SUBMARINER ROADMAP
BEYOND 2021
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Together we improve the Baltic Sea environment
The SUBMARINER Network promotes innovative approaches to the sustainable use of marine resources and offers a cooperation platform to related actors and initiatives in the Baltic Sea Region.
Assessing Seven Years of Submariner Work

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ASSESSING SEVEN YEARS OF SUBMARINER WORK
1. About the SUBMARINER Network

1.1 The evolution of SUBMARINER since 2015

The SUBMARINER Network for Blue Growth EEIG, a flagship umbrella project of the EU Strategy for the Baltic Sea Region, was established in 2013. Since then it has developed into the leading transnational hub in the Baltics for promoting sustainable and innovative uses of marine resources. The Network brings together authorities, research and innovation actors – both public and private – across the Baltic Sea Region, integrating perspectives from local to transnational scale and different scientific and economic spheres.

The work of the SUBMARINER Network for Blue Growth EEIG between 2015 and 2020 has been guided by the topics and actions described in the SUBMARINER Roadmap (dated 2013) as necessary to realise innovative and sustainable uses of marine resources throughout the Baltic Sea Region.

Starting off from an initial set of seven full members only, the SUBMARINER Network has by now attracted many new relevant institutions and individual experts to join currently counting for ten full members and 28 associate members.

With no statutory support, the Network has over the course of the past years, succeeded in leveraging the membership funding by applying for project
funding under the various Baltic Sea Region INTERREG schemes, Horizon 2020, EMFF projects, EEA Norway Grants as well as national programmes.

1.2 Overview on SUBMARINER Projects

Until 2020, the SUBMARINER secretariat has initiated 25 transnational projects, of which 20 received funding with a total volume of more than 41 million €, of which almost 30 million € are for activities in the Baltic Sea Region. The projects provided an extra funding of € 1.25 million to the SUBMARINER secretariat; while an additional total volume of more than 13 million € has been allocated to SUBMARINER members. This funding allowed members to implement the activities defined in the roadmap. Moreover – individual SUBMARINER members have also been able to attract additional projects – in line with the SUBMARINER mission and thus forming part of its Baltic Sea wide knowledge and Actors hub.

The projects have also been a way to reach out and involve many more actors involved within the Blue Bio-economy: apart from the 40+ members, more than 150 other parties have participated in one or more of the SUBMARINER projects.

The original set of topics & actions from the Roadmap have over the course of the past years been slightly adapted as to cover new, important areas of work such as marine litter and underwater cultural heritage. Instead of dealing with reed harvesting only, projects have extended this topic to cover improved use of beach wrack and installation of artificial lagoons. Also new policy instruments such as Smart Specialisation and Maritime Spatial Planning have been added. Moreover, capacity building, training and skills development across all levels (i.e. from civil society to public authorities) have been added as crucial action fields.

SUBMARINER’S 1st GENERATION OF PROJECTS (CONCLUDED IN 2019/2020)

- **Smart Blue Regions**: Smart Specialisation and Blue Growth in the BSR
- **Baltic Blue Growth**: Initiating full-scale mussel farming in the Baltic Sea
- **InnoAquaTech**: Cross-border transfer of innovative & sustainable aquaculture technologies
- **MUSES**: Exploring opportunities for Multi-Use in European Seas
- **Baltic Blue BioTech Alliance**: Advancing marine bio-based product development
- **Baltic RIM**: Integrated Maritime Cultural Heritage Management

SUBMARINERS 2nd GENERATION OF PROJECTS (NUMEROUS TO BE FINALISED IN 2021)

- **GRASS**: Capacity building for public authorities on supporting macroalgae production & use
- **Blue Generation**: Inspire & engage young people to stake up Blue careers
• **Alliance+**: Advancing marine bio-based product development
• **UNITED**: Demonstrating Multi-Use in the North & Baltic Sea
• **Capacity4MSP**: Capacity Building for MSP
• **Blue Platform**: Advancing Blue Bioeconomy Capacities in the Baltic Sea

**SUBMARINER MEMBERS PROJECTS**

Some projects, highly relevant to the overall mission of SUBMARINER, involve SUBMARINER members, but not its secretariat. These projects include among others:

• **AquaLIT**: Working with the aquaculture sector to prevent marine litter (s.Pro)
• **AquaVIP**: Aquaculture Virtual Career Development Platform (Uni Gdansk, KSTP, CORPI)
• **CONTRA**: Conversion of a Nuisance to a Resource and Asset (SDU, Uni Tartu)
• **FUCOSAN**: Health from the Sea (GEOMAR, CRM)
• **SeaFarm**: Macroalgae for a biobased society, culture, biorefineries and energy (KTH, UGOT)
• **BAMS**: Bioeconomy for Blue Sites (CAU, CRM, Geomar)
• **SUSCULT**: Sustainable cultivation of seaweed (SYKE, KTH)
• **AquaVitae**: Low-Trophic Aquaculture in the Atlantic (IVL)
• **Multi-Frame**: Developing an Assessment Framework for Multi-Use

In addition, projects like Coastal BioGas and OPTIMUS are directly linked to SUBMARINER Roadmap actions, but are implemented by actors outside the SUBMARINER network current membership.

**UNSUCCESSFUL TOPICS STREAMS**

The following project applications submitted by SUBMARINER members were not successful:

• Efficient and relevant data & information sourcing to promote the blue bioeconomy
• Wave energy development in the Baltic Sea Region
• Developing sustainable feed systems for aquaculture
• Marketing & labelling of blue bioeconomy products & services
• Promoting blue economy investments & new funding mechanisms
• Promoting blue-green regional solutions
• Streamlining blue biotechnology product biodiscovery

This does not necessarily mean, that the topics in question should no longer be pursued by the SUBMARINER network. In some cases topics have, however, proven to be too far fetched as to offer real innovation boost; i.e. whereas ‘microalgae cultivations’ may play a crucial role in food and high value products and ‘wave energy’ may still be interesting as an additional source of energy in combination of other offshore installations; both are no longer seen as distinct topic fields. Whereas wave energy is now covered
under the ‘multi-use’ topic; microalgae has been included in the topic of blue biotechnology.

### 1.3 The Role of the SUBMARINER Network Secretariat

Right from the outset the SUBMARINER Network decided to install a permanent, central secretariat based in Berlin. The number of team members depend on project resources, but have over the past years included between 4–5 multi-lingual professionals with background in project coordination and communication.

All SUBMARINER members benefit from the following services provided by the secretariat:

- Promotion and representation of members’ competences and interests in news and events via all SUBMARINER network channels; e.g. website, quarterly newsletter, social media
- Exclusive member access to all internal information; funding opportunities; pitching and matchmaking events; annual members’ assembly and specific workshops, study visits and searchable database including more than 3,000 blue bio-economy actors
- Co-ordinated access and set-up of project development consortia, support, administration and facilitation of projects, thematic network working groups and set-up of project development consortia
- Joint formulation and dissemination of policy-oriented position papers
- Expert advice and coaching via the secretariat hub and/or direction to relevant network members

The continuous identification, communication, coordination and match-making between actors as well as ongoing identification of funding opportunities and project development has proven to be the most important overarching service facilitated by the SUBMARINER network secretariat.

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1. Identifying actors, competences and initiatives
2. SUBMARINER match-making: website, newsletter, events, projects
3. Members connected to right partners - taking their idea further in joint initiatives

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1. ABOUT THE SUBMARINER NETWORK
1.4 The SUBMARINER Vision

All activities of the SUBMARINER Network are guided by the strong belief that innovative and sustainable use of marine resources can contribute significantly not only to Baltic Sea Region, but global, challenges – which have by now been framed within the UN Sustainable Development Goals.

Most notably, SUBMARINER actions aim to address

| Reduce Climate Change | instruments and measures to reduce Greenhouse Gas Emissions |
| Reduce Pollution      | new measures for nutrient uptake; including dealing with the internal nutrient load within the Baltic Sea |
| Increase Biodiversity | offering new ways for ecosystem restoration by ‘building with nature’ |
| Increase Protection   | extending the concept to nature protection to noise and the seabed |
| Address Demographic Change | opening up towards new feed, food and material resources derived from the sea; which can be explored sustainably |
| Foster Competitiveness of the Baltic Sea Region | opening new economic activities not only in metropolitan areas, but also in rural, coastal regions offering additional income sources for societal groups, which lose jobs in traditional marine sectors |

By 2013, SUBMARINER topics were far from being commercially viable or politically established, but had already been addressed by numerous studies and research projects. The SUBMARINER Compendium published in 2012 represented the very first systematic compilation of these possible sustainable uses of marine resource; all of which aimed for restoring the Baltic Seas’ good environmental status as well as providing benefits to humans’ well-being. The following SUBMARINER Roadmap provided a strategic and systematic approach towards rolling out the various actions needed, in order to promote them across the Baltic Sea Region.

Seven years later, the following document provides for a first ex-post evaluation of what has been achieved in the meantime; which kind of new developments have to be considered by now and the resulting priorities of SUBMARINER actions for the coming future.
## 1.5 Benefits associated with SUBMARINER Topics

Concretely, the following uses of marine resources promoted by SUBMARINER entail the following benefits:

<table>
<thead>
<tr>
<th>Use</th>
<th>Rationale</th>
<th>Benefits</th>
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</thead>
<tbody>
<tr>
<td>Mussel Farming and Use</td>
<td>Additional sea-based measure to deal with the already existing nutrient load. Mussels can be used as a regional protein source in feed as well as other commercial applications.</td>
<td>Climate Change: ++ Biodiversity: +++ Nature Protection: ++ Demographic Change: ++ Regional Development: +++ EUs' Competitiveness: +</td>
</tr>
<tr>
<td>Macroalgae Harvesting, Cultivation &amp; Use</td>
<td>Baltic macroalgae can provide an important food and feed source, but also a valuable resource for ingredients, materials and energy. Green, red and brown, algae species can grow inside the Baltic proper providing ecosystem services, e.g. nutrient load reduction, habitat provision and increased localised CO2 fixation.</td>
<td>Climate Change: + Biodiversity: +++ Nature Protection: + Demographic Change: ++ Regional Development: +++ EUs' Competitiveness: +++</td>
</tr>
<tr>
<td>Harvest of Floating Emergent Aquatic Plants</td>
<td>Various ecosystem services are supplied by emergent macrophytes and halophytes on floating structures: Nutrients and pollutants are absorbed from the water column and wave energy attenuated. The root network provides shelter to aquatic fauna and increases microbial biodiversity. The flowering plants can create colourful landmarks; enhance the aesthetic value of and benefit tourism. Coastal municipalities have shown much interest.</td>
<td>Climate Change: ++ Biodiversity: +++ Nature Protection: + Demographic Change: ++ Regional Development: +++ EUs' Competitiveness: +</td>
</tr>
<tr>
<td>Collection and Use of Beach-wrack</td>
<td>Wrack along the Baltic Sea coast-line it mainly consists of torn off eelgrass, brown, red and green macro algae, seashells, and dead animals, which are washed ashore on the beach. The methodologies employed and the treatment of this nutrient rich resource do not exploit its full potential for water management and pollution reduction.</td>
<td>Climate Change: ++ Biodiversity: +++ Nature Protection: - Demographic Change: - Regional Development: +++ EUs' Competitiveness: +</td>
</tr>
<tr>
<td>Sustainable Fish &amp; Shrimp Aquaculture</td>
<td>The importance of aquaculture as a source of animal protein has increased dramatically over the past years as fish stocks are decreasing and agricultural systems cannot keep up with the increased demand for healthy food. - Land-based systems such as Recirculating Aquaculture or Aquaponics and Marine systems such as Integrated Multi-Trophic Aquaculture or offshore installations create opportunities for more regional fish &amp; shrimp production.</td>
<td>Climate Change: - Biodiversity: +++ Nature Protection: + Demographic Change: ++ Regional Development: +++ EUs' Competitiveness: +++</td>
</tr>
<tr>
<td>Blue Biotechnology</td>
<td>Baltic marine and freshwater ecosystems host a thriving biological diversity of organisms with many possibilities for further advancements across various value chains. Whereas aquaculture can supply blue biotechnology with primary and secondary resources; blue biotechnology is crucial in all steps from growing biological resources to recovering biomaterials from process side-streams.</td>
<td>Climate Change: - Biodiversity: +++ Nature Protection: + Demographic Change: ++ Regional Development: +++ EUs' Competitiveness: +++</td>
</tr>
<tr>
<td>Multi-Use of Marine Space</td>
<td>Ocean multi-use can contribute to a more sustainable and efficient use of ocean resources, by reducing the demand of 'un-used' sea space and potentially offering significant socio-economic and environmental benefits.</td>
<td>Climate Change: ++ Biodiversity: +++ Nature Protection: +++ Demographic Change: ++ Regional Development: +++ EUs' Competitiveness: +++</td>
</tr>
<tr>
<td>Marine Litter</td>
<td>Marine Litter has not only devastating consequences for the marine environment; but also cause serious economic damage: losses for coastal communities, tourism, shipping and fishing. At the same time, valuable material that could be brought back into the economy is lost, once littered.</td>
<td>Climate Change: - Biodiversity: +++ Nature Protection: + Demographic Change: ++ Regional Development: +++ EUs' Competitiveness: +++</td>
</tr>
<tr>
<td>Cultural Heritage</td>
<td>The Baltic Sea Region underwater and maritime cultural heritage forms a rich and diverse assemblage that has cultural and societal values. New forms of dealing with UCH can provide jobs and revenues due to new tourism services; increase public appreciation of the value and significance of UCH sites; while at same time enabling better protection, maintenance and control of them.</td>
<td>Climate Change: - Biodiversity: + Nature Protection: +++ Demographic Change: ++ Regional Development: +++ EUs' Competitiveness: +</td>
</tr>
</tbody>
</table>
1.6 Strategic Actions foreseen to reap these benefits

The following strategic actions had been identified in the SUBMARINER roadmap to achieve the ambitions set out in the SUBMARINER compendium. The following overview shows how the various projects were able to address these actions:

1.6.1 Actors Mapping / Match-Making

Objective: Continuous identification and matching of public and private actors involved in new marine uses as to achieve better and faster results with less resources

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<thead>
<tr>
<th>Status</th>
<th>Projects</th>
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<tr>
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<td>ALL</td>
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<td>Blue Platform</td>
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<td>ALL</td>
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<td>Alliance</td>
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Collect information, establish and maintain a BSR-wide database on:
- Research institutions, researchers and experts;
- Companies;
- Past and ongoing activities and projects;
- Intermediaries and transfer organizations;
- New research and project ideas;
- (Bio-)technical equipment;
- Available education in various levels;

Support actions for
- information and contact exchange among new marine use stakeholders;
- networking & coordination with other networks;
- organisation of sectoral and cross-sectoral match-making events;
- identify potential linkages between natural and socioeconomic research and introduce research results of both disciplines to each other;
- communication across EUSBSR stakeholders and related BSR projects;
- facilitate good practice transfer from traditional maritime sectors as well as terrestrial bio-economy stakeholders to SUBMARINER cases

Include marine sectors into BSR region wide research and technology development projects, which integrate knowledge for whole the Baltic Sea catchment area, e.g. energy, waste treatment, CO₂ capture and storage, socio-economic aspects.

1.6.2 Data / Tools / Environmental Monitoring

Objective: A structured approach to fill the gaps identified in SUBMARINER Compendium 2012 on blue biomass resources and the environmental impacts associated with their increased use.

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<th>Status</th>
<th>Projects</th>
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<tbody>
<tr>
<td></td>
<td>GRASS CONTRA</td>
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<tr>
<td></td>
<td>BBG CONTRA GRASS</td>
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<tr>
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<td>BBG Ecopelag Optimus</td>
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</tbody>
</table>

- Establish and implement BSR-wide best practices for monitoring and systematic mapping of:
  - biomass resources (macroalgae, reed)
  - nutrient resources and CO₂ sources for microalgae cultivation
- Conduct systematic research on the role of reed beds and harvesting, macroalgae and mussel harvesting and cultivation on local biodiversity and water quality
- Assess consequences for nutrient regeneration, biogeochemical cycling and benthic habitat deterioration arising from increased sedimentation and sediment oxygen uptake by mussel cultivations
1. ABOUT THE SUBMARINER NETWORK

1.6.3 Access to Pilot Sites & Facilities

Objective: establish more such pilot sites around the Baltic Sea Region to enable empirical research.

<table>
<thead>
<tr>
<th>Status</th>
<th>Projects</th>
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<tbody>
<tr>
<td>Mussel cultivation pilot sites</td>
<td>BBG / Ecopelag, OPTIMUS / German Study</td>
</tr>
<tr>
<td>RAS technologies in combination with specific sites around the Baltic Sea</td>
<td>InnoAquaTech</td>
</tr>
<tr>
<td>IMTA: investigate site-specific solutions with varying combinations of fish, algae and mussel farming at one site in order to find optimal technical and economical solutions</td>
<td>BBG / AquaVitae, One case: Musholm / DK</td>
</tr>
<tr>
<td>Macroalga cultivation pilot sites</td>
<td>SeaFarm / GRASS (only sites at West Coast)</td>
</tr>
<tr>
<td>Pilot sites for reed harvesting</td>
<td>CONTRA (use of Beach wrack)</td>
</tr>
<tr>
<td>Microalgae cultivation pilot site(s) for multidisciplinary research around uses for large-scale cultivation, including test sites for nutrient removal from waste streams;</td>
<td>No project but examples in Sweden / cases in Alliance accelerator</td>
</tr>
<tr>
<td>Biorefinery pilot sites</td>
<td>Macrocascade</td>
</tr>
<tr>
<td>Pilot sites for agar production</td>
<td>Wave Project rejected</td>
</tr>
</tbody>
</table>

1.6.4 Technology Development & Transfer

Objective: develop environmentally friendly and cost efficient technologies suitable for Baltic Sea conditions taking into account knowledge and technologies from terrestrial resources

- Collect information about technologies and scientific expertise available at national level;
  - Match-making between technology providers and users;
  - Introduce technologies and know-how available in other BSR countries to national research organisations and companies;
  - Offer study visits, meetings, info websites

- Scout for pilot installations and technology providers; enhance information exchange between technology providers and users, foster technology developments:
  - Underwater mussel and macroalgae farming technologies crucial for Baltic Sea conditions (i.e. ice / open coasts);
  - Environment friendly reed and beach-wrack harvesting technologies;

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<tr>
<th>Status</th>
<th>Projects</th>
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<tbody>
<tr>
<td>BBG InnoAquaTech Alliance SmartBlueRegion GRASS AquaLIT</td>
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<tr>
<td>BBG / GRASS / SeaFarm CONTRA</td>
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### 1.6.5 Regional energy solutions with marine resources

**Objective:** ‘Encourage appropriate consideration of marine resources in energy planning in order to create markets for climate friendly energy production’.

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<td>COASTAL Biogas</td>
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</table>

- Develop concepts for integration of marine resources in regional plans on renewable energy and climate protection;
  - Introduce concept of smart combinations of uses, where a systematic approach to biomass use beyond the energy sector complements the biorefinery concept;
  - Develop economic models for use of marine resources in renewable energy production and well as regional studies & models

- Develop a placement strategy for biorefineries using marine resources around coastal regions;
  - Improve networking among biorefineries across BSR;
  - Use experience of forestry and agriculture in blue refinery concepts;
  - Encourage technology development and continue to refine the process of biogas from marine resources;
  - Optimize techniques and logistics for harvesting biomass, transport to biogas plants, and for refining products;

- Promote use of small scale wave energy generators

### 1.6.6 Introduce ecosystem service payments

**Objective:** ‘Develop an accepted approach to valuation of ecosystem services and propose compensation mechanisms for the provision of ecosystem services by new marine uses’.

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<th>Status</th>
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<td>Mussel WG</td>
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</table>

- Proactively liaise and inform EU, HELCOM and relevant Priority Areas of initiatives related to valuation and compensation of ecosystem services

- Develop recommendations and proposals for establishment of ecosystem service compensation schemes based on:
  - Analysis of existing and proposed (if any) compensation mechanisms;
  - Assess the role of private sector and NGOs and get them involved;
  - Consider and assess various possible schemes, i.e. via taxes (polluter pays, provider of ecosystem services gets subsidized), national and transnational models; possible voluntary initiatives (e.g. Baltic Sea friendly coastal municipality); market opportunities (e.g. farmers buy aquaculture products for fertilizer or biomass, N quotas);

- Generate life cycle assessments and techno-economic models pertinent to local conditions in the BSR to critically examine the costs and benefits of new uses and technologies compared with existing solutions

- Assess the role of Blue Biotechnology products with respect to benefits to ecosystem services

- Develop a practical BSR-wide methodology for valuation of ecosystem services, as the basis for ecosystem services compensation schemes

- Assess the applicability of new marine uses on ecosystem services for different sub-regions of the BSR
1.6.7 Unlock financing for innovative uses of marine resources

Objective: ‘Improve access to finance for collaborative projects for private and public stakeholders.’

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<td>ALLIANCE+ InnoAquaTech</td>
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</table>

Collaborate with investment funds, venture capital organizations:

- Establish contacts with public and private financing organizations;
- Identify offers, interests and needs by financing bodies and fields of cooperation;
- Raise awareness among researchers, research institutes and other stakeholders on requirements of “bankable” projects;
- Study and assess innovative forms of knowledge brokerage;
- Initiate individual and multilateral meetings and consultations.

Improve relationship between public research and private companies:

- Raise awareness among industry on project opportunities and benefits to be gained from participation in public funded programmes and seek their active input;
- Study and assess challenges for private-public collaboration;
- Identify, assess and disseminate good practices of private and public collaboration, develop “vademecum / guidelines”;
- Organize and attend workshops showing case studies on how companies and research can collaborate;
- Encourage and assist networking and concrete development of Public-Private Partnerships at regional and local level.

Develop applications to both public and private funding programmes:

- Inform SUBMARINER Network partners on funding opportunities and their specific requirements and vice versa;
- Develop strong triple-helix project partnerships based on partner institutions strengths.

1.6.8 Create better legal and regulatory conditions

Objective: ‘Reduce vagueness in legislation and regulations for innovative uses of marine resources’.

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<tr>
<th>Status</th>
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<td>BBG, GRASS</td>
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Assess the existing integration of innovative uses of marine resources in relevant EU Directives and establish a dialogue with national authorities and EU Directorates

Consider how new uses of marine resources shall be considered in Maritime Spatial Planning (i.e. develop pilot plans in various regions, develop criteria for “suitable sites”);

BSR-wide agreement on integrating reed and mariculture cultivations as an environmental remediation measure under the HELCOM BSAP

Recommendations on incentives for combinations with offshore wind parks

Assess tools for ensuring the exploitation rights for all actors involved in finding, development and commercialization of Blue Biotechnology products.

Foster a joint interpretation on targets set by relevant EU Directives (Natura 2000, WFD, MFSD) with regard to “harvesting” marine resources (e.g. macroalgae, reed);

Recommendations for a common approach to use fish aquaculture for restocking

1.6.9 Public Awareness

Objective: Create a market in which consumers are aware of the benefits of sustainable blue products and are motivated to contribute to solutions.

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<td>Blue Platform</td>
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Carry out public awareness campaigns:

- Identify and create success stories (local, regional, national);
- Produce and disseminate "SUBMARINER" newsletter and/or magazine;
- Create information material on potential of new and innovative sustainable marine resources;
- Undertake campaigns on value of ecosystem services and nutrient recycling;
- Create cooperation with media to integrate them into public campaign.
<table>
<thead>
<tr>
<th>Conduct market surveys on products from marine resources</th>
<th>GRASS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carry out information campaigns, workshops and involve companies on:</td>
<td>BBG Alliance Blue Platform Fucosan CONTRA</td>
</tr>
<tr>
<td>• new and local fish species (regional level)</td>
<td></td>
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<td>• development of new fish, chicken &amp; cow feed</td>
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<td>• organic fertilizers;</td>
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<tr>
<td>• blue biotechnology applications;</td>
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<td>• reed / beach cast as ecological insulation material;</td>
<td></td>
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<tr>
<td>Support establishment of a Baltic Sea Brand and Distribution Network for:</td>
<td>Sea2Fork rejected</td>
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<tr>
<td>• Fish &amp; Algae from BSR aquaculture;</td>
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<tr>
<td>• Mussel meal products and organic fertilizers;</td>
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<tr>
<td>• Cosmetics, health care and wellness products;</td>
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2. SUBMARINER Topics: Achievements

2.1 Mussel farming in the Baltic

2.1.1 Projects

Since the publication of the SUBMARINER roadmap (2013) a variety of projects have been funded, which relate to Mussel Cultivation at the Baltic Sea Region:

<table>
<thead>
<tr>
<th>Project Title</th>
<th>Funding</th>
<th>Duration</th>
<th>SUBMARINERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baltic Blue Growth</td>
<td>Interreg BSR</td>
<td>2016–2019</td>
<td>Östergötland (SE), LIEA (Lat), Ministry SH (DE), MIG (PL), Uni Tartu (EE)</td>
</tr>
<tr>
<td>OPTIMUS</td>
<td>BONUS</td>
<td>2017–2020</td>
<td>UGOT (SE)</td>
</tr>
<tr>
<td>Rich Waters</td>
<td>LIFE IP</td>
<td>2017–2024</td>
<td>IVL (SE)</td>
</tr>
<tr>
<td>AquaVitae</td>
<td>Horizon</td>
<td>2019–2022</td>
<td>IVL (SE)</td>
</tr>
<tr>
<td>Combined Marine Aquaculture</td>
<td>MV (DE) Funding</td>
<td>2019–2023</td>
<td></td>
</tr>
<tr>
<td>SNOOP</td>
<td></td>
<td></td>
<td>KTH (SE)</td>
</tr>
<tr>
<td>MuMiPro</td>
<td>Danish Innovation</td>
<td>2019–2021</td>
<td></td>
</tr>
<tr>
<td>BalticSeaFeed</td>
<td>Swedish Institute</td>
<td>2020–2021</td>
<td>KTH, Kalmarsund, UGT (SE)</td>
</tr>
</tbody>
</table>

2.1.2 State of Play

By 2020, mussel farming in the Baltic Sea Proper is nevertheless still in infancy, with hardly any large commercial farm being operational yet in the region.

The SUBMARINER Network secretariat has taken the role to coordinate and synthesize the results of the various projects dealing with mussel cultivation in the Baltic Sea Region and to continuously update and feed them with new information coming in from research as well as operational farms. The Mussel Working Group established and facilitated by the SUBMARINER Network secretariat – through regular online meetings – allows for a regular experience and data exchange among all relevant actors.

The Working Group has published a policy paper¹, which summarizes the data and results of the simultaneous projects researching the possibilities of mussel farming in the Baltic proper.

The paper provides the following evidence of the positive results achieved that encourage scaling up:

1. There is **no difference** in the **total amount of mussel meat** (dry matter) between mussels cultivated in high or low salinity areas.

---

2. There is much less difference than previously expected between the nutrient content of mussels cultivated in lower or higher salinity levels.

3. The sedimentation from the studied mussel farms was highly local and less than expected, and no oxygen depletion was noted in the near-bottom waters.

4. The number of mussels produced by farms in the Baltic proper as well as possible negative impacts are heavily influenced by a number of environmental conditions, including availability of nutrients, temperature and movement of the water, as well as the occurrence of predators.

5. Sites should be carefully selected in view of
   - investment and production costs,
   - pricing and market stability,
   - infrastructure to connect to shore,
   - lowering the risk of mussels dislodging from the substrate.

6. The current projects show that there is further potential for cost reductions.

7. Mussel meal is a good raw material and feed ingredient

### 2.1.3 Conclusions and Recommendations

1. Complement land-based nutrient reduction measures with appropriate marine actions for nutrient removal in order to achieve the Baltic Sea environmental goals.

2. Consider restorative aquaculture for the restoration of declining wild mussel populations and in the long-term supporting the declining Eider duck population, should be considered in potential support schemes.

3. Identify and pick most optimal location

4. Invest in more and larger demonstration farms at these strategically selected sites.

5. Develop the mussel market within the feed industry.

6. Look into further commercialization options of Baltic Blue Mussel biomass.

7. Allow for the expansion of an environmentally friendly, sustainable marine fish aquaculture industry at selected sites within the Baltic Sea Region coupled with mussel farms in IMTA systems.

8. Provide further support to first runner mussel farms.

### Areas, Salinity, Meat dry matter% % Soft tissue soft tissue fat % N (% soft tissue dry weight) P (% soft tissue dry weight)

<table>
<thead>
<tr>
<th>Areas</th>
<th>Salinity</th>
<th>Meat dry matter%</th>
<th>% Soft tissue</th>
<th>Soft tissue fat %</th>
<th>N (% soft tissue dry weight)</th>
<th>P (% soft tissue dry weight)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Western Baltic</td>
<td>High</td>
<td>15.1 a</td>
<td>58 a</td>
<td>9.5 a</td>
<td>9.5 a</td>
<td>1.41 a</td>
</tr>
<tr>
<td>Central Baltic</td>
<td>Moderate</td>
<td>14.2 a</td>
<td>52 b</td>
<td>10.3 a</td>
<td>10.3 a</td>
<td>1.48 a</td>
</tr>
<tr>
<td>Eastern Baltic</td>
<td>Low</td>
<td>13.7 a</td>
<td>41 c</td>
<td>9.7 a</td>
<td>9.7 a</td>
<td>1.33 a</td>
</tr>
</tbody>
</table>
2.2 Macroalgae Harvesting and Cultivation

2.2.1 Projects

<table>
<thead>
<tr>
<th>Project Title</th>
<th>Funding</th>
<th>Duration</th>
<th>SUBMARINERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baltic GRASS</td>
<td>Interreg BSR</td>
<td>2019–2021</td>
<td>KTH (SE), SYK (FI), Uni Tartu (EE), NMFRI (PL), SUBMARINER Secretariat</td>
</tr>
<tr>
<td>FUCOSAN</td>
<td>Interreg DE-DK</td>
<td>2016–2020</td>
<td>SDU (DK), Ocean Basis, CAU, GEOMAR (all DE)</td>
</tr>
<tr>
<td>SEAFARM</td>
<td>FORMAS (SE)</td>
<td>2015–2020</td>
<td>KTH (SE), Uni Gothenburg (SE)</td>
</tr>
<tr>
<td>TANG.NU</td>
<td>Villum/Velux (DK)</td>
<td>2017–2020</td>
<td>Guldborgsund Municipality</td>
</tr>
<tr>
<td>Aquavitae</td>
<td>Horizon</td>
<td>2020–2023</td>
<td>IVL</td>
</tr>
<tr>
<td>Macrofields</td>
<td>Horizon</td>
<td></td>
<td>KTH (SE)</td>
</tr>
<tr>
<td>Macrocascade</td>
<td>BBI-JU</td>
<td>2020–2021</td>
<td>KTH, Kalmarsund, UGOT (SE)</td>
</tr>
<tr>
<td>MABA</td>
<td>BBI-JU</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Cultivation technology for

- Ceramium tenuicorne: EMFF Estonia 2020–2022 Uni Tartu, Estonian Marine Institute
- Ulva intestinalis: EMFF Estonia 2020–2022 Uni Tartu, Estonian Marine Institute

Seaweed assessment and management plan Latvia’s seacoast: Latvian FLAG 2018

2.2.2 State of Play

By 2020 production of macroalgae and seaweed is at a nascent phase in the Baltic and almost 100% macroalgae raw material supply come from import from third countries, like Norway, Russia, China, and Japan. Due to the reduced salinity levels fewer species with a commercial value can grow in the Baltic Proper. The most promising seaweed species are *Fucus vesiculosus* and *Ulva intestinalis*. In the Western part of Baltic, where salinity is higher, *Saccharina latissima*, *Laminaria digitata*, and *Palmaria palmata* can also be cultivated, all of which are very popular cultivars in Europe.

Commercial macroalgae production activities in the Baltic are mostly limited to wild harvesting at local radius, with Denmark being the largest seaweed producer (100 tonnes in 2018). Only 6 marine seaweed farms exist; all being located in the Western Baltic and all growing *Saccharina latissima*. In addition to these primary producers, however, already around 60 commercial companies are active in processing and producing seaweed products marketed in the Baltics.

The market potential of seaweed in Europe is estimated as high as 9,3 bn € with high potential for feed, food, pharmaceuticals, cosmetics, biofertilizers, biofuels and ecosystem services. About 30% of this market could be met by European supply by 2030 by producing as much as 8,3 million tonnes fresh weight seaweed, thus increasing the EU production of 2015 27-fold. Also in the Baltic, it is expected that seaweed cultivation activities will grow exponentially in Denmark, Germany and Sweden in the next 3–5 years.
The EU Novel regulation can potentially pose a barrier for new algae food products entering the EU market. *Furcellaria lumbricalis*, is for instance not included, even though it has been used to produce gelling agents for decades. Among the few countries with specific regulations on seaweed harvesting and cultivation the only Baltic Sea country is Denmark. Estonia and Germany have at least some rules on seaweed harvesting. The general aquaculture permit procedures apply as well as the water environment and water law. Permit paths are different in each country and are generally very lengthy and complicated.

### 2.2.3 Conclusions and Recommendations

For the Baltic, the SUBMARINER Network is making the following recommendations:

1. Make marine space available for seaweed production
2. Develop safety standards for the marine environment, and also product, and workers’ occupation health
3. Collaborate with EU Novel Food Regulation authorities to remove from EU novel food list of species consumed in the Baltic.
4. Develop the Baltic seaweed market
5. Raise awareness on the benefits and potential of seaweed
6. Test cultivation of Furcellaria and pilot / demonstrate cultivation of Fucus and Ulva in the Baltic Proper and also cultivation of Palmaria in Western Baltic
7. Improve economy and reduce investment risk of seaweed farming e.g. reduce production costs of *Saccharina latissima* by at least 5 times
8. Incentivize investments that support environmental sustainability and ecosystem services
9. Strengthen education and training in blue biotechnology, aquaculture and entrepreneurship
10. Taking the use / applications of algae a step further
2.3 Harvest of Floating Emergent Aquatic Plants

2.3.1 Projects / State pf Play

<table>
<thead>
<tr>
<th>Project Title</th>
<th>Funding</th>
<th>Duration</th>
<th>SUBMARINERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>LiveLagoons</td>
<td>Interreg South Baltic</td>
<td>2017–2021</td>
<td>Klaipeda Uni (LT)</td>
</tr>
<tr>
<td>Halophytes and other macrophytes for filtration of nutrient-contaminated waste and surface water</td>
<td>BMBF / BAMS (Germany)</td>
<td>2020–2021</td>
<td>CAU, CRM (DE)</td>
</tr>
</tbody>
</table>

The first floating wetlands in the Baltic Sea were installed in 2018 in three different lagoons (Darss-Zingst, DE; Curonian LT and Szczecin lagoon PL). Emergent macrophytes have been harvested since then on an annual basis. Harvested emergent macrophytes can be utilized in various ways; as construction material inter alia for insulation, for herbal medicinal. Halophytes, also known as salt plants, are still underestimated as high-quality products in the food, cosmetics and medical sectors.

2.3.2 Conclusions and Recommendations

Further installation sites in different environments will be necessary to broaden the experience, to improve the technique and to support the achievement of market-readiness. The market potential for macrophytes and halophytes cultivated on floating islands in the Baltic Sea has not been researched yet.

1. Awareness-raising of floating technologies for the cultivation of emergent macrophytes and halophytes as one option to remove nutrient from eutrophicated waters.
2. Study the impact of floating wetlands not only on nutrient removal but also on other pollutants such as the bacterium Escherichia coli.
3. Harvesting techniques offshore on floating structures are challenging and need technological advancements and innovative ideas.
4. Utilization concepts of harvested biomass from these floating green technologies in blue environments are just emerging and need further research.
5. Knowledge transfer on site selection, legal requirements, installation process, growth and harvest of the biomass as well as commercialization.
2.4 Sustainable Trophic Aquaculture

2.4.1 Projects

Some projects have been implemented over the course of the last years; however, none have taken a Baltic Sea wide approach and/or had a Baltic sea wide comprehensive coverage.

<table>
<thead>
<tr>
<th>Project Title</th>
<th>Funding</th>
<th>Duration</th>
<th>SUBMARINERs</th>
</tr>
</thead>
<tbody>
<tr>
<td>AquaCross</td>
<td>H2020</td>
<td>2015–2018</td>
<td>none</td>
</tr>
<tr>
<td>InnoAquaTech</td>
<td>Interreg South Baltic</td>
<td>2016–2029</td>
<td>BioConValley (DE), University of Gdansk, MIG (PL), CORPI, KSTP (LT), DTI (DK)</td>
</tr>
<tr>
<td>AquaLit</td>
<td>EMFF</td>
<td>2019–2021</td>
<td>s.Pro</td>
</tr>
<tr>
<td>FLAVOPHAGE</td>
<td>BONUS</td>
<td>2017–2020</td>
<td></td>
</tr>
<tr>
<td>CLEANAQ</td>
<td>BONUS</td>
<td>2017–2020</td>
<td></td>
</tr>
<tr>
<td>Waseabi</td>
<td>BBI-JU</td>
<td>2019–2023</td>
<td></td>
</tr>
<tr>
<td>AquaVIP</td>
<td>Interreg South Baltic</td>
<td>2020–2023</td>
<td>KSTP, Klaipeda University (LT) Uni Gdansk (PL)</td>
</tr>
</tbody>
</table>

2.4.2 State of Play

The technical development of environmentally sustainable forms of production is progressing rapidly in the field of aquaculture, both in view of making the more traditional open systems more environmentally friendly as well as the more recent, semi-closed and closed production systems.

- In 2021, there are by now more and more commercial RAS plants installed throughout the Baltic Sea Region (7 in DE; 9 in Fi; 5 in PL; numerous in DK). In addition, the InnoAquaTech project tested the farming of new species and innovative combinations of RAS with plant production and/or renewable energy at 4 pilot demonstration sites:
  - Denmark: Fish and macro-algae production under controlled conditions
  - Germany: The ‘FishGlasHaus’: innovative aquaponics in Mecklenburg-Vorpommern
  - Lithuania: Zero emission RAS system combined with geothermal energy
  - Poland: Farming shrimp in Poland: increasing the potential of RAS

The main challenge remains the commercial viability of these RAS; which need low cost energy sources as well as having to be closely aligned with the development of a local high value market.

- Aquaponics are also no longer an artificial endeavour: the scientific idea has entered the mainstream, albeit sometimes seemingly more of a marketing play rather than a commercially viable idea on its own.

- On practical level, also more IMTA systems start to become operational: SUBMARINER member, CRM in Kiel (DE), has established the
first organic mussel and macroalgae farm in the Baltic Sea, ‘following the principles of IMTA’ with the ambition to start fish aquaculture in the coming years. In Denmark, Hjerno Havbrug was the first to establish combined fish, mussels and algae production farms under IMTA principles.

So far, however, algae and mussel farms are not accepted by Denmark as compensation for the nutrient outflow from the fish aquaculture production measures. This is also the case for other Baltic Sea Region countries. In fact also sustainable aquaculture is hampered by environmental objectives, most notably the eutrophication status of the Baltic Sea, the need for cumulative impact assessments and a general lack of nutrient offset/compensation schemes for the sector.

The SUBMARINER position paper on aquaculture legislation highlights how in countries without a unified law on aquaculture (SE/DK), separate orders can be contradictory and licensing processes being unclear, whereas in other countries, definitions, regulations and guidelines for the sector are missing or incomplete. A positive exception is Finland, which foresees to provide incentives to aquaculture farms, which reduce nutrient loading and apply circular economy principles, like RAS; IMTAs or use of Baltic Sea Fish Feed.

2.4.3 Conclusions and Recommendations

Increasing the environmental sustainability of aquaculture, together with a wish to grow the sector, has been on the agenda of Baltic and Nordic countries for many years. However, issued licenses are not corresponding to novel aquaculture production methods; which have by now been increasingly achieved ‘proof of concept’, and consequently do not encourage investors or industrial producers to invest in growing the sector.

What is needed is a harmonized definition of aquaculture throughout the legislative system, as well as improvements of legislation of licensing by including compensatory tools and a fair assessment of nutrient output calculations (separate from land-based nutrient sources).

1. Innovative aquaculture systems such as RAS, IMTA and other combined uses must be carefully examined for each country and region across the Baltic.
2. Interdisciplinary collaborations are needed to scale up the aquaculture sector in the Baltic, with a specific focus on the harvesting, processing and biorefining technologies.
3. Finding the right location for a fish farm is not only a matter for marine farms; also RAS systems – in order to be economically viable should, for instance, be close to energy plants.
4. Investments, projects and support for entrepreneurs are needed to deliver new pilots and demonstration sites to showcase the feasibility of innovative sustainable aquaculture in the Baltic Sea Region.
2.5 Blue biotechnology

2.5.1 Projects / State of Play

The Baltic Blue BioTech Alliance and Alliance+ (INTERREG, 2016-2019-2021) initiated and implemented by the SUBMARINER secretariat and numerous of its members (GEOMAR, SYKE, KTH, KSTP, Tartu BioTech) has been the core Blue Biotechnology project throughout the region over the past years. The SUBMARINER network is therefore by now the renowned Baltic partner for the numerous networks, which have been established in parallel across Europe.

<table>
<thead>
<tr>
<th>Network / Scope</th>
<th>Activities / Scope</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BioMarine</strong></td>
<td>Yearly BioMarine Conventions (congress with exhibition, B2B, workshops)</td>
</tr>
<tr>
<td><strong>Global</strong></td>
<td>Sub-Activities: BioPlastics Consortium, Blue International Coop, Blue Fund</td>
</tr>
<tr>
<td><strong>EMBRC-ERIC</strong></td>
<td>Cluster, which supports fundamental and applied research activities for sustainable</td>
</tr>
<tr>
<td><strong>Europe with Norway</strong></td>
<td>solutions in the food, health, and environmental sectors</td>
</tr>
<tr>
<td><strong>No Baltic partners</strong></td>
<td>• CORBEL: platform for harmonised user access to biological and medical technologies,</td>
</tr>
<tr>
<td></td>
<td>biological samples and data services</td>
</tr>
<tr>
<td></td>
<td>• EMBRC BioBank: Organisms, cultures, strains, specific cell lines, tissues, tissue cultures and their DNA are available on-site or remotely.</td>
</tr>
<tr>
<td><strong>BlueBio Alliance</strong></td>
<td>Network covering the entire marine biotechnology value chain: raw material producers,</td>
</tr>
<tr>
<td><strong>Portugal</strong></td>
<td>R&amp;D units, biotechnology SMEs, transforming centres and manufacturers, public sector</td>
</tr>
<tr>
<td></td>
<td>entities, support companies, final product developers; organises once a year Blue Bio Value</td>
</tr>
<tr>
<td></td>
<td>accelerator programme</td>
</tr>
<tr>
<td><strong>European Algae Biomasss Association (EABA)</strong></td>
<td>Promotes exchange and cooperation in algae biomass production and use incl. biofuel.</td>
</tr>
<tr>
<td><strong>KTH (SE); VTT (FI)</strong></td>
<td>Defends members’ interests at EU level; organises annual AlgaEurope Conference.</td>
</tr>
<tr>
<td><strong>Pilots4U / Europe</strong></td>
<td>Network (database) of open access pilot and multipurpose demo-infrastructures for</td>
</tr>
<tr>
<td><strong>KTH (SE); VTT (FI)</strong></td>
<td>the European bio-economy</td>
</tr>
<tr>
<td><strong>Ocean4Biotech / Europe</strong></td>
<td>• platform for sharing experience, knowledge and technologies,</td>
</tr>
<tr>
<td><strong>GEOMAR, CAU (DE), RUC (DK), Uni Tartu (EE), Uni Gdaňsk (PL)</strong></td>
<td>• designs a roadmap for a more efficient and rapid development of marine biotechnology</td>
</tr>
<tr>
<td></td>
<td>research in Europe and beyond.</td>
</tr>
<tr>
<td><strong>Microbial Resource Research Infrastructure / Europe / Uni Gdaňsk (PL)</strong></td>
<td>Pan-European platform adding value to known and yet unknown microbial biodiversity and</td>
</tr>
<tr>
<td></td>
<td>exploiting novel sources and knowledge to discover and disclose for the bioeconomy and</td>
</tr>
<tr>
<td></td>
<td>bioscience. Provides overview on culture collections</td>
</tr>
</tbody>
</table>
2.5.2 Conclusions and recommendations

A survey done within the Alliance across 24 R&D Baltic Sea Region institutions showed:

1. **A wide spectrum of competencies, resources and interests within blue biotechnology.**
   Among the most popular fields of study were production of algae and bacteria for applications from food and feed to highly specialised markets and bioremediation.

2. **Interesting aquatic biological resources**
   Baltic marine and freshwater ecosystems host a large biological diversity of organisms, including fungi, micro- and macroalgae, bacteria, sponges, and mussels with good possibilities for further advancements.

3. **Integrated biomass production systems**
   Aquaculture and blue biotechnology are two distinct but highly intertwined sectors. Aquaculture can supply blue biotechnology with primary and secondary resources; whereas blue biotechnology is crucial in all steps from growing biological resources to recovering biomaterials from process side-streams. It is a key quality, that the SUBMARINER Network covers both sectors under one roof.

4. **Design new materials supporting the circular economy**
   On global scale, there is a shortage and cost increase for many raw materials. In addition, materials are produced that withstand degradation over long time scales and may harm the environment in general and the Baltic Sea environment in particular (see marine litter), calling for local and closed material circles.

5. **Align blue biotechnology R&D with product market trends, challenges and opportunities**
   Linking R&D with innovation pathways and market applications at an early stage, for example at the bioprospecting stage, can accelerate product development. It also increases the cost efficiency of R&D by reducing costs and minimising risk of failure.

6. **Increase transnational access to pilot-scale facilities**
   The BSR lacks multi-use, open access, pilot-scale facilities relevant to (blue) biotechnology, which makes it difficult to test, validate and de-risk innovation at scale. Some large-scale facilities exist, such as the Kalundborg Forsyning photobioreactors and VTT facilities within the Baltic, but they are often not accessible and others are not modular.

7. **Blue biotechnology study programmes are very rare in the BSR.**
   In many BSR countries, teaching in blue biotechnology is realised by offering elective courses or specialised modules within other study programmes in (industrial) biotechnology or marine biology.
2.6 Promoting Multi-Use in the Baltic Sea

The concept of ocean multi-use has gained attention in the last years as an approach that can contribute to a more sustainable and efficient use of ocean resources, by reducing the demand of ‘un-used’ sea space and potentially offering significant socio-economic and environmental benefits.

What is ocean multi-use?
Multi-use stands for an intentional combination of different ocean uses both in close proximity, through joint operations (e.g. shared human resources), and/or the same platform (e.g. shared installations). Implementation of multi-use requires a radical change from the concept of exclusive resource rights to the inclusive sharing of ocean resources by two or more uses. Whereas the original concept often focused primarily on multi-use of offshore installations, research in past years has also pointed to benefits of combining ‘soft uses’ with each other (e.g. small-scale fishery, tourism & environmental protection).

2.6.1 Projects

<table>
<thead>
<tr>
<th>Project Title</th>
<th>Funding</th>
<th>Duration</th>
<th>SUBMARINERs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multi-Use with Offshore Wind &amp; Soft Use Combinations</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MUSES</td>
<td>H2020</td>
<td>2016-2018</td>
<td>SUBMARINER Secretariat, MIG (PL), KTH (SE), DTI (DK)</td>
</tr>
<tr>
<td>UNITED</td>
<td>H2020</td>
<td>2020-2024</td>
<td>SUBMARINER Secretariat, FuE-Zentrum Kiel (DE)</td>
</tr>
<tr>
<td>MULTI-FRAME</td>
<td>Belmont</td>
<td>2020-2023</td>
<td>s.Pro (DE), KTH (SE)</td>
</tr>
<tr>
<td>BalticRIM</td>
<td>Interreg BSR</td>
<td>2017-2020</td>
<td>SUBMARINER Secretariat, MIG (PL), Uni Tartu (EE), CORPI (LIT)</td>
</tr>
</tbody>
</table>
2.6.2 State of Play & Conclusions

Despite a whole series of theoretical studies conducted on multi-use on additional uses of offshore windparks; especially for tourism as well as ecosystem restoration; in reality, there has not been a major uptake of the multi-use concept throughout the Baltic Sea within the past seven years.

The Multi-Use concept especially of interest for countries only starting now with Offshore Wind

• The studies have shown that it is much more difficult to integrate a new ‘secondary’ use within an existing offshore wind farm, for which a single use permit has already been awarded and insurance premiums agreed upon, than integrating a secondary use right from the onset, i.e. at the design and pre-planning stages, when insurance, permitting and ownership are clarified.

• Countries where the development of offshore wind is still at its inception may benefit most by integrating the multi-use concept already in the design and planning stage of future offshore wind farms.

• Good stakeholder processes are needed due to competition among the ‘secondary users’: fishery, aquaculture or marine protection compete for the space within or around offshore wind farm.

• Small-scale multi-use developments focusing on tourism may hold significant benefits for certain regions, and may pave the way for potential future large scale rollout.

• For existing offshore wind farms due to be decommissioned, early consideration of concepts of re-use and re-purposing may allow for the operationalisation of circular economy concept in these economies.

BEYOND OFFSHORE WIND: LOCAL OPPORTUNITIES FOR COMBINATIONS OF ‘SOFT USES’

Multi-use of selected UCH sites with tourism and environmental protection have already been piloted especially in Finland. They can provide new jobs and new revenues due to new tourism services, such as marine museums and information stands. Public appreciation of the value and significance of UCH sites may be increased; while at the same time enabling better protection, maintenance and control of them.

Combinations between tourism and small-scale fishery or shellfish / seaweed cultivations may benefit

Also soft use combination face multiple barriers:

• better exchange of suitable regulation.
• lack of data on underwater cultural heritage and related tourism activity
• lack of awareness about and interest for underwater cultural heritage
• lack of investments and financing.
local communities around the Baltic Sea. These have, however, not been sufficiently explored to date.

Marketing the whole region as a cultural heritage tourism destination, may be a good option to increase the visibility and attractiveness of such tourism offers.

2.7 Beach-wrack

### Projects

<table>
<thead>
<tr>
<th>Project Title</th>
<th>Funding</th>
<th>Duration</th>
<th>SUBMARINERs</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONTRA</td>
<td>Interreg BSR</td>
<td>2019–2022</td>
<td>SDU (DK) and University of Tartu (EE))</td>
</tr>
<tr>
<td>Coastal BioGas</td>
<td>Interreg South Baltic</td>
<td>2018–2021</td>
<td>NO SUBMARINERs: FNR (DE), Roskilde University (DK), University of Rostock (DE), etc.</td>
</tr>
<tr>
<td>BioFisk</td>
<td>Alliance case</td>
<td>2018–2020</td>
<td>Guldborgsund municipality (DK)</td>
</tr>
<tr>
<td>Beach-wrack anlaysis</td>
<td>Island of Gotland</td>
<td></td>
<td>KTH (SE)</td>
</tr>
</tbody>
</table>

### State of Play

Beach wrack can cover Baltic Sea beaches for weeks after storms, rotting to a smelly soup that leaches back into water until the next storm. It is a specific problem for coastal communities, particularly those whose economies rely on beach tourism. It is already regularly removed as part of community beach cleaning routines in most touristic regions along the southern and western Baltic coast. The methodologies employed and the treatment of this nutrient rich resource do not exploit its full potential for water management and pollution reduction.

Beach-wrack production peaks at late autumn. Clear hotspots of beach-wrack production emerged throughout the whole Baltic Sea area (including Kattegat). The highest production values (up to 4kg per m² per month) were observed in Sweden, the southern coast of Finland, west coast of Estonia and in Gdansk Bay.

Beach-wrack is organic by nature albeit at different stages of decay, but it can be contaminated with litter and can land overnight in voluminous quantities reaching thousands of tons. With regards to costs, the most recent figures from within project CONTRA indicate that beach wrack management is costing municipalities between 20€–40€ per m of beach length annually.
2.7.3 Current challenges and knowledge gaps

- Costs and cost factors for local authorities, specifically for those in 'beach wrack hotspot' areas
- A confusing legal framework – particularly with respect to non-market reuse options on the beach for e.g. coastal protection, and the waste classification
- Further research on the amount of nutrient reduction from the Baltic Sea by removal of the beach-wrack
- A lack of knowledge about the environmental pros and cons of beach wrack removal incl. contamination levels, ecosystem service provision, and
- Societal costs and benefits from beach-wrack harvesting and use.
- Time pressure relating to 1) public demand for its removal and 2) storage/degradation of beach wrack material for recycling.
- Lack of means to cooperate with neighboring municipalities and private recycling companies/industry
- Lack of knowledge about trends and climate change impacts on beach wrack quantities

All solution ideas to improve beach wrack recycling have so far faced legal constraints as beach-wrack is still classed under the European Waste Catalogue (EWC) as "municipal wastes not otherwise specified".

2.7.4 Conclusions and Recommendations

- Validate and control the environmental and biodiversity risks of intensive beach cleaning and wrack removal against the MSFD and the new Biodiversity Strategy
- Pilot and demonstrate sustainable beach wrack reuse options that meet local needs for coastal protection and sand erosion.
- Encourage and reward resource-oriented beach cleaning
- Explore technological means for avoiding sand uptake
- Develop a market for local products and short value chains, esp. for fertilizers, building and feed.

1. **Develop cost-efficient collections** methods with as little environmental impact as possible
2. Work further on **suitable technologies for up-scaling** as well as better harvesting and drying techniques.
3. Analyse and improve details of the **technological procedures** for collection and processing
4. Investigate methods for **harvesting floating macroalgae** and eel grass at sea

The recycling and re-use options for Baltic Beach Wrack include:

- Insect production
- Anaerobic Digestion
- Fertilizers
- Waste Water Treatment
- Carbonisation
- Gasification and anaerobic digestion
- Landfill biocovers
- Coastal Protection
- Insulation mats for housing
5. Address major **gaps in long-term monitoring** of seasonal and spatial differences of beach wrack composition and amounts.

6. **Study micronutrients and probiotic qualities** of beach-wrack for feed applications.

7. **Remove legal obstacles** associated with recycling problematic coastal biomass have to be removed.

8. **Improve public/private cooperation**

9. Change tourists’ expectations of so-called clean beaches through extended **information campaigns** to draw more attention to near-natural beaches and the importance of beach wrack for the beach ecosystem.

10. For commercial uses continue more profound investigation of basic properties of beach-wrack, especially concerning potentially harmful substances and the regional variation in its properties.
3 Topics not covered by original SUBMARINER Roadmap

3.1 Marine Litter

3.1.1 Projects / State of Play

The HELCOM Action Plan on Marine Litter, decided in 2019, is structured according land-based (73%) and sea-based (27%) sources of marine litter. It also tackles the issue of education and outreach on marine litter. The actions are divided into regional, collective HELCOM actions and voluntary national actions.

- The HELCOM Expert Network on Marine Litter (i) facilitates the implementation of the Regional Action Plan on Marine Litter and; (ii) develops core indicators
- The PRESSURE group leads the work on marine litter in HELCOM, including addressing sources on land and coordination of implementation of the HELCOM Regional Marine Litter Action Plan.
- On national level, environmental agencies/ministries coordinate the work to achieve the GES under the MSFD and other EU legal frameworks on marine litter, which is currently changing rapidly.
- These national and regional bodies are in close cooperation with actors at international level, such as UNEP/SDGS, G7/G20, FAO, EU KOM TG Marine Litter Plastic Strategy, IMO, CBD, EPA-Network.

Numerous initiatives have been launched at Baltic Sea level during the last years:

<table>
<thead>
<tr>
<th>Project Title / Actor</th>
<th>Duration / Funder</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plastic Free Baltic / Coalition Clean Baltic</td>
<td>2017</td>
</tr>
<tr>
<td>Plastic Free Ocean / Coalition Clean Baltic</td>
<td>2019</td>
</tr>
<tr>
<td>Keep Sweden Tidy / KTH (SE), Uni Gothenburg (SE)</td>
<td>2015-2020</td>
</tr>
<tr>
<td>Plastic Engineering Day 2020 / Aarhus University</td>
<td>2020</td>
</tr>
<tr>
<td>BLASTIC / Turku (FI), Södertälje (SE) Tallinn (EE); Liepaja (Lat)</td>
<td>Interreg Central, 2020-2023</td>
</tr>
<tr>
<td>Fanpliestic-sea / LUKE (FI), LKIAE (LTV), KU (LT)</td>
<td>INTERREG BSR, 2019-2021</td>
</tr>
<tr>
<td>Micropoll / IVL (SE), NMFRI (PL), KU (LT)</td>
<td>BONUS, 2017-2020</td>
</tr>
<tr>
<td>Cooperative Projects / Ministry for Research (DE)</td>
<td>2016-2020</td>
</tr>
<tr>
<td>MareLitt / WWF, Keep Sweden Tidy, fish producer &amp; divers associations</td>
<td>Interreg BSR, 2016-2019</td>
</tr>
<tr>
<td>Fishing for Litter / KIMO international</td>
<td></td>
</tr>
<tr>
<td>Study: Incentives for collection and treatment of derelict fishing gear / s.Pro (DE)</td>
<td>National Funding, 2018</td>
</tr>
</tbody>
</table>
ASSESSING SEVEN YEARS OF SUBMARINER WORK

### 3.1.2 Conclusions

The impact of the projects described above should not be under-estimated. They have started to support the assessment of political willingness, institutional frameworks and capacity in the BSR.

- Studies fostered the adaptation of national law to EU framework legislation and strategies
- Blastic/AquaLit informed about monitoring gaps and new monitoring/assessment approaches
- Plastic Free Oceans/Marelitt raised awareness and build capacities in regions and municipalities; which also serve as good models for other regional cooperation between fishermen and recyclers
- Cooperation projects promoted sustainable production, establishing research-company networks
- Innovative projects like GoJelly show the opportunity and range of new applications for start-ups and well-established companies, in close cooperation with research.

With the new Single-Use Plastic Directive (2019/904/EU) it can be expected that informed consumer choice and the change of consumer behaviours is gaining more attention in projects and will open discussions about new approaches like nudging. New concepts like „Cradle-to-Cradle“ or so-called “Un-Packed“ shops are offering opportunities for innovative companies and start-ups.
3.2 Maritime Cultural Heritage

3.2.1 State of Play/Projects

The BSR Underwater Heritage Working Group of the CBSS has been engaged with various projects dealing with management and research of underwater cultural heritage in the Baltic Sea or at European level. Projects, such as MoSS\(^2\), Rutilus\(^3\), MACHU\(^4\), Nordic Blue Parks and SASMAP\(^5\) have followed each other.

These projects brought forward a regional awareness of the underwater cultural heritage. The generated insight and valorisation of the significance of the underwater heritage has been gradually infiltrated through governmental management levels and planning processes bringing forth MCH as an important issue to be considered when developing plans for other sectors, maritime uses, technology and recreation.

**BalticRIM** (INTERREG BSR, 2017-2020) initiated with the help of the **SUBMARINER Network**, was the logical continuation of these processes, linking the preservation of maritime heritage of the Baltic Sea to the development of maritime spatial plans in the Baltic Sea assessing data and tools suitable for MSP purposes.

**SUBMARINERS:** MIG (PL), CORPI (LT), Klaipeda University (LT) Uni Tartu (EE), SUBMARINER Secretariat.

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4. Strategic Actions Fields: Achievements

4.1 Actors Mapping / Match-Making

One of the most important activities identified for the SUBMARINER Network secretariat in the 2013 Roadmap was the continuous identification and matching of public and private actors involved in new marine uses as to achieve better and faster results with less resources.

We have identified and mapped almost 3000 individuals in the Baltic Sea region working in more than 1700 different institutions.

<table>
<thead>
<tr>
<th>Organization type</th>
<th>SE</th>
<th>DE</th>
<th>LAT</th>
<th>PL</th>
<th>DK</th>
<th>LIT</th>
<th>FI</th>
<th>EE</th>
<th>RU</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Institutions</td>
<td>233</td>
<td>265</td>
<td>112</td>
<td>357</td>
<td>285</td>
<td>44</td>
<td>226</td>
<td>79</td>
<td>103</td>
<td>1704</td>
</tr>
<tr>
<td>Actors</td>
<td>407</td>
<td>551</td>
<td>211</td>
<td>526</td>
<td>381</td>
<td>72</td>
<td>462</td>
<td>155</td>
<td>119</td>
<td>2974</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Company</th>
<th>SE</th>
<th>DE</th>
<th>LAT</th>
<th>PL</th>
<th>DK</th>
<th>LIT</th>
<th>FI</th>
<th>EE</th>
<th>RU</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Algae</td>
<td>8</td>
<td>32</td>
<td>2</td>
<td>37</td>
<td>29</td>
<td>2</td>
<td>3</td>
<td>6</td>
<td>0</td>
<td>119</td>
</tr>
<tr>
<td>Blue biotechnology</td>
<td>9</td>
<td>53</td>
<td>3</td>
<td>20</td>
<td>31</td>
<td>4</td>
<td>8</td>
<td>10</td>
<td>0</td>
<td>138</td>
</tr>
<tr>
<td>Energy</td>
<td>2</td>
<td>7</td>
<td>1</td>
<td>19</td>
<td>8</td>
<td>0</td>
<td>59</td>
<td>3</td>
<td>1</td>
<td>100</td>
</tr>
<tr>
<td>Environment</td>
<td>2</td>
<td>18</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>25</td>
</tr>
<tr>
<td>Fish aquaculture</td>
<td>24</td>
<td>52</td>
<td>1</td>
<td>30</td>
<td>110</td>
<td>0</td>
<td>33</td>
<td>0</td>
<td>23</td>
<td>273</td>
</tr>
<tr>
<td>Mussels</td>
<td>16</td>
<td>9</td>
<td>0</td>
<td>3</td>
<td>8</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>0</td>
<td>37</td>
</tr>
<tr>
<td>Other</td>
<td>14</td>
<td>23</td>
<td>3</td>
<td>31</td>
<td>10</td>
<td>1</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>87</td>
</tr>
<tr>
<td>Reed/beach-wrack</td>
<td>0</td>
<td>7</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>0</td>
<td>17</td>
</tr>
</tbody>
</table>

Out of these institutions, we have by now already identified more than 650 companies working within the blue bioeconomy throughout the Baltic Sea Region.

The largest number of companies identified come from the traditional fish aquaculture sector (mainly in DK). But a remarkable number of
companies have also been identified, which work with algae and/or blue biotechnology.

Even though the number of companies working in this sector throughout the entire Baltic Sea Region is still low; it presents an enormous relative growth as compared to the figure a decade ago, where it was difficult to identify any company involved in this sector.

At the same time the figure points to the fact, that it is worthwhile for the SUBMARINER network to act as the overarching association of these companies as national blue bioeconomy clusters are still mainly missing.

4.2 The SUBMARINER Accelerator

Over the course of the past years – supported by the ALLIANCE projects – SUBMARINER with its members has developed a systematic transnational science-business cooperative approach to create the critical mass of actors to converge and convert science outputs into marketable products. The SUBMARINER accelerator programme is continuously searching for “cases”; organises pitching and matchmaking events as well as offering flexible support through a dedicated mentoring programme; successfully establishing a new niche innovation and product development support mechanism operating across borders in the BSR.

Until today, the SUBMARINER Alliance has successfully identified and provided advise to more than 34 start-ups originating from all around the Baltic Sea Region. Cases joined at all stages of the value chain, from bio-prospecting to full commercialisation, with the majority (66%) using algae as the biological resource for developing their products. Products target a broad spectrum of market applications, from food and food supplements to healthcare and cosmetics, bioremediation, materials, and energy.

CONCLUSIONS / FINDINGS FROM THREE YEARS OF MENTORING PRACTICE

- A blue economy – rather than a blue biotechnology – network: matchmaking led to partnerships across all elements of the value chain, from biomass sourcing to necessary equipment to market access. Against this background, the Alliance is part of the entire SUBMARINER Network, offering transnational networking across all bioeconomy sectors and actors.
- Without ‘blue detectives’ – no new cases: Ideas have to be pro-actively recruited.
- Finding the right mix of mentors is crucial: Without interested mentors – no accelerator

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6 Service receivers, i.e. companies, spinoff projects of universities, municipalities etc. with a new business idea
• Networking and matchmaking among blue specialists are in high demand by all
• *Scientific/ technical support* is *SUBMARINER`s USP* as opposed to investment oriented accelerators
• Companies need large scale biomass rather than biobanks
• Business knowledge is also vital in early stages of the product development chain

### 4.3 Data / Tools / Environmental Monitoring

#### 4.3.1 Projects / State of Play

Numerous projects implemented within the *SUBMARINER* Network have addressed the issue of improved data sourcing enabling better environmental impact assessments.

Mussel related projects have provided better evidence on the sedimentation caused by the studied mussel farms; which was highly local and less than expected with no oxygen depletion was noted in the near-bottom waters. It is important to *continue the environmental monitoring at the mussel farms* with the focus on bottom conditions, e.g. oxygen levels and benthic fauna.

The *Operational Decision Support System* (ODSS) developed by *SUBMARINER* member, University of Tartu/Estonian Marine Centre showing areas for *macroalgae and mussel growth potential* throughout the Baltic Sea Region has been one of the key outputs of projects implemented *facilitating the start of a more systematic blue bio sites mapping*. No such mapping has, however, been undertaken so far for nutrient & CO₂ sources for microalgae cultivation.

Possible (marine) fish aquaculture sites have been assessed in Finland and Denmark. Whereas the Finnish `fish aquaculture` spatial plan is still taken as basis for current decision making; the sites identified in open Danish sea have, however, been contested on political level.

To promote a systematic and cost efficient approach for environmental monitoring of blue biosites, the project application `OperationalPilots` was submitted in 2016. The project was, however, not approved for funding.

**ALGARITHM EU ALGAE AND SHELLFISH STUDY (ENV.C.2/SER/2013/0041; SUBMITTED 2020)**

To date, there is little knowledge on the production potential of macroalgae and shellfish in Europe. In order to fill this knowledge gap, an EU wide consortium, led by *SUBMARINER* members, has submitted a proposal for an EU wide study tendered by *DG MARE*. The aim of Algarithm is to assess the *potential of shellfish and macroalgae to recycle nutrients and greenhouse gas emissions* from their production and thereby to add to the evidence base supporting the planning of low-trophic aquaculture in European sea regions.
4.4 Access to Pilot Sites & Facilities

By the time of the SUBMARINER Roadmap launch 2013, only some pilot mussel farm sites and recirculating aquaculture sites existed; but not one single macroalgae cultivation or multi-use case. The overall objective was to establish more such pilot sites around the Baltic Sea Region to enable empirical research.

4.4.1 Projects / State of Play

A number of pilot sites have successfully been established over the past years. However, for all applications, actual site development is still lagging behind; mainly due to legal and financial barriers and insecurities; which increase the high risks associated with such new farms anyhow for entrepreneurs.

<table>
<thead>
<tr>
<th>Mussel Cultivation</th>
<th>1. Mushholm, DK (8 ha – depth 0-3 m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Baltic Sea Proper)</td>
<td>2. Limfjorden, DK</td>
</tr>
<tr>
<td></td>
<td>3. Horsens Fjord, DK</td>
</tr>
<tr>
<td></td>
<td>4. Kiel Farm, DE (0,21 ha – depth 0,5-3 m)</td>
</tr>
<tr>
<td></td>
<td>5. Greifswald Bay, DE</td>
</tr>
<tr>
<td></td>
<td>6. St Anna Farm, Kalmar, SE (4 ha – depth 1-10 m)</td>
</tr>
<tr>
<td></td>
<td>7. Byxelkrok, Kalmar Sound, SE (1,2 ha – depth 3-6 m)</td>
</tr>
<tr>
<td></td>
<td>8. Västervik, SE (960 m² – depth 0-4 m)</td>
</tr>
<tr>
<td></td>
<td>9. Hagby Farm, SE (1380 m² – depth 1.5–5m)</td>
</tr>
<tr>
<td></td>
<td>10. Ecoplega Stockholm, SE</td>
</tr>
<tr>
<td></td>
<td>11. Pavliosta, Latvia (625 m sizal rope – depth 5-7 m)</td>
</tr>
<tr>
<td></td>
<td>12. Vormsi, Estonia (126 m rope – depth 0-3,5 m)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Macroalgae Cultivation</th>
<th>2 farms in Germany</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saccharina latissima</td>
<td>3 farms at the Swedish Western coast</td>
</tr>
<tr>
<td>(all Western Baltic)</td>
<td>2 farms in Denmark</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>IMTA</th>
<th>1. Mushholm, DK: Fish and Mussel Cultivation (see above)</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Recirculating Aquaculture Systems / Aquaponics</th>
<th>1. RAS for fish and macroalgae production (DK, Guldborgsund Zoo)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2. Aquaponic: FishGlasHaus (DE, Rostock)</td>
</tr>
<tr>
<td></td>
<td>3. RAS for shrimps with geothermal energy (LT, Klaipeda)</td>
</tr>
<tr>
<td></td>
<td>4. RAS for shrimps (PL, Gdansk)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Multi-Use</th>
<th>1. Offshore Wind &amp; Tourism (Copenhagen, DK)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2. Several cases related to UCH &amp; Tourism</td>
</tr>
</tbody>
</table>

| Waste Treatment by Algae | SwedishAlgaeFactory – but unclear whether a real pilot site yet |

4.4.2 Recommendations and next steps

As indicated across all chapters, all these pilot sites need to be upscaled to real demonstration size. Whereas the empirical research has shown good and promising results at pilot scale; it is necessary in the next years to transfer these results to full scale; in order to cross-check, whether the same results can be achieved. Moreover there is still a dramatic lack of concrete sites especially around the Baltic Sea proper.
4.5 Technology Development & Transfer

The objective as set out in the 2013 SUBMARINER roadmap was to ‘develop environmentally friendly and cost efficient technologies suitable for Baltic Sea conditions taking into account knowledge and technologies from terrestrial resources’.

4.5.1 State of Play

All SUBMARINER projects have fostered an exchange and transfer of suitable technology as well as adaptation of technologies suitable to Baltic Sea region conditions. Most notably, new technologies used within BBG substantially increased the production and harvest of blue mussels within the Baltic Sea proper.

Despite achievements, there is still an enormous need for developing and finding better technology solutions, which enable a financially as well as environmentally sound blue bioeconomy to develop further within the Baltic Sea region. Thus the effective methods established on technology transfer need to be maintained within the coming years.

4.6 Regional energy solutions with marine resources

4.6.1 Projects / State of Play

The COASTAL Biogas concept is implemented at full scale at Solrød biogas plant in Denmark with 1500 tons of cast seaweed were collected and co-digested in the plant in 2019. In this way nutrients are physically removed from the Baltic Sea. The nutrients are recycled through the anaerobic digestion process and utilised as an organic fertiliser, offsetting the use of synthetic fertilisers. Problems with odours from rotten seaweed are eliminated for the benefit of tourism and recreation and the water quality is improved. Carbon dioxide and methane emissions arising, when the seaweed decays on the beach or in the waterline, are eliminated as well. Instead, a high-quality biogas is produced in the controlled anaerobic digestion process.

What is important is to collect the beach-cast when it is still wet, as if it decays and dries ashore about half of biogas is lost to the atmosphere. However, currently the high content of Cadmium in the seaweed hampers the possibility to use seaweed for co-digestion and obtain the associated socio-economic benefits.
4.6.2  Recommendations / Next Steps

- Development of heavy metal removal techniques would open the possibility to use marine biomass as a resource, independent of whether it is used for energy production, nutrient recovery, animal feed products, or for contributing to lower levels of heavy metals in the Baltic Sea.
- In order to be able to implement the concepts in development in a holistic manner further investigation into the challenges, which were discovered during the projects is needed.

4.7  Introduce ecosystem service payments

The ambition as set out in the 2013 SUBMARINER Roadmap was to ‘develop an accepted approach to valuation of ecosystem services and propose compensation mechanisms for the provision of ecosystem services by new marine uses’.

4.7.1  State of Play

As part of the BBG project, the SUBMARINER network secretariat undertook a very comprehensive study on the introduction of possible ecosystem
payment schemes\(^7\). The study focused on mussel cultivations as a possible sea-based measure to deal especially with the already existing internal nutrient load as well as continuous nutrient inflow from non-point sources. Even though the study concentrated on mussel cultivations, it could also be transferred to e.g. algae cultivations, which show similar results in view of nutrient uptake.

4.7.2 Conclusions and Recommendations

- Mussel farms need to be officially accepted as an additional measure at given sites to reduce nutrient load and thus being part of the accepted mix of supported abatement measures.
- Mussel farming can be included in a cost-effective abatement mix.
- Ensure that incentives to reduce nutrient are not impeded
- Examine the financial instruments, which are already available in the region / country.
- Provide support to overcome ‘first movers’ to reach critical mass
- A payment scheme in which the benefactor pays is a good alternative for success.
- Go local (or regional) backed by national support
- Let the beneficiary be the owner or buyer of the services of the mussel farm
- Mussel farm operators have to organise themselves as to speak with one voice!

Whereas we currently still lack the showcase, that such payment scheme has been realized in one of the Baltic States; the efforts of SUBMARINER and contributing projects have led to progress within the political arena:

The Ministerial Declaration adopted at the ‘Our Baltic’ Conference, held 28\(^{th}\) Sept 2020, postulates:

**We will PROMOTE ecologically sustainable sea-based measures, where appropriate with potential for eutrophication abatement such as mussel cultivation and blue catch crops.**

Moreover there are indications that mussel farming may become an approved sea-based measure under the Water Framework Directive.

\(^7\) Angela Schultz-Zehden, A. Steele, B. Weig: ‘How to turn payments for ecosystem services provided by Baltic Blue Mussel farms into reality?’, 2018, Study / Fact Sheet
4.8 Unlock financing for innovative uses of marine resources

SUBMARINER has attracted so far more than 40 applications to its Accelerator services and has reached out to more than 60 public and private investors. Five investors\(^8\) have already participated in one or more of our pitching events. As a result numerous cases having succeeded in raising additional finance. Where possible, SUBMARINER also approaches companies to be included in public funding projects (esp. Horizon).

The past years have shown that the challenge is not so much a lack of venture capital, but that there is a lack of suitable companies:

- For some companies the administration coming with public funding (e.g. Horizon, Interreg) is too high, or the time frame of applications is too long to meet the company development needs. Also, some regulations obstruct financial support to companies (e.g. de minimis regulation for aquaculture/seafood producers). In some cases, companies were also not willing to provide open access to results (share Intellectual Property) achieved with that funding.

- On the other side are the early start-ups, which are not yet ‘investment ready’ and thus require the pre-acceleration and incubation services. In these cases, it would be more important that the SUBMARINER Network would get the funding necessary to provide ‘innovation vouchers’, which the start-ups could use in order to pay for the accelerator services required to bring their venture to investment readiness stage. Such a scheme would be compatible with Smart Specialization Strategies (S3) and the hopefully upcoming Interregional Innovation Investment mechanism (I3).

4.9 Create better legal and regulatory conditions

Legislation, regulation and MSP were or are at the core in numerous SUBMARINER projects: BBG and GRASS assess, how mussel or algae cultivation are covered in the various EU Directives and whether those promote or place a barrier to them. BBG, GRASS, MUSES and BalticRim have developed guidelines for how to consider mussel or algae cultivation, multi-use as well as maritime cultural heritage aspects within MSPs.

Only in view of Fish Aquaculture, the SUBMARINER Network did not pursue a dedicated project; but merely organized two workshops (within Blue Platform) to showcase best practices, differences and problems of how Marine Fish Aquaculture is treated within Baltic Sea region countries’ legislation and regulation.

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\(^8\) Research Council Norway, NewCo Helsinki, Valinor, Kroslid Invest, European Circular Bioeconomy Fund
Real positive change achieved within this field was, as expected, minor, but nevertheless remarkable:

- Mussel cultivation is noted as a sea-based measure under the new HELCOM Baltic Sea Action Plan
- The Finnish government is pursuing a pro-active policy for promoting sustainable fish aquaculture considering the use of Baltic Fish Feed and other compensatory measures
- Algae – and Mussel Growth Maps were at least considered in the preparation of the Estonian MSP
- Multi-Use and Underwater Cultural Heritage are increasingly noted by Maritime Spatial Planners

Nevertheless there is still ongoing need to address the various ongoing challenges related to advocate for a legislative and regulatory framework, which enables innovative and sustainable uses.

4.10 Public Awareness

4.10.1 The Ambition

The SUBMARINER Network’s declared view has long been that products from innovative and sustainable uses of marine resources will fall on fertile ground only in a market in which consumers are aware of the benefits of sustainable blue products and are motivated to contribute to solutions.

The need for a targeted public awareness campaign in cooperation with relevant Baltic companies was reiterated in 2017 as a result of the large scale stakeholder process leading to the Implementation Plan for the Baltic Blue Growth Agenda as well as in the SUBMARINER ‘Better of Blue’ (2017) conference declaration.

4.10.2 Projects / State of Play

Public awareness activities have been part of numerous SUBMARINER projects over the past years. Within the GRASS project a detailed market survey has been carried out on the interest and acceptance of consumers for seaweed based products. The BBG mussel cultivation project received substantial media attention. **Nevertheless, all this is far from a full scale public awareness campaign.** However, so far all project applications submitted focusing on joint public awareness campaign did not receive funding.
4.11 Smart Specialisation for Blue Growth

In 2015, at the time of the elaboration of the follow-up actions to the 2013 SUBMARINER Roadmap, the need to facilitate network initiatives at the regional level became evident. These initiatives are as necessary as networking at the pan-Baltic and European levels, as they serve to connect the levels with one another.

4.11.1 Projects / State of Play

Six regions from across the Baltic Sea (Schleswig-Holsetin (DE), South West Finland; Ida-Viru County (Estonia), Riga (Latvia) and Pomorske (PL) joined forces within the Smart Blue Regions project (BSR INTERREG, 2016–2019), initiated by SUBMARINER, to generate “Blue Growth” for their regions. The involved public authorities aimed to increase their capacity to implement specifically RIS3 targeting Blue Growth in order to benefit the blue sectors in their specific regions.

1. **Riga Planning Region** developed a Maritime and Coastal Smart Specialization Strategy (MCSSS).
2. **Southwest Finland** developed a "Blue Growth" RIS3 implementation plan with regional stakeholders.
3. **Ida-Viru region** revised the “Regional Development Strategy 2019-2030” by establishing a 2.5 km² business park suitable for aquaculture production and the development of a small harbour network.
4. In **Skane** the innovation strategy was updated in 2018/2019 with significant input from the SBR project.
5. In **Pomorskie** two companies developed through the project the idea for “A multi rotor system for offshore wind turbines” and identified international partners to build the prototype.
6. In **Schleswig-Holstein** a monitoring system for blue growth was introduced and tested.

4.11.2 Conclusions and Recommendations

The lessons learned from the Smart Blue Regions project include the following recommendations:

- Working with RIS3 should include a **broad and frequent dialogue with stakeholders** to get more ownership and cooperation.
- It is necessary to **spread the message of the benefits RIS3 and Blue Growth** strategies are intended to accomplish for regional development.
- The RIS3 implementation should be made **more flexible** during its 7-year implementation.
- **Clusters are crucial**, and their role should be further developed.
- More resources should be dedicated to interregional collaboration and collaboration.
- New methods strengthening the innovation capacity within industries connected to the blue sector and **cooperation between large and small companies** within the blue industries play a crucial role.
FUTURE STEPS SUGGESTED FOR THE SUBMARINER NETWORK
5 Topic Related Actions

5.1 SUBMARINER Mussel Working Group

1. **Continue to collect data** and information on the currently operational farms and share this through the Operational Decision Support System (ODSS)
2. Investigate a Baltic Sea wide business plan, showcasing of how many mussel farms / harvest at which locations are necessary to provide the feed industry with a cost-effective alternative protein source
3. Take a collective and coordinated approach towards lobbying for changes in legislation and funding programmes and cooperation with certification bodies
4. Organise dedicated meetings / initiatives to connect the mussel farm community with relevant players in policy and the feed industry
5. **Widen the scope of the SUBMARINER Mussel WG, so that it is more in line with currently popular wider concepts** such as “circular economy”; “IMTA with Fish”; “climate change mitigation”; “environmental protection & restoration services” ; “blue-green infrastructure” or “multi-use”. This would allow for the easier linking and promoting exchange among different interests within the Network as well as other related projects; i.e. the ongoing LIFE project on “artificial / floating lagoons”.
6. The mussel topic should be framed as to provide better help directly municipalities.

5.2 SUBMARINER Macroalgae Working Group

1. Establish a ‘Baltic Seaweed’ Working Group to continue knowledge exchange with the mandate to implement the Roadmap actions
2. Promote development of national roundtables with industry, R&D and regulators on macroalgae in other Baltic states (like those in Sweden and Germany S-H).
3. **Identify and create pilot facilities** that can be accessible to companies (test beds, processing)
4. **Increase visibility** and access of relevant communication materials promoting benefits and opportunities of macroalgae to public authorities and other actors such as e.g. promoting the macroalgae sector, its actor, available tools and reports, Blue Platforms’ best practices
5. **Collect data from operational seaweed farms** and model data to validate environmental benefits and alleviate risks of seaweed production.
6. **Support start-ups and SMEs** at low TRLs that are not “investment ready” and need pre-acceleration and incubation facilities through the Blue Growth Accelerator.
FUTURE STEPS SUGGESTED FOR THE SUBMARINER NETWORK

7. Support Baltic farms in knowledge exchange – also with European counterparts and
8. Investigate technologies available in other regions that could be transferred to the Baltic.
9. Lobby to include seaweed mariculture in MSP and Coastal Plans of Baltic states
10. Promote innovative and sustainable Baltic blue bioeconomy products and services already available by companies. Showcase ‘future blue bioeconomy business canvas’ pathways
11. Develop hackathons with concrete challenges submitted by companies.
12. Foster cooperation between algae R&D capacities with SUBMARINER’s Blue Growth Accelerator, to stimulate technology transfer and product development.
13. Encourage and coordinate development of new cooperative structures of small farms sharing costs (equipment) and knowledge, and secure joint larger contracts – a well-known approach to agricultural cooperatives.

5.3 SUBMARINER Beach Wrack Working Group
1. Building on the network created within the CONTRA project, establish a post-project SUBMARINER beach-wrack WG to enable exchange with municipalities, companies and R&D
2. Promote companies working with beach-wrack products and services and support in development of short local value chains.
3. Collect data on available beach-wrack, actors involved and support in organising a market place collaboration platform among municipalities, collectors and down-stream companies
4. Develop roundtables at national level to remove regulatory barriers, e.g. waste definitions.
5. Promote tech transfer activities for collecting and drying beach-wrack, and downstream processing like anaerobic digestion, composting, gasification and feeding larvae.
6. Develop ocean literacy activities, e.g. tourism campaigns, on definition, perception and citizen actions for clean beaches and coastal biodiversity.

5.4 Promote Floating Structures as part of all SUBMARINER activities
1. Integrate floating structures in multi-use projects (tourism and coastal/marine restoration)
2. Consider floating structures in the overall action on technology development and transfer
3. In addition to mussel and macroalgae cultivations as well as beach wrack removal, promote the installation of floating structures as an additional nutrient removal measure
4. Consider business ideas for the use of the harvested biomass within SUBMARINERS accelerator (including hackathons)

5.5 SUBMARINER Fish and Shrimp Aquaculture Working Group
1. Launch of the pan-Baltic SUBMARINER Fish & Shrimp Aquaculture Group as a Mirror Platform under the European Aquaculture Technology Innovation Platform
2. Promote uptake of sustainable (Baltic Sea) feed in all aquaculture systems
3. Promote sustainable and innovative product development and consumer uptake of Baltic aquatic food

5.6 Promote innovative and sustainable product development for all Baltic aquatic sources
1. Work on Valorisation of Waste from Aquatic Sources; i.e. production of fish oil from fish waste
2. Promote new products and their uptake on currently underutilized sources, such as JellyFish; sea cucumbers; sea urges; small pelagic fish (Round Goby, Sprat, etc.)
3. Promote use of marine ingredients in popular non-blue food products (such as pasta, confectionary, bakery, dairy)

5.7 Baltic Blue Biotechnology Research
1. Link the Baltic aquatic biological resource database to EU wide databases
2. Align Baltic blue biotechnology R&D with product market trends, challenges and opportunities:
3. Design new materials supporting the circular economy
4. Continue to map and integrate capacities, facilities and resources for blue biotechnology R&D and innovation in the BSR; strengthen collaboration with EU wide networks
5. Strengthen education and training in blue biotechnology and entrepreneurship (see actions)
5.8 Promote ‘Baltic Sea Multi-Use’

1. Advise national and local governments about the integration of the multi-use concept into planning, zonation and permitting of an offshore wind farm and analysis of suitable institutional arrangements to enable this (i.e. combined permitting procedure).

2. Assist the offshore wind companies in mediation processes with other uses and local governments and in identifying benefits that certain multi-use combinations may bring depending on the local conditions.

3. Form and facilitate an International Ocean Multi-Use Community of Practice to maximise collaboration and project opportunities between the industry and research community.

4. Conduct studies on the identification of suitable environmental and socio-economic parameters for siting of combined uses and encourage mapping exercises that clearly earmark suitable multi-use zones where the combined use may bring more environmental and socio-economic benefits then the single use.

5. Advocate for the identification of devoted offshore multi-use testing sites (i.e. offshore innovation labs) and demonstration pilots that would showcase the impacts of multi-use and thus improve the confidence of governments and industry, facilitating further uptake of the multi-use concept.

6. Concrete studies on real sites (at planning stage) on the potential of developing multi-species aquaculture offshore, and its combination with future offshore wind farms.

7. Develop AI and sensor technologies for aquaculture farms to optimize farm operations that can reduce operational costs due to improved logistics, boat visits and potential accidents or disturbance.

8. Facilitate co-creation for new products and services contributing to BSRs competitiveness:
   • Projects between offshore wind and tourism/recreation
   • Projects combining tourism and aquaculture.
   • Projects that support ‘building with nature’ solutions that can contribute to increased climate change resilience and resource efficiency (e.g. offshore wind farm artificial reefs, coastal erosion protection solutions, re-use of offshore structures for marine life monitoring and restoration, attractive design for tourism all-year round, etc.).

THE ROLE OF SUBMARINER IN MARITIME CULTURAL HERITAGE

The sectoral topic is well placed within the BSR Underwater Heritage Working Group of the CBSS. Thus UCH will no longer be pursued as a distinct separate topic by the SUBMARINER network. We will, however, keep on considering the issue within wider cooperative Blue Economy – especially within the multi-use and costal development – initiatives and Maritime Spatial Planning.
Thus future activities will focus on:

- Enhance knowledge about MCH and collaborate with relevant stakeholders/bodies
- Foster blue growth and support initiatives to bring MCH closer to those who cannot dive
- Further Integration of MCH into MSP

5.9 SUBMARINER as a driver for Marine Litter Activities

SUBMARINER should become an important driver of Marine Litter activities in the BSR supporting Member States to meet their obligation under the MSFD to develop & implement national Programmes of Measures; coordinate and participate in research and promote clusters of circular economy initiatives to find solutions related to land – and sea-based marine litter.

To that end, SUBMARINER members should in a first step:

- map marine litter / plastic waste actors
- facilitate the creation of national and possibly a BSR wide ‘Single Use Plastic / Marine Litter’ Round Tables
- deal with Aquaculture / fishing gear; promote 'Fishing for Litter Concept

**THESE ACTIVITIES SHOULD LEAD TO PROJECTS COVERING THE FOLLOWING ACTIONS:**

**Land-Based Measures**

- Find ways to reduce the input of plastic waste into the marine environment,
- Support measures to prevent and reduce microplastic,
- Foster efforts to substitute and modify plastic products,
- Reduce the amount of plastic waste through municipal targets,
- Promote citizen awareness

**Sea-based Measures**

- Foster knowledge about the sources of marine litter and microplastics
- Support removal of already existing marine litter in the marine ecosystems of the BSR,
- Foster waste-related measures for fishing nets and gear (including aquaculture)
- Support the structural establishment of the Fishing-for-Litter concept
- Analyse and improve waste management on ships and in ports
- Support the establishment of standardization of fishing gear
6 Cross-Cutting Action Fields

6.1 Actors Match-Making

ENLARGE AND BROADEN THE SUBMARINER NETWORK – ACT AS THE PAN-BALTIC BLUE BIO-ECONOMY COMPANY CLUSTER

- Companies – as a primary target group
- R &D Institutions (and their technology transfer / innovation offices)
- Business Support Institutions and their Networks
- Investors / Business Angels

COLLABORATE AND PROVIDE SERVICES TO COMPANIES

- Develop SUBMARINERS Baltic Blue Bio-economy Product / Company Catalogue; thereby reaching out to more than 300 potentially suitable companies (funded by Nordic Council)
- Facility the development of future business canvas scenarios together with research, companies and company supporters
- Organize on regular basis Innovation Bootcamps, Hackathons, Creative / disruptive Ideation Workshops based on company, environmental and societal challenges
- Thereby foster regional / national circular economy solutions & demonstration projects with industry
- Prepare a ‘blue economy’ funding guide

CONTINUE AND STREAMLINE SUBMARINERS (PRE-) ACCELERATOR SERVICES

- Continue scouting for business ideas and future entrepreneurs
- Continue the 365 days start-up enrolment service offering ‘quick assessment’ of business idea by voluntary SUBMARINER mentors and knowledge transfer within SUBMARINERS working groups
- Create internal save SUBMARINER company collaboration cloud space
- Organize regular (annual or bi-annual) pitching and match-making events across the entire SUBMARINER network as well as with invited large companies and investors
- Offer long-term support through continued marketing and promotion of spin-offs and start-ups to other international funding programmes (e.g. BlueInvest, Circular Economy Fund, etc.)
- Strengthen systematic collaboration with other accelerators and large companies
CONTINUE TO INTEGRATE OUTPUTS AND RESULTS FROM SPECIFIC RESEARCH PROJECTS

- The SUBMARINER secretariat should be the regular communication and dissemination hub in each blue bioeconomy project – not only at the end – but during the entire project duration.

LOBBY FOR A CONTINUOUS TRANSNATIONAL BLUE ASSISTANCE PROGRAMME

- Promote the creation of an inter-regional funding pool.
- Promote the introduction of a transnational innovation voucher system.

6.2 Unlock financing for the Blue Bioeconomy

The emphasis of future actions is not so much on changing or adopting a new approach or project, but merely to sustain and expand those services, which have worked very well especially by raising finance to continue the SUBMARINER Accelerator with its mentoring and service programme.

INCREASE COLLABORATION WITH BIG COMPANIES

- as potential clients of the blue economy start-ups or sponsors of the acceleration services.

DEVELOP AND TEST NEW WAYS OF FUNDING BLUE BIOECONOMY / MARINE LITTER

- Marine Litter Fund: Insurance & Fishery Fund
- Compensation / Water Improvement Fund
- Innovation Vouchers

DEMONSTRATE MULTI-USE

- Including large energy companies as well as regions/authorities

PROMOTE ‘BLUE’ PUBLIC PROCUREMENT & PUBLIC-PRIVATE PARTNERSHIPS (AND ECOSYSTEM PAYMENTS)

- fostering ‘smart’ combinations in public procurement
- fostering alignment of national funding programmes, regulations & licensing

BUILD A COMMUNITY OF PRACTICE
6.3 Technology Development and Transfer

Despite achievements, there is still an enormous need for developing and finding better technology solutions, which enable a financially as well as environmentally sound blue bioeconomy to develop further within the Baltic Sea region.

**FOSTER ONGOING KNOWLEDGE AND TECHNOLOGY EXCHANGE AS PART OF SUBMARINER WORKING GROUPS**

- Initiate dedicated study tours for companies within and especially outside the Baltic Sea Region
- Organize dedicated pitching / match-making sessions, topical workshops and Hackathons not only for start-up, but also established companies (see above)

**BLUEBIOTECH SEED MONEY PROJECT (2020-2021)**

aims to identify the main technology and innovation needs within the industry with focus on Baltic Sea specific and relevant requirements. The main project shall not only foster technology development, but also effective technology transfer among technology providers and users:

- Better solutions for drying, harvesting, processing techniques and general upscaling of micro – and macroalgae, mussel or RAS cultivations.
- Aquaculture systems have to be advanced as to meet the zero emission targets; while nevertheless being economically feasible
- Intelligent combinations of renewable energy technologies with aquaculture biorefineries can lead to cost reductions, which are necessary to enable RAS systems to work economically
- Innovations for the management of the sites, using new technology for controlling health and growth of the respective fish or plants.
- Technology development is also an enabler as submerged or more offshore systems reduce negative environmental impacts as well as visual disturbance.
- Block chain technology, artificial intelligence, digitalization and big data have an enormous effect on enabling more sustainable blue bioeconomy and improved consumer communication.

6.4 Environmental Data and Monitoring

Continue to promote the voluntary exchange and collection of data from existing farms especially in view of environmental impacts, but also blue biomass harvesting results. In the long-run aim for establishing a tracking system (similar to forestry industry), in order to continuously inform potential buyers on quantity and quality of the blue biomass harvested or collected.
SEED MONEY PROJECT BLUEBIOSITES (2020-2021)

The currently running project ‘BlueBioSites’ aims to develop a ‘large scale’ project with the objective to develop a Baltic Sea wide effective system for the identification and monitoring of Blue Bioeconomy sites covering not only mussel & macroalgae cultivations; but also fish aquaculture, microalgae as well as reed harvesting sites. The project shall also tackle the monitoring of existing sites; providing recommendations on the most effective technology means to generate such data (AI, sensors, drones, cameras and submarines).

PROJECTS SUPPORTING THE INTEGRATION OF MONITORING PRACTICES AS PART OF OTHER ACTIVITIES SUCH AS OFFSHORE WIND FARMS AND CENTRALISED DATA COLLECTION PRACTICES

Existing offshore structures can be used to monitor the environment and support the data collection efforts on impacts and changes in marine environment. A regional, transnational project would allow for the agreement on and standardisation of monitoring parameters, methods, data, etc.

PROJECT ON UNDERWATER NOISE POLLUTION / SEA FLOOR INTEGRITY

Widen MSFD descriptors on ‘saving good environmental status’ from nutrient emissions or hazardous substances to “underwater noise pollution” and “sea floor integrity”. Promote related solutions /measures and align national efforts for monitoring of underwater noise (e.g. impact from different sources to different marine lifes) throughout the Baltic Sea Region.

6.5 Promote Ecosystem Payments

The introduction of ecosystem payments is closely connected to activities already mentioned above. As such listed activities are framed specifically to that objective, but are also integral part of other work streams:

- Promote ongoing sharing and collection of monitoring data from given farms (regardless under which project) to continue to gather an empirical basis on the positive environmental impacts of these low trophic cultivations (BlueBioSites / possibly Algae & Shellfish study)
- Promote optimal site selection for possible new farms at sites, where the mussel and/or algae cultivation can achieve highest impact for nutrient and phosphor uptake (BlueBioSites)
- Promote collaboration between the various farms and calculation of optimal process – as to achieve critical mass necessary to use mussels or algae in feed products (BalticSeaFeed).
- Represent SUBMARINER members’ interest in relevant bodies; e.g. HELCOM Observer status.
- Promote the establishment of ecosystem payment schemes at regional and local level as part of circular economy approaches
6.6 Education and Training

Create an education task force within the SUBMARINER network to evaluate the needs and feasibility

- of maintaining a transnational blue bioeconomy ‘career’ and ‘exchange’ service and
- a Baltic Sea wide collaboration on joint or aligned Master Programmes
- relevant skills gaps and needs at company levels to be addressed through formal or informal education & training programmes and
- assess whether an application under ERASMUS+ and/or COST may be an option.

Continue ongoing maintenance and update of SUBMARINER Blue Bioeconomy Information Portal; by updating it with latest articles, studies, reports and training material.

6.7 Public Awareness Projects and Initiatives

Based on the (initially not successful) BalticProBlue and ERASMUS+ Blue Schools applications; the SUBMARINER Network has together with some of its key members – submitted the EU wide Sea2Fork application under the Horizon Green Deal Call.

Even if the currently submitted applications may not receive initial funding; we will pursue such applications further under Horizon Europe, INTERREG and Nordic Council – based on the good partnerships already established both within the Baltic as well as across Europe – as we see it as key to create a market pull in parallel to a product push.

The Baltic Company Catalogue, initiated by SUBMARINER and approved by the Nordic Council for funding, is an important step in creating closer links to the companies already active in this field within the Baltic Sea Region and explore which of them meet SUBMARINERs assessment criteria and are open and interested in collaborative and cooperative joint solutions, necessary to create the push from the producers side.

Extend low cost public awareness initiatives, such as ‘Novel Blue Food Cook Books’; compiling results from other projects and members’ initiatives (i.e. GoJelly European Cook Book)
6.8 Working with Regions

Even though coastal sub-regions and municipalities play a role in all SUBMARINER projects, a dedicated working group of ‘Blue Regions’ has not evolved out of the SmartBlueRegions project under the SUBMARINER network roof. As regions and their blue clusters play a crucial role in the actual implementation / realization of the ambitions voiced by the SUBMARINER network, we advocate for the following future actions:

- **Revive the close connection to the CPMR Baltic Sea Commission** and jointly identify activities to be taken on board, by regions as part of the new SUBMARINER roadmap
- **Offer ‘project related’ regional networks** (e.g. interested in view of use of beach-wrack/CONTRA or promotion of coastal biogas/Coastal Biogas) the SUBMARINER Network as their ‘roof’ post-project time as to continue their cooperation and better link to other related blue bioeconomy initiatives
- **Strengthen intra-Baltic collaboration of regions at ‘blue’ cluster level;** esp. by encouraging to developing a joint application under COSME and other programmes
- **Strengthen collaboration between Baltic and other European Blue Clusters** (such as Pol Mer Bretagne, Flanders Blue Cluster)
7 New Strategic Actions

7.1 Ocean Literacy

7.1.1 Ambition

The concept of Ocean Literacy aims to increase this awareness and understanding of the relationship between people and the ocean and goes one step further. It provides the tools, methods and approaches for taking action – not only in a formal educational context, but also targeting society as a whole.

7.1.2 State of Play

Ocean Literacy is a hot topic and worldwide many initiatives are already in existence, including the recently launched EU4Oceans coalition and the IOC Ocean Literacy Portal and online Toolkit. It is set to be promoted during the United Nations Decade of Ocean Science for Sustainable Development.

At a grassroots level, there is a huge amount of activity in Ocean Literacy across the Baltic, run by SUBMARINER members and beyond. An initial, non-exhaustive mapping of OL activities found 78 organisations and projects already active in the topic.

7.1.3 Ocean Literacy projects with SUBMARINER involvement

<table>
<thead>
<tr>
<th>Project Title</th>
<th>Duration / Funder</th>
<th>Purpose</th>
<th>SUBMARINER</th>
</tr>
</thead>
<tbody>
<tr>
<td>EU4Ocean coalition</td>
<td>DG Mare, 2020–2023</td>
<td>EU-wide initiative to promote ocean literacy by connecting actors</td>
<td>s.Pro acts as Baltic Focal Point</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Topics: Climate, Food and Clean Ocean Targets: Schools, Youth</td>
<td></td>
</tr>
<tr>
<td>Blue Platform</td>
<td>Interreg BSR, 2018–2022</td>
<td>Online hub on Baltic Blue Bioeconomy Better of Blue workshop series</td>
<td>Secretariat, Uni Gdansk (PL) SYKE (FI), SBA (SE), Uni Tartu (EE) KSTP (LT), LAIE (LAT), Guldborgsund (DK)</td>
</tr>
<tr>
<td>Blue Generation</td>
<td>Norway Funds</td>
<td>inspire and engage young people to pursue a career in the Blue Economy</td>
<td>SUBMARINER secretariat</td>
</tr>
<tr>
<td></td>
<td>2018–2022</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ocean Blues</td>
<td>National Funding, 2021</td>
<td>Showcases science activities to address the climate crisis</td>
<td>Uni Gothenburg</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ocean literacy in schools</td>
<td>none</td>
<td>Promote Blue projects &amp; curricula in schools</td>
<td>Secretariat, UGOT SYKE, Havhoest, NMFRI</td>
</tr>
</tbody>
</table>

7.1.4 Recommendations and Next Steps

Using its involvement in the EU4Ocean coalition, SUBMARINER Network has initiated the informal Baltic Sea working group on ocean literacy. Our recommendations for actions are the result of discussions with the working group as well as consultation with the wider community of actors.
USE SUBMARINER’S POSITION AS AN INFORMATION HUB FOR BLUE BIOECONOMY TO ENHANCE THE VISIBILITY OF OCEAN LITERACY AND ITS INTEGRATION INTO EXISTING AWARENESS RAISING ACTIVITIES.

- Establish a library of existing ocean literacy material
- Develop a network between education centres (incl. museums, aquaria) and schools – coordinated by our OL partners Gdynia Aquarium and European Association of Marine Science Educators.

WORK ON A UNIFIED APPROACH TARGETING CONSUMERS AS A KEY GROUP FOR THE PROMOTION OF OCEAN LITERACY.

- We want to work with NGOs and retailers among others to achieve this

INVOLVE THE MEDIA AND ARTS SECTOR

WORK TOWARDS A EUROPEAN “BLUE FOOD MOVEMENT” (CLOSELY RELATED TO RECOMMENDATION #3).

- This is a way of connecting OL to established efforts in citizen science and a starting point with an obvious, engaging and practical application.

INTEGRATE OCEAN LITERACY INTO THE FUNDING LOGIC OF PROGRAMMES

- Adopt OL in the evaluation criteria for proposed projects’ communication and exploitation activities.
- Create a dedicated Coordinating and Support Action for this field.

7.2 Restore biodiversity and ecosystem services

7.2.1 Ambition

The continued degradation of the coastal ecosystems and their services affects biodiversity, climate change, and enhance the risk of severe ecological disasters and pandemics. The European Green Deal and its Biodiversity Strategy request urgent restoration efforts for damaged coastal ecosystems to increase biodiversity and deliver a wide range of ecosystem services:

- Biodiversity in Baltic should be back on a path of recovery by 2030; ecosystems and their services are preserved and sustainably restored at coasts and the sea through improved knowledge and innovation.
- Assessment, valuation and trends of natural capital and ecosystems services, including socio-economic benefits, should be integrated into decision making in policy and businesses; with policy makers getting expert support to determine how to prioritise and deliver ecosystem restoration; science base provided for planning and increasing protected areas with ad hoc flexible ecosystem based management.
Many of the SUBMARINER topics and actions support biodiversity and ecosystem restoration. So far, however, we have not explicitly framed them around this specific goal. Hence, SUBMARINER will establish ‘Marine Biodiversity and Ecosystem Restoration’ as a new transversal focus area for strategic actions.

R&I in the SUBMARINER Network will address the multiple challenges in this area, including by enabling transformative changes and develop a long-term strategic research agenda for Baltic biodiversity:

- **Understanding biodiversity decline and addressing its main drivers** through data-driven science, integrated multidisciplinary knowledge, new tools, models and scenarios
- **Develop tools** to guide decisions, inform and implement policies on environment, water, health, climate, disaster risk reduction, coasts, protected areas management, bio-economy, blue economy, marine spatial planning, and responsible business practices.
- **Consult local and regional company clusters** (e.g. regional Blue Clusters) and identify key stakeholders in the field of innovation, restoration and conservation.
- **Through multi-actor labs** (interactive brainstorming sessions) promote the regional cooperation to boost innovation in the field of restoration approaches.

### 7.2.2 Projects / State of Play

Many Submariner members have past, on-going and future projects related to coastal ecosystem restoration; the following table only showcases those of its Danish member SDU:

<table>
<thead>
<tr>
<th>Project Title</th>
<th>Duration / Funder</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>NordSalt</td>
<td>Biodiversa H2020-ERANET 2021–2024</td>
<td>Assess extent and plant community biodiversity in Nordic Salt and coastal marshes to evaluate how these ecosystems provide climate and coastal protection related benefits</td>
</tr>
<tr>
<td>Sund Vejle Fjord</td>
<td>Interreg BSR, 2018–2022</td>
<td>Planting and protect eelgrass; establish mussel banks and stone reefs; fish up crabs</td>
</tr>
<tr>
<td>Gyldensteen Coastal Lagoon</td>
<td>Aage V Jensen Nature Foundation</td>
<td>Coastal realignment and seagrass, stone reef &amp; mussel restoration</td>
</tr>
<tr>
<td>Reelgrass</td>
<td>Danish Research Foundation</td>
<td>Investigation of environmental stressors for eelgrass recovery</td>
</tr>
</tbody>
</table>

### 7.2.3 Future Steps

The SUBMARINER Network secretariat has taken the role to coordinate and synthesize the formation of an Ecosystem Restoration Working Group. SUBMARINER will screen, facilitate and develop a series of actions and proposal to address the upcoming opportunities (such as BSR Interreg, BANOS, HEU). In addition, the SUBMARINER Network is about to seek stronger contacts to alliances active in restoration like NORA (Native Oyster Restoration Alliance) or NEAMO (North Atlantic & European Shellfish Centre).
The following next steps represent a starting point and are open to revision.

MAPPING OF:

- Competences of SUBMARINER members
- possible collaborators & stakeholders (field & topic specific)
- focus areas (differentiated fields/networks)
- events (where do we have to be / where could we be)

ORGANIZE SEMINARS / WORKSHOPS (ALL THEMATIC)

- Connect the ecosystem restoration community with relevant players in policy and the industry
  Coordinate policy information and activities
- Take a collective and coordinated approach towards lobbying for changes in legislation and funding programmes

INTENSIFY COLLABORATION WITH NGOS AND LIFE PROJECT OWNERS AND MUNICIPALITIES

- to establish or strengthen networks and promote restoration processes stepping upon existing work
- start an exchange of ideas with on-going LIFE project on restoration to exchange approaches – such as allowing a converted areas to recover, removing human pressures, controlling invasive species, allowing wetlands to get flooded regularly, or reintroducing habitats that were formerly present. It could also broaden the networks on local and regional levels with people who experience the benefits
- concretely assist coastal municipalities in finding, developing and implementing coherent restoration solutions, which are inter-twinned with regional development programmes promoting circular economy and local value chains creating jobs and added value for local inhabitants

LINK THE RESTORATION BIODIVERSITY TOPIC TO OTHER SUBMARINER CONCEPTS SUCH AS CLIMATE CHANGE MITIGATION, ENVIRONMENTAL PROTECTION SERVICES, MULTI-USE.
The role of the Baltic Blue Bioeconomy in Climate Change Reduction & Mitigation

7.3.1 Ambition

The Baltic Sea's ecosystems are used intensively by coastal populations, and the sea supports economic activities in the surrounding region and beyond. Climate change is impacting maritime sectors, especially fishing, aquaculture and maritime transport. Conversely, GHG emissions from these activities contribute to global climate change, adding to further impacts in the Baltic Sea (e.g. changing water chemistry, increasing storminess) and will likely continue to pose daunting environmental threats.

As shown in the 1st Chapter of this Report, almost all initiatives supported by SUBMARINER ultimately also address climate change issues. However, similar to the previous chapter on ‘biodiversity and ecosystem restoration’, activities have not been analysed in a comprehensive way in view of their concrete contribution to Europe’s greenhouse gas emission reduction goals.

While many reports draw attention to climate impacts, actual mitigation strategies and actions addressing the blue economy are rare in the climate-related policies of Baltic countries. The situation is particularly critical in the southern & eastern Baltic, where some climate adaptation plans exist, but climate mitigation strategies are yet to be developed at multiple scales.

These countries are simultaneously seeking to expand their blue economies, requiring further work to create a harmonized approach for Baltic blue economy contributions to climate change mitigation. To develop this approach, additional knowledge on climate mitigation potential of maritime sectors is needed for identifying data-driven solutions with the highest cumulative reduction of GHG emissions. Importantly, this knowledge should be shared among key actors to build coherent climate mitigation plans.

7.3.2 Future Steps

The SUBMARINER Network has recently submitted two project applications (evaluation outstanding) related to address these issues.

ALGARITHM EU ALGAE AND SHELLFISH STUDY (ENV.C.2/SER/2013/0041; SUBMITTED 2020)

SUBMARINER members have submitted a proposal for an EU wide study tendered by DG MARE. The aim of Algarithm is to assess the potential of shellfish and macroalgae to recycle nutrients and greenhouse gas emissions from their production and thereby to add to the evidence base supporting the planning of low-trophic aquaculture in European sea regions.
BLUE4CLIMATE (EUROPEAN CLIMATE INITIATIVE, PROPOSAL SUBMITTED IN JANUARY 2021)

The project proposal submitted aims to identify and promote concrete actions across 4 key blue economy sectors – transport, energy, bio-economy and tourism – that will lead to their own carbon neutrality, and in turn, help achieve climate mitigation targets set in existing and developing strategies.

Working closely with regional and national authorities, as well as industry clusters, Blue4Climate would facilitate the much-needed dialogue among these actors to ensure the up-take of blue economy mitigation actions across policy levels. These include both climate and energy plans (e.g. Estonia’s 2030 National Energy and Climate Plan – NECP 2030) as well as smart specialisation strategies (S3) (e.g. Pomorskie Smart Specialisations, PL).

Through connections across engaged regions as well as the broader Baltic Sea Region, the project shall help realize objectives from Baltic-wide strategies relevant to the blue economy and climate mitigation (e.g. EU Strategy for the Baltic Sea Region, CBSS Baltic 2030 Action Plan).

CROSS-CUTTING ACTIONS

Independent of the success of these two current project applications; the SUBMARINER network aims to develop joint efforts as to earmark more clearly the contribution of its activities towards mitigating and reducing climate change impacts.

To this end, it plans to organise a dedicated webinar / workshop on that topic across its own membership as well as continuing to mainstreaming the blue into other climate related initiatives.