MASTER THESIS

REGENERATIVE MARICULTURE

-An architectural exploration of synergies within small scale ocean cultivation, implemented in a design proposal on Hönö.

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Examiner: Liane Thuvander

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“Food arrives on our plates as if by magic, and we rarely stop to wonder how it got there.”

(Steel, 2013, s.9)

ABSTRACT

Food is a central part of our everyday lives, yet food production has never been as secluded as today. Our food systems are built on monoculture principles advocating an antagonistic view of natural forces and diversity. This result in greenhouse gas emissions, soil degradation, biodiversity loss and eutrophication of oceans and lakes.

This thesis examines how design can enable sustainable food from sea farming in Bohuslän with the principles of regenerative design. The aim is to illustrate how design can create a closer connection to food, enhance social interactions and increase the awareness of food production and its environmental impact.

The thesis consists of two parts, the design concept of a sea farm and a design proposal implementing the concept on Långholmen south of Hönö. The design proposal empathizes typology, climate, and building tradition of the local site.

The regenerative design principles urge that we rethink the way we design things to find nurturing solutions that enable a positive impact on the environment with increased activity. It is important to see nature both as a model and the context, letting nature do the work and aggregate, not isolate. The word regenerative accentuates the cyclical importance of thriving systems and implies that humanity not only has the power to damage and endure but also to create and nurture.

The result is a cultivation cooperative creating synergies in a local network. The project includes marine allotments and cultivation farms with algae, mussels, and oysters. The small-scale industry and appurtenant buildings enable processing, cultivation, recreation, food workshops and social gatherings. The cultivation cooperative enables members with different knowledge and backgrounds to create a prosperous environment for sustainable food production.

KEYWORDS

Local context / Marine allotments / Regenerative design
Relationship to food / Social interaction / Sustainable mariculture

VOCABULARY

Mariculture - cultivation and harvest of marine flora and fauna in a controlled saltwater environment.

Aquaculture - the cultivation of aquatic animals and plants, especially fish, shellfish, and seaweed, in natural or controlled marine or freshwater environments; underwater agriculture.

Cultivation - to promote or improve the growth of (a plant, crop, etc.) by labor and attention.

Allotment - a plot of land rented to a gardener.

Monoculture - the use of land for growing only one type of crop.

Eutrophication - a process by which pollution from such sources as sewage effluent or leachate from fertilized fields causes a lake, pond, or fen to become overrich in organic and mineral nutrients, so that algae and cyanobacteria grow rapidly and deplete the oxygen supply.

TABLE OF CONTENT

STUDENT BACKGROUND

2019-	MASTER'S PROGRAM- Architecture and Urban Design ARK258 / Matter, Space, Structure 3 ARK626 / Architectural Heritage and Transformation ARK079 / Nordic architecture ARK650 / Sustainable Development and the Design Professions AUT164 / Future visions for healthcare- housing for seniors AFT107 / From concept to existing building
2016-2019	BACHELOR -Chalmers University of Technology Architecture and Engineering
Autumn 2018	INTERNSHIP Buro Happold Engineering, London
Summer 2015	INTERNSHIP Kungsbacka Municipality
2010-	EXTRA JOB Fishmonger

PERSONAL INTEREST

During the last 10 years, I have worked extra as a fishmonger in Gothenburg, and it has resulted in a greater appreciation and understanding of food from the ocean. On the west coast of Sweden where the salt and streams contribute to good water quality, there are great opportunities for sustainable seafood.

My aim is to some extent produce food for myself, but I do not think that it is a realistic solution for everyone. What I want to achieve with architecture is to re-establish a connection to food and increase the general knowledge of how food is produced. Bringing food production closer to people's everyday lives decreases the scope of the food systems. I think that can lead to more awareness of what we eat, and food systems with lower environmental impact.

INTRODUCTION

INTRODUCTION

BACKGROUND

Sustainable food production will play an important role in addressing the issue of climate change. 20-30 % of the greenhouse gas emissions are caused by the food systems, it is also causing eutrophication of oceans and lakes, and biodiversity loss (Garnett et al., 2016). Today our food is mainly produced in an industrialized way with the monoculture principle that works against nature and the eco-systems.

Regenerative mariculture, with algae, oysters and mussels counteracts eutrophication and can coexist with the eco-systems. The cultivations can generate great food with minimum impact on the environment.

Food production used to be the main occupation for humans, now not many of us know how the food is produced, processed, and discard. Still, food has one of the greatest impacts on our lives with cultural, physical, and social aspects (Steel, 2013).

This thesis addresses the issue of climate change and food production by exploring sustainable sea farming and the unhealthy relationship between people and food.

PURPOSE

This thesis examines how design can enable regenerative and sustainable food production from sea farming on the west coast of Sweden. The thesis aims to, illustrate how design can create a closer connection to food, enhance social interactions and increase the awareness of food production and its environmental impact. It also embodies the potential of local food from the ocean.

The project frames a concept of small-scale sea farming with a focus on creating synergies. It includes aspects of the industry, processing, education, ecosystem services and recreation.

To illustrate the concept, it is implemented in a design proposal on an island south of Hönö, called Långholmen.

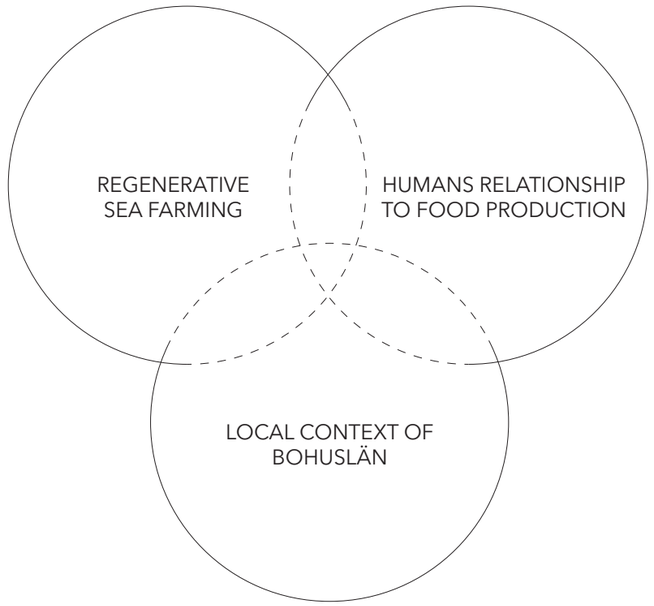

Figure 1. Fields of research

RESEARCH QUESTIONS

- How can a small-scale regenerative sea farm for food production be designed?

- How can design enhance social interactions and strengthen the connection to food?

METHOD

The methodology used for this thesis is research by design. The thesis consisting of two parts, the design concept of a sea farm and a design proposal implementing the concept.

Initiation for the project is the collaboration with the macroalgae farmers Ten Island Seafarming. The idea with the master thesis grew from a study visit on their cultivation. They are based in the Northern archipelago of Gothenburg and suggests a suitable site for the implementation, south on Hönö, on an island called Långholmen. The collaboration includes study visits, valuable contacts, and feedback throughout the process.

The design concept is based on information and knowledge from literature, researcher in the field, study visits and reference projects. The information is analysed and contextualized throw illustrations, mapping, text, and photos.

The design proposal has a local context approach with regards to the typology, weather and climate, local infrastructure, and the building tradition. In the design process study visits, references projects, sketches, site analysis, architectural drawings, and physical models are used.

DELIMITATIONS

The project started with the idea of connecting mariculture and land farming. The inspiration was taken from aquaponics where fish tanks with freshwater are connected with crops in a closed nutrient system. But with the site on Långholmen the aquaponic idea did not seem reasonable any longer. It did not make sense to put freshwater tanks on a small island surrounded by saltwater and with no infrastructure.

The cultivation solutions with cultivation farms and floating docks will not be designed in detail and solutions will be taken from existing cultivations. The cultivations will only include macroalgae, mussels and oysters. These species are chosen because there are existing cultivations on the west coast of Sweden today and therefore more research is to find. However other species like fish or tunicates are possible to include in symbiosis cultivation.

Laws and regulations for ocean cultivations have not been studied and implemented in the project. However, some information regarding laws and permit is included due to direct input from farmers that they thought should be implemented in the design.

The design proposal is not adapted for accessibility. Today the island is only accessed by foot via the barren cliffs. The idea of including overnight cabins in the program was addressed, but the scope of it was not suitable for this thesis.

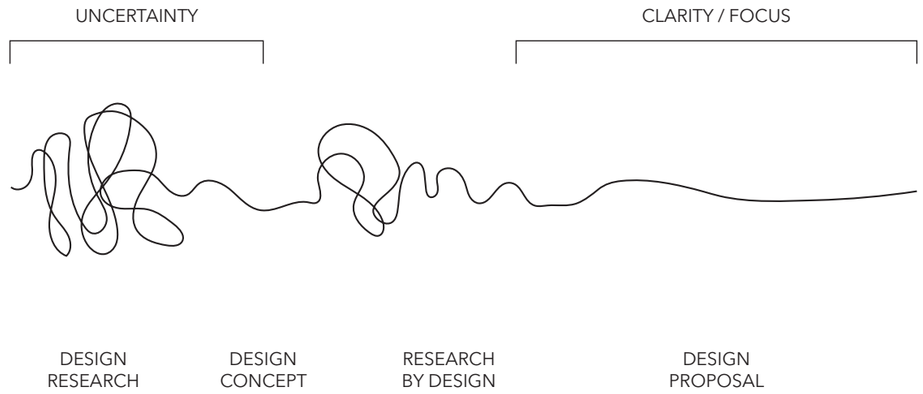

Figure 2. Design process

BACKGROUND

LESS BAD IS NO GOOD

In Cradle to Cradle, McDonough and Braungart (2002) discuss the difference in eco-efficiency and effectiveness. Östlund (Östlund, 2017, p.78) refers to eco-efficiency as mainstream sustainability, which focuses on how we can minimize our footprint, less emission, less use of material and minimizing consumption and waste. McDonough and Braungart argue that ”less bad” is not equal to being good and proposes to use effectiveness which can be seen as an expansion of regenerative design. McDonough and Braungart also problematize the negative language when discussing solutions to the climate crisis. We need to rethink the way we design things and find nurturing solutions that enable a positive impact on the environment with increased activity (Braungart, McDonough, 2002, p.3).

A CULTURE OF MONOCULTURE

With today’s paradigm of development and manufacturing, based on industrial principles with the driving force of maximum profit and output, natural forces and diversity are seen with an antagonistic view. This results in a design that favours homogeneity and works against nature instead of with nature (Braungart, McDonough, 2002, p.32). Lyle (Lyle, 1994) formulated in his book, Regenerative design for sustainable development from 1994, twelve strategies for regenerative design. The first three of them stating the importance of seeing nature as both a model and the context, letting nature do the work and aggregate, not isolate (Östlund, 2017).

REGENERATIVE DESIGN

The principle of regenerative design is based on the view of the relationship between humanity and nature. It criticizes the anthropocentric view where humans are placed in the centre of everything and nature is seen as a service for mankind. The aim of regenerative design is instead a world where nonhumans and humans share habitat and participate to regenerate resources in equal conditions. The design principal shifts focus to system thinking and local narratives with a mutual relationship between societal and ecological values to generate a thriving design (Östlund, 2017, p.69).

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REGENERATIVE

“Together with the prefix re-, meaning “again”, the term generate emphasizes the cyclical nature of healthy systems and the evolutionary process of re-creation. It also suggests breathing new life and prosperity into ailing systems that have suffered from our mismanagement and reminds us that humanity not only has the power to destroy and survive, but also to create and nurture.”

(Östlund, 2017, p.71)

PLANETARY BOUNDARY

The planetary boundary concept is used to illustrate how natural systems are affected mainly by humans. If the levels are beyond the zone of uncertainty, it may be irreversible resulting in changes in the environmental conditions compromising ecosystems and the existence of many species (Garnett et al., 2016, p.19).

Food systems contribute to the changes in several boundaries, the most severely affected: Genetic diversity and Biochemical flows of phosphorus and nitrogen, see Figure 3. The phosphorus and nitrogen flow to the ocean and seas are a direct result of unsustainable fertilisation use in agriculture.

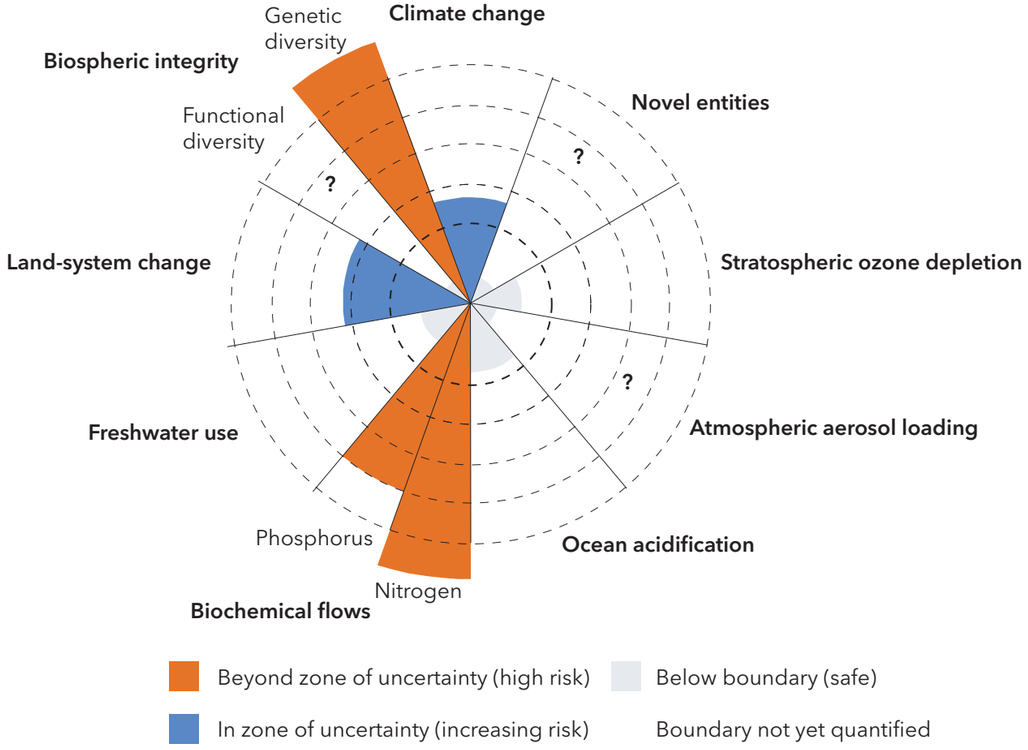


Figure 3. Planetery Boundaries.

FOOD PRODUCTION

Today our food is mainly produced with monoculture and in an industrial way that works against nature and the natural eco-systems. The food systems use high external input and resource-intensive systems that have negative effects on the climate. It results in greenhouse gas emissions, soil degradation, eutrophication of oceans and lakes, and biodiversity loss (FAO, 2018, p.1).

20-30 % of the human-made greenhouse gas emissions are caused by the food systems, including transportation, storage, and processing (Garnett et al., 2016, p.10).

Most impacts have the gases methane and nitrous oxide coming from the soil and manure of animals. The emissions increased radically after starting using industrialized fertilizers which were made possible by the Haber-Bosch process. The fertilizers add phosphorus and nitrogen to the soil and between 1961 and 2019 the use of fertilizers increases by 800 % (Cederberg, 2019). The phosphorus and nitrogen also leak out with watercourse creating a flow to the ocean and lakes resulting in eutrophication which harms the ecosystems (Garnett et al., 2016, p.13). Figure 4. is illustrating the flow of nitrogen from fertilizers.

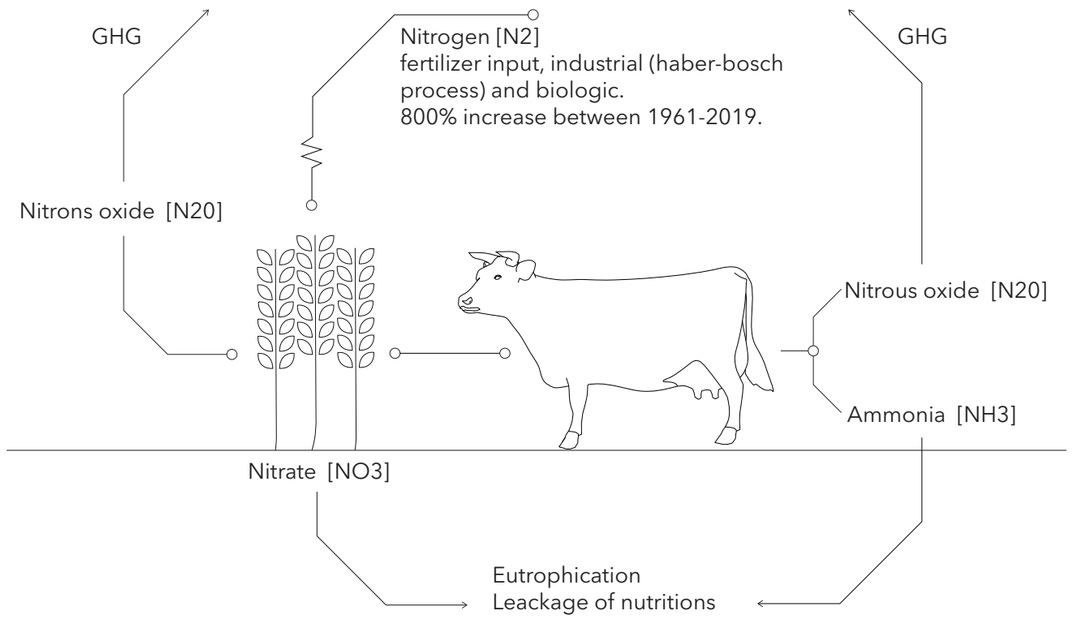


Figure 4. Flow of Nitrogen

FOOD SYSTEMS

Our food systems today have big impacts on our planet and our lives, it affects our health, biodiversity, livelihood, and climate change. Food is also an important cultural and social part of our everyday lives (Steel, 2013). The globalized food systems today are complex and includes everything from production, distribution, retail, consumption, and waste (Garnett et al., 2016, p.3). Garnett argues that to be able to change the food systems we need to understand the complexity of it and how different factors affect others, this is best done by applying system thinking.

One way of looking at food systems is to consider the processes happening from field to fork, see figure 5. It is a good way to get an overview, but this system thinking is misjudging, mainly because the waste and nutrients are not returned to the agricultural production, the systems today are not cyclical. To get a more holistic view of it, different kinds of drivers and actors like social, environmental, and economic is illustrated in figure 6. Here it gives a more equitable image of the complexity around food production and everything that affects it.

Today as many as 20 % of the global population work within the food systems, but the industries are controlled by a few stakeholders (Garnett et al., 2016, p.16) making it hard to impact and change the system.

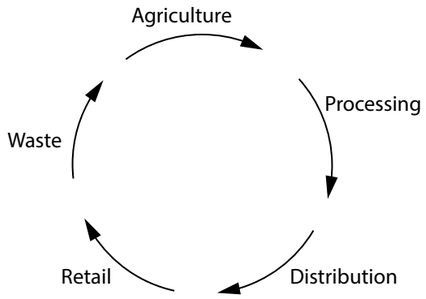


Figure 5. Simplified Food System

FOOD FOR A GROWING POPULATION

The world's population is growing, predicted to be 9-10 billion by 2050. Rising income leads to changed lifestyle and diet to one often including more meat. A large amount of the produced food is wasted along the supply chain (Garnett et al., 2016, p.10). One of the main issues is to produce sustainable proteins for a growing population. Today we can produce vegetarian food with high protein content like the soybean but with the downside of large land areas used and freshwater and nutrition addition (Stedt, 2021).

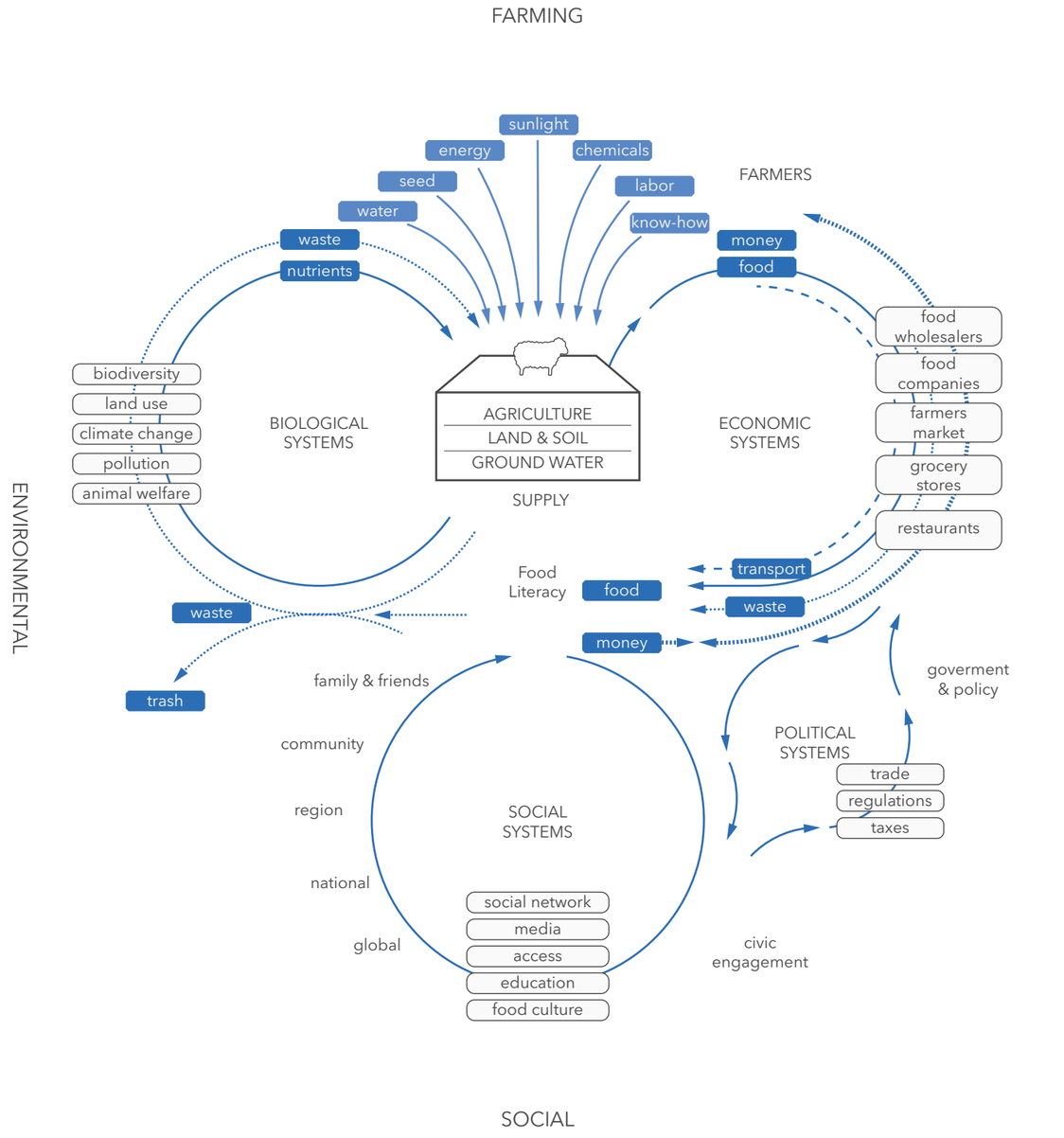


Figure 6. Complex Food System

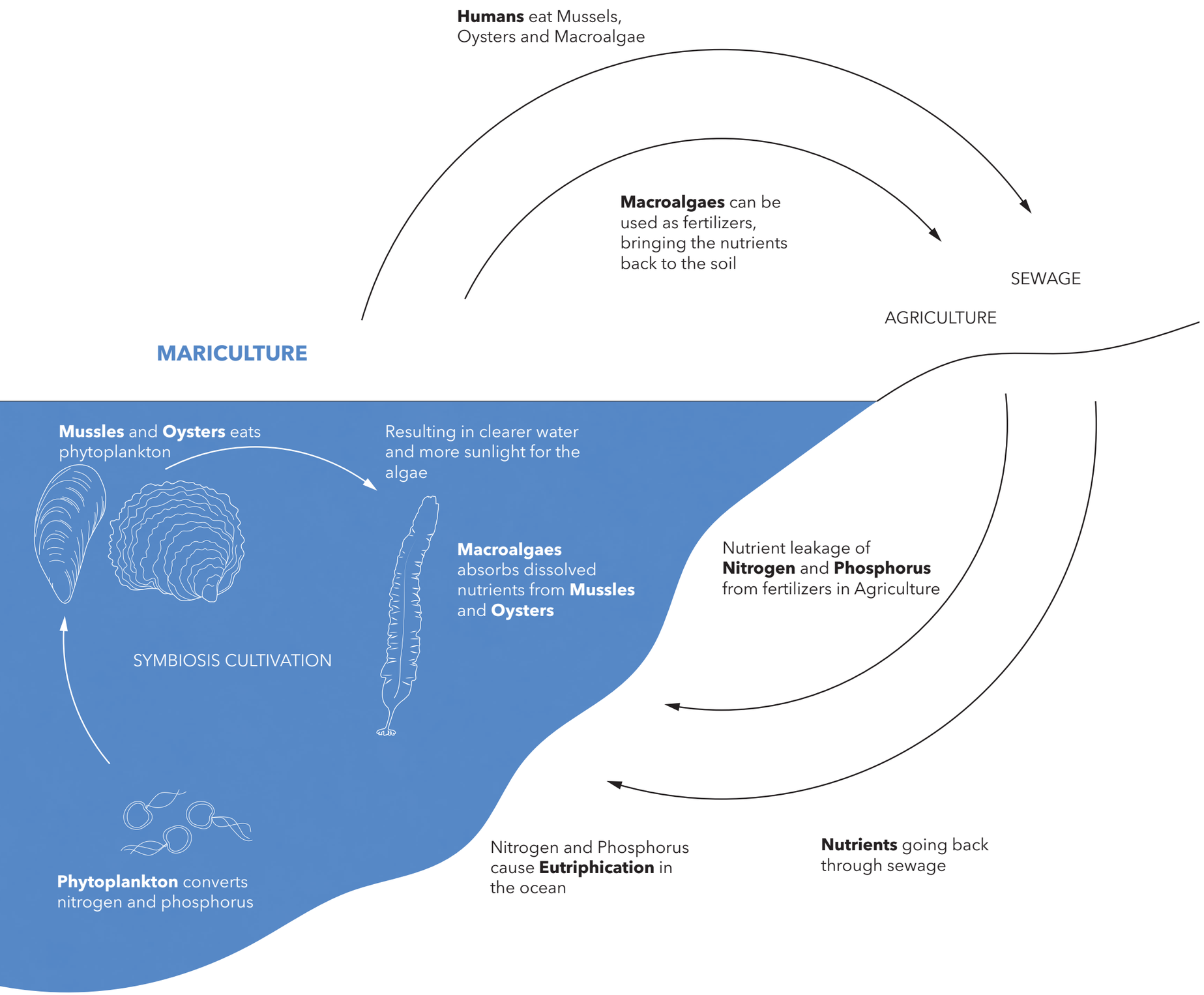


Figure 7. Symbiosis Cultivation.

SEAFOOD

71% of the earth's surface is water, but only about 5% of the food we eat today is produced in the ocean (Sundell, 2020). In Sweden, we often eat fish file from predatory fishes like salmon, cod, and tuna but we do not eat much of the primary producers or primary consumers in the food chain (Appelqvist, Lindegarth, 2019, p.9). Many of the fish species are depleted already, the big potential for food from the ocean is in eating more of the primary consumers and producers like macroalgae, mussels and oysters.

REGENERATIVE MARICULTURE

By cultivating the oceans vegetable, macroalgae, and bivalves like mussels and oyster we can counteract eutrophication (Visch, 2019, s.18).
The best part is that no input like nutrition, water or energy is needed (Seafarm, 2013)

SYMBIOSIS CULTIVATION

The cultivations can include one species or several ones. Symbiosis cultivation is also called integrated multi-trophic aquaculture (IMTA). Symbiosis cultivations are suggested as a more sustainable version, mimicking the natural eco-systems. (Visch, 2019, s.18) The phytoplankton converts the nutrients, which is then filtered and eaten by the bivalves, resulting in clearer water and more sunlight for the algae (Ungfors et al., 2019, s.22). The nutrient cycle will be closed by either using the algae as fertilizers for agriculture or as food for us or other animals, eventually contributing with nutrients from sewage. See Figure 7.

ECOSYSTEMS

The symbiosis cultivations create micro eco-systems. For example, on the mussel shells lives sea anemones, starfish, tunicates, and other small animals. Around the mussel ropes and macroalgae, fishes are gathering to feast on the many small creatures. The micro eco-systems create a favourable environment for many species (Haamer, 1975, p. 11).

RELATIONSHIP TO FOOD

Food production used to be the main occupation for humans, now not many of us know how the food is produced, processed, distributed, and discard. Yet food has one of the greatest impacts on our lives and our planet with cultural, physical, and social aspects (Steel, 2013).

At the same time, there are growing requests for locally produced quality food. The feeling of authenticity and craftsmanship is important for some of today's food consumer (Appelqvist, Lindegarth, 2019, p.10).

A dish or a food product can also help creates a place identity. The west coast of Sweden and especially Bohuslän have a strong identity, part of that is the seafood. Sea cultivations can generate more than a food product. It is an experience to cultivate, harvest, cook and even swim with the vegetables from the ocean. This kind of relationship and experience can promote ecotourism and strengthen the trademark of Bohuslän (Appelqvist, Lindegarth, 2019, p.10).

With a closer connection to food and an understanding of the production and work behind it, the waste can be reduced. A large amount of the produced food is wasted along the supply chain (Garnett et al., 2016, p.10)

Understanding where our food comes from and how much process it is needed is a key towards healthy food choices. If you clean 1 kg of mussels by hand, you will understand they do not look as they do when you buy them in the store. The same thing with a chicken fillet. The work done is covered, taken away, hidden. Because some of the food we eat we do not want to know how it is produced.

FARMERS COLLABORATION

Cassandra Köbbel and Anna Wängmar started Ten Island Seafarm, the name is taken from the ten main islands of Öckerö Municipality in the Northern archipelago of Gothenburg. They are farming suger kelp which is a macro algae found on the west coast of Sweden.

The first cultivation cycle started in autumn of 2020 on 0.2 hectare outside Hälsö. When harvesting during April 2021 they sold the kelp fresh to cooperative costumers that processed the algae themselves. Some of the kelp was also sold on the fishing auction in Gothenburg and fishmongers could sell it fresh at the fish counter. Ten Island Seafarm bought baby plant that were cultivated at Tjärnö laboratory by Nordic Seafarm, using a mother plant from the same location as the farm.

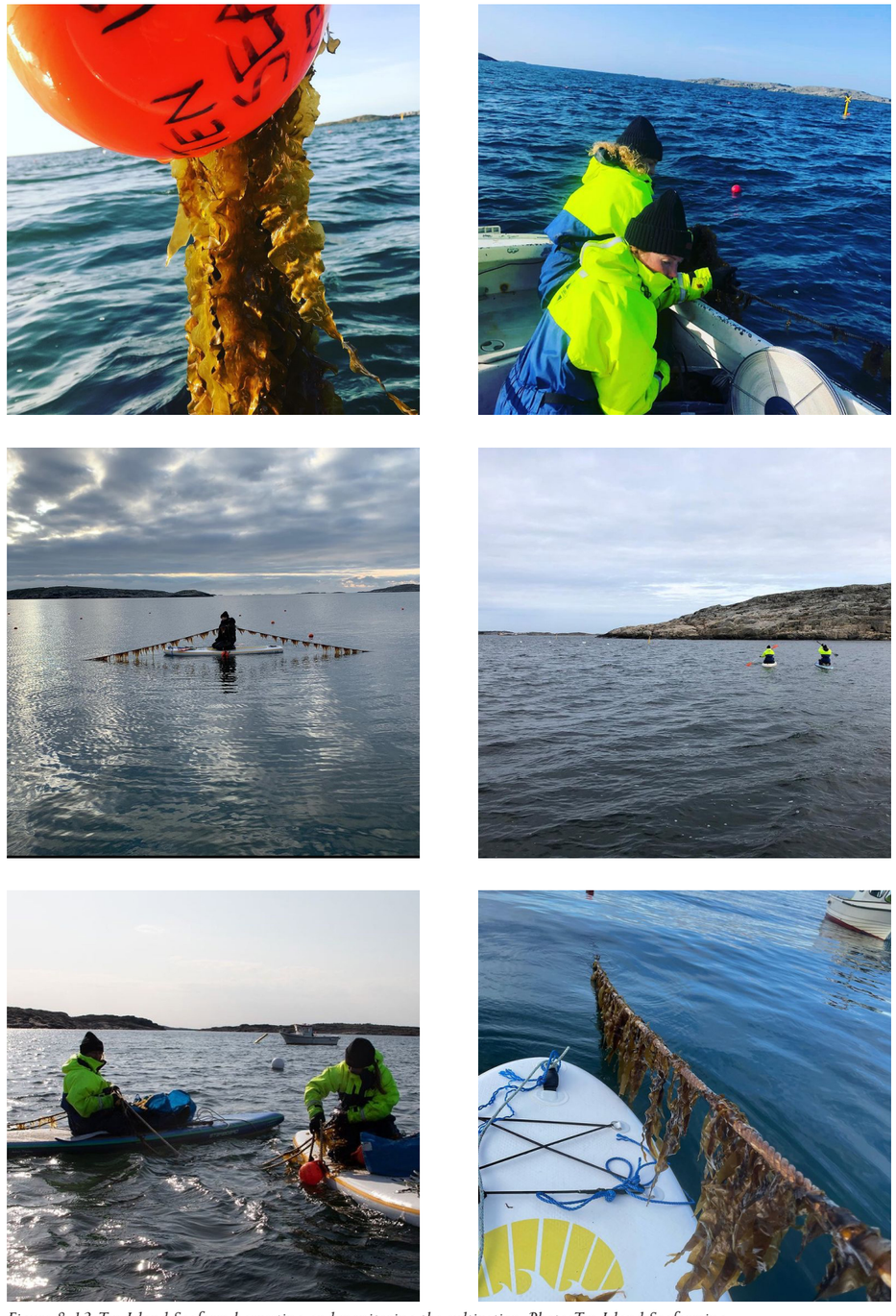


Figure 8-13. Ten Island Seafarm harvesting and monitoring the cultivation. Photo: Ten Island Seafarming.

MACRO ALGAE

Macroalgae also called kelp or seaweed are large algae that live in salt and brackish water. None of the algae has roots, flower or other organs as plants do, but they use photosynthesis and are therefore dependent on sunlight. 50 % of the oxygen production on earth is thanks to algae and the other 50 % is produced by plants on land. The macroalgae are divides into three groups depending on their pigment. The different groups are green, red and brown algae. The green lives closest to the water surface, then the red, and the brown lives deepest and are also the largest ones. Some of the native algae species found in Bohuslän are showed in Figure 14-19. All algae are harvested during late winter/early spring. First, the brown algae can be harvested between the end of January to early May. The green algae are often harvested between April and May. The attachment of the algae is preserved when harvested to enable regrowing of the plant. Some of the species can be as old as thirty years. The algae can be eaten unprocessed or can be dried to obtain durability for up to several years (Bodin, Martinsson, 2021).

Laminaria digitata
"Oarweed"

Fucus vesiculosus
"Bladder wrack"

Saccharina latissima
"Sugar Kelp"

Fucaceae
"Dwarf rockweed"

Ulva intestinalis
"Green Alga"

Ulva lactuca
"Sea Lettuce "

Figure 14-19. Some of the native algae found in Bohuslän.

ALGAE CULTIVATION

In recent years cultivation of the Saccharina latissima, also called sugar kelp has been tested in a small-scale pilot project to develop cultivations techniques in Bohuslän (Visch, 2019, s.12). Today there are a few companies that cultivate on a larger scale, and every year the interest and quantity are growing. The cultivation follows a one-year cycle, starting with pre-cultivation followed by out-planting in October when the water temperature drops below 15 °C and harvesting around April to May. The pre-cultivation is done in tanks with water from the ocean and with a mother plant taken close to the cultivation site to make sure the plants will thrive in the local ocean environment. The farming period is convenient with the absence of heavy boat traffic. The site needs to be semi-exposed with nutrient-rich water that moves, the archipelago in Bohuslän is very suitable because of its many islands creating a semi-protected environment, and very good water quality. The most common cultivation farm uses a long-line system. Horizontal lines are suspended from buoys and hang on a depth of 2 m, anchored on the seabed. From the horizontal lines, vertical lines with pre-cultivated plants are out planted, see Figure 20. (Visch, 2019, s.13)

From a farm of 1 hectare, about 10-15 ton of algae can be harvested each year (Hasselström, 2020, interviewed by Johnson).

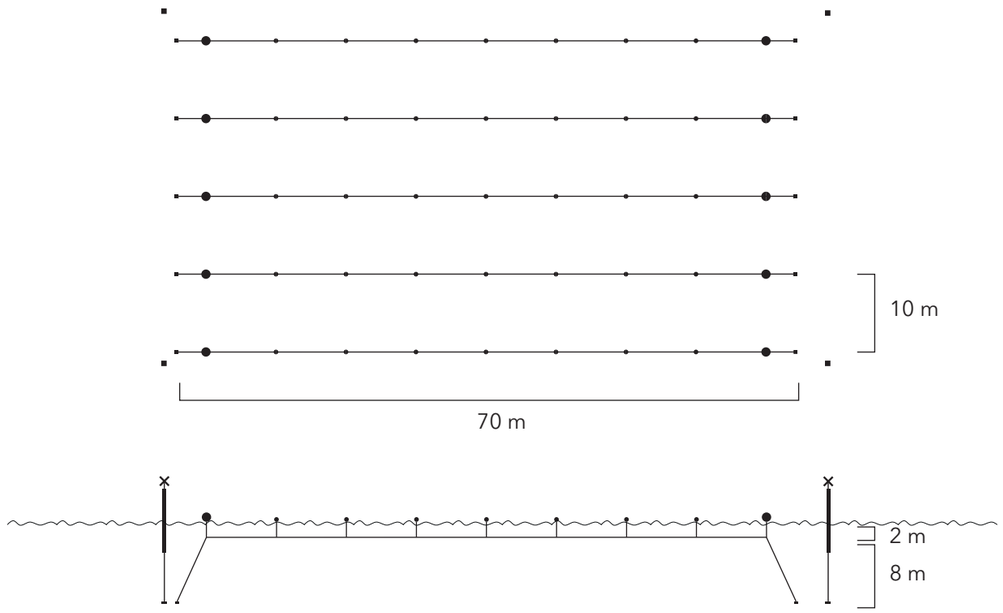
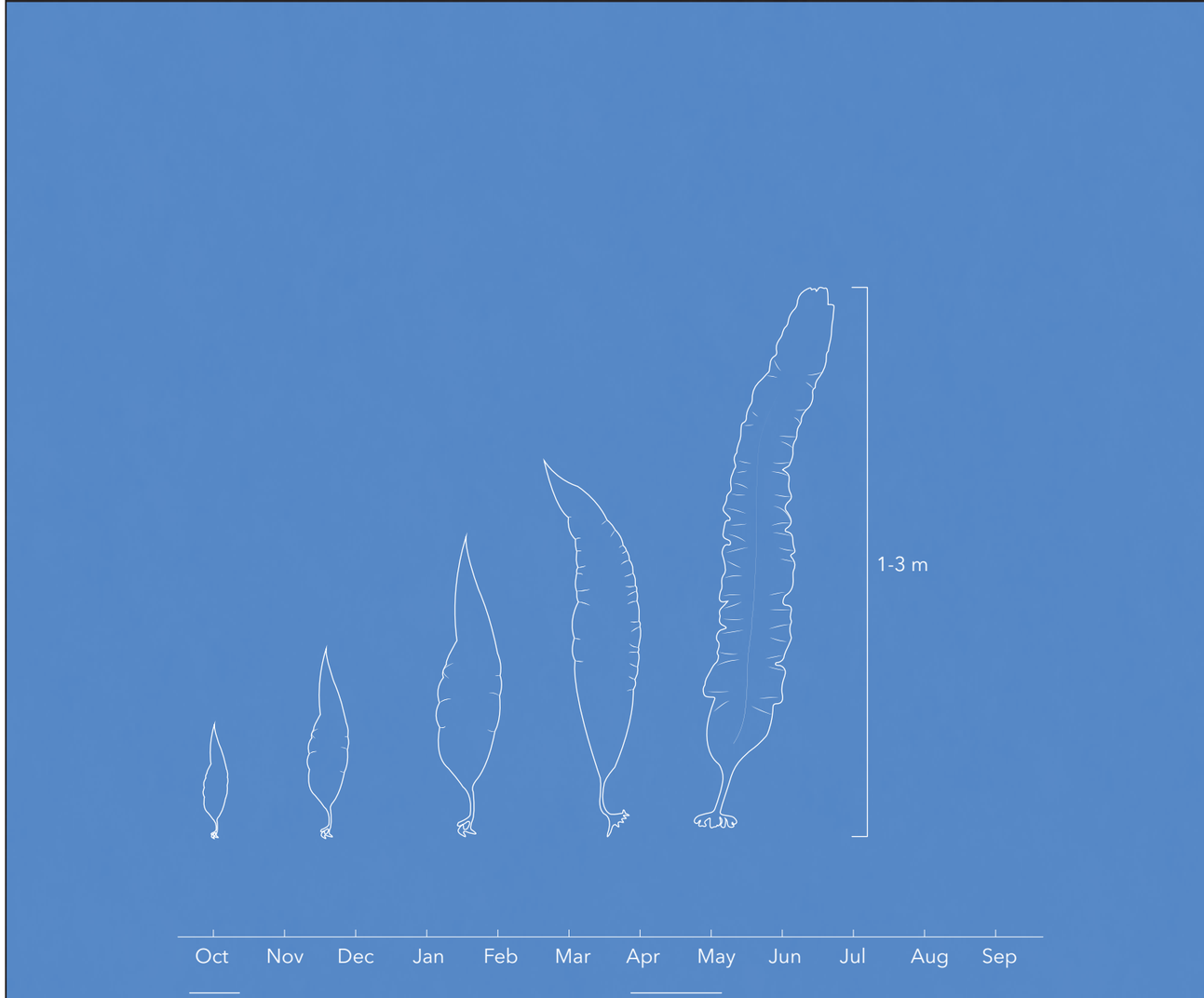


Figure 20. Cultivation farm for sugar kelp.



MUSSEL CULTIVATION

The mussel reproduction time starts when the water temperature reaches 10 °C, often sometimes in April. After the fertilization, larvae are floating around in the water for 3-4 weeks until they settle on a rock or shell on the seabed with their strong byssal threads (Haamer, 1975, p.2). During this period farmers can hang out ropes in the water that the larvae can settle on and natural cultivation is done (Romlin). The hardest task for the mussels is to find a safe place to settle, where they do not get eaten by starfish or common eider. The cultivation gives the mussels a free zone from some of the predators and maximizes the nutrition intake due to the water flow through the farm. The mussels filter the water to obtain the phytoplankton, its main nutrition. One mussel can filter up to 100 litres per day, the more nutrients there are in the water the less water it needs to filter. In its natural habitat, it takes about 3 years for the mussel to grow to a wanted harvesting size, about 6 cm. But due to the favourable conditions on the farm, a farming cycle is reduced to about 1,5 year. The mussels have features that make them very suitable for farming, the two most important being the great asset of larvae on the west coast of Sweden and their ability to settle with the byssal threads. One meter of farming rope can result in 7 kg of mussels (Haamer, 1975, p.4). When harvesting, the sizes of the mussels differ a lot due to younger settles on the one year ahead mussels. Either you harvest all the mussels and get the smaller mussels as a byproduct of you replant the smaller ones, a more labour demanding system but with less waste.

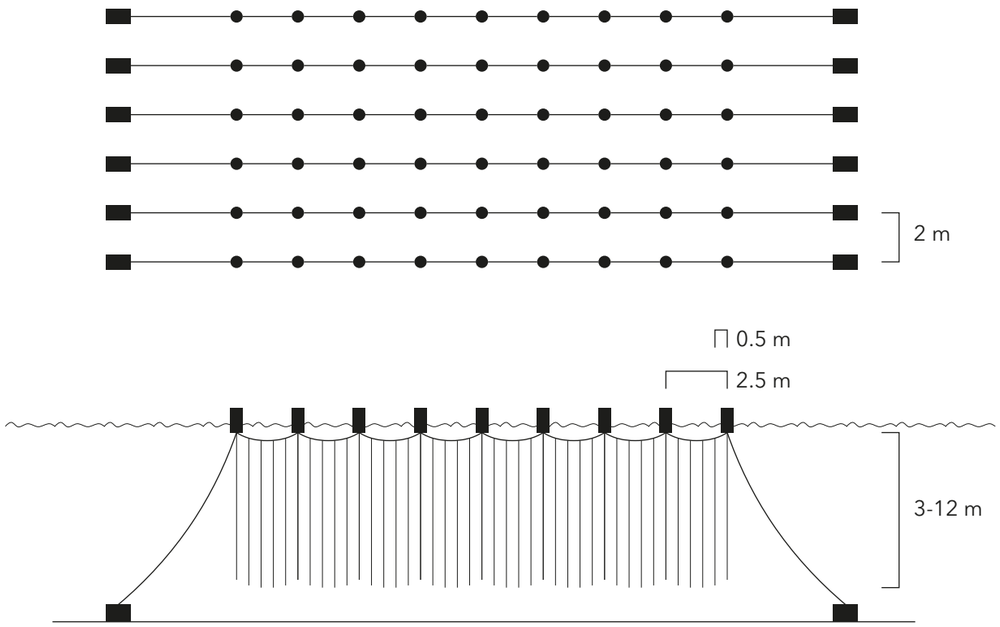
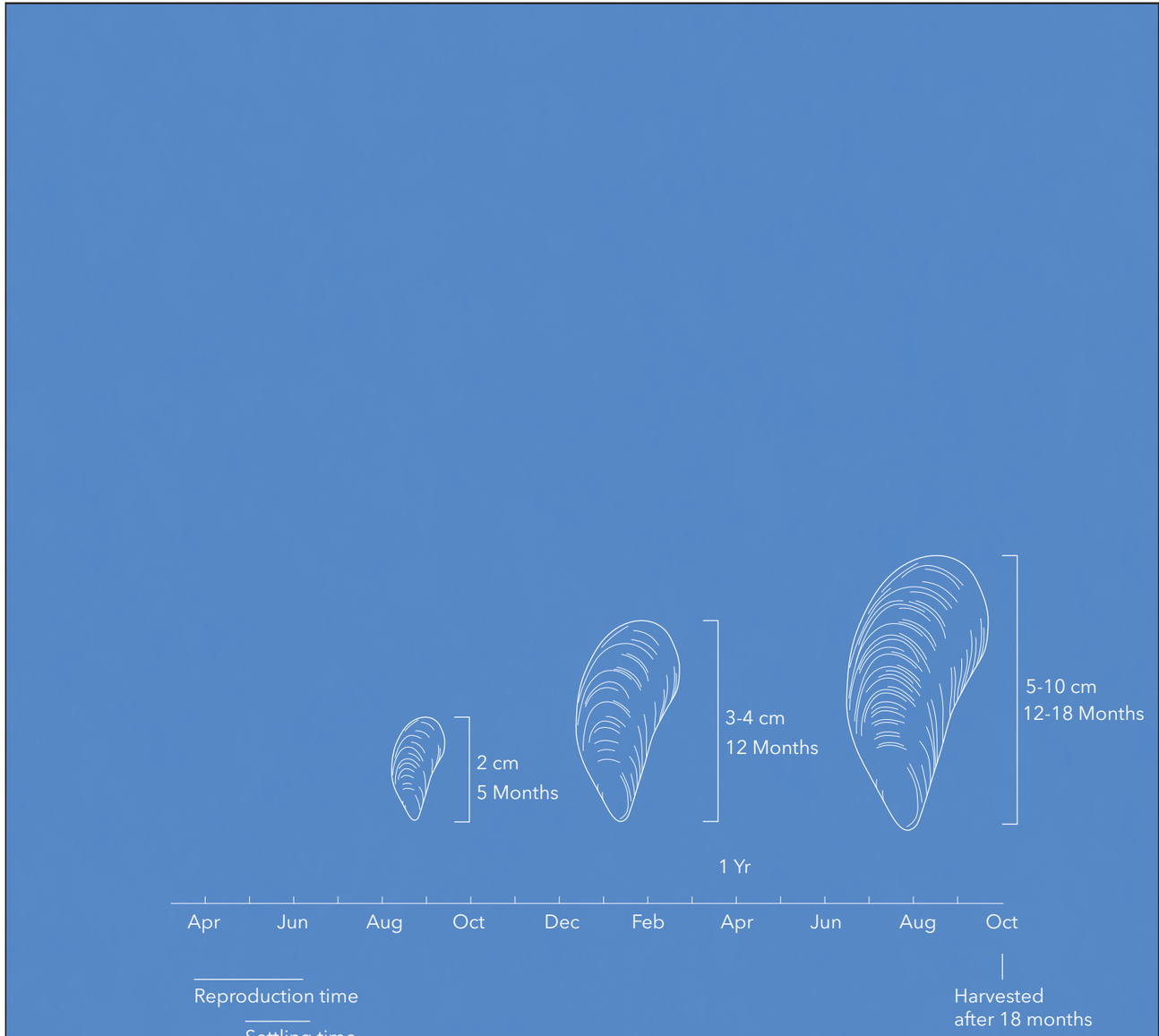


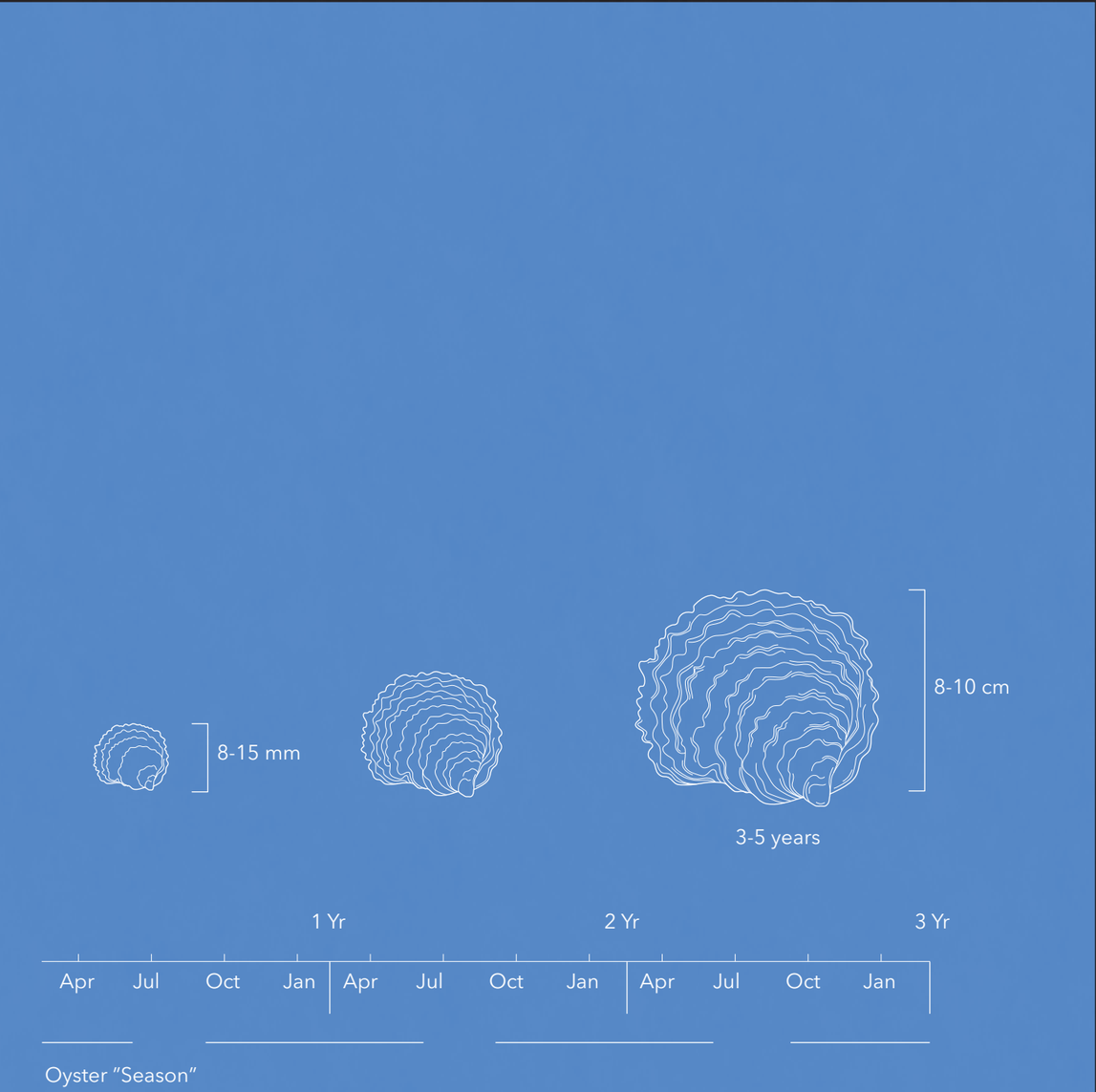
Figure 21. Cultivation farm for mussels.



OYSTER CULTIVATION

Today there is very little oyster cultivation in Scandinavia, mainly because of the complicated reproduction of the oyster and (Nord-Ostron, p.6). Today you mostly dive for the wild oyster.

The flat Swedish oyster called Ostrea edulis has a complicated lifecycle. The oyster shifts between the genders, depending on the time of the year and water temperature. For reproduction time the water needs to be as warm as 16-18 °C. The Swedish west coast is located on the northern border for the oyster range which slows down the growth and some years reproduction does not take place due to the cold water (Nord-Ostron, p.8).
One of the differences between the Ostrea Edulis and the Japanese oyster, Crassostrea gigas, is that the fertilization takes place inside the shell, instead of free in the water as for the Japanese. One other difference is that the Japanese oyster grows much faster, as much as 10 cm in a year, compared to 3-4 years for harvesting size for the Edulis.
When the larvae are 0.3 mm, they transform to an oyster spat and uses the foot to settle. In cultivations, the optimum dept is on 5-12 meters and the basket must not reach the seabed so predators can reach it. The oyster eats microalgae and dead organic material that they filter out from the water.



HAVHØST

Havhøst is an organisation for sea farmers with around 20 independent local association all over Denmark. Denmark has a tradition of aquaculture, but this initiative is about local small-scale food farming for personal use. In total the organisation has about 1000 sea farmer members.

Havhøst has a muck up allotment cultivation in the centre of Copenhagen at Kalvebod docks. The species adequate for the allotments are mussels, algae, and oysters. One important aspect of the project is to spread knowledge of aquaculture. Every year around 6000 school students visit the cultivation at Kalvebod dock. There they learn about the ecosystems, future food, and the climate impact.

Havhøst has started a collaboration with local fishermen, for who it is hard to make a living of the small-scale fishing and today's fishing quotas. The small-scale cultivations can be a supplemental income to the fishermen and at the same time give back to the ocean (Kihlström, 2020).

Figure 22. Underwater photo from Bølgemarken in Copenhagen. Photographer: Lars Helbaek Tram. 2019.

Figure 23. Freshly harvested mussels. Photographer: Eva Helbaek Tram. 2019.

Figure 24. Education at Bølgemarken. Photographer: Eva Helbaek Tram. 2019.

Figure 25. Havhøst education. Photographer: Eva Helbaek Tram. 2019.

MARINE ALLOTMENTS, STRÖMSTAD

In Sweden, there are sea cultivations for commercial farming, but no small-scale cultivations for private use. At the Tjärnö laboratory, marine allotments are tested. The first ropes were out hanged in July 2020.
Mussels, tunicates, European flat oysters, and Japanese oysters were naturally settling on the ropes.

Maria Bodin who leads the project compares the marine allotments with small-scale farming on land. People can farm their seafood either from piers or on floating docks offshore. It is important to only cultivate local species and supervise the cultivations so natural stocks are not eliminated.

One of the obstacles with cultivations is the substantial administrative work needed. The legislations are inexplicit, and several permits are needed to start your cultivation. In Denmark, they have the same problem with legislation, but Havhøst has a close dialogue with authorities and helps the local associations with permits and laws.

Bodin argues that authorities and municipalities should plan for the new opportunities with ocean cultivations, they can include areas for allotments in community planning (Kihlström, 2020).

Figure 26. Marine allotments at Tjärnö. Photographer: Sonya Swan. 2020.

Figure 27. Marina allotments with horizontal ropes. Photographer: Sonya Swan. 2020.

Figure 28. Ropes with tunicates. Photographer: Sonya Swan. 2020.

Figure 29. Cage for cultivation. Photographer: Sonya Swan. 2020.

MUSSEL CULTIVATION AT TJÖRN

In Stigfjorden between Orust and Tjörn, Birgitta Romlin has a mussel cultivation for personal use. The mussels are cultivated on a triangle formed floating rig, see figure 30. The mussels are sorted and cleaned on a floating dock, see figure 31. The small mussels are out planted again and protected from the birds with a net, see figure 32. Romlin has been cultivating for 7 years and says that the regulations and permits needed take a lot of time and energy to obtain. The equipment needed for cultivating like the floating dock for sorting and cleaning is very expensive for a small-scale farm. It is favourable to share equipment between several small-scale cultivations. Romlin collaborates with Orust Shellfish a commercial mussel and oyster company, which makes it feasible (Romlin, Personal communication, 2021).

Figure 30. Triangle mussel rig. Photographer: Birgitta Romlin.

Figure 31. Sorting and cleaning dock. Photographer: Hedvig Kjellander.

Figure 32. Nets to protect the mussels from birds. Photographer: Birgitta Romlin.

Figure 33. Freshly harvested mussels. Photographer: Birgitta Romlin.

BILLION OYSTER PROJECT

Billion Oyster Project is an ecosystem service project in New York with a focus on education and the goal of restoring 1 billion oysters in the waters around New York harbour. The oyster reefs of New York were extinct in the early 20th century due to sewage discharge and environmentally harmful toxins. The project gives opportunities for work, recreation, and education in an attractive urban space.

The restoring of the reefs is done by returning empty oyster shells in baskets or bags to the ocean. The shells create a suitable environment for baby oysters to attach to and with time creating micro eco-systems.

The project has restored 15 oyster reefs and provides habitat for many other species. The shells are recycled from restaurants all over New York.

The oyster reefs are not only water filtering, they can also work as a storm barrier in the ocean, protecting the city from large waves and flooding.

The project collaborates with more than 100 schools in New York. Billion Oyster Project educates about ecosystems and environmental impact and at the same time get help with out planting of the oyster shells. The water quality is improving thanks to the reefs but there are still dangerous substances in the water like heavy metals and it is important to inform people that the oysters are not eatable (Billion Oyster Project, 2021).

Figure 34. Outplanting of oysters. Photo: Billion Oyster Project.

Figure 35. Oyster cage. Photo: Billion Oyster Project.

Figure 36. Measuring of oyster. Photo: Billion Oyster Project.

Figure 37. Recycled shells. Photo: Billion Oyster Project.

Figure 38.Visual connection to the water. Photographer: Hedvig Kjellander

Figure 39. Studio houses. Photographer: Hedvig Kjellander

Figure 40. Sightline. Photographer: Hedvig Kjellander

Figure 41. Organically formed wharf. Photographer: Hedvig Kjellander

STUDIO HOUSES

The studio houses at the Nordic Watercolour Museum in Skärham are designed by the Danish architects Niels Bruun and Henrik Corfitsen. The studios follow the typology and are connected by a wharf that is orthogonal towards the ocean and organically formed towards the cliffs. The studios are placed narrow as the huts in traditional fishing villages which frames the views towards the ocean. A visual connection to the water is created by letting the panel go past the entrance level, still protecting the studios from flooding.

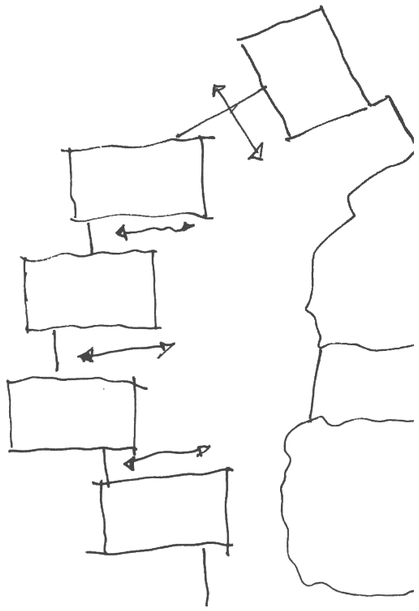


Figure 42. Sightlines between the Studios.

STADSDELSVÄXTHUS

Stadsdelsväxthus is a collaboration between several actors working with urban farming. The idea is to create an infrastructure for food production in the urban environment of Gothenburg. Growing food in the city in greenhouses can be beneficial by using heat waste from server halls and other buildings. It would result in less transportation and a closer connection to the consumer. The Stadsdelsväxthus would work as a node for production, knowledge, meetings, and sales (Stadsdelsväxthus, 2019).

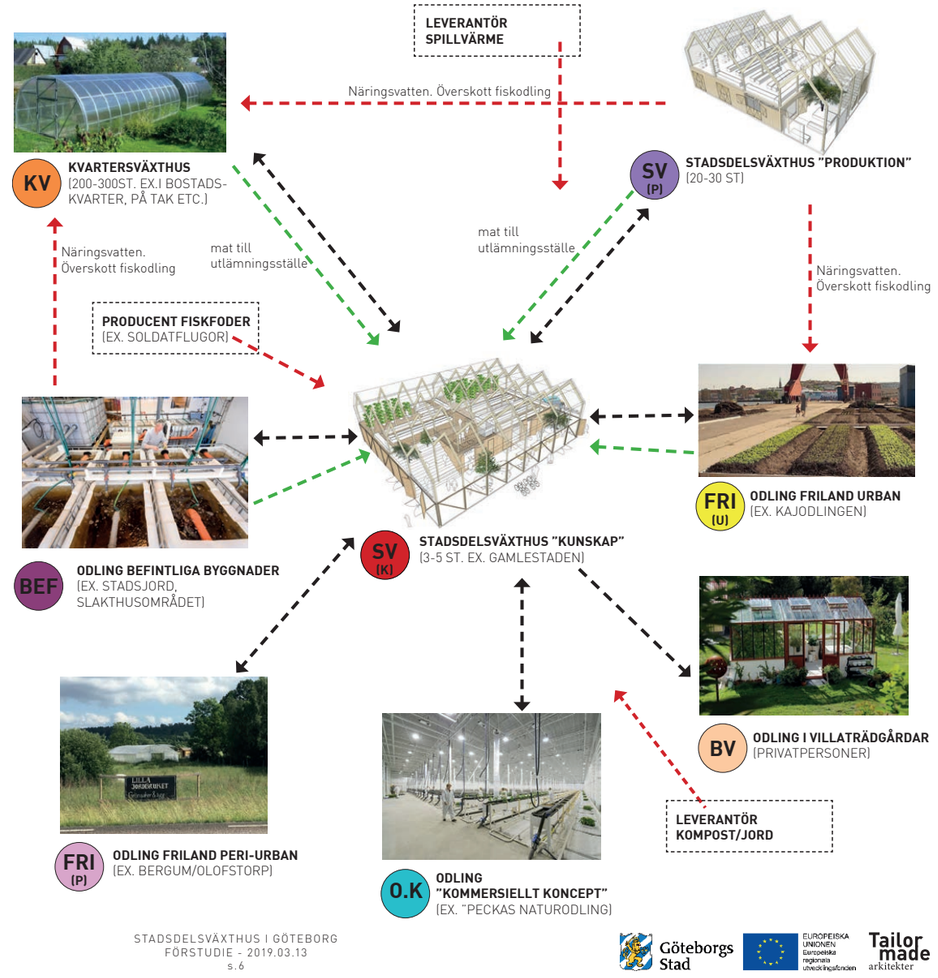


Figure 43. Network system of Stadsdelsväxthus.

CULTIVATION SUMMARY

CONTEXT

APPEARANCE IDENTITY

The characteristic appearance of the nature in Bohuslän resembles few other places, with its barren granite cliffs formed by the harsh climate, and the archipelago with its many islands. Today the fishing villages are recognized by its typical red wooden fishing huts and the white residential villas, but that has not always been the case.

IMPRINTED BY CHANGE

The fishing villages of Bohuslän are used to drastic transformations in the built environment, and communities. The development of society, availability of raw materials and fishing resources have shaped and developed the appearance and content of the unique villages on the western coast of Sweden (Helmrot & Svanbom,1979, p.8). In addition to the fishing community, Bohuslän has historically lived on stonemasonry of the granite, and small agriculture societies (Johansson, 1998, p.6).

HISTORICAL PERIODS

Typically for Bohuslän, business have flourished and had great importance for a short period of time before disappearing and leaving the coast with abandoned buildings or interventions in the archipelago environment. Examples of this is the buildings for herring oil boiling, the “werks” and the salting-house during the herring periods from 16th to 19th century. (Helmrot & Svanbom, 1979, p.8).

During the 19th century bigger fishing huts and warehouses were built for storage of oat, shipping and sail making (Helmrot & Svanbom, 1979, p.9). During the 20th century bigger ships and ports were used for transportation with container vessels and the fishing industry. The small villages transformed to a haven for summer visitors and holidaymakers later resulting in extreme price increase on houses close to the water and relocations of the locals (Helmrot & Svanbom, 1979, p.11).

DEPOPULATION

Since the 60s the fishing industry and other ocean related businesses have decreased or moved to other places (Helmrot & Svanbom, 1979, p.110). This together with the temporary summer guest increasing property prices, showing an alarming development of society. Obvious similarities can be seen with the depopulation in rural areas, the difference being that Bohuslän have a lot of tourism especially during summer but the local all year around business cease (Helmrot & Svanbom, 1979, p.5).

Figure 44. GG 195 Normy. Photo: Fiskemuseet Hönö KLåva.

Figure 45. Asta, Rut and Britt clears herring at Hälsö. Photo: Fiskemuseet Hönö KLåva.

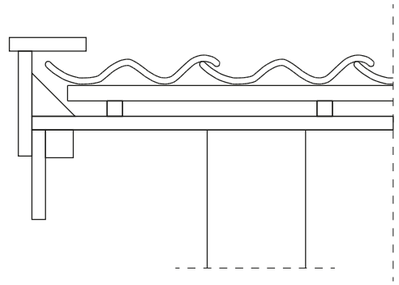
FISHING VILLAGES OF BOHUSLÄN

The fishing villages have a natural placement of functions from the ocean, the boat, the wharf, the fishing hut, and the residential villa. Fishing huts are built close to the water to be used as storage and for processing of fish (Helmrot & Svanbom, 1979, p.8). The huts are built close to each other for protection against the harsh weather, creating narrow, winding paths between them. The buildings are placed with the gables faced towards the ocean, enabling oversight towards the ocean and fast-changing weather (Johansson, 1998, p.6).

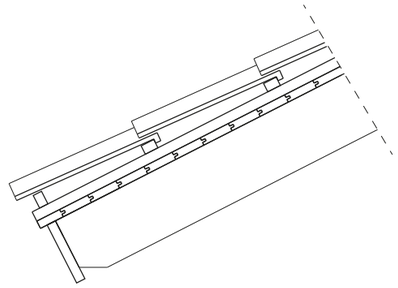
FISHING HUTS

The huts are placed with considerations and in relation to wind, water, and movements between the buildings. The fishing huts are simple buildings often in timber or post-frame structure (Tjörns Kommun, 2016, p.35) with gable roof and eaves with overhangs to protect the building against water damages. The facades typically have a standing wooden panel painted in red or in natural wood. There is often symmetry in the façade and the windows are small to enable outlooks and efficient climate envelope.

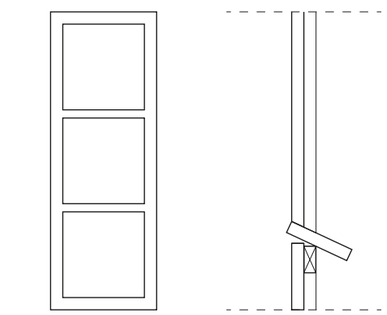
DETAILS



Eave with overhang.



Eave with overhang.



Window proportions and wooden detail.

Figure 46-54. Photographer: Hedvig Kjellander

THE SITE

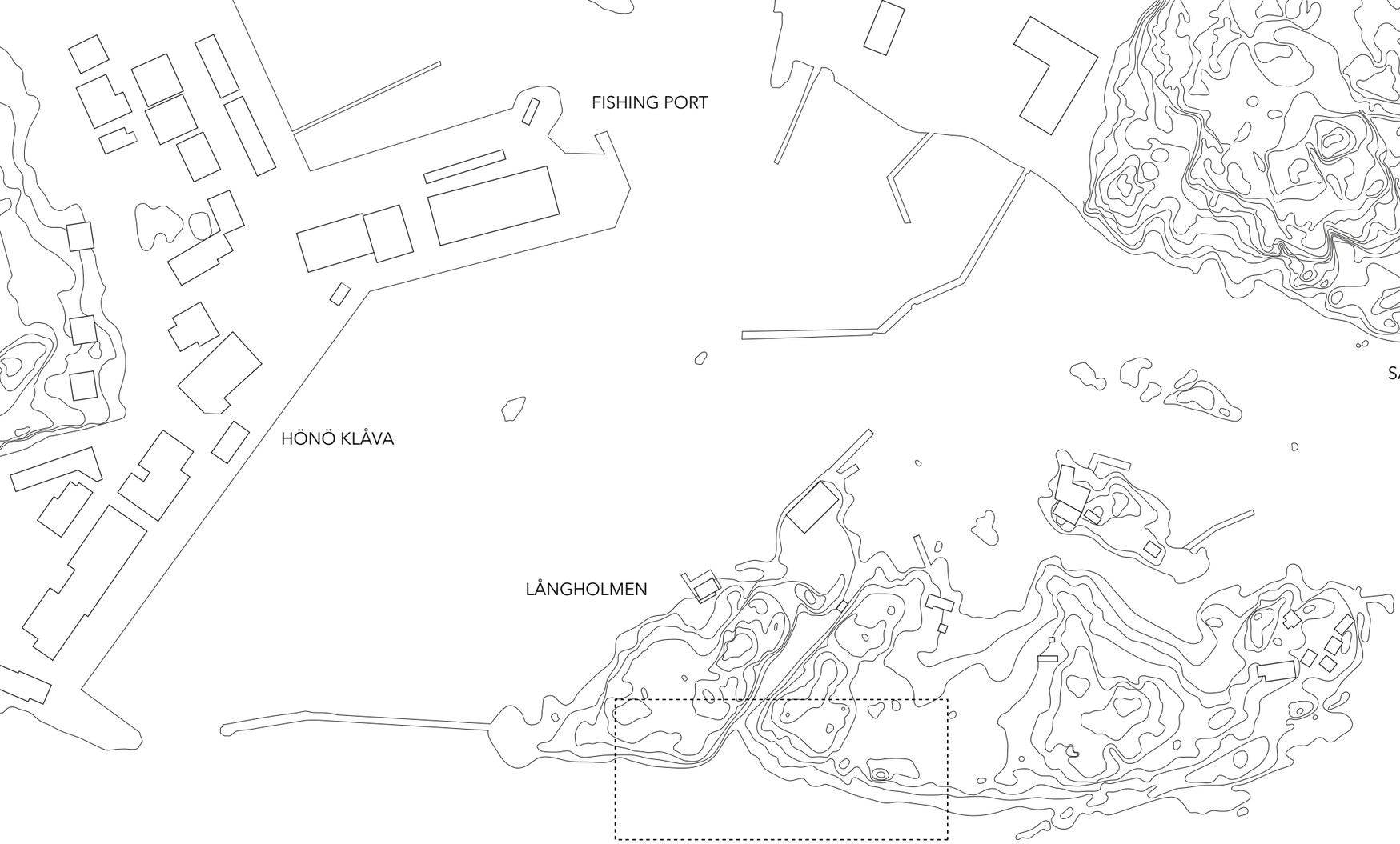
THE NORTHERN ARCHIPELAGO

The site is situated south of Hönö on a small island called Långholmen in the Northern Archipelago of Gothenburg. Hönö is accessed with a car ferry from Hisingen, with about one hour travelling time from Gothenburg city. Hönö and Långholmen is part of Öckerö Municipality which includes ten bigger islands and smaller rocky islets.

During 1850-1950 the northern island was pioneers in Bohuslän on deep-sea fishing and used modern fishing gear and larger boats. New and deeper fishing ports were built, and the population density increased. The islands started to be popular for summer guest, resulting in a direct steamboat connection from Gothenburg. Many extensive decorated wooden villas were built during this period for rich summer guests (Westerlind, 1982, p.8).

The fishing industry and its profitability decreased after 1965 but the car ferry from Hisingen opened during the 1960s and the big industries on Hisingen needed labour so many began to commute to the mainland.

From the south side of Långholmen you have a view of Vinga Lighthouse and Fotö.

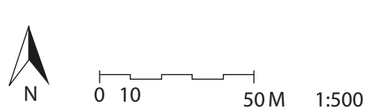


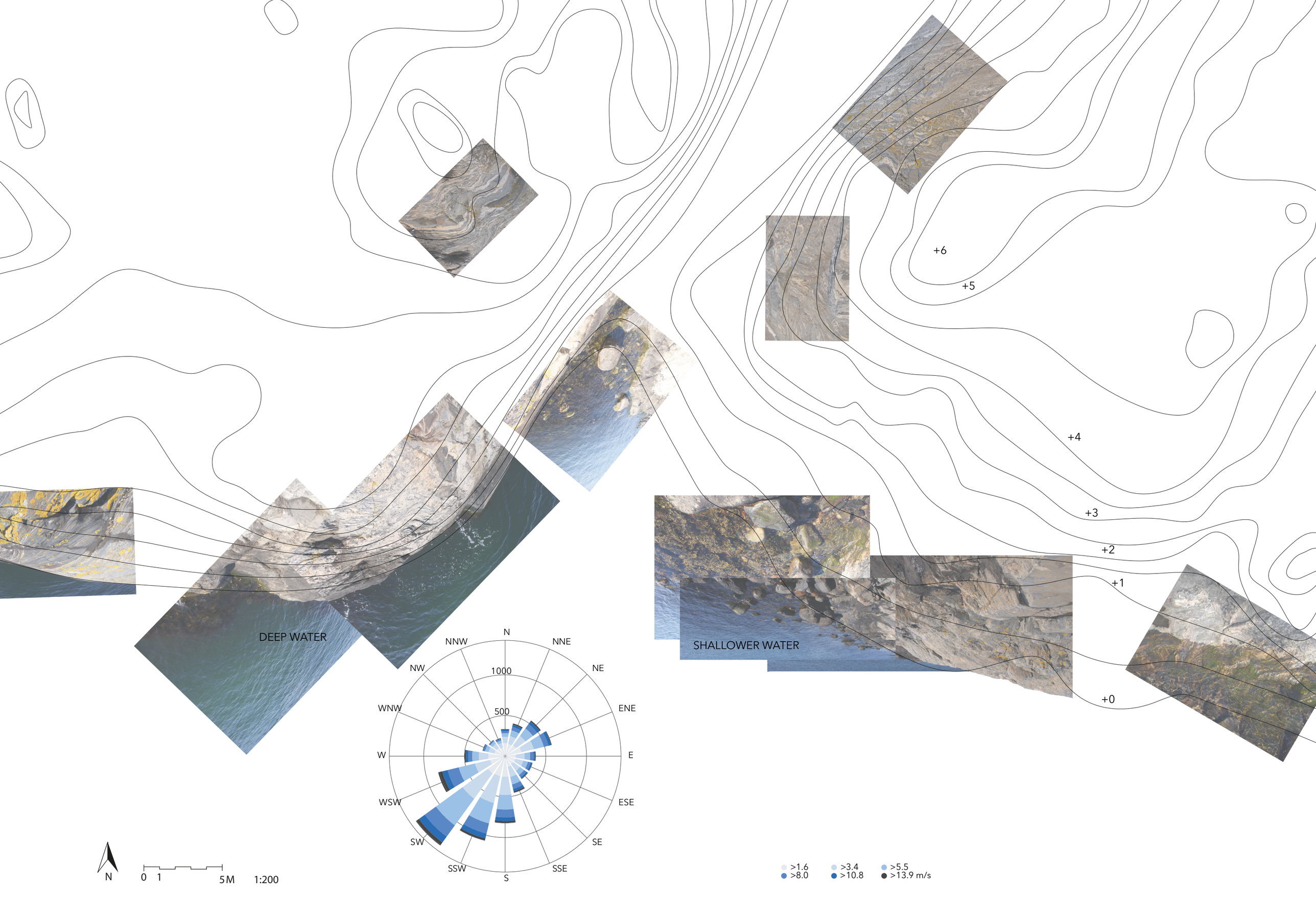
THE SITE

SWOT

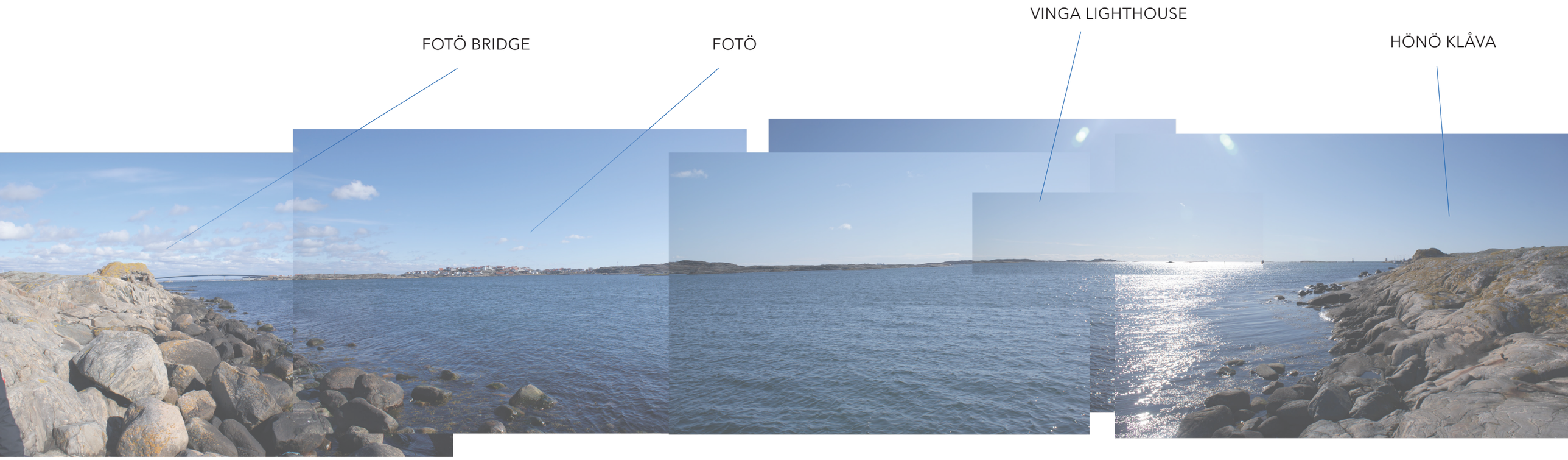
STRENGTHS	WEAKNESSES
Difficult to acces - protects the cultivations	Water a barrier
Undisturbed nature/scenery	Weather exposed site- wind and water
South facing site - sunny	No water and sewage on Långholmen
Close to local centre - Hönö Klåva	

OPPORTUNITIES	THREATS
Rising interest for local food production	Rising seawater, flooding
Alternative ways of buying food	Acces to boats and expensive equipment
Rising interest for outdoor experiences	Not direct connection to Gothenburg
Ecosystem services	
Business synergies on the islands	




+6
+5
+4
+3
+2
+1
+0
DEEP WATER
SHALLOWER WATER
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
1000
500
N
0 1
5M
1:200
>1.6
>3.4
>5.5
>8.0
>10.8
>13.9 m/s

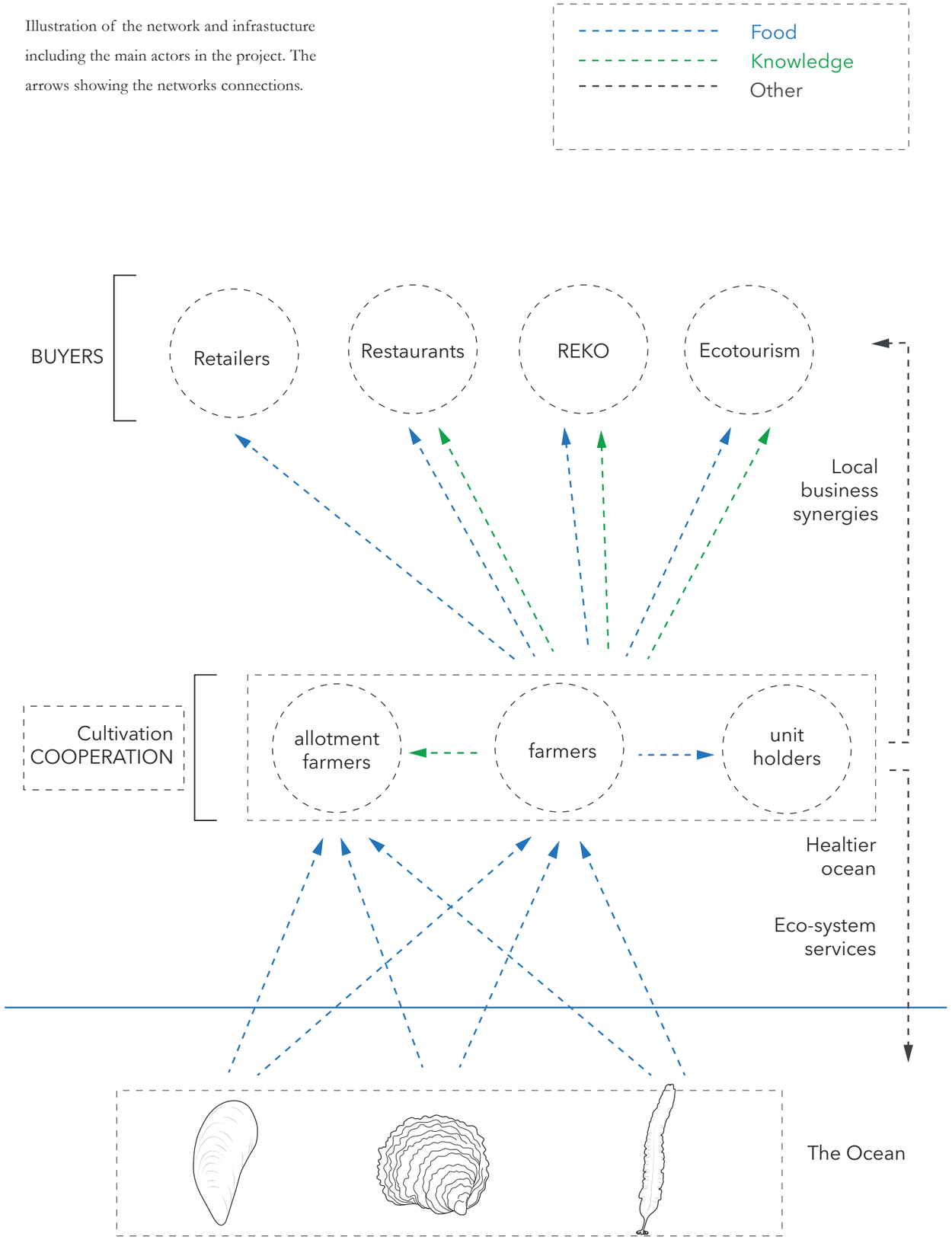
SITE VIEW



CONCEPT

CULTIVATION COOPERATIVE

Illustration of the network and infrastucture including the main actors in the project. The arrows showing the networks connections.



CULTIVATION COOPERATION

To be able to create sustainable marine cultivation with the equipment, investments and knowledge needed, three main actors cooperate.

The Farmers takes care of the administrative work inter alias permits and regulations. They manage, harvests and process the cultivation farms. They also organize workshops, sell to buyers, manage marketing, and help the allotment farmers with expertise.

The Allotment farmers rent a cultivation unit and monitors and harvest it themselves. Equipment is shared with the farmers.

The Unit holders invests and gets a unit harvest. They do not have to participate in work but invests in the cultivation cooperation. As a member of the cooperation, you can rent the sauna for recreation or the meeting room for smaller gatherings.

BUYERS

REKO is a way to buy locally produced food, completely without intermediaries. Consumers and producers join forces and start a REKO-ring where food and products are sold directly from producer to consumer. The REKO-ring creates a close connection between the consumer and producer and enables direct feedback and knowledge which is an important aspect. This can be locally in the Northern Archipelago or further away like Gothenburg.

Restaurants both local and in Gothenburg can buy directly from the Farmers. This also creates a direct knowledge channel. For many restaurants, it is important to know where and how the food they serve is produced and it creates a strong trademark for the restaurant.

Retailers like the Gothenburg fish auction or other wholesalers can also buy from the farmers, but this includes intermediaries, and the direct connection is lost.

VISITORS

Visitors, both tourists and locals can enjoy the cultivations via activities and workshops which can include safari and diving in the cultivations, food workshops or a recreational visit in the sauna with food from the cultivations and nice beverage. They can also check out the processing or go to the shop and buy fresh seafood.

Activities, Functions and related Users

Examples of activities and functions that takes place at the cultivation centre at Långholmen. More activities can be introduced and other groups can use it, it should be seen more as a illustration of what it can be used for.

CULTIVATION
Algaes, mussels and oysters
- farmers
- allotment farmers

PROCESSING
Cooking/preparing food delicacies and fresh seafood for selling
- farmers

EDUCATION
Learn about the cultivations, environmental aspects , food from the ocean and its health benefits
- farmers
- allotment farmers
- unit holders
- visitors

COOKING WORKSHOPS
Learn how to cook the seafood
- farmers
- allotment farmers
- unit holders
- visitors

SHOP
Buy fresh seafood or localy processed food products
- unit holders
- visitors

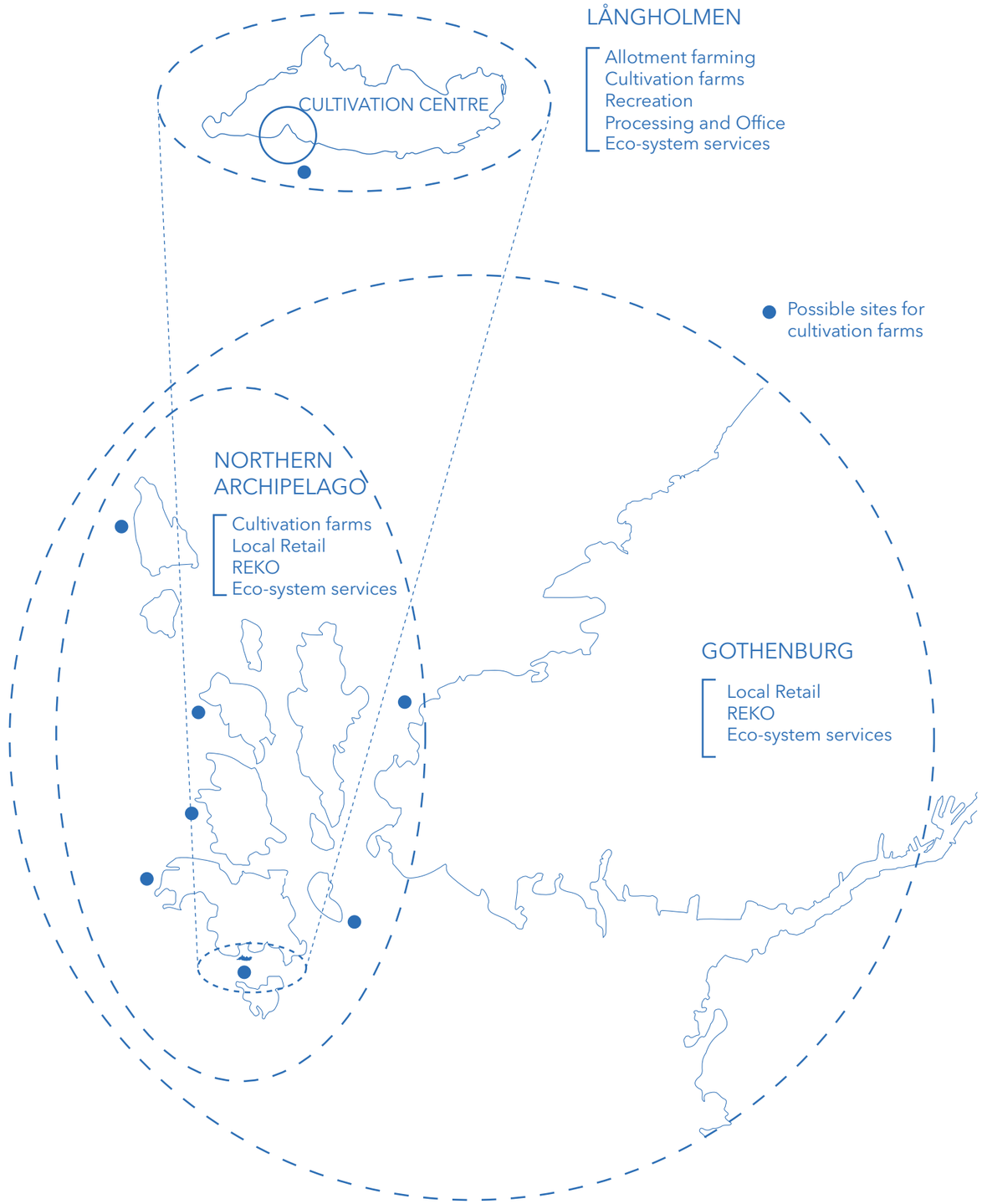
ECO-SYSTEM SERVICES
Outplanting of shells etc.
- farmers
- allotment farmers

RECREATION
Sauna and swim in the ocean
- farmers
- allotment farmers
- unit holders

EXPERIENCE VISIT
Dive and Sup in the cultivations, taste the food and enjoy the sauna
- visitors

Multiple Scale Project

The project can be seen as three different scales. Långholmen as a Cultivation centre with its small scale industry and allotments, The northern archipelago with cultivation farms and local selling, and Gothenburg with retail and eco-system services to improve the water quality in the harbor.



11 FISING HUTS

MEETING ROOM
Meeting table

Small kitchen
Education, Rentable space for locals, Allotment farmers

OFFICE
Small kitchen

Flexible desks

Toilets
Office for the Farmers, Coworking

PROCESSING
Processing kitchen

Changing room
Cooking, Packaging

SAUNA
Wood-fires sauna

Changing room

Outdoor shower
Can be used for drying Algae

STORAGE SUP
Stand Up Paddle (SUP)

Diving equipment

Life jackets, Overalls

STORAGE CULTIVATION
Buoys

Cultivation lines

Baskets

FRIDGE
Store mussles and oysters

Icemaker

DRYING HUT
For drying algae

Can be used as green house rest of the year

ALGAE NURSERY
Tanks with seawater

Artificial light

SHOP
Fresh and processed sea food

STORAGE PROCESSING
Kitchen storage

Goods

Waste

OUTDOOR ENVIRONMENT

ALLOTMENTS
Symbiosis cultivations

Movable to handle changes in water quality and eco-system impact

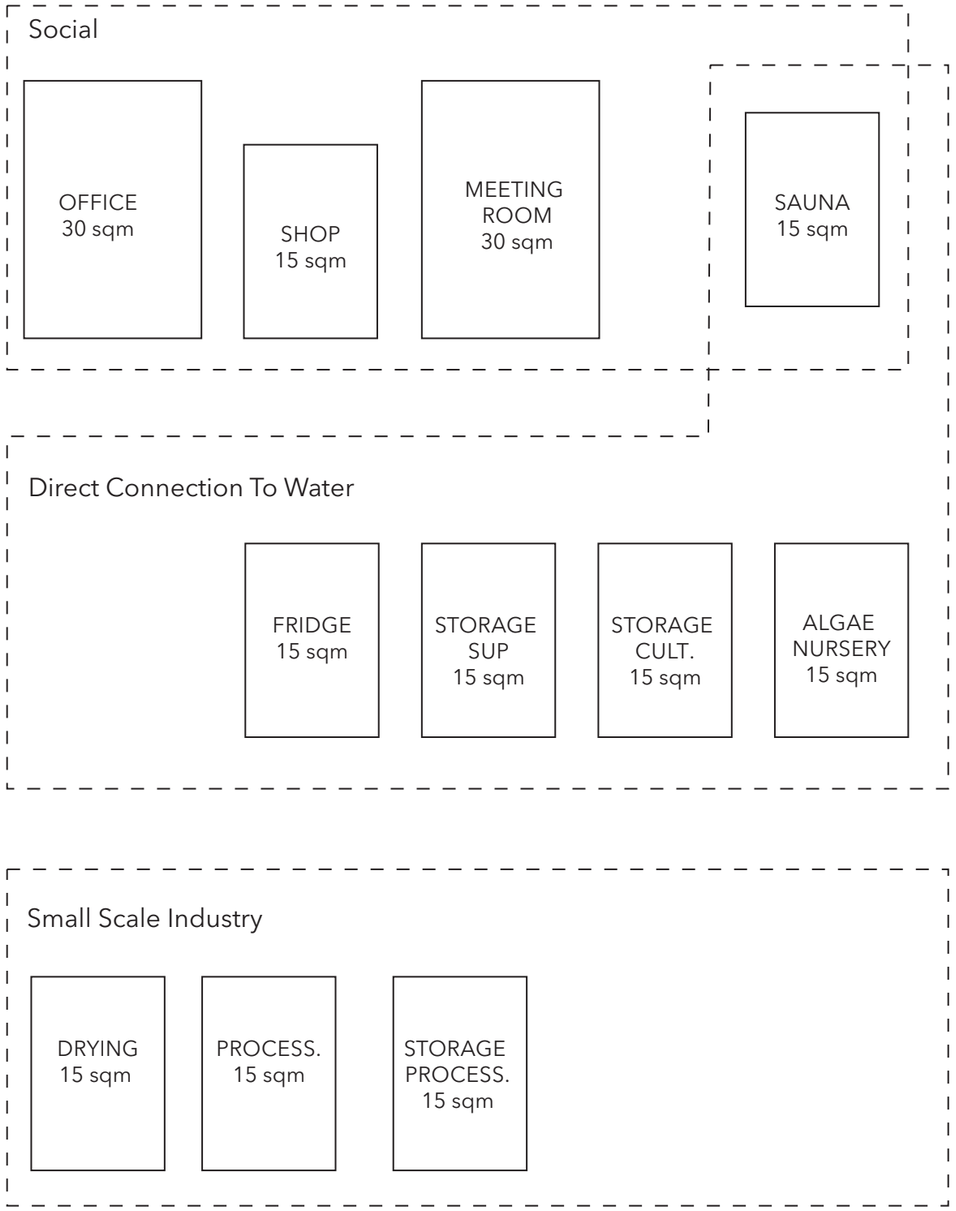
WHARFS
Wharf connecting the huts

Outdoor kitchen

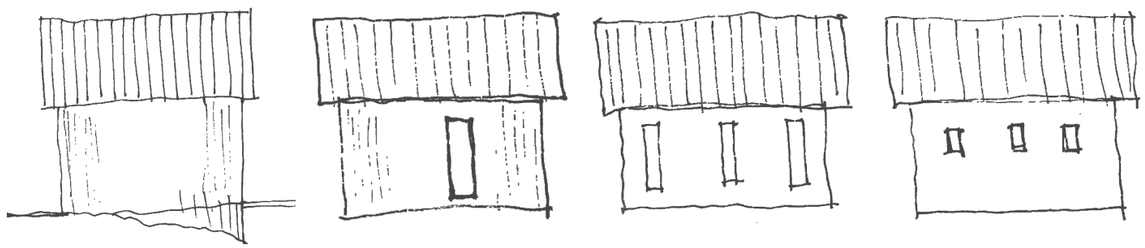
Activity and workshop space

Wharf that connects to the water

CLUSTER OF HUTS

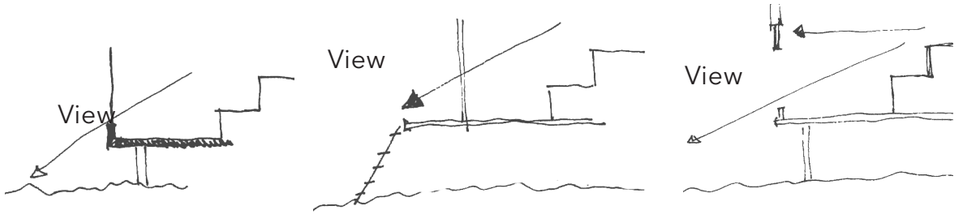


DESIGN

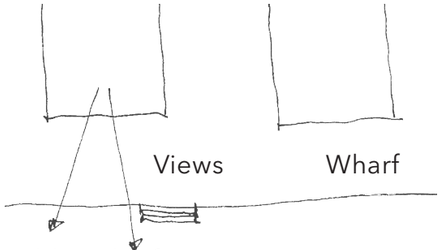


Facade sketches

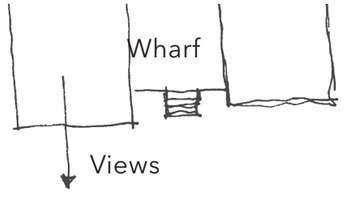
Small windows that frames the views.



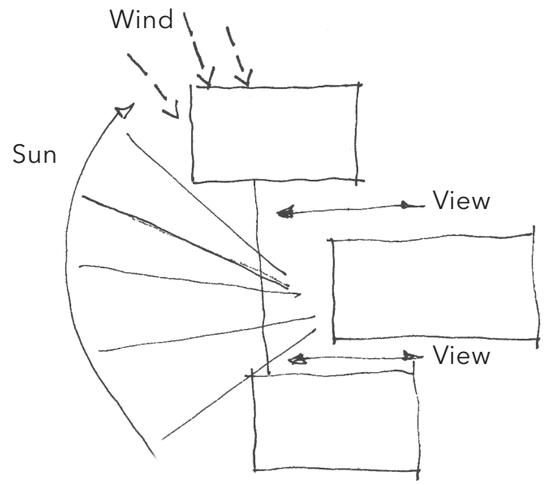
Connection to the ocean



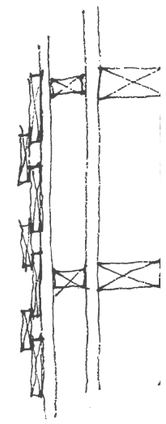
Public Wharf



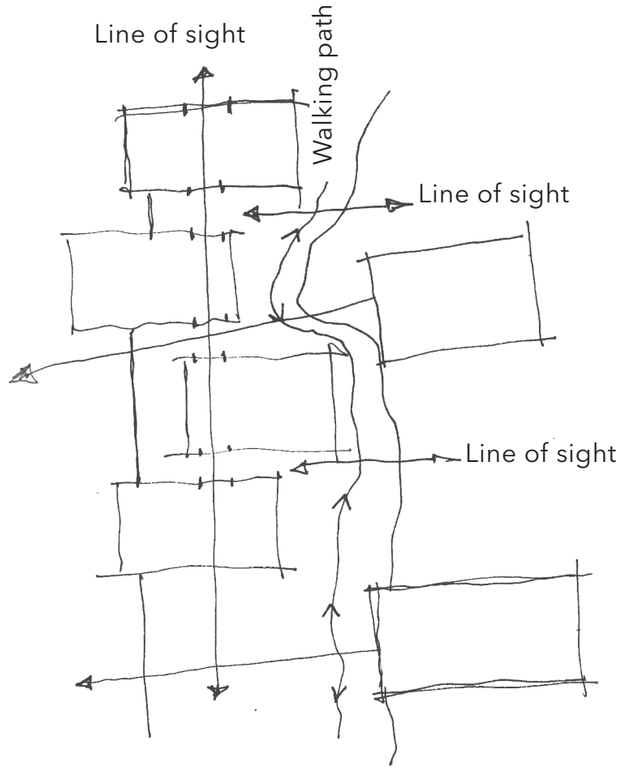
Huts extended over the wharf to create a private place



Wind protection and sun position



Wall detail: Dubble air gap



Dont see the "Fishing huts" as individual buildings but as rooms connected by the wharf.

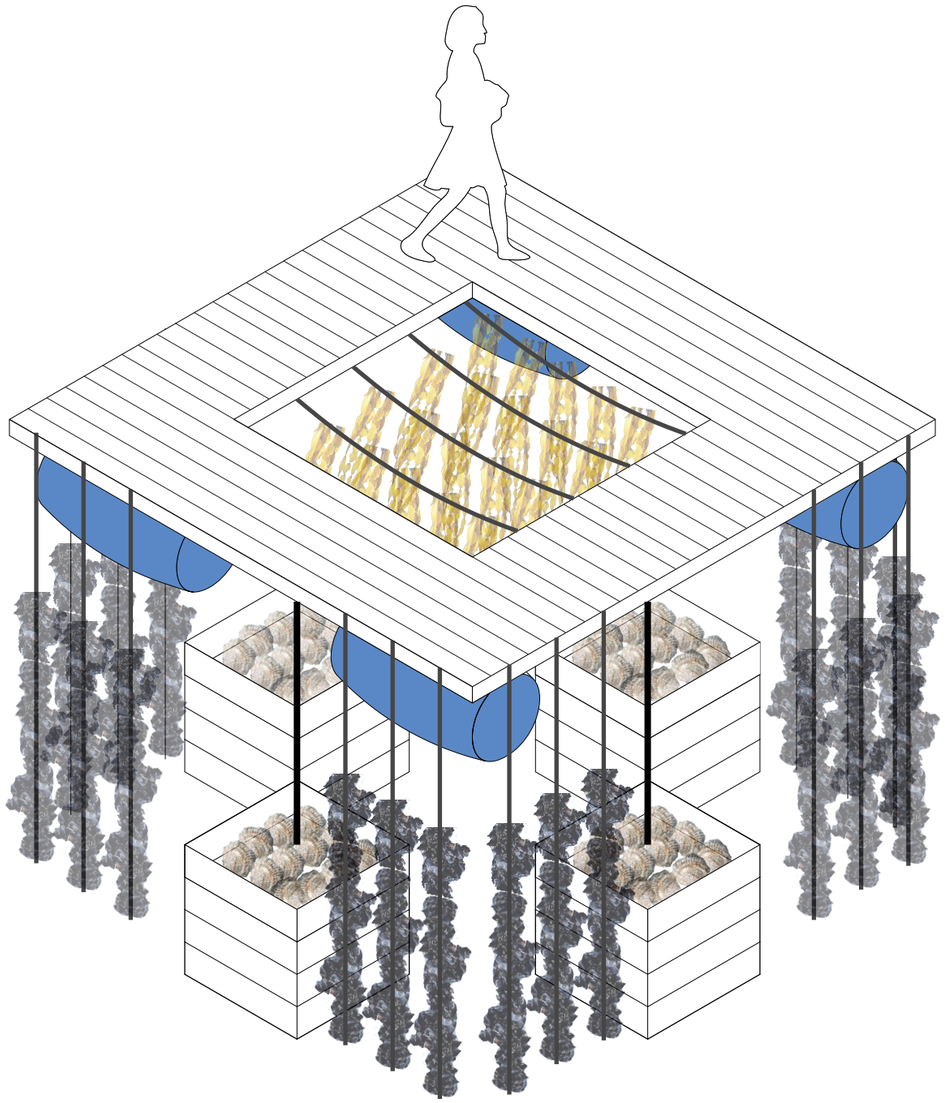
Allotments

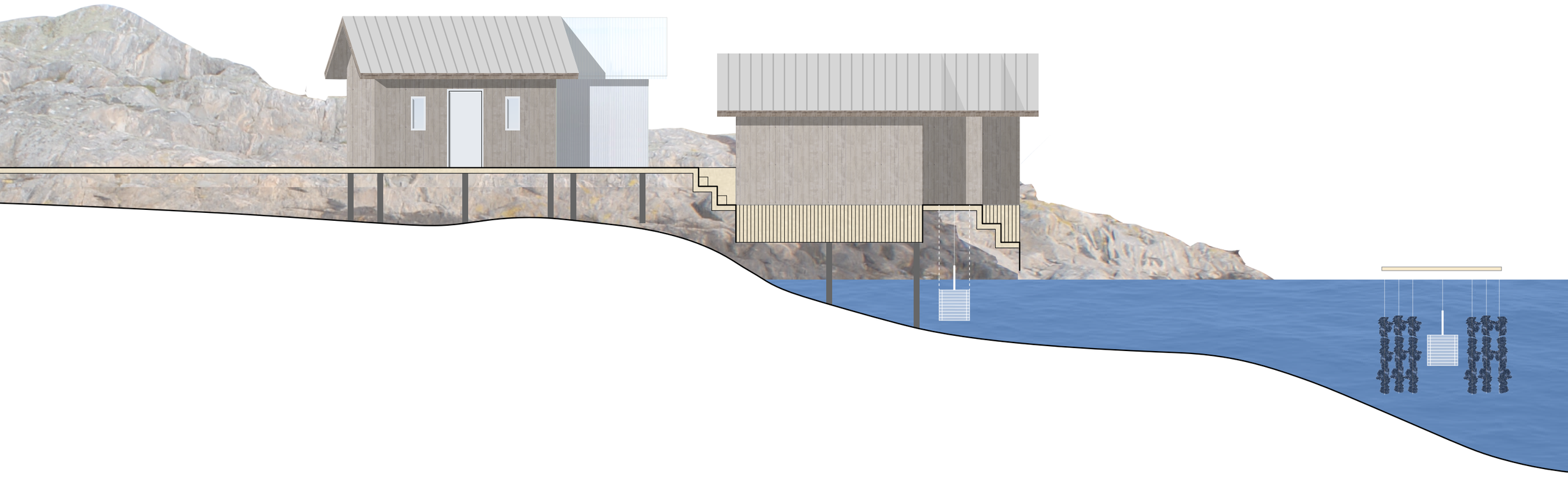
Cultivation Farms

N

0 10 50 M


WC
WC
Office
Outdoor Kitchen
Activities
Walking Path
Shop
+6
+5
+3
+3
Dry
+4
Meeting
Room
+2
Fridge
Process
+2
Storage
+3
+1
Storage
+2
+1
Storage
Nursery
Sauna
+2
+0
Allotments
N
0 1
5 M
1:200





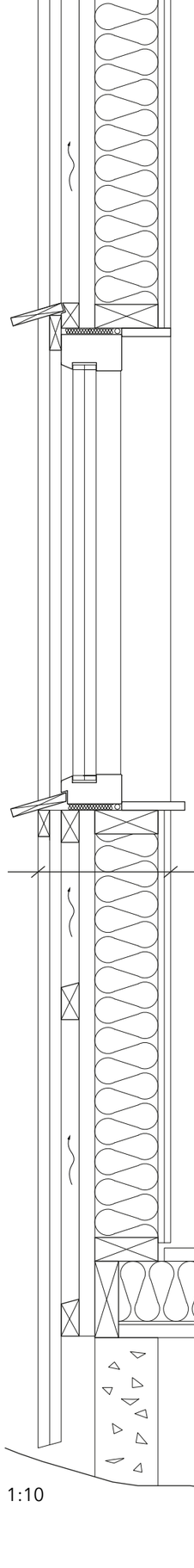
N

0 1 3M 1:100

1. Algae Nursery
2. Cultivation Storage
3. SUP Storage
4. Fride / Packing / Cleaning
5. Natural dock Fridge / Sorting / Cleaning
6. Process Storage
7. Process / Kitchen
8. Algae Drying
9. Shop
10. Outdoor kitchen
11. Outdoor Activities
12. Meeting Room

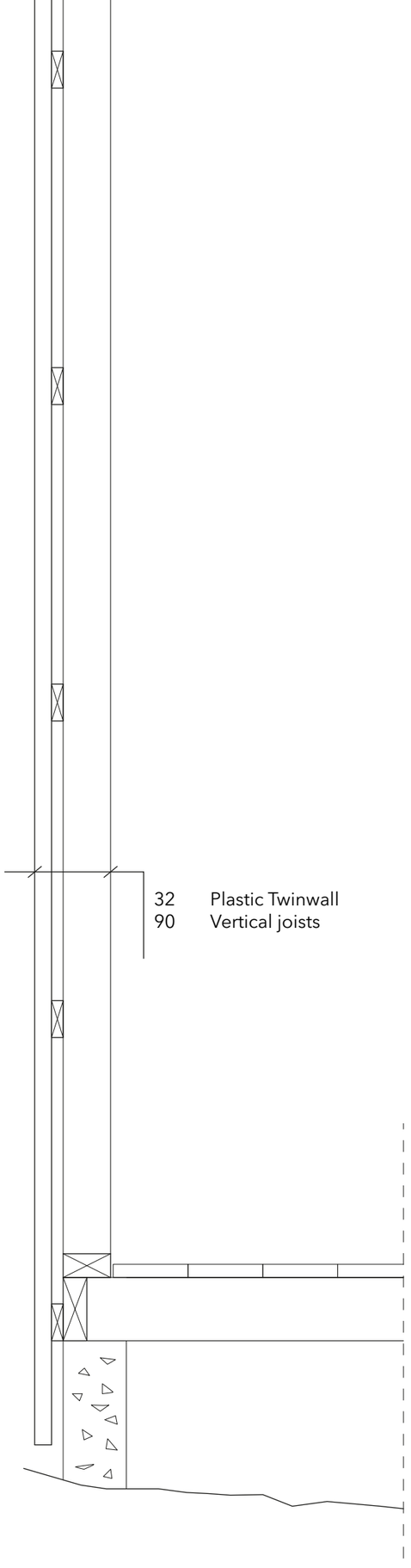
N

0 1 3M 1:100

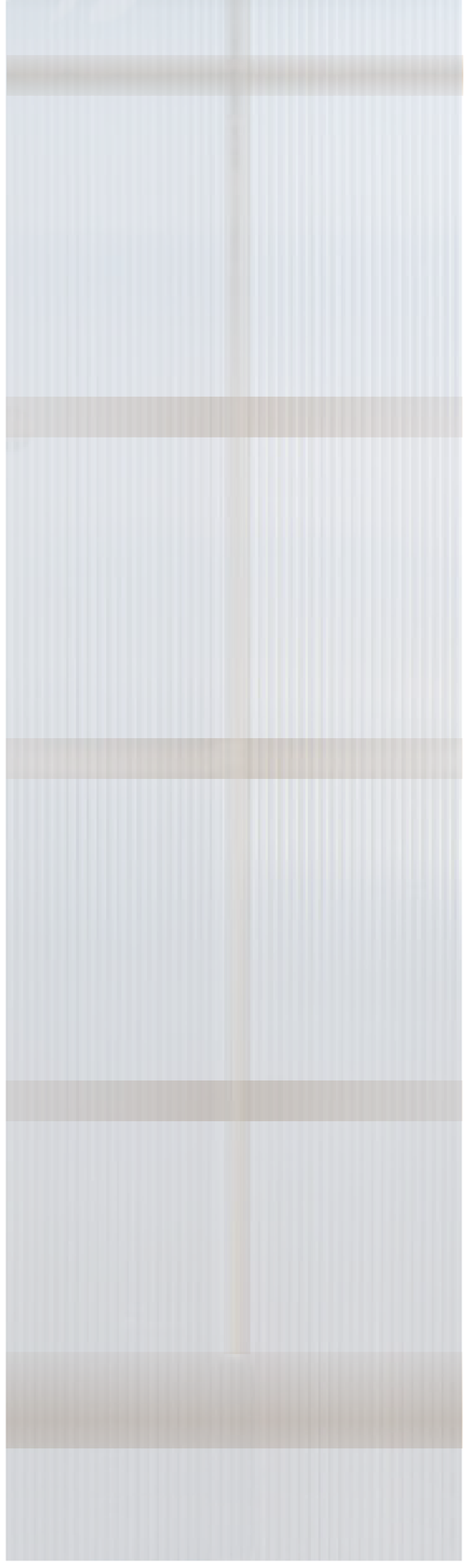


22x50 Board-on-board cladding
22x150 Si00:x, Zink treatment
34 Air gap
30 Rockwool board
120 Insulation between joists
Windprotection
12 OSB-board
Interior cladding

1:10



32 Plastic Twinwall
90 Vertical joists



0 1 5M

DISCUSSION AND CONCLUSION

DISCUSSION

The discussion of include fish farming in the ocean cultivations was addressed in the project. But the concept of regenerative design was very important and to restore the ecosystems in the oceans instead of harming the environment.

Initially, the project was focused on sustainable food production and how architecture can contribute directly to the climate problems with today's food production. But it turned into a more socially based project. Focused on the reconnection to food and how architecture can help enlighten today's food systems. It is a more active project trying to engage people instead of serving them with sustainable food, still without connection. This project encourages us to engage in food and food discussion.

REFLECTIONS

The way to change people's decisions about food is through knowledge and an honest relationship to food. One suggestion is to create easily accessed platforms from urban areas where this can grow.

How the food is produced has more importance than what food we eat. Food production needs to change and today with a few big actors that have a lot of power it is hard. The consumer has the responsibility and the opportunity to choose and affect but with little knowledge that is an impossible task to demand from anyone.

Marine allotments are a great platform to do this, but the infrastructure is not there yet. What is needed is initiative projects showing that it is feasible. The municipalities and other authorities should facilitate and supports the organizations. It needs to be easy and accessible to rent an allotment.

The allotment is also about connecting people, to create a platform where we can exchange knowledge and experience face to face. In today's society that is something, we need more than ever. It is important that it feels including. A life with a marine allotment is so much more than growing food. It can be a whole day activity with friends or family. Monitoring the allotment, harvesting, cook some food with a nice beverage and then end the day in the sauna and a bath in the ocean.

The cultivations generate a stress-free environment for recreation and with its close direct connection to nature. It can bring a positive feeling of producing your food.

I think we will in the future see large scale sea farms with algae, mussels, and oysters. Supplying us with protein-rich food and biomass for energy. But the small-scale project as allotment cultivation is needed to connect people with food. The small-scale farms are not the solution of all the food production problems, but it is a piece of the puzzle.

CONCLUSIONS

With a Cultivation Cooperative, including allotments and cultivation farms the equipment and buildings needed for cultivation and processing are shared. Small fishing huts with different building envelopes makes the farm flexible and adaptable with the opportunity of adding huts if needed. The allotments and cultivations farms are placed offshore on buoys, movable for site suitability.

The Cultivation Cooperative enables allocation of the administrative workload and dispersed knowledge.

The Cultivation Cooperative with many small-scaled allotments enables social interactions between people. Actors with different knowledge and background create a prosperous environment for sustainable food production. A sauna and meeting room is included for recreation, food workshops and social gatherings.

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FIGURE LIST