


Sweden – Research on environmental effects of naval sonars

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a) How does your nation manage the sonar issue?

NOT AT ALL – today, no guidelines!

However, a lot of initiatives has been taken to increase the awareness within the Swedish Navy and a research program has started to estimate the possible impact on marine mammals and fish

-There is a limited number of studies relevant for the Swedish Naval sonars

Research questions:

What marine mammals inhabits Swedish waters?

Are they effected by the sonars?

How do marine animals react to typical Swedish sonar pulses?

What thresholds can be used for behaviour and TTS?

What practical guidelines can be implemented?

What mitigation measures could be useful and effective?

FOI

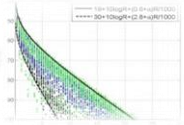
National research program since 2010

Overall goal is that the Swedish Navy's operational behavior in peacetime have a minimal acoustical disturbance to the marine environment

This is done by literature reviews, acoustic measurements of naval activities, experiments and development of guidelines (no software assessment tool at the moment)

Sources: sonars, explosions, ship noise





Home waters and sonarsystems

ASW and minehunting in the shallow and brackish Baltic Sea

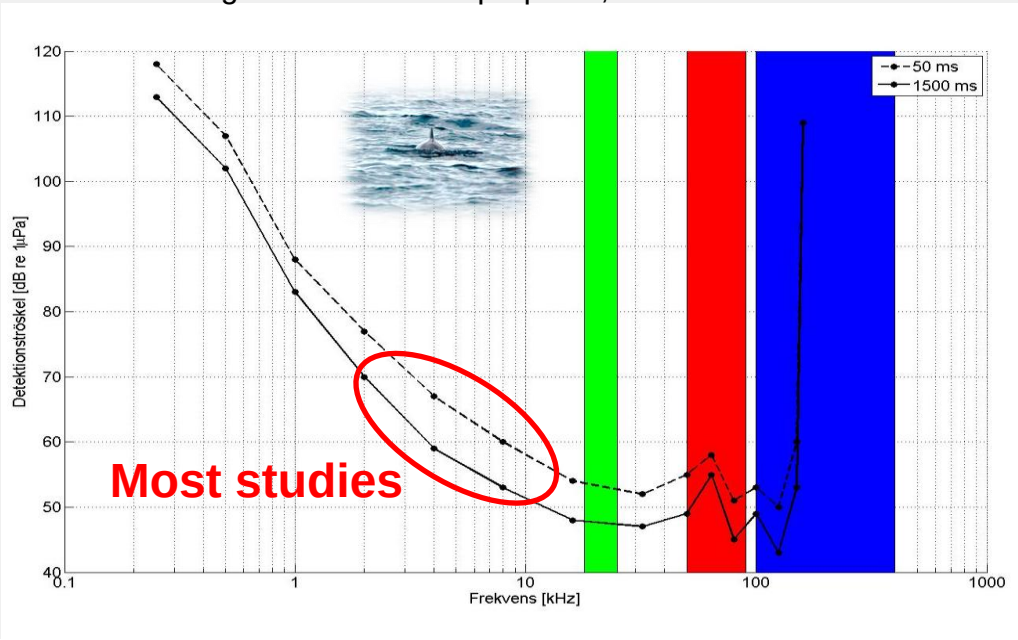
- Shallow (in average 52 m deep) = Lower source level to reduce reverberation
- Complex bathymetry = high spatial resolution required = higher frequencies
- Lower salinity = higher frequencies are possible
- Four species of marine mammals = 1 whale, 3 seals



Home waters and sonarsystems

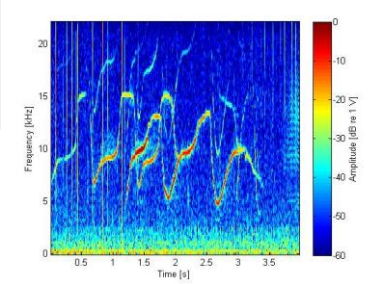
- **Vertical Depth Sonar - VDS (20-30 kHz)**
- **Hull Mounted Sonar - HMS (60-90 kHz)**
- **Minehunting Sonar (100-300 kHz)**

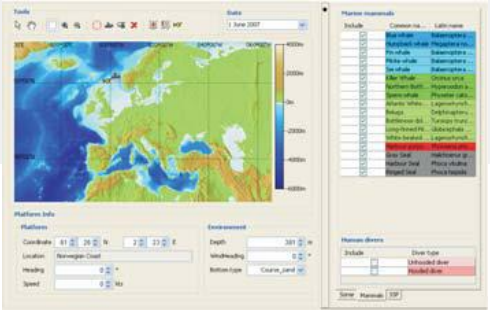
Audiogram of a Habour porpoise; from Kastelein et al 2010



POMM - EDA project

- Participation in EDA project ”PoMM”
  - Marine mammal database-military and civilian data
  - Detection and classification of marine mammal calls
- National efforts
  - Experiments on behavioral responses to sonar pulses (25 kHz)
  - Policy for risk-aware operation of active sonar
  - Study of environmental risks of active sonar, focusing on national systems and environments
  - Evaluation of risk assessment tools for active sonar (ERMC – BAE Systems and SAKAMATA - TNO) e.g. use in littoral environments





Behaviour of Harbour porpoises to 25 kHz sonar pulses

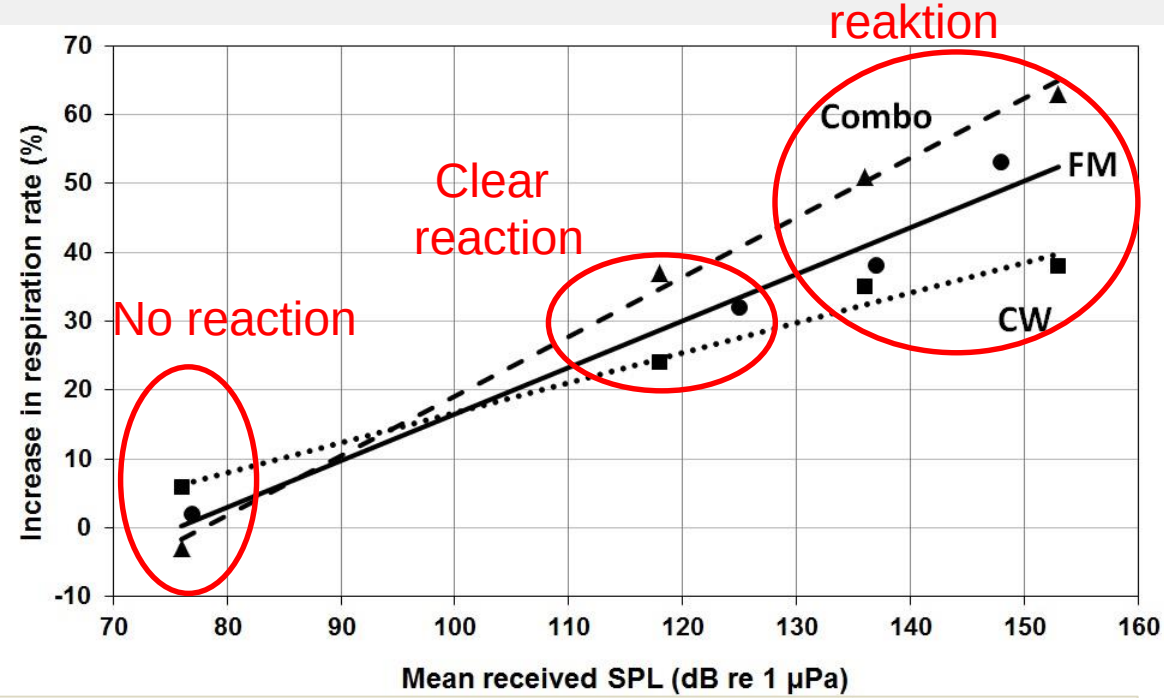
Performed by Ron Kastelein and colleges at SEMAARCO 2012

Results:

- Increased respiration rate
- Increased jumping
- No avoidance

Behaviour threshold SPL:

125-155 dB re 1µ Pa depending on pulse type (Combo, FM, CW)

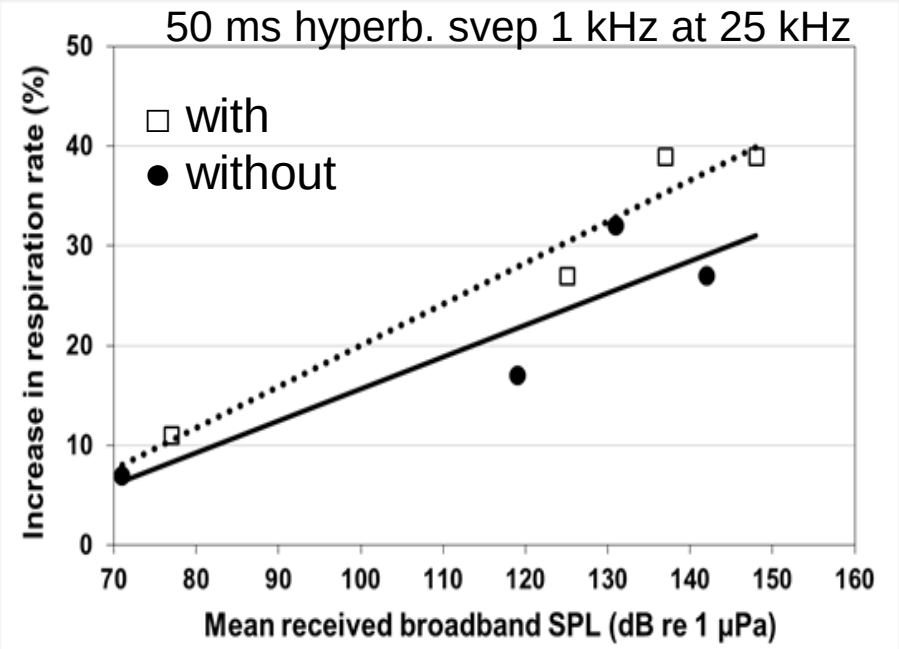


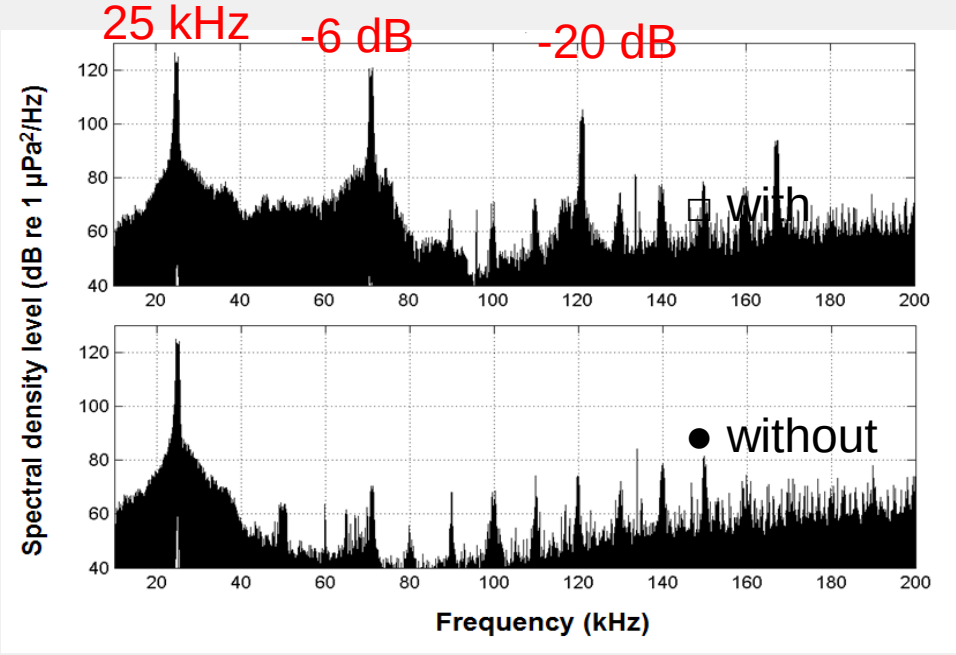
_●_	”FM”	50 ms hyperbolic FM sveep 1 kHz	PRI 2 s
..■..	”CW”	600 ms Amplitude modulation CW with shading	PRI 10 s
--▲--	”COMBO”	300 ms FM + 600 ms cw	PRI 10 s

Kastelein, R.A., van den Belt, I., Helder-Hoek,L., Gransier, R., Johansson, T. (2015). Behavioral Responses of a Harbor Porpoise (*Phocoena phocoena*) to 25-kHz FM Sonar Signals. Aquatic Mammals 41(3), 311-326, DOI 10.1578/AM.41.3.2015.311.

Harmonics and reactions

- Like other acoustical systems, active sonars produce harmonics
- Previous study was repeated with and without sidebands (not true harmonics)
- 6 dB lower than those of the sound type with sidebands, but with equal energy in the fundamental frequency).





Kastelein,R. A., van den Belt, I., Gransier, R, and Johansson, T. (2015c). "Behavioral Responses of a Harbor Porpoise (Phocoena phocoena) to 24.5-25.5 kHz naval Sonar Down-sweeps With and Without Side Bands," (Article in press, Aquatic Mammals 2015, 41(4), xxx-xxx DOI 10.1578/AM.41.4.2015.xxx)

Behaviour of Harbour seals to 25 kHz sonar pulses

2 Harbour seal (*Phoca vitulina vitulina*)

Same sonar signals as for the Harbour porpoise study

Results:

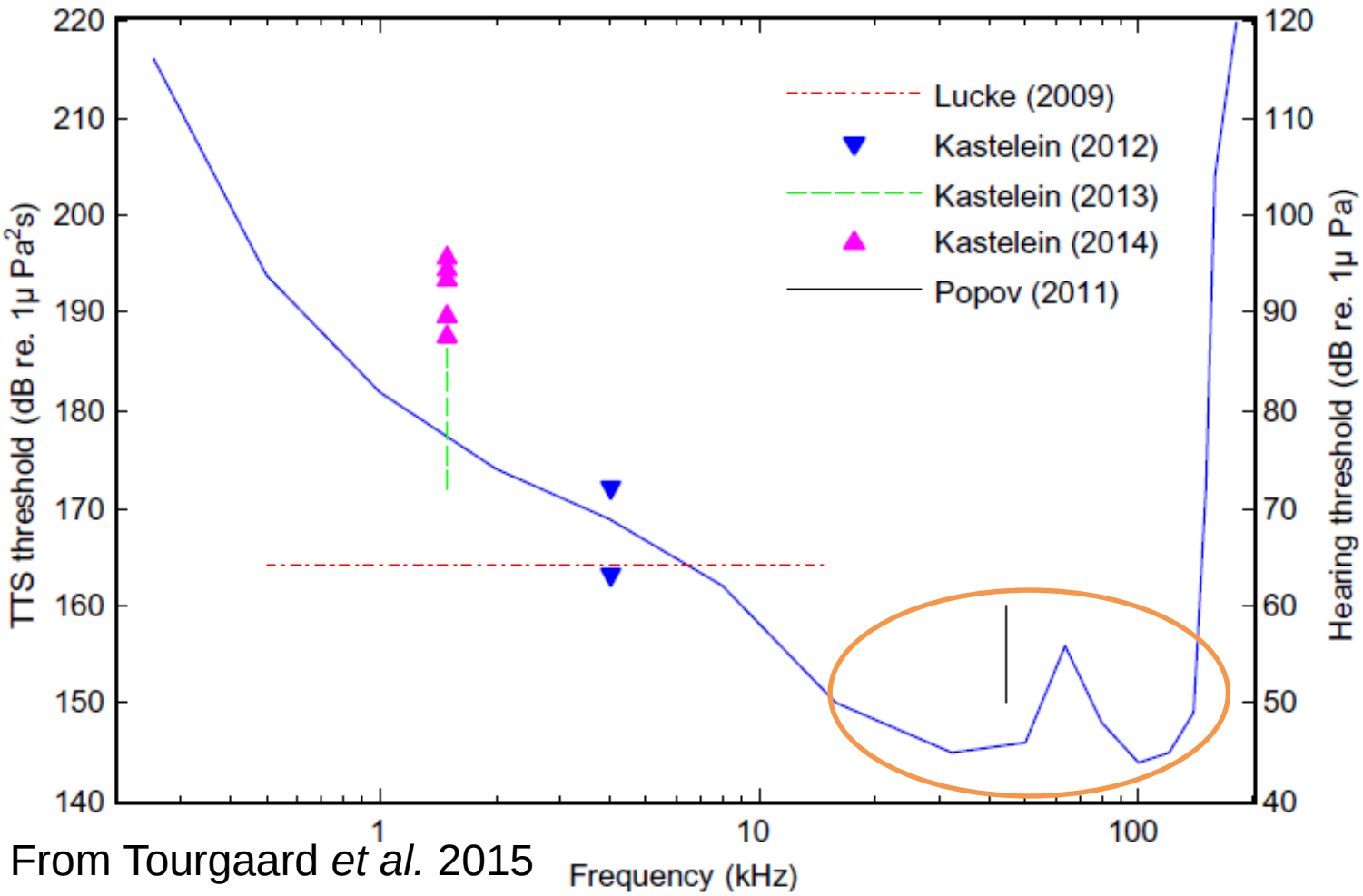
Seals less sensitive than porpoises

No reaction to levels of SPL 125 dB re 1 µPa

Some reactions to FM pulse at SPL 155 dB re 1 µPa

Kastelein, R.A., Hoek, L. Janssens, G., Gransier, R., and Johansson, T. (2015d). "Behavioral responses of harbor seals (*Phoca vitulina*) to sonar signals in the 25 kHz range," ((Article in press, Aquatic Mammals 2015, 41(4), 388-399, DOI 10.1578/AM.41.4.2015.388)

TTS in Harbour porpoise



From Tourgaard *et al.* 2015

TTS in Harbour porpoise – 25 kHz

2015 May-September, performed by:

Andreas Ruser[1], Jakob H Kristensen[2], Magnus Wahlberg[3]

[1]University of Veterinary Medicine Hannover, Germany

[2] Fjord&Bælt, Denmark

[3]University of Southern Denmark

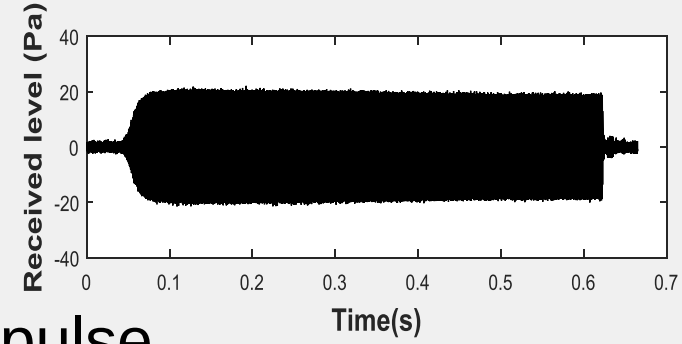
At a semi-open area at Fjord&Bælt

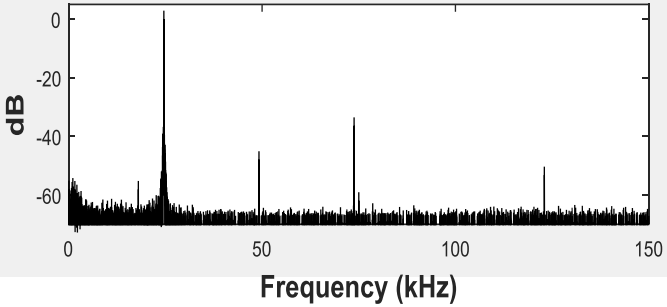
Similar sonar pulse as for behaviour:

<u>One</u> 500 ms amplitud modulated CW pulse

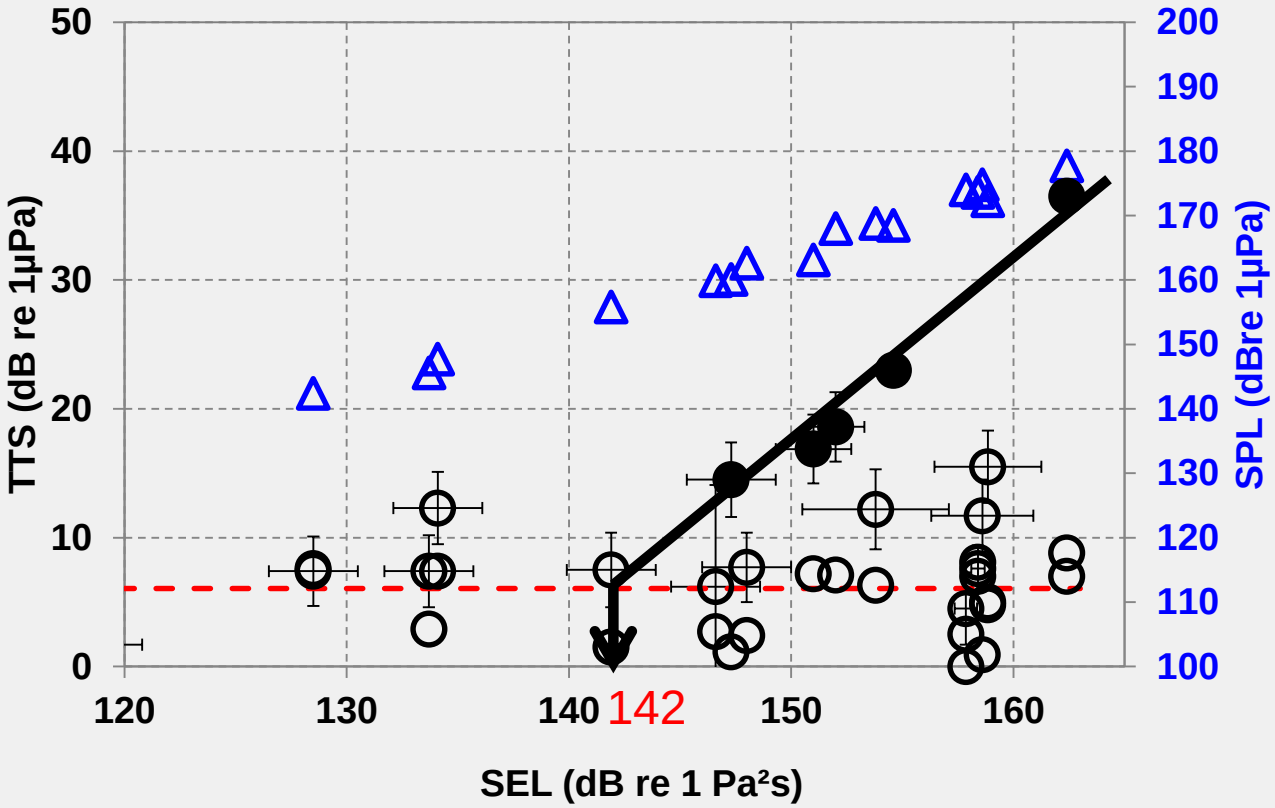
Auditory Brainstem Response (ABR)

Study animal Freja





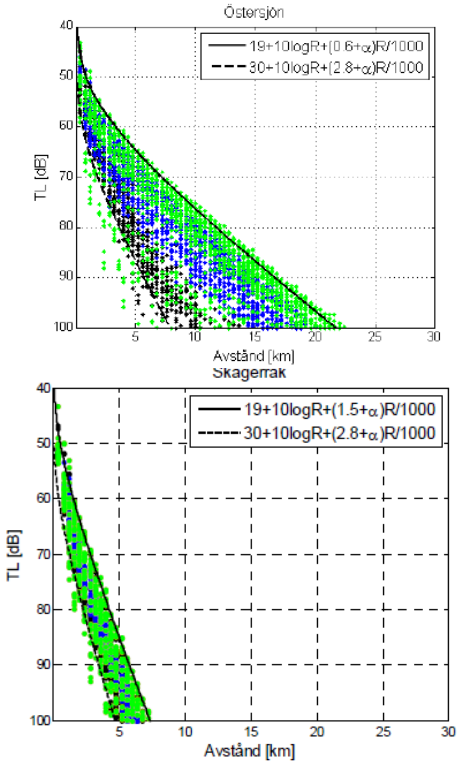
TTS in Harbour porpoise – 25 kHz

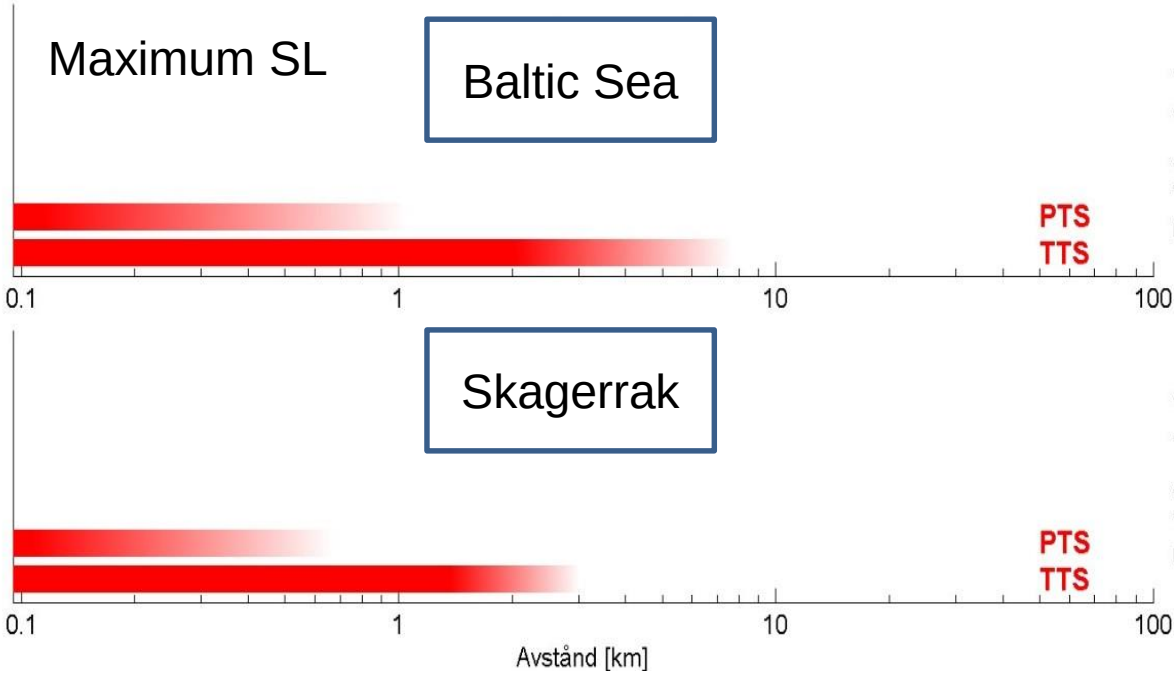


TTS for 25 kHz trials. Filled circles are data points chosen for determining the Threshold of onset of TTS (defined as where the regression line intersects with the Red stipled line, which is a TTS level 6 dB above the baseline hearing threshold.

Riskassesment TTS/PTS

- Modelling of risk distance based on two well known areas
- Thresholds from last study SPL 146 dB re 1 µPa and the literature for PTS





Future

During 2016-2017

- Estimations of thresholds
- Draft guidelines on mitigations and recommendations for sonar use
- Test guidelines during live sonar exercise
- National guidelines be adapter for international exercises as well
- Education of officers and sonar operators

Research topics

B) How is BRS useful?

- Essential to understand impact
- Determining thresholds/dose-response functions
- Calculate distance of impact
- Testing mitigations measures

C) What are the data gaps?

- Dose-response functions for Harbour porpoises and seals
- Usefulness of various mitigation measures
- Responsiveness to different frequencies
- Population distribution

Thank you

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Please contact me for further discussion:

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