



Underwater sound in the Baltic Sea – Status & Driver



Marine Strategy Framework Directive (2008)

It was identified that noise is an issue. The Member States have to deal with it.

Impulsive noise



Continuous noise



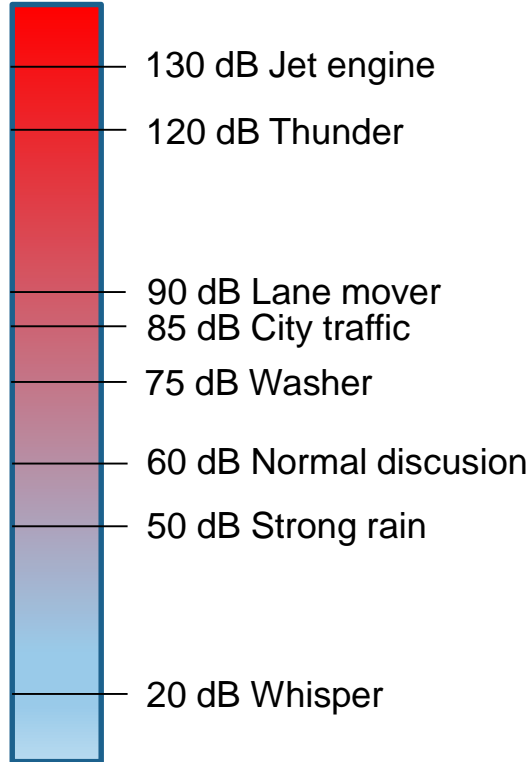
Cummulative effect that leads to significant effects on population level

Sound Level – decibel (dB)

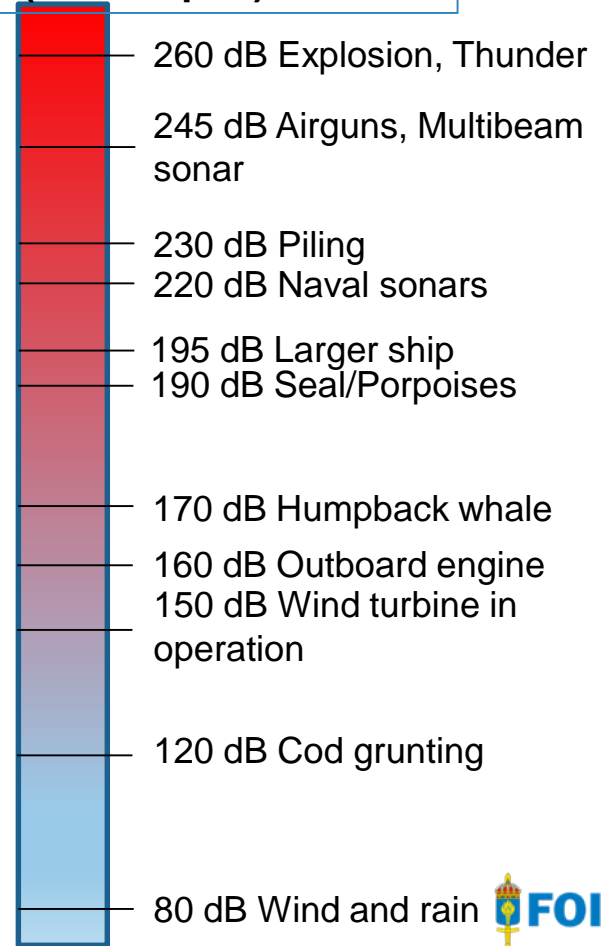
Note: different reference values for air and water



In air (dB re 20 μ Pa) @ 1m



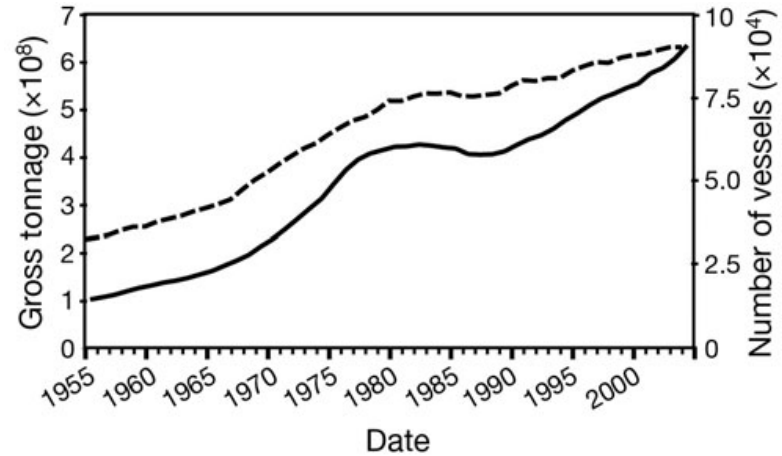
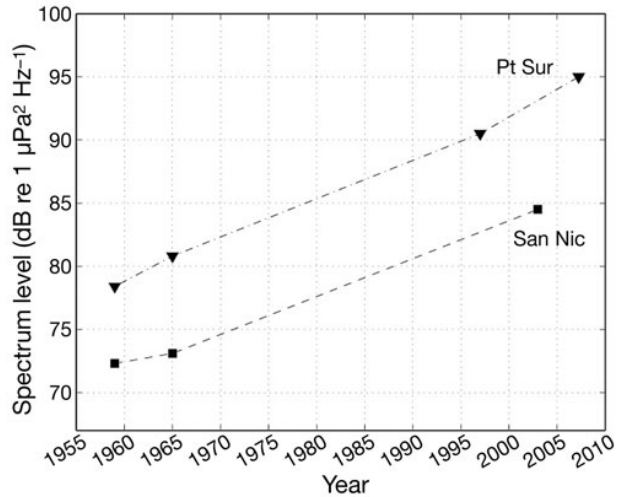
In water (dB re 1 μ Pa) @ 1m



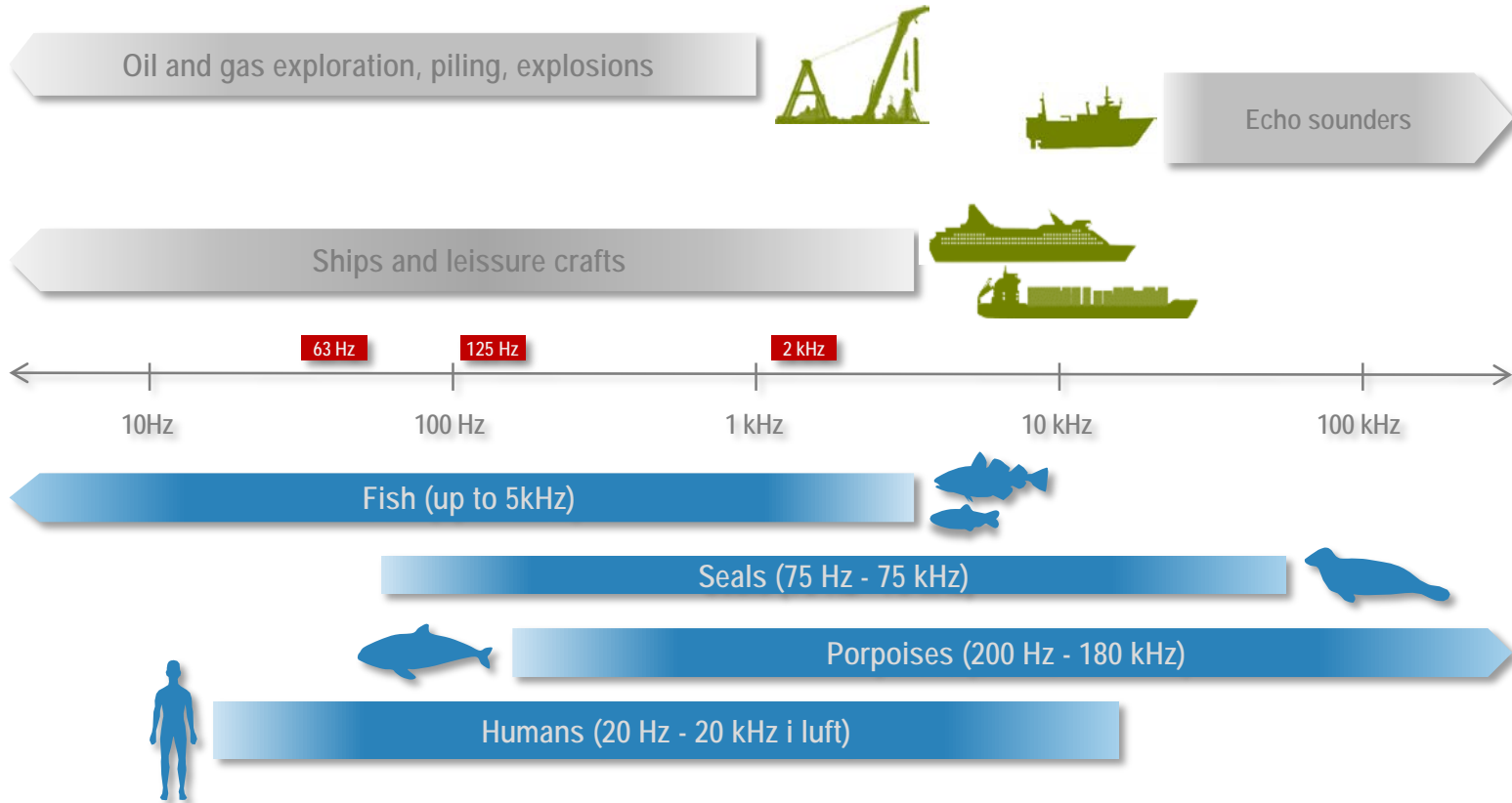
What is the trend?

Few measurements show that the sound levels are slowly raising in the oceans

0.5 dB per year increase



Frequency – in Hertz (Hz)



Estimating the risk/impact

Estimate of
Impact



Source

Level
Duration
Frequency



Environment

Salinity
Temperature
Sediment



↑
Estimate of Pressure

↑
Risk-based

Receiver

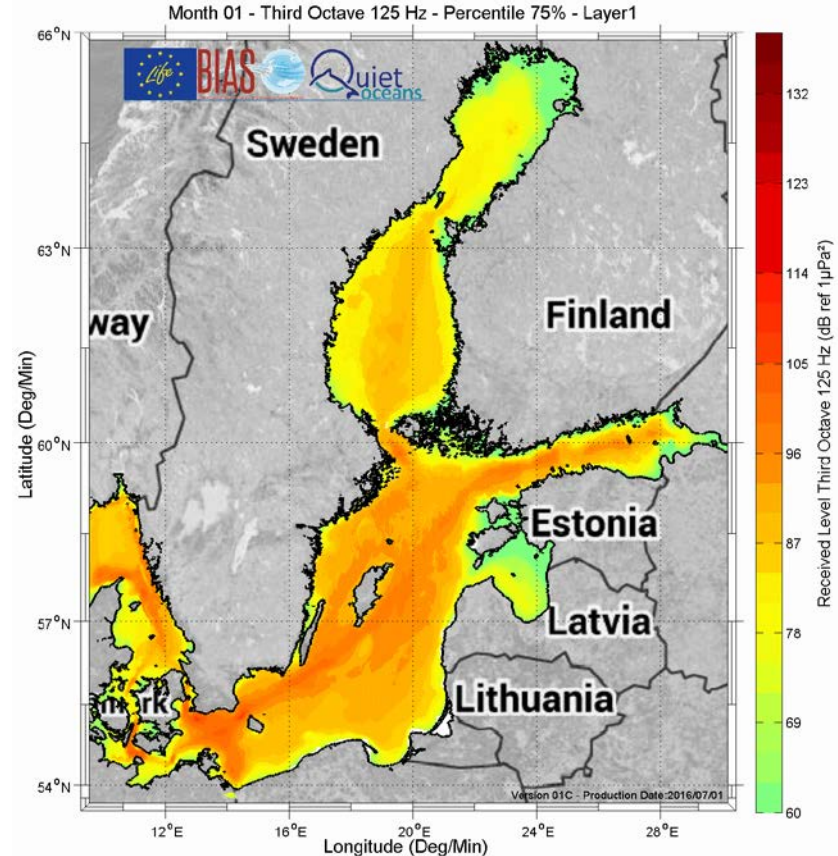
Anatomy
Context/trait
Experience



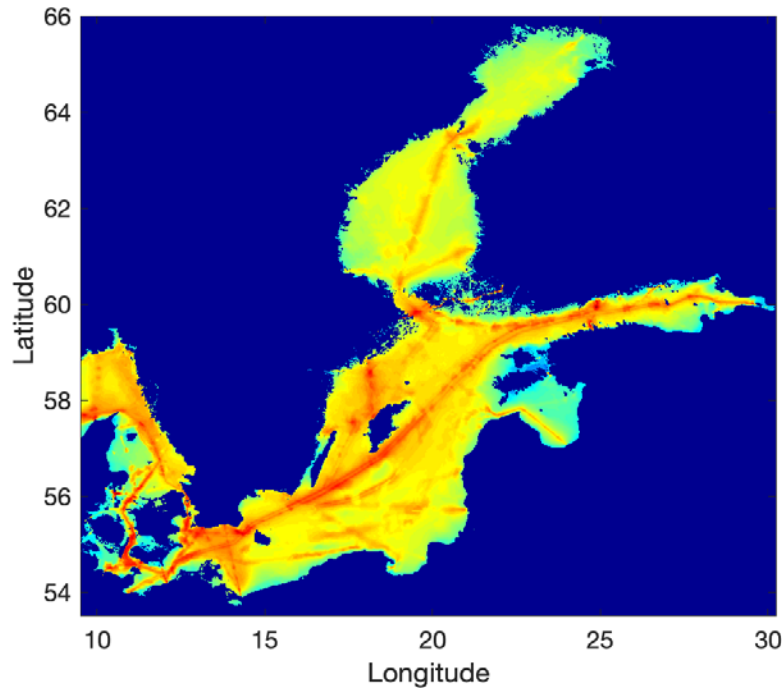
↑
Impact-based

The Soundscape of the Baltic Sea

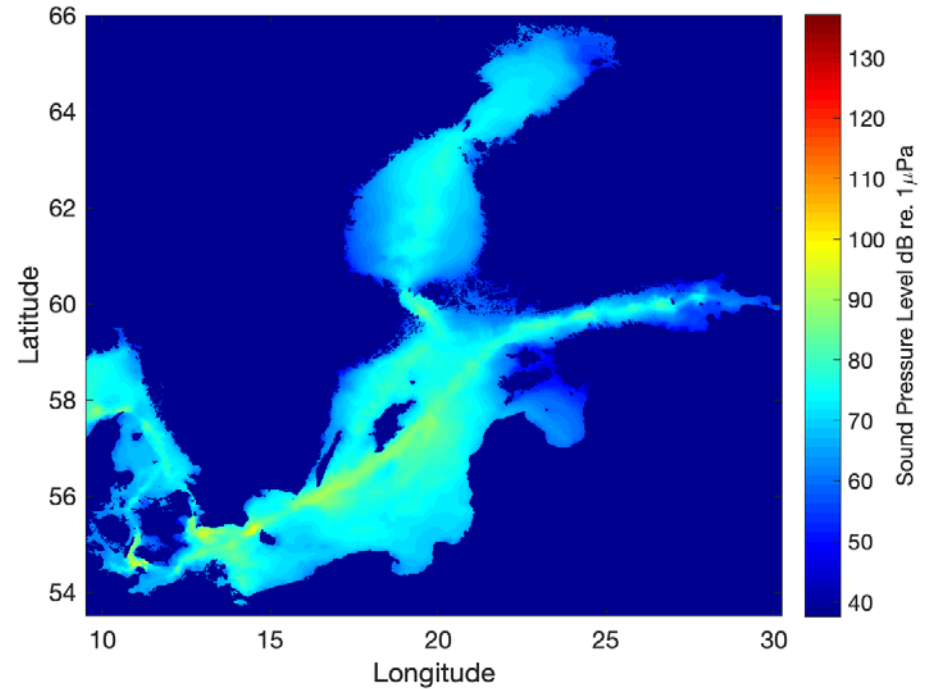
- EU LIFE project BIAS 2014-2017
- Standardized measurements in **37 positions during 2014**
- Large scale acoustic modelling
- Meteorology, AIS, VMS
- **Monthly maps** for specific frequencies and depths



The BIAS sound pressure at 125 Hz



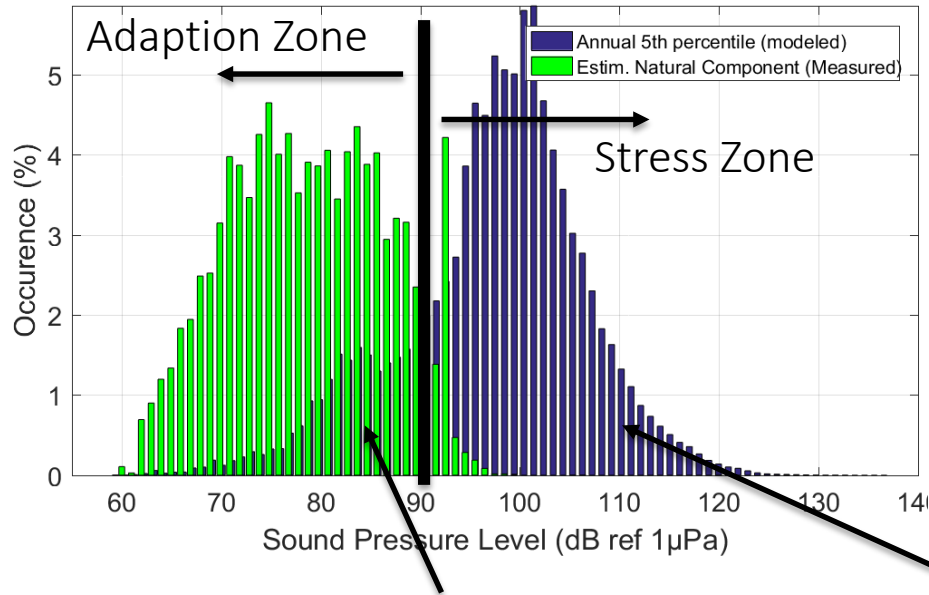
Occasionally levels higher than plotted values (5 % of the time)



In general levels higher than plotted values (95% of time)

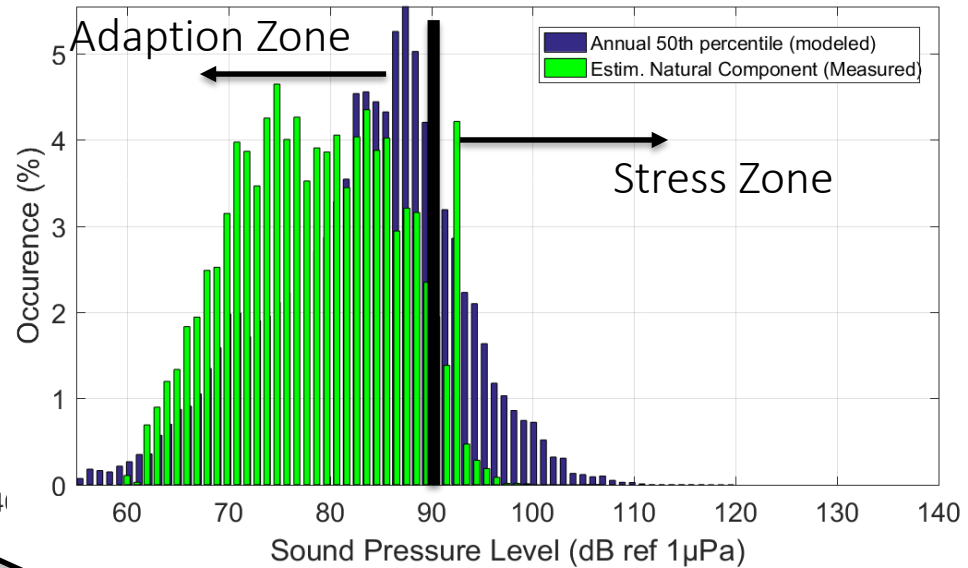
Natural and Human Induced Sound

Third octave 125 Hz



Natural Ambient Sound

Third octave 125 Hz



Human Induced Noise

Zones of impact

Masking

Noise overtakes the soundscape decreasing efficient communication distance

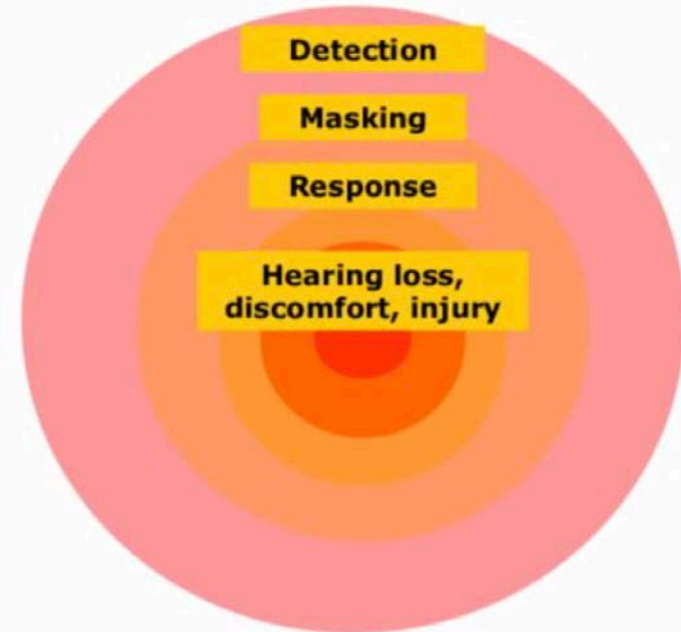
Behavioural impact

Disrupted feed search, escape displacement and separation

Physiological injury

Induced stress
Temporary or permanent hearing loss

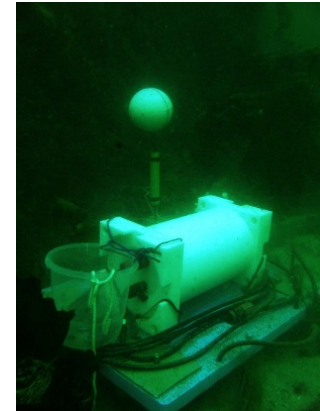
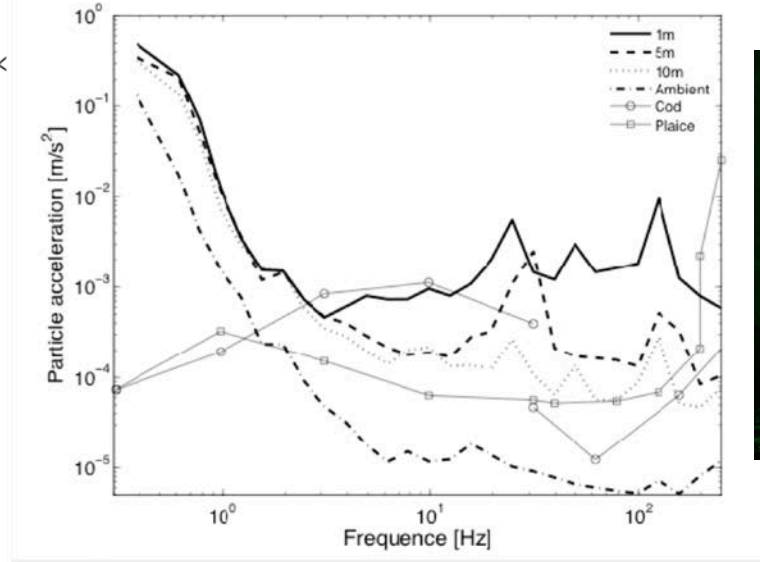
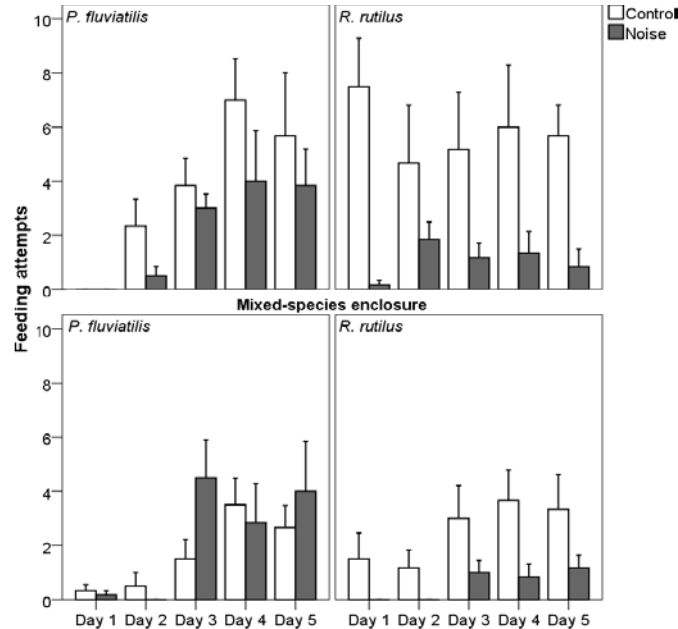
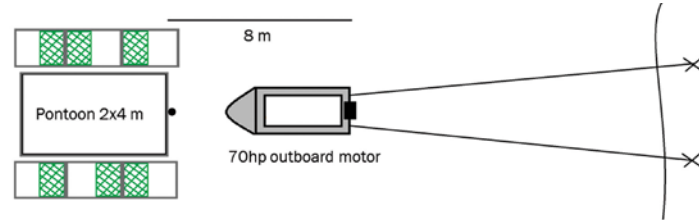
Theoretical zones of noise influence



(Richardson et al. 1995)

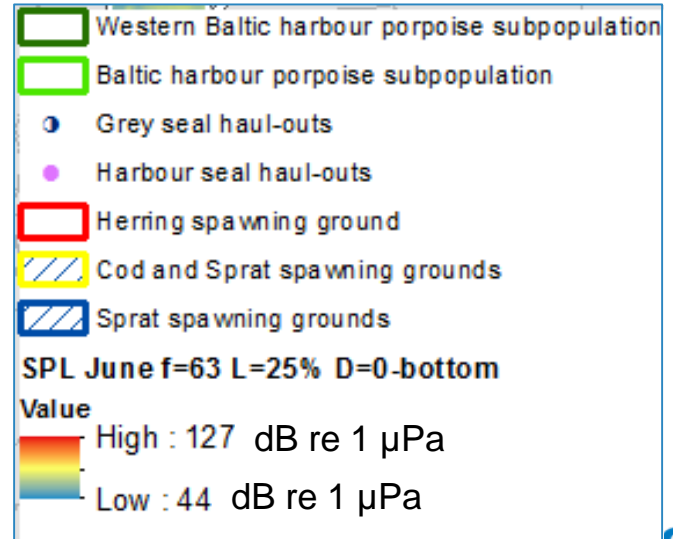
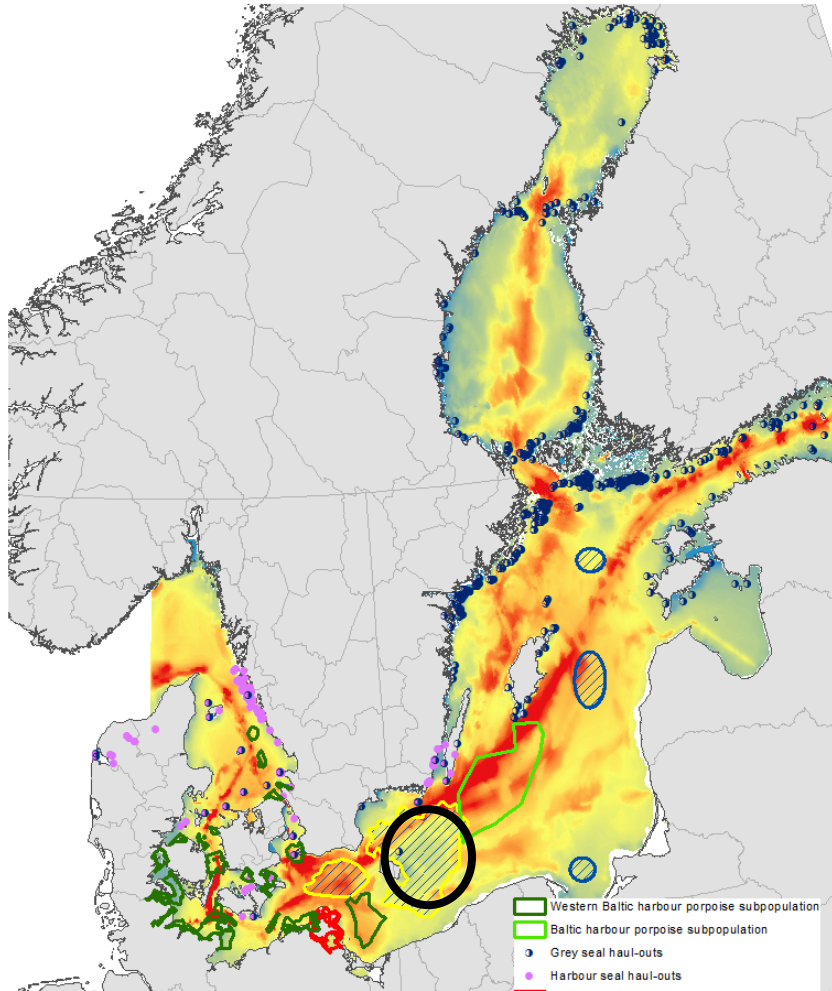
Effects of motorboat noise on foraging behaviour in Eurasian perch and roach

Study of particle motion in the Baltic Sea



Sigraý et. al, J. Acoust. Soc. Am. 130 (1), July 2011

The BIAS project and some (known) important areas for marine species



The Ventral Mount of Cod

- Spread in the Baltic Sea
- Can vocalize by using drum muscle
- Grunt that consists of short pulses of low frequency
- Source Level **125-133 dB re 1 μ Pa @ 1m**
- Cod use sound when spawning both to deter and to attract
- It is assumed that Cod cannot change the frequency

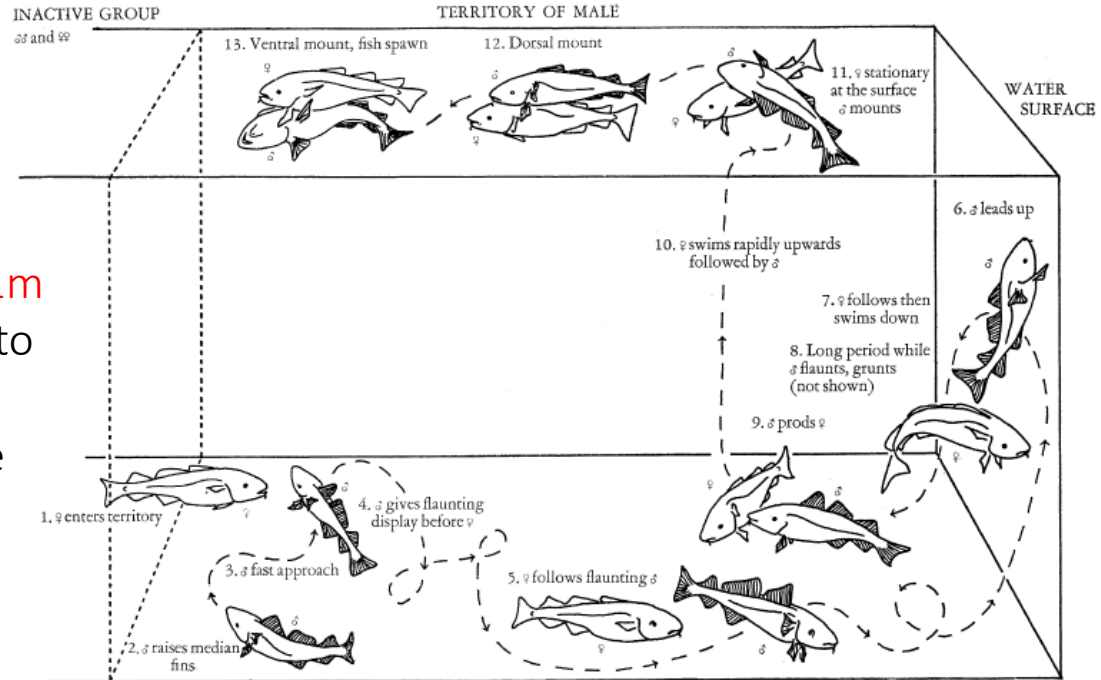
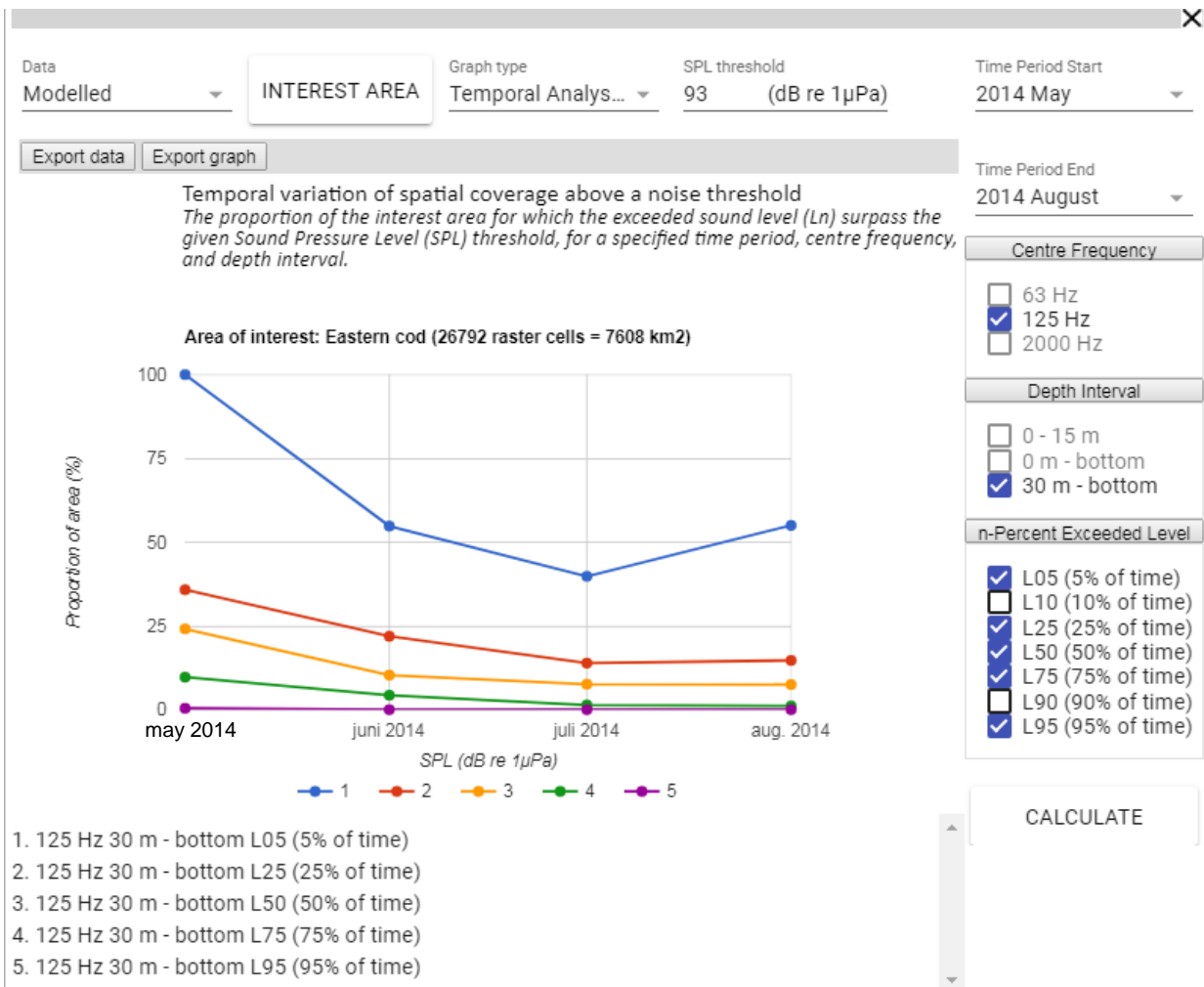


Figure 2. Simplified representation of the courtship and spawning behaviour of cod based on detailed descriptions and a photograph of spawning cod. The dotted line indicates the path followed by the male and the fin rays of the male cod have been shown.



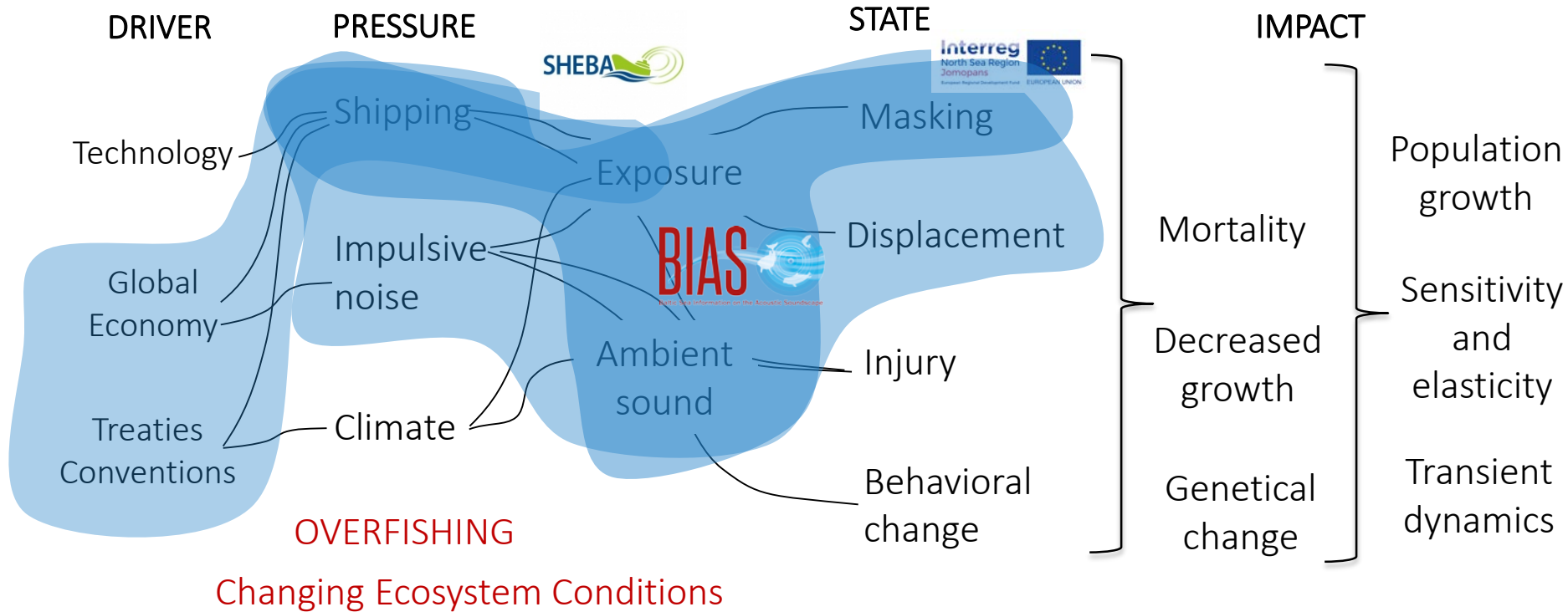
Exposure statistics

- Examine how much area is covered with sound that might mask the communication of the Cod
- This gives the proportion (%) of the management area that is exposed to a sound level higher than 93 dB re 1 μ Pa for the different exceedance levels (time), month by month



An naïve attempt to put sound into a Driver context

Based on: Marine Mammal Populations and Ocean Noise: Determining when Noise Causes Biologically Significant Effects (2005)



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SCIENCE FOR A BETTER FUTURE OF THE BALTIC SEA REGION





Thanks for tuning in!

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Interreg
North Sea Region
Jomopans
European Regional Development Fund



Why can't we hear the noise of a ship leaking up from the sea-surface?

Sound leaking from water to air for a large ship at 1km
 $195 \text{ dB} - 60 \text{ dB} - 80 \text{ dB} - 26 \text{ dB} = 29 \text{ dB in air}$



Source level



Loss due to distance



Transmittance



Factor to correct to Air



Sound propagating in air for a large ship at 1km

$100 \text{ dB} - 60 = 40 \text{ dB in air}$



Source level



Loss due to distance

QED: it is not possible to hear sound leaking out from the water surface

