WODA
Technical Guidance on Underwater Sound in Relation to Dredging

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WODA
World Organisation of Dredging Associations

DHI

Outline

- Background
- Sound and marine life
- Policy
- Guidance paper
- Conclusions

CEDA / WGUS

Central Dredging Association

Underwater Sound
In Relation To Dredging

The Central Dredging Association is committed to environmentally responsible management of dredging activities and this paper – produced by the CEDA Environment Commission – seeks to inform those parties concerned about sounds produced by dredgers

Dredging is an activity that is carried out for many purposes. The dredging process can simplistically be described as the excavation of sediment from a sea, river or lake bed and the handling and transport of the excavated sediments and soils to a placement site elsewhere. Dredging is commonly applied for:

- Construction and maintenance of ports and waterways, dikes and other infrastructures
- Reclamation of new land
- Flood and storm protection and erosion control by maintaining river flows and by nourishing beaches
- Extraction of mineral resources from underwater deposits, particularly sand and gravel, to provide raw materials for the construction industry, and
- Environmental remediation of contaminated sediments.

Thus dredging provides many benefits to society with the goal of sustainable development while protecting natural resources and quality of life.

Objectives

Like many other activities, dredging produces underwater sound. Recently, the issue of effects of underwater sound on aquatic life has received broader attention within the scientific community, with stakeholders and the general public.

In this paper we will:

1). Summarise the effects of sound on aquatic life to set the scene
2). Describe in detail the underwater sounds generated by various components of the dredging process
3). Summarise what is known about potential effects of dredging sounds
4). Identify options for managing dredging-related sound, and
5). Provide conclusions and an outline of future areas of research.

Effects Of Sound On Aquatic Life

What is sound? – It can be described as a moving wave in which particles of the medium are forced together and then apart. This creates changes in pressure that propagate with the speed of sound.

The speed of sound in water is more than four times faster than in air and attenuation is also much less in water compared to air. Thus, water is an ideal medium for sound propagation.

Sounds can be described in terms of their intensity, which is measured or expressed in decibels (dB), pitch or frequency (in Hertz or kilohertz) and their duration (in seconds or milliseconds).

Sources of underwater sound – Both the natural environment and man can produce underwater sound. Natural sources of sound can be vocalisations of marine life – eg the elaborate songs of humpback whales or the snapping of shrimp. Wind, rain, waves, and subsea volcanic and seismic activity all contribute to ambient sounds in bodies of water.

Human-induced sound comes from construction of marine infrastructure (including dredging) and industrial activities such as drilling or aggregate extraction (including dredging); shipping; military activities using various types of sonar; geophysical exploration using seismic surveys, and a variety of other activities.

Anthropogenic sound sources can be broadly divided into high intensity impulsive sources, such as pile driving, and less intensive but more continuous sources like shipping and dredging. It has to be noted here that the dredging fleet represents 0.5% of the world total shipping fleet.

Human activities in the aquatic environment have intensified since the last century and research has indicated that ambient sound has been increasing in some regions too. While ambient sound levels are the result of both natural and anthropogenic sources, it is the latter we have control over since these can be managed.

Use of sound by aquatic life – As sound transits very well underwater, many marine species use it for a variety of purposes.

WODA / WEGUS

- Production of a further state-of-the-art review of ambient sound, dredging induced underwater sound and their impact on aquatic biota
- Development of an underwater sound monitoring protocol/procedure
- Provision of technical guidance on how to assess underwater sound by dredging.

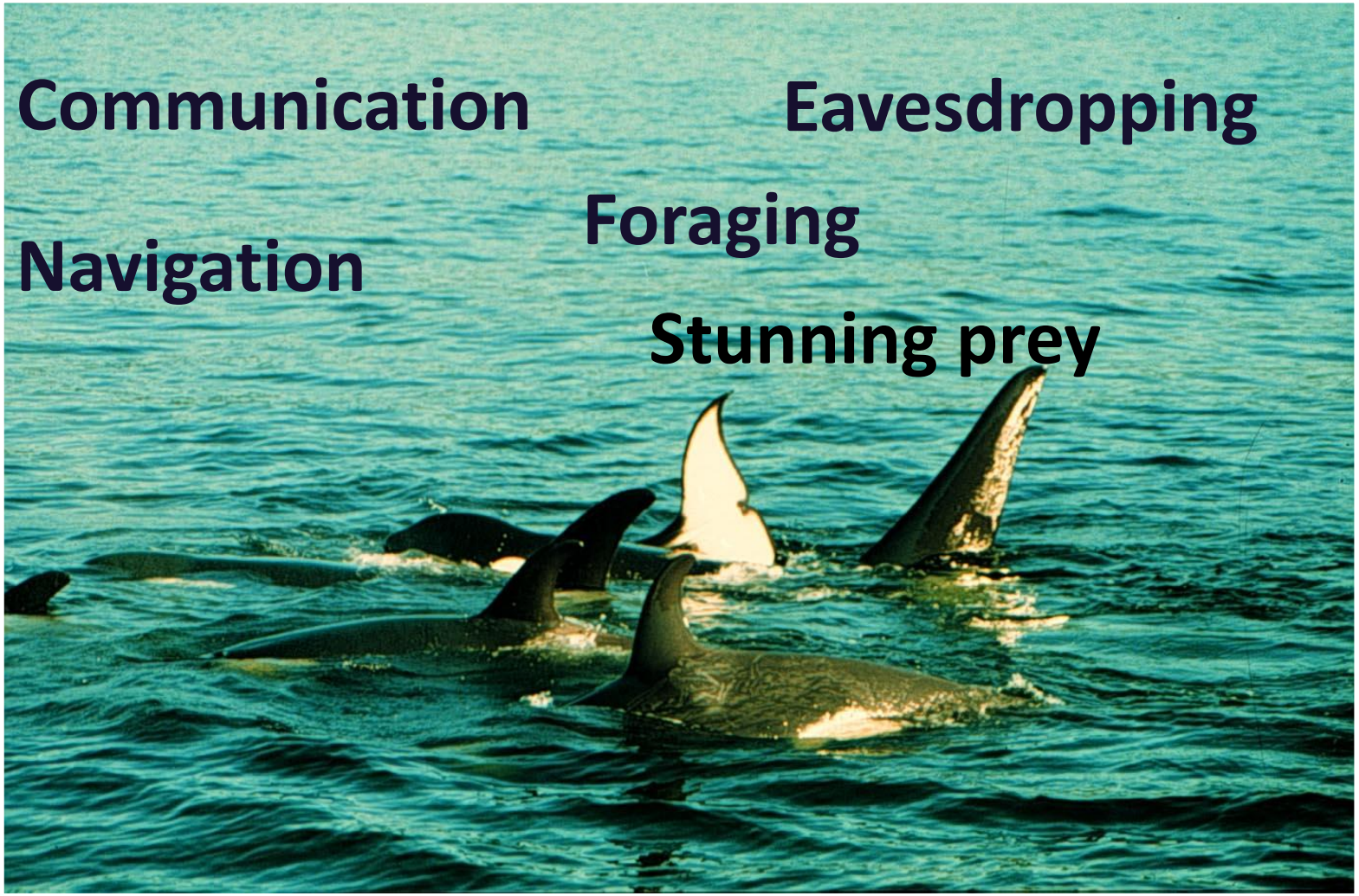
http://www.dredging.org/, special thanks to Anna Csiti and CEDA secretariat

Water is an ideal medium for sound

Sound is more than four times faster underwater compared to air and there is less attenuation

Marine life is noisy!

Use of sound

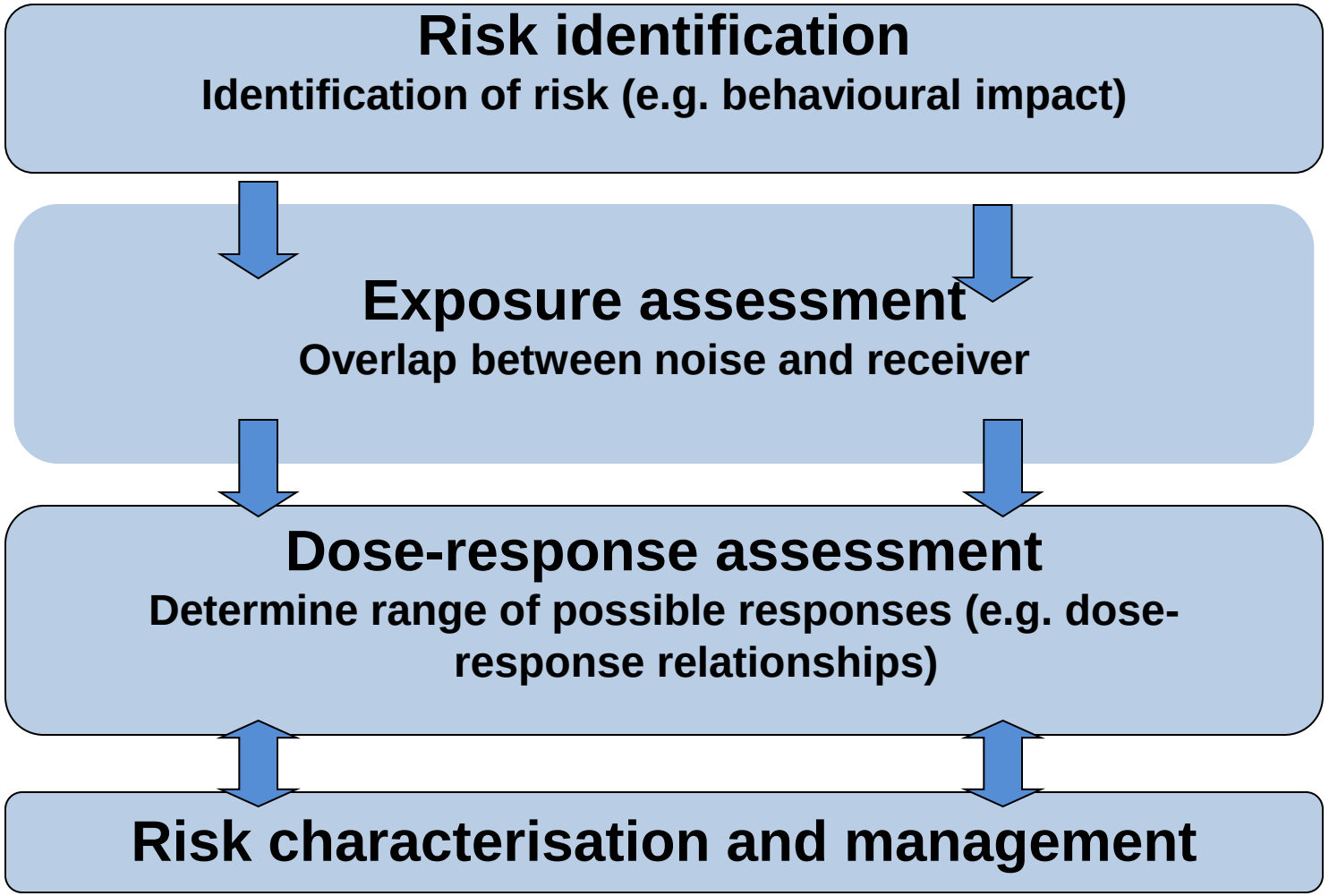

Communication
Eavesdropping
Foraging
Navigation
Stunning prey


Detection
Masking
Response
Hearing loss, injury

Marine Strategy Framework Directive

Introduction of energy, including underwater noise, is at levels that do not adversely affect the marine environment (EU MSFD)

Risk assessment (Boyd et al. 2008)



Dredging

Excavation of sediment from a sea, river or lake bed and the handling and transport of the excavated sediments and soils to a placement site elsewhere

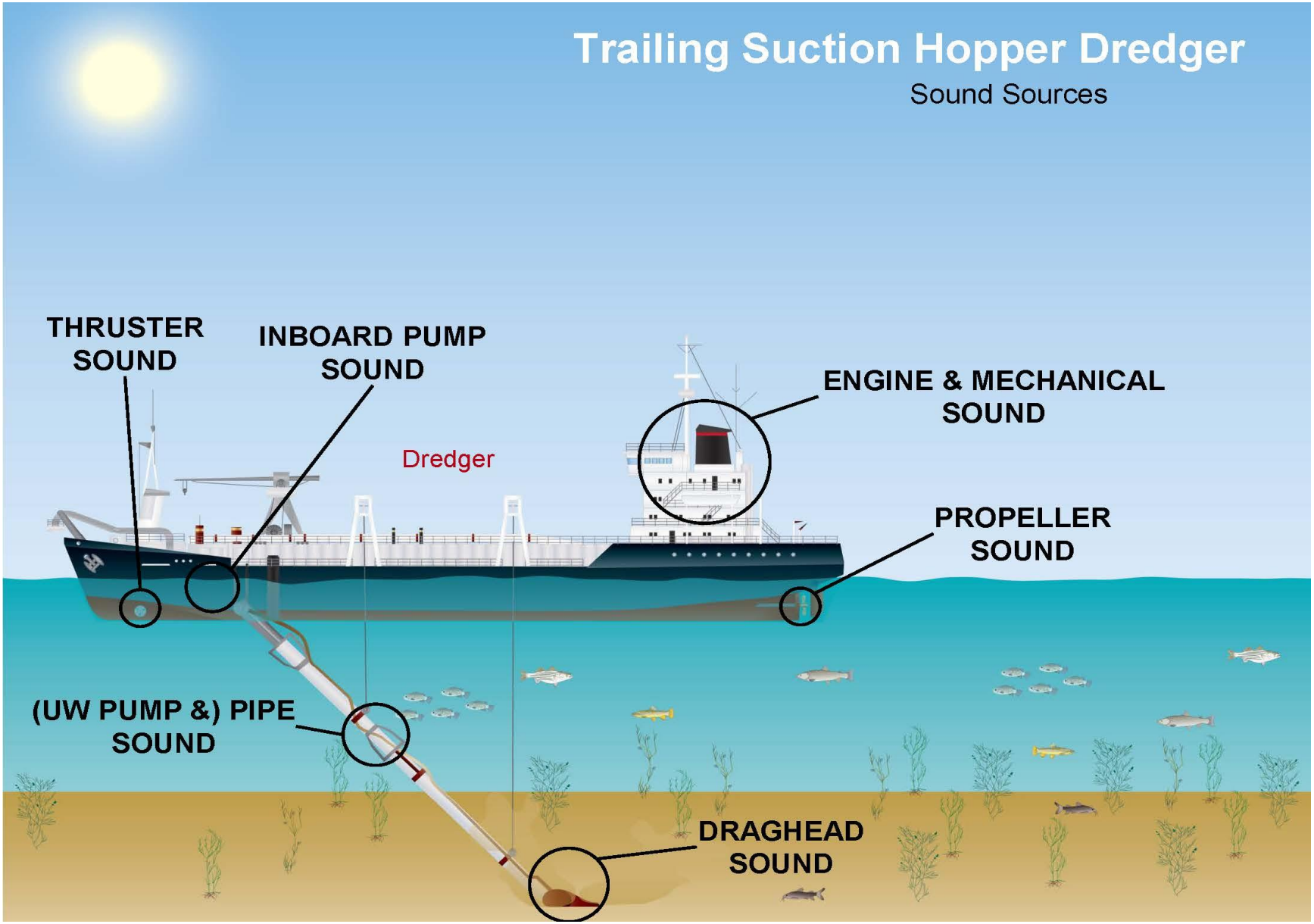
- Construction and maintenance of ports and waterways, dikes and other infrastructures
- Reclamation of new land
- Flood and storm protection and erosion control by maintaining river flows and by nourishing beaches
- Extraction of mineral resources from underwater deposits, particularly sand and gravel, to provide raw materials for the construction industry
- Environmental remediation of contaminated sediments.

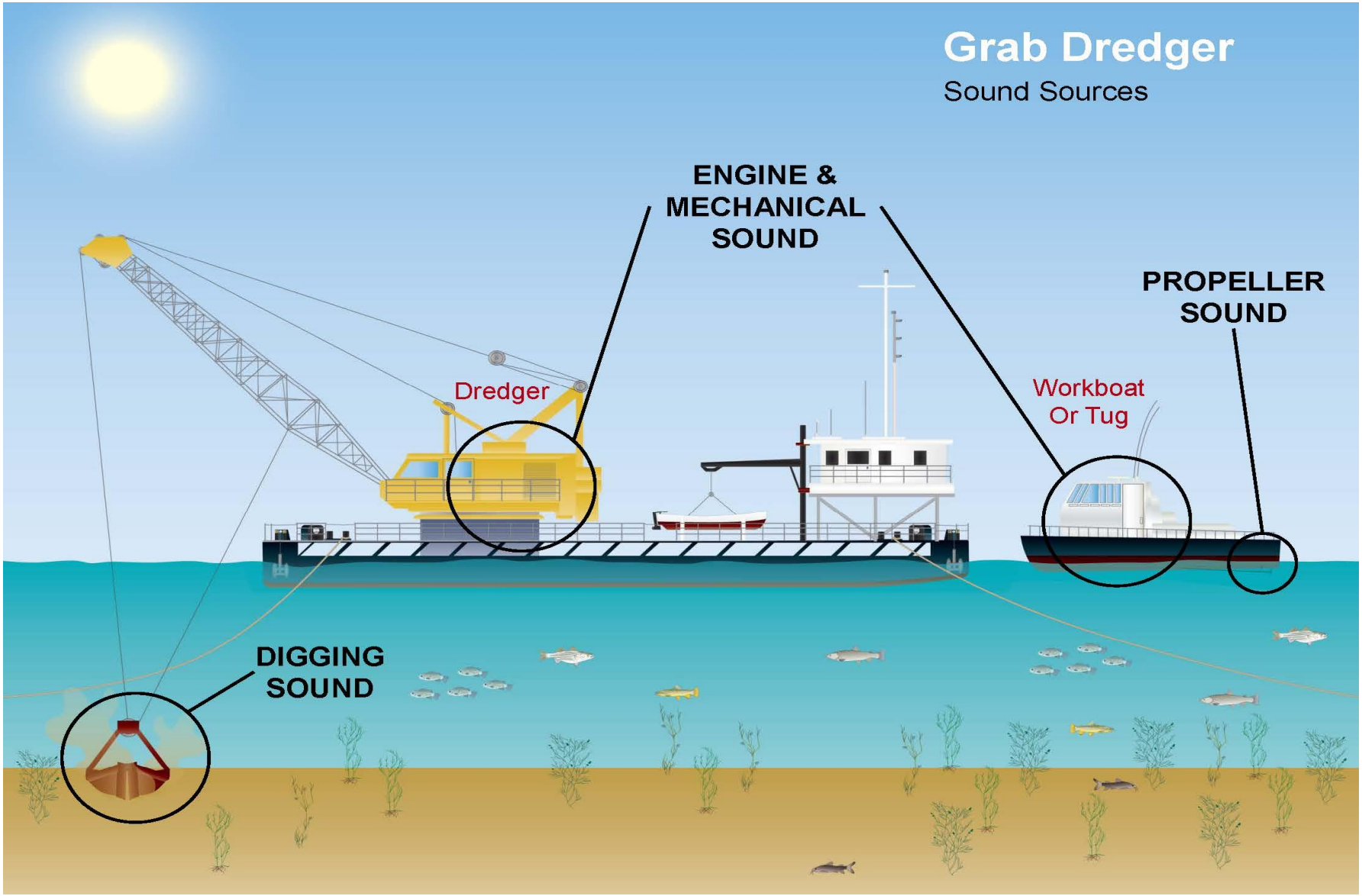
Dredger types and noisy activities

- Cutter suction dredgers (CSD),
- trailing suction hopper dredgers (TSHD),
- grab dredgers (GD)
- backhoe dredgers (BHD)

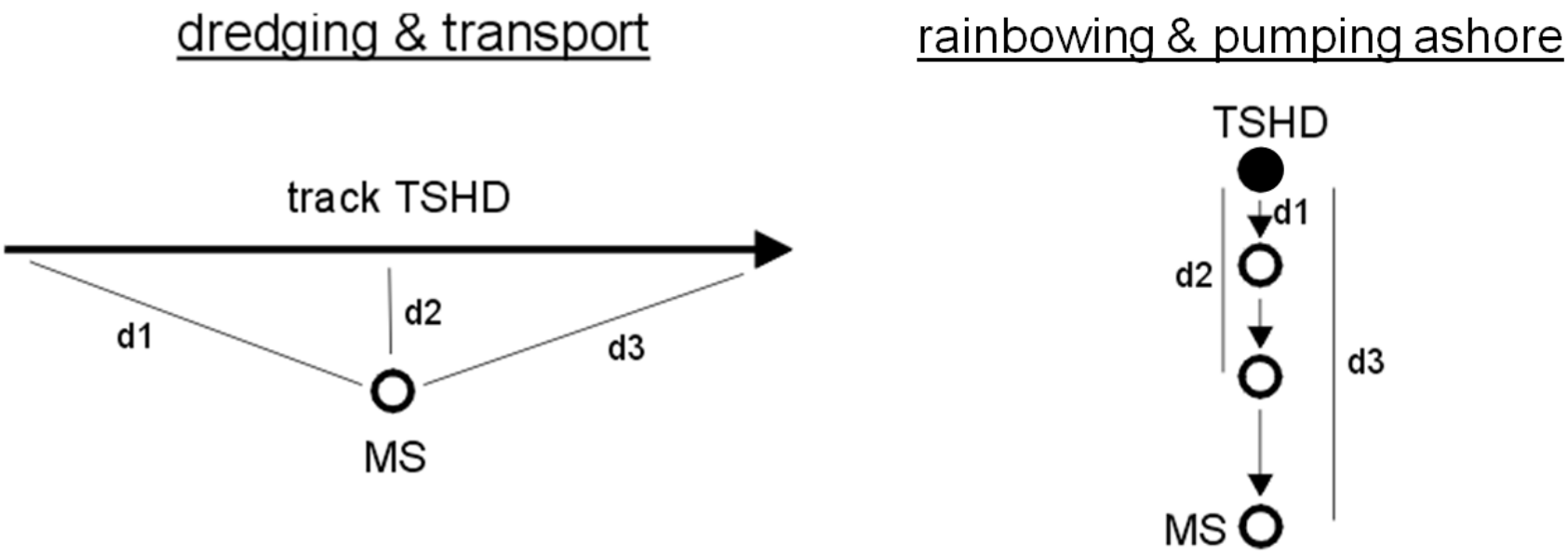
Activities generating sound:

- Dredging excavation
- Dredging vessels during transport
- Dredged material placement


Trailing Suction Hopper Dredger
Sound Sources
THRUSTER SOUND
INBOARD PUMP SOUND
ENGINE & MECHANICAL SOUND
Dredger
PROPELLER SOUND
(UW PUMP &) PIPE SOUND
DRAGHEAD SOUND

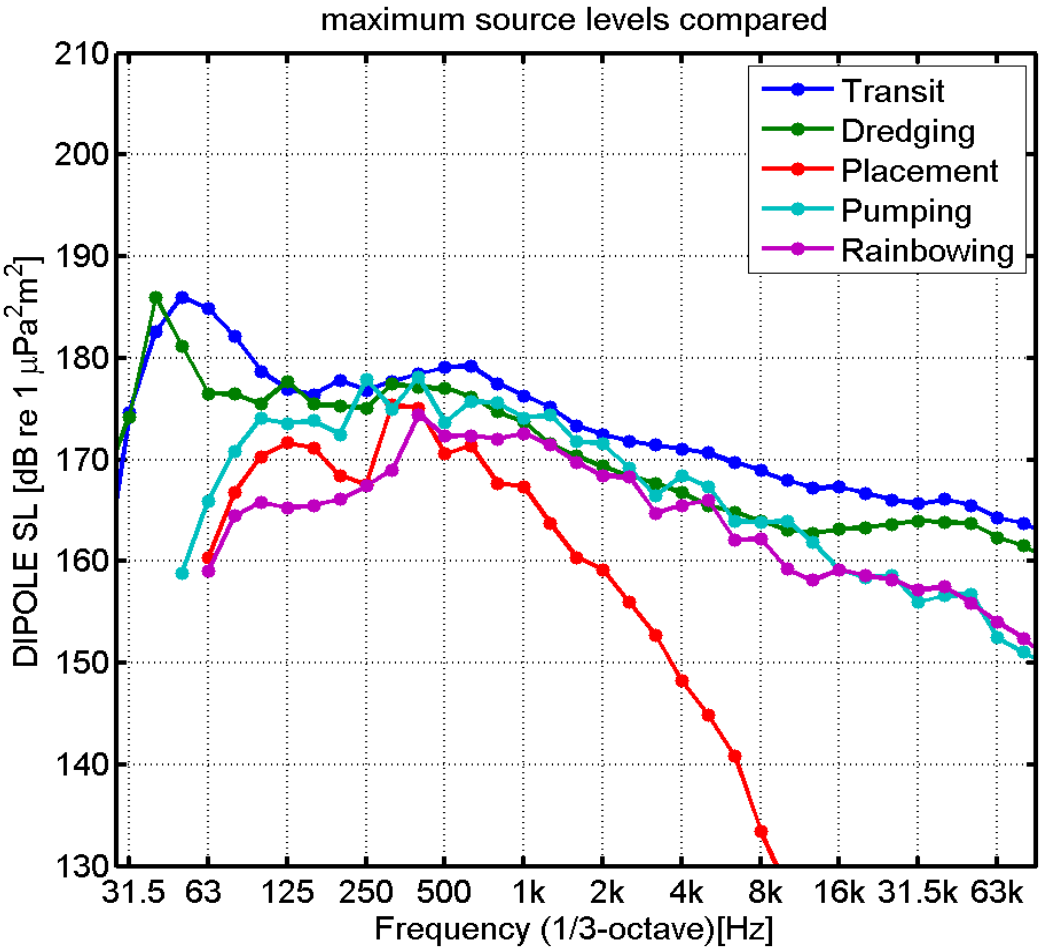

Grab Dredger
Sound Sources
ENGINE &
MECHANICAL
SOUND
PROPELLER
SOUND
Dredger
Workboat
Or Tug
DIGGING
SOUND

Measuring dredging sound



After de Jong et al. 2010; MS = measurement stations; d1, d2, d3 = distances

New TSHD investigations -1



De Jong et al. 2009 Maasvlakte 2, Port of Rotterdam

Marine sound sources

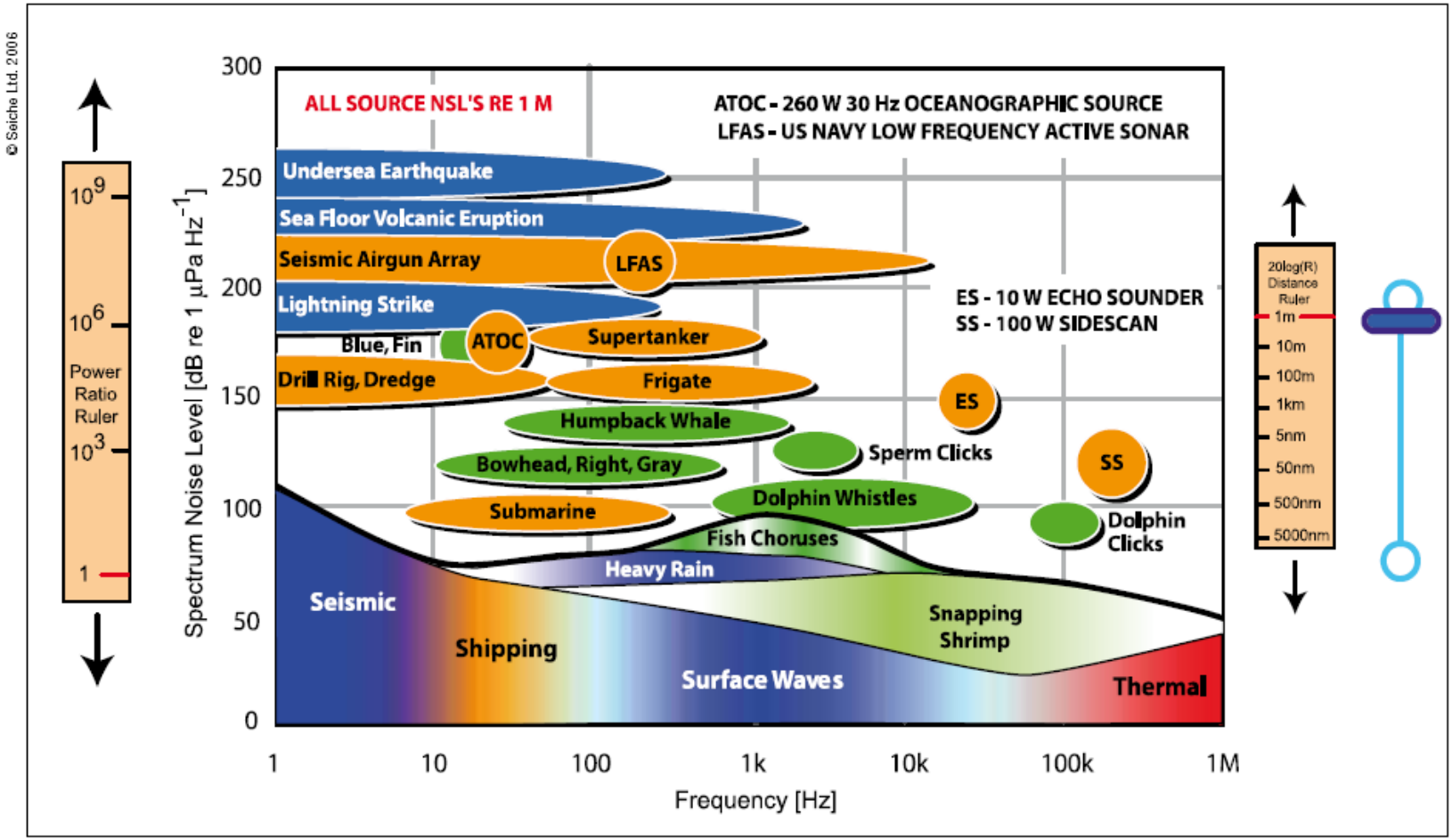
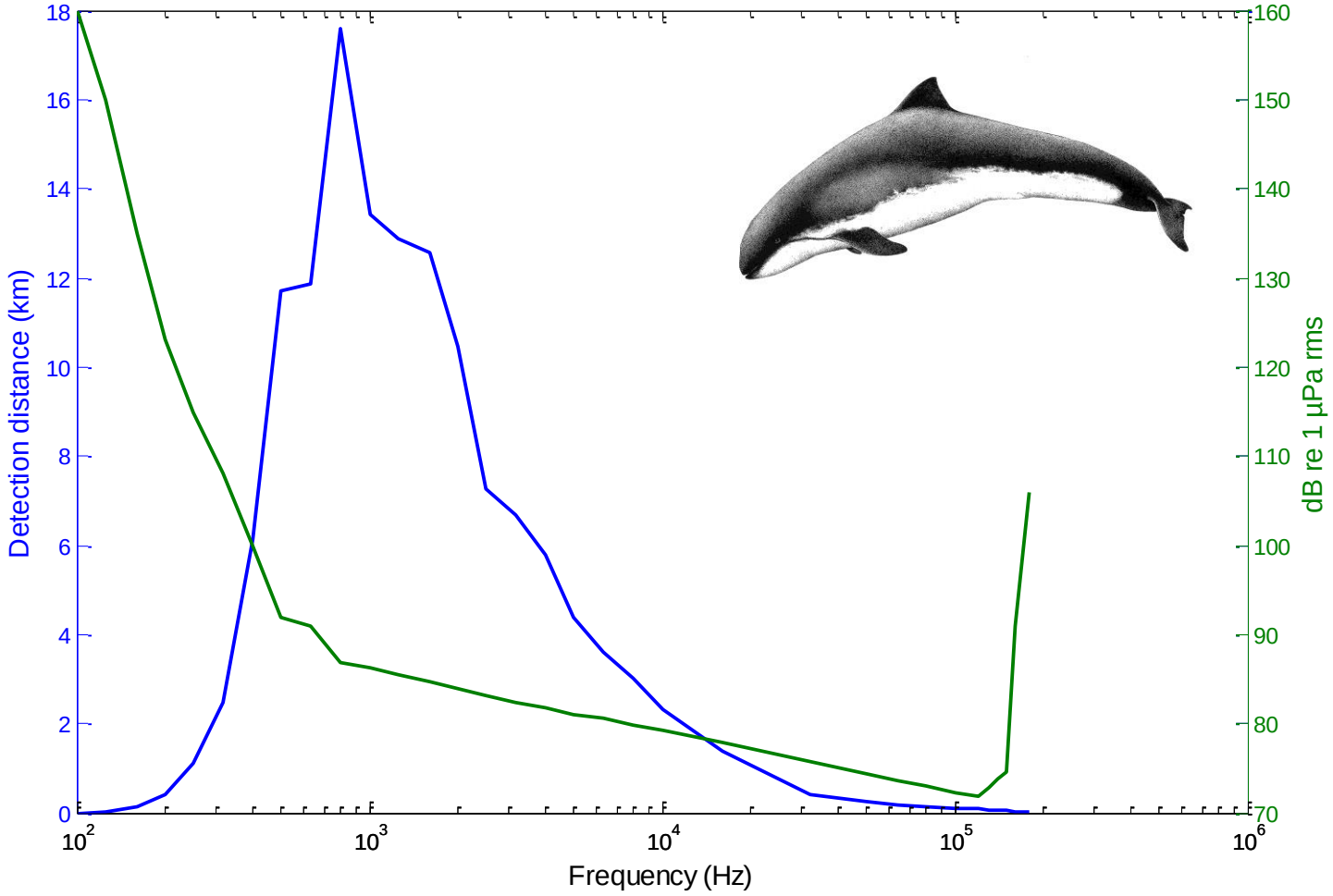


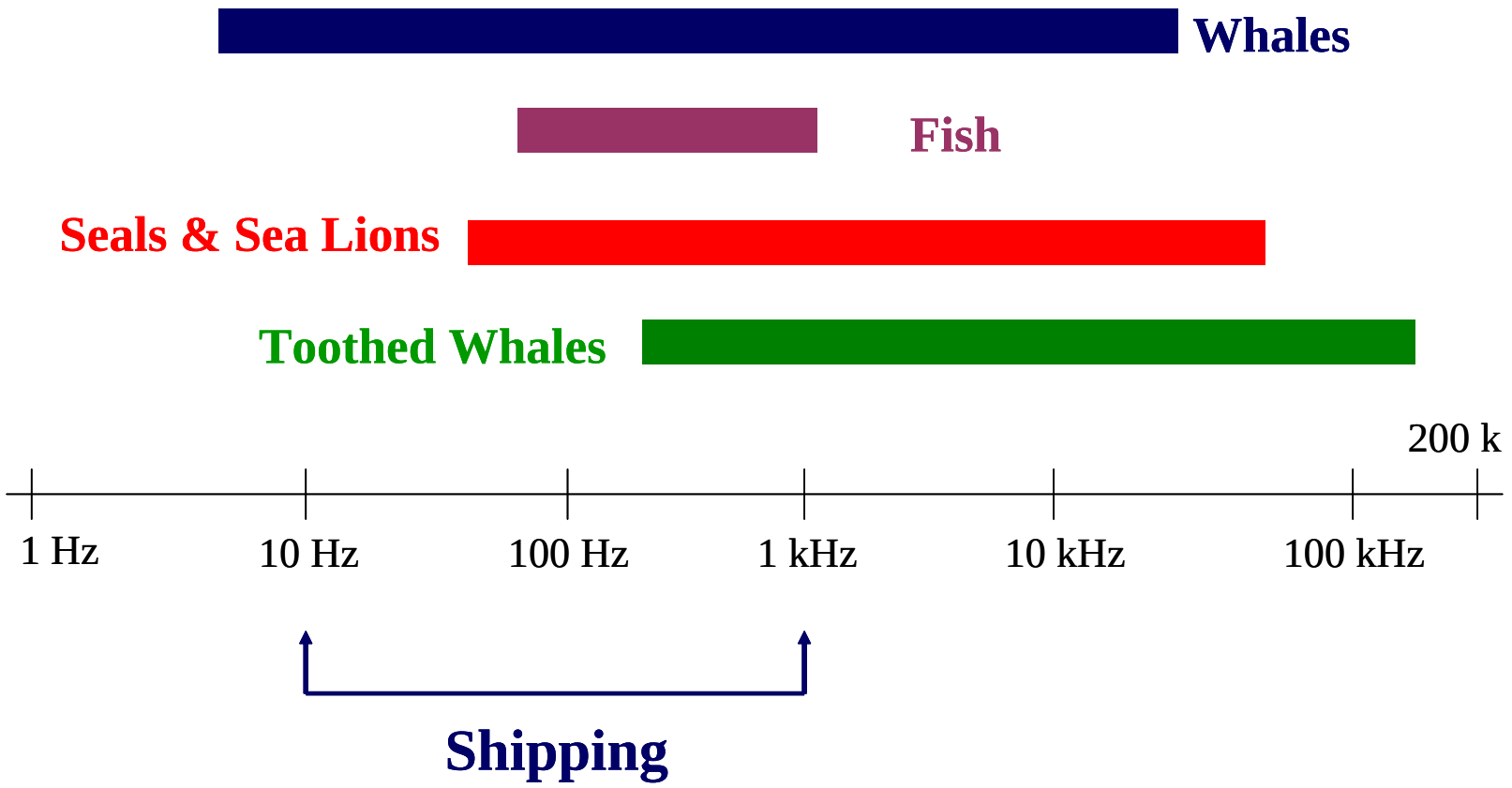
Figure 4. Noise levels and frequencies of anthropogenic and naturally occurring sound sources in the marine environment

Boyd et al. 2008

Detection of dredging sound

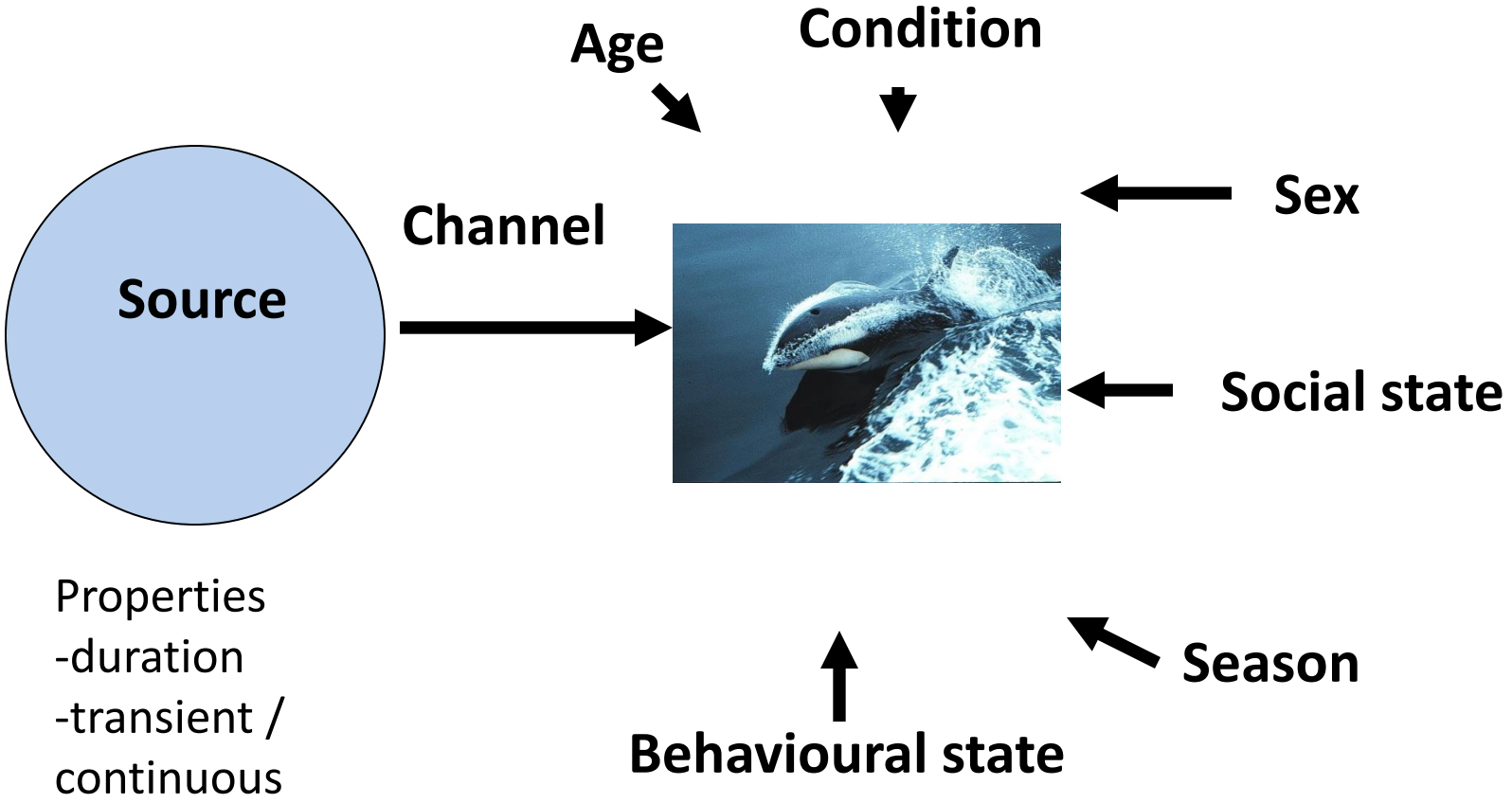


Masking potential of dredging sound



Southall & Hatch in OSPAR 2009

Response



Properties
-duration
-transient / continuous

Documented effects of dredging

- Gray and bowhead whales avoid areas of dredging activity (reviewed by Richardson et al. 1995)

- Harbour porpoises leave areas during sand extraction. The reactions were relatively short term however (Diederichs et al. 2010)

Hearing loss

- TTS studies in a few marine mammal and fish species
- Depending on sound type, duration and pressure
- Long term exposure can lead to TTS

Mitigation

Acoustic devices (e.g. Pinger)

Equipment Design (e.g. pile sleeves)

Timing

Bubble curtain

Monitoring of safety zones (visual and acoustic)

Ramp up / soft-start

Research

Nehls *et al.* 2007

Conclusions

- Dredging assessment shall follow a risk based appaoch as outlined in the guidance paper
- Behavioural impacts and masking are possible
- TTS has to be considered at exposures over long time
- Injury is unlikely
- More studies on dredging sounds and effects on marine life are needed

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