

COMBINING MULTIPLE SOCIETAL BENEFITS IN THE LIVELAGOONS PROJECT



European
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Fund



Introduction

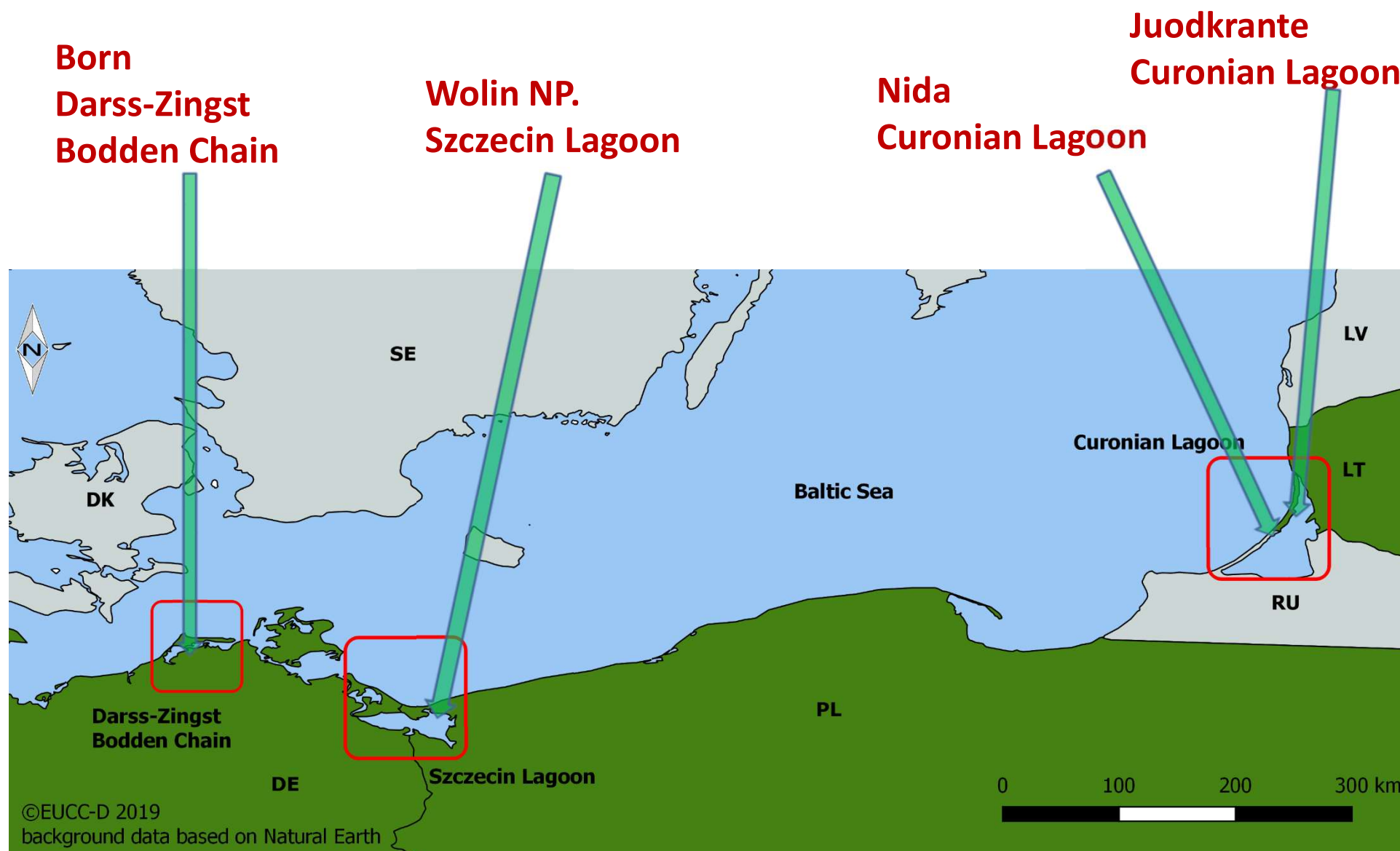


- Baltic lagoons are sensitive transitional waters prone to eutrophication and other water pollution.
- Most acute problems occur in their sheltered areas, which are often the beaches and recreational areas.

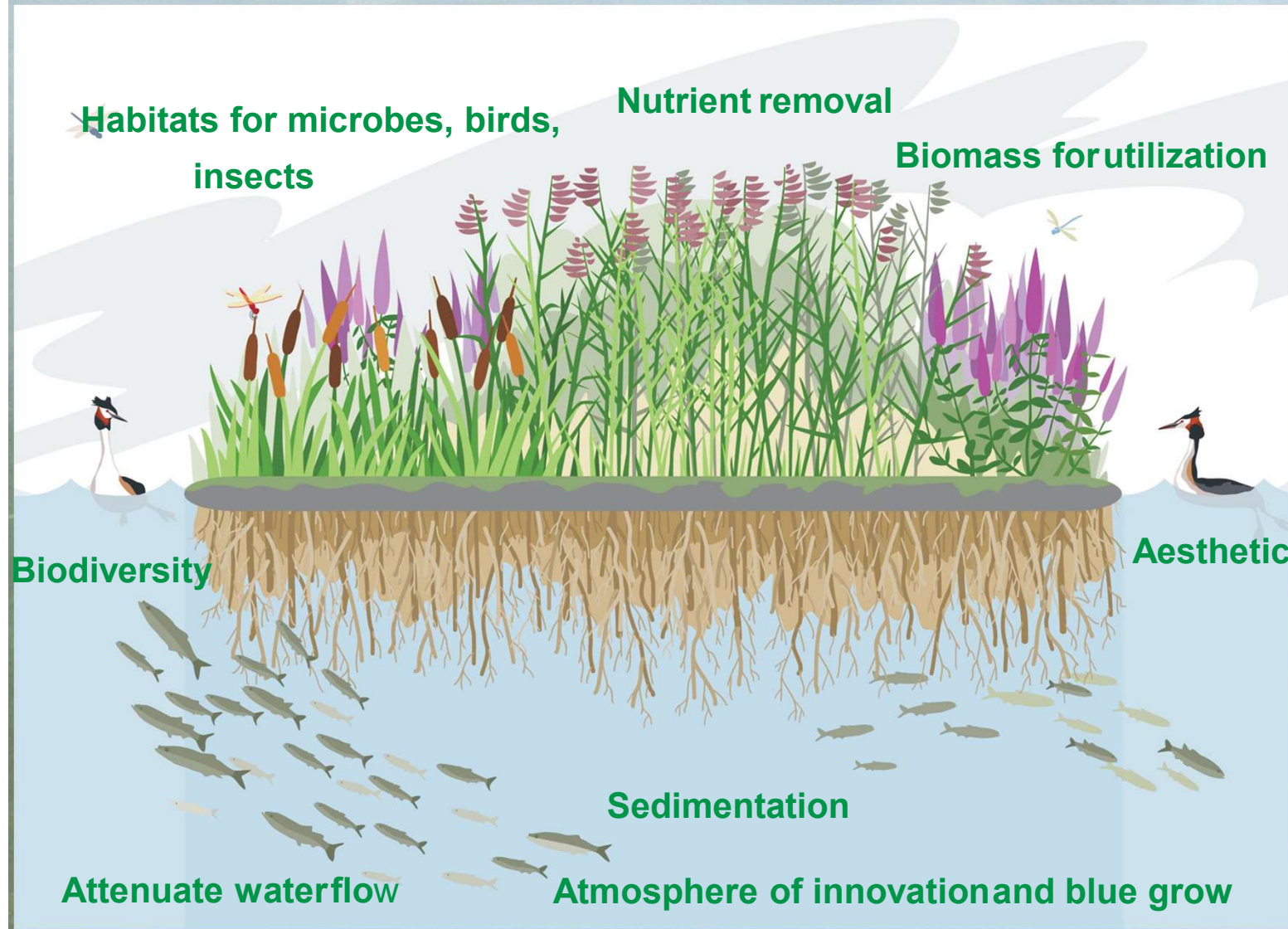


- There is still need for innovative solutions which would combat eutrophication and improve bathing water quality.
- In the **LiveLagoons project** of the Interreg South Baltic programme it was decided to test floating wetlands planted with native macrophytes as a possible solution for water quality enhancement.

Map of locations



Floating emergent macrophyte islands



Commercially available technology

Possibility to use native plants (could be placed in the protected territory)

Possibility to use degradable material

Some of chosen macrophytes



Typha latifolia



Butomus umbellatus



Schoenoplectus lacustris



Lythrum salicaria



Iris pseudacorus



Carex acutiformis / riparia





Bolboschoenus maritimus



Juncus effesus


Technologies applied



Installation site	Applied technology	Supplier	Completed installation date	Type of installation
Juodkrante, Lithuania	Matrices made of recycled and UV-resistant hollow plastic (HDPE) pipes, covered with coconut coir fiber and fastened using a plastic (PP) mesh	Biomatrix	May 2019	2 islands
				
Nida, Lithuania	A custom-made floating rig with mesh size > 11 cm, 200 m length and 1 m height, placed at 1 m depth	Local supplier, custom made	May 2018	net
				

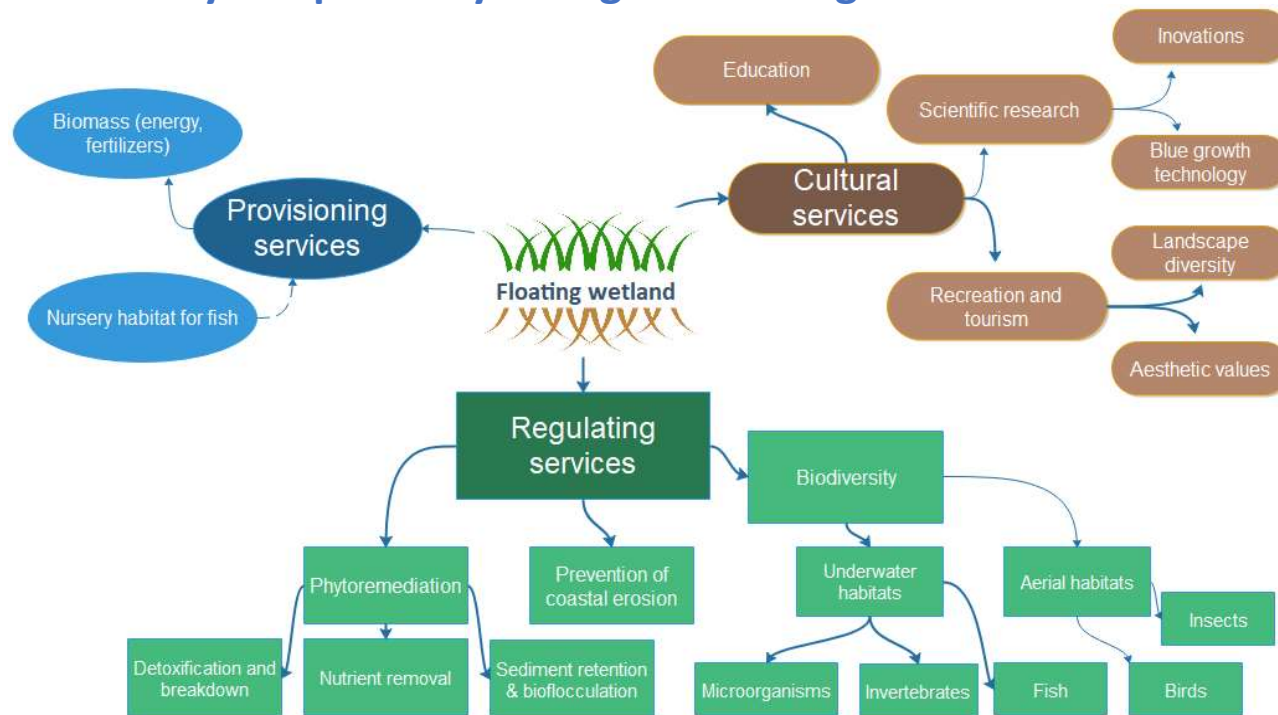
Technologies applied



Installation site	Applied technology	Supplier	Completed installation date	Type of installation
Wolin National Park, Poland	Matrixes made of recycled and UV-resistant hollow plastic (HDPE) pipes, covered with coconut coir fiber and fastened using a plastic (PP) mesh	Biomatrix 	May 2019	island
Born, Germany	Made of a stainless steel mesh which is filled with dry reed stems and hollow stainless steel buoys to enhance the buoyancy effect	Ökon 	May 2018 and 2019	2 islands 

The impact

- The nutrient removal capacity of the island is the sum of nutrients accumulated in the aerial biomass (stems and leaves) and underwater biomass (roots), nitrogen loss by microbial activity, phosphorus uptake by microorganisms and sedimentation.
- Our estimates of plant biomass and nutrient content in the harvest from the 28 m² island installed in the Curonian Lagoon equals to 240g of N and 17g of P.
- The aerial biomass could contribute only ~10% of nutrient removal while the rest is accounted for root-associated microbial community.
- Therefore we could assume that annual removal of 28 m² could be 2400g of N and 170g of P. **For 3 ys respectively 7200g N and 510g P.**



Lithuania: Nida floating net



May 2018



June 2018 - reed

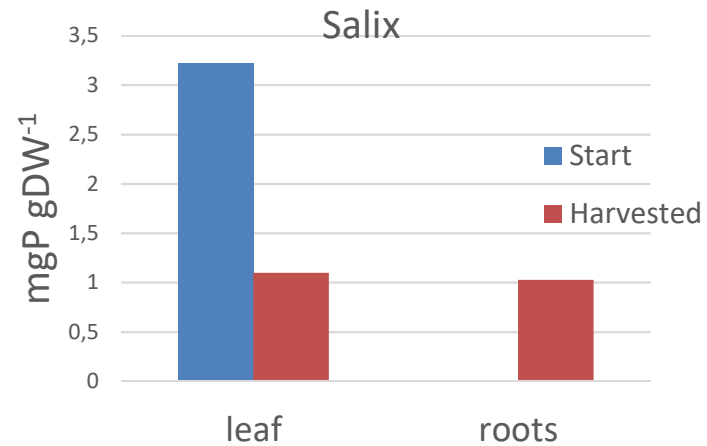


July 2019 - Purple Willows (*Salix purpurea*)

Willows



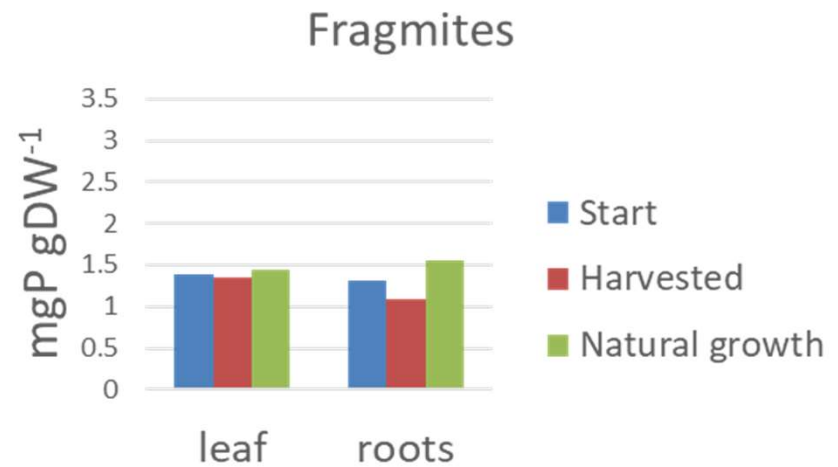
Root production:
 4.9 ± 2.9 gDW/stem equivalent to ~ 5 mgP/stem
 Willow stem 60-80cm underwater
 Leaf production: NA



Reed



Root biomass: 35 ± 28 gDW
 Equivalent to 38.5 mgP



J1

Harvesting of the plants in FTWs plays a vital role to remove
40

nutrients from wastewater permanently

Jurate; 09.11.2018

An additional bonus: zebra mussels



Dreissena production:
 $8.2 \pm 4.3 \text{gDW/stem}$
equivalent to
8 mg of P and 79 mg of N



One stem P uptake $\sim 5\text{mgP}_{\text{roots}} + 8\text{mgP}_{\text{Dreissena}} = 13\text{mgP}$

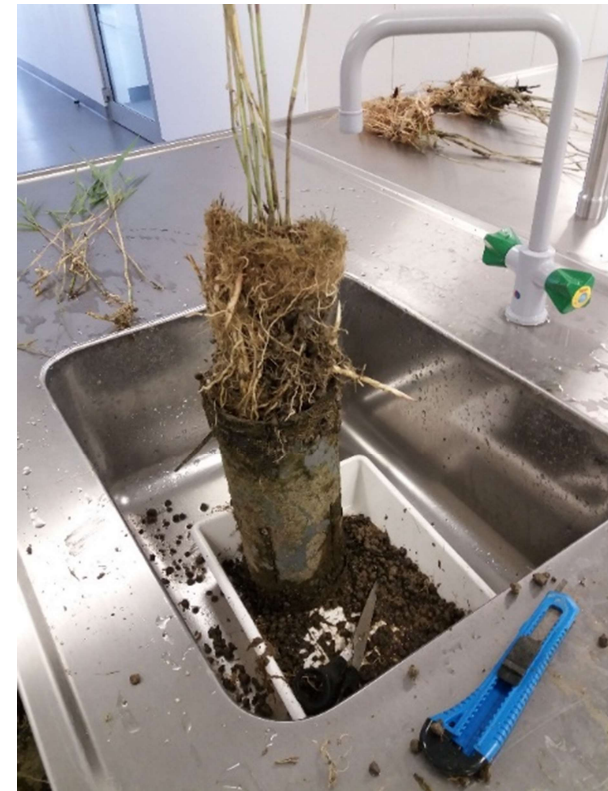
Municipal wastewaters may contain from 5 to 20 mg/l of total phosphorous

Read more: <https://www.lenntech.com/phosphorous-removal.htm#ixzz5WGXngypw>

Conclusions



- Plants growing under sub-optimal conditions produce small amount of 'above ground' tissues but larger amount of root biomass
- Therefore entire plant must be removed to remove nutrients permanently
- *Salix* more easy to harvest than *Fragmites* and *mussels* increase nutrient removal capacity



Islands



Planted on 7th May, 2019



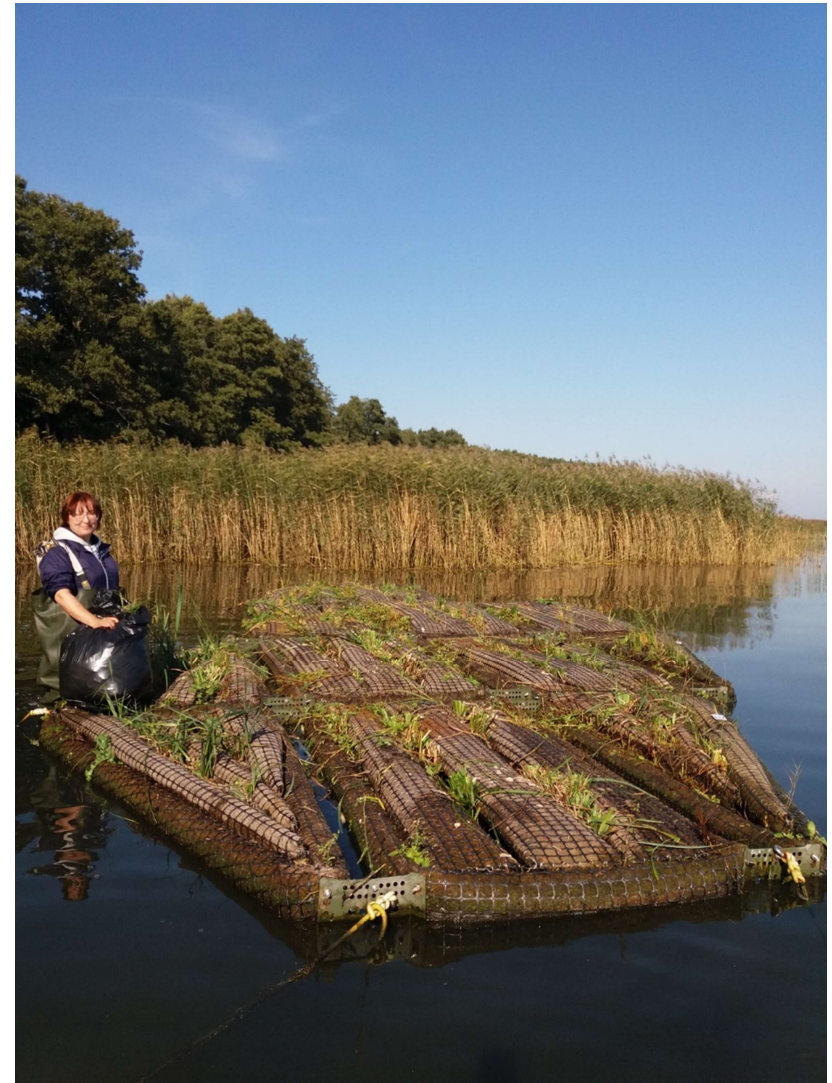
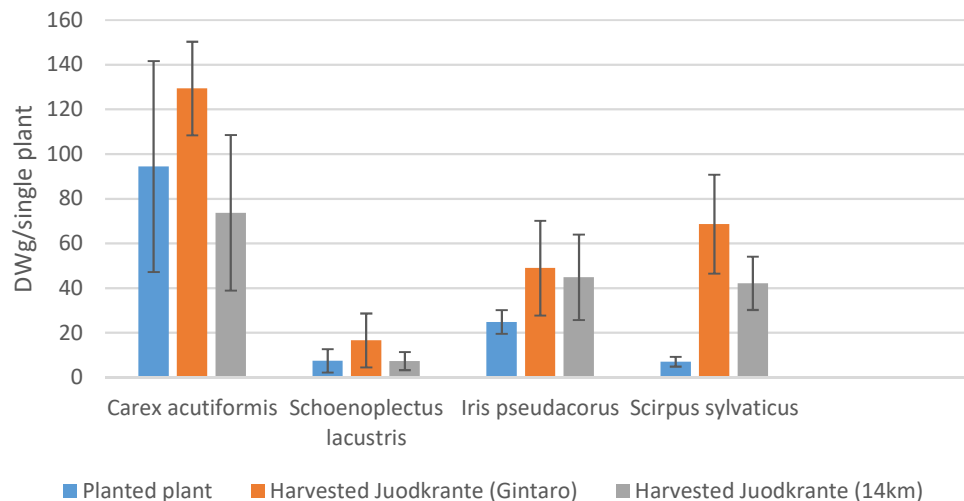
Harvested 20th September, 2019



Estimating harvest after the 1st year



- Only the aboveground biomass could be harvested (as the roots are tightly entangled in the island construction)
- Some species like *Carex acutiformis* produce significant amount of leaves but it is still less than the total weight of planted plant.



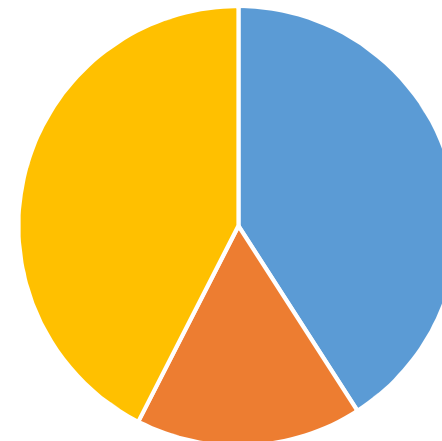


Island area 28m²
Total harvest 15kg



Juodkrante (14km)

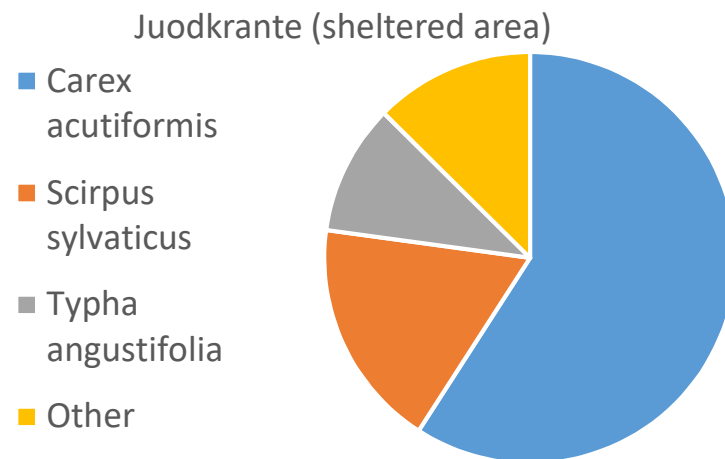
- Carex acutiformis
- Scirpus sylvaticus
- Typha angustifolia
- Other



Other species: Planted (*Typha*, *Iris*, *Shoenoplectus*); Spontaneous (*Rumex*, *Ranunculus*, *Valeriana*)



Area 24m²
Total harvest in 2019 55kg
Over 100 kg in 2020 !!!

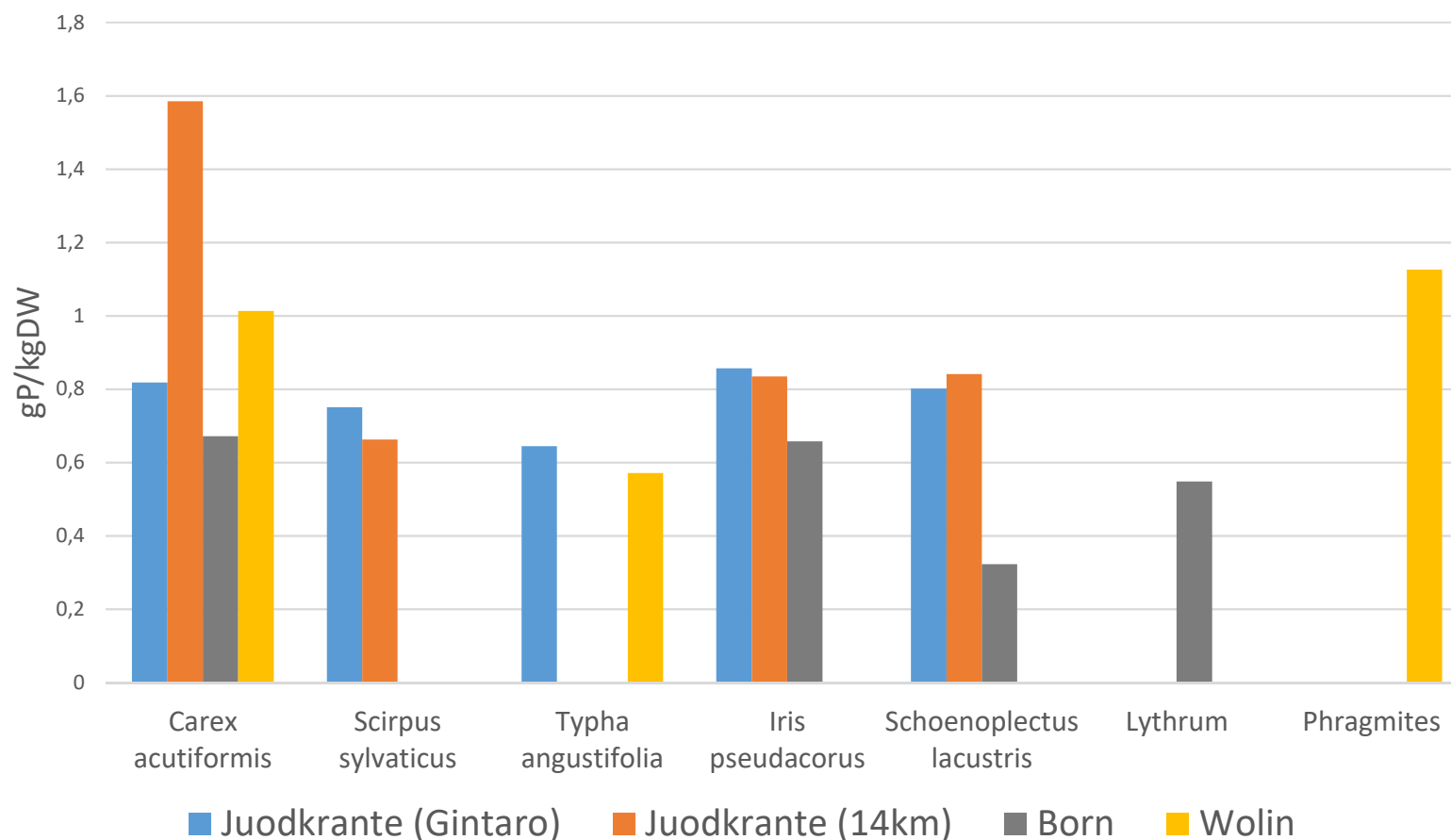


Why harvest is higher in Juodkrante (exposed location) island?

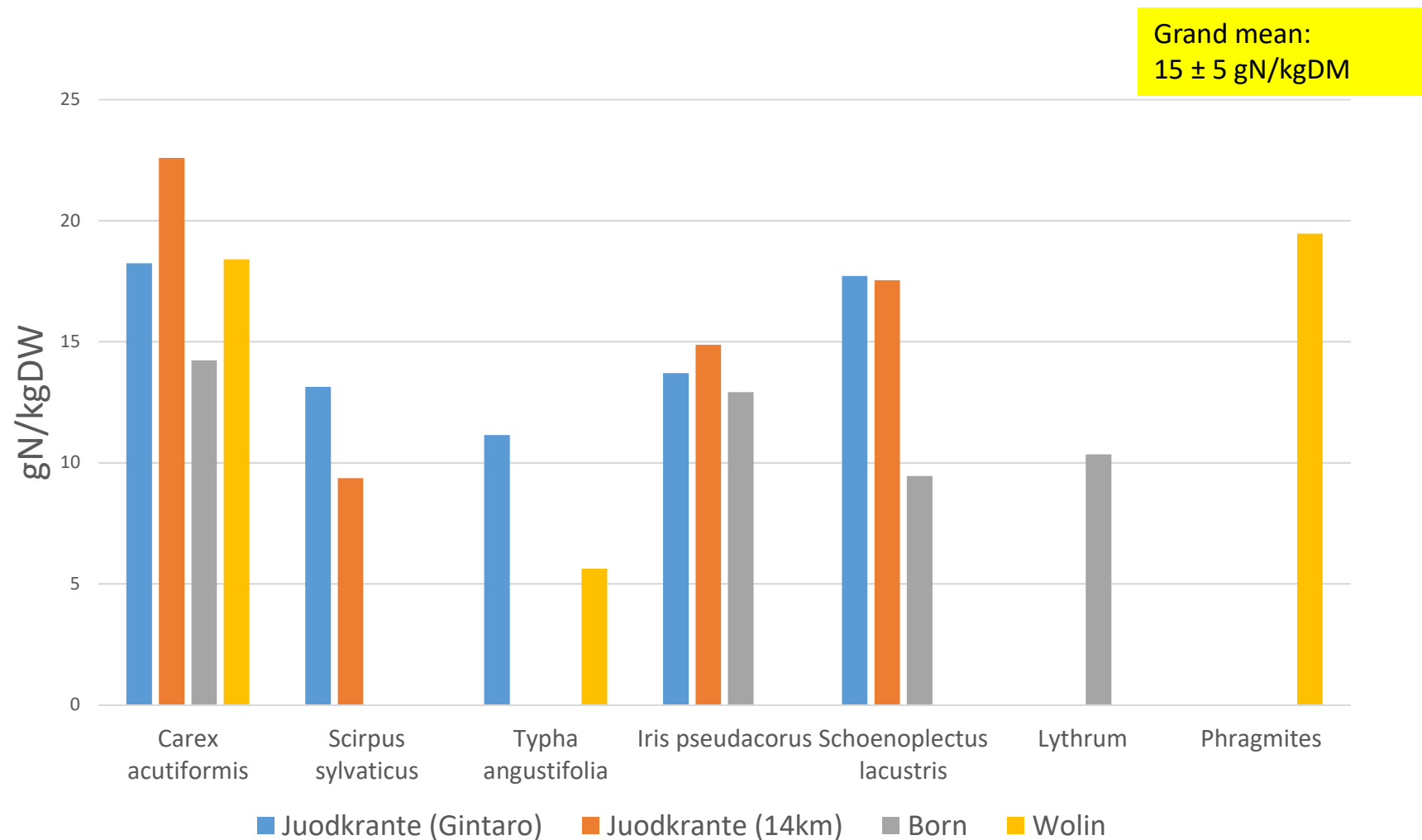
- Less damaged by wave action
- Higher survival of planted plants
- Higher initial density of plants
- Less spontaneous species

P content in plants: comparison of sites

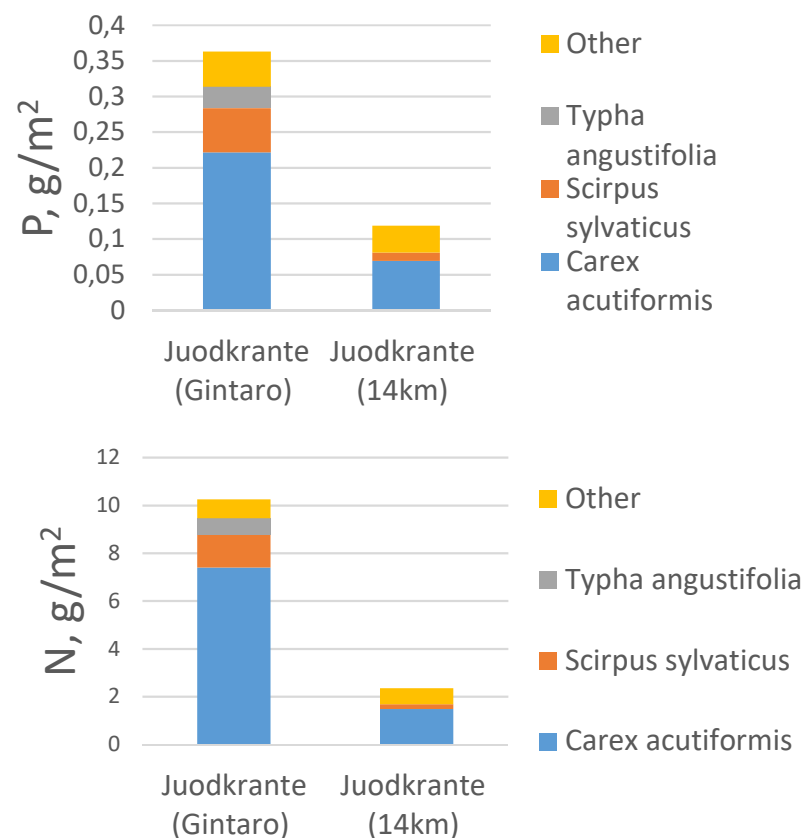
Grand mean:
 0.9 ± 0.4 gP/kgDM



N content in Plants: comparison of sites

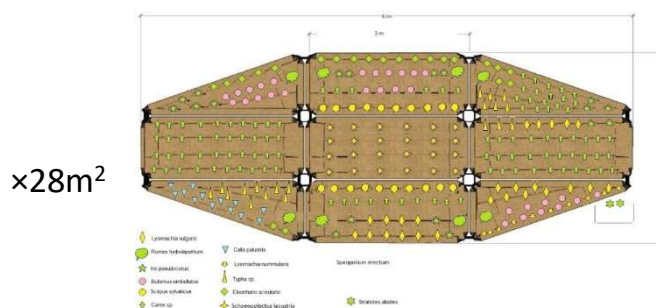


P and N removal capacity by plants



The aerial biomass could contribute only ~10% of nutrient removal, while the rest is accounted for root-associated microbial community.

Total capacity:
up to P– 3,6 gP/m² and N– 103 gN/m²



The annual impact of 28m² island:
~100 gP and 2822 gN

Habitats and biodiversity



Mallard (*Anas platyrhynchos*) nest
on artificial island

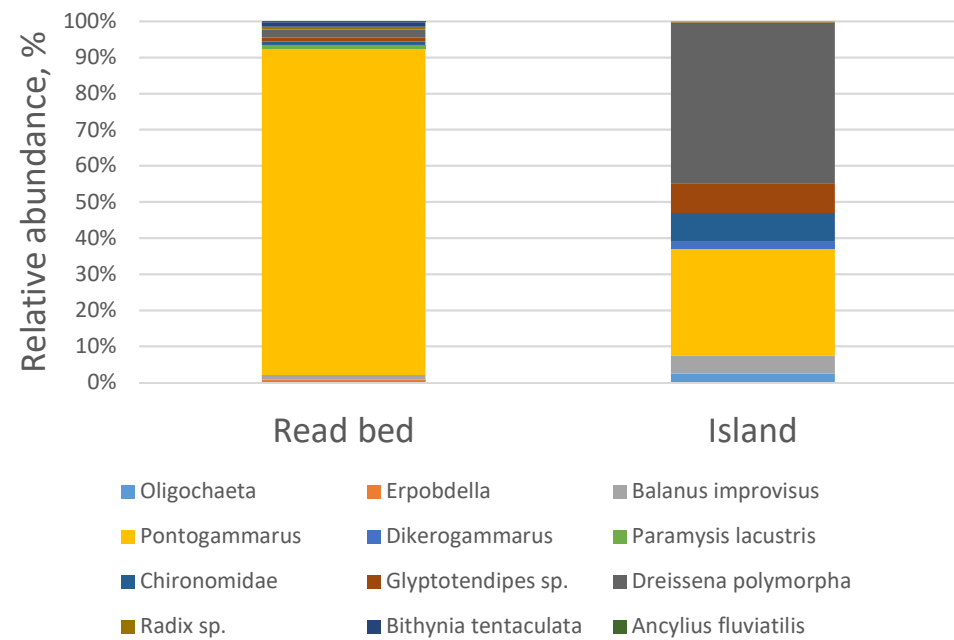


More than eight yellow eels were hiding inside the small islands made out of natural reed stems!



Biodiversity: Reed bed vs. Island underwater habitat

- Taxa number: 11 vs. 9
- Diversity index H' 0.5 vs. 1.5



Conclusions

- Differences in water quality parameters in case of the net type experimental design are rather the result of water circulation restriction than biological activity of plants
- Settling of larvae and subsequent growth of zebra mussels contribute significantly to the nutrient removal capacity of plants
- The plant biomass production varies significantly between the experimental sites, as well as relative content of N and P of the same plant species. Both physical and chemical factors (salinity and nutrient concentrations) are expected to be responsible for
- Artificial floating wetlands provide a habitat which has higher benthic biological diversity than neighboring reed beds being also attractive for fish (yellow eels) and birds
- Artificial island placed in the front of exposed sandy beach altered the erosion/accumulation processes
- Artificial wetlands are more esthetically appreciated in urbanized locations

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