Preliminary results of experimental study on application of *Mytilus trossulus* farming to remediate the environmental state of the southern Baltic Sea (Poland)

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Why to study blue mussel aquaculture in the Gulf of Gdansk?

increasing primary production in the Gulf of Gdansk

subsequent increase in total particulate matter

extending of the spatial distribution and standing stock of *Mytilus trossulus*

worsening light conditions

increase in sedimentation rate

Why to study mussel aquaculture in the Polish coastal zone?

Until today, there are no data available on an overall design of construction for mussel cultivation in the Polish coastal zone.

This is the first study in Polish territorial waters where mariculture has been studied.

The main aim is improvement quality of coastal waters

<u>Detailed goals:</u>

- increase clarity of water through removal of suspended particles from the water column
- removal nutrients from water
- amelioration of light conditions for autotrophic organisms (algae and higher plants)
- reduction of phytoplanktonic blooms with special focus on cyanobacteria and their toxic products
- informing all interested parties (farmers, authorities, companies) about best conditions for cultivating mussels in the Polish coastal zone (*Best-Practice Guide*)
- assessment of prospects for using mussel biomass for industrial purposes

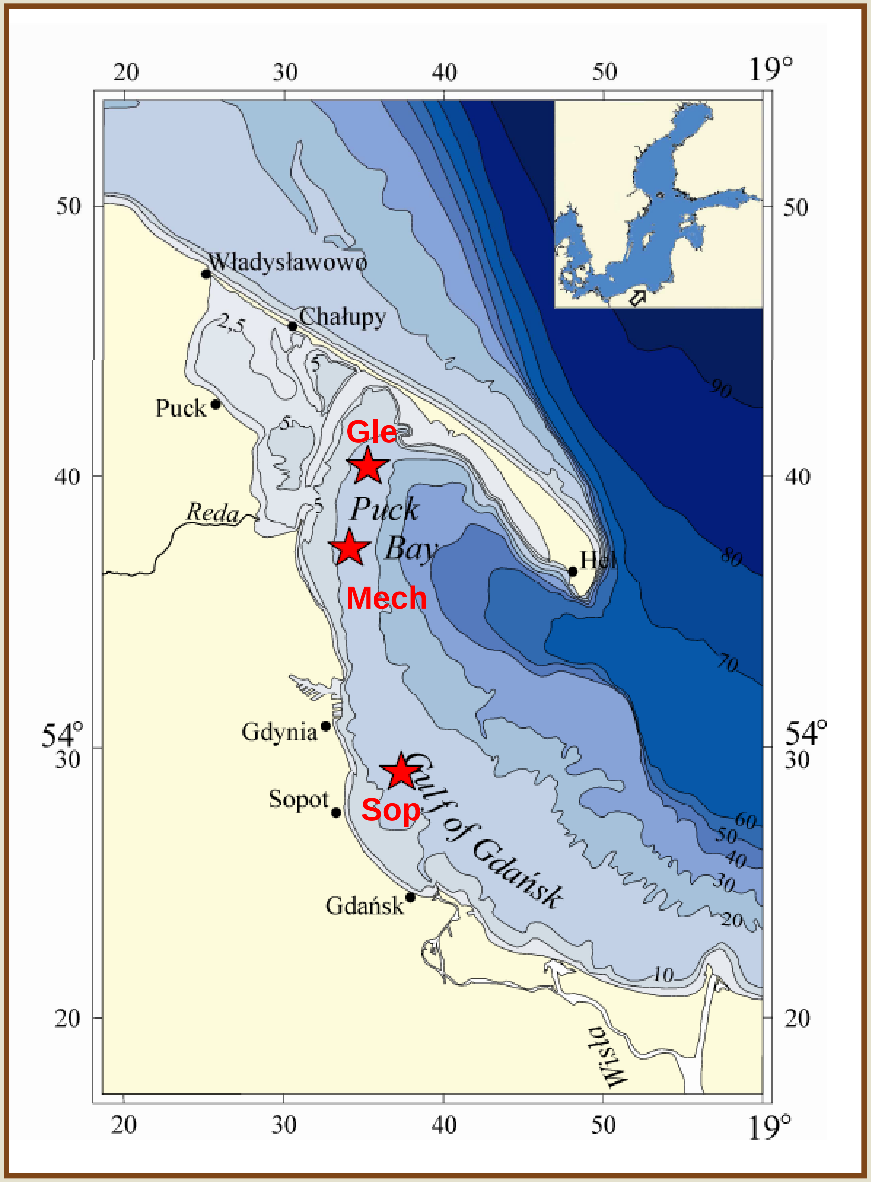
First field experiment – locations

Conditions in Puck Bay:

- semi-enclosed character
- relatively low hydrodynamics
- water currents transporting mussel larvae
- large amount of nutrients

Background to chose test locations:

- benthic community structure
- zooplankton species composition

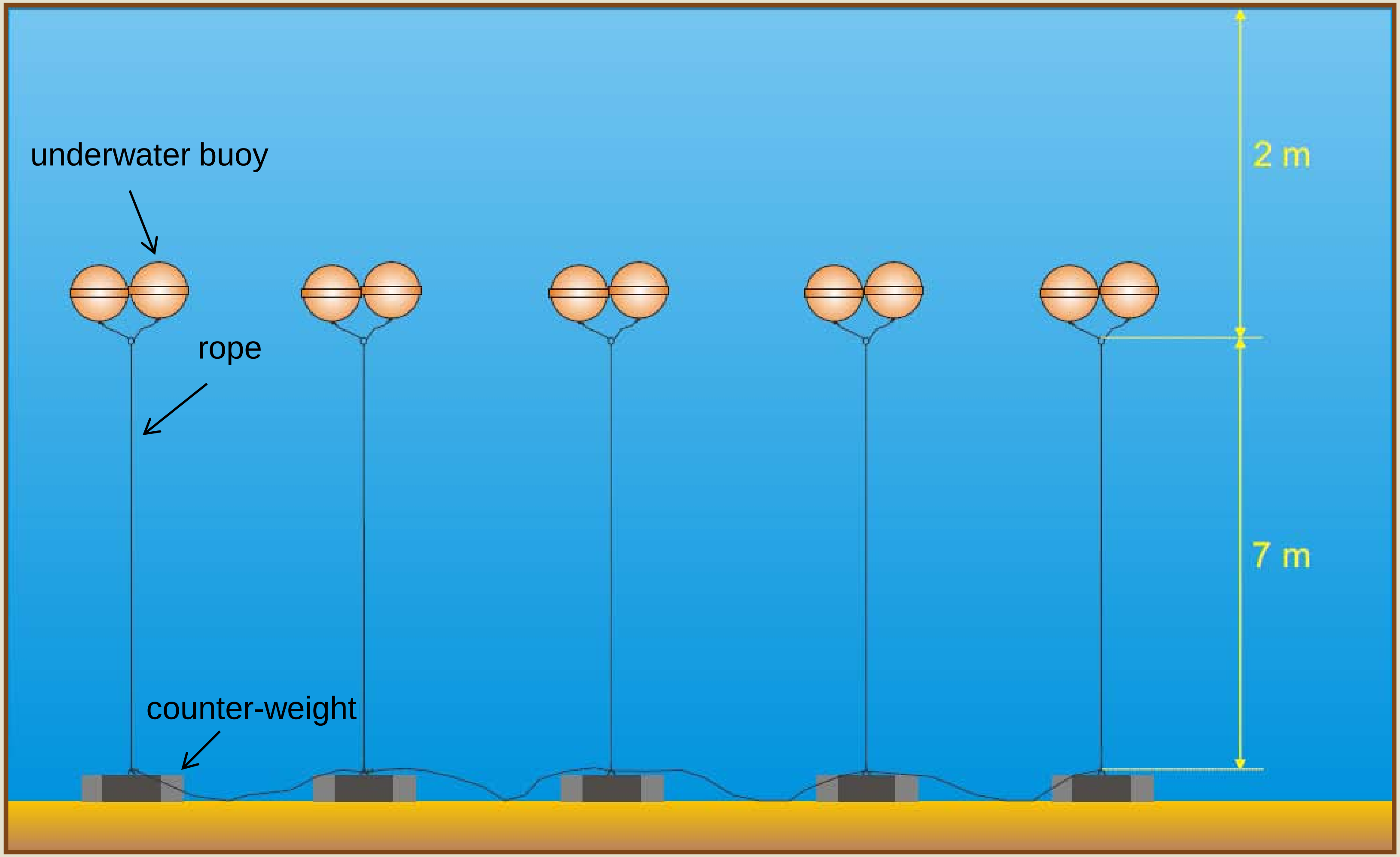


Field experiment – scheme of construction unit

Technical requirements:

- the suitable substratum (kind of material, thickness)
- anchor equipment and buoyancy to provide flotation

Field experiment – scheme of construction unit



Laboratory analyses

To determine spatial variation of mussel larvae in the water column:

- settlement of mussel larvae
- abundance of juveniles

To examine geographical variation of physiological performance of mussels:

- growth rate of young individuals
- physiological condition
- biochemical composition
- reproductive cycle

How to achieve goals

In order to:

- estimate potential of the bivalves to purify water masses from the suspended matter and nutrients
- determine the best period for harvesting mussels in order to maximize biomass removal

After two-year aquaculture in the Gulf Gdansk, analysis of the following parameters has been started to elucidate factors controlling size and production of *M. trossulus* on rope:

- abundance of mussels per 1 m rope
- biomass production
- growth rate of mussels
- shell length, soft tissue wet and dry weights, condition index
- filtering capacity

Preliminary results

- Number of mussels and biomass:

1) density of individuals among locations
2) effect of depth
3) dominance of *Mytilus* sp. on the rope

ad.1

Total number of mussels growing on the rope after one-year exposition:

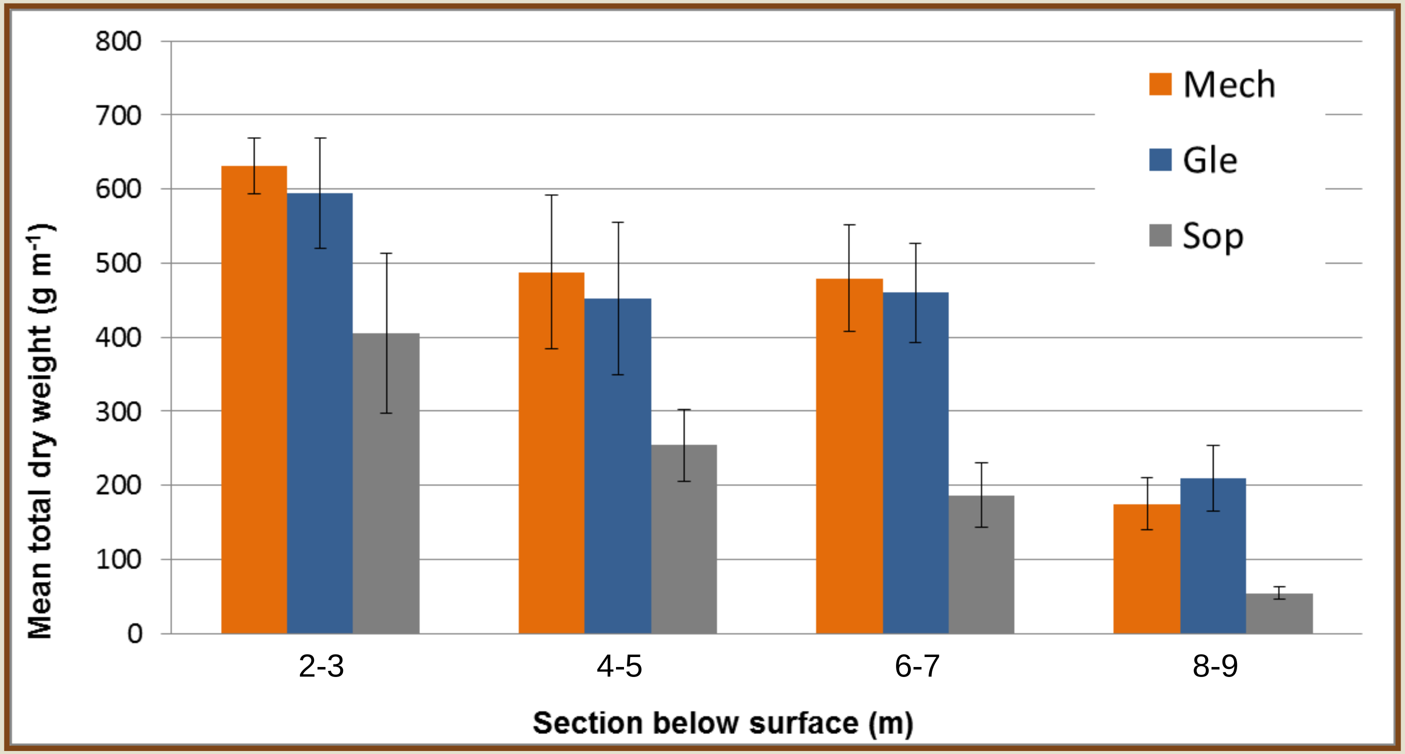
- 23,920 ind. m^{-1} (Gle)
- 25,640 ind. m^{-1} (Mech)
- 26,270 ind. m^{-1} (Sop)

Preliminary results

❖ Number of mussels and biomass:

ad. 2

Effect of depth on mussel weight



The mean total dry weight of mussel *Mytilus trossulus* per meter of rope after one-year exposition in the water, for each site (Gle, Mech, Sop) and for four sections below seawater surface

Preliminary results

Growth rate:

1) geographical variation
2) seasonal variation
3) increase in growth rate during phytoplankton bloom

ad. 1

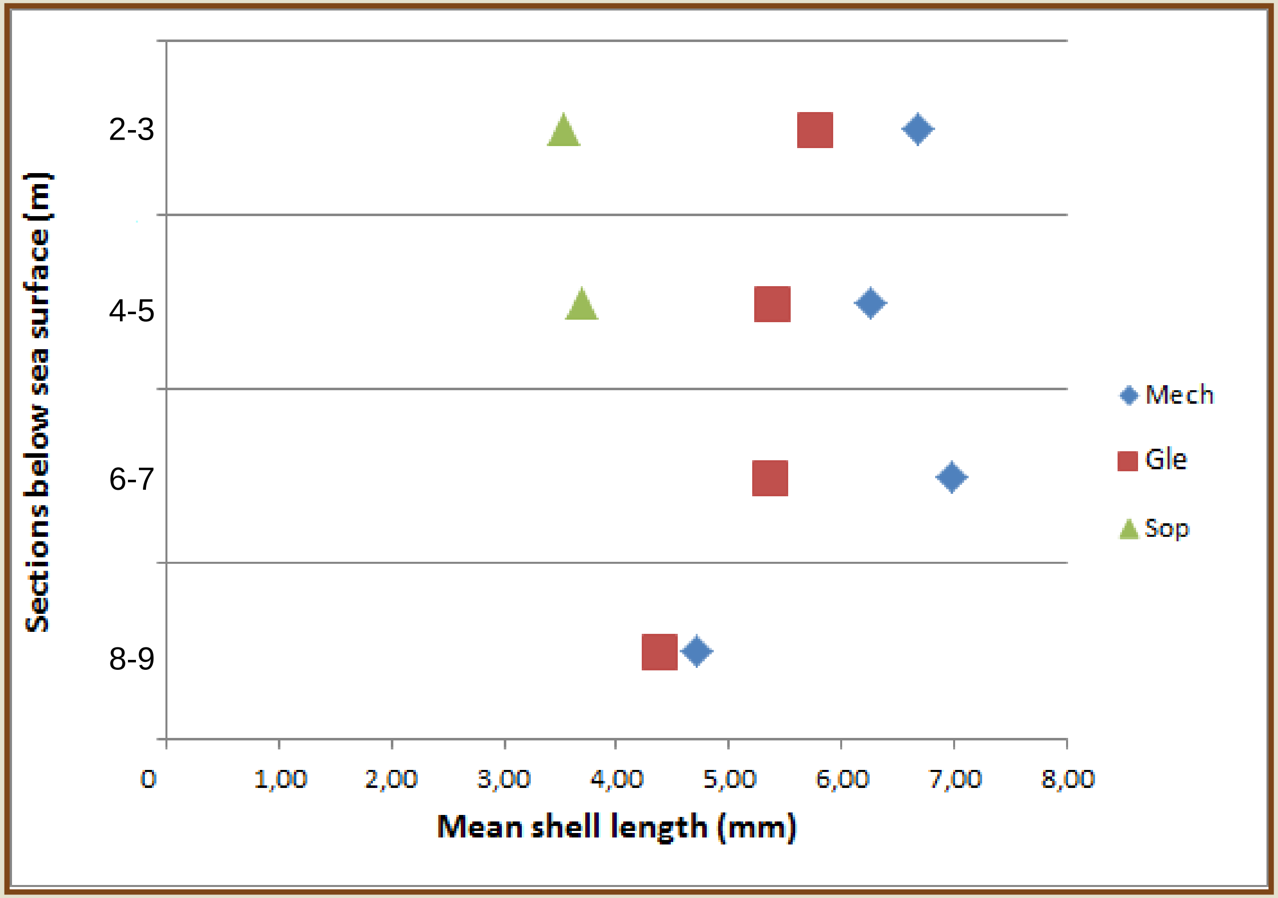
The shell length of individuals can reach the maximum of:

- 21.08 mm (Gle)
- 22.27 mm (Mech)
- 21.11 mm (Sop)

after one-year exposition in the water column

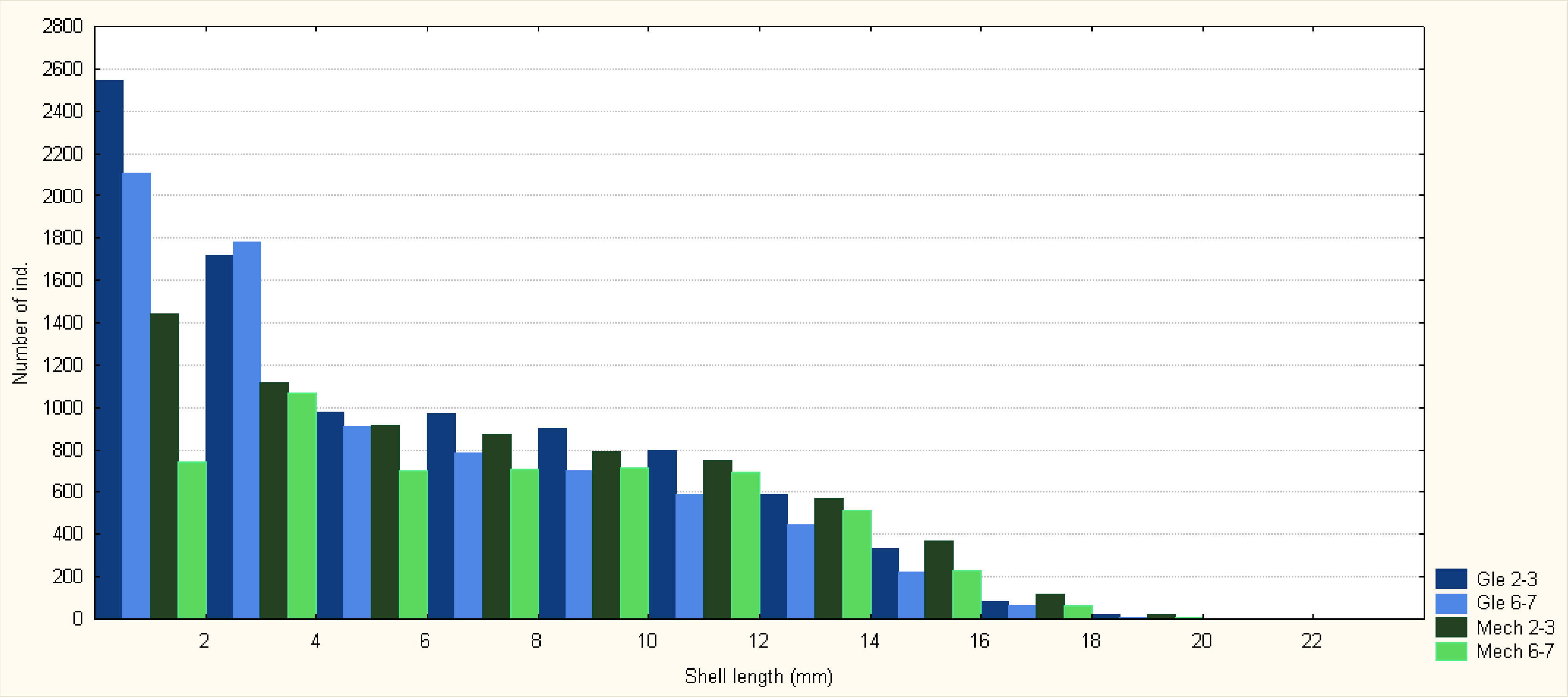
Preliminary results

ad. 1



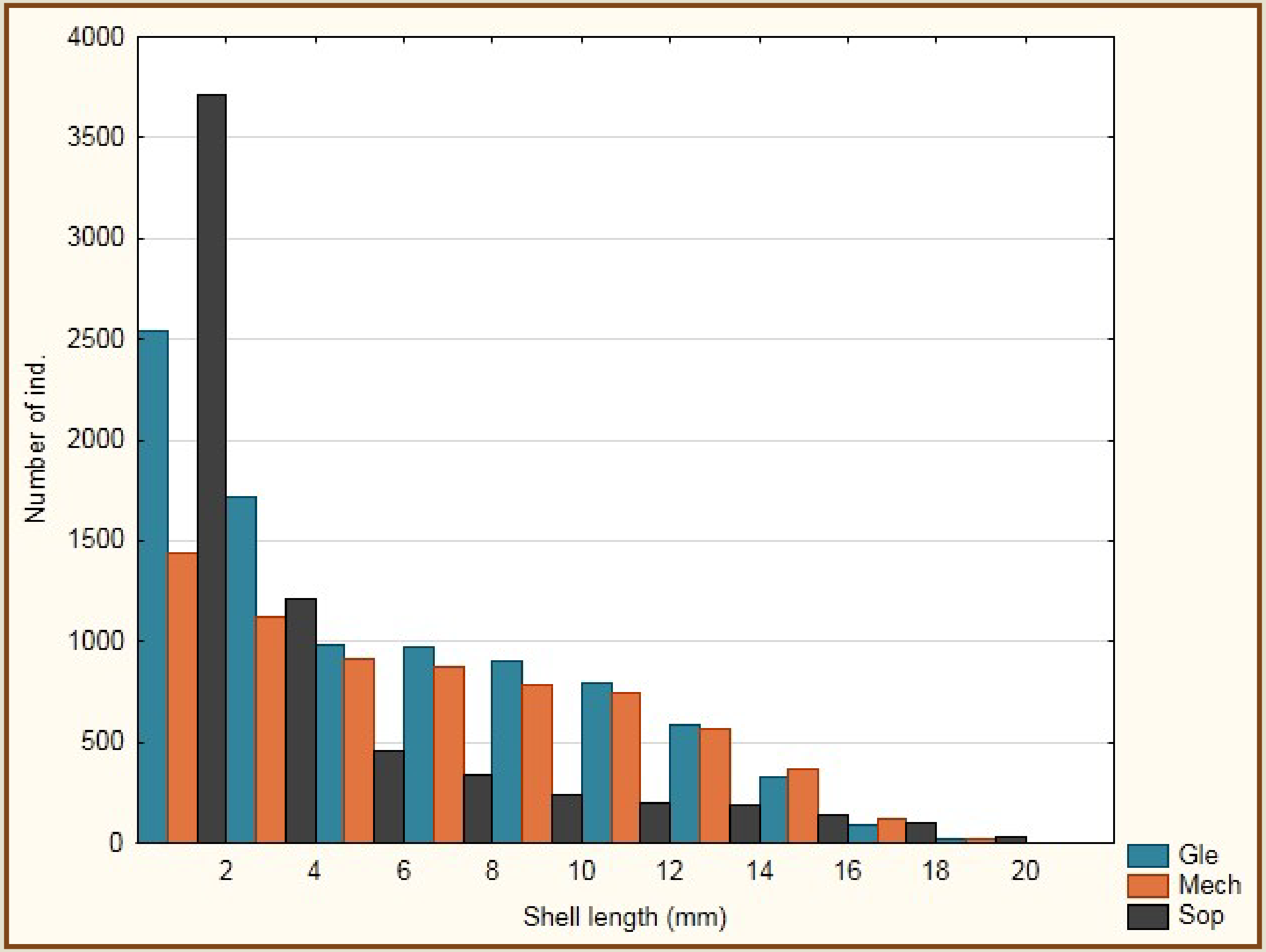
The mean shell length (mm) of mussel *Mytilus trossulus* after one-year exposition in the water, for each site (Mech, Gle, Sop) and for four sections below seawater surface

Preliminary results



Size frequency distribution on line section 2-3 and 6-7 m below surface for two test sites (Gle, Mech)

Preliminary results



Size frequency distribution on line section 2-3 m below surface for all test sites

Filtering capacity of mussels

Based on:

* filtration rate of mussels from the Gulf Gdansk (experimental data):
$12.3\ dm^3\ h^{-1}\ g^{-1}$ d.w. for 10.1-20.0 mm
$27.9\ dm^3\ h^{-1}\ g^{-1}$ d.w. for 20.1-30.0 mm (Lawreniuk, 2010)

* soft tissue dry weight at Mech:
395.04 g d.w. $rope^{-1}$

Estimated filtering capacity could reach more than

800 L d^{-1} for one rope

Nutrient removal

Nutrient content in 1 kg live mussel (Lutz 1980):

8.5-12 g nitrogen
0.6-0.8 g phosphorus
40-50 g carbon

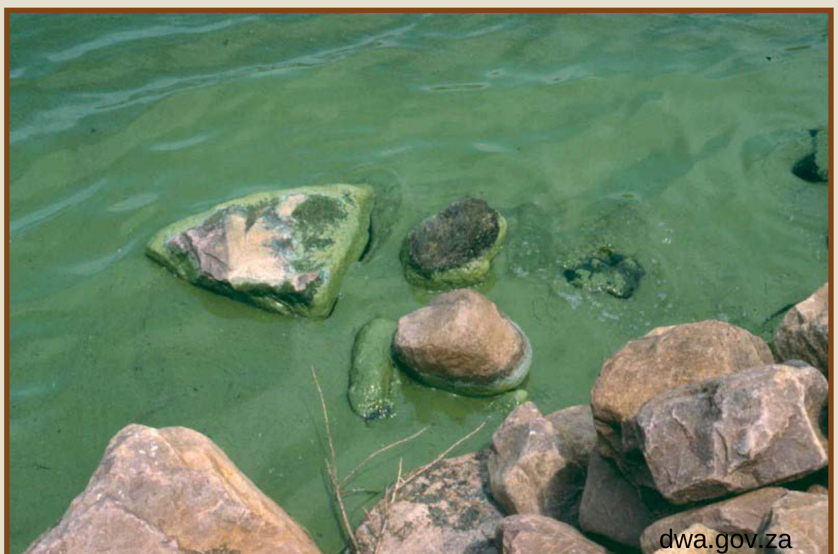
Mussel harvested from one rope at Mech after one-year culture (mean biomass 7.2 kg) would roughly remove from the ecosystem:

60.9-85.9 g N
4.3-5.7 g P
286.4-358.0 g C

The best sites for mussel farming
The best technique

Potential use of the cultivated mussels

- Biomonitors of contaminant bioavailabilities, endocrine disrupting chemicals (EDCs) in the marine environment (e.g. wastewater outputs)
- Biomonitoring of pathologies, diseases and parasite infections in bivalve molluscs
- Sustainable fish aquaculture



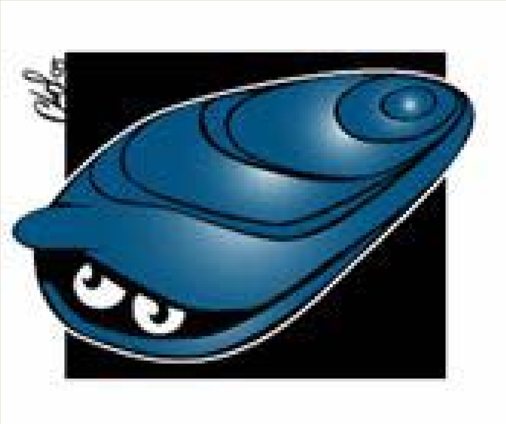
Potential utilisation of the harvested mussels

Non-consumptive sectors (in case of high soft tissue accumulated contaminant concentrations, detected pathologies and parasites)

- as addition to fertilizers for urban green areas
- as a biofuel source to replace fossil fuels

Consumptive sectors (no in excess of contaminant levels, parasite infection rates, etc.)

- for production of active biological substances
- for food production



Thank you
for your attention

Gulf of Gdansk and Puck Bay

Main characteristics of the Gulf of Gdansk and Puck Bay – climate, hydrology, morphometry and sediments

	Gulf of Gdansk	**Puck Bay**
Water temperature (C)	min: -0.43; max: 24.7	min: +1.0; max: 22.0
Ice cover (days a^{-1})	22	60 – 80
Mean freshwater inflow (km^3 a^{-1})	35.1	8,09
Volume (10^6 m^3)	291,460	5.58
Mean depth (m)	59	15.5
Maximum depth (m)	111	54.0
Organic matter content (% d.w.)	0.2 – 25	0.1-25
Sediment fraction <63 µm (% d.w.)	0 - >50	0.1 – 65
Phosphate release (µg P m^{-2} day^{-1})	1 – 612	0.02
Sediment composition	Variously grained sands; silty sands; sandy silts; clayel silts	Clays, sands, gravel, silty sandy sediments, silts, peat, mud

Gulf of Gdansk and Puck Bay

Main characteristics of the Gulf of Gdansk and Puck Bay – biological components, primary production, water chemistry, trophic status

	Gulf of Gdansk	**Puck Bay**
Secchi depth (m)	3.3; max: 6.0	3.7 max: 14.5
Phytoplankton biomass (µg Chl *a* l^{-1})	0.62-51.93	max. 52.0
Total phosphorus (µmol l^{-1})	1.29 (winter max: 0.79)	no data
Annual nitrogen input (t a^{-1})	118,000	2,275
Annual phosphorus input (t a^{-1})	7,000	no data
Trophic level	High eutrophic	Eutrophic