

NOAA Guidelines for Use of Passive Acoustic Listening Systems for Monitoring in Mitigation Programs

The passive acoustic monitoring (PAM) guidelines suggest system components and operating procedures (standardized as appropriate) for underwater PAM plans or protocols that may be required through the Endangered Species Act (ESA), Marine Mammal Protection Act (MMPA), or the National Marine Sanctuaries Act (NMSA). Real-time PAM is particularly appropriate and may be required as a part of a mitigation program for activities involving intense and/or chronic sound sources where vocalizing marine mammals are likely present. The guidelines apply to both real-time and archival PAM that is used in mitigation designed to minimize or document impacts from sounds (continuous, intermittent and/or impulsive) upon marine mammals.

Introduction

PAM is a critical tool for understanding the marine environment and is an area of exponentially-expanding research and development. PAM can allow one to listen for vocalizing animals, identify some species, assess their distributions and/or individual locations to some extent (this is an area of increasing capability), as well as listen to other germane sounds such as anthropogenic sources. PAM involves the use of acoustic equipment, such as towed hydrophones or moored recording buoys, strategically located to (1) provide real-time information for immediate mitigative decision-making, (2) monitor or assess the impacts from specific activities, or (3) gather continuous archival recordings for periodic evaluation and adaptive management.

PAM has been used as a part of mitigation programs developed through section 7 consultations, MMPA incidental take authorizations, and NMSA consultations. The inclusion of PAM in mitigation for the detection, identification, and localization of marine mammals is anticipated to increase due to the limitations of visual observations, which can under many field conditions be quite severe. PAM plans are being developed on a case-by-case basis. The guidelines serve to aid the development of PAM plans by identifying what should be included, while promoting consistency across PAM plans. They provide the minimum set of procedures and system requirements needed for detection, localization, and reporting in designing PAM plans. The selection of PAM components and additional system design and management protocols will need to be developed in coordination with the appropriate NOAA staff to accommodate the specific region, activity, and species for which PAM would be used.

Given the value of recorded information for future evaluations, the guidelines also contain recommendations for standardizing acoustic data provided to NOAA. The Report of the 2006 NOAA National Passive Acoustic Workshop (Van Parijs and Southall 2006) describes the data management and archiving discussions from the workshop and identifies the requirements for passive acoustic recording devices that could eventually be used to inform studies on local impacts of anthropogenic noise. The guidelines incorporate the requirements as developed during the 2006 workshop.

Guidelines

PAM Procedures

- 1) Real-time PAM is not a substitute or replacement for visual monitoring for activities that have visual observers as part of a mitigation program. PAM systems have their limitations as well, such as when animals are not vocally active. Instead, PAM should be considered a means to augment visual monitoring and detection capabilities.
- 2) Any real-time PAM system must be used in conjunction with a visual observer system. Routes of communication and reporting protocols between the PAM operator, visual observer, the appropriate on-site manager, and any other personnel during monitoring should be established in advance in the PAM plan. For example, rules by which acoustic information trigger decisions to cease or proceed with blasting and/or pile driving should be established in advance.
- 3) If not provided during an ESA section 7 consultation, MMPA authorization, NMSA permit, or other process, a zone within which marine mammals should be documented, excluded, and/or provided protections should be determined in advance of using PAM. Such zones typically surround the project sound source. The placement of hydrophone(s) or sonobuoy(s) should be designed to detect vocalizing animals within this zone.
- 4) Hydrophones and related hardware and software need to be calibrated and their performance systematically measured and optimized within frequency bandwidths of interest for the particular activity, species, and environment. A regional or headquarters contact, listed on pages 4-5, can provide assistance in identifying the below information for particular hardware and software.
 - a) Calibration data and relevant settings and sensitivities should be noted for all hardware used in recording/monitoring to ensure consistency among measurements for particular hardware and software. This information should be kept with the recordings.
 - b) All hardware should be tested for low self noise.
 - c) Consideration must be given to the depth of the sensors relative to the depth of sound sources, and other factors influencing sound propagation.
 - d) Periodic CTD (conductivity-temperature-depth) data, important for determining sound velocity profiles and understanding sound propagation conditions, should be collected and made available with the recorded files.
- 5) In addition to calibration, the system should be fully tested to ensure adequate sensitivity in the area where it would be used. If this cannot be done at the project site, the system could be fully tested in a comparable location (i.e., an area exhibiting similar depth, temperature, current, acoustic propagation, and ambient noise).
- 6) If appropriate and feasible, incidental underwater sounds (such as supply vessels at a construction site), particularly those that overlap with the frequency ranges of potentially

present species, should be managed to avoid masking of target animal vocalizations or other relevant signals during PAM.

PAM System Requirements

- 7) To the extent feasible or as required in the mitigation program, multiple omnidirectional hydrophones should be employed to increase the probability of localizing, at least laterally, vocalizing animals. A minimum of 3 hydrophones placed within a range that guarantees overlapping receptivity (i.e., multiple arrivals) is minimally necessary to localize animals. The configuration of the hydrophones should take into account the following factors:
 - a) The characteristics of vocalizations and their propagation from the animals of interest,
 - b) The local ambient sound, and sound propagation, conditions, and
 - c) Sounds from the human activities for which PAM is being required.
- 8) Hydrophones and related hardware and software need to be capable of detecting the frequencies of the marine mammals that could be present and gain-control settings should be appropriate to the source levels of interest.
- 9) Given the current state of vocalization detection software technologies, acoustic data acquired during real-time PAM should be analyzed by experienced PAM operators. If available and appropriate, the PAM system should include software for the real-time detection and identification of vocalizing mammals that may be present.
- 10) The PAM system, whether it includes an automatic detection algorithm or an operator(s) directly examines the data, needs to provide information within a timeframe that allows timely management decision-making and implementation of measures. For example, PAM should provide real- or near real-time data during seismic surveys so that upon detection of vocalizations from mammals within an “exclusion zone,” airgun pulses can be suspended or powered down.
- 11) The system needs to be designed, installed, and operated by those having expertise in designing, building and installing real-time PAM units, including placement in the water, attachment of cables, software use, etc. If multiple units are used simultaneously, knowledgeable and experienced persons should operate each unit.

Reporting

- 12) Reports on the use of PAM need to be provided to the relevant offices within NOAA. Reports should include the following information, as appropriate:
 - a) Information on the sound-producing activity or event including start and end times, frequency and amplitude of sources, distances to isopleths of concern and references to the start and end times for visual and acoustic observations/monitoring efforts.

- b) Description of the PAM hardware and software, including calibration data noted in #4 above, bandwidth capability of hydrophone(s), any filters used in hardware or software, any limitations with the equipment, and other information.
- c) Local environmental conditions, such as references to visibility metrics, transmission loss data collected on-site (or the sound velocity profile), baseline pre- and post-activity ambient noise levels (broad-band and/or within frequencies of concern).
- d) All detected vocalizations, including:
 - i) identification and location of recording unit,
 - ii) species identification (if possible),
 - iii) call type (if known),
 - iv) temporal aspects of vocalization (date, time, duration, etc.),
 - v) comparison with any sightings, and
 - vi) name of observer/data collector.
- e) Location (if geometry/density of bottom-mounted or sonobuoy array allows) or directionality (directional hydrophones and/or lateral information from towed array) of detected calls including references to location of coincident human sound-producing activities.
- f) Mitigation steps taken in response to detection.
- g) Noise budgets, describing the relative contribution of various sound sources to the overall background noise in a particular frequency band (only for stationary, continuously-recording hydrophones).

13) As appropriate, the above information should be submitted to the relevant NOAA offices.

Regional and Headquarters Contacts

The following NOAA staff worked with PAM in the field using a variety of systems and software. They may be available to review or provide input into PAM plans or answer any questions on technical aspects of PAM:

Catherine Berchok, Ph.D. National Marine Mammal Laboratory NMFS Alaska Fisheries Science Center	Tel: 206-526-6331 Email: Catherine.Berchok@noaa.gov
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The following staff has experience reviewing PAM plans and/or applying PAM into mitigation programs and may also be available to review or provide input on PAM plans:

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References

Van Parijs, S. and Southall, B. (Conveners and Workshop Co-chairs). 2006. Report of the 2006 NOAA National Passive Acoustics Workshop: Developing a Strategic Program Plan for NOAA's Passive Acoustics Ocean Observing System (PAOOS), Woods Hole, Massachusetts, 11-13 April 2006.