Development of a Risk-based Framework for Assessing and Managing Dredge Underwater Sounds

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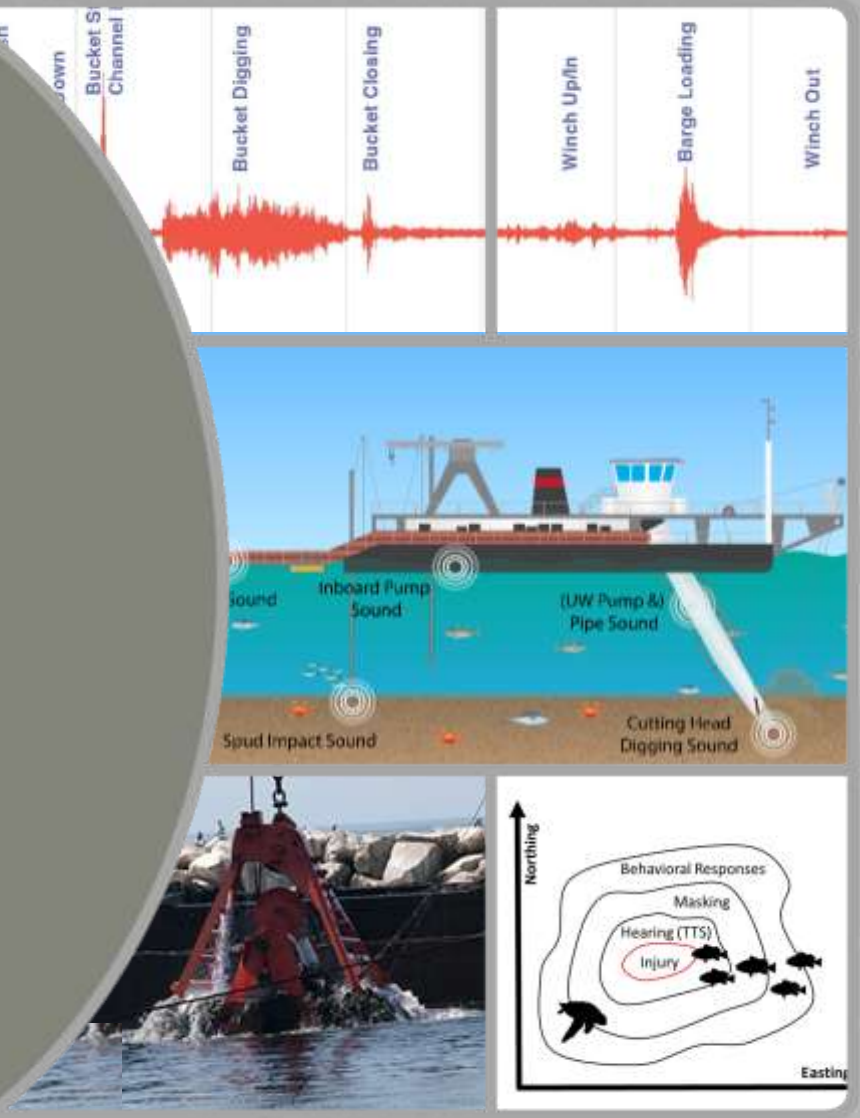

WEDA Pacific 2019

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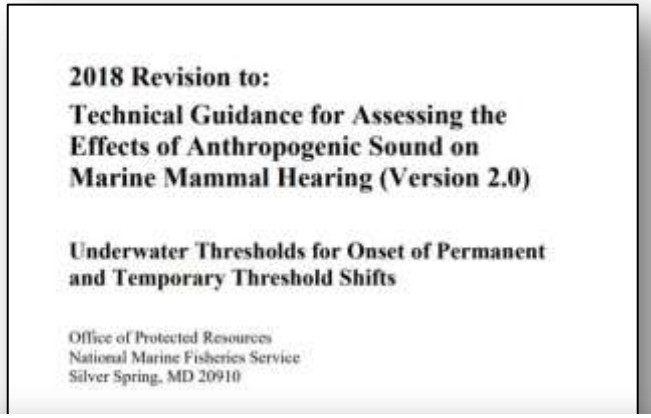
Introduction

- Increasing national and international regulatory focus on adverse impacts from anthropogenic underwater sound
- Marine Mammals, Fish, Invertebrates
- **NOAA NMFS (2018): Advisory Acoustic Thresholds for Marine Mammals**
  - Provides thresholds for onset of auditory threshold shifts in marine mammals for impulsive and **non-impulsive sounds**
- **Where does dredging fit in?**
- USACE reviewed the current state-of-the-science (Suedel et al. 2019):
  - Provides comprehensive review of dredging sound data
  - **Advocates value of a risk-based approach**


2018 Revision to:

Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0)

Underwater Thresholds for Onset of Permanent and Temporary Threshold Shifts

Office of Protected Resources
National Marine Fisheries Service
Silver Spring, MD 20910


ERDC/EL TR-19-18

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Dredging Operations and Environmental Research (DOER)

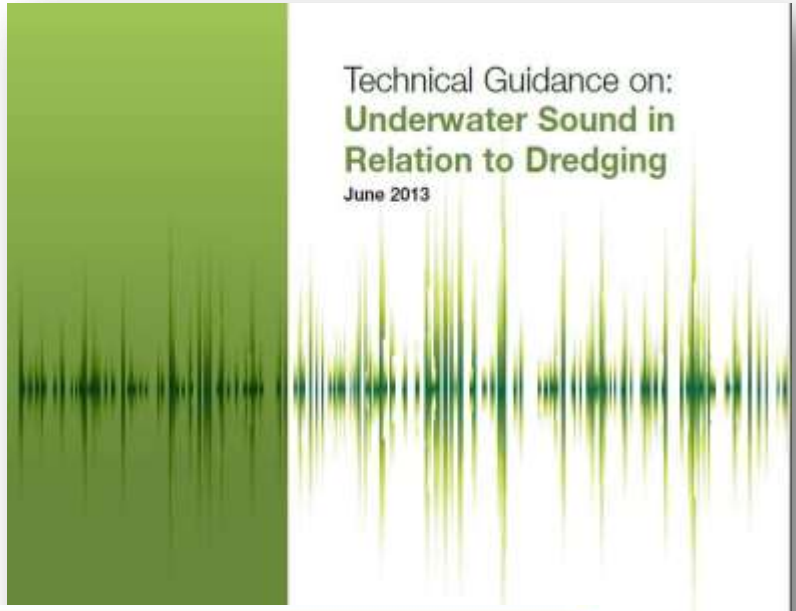
Evaluating Effects of Dredging-Induced Underwater Sound on Aquatic Species: A Literature Review

Burton C. Suedel, Andrew D. McQueen, Justin L. Wilkens, and Morris P. Fields

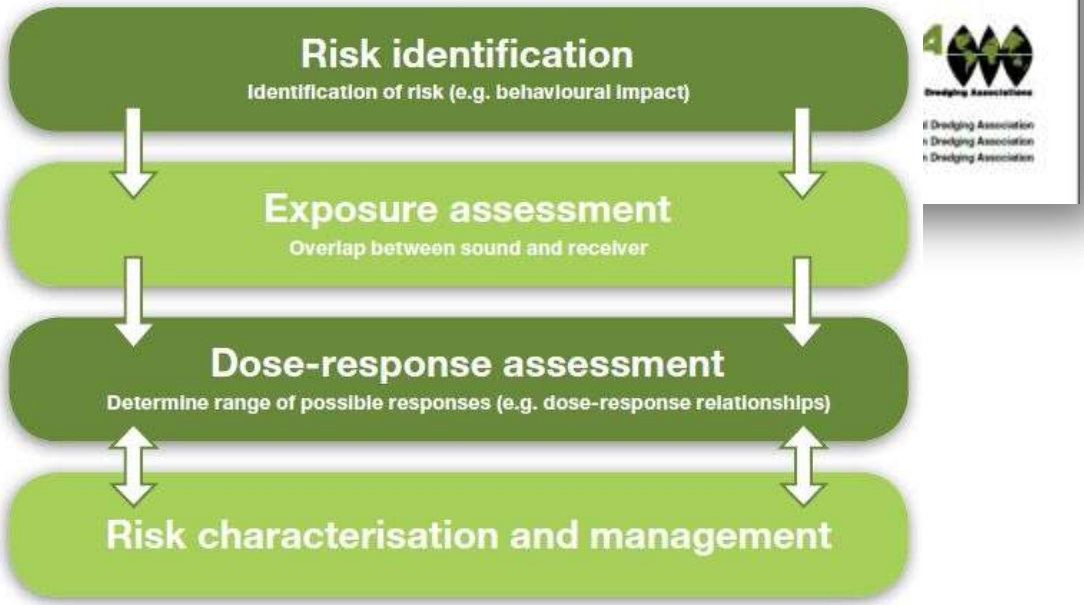
September 2019

Introduction

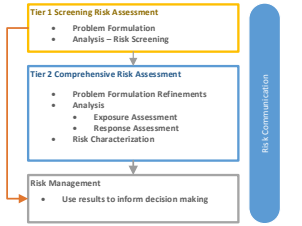
- Prior studies have advocated the use of a risk-based framework
  - WODA 2013
- This approach was met with interest among dredging community and regulatory agencies
- **However, information still needed were:**
  1. **Specific Details of Applying a Risk Framework**
  2. **Demonstration of the Approach**
- Next logical steps…



WODA 2013

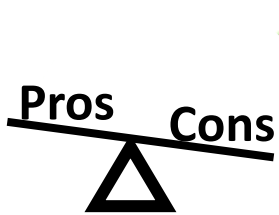


Objectives



1) Develop a tiered risk-based framework for assessing underwater sounds from dredge operations

2) Case study demonstration of the framework

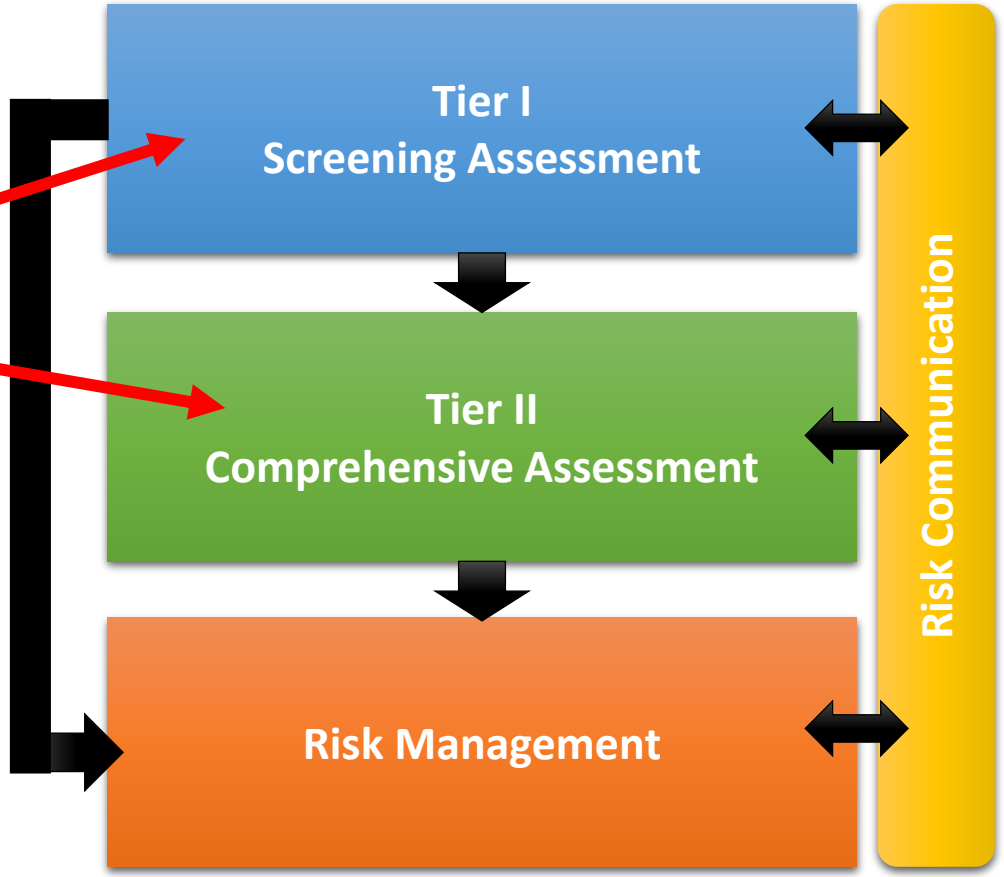


3) Identify strengths and limitations of the approach

Results: Risk Framework Development

Primary Components:

1. Project Formulation
   - Type of Dredge
   - Species of Concern
   - Anthropogenic Background
   - Compile existing data
2. Exposure and Response Analysis
   - Evaluate exposure and effects data
   - Identify sources of uncertainty
3. Risk Management
4. Communication



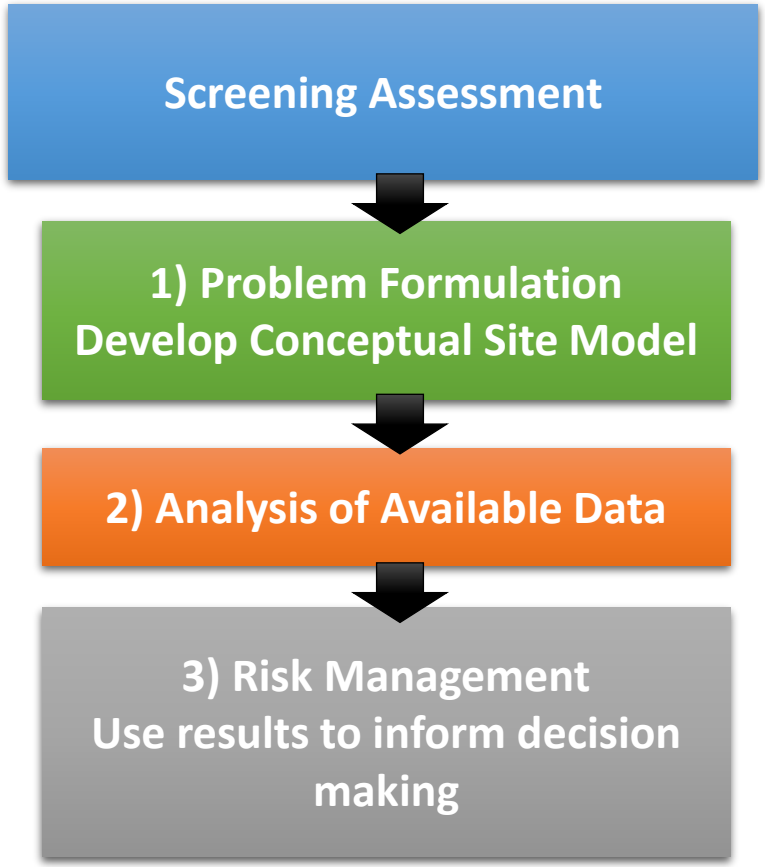
Value: Uniform approach, repeatable, transparent, addresses uncertainties

Results: Risk Framework

Tier 1: Screening Assessment

- Problem Formulation
  - Identify sources of sound
  - Species of concern
  - Develop conceptual site model
  - Compile existing data and other information
- Analysis
  - Evaluate **exposure and effects data** to estimate risks of species of concern
  - Identify sources of **uncertainty**

Key benefits: Eliminate species early from further consideration



Case Study: Port Expansion

- Based on monitoring study (Heinis et al. 2013)
- Trailing suction hopper dredges:
  - n = 7 hopper dredges
  - 8,000 to 30,000 kW installed power
  - 3,000 – 20,000 m^3 hopper capacity
- Maximum broadband sound levels:
- **186 dB re 1 µPA-m (transit)**
- 95% of energy below 2.5 kHz
- Receptors:
- Harbor porpoises, harbor seals, fish (herring)

<u>Risk Assessment goals:</u>

1. **Characterize sound exposures**
2. **Evaluate potential affects to biota**

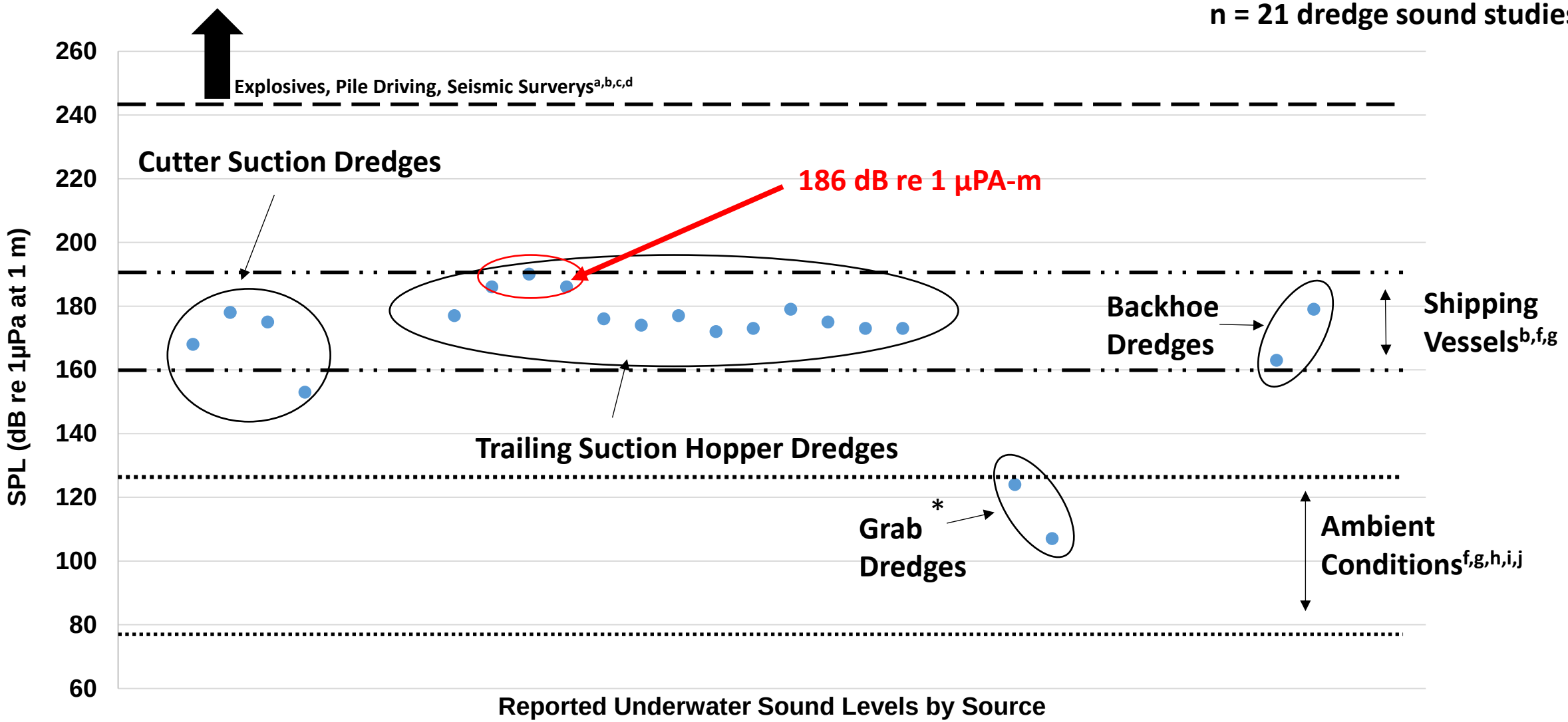
Screening Assessment

1) Problem Formulation
Develop Conceptual Site Model

2) Analysis of Available Data

3) Risk Management
Use results to inform decision making

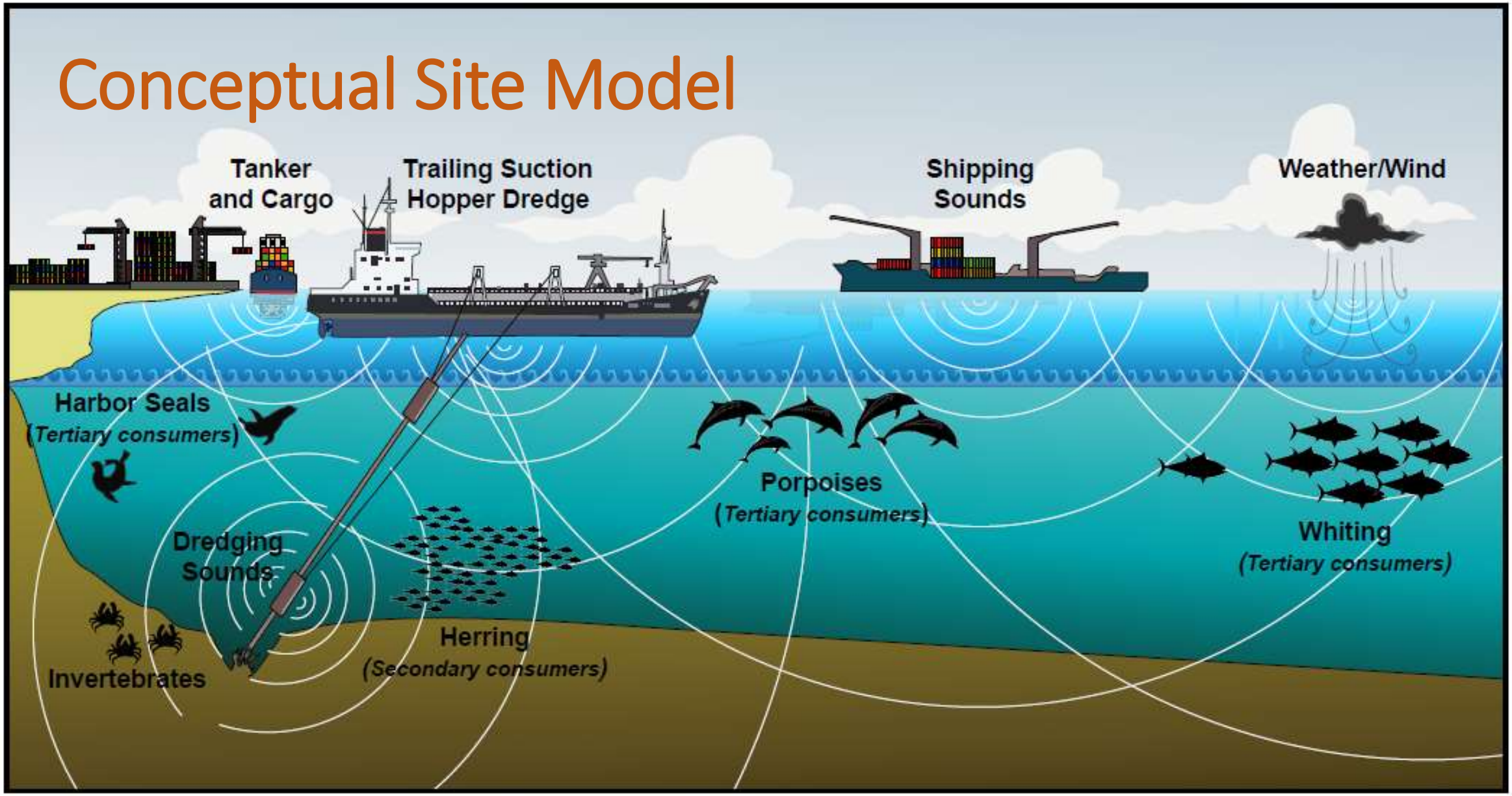
n = 21 dredge sound studies



[a] NRC (2003)
[b] OSPAR (2009a)
[c] Popper et al. (2014)
[d] Reinhall et al. (2015)
[e] McKenna et al. (2012)
[f] Reine et al. (2014)
[g] Merchant et al. (2016)
[h] Wenz (1962)
[i] Lewis and Denner (1987)
[j] Dickerson et al. (2001)

*GD SPL at 124 dB re 1 µ dB was recorded at 158 m from source

Conceptual Site Model



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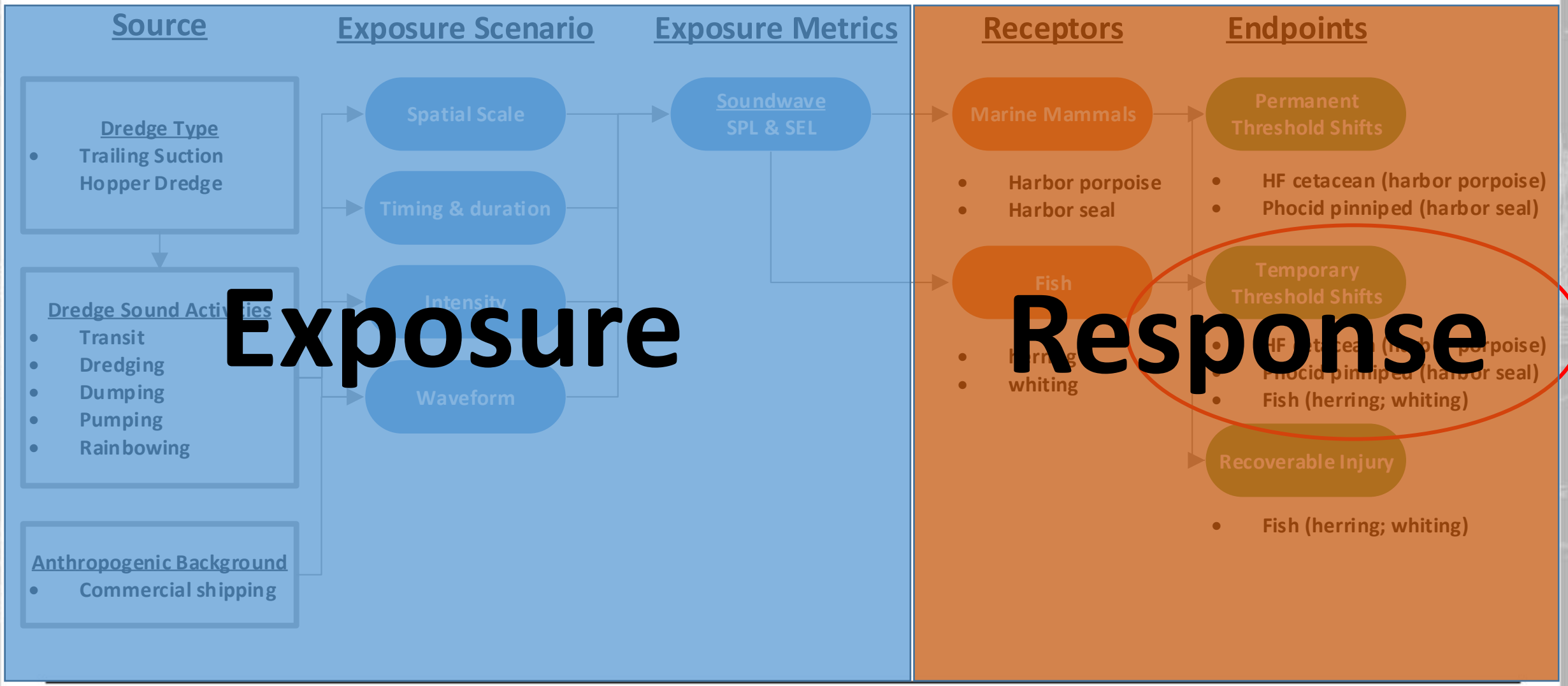
Conceptual Site Model



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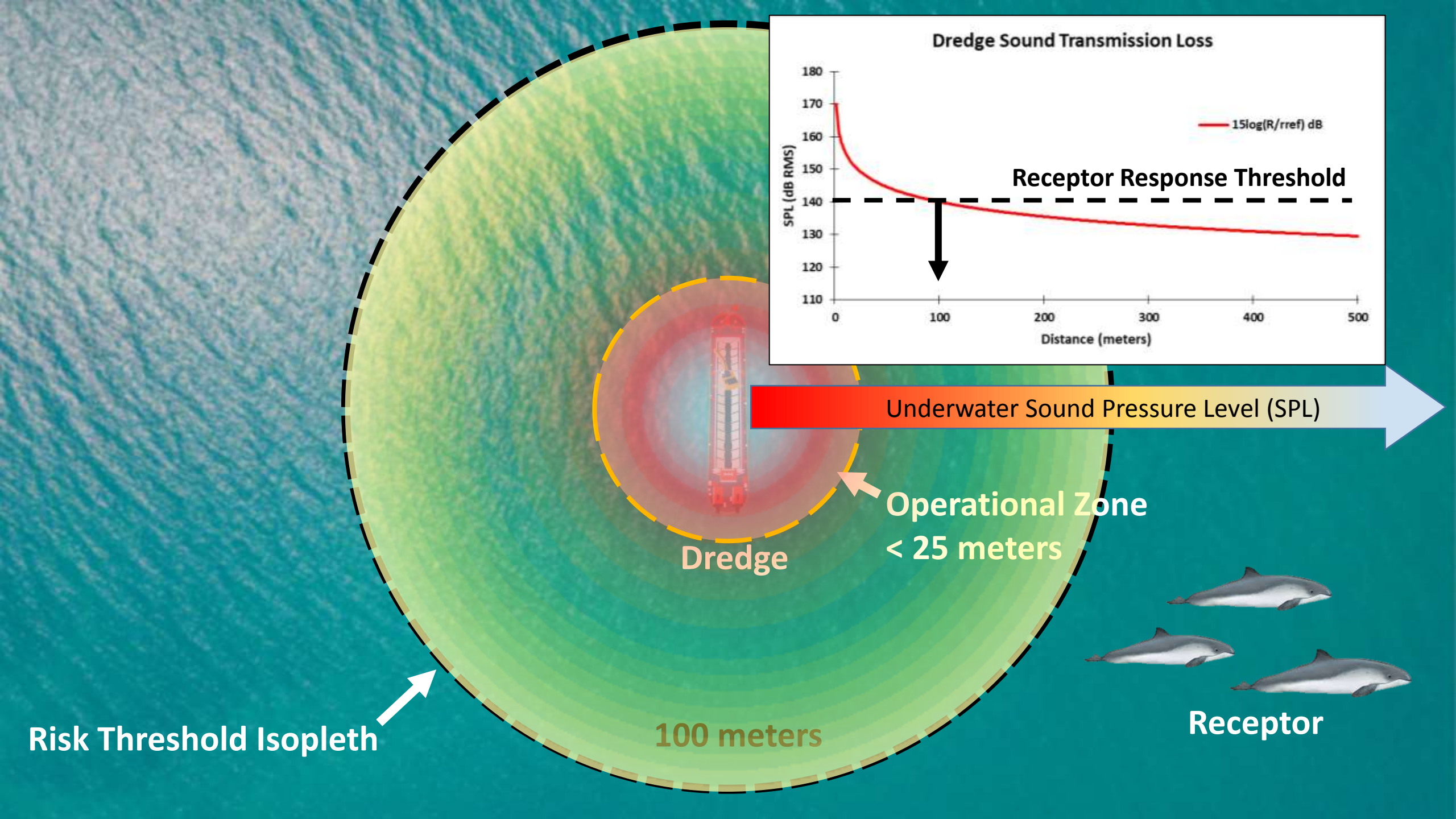

Dredge Sound Transmission Loss
180
170
160
150
140
130
120
110
SPL (dB RMS)
15log(R/rref) dB
Receptor Response Threshold
0
100
200
300
400
500
Distance (meters)
Underwater Sound Pressure Level (SPL)
Operational Zone
< 25 meters
Dredge
100 meters
Risk Threshold Isopleth
Receptor

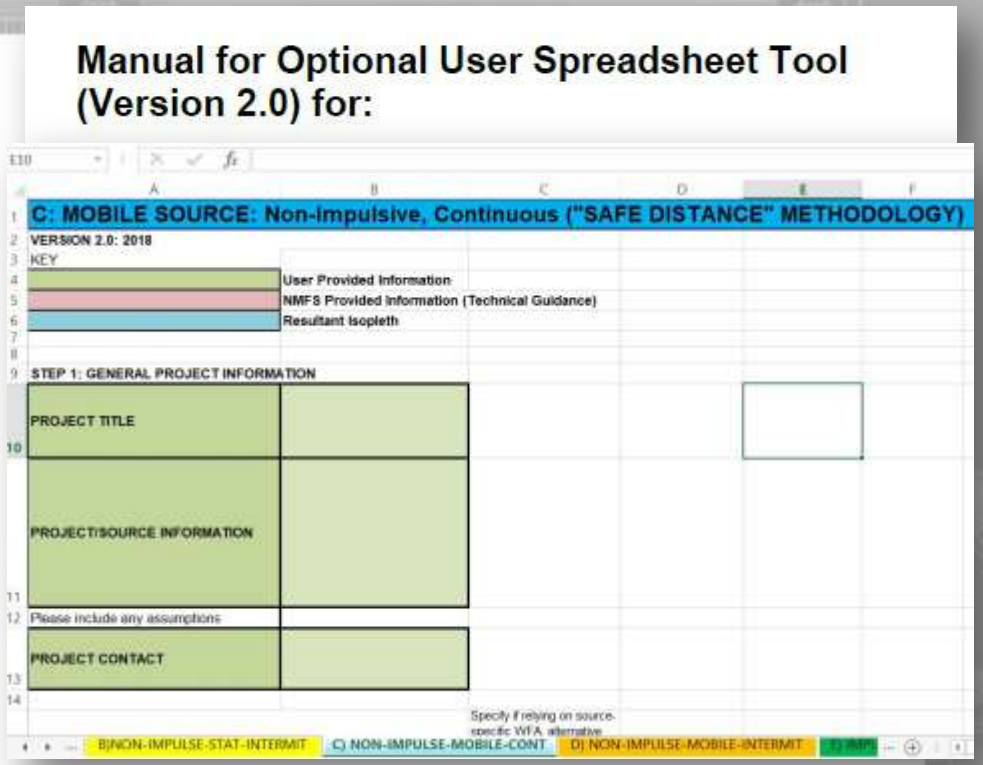
Case Study: Assumptions

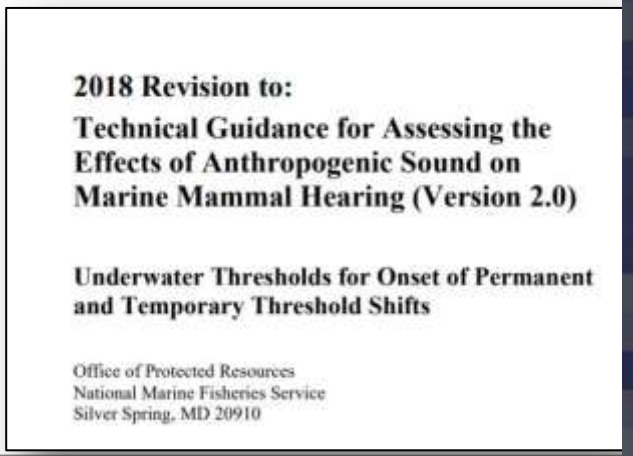
Exposure assumptions:

- **Intensity: 186 dB re 1µPa (maximum observed)**
- Mobile dredge, continuous ("safe distance" method)
- 2.5 meter/sec dredge; stationary receptor
- 20 Log(R) propagation
- Frequency weighted (mammals; NMFS 2018)
- 12 hr maximum sound duration (fish)*

Risk Thresholds

- High frequency cetaceans (porpoise); NMFS 2018
- Phocid pinniped (seal); NMFS 2018
- Fish; Popper et al. 2014
  - TTS = 158 dB (12 hr duration)





Case Study: Results

Risk Threshold Isopleths for Temporary Threshold Shifts (TTS):

Harbor seals:

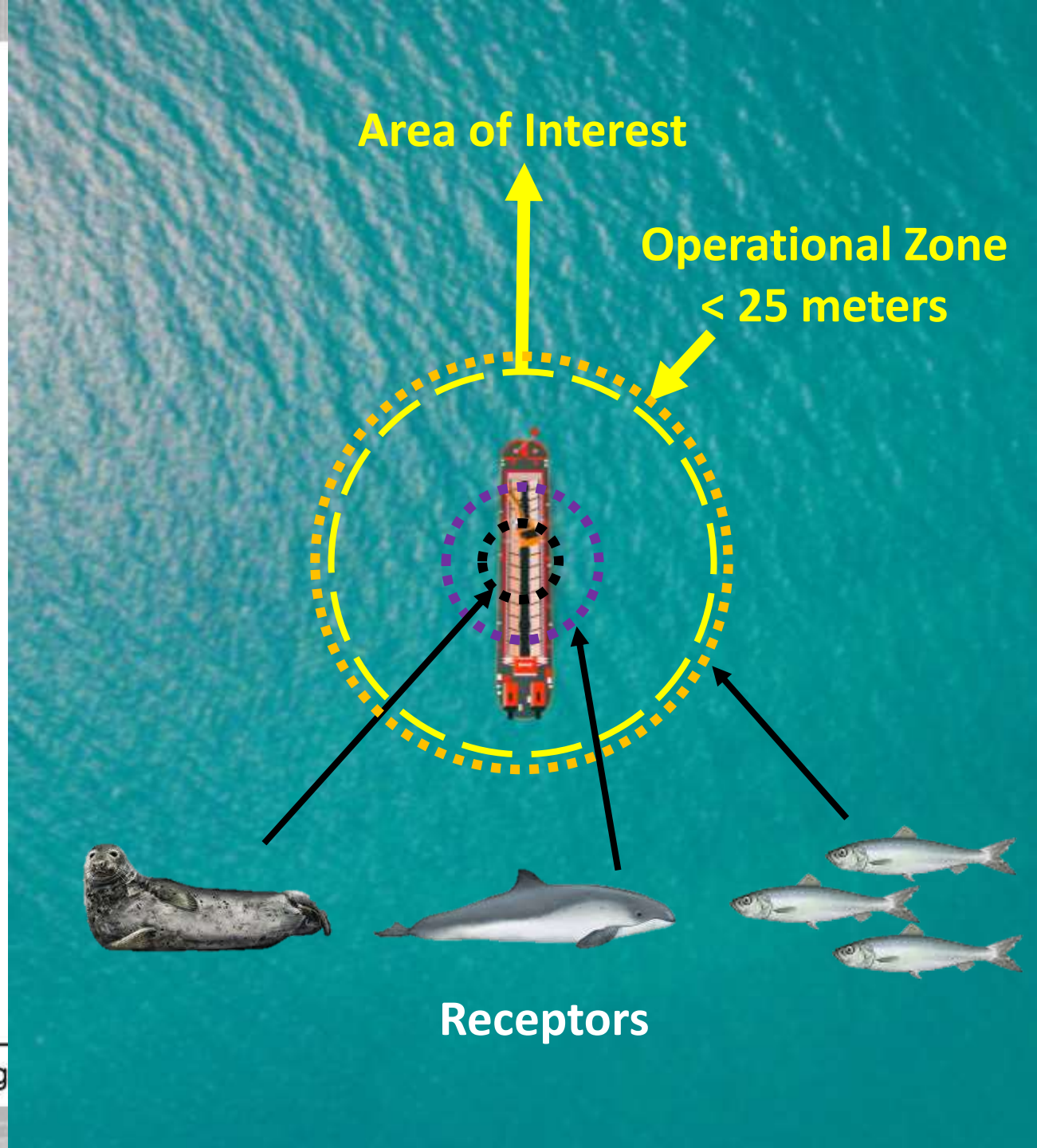
< 3 meters **(no risk)**

Harbor porpoises:

< 11 meters **(no risk)**

Fish (herring)

<26 meters → **Refine Assumptions: 12 hr duration?**



Sources of Uncertainty

Parameter	Source of Uncertainty	Influence on Risk Estimate
Sound levels	Using **maximum** recorded SPL from any source and activity	Over estimation
Sound Duration	Unknown level of actual sound duration at maximum levels. For fish, assumption that they would be **exposed continuously for 12 hours**	Over estimation
Sound propagation	Dependent on site-specific conditions. May under or over predict spatial exposures	Unknown
Thresholds	No available studies with a predictive threshold effects data for dredging sounds. Thresholds are based on tonal or broadband sounds.	Unknown
Auditory endpoint (TTS)	TTS recovery not considered	Over estimation

Strengths and Limitations

Strengths

- The screening-level approach allows receptors or scenarios to be eliminated from further consideration
- Flexible to be adapted as new information emerges

Limitations

- Lack of exposure-response data for low-frequency, non-impulsive sounds
- Current response data show **high degree of uncertainty**

Conclusions

Risk Framework Development

- Provides a mechanism to document and communicate risks and uncertainties to allow for a **transparent** and **repeatable process**
- Sufficiently **flexible** for wide ranging dredge scenarios

Case Study of Screening-level assessment

- Using “worst-case” scenarios were able to eliminate receptors from further consideration

THANK YOU!

QUESTIONS?

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