APPENDIX A

INTERIM PROGRESS REPORT:
ANALYSIS OF LONG-TERM ACOUSTIC DATASETS FROM MIRC

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REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to Washington Headquarters Service, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188) Washington, DC 20503.
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1. REPORT DATE (DD-MM-YYYY)	2. REPORT TYPE	3. DATES COVERED (From - To)
01-2014	Monitoring report	12-02-2013 to 12-02-2014

4. TITLE AND SUBTITLE
Interim Progress Report: Analysis of long-term acoustic datasets from MIRC

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)
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5d. PROJECT NUMBER
NOAA-NMFS-PIFSC-13-008

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Pacific Islands Fisheries Science Center, 1601 Kapiʻolani Boulevard, Suite 1000, Honolulu, Hawaiʻi 96814, U.S.A.

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Sponsoring Agencies: Chief of Naval Operations (N45), 2511 Jefferson Davis Highway, Arlington, VA 22202
Commander, U.S.Pacific Fleet 250 Makalapa Dr. Pearl Harbor, HI

10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSORING/MONITORING AGENCY REPORT NUMBER

12. DISTRIBUTION AVAILABILITY STATEMENT
Approved for public release; distribution is unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT
Existing long-term high-frequency datasets held by PIFSC are being analyzed for the occurrence of baleen whales, sperm whales, and beaked whales. The results of this analysis are expected to provide information on the seasonal use of the MIRC by these species and their seasonal relative abundance.

15. SUBJECT TERMS
Marine mammal, passive acoustic monitoring, Saipan, Tinian

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
			UU	5	Department of the Navy
a. REPORT	**b. ABSTRACT**	**c. THIS PAGE**			**19b. TELEPONE NUMBER (Include area code)**
Unclassified	Unclassified	Unclassified			808-474-6391

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI-Std Z39-18

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Interim Progress Report:
Analysis of long-term acoustic datasets from the Mariana Islands Range Complex (MIRC)

Agreement No. NOAA-NMFS-PIFSC-13-008

Prepared for Commander, U.S. Pacific Fleet Environmental Readiness Office

Erin Oleson, NOAA Fisheries, Pacific Islands Fisheries Science Center, Protected Species Division

Summary of tasks:
Task 1. Analyze existing long-term high-frequency acoustic datasets for baleen whales, sperm whales, and beaked whales

Existing long-term high-frequency acoustic datasets held by PIFSC are being analyzed for the occurrence of baleen whales, sperm whales, and beaked whales. The results of this analysis are expected to provide information on the seasonal use of the MIRC by these species and their seasonal relative abundance. Study objectives are driven by the specific questions outlined in the FY13-15 Marine Species Monitoring Plan for Navy Training in the Mariana Islands Range Complex (MIRC).

Two baseline questions relative to cetacean occurrence, outlined in the FY13-15 monitoring plan, guide the task outlined in this SOW.

1. What species of beaked whales and other odontocetes occur around Guam and Saipan?
2. What is the seasonal occurrence of baleen whales around Guam, Saipan, Tinian, and Rota?

Work Completed to Date
PIFSC maintains long-term acoustic datasets collected near Saipan in March-August, 2010, and at two sites near Saipan and Tinian in April-October, 2011 and June 2012-May 2013. All acoustic datasets were collected using High-Frequency Acoustic Recording Packages (HARPs) sampling at 200 kHz sample rate, resulting in effective bandwidth of 10Hz to 100kHz. Deployment and recording details for all acoustic data collected in the region are provided in Table 1.

Table 1. Acoustic datasets collected near Saipan and Tinian by PIFSC since 2010.

Dataset	Deployment Location		Recording Dates		Sample rate & Duty cycle (min on/total)
	Latitude	**Longitude**	**Start**	**End**	
Saipan01	15-19.0 N	145-27.5 E	3/5/10	8/25/10	200kHz, 5/40
Saipan02	15-19.0 N	145-27.5 E	4/247/11	10/20/11	200kHz, 5/20
Saipan03	15-19.1 N	145-27.4 E	6/20/12	3/8/13	200kHz, 5/6
Tinian02	15-02.3 N	145-45.1 E	4/136/11	11/22/11	200kHz, 5/20
Tinian03	15-02.4 N	145-45.3 E	6/23/12	5/14/13	200kHz, 5/6

A number of analysis components were to be undertaken on the available datasets. Because much of the data had not yet been scanned prior to this effort, it was difficult to know in advance how long it would take to assess daily occurrence of each species of interest with the 5 total data sets. For this reason, work has proceeded on the first three project components listed below. When those are complete, we will evaluate whether it is feasible to continue with determination of species-ID for beaked whale sounds and assessment of the occurrence of minke and sperm whales with the remaining funds and time available.

Data analysis priorities:
1. Model sound propagation and detection range for baleen whale calls under 1kHz
2. Assess daily occurrence of baleen whales with low frequency (< 1kHz) calls in all 5 data sets.
3. Assess daily occurrence of all beaked whales within one dataset
4. Determine species-ID for detected beaked whale sounds
5. Assess daily occurrence of minke and sperm whales within one dataset

Sound propagation modeling at the Saipan and Tinian monitoring sites is intended to inform the range at which baleen whale calls may be heard at these sites. For example, the detection of faint calls may indicate whales are far away from the monitoring location or it could be due to local bathymetric and oceanographic effects on the propagation that result in attenuation of the signal over a relatively short range. This modeling effort has only recently begun for the Saipan and Tinian monitoring sites. Information on which species were present in the datasets has helped to inform the frequency bands of interest and some of the details of how modeling should be carried out. Propagation modeling results will be detailed in full at the final report.
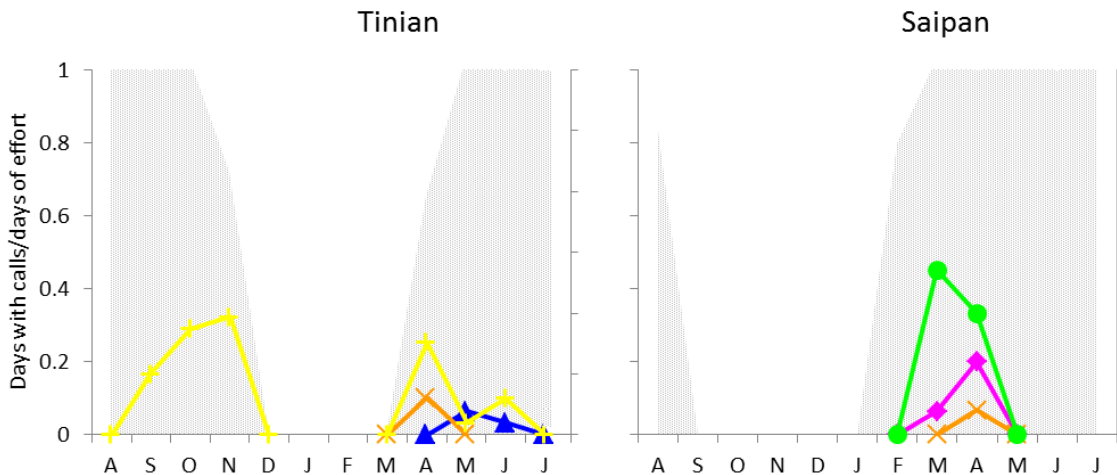

Figure 1. Proportion of days with calls in relation to recording effort, by month with recording effort combined across years. Lines and symbols represent different large whale species, with proportion of calls to effort quantified on left vertical axis. Light gray shading quantifies the proportion of days per month with recording effort. Orange = fin whale, Blue = blue whale, Green = humpback whale, Pink = minke whale, and Yellow = Unidentified whale.

Analysis of 2010 and 2011 Saipan and Tinian datasets for low frequency (<1 kHz) baleen whales is complete, and analysis of the 2012-2013 datasets is underway. Data were scanned as compressed spectrograms in one hour bins. When signal was evident above the background noise, the raw spectrogram was inspected. If the observed sound was from a baleen whale, the period of calling was marked in a logger within the software. Some signals were assigned to an 'unidentified whale' category when the signal was consistent with other sounds known to be produced by baleen whales, but with characteristics that have not been attributed to a specific species. Other sounds in the low frequency band were not logged. Average monthly effort and the occurrence of five baleen whale species within the 2010 and 2011 datasets is shown in Figure 1.
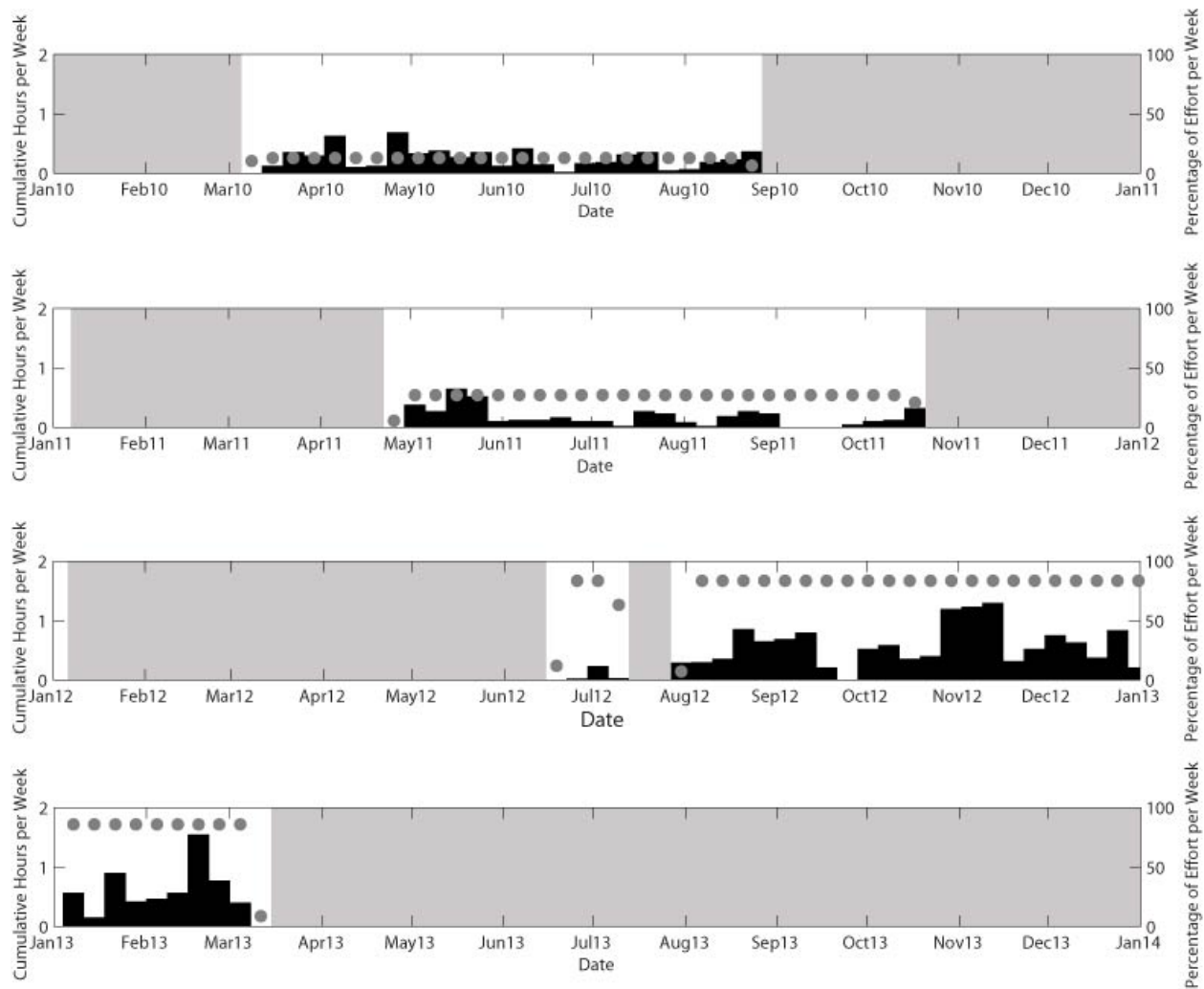

Figure 2. Weekly occurrence of beaked whale echolocation signals at Saipan within the 2010 through 2013 datasets. Gray shading indicates periods with no acoustic data. Black bars show the cumulative hours per week with beaked whale signals and the gray dots indicate the relative amount of available acoustic data given the recording duty cycle (see Table 1).

Although the SOW called for daily assessment of beaked whales within only a single 2012-2013 dataset, a beaked whale echolocation click detector was available for use and as such all Saipan and Tinian

datasets have been evaluated for beaked whales. The detector is designed to look for the upswept nature of common beaked whale echolocation clicks, and has been tested and validated across a broad range of monitoring sites and against known species clicks (e.g. see Baumann-Pickering et al. 2014). The detector does not classify beaked whale click bouts to species. Instead this classification is carried out in a follow-up step by the analyst. The occurrence of all beaked whale clicks was quantified as the cumulative duration of beaked whale echolocation click bouts within a weekly period and is shown in Figures 2 and 3. These quantifications do not account for differences in duty-cycling between datasets, such that higher apparent occurrence in the 2012-13 dataset does not necessarily indicate greater occurrence in the region, but rather a combination of increased recording effort and the contribution of longer click bouts due to the more frequent sampling. The detections do indicate that, as a group, beaked whales appear to occur year-round at both sites. The level of recording effort given the duty cycle of each deployment (i.e. 25% equals 5 minutes of recording in each 20 minutes) is shown on the plots for reference.
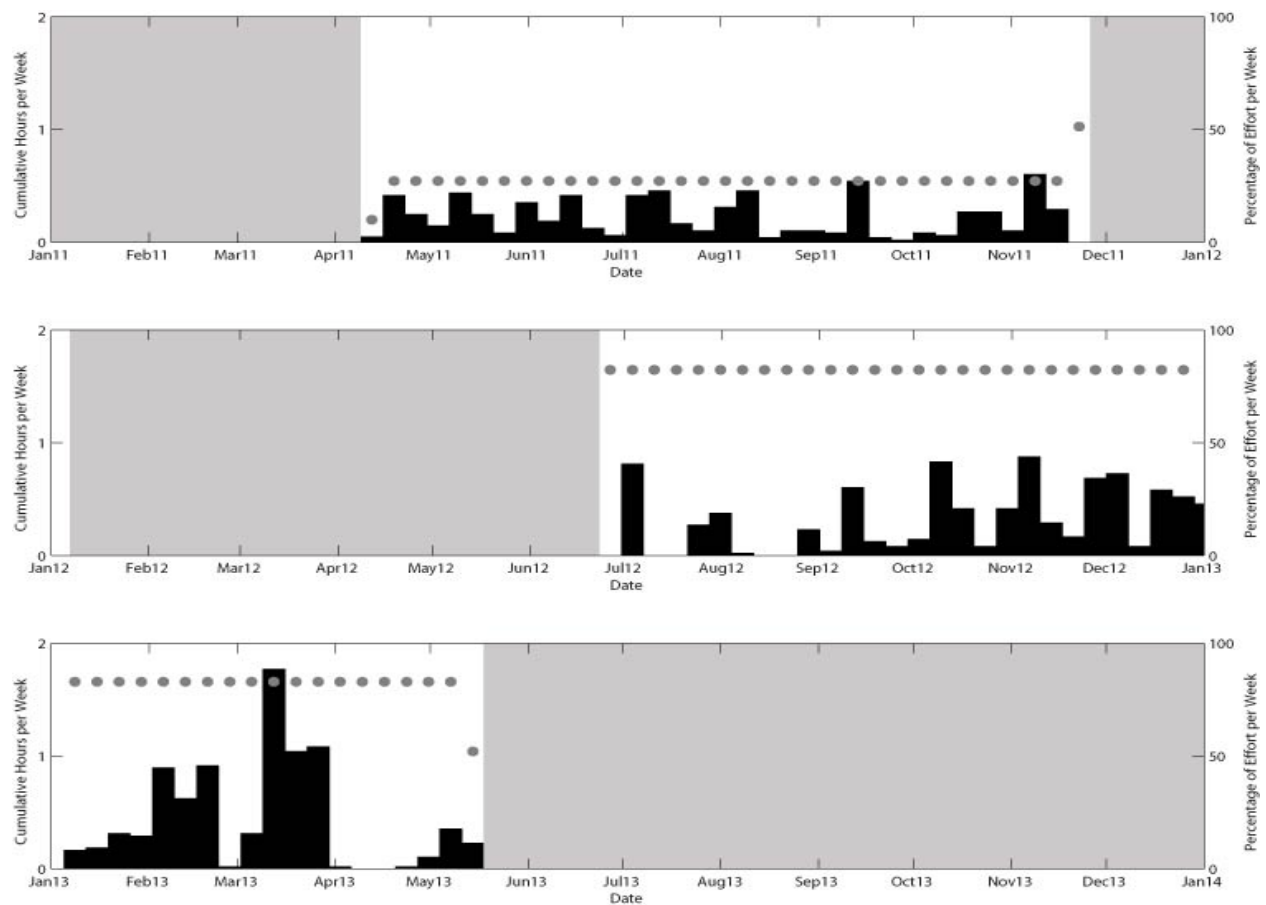

Figure 3. Weekly occurrence of beaked whale echolocation signals at Tinian within the 2011 through 2013 datasets. Gray shading indicates periods with no acoustic data. Black bars show the cumulative hours per week with beaked whale signals and the gray dots indicate the relative amount of available acoustic data given the recording duty cycle (see Table 1).

Classification of beaked whale click bouts within the Saipan and Tinian datasets is still ongoing. Limited assessment of beaked whale occurrence by species using a subset of these data was included in two recent publications (Baumann-Pickering et al., 2013, 2014), indicating that Cuvier's, Blainville's, and an as yet unidentified beaked whale are heard at the Saipan and Tinian sites. Occurrence of beaked whales by species within the Saipan and Tinian data will be provided in the final report. Note that occurrence of Longman's beaked whale cannot be assessed using an automated detector as their clicks do not upsweep like other beaked whale clicks. It is also difficult to distinguish the Longman's beaked whale from delphinid clicks within the long-term autonomous acoustic data. As such, their occurrence is not included here, nor can it be automatically assessed given current analysis methods.

References

Baumann-Pickering, S., M.A. McDonald, A.E. Simonis, A. Salson Berga, K.P.B. Merkens, E.M. Oleson, A.R. Roch, S.M. Wiggins, S. Rankin, T.M. Yack, J.A. Hildebrand. 2013. Species specific beaked whale echolocation signals. JASA 134(3): 2293-2301.
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