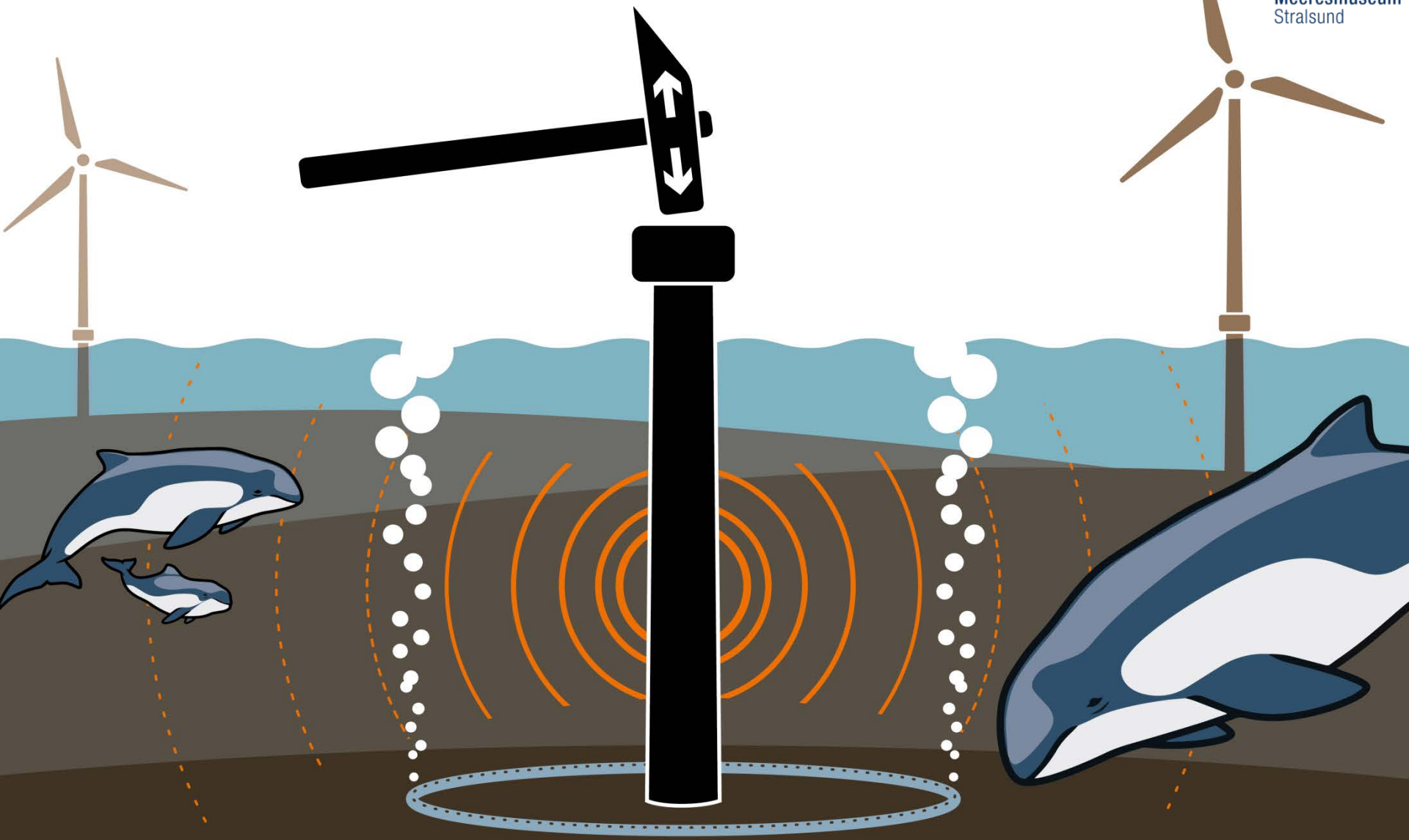
Underwater Noise Impacts on Marine Mammals



Michael Dähne
German Oceanographic Museum

Baltic Earth – Multiple Drivers of Earth System Changes in the Baltic Sea Region
Tallin, 26/27 Nov 2018

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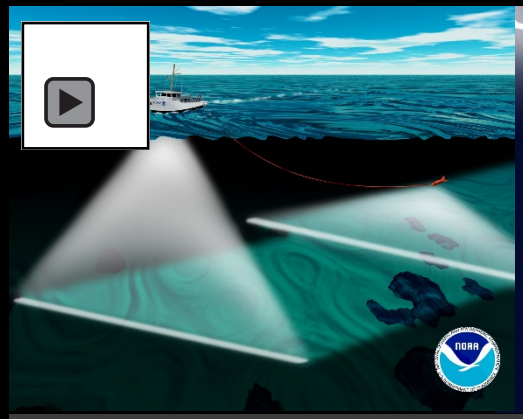
Noise sources to consider

Ships

Explosions

Seismic Surveys



Sonars

Lightning

Rain

Pile driving

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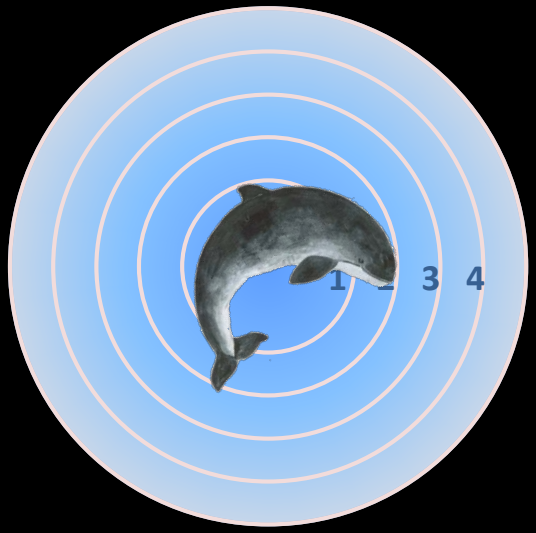
Zones of noise influence



1: Impairment, Injury, Death

~~2: Masking~~

3: Behavioural Reaction

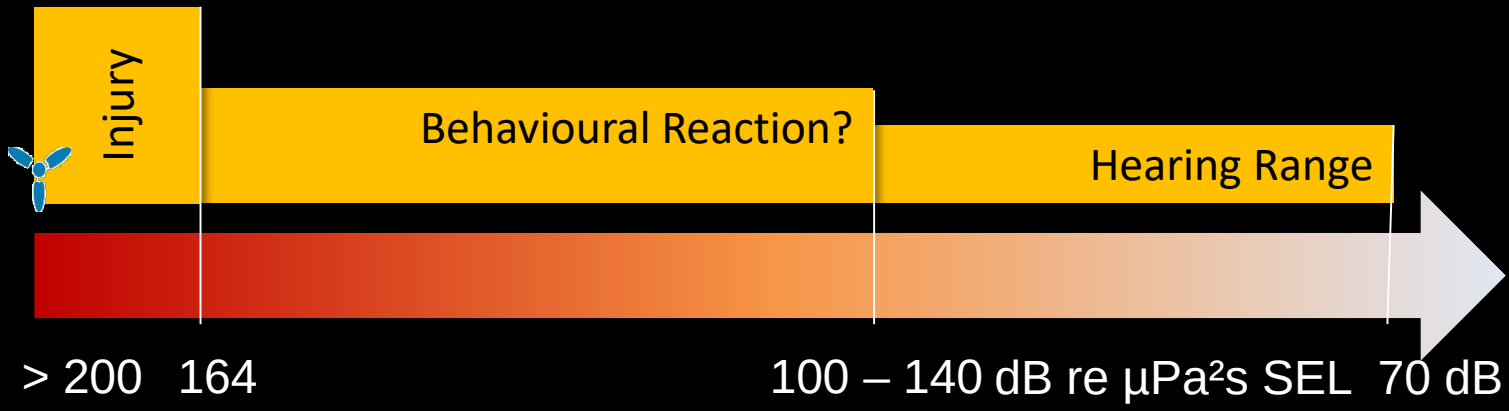
4: Hearing

(Richardson et al. 1995)

TTS onset

?

Audiogram



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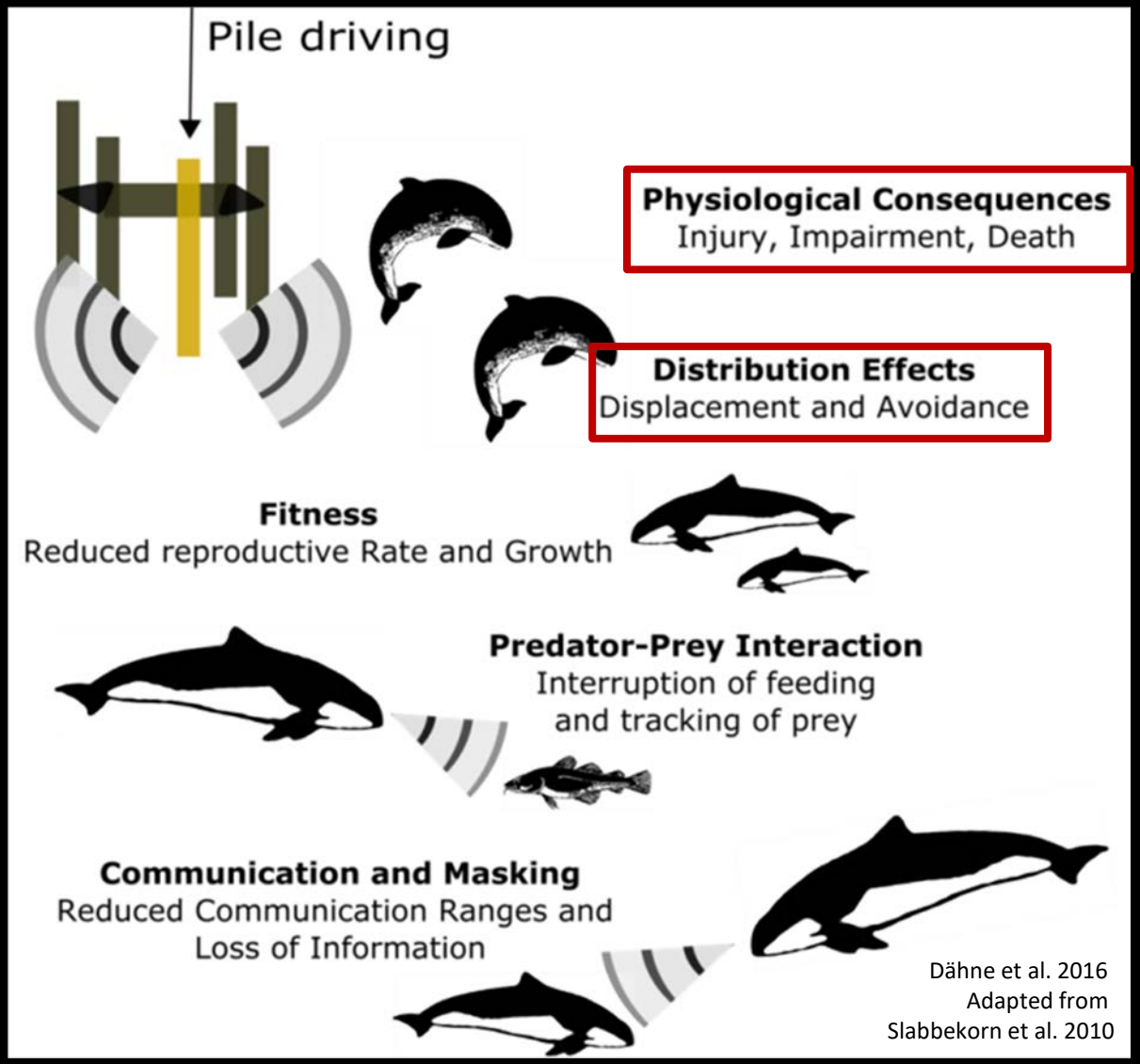
What are the consequences of disturbance?



Dähne et al. 2016
Adapted from
Slabbekorn et al. 2010

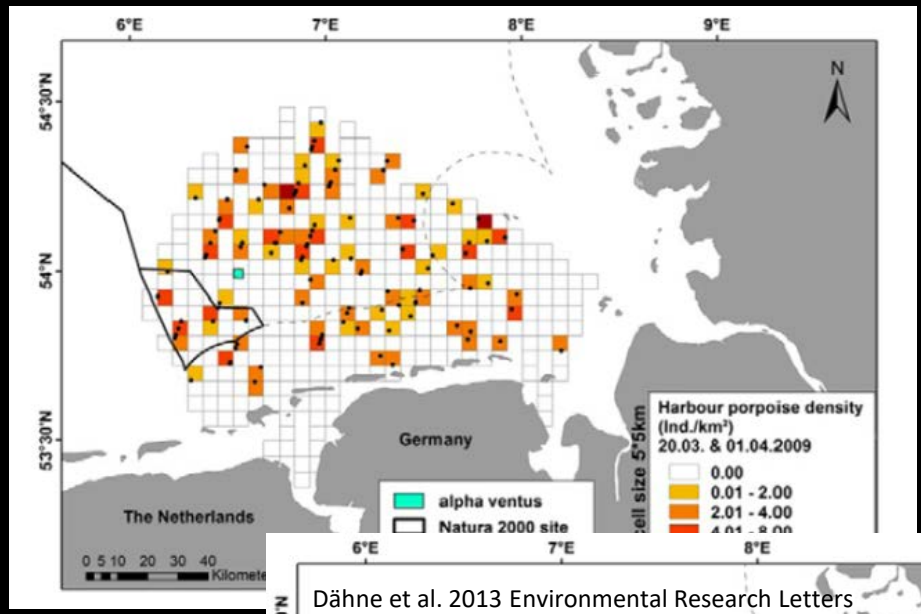
Alpha Ventus – Germanies first offshore wind farm

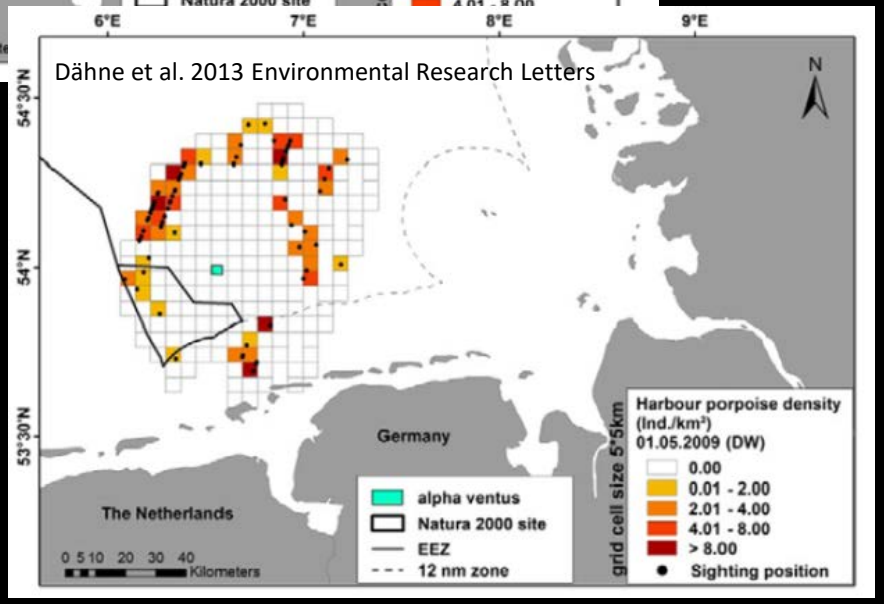
Built 2009, 12 Generators,
Tripods, Jackets (42 foundations)

Aerial Surveys & Acoustic Monitoring

Result:
~ 20 km disturbance radius
~ 17 h duration

Limit of 160 dB re 1 µPa²s in 750 m distance not reached
164 – 170 dB re µPa²s SEL without noise mitigation
~157 dB re µPa²s SEL with noise mitigation





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Taking thresholds into legislation

Year	Progress
2005 - 2007	Lucke et al. (2009): Onset of temporary threshold shift for a single strike in porpoises is ~164 dB re µPa²s SEL and ~ 190 dB re µPa peak
2007 - 2009	German Agencies UBA and BFN propose a preliminary and probably precautionary value of 160 dB re µPa²s SEL and 190 dB re µPa peak-peak in 750 m distance from piling
2009 - 2013	The licensing agency BSH hands out licenses with the obligation to keep the noise below the precautionary limit
2013	Noise Mitigation Concept adopted by the German Bundestag
2015 - ?	Development of a noise mitigation concept for the Baltic Sea
2014 -ongoing	Other countries like Belgium and Netherlands follow the German example

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Mitigation Example – Pile Driving

Avoid exposure	Alter the emitted sound	Displace the animals
Do pile driving in times of low abundance Avoid noisy procedures	Alternative piling hammers Use noise mitigation systems Use alternative pile materials	Pingers Seal Scarers Faunaguard

Cost

Efficiacy to protect animals from injury

Efficiacy to protect animals from disturbance

Willingness to actually implement the mitigation (acceptance)

Use of limits / thresholds

Exposure (injury)
#animals disturbed
…

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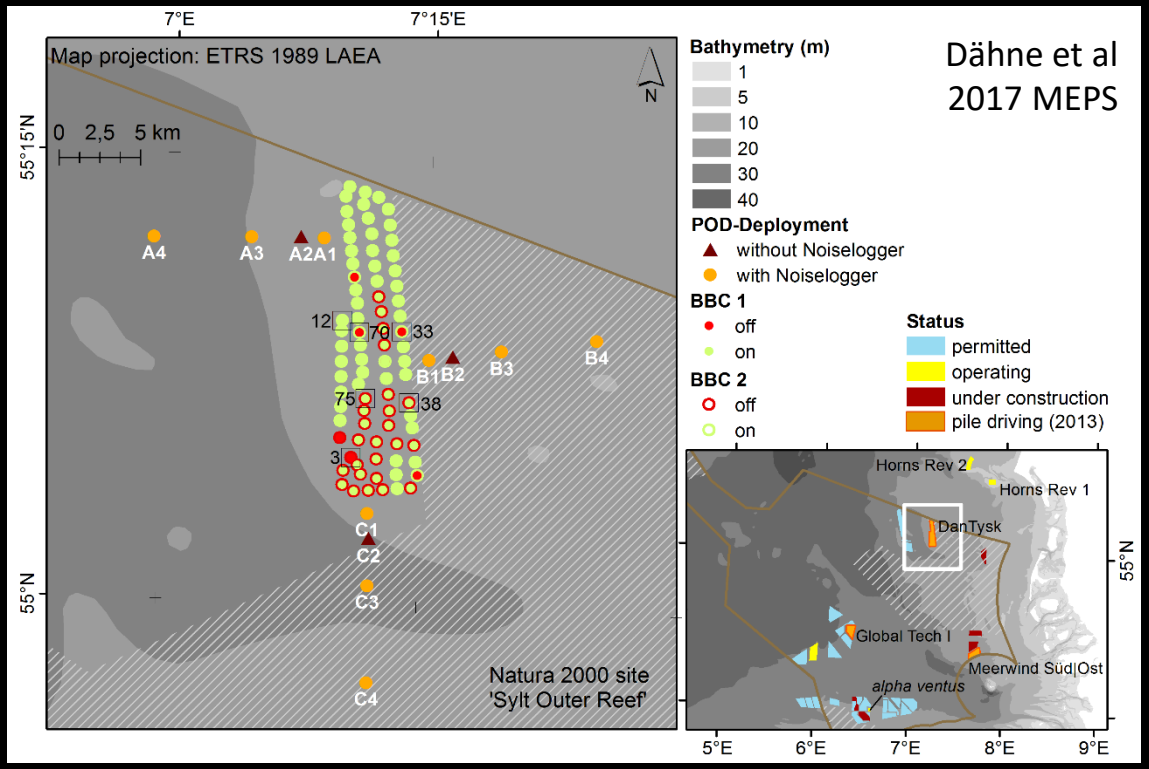
DanTysk Wind Farm (2013)



Dähne et al 2017 MEPS

Noise recorded with 9 noise loggers (DSG Ocean)

Porpoise activity recorded with 12 echolocation click loggers (CPODs)

Seal scarer (14 kHz, Lofitech) preceeded all pilings

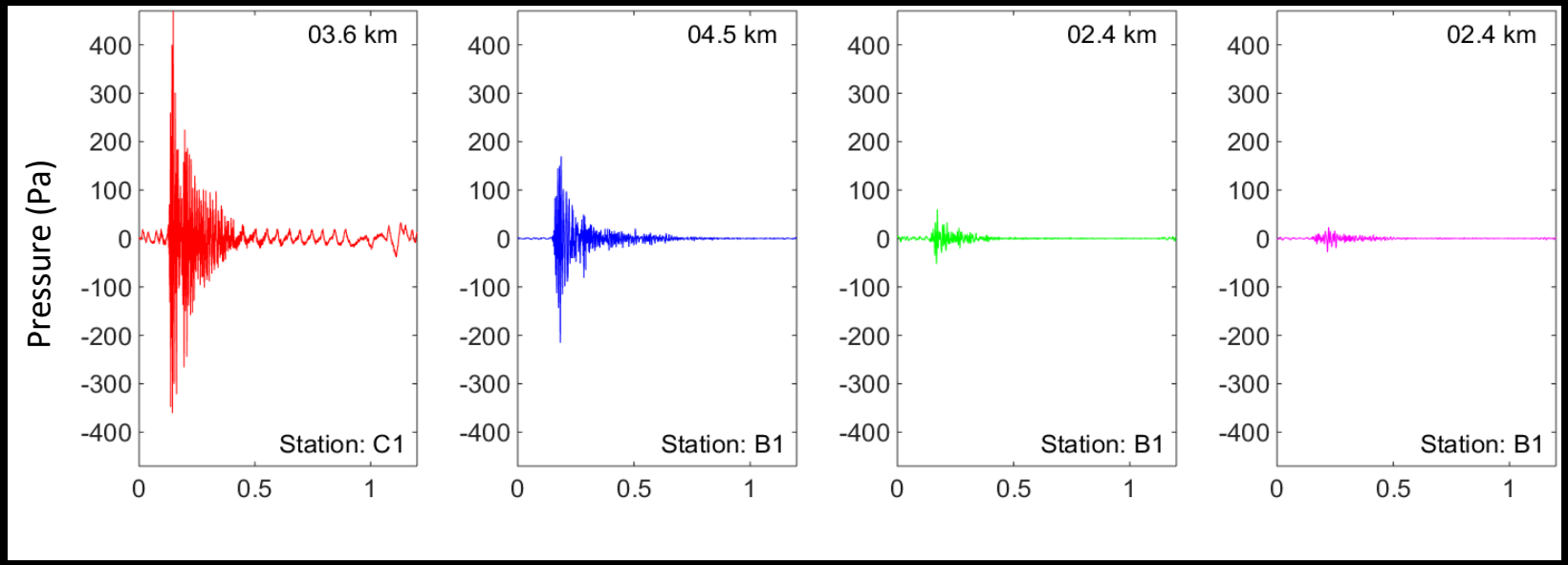
	# trials
No BBC	2
Circular BBC1 only	25
Circular BBC2 only	4
Circular BBC1 + linear BBC2	30
Circular BBC1 + circular BBC 2	21

AARHUS UNIVERSITY

Bio Consult SH

DEPONS

DanTysk Wind Farm (2013)



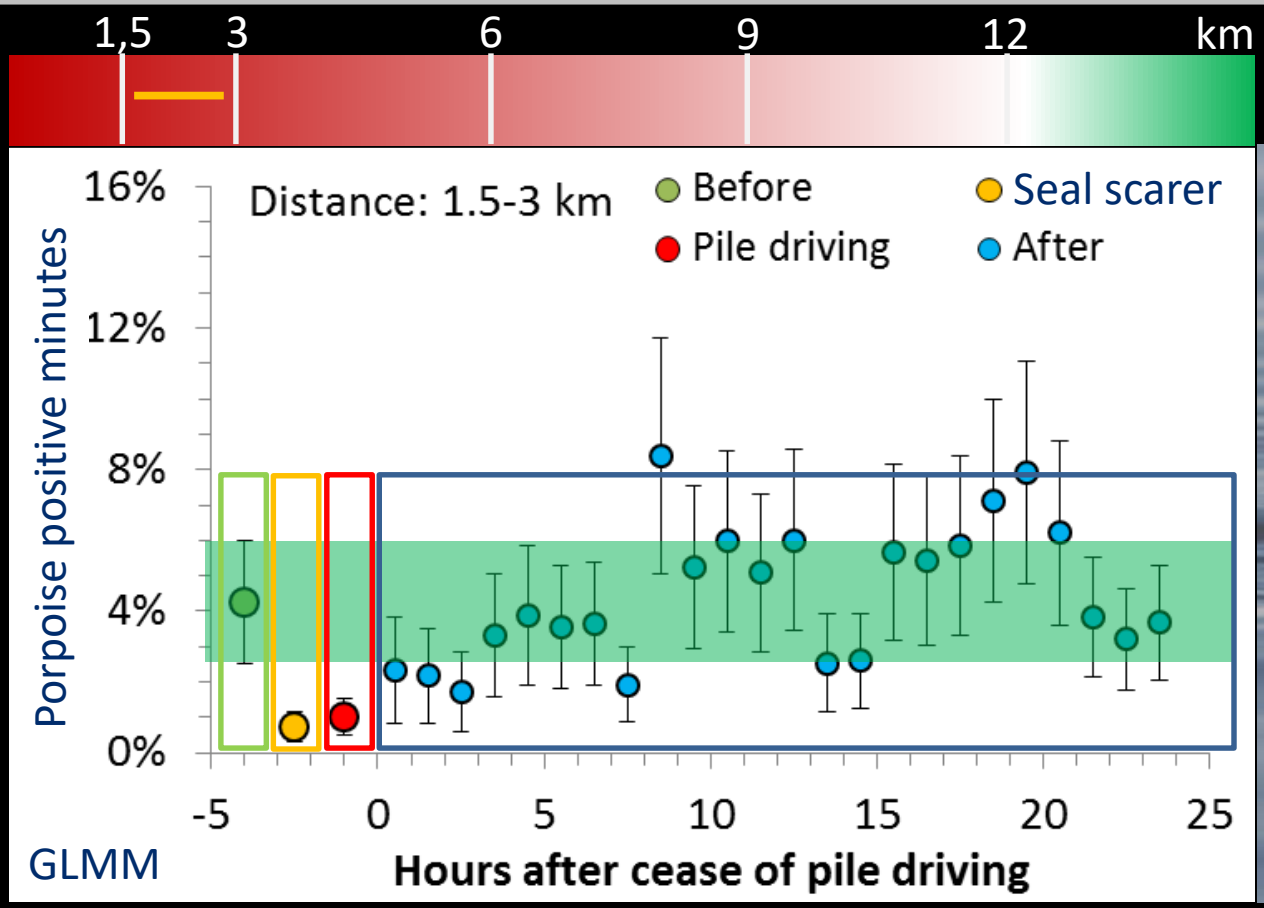
unmitigated | Bubble Curtain 1 | Bubble Curtain 2 | both

2 - 4 km

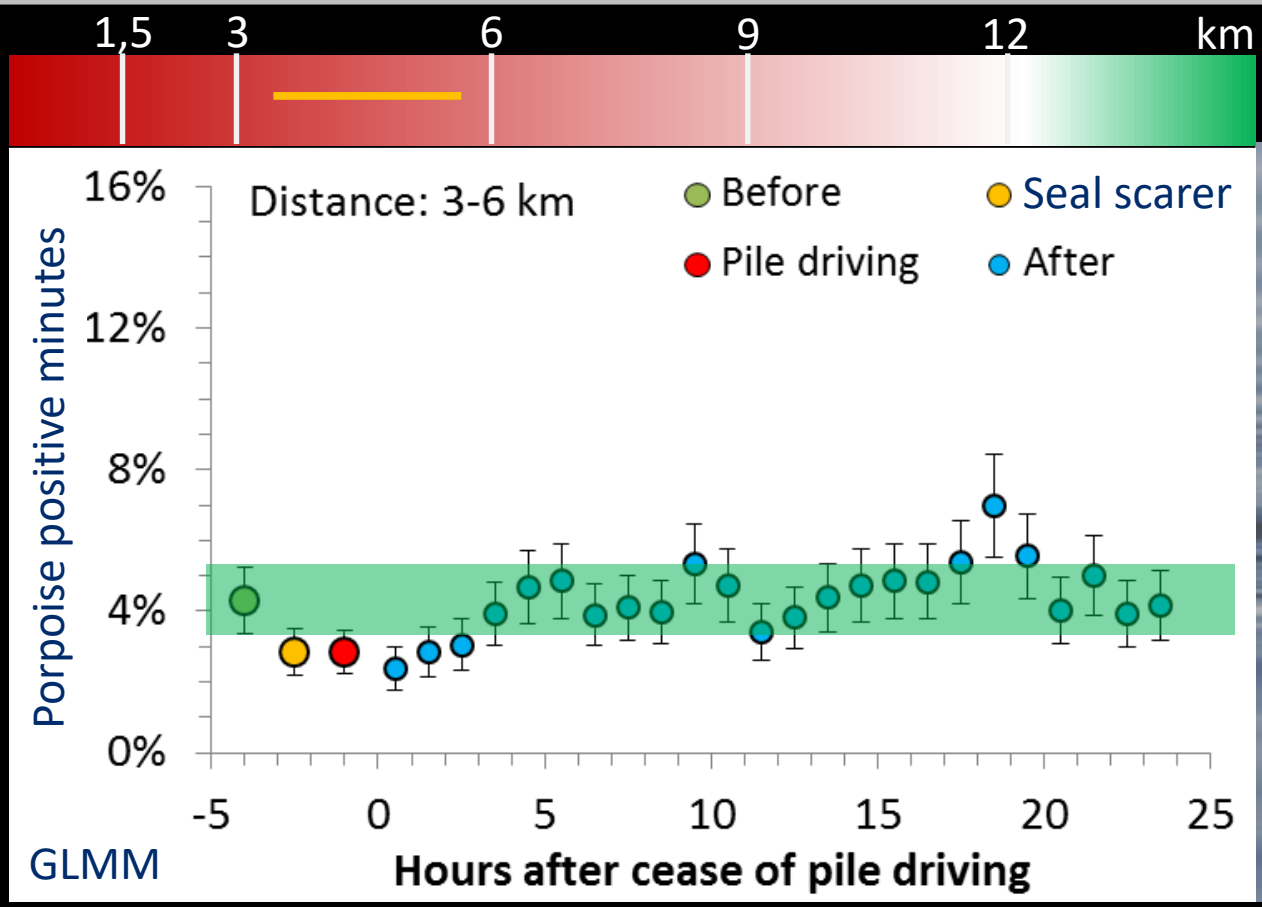
14 -16 km

High frequency content (>1 kHz) can be reduced to ambient noise levels in ~16 km distance

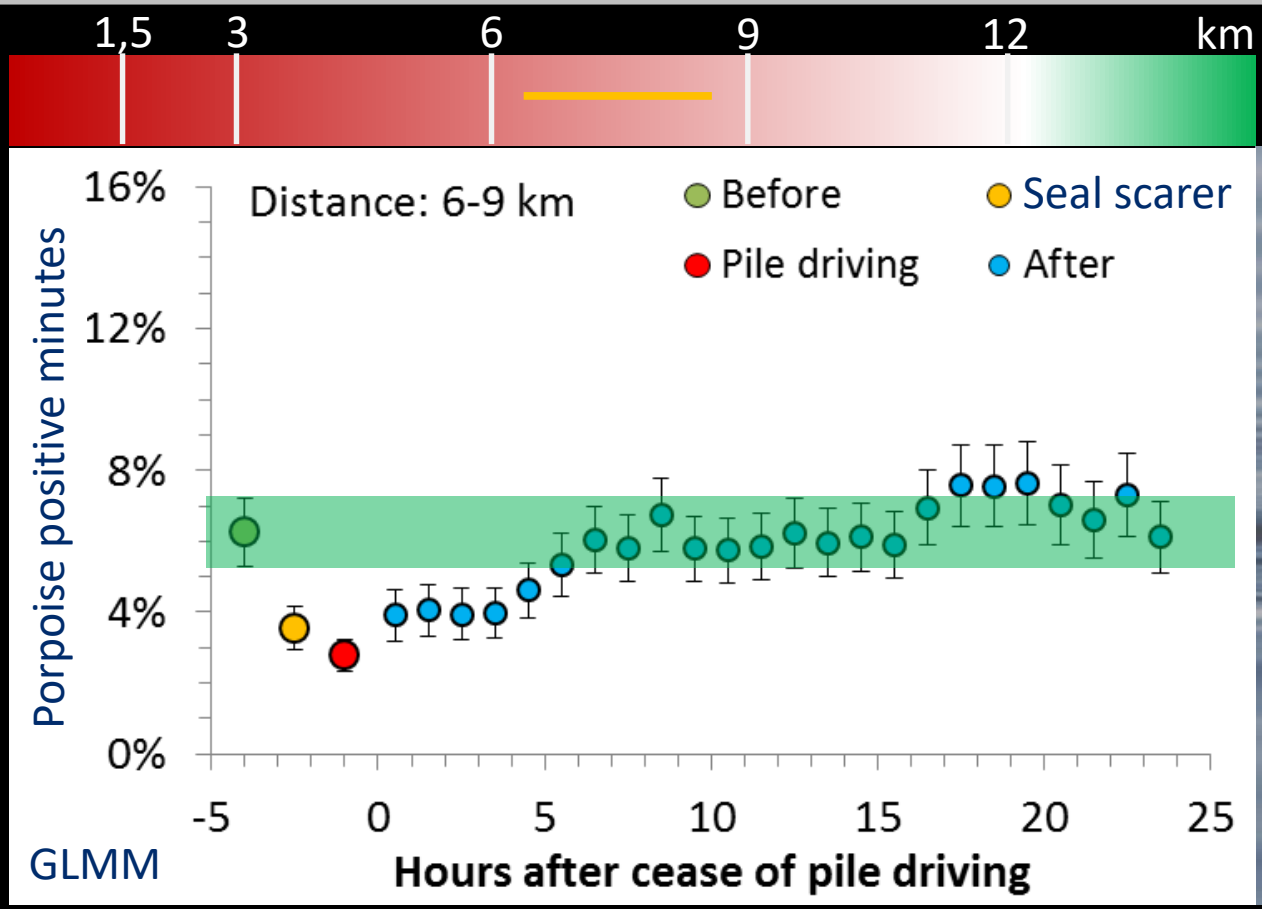
Displacement



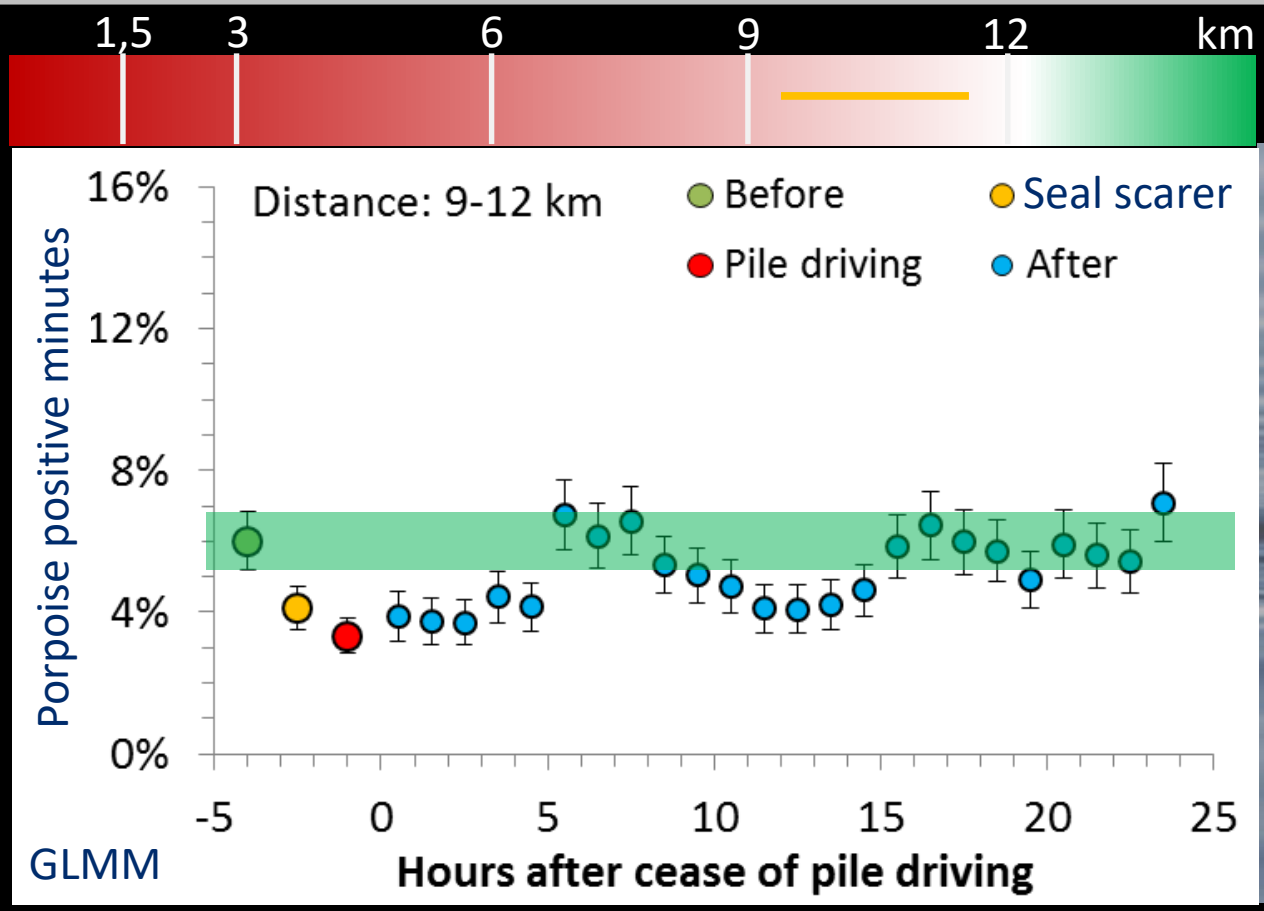
Displacement



Displacement

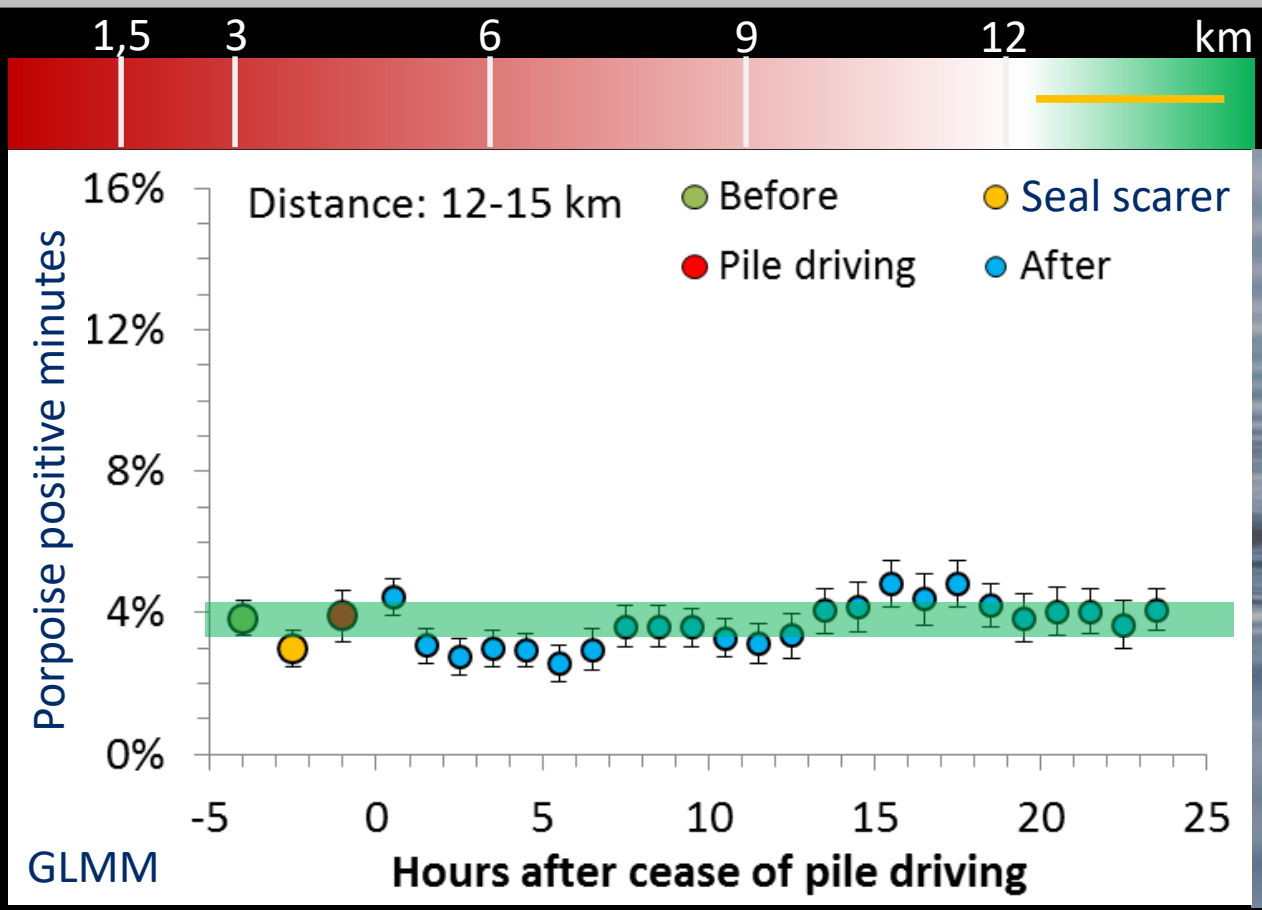


Displacement



Seal Scarer still as effective in displacement as piling…

Displacement



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Short summary

Reduction in displacement distances and duration by bubble curtains

Bubble curtains reduced high and low frequency noise

Seal scarers displaced porpoises effectively

Effect of initial deterrence:
Similiar displacement distances to pile driving using noise mitigation

Effects on population level?

Other Species?

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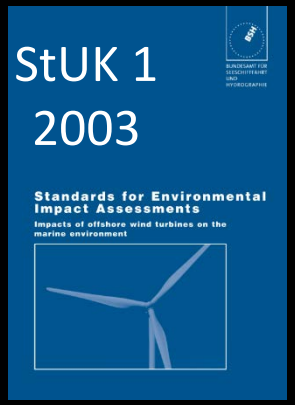
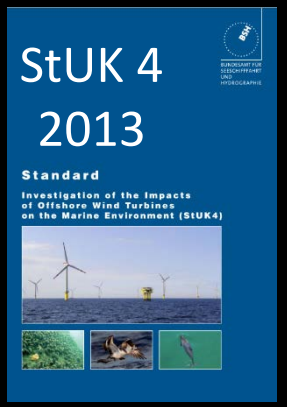
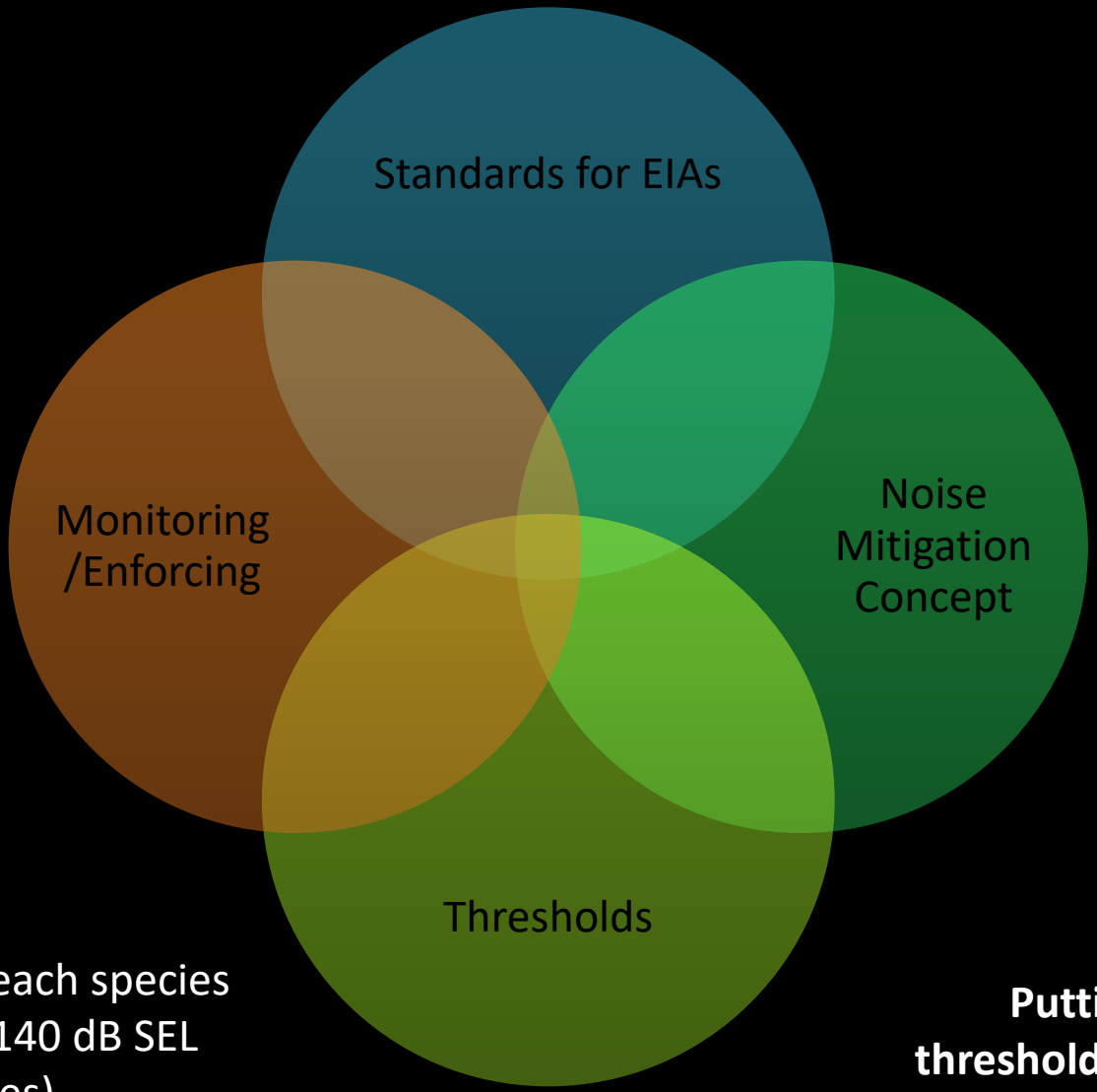
A positive perspective (for the North Sea only?)







160 dB re µPa²s SEL
190 dB re µPa L_{pp}
and
weighted metric for each species of concern? (NOAA: 140 dB SEL weighted for porpoises)
#animals disturbed?

Putting precautionary thresholds into legistlation

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Outlook

- Mitigation
  - Enforcement can only be carried out, when thresholds are established
  - The industry needs guidance, but they will have their own ideas how to achieve their goals
  - Explosions have to be mitigated
- Population consequences of disturbance
  - Trade offs between injury / disturbance
  - Stress / Physiology / Reproduction
  - Biological context
- …ranking of noise impacts necessary
- …species specific reactions are more complex than currently assumed

Thank you for your attention!

Federal Agency for Nature Conservation

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