The Baltic Sea – Commercial mussel farming

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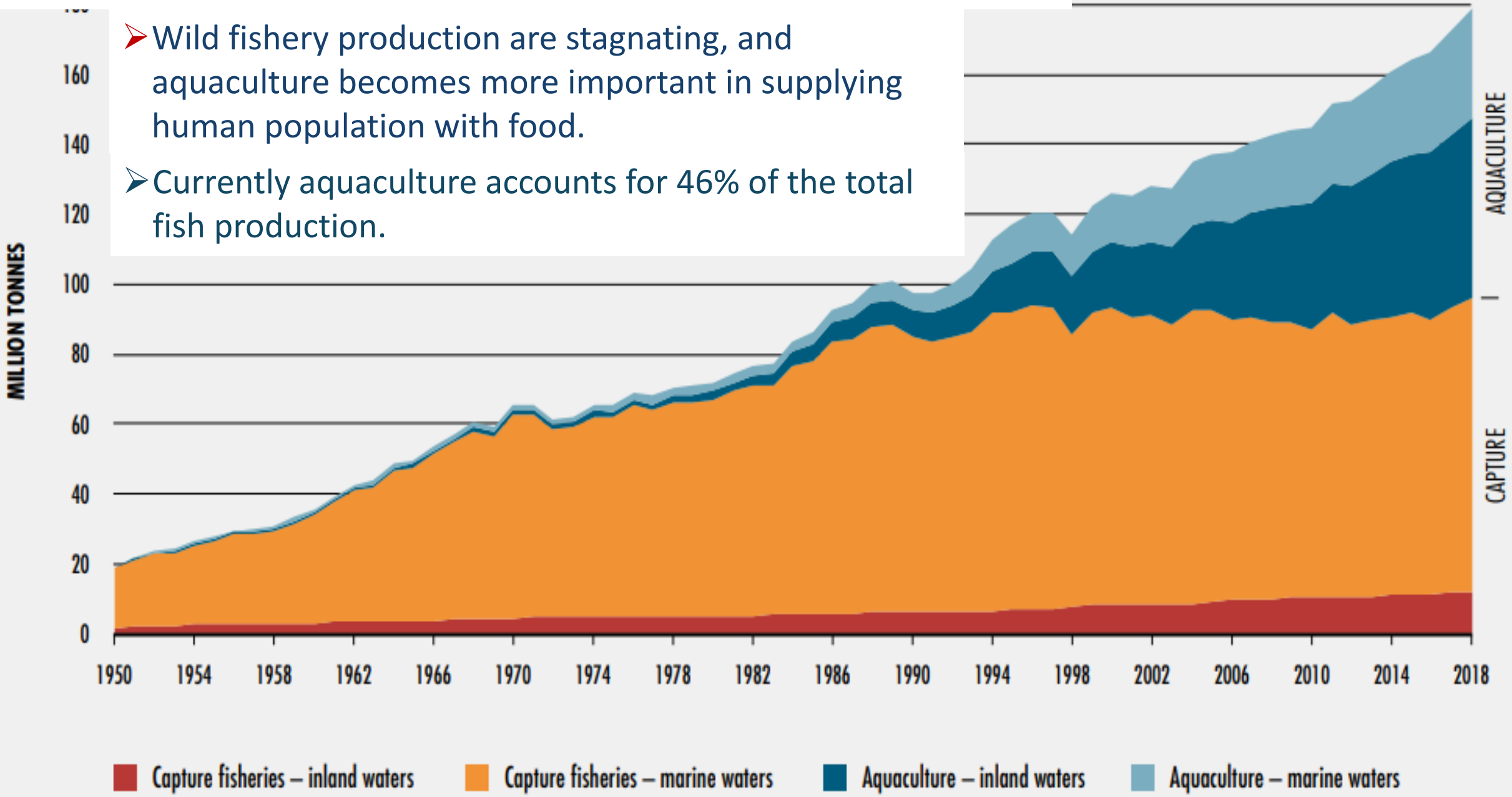
Overview

1. Mussel cultivation worldwide and in the EU
2. Mussel cultivation in the Baltic Sea
3. Longline mussel cultivation in the Baltic Sea
4. Challenges for mussel cultivation in the Baltic Sea
5. Summary

1. World Aquaculture Production

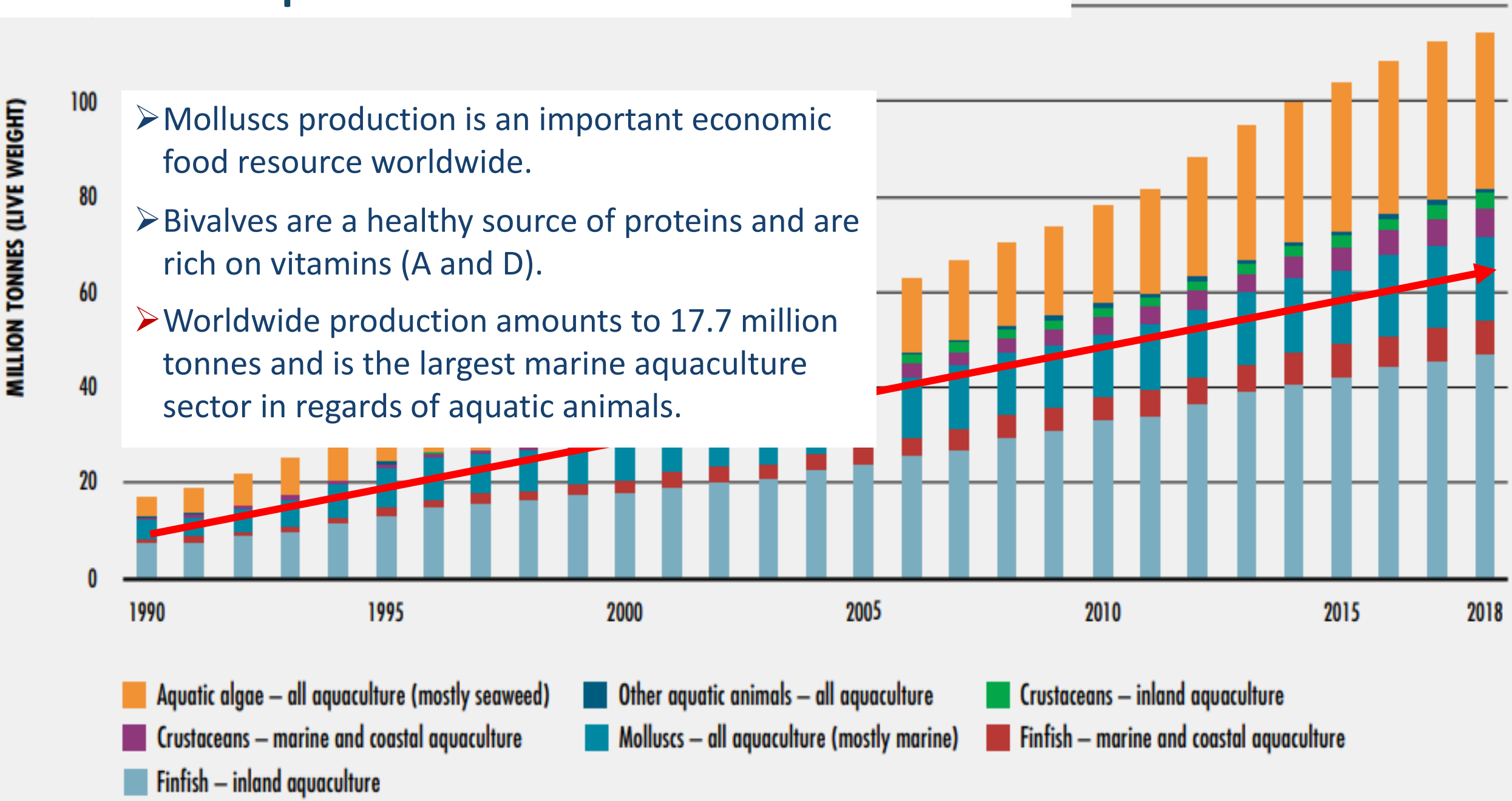
- Wild fishery production are stagnating, and aquaculture becomes more important in supplying human population with food.
- Currently aquaculture accounts for 46% of the total fish production.



FAO. 2020. The State of World Fisheries and Aquaculture 2020

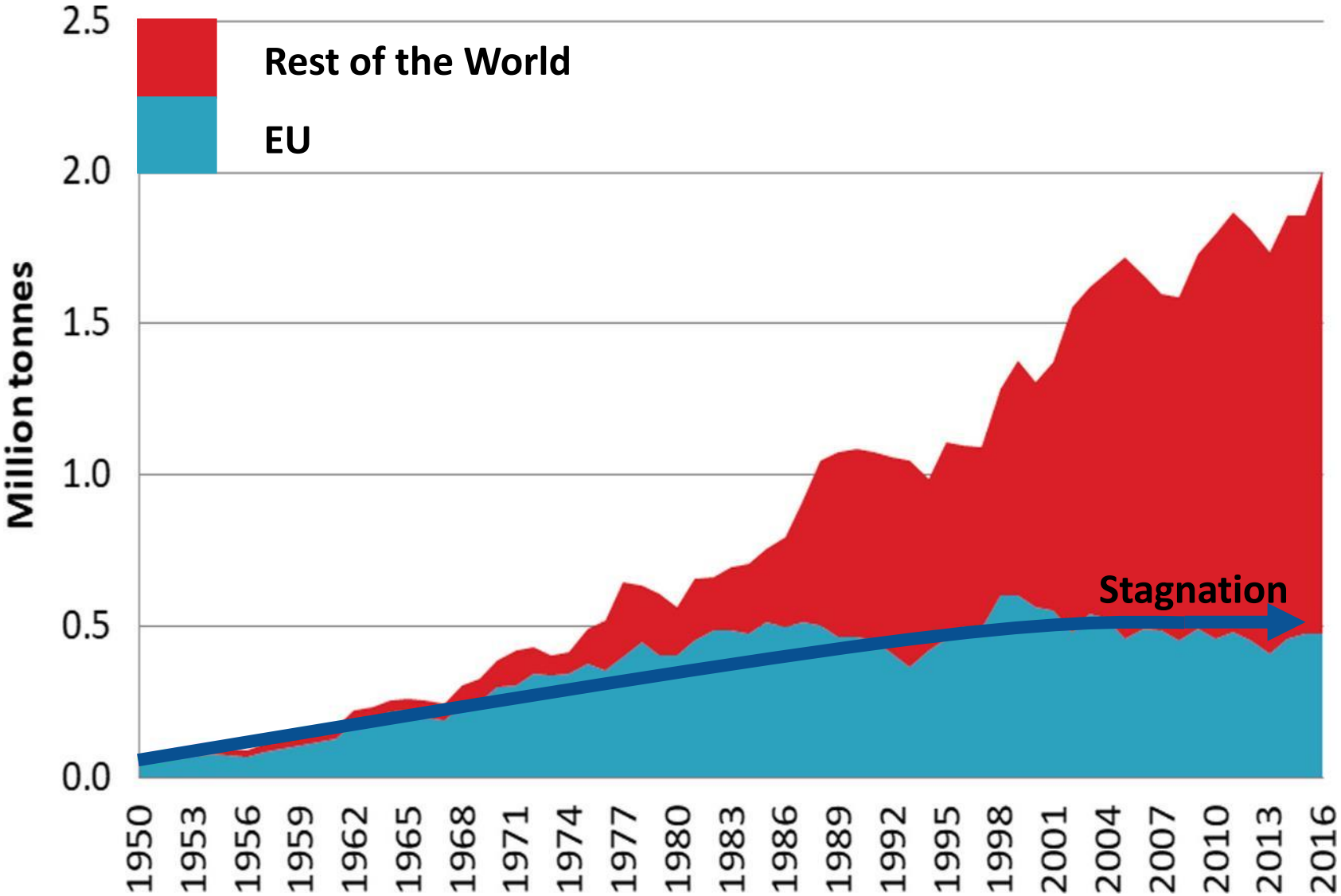
1. World Aquaculture Production

- Molluscs production is an important economic food resource worldwide.
- Bivalves are a healthy source of proteins and are rich on vitamins (A and D).
- Worldwide production amounts to 17.7 million tonnes and is the largest marine aquaculture sector in regards of aquatic animals.



FAO. 2020. The State of World Fisheries and Aquaculture 2020

1. European Mussel Cultivation



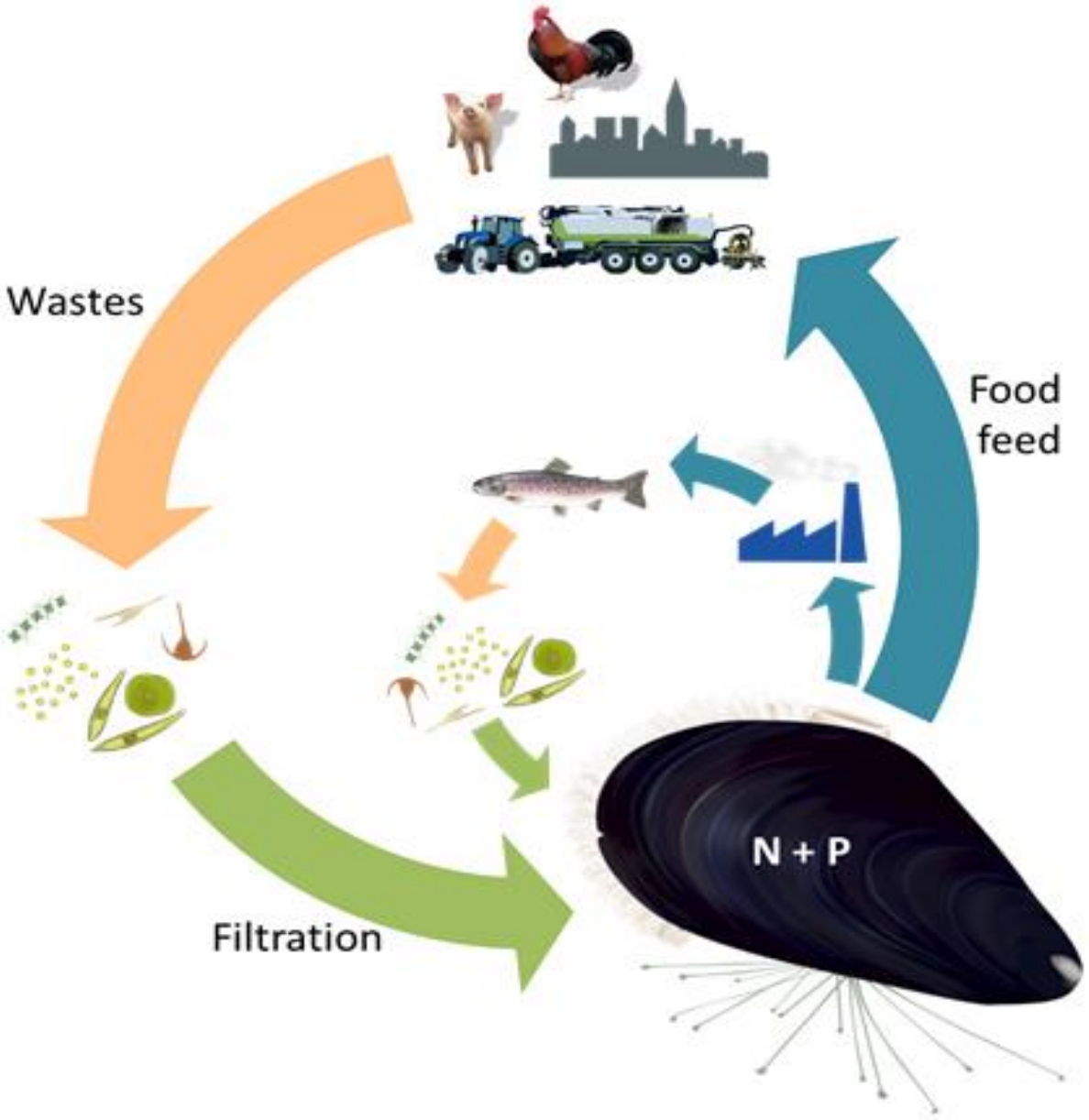
adopted from Avdelas et al. 2021

- Main producer countries are Spain, Italy, France and the Netherlands.

- Reasons for stagnating mussel aquaculture:
  - diseases
  - algal blooms
  - missing mussel spat
  - predation
  - low prices & earnings

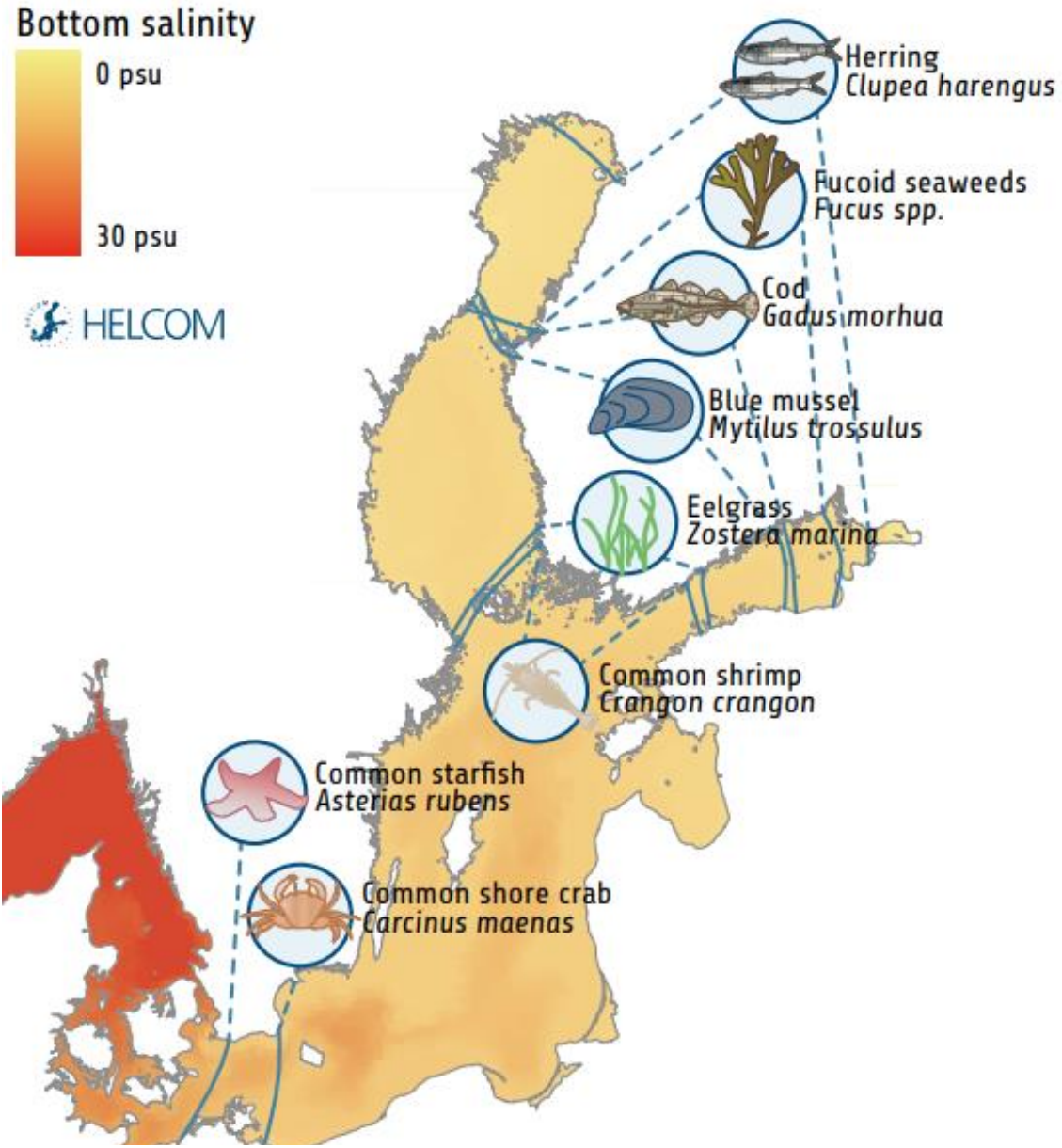
  (Avdelas et al. 2021)

2. Mussel Farming in the Baltic Sea - Motivation



- Mussel cultivation can remove nutrients from the aquatic environment creating a circular economy.
- Mussels are cultivated for human consumption or as an alternative protein source for animal feed.
- Mussel farming has the potential to contribute to a sustainable blue growth in the Baltic Sea.

2. Mussel Farming in the Baltic Sea –salinity, the limiting factor



HELCOM (2018): State of the Baltic Sea – Second HELCOM holistic assessment 2011-2016.

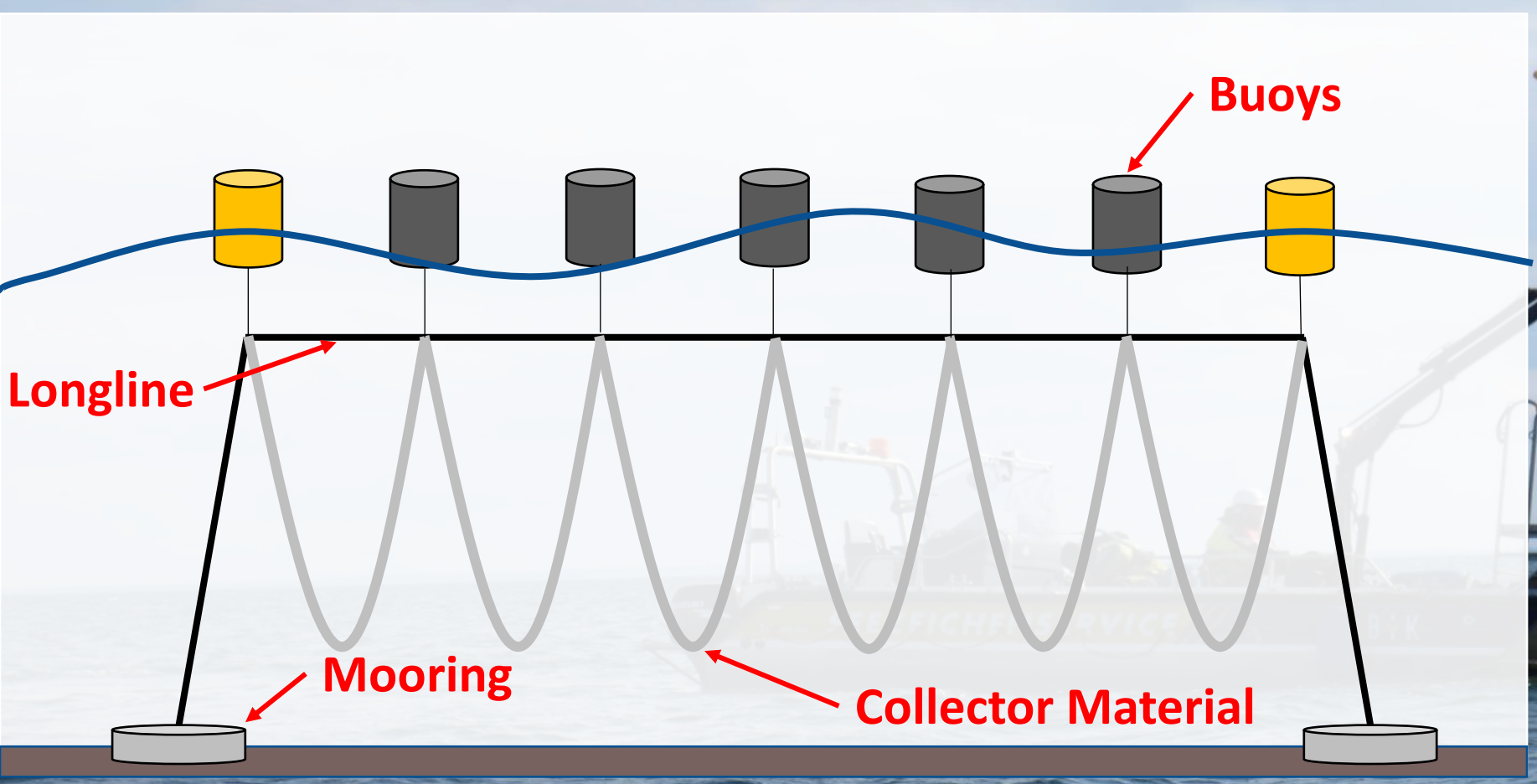
https://balticeye.org/en/eutrophication/policy-brief-musslefarming-in-the-baltic-sea/

- Blue mussels occur in most parts of the Baltic Sea.
- Blue mussels can adapt to lower salinity levels, but at high costs.
- With decreasing salinity mussel growth is reduced.

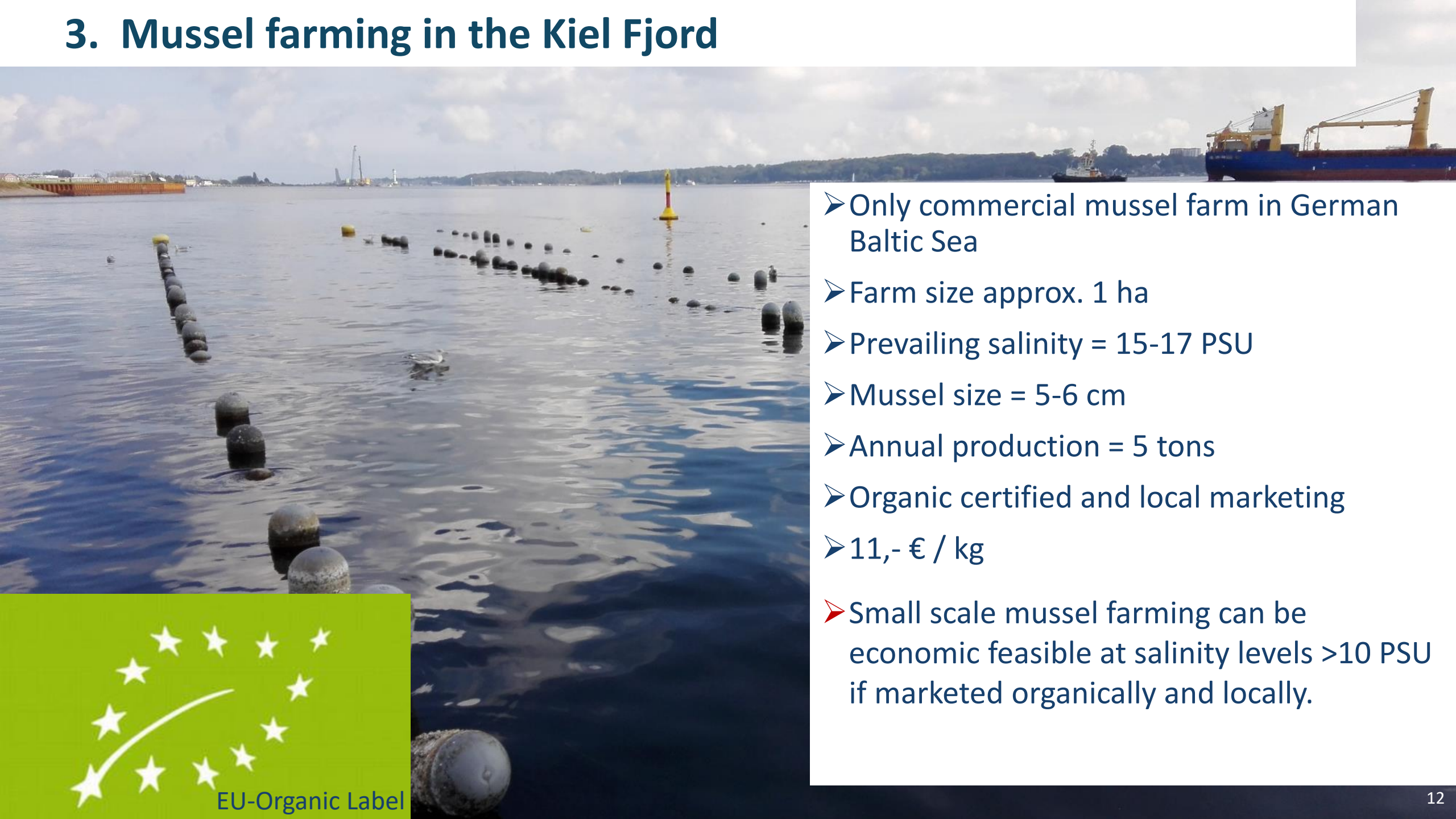
2. Aquaculture candidates in the Baltic Sea – Mytilus spp.

- *Mytilus spp.* is commercial fished and cultivated worldwide (1.2 million tonnes per year (FAO, 2020)).
- *Mytilus* spp. is a filter feeder attached to hard substrate with byssus threads.
- Blue mussel reproduction begins in spring when water temperature exceed 12 °C (Kautsky, 1982).
- Blue mussel larvae are planktonic and naturally distributed by ocean currents.
- Baltic blue mussels' species can be *M. edulis* or *M. trossulus* or a mixture of both.

3. Longline mussel cultivation



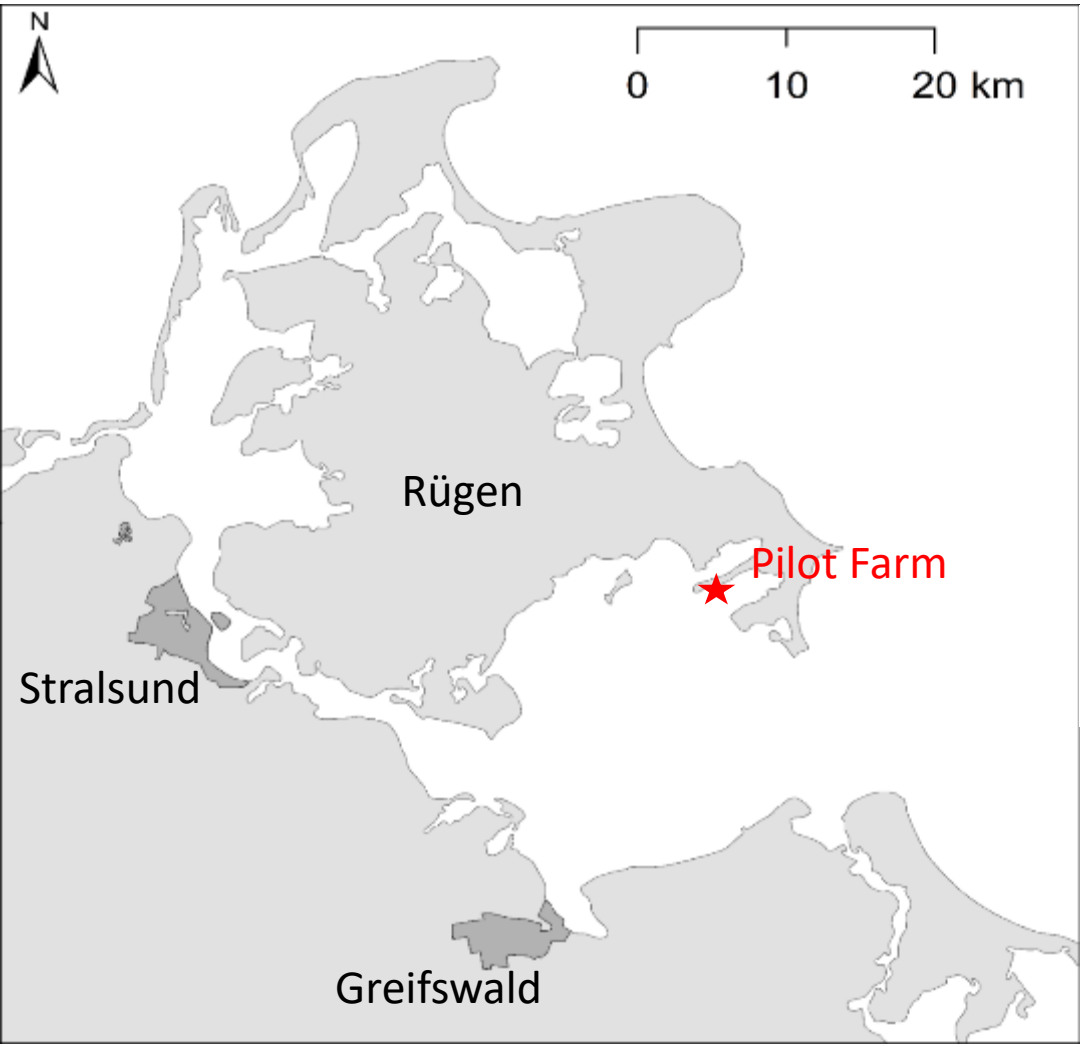
3. Mussel farming in the Kiel Fjord



- Only commercial mussel farm in German Baltic Sea
- Farm size approx. 1 ha
- Prevailing salinity = 15-17 PSU
- Mussel size = 5-6 cm
- Annual production = 5 tons
- Organic certified and local marketing
- 11,- € / kg
- Small scale mussel farming can be economic feasible at salinity levels >10 PSU if marketed organically and locally.

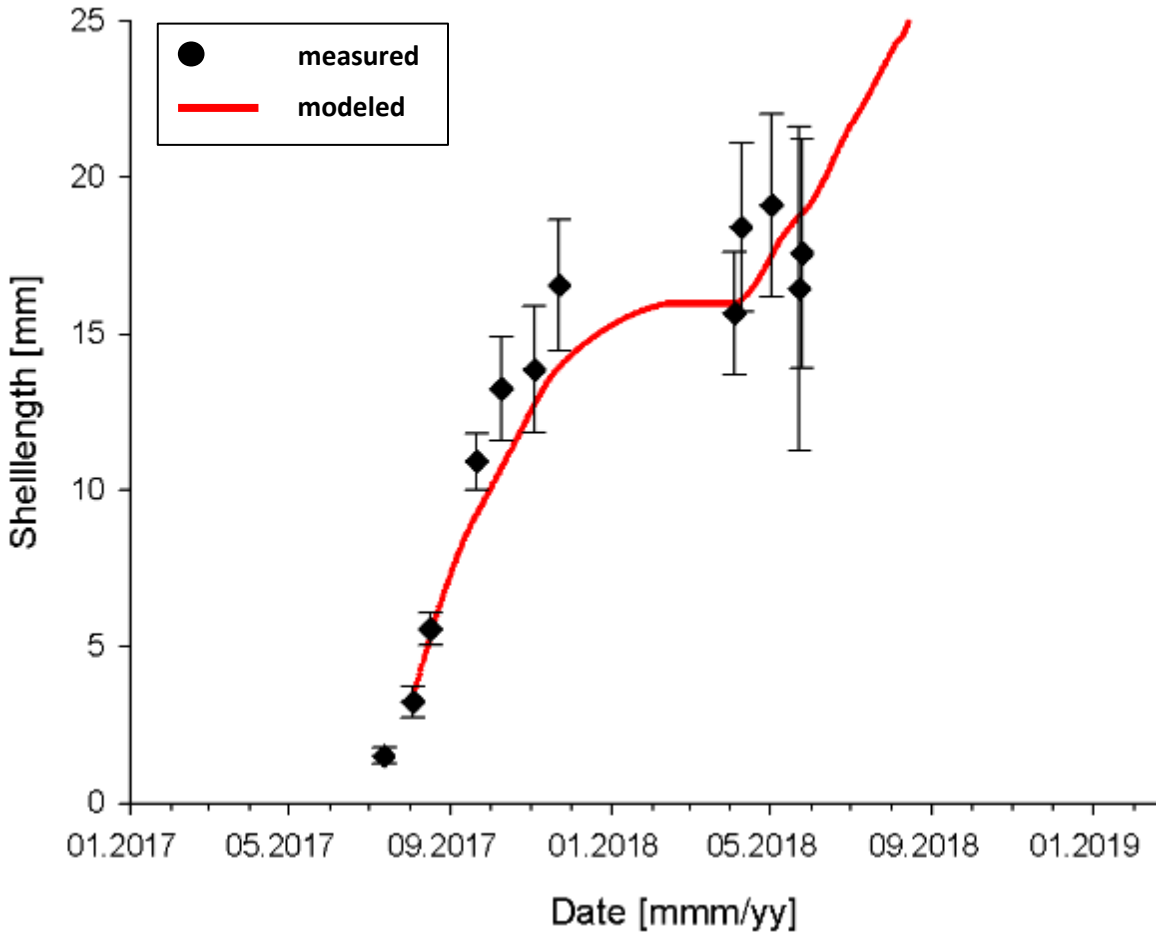
EU-Organic Label

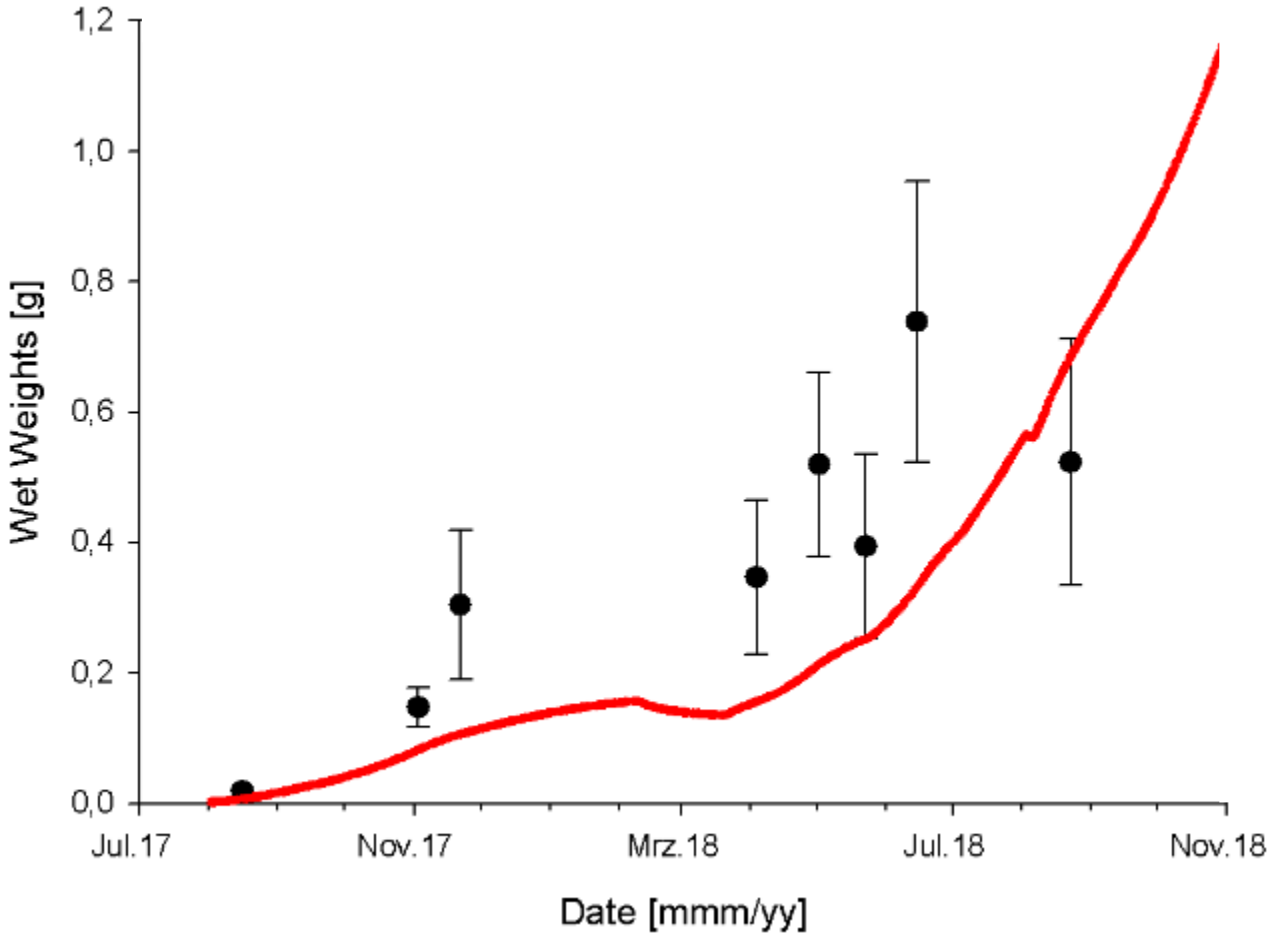
3. Mussel farming in the Greifswalder Bodden



- The Greifswalder Bodden is the biggest lagoon at the German Baltic Sea coast.
- The salinity level ranges between 6-7 PSU.
- Tourism and coastal fishing play an important economical role in this coastal region.
- High nutrient inputs have led to heavy eutrophication and climate change threatens coastal herring fishery.
- Local mussel farming and sales could generate additional income for fishers and remove nutrients.

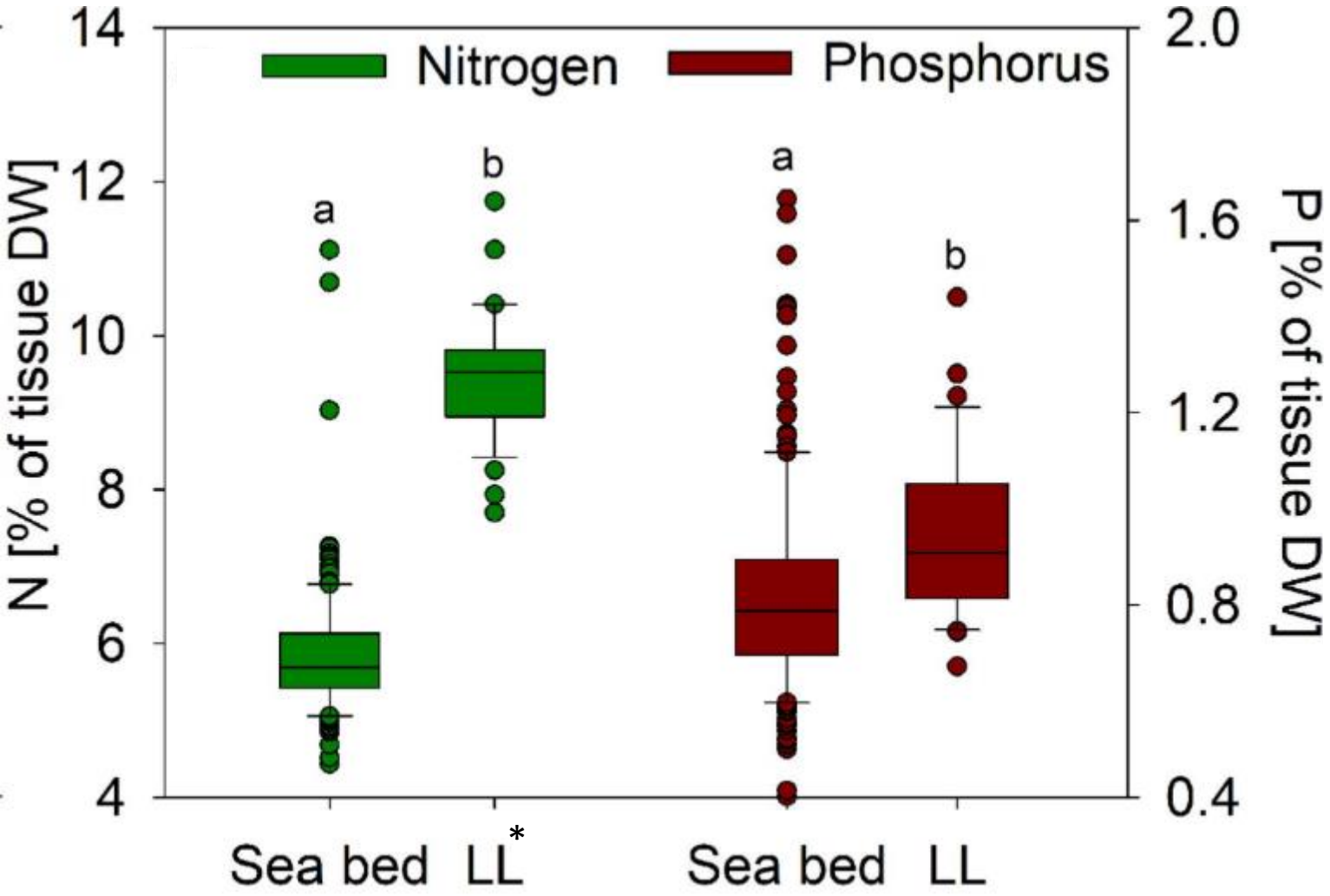
3. Mussel farming in the Greifswalder Bodden





- Blue mussels cultivated in the Greifswalder Bodden only reach a shell length of 1.5 to 2.0 cm within a year.
- A 1 ha farm could produce 3.7 t of small sized blue mussels.

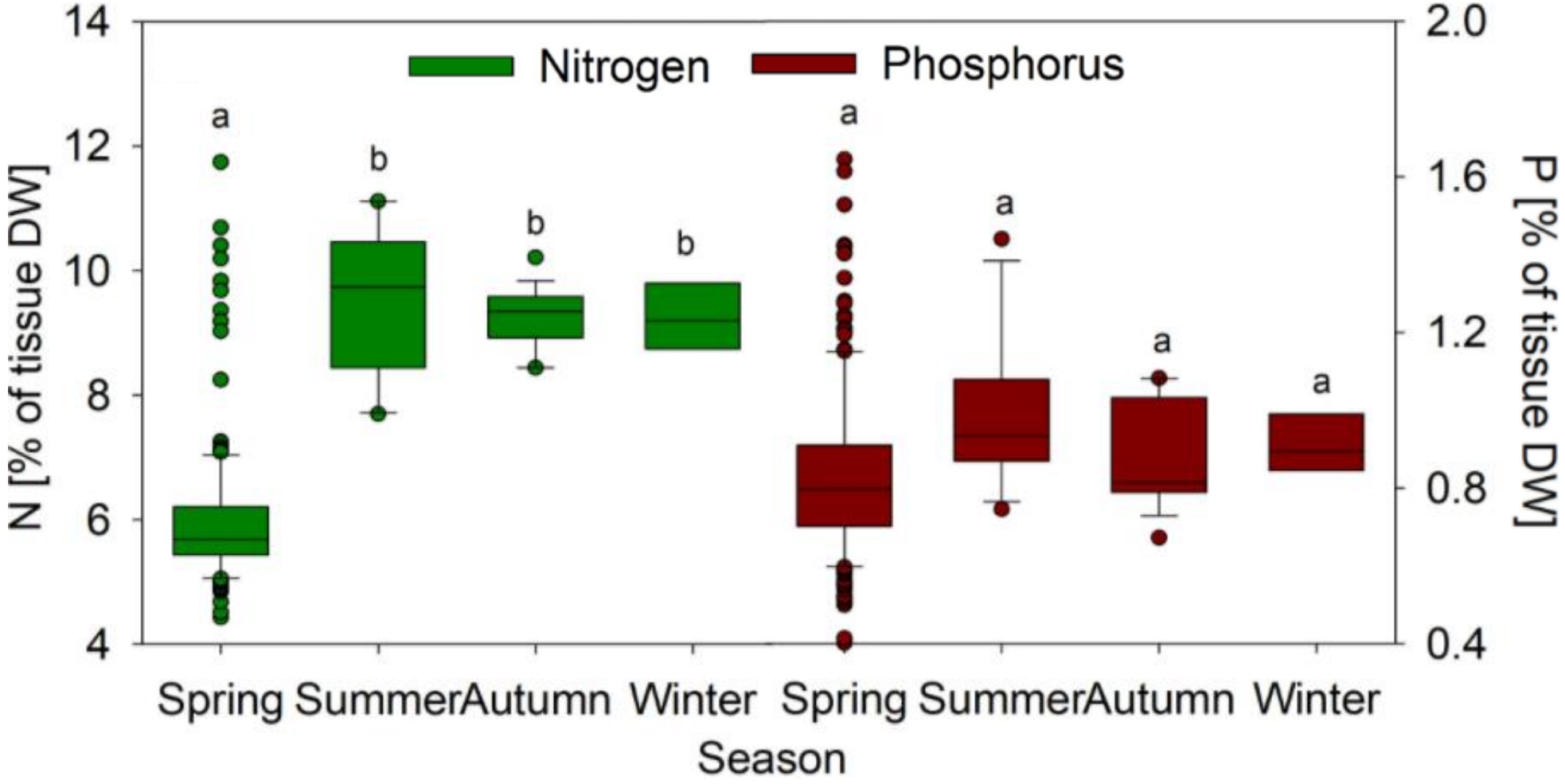
3. Nutrient mitigation potential of longline mussel farming



- Nutrients accumulate primarily in the bivalve tissues, only a minor fraction is stored in the shell.
- 1 t of blue mussels bind 13.7 kg N and 0.9 kg P (Taylor et al. 2019).
- Mussels cultivated on longlines can maximize the nutrient mitigation potential and increase the additional income through nutrient compensation.

Buer et al. 2021 * Longline

3. Nutrient mitigation potential of mussel farming

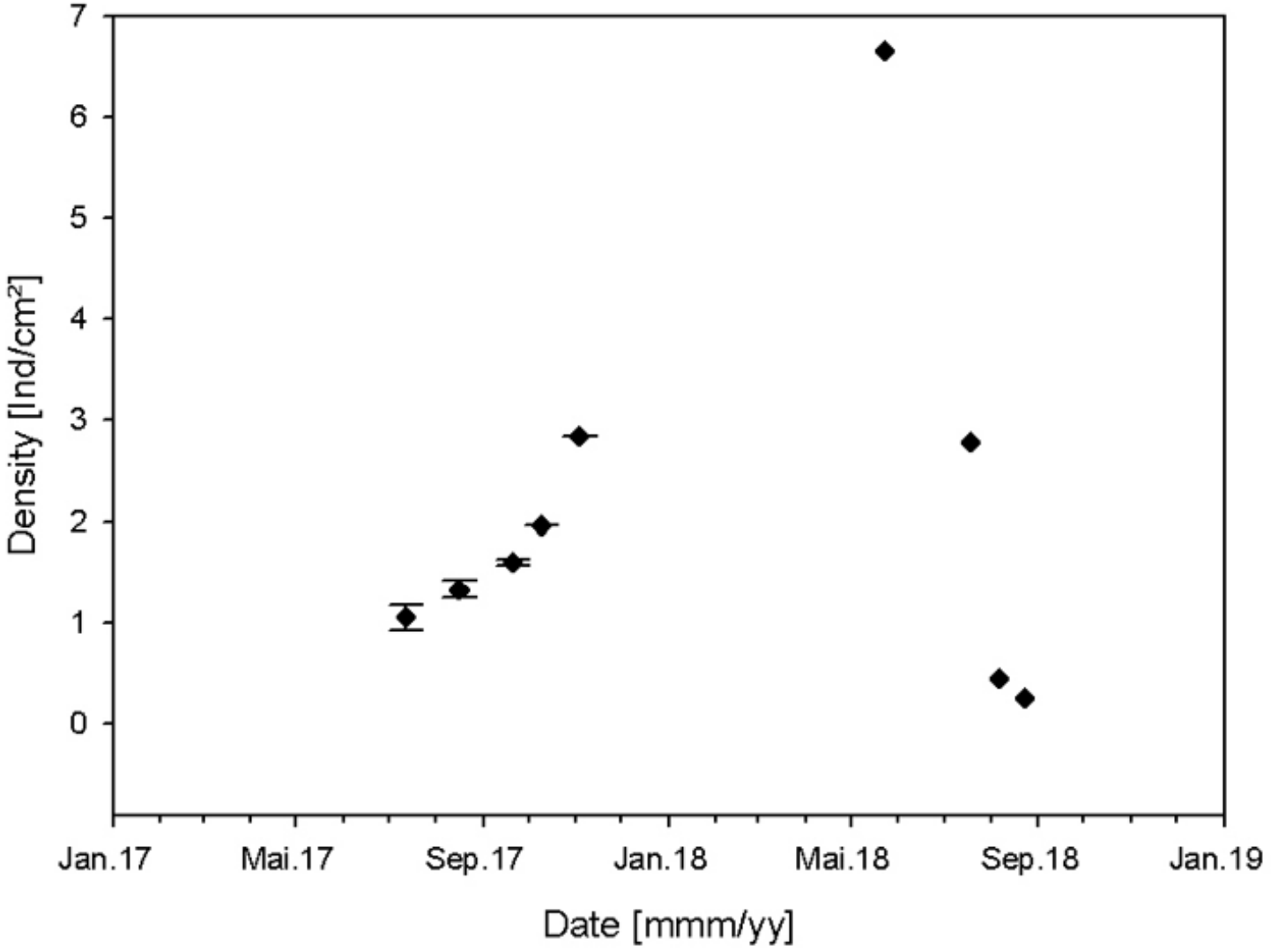


Buer et al. 2021

- From winter till spring mussel use up metabolic energy to maintain their reproduction process.
- Harvest in late autumn optimizes yield and nutrient removal.

4. High-water temperatures during summer

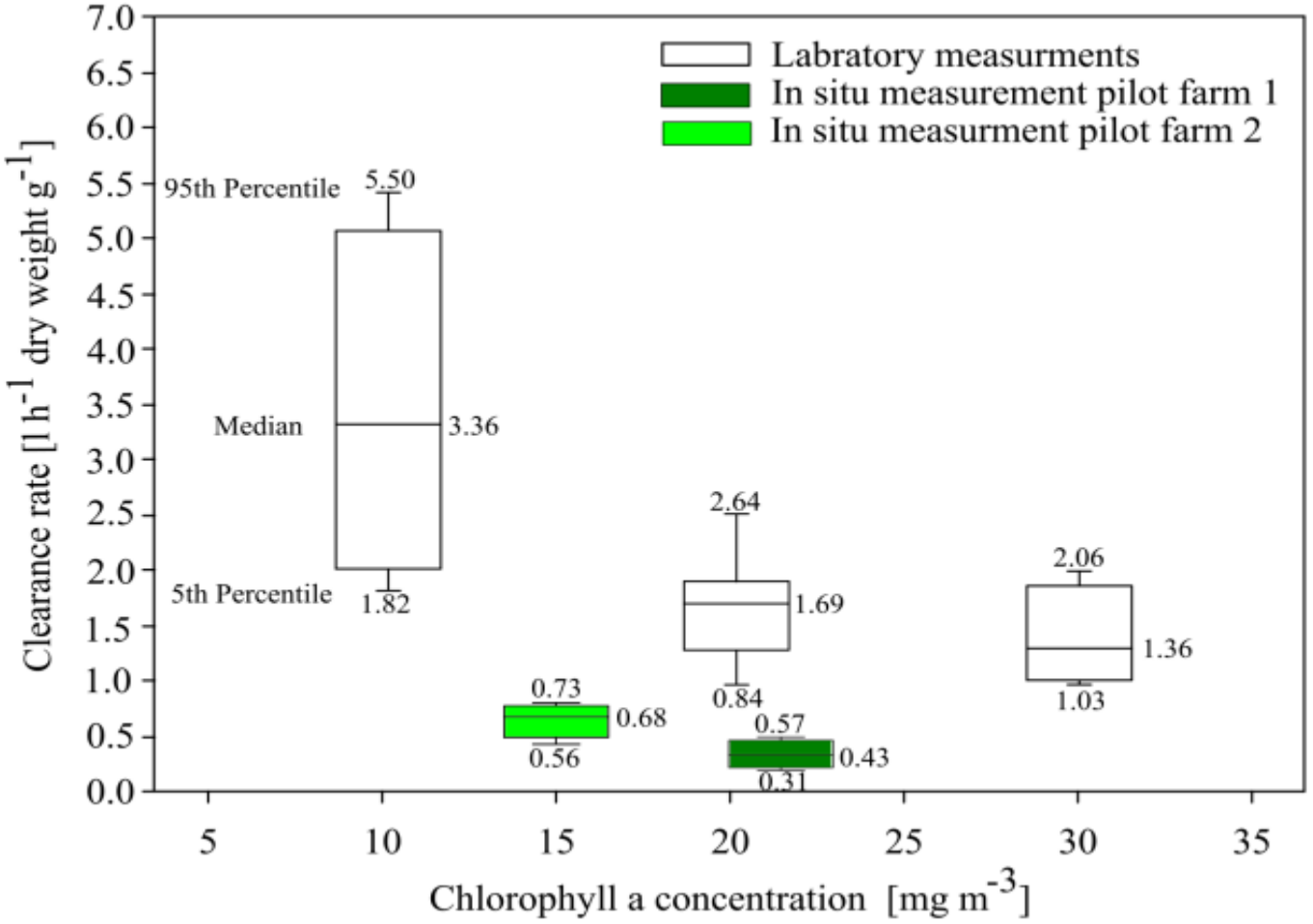
Mussel density in the pilot farm in the Greifswalder Bodden



- At water temperature above 25 °C byssus threads are 60% weaker compared to water temperatures of 10 °C (Fly & Hilbish, 2013).
- High water temperatures in coastal waters can increase mortality.

4. High chlorophyll a concentrations

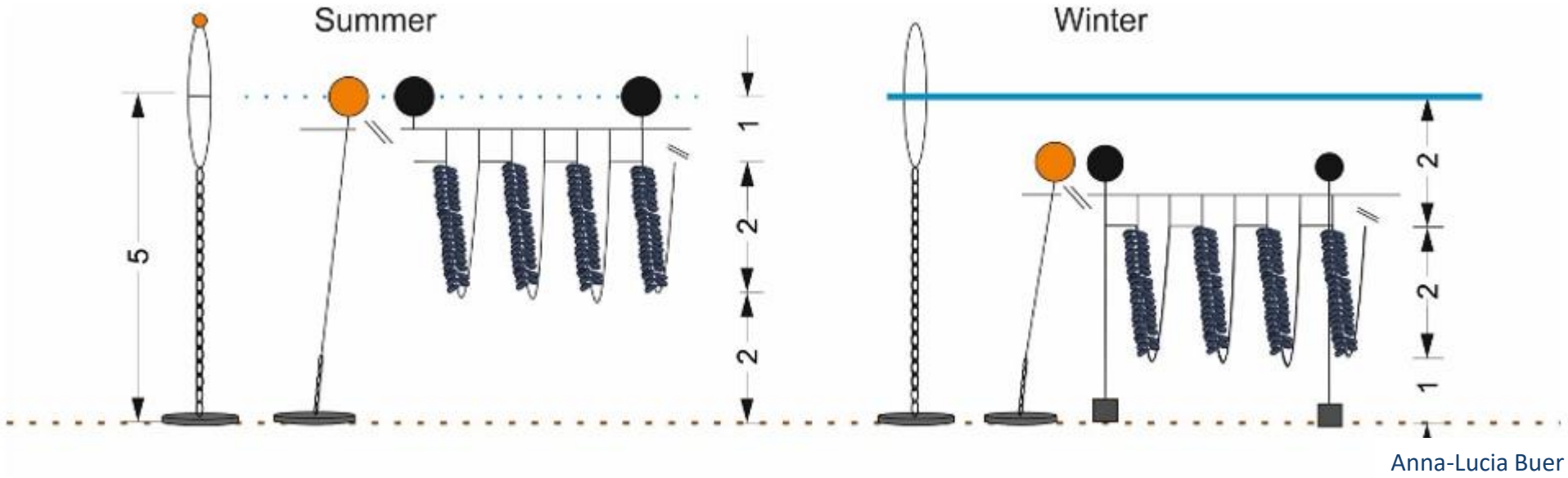
Clearance rate of blue mussels at different Chlorophyll a concentration



Ritzenhofen et al. 2021

- High chlorophyll a concentrations can hamper the clearance rate of blue mussels.
- The reduced clearance rate is a reaction to the satiation of the digestive system (Riisgård et al. 2013).
- Strong algae blooms during spring and frequent cyanobacteria blooms during summer can hamper mussel growth and health (Clausen & Riisgård, 1996).

4. Winter and sea ice



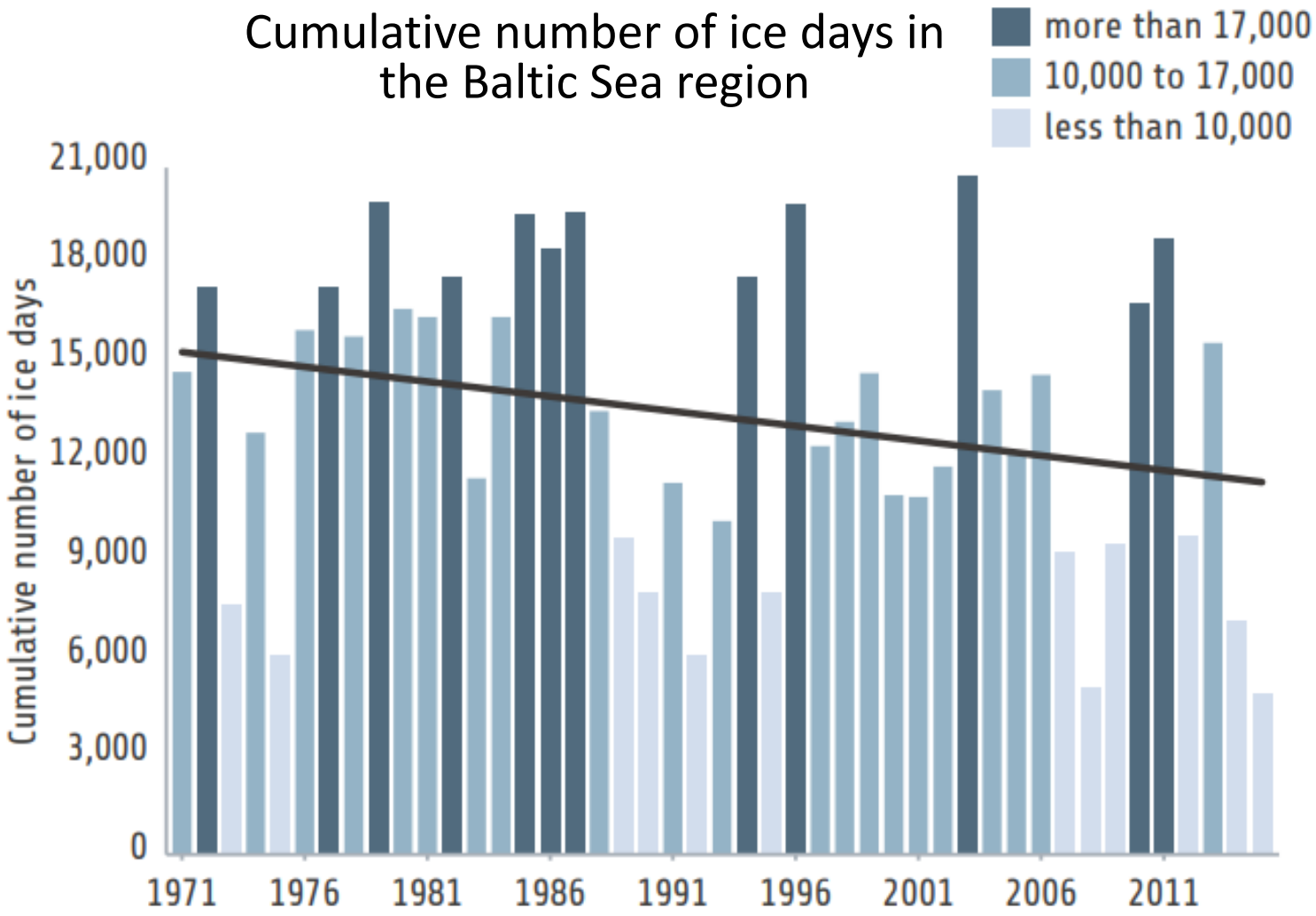
Anna-Lucia Buer

- To protect the mussel farm from sea ice damage, the farm structure has to be submerged beneath the water surface during winter season.

Picture: Friedland

4. Winter and sea ice – Climate Change as a chance

Cumulative number of ice days in the Baltic Sea region

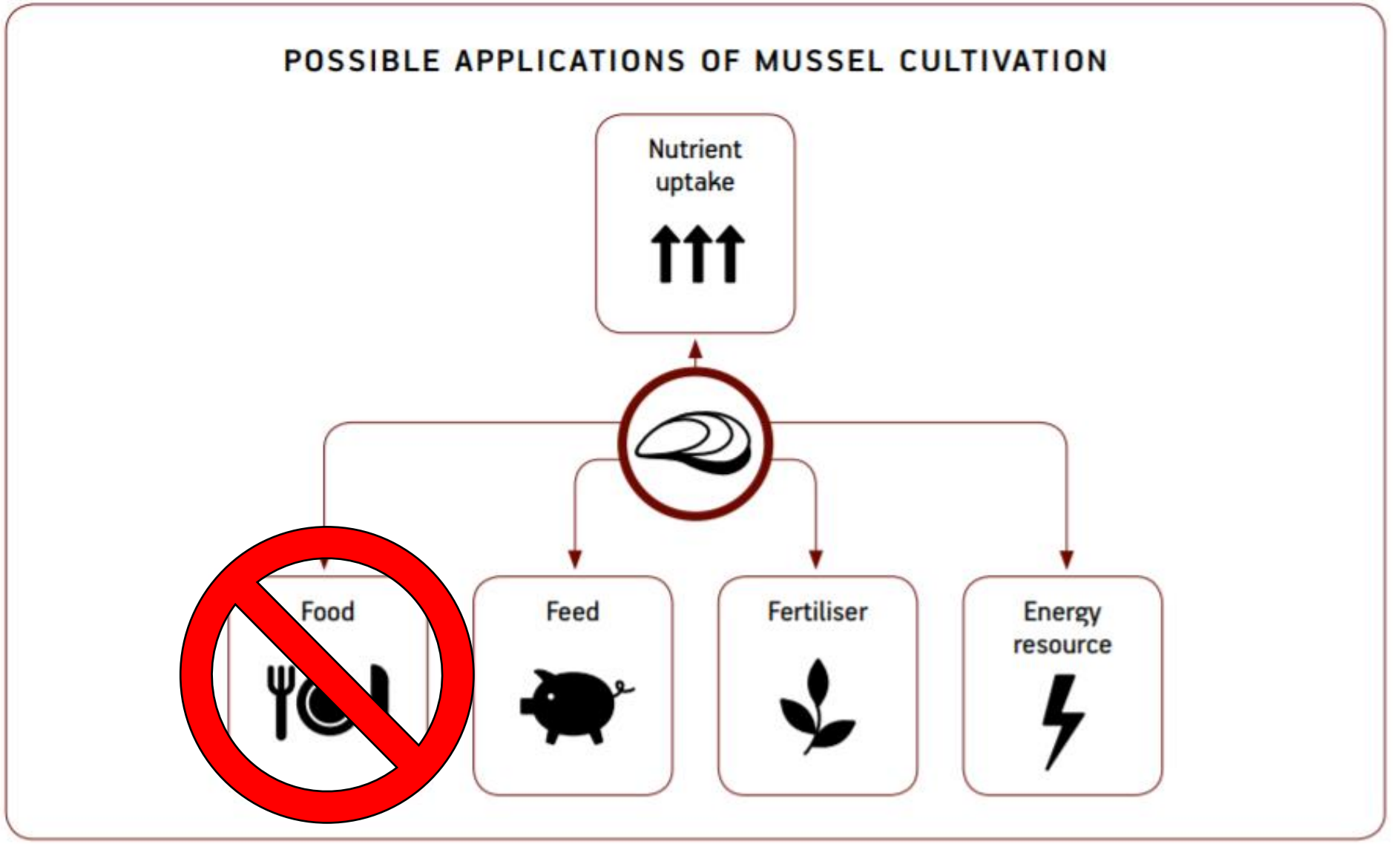


- Higher temperatures can extend the cultivation season and reduce the risk of ice damage.

Picture: Friedland

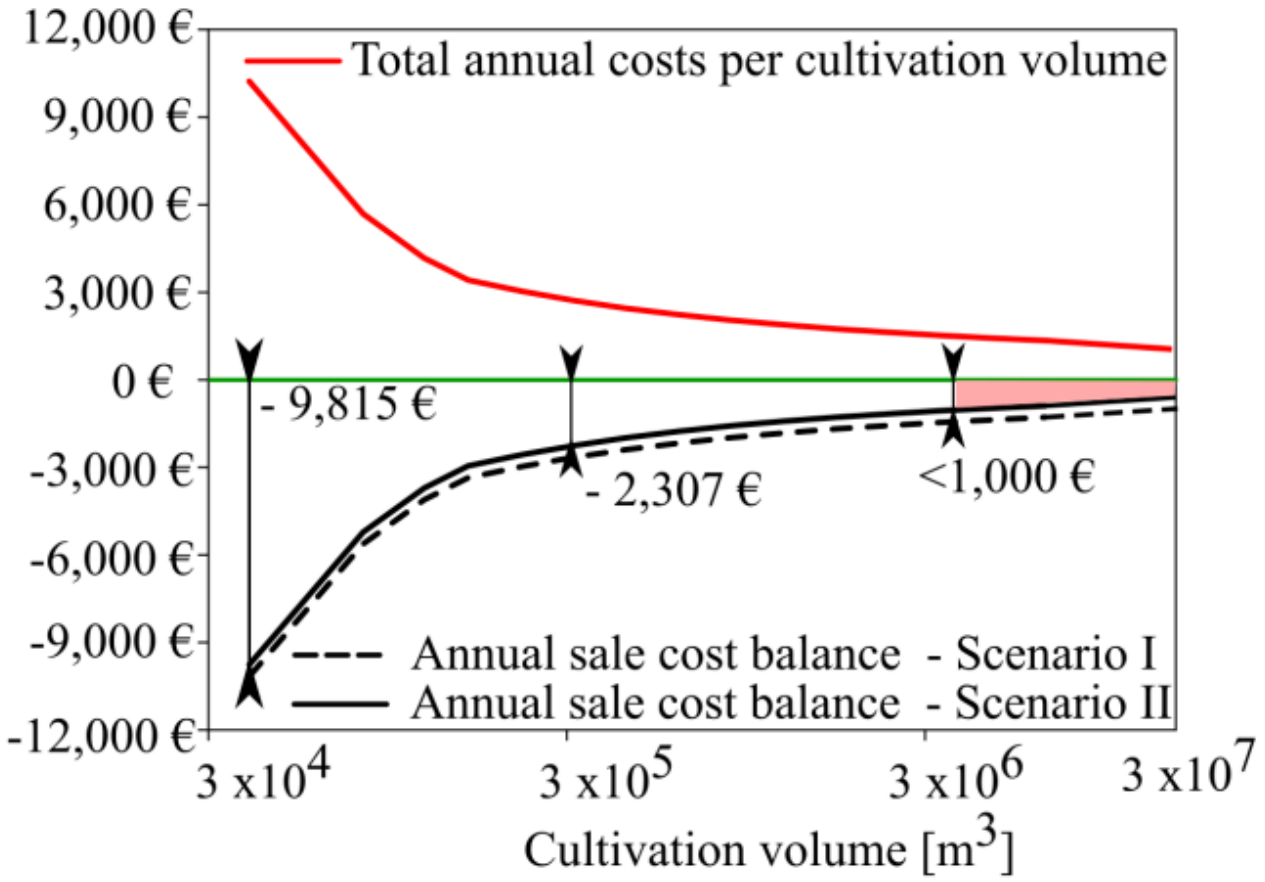
HELCOM (2018): State of the Baltic Sea – Second HELCOM holistic assessment 2011-2016

4. Marketing strategies for small size blue mussels



Submariner (2012): An Assessment of Innovative and Sustainable Uses of Baltic Marine Resources

4. Economy feasibility of small size mussel cultivation



- Scenario I represents a mussel farm, which generate income by selling feed mussels
- Scenario II represents a mussel farm, which generates income by feed mussel sales and nutrient removal derived by removal costs of a wastewater treatment plant.
- Only with increasing mussel production the (cost) break-even point can be
- Increasing mussel production increases environmental risks.

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Summary

- Worldwide commercial mussel production plays an important economic role and is a major sea food producer.
- In the Baltic Sea mussel cultivation has the potential to contribute to a sustainable blue growth.
- Local and organic marketing can increase earning and make small mussel businesses economic viable.
- At decreasing salinity levels (> 10 PSU) small sized blue mussels are not attractive for human consumption anymore and new marketing strategies must be found.
- As of today, additional income by nitrogen and phosphor compensation is not sufficient to support commercial mussel cultivation lasting.

https://www.youtube.com/watch?v=rHvnZCEjP_w

Thank you for your attention!

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References

- Avdelas, L., Avdic–Mravlje, E., Borges Marques, A. C., Cano, S., Capelle, J. J., Carvalho, N., et al. (2021). The decline of mussel aquaculture in the European Union: causes, economic impacts and opportunities. *Rev. Aquac.* 13, 91–118. doi: 10.1111/raq.12465
- Kautsky, N. 1982.Quantitative studies on gonad cycle, fecundity, reproductive output and recruitment in a Baltic Mytilus edulis population. Marine Biology 68.2 (1982): 143-160.
- Clausen, I. B., and Hans Ulrik Riisgård. 1996. Growth, filtration and respiration in the mussel Mytilus edulis: no evidence for physiological regulation of the filter-pump to nutritional needs." Marine Ecology Progress Series 141 (1996): 37-45.
- Riisgård, H. U., Pleissner, D., Lundgreen, K., & Larsen, P. S. 2013. Growth of mussels Mytilus edulis at algal (Rhodomonas salina) concentrations below and above saturation levels for reduced filtration rate. Marine Biology Research, 9(10), 1005-1017.
- FAO. 2020. The State of World Fisheries and Aquaculture 2020. Sustainability in action. Rome. https://doi.org/10.4060/ca9229en
- Taylor D, Saurel C, Nielsen P, PetK. 2019. Production ersen Jcharacteristics and optimization of mitigation mussel culture. Frontiers in Marine Science 6:1–17 DOI 10.3389/fmars.2019.00698.
- Fly, Elizabeth K., and Thomas J. Hilbish. "Physiological energetics and biogeographic range limits of three congeneric mussel species." Oecologia 172.1 (2013): 35-46.
- McCorquodale-Bauer, Kenton, and Nazim Cicek. "Zebra mussel shells as an alternative mineral resource for lime production as a phosphorus precipitant." Environmental Technology (2020): 1-12.
- Spångberg, J., H. Jönsson, and P. Tidåker. "Bringing nutrients from sea to land–mussels as fertiliser from a life cycle perspective." Journal of cleaner production 51 (2013): 234-244.
- Ewald, Nils, et al. "Fatty acid composition of black soldier fly larvae (Hermetia illucens)–Possibilities and limitations for modification through diet." Waste Management 102 (2020): 40-47.