

# From Seabed to Plate

An exploration of the future landscape  
of seaweed as a food in the  
Norwegian market





Title

**From Seabed to Plate**

Candidates

**Cannelle Rambaud-Measson  
and Henrikke Roaldsnes Ulvund**

Field

**Systems Oriented Design**

Supervisor

**Abel Crawford**

Institute

**The Oslo School of Architecture and Design**

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## **Abstract**

The current food system is experiencing many threats and there is an urgent need to shift the system into a more sustainable direction. Seaweed offers many possibilities within food and has the potential to contribute to some of the most urgent global challenges. However, today its potential as food in Norway remains untapped.

The aim of this project is to better understand the challenges and opportunities that seaweed offers as human food in Norway. With a systemic approach, this paper explores a future vision for this sea vegetable to become a part of the Norwegian diet. By focusing on one of the challenges, which is the lack of information, this report provides a portfolio of interventions that the seaweed industry needs to address for seaweed to become a mundane ingredient within the Norwegian diet.

Data was obtained from qualitative research to access key insights from the seaweed industry and get a better overview of the system.

## Personal motivation

Our research interest started with Caroly Steels' book *Hungry City*, which we both read last summer. As she claims (2013, p.51): "Food is the most devalued commodity in the industrialised West, because we have lost touch with what it means. Living in cities, we have learned to behave as if we did not belong to the natural world as if we were somehow distinct from 'the environment'". This was the starting point of our thesis exploration.

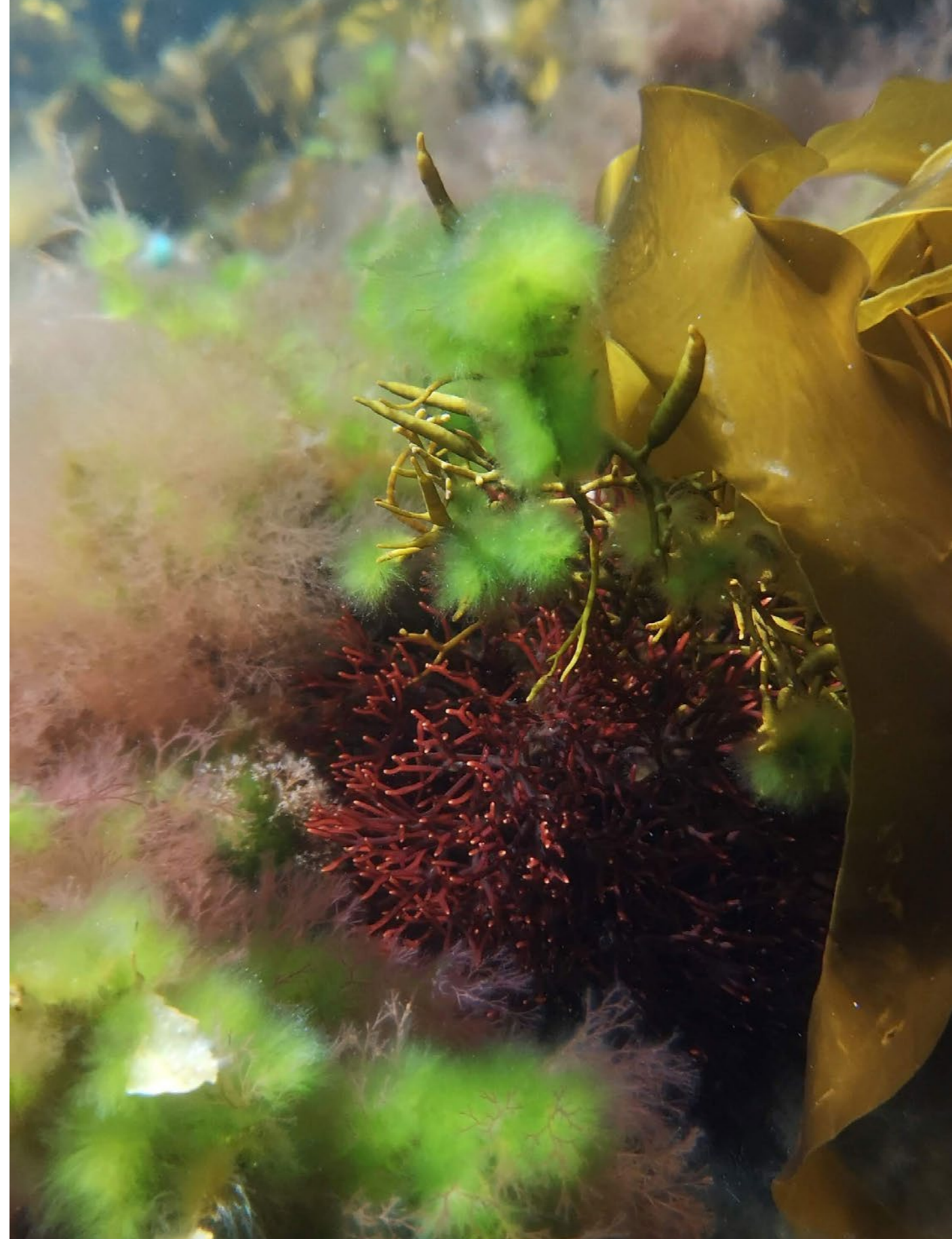
Our curiosity for seaweed originated from a podcast episode from the *Freakonomics Radio* addressing the potential of seaweed as food. As we read more about the possibilities of macroalgae, we decided to look further into the potential of this ocean dweller. Many scientists, food experts, producers and engineers are currently looking into the possibilities that seaweed provides as a safe food ingredient. We wanted to understand how we as designers can bring value to this growing industry.

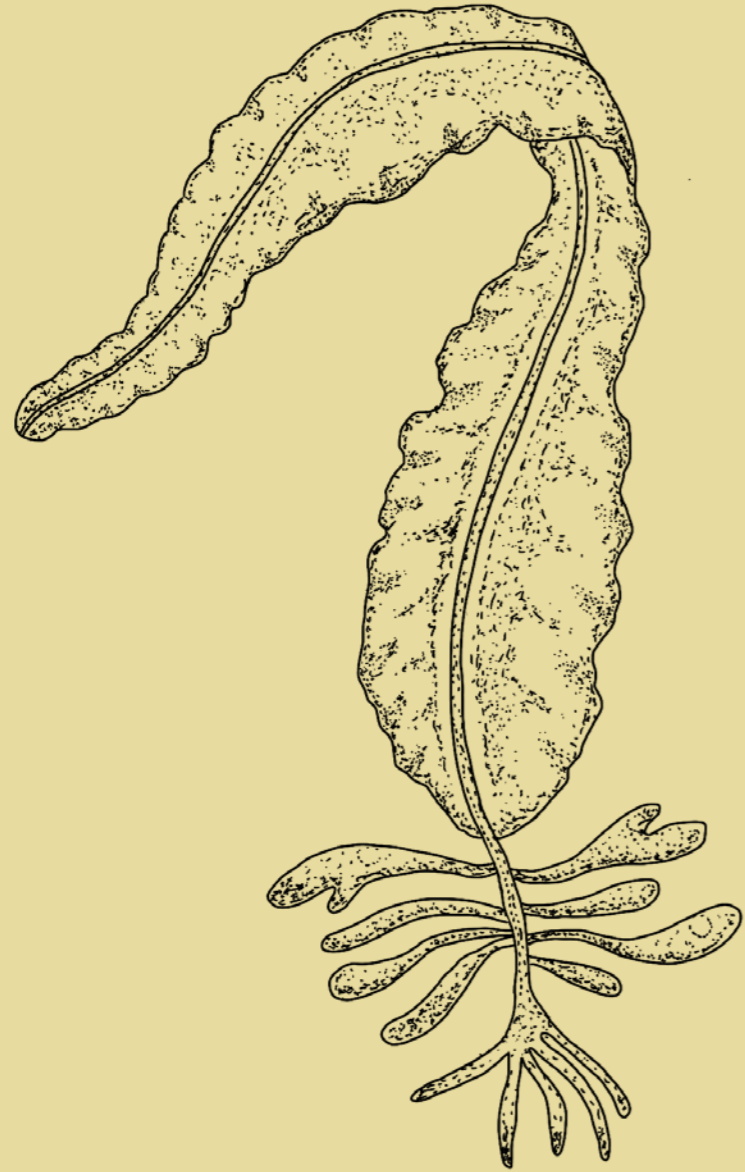
With a background in Service and Interaction Design, we wanted to merge Cannelle's passion

for sustainable food solutions with Henrikke's passion for food and the Norwegian culture. Growing up eating dried seaweed snacks in the break at school, Cannelle has been introduced to this food ingredient early in her childhood. From an unusual early age, she decided to remove meat products from her diet, although she was the only one within her family and surroundings. This raised her curiosity to discover new food alternatives and triggered her creativity in the kitchen.

From fishing and catching crabs to harvesting berries and mushrooms, Henrikke's childhood has had a close connection to nature. Over the years, this has developed an interest of outdoors activities as well as interest in learning about food and experimenting with new ingredients.

With our different backgrounds and our common passion for food, we started the project with motivation and excitement.





## Introduction

## Project overview

A complex problem cannot be tackled on its own. It is a multitude of underlying structures that needs to be addressed in their own manner.

From soil deterioration to climate change, food inequalities, water pollution, food shortage, there are many obstacles that needs to be addressed and tackled for feeding the growing global population.

Seaweed has a great ecological farming potential and offers various food applications. While this marine vegetable already plays a big part of the food in some cultures, it is now becoming more popular in Western countries (Krook, 2022).

Norway has a long and wild coastline with immense potential for a seaweed industry. Being the second biggest exporter of seafood, Norway

has also got existing experience and technology from the aquaculture industry.

In this project, we have decided to look into the potential of seaweed as a future food source in Norway. From Seabed to Plate investigates the present challenges that prevent the seaweed industry to penetrate the food market and addresses the future activities that needs to be accomplished for the industry to grow. By focusing on one of the leverage points, it addresses the current information gaps and suggests an assemblage of interventions that the seaweed industry needs to discuss for seaweed to become an ordinary ingredient.

”Seaweed is a well-known raw material in Asia and is now gaining a lot of interest in the western world!”

Johanna Krook, Orkla



## Context

This chapter gives a brief introduction of why seaweed could contribute to future challenges, its different uses and how the industry operates today.



## The Urge to Find a Sustainable and Healthy Food Solution

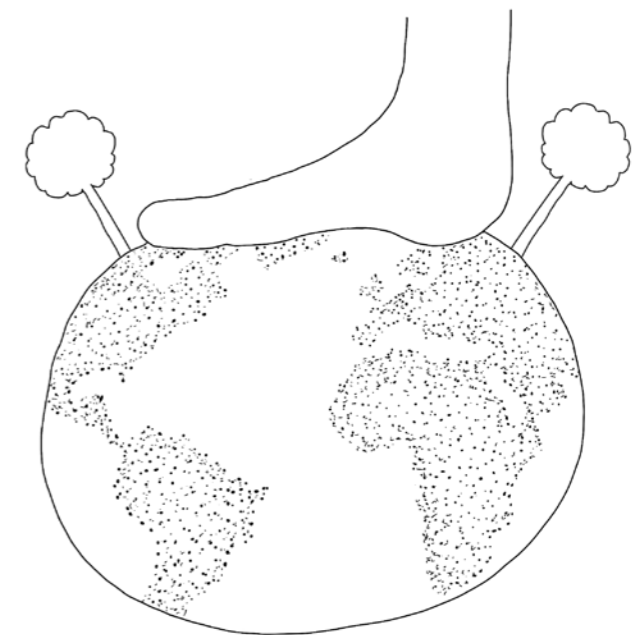
Today's global food system suffers from many problems. According to the United Nations (2019), the global population will keep increasing and is predicted to reach 9.7 billion in 2050. This could have some crucial impact on food shortage. The Food and Agriculture Organisation of the UN (2009) predicts that the global food production has to grow by 70% to reach the increasing demand.

However, this could have some alarming consequences on our environment. The current industrial agricultural practices put a lot of pressure on land and water resources. It also generates an enormous amount of pollution due to fertiliser, CO2 emissions and other chemicals. The food industry is one of the biggest threats to climate change. In fact, it is responsible for 1/4 of the current global greenhouse gas emissions

(Ritchie and Roser, 2016). As we are exceeding planetary boundaries, it becomes increasingly important to find more sustainable production solutions.

With the growing population comes other challenges, such as food inequalities. This includes hunger, food insecurity and malnutrition. The UN (2021) considers that today more than three billion individuals are unable to afford a healthy and nutritional diet. If the world population keeps increasing and the current structure of our food system does not adapt, it could have some tremendous consequences on the planet and on living beings.

Therefore, there is a pressing need to redesign our current food system and find more sustainable and healthy food solutions.



## Seaweed, a Contribution to the Future of Food?

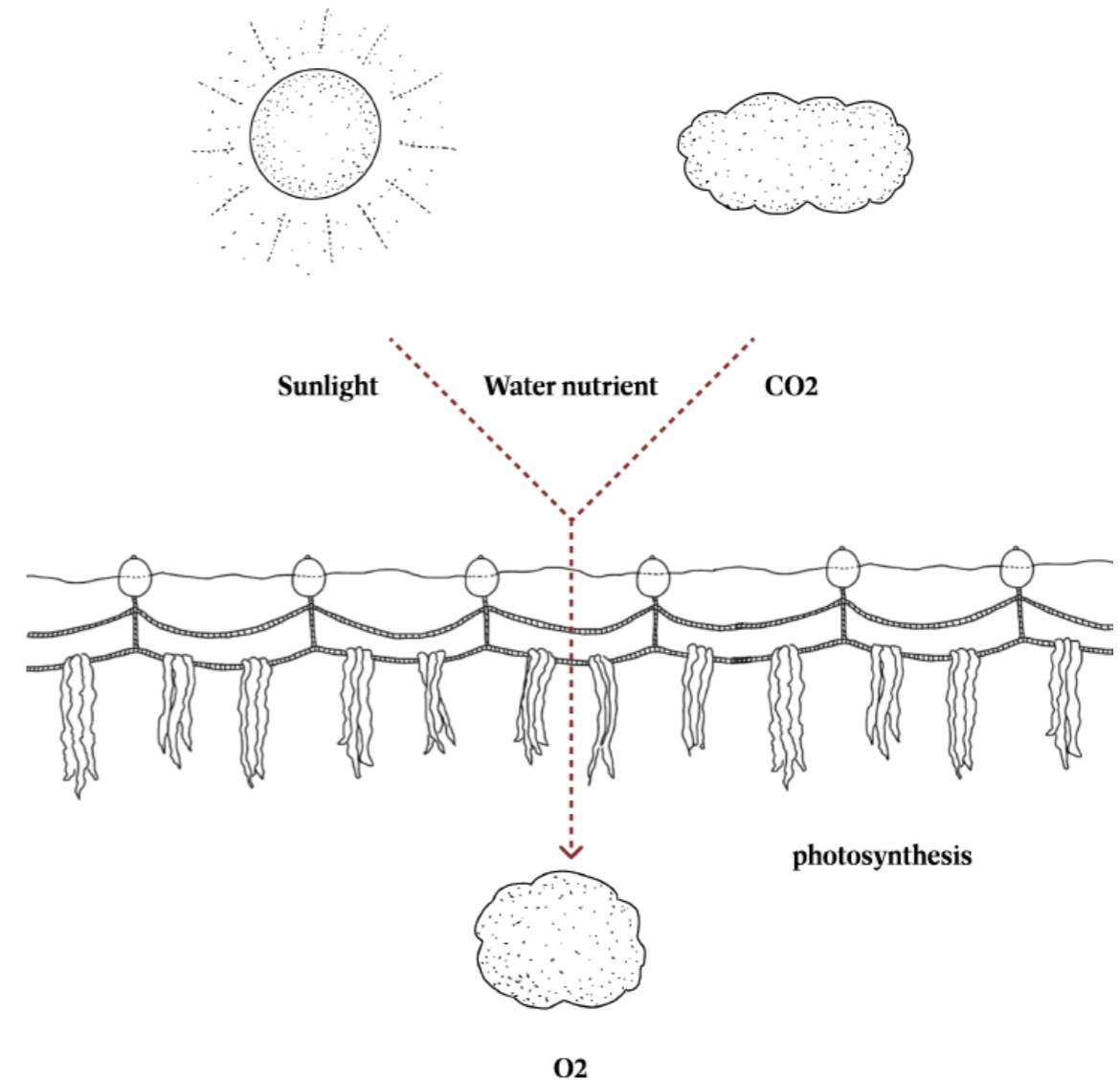
Oceans represent 70 percent of the world surface, however only 2% of this area is used for global food (FAO, 2022). While seaweed is an almost unexplored food source, there is big potential for this ocean organism to become a bigger part of our diets and contribute to the future of food.

In comparison to the production process of most food, cultivating seaweed does not require any fertiliser, freshwater, or feed. Seaweed has also been demonstrated to be an excellent climate change fighter, as it takes up most of the global CO<sub>2</sub>. In fact, it captures about five times more carbon than land-based plants (Ellen MacArthur foundation, no date). In other words, half of the global emissions are captured by macro- and microalgae (Giercksky and Doumeizel, p.6, 2020).

Seaweed being a great carbon sequester, it has also proven to help reduce sea acidification and improve sea deoxygenation Giercksky and Doumeizel, p.6, no date), as well as other advantages such as water purification and flood regulation. (Vibe, 2020, p.19)

Finally, it is also worth pointing out that their existence is key to development of biodiversity as they create new habitats and foods for fish and organisms.

Therefore, seaweed demonstrates some promising opportunities for a more sustainable food solution.

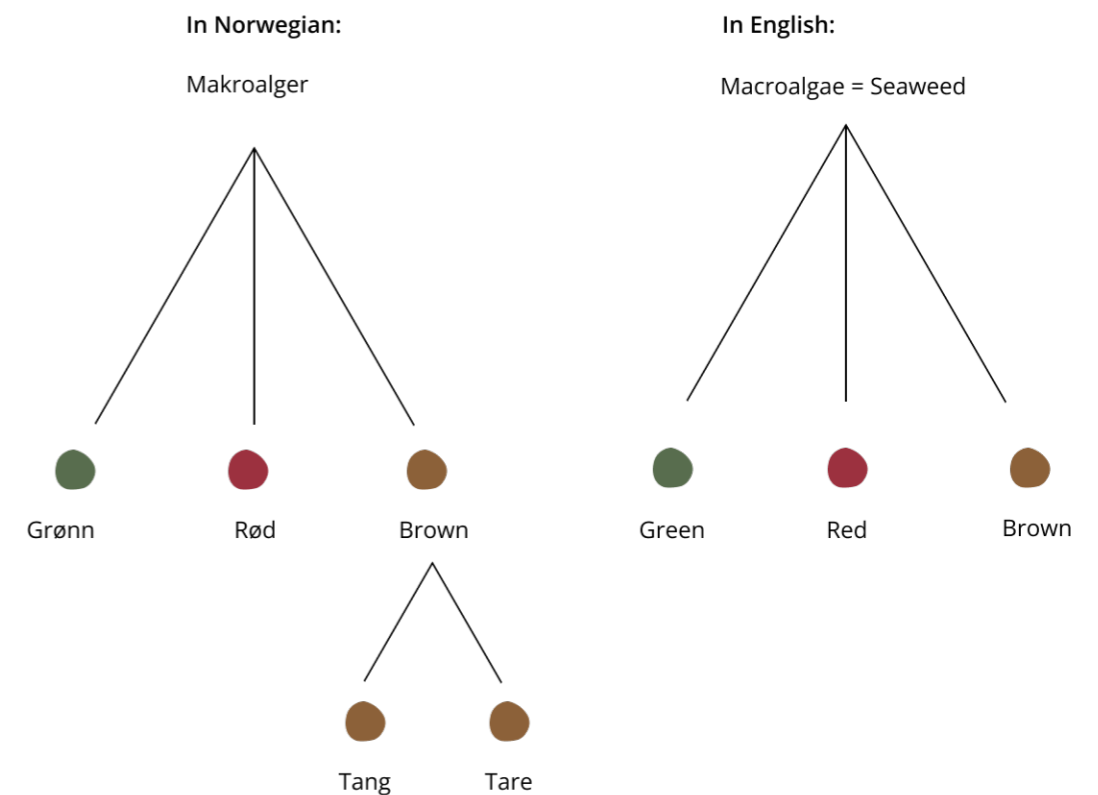


## The Taxonomy and Classification of Algae

There are two types of algae: the macroalgae and the microalgae. Microalgae are one cell organisms invisible to the naked eye, whereas macroalgae are multicellular marine plants that can be seen without microscope (Thronsen & Egeland, 2021). In this report, we will focus on macroalgae, also known as seaweed.

Today, around 10,000 seaweed species have been identified (Mouritsen, 2013, p.2). These can vary in size (from a few centimetres to a couple of meters), in shapes as well as in colours. They are classified based on their pigmentation red (Rhodophyta), green (Chlorophyta), and brown algae (Phaeophyceae). Each species has its own commercial name as well as a Latin name.

In Norwegian, we speak about 'tang og tare', which differentiates the seaweed that growth along the coast (tang) to the one that growth in deep water (tare). "Tang og tare" are also subcategories within the brown macroalgae. Translating it in English, 'seaweed' (tang) and 'kelp' (tare) can cause confusions as kelp is a type within the brown seaweed, and not the only species that growth in deep water.



## Seaweed Markets

In the last 20 years, seaweed production has more than tripled and has reached a market value of USD 14.11 billion in 2020 (Fortune Business Insights 2021; Cawthron, 2021). Every year, more than 30 million tons of seaweed is produced globally, with 99% of it coming from eight Asian countries (Cai, 2021; Radulovich et al, 2015). China is the biggest producer, harvesting an average of 17.53 million tons in 2017 (Kang, Yang and Zhang, 2021).

Today, seaweed is used in many ways. The main market segments are within food and beverage, agriculture, animal feed, pharmaceuticals, nutraceutical, and cosmetics (FAO, Cai and al, 2021).

In food and beverage, seaweed offers a versatility of uses: it is served raw or in food products, but also as a thickener, food stabiliser and emulsifier due to its hydrocolloid properties (Jagtap and Meena, 2022). The hydrocolloids include agar, alginate, and carrageenan, which can be found in many products, ranging from ice cream to yoghurt and chum gum.

Outside of the culinary applications, seaweed has also found valuable uses in agriculture. It has been used as an additive in feed for livestock, which has proven to reduce methane emissions by 80 percent (Baker, 2021). According to the coalition Seaweed for Europe (2020, p.19), the feed sector is considered to become the biggest market segment within seaweed in Europe in 2030. Another interesting use of this marine plant is in fertiliser, as it replaces traditional methods that present chemicals (Lomartire, Marques and Gonçalves, 2021, p.2).

Seaweed also offers a range of useful characteristics for the cosmetic industry. Due to its technical and nutritional qualities, it has been used in various body care products, such as body lotions, shampoo, and toothpaste (Lomartire, Marques and Gonçalves, 2021, p.1).

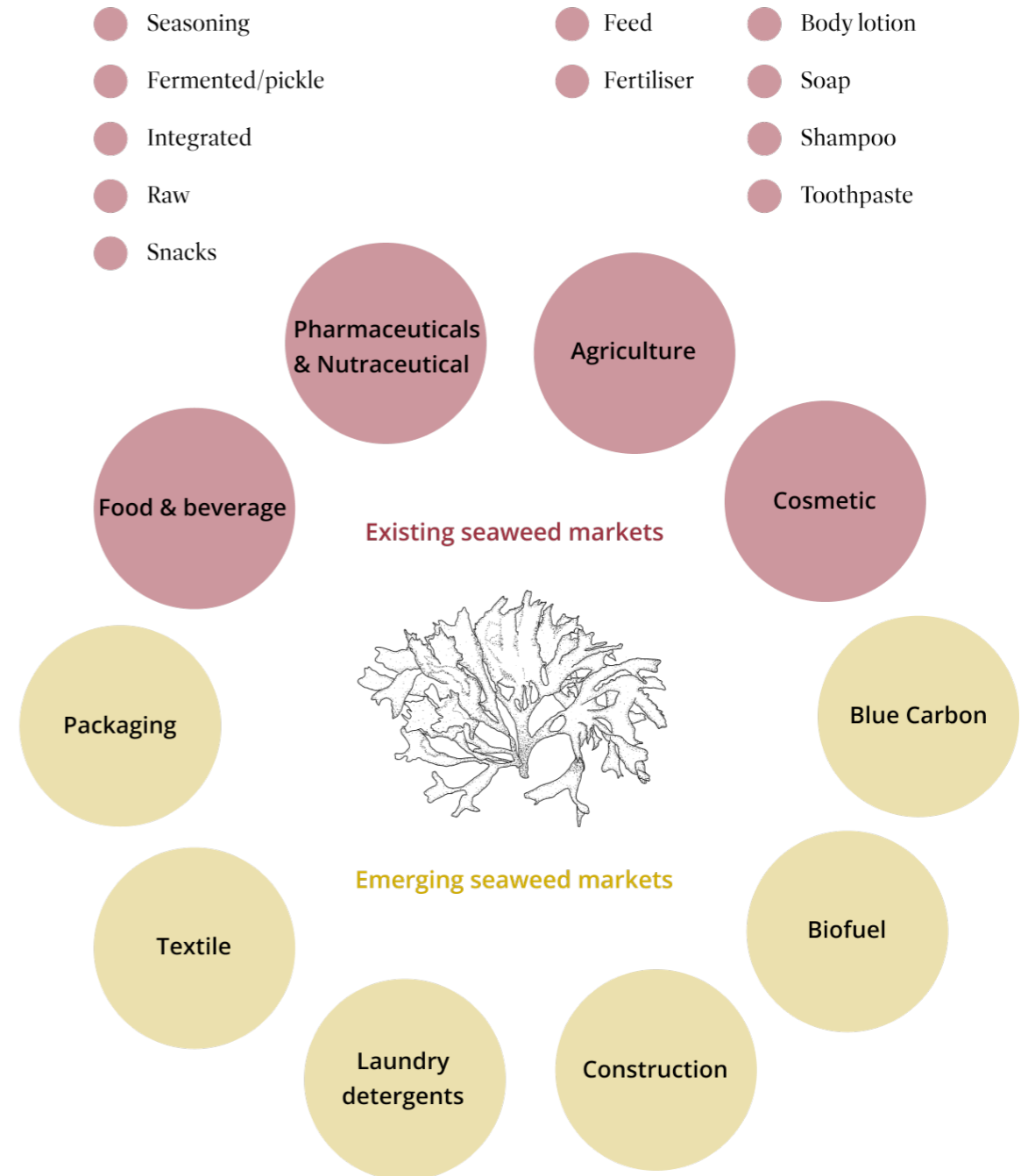
Within pharmaceuticals, seaweed is used to replace “synthetic compounds with natural ones” (Lomartire, Marques and Gonçalves, 2021, p.12). Seaweed has also demonstrated to provide important benefits as “antibacterial, antiviral, anti-inflammatory, anticoagulant, and antithrombotic” (Lomartire and al, 2021, p.2)

Furthermore, seaweed has manifested to be a suitable source for biofuel (Sintef, 2012). Researchers around the world are currently exploring ways to produce algae fuel to replace traditional fossil fuel.

Additionally, with the ongoing intention to restore ocean ecosystems and the need to sequester global emission, there is a growing interest in a Blue Carbon market (Eide, 2022).

Other fields that are looking into the potential of seaweed include the textile, laundry detergents and construction industries (Seaweed for Europe, 2020, p.12). There is also a growing ambition to replace plastic packaging with biodegradable seaweed materials (Seaweed for Europe, 2020, p.29). This has been explored by two previous students at AHO, Frøya Thue and Frida van der Drift Breivik (2019).

With all these markets available, seaweed has wide-ranging possibilities to offer.





## Approach and Methods

In this chapter we will give an overview of the methods we have used to collect our data, how we have analysed it and our approach to our ideation process.

## Approach

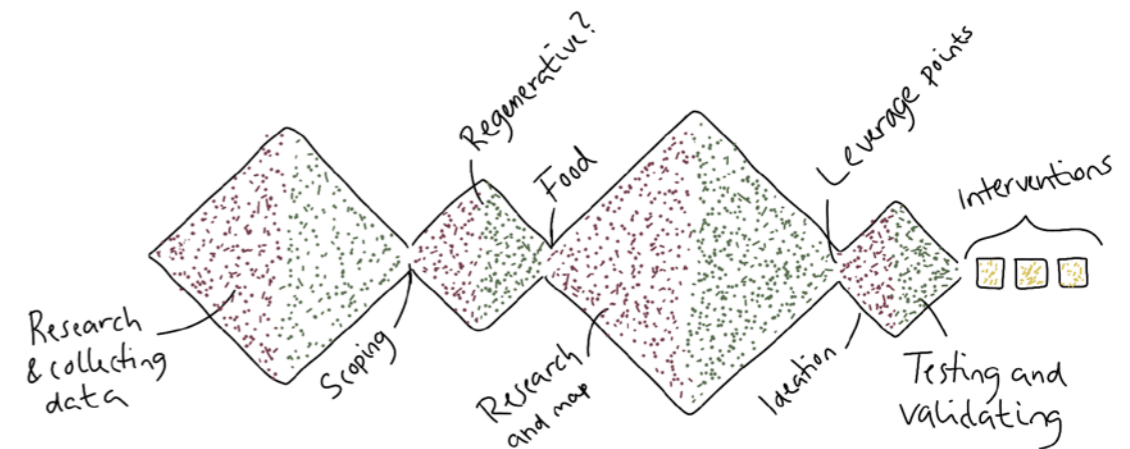
Diving into a new topic for our diploma, we wanted to keep an open mind and let the process shape our outcome and deliveries. To support our research on the seaweed industry, we chose to do a systems-oriented design project and merged our interaction and service design skills to develop prototypes.

Therefore we decided to look into another research topic, which was how to make the seaweed industry regenerative if it scales up.

## Navigating as Designers

Below is a summary of our process. In the first phase of the project, we focused on better understanding the seaweed industry. We first scoped it down to a collaboration with a seaweed producer, but found the angle to be a bit too marketing focused.

As we were worried that this theme might become too technical, we went back to seaweed as food, and tried to understand why it is not part of our diets today. Here we identified and connected the different challenges that the industry faces today, which helped us to zoom into one of them, the lack of information. From our ideation phase, we then tested and discussed our portfolio of intervention with different key stakeholders.



## Disciplines

### Systems Oriented Design

To capture and understand the complexity of the seaweed industry and its potential as food, we have chosen to do a systems-oriented design diploma. By applying systems thinking we wanted to understand the context, underlying symptoms, leverage points and their connections. As Donella Meadows states “The future can’t be predicted, but it can be envisioned and brought lovingly into being” (2009, p. 169 2009). Our goal is to explore the future landscape for seaweed as food and create a vision of what the future might bring.

### Methods

This section presents an overview of the main research methods we have used to collect our data. Our reflections on how we have used them, and the outcomes will be explained further in the Research and Findings chapter.

### Qualitative Research Approach

Our main goal for the research phase has been to learn about seaweed as food, the seaweed industry, its environmental benefits, its context, and consumers. We chose to do qualitative research to collect our data, as this allowed us to get a holistic understanding, discover synergies and go more in depth into different topics (Dalland, 2017).

### Collaboration

To get an angle to our project and help us scope down our area of exploration, we wanted to do a collaboration. This also helped us validate our findings. Ranging from a consultancy to the Norwegian Seaweed Association and a seaweed producer, we had several possibilities.

#### Tilt Lab

Tilt Lab is a consultancy that focuses on finding sustainable transitions for businesses by applying a systemic approach. As the timeline of

their project did not align with our diploma, we decided to decline the collaboration. However, having a lot of experience and expertise in this field, they helped us get a more extensive picture of the seaweed industry in Norway. We did a workshop to sense check our industry mapping and we got some valuable input.

#### Norwegian Seaweed Association

The Norwegian Seaweed Association (NSA) was a key stakeholder in our research process. This association is a membership organisation for farmers and producers of seaweed in Norway. Their main goal is to create a network where knowledge and practice are developed and shared between the actors in the industry. Today 29 companies within the industry have a membership and they represent seaweed farmers, producers, researchers and providers of technology and equipment. In addition to being an arena for networking the association is working with political topics, developing production standards, market research and sustainability.

## Case study

The objective of this case study was to get a more thorough understanding of the status quo of seaweed as food in Norway. We wanted to gain more insights into the seaweed production and learn about the barriers that producers face within the Norwegian market.

The case has offered us opportunities for digging more into the challenges that producers face when it comes to selling seaweed to Norwegian consumers.

### Why the Northern Company?

The Northern Company has been running their business since 2010 and are, therefore, one of the leading seaweed producers in Norway. They have gained a lot of experience and knowledge during these years. Reviewing their success and challenges, has helped us dive even more into the complexities of the seaweed industry.

Being one of few companies in Norway that combines a large production of seaweed with wild harvesting, their focus has been to provide quality food products from raw materials that are harvested in a sustainable way.

The seaweed products are made from Sugar kelp, Truffle seaweed, Dulce, Sea spaghetti and Winged kelp. The amount of seaweed varies from product to product where some consists of seaweed alone, like pickled sea spaghetti, and some are mixed products like fermented vegetables with Sugar kelp.

The Northern Company has two main production locations: one at The Green House in Oslo and one at the island Selvær in Træna. The harvesting and processing happen at Selvær, where they are renting an old fish reception to clean and process the seaweed. They use a boat to access the skerries where the seaweed grows and then cut it by hand.

Frozen, dried, fermented, and pickled seaweed is sent to the Green House for storing, packaging and distribution. The products are re-pack and labelled by hand before it is sent to restaurants, hotels, and niche stores. Some of the products are sold at the farmers market by the owner herself. The company also use The Green House to host tasting events and cooking classes. Being present at farmers markets and hosting food events is an important part of the business, with the goal of teaching people about seaweed as food.

Sustainability and minimal impact on the environment are the core value of the business. Harvesting by hand and cutting the seaweed in the right way makes it grow back faster and changing between locations ensure that the habitat for other species stays intact. At the fish reception, the cleaning of the seaweed is done by hand and without any chemicals.







## Data Collection Methods

### Interviews

An important part of our research has been interviews with domain experts from various parts of the seaweed industry. These have been conducted using a semi-structured technique with the support of interview guides. This technique allows a balance of predetermined questions, the interviewees thoughts and reflections and an opportunity to ask follow-up questions during the interview. (Preece et al., 2015)

Interviewing different stakeholders has given us valuable insight into the seaweed industry and the surrounding context. It has allowed us to ask in-depth questions and been a good arena for discussing our topic.

### Snowballing Effect

During the interviews, workshops, and informal meetings, we used the snowballing technique to contact stakeholders. We started by talking to scientists working with seaweed as food. They then introduced us to other stakeholders within the industry. Using the snowballing technique saved us time as we could rely on their network and knowledge about the seaweed industry. It also opened some doors as we got contact details directly to people working in companies and institutes - the most important ones being The Northern Company, The Norwegian Seaweed Association, The Norwegian Seafood Council and The Food Authorities.

### Field Trips

To gain practical experience and knowledge of how some of the actors in the industry operate we went on several field trips. These gave us both motivation and valuable insights about the context we were studying.

### Workshops

Workshops are a great arena to create, collect and sense information and ideas (Hvidsten et al., 2021). Throughout the project we have invited stakeholders to participate in workshops, where we have prepared an agenda and visuals tools to guide everyone through the process. The workshops have been conducted both physically and digitally.

### Observation

To learn about user behaviour and get a first-hand experience of their perception of seaweed as food we used observation as a technique. Food experiences are very personal. There is a lot that cannot be translated into words. Observations helped us widen our data collection.

### Desk research

Desk research has been an important part for mapping out the seaweed industry and understanding its leverage points. Reading research reports, news articles and books about the topic has laid the foundation of our project and design proposals.

## Analysis Methods

### Synthesis and analysis

When trying to make sense of all our collected data, we broke it down to smaller parts, which helped us to define and understand the different elements of the system. This led us to uncover overall patterns which laid the base of our concepts and ideas.

### Affinity Diagram

To analyse and get an overview of important quotes and findings from the interviews we created an affinity diagram, where it was sorted under various categories. These were later added to our mappings.

### Giga Mapping

Mapping has been an important part of our process during the whole project. In order to make sense of all our collected data and understand the complex systems of the seaweed industry we used the method of giga mapping. We gathered information from different sources, clustered them, found connections and discovered the function of each of the elements. This method helped us to set the boundaries of the system we were researching and develop a common understanding of the system. It has also been a tool for synthesising and analysing all our collected data.

### Iceberg Model

When trying to understand why seaweed is not a part of the Norwegian diet, we used the Iceberg Model. This helped us learn more about the patterns of behaviour, the supporting structures, and mental models, and how they are connected.

### Future Signals

We cannot predict the future, but we can look for signals that help us envision what it can look like. By using a set of parameters, we have mapped out signals of the future and imagined an undesirable and desirable future. We have searched for signals concerning not only seaweed as food but also other factors that might influence our food habits and shifts in the food culture (Colab, n.d.).

### ZIP-Analysis

When gigamapping large systems, it can be hard to keep track of all the information and to know when to stop mapping. To create an overview of problems and ideas, and to decide where we needed more information, we did a zip-analysis. This helped us to concretise and prioritise areas to explore further.

## Ideation Methods

### Six Thinking Hats

To ensure a wide spectre of ideas when brainstorming we used the Six Thinking Hats, a method developed by Edvard de Bono (2000). Using different colors of (imaginary) hats, we were able to step out of our mind frame, use one lens at a time, and come up with a variety of ideas.

### How Might We..

To help us brainstorm ideas we reframed problems and findings into questions starting with “How might we”. Using these questions, we kept our focus on the problem we wanted to solve and a positive feeling of solving something together (Berger, 2012).

### Prototyping

To test ideas and concepts we have made several prototypes, both high and low fidelity. The prototypes have been tools for creating discussions, evaluating aspects of our design solutions, and helped us refine them.

### Testing

To gather insights and validate our concepts, we have conducted several tests using physical and digital prototypes, scenarios, and presentations.

## Reliability and Validity

Reliability refers to the quality of the research in which the study presents trustworthy results (Dalland p.55, 2017). To increase the reliability of our research we have studied the seaweed industry on several levels: the public authorities, the industry, and the consumers. This has given us the opportunity to cross-check and validate information and findings.

The use of Triangulation has also been a key part of our research. Starting with the data triangulation, we collected data from diverse sources, and from various times, places, and people. Another important part of our data collection was by including researchers from diverse backgrounds and expertise (investigator triangulation). To enhance the validity of our findings, we also made sure to apply a variety of methodologies (methodological triangulation) (Wilson, 2014).

In addition, we have tried to keep an open mind and study the chosen topic from several perspectives.

## Ethical Considerations

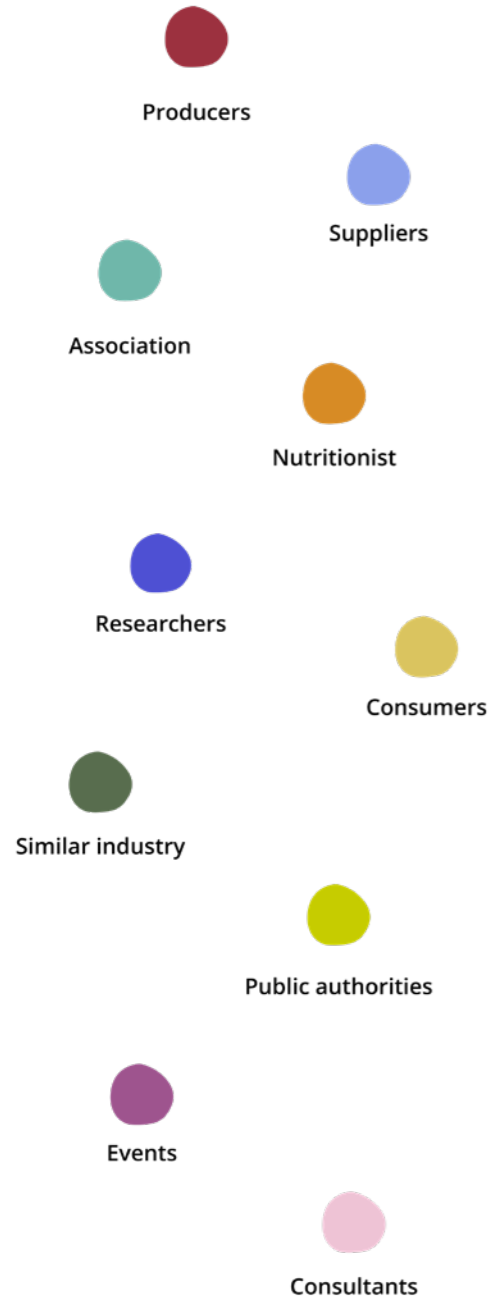
When gathering data for our research we have taken some ethical considerations. As researchers we find it important to explain what they are participating in and to respect their privacy.

Before collecting data through interviews, observations, and workshops, we sent the participants detailed consent forms about their involvement in this project. In this form, we described the scope of the project, where and how the data is stored, and their right to withdraw from it. This one also gave the participant the choice to stay anonymous.


The consent form helped us to build trust with the interviewees and create a safe environment for sharing knowledge and thoughts.

# Stakeholder List


Here is an overview of the stakeholder we have interviewed.



**Quality Manager**  
 Founded in 2019, Seaweed Solutions AS is the leading seaweed farm in Norway. Their focus is on large scale farming methods.



**Founder**  
 Founded in 2016, Tango Seaweed is a seaweed farm that provides frozen and dried seaweed products for human consumption.




**Founder and team**  
 The Northern Company is one of the leading seaweed producer in Norway. They offer a variety of handpicked seaweed products.




**Founder**  
 PurSea is a seaweed farm along the Helgeland coast that growth macroalgae for human food purposes.



**Founder**  
 Based in Hammerfest, Polar Algae is the most north located seaweed producer in Norway. Their main focus is on feed for livestock.



**Business PhD / Industrial PhD student**  
 The Orkla Group is a branded consumer goods supplier that is available in the Nordic countries, the Baltics and selected markets in Central Europe and India. They are currently developing new food products with seaweed, from raw materials from producer Arctic Seaweed AS.




**Product Manager**  
 Leroy Seafood Group ASA is world-leading seafood company. Leroy Seafood Group ASA and the Bellona Environmental Foundation joined forces to create Ocean Forest, an initiative to establish new forms of aquacultural food production.




**Director for market insight**  
 The Norwegian Seafood Council is a public company owned by the Ministry of Trade, Industry and Fisheries. Their objective is to create value for the Norwegian seafood resources.




**Scientist**  
 The Institute of Marine Research (IMR), Havforskningsinstituttet (HI) in Norwegian, is a research institut own by the Norwegian government. They provide research, advisory work and monitoring.




**Senior Adviser**  
 The Norwegian Food Safety Authority, is the state's administration for food and water safety. They conduct risk assessments and provide guidelines to the Ministry of Agriculture and Food, the Ministry of Trade and Industry and the Ministry of Health and Care Services.



**Senior Adviser**  
 The Norwegian Seaweed Association (NSA) is an association that supports seaweed producers within food, feed, ecosystem services and other value chains in Norway.




**Advisor**  
 The Bellona Environmental Foundation is an international independent, non-profit foundation that develops solutions for environmental problems. They have a wide range of industry expertises, with the aquaculture being one of them.




**Marine biotechnologist and food scientist**  
 Moreforskning is a research organisation that focuses on community planning, welfare, logistics, business and transport economics as well as research and development for the marine and maritime industries.



**Senior Scientist**  
 The Netherlands Organisation for Applied Scientific Research, is an independent research institute that focuses on applied science. They developed the first facility to focus specifically on the processing of seaweed into biobased fuels and raw materials on a pilot scale.



**Alumni**  
 We spoke to a graduate from the University of Oslo that wrote her master thesis on seaweed in Norway.




**Consumers**  
 Our target group is the Norwegian consumer. From interviews to tests, we have spoken to 20 people.


**Professor at the Department of Animal and Aquaculture Sciences**  
 The Norwegian University of Life Sciences (NMBU) have a number of projects regarding seaweed and new food solutions.




**Nutritionist & former seaweed producer**  
 Tove Cecilie is a nutritionist that ran her own seaweed company 'Froya Tare' from 2014 until 2019.




**Founders**  
 Tilt Lab is a systemic consultancy that focuses on helping businesses transition to more sustainable outcome.




**Program Assistant**  
 GreenWave is a nonprofit organisation that provides training, tools, and support to ocean farmers.




**Founders**  
 Frævleik is an incubator for products, services and projects, with a focus on food businesses.



**Seaweed enthusiasts**  
 Ran by two seaweed enthusiasts, Ting med Tang provides harvesting and cooking courses for chefs, producers, or to anyone wanting to learn more about the characteristics of seaweed as food.



**Founder**  
 Invertapro is a Norwegian insect rearing and breeding company, focusing mainly on feed but also a bit on human food.





## Research and Findings

This chapter describes the past, present, and future of seaweed as food in Norway. It presents our main findings and research and how we translated them into future scenarios.

## Past

To better understand the present situation, we need to look back to the past: Has Norway got historical records of seaweed as food and what role did it play back then?

### History of Seaweed in Norway

Norway has a long tradition of using seaweed as fertiliser and in feed for livestock. In fact, some seaweed names originate from this use, such as “Grisetang” (pig seaweed) and “Sauetang” (sheep seaweed) (Rueness, 2021). Seaweed is still used in agriculture today and, as a result, milk products are an important source of iodine.

While today seaweed is not a typical ingredient of the Norwegian diet, there is historical evidence of its application by the Viking communities (Stévant, Rebours and Chapman, p. 1378, 2017). In the 800s, seaweed was a part of the trade market, equal to meat and vegetables. The main type of seaweed consumed was dulce,

a red seaweed, which was an important part of the Vikings’ diets (Mouritsen, 2013). Eaten fresh, dried, and as seasoning, it was used to replace other types of vegetables (Dansk Skaldyrcenter, n.d.).

During our research, we also learned that seaweed served Norwegian coastal communities during famine times. As a seaweed producer said: “When I talk to older people along the coast, they tell me that they have a strong connection to seaweed. They are thankful for the seaweed because it has helped them in difficult times”.

Finally, we also find some historical manifestations of dulce being used for its healing features and for helping coastal communities against scurvy illnesses (Mouritsen, 2013).

”When I talk to older people along the coast, they tell me that they have a strong connection to seaweed. They are thankful for the seaweed because it has helped them in difficult times”

Caroline Greiner Haukeland,  
Seaweed Producer



## Present

To create and move towards a common goal, we need to understand the current situation. In this section, we have focused on contextualising the present status of the seaweed industry in Norway. By mapping out the main challenges and opportunities that the industry faces today, this section aims at drawing a common understanding of the current situation. This helped define the future scenarios, described in the next section.

### Why Norway?

With its long and wild coastline, and its cold-water conditions defined by fjordic scenes, Norway presents the ideal landscape to develop a seaweed aquaculture (Stévant, Rebours and Chapman, 2017, p. 1375). Norway is the second biggest exporter of seafood, and has, therefore, already a strong marine infrastructure. By using knowledge from the fishing industry, Norway has a great advantage when developing a large-scale farming of seaweed (Stévant, Rebours and Chapman, 2017, p. 1378).

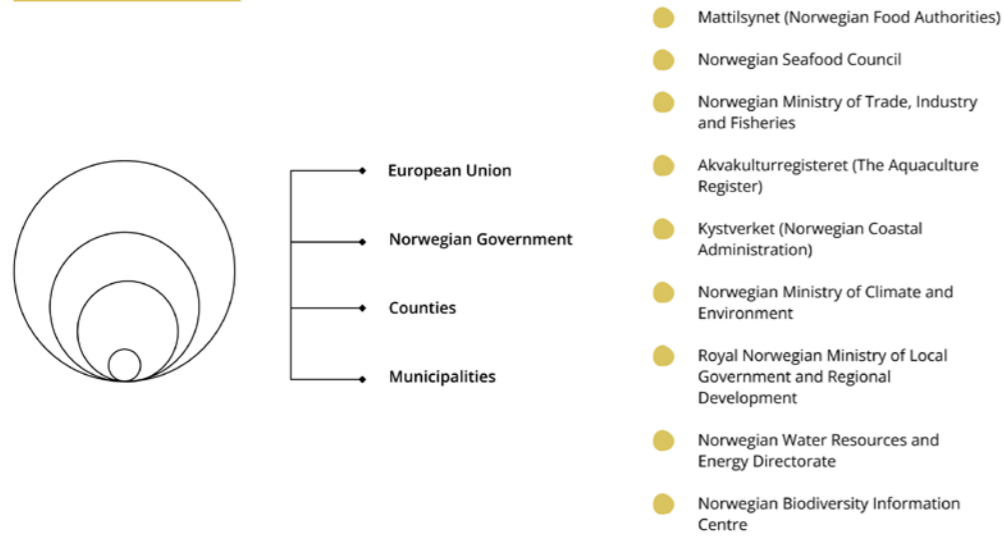
While the seaweed sector in Norway is only limited to a few small markets today, there is a huge potential for Norway to become a frontrunner in the seaweed industry.



## Key Stakeholders

Here is an overview with the main stakeholders working with seaweed as human food.

### Public Authorities



### Research & Development

- Sintef
- The Norwegian Institute of Bioeconomy Research (NIBIO)
- Institute of Marine Research
- Nofima
- University of Bergen
- Møreforskning
- Ocean Forest (Lerøy + Bellona)
- Nord University

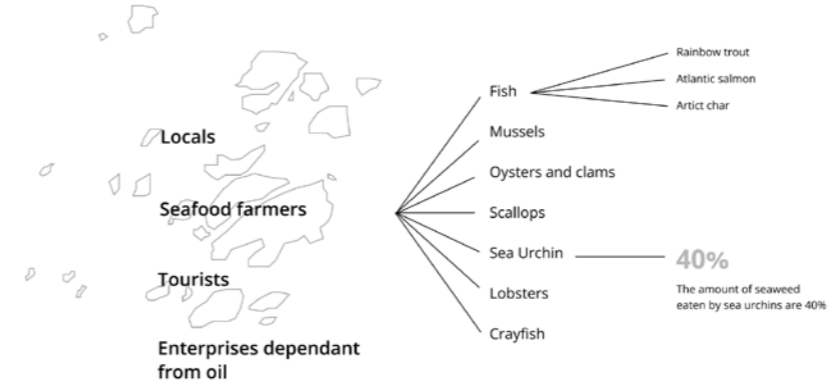
### Network

- Norwegian Seaweed Association
- Seaweed for Europe

### Food experts

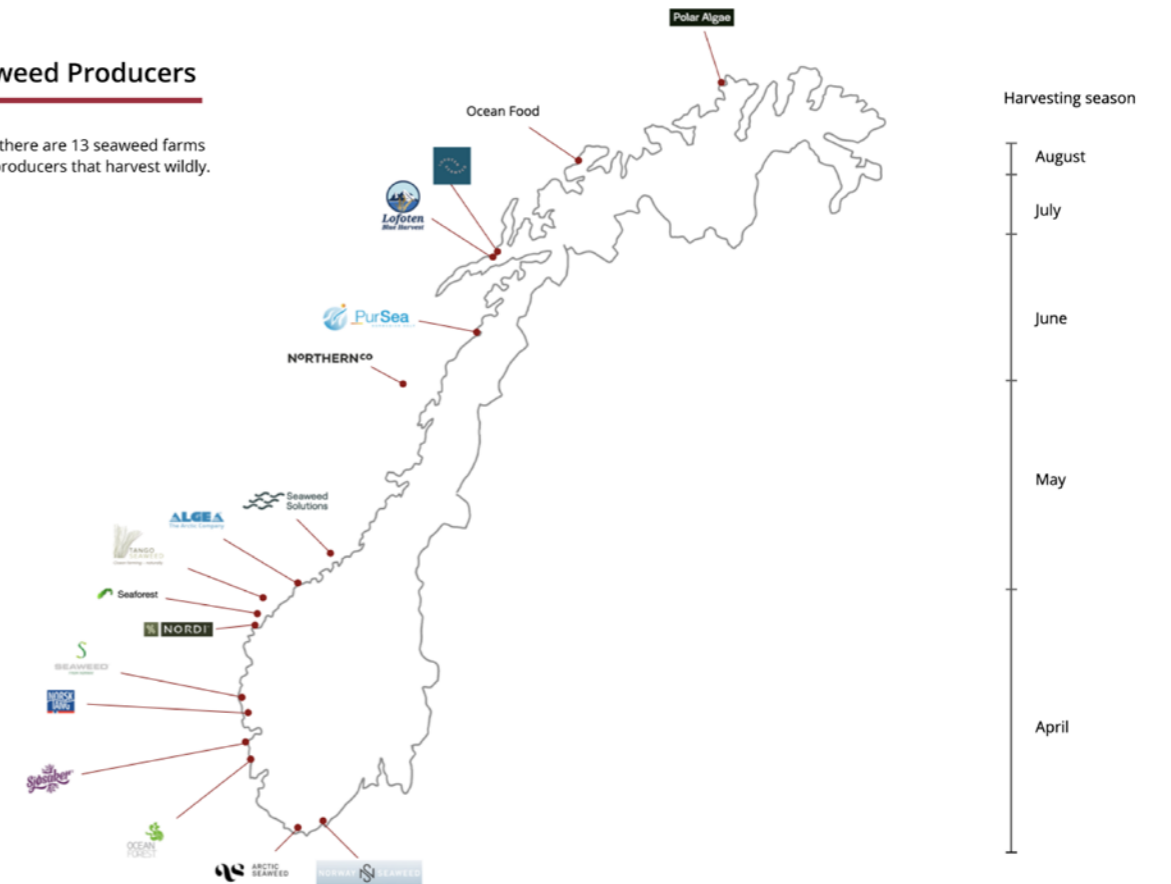


### Coastal Communities



### Seaweed Producers

Today, there are 13 seaweed farms and 4 producers that harvest wildy.

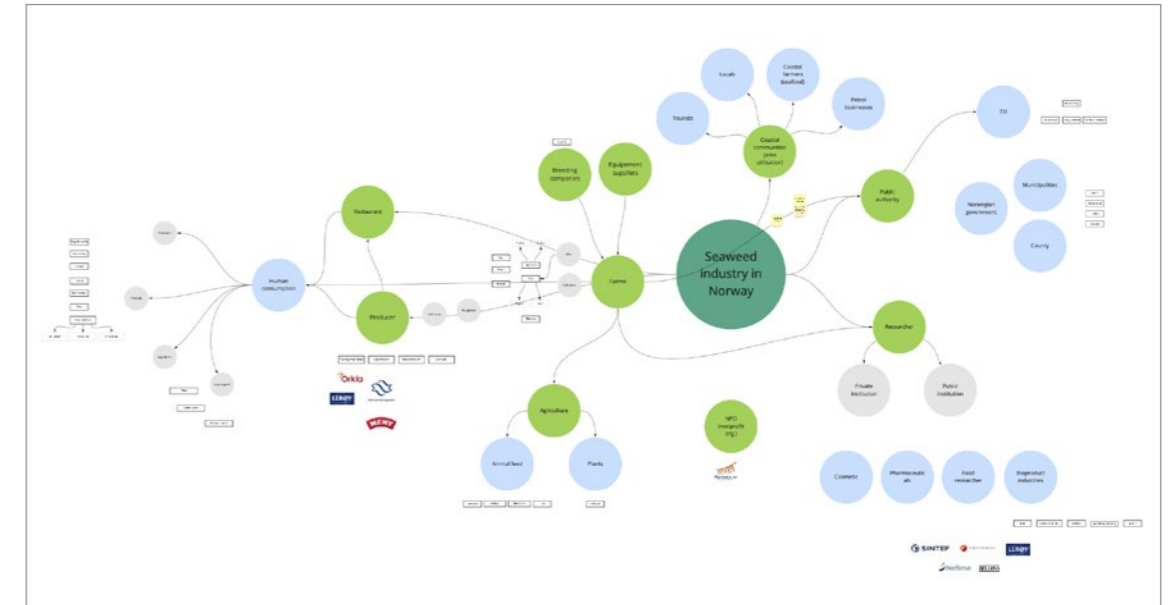




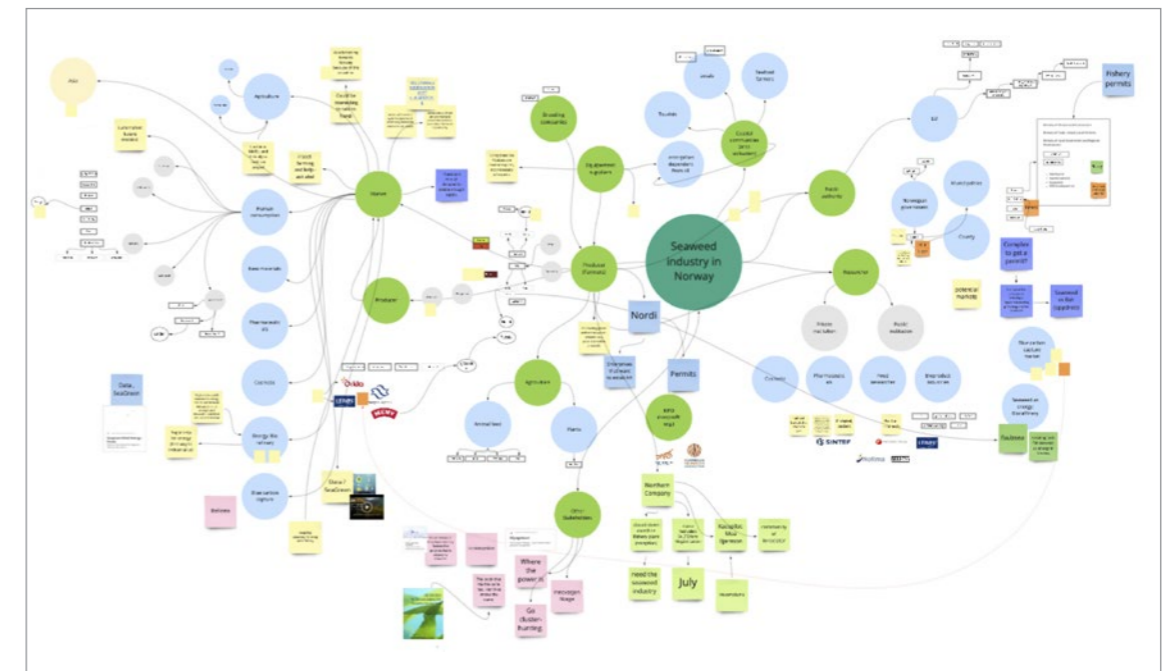
### The Seaweed Industry in Norway Today

To get a better understanding of the seaweed industry, we started the semester by mapping the industry in Norway and the main stakeholders (top visualisation to the right). This helped to shape our understanding of the system and create an overview. We then sense checked our mapping with Tilt Lab, a consultancy that has studied the seaweed industry for some time. As shown to the left they gave us a lot of input in terms of changes, information, new stakeholders to talk to and zoom points to study further.

Before sense check



After sense check



## Seaweed Production Norway

While wild harvesting has been practiced since decades in Norway, the first trials started in 2005 with kelp (Stévant, Rebours and Chapman, 2017, p.1375). In 2009, Seaweed Solution became the first producer to cultivate macroalgae (Saether, 2022), followed by the first commercial cultivation permit of seaweed to be granted in 2014 (Stévant, Rebours, and Chapman, 2017). From this date, the surface allocated to seaweed production in Norway has more than tripled (Stévant, Rebours, and Chapman, 2017).

There are two types of practices for harvesting seaweed: cultivating and foraging. Today, there are 13 seaweed farms and 4 producers that harvest wild. According to The Norwegian Food Safety Authority (2022), Norway is the third biggest harvester of wild seaweed. The illustration to the right shows the series of actions from seeds to pre-processed.

Around 150 000 tons of seaweed is currently produced in Norway (Skjermo, 2015), with its majority used for industrial productions of

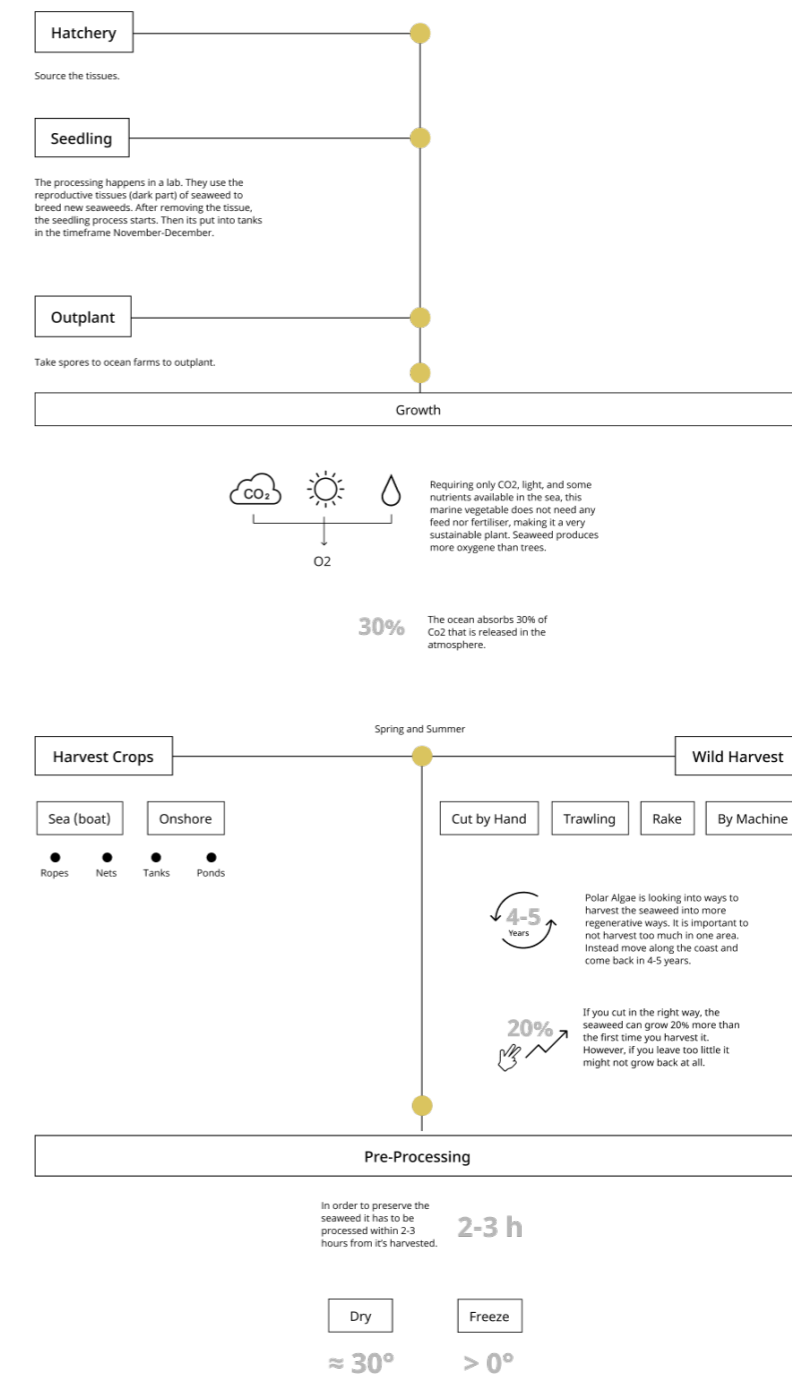
alginate (The Norwegian Food Safety Authority, 2022). However, according to Sintef (Nilsen, 2016) Norway has got the potential to produce much more seaweed in the future: about 20 million tons with a total market value of 40 billion kroner. This is a huge opportunity for the national economy, in comparison to the 1,3 million tons of salmon that Norway exports today (Steinset, 2020).

From its geographical position, the Nordic landscape also offers more opportunities for a seaweed industry, as the rising temperature due to climate change will affect the production of seaweed in the south of Europe (Stévant, Rebours, and Chapman, 2017).

While the Norwegian economy strongly depends on petrol today, there is a growing urge to find a more sustainable national economy. Norway has got the potential to become the leading seaweed exporter in Europe and this could be a bright future for the Norwegian economy.

## Farming

## Foraging



## Field Trip

The most exciting part of this project were the field trips. We wanted to get more hands-on experiences with the seaweed itself and learn about the production system of seaweed.

Carolyn Steel's book *Hungry City* (2013) has been a key element in the initiation of our research question and has pursued us throughout this project. For us, it was important to understand how food reaches our plates and we felt that the field trips got us closer to answering this question.

### The Northern Company

A big part of this project was our field trip in Selvær, an island located in Træna municipality, where we visited the Northern Company's production space. During the visit, we got to participate in processing the seaweed that had been harvested in the morning. From our conversation and observation, we sensed check the mapping we did of their business.

Our main learning from this field trip is that harvesting seaweed can be challenging because

there is no good technology available today and the work varies and depends a lot on the weather forecast. We were also surprised to see how little treatment seaweed needs and how simple the process of preparing the seaweed is.

### Ting med Tang

To better understand how seaweed can become a desirable food ingredient, we joined a seaweed safari with Ting med Tang, an organisation that hosts tasting events, courses, and seaweed safaris along the whole coast of Norway. The goal of this safari was to learn how they raise awareness and knowledge about seaweed through their courses to the public. We also wanted to learn more about the properties of the different types of species and how to cook with them.

Our main learning was that seaweed should be treated just like another seafood ingredient, that can be implemented in any existing meals.





## The Challenges and Opportunities of Producing Seaweed

To better understand how the seaweed industry works and sense check our findings, we talked to several Norwegian seaweed producers: two harvesting wild seaweed and three farming it.

While these helped us get an overview of the current situation, we decided to do a case study on the Northern Company to dig even deeper into challenges and opportunities that the seaweed producers face today.

By mapping out the main activities, the production system, sales channels, visions, and communication strategies, we learned about the production system of seaweed food products in Norway. The mapping was an iterative process: from desk research to a first interview, we then iterated on it during a workshop and defined some zoom points which we investigated further and finalised after our field trip.

Our main findings from this research, addresses consumer, economic, environmental, and societal questions.

### The Consumer


From a consumer point of view, producers taught us that there is a lot of interest in seaweed, but few want to buy it or cook it, as they do not know what to do with seaweed.

Therefore, communication has been a vital role in producers' work. Inspiring and teaching people about seaweed on how to eat it and cook it has been an important part of the marketing strategy. Producers have also put a lot of focus on educating their staff on how to promote and raise awareness about seaweed to make sure the end-consumers know how to use the product. With the lack of experience in cooking seaweed, producers also noticed that there has been more interest in finished products.

### From Environmental Point of View

The result of a burgeoning industry comes with other questions. As of today, there is little knowledge of what the consequences of scaling up this industry would mean. There is a big energy consumption when it comes to drying the seaweed, because seaweed contains a lot of water (Stévant, 2022). Therefore, producers are currently working on trials to reduce that energy. An example is Carl Erik, the founder of the seaweed farm PurSea, who is testing if heat from data centre can be used to dry the seaweed.

Additional challenges to address are the rope losing plastic, genetic modification from farming seaweed and the risk of seaweed taking all the nutrients from the sea.



”When you grow things in large scales it is just not possible to do it sustainably.”

Seaweed producer

### From Economic

As of today, producers are struggling to make a profit from seaweed as human food. The labour costs are high and there is no available technology to harvest and process the sea vegetable. This makes it difficult for producers to enter the international market. With the costs of Asian products being much lower, Norwegian seaweed producers cannot compete with Asian prices.

### From Political

As seaweed is a fairly new food product in the West, the recommendations and regulations vary a lot between the European countries. This results in high prices for exporting seaweed food product.

In Norway, the allocated space for aquaculture is mostly used for fish farms, which is a strong competitor when it comes to farming location.

### Seaweed Species Harvested for Food in Norway

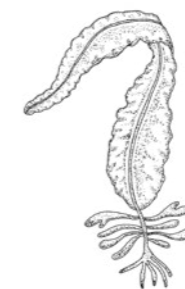
An estimated 450 seaweed species have been acknowledged along the Norwegian coastline (Vibe, 2020). However, only a few have been explored for commercial use. None of them are toxic, but some contain more heavy metals and iodine than others. The most common seaweed to cultivate are the sugar kelp and the wing kelp (Norderhaug et.al., 2020), due to their great growing characteristics and their delicate taste. Among the leading food producers, we also find the sea lettuce, dulce, seaspaghetti and truffle seaweed.



Sea Lettuce



Sugar Kelp



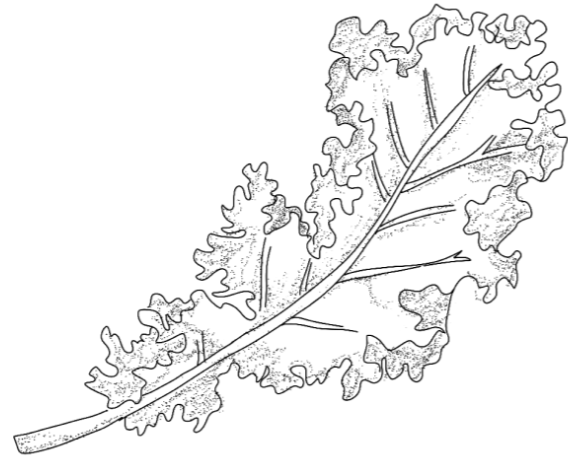
Winged Kelp



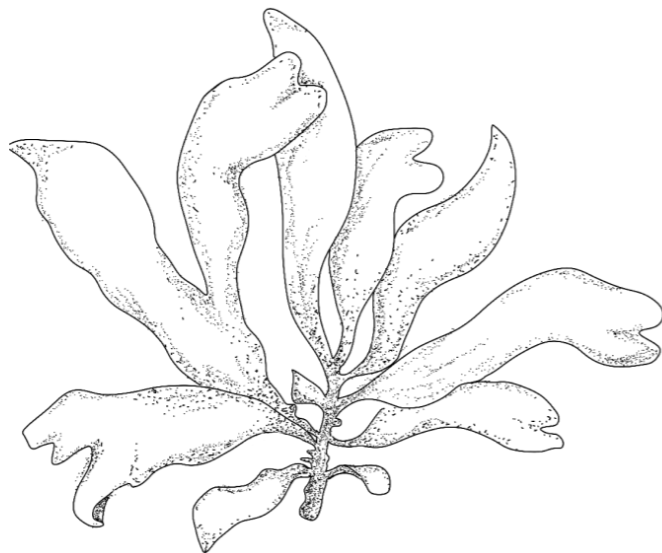
Dulce



Nutrition  
in Kale



Nutritio  
in Dulce



”[dulce] If you fry it in oil or butter it actually tastes like bacon.”

Jaap Willem van Hal

### A Rich Culinary Experience With Healthy Benefits

While seaweed demonstrates promising environmental benefits, you might wonder why you, as a consumer, might want to eat it.

First of all, seaweed is a very nutritious ingredient. It is rich in fibres, minerals, and vitamins (Rebours, 2020). Some species also contain a high amount of proteins, but because seaweed is generally consumed in small amounts, it is not intended to replace protein-rich foods. Studies have shown that seaweed has got 10-100 more minerals than vegetables (Rampelotto & Trincone p.75 2018). In addition, seaweed endowed with a wide range of trace elements and vitamins (Mouritsen, p. 52, 2013). The content of varies between species but the typical vitamins present in seaweed are vitamins A, B, C and E (Mouritsen, p. 55, 2013). Some types of seaweed, like Dulce, contains twice as much nutrition as kale (Oregon State University, 2015). According to Birger Svihus (2022), a researcher at NMBU, it is also a low energy food,

making it a great way to get lots of nutrients with little calorie intake.

Not only is seaweed a great source of nutrients, but it can also enhance your food. Due to its umami taste, which is the fifth flavour of our receptors, seaweed can deepen flavours with a nutty and savoury boost. The aroma of the seaweed varies a lot between species. The red seaweed dulce, for example, is well known for its smoky flavour, which is often compared to the taste of bacon and liquorice. On the other hand, sugar kelp, the most common seaweed produced in Norway, has a strong ocean taste and is saltier. Many seaweed species are also used as a salt replacer. As seaweed producer Tekslo Seaweed (2019) promotes, seaweed contains eight times less sodium than salt but provides a good salty flavour.

Finally, it is also worth mentioning that seaweed is easy to cook with or to add to an existing meal.

### Norwegian Seaweed Products

To create an overview of the existing seaweed food products on the Norwegian market we visited a number of stores in Oslo, searched online and asked producers. Our finding was that the access to seaweed is quite limited, especially when it comes to products made in Norway. The main vendors that offer seaweed are niche stores, specialty stores selling Asian food products and online grocery stores. The number of products offered is limited, and most are mixed products where seaweed plays the role of being a texture or taste enhancer, like soups and spices. To the right you can see an overview of the types of products sold today, that contain fair amounts of seaweed.





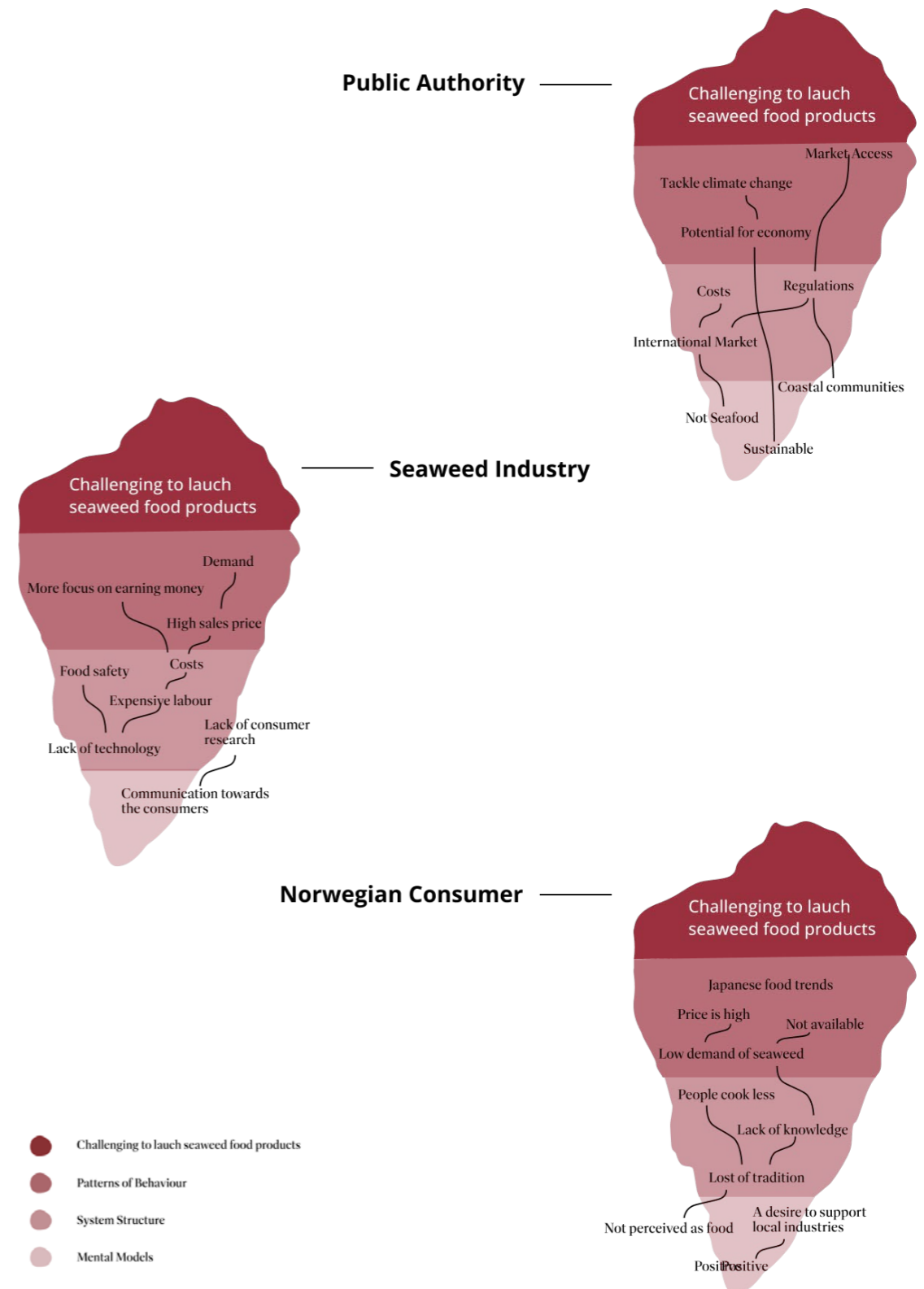
### Root drivers of launching seaweed food products

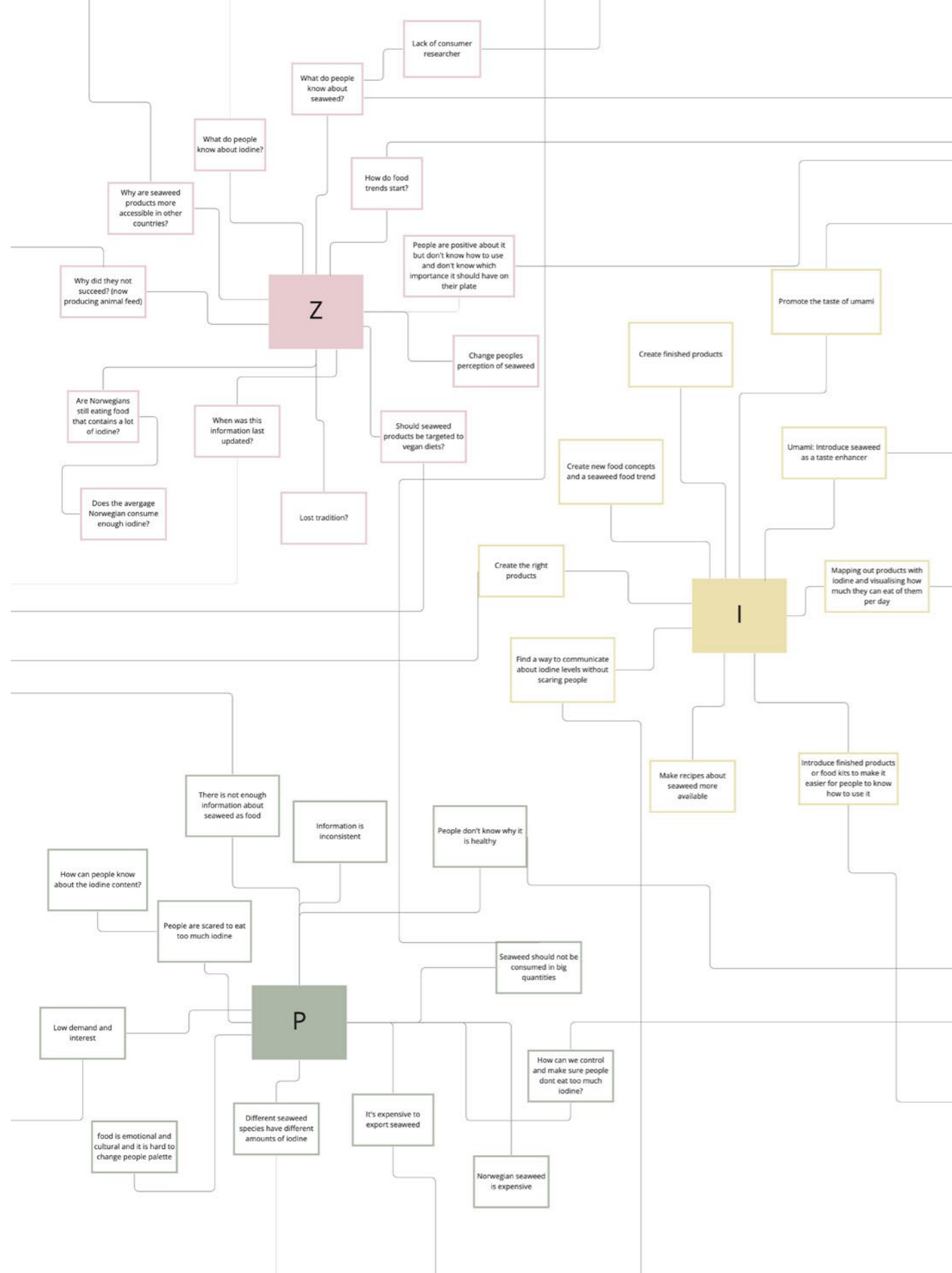
During our research, we came across several challenges when it comes to launching seaweed as food on the Norwegian market. To find out what causes this, we mapped them out using the Iceberg model. By looking at the mental model, systems structure, and patterns of behaviour we uncovered underlying reasons for why it is challenging to sell seaweed as food in Norway.

We used the Iceberg model to study the three most important groups of stakeholders, being the consumers, the seaweed industry, and the public authorities. As illustrated to the right, we did an analysis on each of these levels. This is a simplified version of the mapping (see appendix 2 for more details).

The most important root drivers we discovered are:

- Seaweed is not categorized as seafood
- The industry lacks consumer research
- The lack of technology results in high costs
- We have lost our connection to the traditions of seaweed as food.





## Collecting Data on Information, Regulations, Tradition and Access

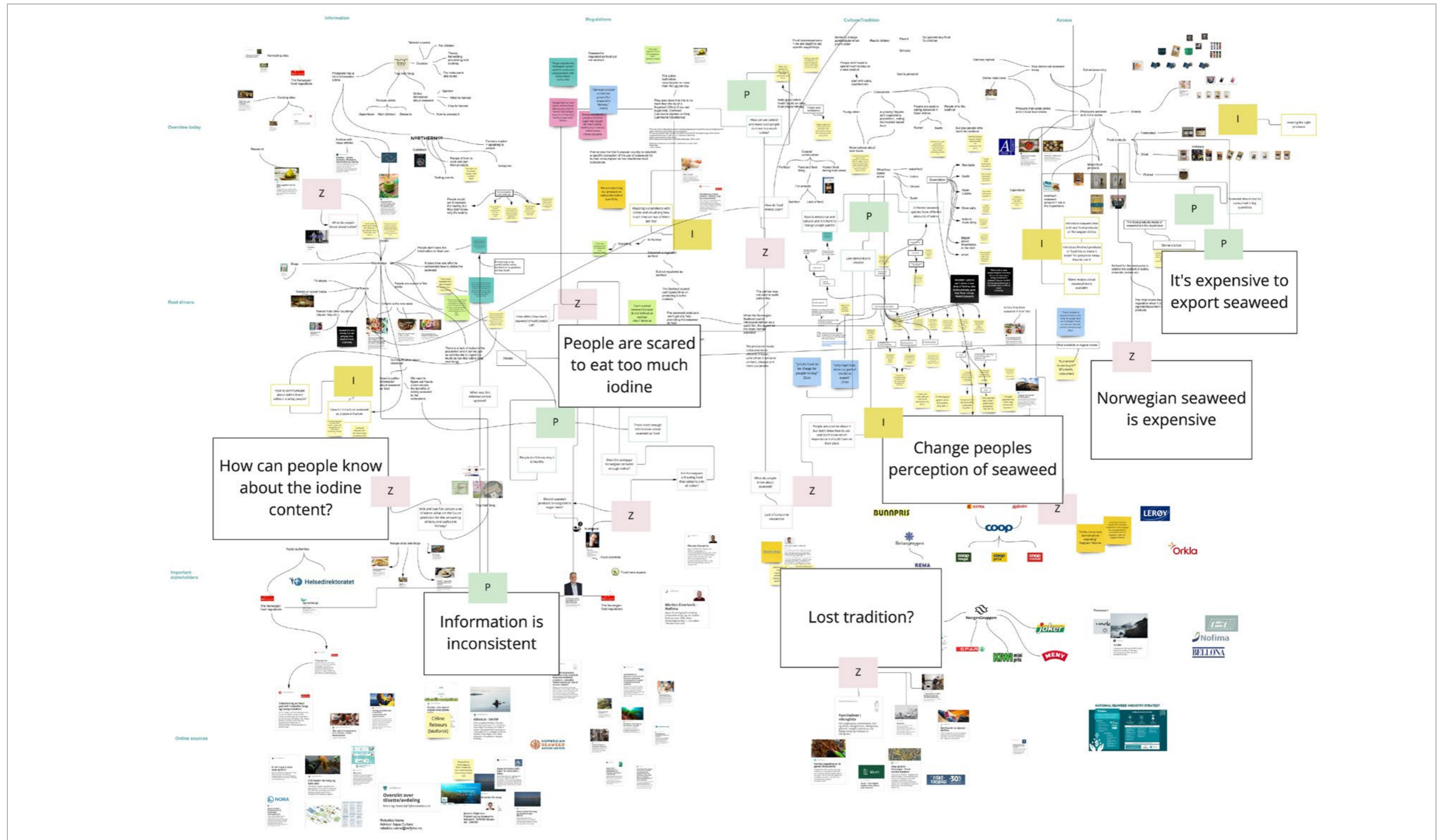
From doing a ZIP-analysis on two of our maps (one of the Northern Company and one on seaweed as food) we detected and highlighted zoom points, problems, and potentials as well as ideas that stood out (see the next two pages). Based on the Iceberg Model, we decided to focus on gathering more data about information, regulation, culture and tradition, and access.

The most important problems we identified are:

- Information is inconsistent
- People are scared to eat too much iodine
- There is a lack of information on iodine
- Different seaweed species have different levels of iodine
- It is hard to reduce the iodine while keeping the vitamins

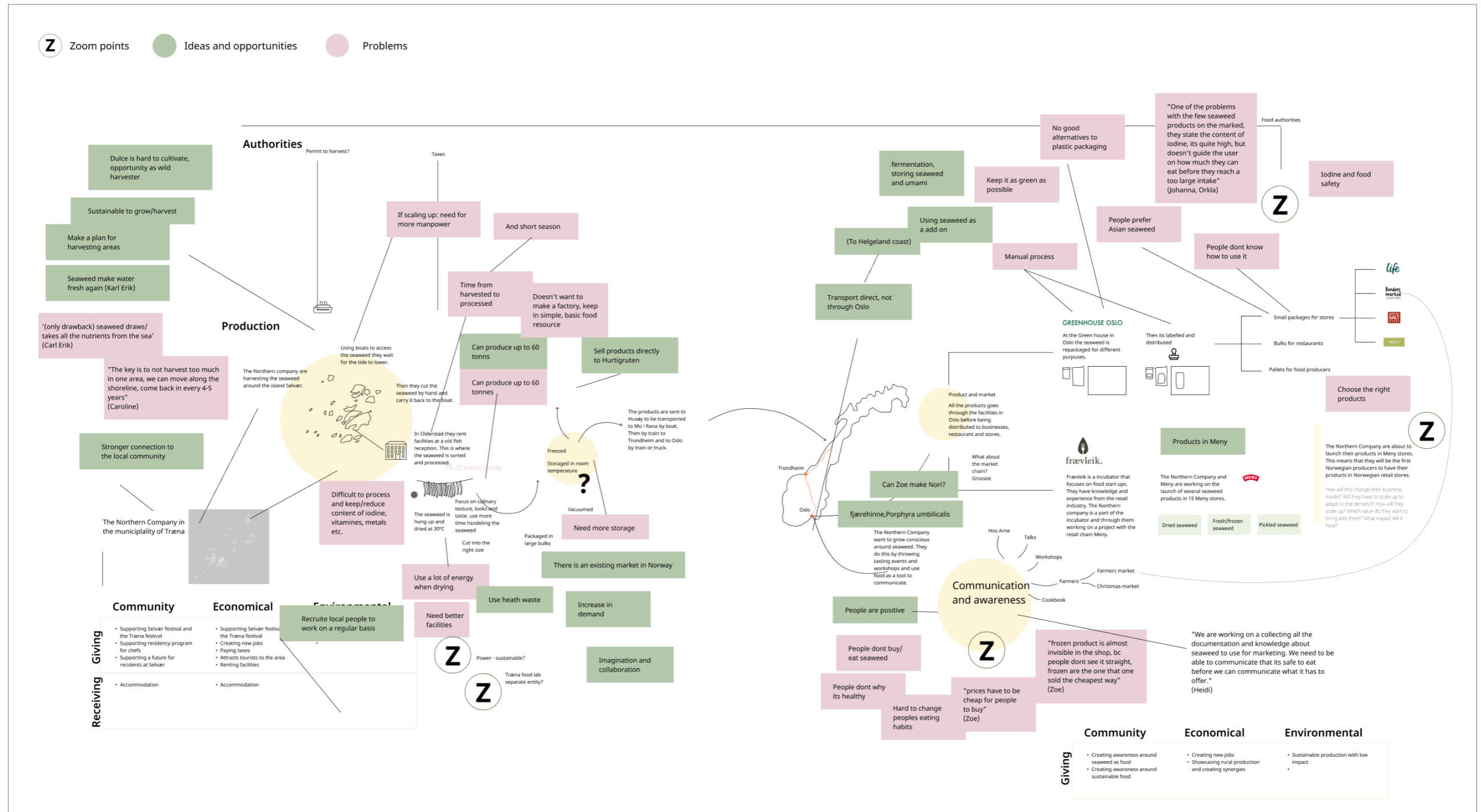
The most important ideas we identified are:

- Recipes with seaweed can be made more available
- Find a way to communicate iodine levels without scaring consumers
- Map out products with iodine and visualise how much you can eat per day
- Create finished products
- Create new food concepts and a seaweed food trend
- Promote the umami taste



Collecting Data on Information, Regulations, Tradition and Access (See appendix 3)

**Z** Zoom points   ● Ideas and opportunities   ● Problems



Mapping the Northern Company



## How can seaweed become a bigger part of the Norwegian diet?

### **Problem Statement**

Seaweed is a delicious, nutritious, and sustainable ingredient, and there are many possibilities to include it in and as food. While Norwegians have lost their tradition of seaweed, we think it is time to regain seaweeds' place in the food culture.

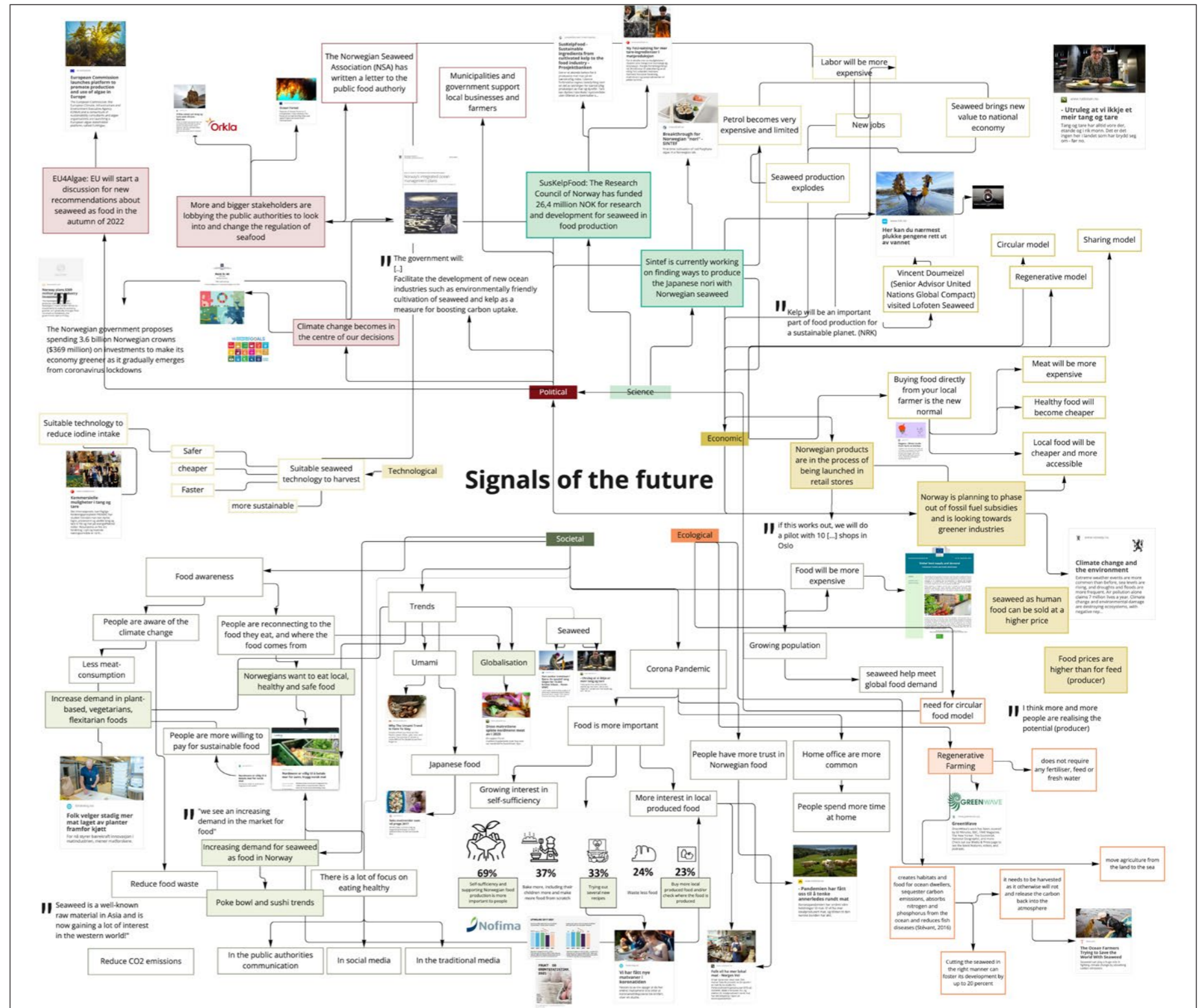
How can seaweed become a bigger part of the Norwegian diet?



# Future

Having defined the past and current situation of seaweed as food in Norway, we will now move to the future. In this section, we have drawn a picture of what a future with seaweed could look like. By looking at the ecological, societal, economic, and political frameworks, we have defined a desirable and an undesirable scenario.

As shown to the right, we started out by collecting and building an overview of the future signals.



### Negative Signals of the Future

While seaweed as human food is becoming trendier and taking a lot of attention in the media, the iodine challenge is delaying the process, and making producers question their work. As a result, some producers had to shift their market to animal feed while others have totally closed their activity down.

“Currently there is a lot of interest about seaweed in the retail market, but not much demand. In the last 2 years it has all gone to animal feed” (Steinsund, 2022).

Developing a new industry comes with new challenges, such as space allocation. According to the Norwegian Directorate of Fisheries (2020) there are 1256 locations for aquaculture permits today, but only 93 of these are permits for cultivating algae. With so many fish farms

already established, and a desire to grow within the fish industry, it can be a challenge to get access to the sea. According to ex-producer Breivik (Vik and Tomassen, 2019), this is one of the main challenges with making seaweed a profitable production. Today, municipalities are lacking experience in this field and struggling to add seaweed into their coastal zone plans.

Another obstacle with algae farms burgeoning along the coastline is the response from local residents. During our interviews, we learned that one producer had to remove one of their sites because of protests from the locals.

With local communities complains and the lack of available space in the sea, it could become a challenge for the seaweed industry to grow in Norway.



“It is a competition to get enough space in the sea.”

Seaweed producer



### Positive Signals of the Future

From societal to economic, political, ecological and scientific changes, we observe positive signals of the future for seaweed to become an important food industry in the next couple of years. These signals and trends helped us to imagine what the future for seaweed as food might look like and create a common vision.

#### Societal Signals

Over the last couple of years, the demand for plant-based food has increased rapidly in Norway (nibio, 2018). With the urge to tackle climate change and meet the sustainable development goals, the public authorities are now recommending the Norwegian people to reduce their meat consumption (Helsedirektoratet, 2022).

In response to the covid pandemic, researchers have seen a change in food habits within the Norwegian consumer: people make more food from scratch, there is a willingness to try new recipes, an inclination for locally

produced options as well as an interest in more transparency (Hægermark, 2020). The pandemic also resulted with an increased interest in being self-sufficient. As a result, we predict the future Norwegian consumer to be more conscious of the origin of their food.

It is also worth pointing out, that the concept of globalisation has transformed the way we eat today. The introduction of Asian cuisines in the West, in particular, has allowed consumers to experience new cuisines and new flavours, such as the umami taste. High quality delicatessen such as sushi became a mass consumed product that has been reinterpreted with the Norwegian salmon (Groth and Hayden, 2015).

With macroalgae being locally available and providing the umami flavour of the East, we believe that seaweed could be an important part of the Norwegian diet.



”There is not a big demand for seaweed as human food in Norway but it’s growing and people are curious about it.”

Heidi Meland

### Economic Signals

Today, the Norwegian economy strongly depends on the petrol industry. With the growing urge to reduce fossil fuel emissions, Norway is planning to phase out of fossil fuel subsidies and is looking towards greener industries (Norwegian government, n.d). As the country has a long history in aquaculture, marine infrastructure, and seaweed growing along the Norwegian coast, we believe that seaweed could become an important part of the Norwegian economy.

From interviews and workshops, we learned that Norwegian seaweed producers are currently working on seaweed food products and that some of these are in the process of being launched in retail stores, starting with small amounts first. Producers informed us that seaweed as human food can be sold at a higher price, making it a big opportunity for the national economy.

Another positive signal for seaweed as food, is the support from the Norwegian government. In 2021, The Research Council of Norway has funded 26,4 million NOK for research and development for seaweed in food production (Møreforskning, 2019). This project, called

SusKelpFood, is a collaboration between Norwegian researchers, food suppliers, and seaweed producers.

### Political signals

In response to global warming, we see that sustainability is becoming an increasingly important part of political decisions.

After speaking to different producers and the Norwegian Seaweed Association (NSA), we also identified that a growing number of stakeholders are lobbying the public authorities to develop better recommendations seaweed in Norway.

In 2018 the European Union (EU) published a recommendation for the European countries to start monitoring heavy metals and iodine levels in seaweed. Based on this data collection, the EU will start a discussion for new recommendations about seaweed as food in the autumn of 2022 (Marit, 2022). This project is called EU4Algae and is run by the European Commission in collaboration with the European Climate, Infrastructure and Environment Executive Agency (CINEA) as well as consultants and seaweed organisations (European Commission, 2022).



### Ecological Signals

People all around the world are working on finding better solutions to grow food in a sustainable way. From vertical farming to locally produced food, more people are trying to find ways to redesign the current food system.

In recent years, there has been a growing interest in designing a circular food model. The production of seaweed is a promising circular industry, as it does not require any fertiliser, feed or fresh water.

There is also an increasing desire to establish a regenerative agriculture, where the aim is not only to minimise the damage but also give something back to the ecosystem (Uldrich, 2021). Seaweed offers great characteristics to become a regenerative industry, as it creates habitats and food for ocean dwellers, sequester carbon emissions, absorbs nitrogen and phosphorus from the ocean and reduces fish diseases (Stévant, 2016). Bren Smith, an US-based ex-fisherman, is currently trying to develop a regenerative farming ecosystem program to support and train fishermen and indigenous coastal communities, by creating polyculture ocean structure that sustains on its own.

Seaweed has the ability to sequester CO<sub>2</sub>, but for this to happen, it needs to be harvested as it otherwise will rot and release the carbon back

into the atmosphere (Godin, 2020). This shows some promising consequences for seaweed to be farmed.

As mentioned by the network Seaweed for Europe (2020, p.9), seaweed has also societal benefits, as it creates jobs for coastal communities.

Methods to enhance seaweed growth have also been explored, where farmers have tested various ways to help the plant grow better after being harvested. One seaweed farm has found out that cutting the seaweed in the right manner can foster its development by up to 20 percent. On the other hand, leaving too little could result in the plant not growing back.

It is also worth pointing out that there is a growing demand to move agriculture from the land to the sea (Bergwitz-Larsen, 2022). With the growing global population, increased people are discussing the potential of farming the sea to meet future food needs (Costello and al, 2019).

### Scientific Signals

As mentioned in the economic signals, the Norwegian government is supporting the growth of the seaweed industry for research and development.




”I think there is a big opportunity  
in the food sector”

Dagbjørn Skipnes,  
Nofima

Throughout the interviews, we learned that scientists are positive about seaweed becoming a mundane food ingredient. There is a lot of progress in processing the iodine levels in seaweed. Recent results have shown that using sea water instead of fresh water improves the retention of minerals and has reduced around 90 percent of the original iodine content (Duinker, 2022).

During this project, we also discovered that research institute Sintef is currently working on finding ways to produce the Japanese nori with Norwegian seaweed (Sintef, 2016).

Furthermore, it is worth mentioning Ocean Forest, the collaboration between the supplier Lerøy Seafood Group and the research institute Bellona, working on an initiative to create food, feed and energy (Bellona, n.d).



”There are a lot of expectations and positive thinking, but no one has achieved anything yet”

Seaweed producer

## Future Scenarios

Based on these signals, we have imagined what an undesirable and desirable future with seaweed could look like. The aim of these future scenarios is to help the seaweed industry move towards a common goal. As we cannot rely on assumptions, we need to draw a clear picture of what a future with seaweed could mean. We hope that these scenarios can help the industry to create a shared vision.

### Undesirable Future

It is 2040. Scientists have not found any effective way to process the seaweed to reduce the iodine content and heavy metals in seaweed. As a result, The European Food Safety Authority (EFSA) has concluded to not promote seaweed as safe food. The Norwegian food authorities

have agreed with this decision and followed the same standards.

Many seaweed producers have decided to close their production facilities, while others have shifted their focus on another market of interest. With the lack of support from the authorities, it has left the seaweed industry unable to invest in developing better technologies.

The only existing seaweed products available in the store are imported from Asian producers. With food travelling from all around the world, there has been an acceleration in climate change. Healthy foods have become very expensive and limited to an elite part of the population, creating big inequalities in the society.

### Desirable Future

As mentioned in the context section, in the future, we will have to find more sustainable, healthy, and affordable food solutions. With this in mind, we envision seaweed to become an important part of the Norwegian diet and food culture in the next 15 to 20 years.


Seaweed will be perceived as an everyday food ingredient that can be added to any other dish. The umami taste that the seaweed provides is desired by the Norwegian consumer and become a dominant flavour within Norwegian cuisine. Seaweed will be used in all kinds of ways: from sprinkled on the traditional waffle, to fermented on your sliced bread with leverpostei or used for marination. Just like the avocado toast or the acai bowl, seaweed interest and popularity will emerge from food trends.

Many recipes will have seaweed in their ingredient list and restaurants will have it

on their menu. Consumers will be able to purchase many different types of seaweeds in supermarkets at a low price.

Seaweed will also gain a lot of attention within the diet culture, due to its rich nutritional value and low caloric content. While the Food Authority will classify seaweed as seafood, the Norwegian Directorate for Health will promote it as a 5 a day vegetable. As scientists are positive about finding better ways to process the iodine in seaweed, we believe that the iodine and heavy metals challenges will be tackled in the future. Additionally, with the future citizen predicted to favour more plant-based options, seaweed will be a popular source of energy for vegan diets.

Information about using seaweed as food will be easy to access with an information hub gathering all the health questions, cooking advices and harvesting tips in one place. This



”It’s only the imagination that puts the limitation of what seaweed offers”

Silje Steinsund,  
Lerøy

will be provided by the Seafood Council and the Norwegian Seaweed Association, which will join forces and create a foundation for educating consumers about seaweed. Other key stakeholders from the seaweed industry will be sharing information on this platform too.

With a growing interest in self-sufficiency, many people will learn how to harvest and process their own seaweed. Just like mushroom picking in the autumn, harvesting seaweed in the spring and summer will become a popular activity among Norwegians.

This marine vegetable will also offer new job opportunities along the coastline, as the number of seaweed farms in Norway will increase. Not only will it attract people from urban areas, it will also strength coastal communities and municipalities. This will play an important part in national tourism.

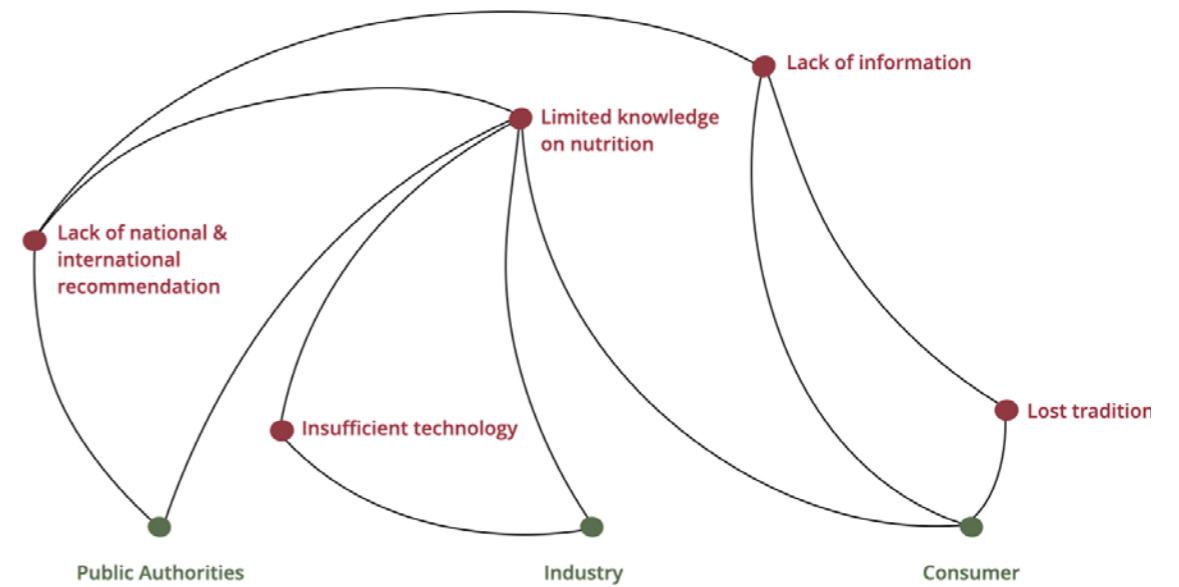
Furthermore, Norwegian aquaculture will have an efficient technology to harvest and produce seaweed at a low cost and in a sustainable way. As a result, Norwegian producers will be able to compete with Asian prices and become the biggest seaweed exporter in Europe. The European Union will have decided on specific recommendations and standards for promoting seaweed as food, making it easier for producers to export their products.

From an environmental point of view, we see that the increasing number of farms along the coastline will capture a large amount of Norway’s national CO2 emissions. Additionally, we believe that this new industry will accelerate the process of phasing out the petrol activity.

## Leverage points

Having drawn a picture of a future with seaweed as food, we now have to consider how to get to this future. As Donella Meadows (2009) states, leverage points are “places in the system where a small change could lead to a large shift in behaviour”. Based on our findings from the Iceberg model and ZIP-analysis, we tried to uncover the most important leverage points. This was then sense checked with a

representative from The Norwegian Food Safety Authority (2022), who said “your presentation matches my understanding of the field”. The five leverage points are linked to either the public authorities, the industry, or consumers, and several are linked to each other. In this section, we will describe each of the leverage points further.



### Leverage Point 1

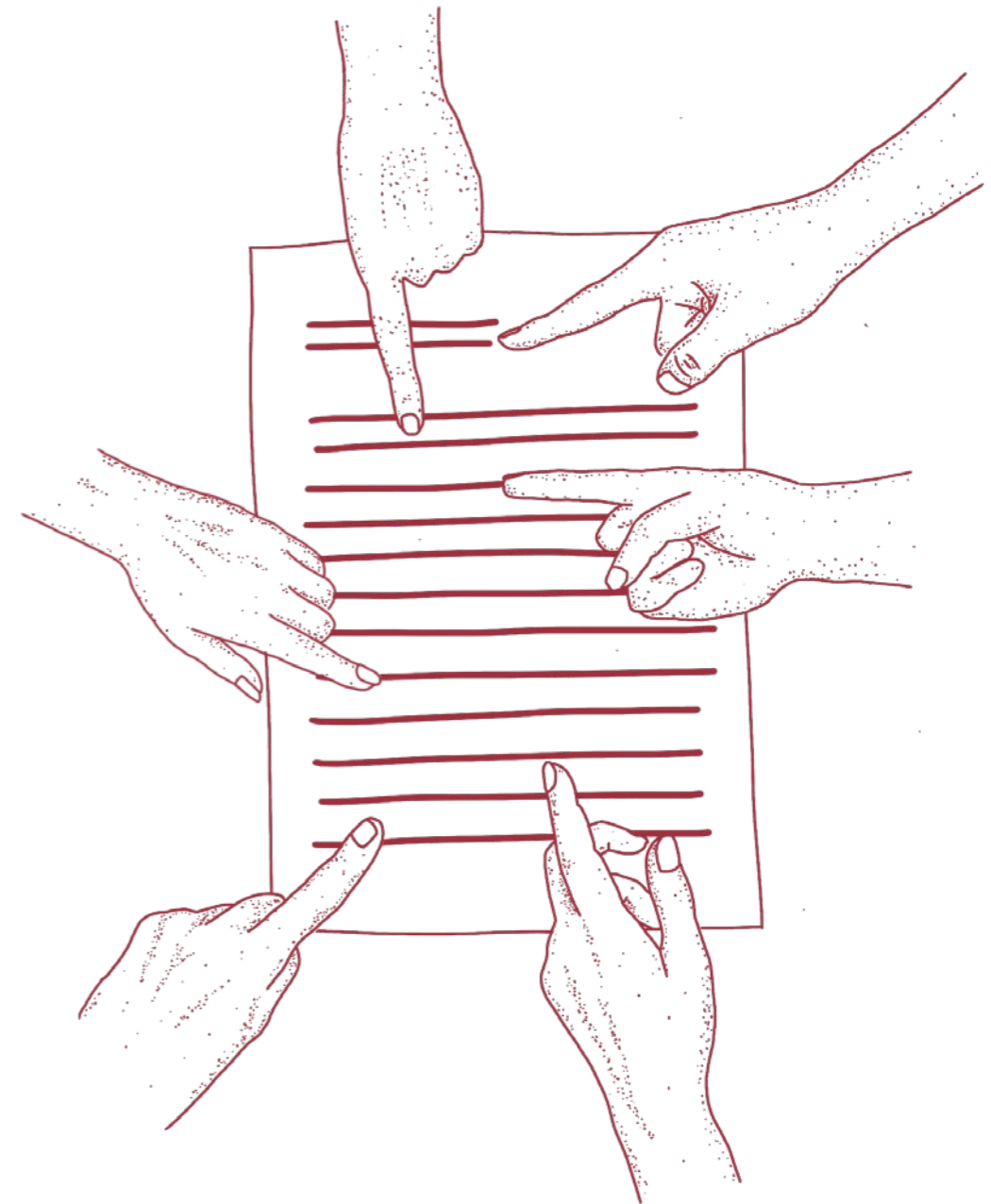
#### Lack of National & International Recommendation

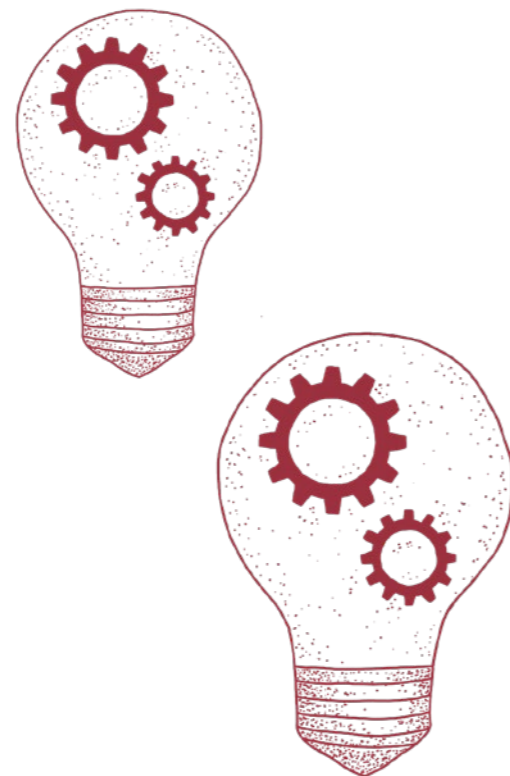
The first leverage point to address is the lack of national and international recommendation. According to the Norwegian Seaweed Association (Gjerstad, 2022), the seaweed industry wants it to be a recommendation rather than a regulation.

European macroalgae have been primarily applied for phycocolloid extraction, such as thickening or as a food stabiliser (Rahikainen and Yang, no date)2020. However, its use in and as food is relatively recent. As a result, the European Union (EU) has not gotten around to developing clear recommendation standards, meaning that all the European countries are processing it differently. The

lack of recommendation makes it hard for the producers to navigate in the national and international markets and exporting seaweed as food is very expensive.

In Norway, the regulations are unclear. According to the Fiskeeksportloven §1 seafood consists of fish and fish products, meaning that seaweed is not regulated as seafood. This means that the Norwegian Seafood Council cannot promote seaweed in their channels, for example on trade shows or in campaigns. In other words, seaweed is not classified within any food categories.





## Leverage Point 2

### Insufficient Technology

Although Norway is a forerunner when it comes to marine technology and aquaculture, there is still a need for new and innovative technology. Today, the biggest bottleneck for developing a profitable industry for macroalgae is related to production costs. This includes treating, processing and storing of the seaweed (Rebours & Stévant, 2020).

The seaweed needs to be treated within hours from its harvested, or else it will go bad (Stévant, 2022). Most of the production of seaweed in Norway is located at rural places with limited infrastructure, and parts of the production is still done manually (Mæland, 2020). This is a drawback for the industry as they are competing with Asian prices, where the labour cost is much lower.

Therefore, to grow such a business, further research into finding the right technology is required.



### Leverage Point 3

#### Limited Knowledge on Nutrition

Seaweed are very nutritious sea vegetables, but their components vary a lot between species and within species (Marit Gjerstad, 2022). As of today, all 500 species are treated in the same way, as there is not enough research on the nutrients within the different species. This lack of knowledge has been a big obstacle for the industry to grow. Therefore, the need to find a way to process and measure this is essential as it will help producers reach out to the consumer.

Additionally, the industry also needs more research on the hazard of seaweed. The main challenges identified when it comes to commercialising seaweed as food are iodine, cadmium, inorganic arsenic and heavy metals, with iodine being the biggest hurdle. These can be dangerous if consumed in high levels. Today, researchers are trying to find better ways to process the seaweed. While they are positive about the iodine challenge, there is still a lack on the nutritional component of seaweeds.

#### Iodine

Iodine (I<sup>-</sup>) is a micronutrient that is essential for the functioning of our brain and thyroid gland (Mouritsen, 2013). Both too much as well as deficiency of iodine over a long period of time can cause sever effects on our health (Helsedirektoratet, 2021). The Norwegian Food Authority recommends a daily intake of 0,15mg a day for adults and children over 10 years old, with a maximum intake of 0.6mg. Breastfeeding and pregnant woman should have a higher intake, to ensure a healthy development of the child's brain.

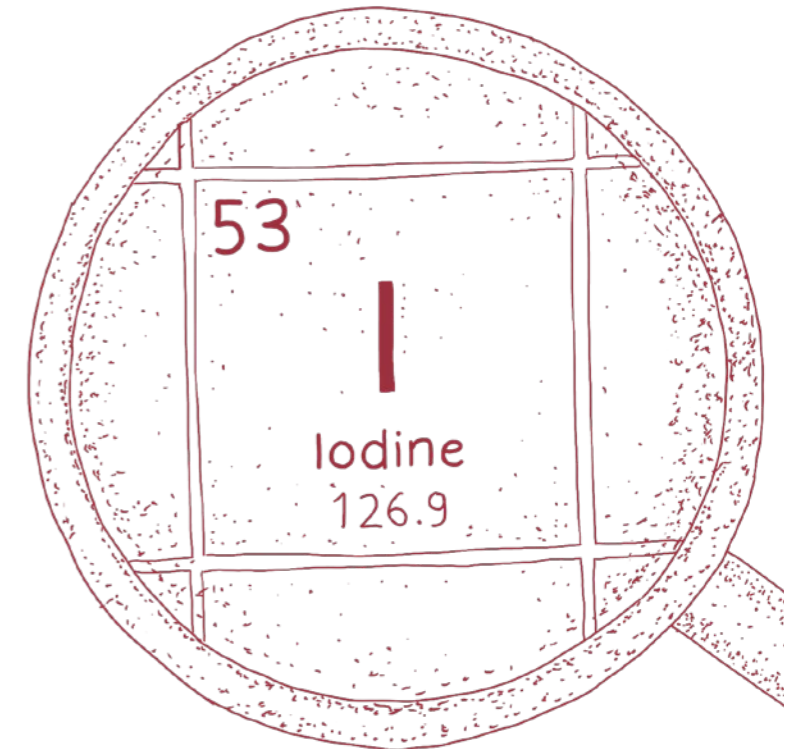
Since iodine is mainly stored in ocean water,

seafood and other marine originated foods have a naturally high amount of iodine (Ahad and Ganie, 2010). Today, most Norwegians get their daily intake from dairy and lean fish (Lerøy,2017). However, according to Lerøy (2017) there has been a growing deficiency in Norwegians, due to a decrease in milk consumption.

Macroalgae are very concentrated in iodine. The levels range from species to species as well as from geographical and seasonal differences (Müssig, 2009). Its content can also be reduced through different processing methods, such as boiling, drying and frying. In fact, boiling seaweed can release up to 90% of the iodine content, frying releases an average of 50% and drying can reduce up to 25% of its original level (Duinker & al, 2020).

Brown species are known to be the most concentrated in iodine (Mouritsen, 2013, p.60). Sugar kelp, in particular, one of the main commercially available species in Norway, is among the ones with the most iodine. On the other hand, dulce, a red seaweed species, which is well known for its bacon taste, has got a relatively low concentration in iodine.

There are a lot of discussions around including seaweed as human food, due to its high level of iodine. Scientists are working on finding better ways to process the seaweed, to reduce the overall amount of iodine in seaweed while preserving other essential vitamins and minerals. While researchers are positive about the iodine challenge, there is still a lack of knowledge on the nutritional component of seaweeds.

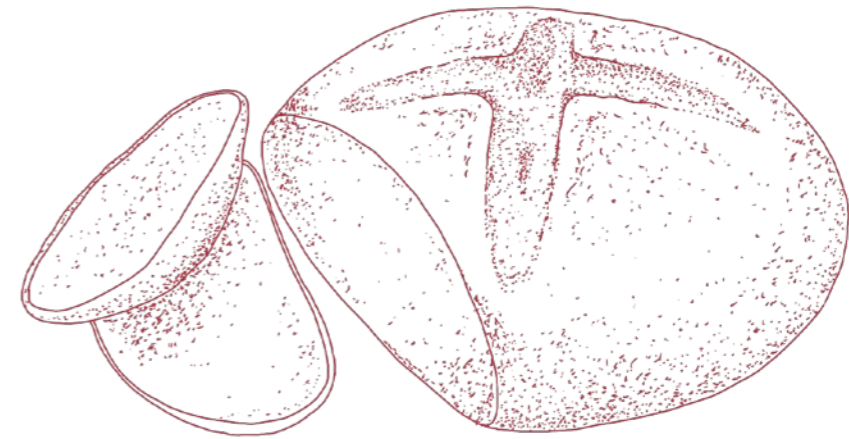


#### Leverage point 4

##### Lost Tradition

As mentioned in the section “History of Seaweed in Norway”, seaweed has played an important role in the past in the Norwegian culture. Looking at the food aspects, it has been used because of its nutritional values, but this tradition has been washed away with the latest generations.

When losing traditions, we also lose knowledge. Culinary knowledge passes from generation to generation and define the culture of society. During our research, we learned that seaweed has been used as flour in bread and as seasoning in recent years in coastal communities (Fasting, 2022). However, this is limited to few communities. Today, Norwegians do not know how to use, treat, or cook it and that is normal as the experience has faded away.



## Leverage point 5

### Lack of information

When we started the project, we realised that accessing information about seaweed as food can be challenging. If you search the internet for seaweed today, you will find a lot of conflicting and scattered information: from seaweed being a wonder superfood to being a dangerous ingredient, with sources ranging from experts and producer to bloggers and food enthusiasts. There is no clear indication on how much to use, and most seaweed recipes are limited to the Japanese nori and wakame. As long as there is no clear information hub from a trusted source, we believe that it can be daunting and confusing to the consumer.

However, information available online was not the only missing part. Other meeting points such as products in stores are lacking key information. We realised that seaweed products in retail stores both from Asian and Norwegian producers were not clear on some information regarding how to use the seaweed or how much to it.

As we continued our research, we concluded that the seaweed industry needs to provide better communication to the consumer.



### Zooming in on Information Access

While all the leverage points are important and interesting, we decided to narrow it down to the lack of information. We did a threshold and impact analysis and found that we can have the most impact within the information access. Before going into the details of our interventions, we would like to have a quick look at the consumers.

### Target Group

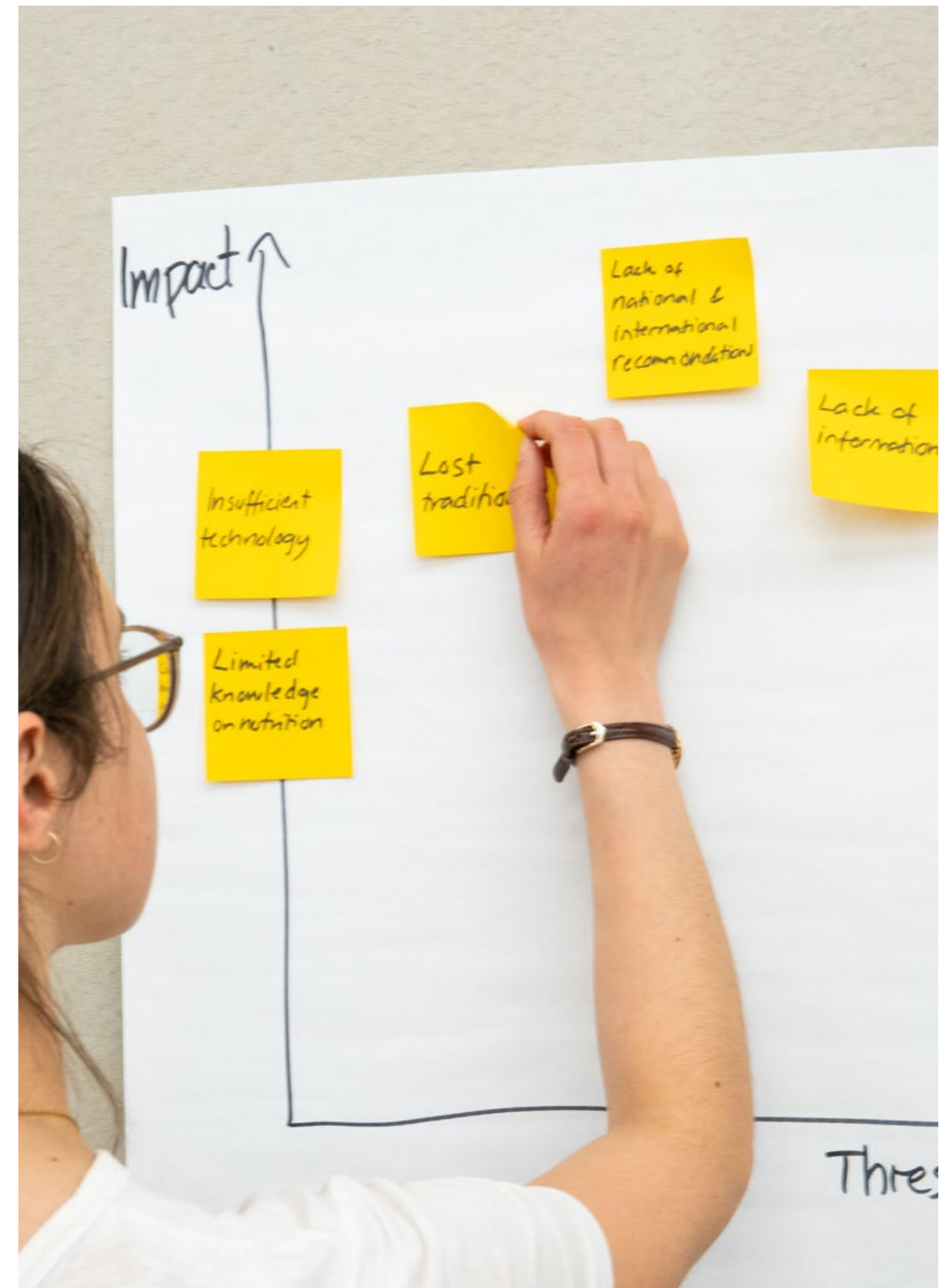
When developing new products, it is important to know who you are designing for. When deciding on a target group one can look at demographic and psychographic metrics (Vikøren & Pihl, 2020) such as age, place of residence, interests, habits etc.

The seaweed products will be a new addition in the Norwegian markets and a suitable target group for the industry can be the “early adaptors”. This term is from the Diffusions of Innovations Model, which explains how individuals in a social system adapt to new ideas

and concepts. The early adaptors are individuals that are open to innovations and embrace new trends (Rogers, 1995).

When researching food trends and target groups we came across a master’s thesis studying attitudes towards increasing the intake of plant-based foods among Norwegian consumers. In the thesis it is stated that people who are flexitarians and are open to vegetarian food are to be found in the segment of innovators and early adaptors, when it comes to increasing intake of plant-based food (Hatlebakk, 2020).

Speaking to Ting med Tang and other producers, we have learned that young adults living in urban areas are more positive towards eating seaweed than older people living in rural areas. Based on this and the two models of the diffusions of innovations, we suggest that the suitable target group are young individuals that are open to plant-based food and are living in urban areas.





## Ideation and Interventions

This chapter will explain our ideation process, how and why we developed our interventions and what we learned from testing them with users and stakeholders.

## Ideation Process

Even though our ideation and interventions are presented late in this report, it has been a focus during the whole project. We have had several ideation sessions and been writing down ideas parallel to researching and mapping. As brainstorming rarely results in the most innovative ideas, we have used ideation techniques to help us think creatively. As mentioned earlier, some of the techniques we have used are questions starting with “How might we..” and Edvard de Bonos Six Thinking Hats.

## Sketching

Sketching has been a part of our process throughout the project. We have used it both for an ideation tool and as a way to discuss and develop common mental models.

When working on the semantics, we have not had a typical design sketching process. Unlike a service that can be sketched through scenarios or an app that can be sketched through prototypes, sketching a language is an abstract process. As a result, we have used a more conceptual approach to sketching, where we talked to different stakeholders and discussed the ideas.



## Rating Ideas

Presented here, is an overview of the main ideas from our last ideation session. From categorising all our ideas, we found three themes: semantic, cooking and nutrition. We then rated these ideas using different parameters related to the feasibility and threshold analysis. In the

feasibility, we looked at time, economic, cultural and stakeholders frameworks. In the impact, we evaluated synergies with other ideas, as well as political and social aspects. Using the model of Sense of coherence (Antonovsky, 1996), helped us ideate even more on the three ideas.

- **Seaweed in TV shows**  
Communicate the properties of seaweed by promoting seaweed in TV shows. For example by collaborating with celebrities or making seaweed dishes in the Norwegian show 'God morgen Norge' (Morning show).



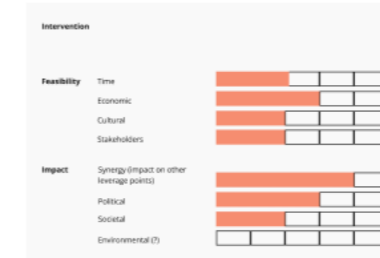
- **Seaweed in school books**  
Add seaweed into the class 'Mat og Helse' to teach children about seaweed



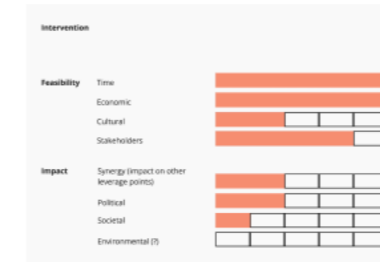
- **A taste label**  
A pairing system that gives information on the taste of the different specie



- **Information hub**  
A website that gathered all information on seaweed



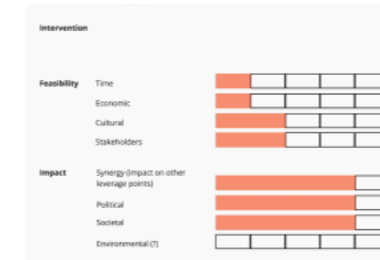
- **Health label**  
Create a label that provides information on iodine and the nutritions of seaweed



- **Promote seaweed through SIO**  
A partnership with the Student Organisation of Oslo to promote seaweed within students



- **Health campaign**  
Create a health campaign that promotes the health benefits of seaweed and showcases seaweed into dieting programs



- **Common language**  
Create a common language for seaweed and a classification system. Integrate seaweed into seafood.



- **Exhibiton on seaweed**  
Raise awareness about the possibilities that seaweed offers as food through an exhibition or a pop up display

## Interventions on Three Areas

To create a strong impact on the system, we suggest a portfolio of interventions, presented through our three focus areas: Semantic and Classification, Cooking, and Nutrition. We will now present each of these with a selection of prototypes.

### Semantic and Classification

Semantic is the study of the content of language, the connection between words, phrases and sentences and their meaning (Simonsen, Gram & Henriksen 2021). As Benjamin Lee Whorf states (1956, The Hannah Arendt Center for Politics and Humanities, 2015) “language shapes the way we think, and determines what we can think about”.

In our research on seaweed, we have discovered that the naming of the seaweed is inconsistent. The species all have Latin names, but when it comes to the vernacular language, they have different ones.

As mentioned in the “Taxonomy of Algae” there is also a challenge when translating “tang

og tare” to English, as kelp and seaweed are referring to other features of the macroalgae. This can cause problems and confusion when marketing and exporting seaweed to the international market.

When the seaweed industry penetrates the food market, it will be essential to have a defined common language, both on a national and international level. The Norwegian Seaweed Association is currently working on a communication strategy by collecting all the documentation and knowledge about seaweed that can be used for marketing (Meland, 2022). We hope to contribute to this work with the research and interventions we present in this section.



### Three Possibilities for Seaweed

From our research, we see three categories for seaweed:

#### Seaweed as a Part of Seafood

From speaking to producers and food experts, we learned that seaweed should be treated as seafood. Therefore, from a cooking and storing point of view, seaweed should be classified as seafood. This means that it will be included in the seafood regulation (Fiskeeksportloven), and that the Norwegian Seafood Council will be able to help the industry grow. In this scenario, they will be able to benefit from the large network within the seafood industry and market access on both a national and international level.

#### Seaweed as a Part of the Vegetables

From a nutritional point of view, seaweed has a lot of similarities to vegetables. Seaweed contains a lot of the same vitamins and minerals, including calcium and iodine. Seaweed also offers a low content of energy.

#### Seaweed as a New Category

With seaweed presenting its own characteristics, it can be hard to implement it into an existing category. To avoid consumer confusions, seaweed could be included into a new category. This would require that the Food Authorities and the Ministry of Trade, the seaweed industry and fish industry put together a committee to define this category and its legislation.



“In Europe we compare it to a vegetable, but that is not right because you eat it very differently than vegetables”

Representativ from the Food Authorities

### Stakeholders Understanding of Seaweed as Food

The Norwegian Seaweed Association has started a process to categorise seaweed. They have recently sent a letter to the Ministry of trade, industry and fishery asking them to change the law and include seaweed in the regulation of seafood. However, in this letter, they talk about macroalgae, which is the scientific name of seaweed. They do not give any hints on what seaweed should be called when communicating to the consumers.



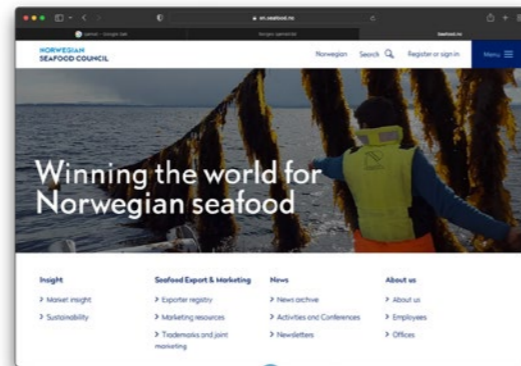
### The Consumers Understanding of Seaweed as Food

As consumers, we are used to put food into categories and speaking about food ingredients in terms of dairy products, vegetables, seafood and so on. But how would you categorise seaweed? We asked the consumers to do a little test where they were invited to classify seaweed as either seafood or a vegetable, based on facts that we gave them. Everyone had different interpretation of where the seaweed goes. The test validated our assumption that there is no collective understanding of seaweed classification. This can lead to confusion in the future when seaweed is launched into the stores.

## A Tool For Discussions

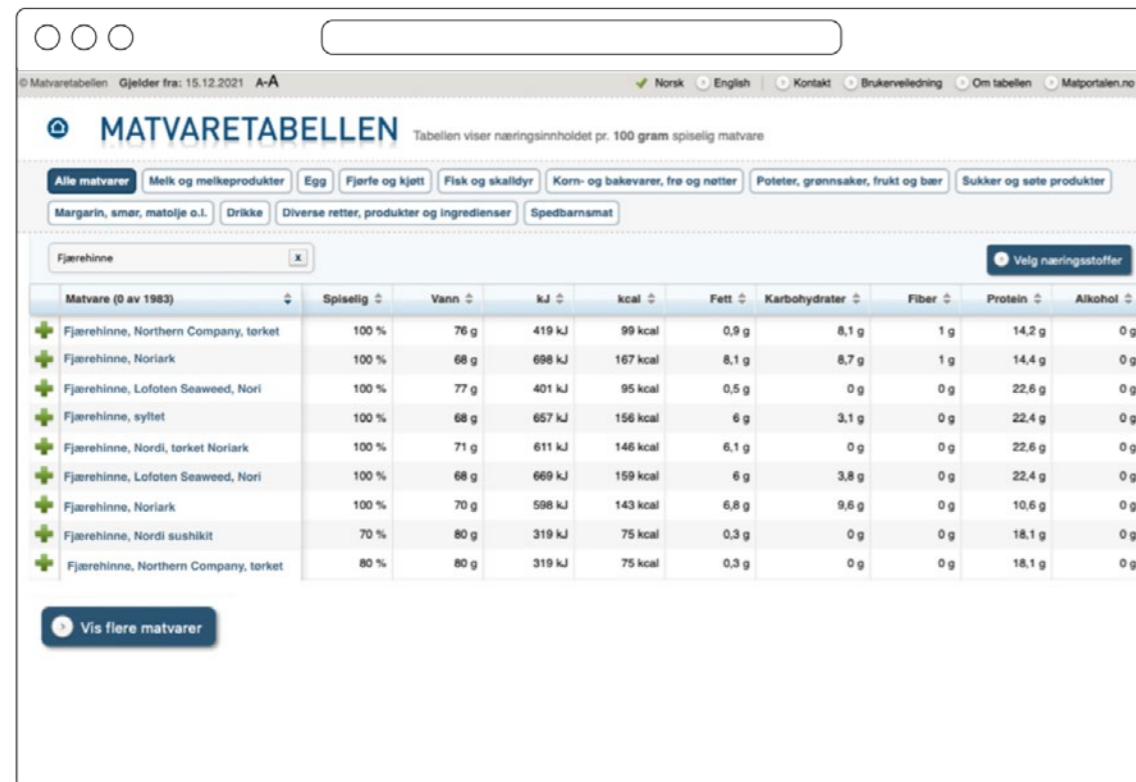
To gather all our thoughts and ideas of how the semantics can affect our surroundings, we created prototypes and presented these to various stakeholders, being: seaweed producers, a nutritionist, a researcher, The Norwegian Food Authorities, and The Norwegian Food Council.

Sketch 1



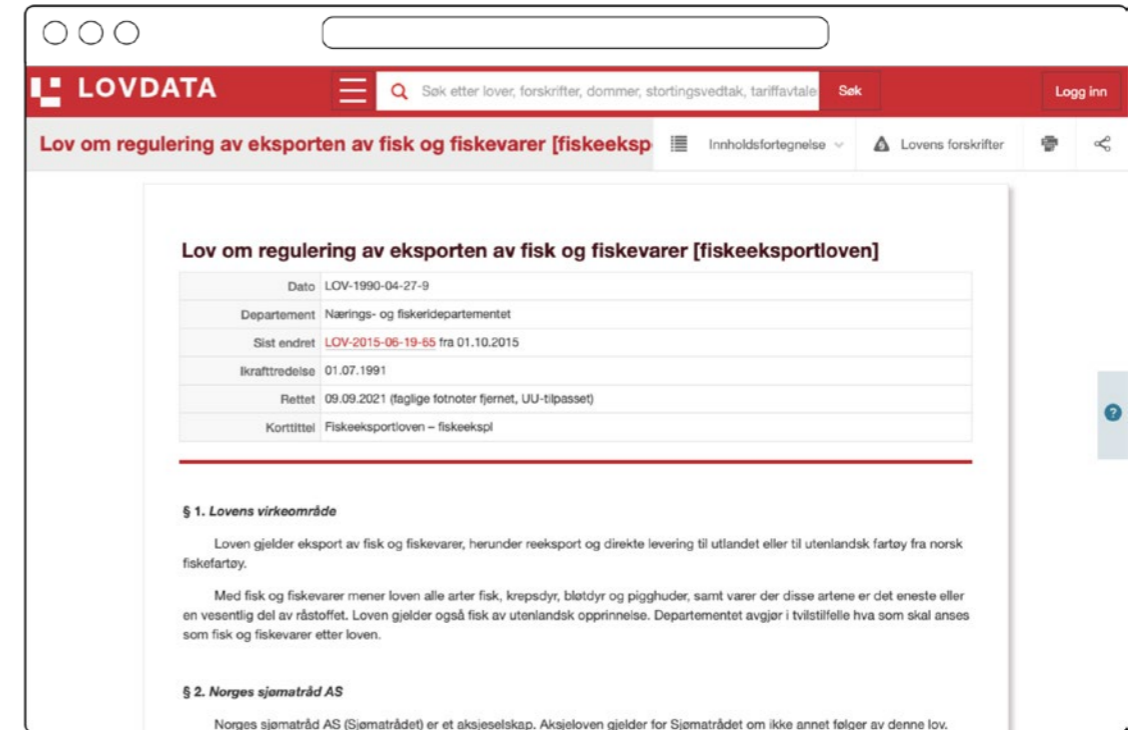
Modified from Seafood.no (2022)  
Image of seaweed: Seaweed Solutions AS

Sketch 2



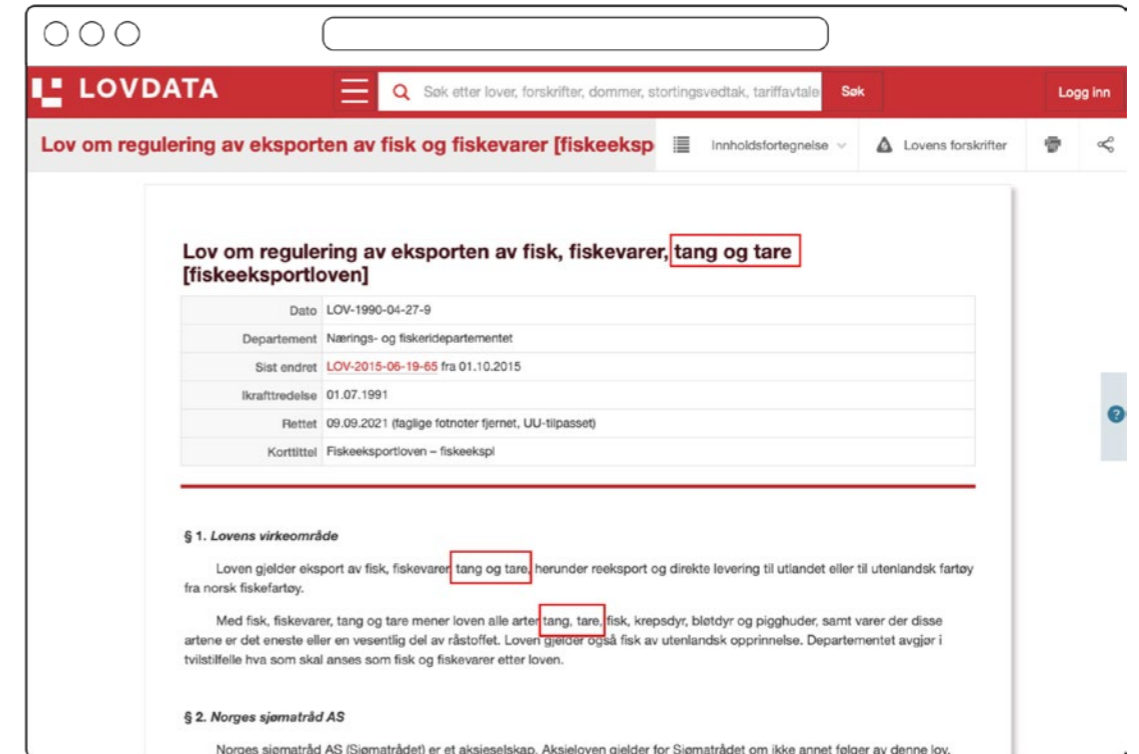
Modified screenshot from Matvaretabellen.no (2022)

Sketch 3



Screenshot from Lovdata.no (2022)

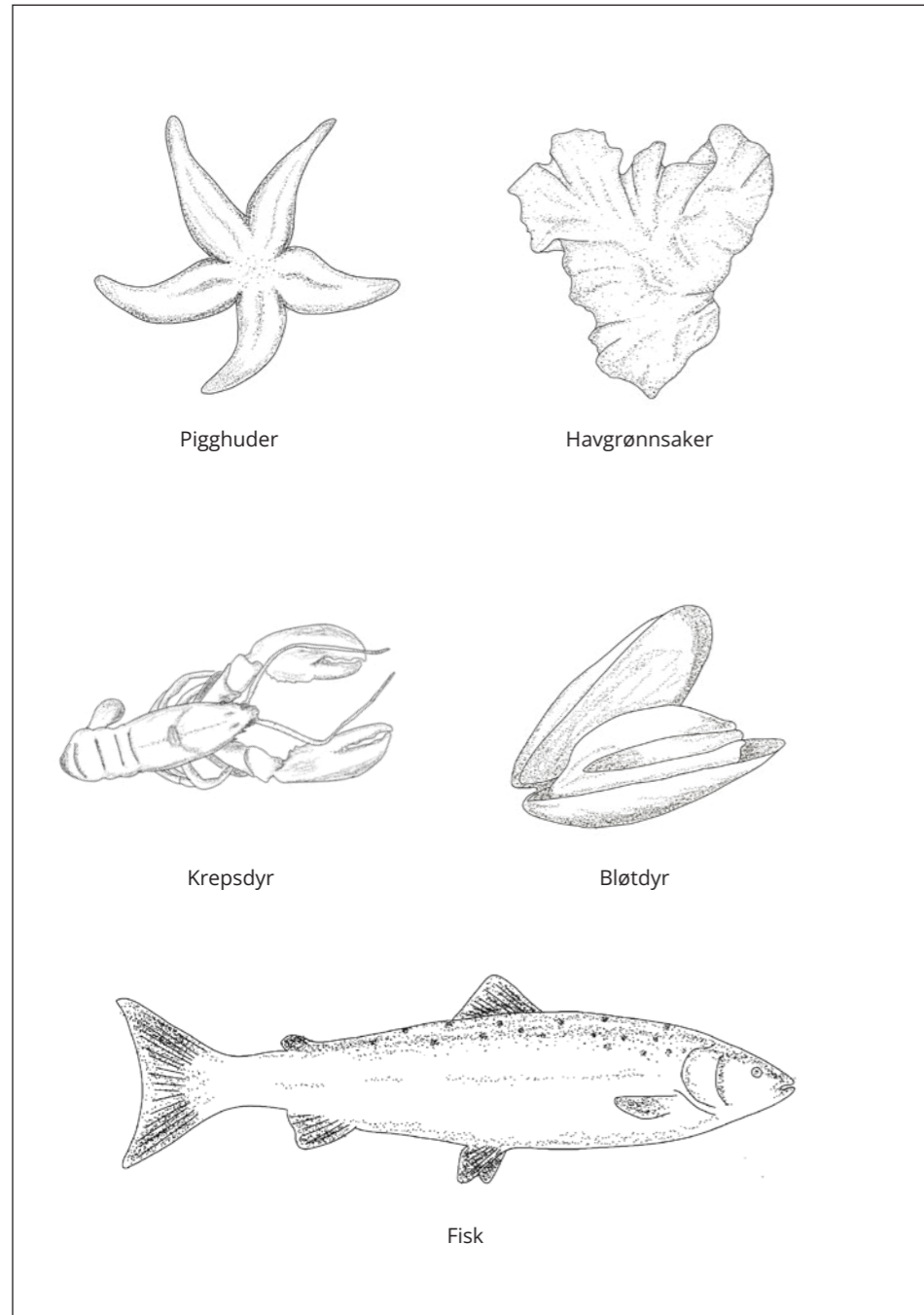
Sketch 4



Modified screenshot from Lovdata.no (2022)

Sketch 4

Our proposal of Norwegian sub-categories of Seafood



### Learnings

We learned that the Seafood Council is positive to including seaweed in their work. They stated that “we have always said it should be a part of seafood, both our board and the administration. If the law changes, we are very happy to include it in our work”. We find this to be a good signal for the Norwegian seaweed industry, as the council have a lot of knowledge on how to do market research and strategy for seafood. In fact, they invented the idea of salmon being a part of sushi, way back in 1985. This laid the foundation for the Norwegian salmon fairy tale (Chrømer, 2017).

The Norwegian Food Authorities told us that they have been discussing what the category that includes seaweed should be called, but nothing is decided. They also told us that the categorisation of seaweed differs a lot within the European countries: “In some countries in Europe they compare it to a vegetable, but that is not right because you eat it very differently than vegetables and seaweed has quite different characteristics and growth environment compared to land plants” (representative, The Norwegian Food Authorities, 2022).

From talking to the Norwegian Seaweed Association, we got feedback on the names

of the categories and subcategories. We then updated the prototype with the proposed law, including “macroalgae”, instead of “tang og tare”, since macroalgae is a broader term.

### Conclusion – Seaweed Should Be a Part of Seafood

Our conclusion is that seaweed should be included as seafood. We support the Norwegian Seaweed Association and think it makes sense to include seaweed in the seafood category. In addition, we suggest creating a new subcategory, called Havgrønnsaker (Sea vegetables). We think that the word Havgrønnsaker communicates its origin, being from the sea (hav) and its nutritional features, similar to vegetables (grønnsaker). It is also easy to say, rather than saying “Tang OG Tare” all the time.

Including seaweed in the seafood category will also benefit the seaweed industry, as they can be supported and promoted by the Norwegian Seafood Council.

The following pages illustrates how changes in the semantic of seaweed can manifest in the world, through evidencing prototypes.

Updated suggestion for the new law, including macroalgae

**LOVDATA** | Søket etter lover, forskrifter, dommer, stortingsvedtak, tariffat | Logg inn

**Lov om regulering av eksporten av fisk, fiskevarer og makroalger** | Innholdsfortegnelse | Lovens forskrifter

Dato	LOV-1990-04-27-9
Departement	Nærings- og fiskeridepartementet
Sist endret	LOV-2015-06-19-65 fra 01.10.2015
Ikrafttredelese	01.07.1991
Rettet	09.09.2021 (faglige fotnoter fjernet, UU-tilpasset)
Korttittel	Sjømateksportloven

**§ 1. Lovens virkeområde**

Loven gjelder eksport av fisk, fiske **makroalger**, herunder reeksport og direkte levering til utlandet eller til utenlandsk fartøy fra norsk fiskefartøy.

Med fisk og fiskevarer mener loven alle **makroalger**, krepsdyr, bloddyr og pigghuder, samt varer der disse artene er det eneste eller en vesentlig del av råstoffet. Loven gjelder også fisk av utenlandsk opprinnelse. Departementet avgjør i tvilstilfelle hva som skal anses som fisk og fiskevarer etter loven.

**§ 2. Norges sjømatråd AS**

Norges sjømatråd AS (Sjømatrådet) er et aksjeselskap. Aksjeloven gjelder for Sjømatrådet om ikke annet følger av denne lov. Staten skal eie alle aksjer i Sjømatrådet.

Styret skal være representativt for fiskeri- og havbruksnæringen. Departementet kan ved forskrift gi nærmere bestemmelser om sammensetningen av styret.

Sjømatrådet skal utføre de oppgaver som er fastsatt i denne lov eller i forskrifter gitt med hjemmel i loven. For øvrig skal Sjømatrådet gi råd til departementet i spørsmål som angår eksport eller omsetning og produksjon i sammenheng med eksport.

Forvaltningsloven gjelder ikke for Sjømatrådet, unntatt i saker om enkeltvedtak som Sjømatrådet treffer etter § 3 i loven her.

Endret ved lov 17 juni 2005 nr. 90 (kr. 1 sep 2005 (lo. res. 19 sep 2005) nr. 90/0. 9 des 2011 nr. 56 (kr. 1 jan 2012 (lo. res. 9 des 2011) nr. 122/1)

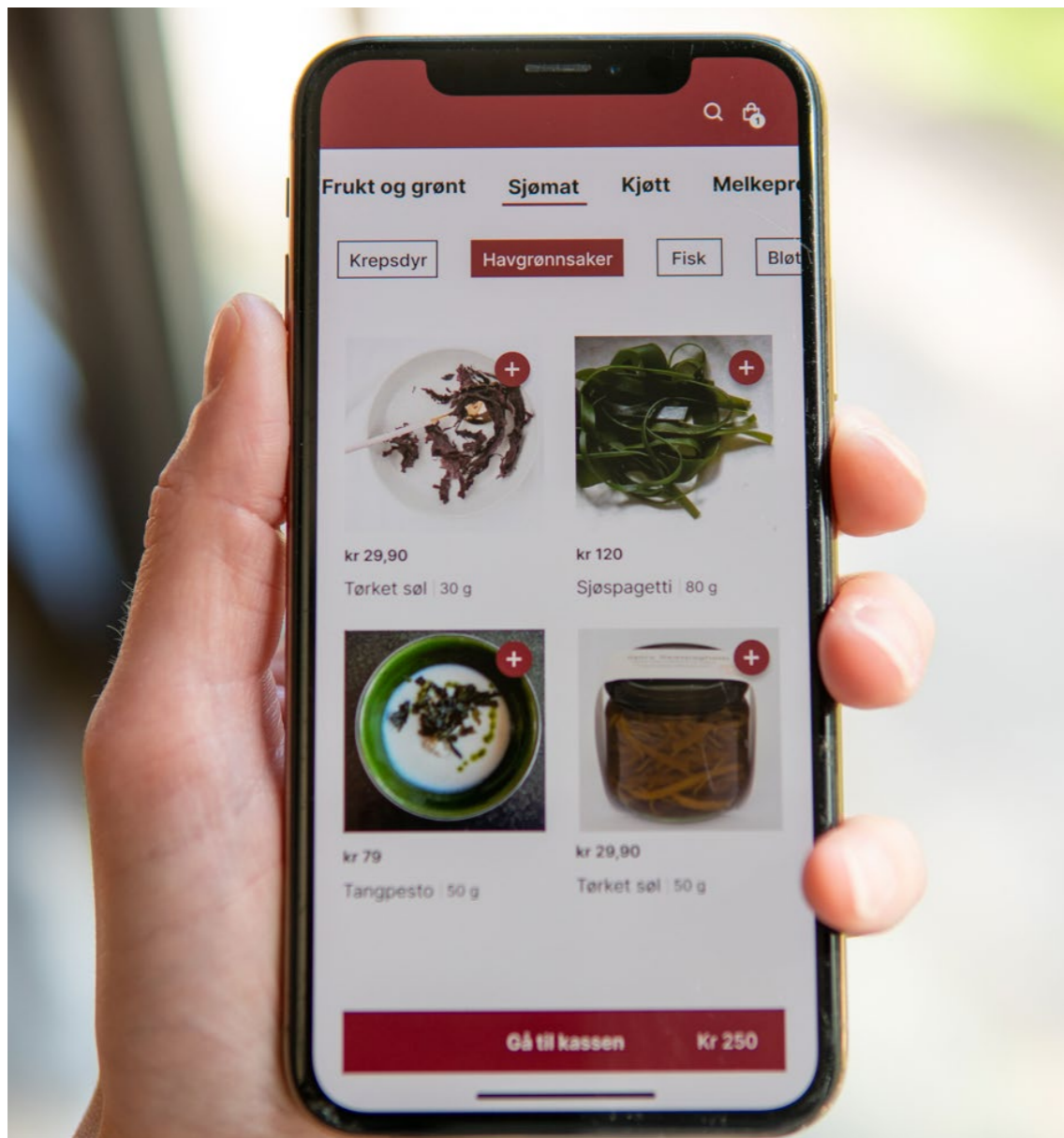
Modified screenshot from Lovdata.no (2022)

Havgrønnsaker as a part of seafood in a school book



Modified image of the book Kokebok for alle

Havgrønnsaker in an online food grocery app



A pairing label at Vinmonopolet specific for havgrønnsaker









Nachos with pickled vegetables & seaweed



Tagliatelle with seaweed, tomato sauce & seaweed balls



Fish Cake, Potato Salad With Seaweed. Topped With Pickled Seaweed

## Cooking

As seaweed will be a new ingredient for most people, knowledge of how to cook it will probably be at a minimum, even for the innovators and early adaptors. We therefore chose to look more into information about cooking with seaweed, focusing on the packaging and online information.

## Dinner Test

After attending a seaweed safari with Ting med Tang, we felt inspired to experiment with seaweed and understand how seaweed can become a part of the Norwegian food culture. As the tasting plays an essential part of the experience itself, we felt the need to host some tasting events, to better understand the Norwegian consumer. As a result, we decided to organise a dinner where we served three courses containing seaweed.

During the dinner we incrementally increased the amount seaweed in each course. As shown to the left, the first course had a small amount of pickled winged kelp on top of the nachos. The second one presented bladder wrack in the tagliatelle with fried seaweed balls made of mermaid hair. The third course was potato salad with pickled bladder wrack topped with dried sugar kelp and large chunks of pickled bladder wrack.

We asked participants to write down their expectations and learnings, before, during and after the dinner. The most interesting learnings from this test was that they expected seaweed to be a bigger part of the dish, the seaweed to be more slimy and salty, and for it to smell more.

From this dinner we validated our assumption that seaweed goes well into the seafood category, not only because of how you treat it, but also because of its taste and how people would pair it with other food.

We did another short tasting event, where we invited several types of users: from amateurs to food experts, to people disliking seafood. It was interesting to see that participants who do not like the taste of seafood, were sceptical in the beginning but after trying the seaweed they wanted some more.

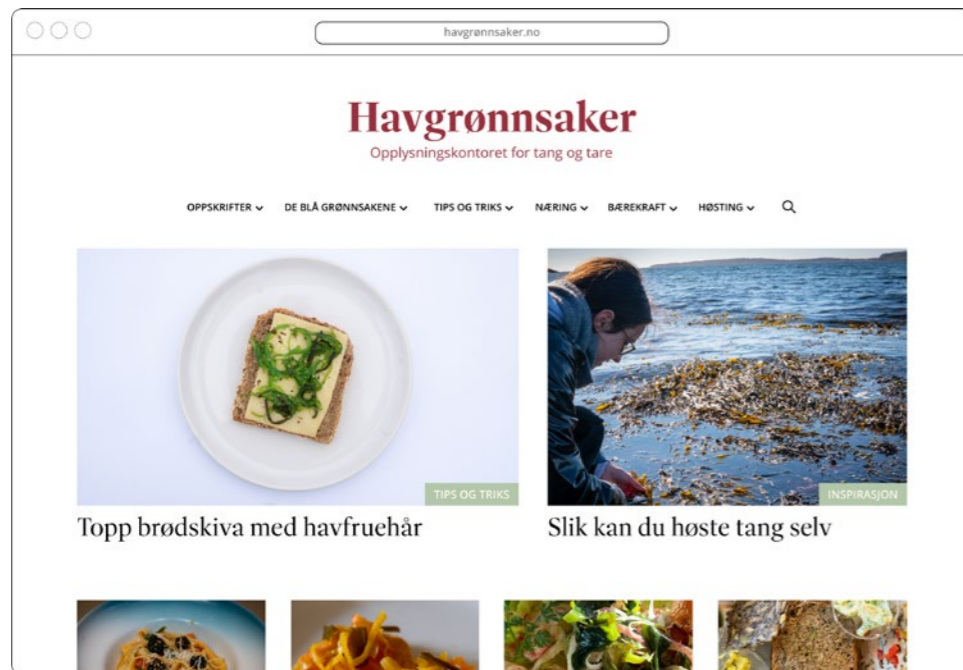
## Tiny Interviews

To understand where people would look for information about cooking seaweed, we conducted quick informal interviews. One participant stated, "If I were to look for a recipe with seaweed, I would just google it online". This resonates well with the answers we got from the other participants.

### Nutrition page prototype



### Landing page prototype



### Prototypes

Based on our findings from the test, the tiny interviews, interviews with stakeholders and desk research we developed prototypes for four concepts.

#### Website With Recipes

As stated earlier, online information about seaweed as food is scattered and inconsistent. As a solution to this we prototyped a website called Havgrønnsaker. This site can work as an information hub guiding the consumers on how to tread, cook and pair seaweed in food. It can also provide information about the nutritional aspects of the sea vegetables. We suggest that the site is operated by a foundation, supported by The Norwegian Seafood Council, The Norwegian seaweed association and other actors in the industry.

### Label with cooking instructions

If seaweed becomes a part of the regular products at supermarkets, we wonder how people will interact with it. What will they do if they happen to walk pass it at the store? Or if they get it as a gift from someone?

Norwegians are not used to using seaweed in and as food. As a scientist during our interviews said: "If you give a Norwegian a bag of seaweed, they don't know what to do about it."

To explore this further we made a prototype with symbols showing cooking instructions on a package, as shown to the top right. This label communicates how the specific seaweed product should be treated. In this example it can be used as it is, no blanching or frying is needed.

After testing this in a scenario with consumers, we validated our prototypes. People understood the information and felt that it was helpful. It made the product less intimidating to use.

For these labels, we believe that more testing is required to verify its use within a specific context, such as at the store or at home.





PASSER TIL	SMAKSPROFIL	PASSER TIL
 Vannmelon	 Sødme	 Pannekaker
 Pastinakk	 Umami	 Pasta
 And	 Sjøsmak	 Suppe

### Taste Profile and Pairing

When we asked one of the participants from our dinner test if they would cook with seaweed they said: “Yes, if I had a recipe and I knew how to cook it.”

We did some research on existing packages with seaweed, found inspiration from other products and made three prototypes for a labelling system that gives the consumer more information on how to use the seaweed product.

Additionally, we made three prototypes to communicate the culinary features of the seaweed: one displaying what ingredients you

can pair it with, another one which dish you can include it in, and the final one defining its taste profile, by including the umami taste, sea taste and its sweetness.

We included these in our testing with consumers and learned that the three labels suited different target groups: the pairing label was most relevant for “foodies”, being people that like to cook at home. The label with the dishes fits novice cooks that need a concrete example of how to use it. Finally, the label with the taste profile is more appropriate for food experts and people that regularly cook with seaweed.

**Psst!**

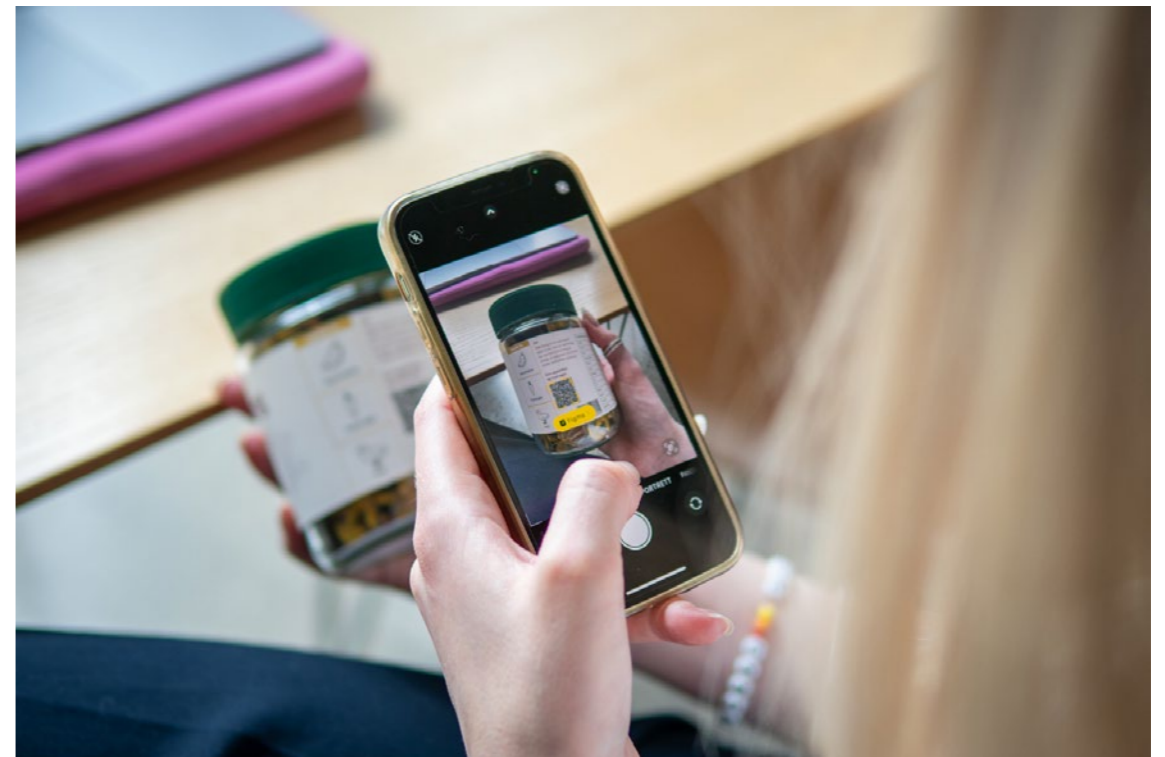
Prøv en av våre oppskrifter!



#### QR-Code

Each of the labels also had a QR code leading the consumer to a page with recipes, located on the webpage Havgrønnsaker. Several of the participants pointed this out to be helpful, especially when they reflected on what to do with the leftovers. We linked the QR-code to the webpage Havgrønnsaker, but we imagine that it might make more sense for producers to link to their own website.

Testing within a scenario





## From Testing

Our main learnings were that the information has to highlight the amount of iodine and provide more details on how much the consumer should consume. It should also be easy to understand with some visual clues.

After testing it with the consumer, we made a new label which we discussed with a representative from the Norwegian Food Authority, producers and a researcher specialised in iodine in seaweed.

From these discussions, we learned that the water boiled with seaweed contains a lot of iodine and should not be used as stock. Thus, we

decided to add some information about it on the label.

A more exciting and optimistic learning from these conversations is that scientists have found new ways to reduce the iodine in seaweed. By using sea water instead of fresh water, results have shown that 95 percent of the origin iodine content can be removed. From our interviews and testing, we also learned that seaweed will naturally be consumed in small quantities, as it is not used to replace a protein. Therefore, while there is a need for clear information about iodine intake today, iodine might not be a challenge in the future.



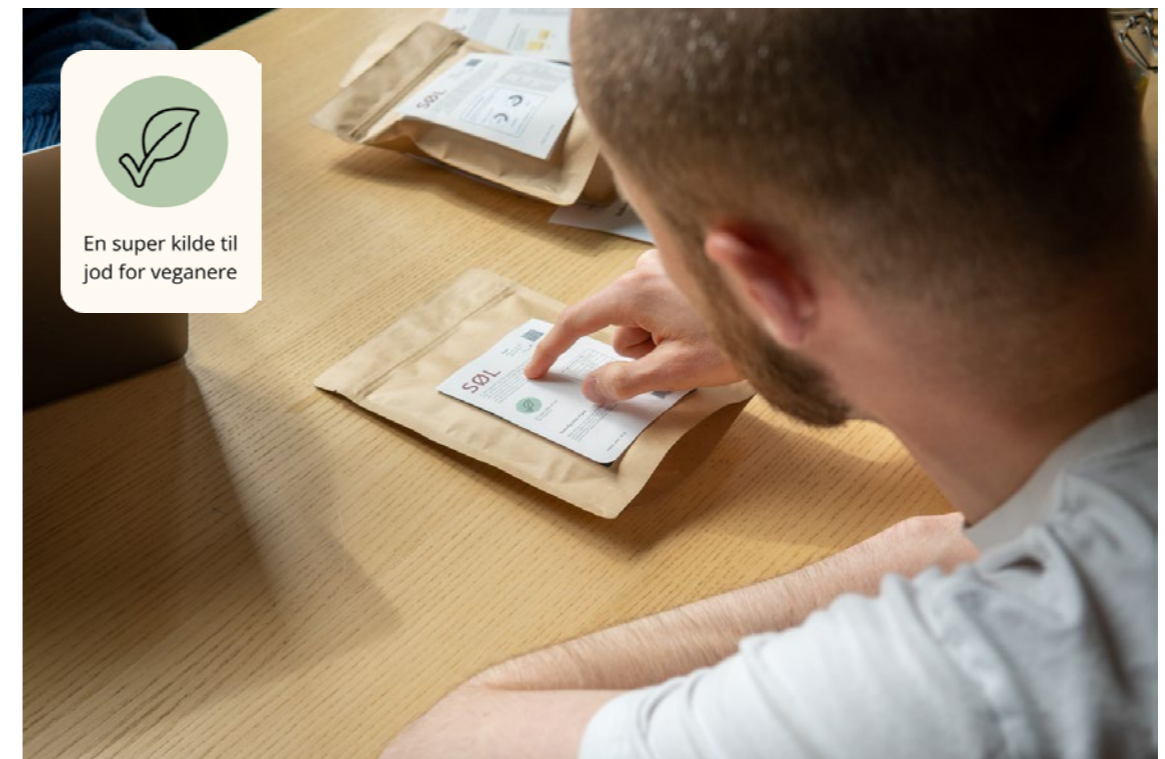
## Final Label



### 5 a Day Label and Vegan Label

Since seaweed contains many nutrients and minerals, we have also tested different types of concepts to communicate its health benefits. For example, we tested adding a label with the five a day campaign on the packaging. Participants were surprised that seaweed was such a nutritious food ingredient and that it could replace the nutrition from a vegetable or fruit. We also discussed the label with a nutritionist who validated that seaweed could be one of the 5 a day.

Iodine being mainly accessible in dairy and fish products, we also assume that seaweed could be promoted to vulnerable groups, such as vegans, vegetarians and breast-feeding women. Studies have shown an important deficiency in iodine within vegan and vegetarian groups in Norway (Johansen, 2016). With this in mind, we made a label targeted specifically at vegan consumers. From testing it, we learned that the information was quickly and positively understood. As we imagine that penetrating the food market will start with early adaptors such as plant-based consumers and food enthusiasts, we see that the information on iodine should not be taken for granted.





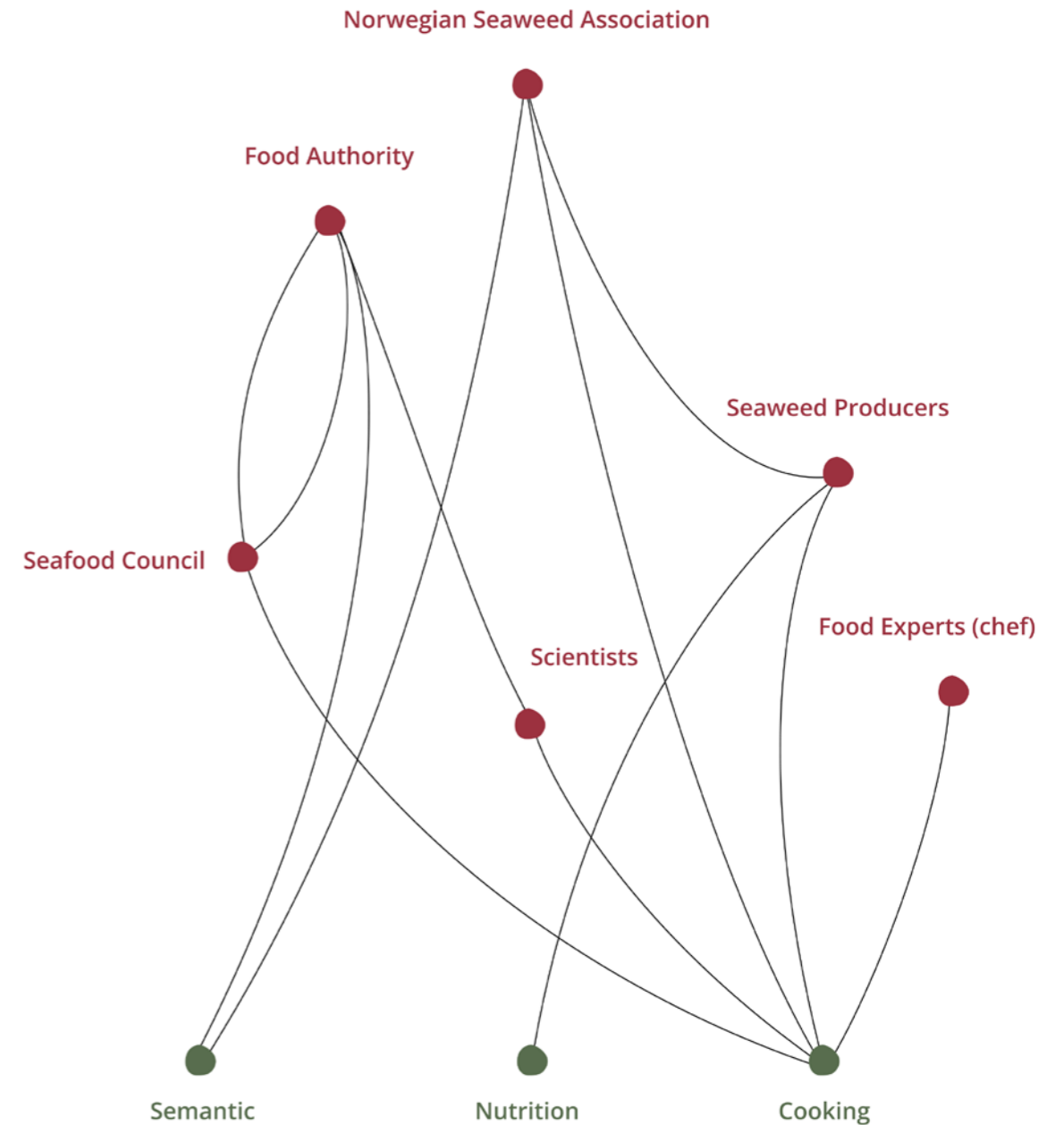
## Conclusion: Portfolio of Interventions

### The key stakeholders for these concepts

For each of these concepts, we tried to understand and map out who would be responsible for these to happen (see visualisation). The main actors are: The Seafood Council, The Food Authority, The Norwegian Seaweed Association, scientists, seaweed producers and food experts.

As illustrated in the visualisation, we imagine that the Norwegian Seaweed Association would provide information on the three topics, but in different ways. While the information on semantic and cooking will be addressed directly to the consumer, the nutritional information will be a guideline for the seaweed producers.

We showed the final prototypes and this responsibility stakeholder map to the Norwegian Seaweed Association and discussed how their network could contribute to providing these information. The idea of having an opplysningskontoret (information office), like the fruits and vegetables (frukt.no) or the milk and dairy (melk.no) hub, seemed like an interesting and natural path to take for the NSA. As these are important questions they are planning to dive more into after the summer, we have been invited to present our portfolio of interventions to the other members in the fall.



### The synergies between the interventions

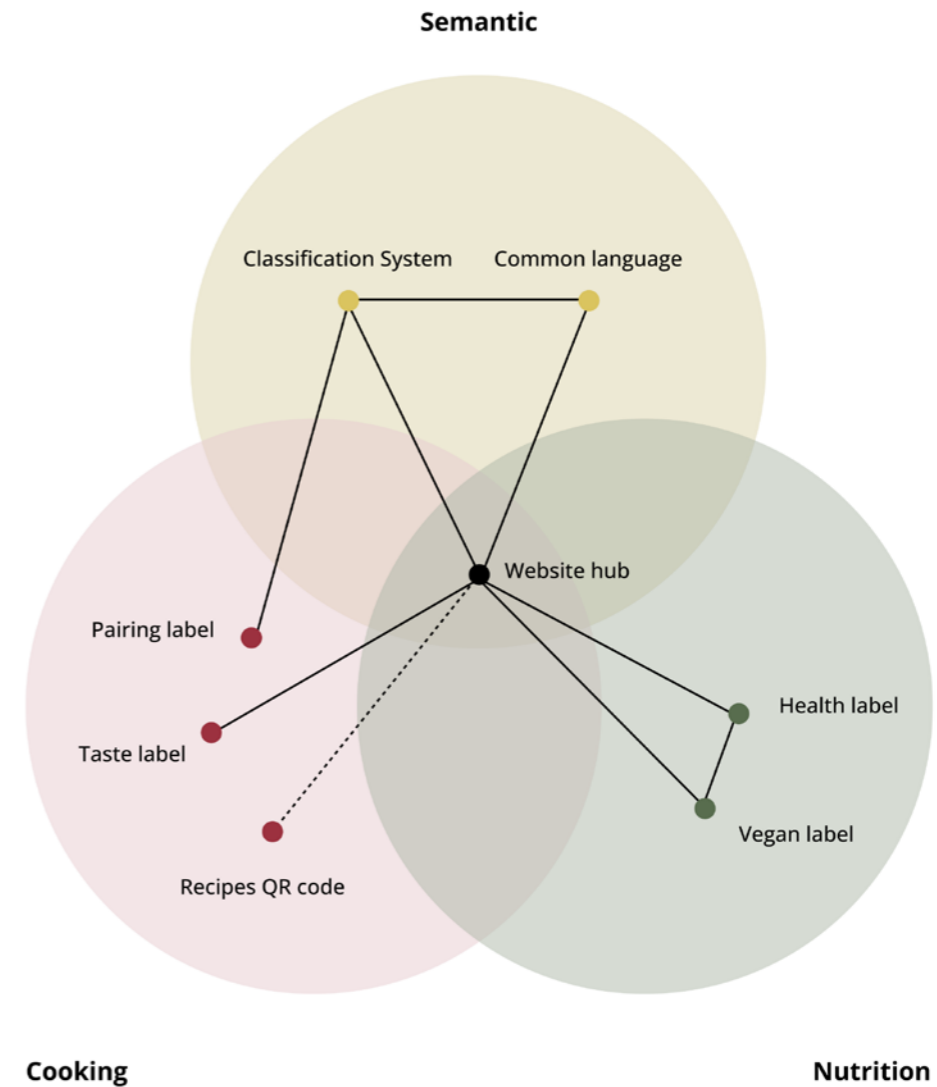
To conclude, this set of interventions are ideas that could support the seaweed industry in penetrating the food industry in Norway. They should be considered as a conversation starter to an emerging field. On their own, the interventions have little impact; it is when combined that they can make a difference.

The semantics will be the basis for all of them, as it shapes the way we perceive, use, and treat the seaweed. By having a common language for seaweed and classifying into a defined food category, the industry actors will be able to raise awareness about this sea vegetable and create new perceptions as well as associations to seaweed. This will help guide the consumer in their decisions and actions. It will also make seaweed edibility more convincing.

With a clear semantic, the seaweed industry will be able to create an information hub and

collect all the information necessary into a website (opplysningskontoret). This site will provide standard information regarding taste, health, recipes, and pairing ideas as well as other topics such as harvesting information and sustainability facts.

While all the important information will be gathered online, other ways to access these guidelines will be available on the product. A standard labelling system will guide consumers during their shopping decisions, and indicate them on how to cook, pair and treat seaweed. For more specific instructions on how to cook it, a QR code linked to the information hub will provide seaweed recipes. However, this might be information that producers provide. The labelling standard will also provide details on the nutritional benefits and risks of seaweed to educate consumers about their individual intake.





## Reflections and Conclusion

This project has been fun, constructive, as well as challenging. In this chapter, we will discuss some of our main learnings and reflections on our delivery.

## Reflections

### New Food, New Culture?

This project has been a bit of a rollercoaster. While some stakeholders were extremely optimistic and visioned seaweed to be the future food, others were discouraging and critical about it.

While the iodine obstacle is certainly something to consider, it is taking up a lot of space in today's research, as well as in our project. However, there are other problems that need to be addressed for seaweed to become a part of our diets.

Changing a tradition is hard and takes time. It is a multitude of small and big adjustments that can influence a culture. While seaweed could be an important part of the future Norwegians food tradition, there are a lot of steps to make these changes in people's habits. Food is emotional and comes with many associations and beliefs. Therefore, we believe that in the future more research must be done on how to make seaweed desirable.

### Effect of Scaling Up

Additionally, there are some ecological considerations to take into account. With new industry comes with a lot of uncertainties. On a small scale, the impact can be ignored. However, what impact will a large-scale seaweed farming industry have on our ecosystem? As a producer said: "When you grow things in large scales, it is just not possible to do it sustainable". As of today, little has been studied about its effect on our environment. Therefore, more research about its impact is needed for the industry to grow.

### Doing a Project in Systems Oriented Design: a Risk?

Having both not taken a semester in system-oriented design choosing this discipline/method was a risk, but a good risk. While it could certainly be one of our weaknesses, we both feel enriched. Not only was a systemic approach more suitable as, there are so many underlying problems that needed to be addressed, it also enabled us to widen our skills and expertise. As we wanted to make the most of our time at AHO and of our design education, we feel grateful for this experience.

### Language Barrier

When starting the project, we did not consider the language barrier. As we had to narrow down our research, we saw a huge potential for seaweed in Norway and it became a natural path. While the linguistic barrier has certainly been a challenge for Cannelle, we have worked our way around it. Whether that means by installing Google Translation's plugin to the web, or Henrikke having to translate important information, we managed to tackle this obstacle.

### The Strength and Weakness of Design

Working on an iodine label, a challenge that is so closely related to the field of science, is certainly a limitation when it comes to having a designerly approach to this problem. On a bigger scale, having never worked with seaweed before, we have encountered some lack of expertise in this field.

On the other hand, the discipline of Design has helped us get a more holistic overview of the current situation. As we need a shared understanding of where we are today to understand where we are heading towards, Design can help draw this understanding and predict the status of tomorrow. To be more precise, Design has the ability to invite various stakeholders to the conversation and move towards the common goal.

Speaking to stakeholders we quickly realized a need to explain what we mean by "design" and show examples of how we could contribute to the seaweed industry. Many associates design to graphic design, and this led to some misunderstandings. We solved this by creating some visuals of how we imagined to contributing. This also helped us to reflect on our skills as designers and the direction of our project.

### The Oslo Fjord is Dead

In the past, the Oslo was inhabited by a rich diversity of marine plants, fish, whales hunting herring and birds (Christensen, 2020). Today, most of this is gone and the fjord is nearly dead. In addition to being a concern to our environment, it has been a limitation to our project. Wanting to do tests with seaweed as food, we have struggled to access suitable products in stores, and harvesting in the Oslo fjord has not been an option, due to it being heavily polluted. To encounter this, we saved what we had from the seaweed safari and Henrikke went harvesting when being in her hometown on the north-west coast.

### Us As a Team

Being two in this project has been a strength, as it has given us the opportunity to bounce off ideas, discuss findings and argue our views/reasoning. It has also been great to have support in on another when plans go wrong or when celebrating wins. Additionally, we have taken our different sets of skills into consideration when splitting tasks.

Both having a bachelor from universities of more academic character than AHO has been challenging from time to time. Knowing how to balance between creative and academic work has been an important learning.

## Conclusion

The seaweed industry in Norway is a growing field and there are many questions that arises from it. Starting this diploma, we wanted to understand how seaweed can become a bigger part of the Norwegian diet. All our research and testing of interventions has brought us closer to understanding why we do not have seaweed in the stores today, as well as what it would take to get it there and create a market for it.

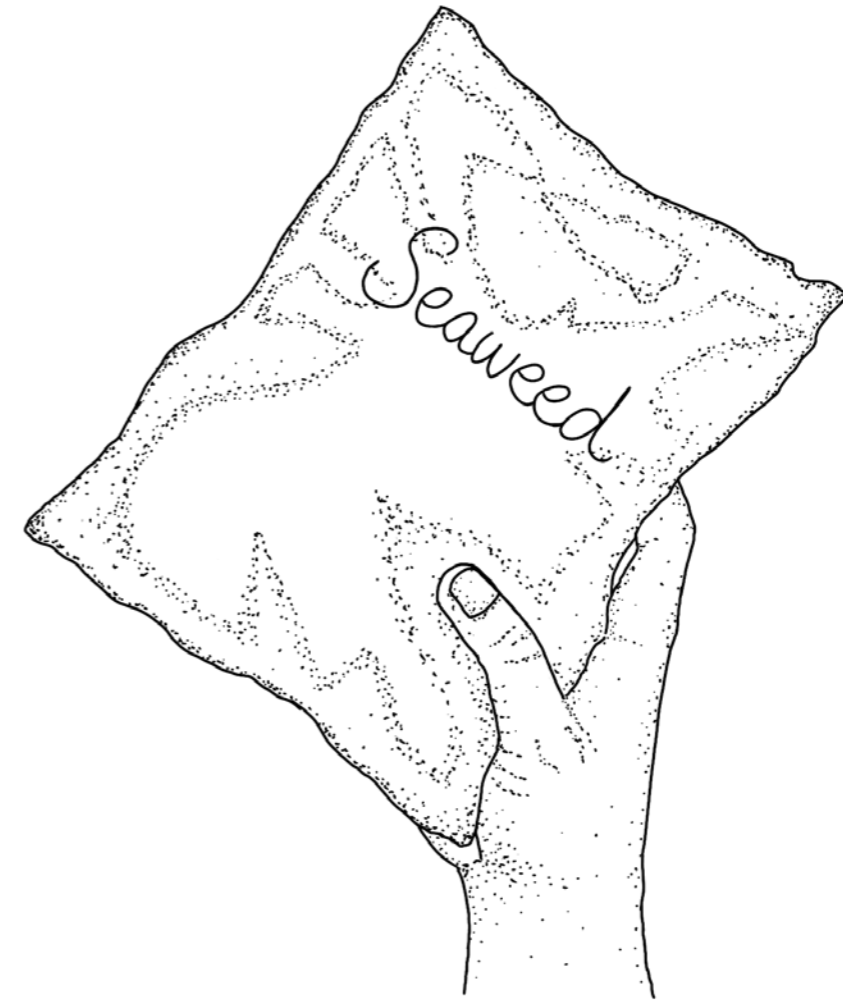
Our main suggestion is to create a common language for seaweed and assign it into a specific food category. This will create a solid foundation for the industry when launching seaweed into the market and create a universal understanding of this product. For this to happen, a collective effort will be required. As a seaweed producer said: "we have to collaborate, alone we cannot achieve anything". Creating new associations to existing perceptions can only be achieved when producers and seaweed networks join forces with public authorities.

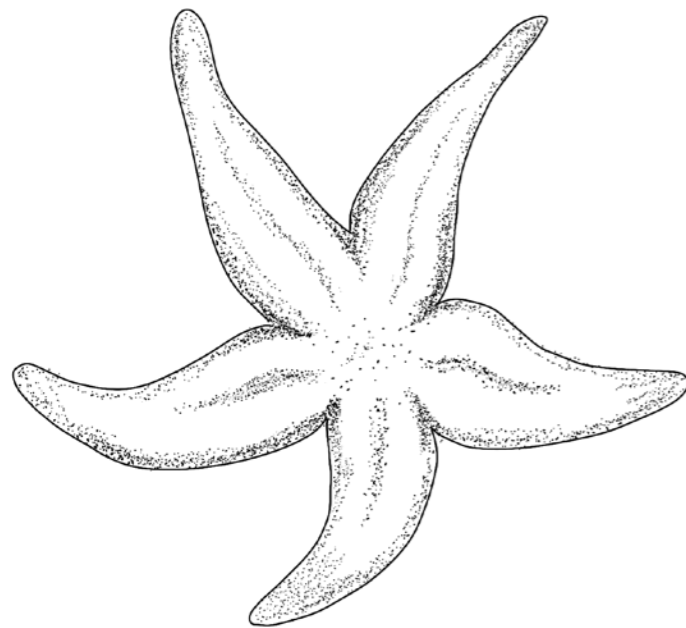
When creating demand for a new food product, one must keep in mind the importance it plays within a culture. Food traditions take time and comes with association to specific values and social connections. An important part of understanding the consumers' needs and behaviour is to understand their motivation of buying seaweed. As Florent Govaerts (2022),

a PhD marketing researcher, said: "people are positive about seaweed as food, but this does not mean that they will eat it or buy it." From our research, we learn that people are both positive but also sceptic towards seaweed.

Our main finding is that Norwegians lack the experience and knowledge of using seaweed in and as food. Few have tried to cook it, and many were scared about the high iodine content. However, once they got to experience the seaweed they were surprised by the taste and positive to try it again. The umami taste offers a lot of potential and there is a reason it has played an important part in some cuisines.

In this project, we feel that we have only scratched the surface of some of the challenges and opportunities uncovered. For the industry to move forward, the producers and scientists needs to develop the right technology and gain more knowledge about the nutritional aspects. The public authorities must address and communicate the recommendations of seaweed and include it into the regulations of seafood. Only then will the industry have enough resources to do the market research required, be able to accelerate the launching of seaweed as food and make it a part of the solution for the future food system.





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