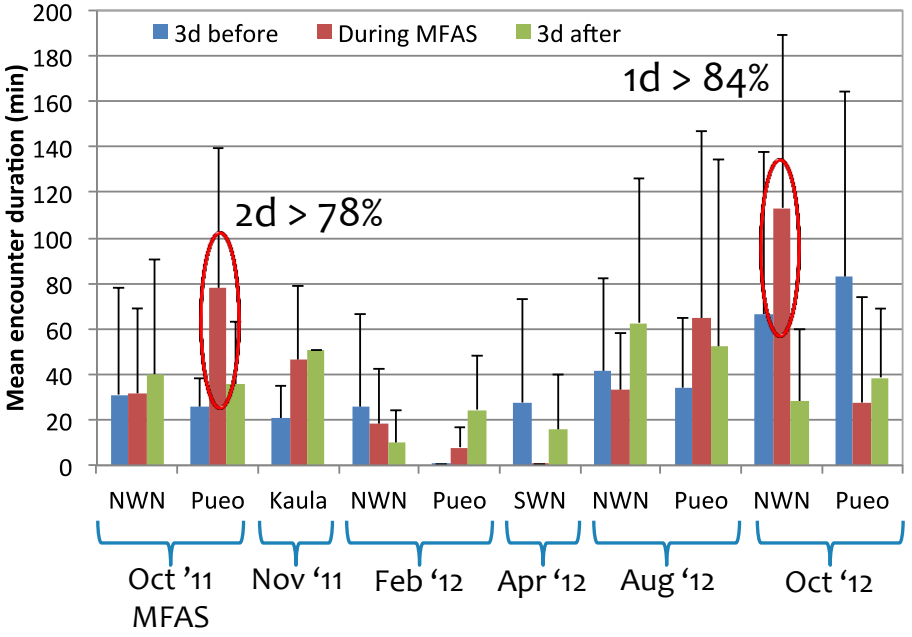
- Chi-square tests revealed no significant differences
- Kruskall-Wallis tests revealed no significant differences

Results

Dolphin detections & MFAS

- Dolphin encounters/day & mean encounter duration by site & by MFAS event

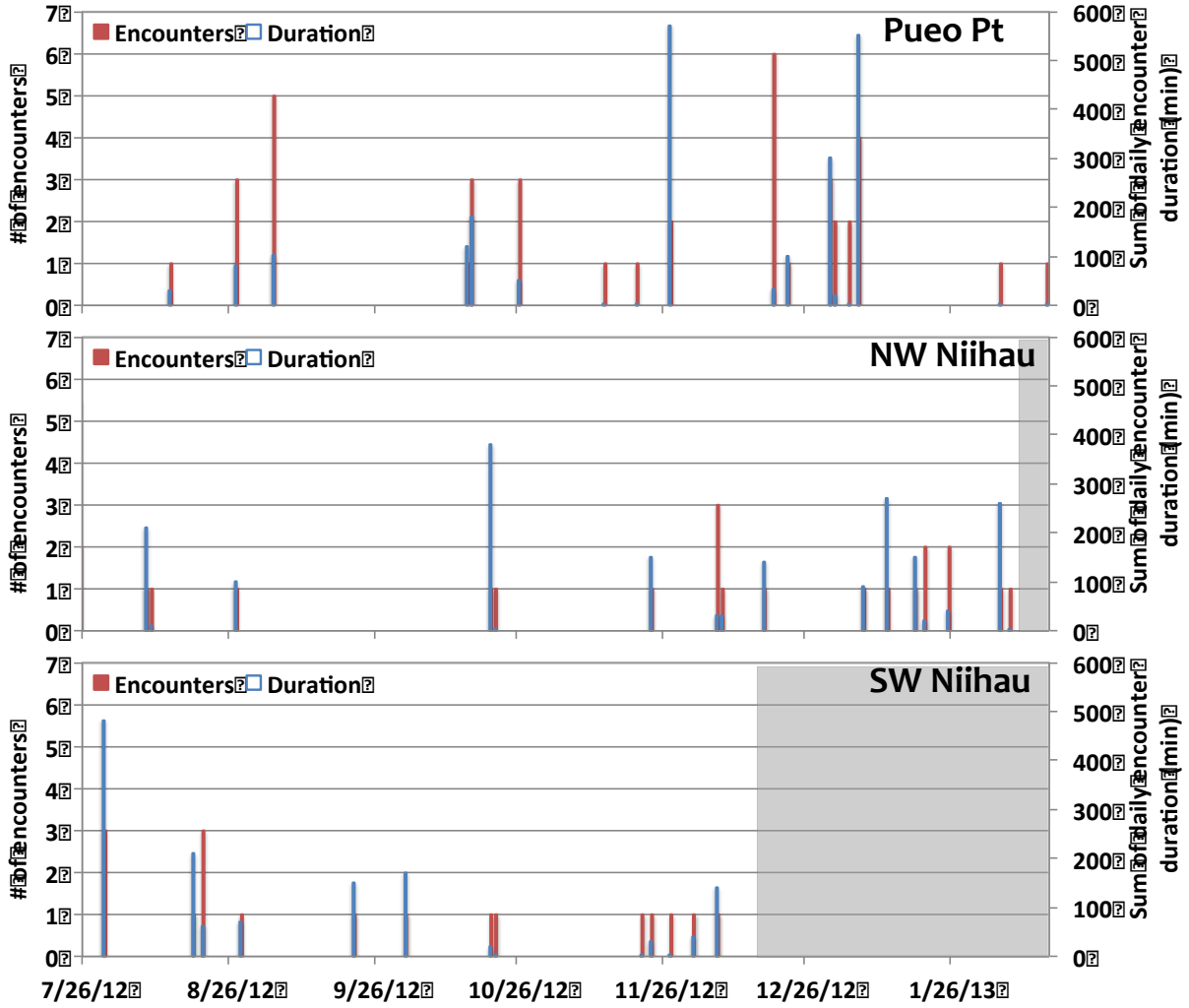




- Dolphin acoustic responses, if they occur, are probably event-specific, not uniform across events

Results

Seasonal detection of sperm whales

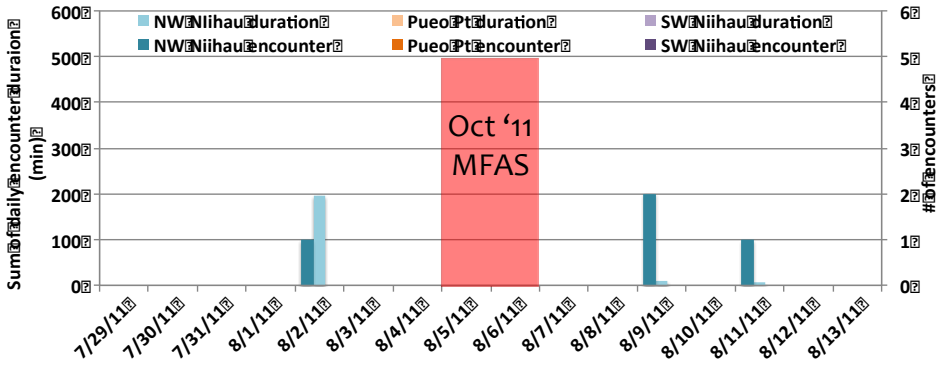


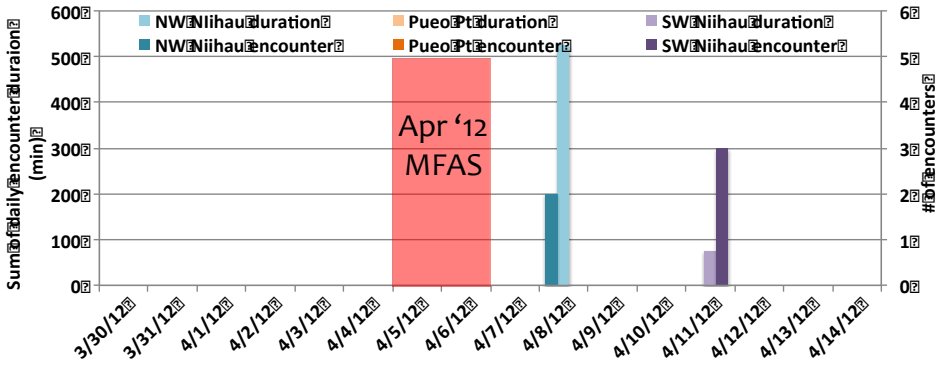
- Sperm whale presence for 3rd deployment (July '12 – Feb '13)
- Detections were sporadic at all 3 sites
- No clear summer/fall/winter trend

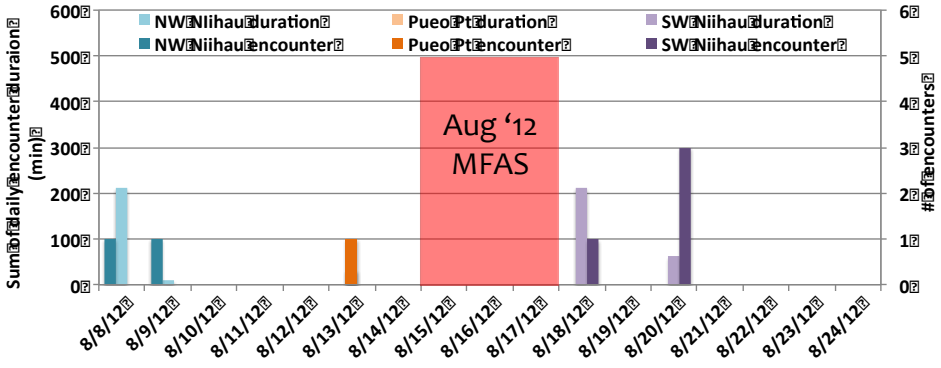
Results

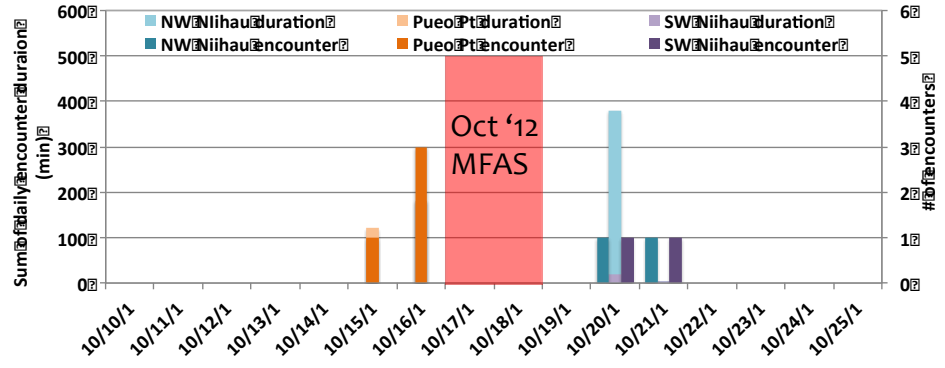
Sperm whales & MFAS

- No sperm whales detected during Nov 2011 & Feb 2012 events
- No sperm whales detected during MFAS



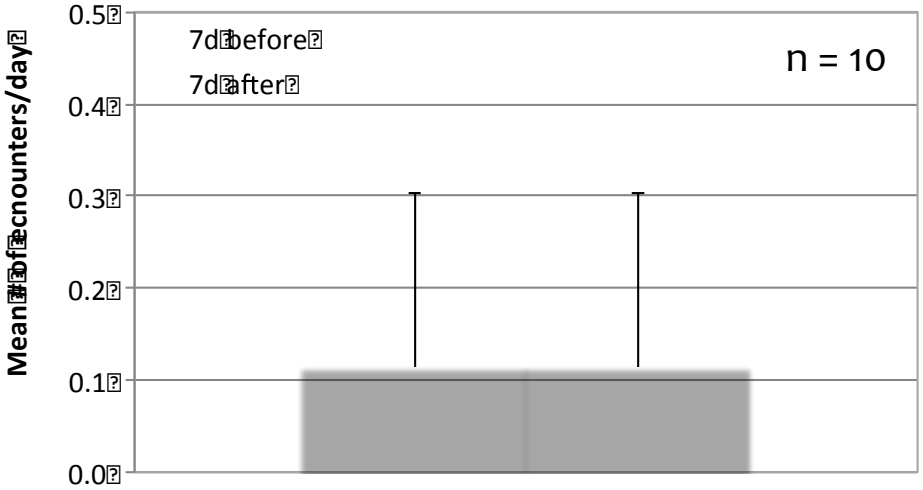


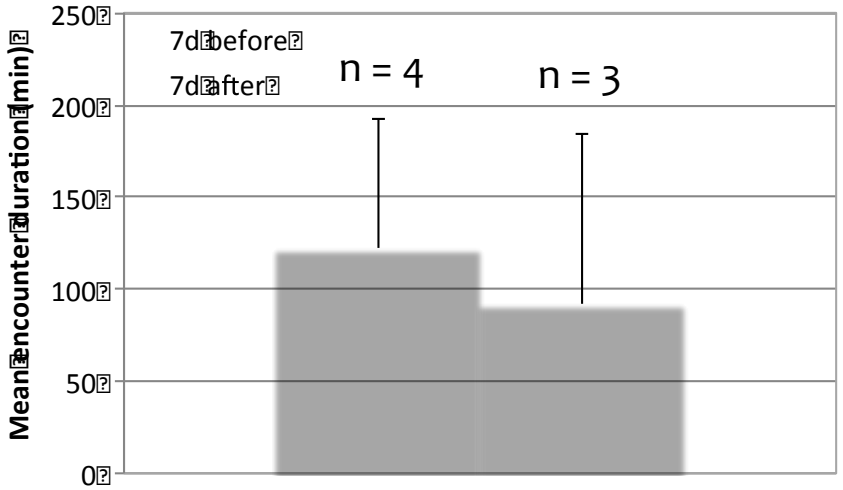




Sperm whales & MFAS

- Sample sizes too small for statistical inference

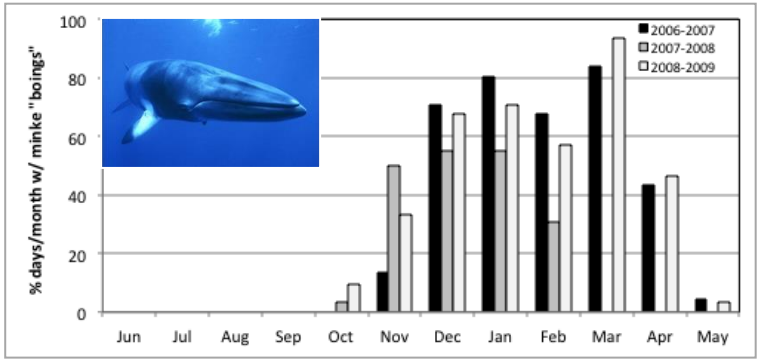


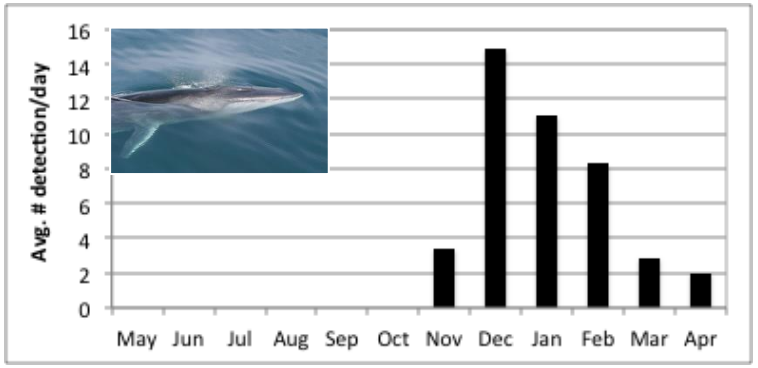


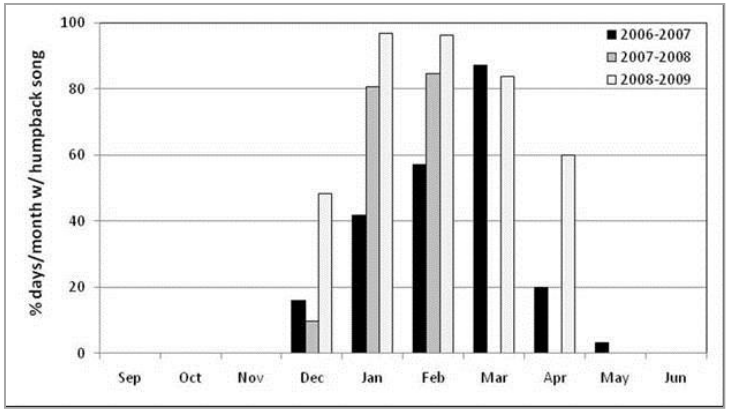
Results

Seasonality of baleen whales

- Performance of HIMB baleen whale detectors being evaluated, so no seasonality results are yet available specifically for HRC.
- However, data from NWHI reveal a strong seasonal trend in occurrence.



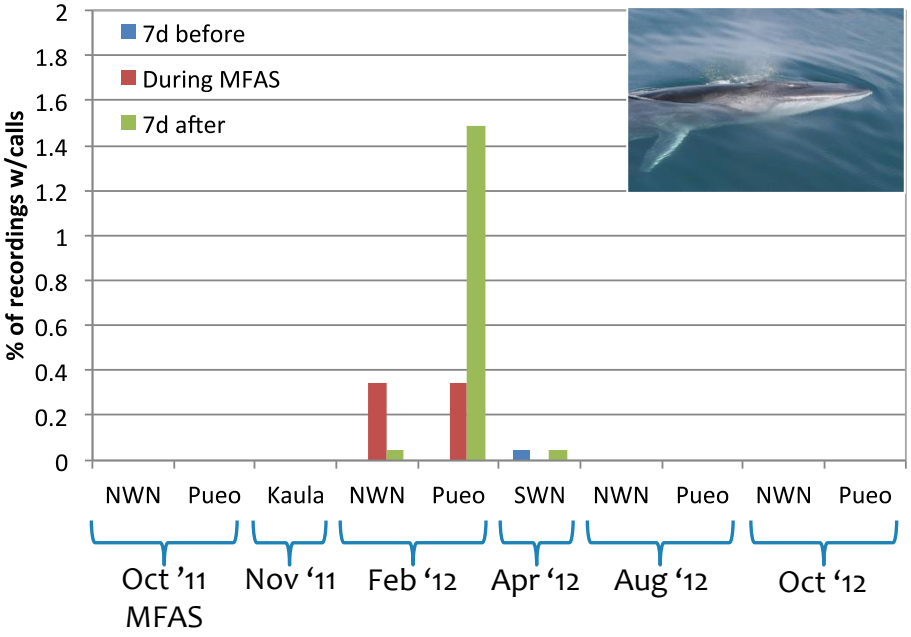


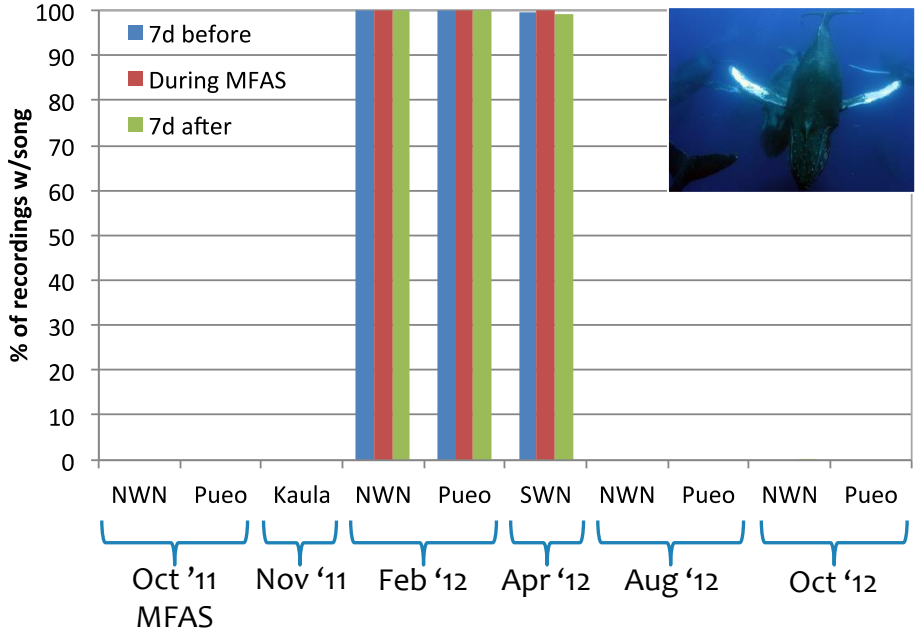


Results

Baleen whales & MFAS

- % recordings with fin/sei whale calls and humpback whale song by site & by MFAS event
- No minke whale calls detected around major MFAS events





Summary

Take home lessons

- Delphinids off Niihau/Kaula, as a group, do not seem to exhibit a predictable, large-scale acoustic response to major MFAS events.
- Any responses to MFAS, if present, may be species-specific, exercise-specific and/or too subtle to be quantified using our methods.
- Sperm whales occur episodically in the area. Any responses to MFAS, if present, are probably too subtle to be quantified using our methods.
- Minke & Fin/Sei whales occurred only rarely in our data. Humpbacks are ubiquitous in winter and require a customized metric for evaluating response to MFAS.

Conclusion

Looking ahead…

- Awaiting M3R interpretation results from Bio-Waves for beaked whales.
- Statistical analyses still to be performed on beaked whale results relative to MFAS.
- Species-specific delphinid responses to MFAS will be examined using ROCCA results.
- Delphinid diel patterns of activity will be examined in relation to MFAS events.
- Final report draft submission planned for end of January 2015.

The Future?

Unresolved questions

- What is the seasonal occurrence of baleen whales near Niihau & Kaula?
- Do humpback whales respond acoustically to MFAS events?
- Is the lack of a detectable response in delphinids due to habituation to MFAS in regularly used range areas (or to other factors)?
- How do these results compare with an area with comparatively less historical MFAS activity (e.g. MIRC)?

Acknowledgements

HDR, Inc

Mark Deakos
Michael Richlen

HIMB

Jessica Chen
Giacomo Giorli
Adrienne Copeland

OSI

Mattie Cifuentes
Helen Meigs
Jesse James
Kimberly James
Sandy Yarbrough

Bio-Waves, Inc.

Julie Oswald, Tom Norris, Tina Yack

Navy M3R group

Susan Jarvis & Dave Moretti

US Fleet & NAVFAC Pacific

Julie Rivers
Sean Hanser
Morgan Richie
Robert Uyeyama