Floating wetlands

Water quality

Biodiversity

Landscape aesthetics

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Too many nutrients in the Baltic Sea

An excessive accumulation of nutrients can impair the ecological conditions of water bodies. The Baltic Sea, especially its coastal waters, are frequently affected by this so-called eutrophication. The increased supply of nutrients, such as nitrogen and phosphorus, results in an increased growth of microscopic algae and cyanobacteria. This large primary production leads to water turbidity. As a result, less light can penetrate into deeper water layers and higher aquatic plants at the bottom may die. Plants are decomposed by bacteria with a high oxygen consumption which decreases the oxygen concentration in the water and worsens animal living conditions.

Additional measures required

Eutrophication is mostly caused by high nutrient inputs from land, for example via municipal wastewater or leaching from agricultural soils. Therefore, the main focus should remain on reducing nutrient inputs. However, to reduce nutrients already in coastal waters and to achieve good water conditions that meet the objectives of the European Water Framework Directive, additional internal measures are also urgently needed. These include, for example, mechanical measures such as sediment dredging or biological measures such as the cultivation of mussels, algae and salt-tolerant plants.

Planted floating wetlands as allrounders

Floating wetlands can be used flexibly as mobile biofilters to improve local water quality. The islands, covered with macrophytes such as rushes or water flags, are really multi-talented and bring many benefits: the plants absorb nutrients such as nitrogen or phosphorus from the water body, oxygen enters the water body through their root system and bacteria ensure that nitrate is converted to molecular nitrogen which can leak into the atmosphere. The floating wetlands also calm currents, enhance sedimentation and particle settling and thus enable increased water transparency which is appreciated by tourists and residents. In addition, the floating wetlands create diverse habitats for birds, fish and insects and can represent local biodiversity hotspots. Eels and shrimps, in particular, appreciate the dense root system as a refuge. Protected red-listed plant species can grow undisturbed and the integration of flowering plant species, such as purple loosestrife, creates attractive places in coastal waters.

Bioremediation especially at point sources

Floating wetlands are not a tool for large-scale water body restoration. However, they are suitable and effective at point sources, for example at aquaculture sites, drainage estuaries or at sites with internal nutrient re-suspension from sediments. Floating wetlands can also compensate for missing ecosystem services along waterside promenades or coastal protection structures where a natural coastal wetland can no longer grow undisturbed.

Planted floating wetlands provide the following ecosystem services:

- ✓ Nutrient regulation
- ✓ Regulation of erosion
- ✓ Improvement of water quality
- ✓ Biodiversity
- ✓ Habitat function
- ✓ Crop plants
- ✓ Food supply
- ✓ Landscape aesthetics

Floating wetlands provide a valuable habitat for insects and refuge for aquatic fauna such as shrimps and eels.

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Implementation sites

In pilot studies within the LiveLagoons project (EU Interreg South Baltic), floating wetlands have already been in use within coastal waters of Lithuania, Poland and Germany since 2018.

Floating wetlands can be an asset in marinas.

The plants on the island are already in full bloom after a few months.

Lagoon	Salinity at site	Cultivated plant species
Darss-Zingst-Bodden-Chain, Germany	2 - 6 PSU	Purple loosestrife (*Lythrum salicaria*) Bayonet-grass (*Bolboschoenus maritimus*) Sea-side aster (*Tripolium pannonicum*) Marsh arrowgrass (*Triglochin palustris*) Water flag (*Iris pseudacorus*) Swamp sedge (*Carex acutiformis*) Lakeshore bulrush (*Schoenoplectus lacustris*)
Szczecin Lagoon, Poland	2 - 3 PSU	Broadleaf cattail (*Typha latifolia*) Phragmite (*Phragmites australis*) Narrow-leaved cattail (*Typha angustifolia*) Water flag (*Iris pseudacorus*) Swamp sedge (*Carex acutiformis*) Lakeshore bulrush (*Schoenoplectus lacustris*) Greater pond sedge (*Carex riparia*)
Curonian Lagoon, Lithuania	0 - 7 PSU	Broadleaf cattail (*Typha latifolia*) Common rush (*Juncus conglomerates*) Narrow-leaved cattail (*Typha angustifolia*) Water flag (*Iris pseudacorus*) Swamp sedge (*Carex acutiformis*) Lakeshore bulrush (*Schoenoplectus lacustris*) Wood bulrush (*Scirpus sylvaticus*)

The different site conditions in the three lagoons along the Baltic Sea require an adaption of the material and plant selection. The following table provides an overview.

Materials used	**Anchoring**	**Nutrient removal**	**Challenges at the sites**
Thermally modified spruce wood, connecting and fixing elements made of stainless steel, planting with cultivated mats	Steel ropes at floating jetty	0.45 g P m^{-2} and 6.96 G N m^{-2} (harvest of biomass on 02/09/2020)	Drift ice, pressure at the jetty due to wind, impairment of habitat function due to a nearby aquaculture facility
Hollow plastic tubes (HDPE) encased with fibrous coconut and a spanning net made of plastic (PP), connecting and fixing elements made of stainless steel, planting via seedlings	Steel ropes at a harbor line of a marina	Data still pending	Drift ice, pressure at the jetty due to wind and waves from boats, impairment of habitat function due to boat tourism, the domination of reeds on the structure already after two years, potential input of microplastics through the island into the water
Hollow plastic tubes (HDPE) encased with fibrous coconut and a spanning net made of plastic (PP), connecting and fixing elements made of stainless steel, planting via seedlings	Polyamide ropes attached to four weights (each 14 kg) at the bottom of the water	0.50 g P m^{-2} and 10.25 g N m^{-2} (harvest of biomass on 20/09/2020)	Drift ice, change in bottom sediment, shading of existing submerged macrophytes, potential input of microplastics through the island into the water

Thermally modified wood – the eco-friendly alternative

The concept of floating wetlands for the bioremediation of aquatic ecosystems is already established worldwide. However, up until now, the materials used have predominantly been based on artificial polymers. Plastics are often advertised as being resistant, recyclable and inexpensive but no consideration is made for the fact that wind, waves and ice lead to abrasion and attrition. Non–biodegradable microplastics can thus be carried into the water body. There is no sustainable method for the recycling of the plastic structures and downcycling often takes place. Polystyrene (PS), polyurethane foam (PU) or polyvinyl chloride (PVC) should be avoided completely. However, in the absence of alternatives, polyethylene (PE) may be useful at sites with strong hydrodynamic loads.

A success story on combining sustainability with robustness is the use of floating wetlands made of thermally modified wood. The floating matrix consists of a thermo pine base with surrounding scantlings made of thermo spruce. The planting is done with pre-cultivated mats. Since April 2019, a wooden island has been successfully used for water remediation at an aquaculture site in the Darss-Zingst-Bodden-Chain.

Pre-cultivated plant mats are placed on the wooden structure, which bloom splendidly in summer.

Aeration tissue of the lakeshore bulrush
More information on **www.blaue-bioökonomie.de**

Learning from the past

Something that has been missing in the product range so far is a completely biodegradable floating wetland made of sustainable materials. Therefore, one objective of the HaFF project – which is funded by the BMBF – is to develop floating wetlands made of native materials such as reeds or bulrushes. Reed beds, which dominate the wetlands along the inner coastal waters, have traditionally been mowed for centuries. Due to their aeration tissue (*aerenchyma*), rushes have good buoyancy and have been used for raft building in the past.

These and other indigenous materials could now experience a revival and contribute to sustainable water remediation. For the first time, traditional medicinal plants such as calamus (*Acorus calamus*), meadowsweet (*Filipendula ulmaria*), watercress (*Nasturtium officinale*) and water mint (*Mentha aquatica)* are also being cultivated on the floating islands. Proposals for use of the produced biomass will be developed and processing routes will be designed.

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From an idea…

Before floating wetlands can contribute their multiple talents for water remediation, numerous questions have to be answered: What size and shape should the floating island be? Should it be able to modularly expand? What materials should be used? Appropriate planting also needs to be considered and chosen depending on whether the structure's primary function is nutrient removal, erosion protection, habitat suitability or aesthetics and whether the harvested biomass will be further used for food, medicine, cosmetics or construction materials? All of these criteria affect plant selection and species composition.

Nevertheless, the following aspects should be taken into account: The selected macrophytes must be native, perennial, moisture-loving and salt-tolerant, if applicable.

Approval procedures for a floating wetland using the example of the Szczecin Lagoon
(>coastal water, water body category 1, federal waterway)

River and shipping licenses	Nature conservation permissions	Water law permissions
Waterways and Shipways Office WSA Stralsund	local nature conservation agency LK Vorpommern-Greifswald	local lower water authority StALU VP
§31 WaStrG	§13 – 18 BNatSchG, § 40 NatSchAG M-V	additional report according to § 89 Abs. 1 LWaG in case of installation in the 200 m coastal strip

Water usage (§ 9 Abs. 1 Nr. 4 WHG) requires permission according to § 8 Abs. 1 WHG.
Exception: research in coastal waters (§ 43 WHG in combination with § 23 No. 1 LWaG)

…to realization

Once these decisions have been made, the relevant documents for the approval process should be prepared. Another aspect that plays a major role for coastal communities is financing. Nutrient removal could, for example, find supporters via crowd funding platforms, harvested biomass could be profitably marketed, or a government grant could be applied.

EUCC-D is pleased to advise and guide you through all aspects from the choice of materials and plants, suitable funding programs, the approval process to installation procedures.

Purple loosestrife adds splendid splashes of color to the landscape. Reeds and bulrushes with their long rhizomes enhance sedimentation.

Who supports you?

EUCC – THE COASTAL UNION GERMANY is committed to the sustainable development of the sea and coast, especially within the Baltic Sea region. Therefore we work closely with science, economy and politics, disseminating knowledge to the public and training decision makers of tomorrow. Our topics range from aquaculture, coastal tourism and beach management to educational measures. The field of water management has been close to our hearts for many years. With our projects on floating wetlands we would like to contribute to the improvement of water quality in the Baltic Sea. Participants from cities and communities as well as interested persons are welcome to join us to meet this objective.

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Consulting and support for…

Plant selection

Site selection

Approval process

Installation

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Project links
www.balticlagoons.net/livelagoons
www.blaue-biooekonomie.de

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