

Auditory studies on marine mammals

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Conducted in close collaboration with:

Marie-Anne Blanchet, Eligius Everaarts,
Ursula Siebert, Paul Lepper and many others...

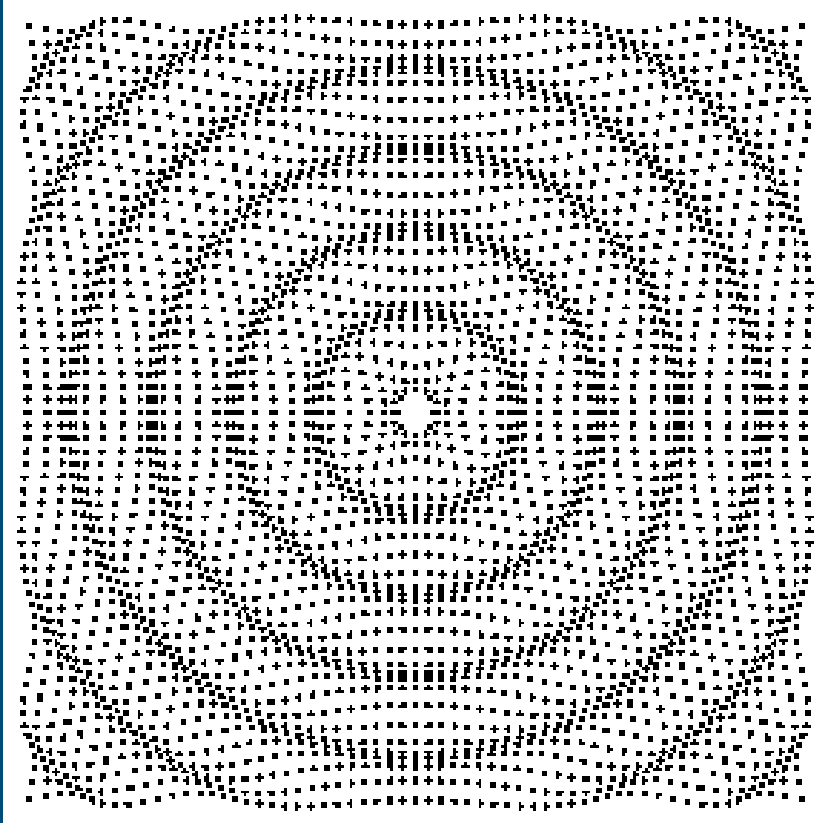


Content

- The auditory system
- Anthropogenic sound
- Marine mammals and sound
- AEP methodology
- Some studies
- Direct consequences

What is sound?

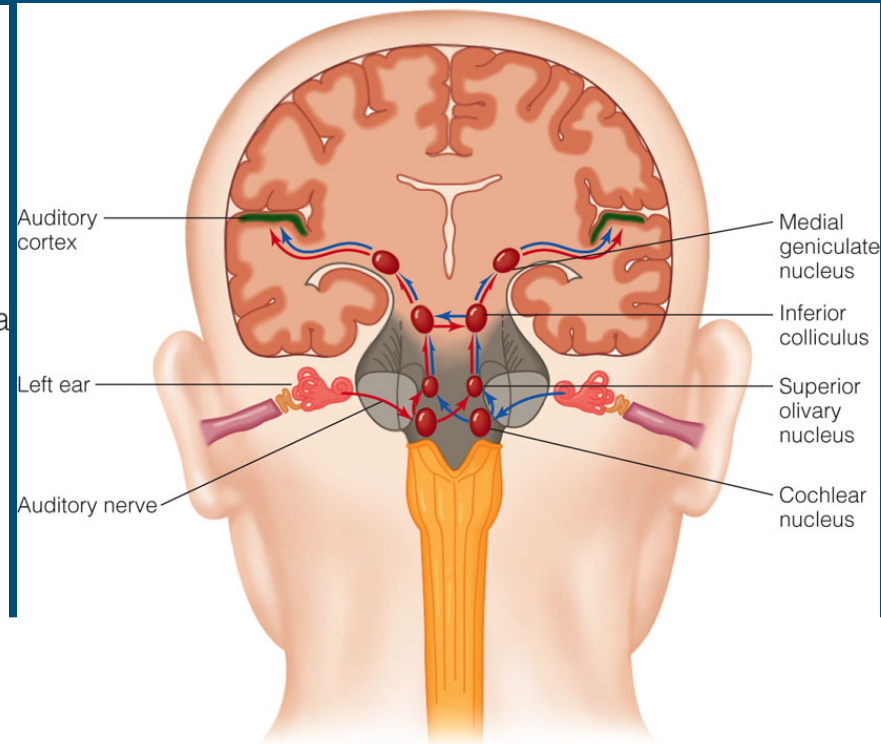
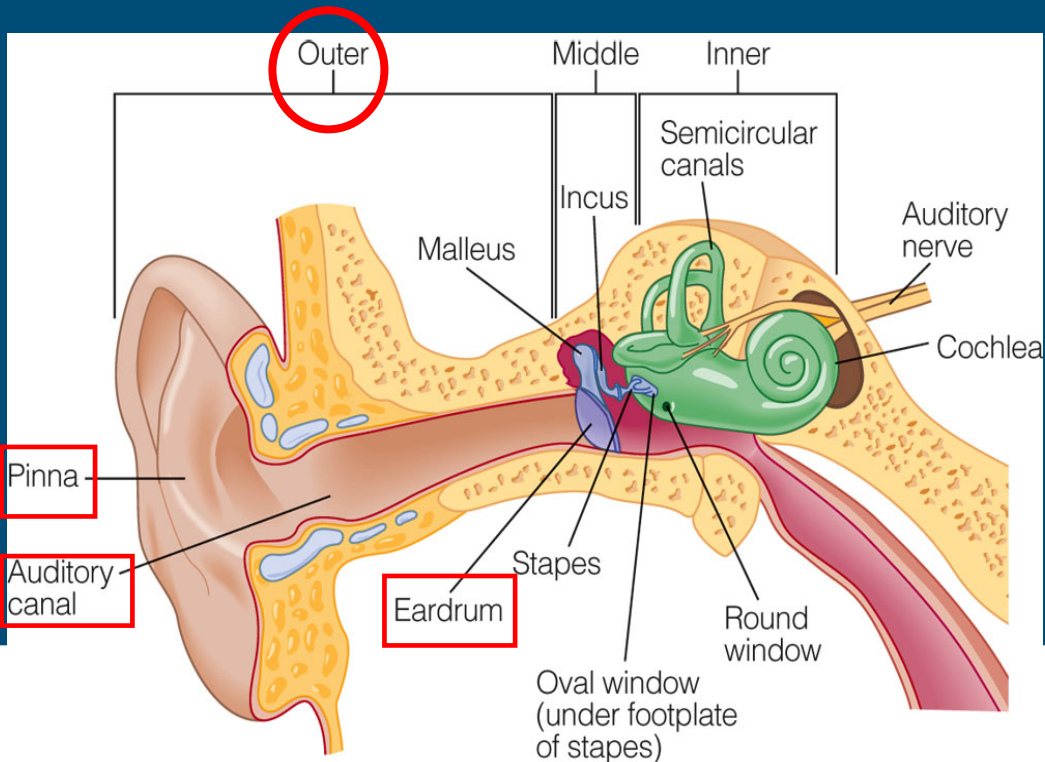
Sound is the perception of a mechanical wave!



- Amplitude
- Wavelength
- Frequency

The Auditory System

- Outer Ear: Pinna and Canal
- Middle Ear ossicles: Malleus, Incus and Stapes
- Inner Ear: Cochlea
- Auditory Nervous System

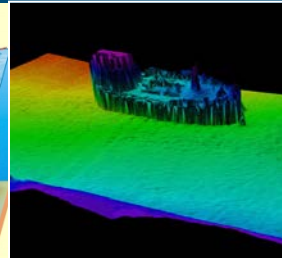
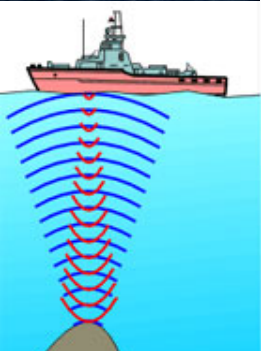


Anthropogenic sound

- Seismic surveys
- Military exercises
(incl. low-/ mid-frequency sonar)
- Explosions
- Offshore construction
- Shipping
- Many more ...

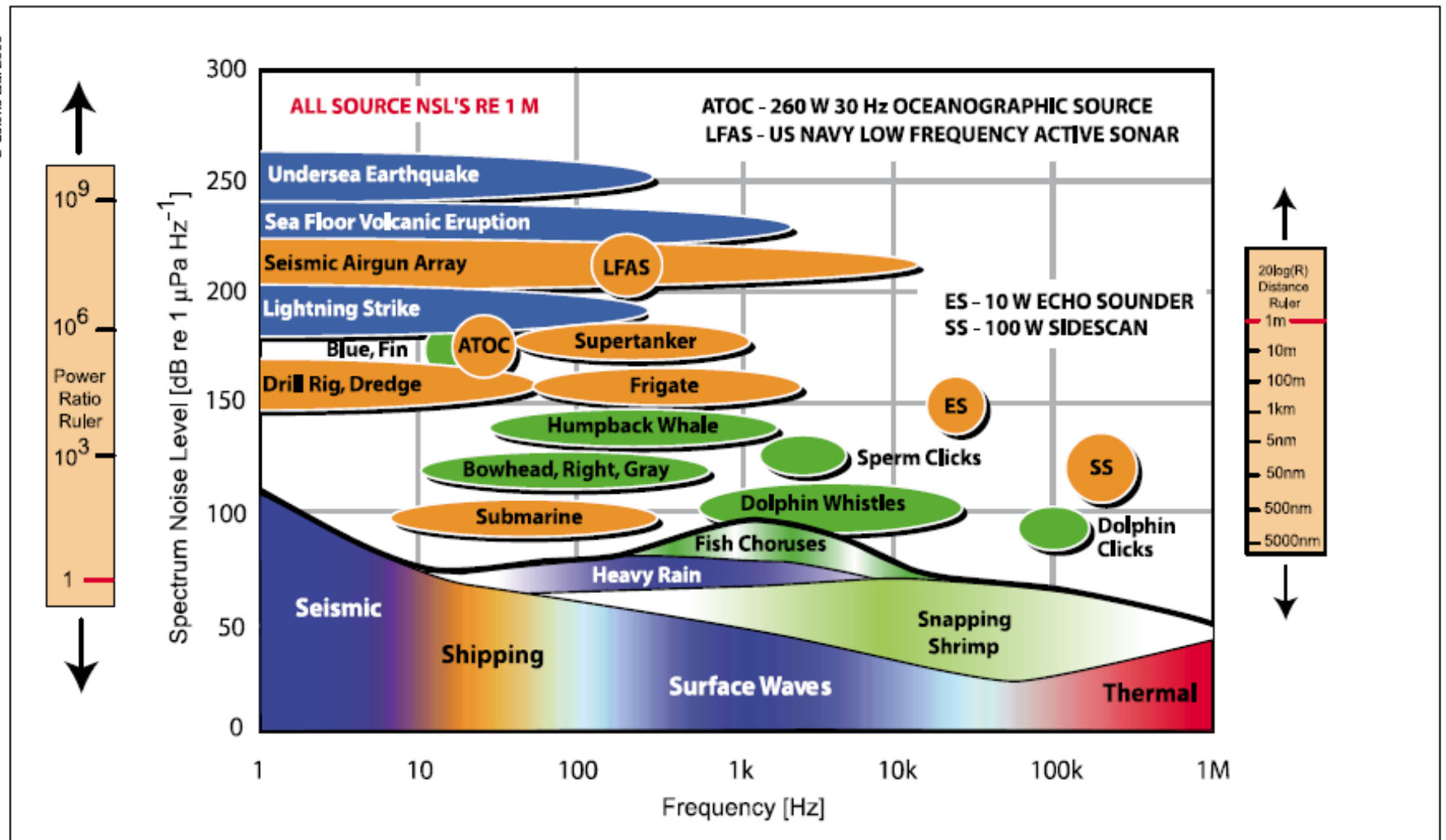
Acoustic characteristics are different:

duration, frequency, energy content,
cycle, rise time, kurtosis, ...

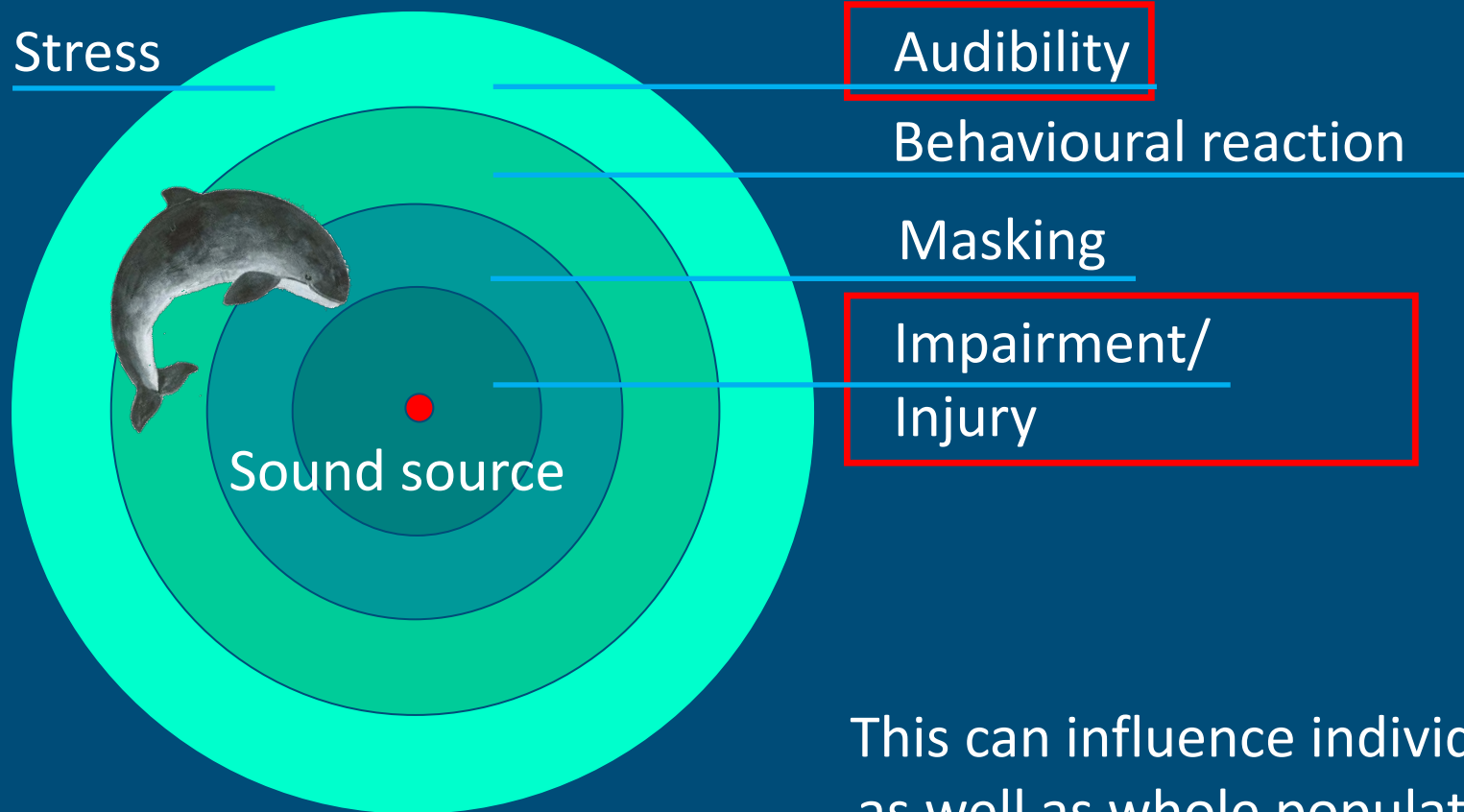


Background noise

© Seiche Ltd. 2006



Sound-induced effects



This can influence individuals
as well as whole populations

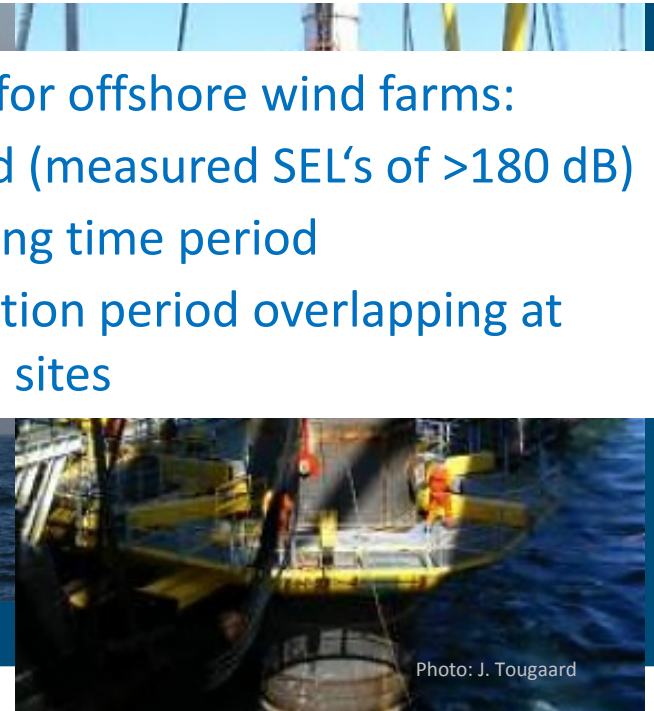
Noise in the marine environment

Operational noise of offshore wind turbines:

- relatively low level (~130 dB SL)
- continuous (20+ years)
- thousands of wind turbines = summation effect?

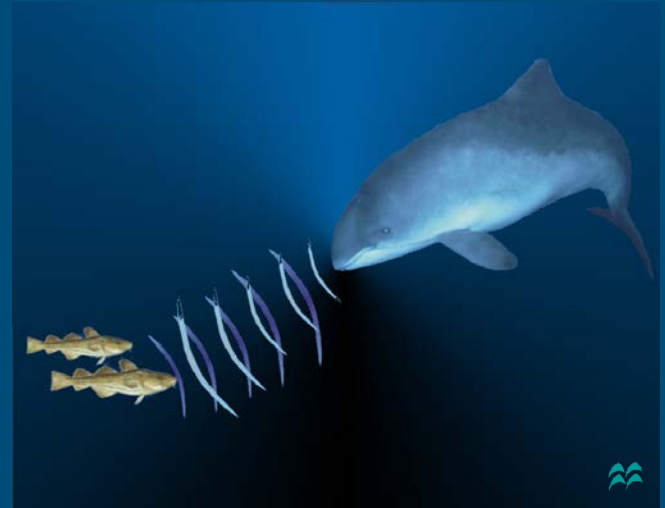
Pile driving for offshore wind farms:

- very loud (measured SEL's of >180 dB)
- over a long time period
- construction period overlapping at different sites



Sound and marine mammals

- Communication
- Orientation
- Finding Food
- Predator Avoidance
- Obstacle avoidance



Underwater sound is one of the primary triggers for behavioural reactions in marine mammals!

1. step: Information on hearing sensitivity

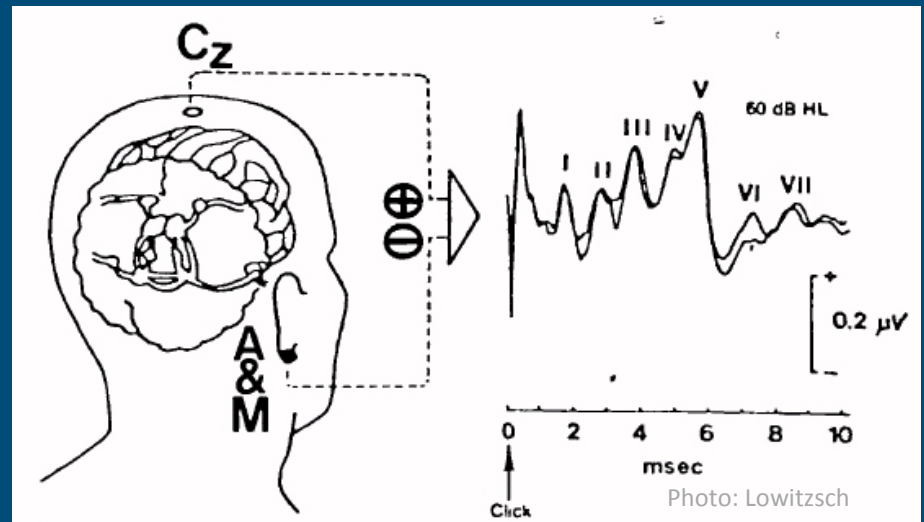
Individual variability (+ wild vs. captive animals)

AEP-Method

Measurement of auditory evoked potentials (AEP method)



Photo: Biomimetica



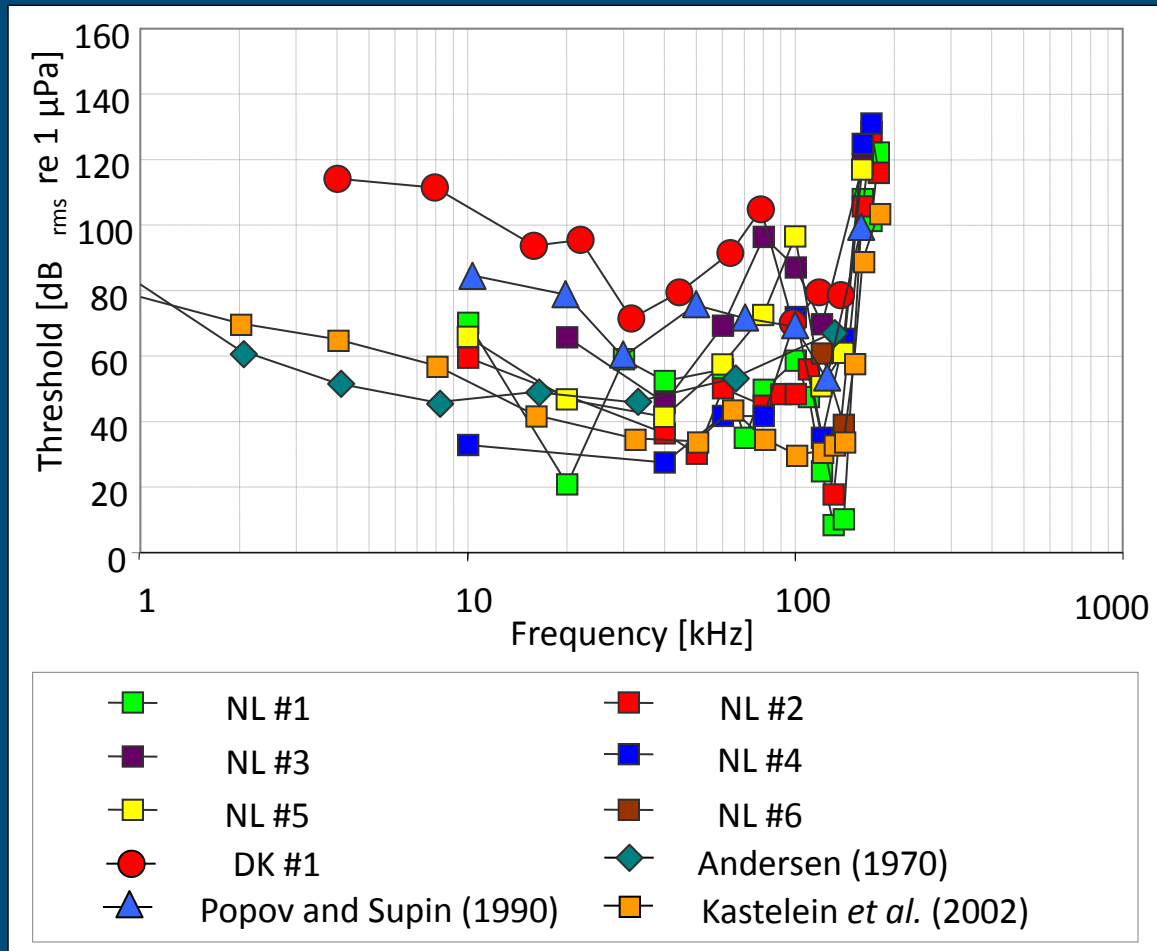
- Pro's:
- Active participation not inevitably necessary (well, for some studies it is of PRIMARY importance)
 - non-invasive
 - rapid

Hearing tests: Procedure



Hearing tests: Results

- AEP-Method established for hearing tests in harbour porpoises
- 10+ audiograms
- Wild and captive animals



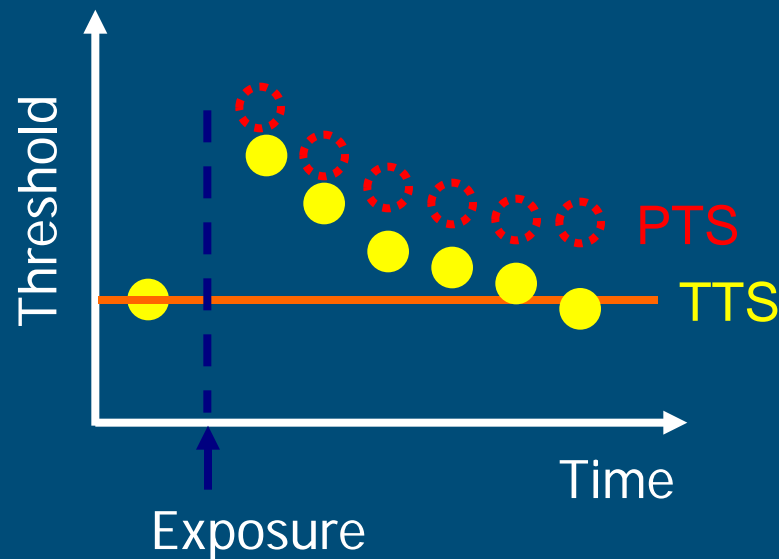
TTS study in harbour porpoises

- How tolerant is the hearing system of harbour porpoises to impulsive sound?
- Determination of the acoustical tolerance limit of harbour porpoises
- Development and testing of method applicable also to free-ranging animals (on-going)

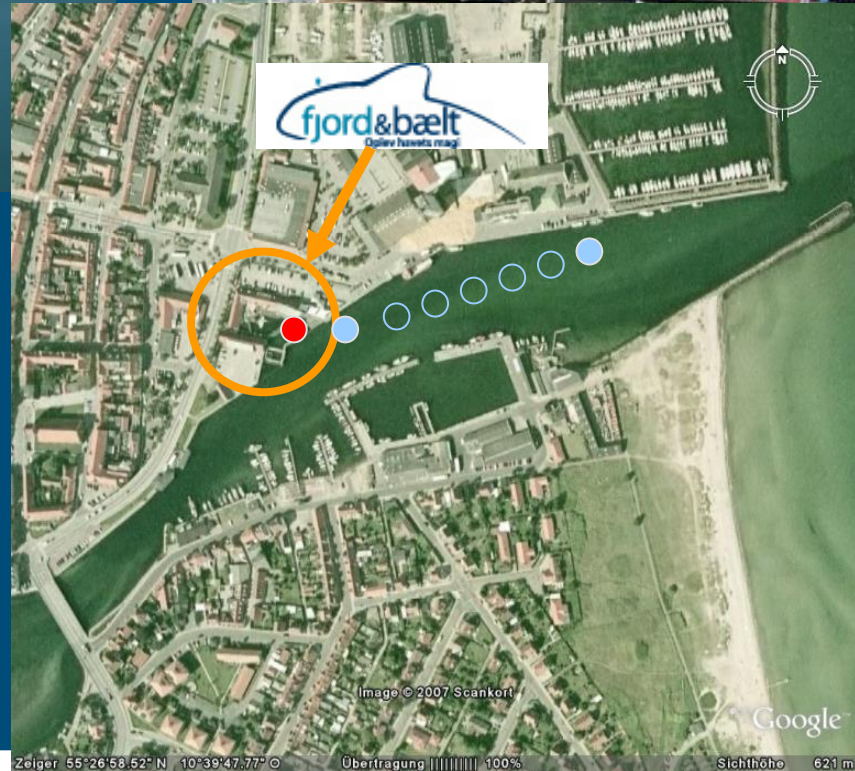


Noise induced hearing loss (NIHL)

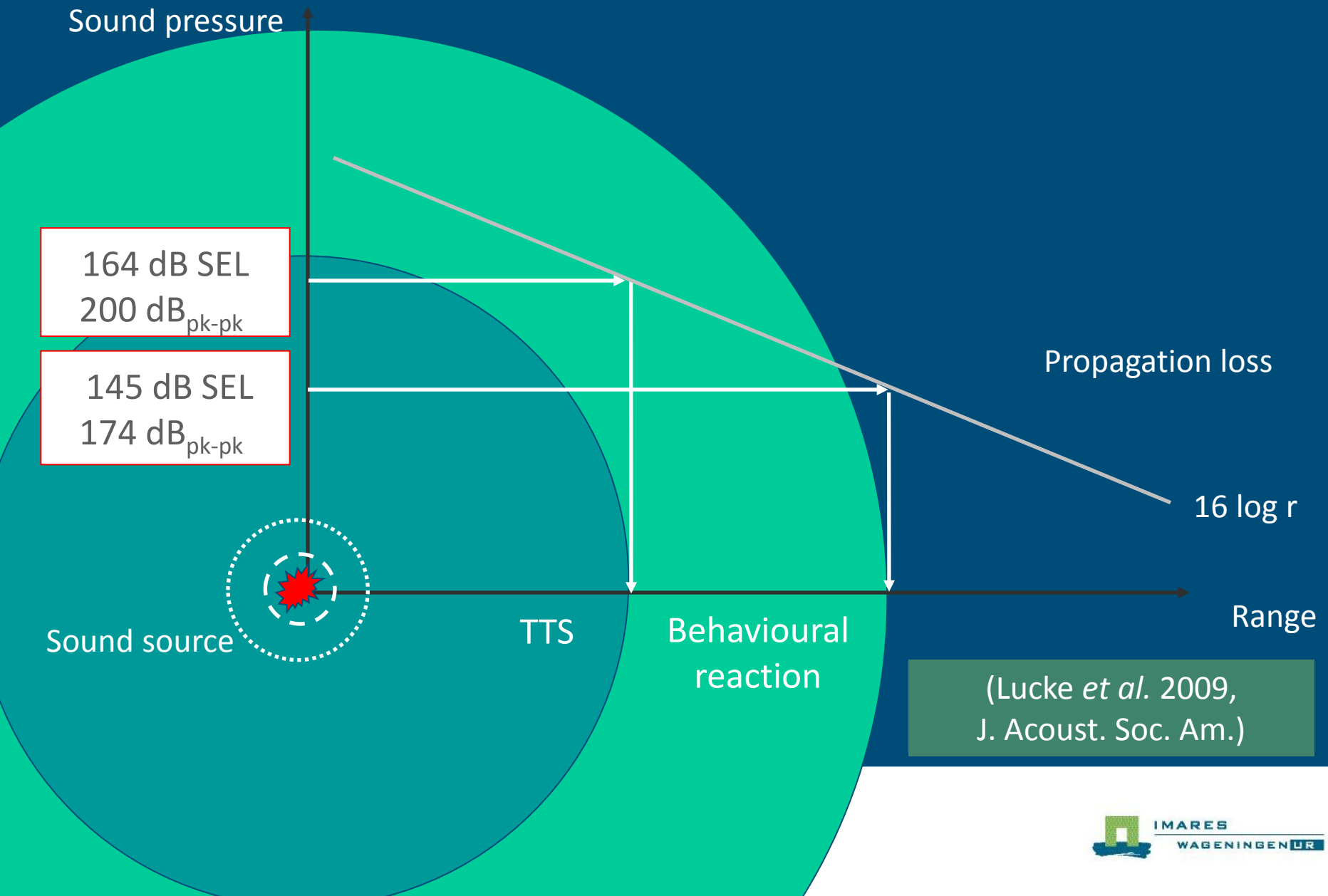
- Noise exposure can lead to a shift in hearing sensitivity (Threshold Shift, TS)
- This effect can be temporary (TTS) or permanent (PTS)



TTS-tests (F&B, Denmark)



Effect range



Noise exposure criteria

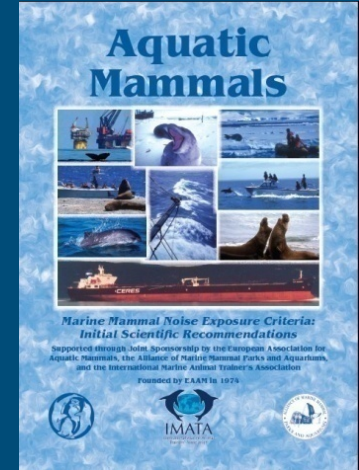
- Southall *et al.* (2007) – general criterion:

Sound energy: 183 dB re 1 $\mu\text{Pa}^2\cdot\text{s}$

Sound pressure: 224 dB_{pk-pk} re 1 μPa

In 2007:

No species-specific data for harbour existing



- Germany 2009 – porpoise specific criterion:

Sound energy: 160 dB re 1 $\mu\text{Pa}^2\cdot\text{s}$

Sound pressure: 190 dB_{pk-pk} re 1 μPa

Result:

Requirement for sound absorption or quieter techniques

Thanks...