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CIRCULAR ECONOMY Blue-Green Bio Lab

Bio-industrial symbiosis

Policy Brief

Design of bio-industrial symbiosis based on blue biomasses – Danish workshop

This brief is a part of the Blue Green Bio Lab Tool Kit, that represents the findings in the Blue Green Bio Lab project. The project targets the urgent challenges of reducing nutrients to waters of the Baltic Sea Region, limiting greenhouse gas emissions, and enhancing European self-supply with food, feed, and energy. Together, aquaculture, agriculture and industry can provide solutions to these challenges through industrial symbiosis based on the sustainable exploitation of local blue and green biomasses initially grown and/or harvested with the objective to produce positive ecosystem services. The Blue Green Bio Lab project is co-financed by Inter-Reg Baltic Sea Region with partners in Denmark, Latvia, and Sweden.

Tine Hahnbak, innovation consultant, Climate Foundation Skive.

This brief contains the findings from the Danish workshop on designing bio-industrial symbiosis based on blue biomasses as part of the Blue Green Bio Lab Project. The purpose of the workshop was to identify challenges and barriers and how to move forward. The workshop was held by Climate Foundation Skive and Skive Municipality in April 2023.

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Resume

The Danish workshop was held April 27th, 2023, with 25 participants representing fishermen, aquaculture interests, suppliers, business support organisations, local politicians, citizens, and academics. The workshop began with an informal lunch and then an inspirational speech by a researcher with extensive practical experience on projects related to blue mussels. The speech set the context for the workshop and had the purpose of ensuring all participants were updated on the latest initiatives and knowledge regarding the local fjord's environmental conditions, where poor water quality is an urgent factor to be addressed. As the workshop progressed, it became evident that there were significant differences in participants' understanding and knowledge about blue mussels and mussel farming. Early in the workshop it also became clear that this was the first time the various stakeholders had been gathered to exchange perspectives. The most significant outcome, prioritized by the participants at the end of the workshop, was the desire to meet again and continue the dialogue. It should be noted that there has been and still is notable opposition to the idea of increased mussel farming from citizens in the Skive area.

Below are the findings collected from the template designed for the event to frame group discussions, the template is a large poster with predefined topics and space for notes (please go to "Participatory workshop design brief" for details); no additional information is added below. The template was placed on tables for each group where a facilitator from the project was responsible for gathering the essence of the discussions of the various topics.

To secure knowledge sharing and cross-pollination, participants were organized into five groups beforehand. After a first round of diving into the topics, they were asked to re-organize into new groups for peer-coaching. And lastly, going back into original groups to build upon their work. The work was then presented in plenary, focusing on strengths and barriers. The workshop concludes with a prioritization of the barriers that need to be addressed to make the greatest positive impact.

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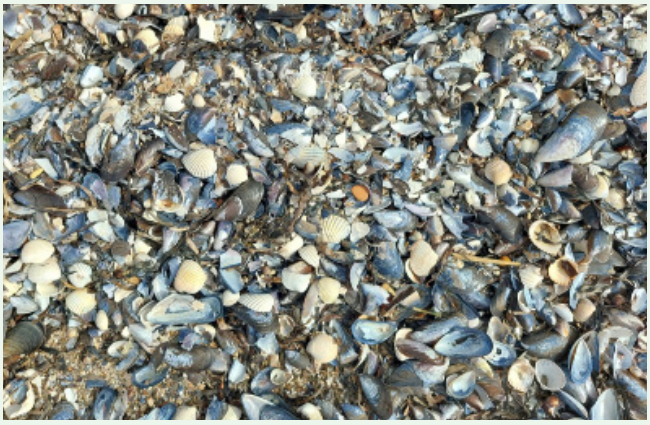
Mapping of bio-industrial symbioses

Choice of biomass

The invitation to the workshop was specifically focused on blue mussels as the primary biomass to discuss, because Skive Municipality sees the potential for using blue biomasses in new ways to achieve both climate goals and improve water quality in Skive Fjord (for details on these potentials, please see the brief "Mussels as a potential biomass for symbiosis"). The fjord is today heavily polluted due to current and former agricultural activities, as well as the deposition of sewage from a now closed slaughterhouse.
All groups discussed perspectives on blue mussels, specifically cultivated blue mussels for human consumption. The groups had different approaches and weighting of topics, yet all the group discussions involved the following topics:

- Nature restoration
- Production/cultivation
- New products
- New marketing opportunities.



Not all groups included information on volume and/or quality of blue mussel production. Those that did pointed out that a mussel farm can harvest 300-500 tons, resulting in a total of 3,000-5,000 tons across 10 facilities. One producer mentioned that they produced 3,000 tons on approximately 80 hectares in 2022 but plan to produce around 2,000 tons in 2023; however, they would like to be able to produce 5,000 tons. They also agreed that blue mussels produced in the inner part of the Limfjord are of high quality. Producers can sell them for DKK 10 per kilogram (app. EUR 1,5) with approximately 50 mussels per kilogram for 2-year-old quality mussels.

Nature restoration

It quickly became apparent that neither producers nor citizens were interested in introducing "ecosystem service mussels", what are also called "mitigation mussels", despite scientific evidence highlighting their environmental benefits particularly the ability of mussels to filter nutrients from the water as presented in the inspirational speech.
Existing blue mussel producers opposed the use of mitigation mussels because as they stated, these mussels are small and have thin shells. Harvesting the mussels would be difficult, resulting in significant losses, and it is currently not economically viable to develop solutions for purification or separation of the mussel meat from the shells. The required technology is currently lacking.

Citizens rejected the idea of mitigation mussels because they do not want additional blue mussel "smart farms". The idea behind smart farms is to submerse them under water during winter months, but this idea has not yet been successful. The visibility of the black pipes of smart farms on the surface of the water are the primary reason for citizens' opposition, however the increased amount of fecal matter, sludge, and resulting odor under the facilities are also among citizens' concerns.

The following topics were also discussed:

- The presence of sludge, especially its thickness and the need for permission to remove it.
- Using seaweed fertilization near streams and the fjord as alternative approach to recycle nutrient discharge.
- Planting of eelgrass and use of stone reefs to enhance biodiversity.
- The establishment of private-driven sea gardens connected to professional facilities.

Production / Cultivation

The first and most important point regarding production and cultivation is that the total current supply of mussels can be sold. Furthermore, there the demand for blue mussels, whether "in one piece" or divided into meat and shells, is higher than the current supply. To balance supply and demand, it is necessary to obtain permits to increase the number of facilities for larger-scale production.
There is a desired shift in production (primarily from

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mussel producers) from harvesting wild mussels to cultivating mussels. Wild mussels account for 65% of the catch (obtained through dredging), take 2-3 years to mature for harvest and consist of 15-25% meat. Cultivated mussels (grown on lines and smart farms) account for only 35% (moving toward 50%) of the current catch and take 10-12 months to mature for harvest, consisting of 40-50% meat. Cultivated mussels are also better at water filtration due to their faster growth.
Several groups express concerns about issues associated with dredging, which they view as very harsh on the fjord's ecosystem. And they point to the fact, that many mussels die in the process.

New products
With the aim of increasing demand for mussels in the Danish market, some groups discussed ideas related to product development to open up more channels and hopefully cater to the tastes of more Danes.
In addition to boiled and frozen mussels (meat), suggestions were made for producing mussel oil (as a flavor enhancer) and breaded or as "Swedish meatballs" since mussel meat is considered a high-quality ingredient.
Regarding the use of shells for purposes other than construction and riding arenas, participants had ideas for incorporating shells into high-value products. Examples included Caviart (type of caviar), shampoo, lotion, and calcium lactate for nutraceuticals.

New marketing opportunities
There was a particular focus during discussions on marketing blue mussel products to children and tourists.
Several groups saw value in developing mussel products that appeal to children, with the logic that if children enjoy eating mussels, so will their parents. One approach is to create mussel meat in child-friendly designs, drawing inspiration from Sweden and Iceland. Another proposal is the establishment of sea gardens as a potential educational setting promoting an understanding of food production, climate and environment, symbiosis, and circular thinking. Another integrated learning program could combine culinary skills with natural sciences.

Participants thought tourism has great potential as a new marketing channel. The idea is to enhance the understanding of mussel production by offering tours. For example, kayak excursions could be organized, similar to "oyster safaris" or diving trips, and boat tours could include visits to mussel farms and exploration of seaweed.
A third potential marketing channel was selling mussels to public cafeterias, emphasizing their ability to replace meat as a protein source, highlighting the health and economic benefits, as mussels are cheaper than beef and pork.

A diagram produced to summarize the workshop using the 3D visualization tool developed in the Blue Green Bio Lab project can be found at the end of this brief on page 5.

Strengths

During the summing up of each group at the end in plenum, participants talked about the strengths of their ideas. Below is a summary of the strengths identified:

- Mussels can become interesting to a wider audience.
- There are health benefits associated with consuming mussels.
- There is a climate advantage if mussels can serve as a meat substitute.
- Production of edible mussels contributes to clearer water, reduced oxygen depletion, and less bottom disturbance.
- Mussel production offers potentials for business development.
- We have a knowledge cluster in the area with both Technical University of Denmark's Shellfish Center and a relatively large industry.

Barriers

A focal point for the project is that barriers are more diverse than just regulatory ones. They can be social, cultural, business-related, etc., which became evident in the discussions. Two recurring themes throughout the workshop were the differences between knowledge and opinions, and the lack of clarity regarding legal requirements for mussel farming. A demand for

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greater transparency regarding the types of mussel farming and the selection of site locations raised questions such as:

- Why are there no production and operational requirements for existing facilities?
- Why is the industry not granted permits for additional facilities?
- Why can dredging occur at depths less than 2 meters (a reference to Natura 2000 areas)?
- Why are smart farms permitted when it is not yet proven that they can be submerged?
- Why are small, discarded mussels not allowed to be used as fertilizers?
- How should invasive species like Pacific Oysters, wandering mussels, and signal crayfish be managed?

There is a lack of knowledge about alternative methods for removing nutrients from the fjord other than mussels. And there is a need to dispel misunderstandings since there is conflicting data from various sources, leading to confusion and mistrust. In this context, the possibility of using seaweed fertilizers near fjords and water bodies is a gentle method to recycle nutrient discharge. However, this "fertilizer" is not recognized as such in Denmark, only as soil improvement tool. Similarly, it is currently not permissible to remove sludge from the fjord bed, which accumulates in thick layers in large parts of the fjord. Additionally, there are no economic incentives for cultivating eelgrass, which would have a mutually beneficial effect alongside mussel beds by increasing fish populations, helping to control invasive species.

Lastly, a significant barrier is that Danes, in general, do not consume much and shellfish. There is tremendous potential for more sustainable business in terms of increased sales and reduced transportation, if the consumption of mussels, preferably without shells, could be increased. Increased production separating the meat from the shells would also help with the current scarcity of shells that could be used in other industries such as cosmetics or the pharmaceutical sector.

Addressing barriers with potential for greatest positive impact

The workshop concluded with a prioritization of the barriers that need to be addressed to have the greatest positive impact. The prioritization process in the workshop involved giving all participants two stickers that they could place on notes describing the different challenges. The stickers were then counted once everyone had placed them.

This process revealed the most important barriers/obstacles to be addressed according to participants, in prioritized order – with the top two being clear "winners":

- How do we communicate better across different sectors?
- Lack of communication and involvement among stakeholders.
- What can we do for the fjord, rather than what the fjord can do for us?
- Failure to utilize existing facilities before establishing new ones.
- How do we sell our products locally? (e.g., to children).
- How do we gather more knowledge?
- Mismatch between science and production competition.
- Difficulty in persuading Danes to consume mussels.
- Where and which activities should be chosen (to intervene effectively)

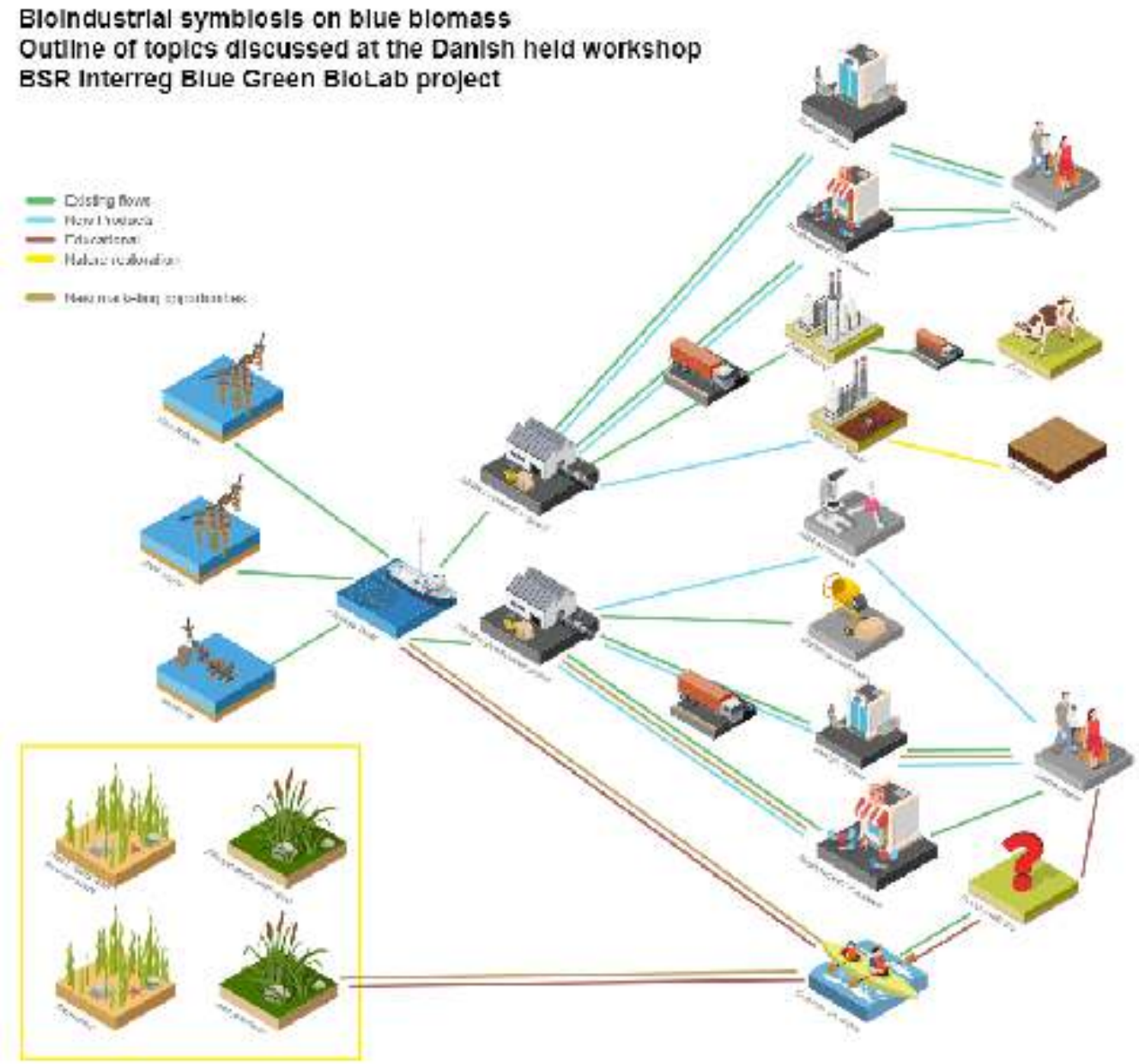
Next steps

On the template, it was possible to write suggestions on how best to move forward in creating future bio-industrial symbiosis using blue biomass. Suggestions were:

- The need for awareness campaigns
- Promoting new dietary habits
- Seeking inspiration from other places to leverage existing technology
- Creating learning programs for students
- Enhancing dialogue and knowledge-sharing across different interests, distinguishing between facts and opinions
- Developing a master plan that ensures a political framework, a democratic process, a possibility to seek funding, and gives a method that can be passed on to the Costal Water Council for the central Limfjord.

Reflections / learnings

- With an open invitation, there will attend participants you do not expect. It requires a thorough frame-setting of the workshop purpose, which is presented at arrival, in the welcome and at the tables with the message that everyone should have time to speak and that the template sets the framework for topics.
- There is a big difference in working with blue biomass compared to green biomass. In green biomass the farmer owns the land, but when we work with blue biomass, the water is a common area. There is thus a great need for marine spatial planning if we are to make full use of blue biomass in the future.



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Project facts

The Blue-Green Biolab project is co-financed by Interreg Baltic Sea Region.

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