APPENDIX F. Preliminary Results from a Deep-water Ecological Acoustic Recorder (EAR) Deployed off NW Ni'i hau during RIMPAC-2010

PRELIMINARY RESULTS FROM A DEEP-WATER ECOLOGICAL ACOUSTIC RECORDER (EAR) DEPLOYED OFF NW NI'IHAU DURING RIMPAC-2010

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PRELIMINARY RESULTS FROM A DEEP-WATER ECOLOGICAL ACOUSTIC RECORDER (EAR) DEPLOYED OFF NW NI'IHAU DURING RIMPAC-2010

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An Ecological Acoustic Recorder (EAR) was deployed on July 17, 2010 at a depth of 800 m off the northwest coast of the island of Ni'ihau (21° 59.613" N, 160° 12.167" W). A map of the deployment site is shown in **Figure 1**. The sampling rate for data acquisition was 80 kHz and the duty cycle for turn-on and sleep was 30 sec of sampling every 5 minutes. The deep EAR was recovered on December 21, 2010 (although it had ceased recording on October 22) with a full disk containing 28,329 files of data.

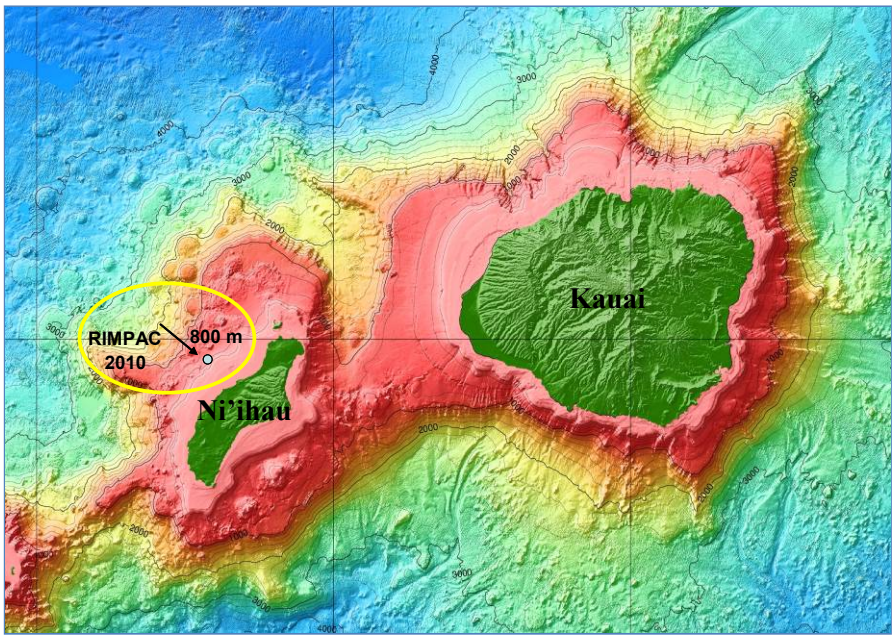

Figure 1. Approximate location of the deep EAR deployed in waters NW of Ni'ihau during RIMPAC-2010.

Three signal detectors were used to determine the presence of beaked whales: 1) the energy ratio mapping algorithm (ERMA) developed by Holger Klinck (Klinck and Mellinger, 2011), 2) the support vector machine algorithms incorporated within the M3R (Marine Mammal Monitoring on Navy Range) developed by Susan Jarvis (Jarvis et al., 2008) and 3) a custom MATLAB algorithm developed for this project. Both ERMA and the M3R algorithms operate automatically and are handy for a first look at the data. The beaked whale detections obtained by ERMA and the M3R were matched against each other, and if both detectors indicated a beaked whale present in a particular file, this constituted a positive identification. If only one detector indicated the presence of a beaked whale, then the file was examined by a custom MATLAB algorithm which examined the waveform, spectrum and the time-frequency distribution obtained via a Wigner-

Ville distribution analysis of signals in the file. Approximately 40 percent of beaked whale detections were matched by the ERMA and M3R detectors, meaning that 60 percent (approximately 1,200 files) of possible beaked detections had to be examined visually with the semi-automatic custom MATLAB program.

The daily detections of beaked whales, and the number of detections at different hours of the day, are shown in **Figure 2**. The panel on the left indicates that beaked whales are detected almost every day, with the number of detections dependent on specific days. There were 9 out of 98 days in which no beaked whales were detected. Most (approximately 87 percent) of the detections occurred at night, as can be seen in the shaded portion of the right panel in **Figure 2**. The reason for detections occurring mainly at night is likely dependent on the behavior of the prey field.

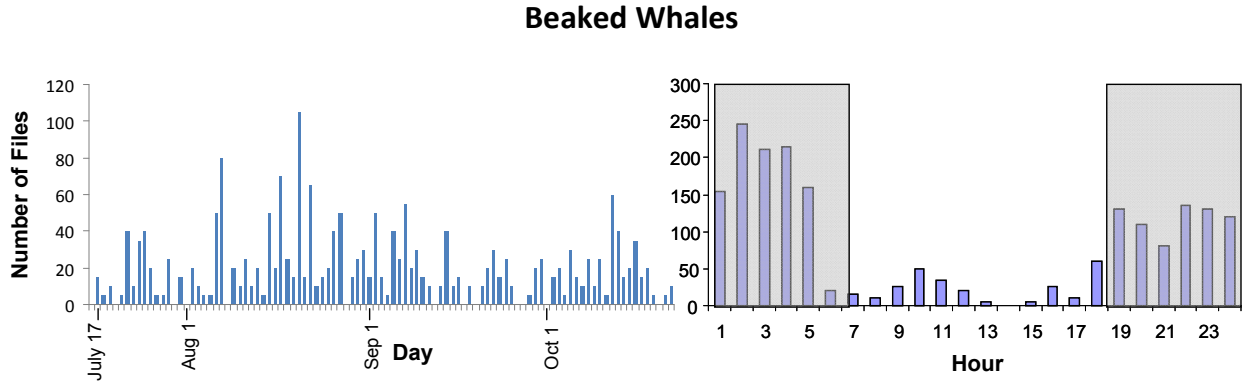

Figure 2. Beaked whale detections from the deep EAR deployed in waters NW Ni'ihau during Rimpac-2010.

The M3R system is also capable of detecting other groups of odontocetes based on the characteristics of their biosonar signals. These include pilot whales (*Globicephala spp.*), Risso's dolphins (*Grampas griseus*), sperm whales (*Physeter macrocephalus*) and dolphins in the *Stenella* genus. The relative numbers of detections of these groups, along with those of beaked whales are shown in **Figure 3**. Pilot whales had the highest number of detections, while beaked whales had the least number of detections. It is interesting that Risso's dolphins were the 2nd most detected odontocetes, since they are not consistently sighted in Hawaiian waters.

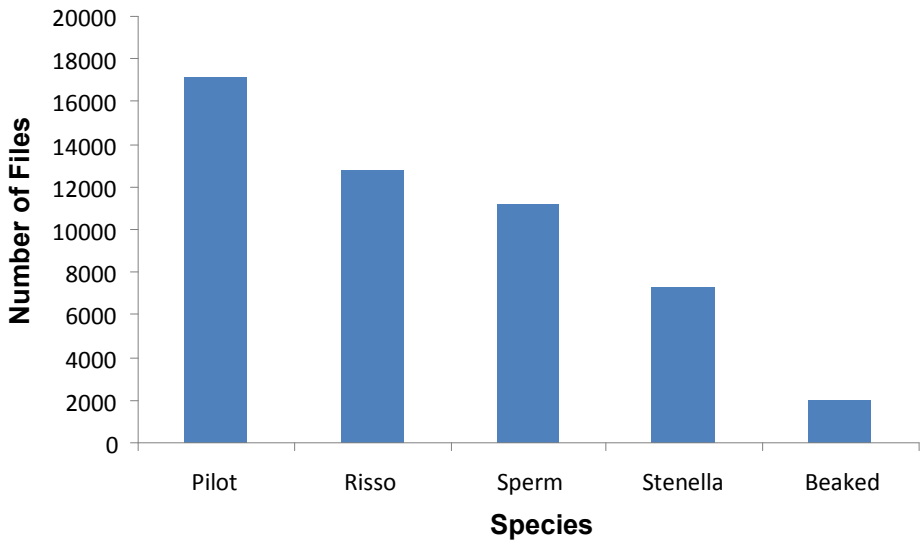

Figure 3. Relative number of files containing the different species of odontocetes detected by the M3R system.

REFERENCES:

Klinck, H., and Mellinger, D.K. (**2011**). "The energy ratio mapping algorithm: a tool to improve the energy-based detection of odontocete echolocation clicks." J. Acoust. Soc. Am. **129**, 1807-1812.

Jarvis, S., DiMarzio, N., Morrissey, R., and Moretti, D. (**2008**). "A novel multi-class support bector machine classifier for automated classification of beaked whales and other small odontocetes," Canadian Acoustics, **36**, 34-40.