A hand-held tool for rapid assessment of underwater sound to inform decision making

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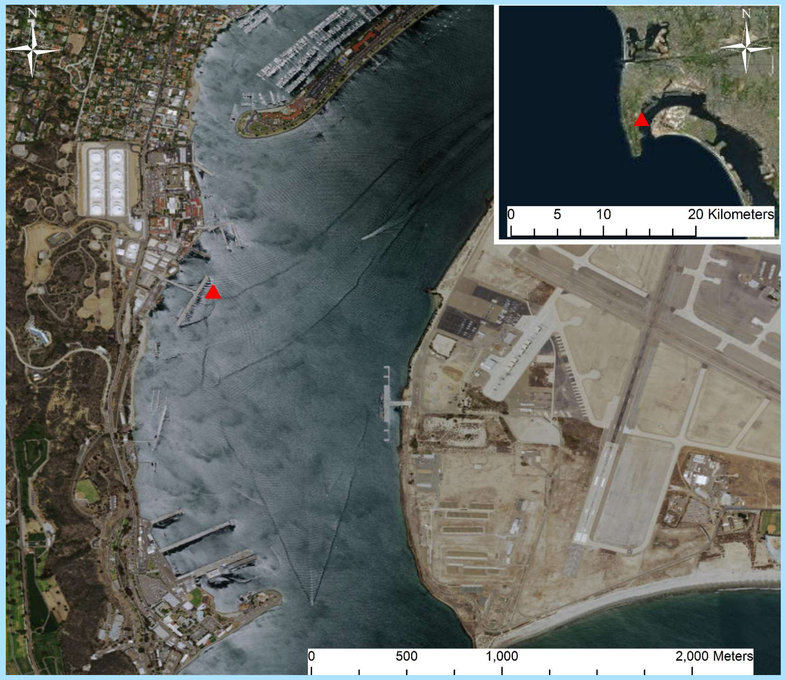
Abstract

Measurements of underwater noise from pile driving were collected during a marine construction project in San Diego Bay. These measurements were used to identify the best placement of marine mammal observers, and to adhere to the requirements of an Incidental Harassment Authorization (IHA). This presentation will focus on a subset of these measurements made with a hand-held device, or Underwater Sound Level Meter (USLM).

The USLM employs an intuitive operating menu, requires no specialized training, and rapidly delivers fully calibrated results expressed in the relevant metric to stakeholders and decision makers, such as peak level, root-mean square (RMS) level and sound exposure level (SEL).

Here we show the evolution of the underwater sound field from pile driving versus range every ~1 m while recording with a USLM from a small vessel that slowly opened in range from the pile source (the USLM also records its own position via GPS.) Results of such fine-scale range sampling are used to verify modeling of underwater sound field from pile driving.

San Diego Bay Naval Fuel Pier Construction



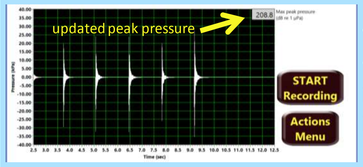
Areal photograph of San Diego Bay showing location (red triangle) of impact pile driving discussed in this presentation (measurements from January 2015).

Work in San Diego Bay funded by Naval Engineering Facilities Command, Southwest

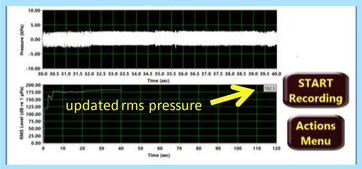
Underwater Sound Level Meter

Stakeholders in both industry and government share the same goal of rapid, calibrated measurements of underwater noise to protect marine life and comply with statuary environmental regulations. The USLM is a time and labor saving device that meets this goal.

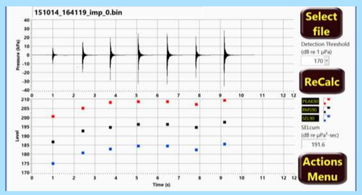
The USLM is based on intuitive menus. One starts by selecting a *Recording* mode, either *Vibratory* or *Impact* option.



The *Impact* option displays the acoustic pressure from impact pile driving strikes in real time



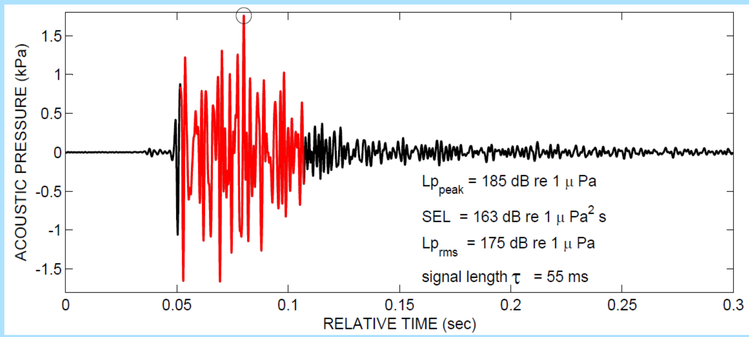
The *Vibratory* option displays the RMS pressure from vibratory pile driving in real time



A full suite of metrics is computed within seconds after the measurements, here showing impact analysis

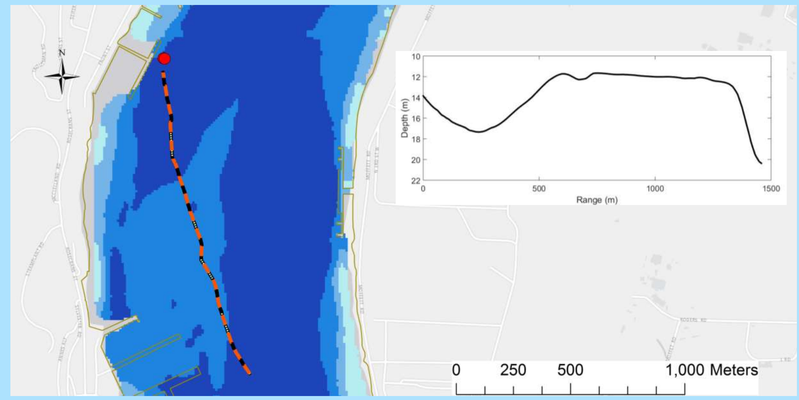
The USLM was developed with partial support from the Washington State Dept. of Transportation (WSDOT) and has been used by WSDOT in numerous underwater noise measurement tasks.

Peak, RMS, and Sound Exposure Level Metrics

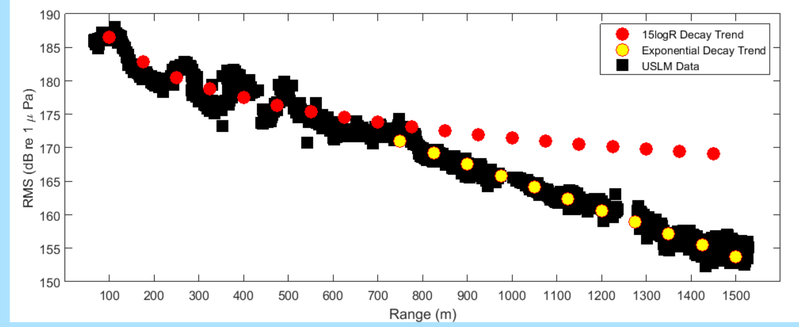


Typical time series of underwater sound pressure from impact pile driving and corresponding metrics (peak pressure, RMS, and SEL) computed automatically by the USLM. The region in red constitutes 90% of the energy from which the RMS and SEL metrics are derived.

Fine-scale Sampling of Underwater Noise from Pile Driving using the USLM



A small vessel (17 ft) slowly moved away from the pile (red dot). The dashed line shows the route followed while taking measurements of underwater noise from pile driving. Inset plot shows depth profile along the track. Measurements were taken over approximately 1 hr, during which ~1600 pile strikes were observed. Two piles approximately 5 m apart were used as the source (driven sequentially.)



The RMS pressure level versus range from pile during impact pile driving along transect shown above. Simultaneous measurements made at range 10 m from the pile source remain at a constant level of 197 dB +/- 2 dB. Red dots show a trend that follows 15 $\log_{10}$ R where R is range from source (also known as practical spreading law). There is much greater exponential decay beginning at range ~750 m (yellow dots) due to bottom attenuation and a 15 $\log_{10}$ R trend significantly over-predicts the level after range 750 m.

Additional Resources

On impact Pile Driving

P. H. Dahl, C. A. F. de Jong, and A. N. Popper, "The underwater sound field from impact pile driving and its potential effects on marine life," *Acoustics Today, Spring 2015* vol. 11, issue 2, pp. 18-25, June 2015.

On vibratory Pile

P. H. Dahl, D. R. Dall'Osto, and D.M. Farrell, "The underwater sound field from vibratory pile driving ," *J. Acoust. Soc. Am.*, vol. 137, pp. 3544–3554, June 2015.