

LMR news

WINTER 2021

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.



INSIDE THIS ISSUE

Program Office Insights	2	Recent Publications	7
Program Participant Updates	3	In-progress Review	8
LMR Project Spotlight	4	Program Schedule	9

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 Energy and Environmental Readiness Division (OPNAV N45) 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

Activities during this past quarter included successfully holding our 2020 In-progress Review (IPR) online (see more in a following section) and completing pre-proposal reviews for Fiscal Year 2021 (FY21) funding, which were completed in late February. Our annual programmatic review with our program sponsor (OPNAV N45), held in February, offered valuable insights and suggestions that will help to guide our work in the upcoming year.

On the budget front, COVID and financial management system overhauls required quite a bit of extra management attention. With particularly careful planning and frequent communication with program participants, we came quite close to meeting expenditure benchmarks. Unfortunately, in the end some factors outside our control meant that we fell just short of the mark, reaching 51 percent rather than the 55 percent goal. It is a testament to our project teams that we were able to get this close to our goal. With COVID restrictions still looming into FY21, program participants will need to continue to remain vigilant to ensure we meet our expenditure goals this year.

Project PIs are continuing to get their results published. As we are notified of new publications, we add them to our *LMR News* "Recent Publications" section (see page 7). In addition, we update our LMR Publications spreadsheet on our website in concert with posting the newsletter.

We also have an update on item from our Fall-20 newsletter concerning a project under the Small Business Innovation Research (SBIR) program. The three Phase I performers studying the feasibility of the topic *Unmanned Underwater Vehicle (UUV) Technology to Enable Readiness of Navy Ranges* concluded their efforts and submitted their



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Program Manager



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Deputy Program Manager

final reports and proposals for Phase II. Based on the scientific or technical merits reported and proposals submitted, Triton Systems was selected to move ahead with Phase II, the research, development and demonstration phase. This work is anticipated to begin in June 2021 and will last for 12 months.

This quarter's Project Spotlight summarizes the project *Temporary Threshold Shifts in Underwater Hearing Sensitivity in Freshwater and Marine Turtles*.

To wrap up this section, note that an exciting find by a Navy-funded marine mammal monitoring team is summarized in the "Program Participants Updates" section below. It appears that team may have discovered a new beaked whale species.

PROGRAM PARTICIPANT UPDATES

A new beaked whale species? Navy research teams conducting environmental compliance monitoring of Navy training ranges off Southern California (SOCAL) had detected unexpected whale vocalizations, which they thought might be from rare Perrin's beaked whales. The Naval Sea Systems Command (NAVSEA) Monitoring Program then funded its researchers to join in a collaborative expedition with Mexico's National Commission of Natural Protected Areas and other U.S. scientific organizations to document if the animal being heard in SOCAL was the same species that had been heard in Baja. Several members of the NAVSEA-funded team also work on LMR projects.

While underway off Baja, Mexico, the researchers picked up acoustic signals of unique vocalizations unlike any other beaked

whales documented to date. While similar to a previously identified Perrin's beaked whale, the vocalizations have distinct variations. Additionally, three animals sighted were unlike other previously photographed or documented beaked whales. Researchers were able to collect environmental DNA (eDNA) samples from the water, which currently are being analyzed, to help confirm if a new species has been found.

For more, see NAVSEA's article at www.navy.mil/Press-Office/News-Stories/Article/2443773/navy-funded-research-team-may-have-discovered-new-whale-species/.



A potentially new beaked whale species off the coast of Baja, Mexico.

Elizabeth Henderson

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 project under Investment Area 1: Data to Support Risk Threshold Criteria.

Temporary Threshold Shifts in Underwater Hearing Sensitivity in Freshwater and Marine Turtles

The Navy, National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NOAA Fisheries) and other federal agencies require quantitative thresholds to examine the potential impacts of underwater sound on protected species' hearing, including sea turtles. Although basic underwater hearing sensitivity data are available for some sea turtle species, data on how susceptible sea turtles are to noise-induced hearing loss (threshold shifts) is lacking.

Because of their protected status under the Endangered Species Act (ESA), it is necessary to first determine the feasibility of generating auditory temporary threshold shift (TTS) in closely related surrogate turtle species.

This project, co-funded by the Navy LMR program and NOAA Fisheries, is examining and testing methods for measuring TTS in non-ESA listed freshwater turtle species.

If feasible, steps to obtain TTS information for an ESA-listed sea turtle may be undertaken in follow-on research efforts. The project team is working to identify the cumulative sound exposure levels and durations that can induce TTS. The work also will include examining turtle ear anatomy to support physiological comparisons between freshwater and marine turtle hearing apparatus. Results can help identify potential TTS susceptibility of sea turtles based on freshwater turtle data, providing researchers, managers and stakeholders critical data to improve estimates of acoustic effects to both freshwater and sea turtles. These data could also help to inform the development of appropriate mitigation measures to reduce potential effects to sea turtles from low-frequency anthropogenic sound.



Loggerhead sea turtle.

The project's lead investigators are Aran Mooney of Woods Hole Oceanographic Institution and Wendy Dow Piniak of NOAA Fisheries' Office of Protected Resources. Applying their complementary areas of expertise in marine animal and sea turtle hearing and behavior, they have defined testing methodologies and target species. Initial underwater hearing measurements and TTS assessments will be conducted with two freshwater turtle species—the eastern painted turtle (*Chrysemys picta picta*) and red-eared slider (*Trachemys scripta elegans*).

The project will use physiological auditory evoked potential (AEP) methodology. AEPs are small voltages that the brain and auditory nervous system generate in response to detected sounds. Recording and measuring AEPs to determine hearing sensitivity has been common practice in human and terrestrial animal research for decades. Testing two species will increase sample sizes, which will support both developing robust TTS measurement methods and identifying if there are methodological challenges/differences between the species. Additionally, comparing TTS onset in the two surrogate taxa will help to identify potential TTS variability between turtle species.

The team will first measure baseline hearing sensitivity by recording AEPs. They will measure the hearing thresholds at a variety of frequencies between 50 and 5,000 Hz (with additional frequencies added as needed). This method is well-established and encompasses the full anticipated range of turtle hearing. At each frequency, sound levels will be decreased until AEP responses can no longer be detected (threshold).

Sound exposure trials will then be conducted to explore duration and sound pressure levels required to induce TTS onset and develop a TTS onset predictive curve. The trials will expose turtles to broadband white noise that spans their auditory frequency range and is likely to cause TTS. Eastern painted turtles and red-eared sliders are anticipated to detect acoustic signals between 30 and 5,000 Hz with maximum sensitivity <1,000 Hz. To determine the onset of TTS, fatiguing noise sound pressure levels will start at 140 dB and increase as needed up to 160–170 dB sound pressure level (SPL), after which durations will be increased to increase overall sound exposure level (SEL).



Eastern painted turtle.
Greg Schechter,
Wikimedia Commons

A third component of the project is to compare the auditory anatomy of control animals and those exposed to sound to identify potential short and long-term anatomical effects of TTS. Auditory hair-cell damage and loss in some marine taxa have served as indicators of sound exposure and these indicators could apply to turtles. Defined methods for assessing hair cell damage could be applied when evaluating hearing in other turtle species in the future.

Based on the results of these efforts, the team will explore dose-dependent effects to begin to create a noise-based, dose-dependent model of TTS. This will allow regulators and data users to predict the sound levels and durations that may produce TTS onset in turtle species. Project products also will outline the methods likely needed to examine TTS in sea turtles, if feasible.



Green sea turtle.
Nick Zachar, NOAA

Although restrictions due to the COVID pandemic delayed initial permits and securing turtles, the team has been working to make up time. Barring any additional delays, the team plans to complete all initial AEP, TTS and anatomy measurements and produce reports by the middle of 2022.

This research will produce underwater audiograms and underwater TTS onset data for two species of freshwater turtles. The project will also provide protocols that will contribute to investigations of noise-induced hearing loss in other turtle species, including sea turtles. Ultimately, these data may help to inform the next phase of TTS criteria development.

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 Winter-21 publication spreadsheet, which includes these entries, is available on our website.

Bouchet, P.J., David L. Miller, D.L., Roberts, J.J., Mannocci, L., Harris, C.M., and Thomas, L. (2020). dsmextra: Extrapolation assessment tools for density surface models. *Methods in Ecology and Evolution*: 11(11), 1464-1469. DOI 10.1111/2041-210X.13469.

Finneran, J.J., Mulsow, J., Strahan, M.G., Houser, D.S., and Burkard, R.F. (2020). Role of the temporal window in dolphin auditory brainstem response onset. *The Journal of the Acoustical Society of America*, 148(5): 3360-3371. DOI 10.1121/10.0002703.

Helble, T.A., Guazzo, R.A., Alongi, G.C., Martin, C.R., Martin, S.W. and Henderson, E.E. (2020). Fin Whale Song Patterns Shift Over Time in the Central North Pacific. *Frontiers in Marine Science*, 7:587110. DOI 10.3389/fmars.2020.587110. (Used analytical tools developed with LMR funding.)

Kastelein, R.A., Helder-Hoek, L., Cornelisse, S.A., Defillet, L. N., Huijser, L.A.E., and Terhune, J.M. (2020). Temporary hearing threshold shift in harbor seals (*Phoca vitulina*) due to one-sixth-octave noise bands centered at 0.5, 1, and 2 kHz. *The Journal of the Acoustical Society of America*: 148 (6), 3873-3885. DOI 10.1121/10.0002781.

Sills, J.M., Parnell, K., Ruscher, B., Lew, C., Kendall, T.L. and Reichmuth, C. (2021). Underwater hearing and communication in the endangered Hawaiian monk seal *Neomonachus schauinslandi*. *Endangered Species Research*, 44:61-78. DOI 10.3354/esr01092.



Hawaiian monk seal.

IN-PROGRESS REVIEW

The 2020 In-progress Review (IPR), the sixth of the LMR's annual event, was held online this time around due to COVID protocols around the world. Holding the three-day meeting online did pose some new logistical challenges, particularly scheduling seventeen project briefs from 19 presenters in seven different time zones spanning 20 hours (that translates to a 6:00 p.m. presentation in The Netherlands starting at 7:00 a.m. in Hawaii and 3:00 a.m. the next day in Australia). But as we have seen so many times with the LMR family, the project PIs, LMR Advisory Committee (LMRAC) members and staff all helped to make it work. Thank you to all of you who kept some weird working hours and were creative in finding reliable internet connections in order to join us during that week.

The seventeen presentations included two final briefs and one new start project, as noted below.



California sea lions
Claire Fackler, NOAA

Final Brief—Project 17

Blue and Fin Whale Density Estimation in the Southern California Offshore Range Using PAM Data

Ana Širović, from Texas A&M University at Galveston, provided her final brief on this project, which focused on developing methods for spatially and temporally explicit density estimates for blue and fin whales in Southern California (SCORE) range to provide the Navy with a realistic, quantitative assessment of levels of impact. Efforts included applying monitoring tags to blue and fin whales within SCORE to collect whale vocalization data for modeling density estimates. A number of variables can influence the type and frequency of vocalizations (cue rate), including month, location, time-of-day and dive behavior. The project has added significant acoustic data on blue and fin whales calls and developed a new blue and fin whale social call detector-classifier and contributed valuable data for cue rate modeling.

Final Brief—Project 33

TTS in Harbor Seals Due to Fatiguing Sound of Several Frequencies

Ron Kastelein, SEAMARCO, reviewed results in his final brief on this project. The project focused on measuring TTS and hearing recovery in harbor seals (*Phoca vitulina*) to derive auditory weighting functions for seals. With their acute underwater hearing, sounds from the training and testing activities are audible to harbor seals. The results contribute valuable data to the previously limited dataset regarding how sounds of different frequencies may affect the hearing of harbor seals across their entire functional frequency hearing range.

Seven fatiguing sounds were tested: a continuous tone (6.5 kHz) and continuous 1/6-octave noise bands centered at 0.5, 1.0, 2.0, 16, 32 and 40 kHz. Results of the testing have been shared in five publications in *The Journal of the Acoustical Society of America*. Citations can be found on the Publications tab of the LMR website (www.navfac.navy.mil/lmr).

New Start—Project 45

Frequency-dependent Underwater TTS in California Sea Lions

Ron Kastelein, SEAMARCO, introduced this new project, which is testing how sounds of different frequencies may affect the underwater hearing of California sea lions (*Zalophus californianus*). It follows an approach similar to previous temporary threshold shift (TTS) projects this team has completed with harbor seals (*Phoca vitulina*) and harbor porpoises (*Phocoena phocoena*) to test hearing across frequencies. This will facilitate comparing results across the species. An additional component to this project is an equal-energy assumption study that will help to address potential effects of naval sonar that often operates at a lower duty cycle and higher sound levels.

We saw a remarkable level of engagement, with valuable exchange of questions and ideas, both within the meeting software’s chat function and the allotted question periods. In addition to the technical content being presented and discussed, program staff worked to inject some levity (photos that imagined some alter egos for the LMR management team, including the Caped Crusader—Batman) and to encourage a bit of personal interaction (bring your pet and/or child to the meeting) that helped to boost the group’s engagement. While we are glad for the virtual option this year, we missed the face-to-face, after-hours discussions that bring us together as a program.

We hope it will be possible to see you all in-person for our next IPR, November 15 to 18, 2021.

PROGRAM SCHEDULE

No.	What	When
1.	Proposal Solicitation & Review	
a.	FY21 pre-proposals review	November 2020 through February 2021
b.	FY21 proposal review	March through May 2021
2.	Quarterly Status Reports (QSR)	
a.	Submit spring QSR	April 30, 2021
b.	Submit summer QSR	July 30, 2021
c.	Submit fall QSR	October 29, 2021
d.	Submit winter QSR	January 31, 2022
3.	In-progress Review	November 15 to 18, 2021

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

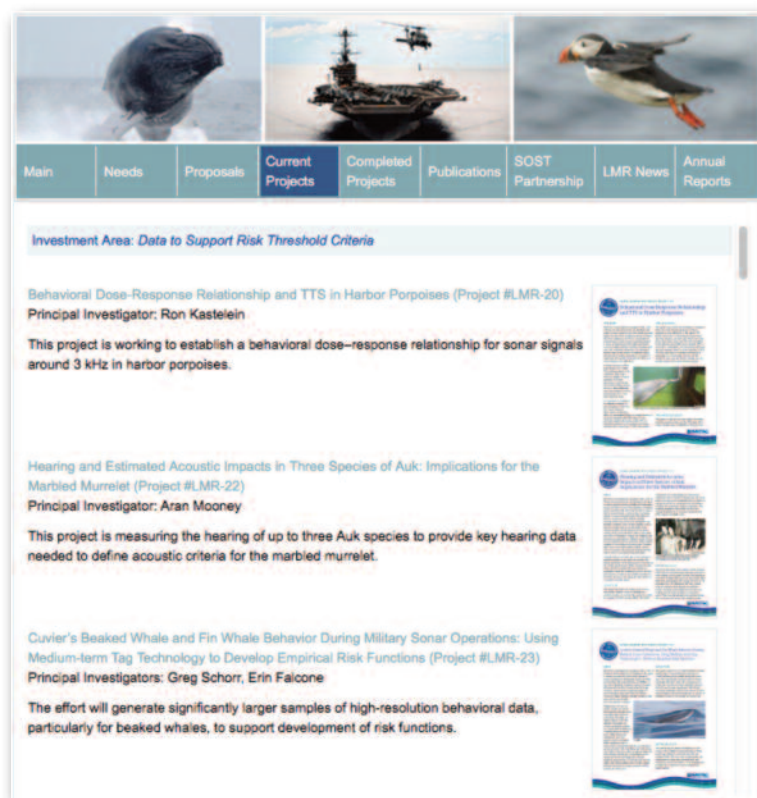
Work to establish interagency and scientific community standards and metrics for data collection, management and analysis. This promotes data comparability and enables data aggregation from different data sets. It ensures consistent, agreed-upon standards and metrics in order to provide cost-effective 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.

OUR WEBSITE

You can find links to all of our informational materials, including fact sheets, an updated publication spreadsheet and our most recent annual report, at our website—www.navfac.navy.mil/lmr.



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If you want to subscribe to, or unsubscribe from, *LMR News*, please send your email address to Lorraine Wass at ljwass@outlook.com.

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 proposal reviews, project updates and other program news.

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