Effect of sonar on whale prey species

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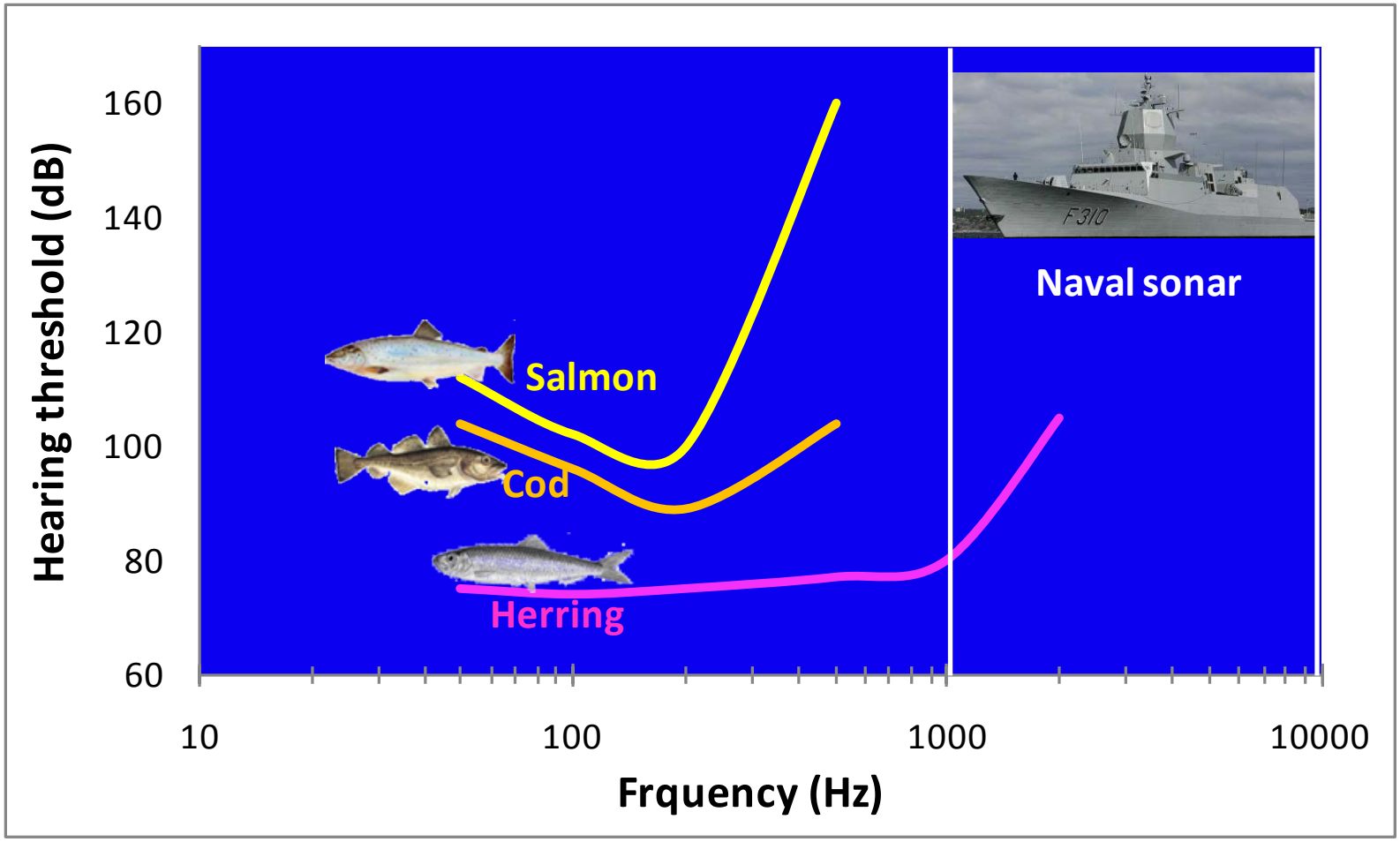
Background

Photo: Tiu Simila

- Fish is important prey for many species of marine mammals.
- If the prey react to sonar exposure e.g. by avoidance or diving, this can potentially make them unavailable for the whales.

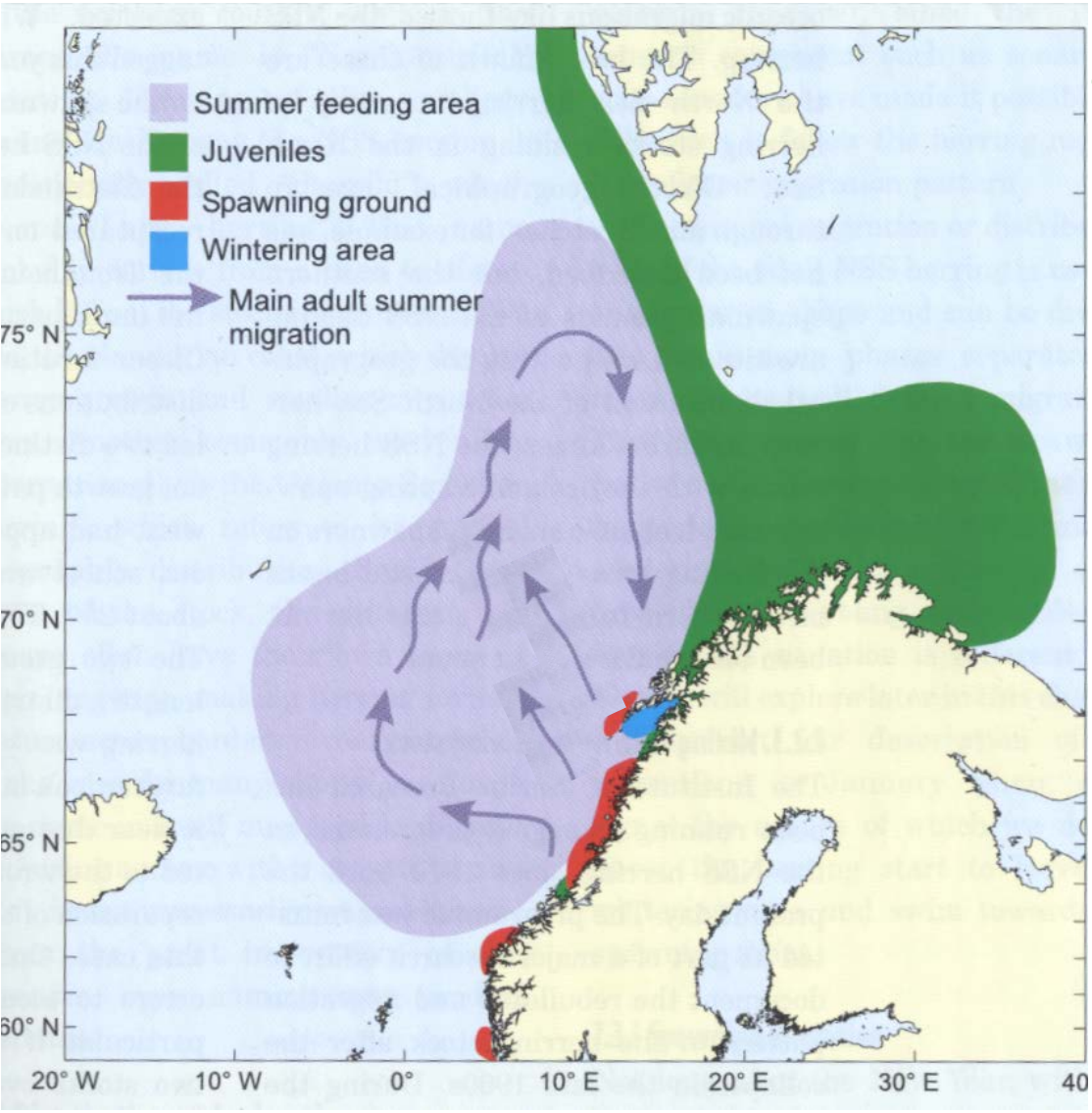
Background



- Modern long range naval sonars operate in 1-10 kHz frequency band.
- Range overlapping with hearing of herring.

Challenge:

Herring behaviour tend to be highly varying with different seasons and different phases (overwintering, feeding, spawning).



Juvenile herring (Jørgensen *et al*. 2005)

- strong avoidance and mortality at high source levels

Overwintering herring

- ??

Feeding herring

- ??

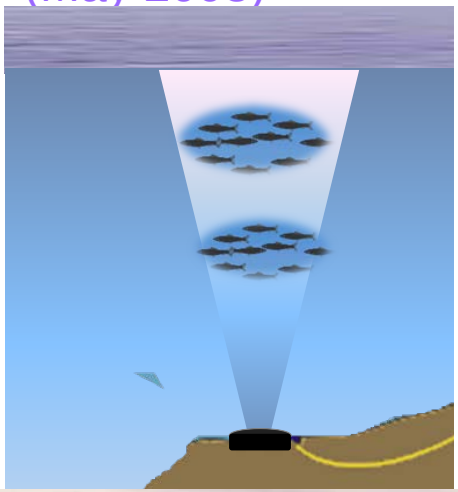
Spawning herring

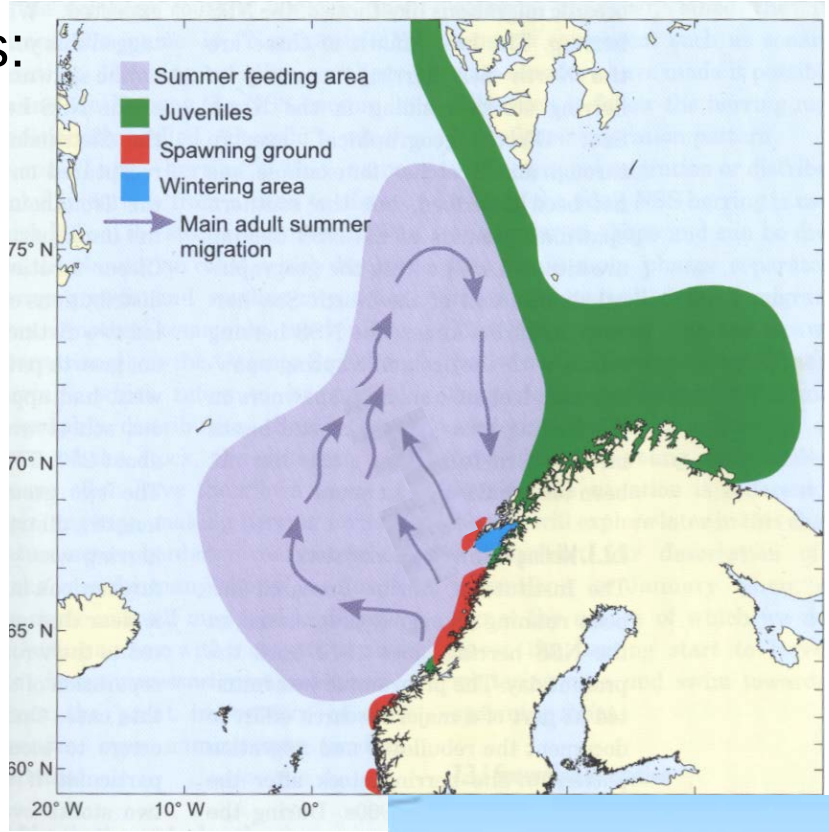
- ??

Free field studies:

Overwintering
(Nov 2006)

Summer feeding
(May 2008)



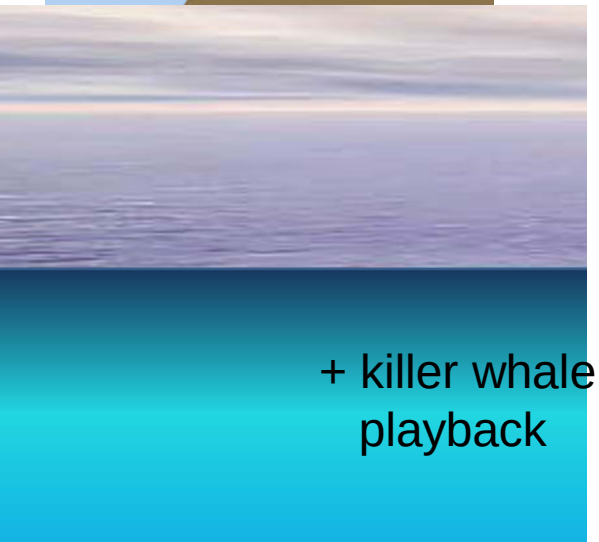


Captivity studies:

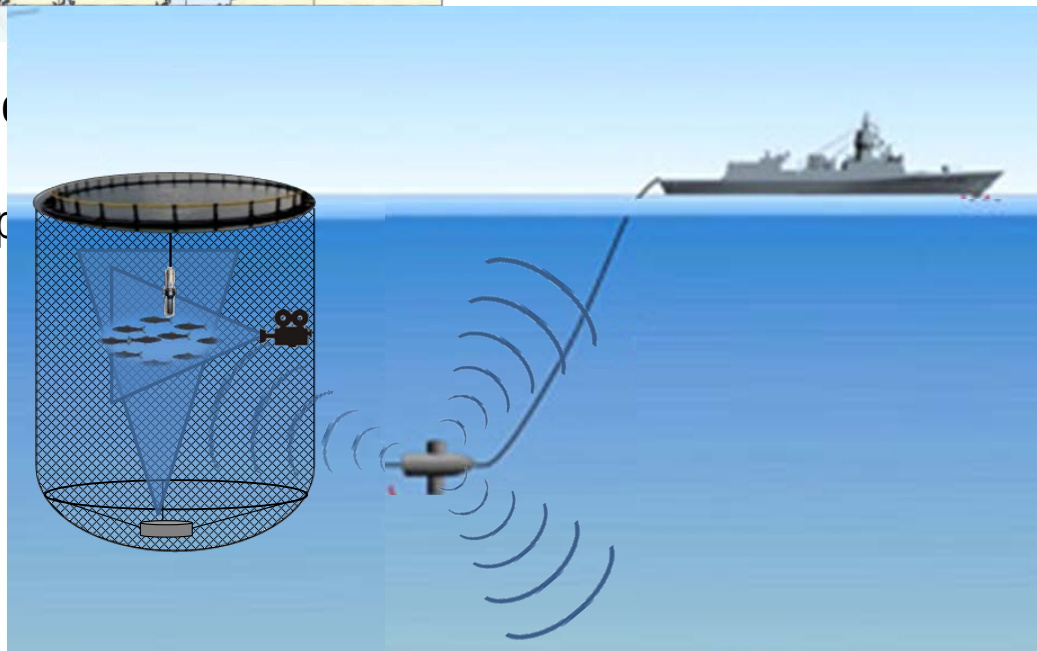
Spawning
(Jan 2009)

Migration period
(Sept 2008 and
Sept/oct 2009)

Typical avoi
herring:
Dive to deep



+ killer whale
playback



Results, free field studies

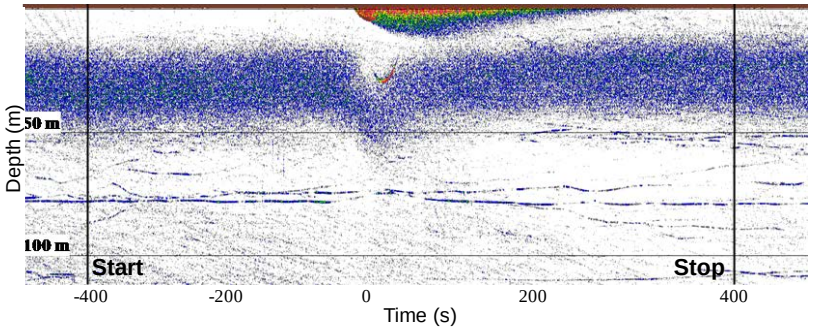
Overwintering:

Diving around vessel passage for all exposures.

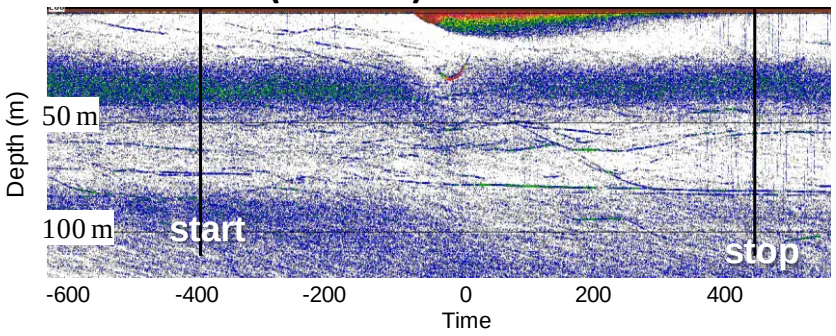
No difference between control and sonar.

Killer whale playback; immediate reaction with reduced density and diving **before** passage.

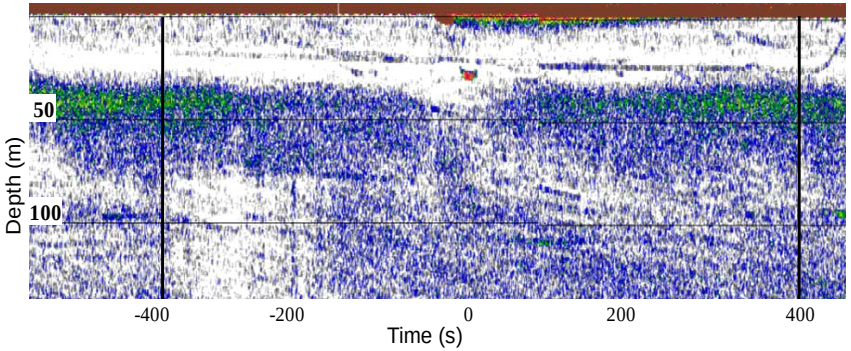
Control (ship, no sonar)



LFAS Sonar (1-2 kHz)



Killer whale playback



Doksæter et al.(2009). Journal of Acoustic Society of America 125, 554-564.

Summer feeding:

Minor diving, decreased density for all exposures.

No differences between control and sonar.

Stronger diving reaction and schools more packed for killer whale playback.

Sivle et al. (2012). ICES J. Mar. Sci. 69 (6)

Captivity Studies: Results, sonar

Doksæter, et al. (2012). J. Acoust. Soc. Am. 131: 1632-1642

Captivity Studies: Results, ”fence strike”

Positive control sound; strong diving response.

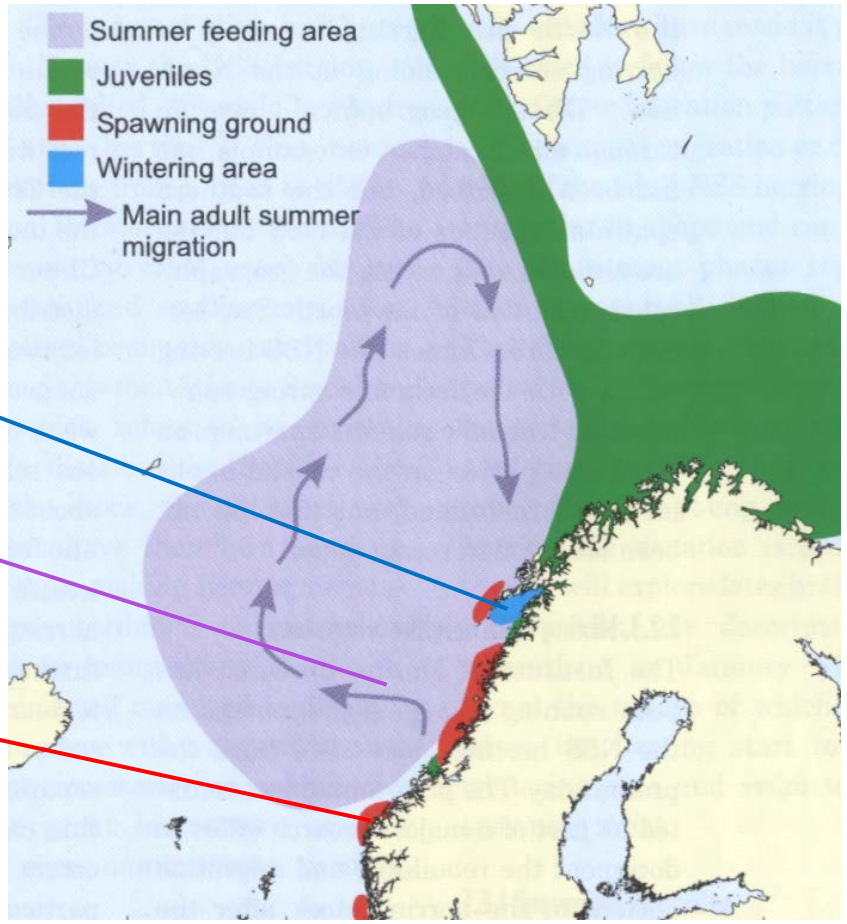
Doksæter, et al. (2012). J. Acoust. Soc. Am. 131: 1632-1642

Summaried results

Overwintering:
No behavioural response,
max SEL = 184 dB re 1µPa^2 s

Feeding migration:
No behavioural response,
max SEL = 176 dB re 1µPa^2 s

Captive herring, all year:
No behavioural response,
max SEL = 181 dB re 1µPa^2 s



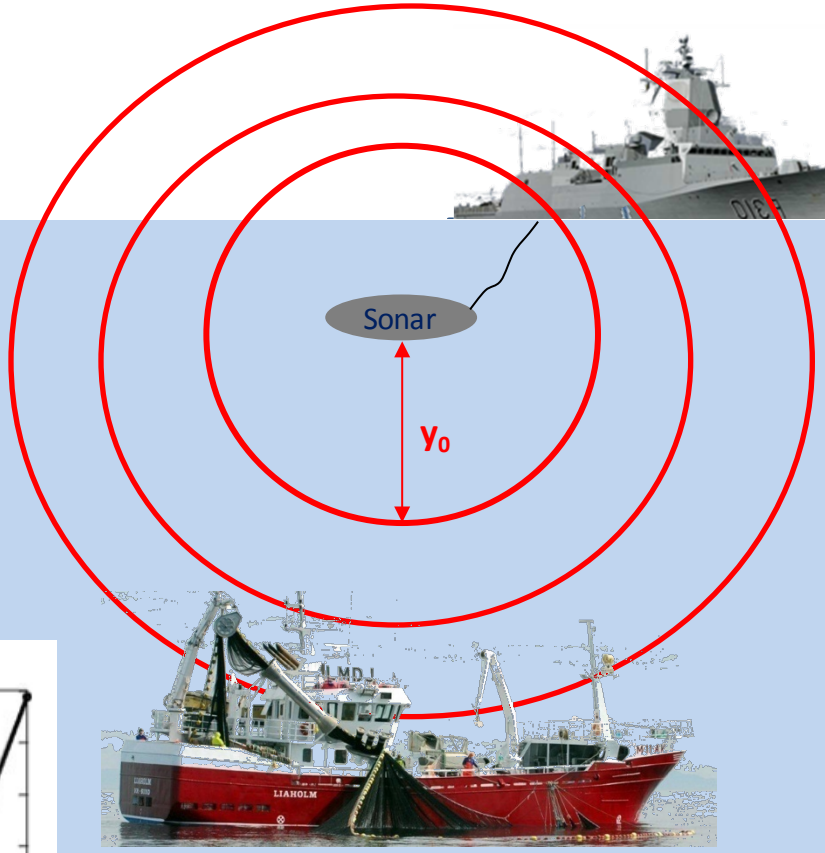
What if higher source levels are used?

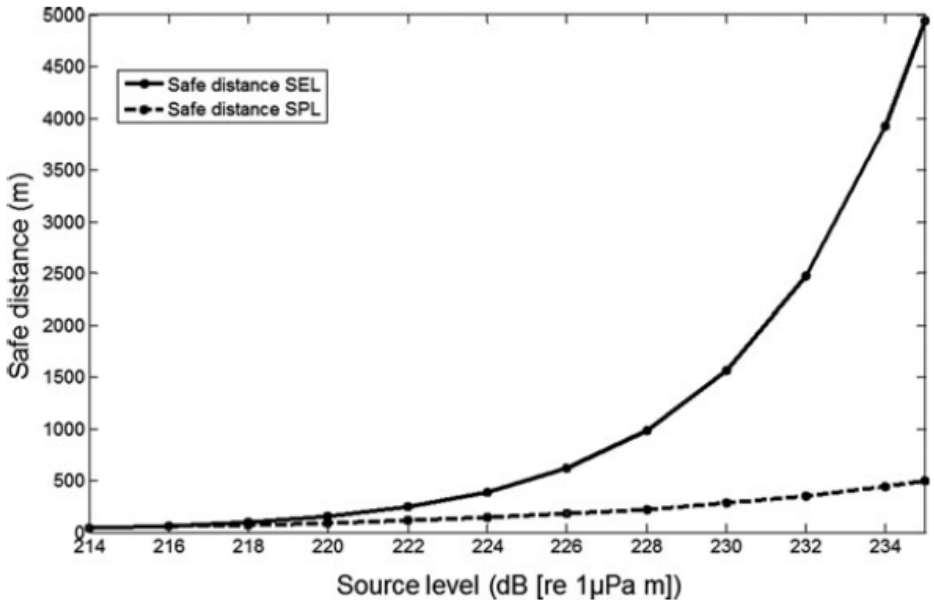
Can that cause potential effects on the population level?

Threshold of ignorance,SEL_0 : SEL of 184 dB re 1µPa^2 s.

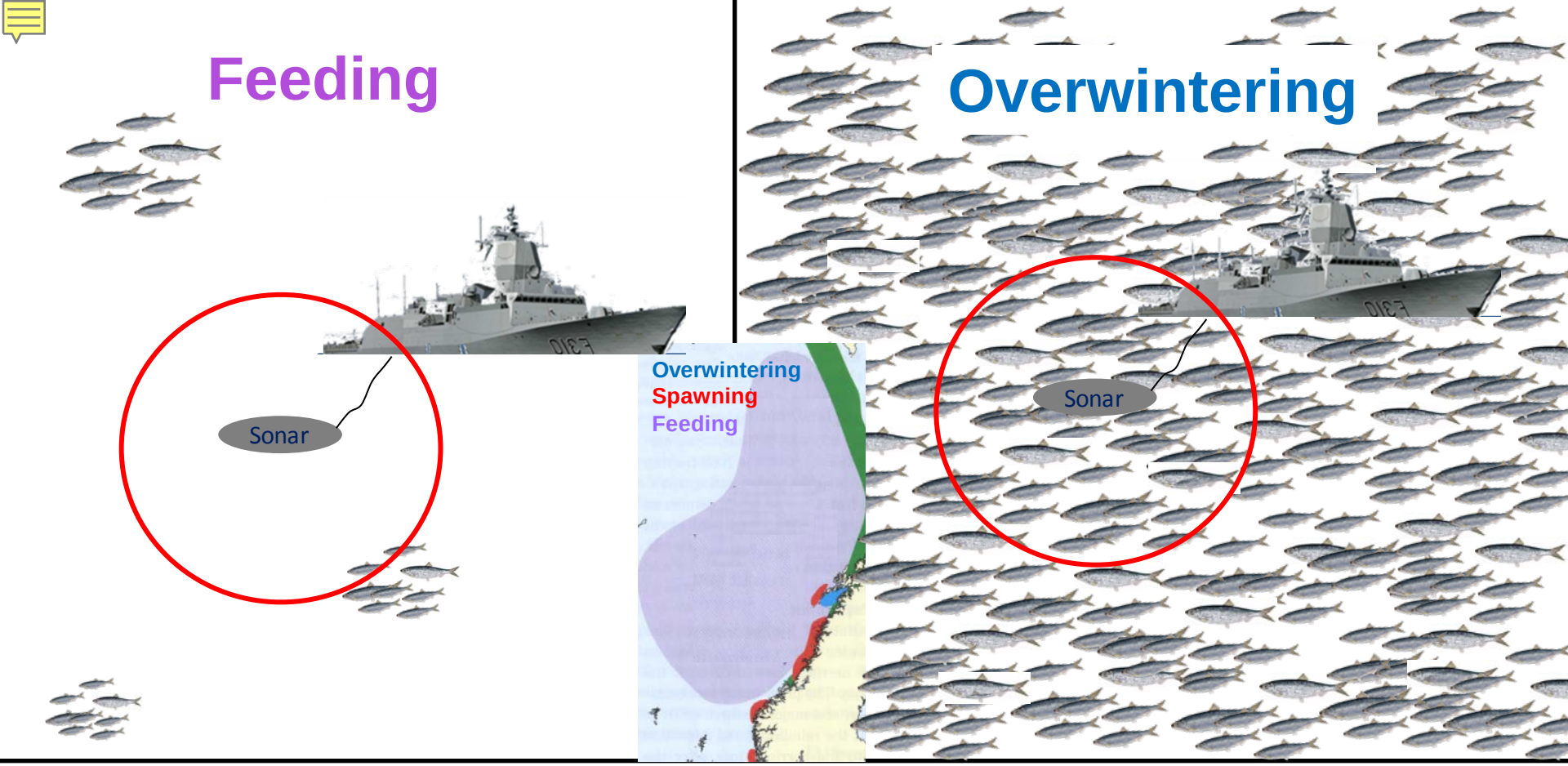
Assume behavioural response above this.

”Safe distance”

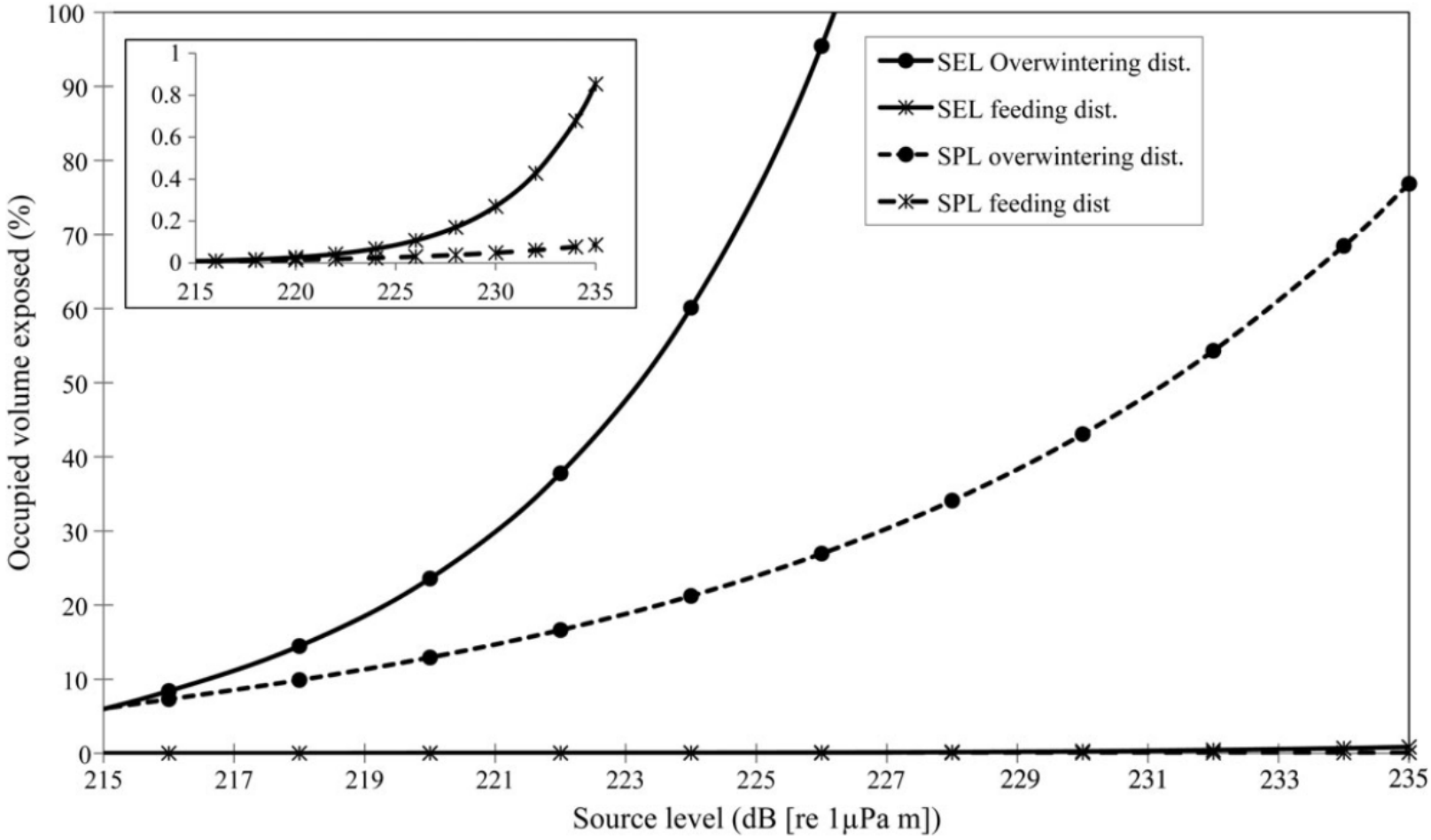




Sivle et al.(2014)
ICES J. Mar. Sci., 72(2), 558–567.

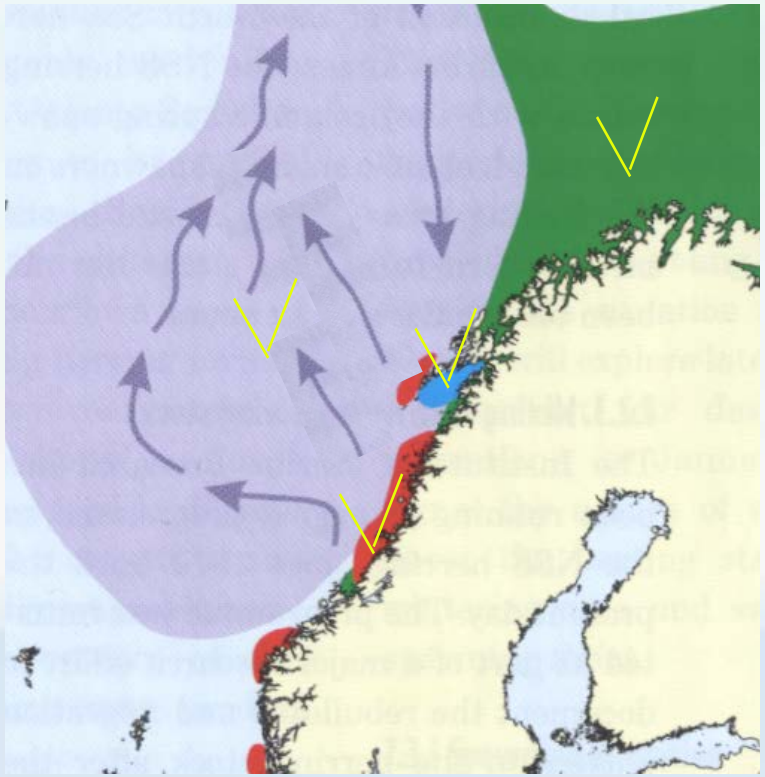


- Assume a 24 h naval sonar exercise with SL > 225 dB re 1µPa, vessel moving systematically throug area.
- Feeding: Minor fraction exposed
- Overwintering: Whole pop. exposed, each fish 89 s.



Highly unlikely that naval sonar exercises have any significantly impact on population of Atlantic herring.

Summary and applications



Consistent results :

- Adult herring does not show any behavioural response to sonar at levels and frequencies tested.

- Highly unlikely population effects.

Control experiments:
Herring CAN react, and our methods detect reactions.

Results incorporated in guidelines used in planning of sonar exercises (SONATE) by all Norwegian Naval ships.

Principle used by NOAA-NMFS for their Noise guidelines for whales : http://www.nmfs.noaa.gov/pr/acoustics/guidelines.htm (Appendix E, section 3.2.1, p.141 in document or p.148 of pdf).

Take home messages

- Adult herring do not show any behavioural response to naval sonars at 1-7 kHz with RL up to 176 dB (re 1µ Pa) and accumulated SEL up to 184 dB (re 1 µ Pa^2 s).

- Highly unlikely that levels above this will have an effect at the population level.