LMR news

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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.

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

INSIDE THIS ISSUE

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 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

It has been a summer stretch of selecting projects, tracking important conferences and catching up on project field efforts and workshops.

We have selected six new projects so far in FY22. The projects are distributed among three of our Investment Areas (IA): one in IA 1 Risk Assessment and Criteria, two in IA 2 Data Processing and Analysis Tools and three in IA3 Monitoring Technology Demonstrations.

Investment Area	Project Title	Principal Investigator	Need
Criteria	Auditory Masking in Odobenid and Otariid Carnivores	Colleen Reichmuth	N-0260-22 Research that pertains to the LMR program investment areas. Data to Support Risk Threshold Criteria
Data Tools	Bryde's Whale Cue Rate and Kinematics	Tyler Helble	N-0260-22 Research that pertains to the LMR program investment areas. Data Processing and Analysis Tools
Data Tools	Historic ARP and HARP Passive Acoustic Recording Archiving with NCEI	Kaitlin Frasier	N-0260-22 Research that pertains to the LMR program investment areas. Data Processing and Analysis Tools
Monitoring Technologies	Integration and Field Evaluation of the Next Generation High-fidelity Sound and Movement Tags to Investigate Behavioral Response	Alex Shorter	N-0258-22 Demonstrate Existing Marine Mammal Tag Technologies
Monitoring Technologies	Demonstrating Suction-cup Tag Systems to Support Behavioral Response Studies (BRS)	Patrick Miller	N-0259-22 Improve the Ability to Identify Calling Individual from Acoustic Tags
Monitoring Technologies	Long-term Sparse Array Localization Feasibility Study Using a SonarPoint System	Marco Flagg	N-0257-22 Demonstrate and Validate the Ability of Existing Sparse Acoustic Array Technology to Address Navy Marine Species Monitoring Goals

The FY23 project cycle is just getting underway. After approving a set of Navy needs in August, we are preparing our FY23 Pre-proposal Solicitation. We expect that to be out in late September or early October, 2022.

For the latest 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.

As a reminder, note that the program website address has changed. The new URL—exwc.navfac.navy.mil/lmr—is now up and running. Please contact the program manager at exwc_lmr_program@navy.mil if you have any trouble accessing the website.

This issue's Project Spotlight is on a project under Investment Area 2 (Data processing and analysis tools) that will be wrapping up soon. See that section to read about the project, The Working Group for the Advancement of Marine Species Density Surface Modeling project (DenMod).

Anu Kumar
Program Manager

IN-PROGRESS REVIEW

The Living Marine Resources Advisory Committee and principal investigators can now save the date for the 2022 IPR. It will be held the week of November 14 to 18, 2022. Details will follow.

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.

Mandy Shoemaker
Deputy Program Manager

And as a reminder, the full and updated Summer-22 publication spreadsheet, which includes these entries, is available on our website.

Miller, D.L., Becker, E.A., Forney, K.A., Roberts, J.J., Cañadas, A. and Schick, R.S. (2022). Estimating uncertainty in density surface models. *PeerJ*, 10:e13950. DOI 10.7717/peerj.13950.

Sweeney, D.A., Schorr, G.S., Falcone, E.A., Rone, B.K., Andrews, R.D., Coates, S.N., Watwood, S.L., DeRuiter, S.L., Johnson, M.P. and Moretti, D.J. (2022). Cuvier's beaked whale foraging dives identified via machine learning using depth and triaxial acceleration. *Marine Ecology Progress Series*, 692:195-208. DOI 10.3354/meps14068.

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 2: Data Processing and Analysis Tools.

The Working Group for the Advancement of Marine Species Density Surface Modeling project (DenMod)

Information on the distribution and seasonal density of marine species is a key input to the Navy's quantitative environmental impact assessments. LMR therefore sponsors several projects aimed at improving the reliability of marine species density estimates. One such project is DenMod, which has developed and demonstrated improved analytical methods for producing spatial density surfaces (i.e., maps) from survey data.

The DenMod project working group included the parties largely responsible for developing analytical methods and the collection and analysis of transect data used in Navy impact assessments: the University of St Andrews, Duke University and four regional NOAA Fisheries labs (Northeast, Southeast, Southwest and Alaska Fisheries Science Centers). To broaden the range of participants in the process, this group held three public workshops, two in advance of Society for Marine Mammalogy (SMM) conferences and one as an online webinar. (See the Spring-22 issue of LMR News for notes on that webinar.)

Initiated in 2017, the project formed the working group, which has met annually. Eight subgroups were formed to focus on key topics that participants identified:

1. **Uncertainty estimation**

   This subgroup focused both on correctly quantifying uncertainties related to individual model components and on how to combine these into final uncertainty estimates for maps and for abundance estimates (abundance is total number in a defined region—calculated as average density multiplied by area) (described in Miller et al. 2022). A tool for variance propagation has been developed in the industry-standard R programming language as part of the "dsm" package and the method is described in Bravington et al. (2021).

2. **Extrapolation**

   Density estimates in areas beyond the bounds of the survey data make assumptions on the correctness of the model used. The subgroup developed a guidance document along with a software toolkit that allows model assessment ("dsmextra", available at densitymodelling.github.io/dsmextra). Additional information was included in the peer-reviewed

manuscript, "dsmextra: Extrapolation Assessment Tools for Density Surface Models" (Bouchet et al. 2020).

3. Model unification

This subgroup looked at the similarities among various modeling techniques that have been used to obtain spatially explicit estimates of density, and completed a mathematical comparison of the different techniques, enabling a more informed choice of methods in the future. Results have been presented in three publications: Pederson et al. (2019), Miller et al. (2020) and Miller (2021).

4. Workflow

Many data preparation and modeling workflows have evolved over time within the different organizations that provide density estimates to the Navy. The workflow subgroup led an effort to encapsulate this information. They have made a range of information and advice publicly available online at https://osf.io/5eza8/wiki.
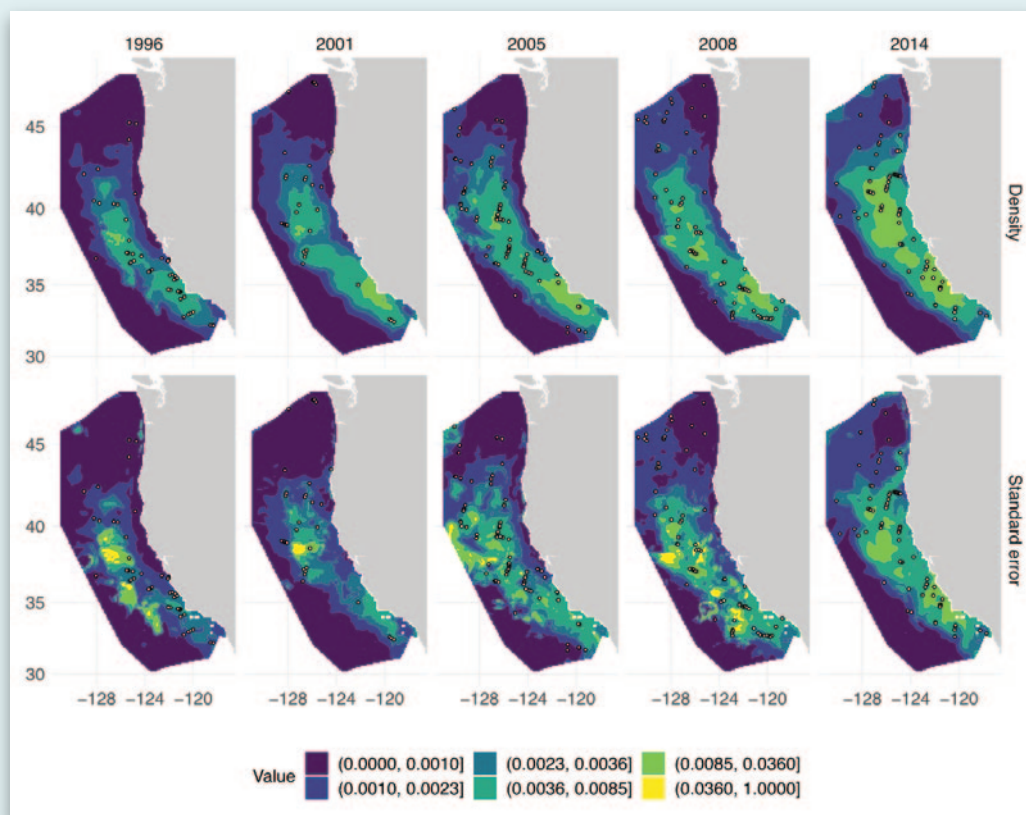
Results of fin whale modelling using the methods in Miller et al. (2022).
Top row: predicted yearly densities for fin whales in the California Current Ecosystem.
Bottom row: yearly estimated standard errors for the predictions.
Standard errors include uncertainty from the detection and spatial models as well as environmental variability in covariates.
Black circles give locations of observations of fin whales.

5. **Acoustic and visual data integration**

   This subgroup investigated methods for integrating density surfaces estimates derived from visual surveys and from separate, but spatially overlapping, acoustic surveys. The group initiated a case study using data from surveys of deep-diving whales from NOAA's Northeast and Southeast Fisheries Science Centers, under the Atlantic Marine Assessment Program for Protected Species. An example analysis, focusing on sperm whales, is in preparation for dissemination during 2022.

6. **Pinnipeds (seals and sea lions)**

   Pinnipeds raise unique issues when it comes to abundance estimation, as at-sea data are scarce, but counts from haul-outs and movement data from tags are common. Operating under separate funding, this subgroup focused on working out how best to use and combine these disparate data. A paper led by the team at the Alaska Fisheries Science Center, describing the advancements that have been made, was published by ver Hoef et al. (2021).

7. **Tool development**

   This subgroup was formed to address requests from NOAA Fisheries Science Centers for software tools for modeling, validation and other analysis needs. Work on this has included improvements to the R package "dsm" and associated tools to support survey data modeling. One example, a tutorial on segmenting survey transects in R, is available at https://examples.distancesampling.org. Another is the ability to easily include data from multiple surveys each using a different survey platform (e.g., combining data from aerial and shipboard surveys), details of which are available in Miller et al. (2021).

8. **Unmanned aerial vehicles (UAV)**

   This subgroup investigated how to incorporate visual data from UAVs into density surface models. The subgroup worked with collaborators at Murdoch University and the Australian Antarctic Division to develop a case study on dugongs in Shark Bay, Western Australia. Mark-recapture techniques were used to obtain probabilities of detection for these surveys, which required adapting methods. This capability was added to the "dsm" R package. In addition, a worked example is being written-up so others can use this approach.

Project participants have produced software tools that support the new approaches, and the group is developing concrete guidance on best practices in this type of modeling. Several products are available at the DenMod project website, https://denmod.wp.st-andrews.ac.uk/. Complete citations for those referenced above are presented in the Publications sidebaron the following page.

PUBLICATIONS

Becker, E.A., Forney, K.A., Miller, D.L., Barlow, J., Rojas-Bracho, L., Urbán, R.J. and Moore, J.E. (2022). Dynamic habitat models reflect interannual movement of cetaceans within the California Current ecosystem. *Frontiers in Marine Science*, 9:829523. DOI 10.3389/fmars.2022.829523.

Miller, D.L., Becker, E.A., Forney, K.A., Roberts, J.J., Cañadas, A. and Schick, R.S. (2022). Estimating uncertainty in density surface models. *PeerJ*, 10:e13950. DOI 10.7717/peerj.13950.

Bravington, M.V., Miller, D.L. and Hedley, S.L. (2021). Variance propagation for density surface models. *Journal of Agricultural, Biological and Environmental Statistics*, 26(2):306-323. DOI 10.1007/s13253-021-00438-2.

Miller, D. L., Bayesian views of generalized additive modelling, arXiv e-prints, 2021. DOI 10.48550/arXiv.1902.01330.

Miller, D.L., Fifield, D., Wakefield, E. and Sigourney, D.B. (2021). Extending density surface models to include multiple and double-observer survey data. *PeerJ*, 9:12113. DOI 10.7717/peerj.12113.

Ver Hoef, J.M., Johnson, D., Angliss, R. and Higham, M. (2021). Species density models from opportunistic citizen science data. *Methods in Ecology and Evolution*, 12:1911-1925. DOI 10.1111/2041-210X.13679.

Wakefield, E.D., Miller, D.L., Bond, S., Carvalho, P., Catry, P., Dilley, B., Fifield, D., Gjerdrum, C., González-Solís, J., Hogan, H., Laptikhovsky, V., Miller, J., Miller, P., Pinder, S., Pipa, T., Thompson, L., Thompson, P. and Matthiopoulos, J. (2021). The summer distribution, habitat associations and abundance of seabirds in the sub-polar frontal zone of the Northwest Atlantic. *Progress in Oceanography*. DOI 10.1016/j.pocean.2021.102657.

Becker, E.A., Forney, K.A., Miller, D.L., Fiedler, P.C., Barlow, J. and Moore, J.E. (2020). Habitat-based density estimates for cetaceans in the California Current Ecosystem based on 1991-2018 survey data. *NOAA Technical Memo NMFS-SWFSC-638*.

Bouchet, P.J., 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.

Miller, D.L., Glennie, R. and Seaton, A.E. (2020). Understanding the stochastic partial differential equation approach to smoothing. *Journal of Agricultural, Biological and Environmental Statistics*, 25:1-16. DOI 10.1007/s13253-019-00377-z.

Pedersen, E.J., Miller, D.L., Simpson, G. and Ross, N. (2019). Hierarchical Generalized Additive Models: an introduction with mgcv. *PeerJ*, 7:e6876. DOI 10.7717/peerj.6876.

PROJECT STATUS UPDATES

Project 37: Collection of AEP Thresholds in Minke Whales

The Project 37 team returned to Norway for this year's field season, which occurred during the month of June. The project, funded in cooperation with the Subcommittee on Ocean Science and Technology Interagency Task Force on Ocean Noise and Marine Life (SOST ITF-ONML), is focused on obtaining in-situ auditory evoked potential (AEP) measurements of the hearing sensitivity of mysticetes. This year a total of 41 whales were observed near the catch basin. The team was able to perform the corralling procedures on two whales, which involves corralling the animal from the basin into the fish farm. The first animal escaped the basin, so the team improved the corralling technique. The second animal was successfully corralled into the

Minke whale.
Wayne Hoggard, NOAA/NMFS

fish farm, and placed in a net hammock for the hearing test. However, the animal was released because it began showing signs of stress. Following the animal welfare protocols, the team released the animal back into the fish farm and then catch basin. Over the next year, the team will be reviewing their approach to determine how to minimize stress to the animal during the capture procedure. They are taking a slow and deliberate approach to handling the animals and now know that it is possible. Additional information on this project is available at www.nmmf.org/our-work/biologic-bioacoustic-research/minke-whale-hearing.

Project 44: Demonstration and Validation of Passive Acoustic Density Estimation for Right Whales

This project team recently returned from a one-month field effort at the study site in Santa Catarina State, Brazil. The team's field plan included collecting passive acoustic data of right whale acoustic signal production from a fixed acoustic monitoring array. The acoustic data collection is coupled with visually verifying whale density and tracking individuals using a shore-based theodolite station. In addition, they expected to deploy acoustic tags on right whales at the site. We look forward to providing some updates on the field effort in the next newsletter.

Project 46: Capability Enhancements for Tethys, a Passive Acoustic Metadata Workbench

This project conducted a beta-user workshop to introduce users to new developments and have them identify areas for improvement. A total of nine users participated from multiple agencies, including Navy, NOAA and academia. During the workshop, participants were able to work on entering a portion of their data into the database, so that the utility of Tethys could be demonstrated. The participants offered valuable insights on additional development that is needed to further improve the utility of Tethys to a larger audience. We appreciate Marie Roch's hard work in putting on this workshop and all of the attendees for participating.

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 most recent annual report. Note that this is a new address for the website.

exwc.navfac.navy.mil/lmr

PROGRAM PARTICIPANT UPDATES

LMR's Program Manager, Anu Kumar, and Deputy Program Manager, Mandy Shoemaker, attended the Effects of Noise on Aquatic Life meeting in Berlin, Germany. Meeting sessions were focused on topics such as hearing, soundscapes, effects of intense sounds (e.g. explosives), priorities for regulation and management, and short or long term effects. These topics are of particular interest to the Navy and pertain to research conducted by the LMR program, with multiple LMR principal investigators presenting results during the meeting. It was a successful meeting and provided opportunities for many valuable collaborative conversations.

Mandy and Anu also participated (virtually) in the 24th Biennial Conference on the Biology of Marine Mammals, held from 1-5 August in Palm Beach, Florida. This conference is focused on promoting science, collaboration and improving the quality of research on marine mammals around the globe. Topics of note included ecology, conservation and marine mammal behavior and physiology, which are important for many LMR projects. This meeting also included presentations by multiple LMR principal investigators. Participating in this conference allowed the LMR management team to remain up to date on priority research needs.

The LMR program welcomed our first-ever summer intern, Kali Fennell-Lyman. Kali learned many details about the LMR program and helped us a lot during her 10-week internship. Some of the things she worked on included updating our database of animal tag technology, creating an online survey for users of passive acoustic monitoring technology, evaluating project proposals and helping us identify updates needed for our LMR website. She was also able to enjoy getting out of the office with a visit to San Nicholas Island and some onboard work with the Channel Islands National Marine Sanctuary staff to recover and redeploy passive acoustic monitoring equipment. During a trip to San Diego, she attended an LMR project meeting, visited Scripps Institute of Oceanography and toured the Navy's marine mammal program facility. She will soon be starting her junior year at the University of California Santa Barbara. We wish her all the best. Thanks, Kali, for spending the summer with us!

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.

PROGRAM SCHEDULE

No.	What	When
1.	**Proposal Solicitation & Review**	
a.	FY23 Needs Approval	August 2022
b.	FY23 Pre-proposal Solicitation Announcement	September 2022
2.	**Quarterly Status Reports (QSR)**	
a.	Submit fall QSR	October 28, 2022 (effort from July–September)
b.	Submit winter QSR	January 31, 2023 (effort from October–December)
c.	Submit spring QSR	April 28, 2023 (effort from January–March)
d.	Submit summer QSR	July 30, 2022 (effort from April–June)
3.	**In-progress Review**	**November 14–18, 2022**

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 *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 newsletter. Submit your photos via email to: exwc_lmr_program@navy.mil.

Bryde's whale.
Gregory S. Schorr, permit 16111

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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.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 Pre-proposal Solicitation, any additional FY22 projects that have been approved and project field effort updates.

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