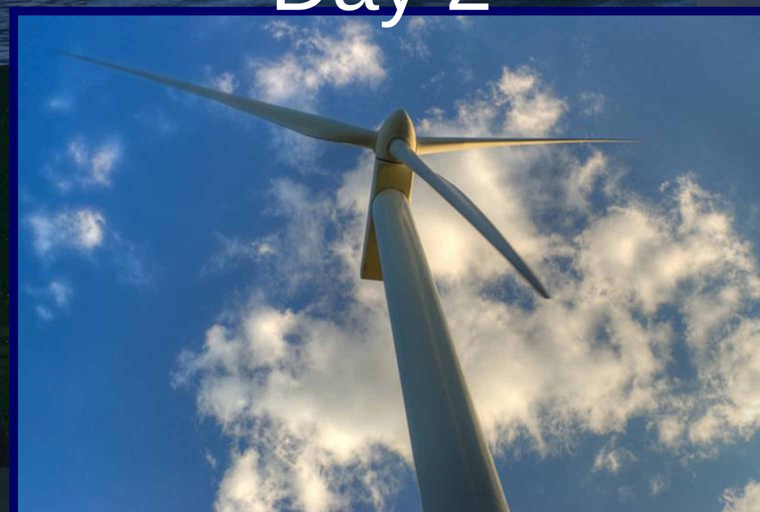
BOEM
Bureau of Ocean Energy Management

Office of Renewable Energy Programs

Workshop on Best Management Practices for Atlantic Offshore Wind Facilities

Day 2



& Marine Protected Species

March 7-9, 2017

NOAA
National Oceanic and Atmospheric Administration
U.S. Department of Commerce

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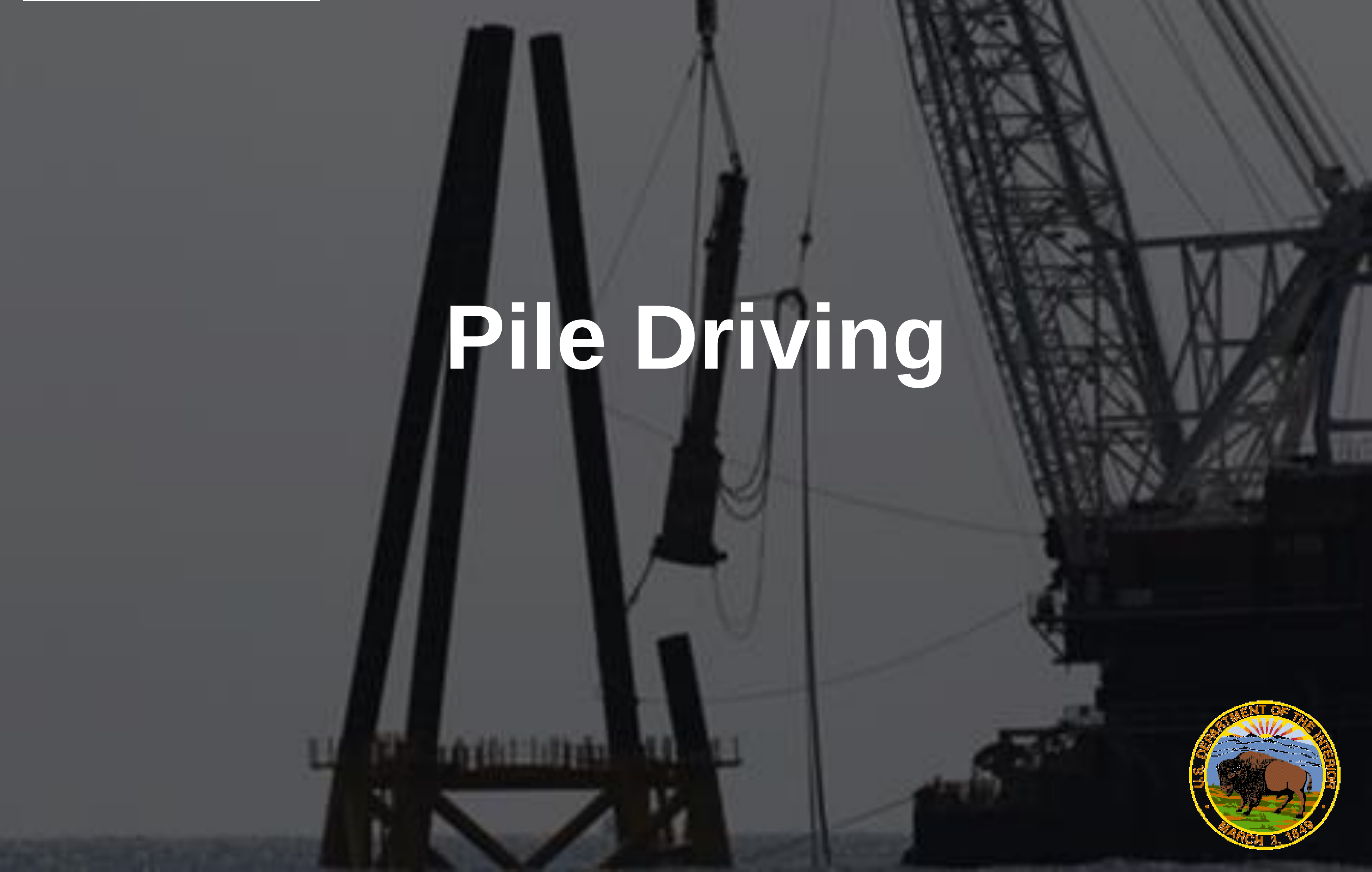
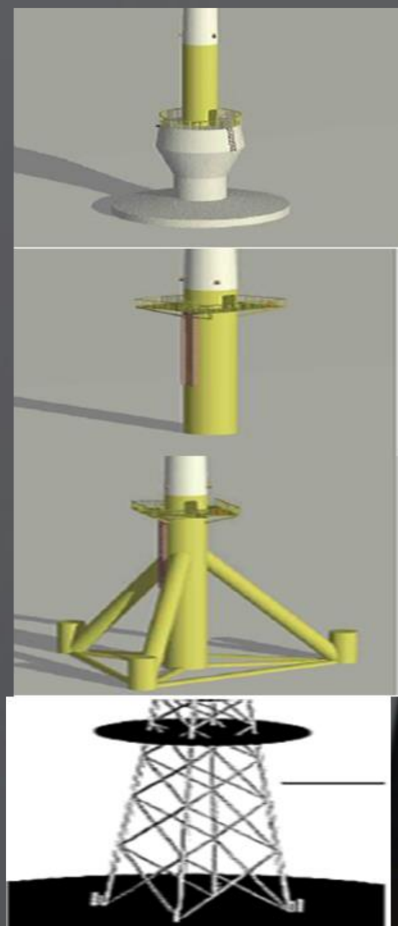
Pile Driving



Pile Driving



Gravity foundations have no piles

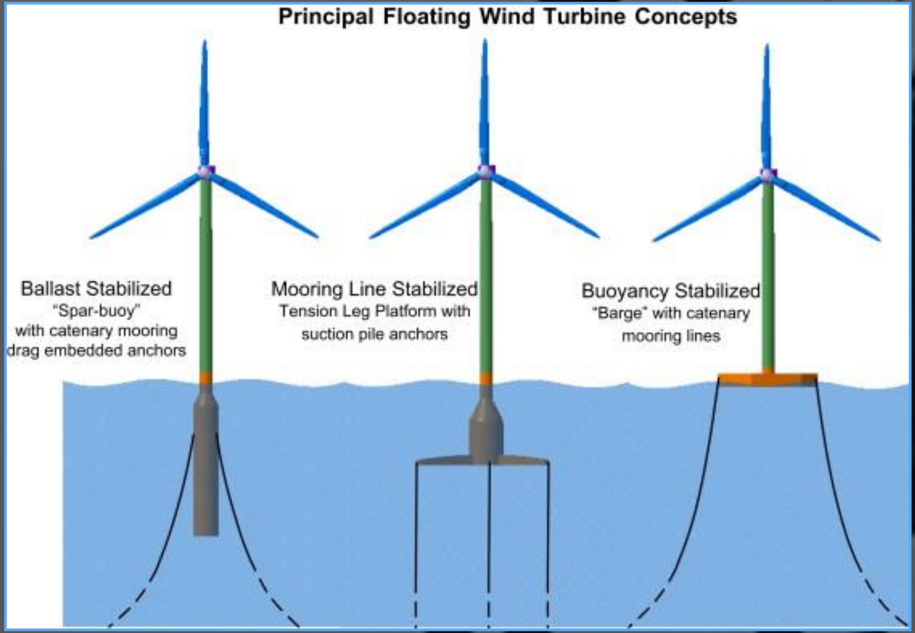
Monopile foundations have 1 pile/foundation

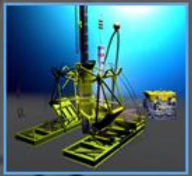
Tri-pod/multi-pod foundations have 3-4 piles/foundation

Jacket foundations have 4 piles/foundation

Floating Foundations

Depths >50-60 m




Driven pile anchor


Suction anchor


Gravity anchor


Drag anchor


Drilled and grouted pile


Driven anchor plate (usually vibratory)


Torpedo anchor

Effects of Noise Exposure

- Permanent hearing loss (PTS)
- TTS
- Stress
- Behavioral Effects
  - Avoidance
  - Attraction
  - No effect
  - Foraging
  - Energetics
  - Reproduction
  - Migration

Pile Driving Noise

- Pile diameter and the bottom type are most influential factors
- Pile diameter affects the loudness and tones produced
- Bottom type effects the energy propagation
- Other project-specific factors include:
  - drive depth
  - pile angle
  - hammer energy
  - water temperature
  - water depth

Representative Source Levels for a Met Tower

Pile Diameter	Source Level (dB re 1 µPa)		
	Peak	RMS	SEL
1 m (40 in)	228	215	200
1.2 m (48 in)	208	215	200
1.4 m (54 in)	229	214	205
1.7 m (66 in)	230	215	206 (est)
2.4 m (96 in)	240	225	214

*Data from Deepwater Wind (2016), Illingworth and Rodkin, Compendium of Pile Driving Data (Version October 1, 2012), and Genesis (2011). In some cases, we have back-calculated using 20 LogR spreading loss to obtain estimated source levels dB re 1 µPa at 1 m.

Pile Driving Cumulative PTS Distances for a Met Tower

Example for 3-8 hr of Cumulative Exposure without a Sound Reduction System (SRS)

Pile Diameter	Cumulative Exposure Distance for Each Hearing Group (meters)			
	LF	MF	HF	Seals
1.4 m	859-1,403	70-115	980-1,560	538-878
2.4 m	2,421-3,954	198-324	2,761-4,508	1,515-2,474

*Distances are conservative estimates using the NOAA spreadsheet tool for cumulative sound exposure

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Example Reduction in PTS Distance for Pile Driving with an SRS

Example for 3-8 hr of Cumulative Exposure with a Sound Reduction System (SRS)

	Cumulative Exposure Distance for Each Hearing Group (Reduction in meters)			
Diameter	**LF**	**MF**	**HF**	**Seals**
1.4 m	216-352 **(-643-1,051)**	18-29 **(-62-86)**	246-402 **(-734-1,158)**	135-221 **(-403-657)**
2.4 (m)	608-993 **(-1,813-2,961 m)**	50-81 **(-148-243)**	693-1,132 **(-2,068-3,376)**	381-621 **(-1,134-1,853)**

*Sound reduction >12 dB can be achieved!

*Distance estimates are based on an average 12 dB reduction in source level using the NOAA spreadsheet tool

Pile Driving Exposure

- Source level (pile size)
- Frequencies (pile size)
- Hearing ability
- Duration of exposure/day (number of piles, time, and strikes/pile)
- Number of days
- Time of year
- Site characteristics affecting propagation

Pile Driving

OBJECTIVES

- What are the major effects of concern?
- Identify any regional-specific concerns
- Identify or species-specific concerns
- Exclusion zone criteria
  - Effects to avoid
  - Effects to monitor
  - How to predict (NOAA spreadsheet and other modeling)

Pile Driving

OBJECTIVES

- Mitigation and methods/technologies for 24/7 operations
  - Sound source verification
  - Survey platforms
  - Protected species observers
  - Real-time and remote monitoring methods
  - Noise reduction
- Standard monitoring methods and data collection
- Identify any financial, logistical, or regulatory mechanisms and constraints

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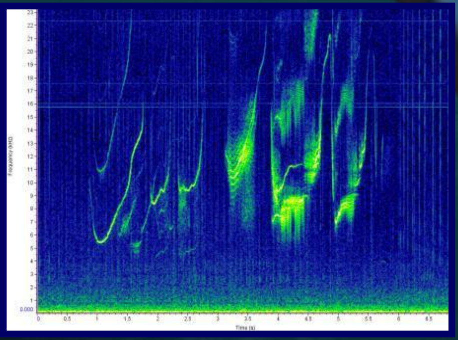


The Baseline is the Pre-Project Conditions

- The baseline is a reference condition
- Projects can be evaluated by comparing pre-project environmental conditions to those after a project begins.

To monitor for change:

✓ Must have reference information

✓ Must know important variables to monitor

✓ Standardized monitoring and data for comparisons

The Affected Environment

Distribution

Prey availability

Abundance

Conservation Status

Population Health

Acoustic Seascape

Critical Habitat

Sea temperatures

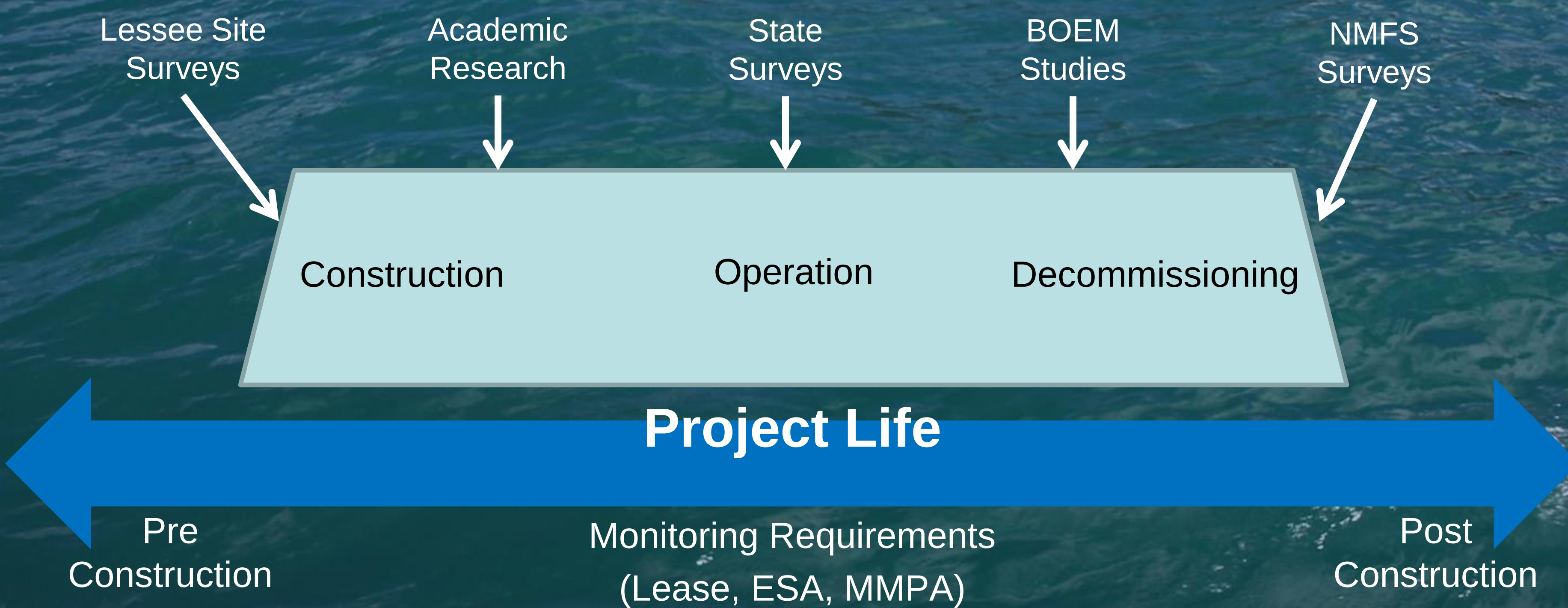
Natural stressors

Chlorophyll-a

Migratory behavior

Anthropogenic stressors

Life Cycle Monitoring



Life cycle monitoring helps detect changes in the environment due to the project, and those that are from other natural or man-made causes.

Monitoring Change

- Project-specific and program-specific
- Possible changes in distribution, abundance, and behavior due to:
  - Avoidance of habitat/physical presence of foundations
  - Attraction of prey, protected species, and predators to structures/reef effect
  - Acoustic environment
  - No change
- Comments received on possible cumulative effects of multiple projects:
  - Changes in migratory behavior
  - Changes in selection/use of critical habitat
  - Contributions to the noise budget

Challenges

- Variable Baselines
  - Geographic differences
  - Annual variation
  - Seasonal variation
  - Large ranges of migratory species/small project areas
  - Shifting baselines from other anthropogenic sources
- Cumulative Effects
  - Detecting effects from multiple projects
  - How to best monitor for possible additive or synergistic effects
- Standards and Comparisons Across Monitoring Efforts
  - Getting the methods and data aligned
- Financial Resources

Monitoring Change

OBJECTIVES

- Understand current pre-construction baseline studies
- Identify important issues and parameters to be monitored for change
- Identify any regional or species-specific considerations
- Identify any financial, logistical, and regulatory constraints
- Identify mechanisms for standardized data collection and management