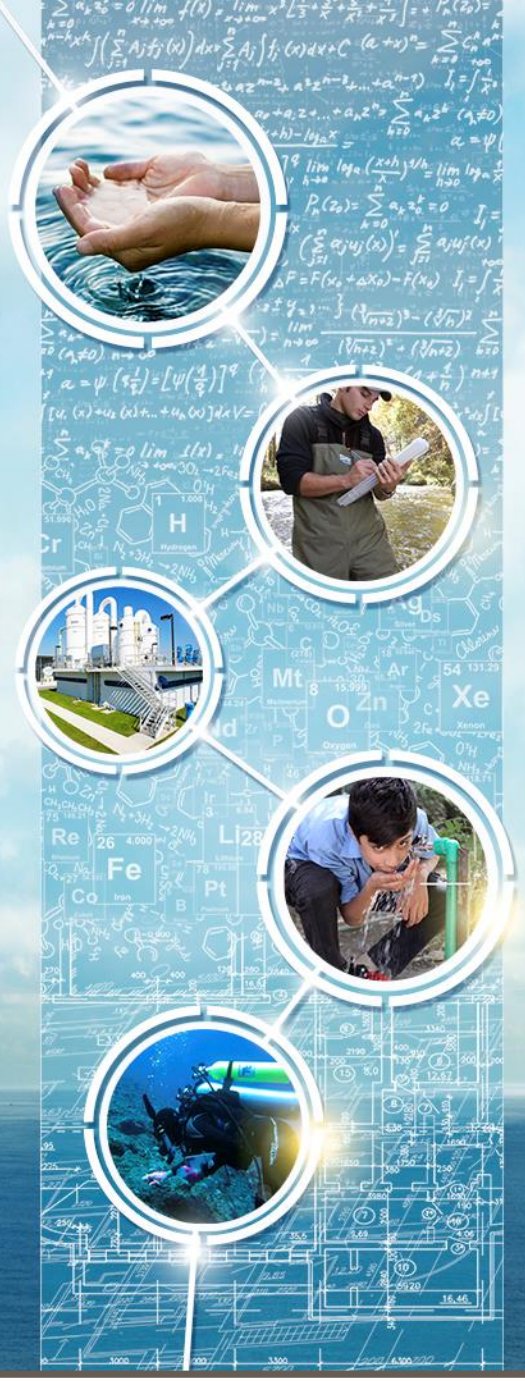


TETRA TECH

Innovations in Addressing Environmental Concerns

How To Manage Adverse Impacts With Noise Mitigation

Erik J. Kalapinski, Principal
Consulting Engineer
Tetra Tech

CALIFORNIA OFFSHORE WIND INDUSTRY SYMPOSIUM 2017

TETRA TECH

complex world | CLEAR SOLUTIONS™

*In a **complex world** with competing demands for limited resources, Tetra Tech offers **clear solutions** made possible with sound science, understanding, innovation, and industry-leading approaches.*

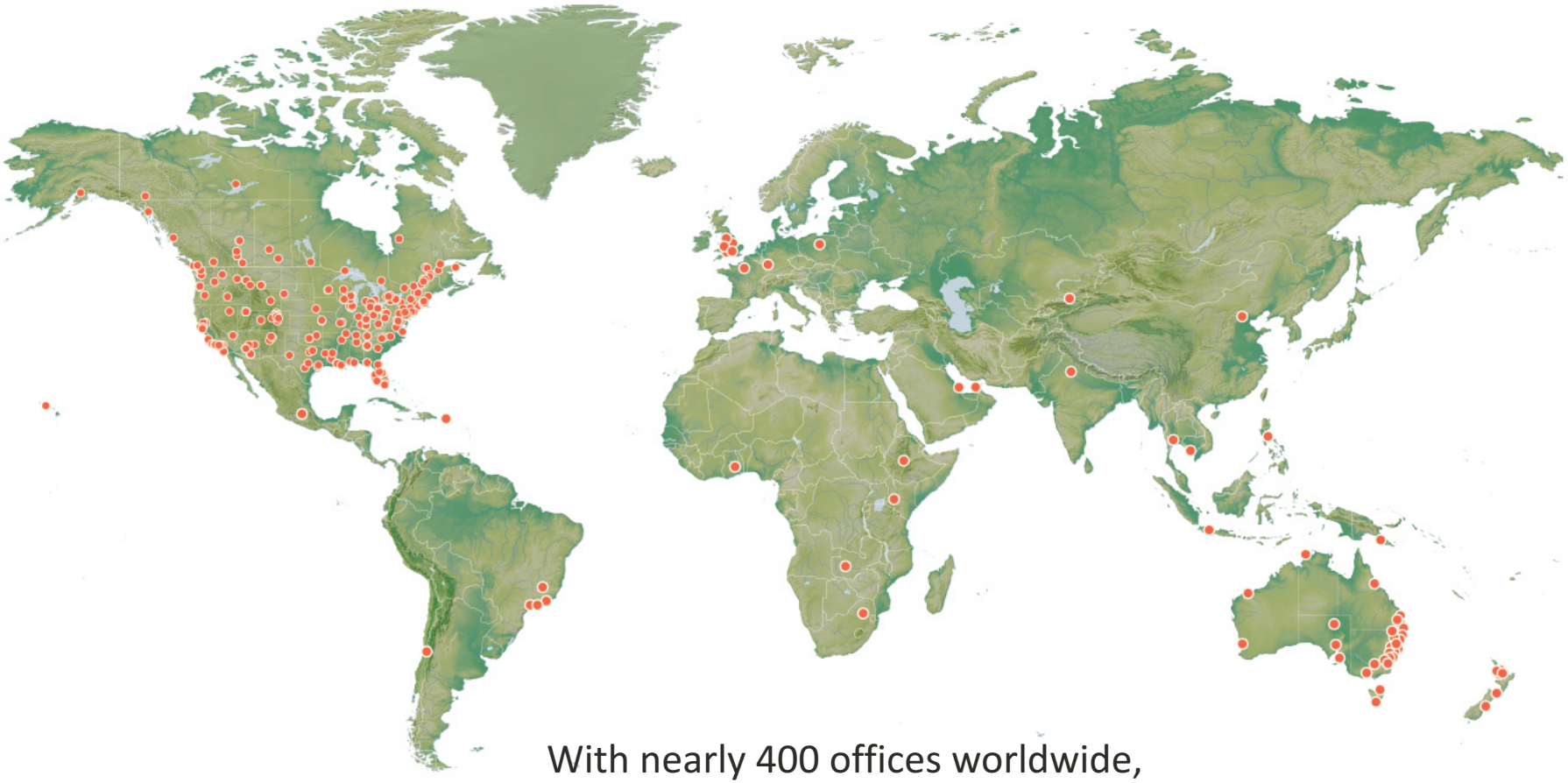
Who is Tetra Tech?

TETRA TECH

TTEK
NASDAQ®
GLOBAL SELECT

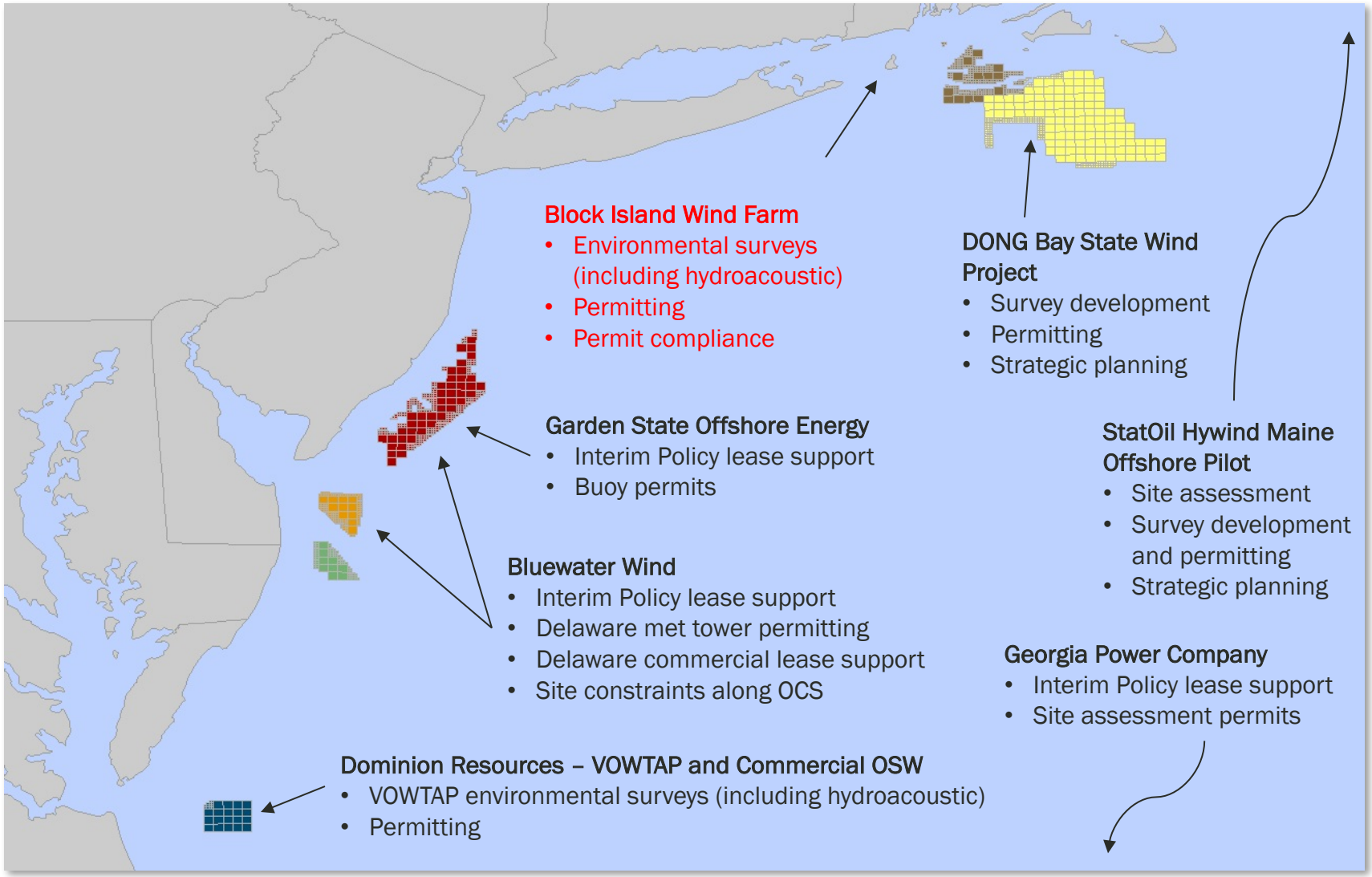
- Founded in 1966
- $2.5 billion annual revenue in FY2016
- 16,000 employees worldwide
- A network of approximately 400 offices
- Worked on 60,000 projects in more than 100 countries in FY2016
- Publicly traded on NASDAQ as TTEK
- Ranked continuously as one of the top 2 firms in Wind Energy
- Extensive recent experience with Bureau of Ocean Energy Management (BOEM)
- Core Energy Program Office headquartered in Boston, MA

Office locations



With nearly 400 offices worldwide,
we can quickly respond to our clients' needs.

Tetra Tech Offshore Wind Energy Experience



Underwater Noise

- Sound propagates through water almost 4.5 times faster than in air.
- Long wavelength, low frequency sounds are relatively unaffected by absorption, scattering and reflection and may travel tens of miles, depending on local environmental conditions.
- The sea itself is inherently noisy, with natural sounds emanating from a great variety of sources, both localized and dispersed, including surface waves, turbulence, water flow, seismic disturbances, and sounds of biological origin.
- There is some indication that increasing levels of underwater sound are being generated by man's activities in the oceans.
- Sound is very important to marine animals. It offers unrivalled advantages for fast, directional, and long distance information transmission especially in an optically poor medium like water.

References:
Urick, R. J. 1983. Principles of underwater sound, McGraw-Hill, New York. xiii, 423 p.
Kinsler, L. E., Frey, A. R., Coppens, A. B., and Sanders, J. V. 1999. Fundamentals of Acoustics, 4th edn. Wiley-VCH, Weinheim, Germany, 560 p.
Rogers, P. H., and Cox, M. 1988. Underwater sound as a biological stimulus. In In sensory biology of aquatic animals, pp. 131–149 Ed. by J. Atema, R. R. Fay, A. N. Popper, and W. N. Tavolga.Springer-Verlag, New York.

Sound Generating Activities

- **Project Construction**
  - Geophysical and geotechnical pre-surveys for site characterization
  - Impact pile driving
  - Construction vessel movements
  - Use of dynamic positioning thrusters
  - Cable lay
- **Operation**
  - Operation of renewable energy devices (wave and tidal)
  - Mooring systems noise (for floating turbines)
  - Sound transmitted from the nacelle through the tower and foundation and into the water column
  - Maintenance activities
- **Decommissioning**
  - Pile severing
  - Use of explosives

Typical Permitting Process

TETRA TECH

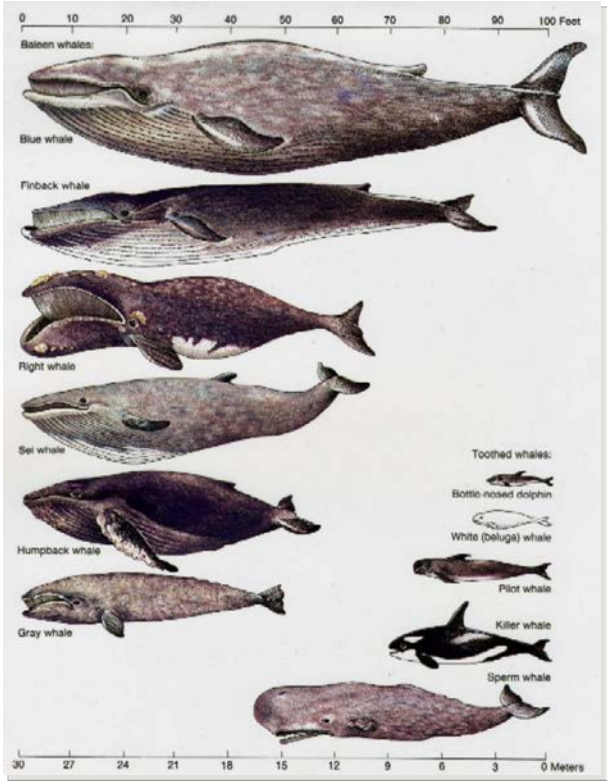
Permitting	Assessment	Mitigation	Hydroacoustic Monitoring
••Application to BOEM with accompanying ER	••Hydroacoustic assessment based on NOAA Fisheries Cause and Effect Noise Criteria*	••Pile Driving ramp up and soft start procedures	••Deployment of real-time hydrophone arrays
••IHA Application submitted to NOAA	••Presence/absence assessment	••Use of floating wind turbine technologies	••Fixed static recorders to document full time series
••IHA posted to Federal Register with 30-day comment period	••Develop Marine Mammal and Sea Turtle Harassment Avoidance Plan	••Design and execution of hydroacoustic monitoring program	••Constant communication between hydroacoustic field staff and PSOs
••NOAA Completes BO	••Reasonable and prudent mitigation measures established	••Field verification of monitoring zones	••Use of passive acoustic monitoring (PAM) to detect marine mammals that are not visible above the waterline
••BOEM issue Final EA and FONSI	••Identification of “Zones of Influence” (ZOI) and “Exclusion Zones”	••Visual monitoring of zones by Protected Species Observers (PSOs)	
••Permit is granted by BOEM and provides ROW Grant			
••NOAA issues IHA and ITS			

Note: New NOAA Fisheries Noise Guidelines recently finalized on August 4, 2016.

Mitigation

Agency-Specified Reasonable and Prudent Mitigation Measures:

- Visual Monitoring of Zones: Two visual monitoring zones are established to minimize harassment (zone of influence) and avoid harm and injury to marine mammals and sea turtles (exclusion zone). A dedicated vessel with protected species observers patrol the monitoring zone. No construction activities are allowed to restart until zones were cleared by the PSOs. Construction activity is immediately (and temporarily) shut down if a marine mammal or sea turtle approached the exclusion zone.
- Seasonal Constraints: Avoiding construction periods during migration of key or endangered species.
- Ramp Up/ Soft Start: Pile strikes at reduced impact force prior to full installation of each individual pile.
- Vessel Speed restrictions: to avoid strikes and reduce noise.
- Bubble Curtains: Can be used to reduce sound from pile driving and are regularly used in European offshore construction.

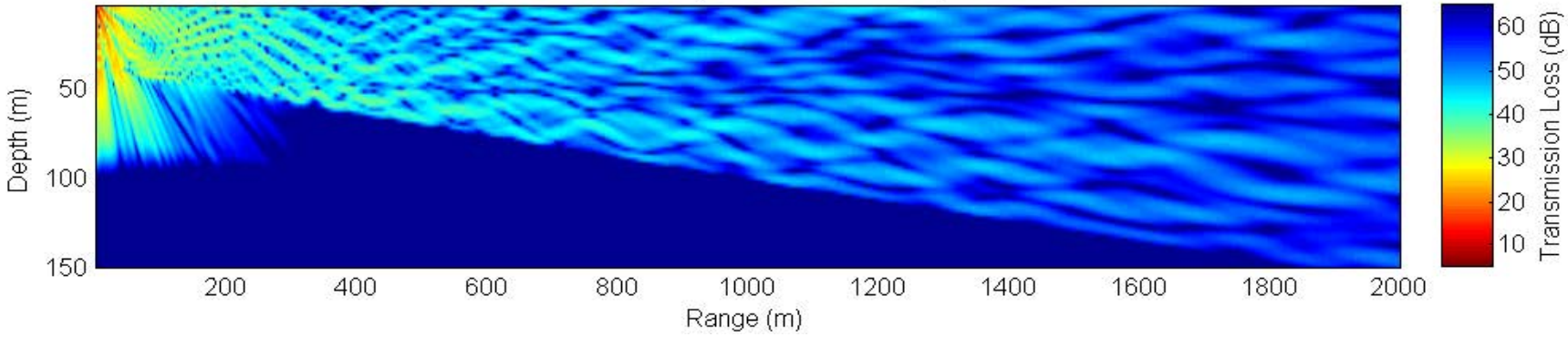


Defining Potential Impact Zones

A **hydroacoustic modeling analysis** of underwater noise is completed, so marine biologists and mammologists can effectively evaluate how sound may affect marine life, ESA-listed species and/or critical habitats. **Modeled results are used to inform distances** to key acoustic thresholds for injury and harassment. The Underwater Acoustic Assessment also provides the **basis for the project's IHA and ITS.**

Modeling uses site-specific inputs including:

- Bathymetry (boundary effects);
- Geoacoustic properties of seafloor;
- Seasonal sound speed profile;
- Source characteristics (1/3 octave band sound power, depth, dimensions); and
- Modeling algorithms accounts for sound reflection, refraction, and scattering within the water column sound field.



Mitigation

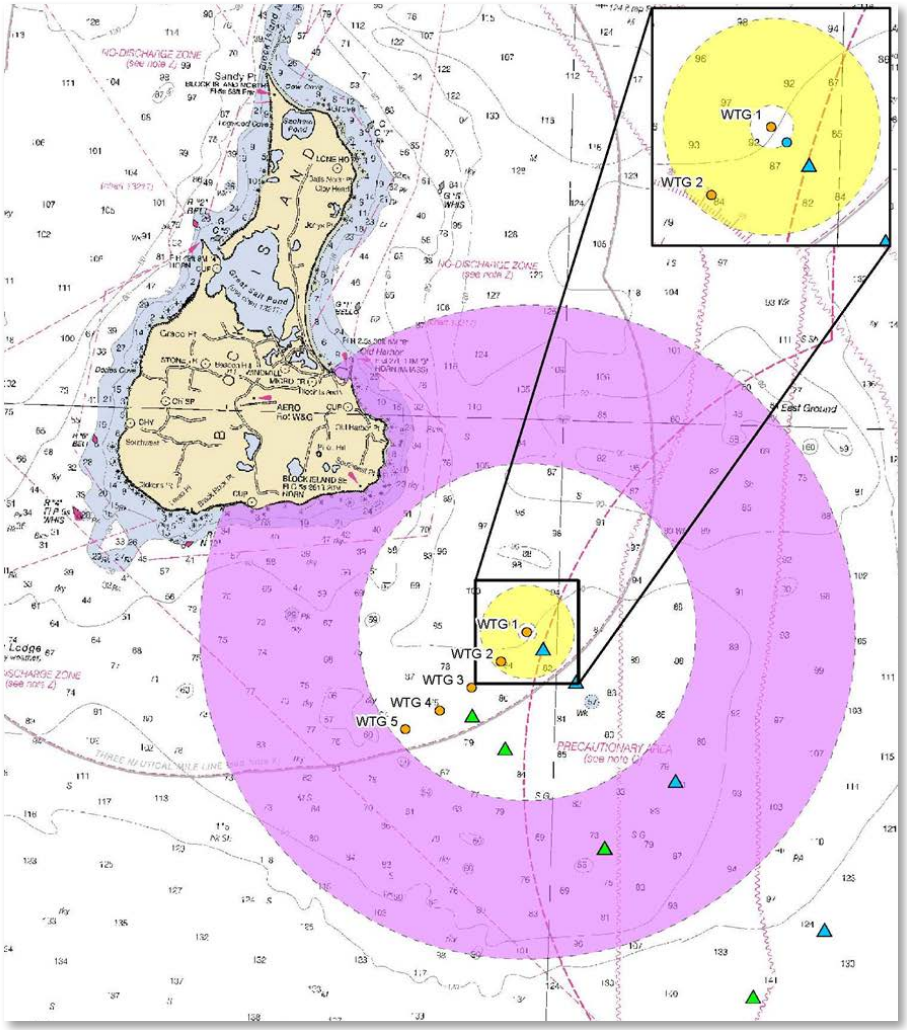
Agency-Specified Reasonable and Prudent Mitigation Measures:

- **Hydroacoustic Measurement Program:** Permits are routinely prescribing field verification and confirmation of acoustic zones during construction activities and determine distances to key acoustic thresholds. The monitoring protocol required agency approval prior to systems deployment. Important to negotiate hydroacoustic field monitoring requirements upfront Primary objectives:
  - Field verify the modeled results of the noise levels for injury/mortality and behavior disturbance of marine mammals, sea turtles, and fish as established during the environmental permitting process;
  - Evaluate apparent sound source levels of pile-driving and other construction related activities throughout the entire installation period; and
  - Confirm, in real time, Exclusion Zones and Monitoring Zone established to ensure the protection of marine mammals and sea turtles from acoustic injury and/or behavioral disturbance during impact pile-driving activities.

Case Study: Hydroacoustic Monitoring

Hydroacoustic field verification monitoring program occurred in two stages:

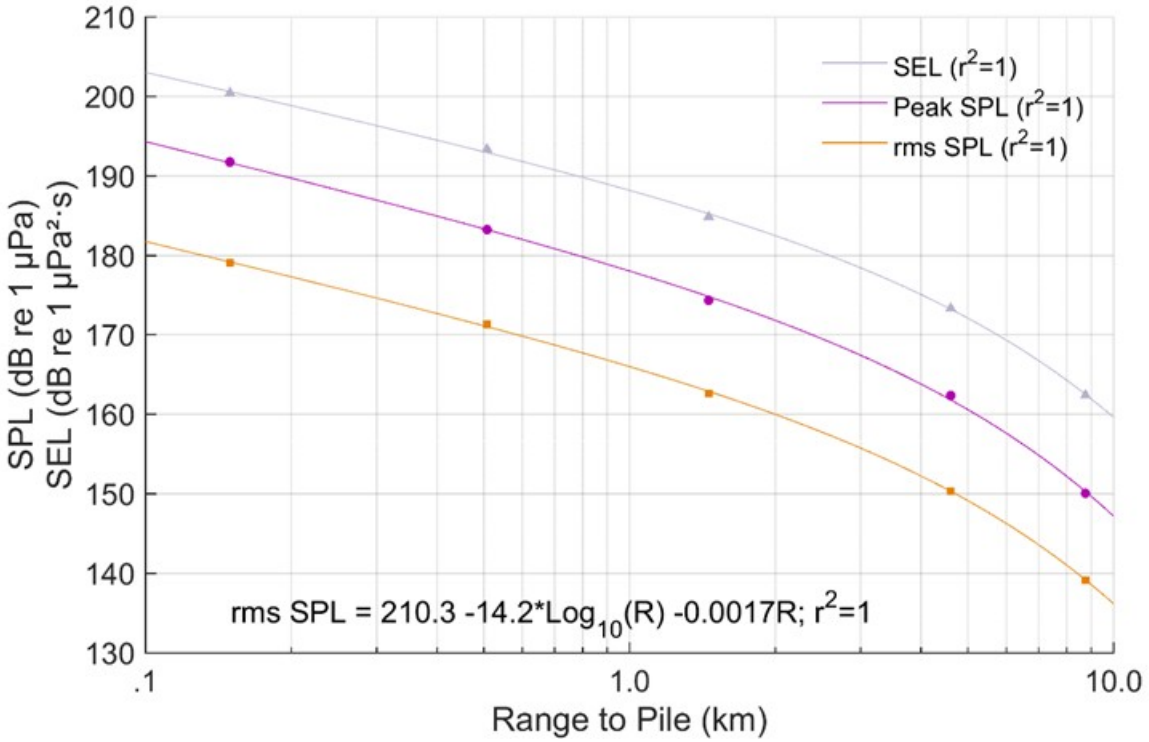
- Short-term monitoring during the installation of the first complete wind turbine generator (WTG) foundation using both real-time and static monitoring techniques; and
- Continuous long-term monitoring during piling of the remaining four WTG foundations with static recorders positioned at approx. distances (m): 200, 500, 1.5k, 4.5k, 9k



Case Study: Hydroacoustic Monitoring

TETRA TECH

Example Regression Analysis:

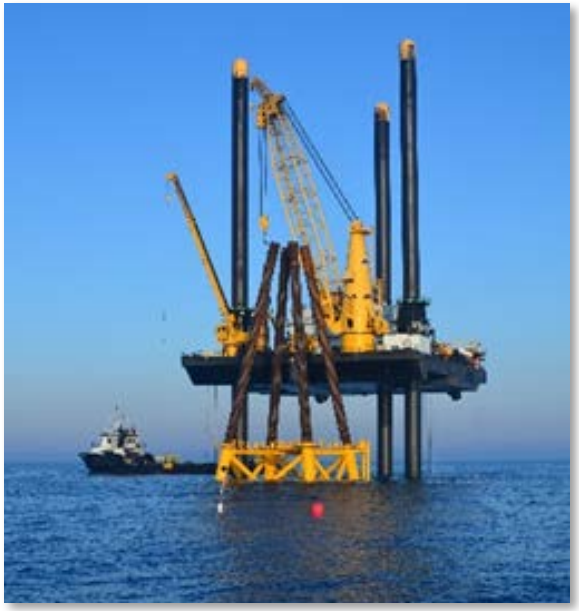


Acoustic quantities versus range, August 30, 2015

Hydroacoustic Monitoring Equipment: Real-time Monitoring Systems

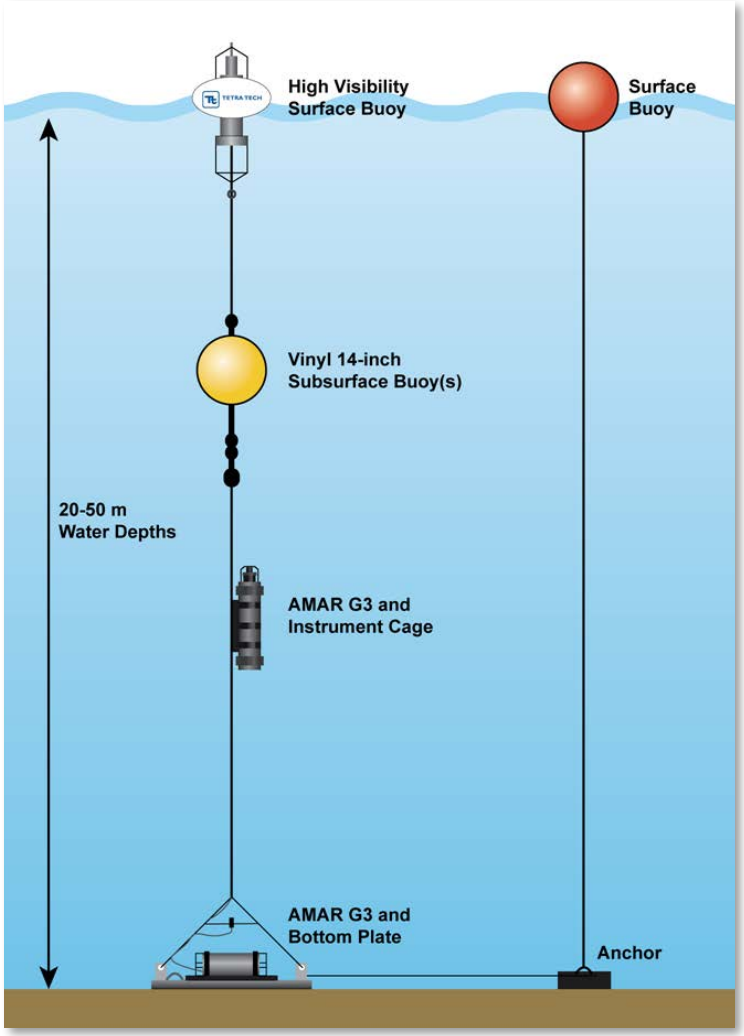
TETRA TECH

- Cabled hydrophone array on a lead weighted line with surface buoy allow for real-time data analysis capabilities throughout the entire water column. The observation vessel can be rapidly moved around the zone to document received sound levels in different compass directions and at various distances.
- Sound levels were continuously monitored during pile driving at the first foundation. The lead PSO remained in constant contact with the acoustics team to confirm zone distances.
- Daily reports due within 24-hours or prior to next day of construction activities.
- Use of PAM systems to detect marine life not visible from the surface.



Hydroacoustic Monitoring Equipment: Static Recorders

- Bottom-mounted Autonomous Marine Acoustic Recorders (AMARs) supplied by JASCO Applied Sciences were strategically positioned at five distances along a given transect. Each AMAR continuously recorded during construction events at one location.
- Daily deployment, retrieval, and analysis of static acoustic recorders occurred throughout installation of the first install. Daily reports contained a description of activities, number of pile strikes, confirmation of soft starts, and distances to the acoustic thresholds based on real-time and static recorder monitored values.
- Have redundant measurement systems at the ready in case of issues.



Source: Jasco Applied Sciences

New NOAA Fisheries Noise Guidelines Finalized

TETRA TECH

Overview:

On August 4, 2016, NOAA Fisheries finalized guidance for assessing the effects of anthropogenic sound on marine mammal species. The new regulations provide updated noise criteria, or threshold levels, above which individual marine mammals are predicted to experience changes in their hearing sensitivity (either temporary or permanent) from anthropogenic sound sources.

- The new regulations consider both the peak received pressure and the cumulative effects of noise impacts. This differs from the previous regulations under the Marine Mammal Protection Act (MMPA) that provided absolute values considering instantaneous sound pressure levels at a given receiver location using the root-mean-square (RMS) descriptor.

- All the acoustic threshold levels for marine mammals are contained in a comprehensive 189-page document. The goal is to improve consistent implementation across the array of relevant laws for marine mammal protection by both consultants with different branches of NOAA. The guidelines are available here:

http://www.nmfs.noaa.gov/pr/acoustics/guidelines.htm

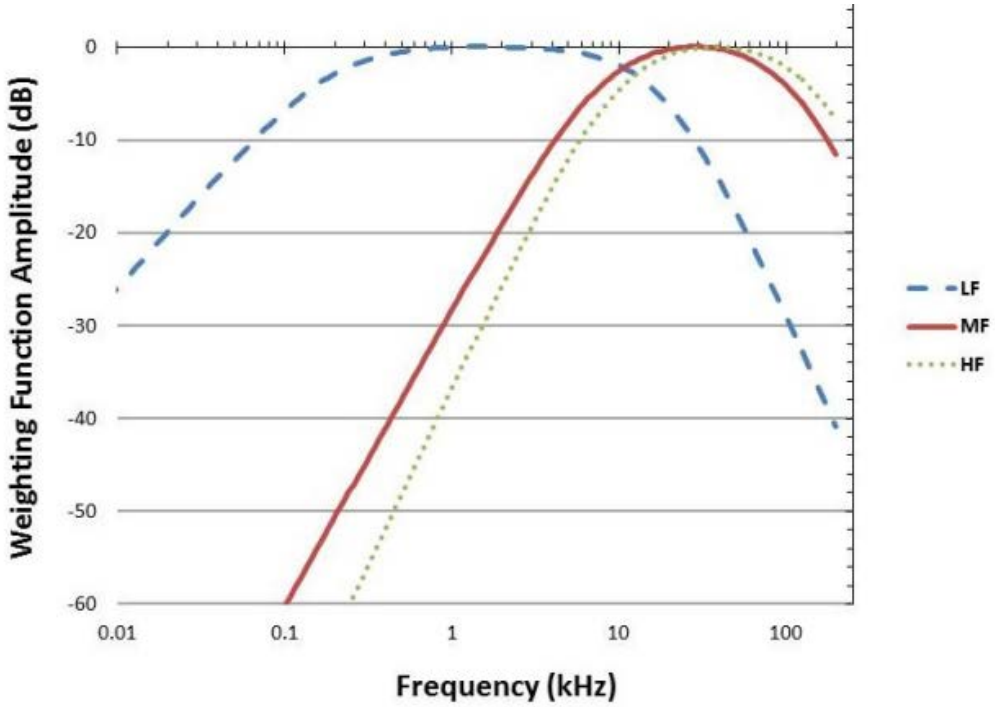
New NOAA Fisheries Noise Guidelines Finalized

TETRA TECH

Overview:

Under the new technical guidelines, marine mammals are categorized in five different groups to account for an animal's hearing ability either for individual species or classes of species, and therefore a measure of the potential of the sound to cause an effect. The plot below shows the hearing curve of three different marine species.

For example, most dolphins (HF) have excellent hearing high frequencies between 10,000 and 100,000 Hz. Their sensitivity at lower frequencies below 1000 Hz, however, is quite poor. On the other hand, the hearing sensitivity of most sea turtles and whales (LF) appear to be best at frequencies between about 200 Hz and 6000 Hz. As a result, these species might be expected to suffer more harmful effects from low frequency noise than would dolphins.



NOAA Technical Memorandum NMFS-OPR-55, July 2016

New NOAA Fisheries Noise Guidelines Finalized

TETRA TECH

What you need to know:

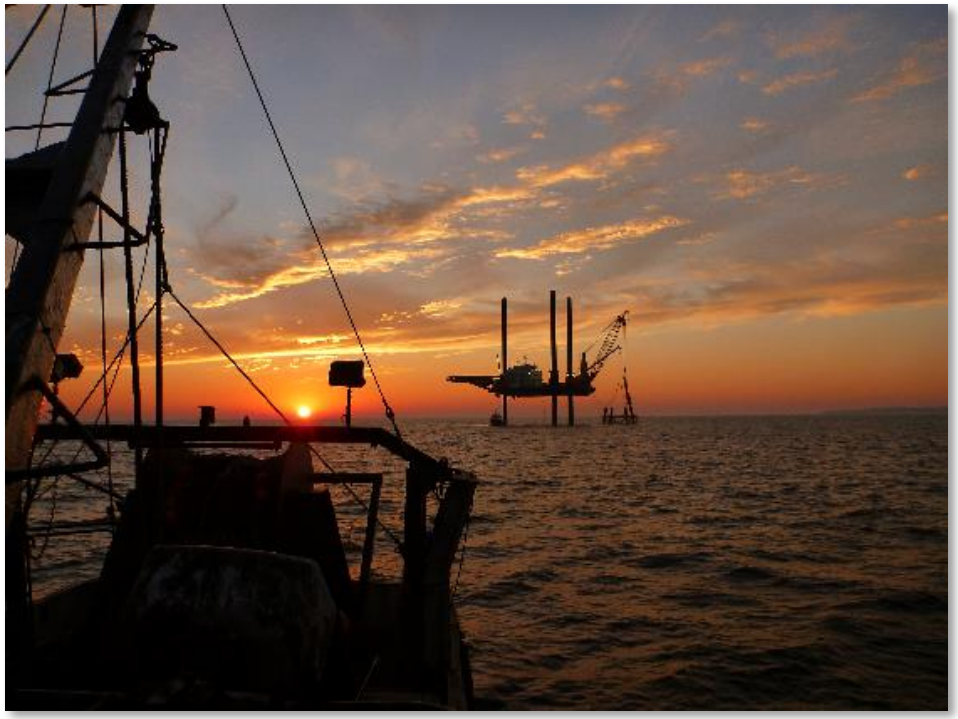
Existing Projects

- For analyses that may have already substantially progressed using the existing MMPA regulations, it may be impractical to begin those analyses anew. In such "pipeline" cases, the applicant or action agency should contact NOA Fisheries as soon as possible to discuss how to best include consideration of the Technical Guidance to satisfy the applicable requirements. – NOAA (Federal Register)

Future Projects

- Prospective applicants for incidental take authorizations under the MMPA and federal agencies seeking ESA section 7 consultations that have not yet started their acoustic analyses should begin using the new Technical Guidance immediately. – NOAA (Federal Register)

THANK YOU!



Erik J. Kalapinski, INCE
Consulting Engineer – Acoustics Group
Energy Program
Tetra Tech
Erik.Kalapinski@tetratech.com
+1 (617) 443-7538

California Offshore Wind Industry Symposium

2 March 2017