



## LIVING MARINE RESOURCES PROJECT 26

# The Effects of Underwater Explosions on Fish

### NEED

Navy at-sea training activities must comply with a suite of Federal environmental laws and regulations, including the National Environmental Policy Act (NEPA) and the Endangered Species Act (ESA). U.S. Navy Explosive Ordnance Disposal (EOD) team training activities can include underwater explosive charges, and additional data are needed regarding the effects of such explosives on fish. In order to quantify potential impacts to threatened and endangered species of fish, data are needed related to sizes, depths, and distances to the subjects that are relevant to Navy explosives training activities.

### SOLUTION

A multidisciplinary team of researchers and Navy EOD technicians will conduct field-based experiments to collect data needed to develop guidelines and threshold criteria for effects on fish resulting from exposure to underwater explosives. The results will help to predict potential effects that may occur during Navy training activities.



*Lee H. Shannon, NAVFAC EXWC*

Measuring underwater explosives on the Pu'uloa naval test range.

### METHODOLOGY

The project team will quantify the physical effects on fish after exposure to accurately measured energy from underwater explosives. The team will use fish species with differing characteristics (e.g., different relationship between pressure detector and the ear) and size, at varied water depths and distances from the source. Tissues from exposed fish (as well as

from an extensive set of control samples) will be examined using quantified necropsy techniques. The effects will be correlated with both the scalar (pressure) and vector (particle velocity) components of the explosive energy received by the fish.

The project plan is to use fewer species and test each under a wider variety of conditions as opposed to testing more species under fewer conditions. This approach will provide a broader and more comprehensive understanding of potential effects and dose-response relationships.

## SCHEDULE

Following project organizing activities in 2016, detailed study design, protocols and approvals will be developed and secured in 2017, as will equipment testing and refinements. The primary field work will be conducted in 2018 and 2019. The team will complete its data analyses and reports and present results during 2020.

## NAVY BENEFITS

The results of the proposed applied research can be directly applied to the Navy's analysis of explosive impacts to marine fish by providing thresholds for mortality, injury and hearing loss for a variety of species at varying depths. Collecting exposure data, notably in an open-water environment, will enable criteria development using the most appropriate and accurate metrics available.

## TRANSITION

The peer-reviewed publications and technical report will transfer the knowledge gained to end-users. The Navy technical report will include peer-reviewed results, as well as results from past studies, that are needed to recommend criteria for explosive impacts to marine fish. Applying computer-modeled ranges to these criteria, ranges-to-effects (i.e., range of distances within which effects could be expected) for different types and sizes of fish could be predicted to satisfy regulatory concerns. Research results and accompanying derived criteria would be immediately useful for Navy environmental compliance when quantifying potential explosive impacts to fish and habitat (e.g. forage fish).

## ABOUT THE PRINCIPAL INVESTIGATOR

Peter Dahl is a Senior Principal Engineer in the Acoustics Department and a Professor in the University of Washington's Department of Mechanical Engineering. Dahl's research is in areas of acoustics with primary focus on underwater sound. Dr. Dahl earned his Ph.D. from the Massachusetts Institute of Technology and Woods Hole Oceanographic Institution in 1989.



*Key collaborators include Keith Jenkins from the Space and Naval Warfare Systems Center Pacific and Art Popper from the University of Maryland.*

## About the LMR Program

The Living Marine Resources (LMR) program seeks to develop, demonstrate, and assess data and technology solutions to protect living marine resources by minimizing the environmental risks of Navy at-sea training and testing activities while preserving core Navy readiness capabilities. For more information, contact the LMR program manager at [exwc\\_lmr\\_program@navy.mil](mailto:exwc_lmr_program@navy.mil) or visit [www.lmr.navy.mil](http://www.lmr.navy.mil).

