Picture 1. Bladder wrack (Fucus vesiculosus).

Policy Brief

Promoting Sustainable Macroalgae Business

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Macroalgae, or seaweeds, are simple, plant-like organisms found worldwide. They grow primarily along the coastline, but they can also be found in freshwater ecosystems such as rivers and lakes. Macroalgae are divided into three major groups: green, brown and red algae.

THE GLOBAL VALUE of the macroalgae industry is currently more than 6 billion USD (FAO 2019), out of which 85% comes from food products for human consumption (FAO 2018). In the last decade, the global cultivation of macroalgae has doubled to an annual production of 32 million tons fresh weight (FW), whereas the harvesting of natural macroalgae has stayed constant at approximately 1 million tons FW per year (FAO 2019). According to Seaweed for Europe Coalition (2020), European seaweed production will have to rapidly expand from present production of 300,000 tons FW (2020) to 8 million tons FW by 2030, to cover 30% of the need of the European seaweed industry, with an estimated market value of €9.3 billion in 2030.

The benefits of macroalgae/ seaweeds

MACROALGAE BIOMASS IS a rich source of bioactive products. Relevant macroalgae end uses include medicinal products, food (direct consumption, food ingredients, supplements, and additives), feed and feed additives, cosmetics, bioplastics, fertilizers and agricultural biostimulants, and biofuels/biogas. Due to their high protein content, favorable amino acids, antioxidants and vitamins, macroalgae have many benefits for humans (SAPEA 2017).

MOST IMPORTANTLY, macroalgae do not need land, fertilizers or freshwater in their production. Macroalgae production can mitigate the effects of eutrophication and enhance water quality through nutrient uptake. Algae production mitigates climate change through binding CO2 in algal biomass. According to Seaweed for Europe (2020), 27,300 hectares of macroalgae farms can take up 20,000 tons of nitrogen, 2,000 tons of phosphorus and 5.4 million tons CO2e. In sum, macroalgae can have a significant role in reaching various sustainable development goals related to food security, human health, and planetary health, in addition to providing opportunities for sustainable blue economic growth.

Current status of cultivation & harvesting in Europe including the Baltic Sea

IN EUROPE, harvesting of natural growing macroalgae has a long history and is still considerably larger in terms of tonnage than the cultivation industry. Most of the collection of macroalgae has been for the extraction of compounds such as alginate. Beach cast algae and wild macroalgae populations have also been utilized as fresh food, animal feed, fertilizer and in the extraction of potash, iodine and algal polysaccharides. Currently, the most rapidly growing

Picture 2. Macroalgae harvesting has a long history.

macroalgae segment in Europe is in the healthy 'superfood' section, and macroalgae food supplements are becoming more commonly found in grocery stores. Producers of cosmetics have also an increasing interest in bioactive compounds extracted from macroalgae. The European market of macroalgae food products is still dominated by imported products (FAO 2019), but the potential of native European macroalgae species is now gaining attention (e.g. Barbier et al. 2019). The growing demand for macroalgae as raw material has led to more interest in macroalgae cultivation in Europe, with several start-up companies interested in addition to the traditional fish-aquaculture industry. Harvesting and cultivation of brown algae, such as *Saccharina latissima, Laminaria digitata, Laminaria hyperborea, and Ascophyllum nodosum* is currently (2020) taking place in e.g. France, Scotland, Norway, Denmark and the west coast of Sweden.

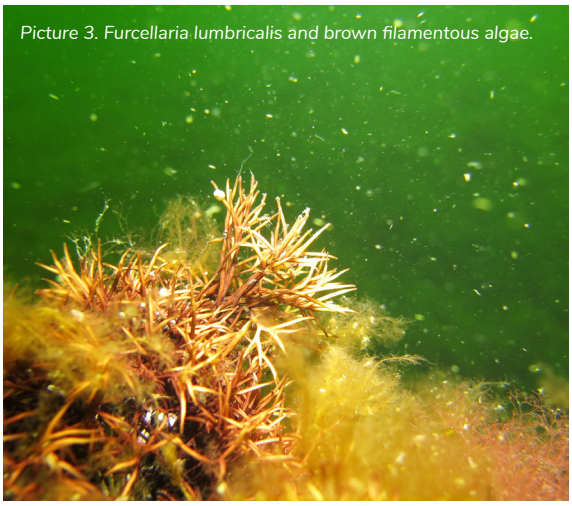
MOST BALTIC SEA COUNTRIES now mention algae in their blue bioeconomy strategies. Scientists and businesses currently see *Furcellaria lumbricalis* (red algae), *Fucus* spp. (brown algae) and *Ulva* spp. (green algae) as the most promising macroalgae species for cultivation in the Baltic Proper. *Furcellaria lumbricalis* (red algae) is harvested in Estonia to produce a thickener called furcellaran and also food colorants, with a currently pending cultivation permit. Cultivation of *Fucus vesiculosus* (brown algae, bladderwrack) is piloted in southern Finland with a plan to build a marine biorefinery, and Fucus is tested in Germany and Denmark for cosmetic, tissue engineering and ophthalmology applications. In the western Baltic Sea (close to Danish Straits), there are a handful of commercial farms and the main target species are *Saccharina latissima, Palmaria palmata and Laminaria digitata*.

Further research and better regulation

FURTHER RESEARCH and innovation activities are needed to discover the potential of various algal species, to develop cultivation methods, to ensure product safety, and to respond to consumer needs. Macroalgae should be understood both as a bioeconomy resource and as a potential tool for environmental management. All Baltic states should sign and endorse the UN Global Compact Seaweed Manifesto (2020), which is the first global memorandum of understanding on seaweed.

THE EUROPEAN and national regulations on macroalgae cultivation and macroalgae products must protect consumers and the environment while not discouraging sustainable innovation. Governments may refer to global standards, mainly the ASC-MSC Seafood Standard (Aquaculture Stewardship Council and Marine Stewardship Council 2018) in determining the rules for sustainable macroalgae business.

THE LICENSING PROCEDURES for macroalgae cultivation in the sea are a central regulatory issue. Permitting is based on environmental and water law. For EU Member States, the Maritime Spatial Planning Directive 2014/89/EU, the Water Framework Directive 2000/60/EC, the Marine Strategy Framework Directive 2008/56/EC, and the Habitats Directive 92/43/EEC are central. Multi-use of sea and synergies between sectors can be promoted through maritime spatial planning: macroalgae cultivation can co-locate for example with offshore wind farms. As an opposite


Picture 3. *Furcellaria lumbricalis* and brown filamentous algae.

to fish aquaculture, macroalgae cultivation can potentially improve water quality by reducing nutrient loads in the ecosystem. Macroalgae can be part of Integrated Multi-Trophic Aquaculture (IMTA) systems, where macroalgae can offset nutrients released from fish or mussel farming. Macroalgae cultivation is a new activity in the Baltic Sea region, and the Baltic Sea countries do not have specific regulations on the activity. In many countries, several different authorities are involved in aquaculture licensing, and the procedure is time-consuming. One-stop shops for macroalgae cultivation and IMTA permits are needed, even in federal countries if possible. A joint statement from the ministries and permitting authorities expressing a favorable attitude towards macroalgae farms would encourage the business.

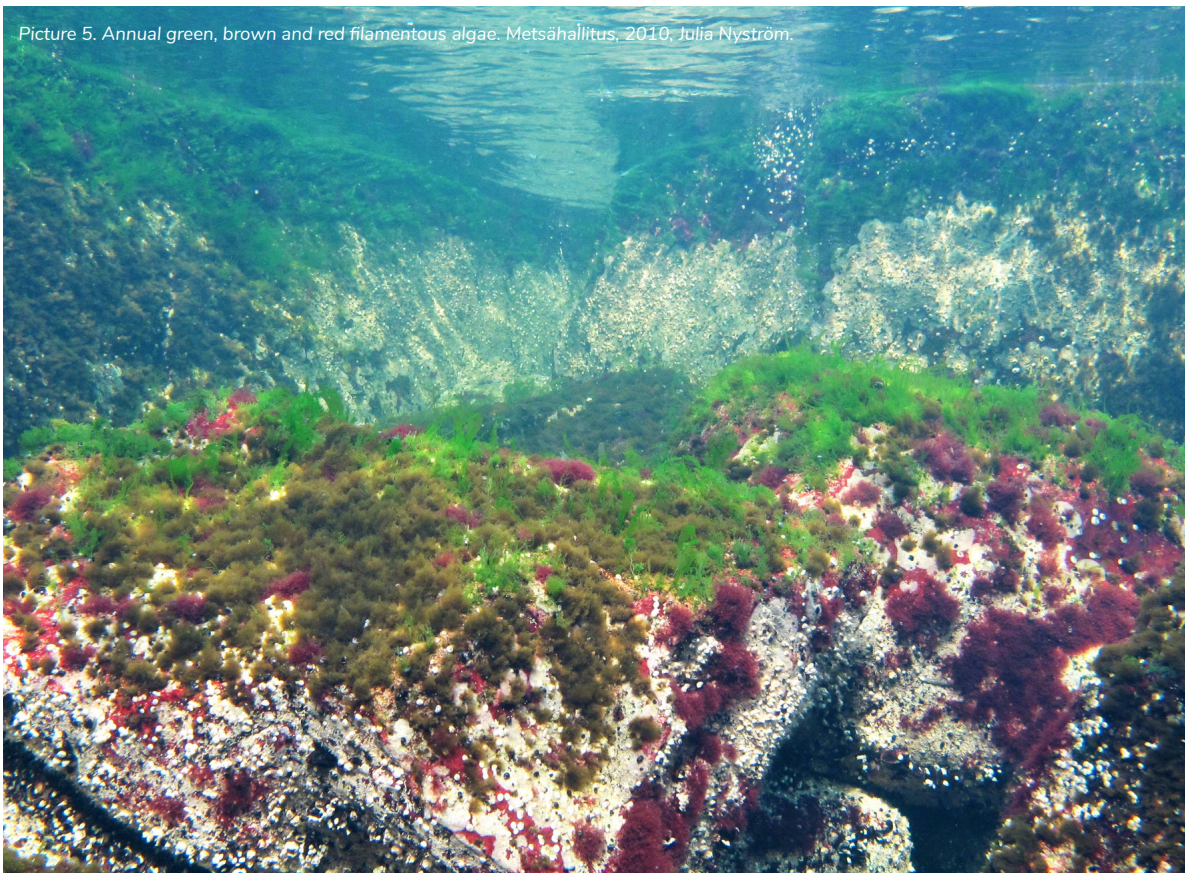
THE REGULATIONS on macroalgae products are another critical issue for the development of this industry. Improving and clarifying the European rules on macroalgae products is mainly a task for the EU. The novel food status (Regulation 2015/2283/EU) of some edible macroalgae species has not yet been evaluated and clarified. Uniform safety rules are needed as regards heavy metals and toxins in macroalgae foods (under Commission Regulation 2006/1881). Fishery product labelling rules (Regulation 2013/1379/EU) seem unsuitable for macroalgae products, and health claim substantiation (Regulation 2006/1924/EU) is demanding for any food company.

THE MARKETS for macroalgae products are importantly shaped also by the more general regulatory instruments impacting either the supply of macroalgae products or their demand. Many macroalgae products have their added value in replacing more resource intensive, larger-carbon footprint and less healthy alternatives such as meat or soy. A regulatory framework that adds weight to sustainability criteria will work in their favor:

- **RECOGNIZING MACROALGAE** cultivation and wild harvesting as a compensation measure for nutrient and carbon emissions promotes innovation in multi-trophic biocircular systems. In addition to selling the biomass, algal biomass producers could receive income through tradeable offsets.*
- **PUBLIC PROCUREMENT** rules that add weight to environmental criteria broaden the markets for eco-innovative products. European procurement policies are based on European and national laws, but concrete procurement criteria are decided at the level of individual procurement units.
- **TAX SCHEMES** that add weight to environmental criteria benefit sustainable products. The EU sets the amount of possible VAT rate categories (a Member State can have three), whereas tax rates are decided at Member State level.
- **TRADE AGREEMENTS** between the EU and other countries or trade blocks may adopt criteria that favor sustainable products while blocking or limiting the imports of unsustainable products.
- **REMOVING THE SUBSIDIES** from the production of competing, high-carbon raw materials lowers the relative prices of more sustainable products.

* *In the absence of a European trading system for nutrient sinks and/or carbon sinks, national trading schemes might be used to promote a sustainable blue bioeconomy. Offset refers to a verified, certified and registered unit that corresponds to a unit of additional nutrient (Belinskij et al. 2018) or carbon reduction. The creation of a credible offset system would require additional pilot studies especially targeting how to calculate the offset value of cultivated macroalgae biomass (Kostamo et al. 2020).*

Picture 4. Bladder wrack (Fucus vesiculosus).



Picture 5. Annual green, brown and red filamentous algae. Metsähallitus, 2010, Julia Nyström.

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