Dredging Operations and the Potential Impacts of Underwater Sound

WEDA Western Dredging Association

WEDA Midwest Chapter 2016 Meeting

Davenport, IA | March 23-25, 2016

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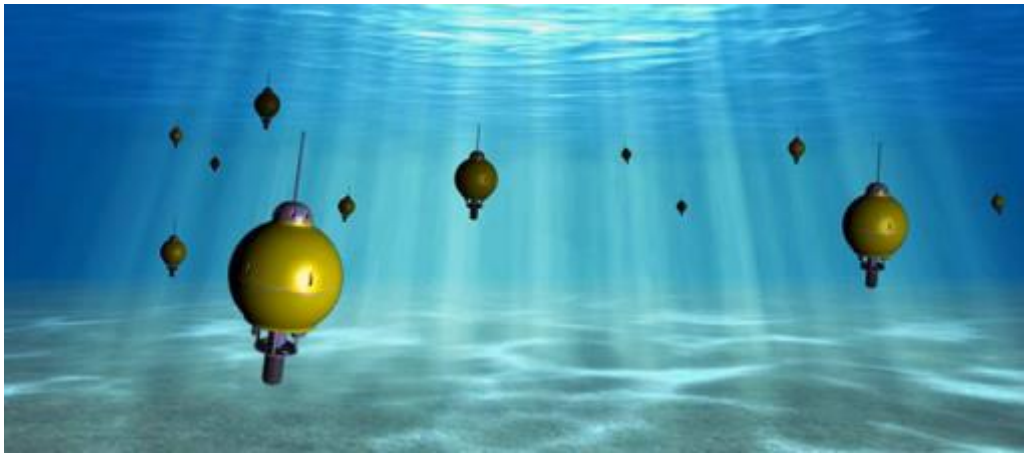
Topics Covered

- Background on the issue of Underwater Sound (UWS) as related to dredging
- UWS case study – Passaic River Phase I Removal Action
- Lessons learned: applicability of UWS monitoring to environmental dredging programs

State of Affairs

- The complexity of in-water environmental remediation programs has increased
- These programs now require extensive monitoring and BMPs
- One such requirement may be underwater sound monitoring



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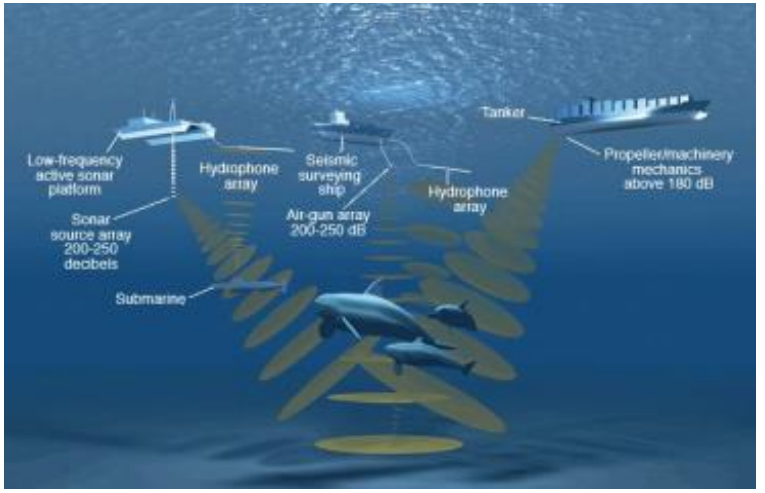
Background

- Various organisms use sound for navigation, feeding, and communication
- Anthropogenic underwater sound can interfere with these behaviors
- Very intense sound can cause mortality and/or permanent damage to exposed organisms
- This intensity of sound is not associated with dredging operations but may be associated with pile driving
- Various studies conducted and published on the underwater sounds produced by dredges



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Sound is Everywhere in the Underwater Environment

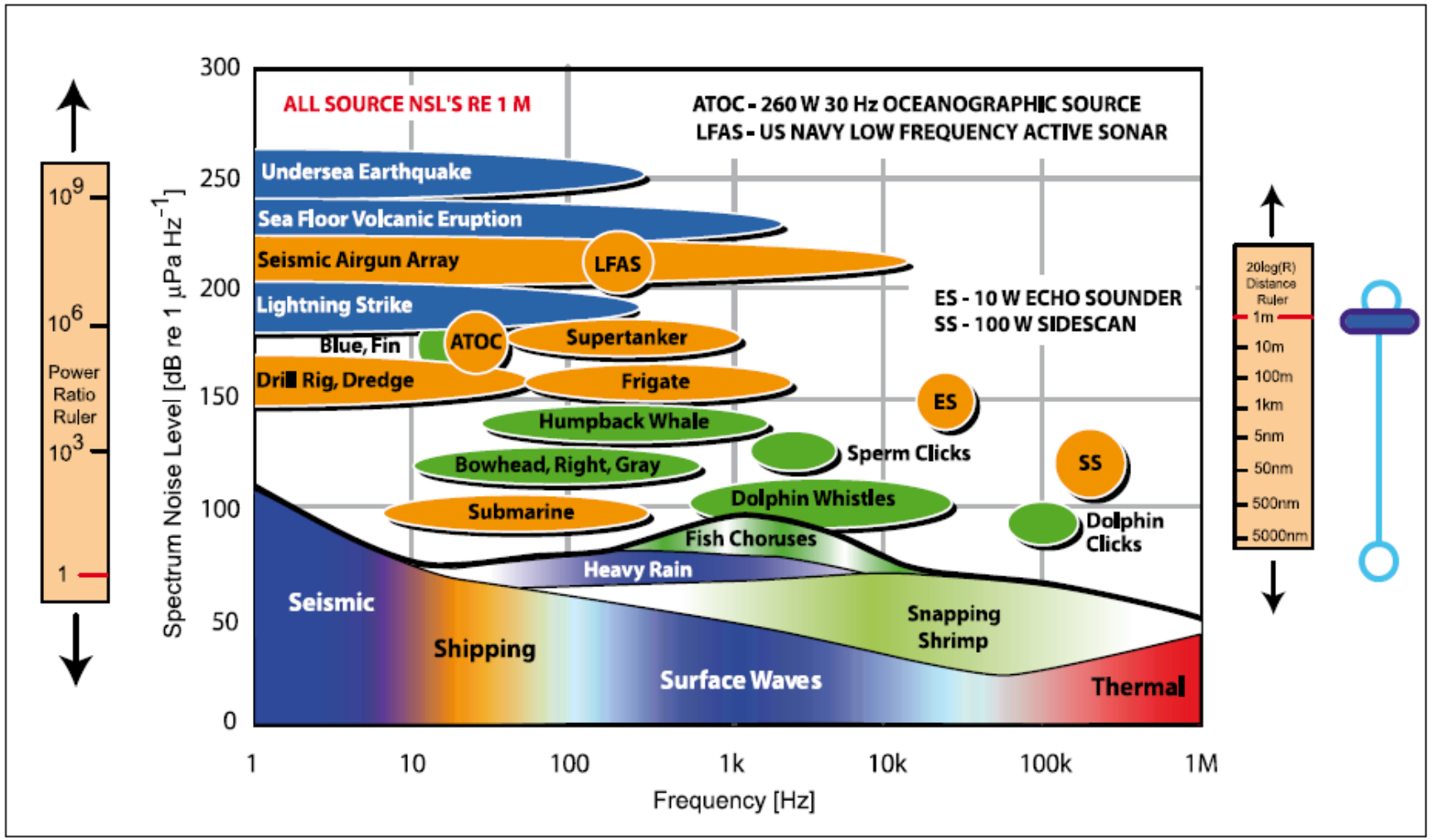
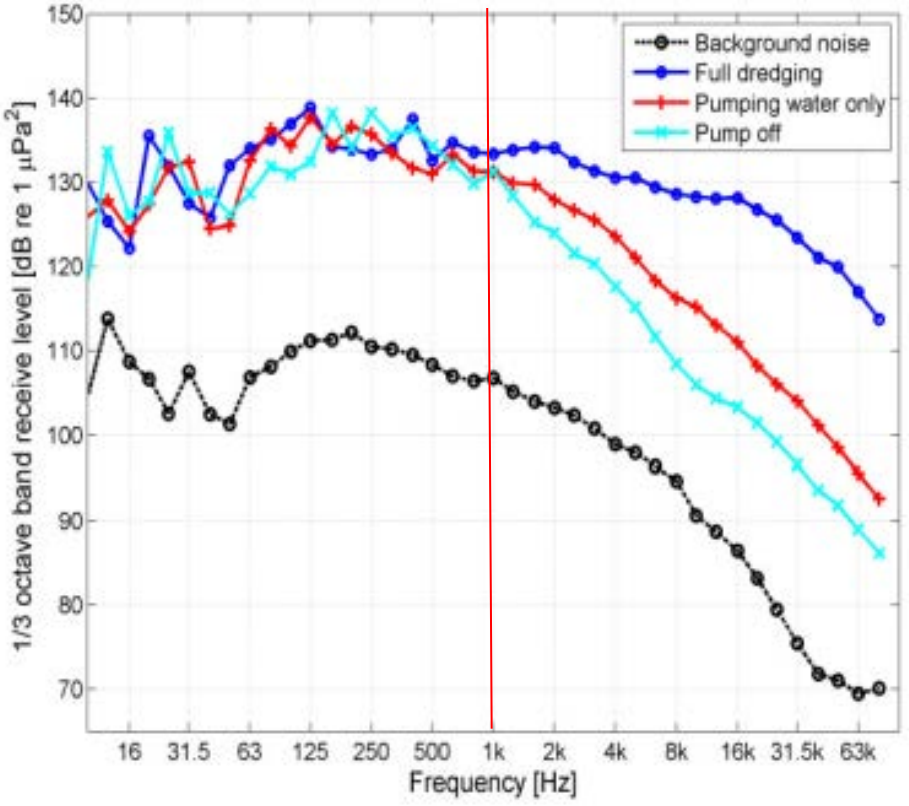


Figure 4. Noise levels and frequencies of anthropogenic and naturally occurring sound sources in the marine environment

Dredging Sound

- Medium intensity
- Mainly below 1 kHz



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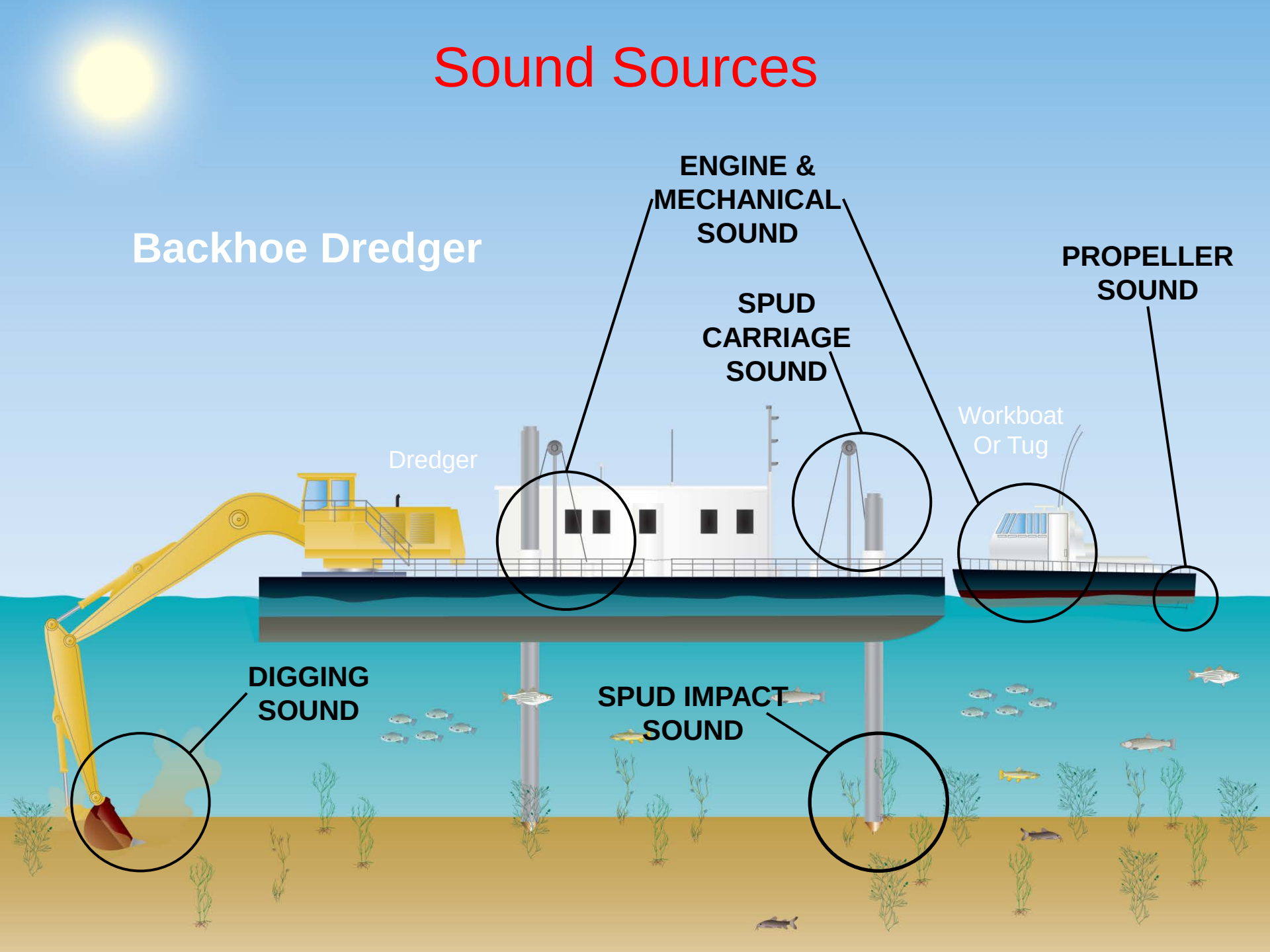
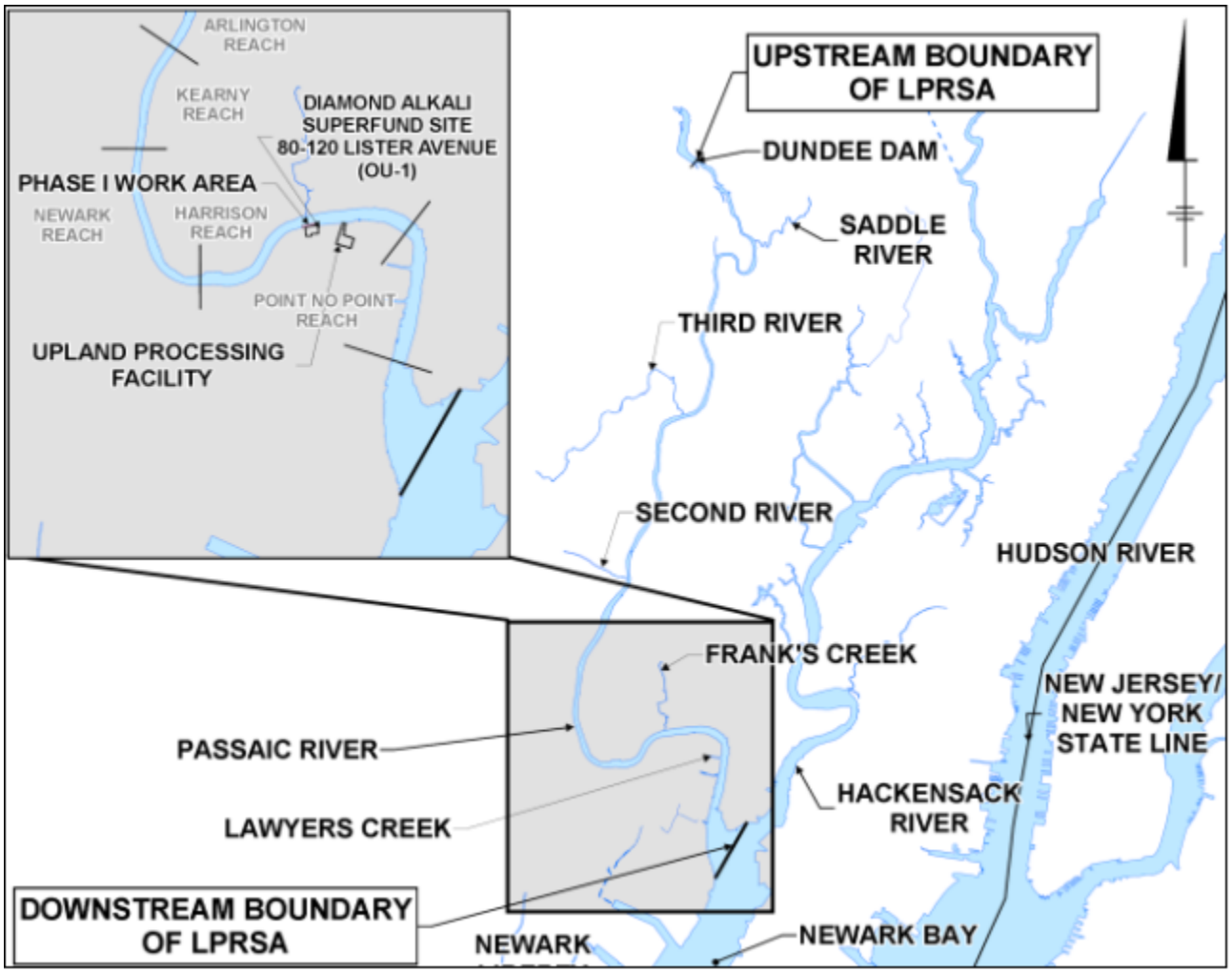
Sound Sources



Phase I Removal Action Project



- In 2009, Tierra Solutions, Inc. (Tierra) initiated a sediment dredging program located within the Passaic River
- Program directed by the United States Environmental Protection Agency (USEPA) and involved removing approximately 40,000 cubic yards of contaminated sediments to a depth of 12 feet

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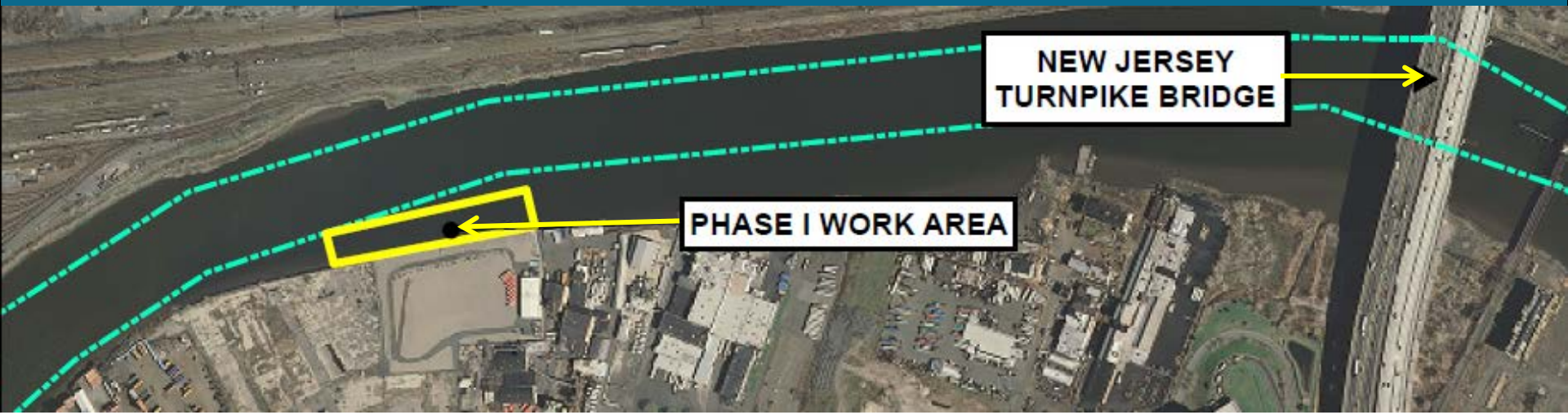
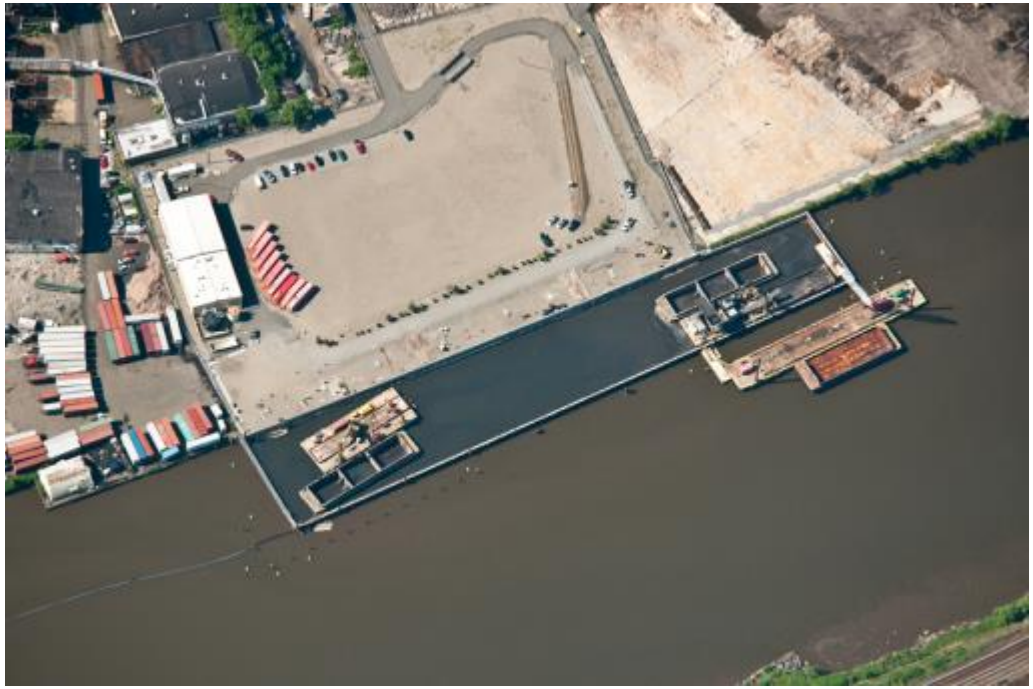
Project Overview



- Overall goal to reduce inventory and source of dioxins in the Passaic River by removing highest concentrations of 2,3,7,8-TCDD
- 40,000 cy sent for treatment/disposal
- Removal conducted via clamshell dredge within sheet pile enclosure
- Area backfilled and restored



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Phase I UWS Monitoring Program

- As part of sheeting installation and dredging, NMFS requested underwater sound data
- To be used for information purposes only - no association with compliance
- Interested in understanding effects on local native fish species (however no specific target species were identified)

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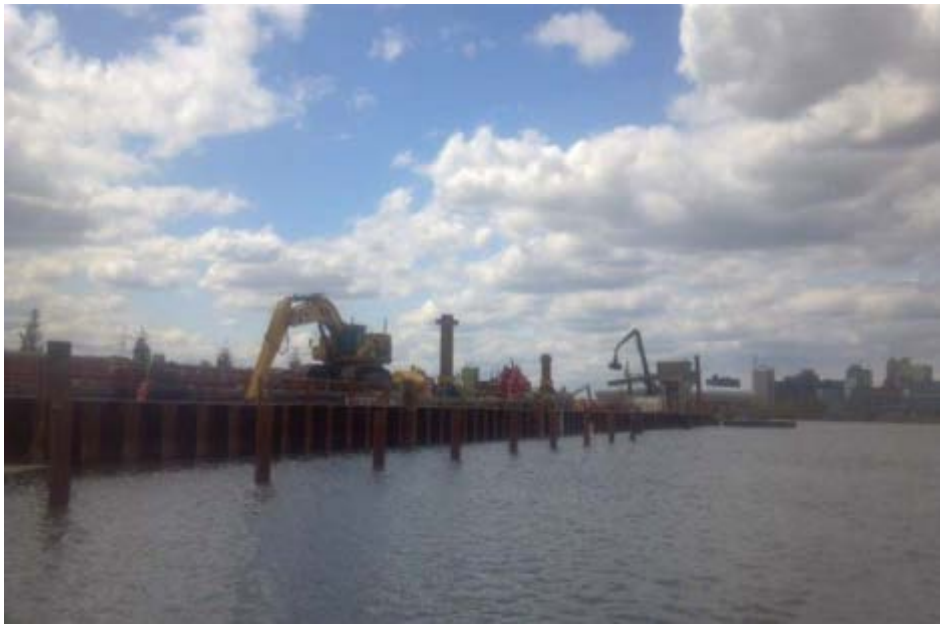
Phase I UWS Monitoring

- Focus was to collect underwater sound data:
  - During enclosure installation
  - During sediment removal operations
  - Ambient conditions measured before start of construction



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Phase I UWS Monitoring

- Sound Monitoring Methodology
  - Hydrophone system measured frequencies between 20 Hz and 20,000 Hz
  - Data were obtained from 26 stations spaced at 200 ft intervals
  - Hydrophone placed in middle of water column
  - Each station was monitored six times at various phases of the tide over the 2-day survey window

Phase I UWS Monitoring

- Data were acquired at 13 locations along two transects for a total of 26 monitoring locations

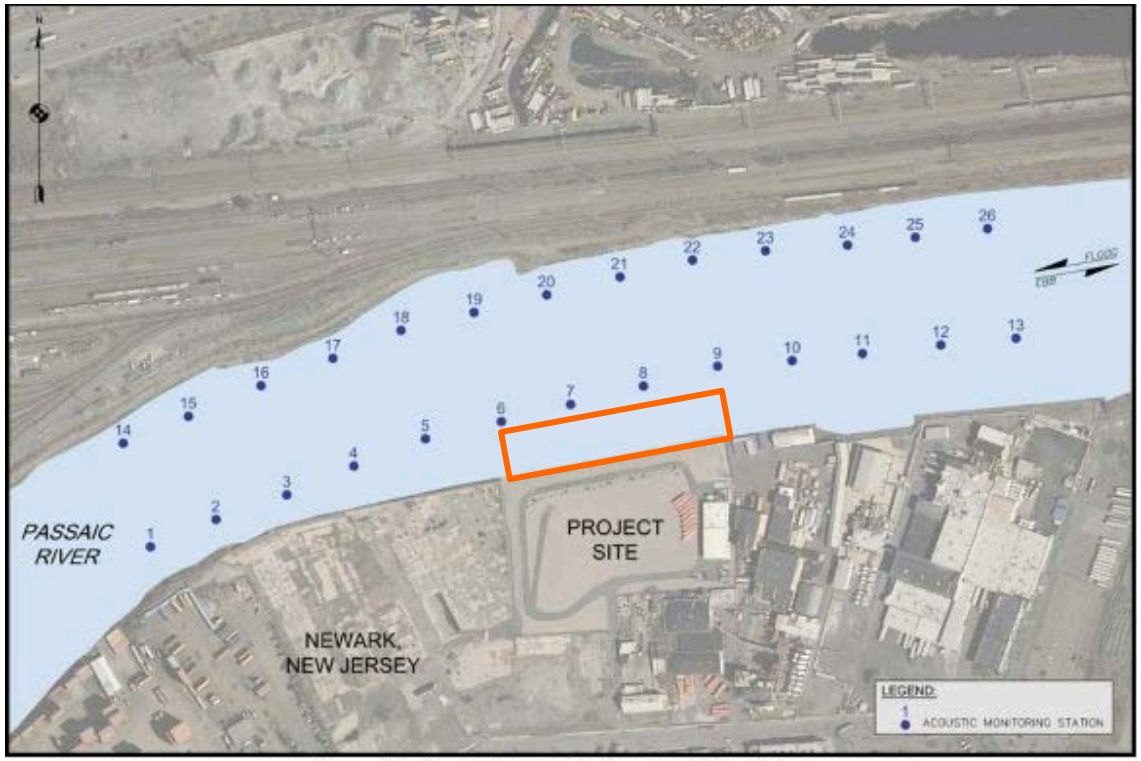

Figure 2. Acoustic monitoring sampling stations.

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Phase I UWS Monitoring

- The monitoring campaign consisted of three phases:
  - August 2011 – Pre-construction background monitoring
  - November/December 2011 – Sheetpile installation
  - April/May 2012 – Dredging
- 468 individual sound data files

Background Peak SPL

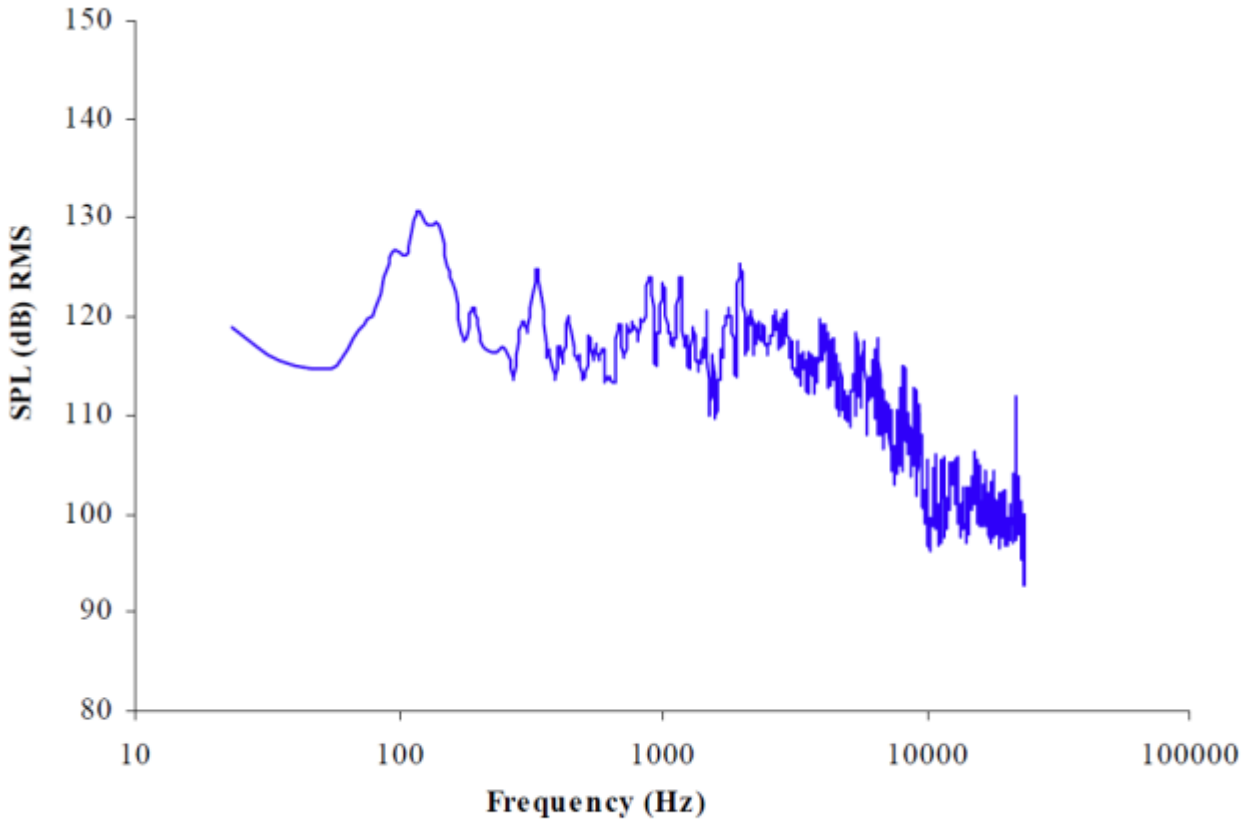

Figure 2. Peak SPL (RMS) Spectrum Data from Mappings 1-6 combined.

- Spectrum data range from 90db to 130db
- Higher SPL values below 1000Hz

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Sheetpile Peak SPL

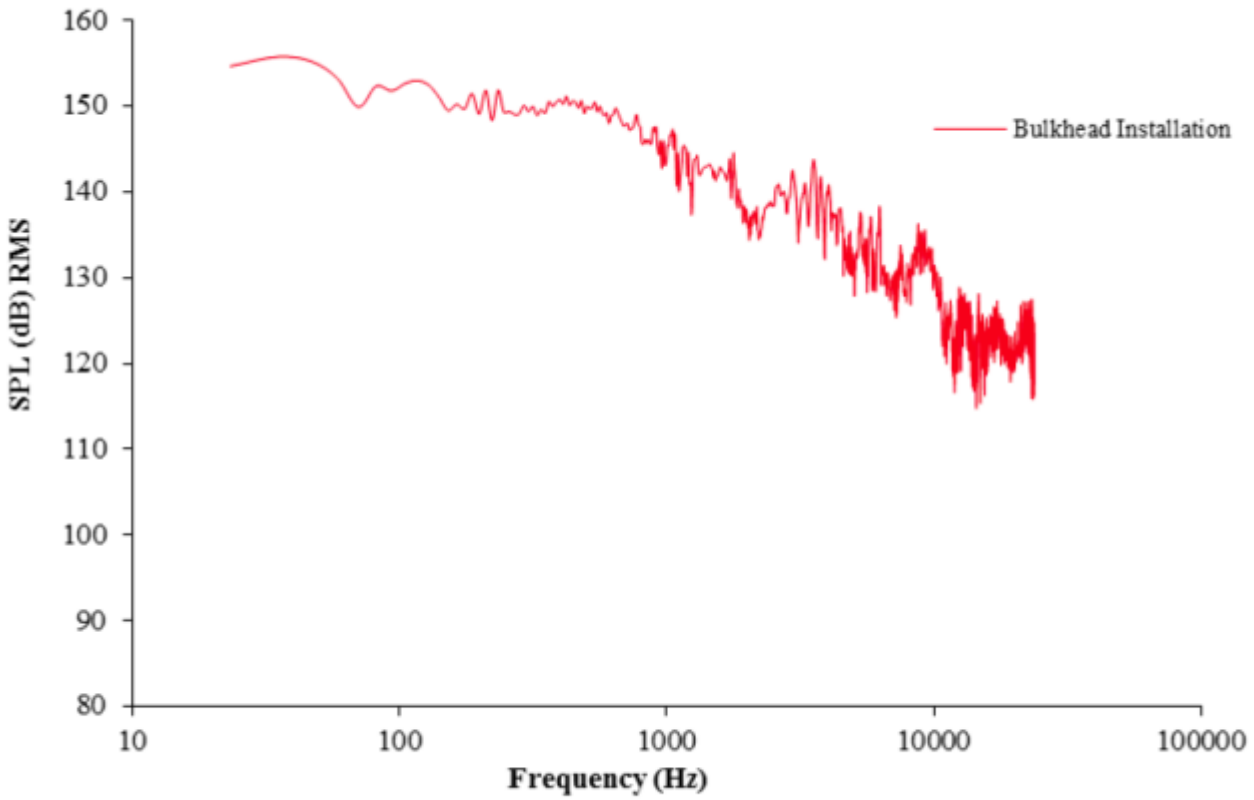

Figure 5. Peak SPL (RMS) Spectrum Data from Bulkhead Installation.

- Spectrum data range from 110db to 155db
- Higher SPL values below 1000Hz

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Dredging Peak SPL

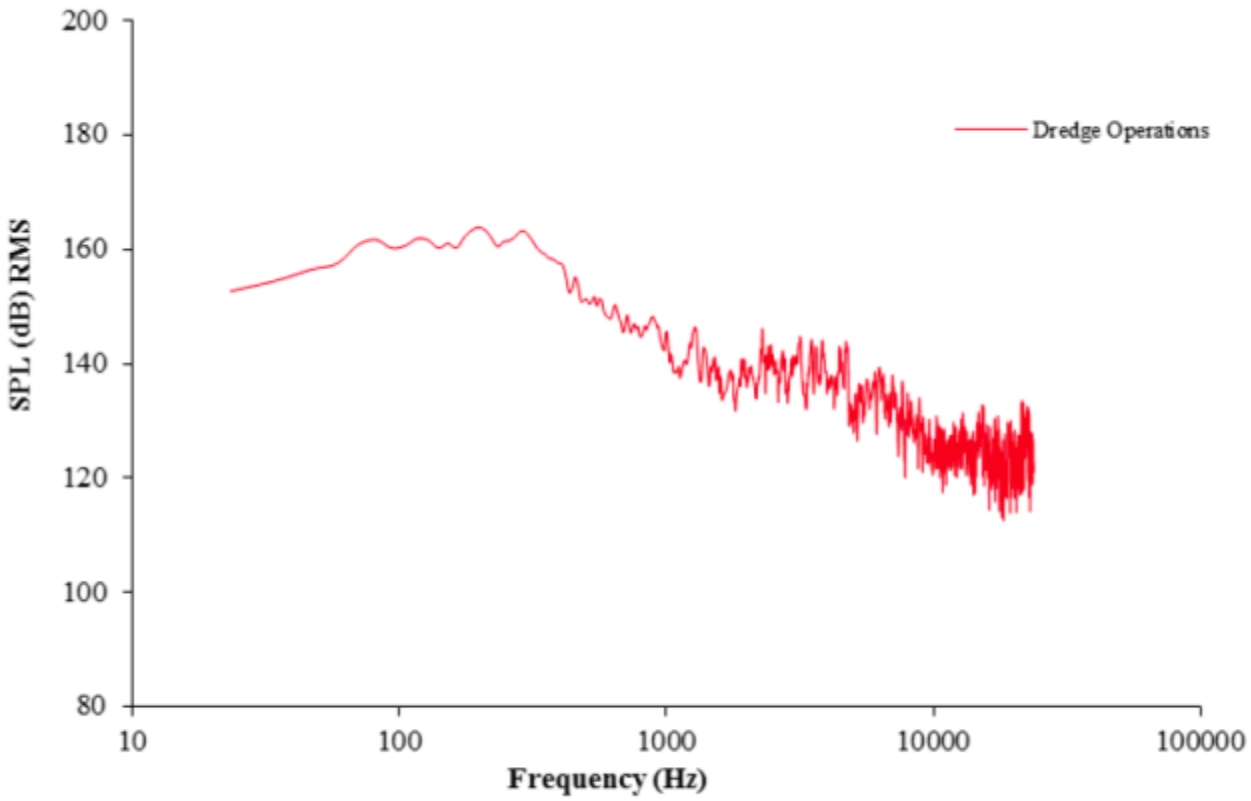

Figure 5. Peak SPL (RMS) spectrum data during dredging operations.

- Spectrum data range from 90db to 165db
- Higher SPL values below 1000Hz

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Comparison of Results with Other Studies

- Results generally consistent with those of Reine, Clarke, and Dickerson (Characterization of Underwater Sounds Produced by a Backhoe Dredge Excavating Rock and Gravel, December 2012)

ERDC TN-DOER-E36
December 2012

Characterization of Underwater Sounds Produced by a Backhoe Dredge Excavating Rock and Gravel

by Kevin Reine, Douglas Clarke, and Charles Dickerson

PURPOSE: This technical note characterizes underwater sound produced by a backhoe dredge during rock removal as part of the widening and deepening of New York/New Jersey Harbor. Both continuous sounds (e.g., engine and generator sounds transmitted through the hull) and repetitive, punctuated sounds (e.g., associated with bucket bottom contact and the repositioning of spuds) comprise a broad spectrum of dredging-emitted underwater sound sources. The various sound sources can be characterized in terms of intensity, periodicity, and attenuation with distance from the source. Likewise, the sounds must be placed into context with ambient levels of sound in the surrounding body of water. Such characterizations are required components of environmental assessments that address newly emerging concerns for detrimental impacts of underwater noise on many aquatic organisms. In order to adequately assess the risks associated with backhoe dredging operations, sounds were characterized with respect to sound pressure levels (SPLs) generated by this dredge type across the broad 20-Hz to 20-kHz spectrum. In addition, SPLs were measured in the 50- to 1,000-Hz range generally detectable by fishes and the 100- to 400-Hz range in which certain fish species show a greater sensitivity. Given the scarcity of existing accurate information quantifying underwater sounds generated by different dredge types and sizes, differences in geotechnical properties of material being excavated, and site specificity of working environments (i.e. bathymetry, hydrodynamic conditions, prevalence of non-dredging ambient sounds), this study fills important knowledge gaps that contribute to better-informed dredging project management practices.

BACKGROUND/INTRODUCTION: In recent years, concerns have been raised regarding underwater noise of anthropogenic origin and its potential impact on aquatic organisms. Originally focused on sounds associated with seismic exploration, military exercises, and pile-driving and similar construction activities, concerns have expanded to include dredging and dredged material disposal processes (Richardson et al. 1995). For example, it has been hypothesized that dredging-induced sounds could block or delay the migration of fishes through navigable waterways, interrupt or impair communication, or disrupt foraging behavior. Persistent concerns have dealt with disturbance of communication among marine mammals. Concerns are often heightened where projects occur in proximity to species listed as either threatened or endangered at either the Federal or state levels. Protective measures have been developed to avoid impacts by known intense sound sources. For example, the National Marine Fisheries Service (NMFS) requires an Incidental Harassment Authorization (IHA) for pile-driving activities where marine mammals are likely to occur. The authorization requires that a 500-m safety zone must be established in all areas where underwater SPLs were anticipated to exceed 190 dB re 1µPA. California Department of Transportation (Caltrans) (2001) examined fish that died as a result of exposure to underwater sounds from pile-driving operations. Mortalities were observed in several species, attributed primarily to injury to the swim bladders of fishes within 50 m of the pile-driving operation. SPLs

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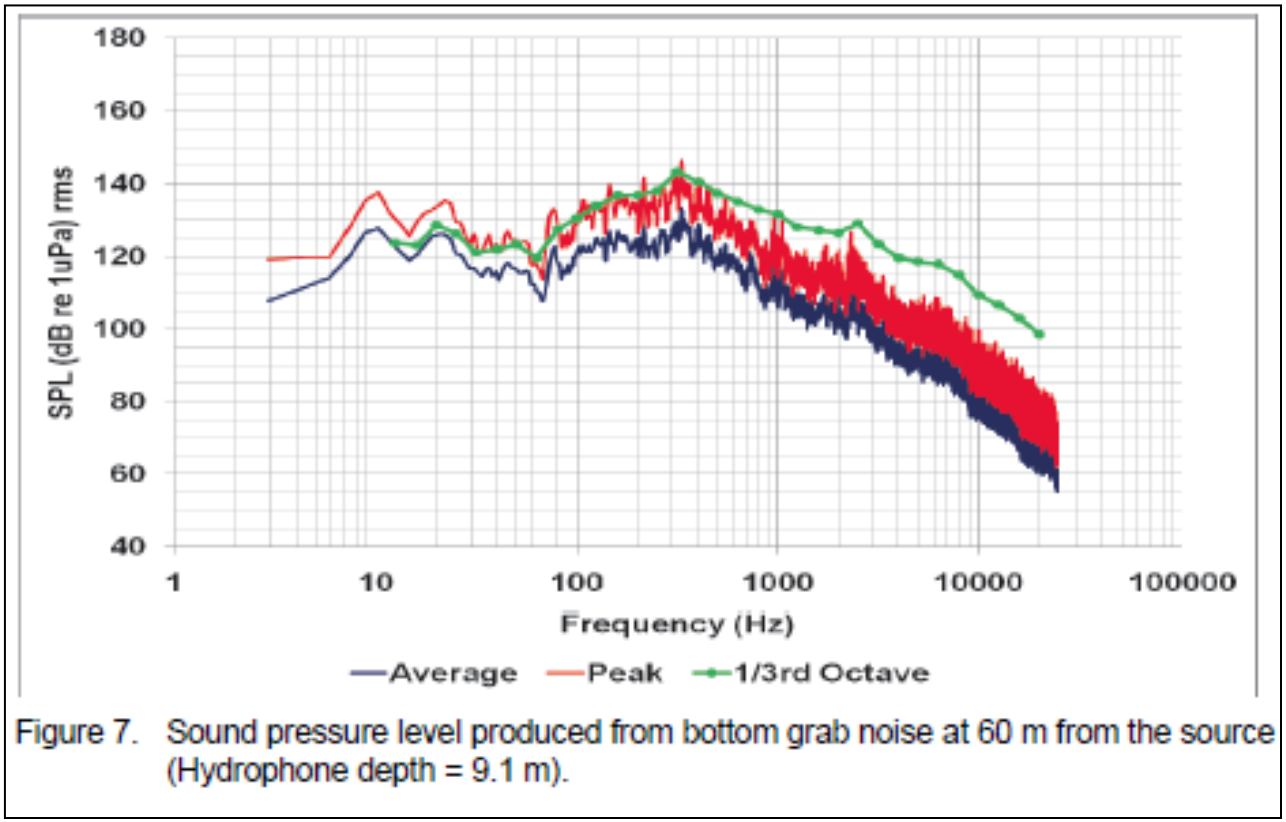

Figure 7. Sound pressure level produced from bottom grab noise at 60 m from the source (Hydrophone depth = 9.1 m).

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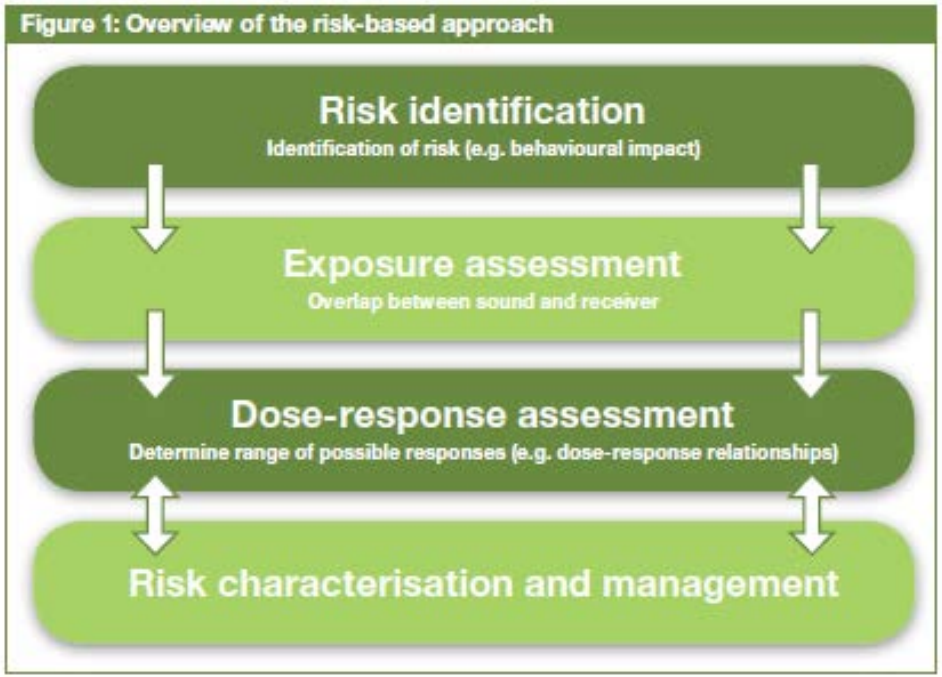
Phase I Findings / Conclusions

- Sheetpile installation and dredging were associated with increased Peak Sound Pressure Level (SPL) spectrum relative to the ambient levels
- Levels observed were not in the range expected to cause injury or mortality
- Significant acoustic sources observed during all three testing stages were not related to underwater activity
  - Overhead aircraft
  - Passing trains
  - Other nearby construction

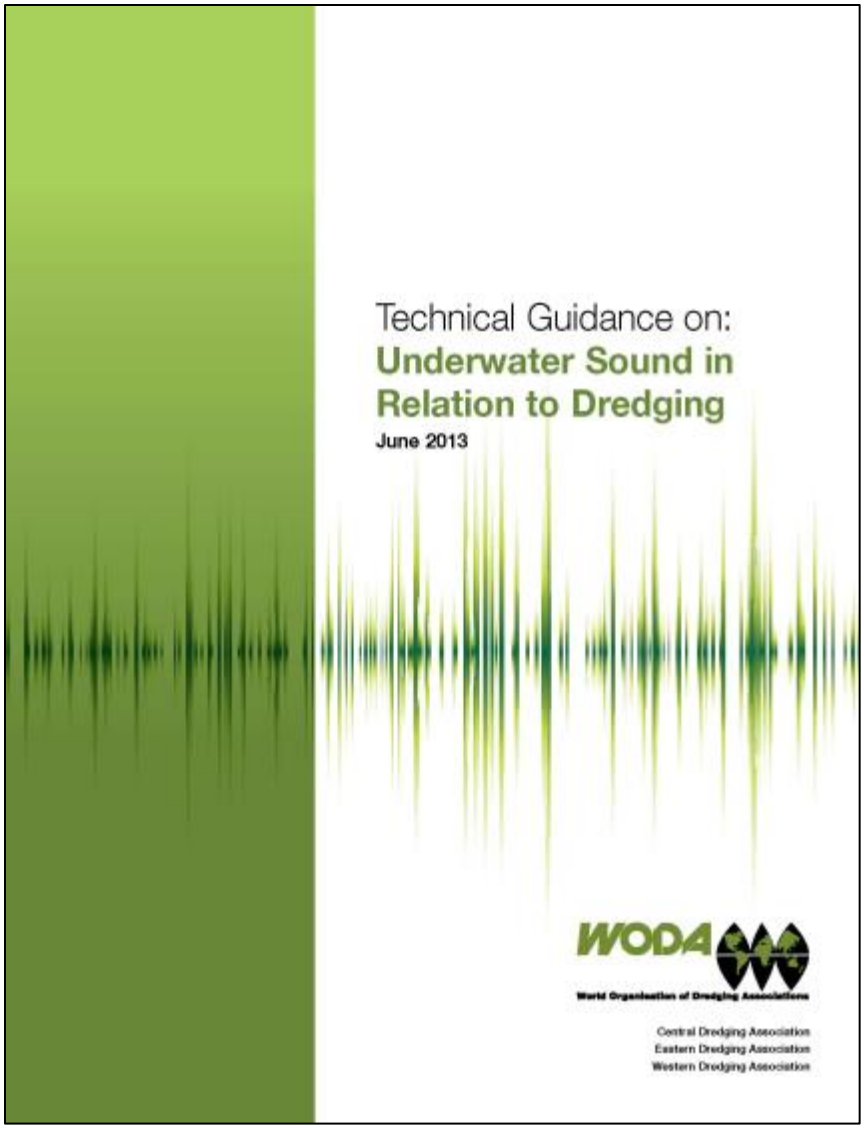
Overall Conclusions and Recommendations

- Environmental dredging is of generally medium intensity but yet does constitute an elevation above ambient levels
- As expected, sheetpile installation is of higher intensity than dredging
- Target species must be identified to appropriately gauge anticipated effect
- Environmental dredging is not likely to produce SPLs within the range that might lead to serious effects such as injury or mortality
- Pile driving must be evaluated separately as the SPLs in the near field could cause harm
- However, potential harm to individual organisms should not be overlooked in future programs
- Long duration environmental dredging programs, such as those currently envisioned in the Passaic River or other locations should be scrutinized for potential adverse effects on fish behavior (existing environmental windows may mitigate this potential)

Guidance Published in 2013



- The process begins with identification of the risk
- Beware of monitoring for its own sake



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Thank You!

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