# LMR news

WINTER 2019

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## 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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livingmarine RESOURCES

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NAVFAC Naval Facilities Engineering Command
ENGINEERING AND EXPEDITIONARY WARFARE CENTER

## WHO WE ARE

Anu Kumar, Program Manager

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

Transitions, proposal reviews, project field efforts and our annual In-progress Review are key topics for this issue of *LMR News*.

Our first topic regards a significant transition for a person who has been instrumental in the LMR program and marine mammal research.

Dave Moretti

Dave Moretti, originally from Pewaukee, Wisconsin, retired in December after more than 30 years of government service. Dave's groundbreaking development of the Marine Mammal Monitoring on Navy Ranges (M3R) system has provided an invaluable tool that enabled a wealth of knowledge gained about beaked whale biology, behavior and ecology over the past twenty years. After completing Bachelors' degrees in both Genetics and Resource Management from the University of Wisconsin, Madison, Dave earned a teaching license and taught high school for several years, before switching careers and completing a Masters' degree in electrical engineering from Marquette University. In 1985 Dave joined the Naval Undersea Warfare Center (NUWC) in Newport, Rhode Island, and by 1990 he was leading the Digital Signal Processing Team (continuing until 2007).

In 1999, his biology background converged with his engineering work implementing digital signal processing for the tracking ranges, leading to the start of the M3R system. Early efforts focused on developing methods to use passive acoustics to detect, classify, localize and monitor marine mammals on Navy undersea hydrophone ranges. The M3R system was first fielded on the

U.S. Navy's Atlantic Undersea Test & Evaluation Center (AUTEC) off of Andros Island in the Bahamas, followed by the Southern California Anti-submarine Warfare Range (SOAR) off of Southern California and the Pacific Missile Range Facility off Kaua'i, Hawaii. This year the system will be installed at the new Undersea Warfare Training Range (USWTR) off of Jacksonville, Florida.

Dave's M3R work has provided new ways to study marine mammal behavior. He has been an instrumental part of numerous behavioral response studies (BRS) on the east and west coasts of the U.S. and in the Mediterranean Sea. His open and cooperative nature helped propel the field of passive acoustic monitoring forward by providing access to the valuable M3R resource to a large network of academic, government and private industry collaborators.

Blainville's beaked whale.
*Mark Deakos, NMFS permit 14451*

Returning his attention to biology, Dave is completing a PhD at the University of St Andrews in Scotland, focusing on using bioenergetics models to examine possible population-level effects of mid-frequency active sonar on beaked whales at AUTEC. Dave has received numerous awards during his career, including the Delores M. Etter Top Navy Scientists and Engineers of the Year Award in 2009 and the National Association of Environmental Professionals award for Best Available Environmental Technology in 2018. He is author or co-author of over 70 papers, book chapters, and reports, and holds five patent disclosures for environmental sensors and signal processing applications.

We would like to thank all of our colleagues at NUWC for putting together this biography on Dave's career. Dave has played a big role in a number of LMR projects over the years and will be impossible to replace. His expertise in both signal processing and biology has allowed him to be a bridge between these two communities, which has been invaluable to our program and to the Navy.

Dave, from all of us at the LMR program, we wish you fair winds and following seas.

In other updates, program staff and the LMRAC are in the midst of reviewing pre-proposals received from the FY19 Broad Agency Announcement (BAA). The six needs listed in the BAA generated significant interest and a breadth of responses. Those proposals selected will be our new start projects for 2019.

Our annual In-progress Review took place in December 2018. For more on this, see the In-progress Review 2018 section later in this issue.

Project principal investigators have been busy with field work. Among the productive efforts were experiments for the project *Effects of Underwater Explosions on Fish* led by Peter Dahl and Keith Jenkins. That work is summarized in the LMR Project Spotlight section, below. In addition, several animal tagging efforts have been underway in support of four different projects, including:

- **Project 17**: *Blue and Fin Whale Density Estimation in Southern California Offshore Range Using PAM Data*, PI Ana Širović.
- **Project 21**: *Extended Duration Acoustic Tagging of Right Whales*, PI Susan Parks.
- **Projects 23 and 30**: *Cuvier's Beaked Whale and Fin Whale Behavior During Military Sonar Operations* and *Measuring the Effect of Range on the Behavioral Response of Marine Mammals Through the Use of Navy Sonar*, PIs Gregg Schorr and Stephanie Watwood.


Southern right whale.

Taken together these tagging efforts resulted in tags on 15 animals—four humpbacks, three southern right whales, three Cuvier's beaked whales and five fin whales. The data from these tags continue to contribute to our understanding of marine mammal behaviors and how we can improve our work.

## 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.

## 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 one our ongoing projects, which successfully completed its first year of field tests.

### Effects of Underwater Explosions on Fish (FISHEX)

The Navy needs more data to improve the Navy's acoustic and explosive impact assessments for marine species. Priority interests include the effects to fish from the detonation of explosive devices of various charge sizes, depths and distances to the subjects. Navy training and testing activities can include underwater explosive charges, and additional data are needed regarding the effects of such explosives on fish in order to update risk threshold criteria, reduce the uncertainty of the current impact assessments and validate mitigation measures.

A multidisciplinary team of researchers, led by Dr. Peter Dahl from the University of Washington and Keith Jenkins from the Space and Naval Warfare Systems Center Pacific, are working with Navy Explosive Ordnance Disposal (EOD) technicians to conduct field-based experiments to collect needed data. Careful attention has been focused on ensuring a bio-statically valid design and sample size to provide a broader and more comprehensive understanding of potential effects and dose-response relationships.

Fish cages deployed off of San Diego.
*Keith Jenkins*

During 2018 the team completed experimental and biostatical planning, obtained the required approval from the Institutional Animal Care and Use Committee (IACUC), sourced Pacific sardines from the National Marine Fisheries' Southwest Fisheries Science Center, completed Explosive Ordnance Disposal logistical coordination, and conducted both a valuable pilot study and successful Phase I explosives trials.

The trials, conducted during October, included four events over two weeks. Cages holding Pacific sardines were deployed at 10 meters depth at multiple distances from the explosive source. Cages were immediately raised, survival and external effects were documented, and the fish were prepared for necropsy (animal autopsy) to evaluate internal effects. An important component to the statistical design was including control fish (not exposed to explosive forces) in the study. The fish were presented for analyses in a manner to ensure that investigators did not know if they were analyzing exposed or control animals. In addition to fish necropsy analyses, the team collected critical data on acoustic explosive energy at the fish cages and along multiple pathways. Overall data analyses of the Phase I trials are underway at the time of this writing.

Deploying fish cage for testing.
*Keith Jenkins*

Trials in 2019 will collect data on another type of fish, potentially one with different swim bladder morphology than the sardines used in 2018. A number of procedural lessons-learned—including sourcing and maintaining target species and ear tissue preservation and analysis techniques—will smooth the way for the 2019 trials.

The data from these trials will provide important input to risk assessment criteria needed by the Navy and the broader environmental compliance community. The researchers will report the results in scientific manuscripts for submission to peer-reviewed journals and presentation at scientific conferences.

## IN-PROGRESS REVIEW 2018

We held our annual In-progress Review (IPR) in December. As in past years, this meeting brought the principal investigators (PI) on LMR-funded projects together with members of the LMR Advisory Committee (LMRAC), program managers and program sponsor to exchange information on project status. This year's agenda included 25 project presentations, including five project close-outs, four new starts, 14 ongoing efforts, an update on a valuable modeling tool used in behavioral response studies (*The BRS Tool*, John Joseph and Tetyana Margolina, Naval Postgraduate School) and one partnership project (*Developing Tools for Acoustic-only Behavioral Response Studies at Navy Instrumented Ranges*, Tyler Helble, Space and Naval Warfare Systems Center).

The five project close-out presentations were for projects completing their LMR contracts in 2018 or early 2019. They are:

### PROJECT 2: *SOCAL Behavioral Response Study (BRS)*

Brandon Southall discussed the history, progression and outcomes to date of this expansive effort. This project transitioned from using large research vessels to employing smaller, more nimble boats for tagging whales and conducting focal follows. The project also involved both controlled exposure experiments and actual naval sonar to study behavioral responses. These techniques contributed to new approaches to studying cetacean behaviors relative to Navy training activities. Many of these techniques are now being used in the Navy's Marine Species Monitoring Program's Atlantic BRS project.

Tagged Risso's dolphin in the SOCAL-BRS project.
*Ari Friedlaender, NMFS permit 14534*

### PROJECT 3: *Simple Performance-characterized Automatic Detection of Marine Mammal Sounds*

This project, led by Dave Mellinger, focused on improving the user interface and conducting training workshops to support using the Ishmael signal processing toolkit. Two highly reviewed workshops were completed in 2017 and 2018 in which individuals from Navy, National Marine Fisheries Service, universities, private companies, and non-profit organizations were in attendance. A new version of Ishmael, an updated User Guide and links to training videos are now available online at www.bioacoustics.us/ishmael.html.

## PROJECT 12: *Integrated Real-time Autonomous Passive Acoustic Monitoring System (IRAP)*

This final brief, presented by Vince Premus on behalf of himself and Phil Abbot, summed up the development and demonstration for the IRAP system. The IRAP system includes high frequency (1-100 kHz) and low frequency (25-4,000 Hz) passive acoustic sensors. These sensors are arrays that provide increased detection ranges (3-10x) and area coverage (10-100x) relative to a single hydrophone. In addition, the system is capable of providing bearing and tracking of marine mammal detections. The IRAP system was deployed on a REMUS 600 powered unmanned underwater vehicle during four field deployments and successfully demonstrated detection of humpback and beaked whales.

## PROJECT 13: *Standardization of AEP Audiometry Methods*

Dorian Houser summarized this project's highlights, which include training stranding network volunteers in obtaining auditory evoked potentials (AEP) from stranded animals using the portable Evoked Response Study Tool (EVREST), achieving development and approval of an AEP standard (American National Standards Institute / Acoustical Society of America. 2018. Procedure for Determining Audiograms in Toothed Whales through Evoked Potential Methods. S3/SC1.6-2018) and updating EVREST to support consistent AEP data collection. (For more on this project, see the Summer-18 issue of *LMR News*.)

## PROJECT 21: *Extended Duration Acoustic Tagging of Right Whales*

This project focused on new suction cup designs that would help keep DTAGs on whales for longer periods. Project PI, Susan Parks, reviewed project objectives and progress. The project was to test suction cup designs, materials and bio-compatible glues on North Atlantic right whales in conjunction with planned monitoring efforts. Due to low numbers of North Atlantic right whales during two monitoring seasons, tags were tested on humpback whales and southern right whales. Tests ultimately included various material stiffness with micro-texture but did not include glues. Final results will be provided in spring 2019.

## PROJECT 27: *High Fidelity Acoustic and Fine-scale Movement Tags to Enable Behavioral Response Studies on Deep Diving Whales*

This project, led by PI Alex Shorter, has focused on new approaches to manufacturing and offering DTAGs to researchers. The project established a lease pool that has streamlined tag availability while also enabling researcher feedback and tag upgrades. This team also provided mechanical testing support to the suction cup designs in project 21. By project completion in spring 2019, the project is expected to have produced a minimum of 20 tags for issue via the lease pool. It currently appears that an additional ten tags, for a total of 30, will be manufactured.

The following four new start projects were introduced at the IPR:

- **Project 33**: *TTS in harbor seals due to fatiguing noise of several frequencies: temporary threshold shift onset sound exposure level and growth curves for permanent threshold shift onset SEL estimation to set criteria*. Ron Kastelein, SEAMARCO.
- **Project 34**: *Standardizing methods and nomenclature for automated detection of Navy sonar.* Elizabeth Henderson, Space and Naval Warfare Systems Center.
- **Project 35**: *Multi-spaced measurement of underwater sound fields from explosive sources*. Peter Dahl, University of Washington.
- **Project 36**:*Analytical methods to support the development of noise exposure criteria for behavioral response*. Len Thomas, University of St Andrews.

Harbor seal.
*Peter Pearsall, USFWS*

Fact sheets summarizing these new projects soon will be available on our website.

The interactions among PIs, LMRAC members and program managers continue to provide any needed course corrections and valuable input to the projects.

## LMR PROGRAM PARTICIPANT UPDATES

The Oceans 2018 Conference, held in Charleston, South Carolina, included a presentation of Behavioral Response Study modeling tool. Tetyana Margolina, faculty associate and researcher at the Naval Postgraduate School, presented the current status of the modeling tool. Her presentation, entitled *BRS Sound Exposure Modeling Tool: A System for Planning, Visualization and Analysis*, was presented in the data visualization session. This tool was used in conjunction with the Southern California Behavioral Response Study (BRS) and is being adapted for the Atlantic BRS. The citation for this presentation, currently in press and to be published as part of the conference proceedings, is provided in the Recent Publications section of this newsletter.

**navysustainability.dodlive.mil/LMR**

## RECENT PUBLICATIONS

This section includes recent publications and reports resulting from projects that are 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.


Burkard, R., Finneran, J.J., and Mulsow, J. (2018). Comparison of maximum length sequence and randomized stimulation and averaging methods on the bottlenose dolphin auditory brainstem response. *The Journal of the Acoustical Society of America*, 144, 308-318.

Cade, D. E., Barr, K. R., Calambokidis, J., Friedlaender, A. S., & Goldbogen, J. A. (2018). Determining forward speed from accelerometer jiggle in aquatic environments. *Journal of Experimental Biology*, 221(2), jeb170449.

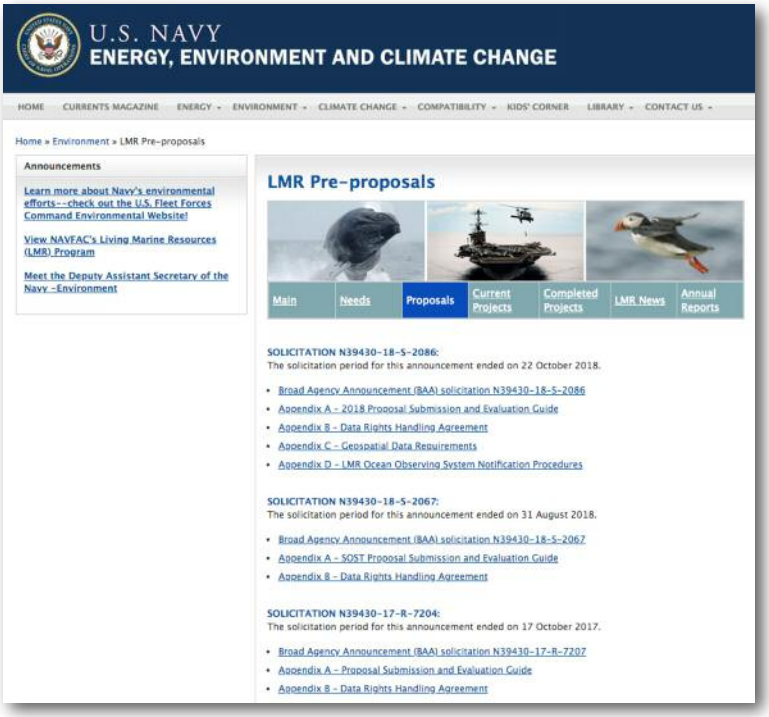
Lewis, L.A., Calambokidis, J., Stimpert, A.K., Fahlbusch, J., Friedlaender, A.S., McKenna, M.F., Mesnick, S.L., Oleson, E.M., Southall, B.L., Szesciorka, A.R., and Širović, A. (2018). Context-dependent variability in blue whale acoustic behavior. *Royal Society Open Science*, 5(8), p.180241.

Margolina, T., Joseph, J. E., and Southall, B. L. (in press). BRS Sound Exposure Modeling Tool: A system for planning, visualization and analysis. *IEEE Journal of Oceanic Engineering, Proceedings of the Ocean 2018 Conference.*


For lists of other publications, please see our annual program reports and recent issues of *LMR News*.

## OUR WEBSITE

On our website you can find project highlights, our annual reports and other LMR information. The address is navysustainability.dodlive.mil/LMR.



## PROGRAM SCHEDULE

| No. | What | When |
|---|---|---|
| 1. | **Proposal Solicitation & Review** | |
| a. | FY19 Full Proposals Requested | February, 2019 |
| b. | FY20 Needs Approved | June, 2019 |
| 2. | **Project & Contracts Management** | |
| a. | FY19 New Start Contracts | September 30, 2019 |
| 3. | **Quarterly Status Reports (QSR)** | |
| a. | Submit winter QSR | January 31, 2019 |
| b. | Submit spring QSR | April 30, 2019 |
| c. | Submit summer QSR | July 31, 2019 |
| d. | Submit fall QSR | October 31, 2019 |

## 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 newsletter 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.

Bryde's whale.
*Gregory S. Schorr; NMFS Permit 16111*

## HELP WITH OUR MAILING LIST

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 updates on our proposal review process, project field work and more as available.