2015 Passive Acoustic Monitoring (PAM) Plan for Marine Mammals Off the Coleville River Delta, Alaska

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Introduction

Passive acoustic monitoring (PAM) using autonomous recorders deployed on the seafloor is an effective method for long-term monitoring of marine mammals and noise (Mellinger et al. 2007). Autonomous acoustic recorders (AARs) have been used to monitor the distribution, occurrence, and acoustic behaviors in relation to noise for a variety of marine mammal species and geographic locations (Castellote et al. 2012; Norris et al. 2012; Risch et al. 2012). AARs have also been used in arctic environments to monitor marine mammal and noise (Berchok et al 2014; Lammers et al. 2009, 2013; Magnúsdóttir et al. 2014; Thompson et al. 2012; Yack et al 2014). We propose to use a small compact autonomous recorder system, known as the micro Marine Autonomous Recording System or microMARS (**Figure 1**) to monitor the aa shallow water areas off the Coleville River Delta in the Beaufort Sea, Alaska immediately before and during seismic operations.

The goal of this PAM effort is to collect data using microMARS deployments to address the following questions:

- Are marine mammal species present in the study area during the period of deployment and if so, what species?
- When and where are marine mammals detected (i.e. temporal/spatial patterns)?
- What are ambient noise levels, and how do they vary in time and space?
- Are there any obvious relationships between seismic survey activity and acoustic detections?

Figure 1: microMARS (left) attached to orange float (above it) and ARC-1 acoustic release device (right of it). Transducer and over-the-side cable (middle) is connected to a surface communication box and a netbook computer to run release device communication software.

Methods

AAR Deployments and Package

As soon as logistically possible before seismic survey activities commence, (depending on weather and vessel availability), AAR mooring packages will deployed at the four corners of the study site. Each AAR mooring package site will include two microMARS units coupled with an ARC-1 release device, a float and a retrievable mooring. Deploying two microMARS at each monitoring location will allow redundancy in the system to reduce the likelihood of failures and/or data loss. Detailed specification on the microMARs recorders and ARC-1 are provided in appendices I and II[1].

The deployments will occur for approximately 4-6 weeks or until ice-conditions require removal of the packages. Ideally, recording would begin at least one week prior to the start of seismic operations and end at least one week after seismic operations cease. This would allow for a minimum amount of baseline monitoring activity so that occurrence of marine mammals acoustic events could be compared before, during, and after operations. However, this plan may need to be modified depending on weather, logistics and other considerations.

Data Post-Processing and Analysis

Acoustic data will be analyzed for two frequency bands, low (below 2 kHz for walruses, baleen whales and low-frequency noise) and high (2 kHz - 32 kHz for beluga whales and high-frequency noise). This will allow sounds produced by different species and anthropogenic sources to be reviewed and analyzed in greater detail. Specialized acoustic review and analysis software, Trition (Wiggins 2007) will be used to create long-term spectral averages (LTSAs) for all acoustic files downloaded from the recorders (**Figure 2**).

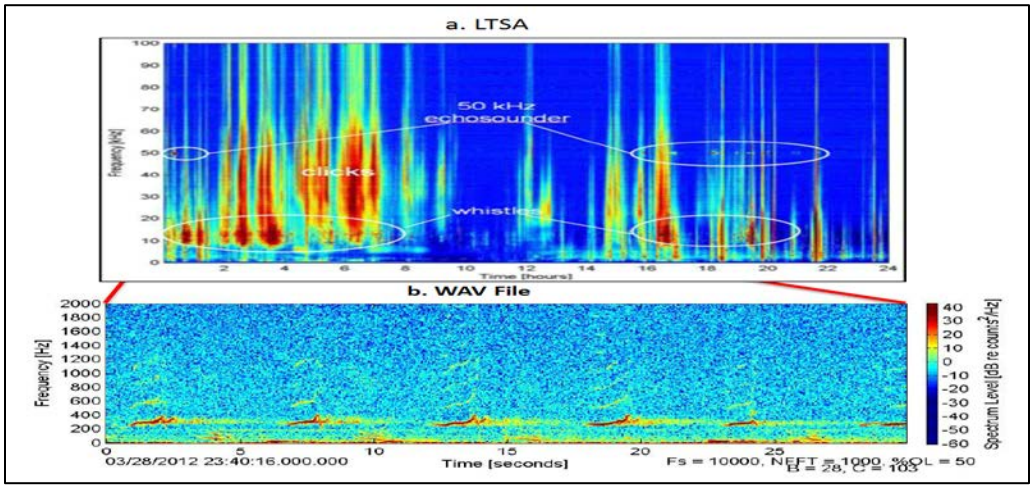

Figure 2: Example of an LTSA and a spectrogram of the associated wav (acoustic) file. The LTSA shows 24 hours of data and the spectrogram shows 10 seconds of data. LTSA's provide a visual representation of sounds that are condensed in time to allow for quick and efficient review of all data. Both provide time-frequency representations of sound.

[1] The microMARS/ARC-1 PAM package was field tested in the Puget Sound area, and has since been used successfully during a noise monitoring project in the Santa Barbara channel in Fall of 2014.

Once LTSAs of all the acoustic data have been created and preliminarily reviewed, experienced bioacoustic data analysts will perform a detailed review of the data. Analysts will log the time of occurrence of all biological sounds, seismic source events (if audible), and other relevant acoustic signals (e.g. ships, small boats, and other noise events). Combined event log data will then be organized into tables to provide summaries including 1) the number and type of acoustic events 2) the number of days each event occurred at each site and 3) event durations for each deployment and site. Graphs of daily event occurrence will be made for each identified marine mammal species that have sufficient data to plot (e.g. **Figure 3**). Graphs of the percentage of time for which signals from each species were detected with respect to total recording time at each site will be plotted by species.

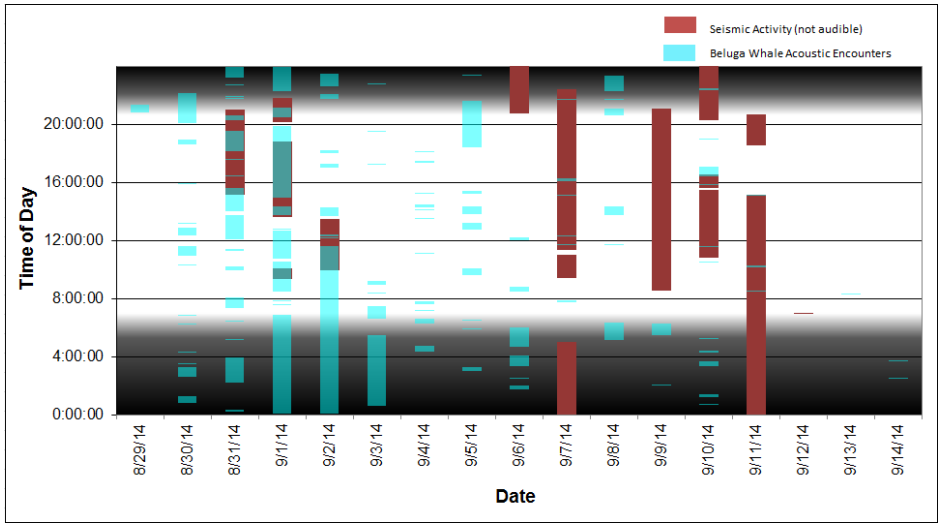

Figure 3. Beluga whale acoustic encounters at all EARs (blue) overlaid with reported seismic activity (red). Shaded areas denote periods of darkness (From Yack et al. 2014).

Noise analysis will be performed on all recorded acoustic data. Sound levels will be measured for full and octave frequency bands. This analysis will be conducted using automated algorithms that measure root-mean-square (RMS) sound pressure level (SPL) each octave bands. These results will be averaged both hourly and daily to provide a synoptic representation of the ambient noise levels present at each location for each of the different frequency bands measured.

Reporting

A final report (with 1 round of revisions by NOAA) will be provided at the end of the project, approximately 120 days after the end of the field season (the date when recorders are retrieved). If a 90 day report is required, we will provide a preliminary report with the data that has been reviewed and analyzed up to that date. The report will include a summary of marine mammal detection events, seismic source events and a discussion of the results with respect to any observable effects of seismic survey activities on the acoustic behaviors of marine mammals. Recommendations for future passive acoustic monitoring of mammals and noise will also be provided.

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Appendix I. Specifications for microMARS recorders.
The micro-Marine Acoustic Recording System (MARS) was recently developed with a NOAA Advanced Technologies Sampling Group grant to Desert Star Systems LLC in partnership with Bio-Waves Inc. The base model microMARS has a 300m depth rating, and includes storage capacity up to 4 Terabytes using SD cards. It can record continuously or on a duty cycle for up to several months, depending on the model type and configuration settings.

Parameter	Single Battery Version	Four Battery Version
Size	196mm L x 63mm D	399mm L x 63mm D
Weight in air (w/ lithium battery)	673g	1294g
Weight in water (w/ lithium batteries)	58g (slightly negatively buoyant)	28g
Housing Material	Delrin (Titanium upon request)	Same
Depth rating	300m (5000m with titanium option)	Same
SD Card Slots	Two cards (-2 version) Eight cards (-8 version)	Same
Memory Capacity	1024 GB (two SD card version) 4096 GB (eight SD card version)	Same
Supply Voltage and Source	3.1V-5.0V battery voltage 5.0V USB cable (to configure)	Same
Battery	1 lithium cell = 17000mAh (Tadiran TL-5930/F) -or- 3 x AA alkaline cells ~2500mAh	4x lithium cells = 68000mAh (Tadiran TL-5930/F) -or- 12 x AA cells ~ 10000mAh
Power Consumption (SanDisk Extreme Pro)	0.06mA Standby 4mA acoustic event detection 40mA @ 25kHz sample rate 42mA @ 100-250kHz sample rate	Same
Endurance relative to sampling requirements (w/ Tadiran TL-5930/F lithium batteries)	18 days @ 25kHz / 76 GB 17 days @ 100kHz / 291 GB 17 days @ 250kHz / 728 GB 6 months acoustic event detection	72 days @ 25kHz / 304 GB 68 days @ 100kHz/1164 GB 68 days @ 250kHz/2912 GB 24 months event detection
Operating Modes	• Continuous Recording • Duty Cycled • Acoustic Event Detection	Same
Dynamic Range	96dB (16-bit conversion)	Same
Hydrophone	Modular and exchangeable end cap. (See specifications Table 1.)	Same

Appendix II. Specifications for ARC-1 underwater release device.
ARC-1 is a release device produced by Desert Star Systems. It is a small but cost-effective release system that has been in use for several years. It uses a rapid-burn wire fuse to allow for a very quick and reliable release mechanism. It is ideally suited to be coupled with the microMARS units.

Parameter/Item	**Details**	**Comments**
Size	2.25" Diameter housing 21.5" length	57mm (D 267mm (L)
Buoyancy	Slightly negative	
Payload	Capable of supporting a payload of 40 pounds (See Load Ratings below)	
Depth Rating	1000 feet	750m
Power	Standard alkaline batteries	
Operating Frequency	34-42kHz	
Battery Life	6 months	2X safety factor
Housing Material	Delrin and Noryl plastic	
Release hardware material	stainless steel	
Release wire material	Nickel Chromium Alloy	(60% nickel, 16% chromium, 24% iron)
Release Wire gauge	26AWG	
Load Ratings		
Design Strength of components	200 lb	Excluding release wire
Factory acceptance load test	80 lb	with 26AWG wire
Recommended pre-deployment load	50 lb	
Maximum load	40 lb	This is the rated load
Nominal load	15 lb	Recommended load
Minimum load	10 lb	This is the rated load
Other Features & Capabilities		
Reliable fusible link mechanism with a single moving part	Rapid 0.002 sec typical actuation time for synchronous multi-point release	
Surface stations	Standard Desert Star surface stations can be used as interrogators	See Desert Star Website for details on Surface stations