Harbor porpoise energetics & Harbor seal surface hearing (WOZEP)

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WOZEP meeting
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Utrecht

Structure of talk

- Background

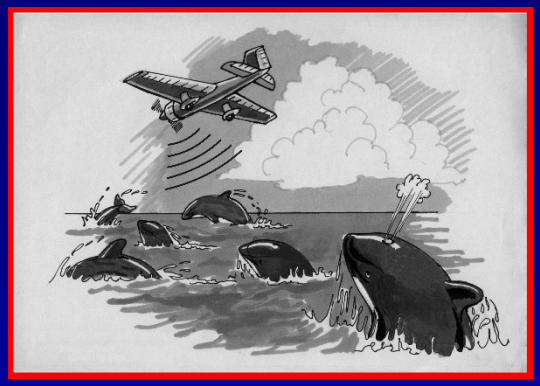
- Completed studies By SEAMARCO
  - ✓ Harbor porpoise energetics
  - ✓ Harbor seal surface hearing

- Ongoing studies
  - ✓ Harbor porpoise energetics
  - ✓ Harbor porpoise fish catch ability

SEAMARCO Research Institute, The Netherlands

Remote, quiet location & pools designed for acoustic research. Water & air temperatures similar to those of areas in which wild porpoises and seals occur (*i.e.*, on the other side of the dyke)

Background



Harbor porpoise research at SEAMARCO related to wind parks so far focused on:

- **Effect of pile driving sound on hearing (TTS)**
- **Effect of pile driving sound on behavior (dose-response)**

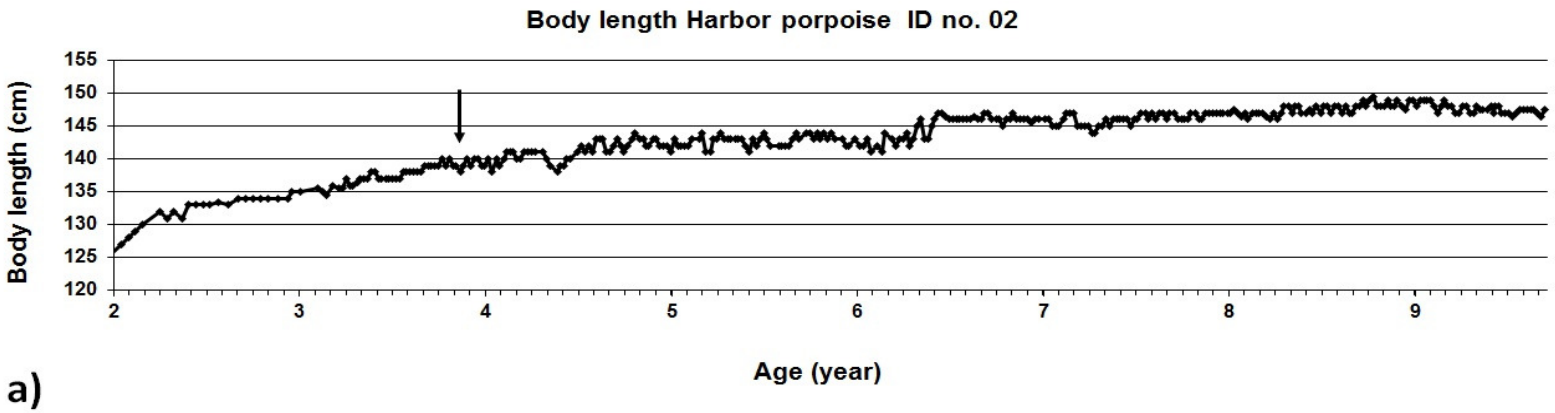
This research focused on the effect of sound on individuals

Ultimate goal: Effect sound on population dynamics

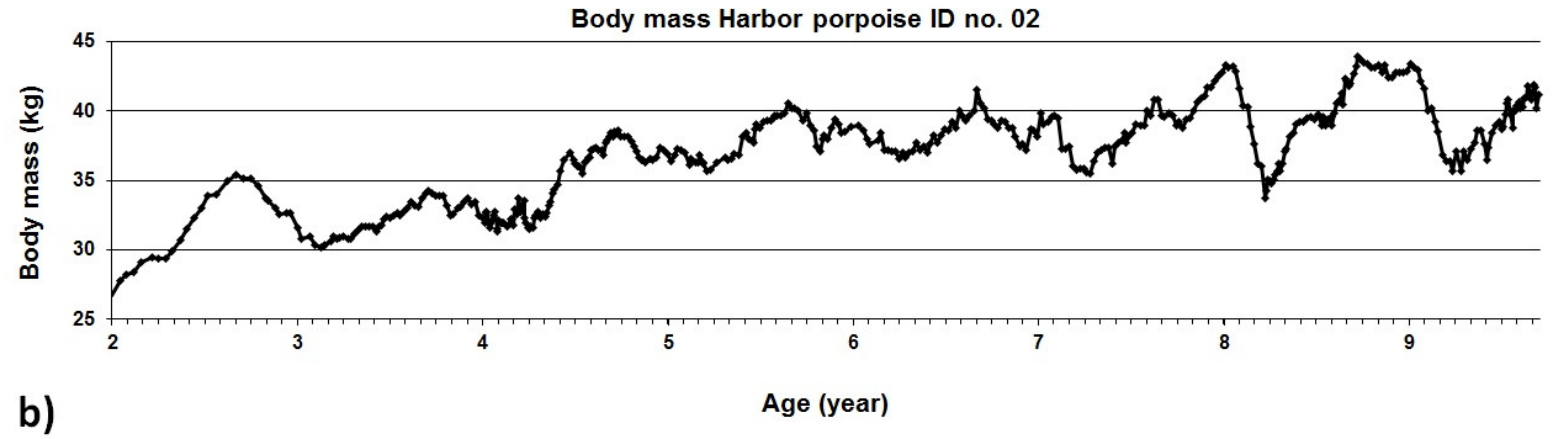
- **iPCoD model developed to estimate effects on populations**
- **Effect of sound on fitness, longevity and reproduction**
- **Important input parameter for iPCoD model: energetics**
- **Harbor porpoises live “in the fast lane”: high metabolism**

Food consumption & growth in a harbor porpoise (2016-2017)

Is body condition (mass) the same throughout the year ?



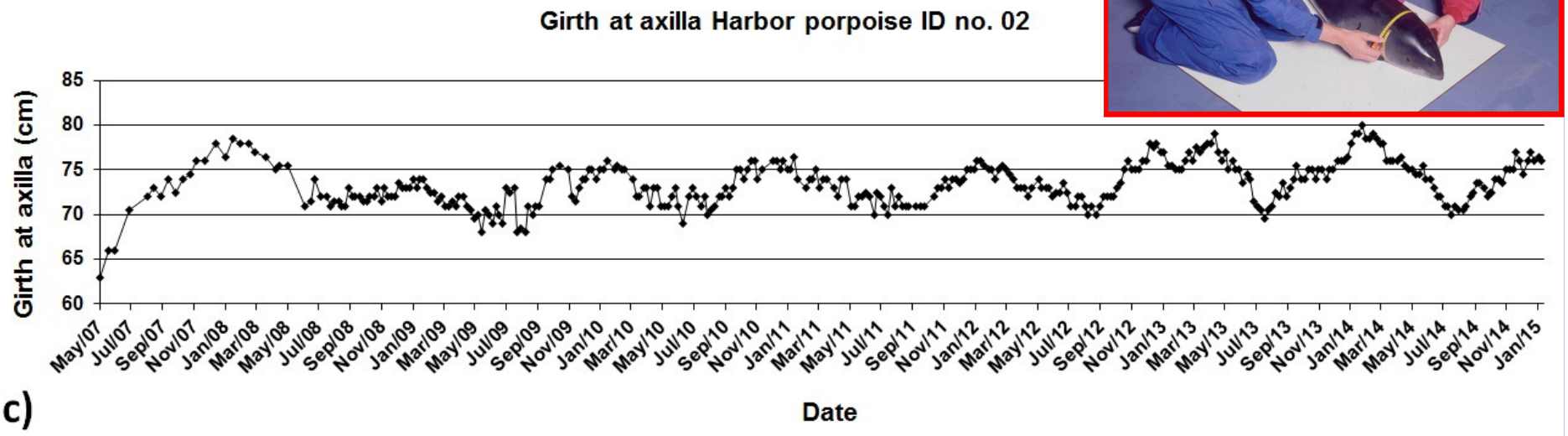
Weaning around 100 cm



Combination of length growth and seasonality

Weekly measurements body mass, length, girth and blubber thickness

Seasonal fluctuations in girth



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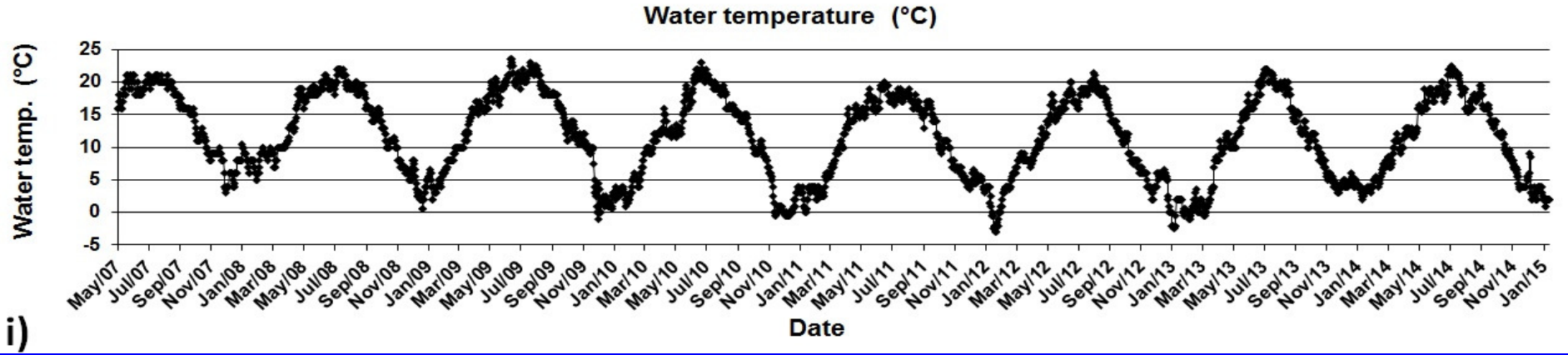

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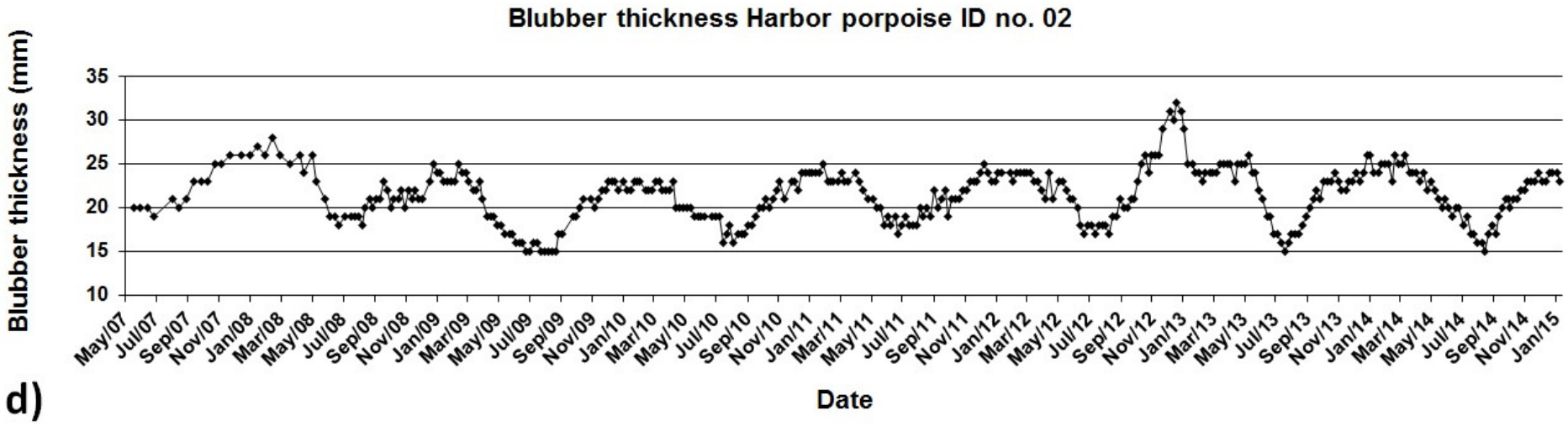
Seasonal fluctuations blubber thickness



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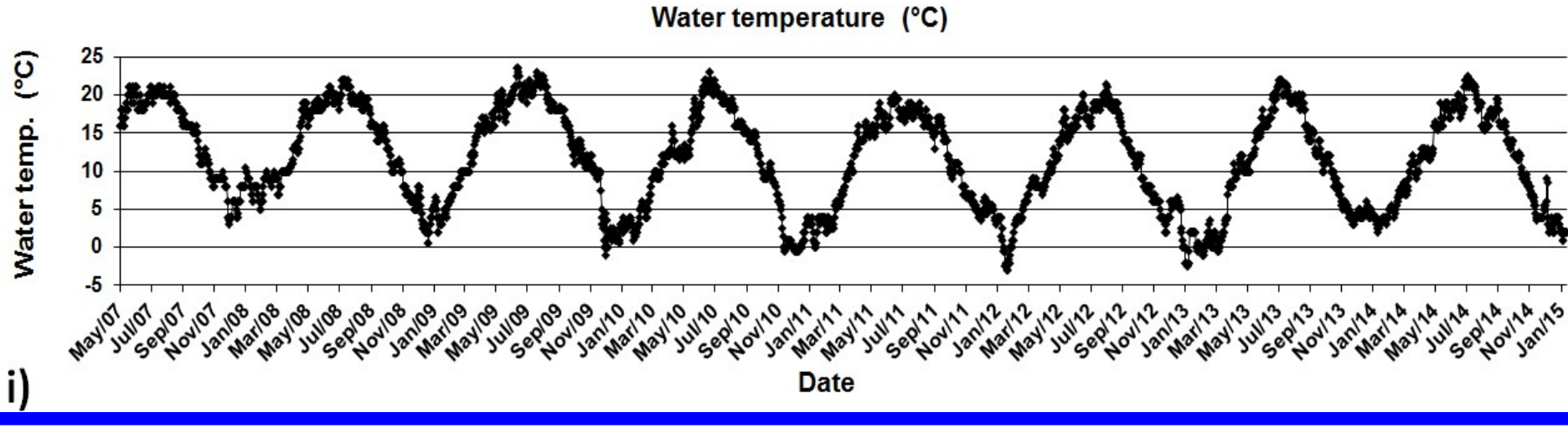


i)

Conclusion

The body mass, blubber thickness, & food consumption of harbor porpoises fluctuate seasonally & are correlated with water temperature.

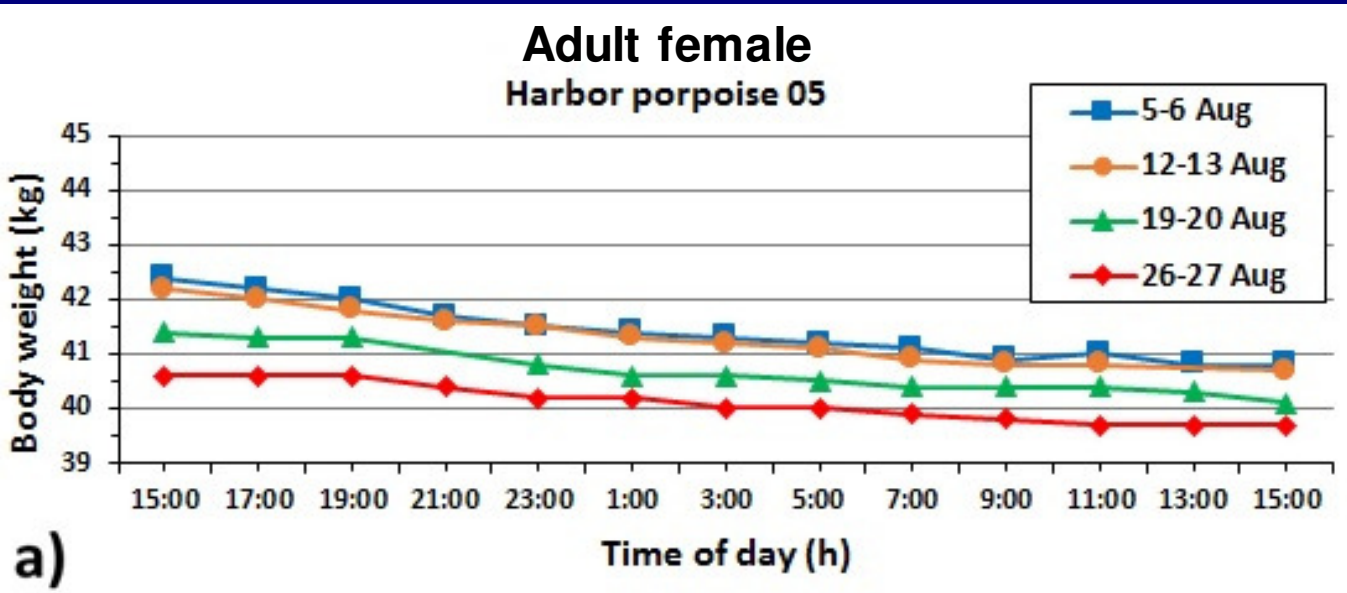
Kastelein, R.A., Helder-Hoek, L., and Jennings, N. (2018). Seasonal changes in food consumption, respiration rate, and body condition of a male harbor porpoise (*Phocoena phocoena*). Aquatic Mammals, 44, 76-91, DOI 10.1578/AM.44.1.2018.76

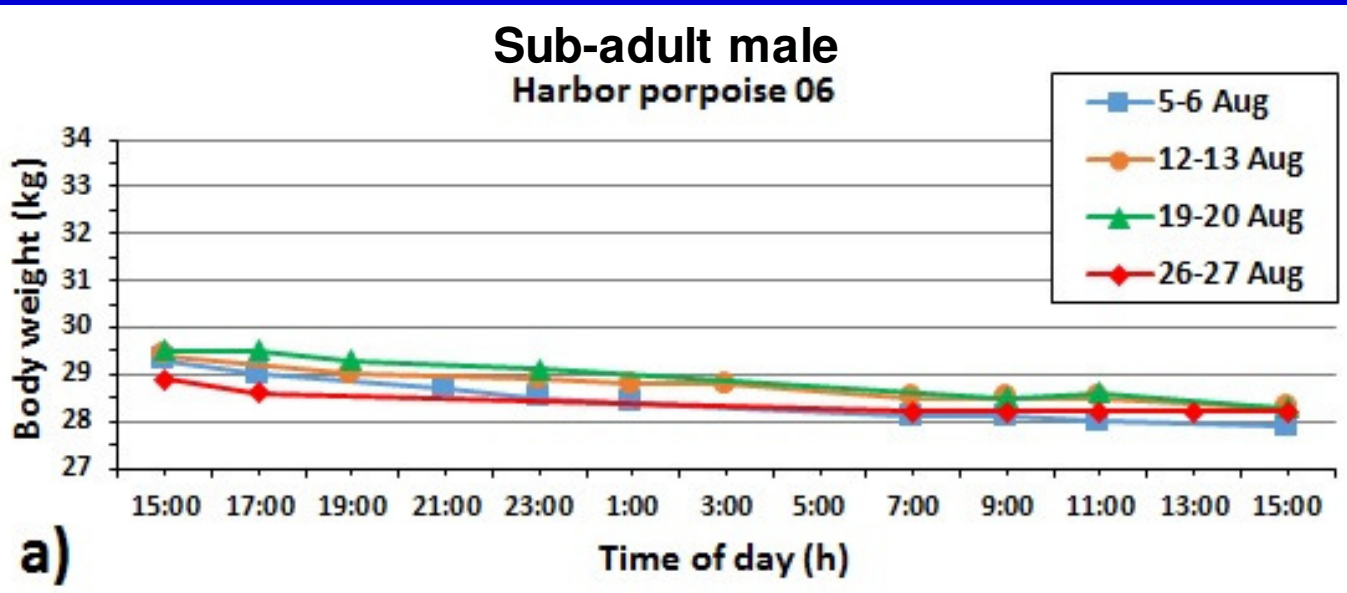
Effect of 24-hour fasting on harbor porpoises (2016-2017)

If a disturbance reduces foraging, how does it effect a harbor porpoise ?
Is there a season in which porpoises are more vulnerable to disturbance ?

- **Two porpoises (adult female and sub-adult male)**
- **Four 24-h fasting periods per season**
- **Body weight: max, min and transition periods**

Example of results





Conclusions fasting study

- Body mass loss occurred in every season in both porpoises (~ 4% of body mass/24 h).

- Decrease blubber thickness: 0 - 3 mm.
- Mass loss greatest in autumn & lowest in summer.
- Harbor porpoises thus appear to be most vulnerable to the effects of fasting due to disturbance in autumn (a period in which their blubber layer has to increase, to cope with the decreasing water temperature).
- Not taking food availability into account !

Kastelein, R.A., Helder-Hoek, L., Jennings, N., van Kester, R. & Huisman, R., Reduction in body mass and blubber thickness of harbor porpoises (*Phocoena phocoena*) due to fasting for 24 hours in four seasons. Aquatic Mammals (in review).

Ongoing harbor porpoise energetic studies (funded by Gemini)

- **Maximum food intake after fasting in harbor porpoises (2017-2018) = Indication of ability of recovery of blubber layer**
- **Effect pile driving sound on harbor porpoise fish catch ability (2017-2018)**

Gemini

Hearing thresholds, for underwater sounds, of harbor seals (*Phoca vitulina*) swimming at the water surface

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Introduction

- Pile driving for offshore wind farms creates very high sound pressure levels near the construction site
- These high SPLs may cause hearing damage in harbor seals (Temporary or Permanent Threshold Shift; TTS or PTS)
- When fleeing from a piling location, seals are not always swimming below the water surface, they swim part of time at the water surface to breathe.

Question

Which amount of the energy of underwater pile driving sound reaches the seal's inner ear when it swims at the water surface ?

(Can seals reduce the danger for PTS by swimming at the water surface? Seals have amphibious hearing

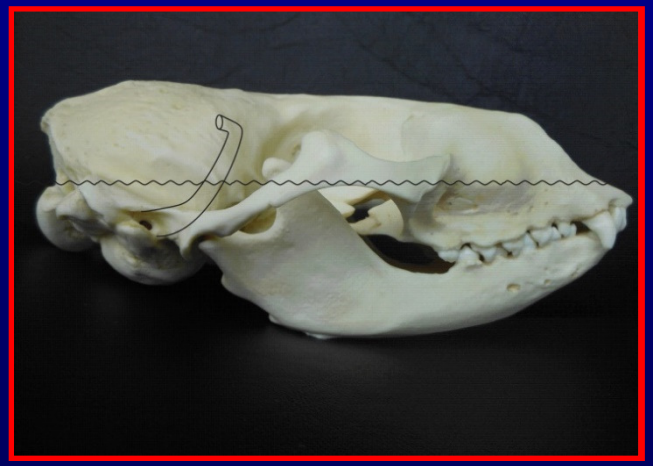
Goal

Measure the hearing sensitivity of harbor seals for underwater sounds, for their entire frequency hearing range, when they are with their heads half out of the water, in the same position as when they are swimming at the water surface

Swimming at water surface

At the listening station

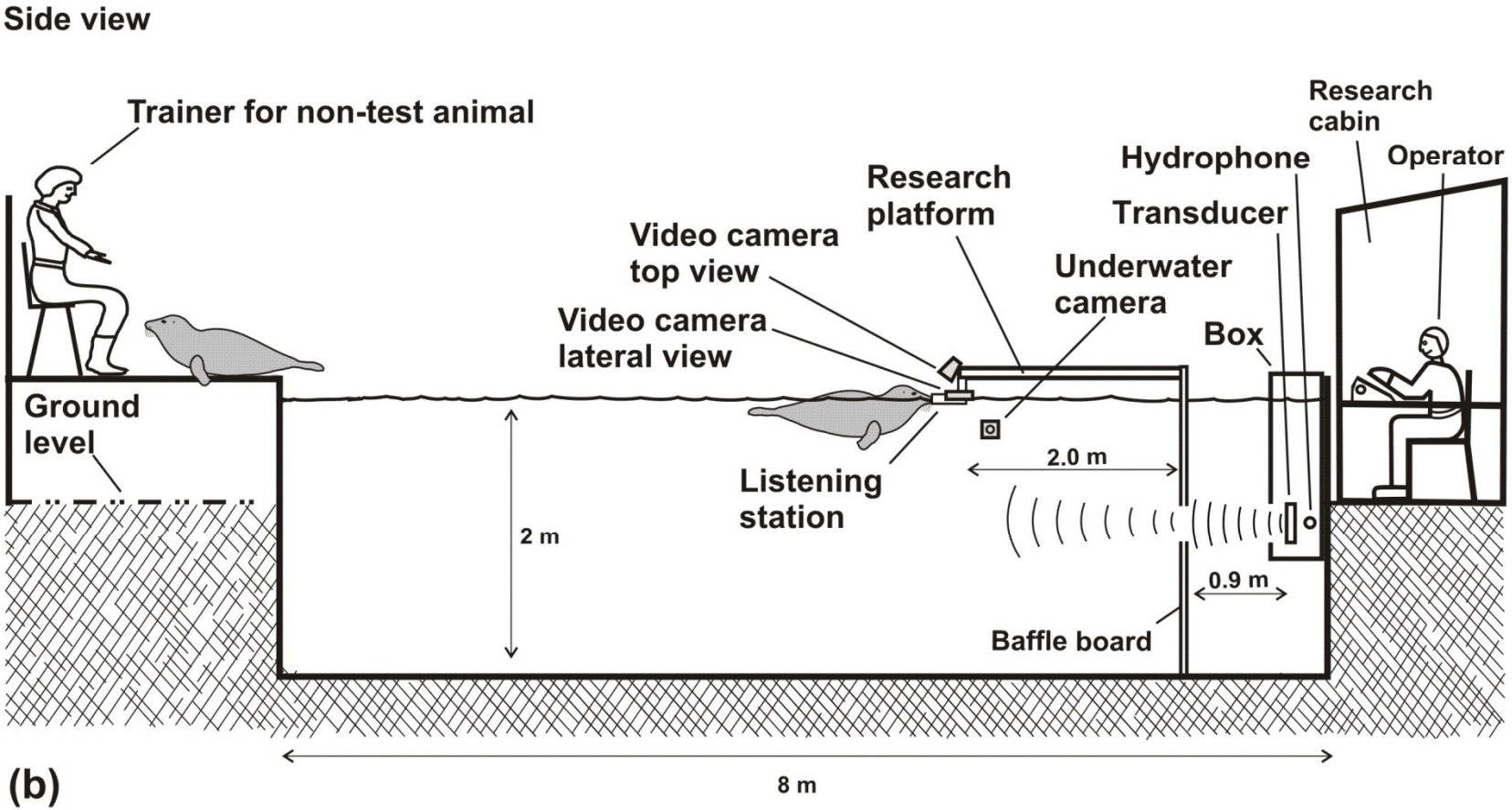
at the water surface (set-up)



Inner & middle ear below water surface, outer ear half below the water surface

Psychophysical method (go/no-go technique)

H seal surface hearing | Figure 1b | 15-10-2013/16:52



Transducers

USRD J-11
(0125-0.5 kHz)
“Woofer”

Lubell LL916
(1-16 kHz)

EDO 337
(16-63 kHz)
“Tweeter”

Calibration of received SPL

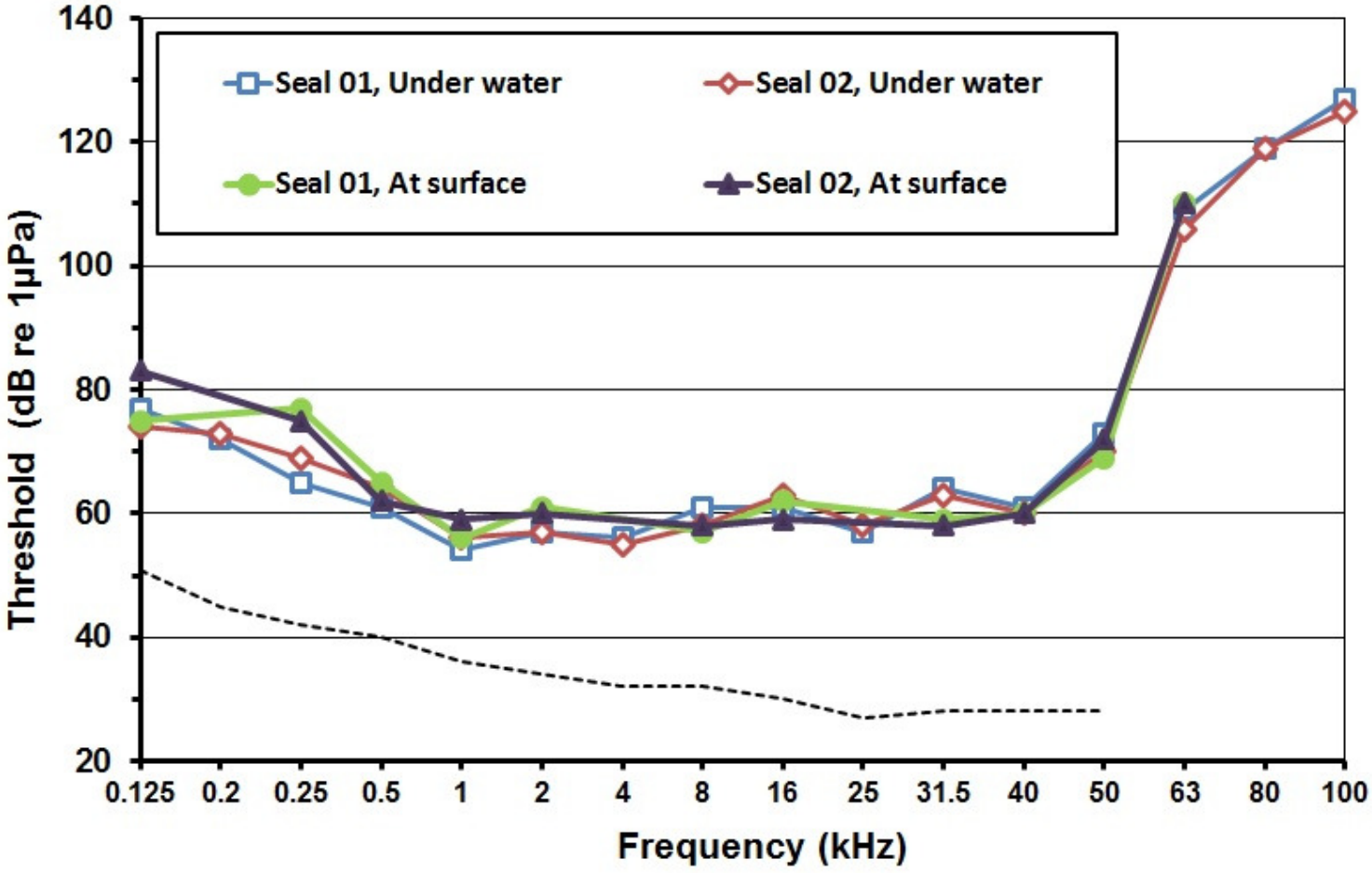
Calibrations by TNO

Hydrophones just below water surface, at location of the seals' ears.

3 trials (Video)

Heard > not heard > heard

Results



Surface hearing thresholds of both animals similar.
Surface and underwater hearing thresholds are similar.
When at sea, seal hearing is focused on underwater sounds.

Conclusion Harbor seal surface hearing study

When calculating the cumulative sound exposure level for hearing damage assessment in seals, the SPL in the water column, and just below the water surface needs to be measured, or modeled, and the proportion of time seals normally swim at the water surface needs to be estimated, in order to estimate the sound energy that reaches the seals' ears.

(Seals cannot reduce the chance of PTS by swimming at the water Surface)

Kastelein, R.A., Helder-Hoek, L., and Terhune, J. M. (2018). "Hearing thresholds, for underwater sounds, of harbor seals (*Phoca vitulina*) swimming at the water surface," Journal of the Acoustical Society of America. In press.

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