SUBMARINER NETWORK

Roadmap

Towards a blue-green economy in the Baltic Sea Region

2nd edition, June 2015

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About the SUBMARINER Roadmap

Dear Reader,

Almost two years have passed since the first edition of the SUBMARINER Roadmap was published in September 2013. And still we experience an ever-increasing interest in the SUBMARINER vision: to maintain and improve the Baltic Sea Region's natural capital, to provide marine-based feedstock and energy solutions and to improve human well-being by promoting bio-based innovation and integrated uses of blue-green solutions.

This interest is best expressed by the institutionalisation of the SUBMARINER Network for Blue Growth: Following the successful completion of the Baltic Sea Region Programme project "SUBMARINER – Sustainable Uses of Baltic Marine Resources" (2010–2013), eight research institutions, public administrations, NGOs and business parks from all around the Baltic took the joint initiative to register the SUBMARINER Network as a European Economic Interest Grouping (EEIG), with the aim of creating a free-standing cooperation and communication platform for promoting innovative approaches to the sustainable use of marine resources. Numerous new associate members have since joined the original network founders, and several new project initiatives with many new partners have been brought to life.

This document, the SUBMARINER Roadmap, is the most important reference point for the broad range of initiatives that the SUBMARINER Network engages in. The SUBMARINER Network Action Plan presented in chapter 5 organises them along eight strategic action fields that combine thematic and transversal elements. The focus is on key issues that require joint efforts in the Baltic Sea Region in order to reach the objectives of our SUBMARINER vision.

Figure 1: Integrated longline system for cultivation of mussels and algae in the Kiel Fjord (picture: CRM – Coastal Research & Management)

The fact that the first edition of the SUBMARINER Roadmap was out of print within less than a year shows how well the idea of providing a comprehensive framework to guide a broad range of stakeholders throughout the Baltic Sea Region has been received. This is why we are now releasing this second edition.

In addition to the Roadmap document as such – which has not been changed apart from some corrigenda – we will start to publish regular update reports on the implementation of our Roadmap as a way to summarise and showcase what kind of new initiatives have started in the field of innovative and sustainable uses of marine resources over the last years. The first report is scheduled for summer 2015.

The Swedish Agency for Marine and Water Management is proud to sponsor the reprint of this second edition of the SUBMARINER Roadmap. Together with the Ministry of Economic Affairs, Employment, Transport and Technology Schleswig-Holstein and the Maritime Institute in Gdańsk we also remain committed to fulfilling our role as co-leader of the SUBMARINER Network flagship project under the Priority Area "Innovation" of the EU Strategy for the Baltic Sea Region (EUSBSR).

I hope that also you will be inspired by the SUBMARINER vision and that you will join us in our efforts to turn it into reality!

Thomas Johansson

Head of Unit
Swedish Agency for Marine and Water Management

Swedish Agency
for Marine and
Water Management

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Key Messages

What are the key benefits of a conscious and sustainable use of Baltic marine resources and key factors needed to achieve them?

Which are the most important steps to be taken within the next years?

THE SUBMARINER VISION 2030 STIPULATES that a more widespread conscious and sustainable use of Baltic marine resources, based on innovation and smart combinations, can contribute substantially towards:

a Achieving good environmental status and thus maintaining the BSR's natural capital which in turn supports a broad range of ecosystem services;

b Transforming the BSR into focal point and resource for renewable energy, locally meeting EU targets, mitigating climate change and enhancing energy security;

c Developing of a broad range of new biobased products enhancing human health and well-being (medicines, health food, etc.);

d Creating new jobs and economic growth by attracting new industries and businesses in the sector of blue-green technology and product development, especially in coastal regions.

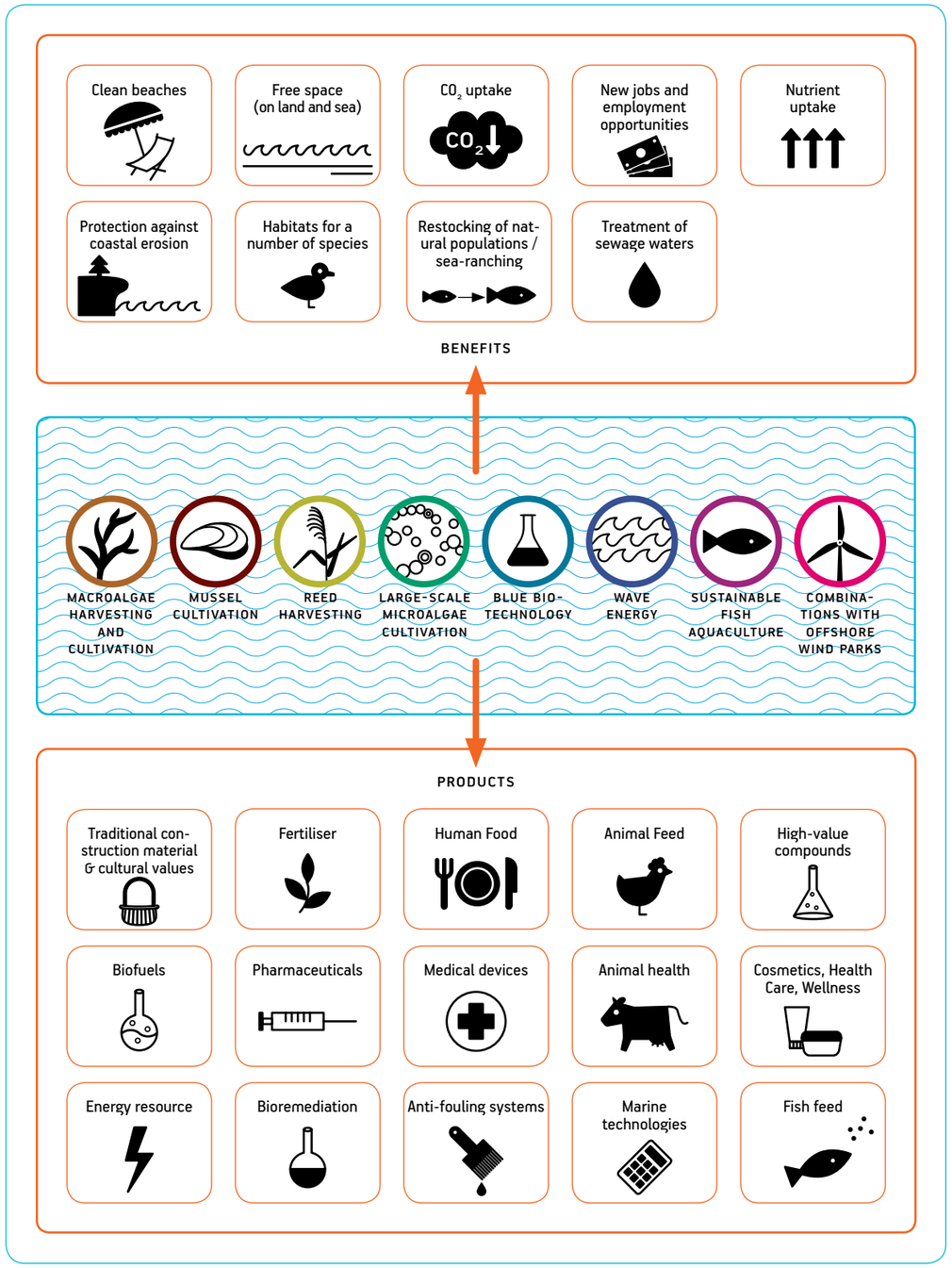
Smart combinations and system innovations have been identified as the two key factors, which are necessary to turn the SUBMARINER vision into reality:

- Smart combinations refers to integrated concepts where multiple products (e.g. biogas, fertilisers, seafood, high-value products) and services (e.g. nutrient harvesting, carbon sequestration, clean beaches) are delivered from the same space:
  - Biorefineries, where a production of various algae commodities may be used for biofuel, extraction of high-value compounds, nutrient removal from waste streams and utilisation of CO_2 from flue gas;
  - Integrated multi-trophic aquaculture (IMTA) systems combine mussel and algae cultivations with fish aquaculture in order to reduce the environmental impact while at the same time delivering more valuable products;
  - Mariculture systems or wave energy devices may be placed within offshore wind parks;
- System innovations make best use of already available knowledge and technologies from related sectors such as forestry, offshore wind as well as other biotech industries. While technology development is especially important to enable upscaling of cultivation processes to large volumes, new approaches also need to be developed in order to better understand the combined effects of new marine uses and internalise their social and environmental benefits.

Within the next financial period until 2020, emphasis should be placed on actions to remove the most critical barriers. These should be implemented by mutually beneficial private-public collaborations with strong and long lasting support from funding institutions (EU-wide or national programmes) towards:

- Creation of many more pilot sites in different parts of the BSR in order to better understand

Figure 2: Summary of benefits and products delivered that can be obtained from a sustainable use of marine resources.



the cumulative impacts of new marine uses both in environmental as well as economic terms; The sites should be open for joint (international & interdisciplinary) research;

- Valuation of ecosystem services such as nutrient removal, clean beaches or fish restocking and design of appropriate mechanisms that translate them into benefits for those who deliver them;
- Strengthening cooperation and networking to bring together the various actors and to foster knowledge exchange within a structured process;
- Alignment of short term project and financial cycles in order to synchronise with the medium to long term processes necessary to reach the full production capacity

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The Current Situation

What do we already know about marine resources and their potential benefits?

What are the main findings of the comprehensive sustainability assessment carried out in the SUBMARINER Compendium?

SUBMARINER HAS CARRIED OUT THE FIRST EVER comprehensive sustainability assessment for the whole product chain for each of the innovative and sustainable uses of Baltic Marine Resources described below.

Oceans and coastal waters do not only play an important role for the global climate and environment, they also host a vast diversity of so far untapped resources. With new technologies, increasing knowledge and multi-disciplinary, cross-sectoral systematic approaches, the sustainable use of these marine resources may generate great economic opportunities and contribute to mitigation of environmental problems.

POLICY INITIATIVES

The phenomenon has recently found its expression in a number of **European Commission policy initiatives**:

- The **strategy for a sustainable bioeconomy** in Europe, adopted by the European Commission in February 2012, is part of the Europe 2020 strategy. It aims towards the development of a more innovative and low-emissions economy, which uses biological resources from the land and sea as inputs to food and feed, industrial and energy production as well as biobased industrial and environmental protection processes.
- The Commission's Integrated Maritime Policy and more specifically the **Blue Growth initiative**, aims to harness the untapped potential of Europe's oceans, seas and coasts for job creation and growth whilst safeguarding the services of healthy and resilient marine and coastal ecosystems. Thus the Blue Growth initiative is strongly linked with the **EU Marine Strategy Framework Directive** to reach a good environmental status by 2021.

Also the Baltic Sea represents a huge arena for innovation. Despite the fact that some of its resources, like fish stocks, are already heavily exploited, new innovative approaches towards their utilisation need to be developed that can proactively improve the Baltic Sea's vulnerable ecosystem and contribute to the BSR's long-term economic prosperity:

Macroalgae Harvesting and Cultivation: Free floating or beach cast macroalgae can be collected or may be cultivated in near shore installations leading to improved water quality and nutrient reduction, and serving as a resource for biogas, fertilisers and food or feed additives.

Mussel Cultivation: Near shore mussel farms may improve water quality and nutrient recycling and offer valuable feed stuff and fertilisers.

Reed Harvesting: Cutting out reed from near shore reed beds can support nutrient removal and provide a resource for bioenergy production as well as environmentally friendly construction material.

Large-Scale Microalgae Cultivation: Algae fuels may in the future be produced in an economically and environmentally sustainable way if cultivations are coupled with utilising CO_2 from flue gas and nutrients from waste water and production of highvalue compounds (biorefinery concept).

Blue Biotechnology: By extracting valuable substances produced by marine micro- and macroorganisms, high-value products in the field of medicine and cosmetics, food and feed supplements, environment as well as industrial applications may be developed.

Wave Energy: New concepts like versatile, small-scale prototype installations powered by low-cost and high capacity linear generators have proven to be attractive solutions for low wave energy basins and may, therefore, open this untapped energy resource also for the Baltic Sea Region.

Sustainable Fish Aquaculture: Integrated multi-trophic aquaculture (IMTA) is a form of aquaculture that combines the production of species from different trophic levels, e.g. mussel and algae farms with open net cages for fish. Via this innovative technique, the environmental impacts of fish farms may be decreased. Also land-based recirculating aquaculture systems (RAS) may offer environmentally friendly, all year round fish production for human consumption and restocking purposes. Both technologies may open the door to expand fish aquaculture in the Baltic Sea Region.

Combinations with Offshore Wind Parks: Placing macroalgae, mussels and fish cultivation sites within offshore wind parks or linking wave energy installations to them may lead to win-win situations with a more efficient, joint use of valuable marine space as well as infrastructure and human resources.

The following analysis provides an overall picture of the strengths, weaknesses, opportunities and threats (SWOT) for innovative marine techniques within the BSR identified in the SUBMARINER Compendium.

swot Analysis

STRENGTHS

- Mussel, macroalgae and reed harvesting and cultivation offer additional and flexible solutions for nutrient harvesting to combat eutrophication and to close the nutrient cycle within fish aquaculture;
- Algae, reed and mussels are all common BSR local, renewable and climate neutral resources;
- Low capital / investment requirements and operational costs for these nutrient removal methods;
- Mussel and algae cultivations enhance local biodiversity and coastal protection;
- Mussel meal may become an environmentally sustainable alternative source of feed stuff for aquaculture, replacing fish meal;
- Mussels and algae as resource for organic fertilisers;
- Marine microorganisms are a valuable resource for products improving human health & wellness;
- Collection of beach cast macroalgae and reed removal lead to increased value of coastal area, higher recreational values and better visibility of the seaside;
- Multiple products (e.g. biogas, fertilisers, seafood) and services (e.g. wastewater treatment, carbon sequestration) can be delivered from the same space;
- Highly equipped labs in almost all countries along the Baltic Sea for genomic approaches
- No competition with use of arable land for food production or use of fresh water;
- Bioenergy from marine resources and use of CO_2 from flue gas contribute to climate change mitigation;
- Competent researchers with some experience, pilots and case studies within the BSR;
- Growing number of authorities in the BSR actively supporting Blue Growth topics;
- Growing public awareness on protection and use of marine resources (environmental technologies)
- Availability of scientific knowledge and well equipped facilities;
- Technology companies in related industries available within the region.

WEAKNESSES

- Low growth rates of marine species in sub-optimal Baltic Sea conditions and relatively low biodiversity;
- Essential gaps in knowledge on environmental impacts;
- Lack of knowledge on impacts of climate change implications to Baltic ecosystem
- Lack of experience on commercial implementation as there are only few commercial operations in place throughout the BSR;
- Limited and unreliable knowledge / evidence on economic efficiency, especially of use of marine resource as energy resource due to lack of empirical evidence;
- Relatively high transportation costs of energy produced from marine resources
- In case of energy, relevance limited to coastal areas due to transportation costs;
- Seasonality of biomass production due to cold and dark winter period;
- Ice conditions create challenges for installations;
- Limited tradition for mariculture and their products throughout BSR;
- Long process for new products to achieve market appeal;
- Socio-economic benefits are difficult to valuate as no agreed / standard approach for valuation and compensation of ecosystem services exists;
- Currently insufficient solutions of environmentally friendly and cost-effective technology;
- Lack of technology developments for BSR specific conditions in certain fields;
- Low technology transfer;
- Substantial amount of (non arable) land and water required for large scale microalgae cultivations;
- Skills shortage, esp. in cross-cutting disciplines and commercialisation (financial and marketing skills);
- No systematic approach towards research collaboration among BSR actors.

OPPORTUNITIES

- Multi-product, zero waste combinations increase economic and environmental sustainability;
- Growing political will both in the EU and the BSR to combat eutrophication (EU directives, HELCOM) and growing acceptance of non-point sources nutrient removal measures;
- Growing recognition at EU, BSR and National levels for the need to establish a common framework for valuation of ecosystem services;
- EU support concerning renewable energy, climate change, Integrated Maritime Policy and Blue Growth, SME support initiative;
- With more offshore wind parks more space available that could be used for various forms of mariculture;
- Growing demand for
  - Energy from alternative sources;
  - Local Baltic Sea products;
  - High-value products, such as medicine and cosmetics, bioengineering products;
  - Sustainable feeds for organic farmers and aquaculture enterprises;
- Growing Baltic Sea tourism industry leads to growing demand for clean beaches and improved water quality;
- Growing prices for traditional energy carriers;
- Developments in high-technology and bioenergy production;
- Few alternative measures available to recycle nutrients from coastal waters, i.e. non-point source;
- New job opportunities in rural coastal areas;
- BSR advanced in political processes for Maritime Spatial Planning;
- Growing willingness of technology and energy companies to invest in research;
- Global drive towards sustainable development;
- Growing support for decentralised network economies.

THREATS

- Lack of willingness/incentives for public-private collaboration;
- Challenging framework for creation of new companies in this field;
- Potential changes of nature protection requirements (Natura 2000 habitats) may not allow uptake of marine resources from coastal areas or installation of new mari-cultivations;
- Limited duration and institutional discontinuity of public research projects;
- Spatial conflicts with other (traditional) uses in coastal areas lead to insufficient availability of marine space;
- Scaling up of highly productive systems at low cost may not be feasible;
- Insufficient monitoring about availability of Baltic marine resources;
- Changing Baltic hydro- and meteorological conditions due to climate change;
- Lack of financial support due to current economic and financial crisis;
- Fluctuating market prices / new cheaper forms of energy resources (i.e. shell gas) may have impact on production and pricing of renewable energy;
- Lack of political support at national level ensuring a stable level of energy prices from renewable sources;
- Competition from other countries (sea-basins) producing cheaper products;
- Lack of public support for sea-based products due to low awareness;
- Lack of long-term perspectives in research and commercialisation of blue biotechnology products;
- Limited willingness of pharmaceutical industry to invest at early stage of product development;
- Lack of venture capital.

The Baltic Sea Region as a Potent Partner in Global Blue Growth

Large-scale microalgae cultivation for biofuel, Blue Biotechnology, wave energy and sustainable fish aquaculture are among the new marine uses for which enormous growth and market potential is anticipated not only at European, but also global level.

Although the Baltic Sea conditions may be less favourable than those in other European or global seas, the region can still become an important player in the sectors related to these uses within a relatively short time.

Positive factors are not only the existing R&D capacities and skilled people in aquatic science as well as marine/energy technologies but also the high level of transnational cooperation across the region (as encapsulated within the EU Strategy for the Baltic Sea Region. While these sectors may be significantly fostered by specific sub-regional approaches (e.g. cluster building), their development would greatly benefit from a higher level, BSR-wide, cooperation.

Baltic Sea resources may be directly suitable for applications to take place in the region itself. In addition, socio-economic benefits can be achieved by becoming the knowledge and technology development hub, even if the application itself is realised elsewhere and/or with resources from other seas.

REGIONAL CASE

In the area of Trelleborg, Sweden, a case study was performed to assess the biomass potential for biogas production. The harvesting potential was set to 10–30 % of the summer stock (growing attached and free-floating algae), which corresponds to 2,000–6,000 tonnes (dry weight) of biomass. This corresponds to a maximum nutrient reduction of approximately 50–150 tonnes of nitrogen, which is about 5–15 % of the freshwater run-off input of nitrogen to the Baltic Sea in this area. •

An important contribution to regional challenges

Although reed and macroalgae harvesting as well as mussel farming for other purposes than seafood may not have such a global and/or European appeal, they may be attractive to some of the Baltic Sea coastal regions in search of cost-efficient environmental remediation schemes and/or renewable energy sources.

In view of their contribution to water quality remediation, they also help promote coastal tourism. More importantly, these uses can be turned into real applications with only limited investment and clear, immediate benefits for the local communities.

The extent to which their potential can be exploited depends on political will and action to reduce existing regulatory barriers. In most cases, private investments will only become attractive if real accounting is introduced for the ecosystem services delivered by those uses. Furthermore, all three marine uses are affected by EU Directives (such as the EU Habitats and Birds Directives or Marine Directive), which are entered into national laws with unified targets but currently lack coordination of means and measures necessary to reach these targets. From BSR sub-regions' perspectives a joint interpretation on how to reach the targets set by the directives is crucial if these sub-regions are to benefit from innovative marine uses.

The need for a Baltic-wide cooperation strategy

A BSR-wide strategic approach or network was not identified for any of the innovative uses analysed. Initiatives take place either at local scales or on a project oriented. If the BSR wants to become a model in blue growth and sustainable exploitation of the sea, different forms of Baltic-wide cooperation and networking have to be established between interested decision and policy makers from sub-regional up to transnational levels, researchers, financial intermediaries, development agencies, companies and the resource sectors.

The SUBMARINER Compendium identified the field of Blue Biotechnology (including large-scale cultivation of microalgae, bacteria and fungi) as the area which would benefit most from the adoption of a Baltic Sea focused strategy. Given the wide range of potential applications within this field it is necessary to pick out the most relevant ones for the BSR. But all other innovative uses considered here, including those with more regional dimensions, would also benefit from such structural cooperation. As has been shown in the field of reed or macroalgae harvesting for instance, no common inventory or monitoring is taking place, which makes it difficult to assess the true regional potential for those applications.

REGIONAL CASE

Evidence from current mussel cultivation pilot sites in the Baltic Sea show that on average 100–150 tonnes per hectare mussel biomass can be harvested every second year containing 1.2–1.8 tonnes of nitrogen and 0.08–0.12 tonnes of phosphorous.

Also a total of 100.000 hectare of reed bed area may eventually be possible to be harvested – which would amount to a total of about 5.000 – 10.000 tonnes of nitrogen and 500 – 1.000 tonnes of phosphorous. •

Ecosystem service compensation

The introduction of a mechanism to compensate for providing ecosystem services, e.g. nutrient payment schemes, is a key issue identified for reed, mussels,

Figure 3: SUBMARINER Blue Biotechnology Cooperation Event in Kiel, Germany in May 2012

IMPORTANT ASPECT

So far there is no agreed methodology on how to undertake the socio-economic valuation of ecosystem services. In fact, several studies have shown that large differences may occur not only depending on methodology applied (i.e. "willingness to pay" or "marginal cost") but also between regions since the value given to good water quality or political goals may vary substantially.

micro- and macroalgal applications or for novel feed and breeding conditions. Sustainable aquaculture also partly depends on public funding, e.g. for restocking measures. If the BSR countries are serious about reaching their nutrient reduction targets as well as good environmental status in general, transparent economic assessment of ecosystem services is needed to substantiate any proposed financial incentives for those who contribute to achieving them. Nutrients payment schemes may change the entire philosophy of fighting against eutrophication and make room for new solutions in this field.

The applications demonstrated in the SUBMARINER Compendium shall be given due regard within the mix of possible environmental remediation measures. Payment schemes could be designed so as to be applicable to both aqua- and agriculture based possibilities. The extent to which an application provides an ecosystem service will be largely site dependent, thus it is anticipated that the market will regulate itself to ensure an optimal mix of measures will be found in each case.

Innovation: More than just technological advance

Uses analysed differ in their actual stage of development, ranging from initial concepts and preliminary research up to pilot stages or even some local scale start-up applications. But even for the most long-standing uses such as reed harvesting, some serious knowledge gaps and question marks still remain, especially in the field of socio-economics and governance.

Their advances do not only depend on technological development but also on the introduction of innovative, system based solutions within the underlying legal and economic framework.

Blue Biotechnology, both for the exploitation of high value ingredients or for large-scale cultivations, not only depends on excellence in the natural science field but also on finding viable solutions for collaboration between private industry and publicly financed research. Similarly, the potential for using marine resources for bioenergy is not merely a technical question; it also depends on the development of decentralised energy networks, smart logistics and business solutions. In cases such as mussel farming and macroalgae or reed harvesting, technological barriers are expected to be overcome in the near future, with innovation mainly required in the way in which ecosystem services can be recognised as real quantifiable values.

Smart combinations

All new uses require holistic approaches to the analysis of their effects. Separately they might not seem economically feasible but considering all effects together reveals interesting opportunities. There is a need for new instruments allowing for holistic measurement and synthesis of different types of benefits taking into account the extent of positive, negative as well as cumulative effects both from environmental as well as economic point of view.

The concept of harnessing multiple uses is best exemplified by the biorefinery concept. In the case of reed, mussel or macroalgae, the capacity for nutrient removal alone may not justify their harvesting and/or cultivation. However, further processing of these resources into biogas, feed, fertilisers or insulation material leads to additional environmentally friendly products with an economic value, as well as added benefits such as clean beaches or more sustainable fish feed.

Integrated multi-trophic aquaculture (IMTA) takes the idea even further by not only looking for multiple products from one application but also combining various applications. Also Blue Biotechnology should not be understood merely as an independent discipline with immediate applications (e.g. in human health). It is also a supporting discipline that provides the basis for making other blue growth applications feasible, e.g. by providing sustainable feed supplies for fish aquaculture, improving the efficiency of the macroalgae digestion process for biogas production or offering new solutions for environmental monitoring, as well as contributing to other areas of bioeconomy (e.g. more resource efficient industrial processes).

Figure 4: Harvesting mussels at the Åland Government's mussel farm at Kumlinge, Åland (picture: Jacob Saurén, Ålandstidningen)

REGIONAL CASE

Regions like Schleswig-Holstein (DE), Aland or Kalmarsund (SE), municipalities like Trelleborg (SE) or Solrod (DK) – but also small companies like Coastal Research and Management (DE) or AstraReal (SE) all have in common that they have already by now perceived the value of some of the products and services derived from innovative use of Baltic marine resources and turned them into viable business and/or public service models at local or regional scale.

Working with traditional (maritime and non-maritime) sectors

All of the applications considered by SUBMARINER are complementary to the traditional maritime sectors such as fisheries, shipping or coastal tourism as well as the new players such as offshore wind energy production. Many technologies can evolve from those used by more traditional sectors, as evidenced by the strong linkages between wind and wave energy technology companies. New applications offer alternatives for traditional jobs (e.g. fishermen running mussels farms etc.)

In many areas, innovation does not mean development of a completely new sector but merely the transfer of perspectives from land to sea resources, e.g. by making use of existing biotechnology laboratories for "blue" research, bringing marine resources as an "add on" to terrestrial resource considerations in bioenergy strategies and making use of relevant knowledge from the forestry sector.

Developing local success stories: Regional interactions with research

Blue Growth is a bottom-up idea. Within the BSR the actual drive for innovative applications comes from bottom up initiatives of successful local or sub-regional collaboration between a few individual

scientists and forward thinking decisionmakers in political or private sector spheres.

These cases show that action is possible even at the current stage of development. And they are needed as important forerunners for the possible mainstreaming of some of the SUBMARINER ideas. Thus, there is a need for joint BSR efforts to create more of such pilot sites and "known practices", promote and disseminate success stories and collaborate within and beyond the BSR scope.

Creating necessary framework conditions for win-win solutions

Inconsistent or rather unclear legal regulations and complicated spatial planning procedures are additional barriers. It seems that they are mainly tied to the fact that most uses are at such early and innovative stages of development that they were not sufficiently considered when these provisions were designed. This has been particularly highlighted in the case of macroalgae, microalgae, reed and combined uses.

A holistic approach to marine resource uses does not only require review of some directives and following them normative acts implemented in national legislative systems, but also the provision of positive incentives to support collaboration and promoting win-win solutions. This is due to the high transaction costs of cooperation between sectors (e.g. energy and mariculture) having no tradition of doing so, no cooperation channels and no common language despite the fact that such combinations are politically desirable (e.g. spatial efficiency).

The Blue Growth and Bioeconomy Initiatives of the EU Commission can be useful vehicles but should be translated into national procedures, instruments and targets.

Such incentives could cover non-sectoral or cross-sectoral funding or venture capital funds for public-private partnerships as well as holistic approaches to planning and programming, political demand and more attention to corporate social responsibility. The already existing cooperation between VASAB and HELCOM in promoting Maritime Spatial Planning in the BSR based on cross-sectoral dialogues seems to be a good practice example for developing a reasonable and commonly (across nations and societies) accepted system of such incentives.

See the sea

Overall the work on the SUBMARINER project revealed a low level of awareness for the potential of marine resources among the general public but also among national stakeholders and beneficiaries. This applies not only to the innovative potential of the sea, but also to the role of the sea in general for the economy as well as the environment. Naturally, coastal regions are closer to new developments, but even here – with a few exceptions like Schleswig-Holstein (DE) – the majority of political strategies do not take the sea into due account.

There is a need to increase the visibility of the role of the sea for the economy and environment, and its innovative potential across the whole region while also allowing for continued and strengthened interdisciplinary, cross-sectoral approaches and various combinations between research initiatives and practical applications.

All of these components are necessary to realize the win-win solutions described in this chapter and the Compendium. The establishment of the SUBMARINER Network is the first step in this direction.

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The SUBMARINER Vision 2030

How could the Baltic Sea Region look like in 2030 if marine resources were used more widely?

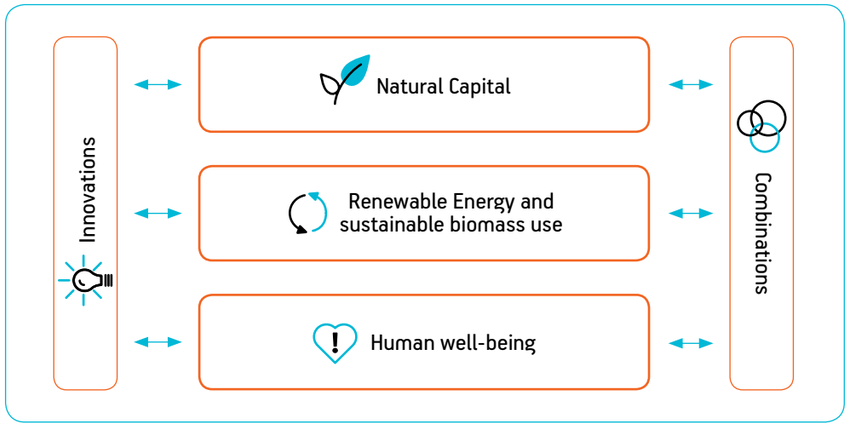
What will be the effects on the natural capital, the regional energy and biomass portfolio and human well-being in the region?

A SUSTAINABLE AND INNOVATIVE USE of Baltic Marine Resources will maintain the Baltic Sea Region's natural capital, offer solutions for a sustainable energy and biomass portfolio, improve human well-being and make the BSR a model region for biobased innovations and smart combinations.

The SUBMARINER Vision 2030 consists of the three following main pillars:

- Maintaining the Baltic Sea Region's natural capital
- Marine resources as part of a BSR sustainable energy and biomass portfolio
- Improve human well-being via new maritime products as well as of the two following horizontal issues:
  - The Baltic Sea Region – A biobased innovation showcase
  - A smart Baltic Sea Region – Making use of blue-green combinations of uses

Figure 5: Interrelations between the SUBMARINER Network Action Plan and the SUBMARINER Vision 2030 (see the tables in the Annex for more details)



4.1 Maintaining the Baltic Sea Region's natural capital

Despite numerous efforts, the environmental status of the Baltic Sea has not improved as expected. Therefore more innovative approaches are required. An important way forward is a more conscious use of sea resources, which contributes to reduce nutrients pollution, and which recognizes the value of ecosystem services.

VISION IN BRIEF

The BSR's natural capital is maintained and able to offer a broad range of ecosystem services in line with the sustainable development paradigm and the HELCOM Baltic Sea Action Plan (BSAP) and the EU Marine Strategy Framework Directive (MSFD) spirit. This is made possible by a more widespread conscious use of the sea resources to that end.

VISION DETAILS

1 Holistic analyses are in place which cover and compare costs and benefits of different measures for prevention, removal or diminishing transfer of pollutants to the sea.

2 Analyses take into consideration ecological, political, societal, cultural and economic aspects such that the whole value chain of different public investments and business activities is recognized.

3 In support of MSFD and HELCOM monitoring and assessment objectives, sea resources important for the maintenance of good ecological status of the sea ecosystem have been identified and are regularly monitored.

4 There is a knowledge and societal awareness on costs and benefits of different sea resources with regard to safeguarding the good ecological status of the Baltic Sea and their impact on supporting and maintaining ecosystem services.

5 The rules on securing sea and coastal space necessary for the maintenance of the sea resources performing important ecological functions have been agreed by maritime spatial planners.

6 In the majority of the BSR countries, the necessary legal, financial and institutional conditions exist (e.g. ecosystem service compensation) to advance ecological mariculture ideas from the testing phase into operational products or technologies. Appropriate links between different administrative and economic regimes are in place to support the provision of ecosystem services.

7 The work on concluding a BSR-wide agreement on a common approach to using fish mariculture as a restocking measure for endangered wild fish populations is advanced. Necessary regulations have been prepared.

8 Priorities have been identified and set for the most important environmental fields for the Baltic Sea where Blue Biotechnology applications may make a positive contribution.

4.2 Marine resources as part of a BSR sustainable energy and biomass portfolio

Production of certain bioenergy from terrestrial crops can include negative side effects such as increase in food prices or negative energy balances i.e. higher costs of energy crop cultivation (in terms of energy intake) than the energy derived from them. This is not necessarily the case for energy derived from sea resources, making it desirable to promote their potential as a viable renewable energy source. Sustainable processing of biomass into a spectrum of biobased products (food, feed, chemicals, materials) and bioenergy (biofuels, power and/or heat) using the biorefinery concept has yet to be realized. Also wave energy might be expanded as a part of broader coastal protection undertakings.

VISION IN BRIEF

The BSR becomes an important place for smart production of renewable energy and sustainable biomass including marine resources in order to meet EU targets and mitigate climate change. Such production enhances the security of the energy supply and attracts new industries and businesses to the coastal municipalities. •

VISION DETAILS

1 Due to better monitoring clear knowledge and societal awareness of the potential /and availability of various (bioenergy) resources throughout the BSR is available.

2 Techno-economical models and environmental impact assessments have been used to estimate sustainability of marine biomass as a raw material for bioenergy. Various operational scales have been analysed.

3 Use of different sea resources in biogas plants is "known practice" (incl. economic models) for regions/municipalities. Optimised processes for the production of biomass from some sea resources are available.

4 By 2020 most suitable locations have been identified for a number of (large-scale) biorefineries in the BSR, using biomass both from land and from sea. Biorefineries are strategically placed (close to both: sea resources and end-users).

5 Wave energy is used as a niche contribution for certain specialized systems at sea. Full-scale prototypes (pilots) with help of public finance have been tested, thus proper knowledge levels exist to start commercial applications.

6 Greater attention is given to the use of sea resources in (regional) sustainable energy action plans both at national and regional levels. Comprehensive assessments of the available potential and the cost and benefits of using Baltic Sea resources exist.

7 Relevant innovation clusters exist and co-operation between companies and public research institutes has been established. Key players (interest groups) in the field have been identified (companies, research institutions, public administrations) and are working with each other on the basis of mutually beneficial cooperation agreements.

4.3 Improve human well-being via new marine products

Coastal regions that recently came through the period of traditional maritime economy decline require new development perspectives to maintain their demographic base, make them an attractive place to live and secure well-being for coastal societies.

VISION IN BRIEF

Blue biobased products, such as new medicines and healthy food, contribute to human health and well-being in the BSR. Also the biobased economy creates new jobs and thus improves employment opportunities in the coastal states and regions. •

VISION DETAILS

1 A Baltic Sea wide strategy for the implementation of a biobased economy around the Baltic Sea exists and is aligned with EU level developments. The strategy is complemented by national action plans securing financing for research, new product testing and their commercialization.

2 Industries, including small companies, cooperate with existing research centres making new bio-products available and attractive for customers.

3 High awareness exists among Baltic industries, which type of marine material (such as raw material, valuable ingredients, enzymes, genes, cells or whole organisms) are suitable and can be sustainably used as components for biotechnological products or catalysts in different manufacturing processes.

4 The full scope of externalities (multiple benefits and costs) is understood and reflected in the pricing of marine products through the conscious decisions of the BSR decision makers. Awareness of societal benefits should be promoted.

5 New products become available due to innovative use of sea resources. Spa, wellness tourism and cosmetic industries flourish around the Baltic Sea. New food and feed products are increasingly gaining acceptance and are recognised as regional and premium quality products. New medicine and medicinal products will essentially improve human health.

6 Use of marine resources becomes an important part of the existing industry and service clusters around the Baltic Sea. The multiplier and clustering process is facilitated by close co-operation of marine industries with local developmental organizations and civic sector.

Figure 6: New blue bio-based products contribute to human health and well-being in the BSR

4.4 The Baltic Sea Region – A biobased innovation showcase

Biobased economy offers one of the highest innovation potential and high value product potentials. Developing countries like China, India etc. can be expected to reach the barrier of exhaustible natural capital and face the need to reduce their dependence on non-renewable resources. Therefore, the demand for blue-green biotechnologies will increase.

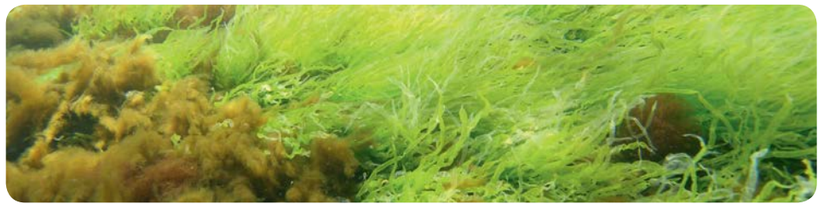
VISION IN BRIEF

In 2030 the BSR becomes an important EU biobased innovation and model hub specialised in biobased technologies.

VISION DETAILS

1 Development of biobased technologies becomes one of the key dimensions of the BSR smart specialization.
2 BSR R&D on biobased technologies and expertise reaches maturity level necessary for creation of numerous spin-offs in this field.
3 Several BSR biobased clusters exist and actively co-operate. Their leaders are well known in the EU and perform their leadership duties raising the issue of marine innovations at EU political agenda level.
4 Key players (interest groups) in the field have been identified (companies, research institutions, public administration) and are working with each other on the basis of BSR-wide cooperation agreements.
5 Research institutions commercialize products together with companies with regulated patenting / publishing rights.
6 This development is coherently supported by policies at various levels: from regional and local strategies and spatial plans up to EU strategies and Community Support Framework (CSF).
7 The BSR becomes an education hub on biobased economy. The education offered is of a multidisciplinary character i.e. combines natural sciences (e.g. biology, ecology), social sciences (e.g. economics), and technical sciences (e.g. energy, mechanics, biotechnology etc) at all levels (technical schools, colleges, universities).

Figure 7: Natural macroalgae (picture: Metsähallitus Nature Services JTR)



4.5 A smart Baltic Sea Region – Making use of blue-green combinations of uses

With more intensive use of the sea in the future, generating multiple products and services from the same sea space will gain political importance. By combining different uses/activities from the same area, valuable synergies (e.g. cost efficiency) and axiological benefits (order of the sea space) can be extracted. To maximize value and sustainability, it is imperative that such smart combinations of uses are exploited in full. This will result in an increase of demand for relevant technologies enabling combinations of uses and for know-how on rules and procedures to that end.

VISION IN BRIEF

The BSR becomes a model EU region on conscious sea use combination, shaping its unique EU brand in this field.

Figure 8: Harvesting cultivated macroalgae (picture: Green Center Holland)

VISION DETAILS

1 The imperative to combine uses has been introduced into the maritime spatial plans as a matter of routine and more in depth instruction and guidelines have been elaborated by the Baltic organizations.
2 Different types of sea use combinations have been investigated and tested.
3 There are financial and information tools (planning guidelines, BSR discussion fora, financial incentives) supporting use combination in majority of BSR countries.
4 Smart use of resources has become a rule. Pilot bio-refineries are used for energy production, removal of pollutants from waste streams and extraction of high-value substances for the biotech industry.
5 The BSR consciously furnishes other regions with experience and know-how on benefits, challenges and preconditions for combination of sea uses.
6 The combined coastal and maritime resources have established legislative frameworks for blue-green innovative establishments.

1 — 2 — 3 — 4 — **5** — 6 — A

The SUBMARINER Network Action Plan

Which actions have to be taken in order to reach the objectives of the SUBMARINER Vision 2030?

Who are the coordinators and actors to implement them within the SUBMARINER Network?

picture: Anders Fredenslund, Roskilde University

BASED ON THE RESULTS OF THE SUBMARINER COMPENDIUM ASSESSMENTS and discussions with SUBMARINER stakeholders the following strategic action fields have been identified as necessary to reach the objectives of the SUBMARINER Vision 2030:

Actors: Baltic Sea actors and activities

Data: Data sets of Baltic Sea resources

Environmental impacts: Environmental impacts on water quality and habitats

Pilot sites: Pilot Sites for Empirical Research

Energy: Regional energy solutions integrating marine resources

Ecosystem services: Valuation and compensation of ecosystem services

Technology: Technology development and transfer

Blue Biotechnology: BSR-wide systematic approach to Blue Biotechnology research

Finance: Unlock financing for innovative uses of marine resources

Regulation: Create better legal and regulatory conditions

Image: Create positive image for products and services from marine resources

Having in mind that all above listed action fields are equally important, the SUBMARINER Network's constituting bodies postulate that each of the above mentioned action field desire the same in-depth attention and shall be undertaken in a coordinated manner by all members of the Network ensuring smooth and most feasible implementation of the SUBMARINER Network Action Plan.To this end the Network Coordinators will seek to undertake the following within their given strategic action field:

- Attract relevant actors to join the strategic action,
- Ensure exchange of information among those actors on ongoing or planned initiatives at regional / national / BSR / EU level which are of relevance for this action,
- Develop jointly with those actors initiatives / projects in order to turn the activities as mentioned in the Roadmap into reality,
- Develop jointly strategic action documents / policy papers as input to policy makers & decision makers concerning the strategic action across all governance levels,
- Communicate and coordinate across the SUBMARINER Network with the other coordinators on activities planned within their strategic action field,
- Represent the strategic action field at SUBMARINER Network meetings.

5.1 Baltic Sea actors and activities (Actors)

OBJECTIVE: Public and private actors involved in new marine uses know of each other and their activities and thus achieve better and faster results with less resources

NETWORK COORDINATOR: SUBMARINER Network Secretariat (BSR) and Maritime Institute in Gdańsk (PL)

ACTORS: All stakeholders

- Collect information, establish and maintain a BSR-wide database on:
  - Research institutions, researchers and experts;
  - Companies;
  - Intermediaries and transfer organizations;
  - Past and ongoing activities and projects;
  - New research and project ideas;
  - (Bio-)technical equipment;
  - Available education in various levels;
- Identify potential linkages between natural and socioeconomic research and introduce research results of both disciplines to each other;
- Support actions for information and contact exchange among new marine use stakeholders;
- Integrate marine sectors into BSR region wide research and technology development projects, which integrate knowledge for whole the catchment area of Baltic Sea, e.g. energy sector, waste treatment, CO_2 capture and storage, socio-economic aspects, i.e. via
  - ongoing communication across EUSBSR stakeholders and related BSR projects;
  - facilitate contact and information exchange, networking and coordination with other networks;
  - organisation of sectoral and cross-sectoral match-making events;
  - facilitate good practice transfer from traditional maritime sectors as well as terrestrial bio-economy stakeholders to SUBMARINER cases.

5.2 Data sets of Baltic Sea resources (Data)

OBJECTIVE: Filling the identified gaps in data availability on Baltic Sea Resources

NETWORK COORDINATOR: Tallinn University of Technology (EE)

ACTORS: Research institutes and responsible regional / national bodies for monitoring of marine and coastal resources

- Establish and implement BSR-wide best practices for monitoring and systematic mapping of:
  - biomass resources (macroalgae, reed);
  - nutrient resources and CO_2 sources for microalgae cultivation;
- Identify and recommend institutional structures for permanent monitoring as well as structures for data-sharing and visualisation (GIS);
- Link the data sets with surveys and mapping of other local (terrestrial) resources and demand for biogas or any other biomass refinery process;
- Develop a system to support the use of existing monitoring data (e.g. water depth, hydrographical – biological – use – exposure data) to identify best sites (environmental and cost-effectiveness) for mussel cultivation, fish aquaculture sites and macroalgae cultivation.

Figure 9: BSR-wide best practices for monitoring and mapping of reed bed areas should be established (picture: Ülo Kask, Tallinn University of Technology)

5.3 Environmental impacts on water quality and habitats (Environmental impacts)

OBJECTIVE: Close knowledge gaps on environmental impacts of innovative sea uses

NETWORK COORDINATOR: Latvian Institute of Aquatic Ecology (LV) and KTH Royal Institute of Technology (SE)

ACTORS: Relevant public and private research institutions and intermediary bodies

- Promote and conduct systematic research on the role of reed beds and harvesting, macroalgae harvesting and cultivation as well as mussel cultivations on local biodiversity and water quality;
- Assess the consequences for nutrient regeneration and biogeochemical cycling and benthic habitat deterioration arising from increased sedimentation and sediment oxygen uptake by mussel cultivations;
- Assess the relationship between offshore, attached, living macroalgae stocks and beach cast macroalgae in terms of biomass, density and annual production rates of stocks of attached, living macroalgae to support the derivation of sustainable quantities of beach cast and free-floating algal mats that can be removed;
- Investigate the cumulative ecological impact of biomanipulation of bivalve populations;
- Investigate the danger of releasing bioengineered or invasive compounds, bacteria and microalgae into the marine environment on marine habitats and species;
- Investigate effects on water quality and animal health through analyses and cultivation of microorganisms in bioponds and -filters;
- Investigate the impact of wave installations on the marine environment;
- Open net cages: further investigate feed supply and efficiency.

5.4 Pilot Sites for Empirical Research (Pilot sites)

OBJECTIVE: Create pilot sites around BSR for empirical research

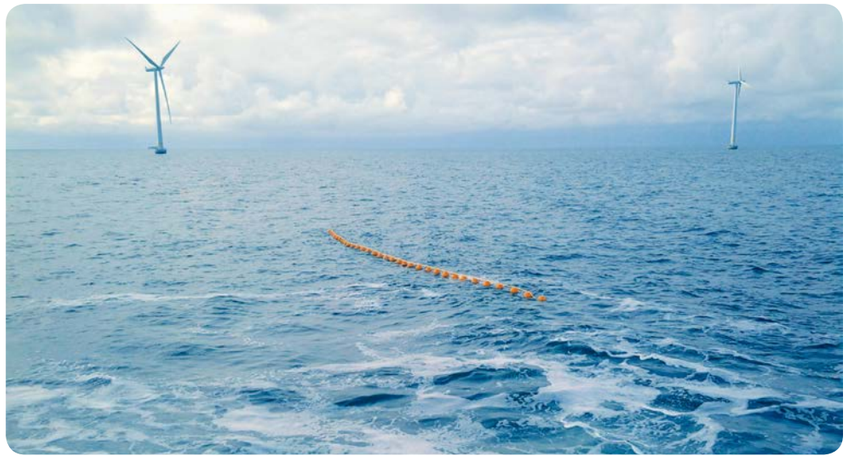
NETWORK COORDINATOR: Environmental Development Association (LV) and KTH Royal Institute of Technology (SE)

ACTORS: Regional and National funding organisations with research and industry, Local and regional business development parks, private companies, maritime clusters, municipalities, etc.

- Promote investments into concrete pilot sites for new uses of marine resources by:
  - Study existing cases inside and outside BSR;
  - Develop feasibility studies and business plans for concrete cases (i.e. joint algae research centre, bio-refineries, mussel cultivations, macroalgae and reed harvesting, wave energy installations);
  - Present them to public and private funding institutions;
- Pilot Site Applications:
  - IMTA: investigate site-specific solutions which could mean different combinations of fish, algae and mussel farming at one site in order to find optimal technical and economical solutions;
  - RAS technologies in combination with specific sites of the Baltic Sea;
  - Pilot sites for agar production;
  - Macroalgae and mussel cultivation pilot sites;
  - Pilot sites for reed harvesting;
  - Microalgae cultivation pilot site(s) for multidisciplinary research around BSR for large-scale cultivation, including test sites for nutrient removal from waste streams;
  - Biorefinery pilot sites;
  - Pilot sites for wave energy production;
- Identify most suitable sites within wind parks in relation to cultivation technologies.

Figure 10: Harvesting of beach-cast macroalgae (picture: Trelleborg Municipality)

Figure 11: Pilot line for mussel and macroalgae cutivation installed in the Rødsand 2 Wind Park in Lolland, Southern Denmark (picture: Kingfisher Offshore AB)



5.5 Regional energy solutions integrating marine resources (Energy)

OBJECTIVE: Encourage appropriate consideration of marine resources in energy planning in order to create markets for climate friendly energy production

NETWORK COORDINATOR: AgroTech (DK)

ACTORS: Other municipal and regional authorities

- Develop regional concepts for integration of marine resources in regional plans on renewable energy and climate protection ensuring the use of both existing and new marine and terrestrial resources, e.g. wind mills, solar energy, biogas;
- Introduce concept of smart combinations of uses, where a systematic approach to biomass use beyond the energy sector complements the biorefinery concept;
- Promote marine resource use in renewable energy production with stakeholder involvement and policy support; i.e. introduce concept as part of sustainable region development with the authorities, politicians and business representatives;
- Develop economic models for use of marine resources in renewable energy production;
- Develop regional and national case studies and models;

Figure 12: Prototype of a linear wave generator attached to a pier in Palanga, Lithuania (picture: Klaipeda University Coastal Research and Planning Institute)

Figure 13: Photobioreactor for the production of green algae (picture: IGV GmbH)

- Develop a placement strategy for biorefineries including marine resources around coastal regions;
- Improve networking among biorefineries across BSR;

- Use experience of forestry and agriculture in blue refinery concepts: collect relevant information about their experience on biorefinery concepts to help to transfer to blue concepts;

- Encourage technology development and continue to refine the process of biogas from marine resources;

- Optimise techniques and logistics for harvesting biomass, transport to biogas plants, and for refining products;

- Promote use of small scale wave energy generators;

5.6 Valuation and compensation of ecosystem services (Ecosystem services)

OBJECTIVE: Develop an accepted approach to valuation of ecosystem services and propose compensation mechanisms for the provision of ecosystem services by new marine uses in BSR.

NETWORK COORDINATOR: Swedish Agency for Marine and Water Management (SE), Maritime Institute in Gdańsk (PL) and Swedish Board of Agriculture (SE)

ACTORS: Relevant public and private research institutions and intermediary bodies

- Assess the applicability of new marine uses on ecosystem services for different sub-regions of the BSR;
- Proactively liaise and inform EU, HELCOM and relevant BSR Priority Areas of SUBMARINER initiatives related to valuation and compensation of ecosystem services;

- Develop a practical BSR-wide methodology for valuation of ecosystem services, as the basis for ecosystem services compensation schemes, based on:
  - Identification of pertinent HELCOM/MFSD-based environmental indicators of Good Environmental Status (GES) which will serve as a basis for ecosystem service accounting and valuation;
  - Assessment of the relevance of different valuation methods for different sub-regions of the BSR including a comparison of integrated valuation methods;
  - Valuation analysis examples using SUBMARINER case study remediation instances addressing e.g. nutrient recycling, waste treatment and CO_2 capture;
  - Cross-sectoral dialogue and approach to integrated remediation measures;

- Develop recommendations and proposals for establishment of ecosystem service compensation schemes based on:
  - Regional analysis of existing and proposed (if any) compensation mechanisms;
  - Assessment of the role of private sector and NGOs and their capacity for ecosystem service system development; get them involved;
  - Investigation and development of relevant case studies;
  - Consideration and assessment of various possible schemes, e.g. via taxes (polluter pays, provider of ecosystem services gets subsidised), 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);
  - Formulation of proposals for regional and BSR-wide policy requirements;

- 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 (e.g. waste water treatment plants).

- Assess the role of Blue Biotechnology products which are applied to the protection and management of marine ecosystems with respect to benefits to ecosystem services;

Figure 14: Many marine resources provide important ecosystem services, but there is so far no accepted approach towards their valuation and compensation.

5.7 Technology development and transfer (Technology)

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

NETWORK COORDINATOR: Ministry of Economic Affairs, Employment, Transport and Technology (DE) and Coastal Research and Planning Institute – CORPI (LT)

ACTORS: Maritime and innovation clusters, technology parks, private companies

- Foster communication, collaboration and technology transfer in and between BSR countries by:
  - Collecting information about technologies and scientific expertise available on national level;
  - Match-making between technology providers and technology users to encourage communication between two communities;
  - Introducing technologies and know-how available in other BSR countries to national research organisations and companies;
  - Offering study visits, meetings, easy websites for registering needs and offering services.
- 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);
  - Environmental friendly reed and beach cast harvesting technologies;
  - IMTA production methods
  - Aquaculture developments, including solutions combined with different kinds of wind parks and new production methods for IMTA and RAS systems;
  - New RAS systems combined with energy efficient solutions
  - Water treatment technologies using blue biotechnology or algae cultivation;
  - Microalgae cultivation technology (open pond/photobioreactor, structure of the photobioreactor, cooling/heating and mixing of microalgae cultures) suitable for seasonal fluctuations of temperature and light in the BSR;
  - Scale-up of sustainable processes necessary for getting the basis materials such as raw materials, valuable ingredients, or cells from marine organisms for the Blue Biotechnology products;
  - Adapt and develop biosensors suitable for marine resources;
  - Develop combined wave energy converter deployment with existing installations.

Figure 15: Fermenter at GEOMAR (picture: GEOMAR Helmholtz Centre for Ocean Research Kiel)

5.8 BSR-wide systematic approach to Blue Biotechnology research (Blue Biotechnology)

OBJECTIVE: Efficient and effective use of Blue Biotechnology research capacities across the BSR

NETWORK COORDINATOR: Ministry of Economic Affairs, Employment, Transport and Technology Schleswig-Holstein (DE), Finnish Environment Institute – SYKE (FI) and BioCon Valley Mecklenburg-Vorpommern e.V. (DE)

ACTORS: Biotechnology clusters, relevant research institutions

- On the basis of the systematic mapping of research capacities, research fields and laboratory equipment across the BSR and analysis of BSR and national priorities / needs for Blue Biotechnology applications contribute to development of national (blue) biotechnology strategies;
- Develop pan-Baltic research agenda and create respective pan-Baltic research groups for:
  - Investigation, development and use of marine (macro)molecules from micro- and macroorganisms or the use of marine microorganisms for all kind of applications;
  - Use of biomarine material for medical and health applications;
  - Exploitation of feed and food supplements from marine cell cultures and any kind of cultures from marine organisms;
  - Establishment of suitable expression systems for marine proteins;
  - Development of environmental monitoring systems based on biochips.

- Identify and test Baltic Sea organisms for various applications
  - Isolate new microorganisms such as microalgal, bacterial and fungal species and distribute them to relevant network partners around the Baltic Sea who can further screen the isolates for different kind of applications (e.g. controlled cultivation of biomass in large scale in BSR conditions; production of the biofuels and various high-value compounds; removing nutrients and pollutants from waste streams);
  - Emphasize naturally occurring species with the potential to produce high amounts of valuable ingredients and possibly tolerating wide range of environmental conditions;
  - Evaluate possibilities of macroorganisms e.g. macroalgae, mussels and reed in production of high value compounds;

- Identify suitable combinations of fish / macroalgae / mussel species to be used in IMTA to produce blue biotech products;

- Establish a BSR centre for bioprospecting of Baltic Sea microorganisms
  - Creating a (virtual) centre comprising all actors from public research institutions and companies working at the research and the sustainable use of marine microorganisms;
  - Enhancing the national, transnational and international awareness and the visibility of the BSR activities, which are carried out in the research and the exploitation of marine microorganisms for biotechnological products;
  - Establishing a central information base for marine biomaterial: Central management, good practice standards and legal pre-conditions for take-over of the biomaterial in culture collections, genetic and compound libraries as well as the respective data in the database; utilisation of the biomaterial for research and application;
  - Promote the scientific expertise and the know-how in product development and marketing of the partners participating in the BSR centre.

Figure 16: Blue Biotechnology research capacities around the Baltic Sea should be used efficiently. (pictures: Johannes Jansson, norden.org)

5.9 Unlock financing for innovative uses of marine resources (Finance)

OBJECTIVE: Improve access to finance for collaborative projects involving private and public stakeholders

NETWORK COORDINATOR: Maritime Institute in Gdańsk (PL) with the SUBMARINER Network Secretariat (BSR)

ACTORS: Private companies, maritime clusters, funding / financing bodies

- Collaborate with investment funds, venture capital organisations, etc. :
  - Establish contacts with public and private financing organisations;
  - Identify offers, interests and needs by financing bodies and possible 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 and vice versa;
  - Study and assess challenges for private-public collaboration;
  - Identify, assess and disseminate good practices of private and public collaboration, develop "vademecuum / guidelines";
  - Organise 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 target and output-oriented 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.

5.10 Create better legal and regulatory conditions (Regulation)

OBJECTIVE: Reduce vagueness in current legislation and regulations in view of innovative uses of marine resources

NETWORK COORDINATOR: Maritime Institute in Gdańsk (PL) and Swedish Agency for Marine and Water Management (SE)

ACTORS: Responsible national and regional authorities, relevant research institutions

- Assess the existing integration of innovative uses of marine resources in relevant EU Directives;
- Establish a dialogue with relevant national authorities and respective EU COM Directorates

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

- Consider how new uses of marine resources shall be taken into account in Maritime Spatial Planning and Integrated Coastal Zone Management Plans (i.e. develop pilot plans in various regions, develop criteria for "suitable sites");

- Draw recommendations for EU policy development on Baltic Sea resources uses;

- Draw recommendations and encourage BSR-wide agreement on integrating reed and mariculture cultivations as an environmental remediation measure under HELCOM BSAP;

- Draw recommendations on creating incentives for combinations with offshore wind parks;

- Draw recommendations for a common approach to use fish aquaculture as a suitable measure for restocking;

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

5.11 Create positive image for products and services from marine resources (Image)

OBJECTIVE: Raise awareness on environmental functions / services provided by new uses of marine resources and create markets for new products from marine resources

NETWORK COORDINATOR: SUBMARINER Network Secretariat (BSR) and Maritime Institute in Gdańsk (PL)

ACTORS: Relevant sector organisations, clusters

- Carry out public awareness campaigns:
  - Create information material (flyers, presentations, etc.) on potential of new and innovative sustainable marine resources;
  - Identify and create success stories (local, regional, national);
  - Undertake regional and national campaigns on value of ecosystem services and nutrient recycling for various stakeholder groups;
  - Produce and disseminate regular "SUBMARINER" newsletter and/or magazine;
  - Create cooperation with media to integrate them into public campaign.
- Conduct market surveys about potential of products from marine resources:
  - Collect relevant data about new products from marine resources;
  - Conduct studies on current market situation for products from marine resources at appropriate scale (from regional to international);
  - Identify potential target organisations and associations / companies as customers of new applications;
  - Conduct studies on the acceptance of genetically modified microorganisms for use in bioenergy, cosmetics, food;

- Carry out information campaigns, workshops and involve companies on:
  - Possible new and local fish species (regional level);
  - Development of new fish and chicken feed (from mussels);
  - Organic fertilisers;
  - Blue Biotechnology applications;
  - Reed as ecological insulation material;
- Support establishment of a Baltic Sea Brand and Distribution Network (mid-term) for:
  - Fish from BSR aquaculture;
  - Mussel meal products and organic fertilisers;
  - Cosmetics, health care and wellness products;
  - Production of raw materials from Baltic Sea organisms such as agar from the algae *Furcellaria*.

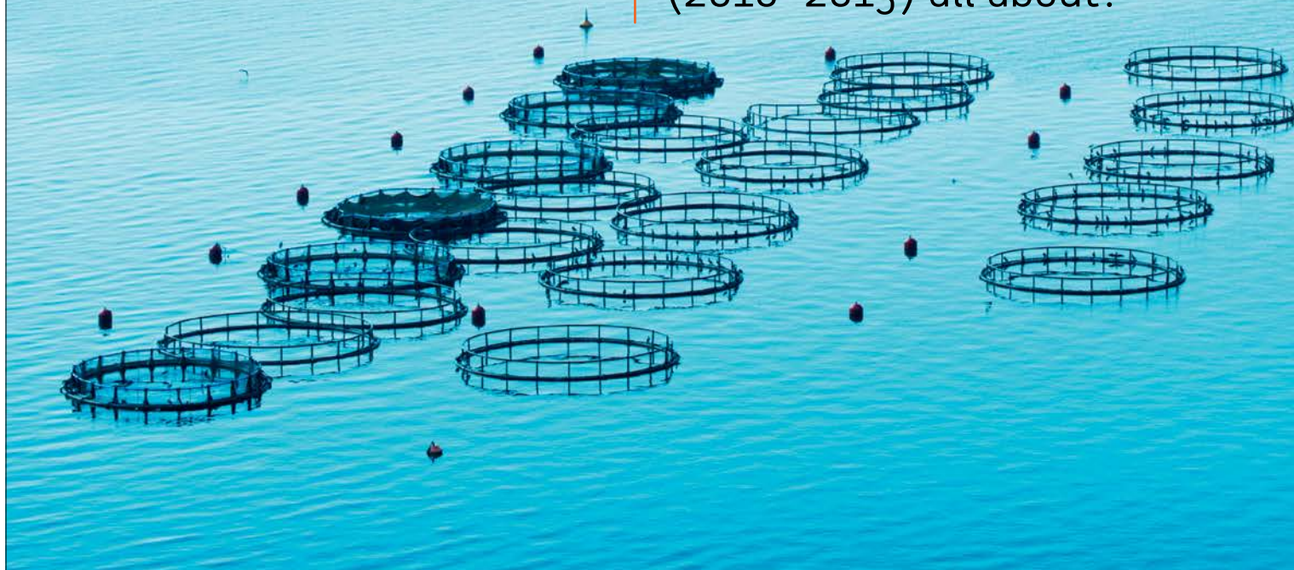
Figure 17: Seagulls on a mussel cultivation line (picture: Royal Swedish Academy of Sciences)

1 2 3 4 5 **6** A

SUBMARINER Facts

How does the SUBMARINER Network promote sustainable blue growth in the Baltic Sea Region?

And what was the SUBMARINER project (2010–2013) all about?



THE SUBMARINER NETWORK PROMOTES sustainable and innovative uses of marine resources. It offers a cooperation platform for relevant actors and initiatives in the Baltic Sea Region.

Working together to improve the Baltic Sea environment and economies

The SUBMARINER Network is a unique platform that brings together actors from the Baltic Sea Region to actively promote innovative and sustainable uses of marine resources. It operates across the entire knowledge triangle, integrating local and international perspectives, different scientific disciplines as well as policy and economic stakeholders.

While its roots lie in the Baltic Sea Region, the SUBMARINER Network also operates and reaches out beyond its geographical base to engage in partnerships with actors across Europe that share its thematic vision.

The network is a hub for projects, initiatives and activities at all levels. It encompasses transnational and cross-border regional development, innovation and research projects, as well as various initiatives at local and business level. The network assists its members in applying for appropriate funding and in coordinating and communicating relevant initiatives. Current project developments initiated within the network deal with the creation of a Baltic Sea Region wide alliance of blue biotechnology actors, the cooperation of regions with regard to maritime aspects in their smart specialisation strategies (RIS3), the expansion of mussel cultivation in the Baltic Sea, as well as the remediation of enclosed marine waters as a driver for sustainable blue growth. Starting in 2015, the SUBMARINER Network will also issue regular update reports on the implementation of its Roadmap.

Meetings, workshops, conferences and a comprehensive set of dissemination tools provide network members with a continuous platform for communication, exchanges of experience, joint project development and implementation.

As a flagship project under the priority area "Innovation" of the EU Strategy for the Baltic Sea Region (EUSBSR), the SUBMARINER Network links the various initiatives in the field of sustainable blue growth to the EUSBSR.

The SUBMARINER project (2010–2013)

The SUBMARINER Roadmap and the creation of the SUBMARINER Network result from the project "SUBMARINER – Sustainable Uses of Baltic Marine Resources" which has paved the way for promoting innovative and sustainable uses of marine resources in the Baltic Sea Region between 2010 and 2013. Another main output was the SUBMARINER Compendium, a comprehensive sustainability assessment of the entire product chain for the following eight SUBMARINER topics:

- Macroalgae Harvesting and Cultivation
- Mussel Cultivation
- Reed Harvesting
- Large-Scale Microalgae Cultivation
- Blue Biotechnology
- Wave Energy
- Sustainable Fish Aquaculture
- Combinations with Offshore Wind Parks

The project also comprised regional pilot activities as well as numerous workshops, round tables and cooperation events. It was lead by the Maritime Institute in Gdańsk. Its overall budget of € 3.7 million was co-financed by the Baltic Sea Region Programme 2007–2013. More information on the project can be found at www.submariner-project.eu.

SUBMARINER NETWORK FOR BLUE GROWTH EEIG

The SUBMARINER Network was registered as a not-for-profit European Economic Interest Grouping (EEIG) by the following founding members:

Schleswig-Holstein Ministerium für Wirtschaft, Arbeit, Verkehr und Technologie

Maritime Institute in Gdańsk

BioCon Valley®

corpi

AB Environmental Development Association

AgroTech

KTH Vetenskap och konst

s.Pro sustainable projects

A constantly updated list of all members – including associate members – can be found on our website at **www.submariner-network.eu/network/members**.

The SUBMARINER Network is open to new members. Admission is subject to prior approval by the current full members. If you are interested in learning more about joining the SUBMARINER Network, please visit www.submariner-network.eu/network/join-us and contact the Network Secretariat:

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Annex

How does the SUBMARINER Network Action Plan contribute to fulfilling the visions of the SUBMARINER Vision 2030?

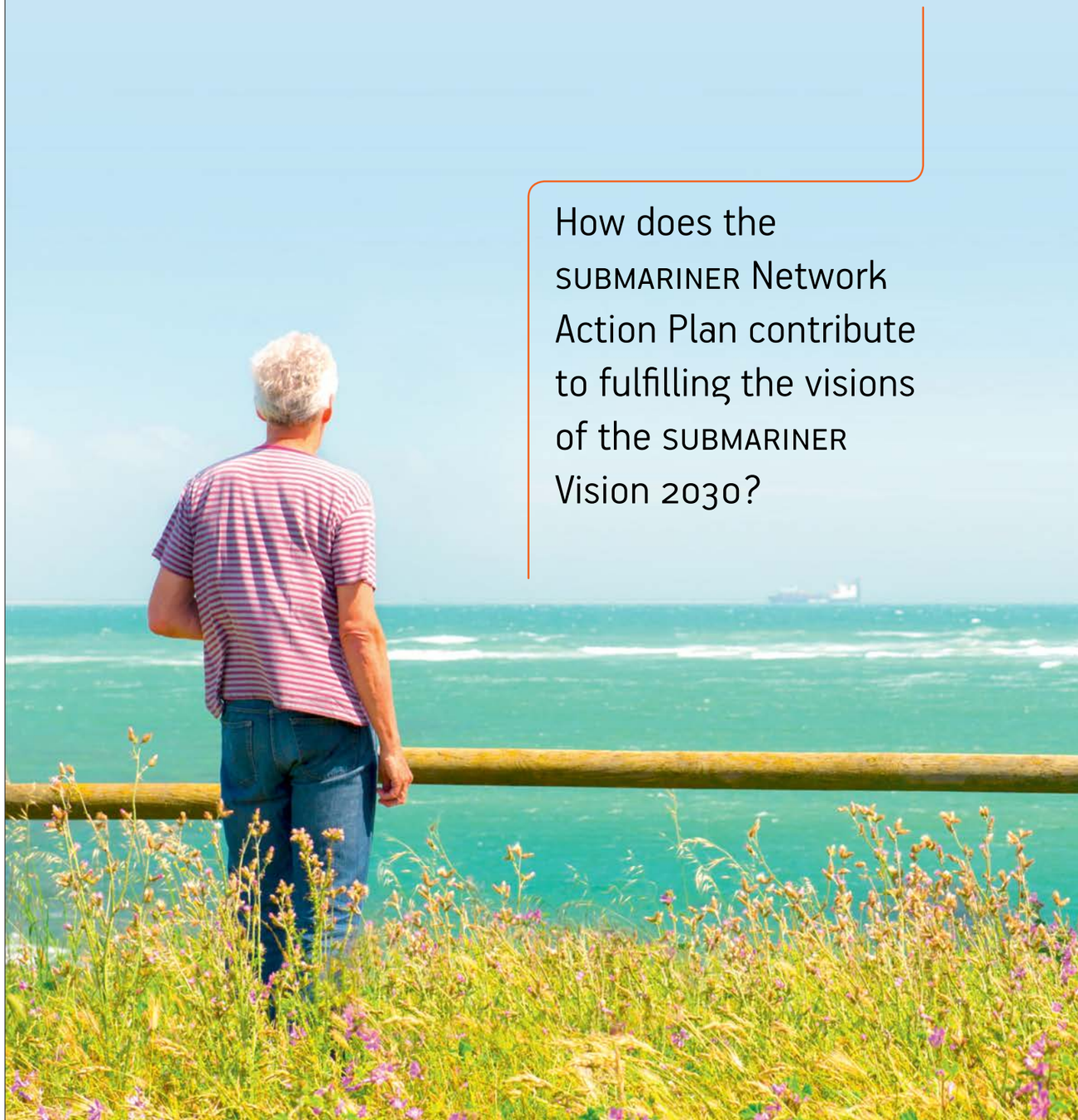

Table 1: The below table provides an overview on how the SUBMARINER Action Plan contributes to fulfilling the visions of the SUBMARINER Vision 2030.

Maintaining the Baltic Sea Region's natural capital	Actors	Data	Environmantal Impacts	Pilot Sites	Energy	Ecosystem Services	Technology	Blue Biotechnology	Finance	Regulation	Image
1. Holistic analyses are in place which cover and compare costs and benefits of different measures for prevention, removal or diminishing transfer of pollutants to the sea.			●	●	●	●			●	●	
2. Analyses take into consideration ecological, political, societal, cultural and economic aspects such that the whole value chain of different public investments and business activities is recognized.	●		●	●	●	●	●	●	●	●	
3. In support of MSFD and HELCOM monitoring and assessment objectives, sea resources important for the maintenance of good ecological status of the sea ecosystem have been identified and are regularly monitored.		●	●			●				●	
4. There is a knowledge and societal awareness on costs and benefits of different sea resources with regard to safeguarding the good ecological status of the Baltic Sea and their impact on supporting and maintaining ecosystem services.		●	●	●		●					●
5. The rules on securing sea and coastal space necessary for the maintenance of the sea resources performing important ecological functions have been agreed by maritime spatial planners.			●	●						●	●
6. In the majority of the BSR countries, the necessary legal, financial and institutional conditions exist (e.g. ecosystem service compensation) to advance ecological mariculture ideas from the testing phase into operational products or technologies. Appropriate links between different administrative and economic regimes are in place to support the provision of ecosystem services.	●					●	●		●	●	
7. The work on concluding a BSR-wide agreement on a common approach to using fish mariculture as a restocking measure for endangered wild fish populations is advanced. Necessary regulations have been prepared.				●		●				●	
8. Priorities have been identified and set for the most important environmental fields for the Baltic Sea where Blue Biotechnology applications may make a positive contribution.			●					●			

Marine resources as part of the renewable energy mix in the Baltic Sea Region	Actors	Data	Environmantal Impacts	Pilot Sites	Energy	Ecosystem Services	Technology	Blue Biotechnology	Finance	Regulation	Image
1. Due to better monitoring clear knowledge and societal awareness of the potential /and availability of various (bioenergy) resources throughout the BSR is available.	●	●								●	●
2. Techno-economical models and environmental impact assessments have been used to estimate sustainability of marine biomass as a raw material for bioenergy. Various operational scales have been analysed.	●		●		●	●	●		●		
3. Use of different sea resources in biogas plants is "known practice" (incl. economic models) for regions/municipalities. Optimised processes for the production of biomass from some sea resources are available.				●	●		●		●		
4. By 2020 most suitable locations have been identified for a number of (large-scale) biorefineries in the BSR, using biomass both from land and from sea. Biorefineries are strategically placed (close to both: sea resources and end-users).		●	●	●	●			●		●	
5. Wave energy is used as a niche contribution for certain specialized systems at sea. Full-scale prototypes (pilots) with help of public finance have been tested, thus proper knowledge levels exist to start commercial applications.				●	●		●				
6. Greater attention is given to the use of sea resources in (regional) sustainable energy action plans both at national and regional levels. Comprehensive assessments of the available potential and the cost and benefits of using Baltic Sea resources exist.					●	●				●	●
7. Relevant innovation clusters exist and co-operation between companies and public research institutes has been established. Key players (interest groups) in the field have been identified (companies, research institutions, public administrations) and are working with each other on the basis of mutually beneficial cooperation agreements.	●				●		●	●	●	●	

Improve human well-being via new marine products	Actors	Data	Environmantal Impacts	Pilot Sites	Energy	Ecosystem Services	Technology	Blue Biotechnology	Finance	Regulation	Image
1. A Baltic Sea wide strategy for the implementation of a biobased economy around the Baltic Sea exists and is aligned with EU level developments. The strategy is complemented by national action plans securing financing for research, new product testing and their commercialization.	●	●	●	●	●	●	●	●	●	●	●
2. Industries, including small companies, cooperate with existing research centres creating demand for new bio-products.	●						●	●	●		●
3. High awareness exists among Baltic industries, which type of marine material (such as raw material, valuable ingredients, enzymes, genes, cells or whole organisms) are suitable and can be sustainably used as components for biotechnological products or catalysts in different manufacturing processes.	●	●					●	●			●
4. The full scope of externalities (multiple benefits and costs) is understood and reflected in the pricing of marine products through the conscious decisions of the BSR decision makers. Awareness of societal benefits should be promoted.	●					●		●	●	●	●
5. New products become available due to innovative use of sea resources. Spa, wellness tourism and cosmetic industries flourish around the Baltic Sea. New food and feed products are increasingly gaining acceptance and are recognised as regional and premium quality products. New medicine and medicinal products will essentially improve human health.	●						●	●	●		●
6. Use of marine resources becomes an important part of the existing industry and service clusters around the Baltic Sea. The multiplier and clustering process is facilitated by close co-operation of marine industries with local developmental organizations and civic sector.	●				●		●		●	●	

The Baltic Sea Region – A biobased innovation showcase	Actors	Data	Environmantal Impacts	Pilot Sites	Energy	Ecosystem Services	Technology	Blue Biotechnology	Finance	Regulation	Image
1. Development of biobased technologies becomes one of the key dimensions of the BSR smart specialization.	●						●	●			
2. BSR R&D on biobased technologies and expertise reaches maturity level necessary for creation of numerous spin-offs in this field.	●						●	●	●		●
3. Several BSR biobased clusters exist and actively co-operate. Their leaders are well known in the EU and perform their leadership duties raising the issue of marine innovations at EU political agenda level.	●						●	●			●
4. Key players (interest groups) in the field have been identified (companies, research institutions, public administration) and are working with each other on the basis of BSR-wide cooperation agreements.	●						●	●	●	●	●
5. Research institutions commercialize products together with companies with regulated patenting / publishing rights.	●							●	●	●	●
6. This development is coherently supported by policies at various levels: from regional and local strategies and spatial plans up to EU strategies and Community Support Framework (CSF).	●			●	●	●				●	●
7. The BSR becomes an education hub on biobased economy. The education offered is of a multidisciplinary character i.e. combines natural sciences (e.g. biology, ecology), social sciences (e.g. economics), and technical sciences (e.g. energy, mechanics, biotechnology etc) at all levels (technical schools, colleges, universities).	●						●	●			●

A smart Baltic Sea Region: Making use of blue-green combinations of uses	Actors	Data	Environmantal Impacts	Pilot Sites	Energy	Ecosystem Services	Technology	Blue Biotechnology	Finance	Regulation	Image
1. The imperative to combine uses has been introduced into the maritime spatial plans as a matter of routine and more in depth instruction and guidelines have been elaborated by the Baltic organizations.	●									●	
2. Different types of sea use combinations have been investigated and tested.			●	●	●		●				
3. There are financial and information tools (planning guidelines, BSR discussion fora, financial incentives) supporting use combination in majority of BSR countries	●					●			●	●	●
4 Smart use of resources has become a rule. Pilot bio-refineries are used for energy production, removal of pollutants from waste streams and extraction of high-value substances for the biotech industry.	●			●	●		●	●			
5. The BSR consciously furnishes other regions with experience and know-how on benefits, challenges and preconditions for combination of sea uses.	●										●
6. The combined coastal and maritime resources have established legislative frameworks for blue-green innovative establishments.	●								●	●	

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RECOMMENDED REFERENCE

Przedrzymirska, J.; Zaucha, J. & Schultz-Zehden, A. (eds.) 2015: SUBMARINER Roadmap. Towards a blue-green economy in the Baltic Sea Region. Gdańsk. 2nd edition.

SPONSOR

The production of this 2nd edition of the SUBMARINER Roadmap has been realised with the support of the Swedish Agency for Marine and Water Management.

Swedish Agency for Marine and Water Management

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Based on the findings of the SUBMARINER Compendium, **the SUBMARINER Roadmap** presents the key issues that require joint efforts in the Baltic Sea Region in order to enhance blue-green growth in the region while sustaining and improving its natural capital and, in particular, the Baltic Sea itself.
The SUBMARINER Roadmap is the most important strategic reference document for the broad range of initiatives that the SUBMARINER Network engages in.

ACKNOWLEDGEMENT
The SUBMARINER Roadmap and the creation of the SUBMARINER Network result from the project "SUBMARINER – Sustainable Uses of Baltic Marine Resources" (2010–2013).

Part-financed by the European Union (European Regional Development Fund)

SPONSOR
The production of this 2nd edition of the SUBMARINER Roadmap has been realised with the support of the Swedish Agency for Marine and Water Management.

EUSBSR FLAGSHIP
The SUBMARINER Network is a flagship project of the EU Strategy for the Baltic Sea Region (EUSBSR).