

LMR news

FALL 2019

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 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

Pre-proposal solicitations and field work were key features of this past quarter.

The program's request for pre-proposals for Fiscal Year 2020 (FY20) was published September 3, 2019 and closes November 12, 2019. The solicitation includes three specific need topics:

1. N-0228-20: Marine Mammal Acoustic Software Application Enhancements
2. N-0225-20: Marine Mammal Conditioned Attenuation of Hearing Sensitivity
3. N-0224-20: Frequency-dependent, Underwater, Temporary Threshold Shift in California Sea Lions

The program staff and the LMR Advisory Committee will review all pre-proposals. The most promising submissions will be asked to submit full proposals. The request for full proposals is expected by late January 2020.

The LMR program also submitted a research topic under the Small Business Innovation Research (SBIR) program, which was selected for the September SBIR Broad Agency Announcement (BAA) Solicitation. The SBIR program provides an opportunity for domestic small businesses to engage in Federal research and development that has the potential for commercialization. The research topic, Unmanned Underwater Vehicle (UUV) Technology to Enable Readiness of Navy Ranges, seeks technologies that can collect a broad spectrum of ocean acoustic data to support large scale spatial and temporal research on ambient and biological sources of sound. The BAA solicitation period closed on October 23, 2019.



Anu Kumar, Program Manager

Highlights of three field efforts for four LMR projects—3S3: *Behavioral Responses of Cetaceans to Naval Sonar* (project 29), *Effects of Underwater Explosive Sound on Fishes* (project 26) and *Cuvier's Beaked Whale and Fin Whale Behavior During Military Sonar Operations* (projects 23 and 30)—can be found below in the Program Participant Updates section.

IN-PROGRESS REVIEW 2019

LMR principal investigators, LMRAC members and program staff will be gathering for the 2019 IPR, the week of November 4th. This annual event provides a valuable opportunity for program participants to exchange information on project status. Highlights from the meeting will be shared in the Winter-20 issue of *LMR News*.

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.

Kastelein, R. A., Helder-Hoek, L., Cornelisse, S., Huijser, L.A.E., & Gransier, R. (2019). Temporary hearing threshold shift in harbor porpoises (*Phocoena phocoena*) due to one-sixth-octave noise band at 32 kHz. *Aquatic Mammals*, 45(5), 549-562.

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



Cuvier's beaked whales.
Gregory S. Schorr

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 acoustic effects projects, which contribute critical data to Navy risk assessment criteria.

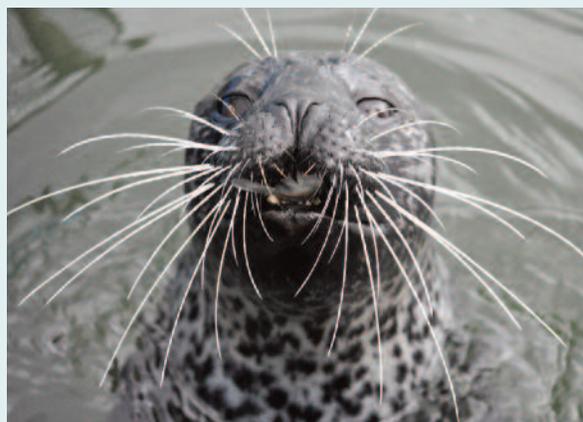
TTS in Harbor Seals Due to Fatiguing Sound of Several Frequencies

In its continuing effort to improve acoustic impact assessments for marine species, the Navy needs data on temporary threshold shift (TTS), particularly for species for which no, or insufficient, data are available. This project focuses on TTS and hearing recovery in harbor seals, which will contribute to defining auditory weighting functions for seals. Harbor seals are appropriate subjects for multiple reasons. They have a wide distribution in the northern hemisphere and sometimes overlap with areas used for U.S. Navy training and testing activities. With their acute underwater hearing, sounds from the training and testing activities are audible to harbor seals. In addition, while susceptibility to TTS has been shown to be frequency-dependent in bottlenose dolphins (*Tursiops truncatus*) and harbor porpoises (*Phocoena phocoena*), currently it is not clear how sounds of different frequencies may affect the hearing of harbor seals across their entire functional hearing range.

Dr. Ron Kastelein, director and owner of SEAMARCO (Sea Mammal Research Company, Inc.) in The Netherlands, is leading this project to evaluate the frequency-dependence in seal hearing susceptibility to TTS. Specific project goals are to:

1. Determine the susceptibility to TTS of harbor seals over their entire hearing range
2. Determine TTS onset, relationship between sound exposure level (SEL, a unit which contains both the exposure level and the exposure duration) and TTS after the harbor seals have been exposed to sounds of various frequencies.
3. Determine which hearing frequency is most affected by each fatiguing sound frequency
4. Determine the recovery rate of hearing after the fatiguing sound stops
5. Based on the information derived for goals 1-3, construct equal-TTS curves [one of which will be the TTS onset (= 6 dB TTS) curve].

Results from these tests on harbor seals will be used as the model for all true seals (phocids).



Female harbor seal swallowing a fish reward after a trial during a hearing test for the TTS study.
Léonie Huijser, SEAMARCO

The project is employing two harbor seals that have been trained for research and have participated almost daily in psychophysical acoustic research for 14 years. During a hearing test, the trained harbor seals wait at a listening station that is at a specific distance from the underwater loudspeaker. When they hear a sound, they leave the station and swim towards the trainer for a reward. Each TTS session includes a pre-exposure hearing test, exposure to a fatiguing sound of a particular frequency, and several post-exposure hearing threshold measurements to determine the rate of recovery of hearing.



The study's harbor seals.
Léonie Huijser, SEAMARCO

Seven fatiguing sounds are being tested: a continuous tone of 6.5 kilohertz (kHz) and continuous 1/6-octave noise bands centered at 0.5, 1, 2, 16, 32 and 40 kHz. Control sessions are conducted for each hearing test frequency. Exposure duration is generally one hour per session, but in order to try to elicit TTS due to 0.5 kHz longer sessions were needed. Each fatiguing sound is produced at five sound pressure levels (SPL), of which three result in approximately the following TTS levels: 6, 12 and 18 decibels. This approach provides insight into the relationship between TTS and SPL. Two or three hearing frequencies are tested per fatiguing sound frequency (often the highest TTS occurs at a higher frequency than the frequency of the fatiguing sound). Each of the three highest SPLs (and the controls) are being replicated multiple times.

Data collection for all but one frequency is complete, analysis is ongoing and manuscripts are being written. The original plan included testing 0.125 and 0.250 kHz frequencies as well, but when conducting the tests for 0.5 kHz, it took exposure durations of 6 hours or more to elicit any TTS (indicating the seal hearing is not very susceptible to TTS due to low-frequency sound, despite the fact that seals can hear low-frequency sounds relatively well compared to, for instance, dolphins and porpoises). Therefore, the 0.125 and 0.250 kHz frequencies were not tested, and the remaining data collection time is used to try to elicit higher TTSs at 1 and 2 kHz.

The resulting data will be used to define the Navy Phase IV hearing weighting function and temporary/permanent threshold shift values for the phocid (seals) group. The data will be directly applicable to all Navy environmental documents analyzing acoustic effects of tonal sounds (e.g., sonars) and broadband noise sources.

A first publication resulting from this work is:

Kastelein, R.A., Helder-Hoek, L. and Gransier, R. (2019). Frequency of greatest temporary threshold shift in harbor seals (*Phoca vitulina*) depends on the fatiguing sound level. *The Journal of the Acoustical Society of America* 145, 1353-1362.

LMR PROGRAM PARTICIPANT UPDATES

Three field efforts, providing data to four LMR-funded projects, are highlighted this quarter.

3S3: Behavioral Responses of Cetaceans to Naval Sonar (LMR project 29)

The 3S3 team returned to the waters off Norway for another round of cetacean tagging, controlled exposure experiments (CEE) and behavioral response data collection. The 2019 field work, conducted from mid-August to mid-September, included CEEs using both the previously used prototype (simulated) source (Socrates) from the research vessel HU Sverdrup II (HUS) and an operational source (Captas) from the Norwegian Navy frigate KNM Otto Sverdrup (OSVE). In addition to its many other tasks, the team successfully completed a primary task—to tag sperm whales with mixed-DTAG (recording sound, movement, location) and conduct CEEs using pulse active sonar (PAS) at different levels and ranges using the operational source on the Norwegian Navy Frigate. Using the simulated source, the team completed additional CEEs mimicking the operational source transmission scheme. Overall the team deployed 24 tags and conducted 11 CEEs. Data analyses are now underway. For background on this project see the Project Spotlight section of the Summer-17 issue of *LMR News* and the project fact sheet on the new LMR website (www.navfac.navy.mil/LMR).



Sperm whale tagging.
3S/Saana Isojunno, NARA permit 18/126201

Effects of Underwater Explosive Sound on Fishes (LMR project 26)

The Fish Explosion Experiment (FISHEX) Team successfully completed its second field season examining the effects of explosive sound on fishes. This round of tests, to support the LMR project *Effects of Underwater Explosive Sound on Fishes*, were conducted on the Silver Strand Training Complex off of San Diego, California during mid-September.

Data were collected for two distinct goals—to record acoustic measurements of six underwater detonations and to document physical injuries on more than 400 Pacific mackerel (*Scomber japonicus*). Each of the six underwater detonations (UNDET) was comprised of 10 pounds of C4 explosive. For each test, fish were confined to cages in mid-water (10 meters deep in 20 meters of water) at various distances (20 to 500 meters) from the underwater detonation (UNDET), while acoustic recording instruments in the cages captured the received levels of sound from each UNDET. An acoustic vertical line array also measured sound as function of depth at one of the cage locations.

Post-exposure, the team recovered the cages and euthanized the fish onboard the research vessel *Ecos*. The mackerel were transported to the laboratory for necropsy and examination of internal injuries. The ear tissue from a sub-set of mackerel was sampled and preserved. These tissues will be microscopically observed for effects to auditory tissues.

Together, the data will help to identify quantitative thresholds for mortality and physical injury in fish. It also will contribute to the development of an effects dose-response curve for use in the Navy's at-sea environmental compliance and permitting processes.

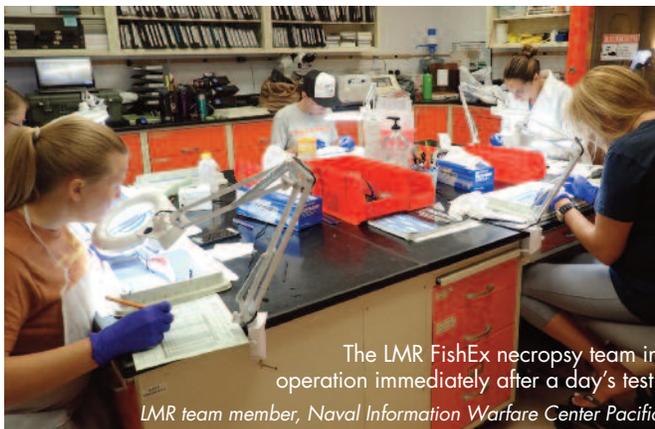
A multi-service team worked together to collect the data. The field team included scientists and engineers from Naval Information Warfare Systems Center Pacific, University of Washington Applied Physics Lab, Naval Submarine Medical Research Lab and Naval Facilities Engineering Command Southwest. Explosive Ordnance Disposal technicians from Navy Region Southwest Shore Detachment set and triggered underwater detonations.

Although the acoustic and necropsy data are still being analyzed, preliminary analysis suggests that mackerel within approximately 25 meters of an underwater explosion of this size are unlikely to survive. Less severe injuries were documented to approximately 300 meters.

For background on this project see the Project Spotlight section of the Winter-19 issue of *LMR News* and the project fact sheet on the new LMR website (www.navfac.navy.mil/LMR).

Cuvier's Beaked Whale and Fin Whale Behavior During Military Sonar Operations (LMR projects 23 and 30)

The project team successfully completed another field event over ten days in early October 2019. Tagging efforts included the use of the new Sound and Motion Recording and Telemetry (SMRT) tags. The SMRT tags record acoustics, depth, speed and GPS location, which can be used to help analyze fine-scale behavior of the animal. In addition, the tags can collect data for approximately two full weeks. Two SMRT tags were deployed on Cuvier's beaked whales, one on an adult female and the second on a sub-adult (sex unknown). In addition to any opportunistic exposures experience by these two animals, a coordinated exposure experiment with helicopter-dipping sonar was conducted on the tagged adult female. Both tags were successfully recovered and an initial inspection of the tags showed data was recorded. Data analysis will begin soon.



The LMR FishEx necropsy team in operation immediately after a day's test.

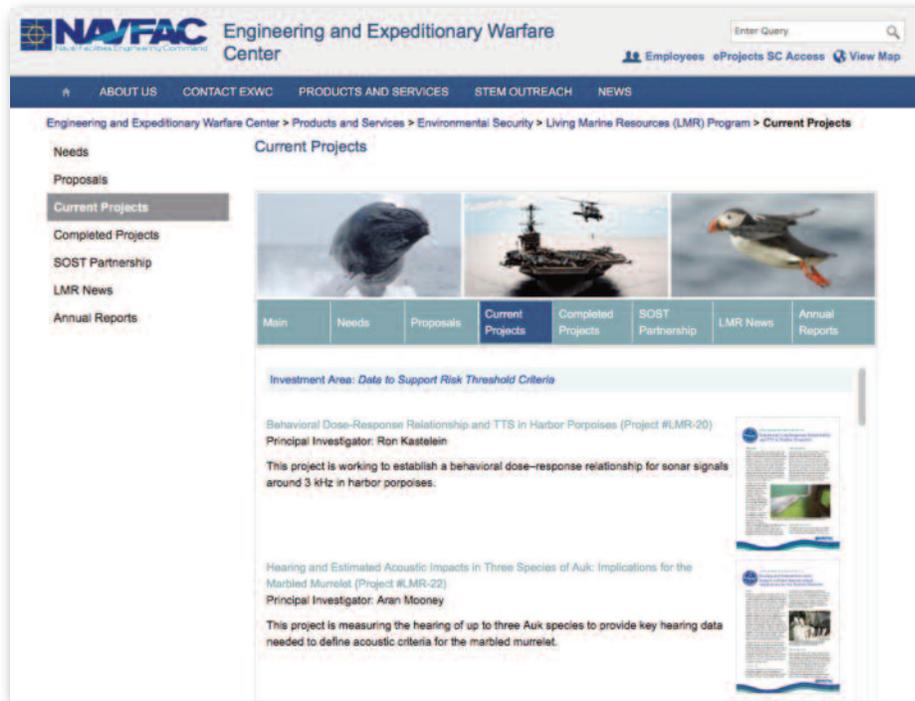
LMR team member, Naval Information Warfare Center Pacific

PROGRAM SCHEDULE

No.	What	When
1.	Proposal Solicitation & Review	
a.	FY20 pre-proposal solicitation closes	November 12, 2019
b.	FY20 proposal request notification	January 2020
2.	Quarterly Status Reports (QSR)	
a.	Submit winter QSR	January 31, 2020
b.	Submit spring QSR	April 30, 2020
c.	Submit summer QSR	July 31, 2020
d.	Submit fall QSR	October 30, 2020

OUR WEBSITE

You can now find links to all of our informational materials, including our 2018 annual report, at our new website address—www.navfac.navy.mil/lmr.



www.navfac.navy.mil/lmr



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-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

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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 highlights from the 2019 IPR and project updates as available.



Frigate KNM Otto Sverdrup.
Frans-Peter Lam