Prospects for mussel farming in the Gulf of Gdańsk (southern Baltic Sea)

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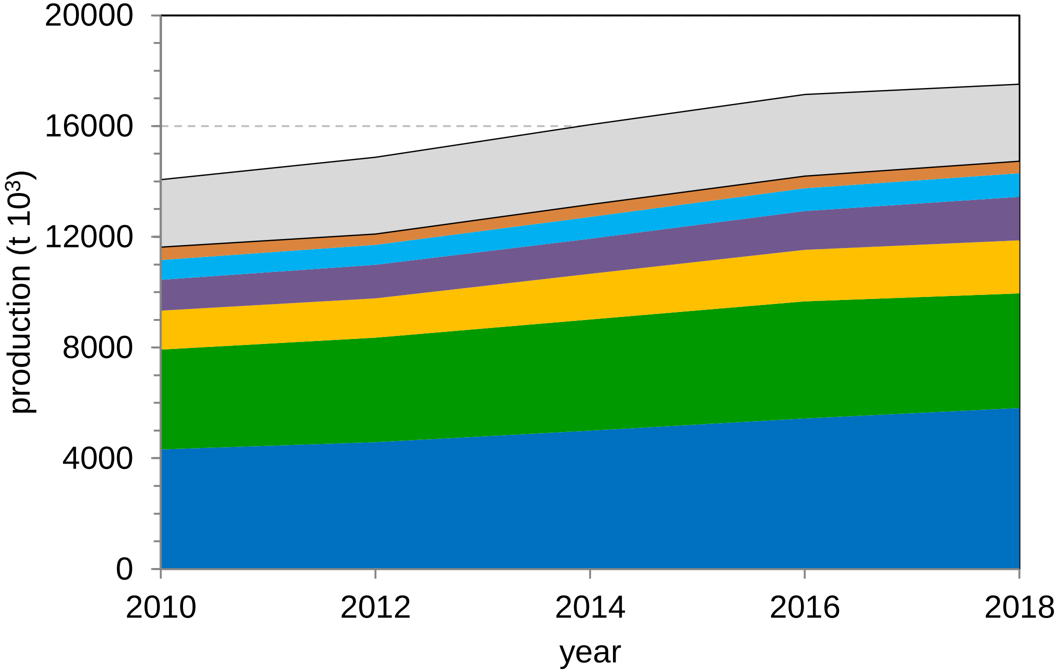
Aquaculture of marine bivalves

Rapid growth of mariculture worldwide over the last decades

Expansion of bivalve mariculture production

2010-2018

+ 25.5 %



(FAO, 2020)

Principle use

➡ human consumption (increased global demand for seafood)

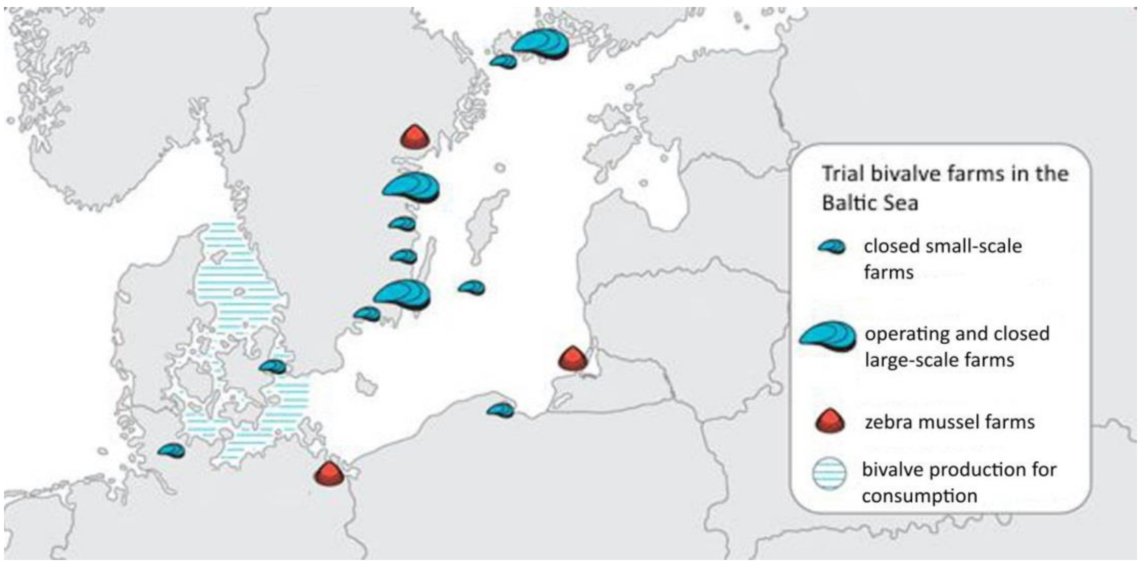
- ❑ production of agricultural fertilizers
- ❑ source in biogas production
- ❑ support for marine fish farming (polyculture)

Mussel aquaculture in the Baltic Sea

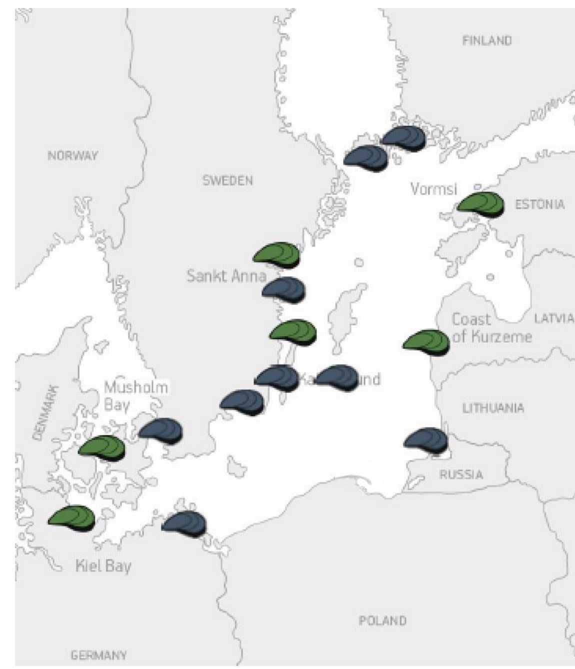
Increasing interest in coastal and off-shore farming since 90. XX

Small-scale and development projects (Germany, Denmark, Sweden, Russia, Latvia), e.g.

- the Baltic Sea 2020 research project
- Baltic Ecomussel (EU Central Baltic Interreg program 2012 – 2014),
- Baltic Blue Growth (EU Interreg Baltic Sea Region 2014 – 2020)
- LIFE IP Rich Waters (EU Life 2014 – 2020)



(Lindahl, 2011 modified)



(Stybel and Posern, 2019 modified)

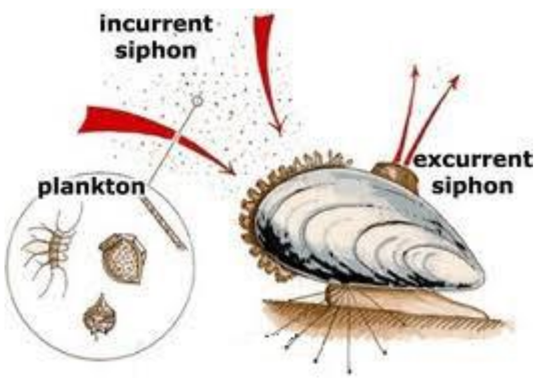
Specific environmental conditions of the Baltic

- (brackish salinity, low temperature) → farming bivalves for human consumption not justified
- severe eutrophication and pollution

↓

the need to improve the state of the natural environment

Through filter-feeding activity mussels remove suspended matter, biogenic substances and other contaminants



(www.friendsofthefoxriver.org)

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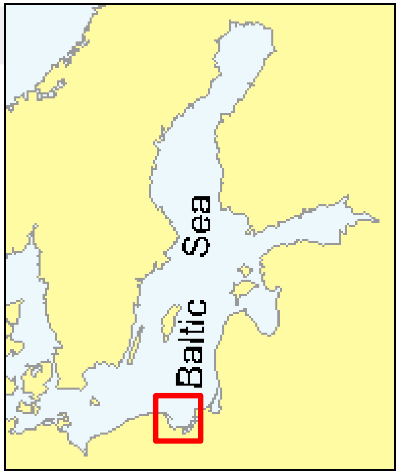
ENVIRONMENTAL APPLICATION OF MUSSEL FARMING

counteracting the negative effects of eutrophication

removal of contaminants (e.g. metals, POP)

amelioration of environmental state

Mussel farming in the Polish sector of the southern Baltic Sea (Polish EEZ)



Not attempted yet

Mussel aquaculture in the Gulf of Gdańsk

Aims

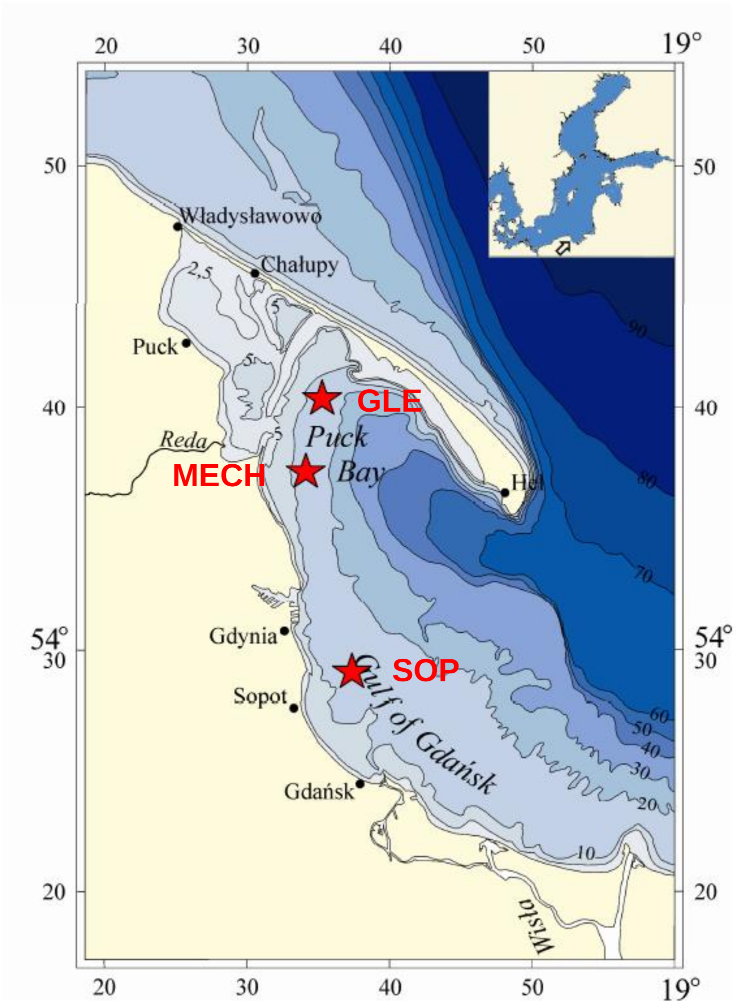
- assess the potential of mussel farming for the purpose of human consumption, nutrient uptake and improvement of the quality of the coastal environment

- define optimal environmental and technical solutions

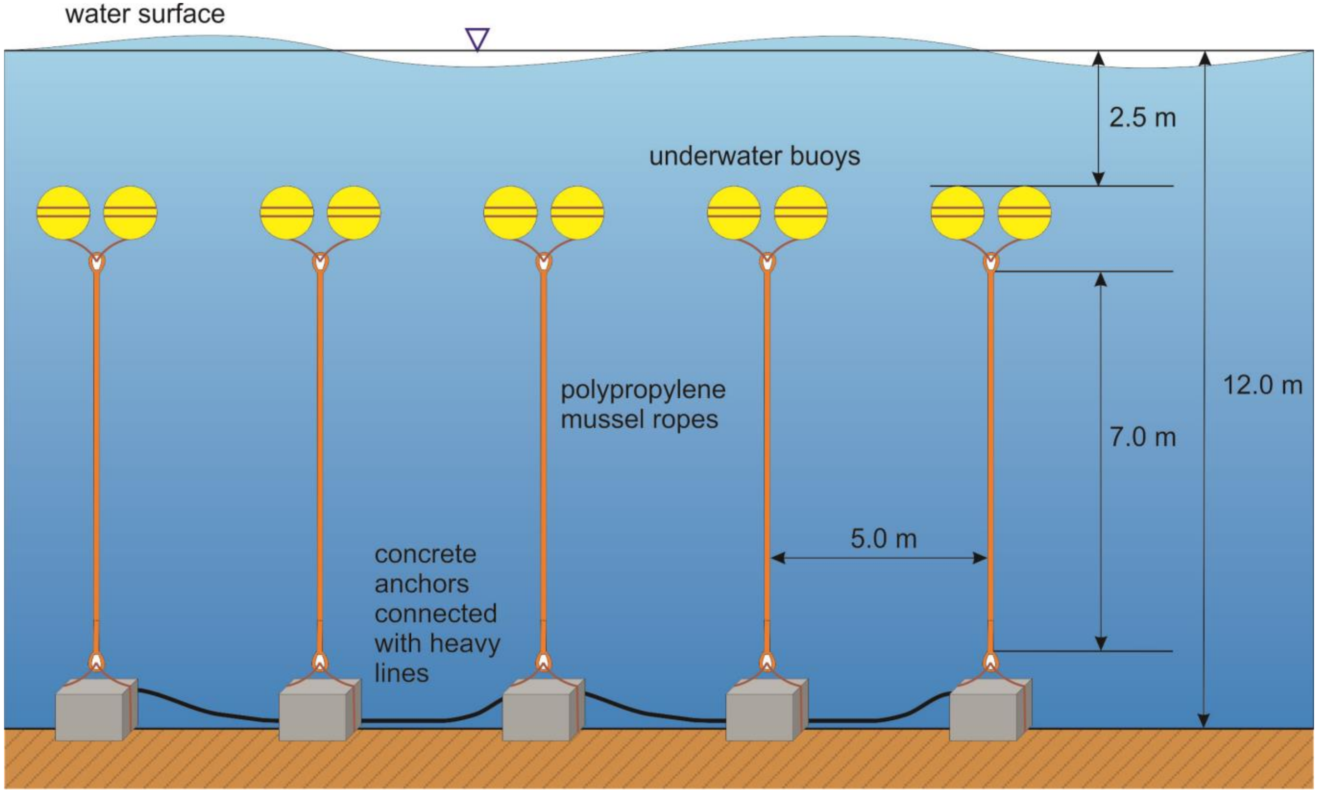
- delineate economic performance

Pilot mussel farming in the Gulf of Gdańsk (field experiment)

- three coastal sites (11.8 – 12.0 m)
  - Mechelinki (MECH)
  - Sopot (SOP)
  - Głębinka (GLE)
- one experimental unit at each site
- exposure time: April 2009 – April 2012
- sampling by SCUBA
  - every four months in 1st year
    end of two following years
  - four different depth zones
    3 – 4 m, 5 – 6 m, 7 – 8 m, 9 – 10 m
- laboratory analyses (size, abundance, growth rate, wet and dry weight, C, N, P content)



Experimental unit

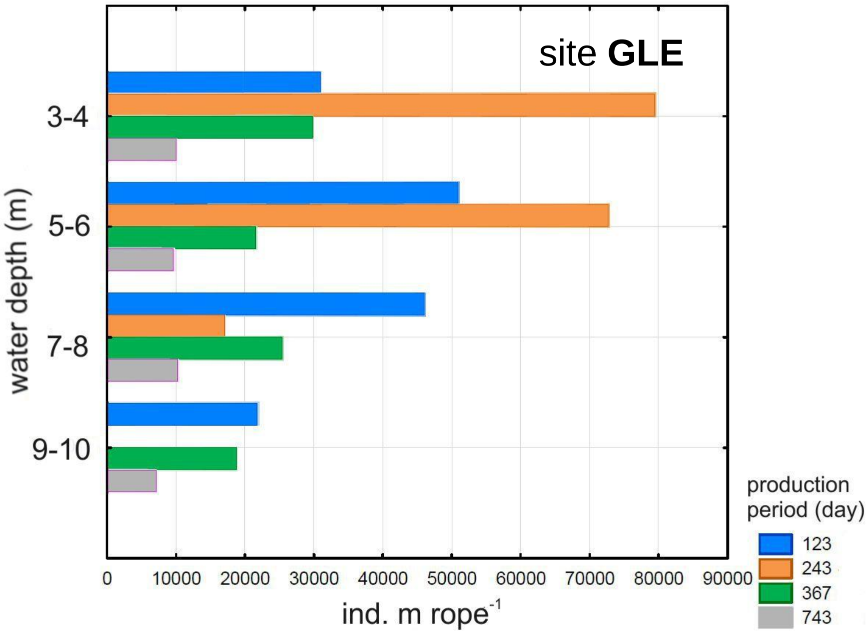


Abundance, shell length and growth rate

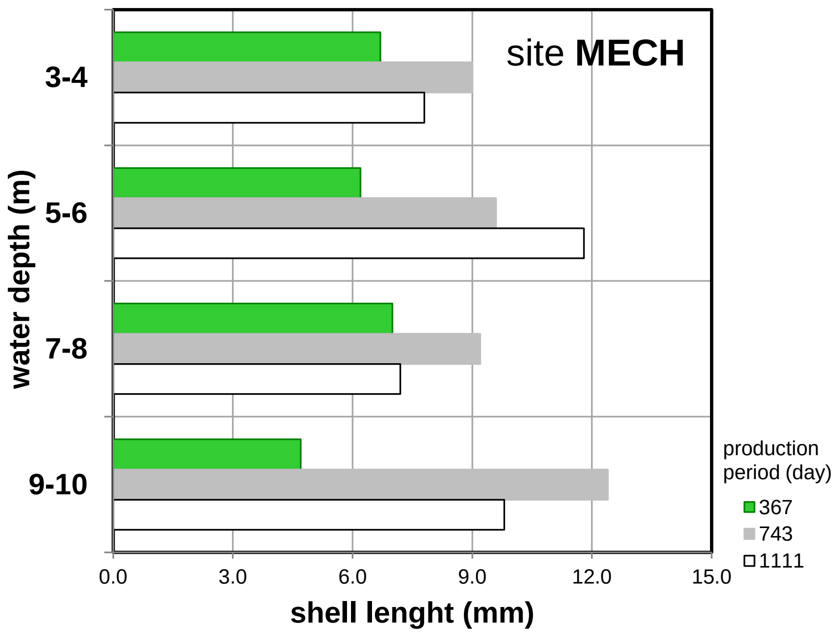
Massive colonization of ropes by mussel larvae

Highest abundance after 8 months, at water depth 3 – 4 m and 5 – 6 m

Largest animals (mean 14.2 mm) after 2 years at water depth 3 – 4 m and 5 – 6 m



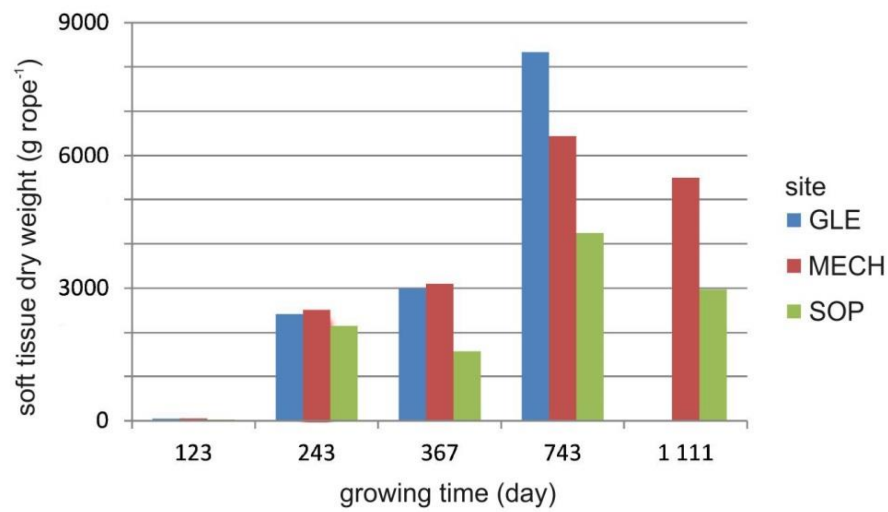
(Sami Alias, 2014 modified)



Gulf of Gdańsk	3.0 – 6.7 mm y^{-1}
central-eastern Sweden	2.2 – 3.1 mm y^{-1}
western Finland	3.4 – 3.8 mm y^{-1}
western Baltic Sea	30 mm y^{-1}

Mussel biomass

Largest tissue weight (up to 1.6 kg m rope^{-1}, i.e. 8.2 kg rope^{-1}) after 2 years at water depth 5 – 6 m



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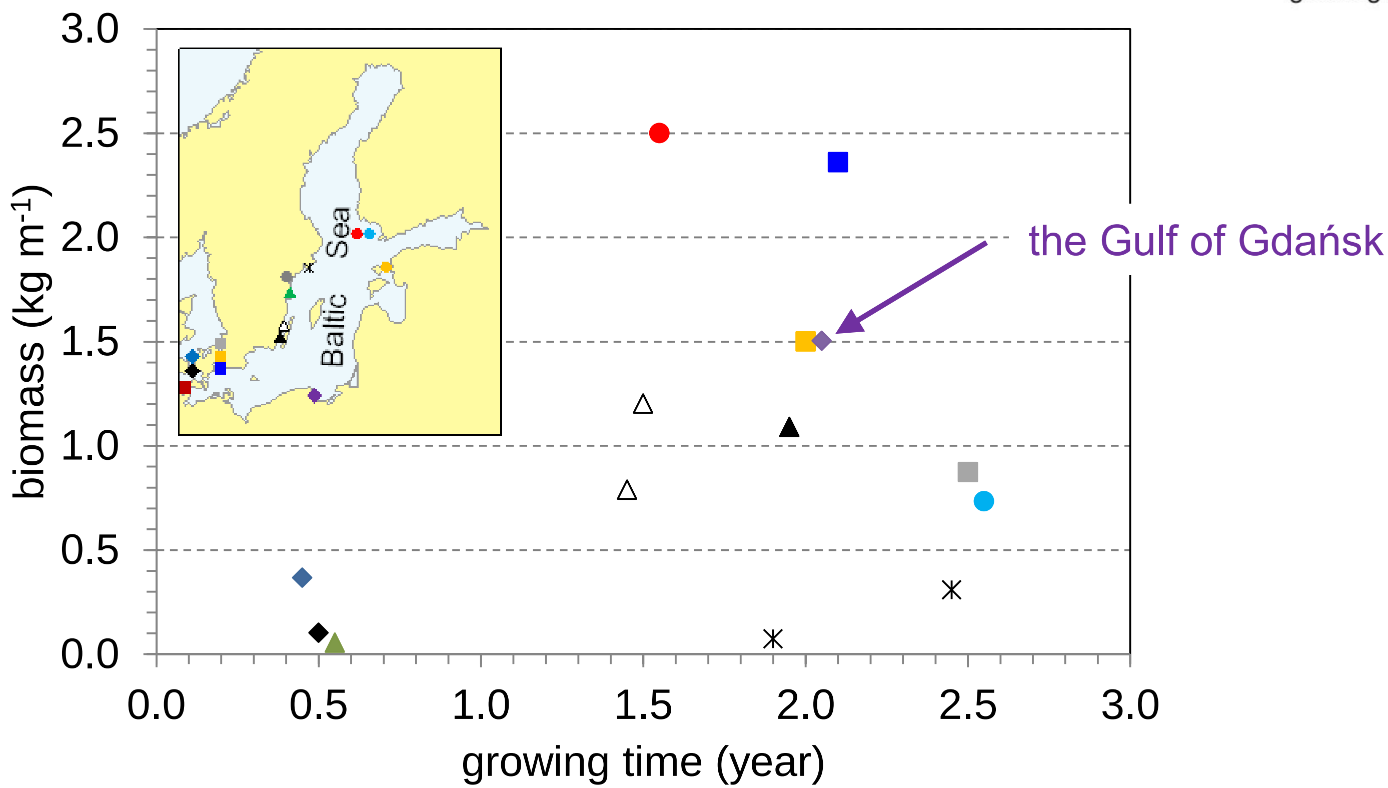

(https://balticbluegrowth.eu modified)

Nutrient mitigation capacity

- 0.2 % of the mussels were > 35 mm long (market size)
(only 1.0 – 1.7 % of the mussels reached shell length > 30 mm)

Nutrient removal

(calculation: biomass data from MEC after 2 years of farming (11.2 kg of wet weight rope^{-1}), elemental analyses)

C: 48.6 – 49.2 % dry weight (DW)
N: 9.3 – 9.8 % DW
P: 1.1 % DW

7 m-long rope → 483 g C, 97 g N, 11 g P

20 000 m^2 (2 ha)
(4000 ropes) → 2.3 kg C, 0.5 kg N,
1 year 0.05 kg P

Sewage Treatment Plant ”Dębogórze”
(additional reduction by 0.16 % N and 0.20 % P)

Economic performance – market use

(calculation: mean biomass data (44.8 t) during 2 year-farming cycle
market retail prices available for individual customer in 2020
20 000 m^2 (2 ha, 4000 ropes), total rope length 28 000 m
operating life expectancy 15 years

per cycle (€)

Costs*		**Revenue**	
Investment		sale for consumption (1.7% = 0.76 t)	3800
units	9585	sale for animal feed production (98.3% = 44.04 t)	4404
equipment	2507		
Operational/maintenance			
labour (deployment, monitoring, harvesting)	18054		
boat renting	45000		
	69670		8204

*Additional not-listed costs: human labour on land, interest on fixed capital, insurance premium, accounting services and administrative cost, road transport

return 12 %

Economic performance – „mitigation culture” (Taylor et al., 2018)

removal of 1 kg nitrogen
in the Gulf of Gdańsk

Sewage Water Treatment Plant "Dębogórze” (90 % efficiency) 11.8 €	$<$	biomass of mussel harvested on culture ropes (20 000 m^2) 130 €

Alternative co-funding

- private foundations, private persons via crowdfunding
- companies from benefiting economic sectors or public authorities
- international financing programmes such as European Maritime and Fisheries Fund (EMFF) and the Natural Capital Financing Facility (NCFF)
- selling carbon credits to industry (estimate 12 € t C^{-1})

Conclusions

- Effective development of mussels on spat collectors → high availability of larvae throughout a year and successful settlement on polypropylene ropes.
- Highest abundance and biomass after two years of farming at water depth 3 – 4 m and 5 – 6 m → optimal aquaculture conditions.
- Biomass gain and growth rate of mussels in the Gulf of Gdańsk among the highest in the Baltic Sea.
- Effective nutrient removal from the water column but little significance at scale of the entire water-basin. Potential application of mobile farms to mitigate nutrients in tourist resorts.
- Negative budget balance (deficit) of mussel farming both for human consumption/animal feed production and nutrient mitigation.