

LMR news

ISSUE 34

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.



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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 Installations (OPNAV N4I) and managed by the Naval Facilities 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 preserves 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

The time since our last issue of *LMR News* has been packed with project field work, our annual In-progress Review (IPR) and the Navy Needs review and selection. In addition, we are particularly glad to share that our Fiscal Year 2024 (FY24) pre-proposal solicitation was posted on December 5, 2023. The pre-proposal solicitation details are posted on the LMR website (exwc.navfac.navy.mil/lmr) under the Proposals tab. It is soliciting pre-proposals on two FY24 needs:

- Need Topic LMR-N-0291-24: Pinniped Behavioral Response Study
- Need Topic LMR-N-0292-24: Improvement of Sea Turtle Density Estimates.

Pre-proposal submissions are due no later than 11:59 pm, Pacific Standard Time on January 18, 2024.

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

This issue's Project Spotlight is on two recently completed projects. See that section to read about the projects.



Program Manager Anu Kumar and Deputy Program Manager Mandy Shoemaker.

IN-PROGRESS REVIEW

Santa Barbara, California was the setting for our 2023 In-progress Review (IPR). It was one of our best and most attended meetings yet. This year included almost 30 project presentations, of which nine were final project close-out presentations in three investment areas:

Investment Area 1: Data to Support Risk Threshold Criteria

1. Project 61—Auditory Masking in Odobenid and Otariid Carnivores
2. Project 55—Dolphin Conditioned Hearing Attenuation
3. Project 40—Temporary Threshold Shifts in Underwater Hearing Sensitivity in Freshwater and Marine Turtles
4. Project 26—Effects of Underwater Explosions on Fish

Investment Area 2: Improved Collection and Processing of Protected Species Data in Areas of Navy Interest

1. Project 44—Demonstration and Validation of Passive Acoustic Density Estimation for Right Whales
2. Project 58—Bryde's Whale Cue Rate/Kinematics
3. Project 43—MSM4PCoD: Marine Species Monitoring for the Population Consequences of Disturbance



Investment Area 5: Emergent Topics

1. Project 35—Multi-spaced Measurement of Underwater Sound Field from Explosive Sources
2. Project 48—Collection of *in situ* Acoustic Data for Validation of Navy Propagation Models of Ship Shock Trial Sound Sources

The relatively high number of final presentations, compared to three in 2022, reflected two years of COVID-caused delays. Results of these projects are now available to support Navy environmental monitoring and compliance efforts.

We had 55 participants during the week and many lively conversations, during both the formal sessions and social interactions. Members of the LMR advisory committee (LMRAC) dedicated themselves to discussion and important questions around current and potential future projects. The conversations and discussions among LMRAC members and between LMRAC members and project principal investigators throughout the meetings make for better projects outcomes and ensure strong information flow among the many Navy organizations and commands that LMR works to support.

Thanks to all for a great and productive meeting.

PROGRAM PARTICIPANT UPDATES

U.S. Geological Survey Capabilities

One of our former LMRAC members, Danielle Kitchen, was able to join us for this year's IPR to provide valuable information exchange. Danielle is now the Branch Chief for the U.S. Geological Survey's Wildlife, Imperiled, and Invasive Species branch within the Wetlands and Aquatic Research Center (WARC). The U.S. Geological Survey (USGS) has a unique role within the Department of Interior as a research-focused, rather than regulatory, agency. In addition to ensuring that her LMR knowledge was fully shared with us, she briefed committee and program members on USGS and WARC efforts that are potentially relevant to LMR and the Navy. Examples include sea turtle monitoring and genetic tracking, identifying threatened species in coastal areas and using environmental DNA in monitoring.

Vandenberg Space Force Base Tour: Navy and Space Force Share Environmental Insights

A site visit to Vandenberg Space Force Base following the LMR IPR provided valuable information exchange between Navy and Space Force environmental staff. A small LMR group, including LMR's program managers and three LMRAC members, participated in the tour.

Vandenberg's Natural Resources Manager, Rhys Evans, and LMRAC member Laura Busch are former colleagues and organized the tour. Evans and his team shared an overview of the species and habitats found on Vandenberg's 100,000 acres and 42 miles of coastline. Vandenberg is a location for U.S. government and commercial space rocket launches, including SpaceX Starlink launches.

Evans and team members Jessica, Zia and Katie escorted the group to two study sites. First was an overwintering area for Monarch butterflies. There are 34 identified locations on the facility, with two more being assessed. A graduate student is collecting data in one area to evaluate how temperature, wind speed and wind direction might influence clustering of these butterflies. Results could help the resource managers understand ways to protect the overwintering habitats.

The second location overlooked a beach with pinnipeds, including elephant and harbor seals. The elephant seal population can include individuals from other areas along the California coast and the Channel Islands. The monitoring team looks for flipper tags, with different colors representing different locations where the seals have been tagged. This allows the team to understand more about how the individuals use the local haul-out locations. One location can be San Nicolas Island, a Navy property where the Navy monitors seal and otter populations. LMRAC member Elizabeth Seacord, from the Point Mugu Sea Range Sustainability Office, was on the tour and provided insights into that installation's monitoring efforts. The pinnipeds on San Nicolas Island and on Vandenberg's coastline may have common intermittent acoustic exposures from missile and rocket launches. The teams discussed options for future cooperative monitoring of the species.

With many overlapping permitting responsibilities, from the Marine Mammal Protection Act to the Endangered Species Act and National Environmental Protection Act, these resource managers found significant common ground and shared new ideas for meeting the requirements. The participants saw potential opportunities for collaboration.



Well-camouflaged elephant and harbor seals hauled out on a protected beach.

Cordelia Shea

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.

PROJECT STATUS UPDATES

Three project teams conducted field efforts during Fall 2023.

Project 38—Towards a Mysticete Audiogram Using Humpback Whales Masked Behavioral Response Thresholds

This project is using behavioral response methods to test the hearing sensitivities of migrating humpback whales (*Megaptera novaeangliae*). These behavioral response experiments are designed as a proxy for audiometric measurements to estimate hearing sensitivity in baleen whales.

Principal investigators (PI) Rebecca Dunlop and Michael Noad, from the University of Queensland in Australia, completed their third field effort in October 2023. They successfully conducted 30 experimental and eight control trials and deployed six acoustic recording tags.



Humpback whales.
NOAA

Whale behavior was tracked by land observers, selected on-water focal follows and tag data. This season brought their total data collection over three seasons to 82 experimental trials, ten baseline trials and 12 tags deployed (11 recorded). The combined experimental and tag exposures in 2023 included several frequencies: 63 Hz, 250 Hz, 4 kHz, 16 kHz and 22 kHz. The data collected are being analyzed.

Project 41—Improved Tag Attachment System for Remotely-deployed Medium-term Cetacean Tags

This demonstration project is developing a new tag attachment element for the Low Impact Minimally Percutaneous External-electronics Transmitter (LIMPET) tag system. The new attachment mechanisms are designed to be more compatible with the animal's tissue and remain attached for longer periods. The prototypes are designed to work with the current suite of LIMPET tags and Sound and Motion Recording and Transmitting (SMRT) tags.

After addressing design issues identified during 2022 field tests, project PI Russ Andrews and his team returned to Hawaii in November 2023 for testing the improved designs. Persisting through several days of no animal

sightings, the team was able to deploy four tags with the prototype elastic anchors on short-finned pilot whales. The four tags remained attached and three of the four were transmitting over several days. While follow-up visual monitoring will continue as possible, the first photos of two tagged animals showed no issues at the implant sites. The next test effort is planned for January 2024 in southern California on fin, blue or beaked whales.



Short-finned pilot whale.
Suzanne E. Yin, permit 14451

Project 64–3S4–Effect of Continuous Active Sonar and Longer Duration Sonar Exposures in Killer Whales, Humpback Whales and Northern Bottlenose Whales

This multinational project, led by PIs Frans-Peter Lam (The Netherlands), Petter Kvadsheim (Norway) and Patrick Miller (United Kingdom), completed its 2023 field effort in November 2023. This was the first of two planned field efforts under Phase 4 of the 3S (Sea Mammals and Sonar Safety) project. (For more information on this recently funded project, see the Project 64 fact sheet under the Current Projects tab of the LMR website: <https://exwc.navfac.navy.mil/LMR/Current-Projects/>.)

The two primary objectives of this phase of the 3S project (3S4) are 1) to investigate if exposure to Continuous Active Sonar (CAS) leads to different types or severity of behavioral responses than exposure to traditional Pulsed Active Sonar (PAS) signals in killer whales, humpback whales and bottlenose whales, and 2) to investigate if responses from short duration experiments predict responses from longer duration exposures conducted over an operationally relevant duration.

Despite weather and sound source issues, the team concluded the effort with 22 tags deployed and four controlled exposures (two CAS and two PAS) on multiple animals, primarily killer whales and humpback whales. One type of tag used was the Mixed-DTAG++. This tag includes a DTAG core unit, a Fastlock GPS logger/transmitter, an ARGOS transmitter, a small video logger and a VHF-transmitter. The team also used a smaller number of LIMPET splash tags that included a Fastlock GPS transmitter, an ARGOS transmitter and a depth recorder. Data collected by team included behavioral responses (e.g., dives, vocalizations), context (e.g., feeding, prey mapping), social observations, environmental conditions and sonar signals.

Another field effort is planned in 2024.

Norwegian Animal Research Authority photo permit 23/110085 (acquired by Petter Kvadsheim)



Martijn van Riet



Jacqueline Bort



Rune Roland



George Sato



Alec Burslem



George Sato



George Sato

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 two recently completed projects.

Project 58—Bryde’s Whale Cue Rate/Kinematics

Investment Area 2: Improved Collection and Processing of Protected Species Data in Areas of Navy Interest

This project modified existing passive acoustic monitoring (PAM) tools, previously developed at Naval Information Warfare Center (NIWC) Pacific, to acoustically detect, localize, classify and track Bryde’s whales (*Balaenoptera brydei*) on the Pacific Missile Range Facility (PMRF). The results also are helping to determine animal cue rate (calling rate) and stability, necessary for acoustic density estimation.

The NIWC team—Tyler A. Helble, Regina Guazzo and Elizabeth E. Henderson—updated and applied detection/localization software code to long-term recordings (from 2011–2022) from Pacific Missile Range Facility (PMRF) to obtain 150 acoustically derived Bryde’s whale tracks. After manually validating tracks to include any missed calls and eliminate false localizations, they adapted existing code, including continuous-time random walk (CRAWL) model and Hidden Markov models (HMMs), to analyze Bryde’s whale cue rates and swimming behavior (kinematics).

The team identified seasonal and day/night (diel) patterns of movement and calls. Tracks were organized into three seasonal groups with most tracks falling within one season and showing a distinct directional heading. Bryde’s whale swam faster in the daytime and slower at night. Applying a labor-intensive process to analyze and manually add missed calls, the team was able to obtain accurate inter-click intervals (ICI) and call types. There is some indication that the median ICI is lengthening over time for Bryde’s whales. The results may offer insights into population groupings around Pacific regions and will contribute to cue rates needed for



Bryde’s whale.
Wayne Hoggard, NOAA

density estimation. A manuscript with details of the analyses and results, Swim Kinematics and Acoustic Calling Behavior Attributed to Bryde's whales in the Central North Pacific, is currently in review for publication in *Frontiers in Marine Science*.

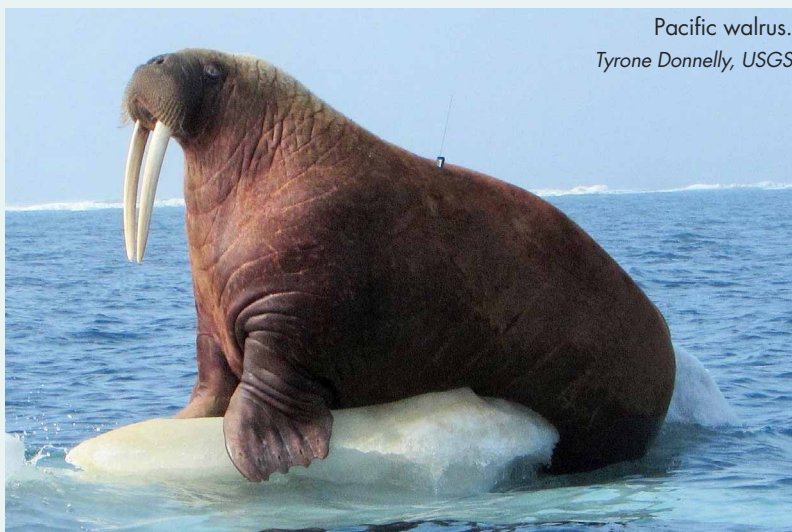
This research resulted in new acoustic capabilities and is the first to shed light on seasonal Bryde's whale movement in the central North Pacific. With little previous movement data, the swimming behavior of Bryde's whales is poorly understood, and this information could inform models such as ship-strike risk and sonar exposure models. The adapted and tested tools also expand the Navy's ability to automatically track and measure kinematics of key species on PMRF.

Project 61—Auditory Masking in Odobenid and Otariid Carnivores

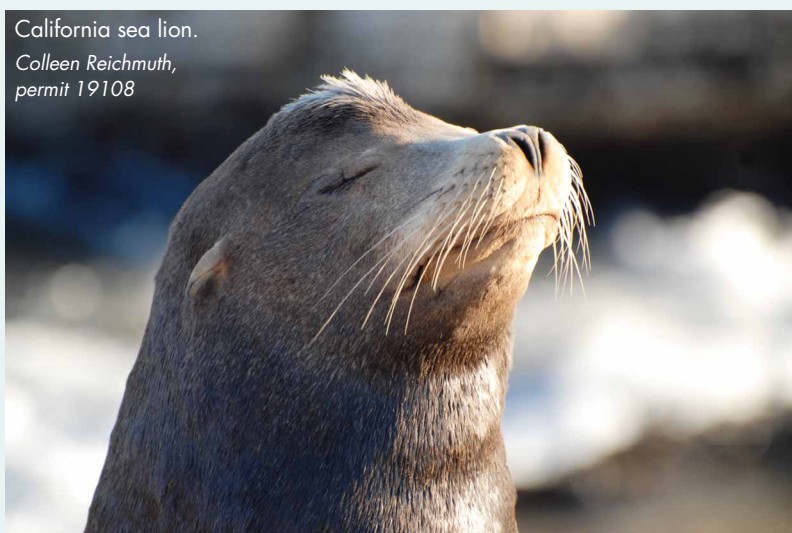
Investment Area 1: Data to Support Risk Threshold Criteria

This project produced auditory data for odobenid and otariid carnivores (walruses and sea lions, respectively) that will enable acoustic sensitivity comparisons between these marine mammal taxa and support environmental compliance efforts. The LMR program funding to this project supplemented an ongoing effort supported by the U.S. Fish and Wildlife Service in partnership with the U.S. Geological Survey to characterize auditory masking from simultaneous noise in the Pacific walrus (*Odobenus rosmarus divergens*). The added support from LMR enabled the project team to expand the study scope to include a California sea lion (*Zalophus californianus*) and collect additional comparative and validating data.

The project team from University of California Santa Cruz—including Colleen Reichmuth, Jillian Sills and graduate student Ryan Jones—worked with one California sea lion and two Pacific walruses.



Pacific walrus.
Tyrone Donnelly, USGS



California sea lion.
Colleen Reichmuth,
permit 19108

While the sea lion had previous experience in this type of work, the two walrus were trained for voluntary participation in this behavioral audiometric testing. Ambient hearing thresholds were collected in outdoor conditions; background noise was characterized in the testing environment to allow measured thresholds to be evaluated. Masked hearing thresholds were then collected in the presence of spectrally flattened, spatially mapped octave-band noise set at or above the sound pressure level of the ambient hearing threshold. Based on these measurements, auditory critical ratios were calculated for each frequency. These ratios were used to evaluate the ambient hearing measurements obtained in natural noise, to determine which threshold measurements were influenced by the surrounding environmental conditions. Importantly, the critical ratios measured in this study can be used to predict masking across a broad frequency range due to the presence of noise in both terrestrial and marine environments.

This project's results reveal that in terms of absolute hearing ability, walrus are more sensitive than sea lions at lower frequencies and less sensitive at higher frequencies. However, despite differences in their hearing profiles, odobenid and otariid carnivores are similarly able to detect signals in noisy conditions. This unusual method of estimating masking parameters in outdoor conditions—validated through testing of human and sea lion subjects—can be applied to species that cannot be tested in ideal conditions.

Study details and results are available in the following publication:

Jones, R., Sills, J. M., Synott, M., Mulsow, J. M., Williams, R. and Reichmuth, C. (2023). Auditory masking in odobenid and otariid carnivores. *Journal of the Acoustical Society of America* 154(3), 1746-1756. DOI 10.1121/10.0020911.

Sea lion Ronan.
Colleen Reichmuth



Pacific walrus Mitik.
Colleen Reichmuth, permit 23554

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 2022 annual report.

PROGRAM SCHEDULE

No.	What	When
1.	Proposal Solicitation & Review	
a.	FY24 Pre-proposal Solicitation Announcement	December 5, 2023
b.	FY24 Pre-proposals Due	January 18, 2024
2.	Quarterly Status Reports (QSR)	
a.	Submit winter QSR	January 31, 2024 (effort from October–December)
b.	Submit spring QSR	April 30, 2024 (effort from January–March)
c.	Submit summer QSR	July 31, 2024 (effort from April–June)
d.	Submit fall QSR	October 31, 2024 (effort from July–September)
3.	In-progress Review	December 2024

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.

Hansen, K.A., Mooney, T.A. and Wahlberg, M. (2023). Obtaining Underwater Hearing Data for the Common Murre (*Uria aalge*). In: Popper, A.N., Sisneros, J., Hawkins, A.D., Thomsen, F. (eds), *The Effects of Noise on Aquatic Life*. Springer, Cham. DOI 10.1007/978-3-031-10417-6_4-1.

Jones, R.A., Sills, J.M., Synnott, M., Mulsow, J., Williams, R. and Reichmuth, C. (2023). Auditory masking in odobenid and otariid carnivores. *The Journal of the Acoustical Society of America*, 154(3):1746-1756. DOI 10.1121/10.0020911.

Kastelein, R.A., Helder-Hoek, L., Van Acoleyen, L., Defillet, L.N., Huijser, L.A.E., and Terhune, J.M. (2023). Underwater sound detection thresholds (0.031-80 kHz) of two California sea lions (*Zalophus californianus*) and a revised generic audiogram for the species. *Aquatic Mammals*, 49(5):422-435, DOI 10.1578/AM.49.5.2023.422.

Marques, T.A., Marques, C.S. and Gkikopoulou, K.C. (2023). A sperm whale cautionary tale about estimating acoustic cue rates for deep divers. *The Journal of the Acoustical Society of America*, 154(3):1577-1584. DOI 10.1121/10.0020910.

Mulsow, J., Finneran, J.J., Strahan, M.G., Houser, D.S. and Burkard, R.G. (2023). Input compensation of dolphin and sea lion auditory brainstem responses using frequency-modulated up-chirps. *The Journal of the Acoustical Society of America*, 154(2):739-750. DOI 10.1121/10.0020566.

Ryder, M., Booth, C., Oedekoven, C., Marques, T., Joy, R. and Harris, D. (2023). Passive Acoustic Monitoring Power Analysis: A Tool for Designing an Acoustic Monitoring Program. In: Popper, A.N., Sisneros, J., Hawkins, A.D., Thomsen, F. (eds), *The Effects of Noise on Aquatic Life*. Springer, Cham. DOI 10.1007/978-3-031-10417-6_140-1.



Bottlenose dolphins.
Gary Barone, NOAA

Salas, A.K., Capuano, A.M., Harms, C.A., Piniak, W.E.D. and Mooney, T.A. (2023). Temporary noise-induced underwater hearing loss in an aquatic turtle (*Trachemys scripta elegans*). *The Journal of the Acoustical Society of America*, 154(2):1003-1017. DOI 10.1121/10.0020588.

Southall, B.L., Allen, A.N., Calambokidis, J., Casey, C., DeRuiter, S.L., Fregosi, S., Friedlaender, A.S., Goldbogen, J.A., Harris, C.M., Hazen, E.L., Popov, V. and Stimpert, A.K. (2023). Behavioural responses of fin whales to military mid-frequency active sonar. *Royal Society Open Science*, 10:231775. DOI 10.1098/rsos.231775.



Loggerhead sea turtle.
GP Schmahl, NOAA

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

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If you want to subscribe to, or unsubscribe from, *LMR News*, please send your email address to Eric Rasmussen at eric.w.rasmussen6.civ@us.navy.mil.

CONTACT THE LMR PROGRAM

Note that we have had a slight change in our program email address. It now includes 'us.' before navy.mil. For more information about the LMR program and its operations, please use this new format to contact Anu Kumar, Program Manager, at EXWC_LMR_program@us.navy.mil and 805-982-4853.

IN THE NEXT ISSUE OF *LMR NEWS*

Our next issue will provide available information on field efforts planned for January, new projects, publications and project updates, as well as the status of FY24 pre-proposal reviews.

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