LMR news

SCIENCE • STEWARDSHIP • NAVY READINESS

Welcome!

Welcome to the latest issue of *LMR News*—the newsletter from the Living Marine Resources (LMR) program. Our goal is to provide you with the latest information about program operations, significant accomplishments and future focus areas for the LMR program. We hope you will find the content useful and that it provides insights into our efforts to improve our understanding of how Navy at-sea training and testing activities could affect marine species—their occurrence in training areas and potential exposure, response and consequences.

NAVFAC
Naval Facilities Engineering Systems Command
EXWC Engineering & Expeditionary Warfare Center

WHO WE ARE

The LMR program is one of the U.S. Navy's applied research (6.4) programs, sponsored by the Chief of Naval Operations for Fleet Readiness and Logistics (N4) (OPNAV N4) and managed by the Naval Facilities Command Engineering and Expeditionary Warfare Center (NAVFAC EXWC) in Port Hueneme, CA. The LMR program's fundamental mission is to support the Navy's ability to conduct uninterrupted training and testing, which preserve core Navy readiness capabilities. Our efforts to achieve that mission include working to improve the best available science regarding the potential impacts to marine species from Navy activities, demonstrating and validating projects ready for applied research, and broadening and improving the technology and methods available to the U.S. Navy Marine Species Monitoring Program.

PROGRAM OFFICE INSIGHTS

Some of the topics covered in this issue include highlights of our annual In-progress Review (IPR), LMR and NAVFAC EXWC support to one of our federal partners, LMR program manager Anu Kumar's annual briefs in Washington and updates on two projects. Each of these is discussed in following sections.

We have three additional Fiscal Year 2022 (FY22) projects to announce. These projects fall under our Investment Area 2: Data Processing and Analysis Tools.

Investment Area	Project Number & Title	Principal Investigator	Need
Data Tools	Project 62—RAVEN-X	Peter Dugan	N-0260-22 Research that Pertains to the LMR Program Investment Areas. Data Processing and Analysis Tools
Data Tools	Project 63—Cetacean Caller-ID [CETACID]: Validating Approaches for Identifying Focal Communication Signals Using Acoustic Recording Tags	Frants Jensen	N-0259-22 Improve the Ability to Identify Calling Individual from Acoustic Tags
Data Tools	Project 65—Using Passive Acoustic Tracks from a Navy Array to Study Large Whale Behavior in the North Atlantic	Regina Guazzo	N-0260-22 Research that Pertains to the LMR Program Investment Areas. Data Processing and Analysis Tools

Fact sheets on these projects will soon be available on the LMR website, exwc.navfac.navy.mil/lmr.

The FY23 project cycle is continuing. Our FY23 Pre-proposal Solicitation was published October 20, 2022 with pre-proposals due by December 5, 2022. LMR staff, the LMR Advisory Committee (LMRAC) and technical reviewers recently completed their reviews and made their recommendations. Final contract approvals are expected soon.

For the latest LMR publications, go to the Recent Publications section of this issue and for a spreadsheet listing all LMR-related publications, checkout the publications tab at our website.

Program Manager Anu Kumar and Deputy Program Manager Mandy Shoemaker.

This issue's Project Spotlight is on a recently completed project under Investment Area 1: Data to Support Risk Threshold Criteria. See that section to read about the project, Hearing and Estimated Noise Impacts in Three Species of Auk: Implications for the Marbled Murrelet.

PROJECT STATUS UPDATES

Project 57: Demonstrating Suction-cup Tag Systems to Support Behavioral Response Studies (BRS)

Patrick Miller, PI

This 2022 new start got right to work, completing their 2022 pilot study trial in August 2022. The project goals are to demonstrate, maintain and iteratively improve the capabilities of existing state-of-the-art mixed-DTAG+ and integrated-DTAG systems. During the 26-day trial, the team only had eight good weather days. Nevertheless, the team was able to successfully deploy four tags on killer whales. Of these four tags, three remained attached until the scheduled release time. For the first time, video recordings were made alongside DTAG deployments using a dedicated video and data logger. These data will be valuable for novel documentation of feeding and social behavior. The team also conducted ship-to-ship GPS-goniometer tests that effectively characterized the distance at which the GPS signal could be detected by the goniometer (instrument used on the ship to pick up the GPS signal). If successful, the goniometer could help to improve DTAG tracking. These data, to be supplemented by more trials in 2023 and 2024, will contribute to continued development and improvements to the Mixed-DTAG+.

Killer whale.
NOAA

Project 38: Towards a Mysticete Audiogram Using Humpback Whales' Behavioral Response Thresholds

Rebecca Dunlop and Michael Noad, co-PIs

This project is using behavioral response experiments as a proxy for behavioral audiometry experiments to estimate hearing sensitivity in humpback whales. The team conducted fieldwork from September 11 to October 19, 2022. A total of 27 sound and six baseline trials (i.e., no source vessel in area) were successfully completed, more than twice the 15 trials completed in 2021. Frequencies tested in 2022 included 250Hz (sweeping up to 315Hz), 1 kHz (sweeping up to 1.25 kHz), 4 kHz (to 5 kHz) and 16 kHz (to 20 kHz). During five of the trials, Acousounde (sound recording) tags were deployed, with four successfully recording data (i.e., one failed to record). Analysis is ongoing and there is

Humpback whale.
Wayne Hoggard, NOAA

one final field effort planned for 2023, but this project is making great strides in understanding mysticete hearing.

PROGRAM PARTICIPANT UPDATES

LMR and EXWC Help a Federal Partner

LMR facilitated the successful recovery of a lost buoy owned by National Atmospheric and Oceanographic Administration (NOAA). The NOAA buoy was deployed in 2015 as part of an underwater noise monitoring program, the Ocean Noise Reference Station Network, that measures changes in ambient ocean noise over long periods of time. The hydrophone-equipped buoy was designed to be moored underwater and record for two years. When NOAA tried to recover the buoy in 2017, the acoustic release system failed and it appeared that the buoy and its data were lost.

During an unrelated meeting, LMR's program managers, Anu Kumar and Mandy Shoemaker, and Jason Gedamke from NOAA's National Marine Fisheries Service (NMFS) realized that the Naval Facilities Engineering Command Expeditionary Warfare Center's (EXWC) ship, the MV *Independence*, might be an option to help recover the buoy. The *Independence* and its crew had helped LMR recover acoustic monitoring buoys in 2018. LMR asked EXWC managers if the *Independence*
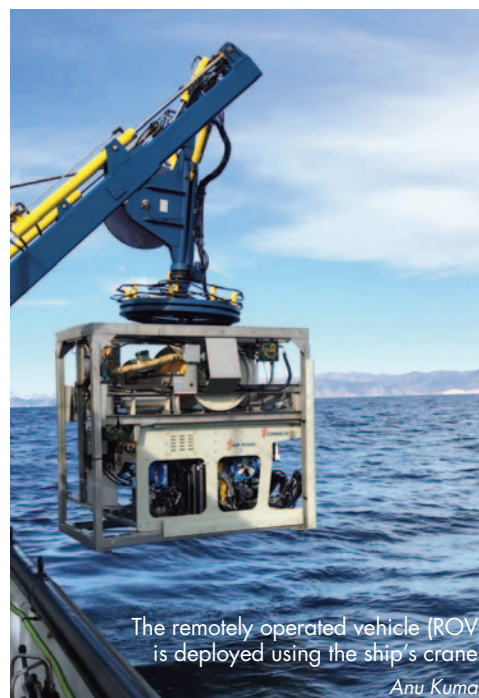
The remotely operated vehicle (ROV) is deployed using the ship's crane.
Anu Kumar

could help this new need, and they agreed to assist in the recovery. In December 2022, LMR's Kumar and Lauren Roche, a marine technician from NOAA's Pacific Marine Environmental Laboratory (PMEL) and Oregon State University's (OSU) Cooperative Institute for Marine Ecosystem and Resources Studies (CIMERS) in Newport, Oregon, set out with the crew of the *Independence.*

Working with GPS coordinates from the buoy deployment, the ship's crew located the buoy 2,500 feet below sea level near the Channel Islands in Southern California. After trying again to signal the buoy without success, the crew deployed a camera equipped ROV (remotely operated vehicle) to the buoy's location and released its mooring line. When the buoy surfaced, the crew used the ship's robust A-frame arm to successfully bring the 3-foot diameter buoy aboard the ship.

The buoy and its data are being analyzed by NMFS and PMEL to understand why the release failed and if the data are still intact. If recoverable, the acoustic data recorded on this buoy will contribute important information about the historical changes in background ocean noise. This helps us to evaluate how changes in human activity can affect overall ambient ocean noise, information that is valuable for both NOAA and the Navy. For more on NOAA's project, see https://www.pmel.noaa.gov/acoustics/noaanps-ocean-noise-reference-station-network.

The buoy emerging from the ocean.
Anu Kumar

This is great example of the Navy helping our partner agency NOAA in supporting an underwater monitoring program of mutual interest and benefit.

Anu Kumar goes to Washington

Anu Kumar traveled to Washington, D.C. in January to provide the annual brief to the LMR resource sponsor, OPNAV N4, and NAVFAC headquarters. Kumar introduced the program and its role within the Navy to OPNAV's new leaders, Rear Admiral Marc Lederer, Reserve Deputy, Chief of Naval Operations for Fleet Readiness and Logistics, N4R and Mark Sinder, Director of Operations N4I.

In addition to informing those who are new to the program, this annual briefing offers a direct opportunity to delve into program details, answer questions about funding and plans and prepare for upcoming funding cycles.

LMR PROJECT SPOTLIGHT

Wondering about some of the LMR-supported projects? This section provides a brief overview of one or more projects underway in the LMR program.

For this issue we present an overview of a recently completed project under Investment Area 1: Data to Support Risk Threshold Criteria.

Hearing and Estimated Noise Impacts in Three Species of Auk: Implications for the Marbled Murrelet

This recently completed project is providing previously unavailable data on hearing sensitivity in three related Auk species: common murres, puffins and marbled murrelets.

Navy training and testing activities can occur in areas that overlap with the natural habitat of the marbled murrelet (*Brachyramphus marmoratus*), a member of the Auk family that is listed as threatened under the Endangered Species Act in Washington, Oregon and California. It also is state-listed as endangered in California and as threatened in Oregon and Washington. Navy training and testing activities that produce sound both in-air and underwater have the potential to affect marbled murrelets. Potential effects from sound might include temporary and permanent hearing threshold shifts as well as behavioral effects.

At the time this project was funded in 2016, there were no basic data on the hearing capabilities of marbled murrelets or any other Auk species, which limited what was known about the frequencies or sound levels that would induce effects. The project team, working in Iceland, Denmark and Alaska, pursued multiple methods to test Auk hearing. The project was led by Aran Mooney (head of Woods Hole Oceanographic Institution's Sensory Ecology and Bioacoustics Laboratory)

Marbled murrelet.

and supported by key contributors Marianne Rasmussen (University of Iceland) and Magnus Wahlberg, Adam Smith and Kirsten Hansen (University of Southern Denmark).

Over the course of the project, researchers conducted both auditory evoked potential (AEP) methods and behavioral audiometric methods. Data collection efforts included in-air AEP tests, in-air behavioral audiometry tests and underwater behavioral audiometry tests. These tests allowed researchers to compare AEP and behavioral audiometric methods and to compare in-air and underwater measurements. In addition to AEP and behavioral audiometry testing, the team also completed micro computed tomography (micro-CT) scans to define anatomical differences and similarities among the species.

Marbled murrelet.

Between 2017 and 2021, the team successfully completed field-collected in-air AEPs on puffins and common murres in northwestern Iceland and marbled murrelets in Alaska (where the murrelets are not listed as endangered). These experiments followed the same AEP collection method on all three species, which supports audiogram comparisons among the three. The murre and murrelet audiograms are quite similar in terms of their overall sensitivity whereas the puffin is consistently more sensitive by about 10 dB across the majority of the auditory bandwidth.

The project also conducted behavioral hearing tests, both in-air and underwater, with common murres. With significant effort and persistence, the team trained birds for sound-sensitivity tests. They collected underwater behavioral hearing data, revealing that these birds do hear underwater, which previously was unknown. Through hundreds of in-air and underwater behavioral audiogram testing sessions of the trained common murres, the team worked to resolve the behavioral responses and evaluate their sound-sensitivity and perception. The common murres showed sensitive in-air hearing, supporting the field-based physiological tests. Underwater, the animals had difficulty with the conditioned underwater tasks, particularly at lower sound levels, implying that while sound sensitive, they may not readily utilize underwater acoustic cues.

Micro-CT scanning and anatomical modeling efforts have helped to provide initial measures of the auditory structures and comparative analyses. These assessments suggest that hearing anatomy may have some small adaptations for deep diving but the structures are largely similar across Auks, underscoring the ability to compare these data.

The project has provided new approaches for studying Auk hearing and new data to support refining acoustic criteria for the marbled murrelet. In addition to audiograms for murres, puffins and marbled murrelets, the project has provided new methods for conducting AEPs on wild birds in the field as well as insights on conducting behavioral testing of seabird hearing. Project methods and results are being shared through peer-reviewed manuscripts and presentations, with four published, one in press, one in review and several more in progress. (See sidebar for citations.)

These results will allow the Navy to improve the assessment of potential effects of training and testing activities on Auk species, including marbled murrelets, and will contribute to more realistic mitigation zones.

PROJECT PUBLICATIONS

Smith, A.B., Kissling, M., Capuano, A.M., Lewis, S.B. and Mooney, T.A. (In press). Aerial hearing thresholds and ecoacoustics of a threatened pursuit-diving seabird, the marbled murrelet (*Brachyramphus marmoratus*). *Endangered Species Research*.

Mooney, T.A., Smith, A., Larsen, O.N., Hansen, K.A., Wahlberg, M. and Rasmussen, M.H. (2019). Field-based hearing measurements of two seabird species. *Journal of Experimental Biology*, 222(4):jeb190710. DOI 10.1242/jeb.190710.

Mooney, T.A., Smith, A., Hansen, K.A., Larsen, O.N., Wahlberg, M. and Rasmussen, M. (2019). Birds of a feather: Hearing and potential noise impacts in puffins (*Fratercula arctica*). *Proceedings of Meetings on Acoustics*, 37(1):010004. DOI 10.1121/2.0001037.

Hansen, K.A., Hernandez, A., Mooney, T.A., Rasmussen, M., Sørensen, K. and Wahlberg, M. (2020). Common murres (*Uria aalge*) react to underwater noise. *Journal of the Acoustical Society of America*, 147:4069-4074. DOI 10.1121/10.0001400.

Mooney, T.A., Smith, A.B., Larsen, O.N., Hansen, K.A., Rasmussen, M. (2020). A field study of auditory sensitivity in the Atlantic puffin, *Fratercula arctica. Journal of Experimental Biology*, 223(15): jeb228270. DOI: 10.1242/jeb.228270.

IN-PROGRESS REVIEW

Our annual In-progress Review (IPR), held during the week of November 14–17, 2022, was a successful and information-packed event. With the COVID pandemic still in the air, we opted for a hybrid in-person and online meeting again this year. The strong in-person attendance, with 50 participants in Ventura, California, contributed to great discussions and information exchange. An additional 16 people attended online. Thanks to great technical support from Luners Production Services, the hybrid approach was again smooth and inclusive for all attendees.

Principal investigators (PI) presented project updates on 29 projects, including eight of our new FY22 projects and 18 ongoing projects. PIs from three projects that are now completed provided their final briefs:

- **Aran Mooney**

  Project 22—Hearing and Estimated Noise Impacts in Three Species of Auk: Implications for the Marbled Murrelet

- **Greg Schorr and Stephanie Watwood**

  Project 23—Cuvier's Beaked Whale and Fin Whale Behavior During Military Sonar Operations: Using Medium-Term Tag Technology to Develop Empirical Risk Functions

  Project 30—Measuring the Effect of Range on the Behavioral Response of Marine Mammals Through the Use of Navy Sonar

All three projects, falling within Investment Area 1 Data to Support Risk Threshold Criteria, have produced valuable data and analyses for Navy environmental compliance efforts. See this issue's Project Spotlight section for an overview of Project 22.

The IPR continues to offer valuable opportunities for discussions among PIs, LMRAC members and program managers, which support any needed course corrections and provide useful input to the projects. The 2023 IPR is scheduled for November 13–17, 2023.

RECENT PUBLICATIONS

This section includes recent publications and reports resulting from projects that are or have been partially or fully funded by the LMR program. The information provided in the publications is of significant value to the Navy's at-sea environmental compliance process and directly feeds into the National Environmental Policy Act, Marine Mammal Protection Act and Endangered Species Act compliance documentation.

And as a reminder, the full and updated publication spreadsheet, which includes these entries, is available on our website.

Fregosi, S., Harris, D.V., Matsumoto, H., Mellinger, D.K., Martin, S.W., Matsuyama, B., Barlow, J. and Klinck, H. (2022). Detection probability and density estimation of fin whales by a Seaglider, *The Journal of the Acoustical Society of America*,152(4):2277. DOI 10.1121/10.0014793.

Houser, D.S., Noble, L., Fougeres, E., Mulsow, J. and Finneran, J.J. (2022). Audiograms and click spectra of seven novel and seldom-tested odontocetes. *Frontiers in Marine Science*, 9:984333. DOI 10.3389/fmars.2022.984333.

Jenkins, A.K., Dahl, P.H., Kotecki, S., Bowman, V., Casper, B., Boerger, C. and Popper, A.N. (2022). Physical effects of sound exposure from underwater explosions on Pacific mackerel (*Scomber japonicus*): Effects on non-auditory tissues. *The Journal of the Acoustical Society of America*, 151(6):3947. DOI 10.1121/10.0011587.

Smith, M.E., Accomando, A.W., Bowman, V., Casper, B.M., Dahl, P.H., Jenkins, A.K., Kotecki, S. and Popper, A.N. (2022). Physical effects of sound exposure from underwater explosions on Pacific mackerel (*Scomber japonicus*): Effects on the inner ear. *The Journal of the Acoustical Society of America*, 152(2):733. DOI 10.1121/10.0012991.

Mackerel.

Note that the following two publications from 2018 and 2019, which were not previously listed in the spreadsheet, have been added to the LMR Publications spreadsheet:

American National Standards Institute (ANSI) (2018). Procedure for determining audiograms in toothed whales through evoked potential methods.

Houser, D. (2019). Establishment of ANSI/ASA S3/SC1.6—Standardization of evoked potential hearing test methods in toothed whales. *The Journal of the Acoustical Society of America*, 146(4):2935. DOI 10.1121/1.5137192.

PROGRAM SCHEDULE

No.	What	When
1.	**Proposal Solicitation & Review**	
a.	FY24 Needs Submission Deadline	June 2, 2023
b.	FY24 Needs Approval	August 2023
c.	FY24 Pre-proposal Solicitation Announcement	September 2023
2.	**Quarterly Status Reports (QSR)**	
a.	Submit spring QSR	April 28, 2023 (effort from January–March)
b.	Submit summer QSR	July 31, 2023 (effort from April–June)
c.	Submit fall QSR	October 31, 2023 (effort from July–September)
d.	Submit winter QSR	January 31, 2024 (effort from October–December)
3.	**In-progress Review**	November 13–17, 2023

OUR WEBSITE

At our website—exwc.navfac.navy.mil/lmr—you can find links to all our informational materials, including fact sheets, an updated publication spreadsheet and our 2021 annual report.

LMR-RELATED PHOTOS—KEEP THEM COMING

We encourage all LMR participants to share photos of marine mammals, survey efforts, personnel who were involved and the equipment used. We'd like to include some of those images in a future issue of the *LMR News* and give you credit—right there with your photo.

Surely among all of those photos from field work you have a few that you're particularly proud of. Please send them along, accompanied by a caption, photo credit and permit number (as applicable) and be sure that the photos are in high resolution format. Who knows, you may see one of those photos in a future issue of the LMR newsletter. Submit your photos via email to: exwc_lmr_program@navy.mil.

Hawaiian monk seals.
Morgan W. Richie, permit 14451

HELP WITH OUR MAILING LIST

If you want to subscribe to, or unsubscribe from, *LMR News*, please send your email address to Eric Rasmussen at eric.rasmussen@navy.mil.

CONTACT THE LMR PROGRAM

For more information about the LMR program and its operations, contact Anu Kumar, Program Manager, at exwc_lmr_program@navy.mil and 805-982-4853.

IN THE NEXT ISSUE OF *LMR NEWS*

Our next issue will provide available information on the FY23 project selection, updates on ongoing projects and notes from upcoming meetings,

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LMR INVESTMENT AREAS

The LMR program focuses its research funding in five investment areas:

1. Data to Support Risk Threshold Criteria

Collect data to improve the Navy's acoustic and explosive impact assessments and validate mitigation requirements, information critical to the Navy's environmental compliance and permitting process. This includes data on how well animals can hear, how and when animals may be exposed to acoustic and explosive sources, and how animals respond or are affected when exposed. Projects in this area can include hearing studies, sound exposure and behavioral response studies.

2. Data Analysis and Processing Tools

Make required monitoring program data processing and analysis more efficient and cost-effective. This includes developing tools to automate the processing of large amounts of data to reduce costs, increase efficiency and provide consistency. These tools support the Navy's environmental compliance process and permitting process. Projects in this area can include new detection and classification algorithms, improvements to software programs, or development of novel analytical methods.

3. Monitoring Technology Demonstrations

Continue to develop and demonstrate technologies that can improve field data collection methods. The technologies enable efficient and cost-effective implementation of the Navy's Marine Species Monitoring program. Examples include new monitoring technologies and platforms, including sensors, tags, moored devices, buoys, gliders and REMUS 600s.

4. Standards and Metrics

Work to establish interagency and scientific community standards and metrics for data collection, management and analysis. This promotes data comparability and enables data aggregation from different data sets. It ensures consistent, agreed-upon standards and metrics in order to provide cost-effective improvements to data and results that can be incorporated into the environmental compliance process. Projects in this area can include standards for data collection methods, standardized data management tools, and new metrics for reporting performance of data analysis methods.

5. Emergent Topics

This investment area is reserved for other priority topics needed by the Navy that may come up and do not fall within the preceding topics.