The physical characteristics of the Baltic Sea might act as a bottleneck for the *Mnemiopsis leidyi* population expansion in this newly invaded area

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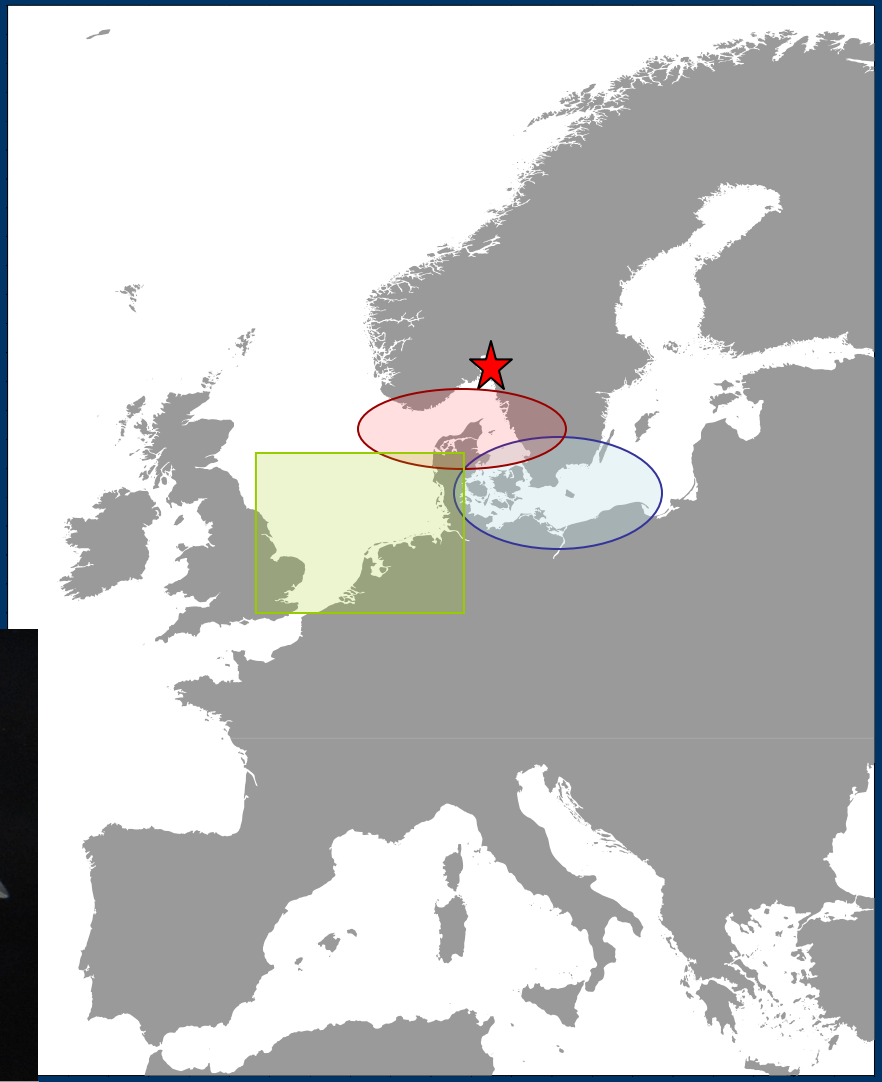
National Institute of Aquatic Resources, Technical University of Denmark

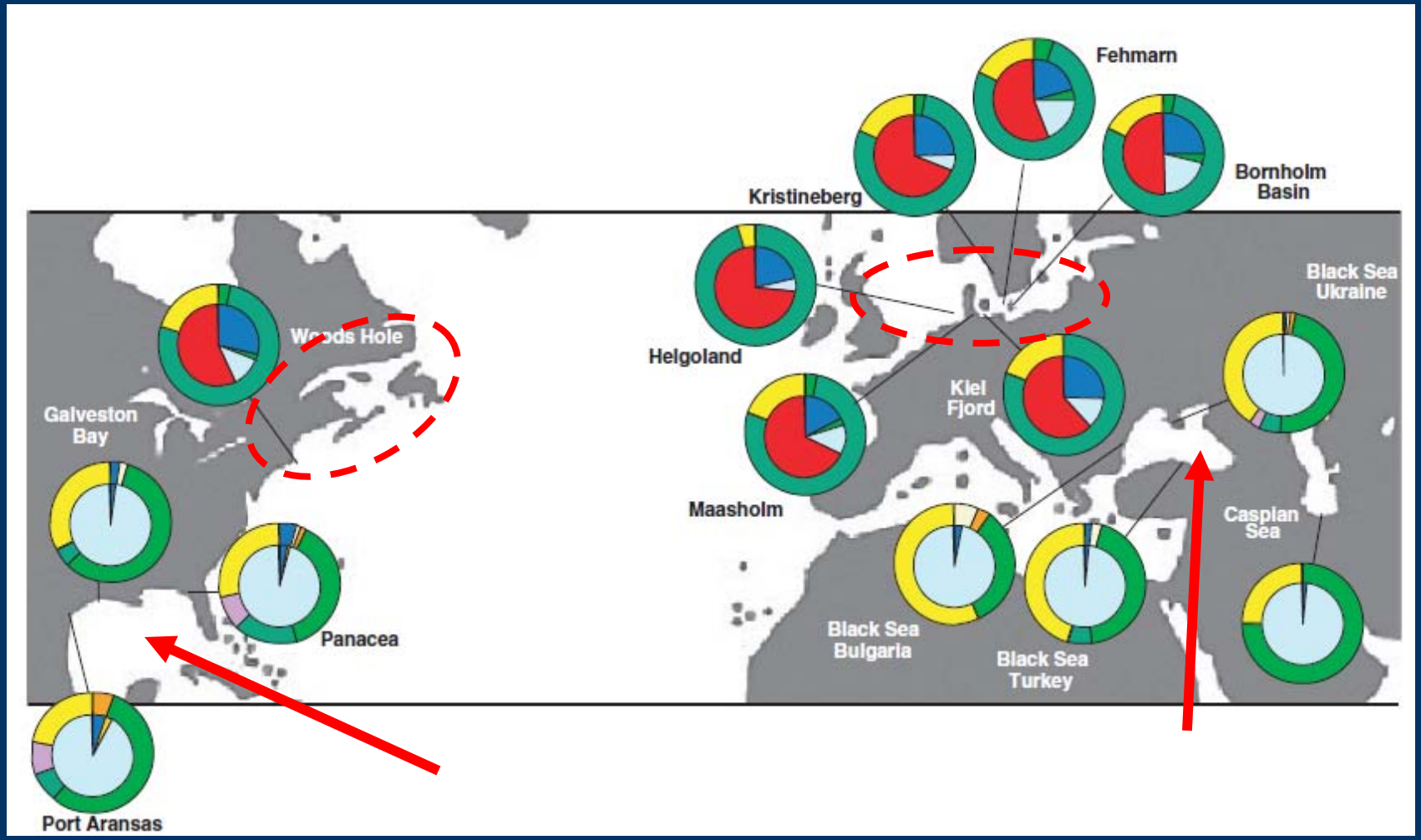
Invasion history of *Mnemiopsis*

Mnemiopsis leidyi

First observed 2005 in northern European waters (Oliveira 2007)



Mnemiopsis invasion route



Reusch et al. 2010 (Mol. Ecol.)

Fecundity

Egg production is high and maximum rates are reported

- 14 000 eggs day^{-1} US (Kremer, 1976)
- 12 000 eggs day^{-1} Black Sea (Zaika & Revkov, 1994)
- 12 000 eggs day^{-1} Kattegat (Jaspers p.obs.)

Furthermore

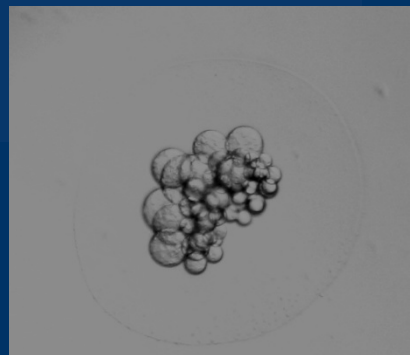
- Hermaphrodites
- 24-48 hours from fertilisation to hatching
- Disoogenie (larval reproduction) (Chung 1892, Martindale 1987)

Egg production

Egg production in *Mnemiopsis* has been shown to vary with
(Kremer,1976; Reeve et al., 1989; Purcell et al. 2001)

- Size
- Food availability
- Temperature

- Production is regarded as highly sensitive to food environment
- 2-4 days of starvation leads to a cessation of egg production (Båmstedt in Purcell et al. 2001)



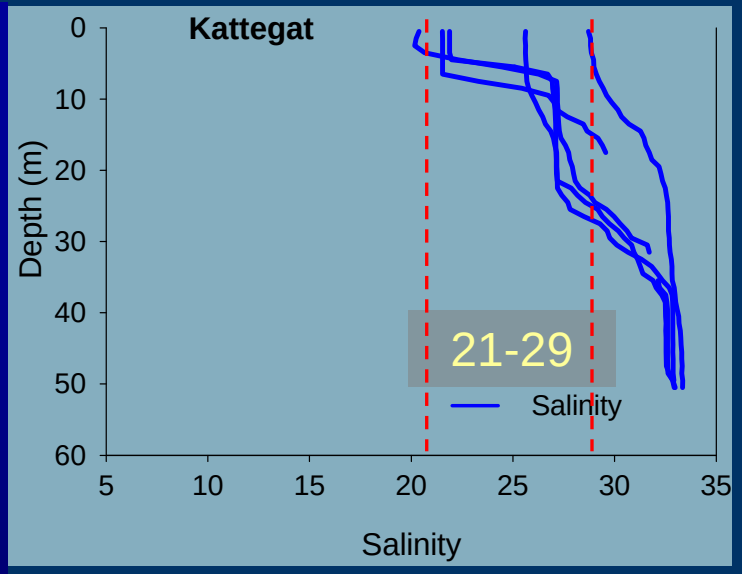
What does this mean for the Baltic Sea?

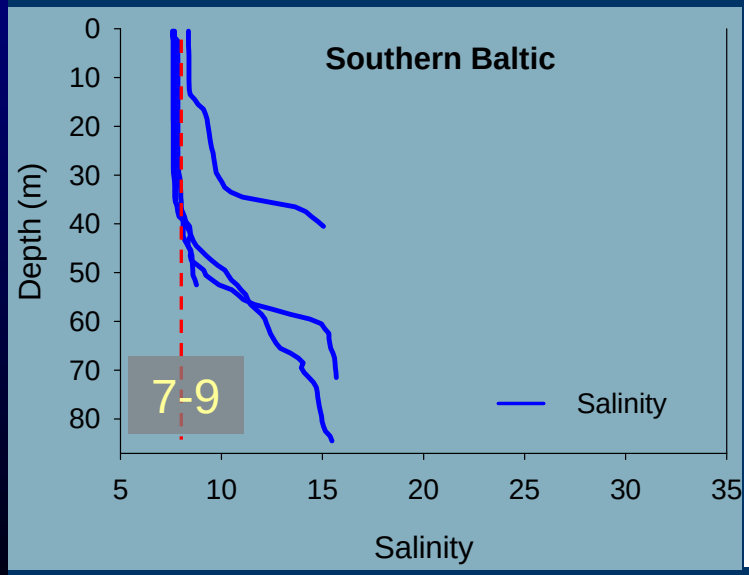
What does this mean for the Baltic Sea?

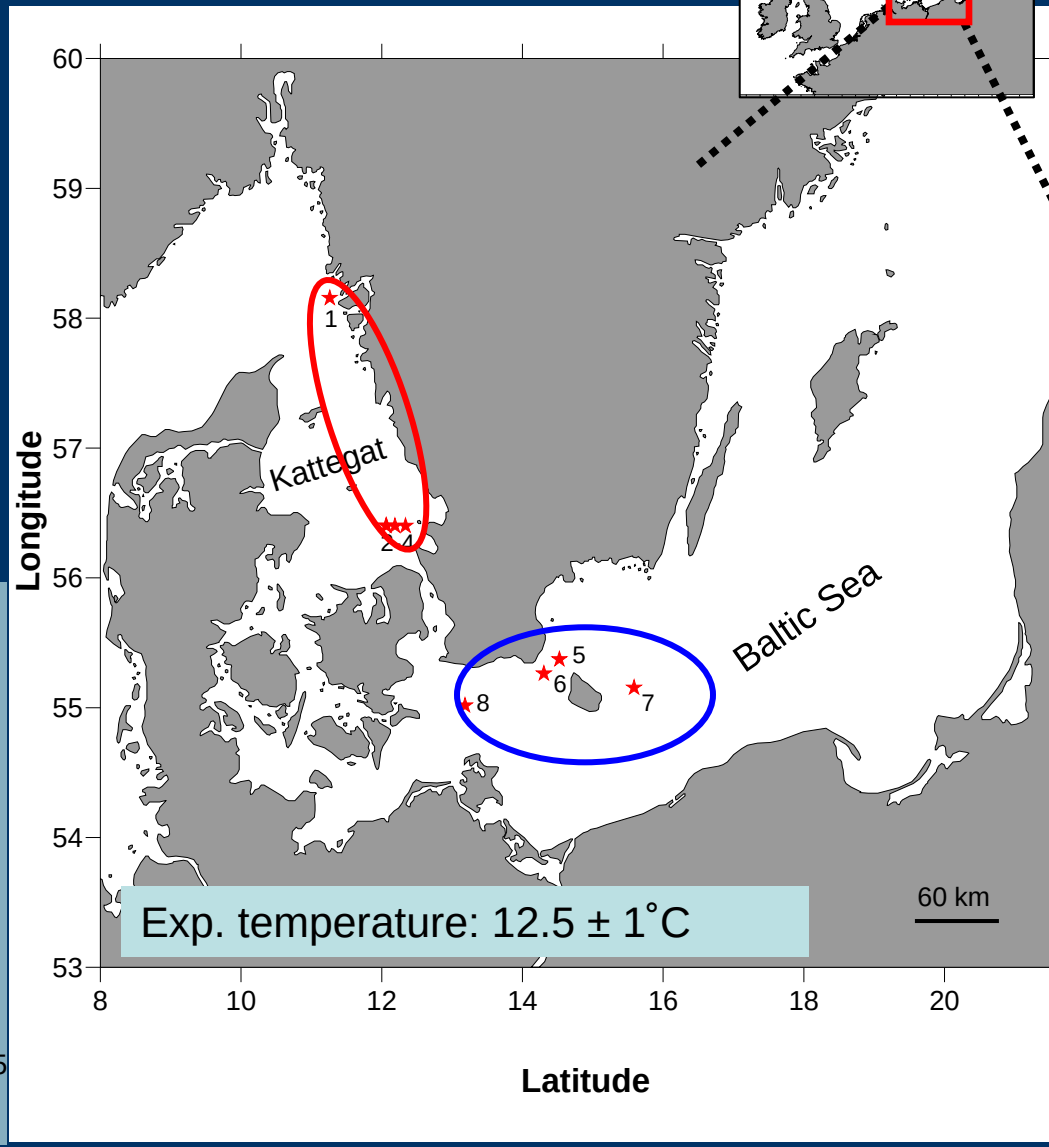
Objectives:

Understand the *in situ* reproduction rates of *Mnemiopsis* in the Baltic Sea

Investigation area

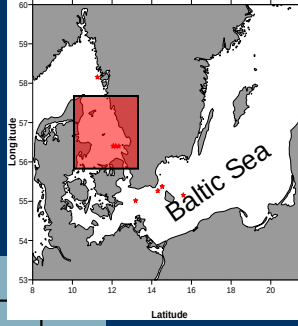


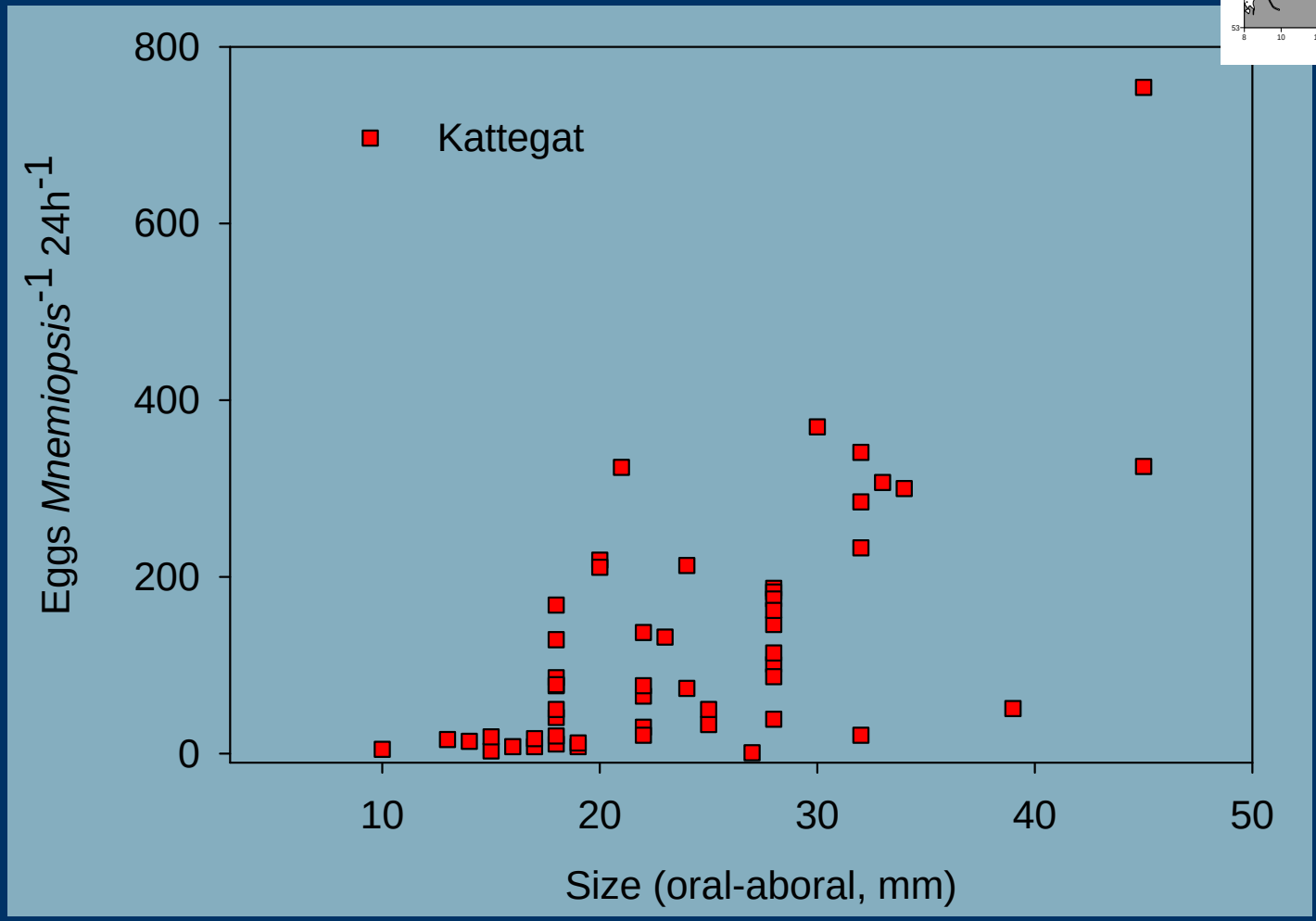




Results

Size dependent egg production

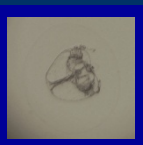


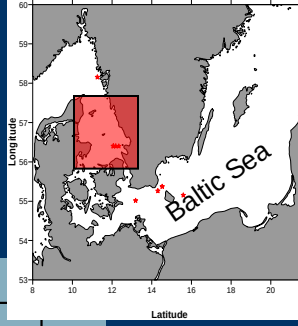


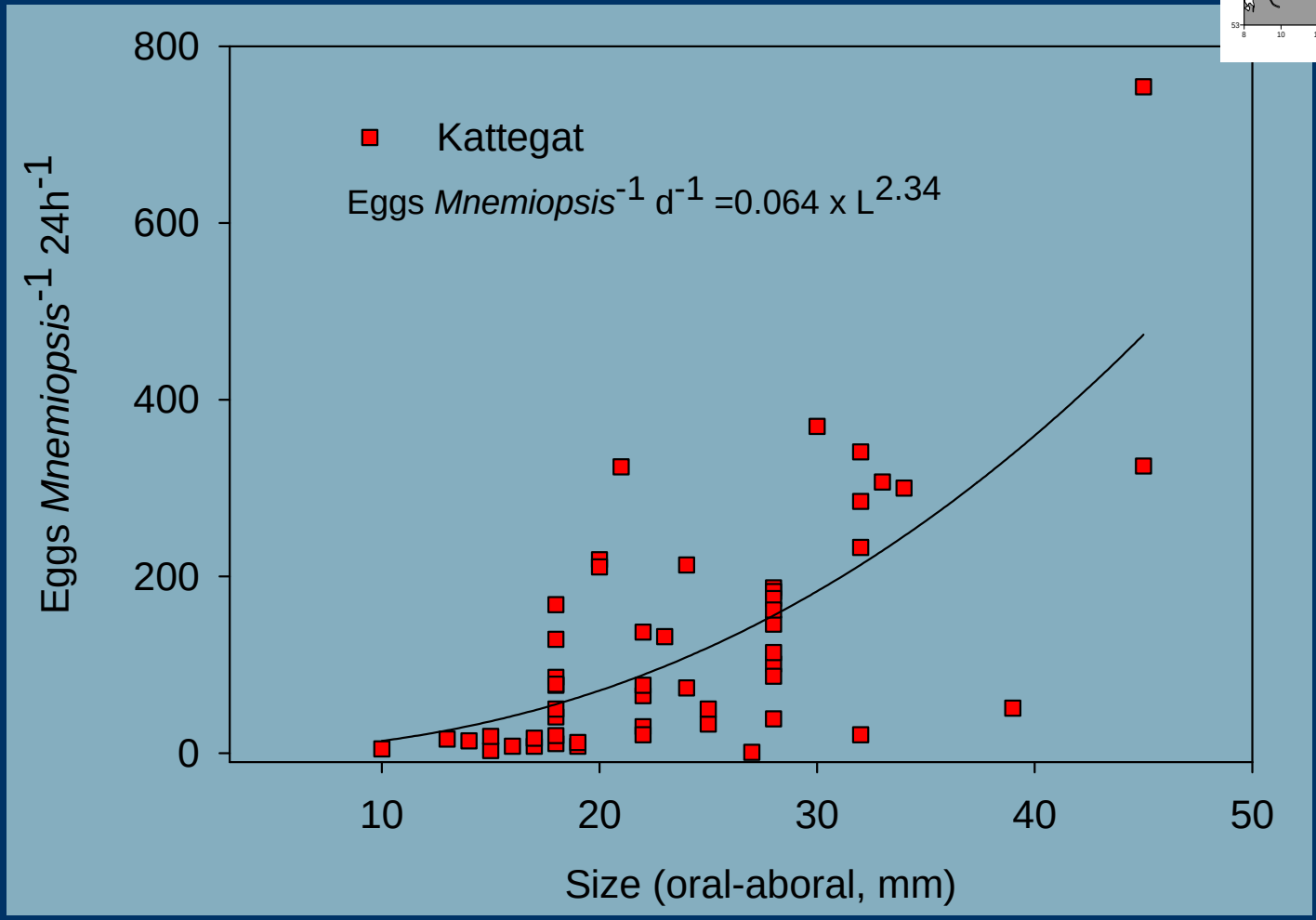
Egg production in the Kattegat at 12 ± 1.5˚C in October 2009
(R^2=0.48, p<0.0001)

Results

Size dependent egg production







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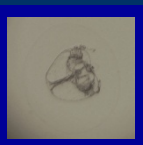
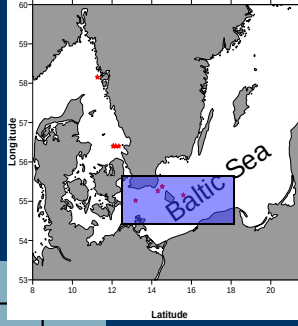
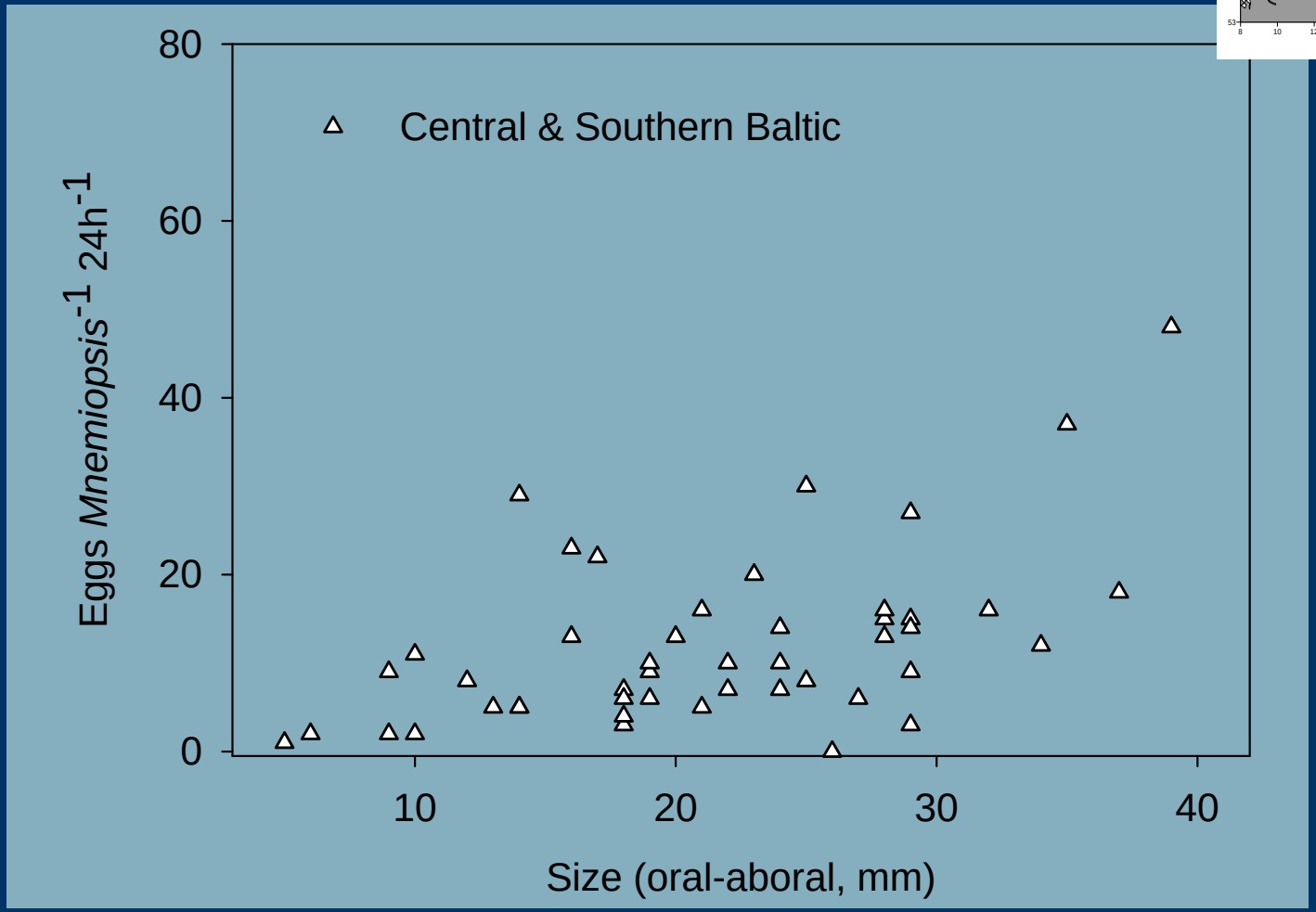


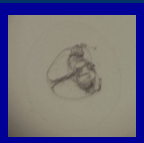


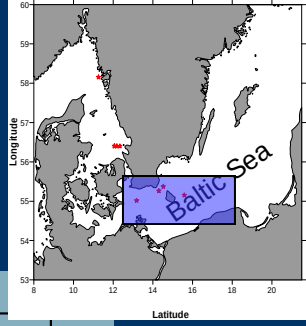


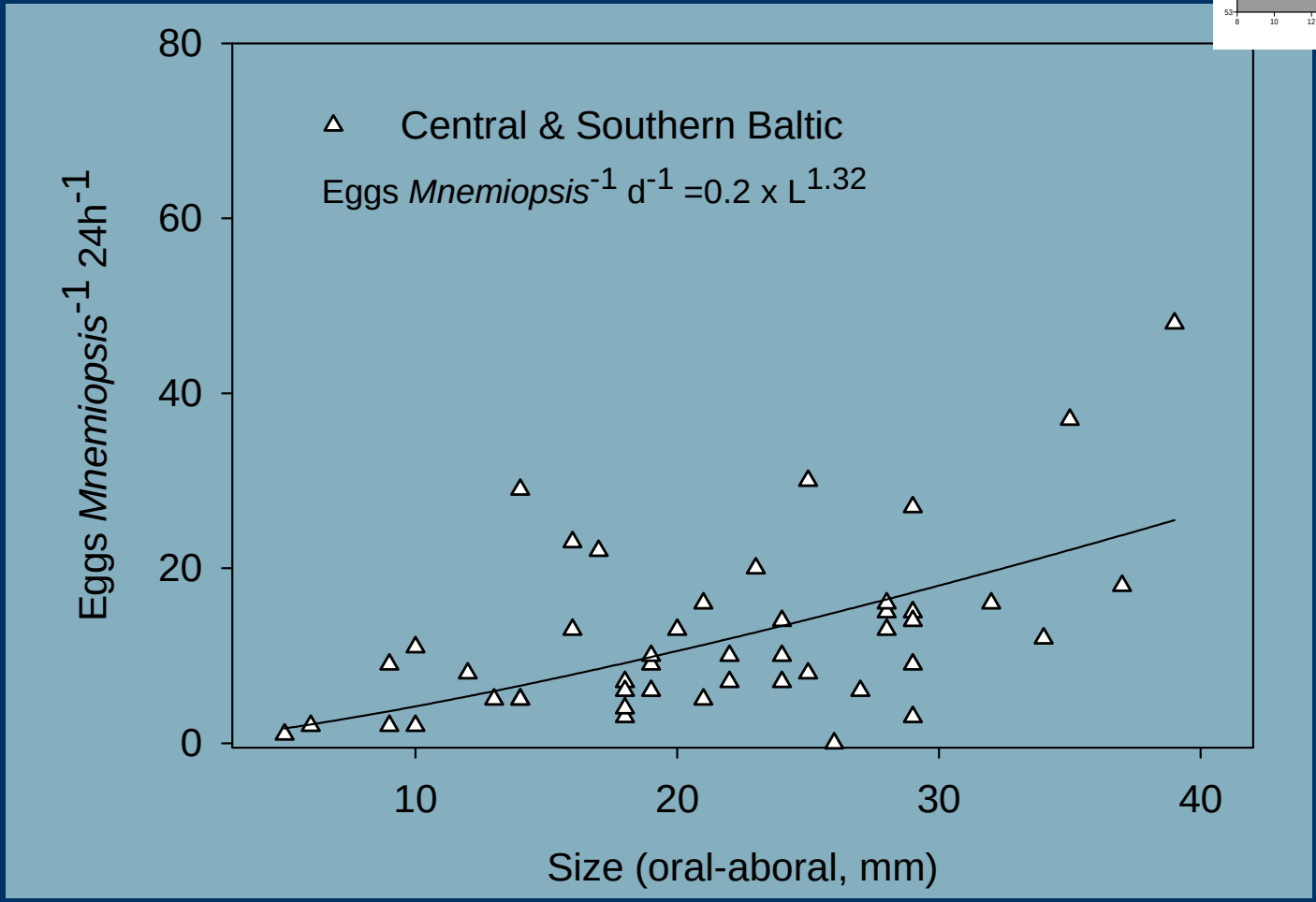
Egg production in the Southern Baltic at 12 ± 1.5˚C

Results

Size dependent egg production



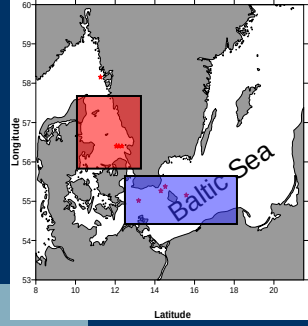


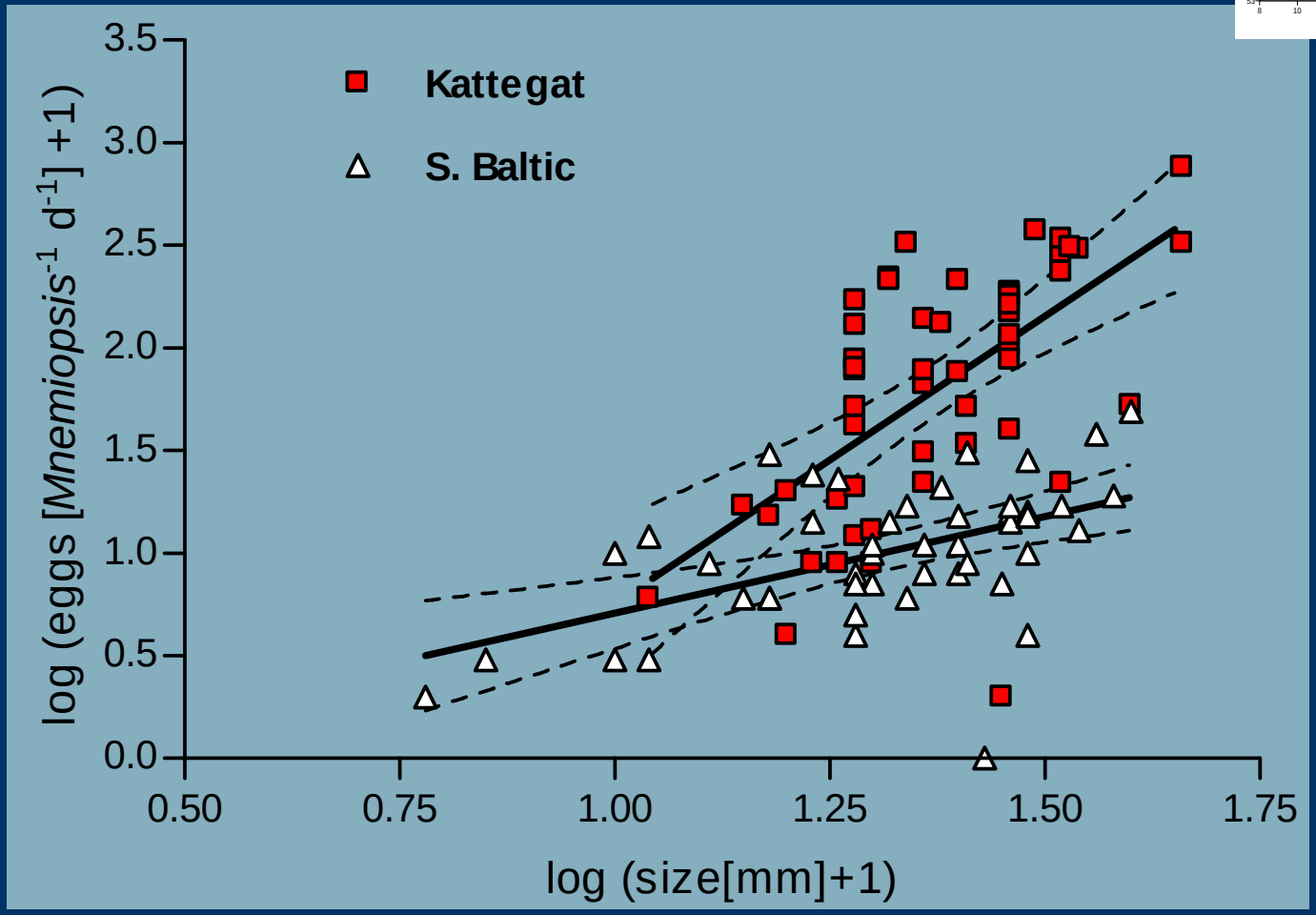


Egg production in the Southern Baltic at 12 ± 1.5˚C
(R^2=0.27, p=0.0002)

Egg production rates

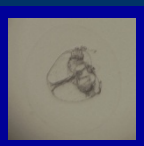
Kattegat vs. Southern Baltic

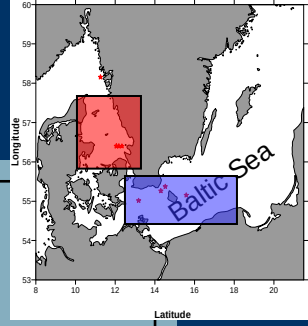


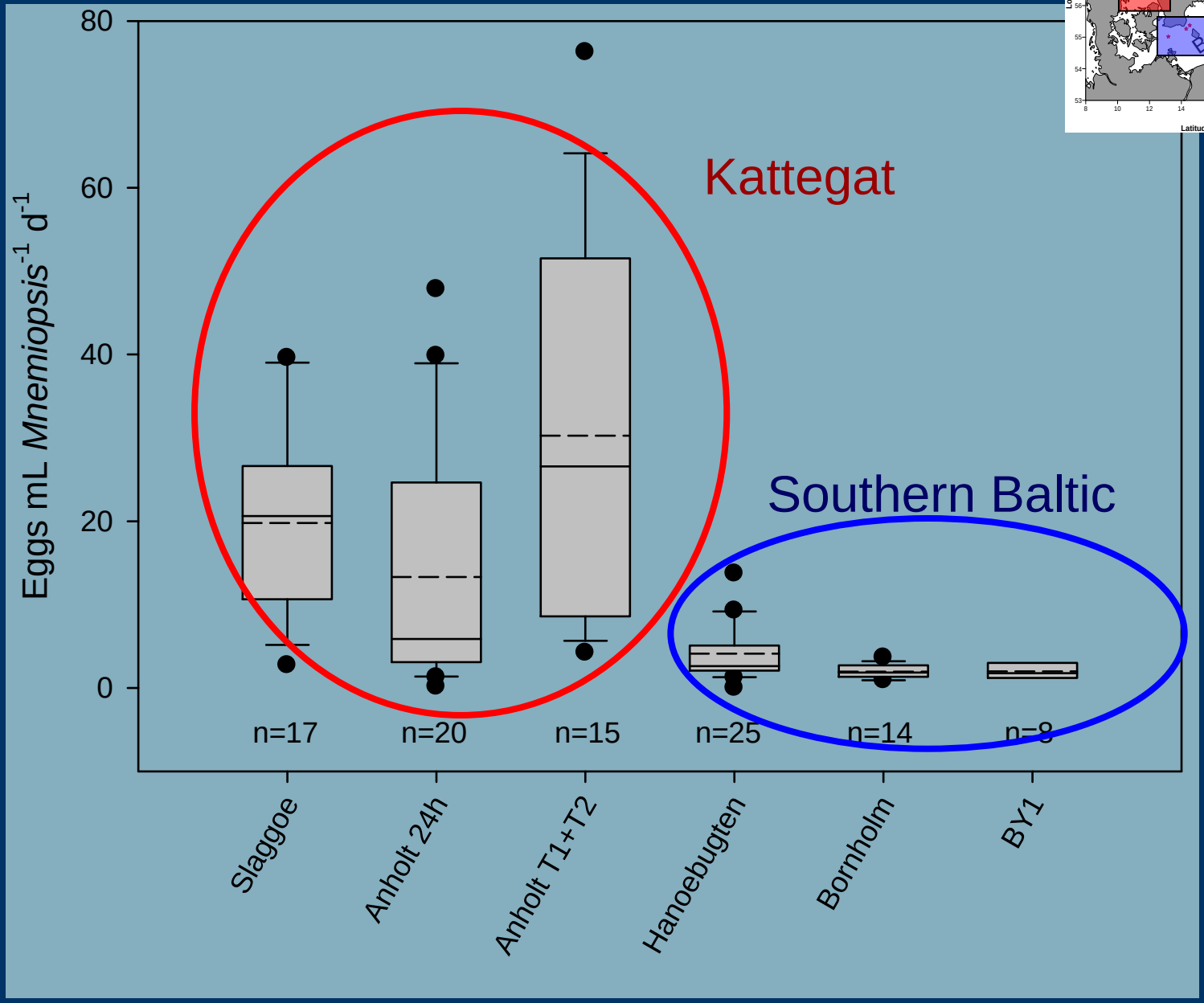


Slopes of Kattegat versus Southern Baltic egg production rates differ significantly ($p=0.0007$, $F_{1,95}=12.28$)

Volume specific egg production

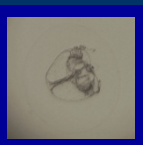


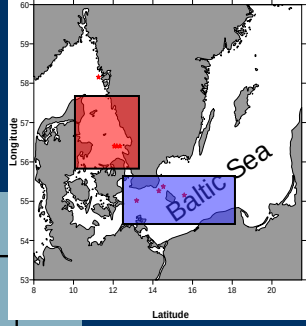


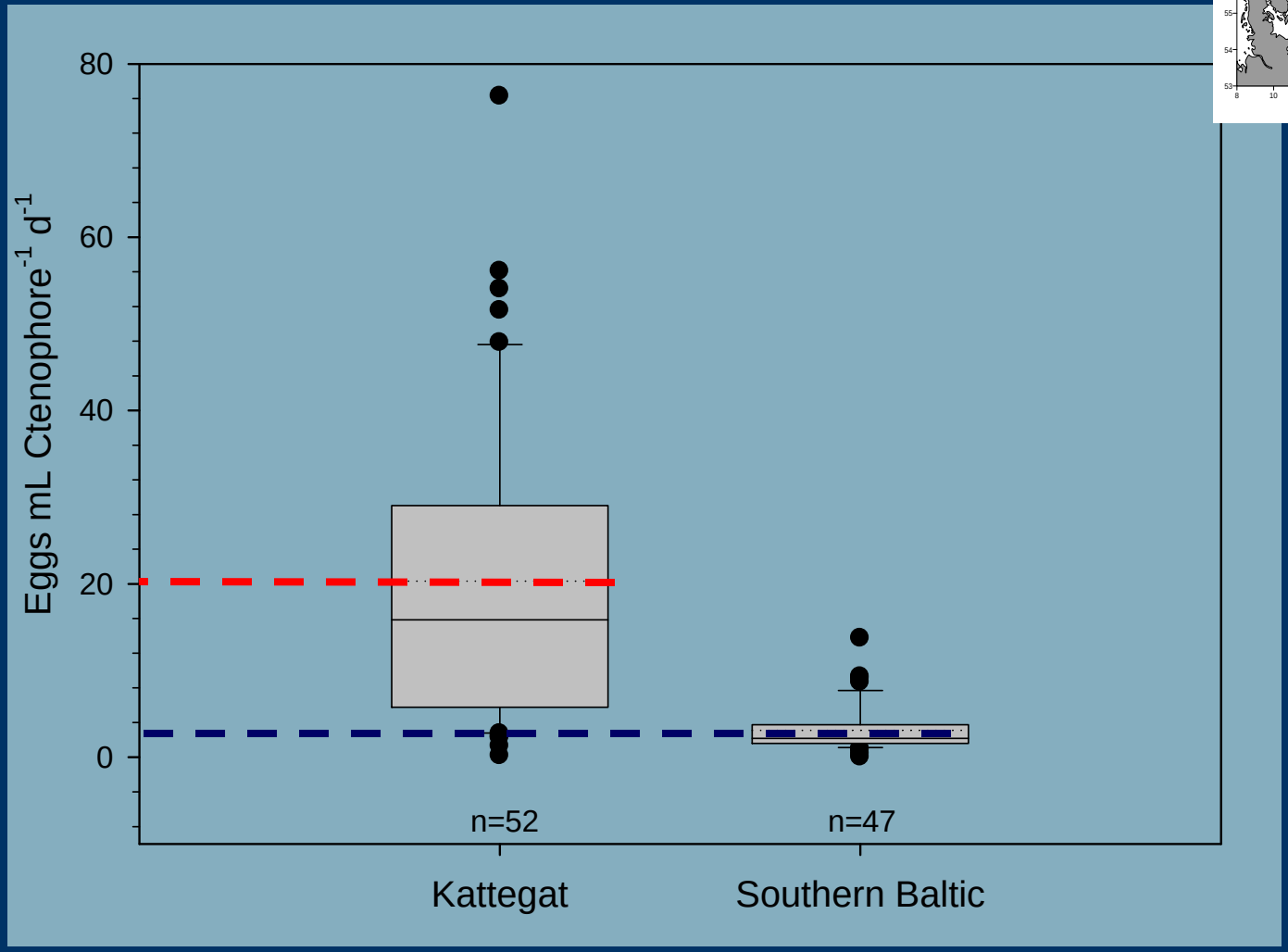


Results

Volume specific egg production







Egg production varies significantly between high saline Kattegat 20±17 and low saline S. Baltic 3.0±2.5 ($t=6.77$, $DF=97$, $p<0.0001$).

Summary I

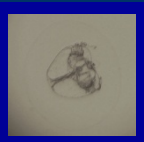
In situ egg production rates *Mnemiopsis leidyi*

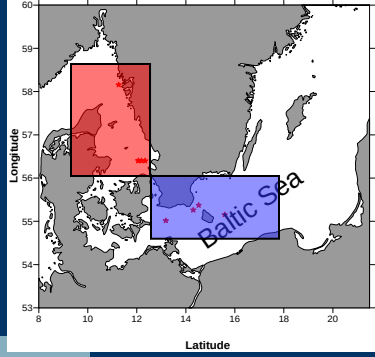
- Similar temperatures
- Salinity differs
  - 21-29 (Kattegat)
  - 7-9 (Baltic)
- Egg production rates are significantly higher in the higher saline Kattegat

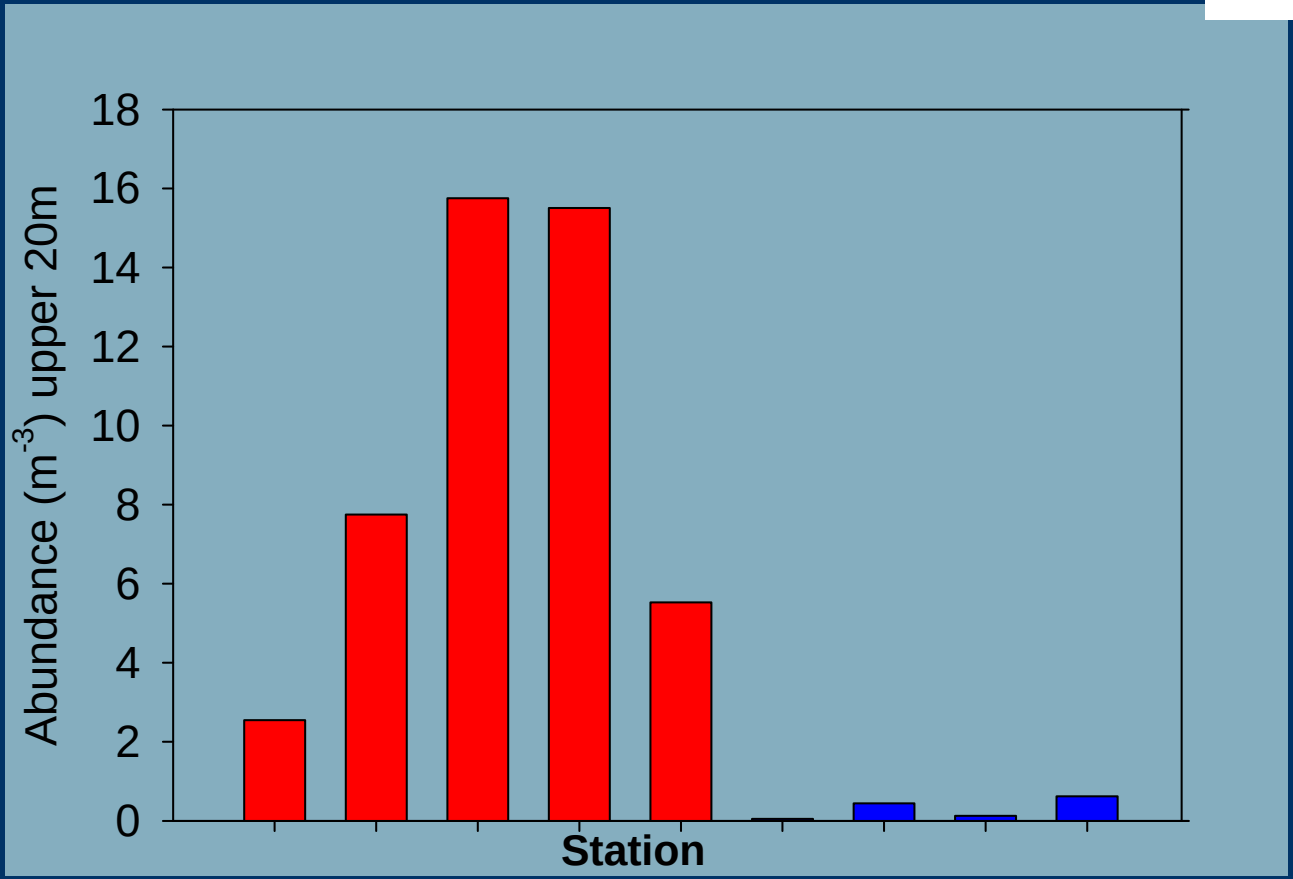
⇒ How does the community composition look like in both areas?

Results

Mnemiopsis leidyi abundance m^{-3}

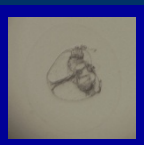


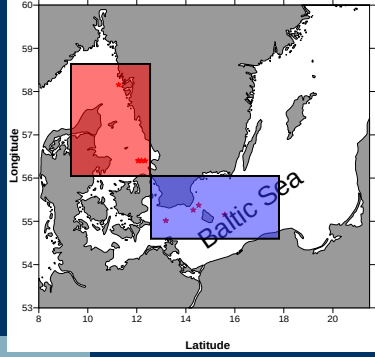


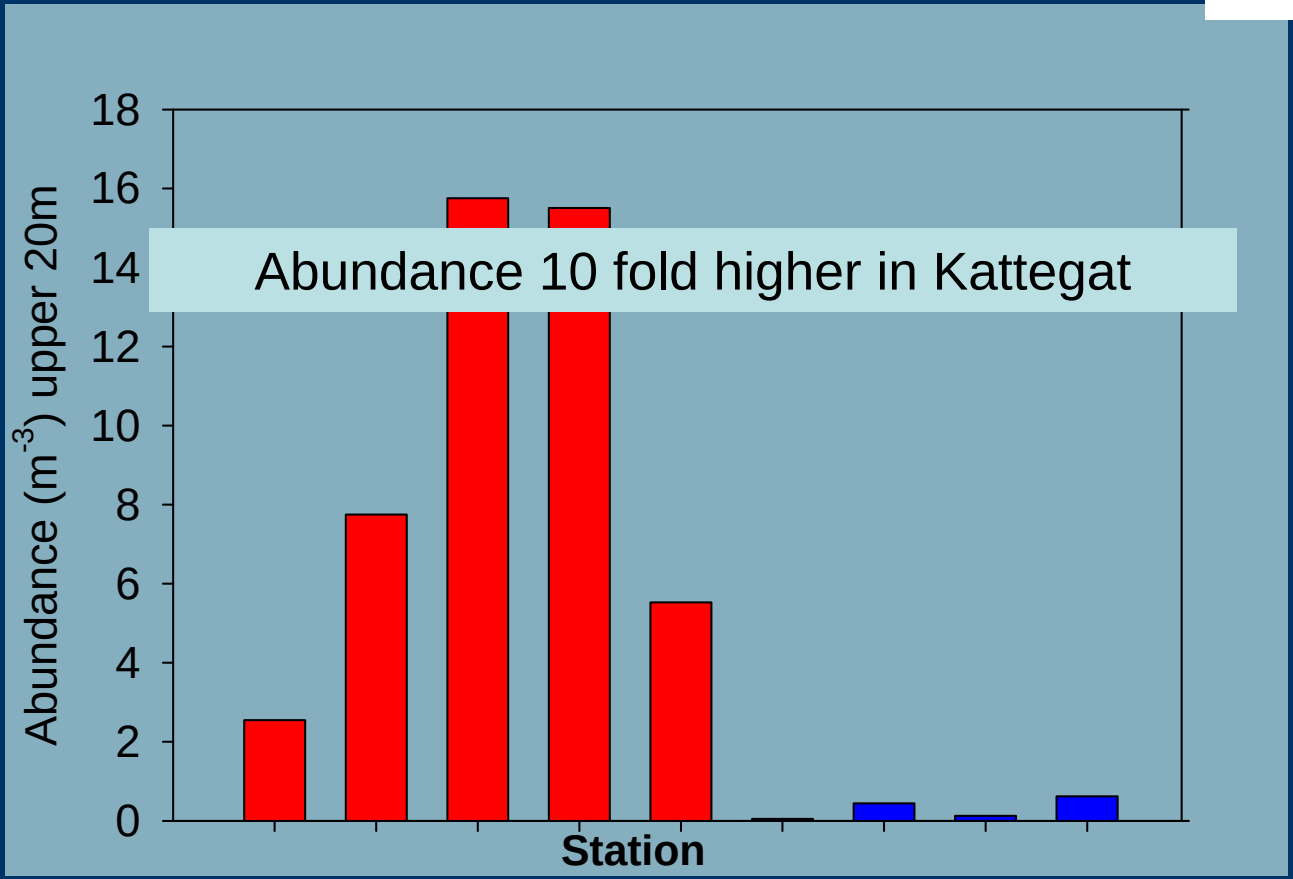


Depth distribution: Accumulation in the surface (20 m)

Mnemiopsis leidyi abundance m^{-3}



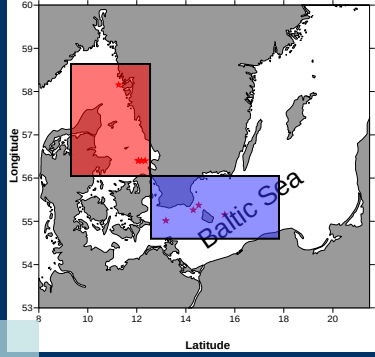


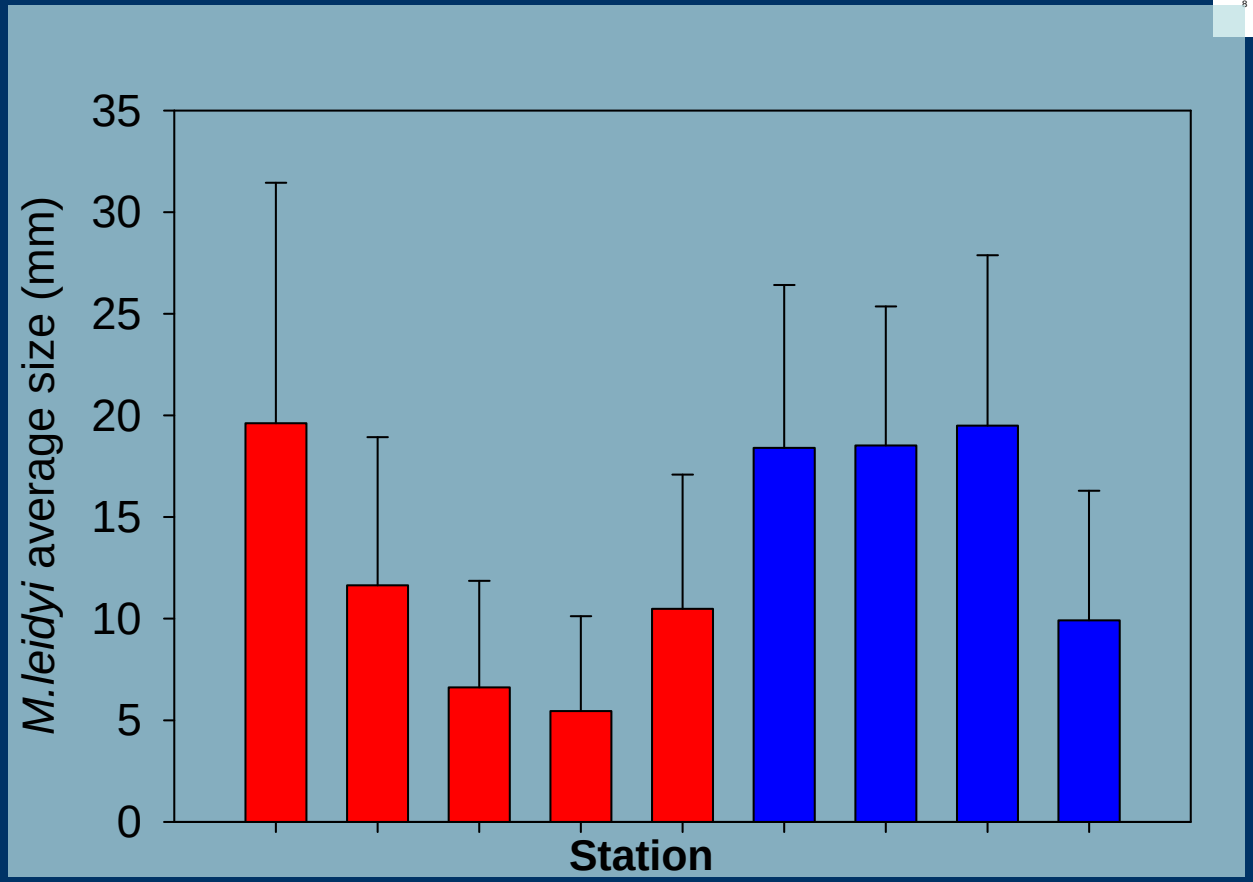


Depth distribution: Accumulation in the surface (20 m)

Results

Mnemiopsis leidyi population size distribution





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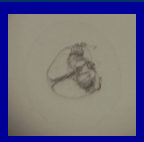

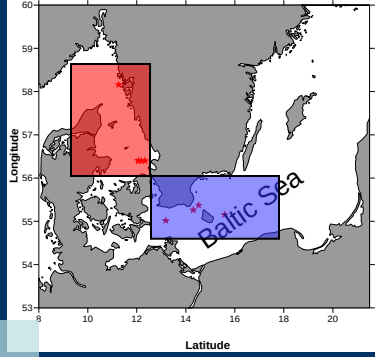

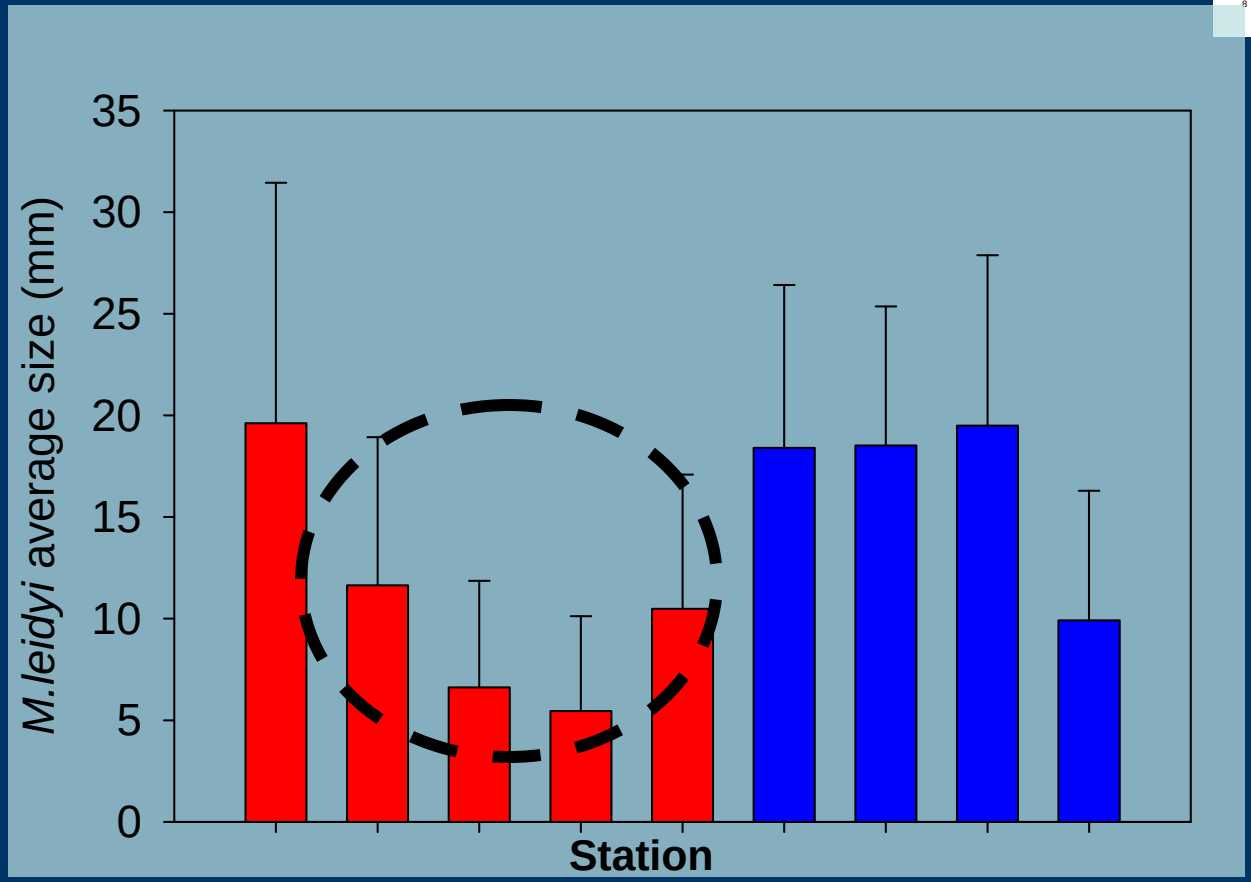

Results

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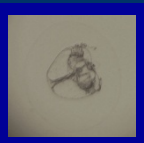

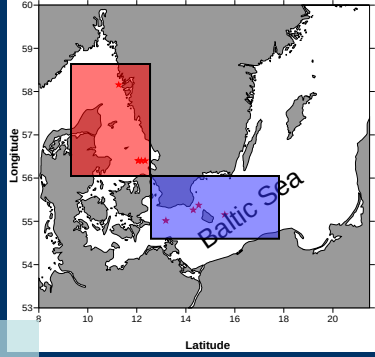

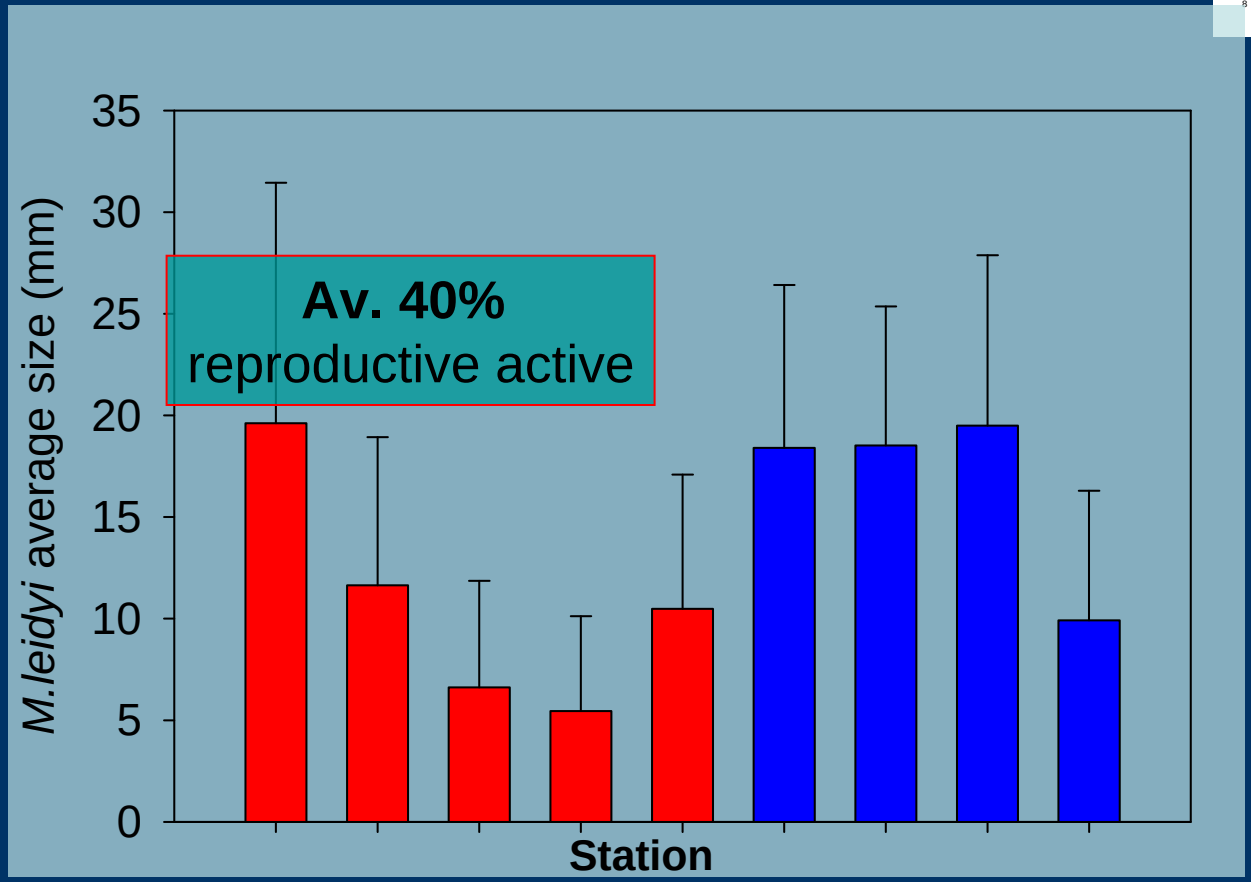

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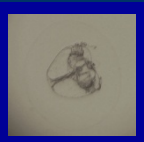

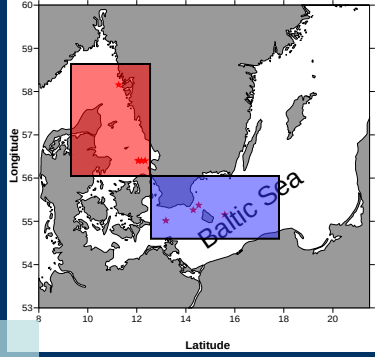

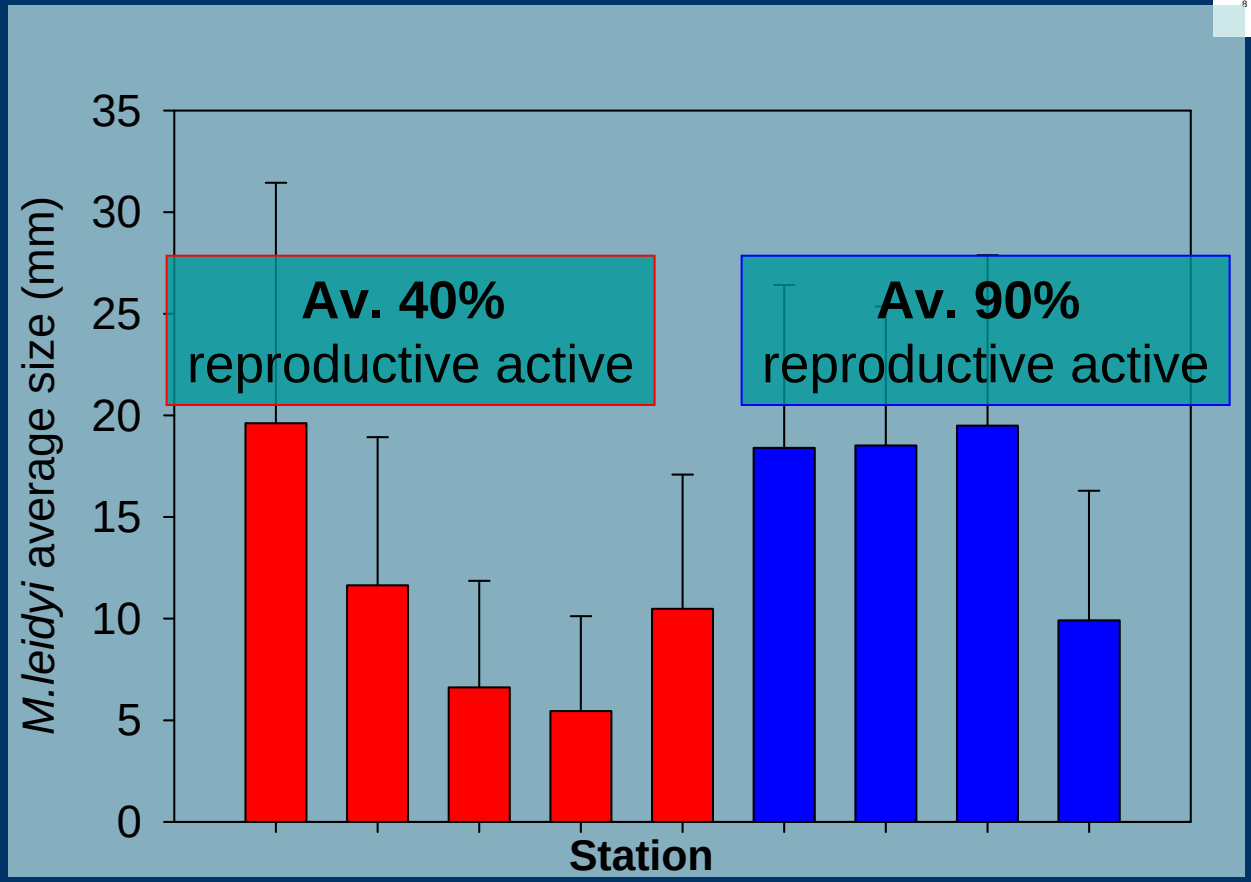

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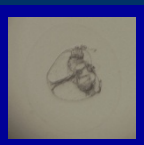
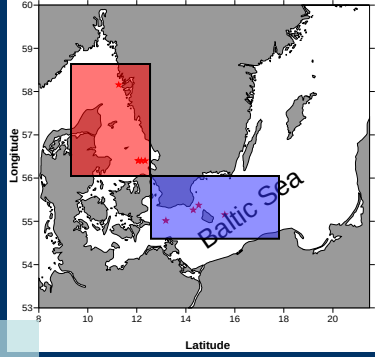
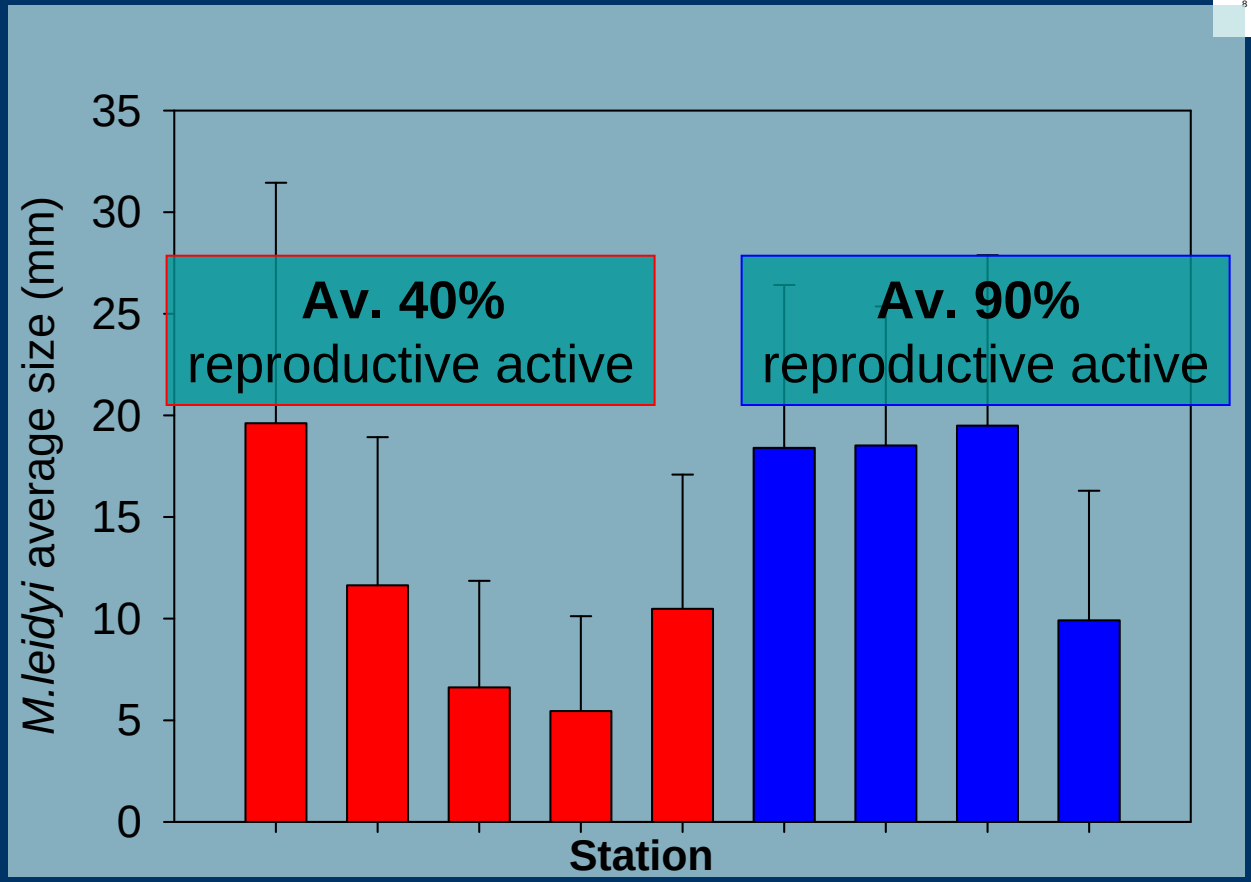
Mnemiopsis leidyi population size distribution

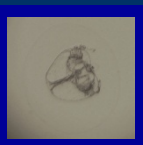


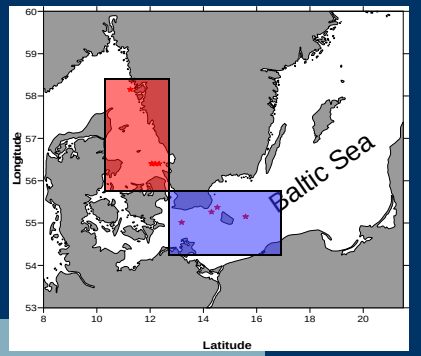


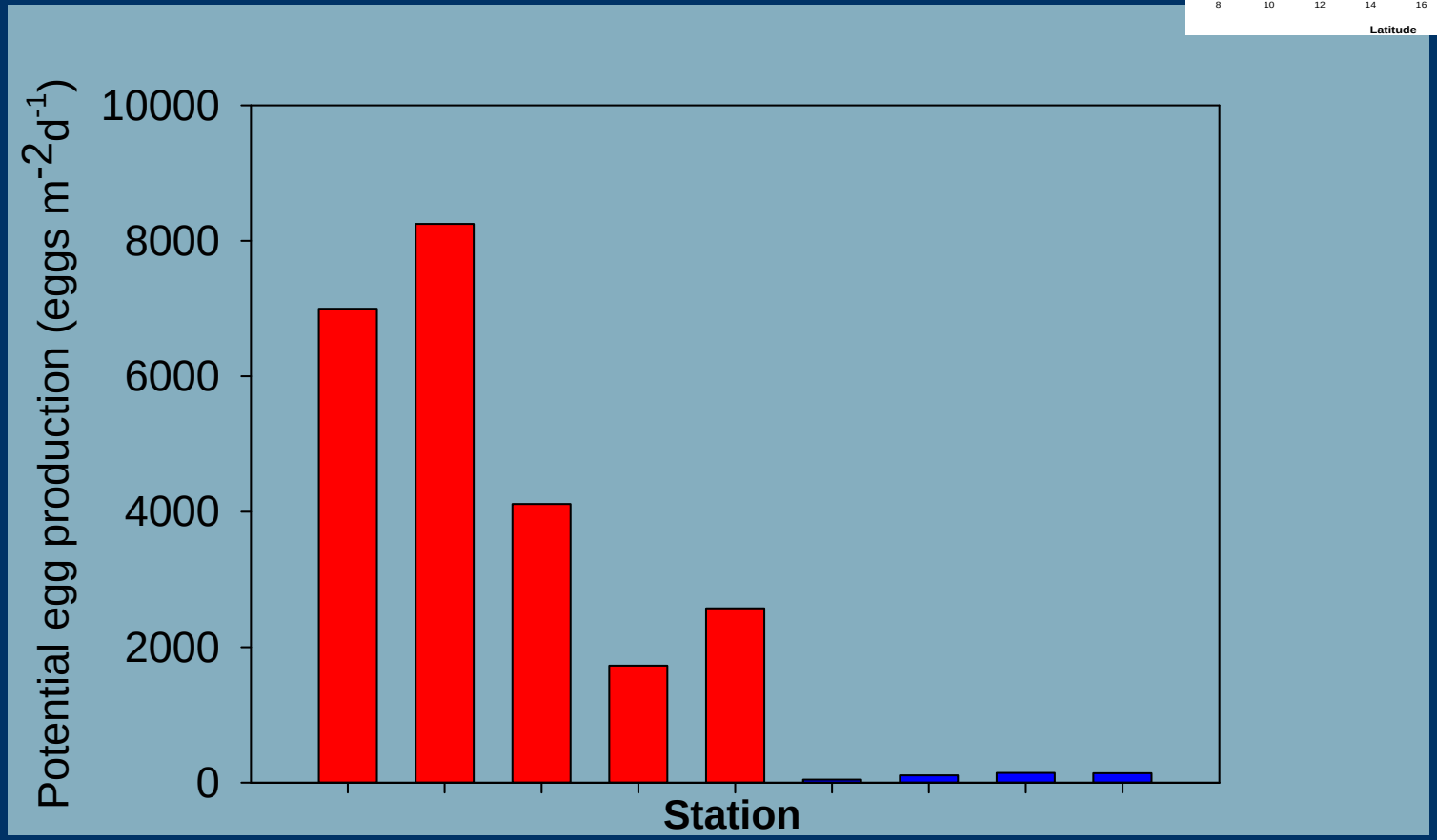


Higher active recruitment in the Kattegat

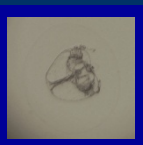
Potential egg production
Mnemiopsis leidyi

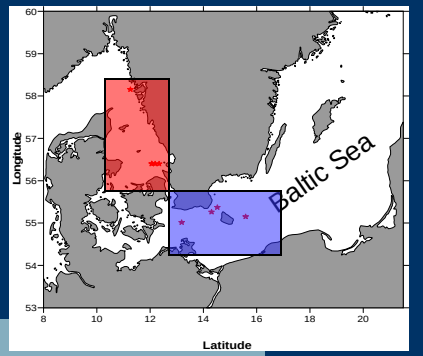


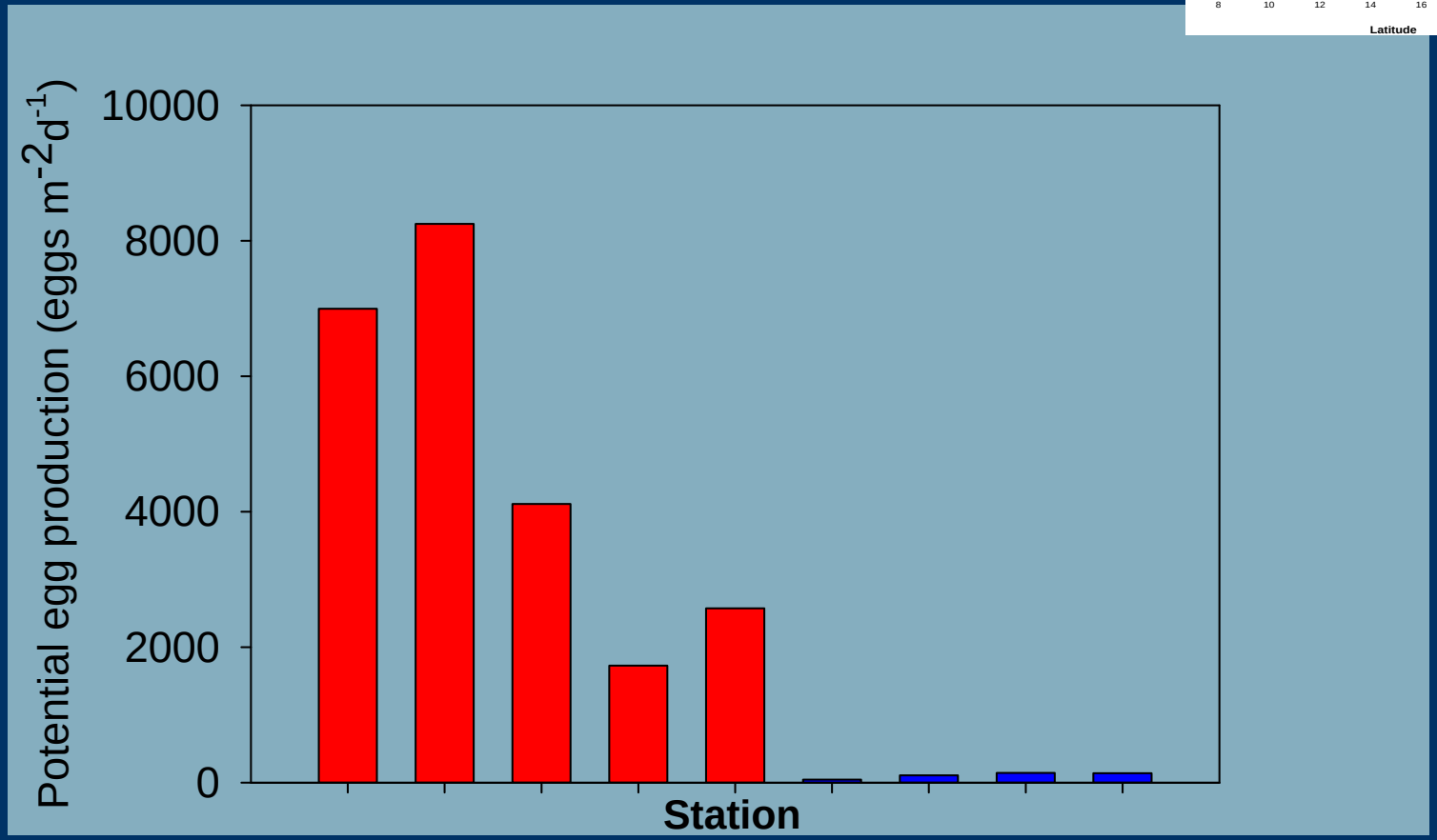




Potential egg production
Mnemiopsis leidyi

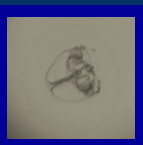


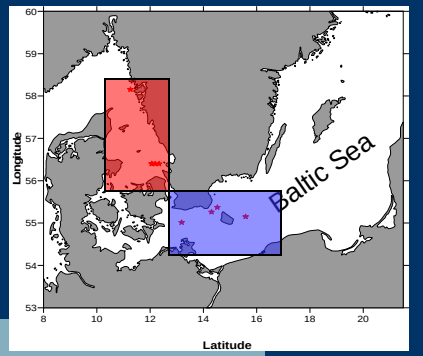


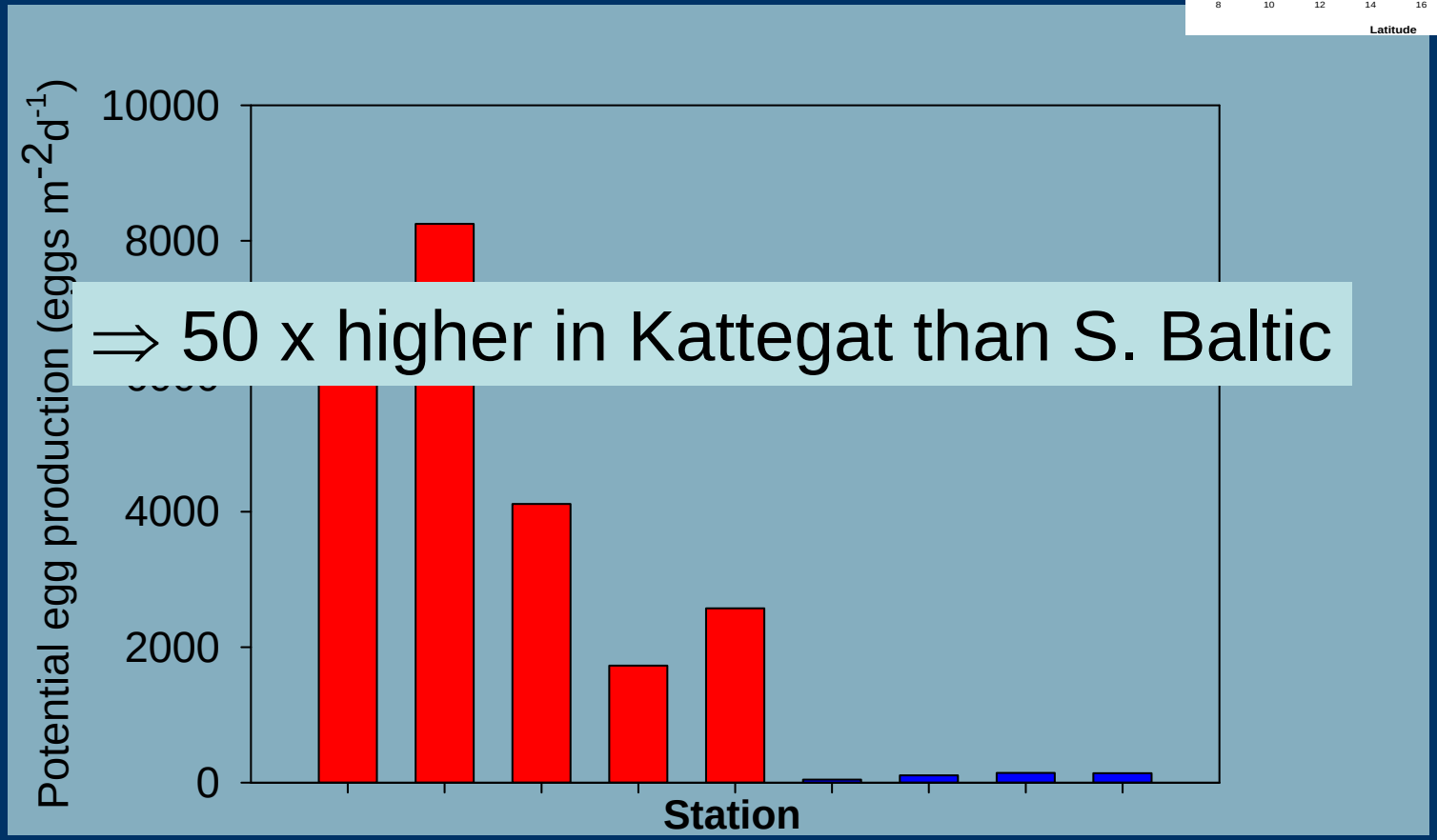


Potential population egg production higher in the high saline Kattegat

Potential egg production
Mnemiopsis leidyi







⇒ 50 x higher in Kattegat than S. Baltic

Potential population egg production higher in the high saline Kattegat

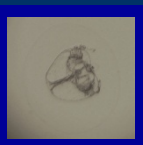
Summary II

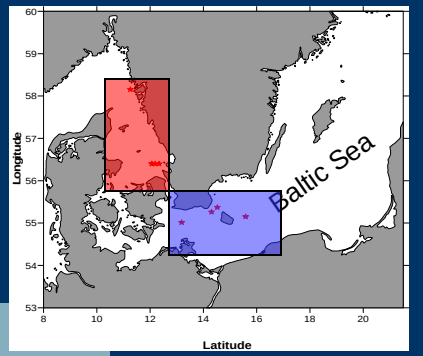
Population structure
Mnemiopsis leidyi

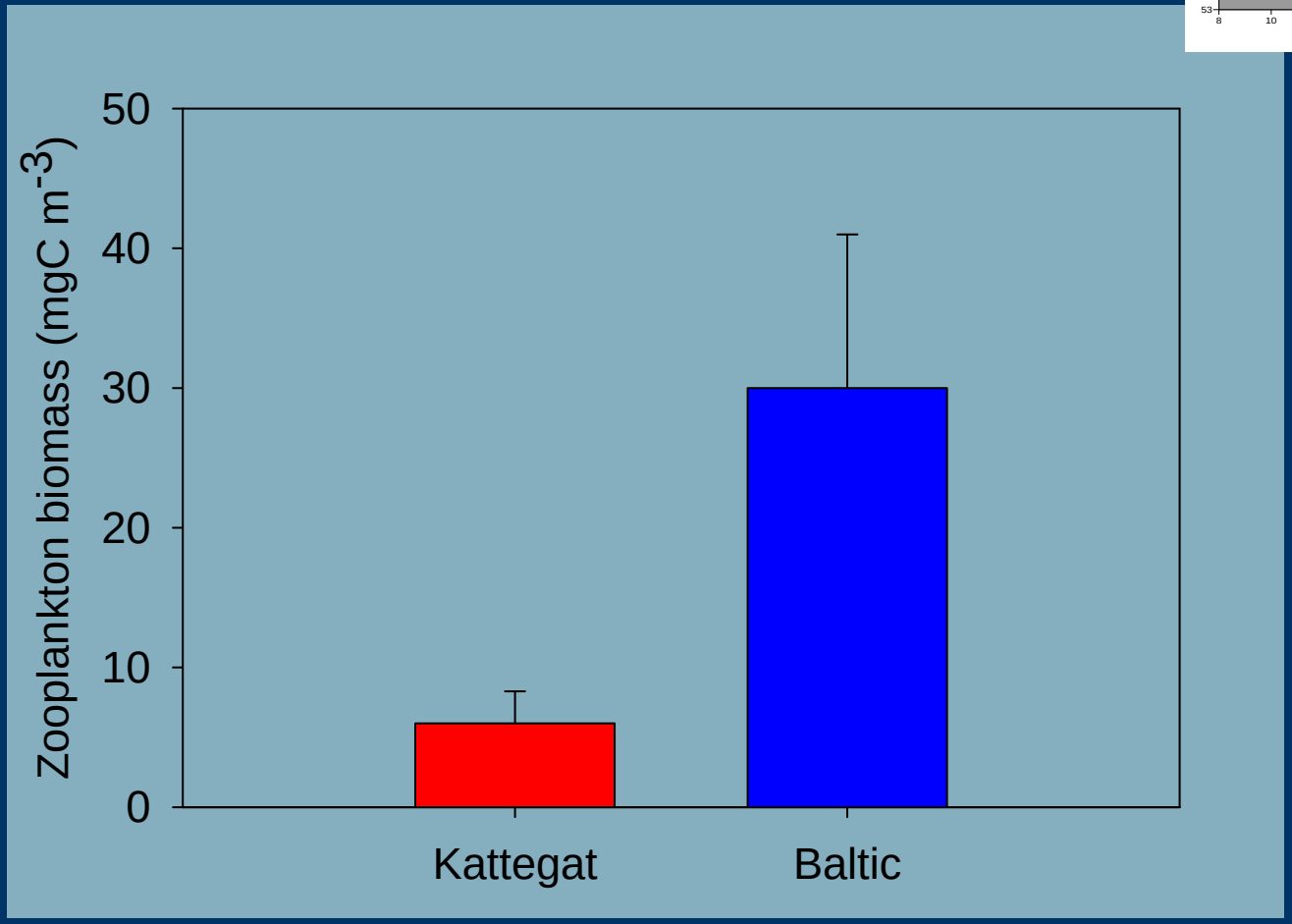
- Factor 10 higher abundances in Kattegat
- Higher fraction of small sized animals in the Kattegat => recruitment
- Higher potential population reproduction in the Kattegat

⇒ How does the food composition compare?

Zooplankton standing stock: 5 fold difference



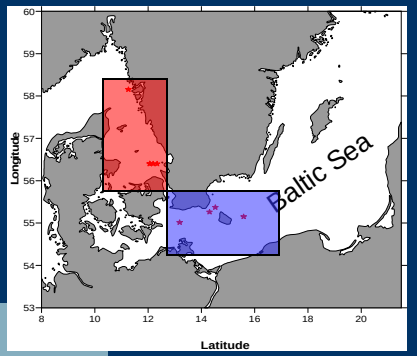


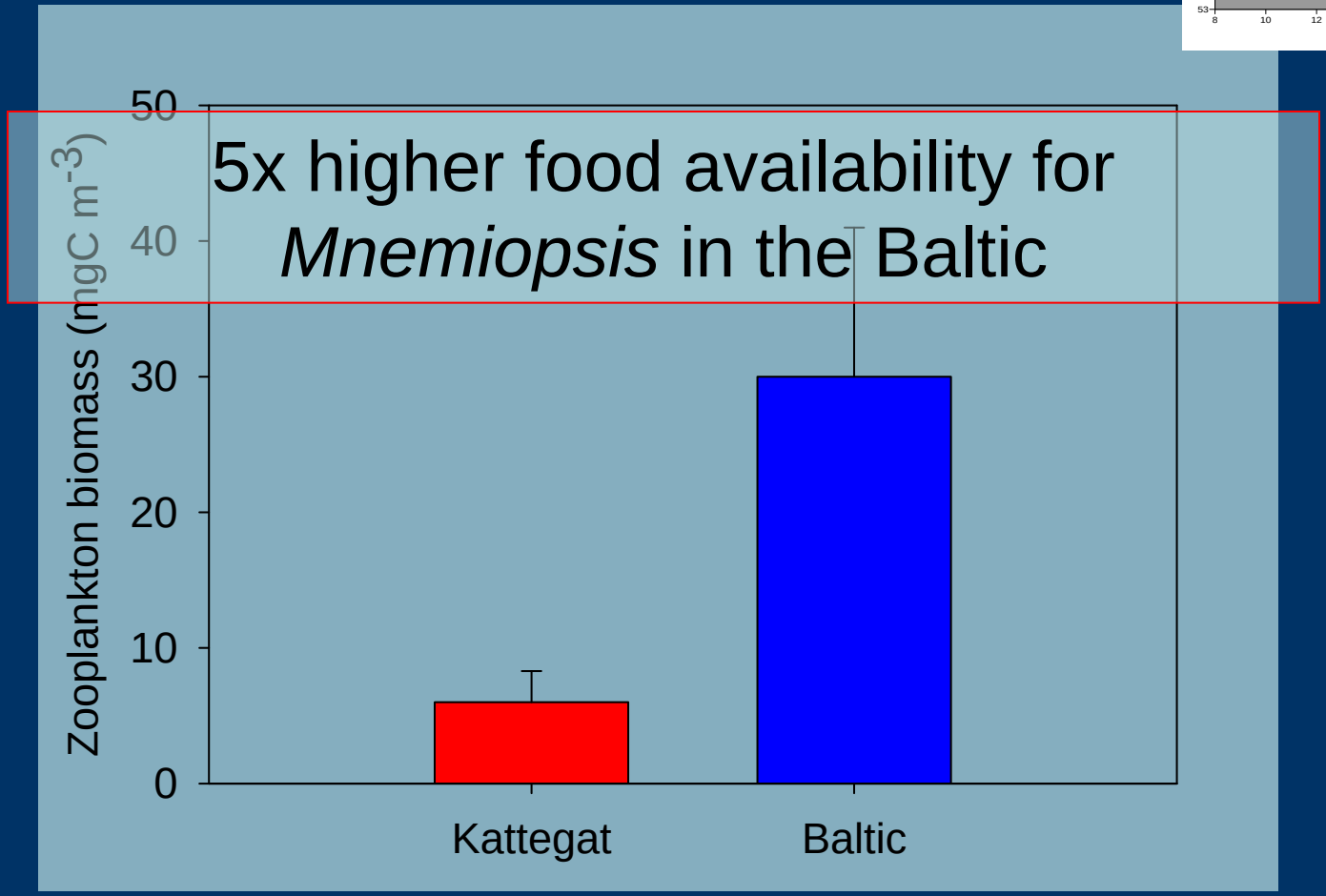


Total zooplankton carbon from lengths (90µm samples), averaged

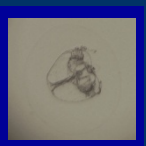
Biomass

Zooplankton standing stock: 5 fold difference

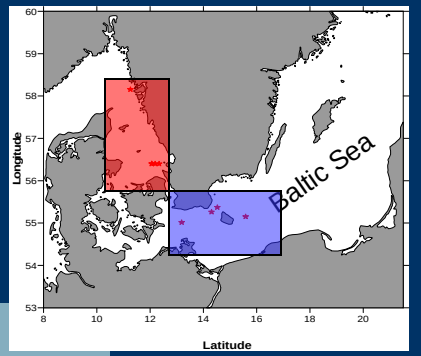


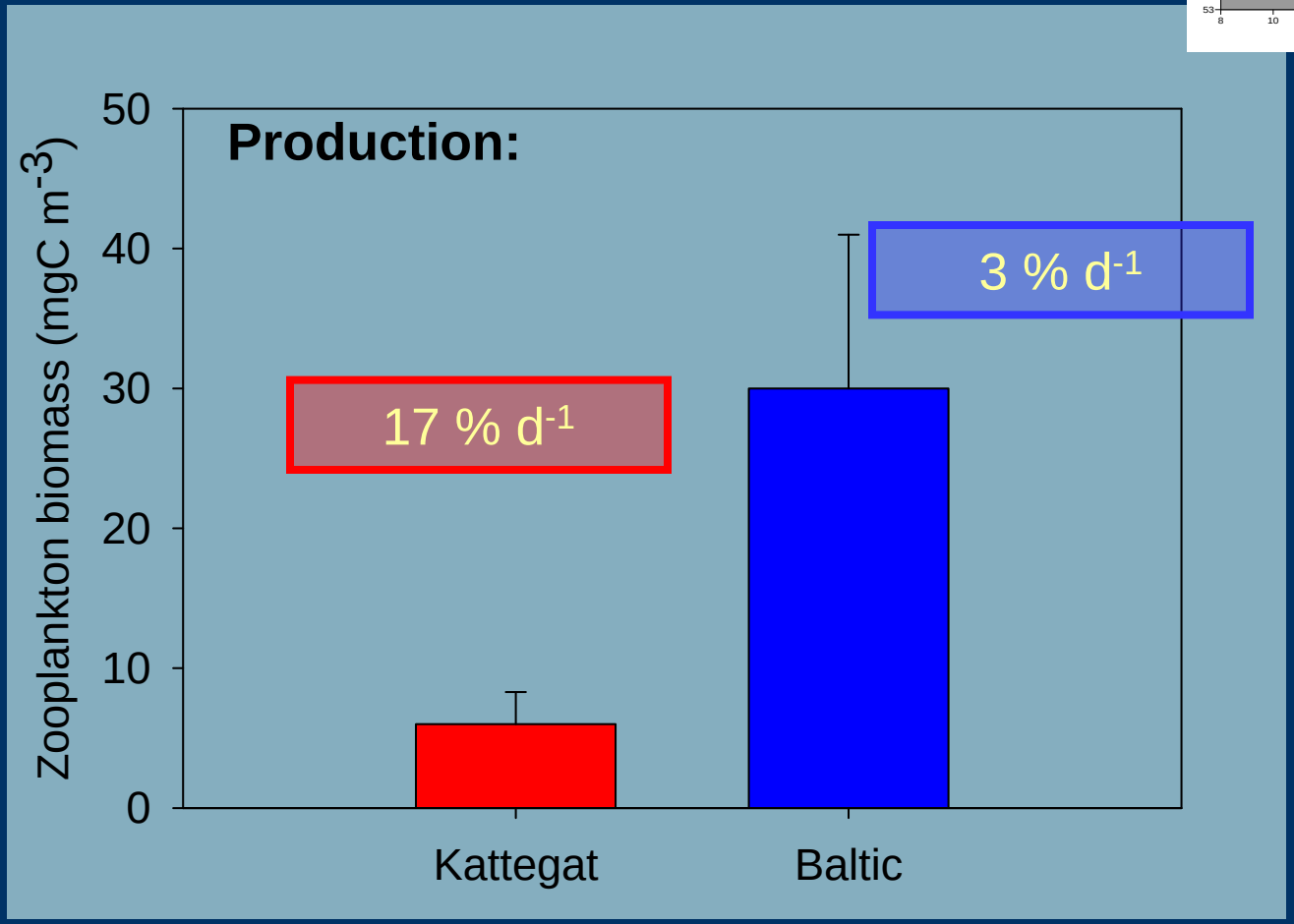


Total zooplankton carbon from lengths (90µm samples), averaged

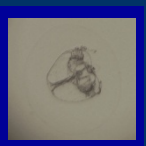


Zooplankton production:
5.5 fold difference

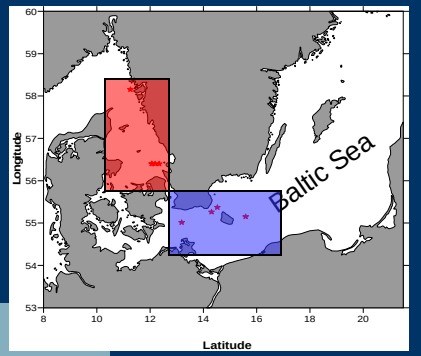


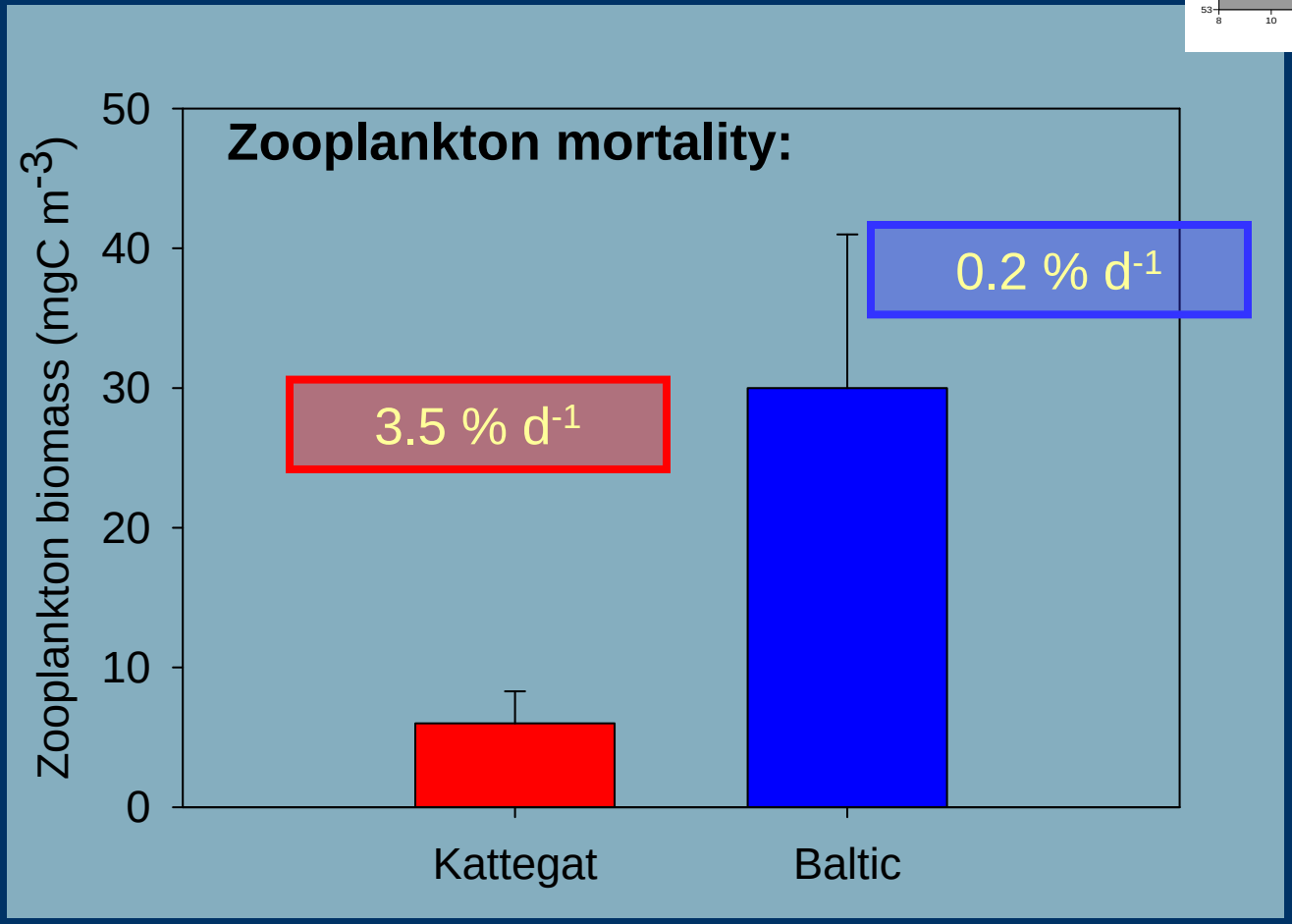


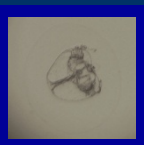
Higher copepod production rates in the Kattegat



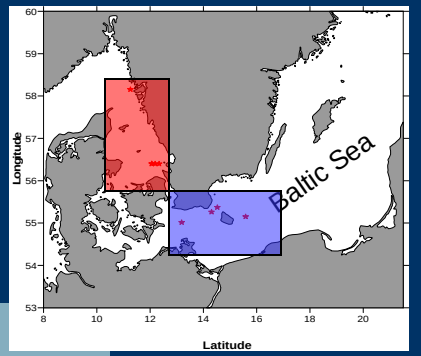
Zooplankton mortality: due to *Mnemiopsis*

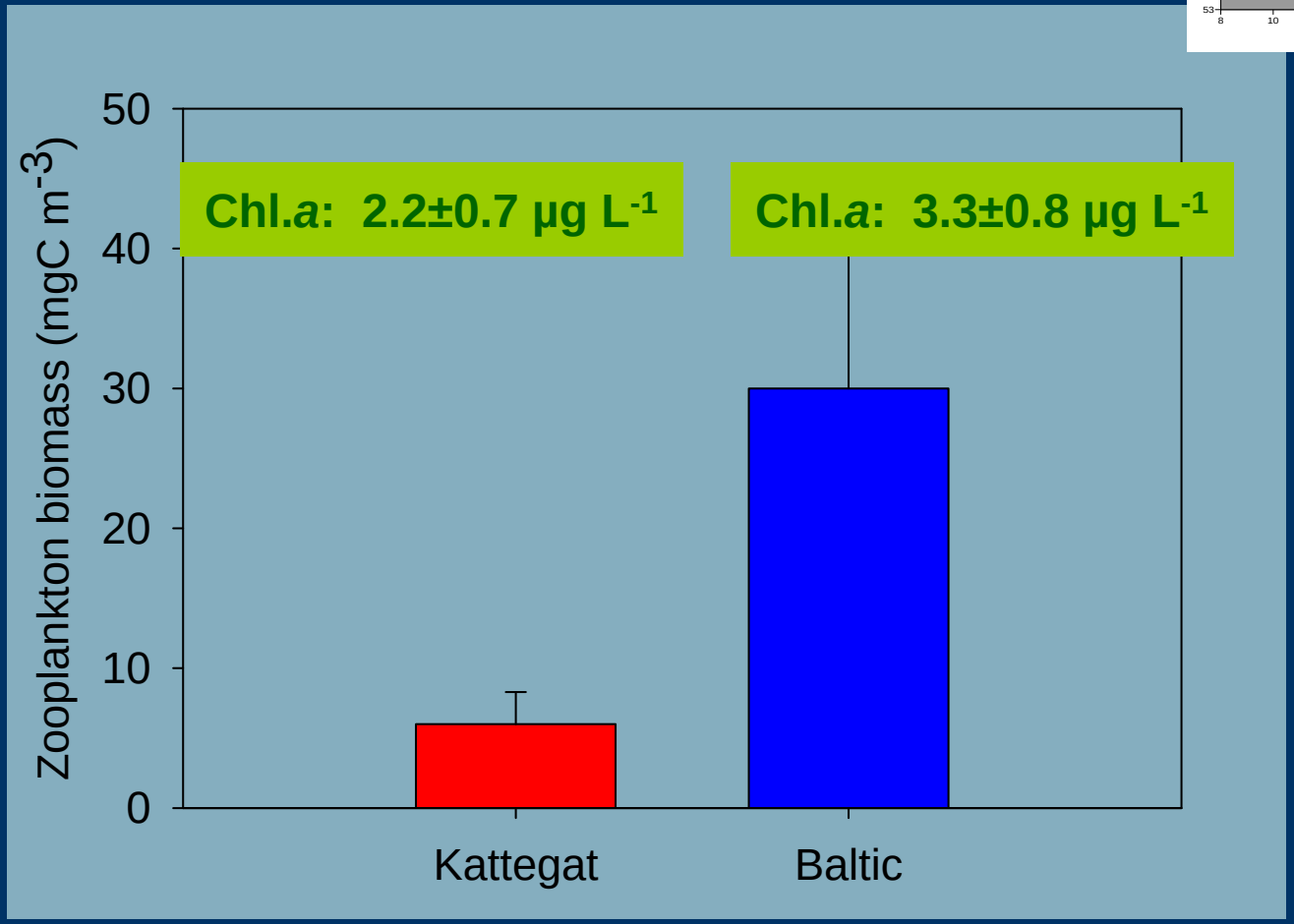


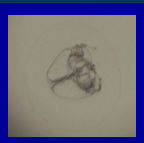




Zooplankton
Chl *a* concentrations

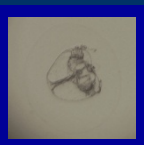






Zooplankton standing stock
Mnemiopsis leidyi

- Zooplankton standing stock 5 times higher in the Baltic, but *Mnemiopsis* reproduction rates are much lower



Zooplankton standing stock
Mnemiopsis leidyi

- Zooplankton standing stock 5 times higher in the Baltic, but *Mnemiopsis* reproduction rates are much lower

Conclusion:

⇒ Salinity acts on the reproductive output of *Mnemiopsis* in the Baltic Sea

Egg morality rates

"Back of the envelope" calculation (assuming steady state):

$\mu(d^{-1})$= (egg prod.m^{-2} d^{-1}/egg obs.m^{-2}) - 1/egg hatching time d^{-1}

High mortality rates in both areas, but 3 times higher in the Kattegat than Southern Baltic. Abundance and size distribution suggest that the recruitment success is higher in the Kattegat even though eggs face higher mortality rates.

Can *M. leidyi* sustain a population in the Baltic?

⇒ Salinity might constrain population expansion under current situation in the central Baltic Sea

⇒ *M. leidyi* population in the Baltic is probably sourced from Kattegat

⇒ *Mnemiopsis* population in the Baltic depends on drift of animals from high reproduction area - Kattegat

Temporal and spatial *M. leidyi* abundance in the Kattegat & Baltic: Poster Haraldsson et al. GP: 7157

Collaborators & Funding

Acknowledgements…

www.bazooca.se

BAZOOCA Team
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BAZOOCA

Danish Agency for Science Technology and Innovation
Ministry of Science Technology and Innovation