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Preface

Writing a master's thesis has been a demanding but educational process. It has been very exciting to get used to a topic that is very relevant both now and in the future. The professional yield has been great, but I have learned so much more than what is on the paper you are holding. The amount of work and understanding invested into these past months is indescribable. The Master's thesis is written as a final part of my master's degree in industrial economics at the University of Stavanger, Department of Security, Economics and Planning. The thesis amounts to 30 credits and was prepared during the spring semester 2019.

Before I started the thesis, I had little prior knowledge of the subject, but after a lot of hard work I realized that it has been an incredibly exciting topic to work with, at the same time as it has been challenging. One of the biggest challenges has been the scope of this field as there is so much information on the topic. Aquaculture has proven to be a huge industry where it has been difficult to determine which aspects that is most important. Through my work, I have acquired impressing amounts of new knowledge that I am convinced that will be of further use.

I would like to show my gratitude to Roxel Aqua, especially Tord Ludvigsen and Åsmund Berget, for the commitment and guidance associated with the work on this thesis. I would like to thank Ragnar Tveterås who has been the supervisor and made the study trip to the Faroe Islands possible. I would also like to thank my academic director, Sigbjørn Landazuri Tveterås, for good advice and encouragement throughout the process.

Ultimately, I must thank family and friends who have motivated me further throughout heavy period this semester.

Author

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Abstract

The current conventional aquaculture industry represents a need for technology development as the locations suitable farming are limited. At the same time, there are other challenges such as salmon lice and pollution of the seabed that should be improved in order to preserve the environment as much as possible. Significant growth in demand in recent years has driven production to maximum capacity and the fjords are filling up, which has led to various consequences in terms of quality, the welfare of the fish and the environment surrounding it. This thesis assesses one of the possible solutions “Octopus”, which is an offshore installation modified for fish farming developed by Roxel Aqua. By moving the fish farming to more exposed areas offshore may contribute to an increase the production of farmed salmon, lower the mortalities and prevent diseases. In order to find the most suitable areas for “Octopus”, a PESTEL analysis as a decision tool is used to assess the external factors that could affect a business entering a new market. This tool showed that of Iceland, Scotland, Ireland and the Faroe Islands, it is the Faroe Islands that is the most suitable location for “Octopus” based on political, economic, social, technological, environmental and legal factors. There are recommendations for Roxel Aqua to be considered as they enter a new market, such as keeping up with the political landscape, be prepared for possible future foreign competition, enter the market with open communication and provide knowledge of the industry along with honouring the traditions and to ensure that operations goes in accordance with a sustainable future.

Nomenclature

ABS	"American Bureau of Shipping", a maritime classification society
AGMD	Aquaculture and Foreshore Management Division
ALAB	Aquaculture Licenses Appeals Board
ASC	Aquaculture Stewardship Council
BAP	Best Aquaculture Practices, Sea fisheries board
BFCR	Biological Feed Conversion Ratio
BIM	Bord Iascaigh Mhara
CAR	Controlled Activity Regulations
Cm	Centimetres
DNV GL	"Det Norske Veritas Germanischer Lloyd", international accredited registrar and classification society
EIA	Environmental Impact Assessment
EPA	Environmental Protection Agency
EU	European Union
FAO	Food and Agriculture Organisation
GDP	Gross Domestic Product
HRA	Habitats Regulation Appraisal
H_s	Significant wave height, the mean wave height of the highest third measured waves
IMO	International Maritime Organisation
ISA	Infectious Salmon Anemia

Kg	Kilograms
Kg/m^3	Kilograms per cubic metre
Km	Kilometres
Km^2	Square kilometres
MAB	Maximum allowable biomass
MAFM	Minister for Agriculture, Food and Marine
MED	Marine Engineering Division
MI	Marine Institute
m/s	Metres per second
NGI	Norwegian Geotechnical Institution
Peta	People for the Ethical Treatments of Animals
ROV	Remotely Operated Vehicle
SEPA	Scottish Environment Protection Agency
SFPA	Sea Fisheries Protection Authority
STECF	Scientific, Technical and Economic Committee for Fisheries
UK	United Kingdom

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1 Introduction

1.1 Background

The aquafarming industry has in the recent decades experienced a significant growth in the world market, which has led to numerous positive ripple effects such as employment, good economic results and easier access to seafood to feed the world's growing population. Nevertheless, according to Scotland´s National Marine Plan (2015), estimates show that 2/3 of the world's food consumption will come from aquaculture by 2030. Another prediction undertaken by the International Salmon Farming Association (2018) is that by 2050, the worldwide animal protein consumption will rise with nearly 73% and that the amount of food that will be consumed in the next 50 years will exceed the total amount of food eaten in the human history. Along with the increasing success of the farmed salmon, the demand has escalated, and the aquafarmers have been forced to expand the production (International Salmon Farming Association, 2018; Marine Scotland, 2015).

Fish is one of the largest food sources for the world's population and have surpassed beef in consumption leading to an expectation of continuous growth. Salmon is one of the most demanded fish species within aquaculture due to its high content of protein and other important nutrients. An analysis conducted by Asche, Guttormsen & Nielsen (2013), shows that the salmon production has been increasing by an average of 8% each year from 1998 to 2008 which has left the industry with a set of challenges. According to Aquaculture Stewardship Council (2019), an international organization that manages the world´s leading certification and labelling programme for responsible aquaculture, some of the biggest concerns associated with salmon farming are fish escapes, negatives impact on wild salmon, diseases and parasites, the use of antibiotics and impact of pollution of the seabed. Even though the demand has escalated and forced the industry to grow, the analysis showed that the prices of the salmon has not increased proportionally with the cost leading to a more expensive production. Consequently, the available space for conventional fish farming has become scarce. Increasing density of farms in coastal areas cause a greater risk for diseases and the wellbeing of the fish. The fjords are filling up and the access to licenses are limited, resulting in an industry that in the near future will reach a critical point when it comes to meeting the worlds demand unless other solutions become available (Asche et al., 2013; Marine Scotland, 2015).

The graph in Figure 1 below shows the production of Atlantic salmon in the last 27 years in the leading countries worldwide within salmon farming. In recent years, the growth in production has slowed down and stabilized despite the growth in demand. A likely explanation could be a mixture of limited locations suitable for conventional fish farming, more stringent and more extensive processes for obtaining licenses, salmon lice and other diseases.

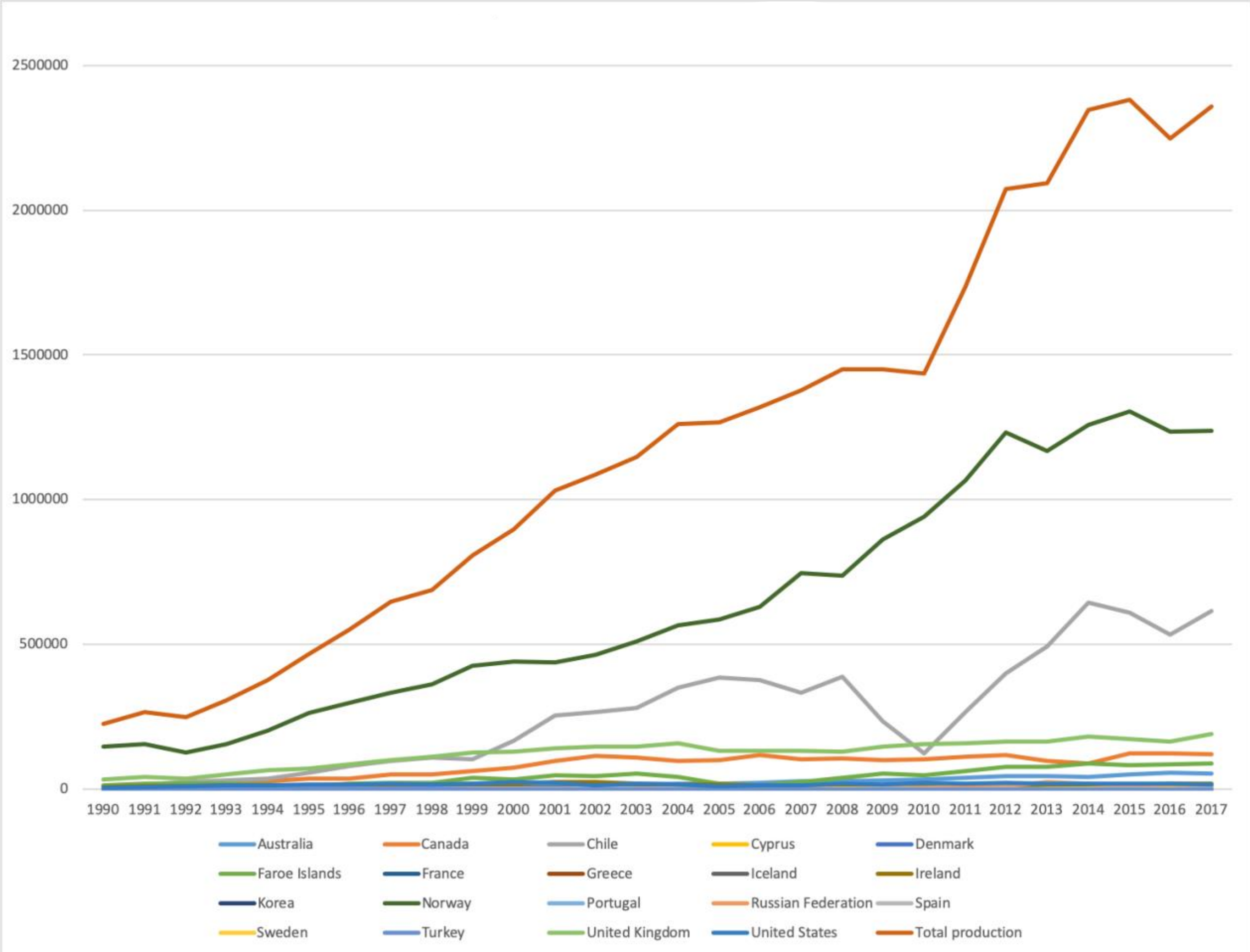

Figure 1: A graphical representation of the production of Atlantic salmon from 1990 to 2017 (Food and Agriculture Organization of the United Nations (Fisheries and Aquaculture Statistics), 2019).

This has forced the industry to be creative and innovative when it comes to fish farming, which is exactly what Roxel Aqua AS did. They have presented a new technology for fish farming, known as "Octopus". This installation allows offshore fish farming in areas with rough weather conditions using old jack-up rigs known from the petroleum industry as a base connecting the cages with fish surrounding it. This project is currently in its development phase and is so far been mostly adapted to salmon farming.

For this technology to be as beneficial as possible, there is a need to find the most suitable location for the offshore fish farm. There has been no need to come up with new solution of how to run fish farming inside fjords and sheltered sites. The conventional way of aquafarming has been inadequate, but licenses are short in supply. To be able to increase production significantly in the near future, brand new areas to farm should be considered such as land based or offshore. “Octopus” is adapted for a location that is exposed and isolated, but also easily interconnected to infrastructure and export opportunities and could be one of the solutions to solve challenges that prevent conventional aquaculture from expanding (Roxel Aqua AS(Tord Ludvigsen), 2019).

1.2 Statement of the problem

Considering the background of the problem described above, following research questions can be stated in the thesis:

1. What are the advantages/disadvantages of “Octopus” compared to conventional aquafarming?
2. Which country in Europe would be the most suitable location for “Octopus” and why?
3. By running a PESTEL analysis of the country settled in the question above, what are the main factors to consider if one wants to establish in the current market in this country?

1.3 Objectives and scopes

Objectives of this thesis are:

- Introduce Roxel Aqua AS´s new technology “Octopus”
- To run a brief comparative analysis of conventional farming vs. “Octopus”
- To run a rough PESTEL analysis of possible countries suitable for “Octopus”
- To run a PESTEL analysis of specified country to determine the conditions that will affect a possible establishment in the market

1.4 Approach

In order to achieve the objectives of this study, the following workflow and methodology was used:

- Analysing literature and methods
- Present Roxel´s “Octopus”
- Evaluating “Octopus” compared to conventional aquaculture by finding advantages/disadvantages by literature and/or self-reflected thoughts

- Conducting a PESTEL analysis to decide which country in Europe that could be a possible location for establishing “Octopus”
- Interviews of related companies and citizens of that country.

1.5 Limitations

- The production of fish in the aquaculture industry will be limited to production of Atlantic salmon only. This is justified by the extent of all the factors that has to be taken into account considering the fish species.
- By referring to “conventional aquaculture”, this is limited to the most common system which is to be introduced in the thesis.
- The area covered is limited to Europe to make the analysis as accurate as possible.
- As the analysis is so extensive, the physical restrictions of the salmon are mainly limited to temperature. The extensiveness of the salmon´s total welfare in offshore facilities should be further researched.
- The economic part of the PESTEL analysis will be excluded. This is to ensure the quality of the rest of the analysis, as the economic aspect of the aquaculture industry is comprehensive and complicated.

1.6 Structure of the thesis

Chapter one gives an introduction of the thesis with a description of the background of the problem, research questions, approach, limitations and objectives.

Chapter two is a literature-based chapter introducing conventional aquaculture and the challenges associated with it. Further on, “Octopus” by Roxel Aqua is presented together with a brief analysis describing the advantages in relation to challenges presented with conventional aquaculture.

Chapter three presents the methodology in the thesis. There will be a short description of methods in general and justification of the methods that has been used in the thesis.

Chapter four contains a brief PESTEL analysis determining which of the selected countries in Europe that is most suitable for an establishment of “Octopus”. Iceland, Scotland, Ireland and the Faroe Islands have been roughly evaluated.

Chapter five gives a more thorough PESTEL analysis of the country that was concluded as the most suitable in chapter four.

Chapter six contains a discussion on important and relevant findings from chapter five.

Chapter seven presents the answers to the problems stated in chapter one as a conclusion of the thesis.

Chapter eight cite the references used in the thesis.

2 Aquaculture

Fish farming goes under the term aquaculture and may include parts or all of the fish life cycle. This includes artificial fertilization, breeding, care and growth of fry and feeding of fish in captivity. Aquaculture is a technologically advanced and export-oriented industry based on biological production. It is a continuously changing industry with respect to production regimes, species and framework conditions. Fish farming is an important industry that influences the surroundings to varying degrees. In many countries all over the world, fish farming plays an important role in providing cheap protein to the rapidly growing population. To protect the environment from adverse effects of discharges from fish farms, the government has set regulations and requirements to monitor these emissions at all times (Gjedrem, 1993; Hallenstvedt, 2015; Sveier, 1996; Utdanningsdirektoratet, 2015).

2.1 Conventional Aquaculture

Farmed salmon is and has been an important breeding species since back to the 1970´s. Salmon is referred to consistently as wild salmon and farmed salmon. The wild salmon live all or part of their life in the free nature, while farmed salmon live usually their entire life trapped in controlled environments. According to Kim Larson (2015), spokesperson for the Academy of Nutrition and Dietetics and founder of Total Health in Washington, salmon is, wild or farmed, superfood due to the fact that it is one of the best sources for high quality protein along with omega-3 fatty acids which is vital to a healthy diet. By eating salmon, you can prevent getting heart diseases, lower your cholesterol level and blood pressure, prevent depressions along with a rich number of other effects that contributes to a better health (Ingebrigtsen, 1982; Rosenbrock, 2015).

Fish is a poikilotherm animal which keeps the body temperature equal to its surroundings and the optimal temperature for salmon is between 12 ^{o}C and 16 ^{o}C. Therefore, wellbeing, growth and activity is closely dependent on the temperature in the water. Usually, the salmon can survive at temperatures down to -0.5 ^{o}C and up to +25 ^{o}C, but towards the extremes their wellbeing, growth and activity is low (Tvenning & Bachmann, 1991).

However, the salmon is an anadromous fish which means that the salmon has two phases of life; the first couple of years it lives in freshwater rivers until a range of physiological changes including a silver-shimmering exterior prepare it for the sea, known as smoltification. Smoltification is the process where the young fish in freshwater gets adapted for the sea water by making it able to separate salts from the water. If the fish is exposed to sea water before it is through this process, it will not survive. The time it takes for the fish to smoltify depends on the species, water temperature, day length, feed availability and growth capacity. After the transformation from fry to smolt, the salmon hikes along the fjords out into the sea where it stays from one to four years and grows (Gjedrem, 1993; Tikkanen, 2008; Wennevik, 2016).

In aquaculture, the smolt is bred in specialized facility plants before it is released into the sea. This divided life in water and sea has offered both challenges and advantages when it comes to the farming of the salmon. One of the biggest advantages of breeding salmon is that it can be decided when to release the fish as smolt into the sea for further growth. By customising the parameters mentioned above, mainly food supply and light conditions, the smoltification process can be modified to result in bigger, stronger and more robust smolt before it is released into the sea. The size of the farmed smolt when it is released is usually decided by the facility itself. It takes around 6-12 months to breed smolt to a weight of 200-300 grams in specialized facilities. Wild smolts, on the other hand, usually migrate towards the sea when it is around 4-6 years, 12-20 cm long and weigh between 100-150 grams, but due to waterways, power plants and other obstacles on the migration to the sea, many of them die on the journey (Tvenning & Bachmann, 1991; Vøllestad, 2018).

The weight and the size of the salmon released into the sea strongly depends on whether the salmon is farmed or wild. Typically, a wild salmon spending a year, two years or three years in the sea weights around 2 kg, 5 kg and 10 kg respectively and the average weight varies between 3.5 kg and 5.5 kg. The average length varies from 70 cm to 75 cm, but some of the wild males can become over 150 cm and weigh over 40 kg. The farmed salmon usually gets between 4-6 kg in 10-18 months depending on location and diet. The feed is delivered by tubing and scattered in the cages, as shown in Figure 2. The feed is supplied by a nearby lying permanently located barge equipped with a food storage container that is occasionally filled up with feed shown in Figure 3. These barges are able to withstand a H_s of approximately 7-8 metres (Fjeldstad, 2012; Tikkanen, 2008; Vøllestad, 2018).

Figure 2: Picture illustrating how the farmed fish is fed. A facility operated by Bakkafrost. The scatter mechanism is shown in the middle right. Photo taken on the Faroe Islands 09.04.19.

Figure 3: A barge equipped with a food storage container and tubes where the feed going to the cages. Photo taken on the Faroe Islands 09.04.19.

The amount of feed the fish is able to digest to grow increases with the temperature up to a given temperature, which is about 14-16 ^{o}C. Even if the fish eat more at a higher temperature, does not mean it is going to grow faster. This is due to the fact that a larger part of the energy from the feed is consumed by swimming, oxygen uptake and maintenance of the body. Similarly, in too cold water the fish have difficulties in absorbing enough oxygen from the water and use its energy on that rather than to grow. Therefore, it is essential for aquaculture facilities to have the optimal temperature in the water (Tvenning & Bachmann, 1991).

It is common knowledge that animals thrive best when they live in habitats that are as similar as possible to their natural habitat. The reason they stay in one particular place is usually because it is safe, access to food and a comfortable environment in relation to the animal's own preferences. Hence, the farmed Atlantic salmon, which goes under the academic name *Salmo salar* and is the largest salmon species in the world, should be kept as close as possible to their natural habitat in terms of temperature, water quality and food sources. As an example, the wild salmon´s need to access fjords and rivers, gives Norway in particular a good base for development and production of farmed salmon. As the name states, the wild Atlantic salmon is commonly found in the Northern part of the Atlantic Ocean along with rivers flowing out into the Atlantic as illustrated in Figure 4. The salmon is now scattered across rivers on both sides of the Atlantics, from Spain to northeast Russia and from Maine in the United States of America (USA) to northern Canada as well as the Baltic Sea. In recent years, it has also been found the northern Pacific Ocean due to human introduction (Rosenbrock, 2015; Tikkanen, 2008; Tvenning & Bachmann, 1991; Wennevik, 2016).

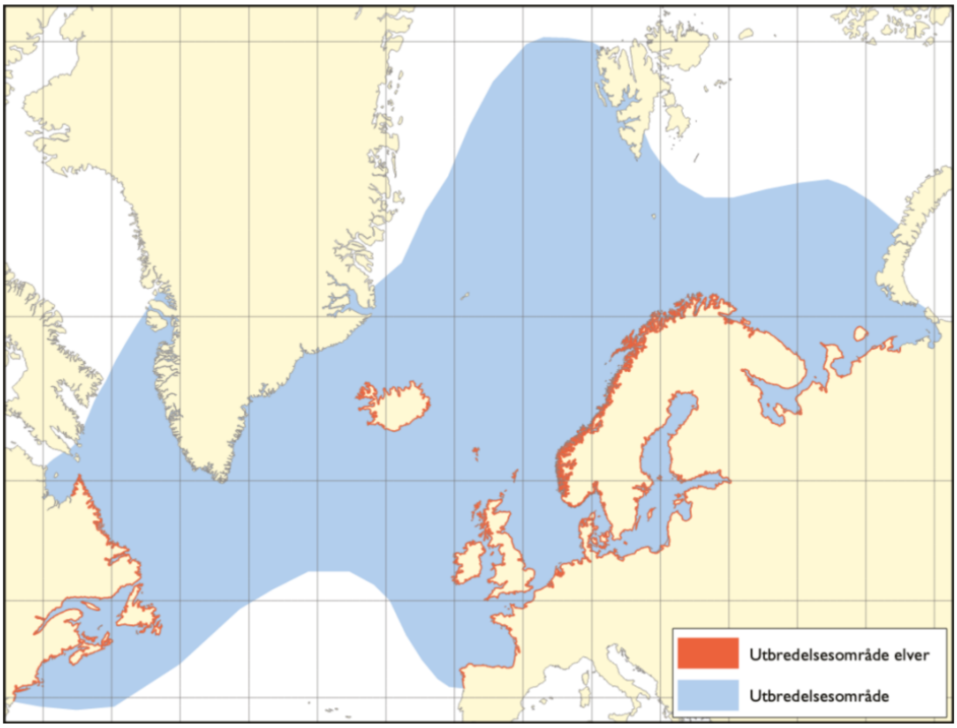

Figure 4: Overview of the prevalence of wild Atlantic salmon in the Atlantic sea shown in blue and in rivers shown in red (Wennevik, 2016).

However, keeping the farmed salmon close to the wild salmon causes challenges that can threaten the wild stock of salmon. According to a report published by Intrafish Media (2019), salmon lice is known as the farming industry's biggest challenge. A fish affected by lice is shown in **Error! Reference source not found.**. The louse is a parasite that lives naturally on t he fish and gets attracted to the salmon even in small concentrations. The treatment of lice often ends in a significant number of deaths due to the stress it inflicts on the fish. By stressing the fish, the immune system gets insufficient making it vulnerable to lice and diseases, like a vicious cycle. Therefore, the farmers are imposed to keep control over the number of lice in the facility and is obligated to take action if the concentration gets too high (IntraFish, 2019).

Figure 5: Lice living and reproducing on the salmon (Sjømatråd/Sjømat Norge, 2016).

One of the most commonly used measures against salmon lice is biological control by using cleaning fish which eats the lice on the salmon or other medical treatments. All treatments have to be approved before it is implemented. It can be compared to a child in the kindergarten who has received head lice. Louse thrives well if it gets to jump from head to head where access to food sources is good. If the access decreases by the children being treated and not giving the louse the opportunity for spreading, the louse dies out or gets dramatically reduced (BioMar; Sjømatråd/Sjømat Norge, 2016).

The same applies for the farmed salmon, if it gets treated by chemicals or additives in the feed, the number of lice will most likely go down, but the mortality of farmed fish due to the treatments is still significant. Even though the amounts of lice never usually reach the zero vision in the industry, it gets continuously controlled and the fish are treated accordingly. However, these treatments do not apply to the sea life outside the fish farm. Even though the fish in the farm gets leached for lice, the fish and other wildlife right outside does not and can get significant ill or die. Wild sea animals do not have access to treatments and will probably eventually die due to ocean currents, tides and wind that brought the lice from faming facilities. This does not include the grown wild salmon because they live in deeper water at the sea where it is no farming and the lice does not thrive. The younger smolt have not gotten that far and are under severe exposure when migrating from rivers to deeper water (Sjømatråd/Sjømat Norge, 2016; Sveier, 1996).

According to Dan Norsowitz (2018), escape of the farmed salmon is another challenge in the aquaculture industry. Even though the regulation and guidelines are strict on counting and prevent the escapes, a significant number still escapes. It is not only an economic issue for the farmer, but it is illegal and an environmental issue. This is due to the fact that most of the farmed salmon is not capable of taking care of itself and that genetics of the farmed salmon is mostly uniform compared to the genetic variation of the wild salmon. Therefore, there is a fear of losing the diversity of the wild salmon in the generations to come if they constantly are surrounded with farmed fish. This may result in a weakened wild salmon and less variety in the species (Nosowitz, 2018).

As mentioned, the farmed salmon is usually located in fjords or other locations relatively sheltered from harsh weather. The marine farms usually comprise of a group of cages consisting of net and three float rings, two in the surface and one in the bottom. The number of cages, also known as net-pens, in each facility depends on the location, capacity and the production intention of the operating company. The pens are arranged in structures consisting of floating rings, or squares, on the surface which supporting the large net bag hanging in the water, as illustrated in Figure 6 and Figure 7.

Figure 6: An example of how a fish farm look. Taken on the Faroe Islands 09.04.19.

Figure 7: Another example of a fish farm. Taken on the Faroe Islands 10.04.19.

Modern aquaculture can have over a million individual fishes distributed over several cages and the localization of the facilities are therefore very important. The floating rings and the design within conventional aquaculture have developed over the recent years as shown in Table 1. The net bags are usually hanging 25-40 metres below the surface with a volume of 80,000-160,000 cubic meters of water. To make a comparison, this is equivalent to approximately 64 Olympic swimming pools. To avoid that the cages float away or get moved by the wind, they are anchored to the seabed using chains, ropes and specialized anchors. The maximum density of fish in a cage is regulated by laws and is usually 25 kg/m^3, as theoretically speaking will mean that 25 fish with a weight of 1 kg each can live within 1 m^3. In intensively crowded aquafarms, small fish are "bullied" and killed by larger ones, so fish are continually sorted to make sure that faster-growing individuals are moved to the appropriate size grouping (Meade, 1989; Rusten & Aarset, 2007; Scotland).

Table 1:An overview of the development of fish cages from 1970-2015 (Teknologirådet, 2012).

Year		1970-2000				2000-2015		2015->
Cage size	Circumference (m	40	60	90	120	157	160	200
	Depth (m	5	10	15	20	30	40	25-40
	Volume (m^3	637	2,865	9,669	22,918	58,845	81,487	Up to 160,000

According to Peta, People for the Ethical Treatments of Animals, when the fish is sorted, the fish is usually pumped in a pipe that is normally used for transportation as shown in Figure 8 and Figure 9. In the facilities, there is usually a pipe that sort the fish according to their size so that equally sized fish ends up in the same tank. They are separated so that the smaller fish falls into small gaps into one tank and larger fish into the larger gaps into another tank. The fish may also be starved for 24 hours in advance in order to prevent stress by separating them from the other fish. This sorting practice is known as "grading" and is very stressful for the fish resulting in scraping of their skin and loss of scales which protects them from diseases. The same amount of stress and scraping applies for transportation processes. Mortality rates, diseases and parasite infestation comes with farming in additions to deformities and stress injuries as mentioned. Peta also indicates a concern for problems that is not addressed. According to the animal protection organization 40% of farmed fish are blind, but since this does not affect the net profit or the quality of the fish, it is not addressed as a problem in the aquaculture industry. The web magazine Fish farming expert (2017) supports the statement and they describe the situation as a serious welfare problem for farmed salmon (Hoyle, 2017; Peta).

Figure 8:Transportation of fish from tanks through a pipe into the sea. Taken on a Mowi facility at the Faroe Islands 09.04.19.

Figure 9: Fish in a pipe in conjunction with transportation. Photo taken on Mowi facility in the Faroe Islands 09.04.19.

The cages available are adequate for today's location of fish farms, but with an inevitable urge to increase production and hence new areas in more exposed environments, the present cage technology will not be sufficient. According to Finnur Johannesen which is the operating manager of Mowi, formerly known as Marine Harvest, on the Faroe Islands, the biggest problem with current cages in conjunction to more exposed sites is the net and bottom line. Most of today's cages are anchored to the bottom and are held in place by weight such as concrete, which leads to relocation during strong winds and currents. Mowi has experimented with the use of current equipment in more exposed areas with empty cages. Great damage has been observed to the net in the cages and a considerable relocation of the anchors (Johannesen, 2019)

Exposed aquaculture is can be recognized as waves larger than H_s of 3 m, currents over 1.5 m/s and strong winds that often take place outside of the fjords. The development of cages has primarily concerned the size, but also the ability to withstand an increased load the exposed locations will provide. As it has been attempted to move the cages out into more exposed areas in experimental tests, there has been some limited experience of how the welfare of the salmon has been affected. As the salmon live naturally in fairly exposed environments throughout the North Atlantic, it is therefore natural to assume that the salmon master this environment. Nevertheless, it is not entirely correct to assume that it is the same case if they live inside a cage in exposed locations, as they can no longer choose where they will reside. Therefore, it is important to consider the salmon's physical limitations when it comes to power, waves and temperature. Although exposed areas may be a positive direction for the development of aquaculture, it will also be associated with more difficult conditions for carrying out operations on the fish farm (Johannesen, 2019; Larsen, 2019).

A major challenge stated by the European Commission Directorate-General for Environment (2011), is the waste from the salmon is left on the seabed. There is grid pattern in the nets surrounding the fish that allows the surrounding water to flow past replacing anoxic water, getting rid of waste products and continuously adding fresh water. Other waste products such as faeces fall down to the seabed below the cages and get carried away with wind and tide. Chemical, biological, organic and inorganic waste are dropped onto the seabed resulting in a negative impact on the wildlife and the seabed-ecology. Even though the tide, currents and wind carry most of it away, the problem is just moved to another location and the impacts on the adjacent seabed are significant such as emissions which can affect fish fry’s and other vulnerable organisms hidden in it. Nevertheless, by moving the facility offshore, the water replacement will be better as the currents are more powerful and the pollution of the marine environment will most likely decrease (European Commission DG ENV, 2011).

To establish an installation for fish farming, one must have one or more approved sites and a license that determines the allowable biomass in the aquaculture plant, based on environmental conditions and the geographical site you are allowed to operate in. To prevent infection and parasites, it is established regulations for the fallowing periods and the distance between each of the aquaculture facilities. Fallowing is a given period that the sea should be free of fish for a certain amount of time before the next generation of smolt is released into the sea. In other words, a break for the sea between each of the releases of smolt. Due to the rapidly replacement of water offshore, these periods and possibly the distances between each fish farm may become smaller in the future (Joensen, 2019; Johannesen, 2019).

2.2 Octopus by Roxel Aqua AS

Roxel Aqua AS is a subsidiary of the Norwegian enterprise Roxel AS. Roxel consists of several companies with niches within construction, industry, aquaculture, logistics, infrastructure and rig solutions. The company is constantly growing and had an annual turnover of NOK 340 million in 2018 ("About Roxel,").

“Octopus” is an offshore aquaculture concept developed by Roxel Aqua AS based on a modified jack-up rig with a potential biomass of 30,000- 50,000 tonnes of fish. Attached to the rig is 12-14 cages which are placed around as shown in picture nr. 5 in Figure 10. A jack-up is a self-elevating rig from the petroleum industry with requirements of standard classification societies such as DNV GL/ABS and Lloyds and will be modified to production of fish and withstand a H_s of 15 metres. A jack-up has normally 3-4 legs that stand on the seabed providing the employees with more stability, easier working conditions and less seasickness. The platform deck itself can be elevated up and down as required. The rig is planned to be installed at a depth of maximum 110 metres, where the minimum depth for the cages are 80-90 metres. The rig will be able to withstand around 30 metres wave height at its maximum and currents of about 2 m/s and windspeed of 45 metres per second (Lie & Osland, 2018).

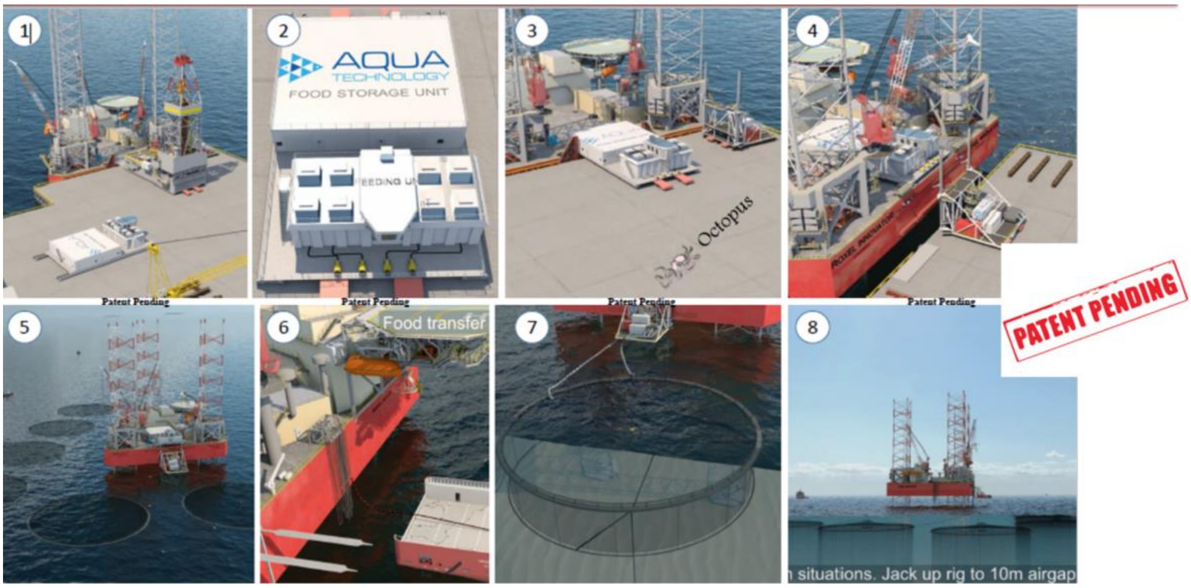

Figure 10: Illustrations of "Octopus" by Roxel Aqua AS (Roxel Aqua AS, 2018).

The cages are normally floating at the surface, similar to the conventional cages, but has the ability to be pulled down below the water surface at wave conditions above H_S 4 meters. The farmed fish can, incredible enough, become seasick which often happens in storms or harsh weather. This usually happens when the waves cause the cages to be “tossed around” which is disrupting the swimming pattern of the fishes and thereby their balance causing them to “lose” their sense of orientation and become sick, such conditions in conventional aquaculture are illustrated in Figure 11. The cages designed as a part of “Octopus” can be pulled down under the surface making it able to withstand a more exposed environment since the waves, and thereby the load, of the waves decreases with depth. (Roxel Aqua AS(Tord Ludvigsen), 2019).

Figure 11: An example of rough conditions for conventional aquafarming (Fon, 2019).

Barents Watch (2016), a subject to the Ministry of Transport and Communications, and the Norwegian Coastal Administration, supports the allegation of salmon lice as one of the main challenges in the conventional fish farming industry and lives on the fish like a parasite. It feeds of the blood, skin and the mucus and sticks to the fishbody like a suction cup. Removal of these require, as mentioned, chemicals or a treatment which is stressful for the fish. The salmonlouse does not thrive in environments with low temperatures below 7°C or above 15 °C. By moving the farming facility offshore instead of farming in the fjords, the average temperature becomes lower during the summer and higher during the winter. By lowering the cages in the sea contribute to less lice, poisonous algae, jellyfish as they live by the surface along with preventing damages from driftwood, drifting vessels and equipment icing. Additionally, the temperature in the sea is more stabilised and optimal in deeper waters, which may contribute to a larger growth of the fish (BarentsWatch, 2016; BioMar; Roxel Aqua AS(Tord Ludvigsen), 2019).

With respect to the temperatures, a theory by Poul Michaelsen states that a smaller delta between the summer and winter temperatures can make the fish grow faster and/or bigger. In the winter when it gets too cold, it is believed that the fish uses energy to "put on winter clothing" and vice versa regarding the summer. If the temperature is stable throughout the year, the fish does not need to use energy on this and can use the energy to grow instead and their exposure time at the sea decreases (Michaelsen, 2019).

The pull-down mechanism is based on wire/rope connected between the cages and the rig by two anchored pulleys. Each cage should be lowered below the surface using a winch, crane or the rig´s jacking system. This enables the facility able to operate in open waters without restrictions with respect to the wave height which makes it suitable for other locations than where traditional aquaculture is located. These cages are developed based on a cone bottom to collect excess food, dead fish and other waste to prevent the pollution of the seabed and the marine environment. The pull-down effect also takes the cages to a depth where the lice do not thrive and can therefore contribute to a decrease in the licestock on the fish (Hall, 2009; Roxel Aqua AS(Tord Ludvigsen), 2019).

Nevertheless, the cages need to be able to withstand stormy weather out in the open ocean, and a possible deformation/damage to the net will increase fish mortality and escapes compared to conventional aquaculture. In order to keep the cages stable and in place, suction anchors will be used. A suction anchor is an anchor that creates an under-pressure keeping the anchor to the seabed. A comparison made by NGI, the Norwegian Geotechnical Institution, makes the function of the anchor clearer; a suction anchor can be compared to a huge canister that is open at the downward end. The "canned box" is first put on the bottom, and then the water trapped inside the box is pumped out, creating an under-pressure. This a method that is used by the petroleum offshore industry worldwide to ensure secure anchoring in harsh weather. In addition, the cages are planned to have a sensor device, a collector of dead fish, feedspreader, surveillance system, sensors and a dock (Norges Geotekniske Institutt; Roxel Aqua AS(Tord Ludvigsen), 2019).

As mentioned, the cages for "Octopus" will be designed for wave heights of H_S 15 metres in pull down position if the depth is more than 120 metres on the site. The cage construction, named "Brilliant" is a cage that is tailormade for exposed and offshore locations and has features such as semi-automatic herding with less manual operations than in traditional net pens. The cage consists of an inner and possible outer mesh with a ceiling, three floating rings and mooring. There is one ring on top at the surface with a diameter of 32 metres that will give access to the inside of the cage. The middle one has a diameter of 60 metres that will have 2-3 docks and shall be designed to withstand the forces caused by the encounter of a wellboat. The middle ring should have no sharp edges in case of a tear and the rings shall be perforated so they can be filled in case of pull-down. The third one is at the lowest point in the cage connected to the bottom cone. Total height of the cage construction is approximately 35 metres (Lie & Osland, 2018; Roxel Aqua AS(Tord Ludvigsen), 2019).

The modification of the jack-up rig involves installing three main components; an aquaculture module, a fish health module and support systems. The aquaculture module contains a feed- and deadfish system. The cartridges with feed are planned to be lifted by cranes from a supply vessel to the cages. The tubing system will transport the feed under the water and to the feedspreader while transporting the deadfisk from the capsule from under the cage back to the rig. A feedspreader will be submerged with the cage as it is pulled down and will be adapted to underwater feeding. A sensor unit will contain all relevant sensors, lights, cameras in a unit which can be lowered and raised in the cage. In conventional farming, the sensors are disconnected from the cage using divers prior to herding operations. This manual operation will not be required in the Brilliant net cage. The tubing should consist of offshore quality adapted to use for aquaculture (Lie & Osland, 2018; Roxel Aqua AS(Tord Ludvigsen), 2019).

As mentioned earlier, another critical factor limiting conventional aquaculture is the conditions of the seabed under the cages. The feed, faeces and other waste falls down to the seabed causing pollution of the lower layers in the fjords. With “Octopus” offshore, this waste will either be collected in the bottom cone under the cages or get drifted away much more rapidly than in conventional farming in the fjords. This results in a less polluted seabed and will most likely be a less significant problem in the aquaculture industry (Lie & Osland, 2018; Roxel Aqua AS(Tord Ludvigsen), 2019).

The fish health module is for the treatment of the fish and will consist of two parts: a stationary and a floating piece, further on referred to as floatilicer. The unit will be able to be moved between different locations according to needs and should be able to be arranged for medical treatment. The floatilicer may use freshwater, tempered water and water with different pressure in the treatments. The water is supplied by the rig and brought back to a treatment unit which will cleanse and filtrate the emissions before it is released into the sea. When the unit is not used, it is stationed at the rig floor. This may contribute to less stress and exposure regarding transportation for the fish and manual operations for employees. In conventional aquaculture, the fish are put through a process from the cage into a treatment facility and then transported back to the cage. With the fish health module, the fish will be treated close to the cage, resulting in less stress for the salmon with respect to transportation (Lie & Osland, 2018; Roxel Aqua AS(Tord Ludvigsen), 2019).

The wellboat that is going to transport the fish to and from “Octopus” in relation to harvesting and release, may use dynamic positioning or the cages ‘quays. The crowding is further completed with semi-autonomous systems. The cleaning of the cages is to be done by a remotely operated vehicle (ROV) controlled from the rig instead of by divers used in conventional aquafarming. The support system on the rig will consist of a control room with screens, alarm systems and state information of systems, for example cranes, water tank, generator and hydraulics. Other systems as accommodations, compressors, helicopter deck and platform supply vessels have to be monitored at all times as well. For the future, freezing and butchery may be permanently mounted on the rig to reduce the wellboat activity. Wellboat is a boat that harvests the salmon when it is ready to be brought to the butchery onshore and is also used for transportation and treating diseases and lice (Lie & Osland, 2018; Roxel Aqua AS(Tord Ludvigsen), 2019).

However, limited statistical basis and a lack of experience on offshore facilities makes it difficult to quantity the possible decrease of lice and other advantage/disadvantages. For example, there is a risk that the lice find a way to adapt to the offshore aquaculture and treatment will then be required. Cleaner fish, which are different species of fish removing sea lice from the salmon is not relevant for “Octopus” since these fishes are not adapted to exposed environments. However, other treatments and equipment are available such as mechanical washing, freshwater, laser and feed additives. These alternatives will then be adapted to the rig and the fish health module mentioned earlier.

3 Methodology

3.1 A PESTEL analysis

A PESTEL analysis is an external analysis that evaluates the broad macro circumstances concerning a specific case, project or business using qualitative research methods. It is used as a decision tool and the purpose is to enlighten how different categories in the surroundings affect the business. These factors affect, to a greater or lesser extent, all organizations within the same field. Hence, PESTEL can be used as a guideline or a checklist to predict how future external factors within the areas of political, economic, social, technological, environmental and legal can influence strategy processes in an organization. Examples of some factors within all of these categories are listed in Figure 12 (Business to you, 2016).

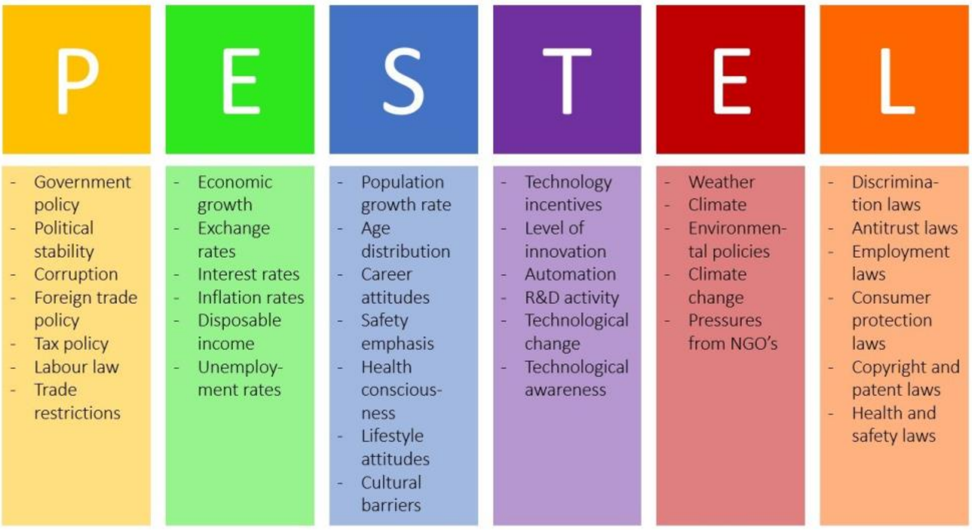

Figure 12: PESTEL analysis with underlaying factors (Business to you, 2016).

Both PESTEL as a model and the various scenarios included in it may become overwhelming in scope and dimension, as well as the amount of possibilities that fall under the different perspectives. The analysis is considered suitable for highlighting matters that are assumed to have a significant influence on the future of an industry or market. (Johnson, Whittington Sir, Angwin, Regner, & Scholes, 2014).

PESTEL can be criticized precisely because of its high macro level compared to a company's immediate environment. Based on this, the model can be said to have limited strategic value. However, early in the design phase, this can be a very useful tool when deciding where a project will be most achievable and profitable to implement based on the outcome of the analysis (Roos, Krogh, Roos, & Boldt-Christmas, 2013).

Roos et. Al (2013) claims that the factors included in a PESTEL analysis should be taken into account when the business is in the strategic planning process. The importance of the various factors will naturally vary in a larger time perspective. There may be reason to assume that for "Octopus" political, economic, technological, environmental and legal issues could be more important for the strategic choice than socio-cultural conditions. However, it is still important to investigate all areas to see if there can be external conditions of significance in the social area. Roos et Al. (2013) also describes how the PESTEL analysis can provide insight into four different areas. It is a tool to capture critical factors, to identify underlaying forces of change and to identify external factors that may have different impacts in the organization.

Checklist

The PESTEL analysis can be considered as a checklist for assessing key environmental factors. One limitation is that there is only a list of relevant areas which may be of limited strategic value. In the processes in a business that is about determining strategy, it will therefore often be necessary to combine an assessment of these areas with other analysis methods (Roos et al., 2013).

Aid to identify critical factors

The use of a PESTEL analysis as an aid is related to the same function as a checklist. As an aid, the areas in such an analysis can contribute as a framework that focuses on key issues that can be of crucial importance for long-term development. The areas can be assessed and investigated by in terms of relevance. This applies in particular to conditions that may have an impact on the organisation's long-term development. As a checklist aimed at macro benefits, it can be seen that several of the areas in the PESTEL analysis are relevant to "Octopus". E.g. How a new company will be received by the citizens and already existing companies, the costs related to operate etc (Roos et al., 2013).

Identifying underlaying forces of change

The players in the aquaculture are in complex surroundings. This can be illustrated by the fact that the industry is regulated in most areas of the operation. International regulations from EU are increasingly becoming applicable in large portions of the aquaculture industry and is making the market harder to enter. The industry engages many different organisations due to its impact and connection with the environment. Ocean farming is continuously interacting with the nature and its surroundings, which results in focus from both environmental authorities and organisations and the public. The competition between the aquaculture companies is increasingly pressured by new technology and increasing global focus on the environment. This means that it is also important to focus on both their own and their competitors' framework conditions. More recently, we have seen that employment relationships and employee affiliation and the employment location have played a significant part in a company's operations and success. In such a complex environment, the PESTEL model can act as a framework that captures such areas (Roos et al., 2013).

External factors with different influence on the organisation

Some external factors can also affect the same organisation differently from a historical perspective. To mention one example, the environmental consciousness among the locals will, among other things, be a challenge when it comes to further expansion of the industry into the nature. If there are accidents that may have occurred in the past that have affected the local environment negatively, it can affect the future scepticism of new technology and expansions in fear of that it may happen again (Roos et al., 2013).

3.2 Research methods

Research is a way of establishing knowledge, where the method is to provide new insights with high credibility. The choice of method depends on whether it is possible or not to verify the results, while it should be possible to assess the quality of the work performed by the researcher. This chapter will present the study's method of research by describing method in general and the types of methods that can be used to collect data. The selection of method depends largely on the research question, but also by other conditions such as feasibility and time aspects (Dalland, 2007).

The reason for choosing one particular method is that we believe that exactly that method will give us good data to shed light on the question or the issues we have posed in the best possible professionally interesting way (Dalland, 2017).

3.3 Qualitative and quantitative research methods

Qualitative research often takes a starting point in one or more theoretical traditions to define the framework of what types of interesting issues given within a field of study. The quantitative research mostly evolves around numbers and calculation. To evaluate what type of research that will give the information required to draw a conclusion, an analysis of the differences in the two methods should be conducted and is presented in Table 2 (Creswell, 2014; Tjora, 2012).

Table 2: The main differences between a quantitative method and a qualitative method (Creswell, 2014).

Quantitative method	Qualitative method
Information based on numbers and statistics	Information given by text and/or illustration
A large degree of verifiability	A low degree of verifiability
Focus on the specifics	Focus on the larger context/perspective
Specific blueprint on a subject	Several opinions of the subject
Data is collected from statistics and observations	Data is collected from interviews, literature, observations and experiences
Understanding and interpretation happens after collecting the data	Collecting the understanding and the interpretation of the data while it is gathered

Reliability and validity are two criteria often used as indictors of the quality in the qualitative research. To be able to draw a valid conclusion on the data obtained, both good validity and good reliability is required. Low reliability goes to the source´s credibility, while low validity refers to how realistic obtained data is. If the person interviewed has adequate experience to make a statement, there is used scientific articles or other verified encyclopaedias in his/her studies as well as the researcher´s subjective convictions, then the research is believed to be reliable. These are all relevant factors that will affect the reliability and the validity of the study and thereby also the validity of the study (Creswell, 2014; Tjora, 2012).

An example of a qualitative analysis is a PESTEL analysis. In such an analysis, as mentioned above, it is especially important to consider the sources and the reliability of them in order to draw a conclusion on the best possible basis. This research paper is based on the qualitative analysis PESTEL because this allows the researcher to investigate several aspects of ripple effects a decision might have. E.g. even though it is environmentally suitable to install "Octopus" in one location, does not mean that it is socially accepted. This is why it is beneficial to know every angle of a decision before the final settlement is made.

3.4 Literature study

In this sub- chapter I will present the background for the fact that literature collection is important for a study that is based on a qualitative research method. I will present how I have chosen to carry out the collection of literature and the justification for this method of implementation.

Some emphasize that early in the research study one should review previously published literature that is relevant to the research topic. This is performed to get to know the topic, which means that you have to search for, get hold of and read as much as possible of available and relevant literature. An analytical reading of existing literature will then be a prerequisite for the research. According to Hart (2001), the reason for this is that conducting a literature study will:

- help identifying work that has already been done that is relevant to the studies
- prevent duplication of something that has already been done
- help avoiding problems that have arisen from previous research
- help designing the method by identifying key aspects and techniques appropriate to the topic
- enable to find holes in existing research and thus promoting a unique theme for the study.

The literature study will thus set the framework for the present study (Hart, 1998, 2001).

The literature study was based on the research questions stated in chapter one. Therefore, I first tried to find relevant literature regarding farmed salmon and generally the optimal environment of wild salmon. Further on, I tried to find relevant information on how conventional farming works and various other aspects about running a fish farming company such as licenses, challenges and environmental requirements. This was performed to get the overall perspective on where and what the challenges are and how this is managed today.

Obtaining literature mainly involved searches in the University Library's databases, where databases such as Oria, Google Scholar and Science Direct were used. The words usually used in the search was Atlantic salmon, fish farming, aquaculture, fish industry and farmed salmon. In addition, books from the library where diligently used as these provided the most general information needed.

3.5 Interviews

It is as a qualitative interview in this thesis used unstructured and semi-structured interviews. In unstructured interviews the questions are adapted to the individual interview situation, and a subject has been given in advance. The selected questions are presented which can be answered freely. The interview object is guided in to the areas where the interviewers require more information. The method is very flexible since issues arise at the same time as the analysis takes place along the way in the interview. Unstructured interviews therefore provide a comprehensive insight into the interview object´s thoughts, experiences and opinions on the topic (Dalen, 2004; Lilledahl & Hegnes, 2000).

Half-structured interview is an interview form in which there is an interview guide as the starting point for the interview presented in Appendix B. Here the questions position, order and subjects are varied and adapted in relation to the interview situation. Half-structured interviews are typically used after acquiring basic knowledge from other methods. The goal of these interviews was to provide knowledge of various components within the relevant community (Lilledahl & Hegnes, 2000).

Benefits of using qualitative interviews include the freedom of the interview objects to deepen their thoughts and opinions, as well as the possibility of follow-up questions both from interviews and interview objects. Qualitative interviews can be both time-consuming and resource-intensive. One must also make sure that the questions are not leading, or that the interviewee does not answer honestly due to lack of anonymity. An example of this is if the interview object responds strategically correctly in relation to the company´s vision and policy because of the fear of negative consequence by making the "wrong" answer (Dalen, 2004).

The goal for qualitative interviews is to get a comprehensive picture of the informant´s experiences, thoughts and feelings regarding the subject. In order to achieve this goal, it is good to encourage the interviewee to describe what he/she thinks and bring out his/hers views by means of proper terms. In the case of qualitative interviews, great pressure is placed on the interviewer´s mastering of social interaction (Dalen, 2004; Lilledahl & Hegnes, 2000).

3.6 Research design

The research design should describe the process of how to collect the data to solve the issue this thesis covers. The design is a strategy for how the problems should be answered and is critical to arrive at logical conclusions (Yin, 2009).

The research design chosen for this thesis was a start with emphasis on getting the proper knowledge of the topic, in this case Atlantic salmon and aquaculture. To be able to ask the most relevant questions, it is crucial to have the right background information. Articles, web sites, books, short films and communication with farmers and other professionals in the industry gave the knowledge needed before deciding how to approach the questions stated in this thesis.

To understand the challenges in the industry, a further literature study and personal communication with employees in the field was conducted. A list of the persons I have been in touch with, is listed below in the end of this sub chapter. Then the subjects and questions for the interviews were made along with the knowledge study. To get a comprehensive understanding of one country´s political, social, environmental and legal status, a trip to the relevant country was preferred. In an early phase of the study, a decision of a trip to the Faroe Islands was made according to the result in the coarse PESTEL analysis.

A five-days trip to the Faroe Islands was made from the 8th to the 12th of April. Appointments with all three farming companies of the Faroe Islands (i.e. Bakkafrost, Hiddenfjord and Mowi), including a researcher, an experienced long timer within the aquaculture industry and the Minister of trade and foreign affairs of the Faroe Islands was planned. The interviews in this thesis are performed in a two-person basis, where notes and recording were made, but as mentioned went freely. I consequently chose to keep the interviews within the three companies as similar as possible in order to compare their opinions. Further on, the interview was allowed to go off in the direction which felt natural in the conversation. Therefore, there is no transcript of the interviews, but a guide of the interview and reference to who the information came from within the thesis. After the interviews, the gathered information had to be sorted, analysed and filled out to get the arguments for the discussion ready.

Persons that I have been in personal contact with through face to face interviews and email communication regarding this thesis:

- Finnur Johannesen: Manager in Mowi (Marine Harvest) department at the Faroe Island.
- Bjarní Larsen: Farming optimiser in Bakkafrost at the Faroe Islands
- Pól Edvard Egholm: The Director of Industry and Trade at the Faroe Island
- Ragnar Joensen: an experienced long-timer in aquafarming, former operational manager in Mowi
- Poul Michaelsen: The Minister of Trade and Foreign Affairs at the Faroe Islands
- Signar Pæturssonur Dam: Biological developer in Hiddenfjord
- Guðmundur Gíslason: Chairman in the board of Ice Fish Farm on Iceland
- Øystein Patursson: Researcher on the Faroe Islands, former employed in Fiskaaling

4 Coarse PESTEL analysis

According to the Salmon Farming Industry Handbook produced by Marine Harvest (2018), due to factors such as the requirements of temperature in the seawater, biological and other natural constraints, Norway, Chile, Scotland, the Faroe Island, Ireland, Iceland, Canada, Tasmania Japan and New Zealand, as shown in Figure 13, are the most feasible locations of production of farmed salmon (International Salmon Farming Association, 2018).

Figure 13: Coastlines feasible for salmon farming (International Salmon Farming Association, 2018).

The optimal sea temperature for the salmon is as earlier presented as 12-16 °C. However, it is important that the temperature does not get too low because the salmon is poikilotherm and it would result in little growth. It is important that the temperature does not get too high, since that will limit the growth due to the energy the fish uses to cool down rather than grow. To be able to meet the temperature requirements, the northern hemisphere of the globe or similarly distance from the equator in the south, are the most optimal location for farming salmon due to the temperature constraints. In order for the location to be suitable for "Octopus", other essential factors need to be taken into consideration such as the depths, wave heights, strength of sea currents, existing infrastructure, average wind profile, licensing regime etc. Some of them is assessed, but it has been limited access to time and resources.

In Figure 14, the Gulf Stream is represented. To fulfil the temperature requirements, there is countries close to this warm ocean which is to be evaluated. Selected countries for this thesis are therefore Iceland, Ireland, Scotland and the Faroe Islands. These countries also provide a relatively small delta temperature between summer and winter and has already established an aquaculture industry to varying extents. In a report from 2016 European Union (EU Scientific, Technical and Economic Committee for Fisheries, STECF, states that all sectors of aquaculture production have their own challenges whether it is slow processing of license application, weather conditions, algae blooms, diseases and availability of raw material. In this brief PESTEL analysis some of these challenges will be presented and based on an overall review, the analysis will conclude with the most suitable country for Roxel Aqua´s offshore fish farm "Octopus".

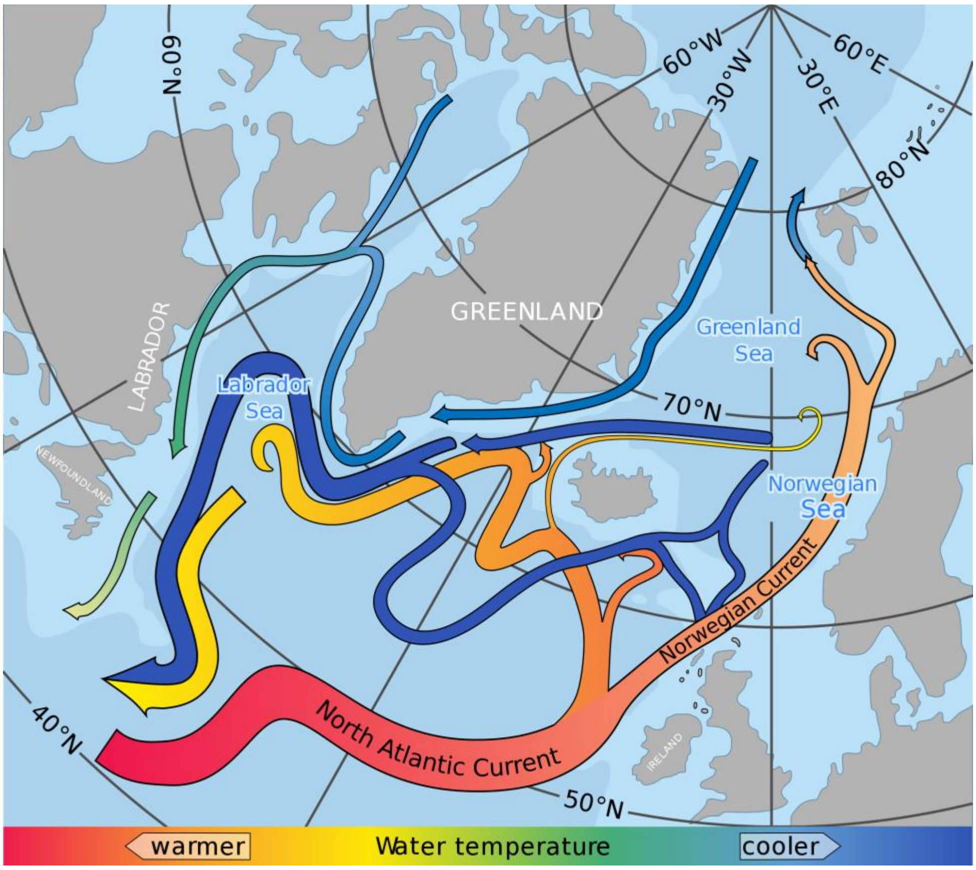

Figure 14: The currents in the North Atlantic (Goddard Space Flight Center, 2004).

In order to be able to operate with "Octopus" in any of these countries, the depth cannot be too deep. Preferably, as mentioned, "Octopus" should be installed at a depth around maximum 110 metres. As shown in Figure 15, the pink areas are <200 metres in depth, the yellow areas are 200-800 metres and the blue are >1000 metres. This shows that all these countries have coasts with less than 200 metres depth and are thereby suitable regarding the depth to be assessed (Divingglore, 2015).

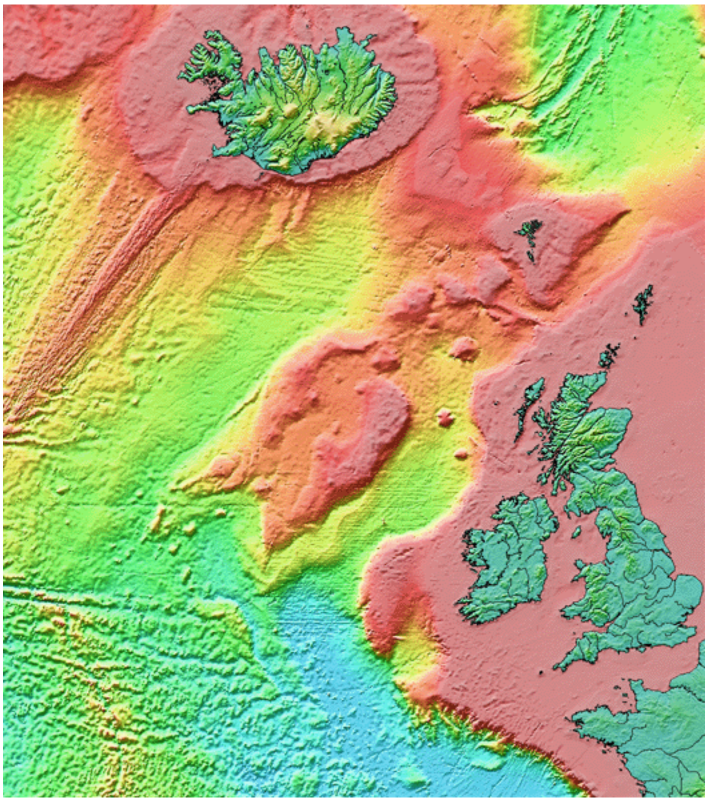

Figure 15: Depth topography of UK, Ireland, Iceland and the Faroe Islands (Divingglore, 2015).

4.1 Iceland

Iceland is an island in the North Atlantic between Greenland and Norway. With a population of 338,349, Iceland is one of the least populated countries in Europe and has a land area of 103,000 km^2 and a coastline of approximately 4,970 km. The ocean climate at Iceland is an interaction of the cold polar currents and the warm Gulf Stream on top of the Mid-Atlantic Ridge which makes the summers cold and winters mild, and thereby the delta temperature small. Aquaculture on Iceland goes back to the 1950s and had an annual production of 11,265 tonnes in 2017, including landbased production. Theoretically, the environmental conditions for farming at Iceland is good, but there are several challenges that needs to be considered (CIA; Lundal et al., 2019).

Firstly, according to The Great Norwegian Encyclopaedia (2019), the average air temperature at the island countrywide is +5.5°C. There are only two seasons on Iceland, 26 weeks of winter, from end of October to the end of April, and 26 weeks of summer. The difference in the air temperature between summer and winter is approximately 10-11°C and in extreme cases the temperature can go up to +30°C and down to -39.7°C. The temperature in the sea varies between 6°C -10°C, which is slightly below the temperatures where the salmon thrives best. The wind speed varies from 3.5 m/s to extreme cases such as 62.5 m/s, which is one of the biggest challenges in the fish farming industry on Iceland. The wave height might also be a challenge outside of the fjords in Iceland. According to Science Nordic (2018), the biggest waves in the world have been generated south of Iceland, which indicates Iceland as a critical location with respect to exposed sites. A summary of average temperatures and wind speed is presented in Table 3 to give a quick overview of the Icelandic climate. This indicates that the Icelandic climate is in principle too old for the Atlantic salmon to thrive (Bazilchuk, 2018; Icelandic Meterological Office, 2008; Komjáti, 2018).

Table 3: A summary of average temperatures, average wind speed and hours of daylight in Iceland (Icelandic Meterological Office, 2008; Komjáti, 2018).

	Average temperatures	**Average wind speed (m/s**	**Hours of Daylight in Reykjavík.**
January	• -3 to 2°C in Reykjavík • -6 to 1 °C in the north and east	• 7.22 m/s (one of the windiest months	• 4.5- 7 hours
February	• -2,1 to 2.8°C in Reykjavík • -4.7 °C in the north and east	• 6.9 m/s	• 7-10 hours
March	• -2 to 3.2°C in Reykjavík • -4.2°C in the north and east	• 6.2 m/s	• 10-13.5 hours
April	• 0 to 3°C in Reykjavík • -1.5°C in the north and east	• 5.5 m/s	• 13.5-16.75 hours
May	• 2.3 to 9.5°C countrywide	• 3.8 m/s	• 17-20 hours
June	• 6 to 13.2°C countrywide	• 3.8 m/s	• 20-21 hours
July	• 7.5 to 13.3°C countrywide	• 3.6 m/s	• 18-21 hours
August	• 7.1 to 13.9°C countrywide	• 3.8 m/s	• 14.75-18 hours

September	• 3.5 to 10.1 °C countrywide	• 4.7 m/s	• 11.5-14.5 hours
October	• -0.4 to 6.8°C countrywide	• 10.9 m/s	• 8-11 hours
November	• -3.5 to 3.4°C countrywide	• 6.1 m/s	• 5-8 hours
December	• -5.1 to 2.2°C countrywide	• 6.9 m/s	• 4-5 hours

Despite the challenges with the cold weather, according to the Government of Iceland, they have several geothermal sources which is implemented in the facilities to warm up and create optimal temperature for the salmon in order to promote the growth. Nevertheless, as the price with the salmon have not grown proportionally with the costs, this method has proven to be less profitable due to the high cost associated with pumping the warm water into the sea, so the method is therefore not currently commercially used (CIA; Innovation).

In the report conducted by the Icelandic Road Infrastructure and Policymaking (2012), an illustration, shown in Figure 16, was presented of the road system on Iceland. The red lines are primary roads that are the main roads when it comes to maintenance and access. The yellow/orange is highland roads which are usually over mountains and are closed during the winter season. The green are secondary roads and the blue are local roads. Some ferries are also displayed in the illustration. Even though the infrastructure overall seems adequate connected, the winter season can cause problems with closed roads and ice inside the fjords preventing ferries (Jóhannesson & Sigurbjarnarson, 2012).

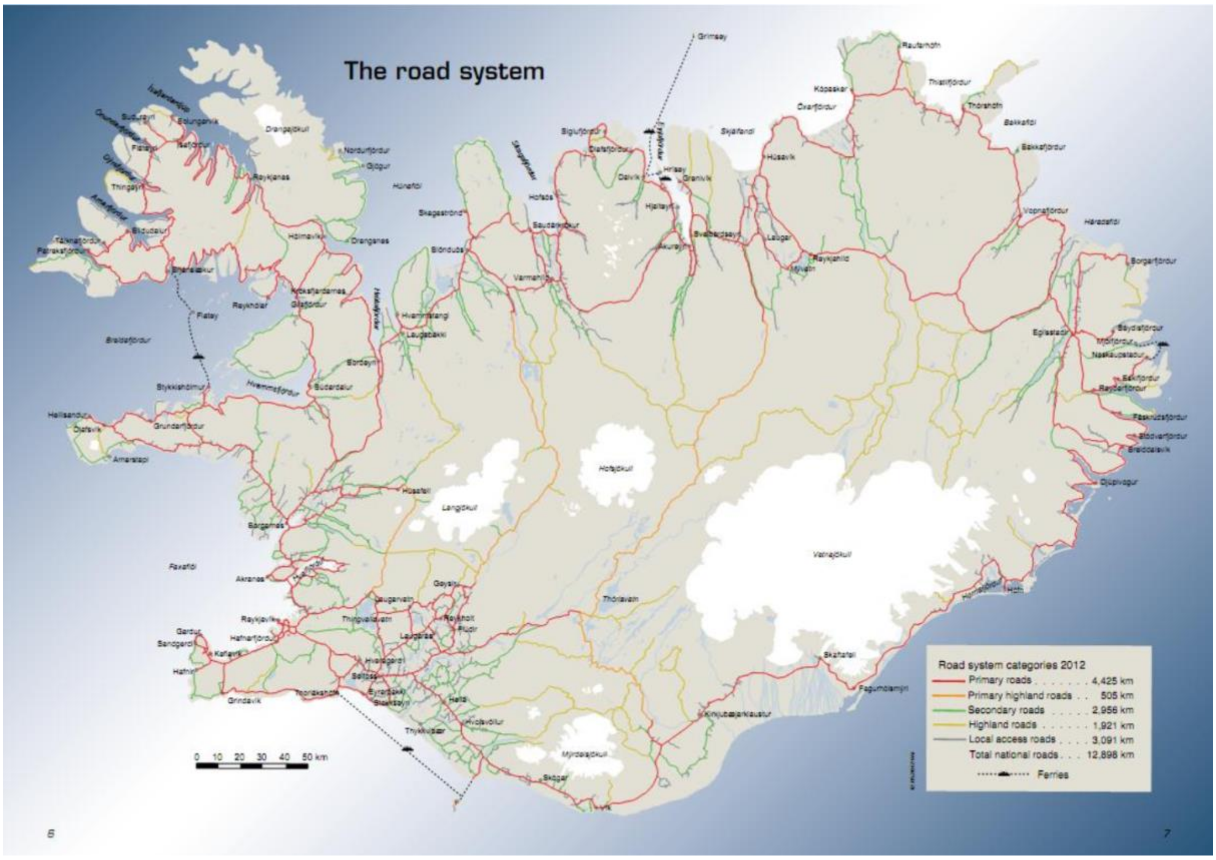

Figure 16: An overview of the road system on Iceland (Jóhannesson & Sigurbjarnarson, 2012).

Further on, the fact that the island is located in the middle of the Atlantic relatively far north makes it particularly exposed to rough weather and the risk of icing at both equipment and in the fjords. The Government of Iceland stated that there has been serious damage to equipment in the past due to these weather conditions. Most of the island is exposed to rough weather which makes conventional farms difficult to operate since they are usually are made for farming in fjords and close to shore with relatively limited exposure (Innovation; Komjáti, 2018; Lundal et al., 2019).

Nevertheless, according to an article in the net magazine Salmon Business (2019) and Kyst.no (2019) the local company, Ice Fish Farm, have been given permission to increase the production on the east coast from 6,000 tonnes to 20,800 tonnes salmon per year. This indicates that the island is capable of increasing the production in terms of environment and sustainability. However, whether this supports that equipment and the marine environment conditions are adequate is debatable, but according to the chairman in Ice Fish Farm (2019), the growth has been expected and the company have expanded accordingly. This will increase export and contribute to employment on the island. In Figure 17, a graph is illustrating the development of production of salmon in Iceland the last 27 years, which shows that the increase in production in Iceland has been significant recent years (Blaalid & Jensen, 2019; Fontaine, 2017; Guðmundur Gíslason, 2019).

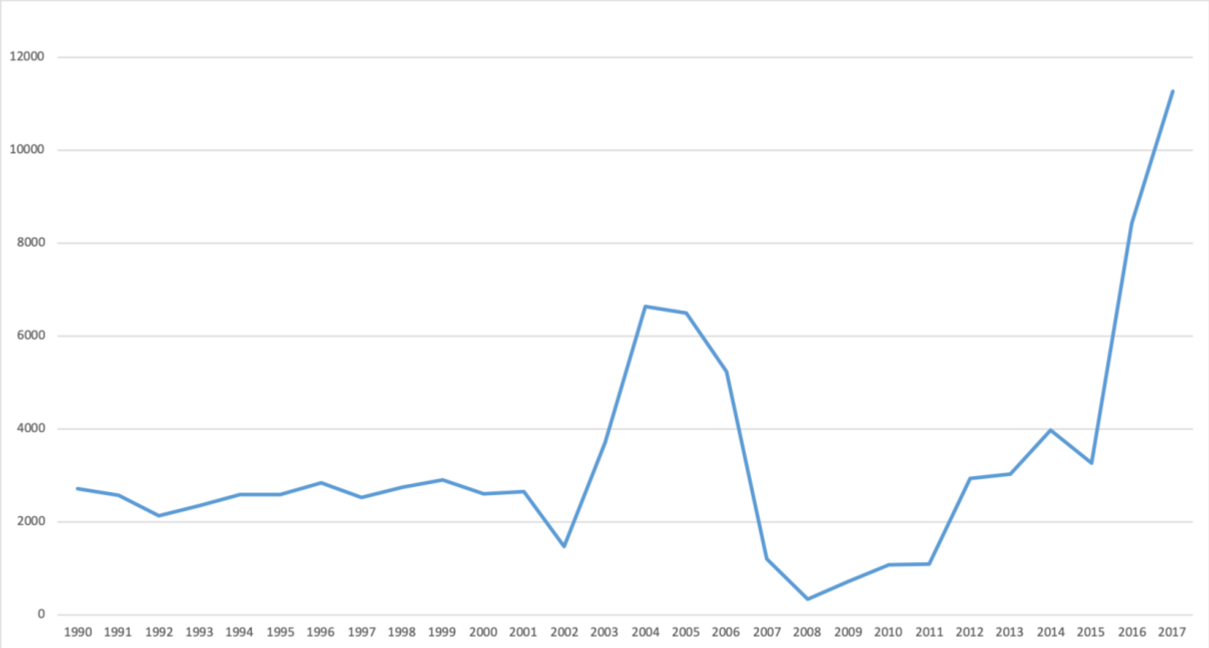

Figure 17: Production of farmed salmon the last 27 years, from 1990 to 2017(Food and Agriculture Organization of the United Nations (Fisheries and Aquaculture Statistics), 2019).

Additionally, another statement by the Chairman of the board Ice Fish Farm (2019) is that the biggest advantages for salmon farmers in Iceland compared to other regions/countries are that there are no sea lice on the east side of Iceland probably due to its cold waters. The brand of Iceland itself outward to the world are already established and the experience is "built into" the culture of the citizens (Guðmundur Gíslason, 2019).

The average size of the smolt released in Iceland is 170 grams and the biggest have been around 400 grams, which means that bigger smolt is not an experienced field. The smolt are in the sea for about 18 months until they get harvested with an average weight of 6.3 kg. Two of the operating places are Berufjordur and Faskrudfjordur, illustrated approximate location in Figure 18 as purple and yellow respectively, both are a part of Ice Fish farm. These are located on the east part of the Iceland, also known as Austurland, where the weather is most stable. The red lines shown in Figure 18 are the boarders of protected marine areas. The landscape otherwise on the island is characterized by small villages, coastlines, narrow fjords, waterfall and mountains (Guðmundur Gíslason; Guide to Iceland, 2019).

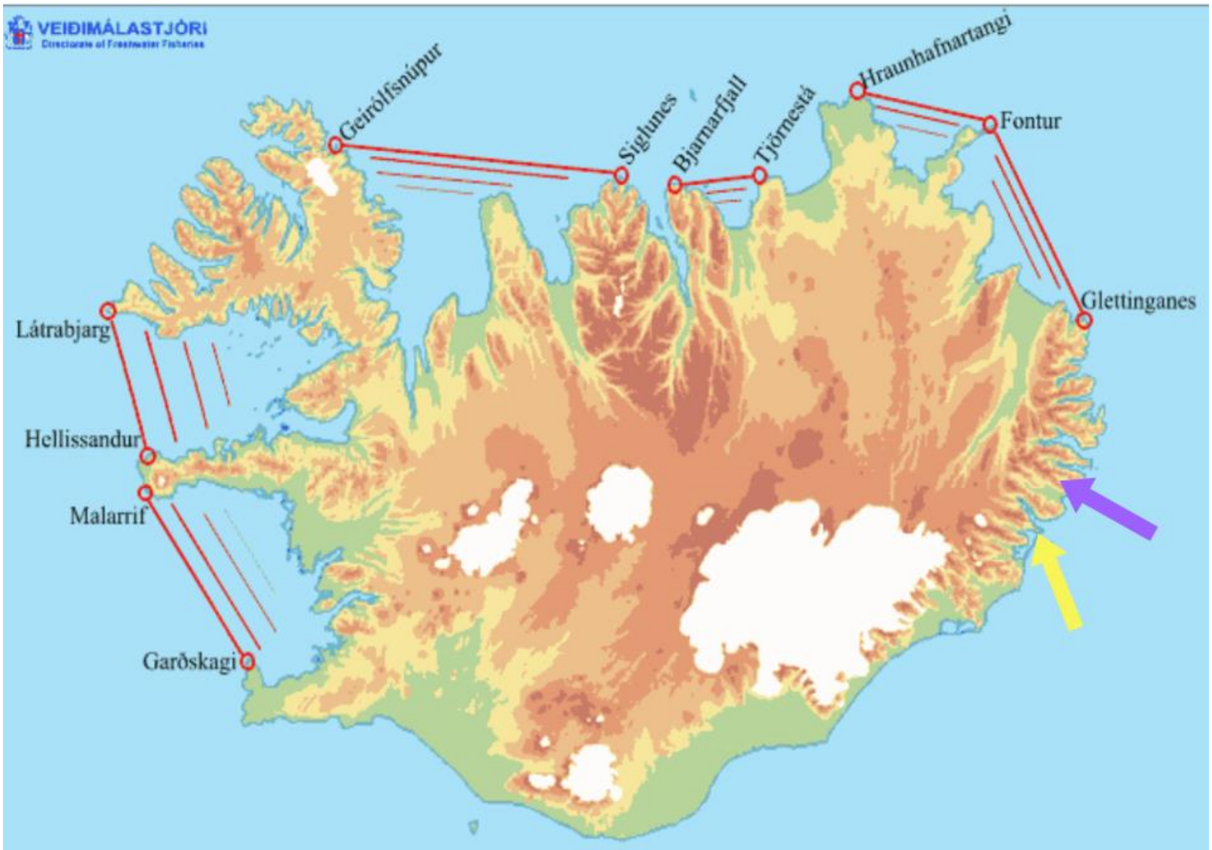

Figure 18: An illustration of the localization of two of the operating farms in Iceland, owned by Ice Fish Farm, and protected areas (Guttormsdóttir, 2018).

The process from an application to a license was not found on any public places other than the figure shown below as Figure 19. However, based on the information given to me by personal communication with the Chairman in Ice Fish Farm, Guðmundur Gíslason, the process is comprehensive and one of the main challenges by operating on Iceland. Even though the application is only required to be approved by The Icelandic Food and Veterinary Authority, the Icelandic Planning Agency, Environmental and Health Inspection and the Directorate of Freshwater Fisheries, the application is demanding, difficult to get granted and have a long timeframe (Guðmundur Gíslason,2019).

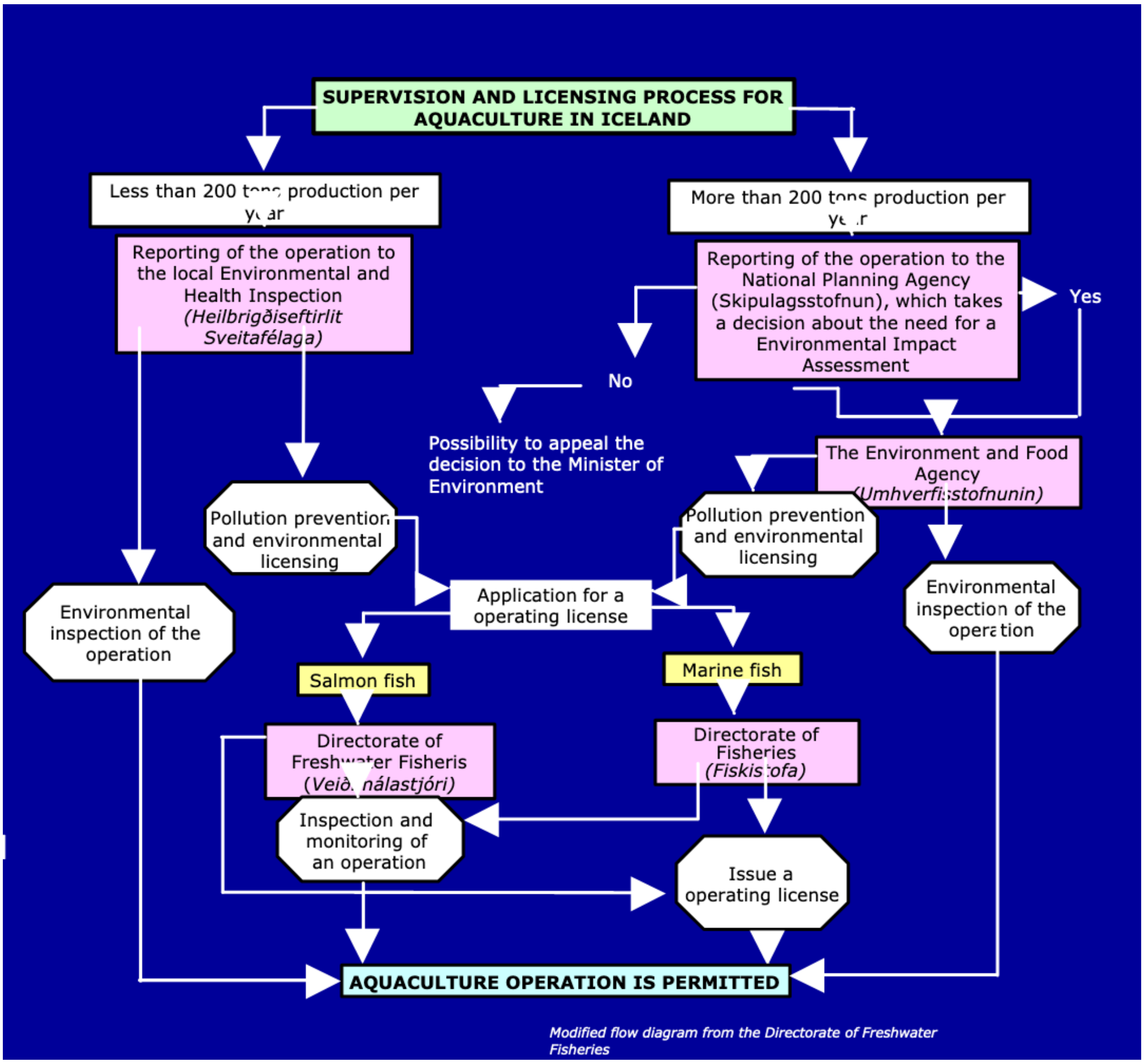

Figure 19: An illustration of the supervision and the licensing process for aquaculture in Iceland (Böðvarsdóttir, Guðmundsdóttir, Þóroddsson, & Marteinsdóttir, 2004).

A minor conclusion of the status of the aquaculture and on how topical Iceland is as a location for "Octopus" is evaluated as not optimal. Although Iceland is free of salmon lice on the east side, which is one of the biggest challenges in the industry, and has a good level of knowledge, other factors like the low temperature, the licensing process and the distance to the rest of Europe are limiting factors that may be a restriction of "Octopus".

4.2 Scotland

The northern part of the United Kingdom is Scotland with an area of 78,282 km^2 and a population of approximately 5,400,000 people. Scotland is divided into three main areas: The Highlands in the north, the Southern Upland in the south and Lowlands in between. The west coast is similarly to Irelands west coast, characterized with incisions resulting in fjords and islands. The east coast is relatively flat without archipelago. In addition, Scotland have two small groups of islands: Orkney Islands and Shetland Islands. The marine farms are located in the West and North coasts of the mainland and on the isles Orkney and Shetland (Jørstad et al., 2018).

According to Scotland´s Aquaculture website, the dominating aquaculture production consists of Atlantic salmon and Scotland is currently the largest producer of salmon in EU and the third largest in the world after Norway and Chile with an annual production of 1.2 million and 633,000 tonnes respectively. By 2012, Scotland exported aquatic food to over 55 countries worldwide. Export of the food and drink sector is identified as the biggest potential for an increase the economic growth. Rainbow trout, Sea trout and other marine species such as Cod, Haddock and Halibut have also been produced in small quantities the recent years to adapt techniques and equipment to the differ in requirements needed for each species. An overview of a complete aquaculture location is presented in Figure 20 (Fish farming expert, 2019; Marine Scotland, 2015; Scotland; Statistics Norway, 2019).

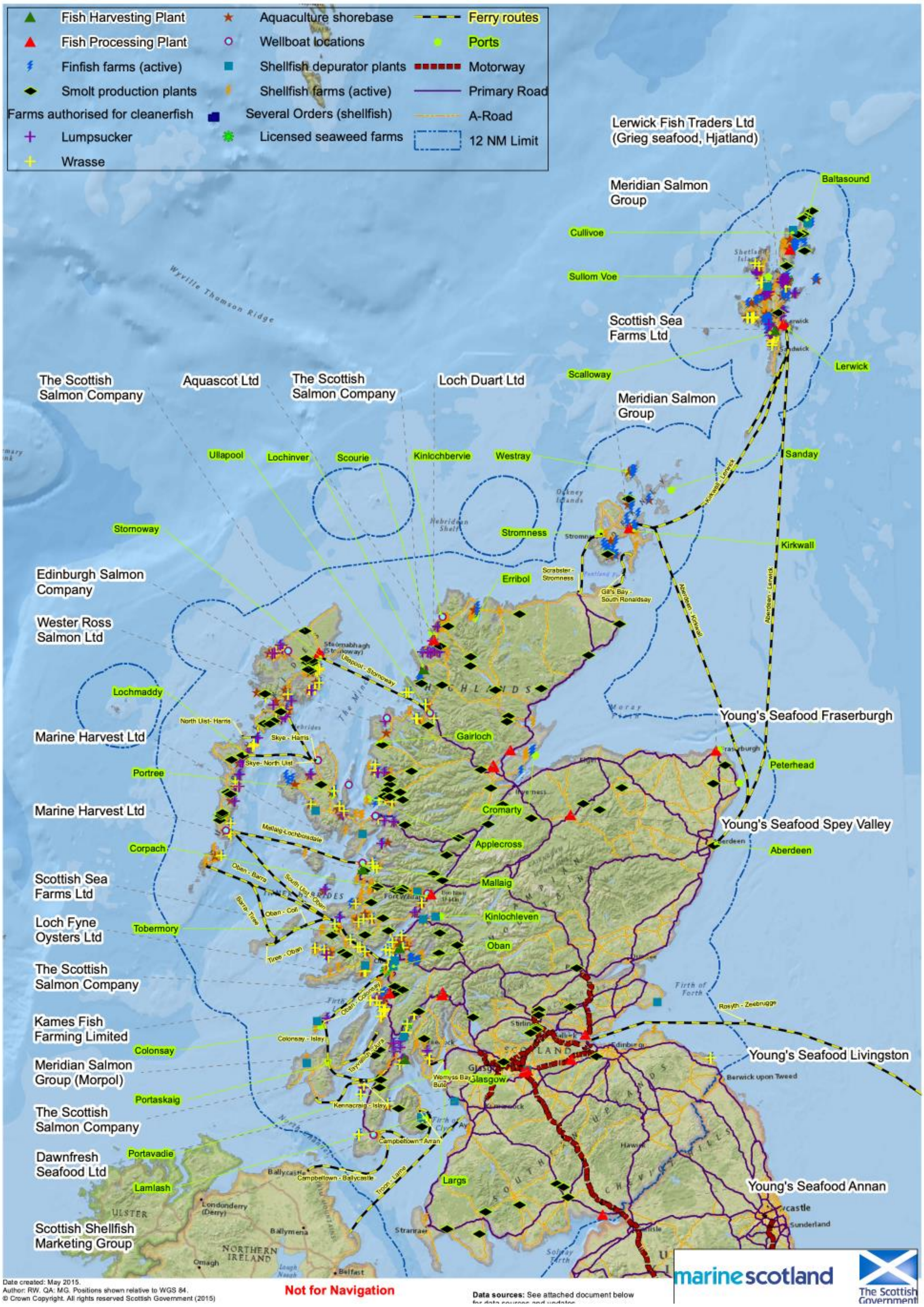

Figure 20: A map of the aquaculture infrastructure of Scotland.

As you can see from the figure above, most of the aquaculture locations is placed on the west and north side of the country. This is most likely due to the Gulf Stream which brings the warm water from the south part of the globe. Nevertheless, according to the British newspaper The Telegraph (2018), Scotland is the part of the UK that has most snow days within a year, 76.2 days on an average displayed in Figure 21 which also makes it the coldest (Smith, 2018).

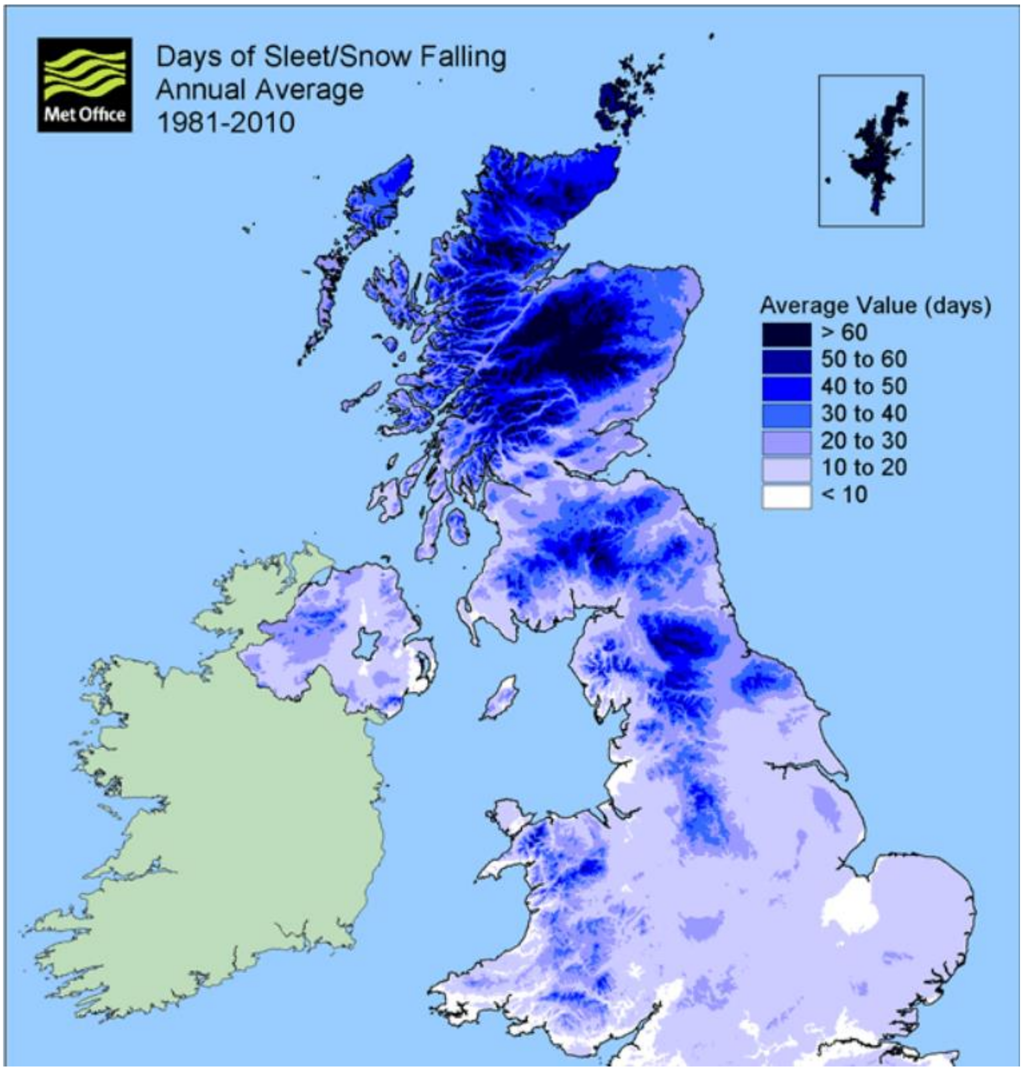

Figure 21: Annual days of sleet/snow falling in Scotland from 1981-2010 (Smith, 2018).

According to the Great Norwegian Encyclopaedia (2018), the climate of Scotland is maritime with mild winters with an average air temperature of 3.5°C in January, and cool summers with an average temperature of 14.5°C in July. The temperature in the sea varies from 7°C -9°C, which is a feasible temperature for the Atlantic salmon, but it is not optimal with respect to growth and welfare. The wind in Scotland is featured as the strongest winds in Europe. The strong winds are due to the Atlantic depressions the winds are most aggressive on the north and west part of the country as shown in Figure 22. One of the strongest winds recorded had a speed of 72.2 m/s (Jørstad et al., 2018; Lew, 2017).

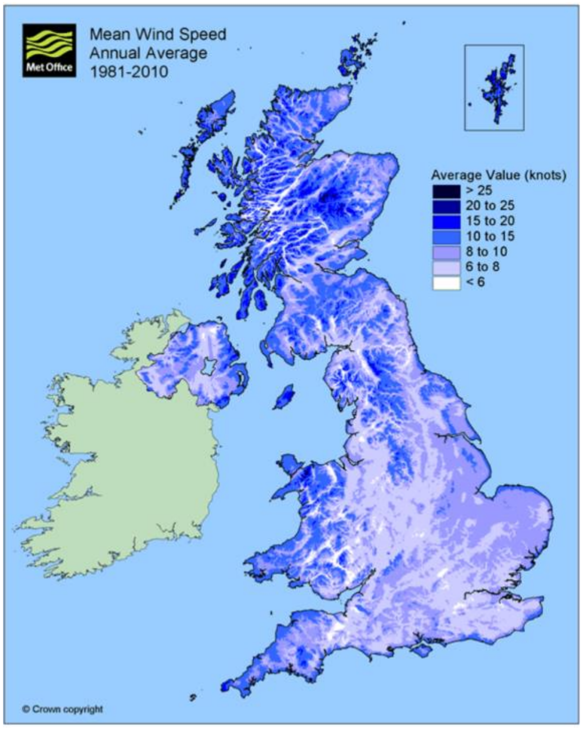

Figure 22: Mean annual average wind speed in Scotland from 1981-2010 (Smith, 2018).

The main export industries in Scotland is technology, oil and gas, textile, aliment and whiskey. The fishing industry is mainly placed in the north and provides about 2/3 of the total catch in the UK. In Figure 23, the production graph of farmed salmon the last 27 years is illustrated and shows that there has been an continuous increase and it is not expected to decrease in the coming years (Jørstad et al., 2018).

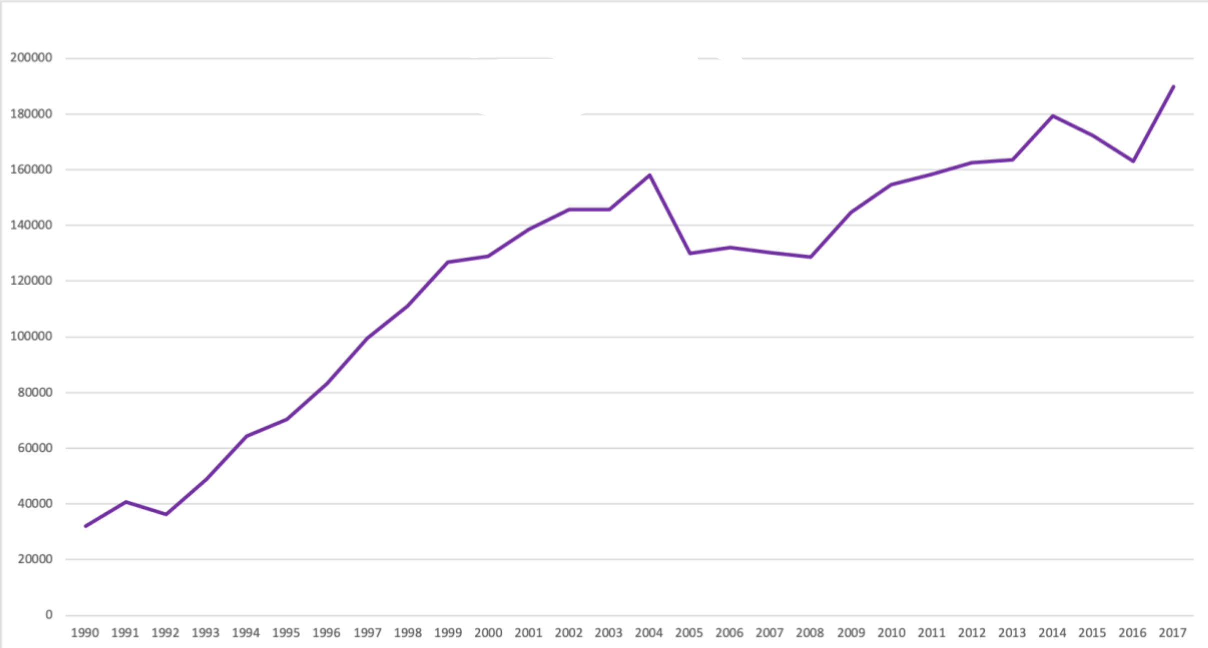

Figure 23: An overview of the production of farmed salmon in UK, 2/3 is Scotland, the last 27 years from 1990 to 2017 (Food and Agriculture Organization of the United Nations (Fisheries and Aquaculture Statistics), 2019).

The facilities are located at the west and north coast of Scotland and some on the two islands earlier mentioned. Due to rough weather, they are usually stationed sheltered at sea lochs, feet and inlets shown in Figure 24 (Jørstad et al., 2018; Scotland).

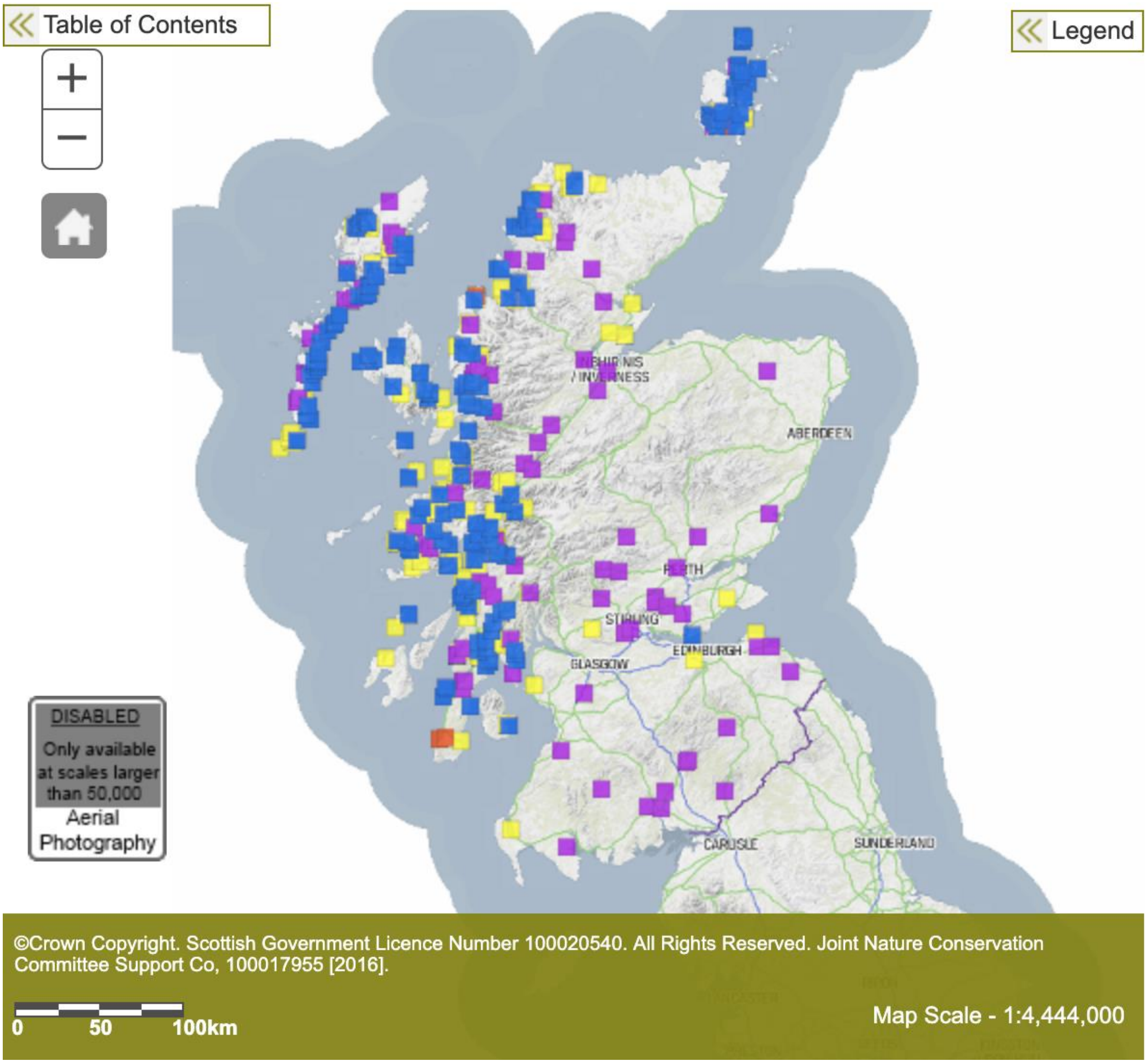

Figure 24: A Map of existing farming sites in Scotland (Scottish Governemnt, 2019).

As stated in the Review of the Aquaculture Licensing Process, The Scottish Licensing system do not consist of getting a formal license but rather a consent from between five and seven of the governmental bodies stated in the list below. According to the Salmon Farming Handbook (2018), generally in order to set up a fish farming site permission from three main institutions must be granted; local regional Council for the planning permission, a Marine License from Marine Scotland and an environmental discharge license from the Scottish Environment Protection Agency (SEPA). That means that it is necessary to get between two and four or more permissions from the list below. Listed below are the requirements from the report where five to seven must be consented (Kenyon & Davies, 2018):

- *"Seabed/Foreshore Lease issued by The Crown Estate/Crown Estate Scotland, is the equivalent of the foreshore lease determined by MAFM and processed by AFMD in Ireland.*
- *Planning Permission granted by the Local Authorities, is equivalent to permission granted as part of the aquaculture license determined by MAFM and processed by AFMD.*
- *Environmental Impact Assessment (EIA), if required, assessed by the Local Authorities. The equivalent in Ireland is assessed as a part of the aquaculture license and is assessed by MAFM and processed by AFMD.*
- *Authorization to operate an Aquaculture Production Business issued by Marine Scotland Science Fish Health Inspectorate. This is equivalent to the Fish Health Authorization issued by the MI.*
- *Controlled Activity Regulations (Barrett & Hegarty), issued by Scottish Environmental Protection Agency, SEPA. This is the equivalent of EPA consent in the case of land-based saltwater and freshwater operations. In the case of marine finfish these considerations form part of the general aquaculture application determined by MAFM and processed by AFMD.*
- *Habitats Regulation Appraisal (HRA), if required, issued by any of the following: the Local Authorities, Marine Scotland Licenses Operation Team, The Crown Estate/Crown Estate Scotland, Marine Scotland, Science Fish Health Inspectorate. The equivalent process in Ireland is an AA. It is assessed by MAFM and processed by AFMD with the support of their technical and scientific advisors."*
  - (Moylan, Ciennéide, & Wheland, 2017, p. 29)

According to the salmon handbook produced by Marine Harvest (2018), each application takes around 10-18 months to get granted. The permissions that last for a 25-year period, come with regulations that have to be applied at the farming site such as maximum allowable biomass (MAB). As opposed to Norway, the MAB is not a given value based in location in the country, but rather on the environmental concerns at the specific site as it is the local marine environment which is to be exposed. However, MAB is usually given between 100 to 2,500 tonnes, but special permissions can be given to MAB >2,500 tonnes (Marine Harvest, 2018).

Many of the applications in Scotland require a pre-application process which ensure against delays and this pre-application is not a part of the determining timeframe which implies that the application process will have an ever longer timeframe. Another distinctiveness with the application process in Scotland is that they have a sophisticated technological support system which includes a databases and maps along with a SEPA modelling system named ‘Autodepmod’ and a data sharing to ensure a streamlined system. (Dey, 2018).

However, the report on the environmental impacts of salmon farming conducted by the Environment, Climate Change and Land Reform Committee (2018) states that the development of the Scottish fish farming is critical in terms of a sustainable future. The expansion plan over the next 10-15 years is a growth resulting in targets of 300,000 – 400,000 tonnes of fish. However, the fjords and technology available for conventional aquafarming do not have the capacity to enquire these targets, which means that this is dependent on development within the aquaculture (Dey, 2018).

To mention a few other possible complications, the report also states that the technology is not developed enough for the expansion plan. Scotland have gaps in knowledge, data and research to highlight some of the areas indicated in the report (Dey, 2018).

Scotland is a suitable candidate with respect to “Octopus” in terms of climate and infrastructure, but the current knowledge and expertise within the field along with the strict licensing process and the EU standards, does not seem adequate for a project in its development phase such as “Octopus”.

4.3 Ireland

Ireland is an island on the west coast of the UK. The island is separated into two parts, North-Ireland, which is a part of the UK and the Republic of Ireland. According to the Central Statistics Office of Ireland (Barrett & Hegarty) the population is approximately 4,857,000, recorded in April 2018, and the country stretches over an area of 70,280 km^2.

The west coast is characterized by a lot of incisions and several islands. Areas where most of the fish farms are located are illustrated in Figure 25. The east coast is more even both domestic and coastal. The ocean climate is tempered so the temperature difference between summer and winter is small with an average air temperature of 18°C and 7°C respectively. The average temperature in the sea is around 12°C which is right within the optimal temperature for the Atlantic salmon. The Atlantic Ocean brings low pressure causing significant amounts of rainfall over the island. Large amounts of rainfall usually mean great vegetation, nevertheless, Ireland have a lack of forest and consists mostly of marsh, heather and lichen (Barrett & Hegarty, 2018; Mustad & Thuesen, 2019).

Figure 25: Illustration of the fish farms on the west coast of Ireland (Foras na Mara Marine Institute, 2019).

The wave climate in Ireland is according to the Irish Meteorological Service Met éireann suitable for holding an installation like "Octopus". The average significant wave heights vary from 3 m off the west coast to less than 1.2 m in the Irish sea. In Figure 26, the mean values in all the four seasons are shown and none of the seasons provide a treat in conjunction with wave height as "Octopus" can withstand a H_s of 15 m (Met éireann).

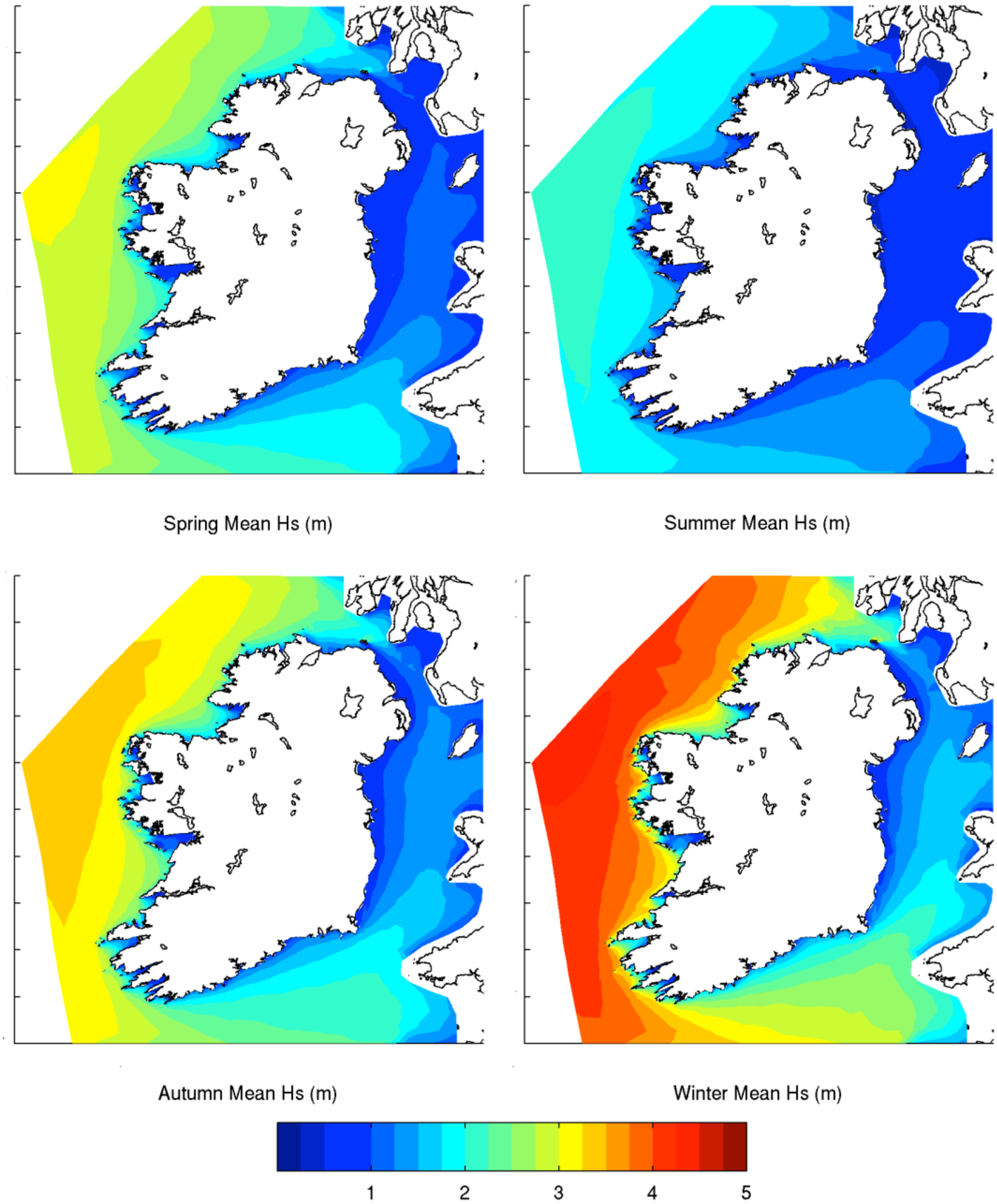

Figure 26: Seasonal variation in the Significant wave height (Met éireann).

According to the Great Norwegian Encyclopaedia, it is production within agriculture, deposits of metals, electronics, medicines, textile, machine and transport equipment which is central in the Irish industry. Currently the fish industry is limited and modest but recently The Ireland's Seafood Development Agency (2018) stated that the future is looks promising, and that the industry is constantly evolving. Ireland have been farming salmon since the 1980´s and have developed a set of experiences along the way. And according to the Salmon Farming Handbook, Ireland have been early to experiment with offshore farming in the early 1990´s, but there is a lack of political and government support and involvement making the development slow and expensive. As the interest in farming salmon increases, as shown in Figure 27 , other challenges as lice and other salmon related diseases increase too. The peak in 2001/2002 can be due to the new regulations implemented at that time (Holmyard, 2017; Mustad & Thuesen, 2019).

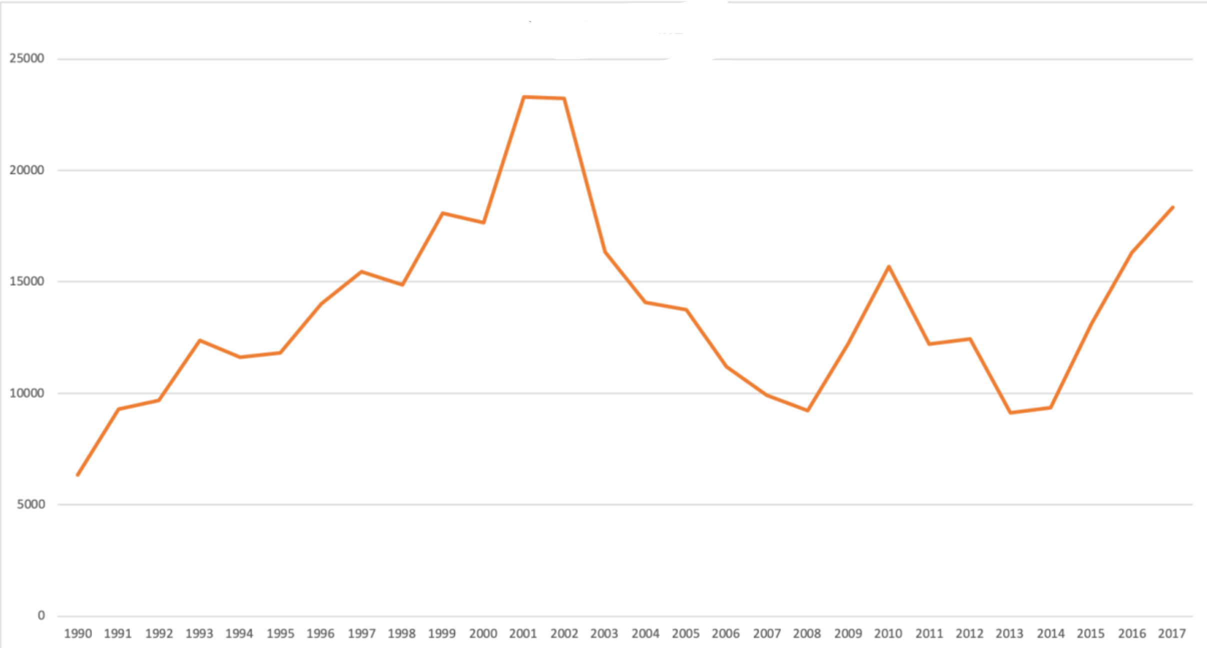

Figure 27: An overview of the production of farmed salmon in Ireland from 1990-2017(Food and Agriculture Organization of the United Nations (Fisheries and Aquaculture Statistics), 2019).

In a fresh article published at the Irish Farmers´ Association website (2019), there has been a dramatical fall in production of salmon with 39% from 2018 to 2019. The fall is due to a lack of support from the government along with a failure in the promotion of the Irish Aquaculture industry. In the same article, it is also mentioned that there are applications for licenses submitted in 2005 that has not yet been processed 14 years later. This indicates a lack of enthusiasm and cooperation with the authorities in the aquaculture industry (Irish Farmers´ Associasion, 2019).

In Europe and in general globally, Ireland have a small sector for aquaculture. Responsible for the allocation of licenses is mainly The Aquaculture and Foreshore Management Division (AFMD) on behalf of the Minister for Agriculture, along with Food and Marine (MAFM) and the all evaluations and decisions are anchored to The Fisheries Act 1997 and its associated regulations. The Fisheries Act 1997 is an amendment that operates as a law of commission within aquaculture in Ireland. Ireland is a member of EU and have to follow standards provided. According to the Salmon Farming Handbook (2018), the licensing process is complex and requires passing by many organizations and institutions before a final decision is made (Marine Harvest, 2018; Moylan et al., 2017).

During the process of an application, the Ministry is obligated to consider a wide range of factors considering the applicants similarly to Scotland, so other participants such as The Marine Engineering Division (MED), The Marine Institute (MI), Bord Iascaigh Mhara (BIM) and the Sea Fisheries Protection Authority (SFPA) to mention a few, is also involved with research and advise in order to secure an appropriate decision. Even though the application may be approved by the Minister, the Aquaculture Licenses Appeals Board (ALAB) which was establish under the Fisheries Act 1997, have the authority to confirm, refuse or change a decision (Marine Harvest, 2018; Moylan et al., 2017).

According to The Environmental Protection Agency (Department of International Trade, Hollingbery, & Eustice MP) (2017), the maritime space in Ireland is increasing as the farming activities along the cost are intensifying. This leads to great competition regarding space and other conflicts which can again lead to negative consequences for the areas which are under protection of the marine environment, illustrated in Figure 28. To secure a sustainable future for the Irish marine environment and all involvement, a new management manual is needed to ensure a balance between the social, economic and the environmental interests (Moylan et al., 2017).

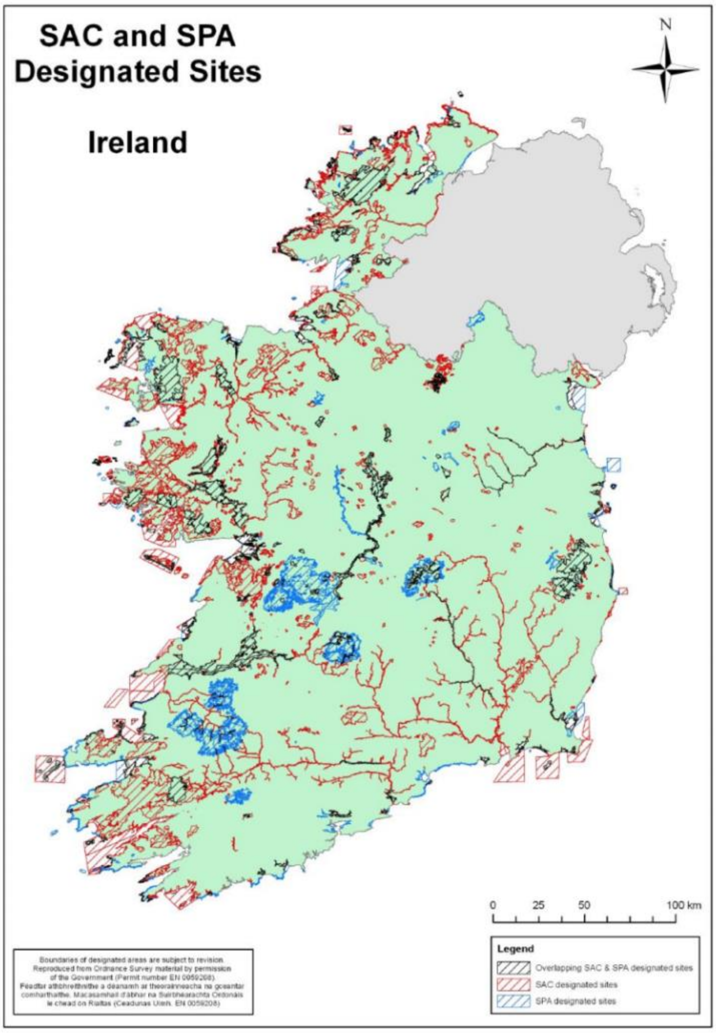

Figure 28: An overview over special protected areas along the coast of Ireland (Bleasdale, 2014).

As a brief conclusion, "Octopus" is going to need support and enthusiasm from the government in order to become a success in a new market. Even though the wave profile and temperature are optimal, the government in Ireland does not seem to prioritise innovation within aquaculture industry and is therefore not a recommended location to proceed with the development of "Octopus".

4.4 The Faroes Islands

The Faroe Islands is located in the Northeast Atlantic and consists of an archipelago of 18 islands. The autonomous country is positioned between Europe and North America in the Gulf Stream. The islands have a total land area of 1,399 km^2 and 274,000 km^2 of sea surrounding them, illustrated in Figure 29. The population is approximately 50,000 where approximately 40% lives in Tórshavn, which is considered as the capital of the islands. Other settlements are located by the fjords and channels with opportunities for fishing and agriculture (Thuesen & Phil, 2019).

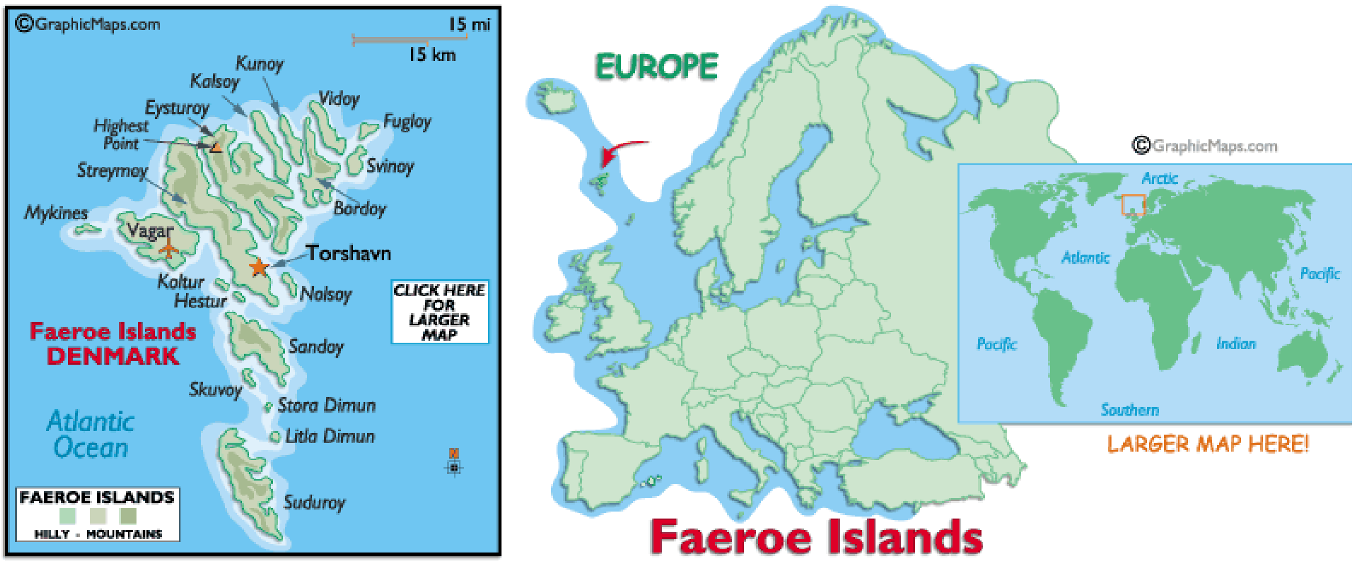

Figure 29: An illustration of positioning and mapping of the Faroe Islands (Atlas, 2016).

The climate is stable and the difference in the air temperature between summers and winters are low, and the temperatures in the sea are similarly to Ireland. Normally, the largest waves height are, according to Mowi, one of the companies on the islands, H_s of around 5 metres. The landscape is characterized by heather, fields, fjords and mountains. Animal life is limited due to lack of hiding and shelter, so pretty much all of the wildlife is by the coast and consists of birds and marine animals (Johannesen, 2019; Thuesen & Phil, 2019).

According to the Faroe Fish Farmers Association, these islands have stayed relatively isolated in the preservation of ancient traditional for centuries that has shaped the Faroe Islands to an independent and welfare society. With fish production standing for between 90%- 95% of the export, fish farming has been an important resource both for business and pleasure throughout the history, which the Faroese have taken good advantage of and have therefore developed an advanced experience within this field. With an hour drive from the north to the south and from the east to the west, ocean is a big part of the Faroese culture where the fish farming goes back to 1967. A graph illustrated in Figure 30 shows the development of production of salmon the last 27 years. The recent decrease in the production may be due to lack of capacity of fjords and licenses (Faroe Fish Farmers Association; Føroya landsstýri).

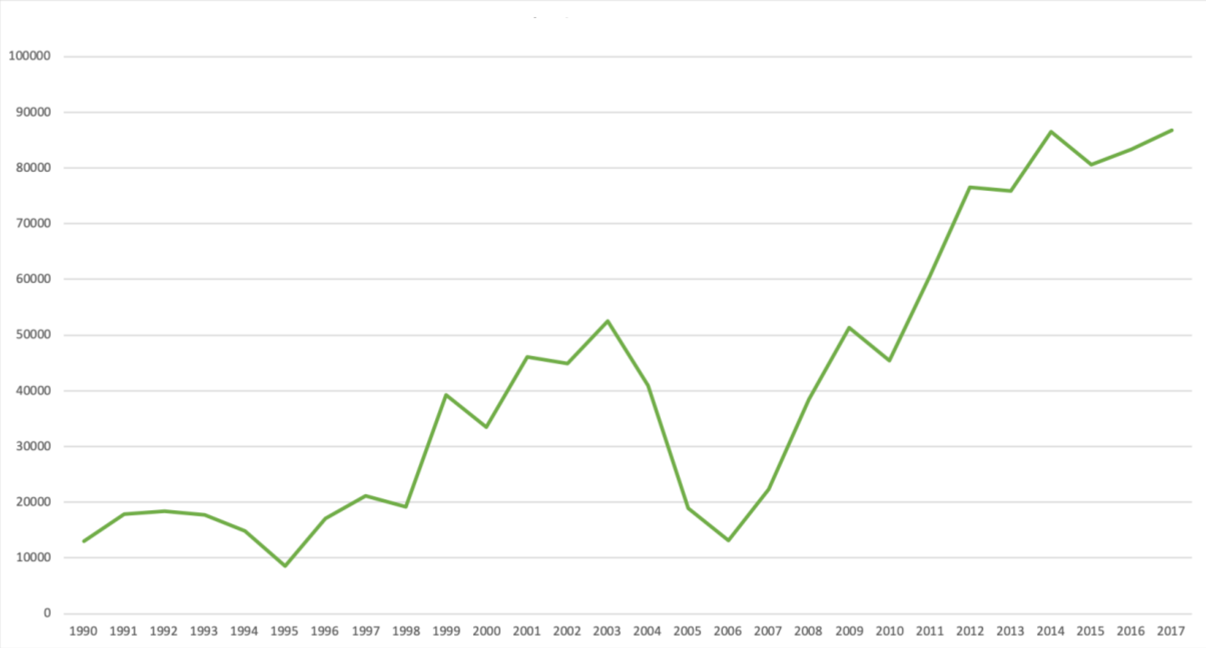

Figure 30: A graph of development of production of salmon from 1990 to 2017 (Food and Agriculture Organization of the United Nations (Fisheries and Aquaculture Statistics), 2019).

Nevertheless, in the information given by the Minister of Trade and Foreign Affairs on the Faroe Islands, Poul Michaelsen, the biggest treat towards the salmon farming industry is the salmon lice. Salmon lice is as mentioned able to be treated, but the lice can, like humans, become resistant to the chemical treatments by continuous exposure. The lice limit on the island is 1.5 sexual mature female lice per fish, which is a generous limit compared to Norway where the limit is 0.5. This causes the island to be significantly more exposed to the parasite by enabling it to reproduce and obtain a large stock. However, recently, the Faroese have been recognized for their big smolt which has proven to withstand more exposed environments and are less exposed to diseases. In addition, it needs less time in the sea before it gets harvested. By having larger smolts, it will be ensured that they are able to endure the lice and more of the smolts will survive (Michaelsen, 2019)

Even though the Faroe Islands is a part of Denmark, it is a self-governing nation with extensive autonomous powers and responsibilities, which means that they have the exclusive competence to legislate and govern independently on a wide range of areas. Although Denmark is a part of EU, the Faroe Islands is not and is thereby not required to comply with the regulations set by the EU. This allows the islands to be led by someone who is familiar with the islands and knows how it will work best. If something does not work, they have the ability and freedom to change it just like an independent country. On the other hand, this mean that the regulations implemented on the island have to be carefully evaluated. If something goes wrong, either environmentally, economically or legally, The Faroe Islands must be responsible for all the choices made and hold accountable (Føroya landsstyri).

As stated in the Salmon Farming Industry Handbook (2018), the most important regulations regarding aquaculture in the Faroe Islands is the Aquaculture Act, the Environmental Act and the Food Safety Act. Each license is given for a specific area and production limitations is specified on each individual license. Sanitary and environmental conditions on the site is the main factors deciding the density limit in the area. The biggest difference between limitation on the Faroes compared to other countries is that the production is not limited by MAB but is usually varies between 1,200- 5,800 tonnes per year per license. This limitation also depends on the environmental conditions at each specific site (Marine Harvest, 2018; Moylan et al., 2017).

In order to get a license, an application to the Food and Veterinary Authority is required. They assess it while getting advices from several organisations protecting the environment and marine and other habitats. The application has to contain an operating plan, evaluation of emissions, placement, feeding and other relevant information regarding how the farm will be ran. When the application is approved by the Food and Veterinary Authority it goes to the minister of trade and foreign affairs for final approval (Marine Harvest, 2018; Moylan et al., 2017).

However, in 2012 the Government implemented a regulation that ensures that no foreign company can own more than 20% of a fish farming company to secure the sustainable growth in the industry on the island. According to the Faroese Government, this is due to the historical picture of preserving the citizens and that the new regulations applies to the new applications to get license. However, there are three fish farming companies on the islands; Mowi (former known as Marine Harvest), Bakkafrost and Hiddenfjord. It is only Hiddenfjord that is 100% owned by Faroese and is the smallest company. Mowi is 100% Norwegian, while Bakkafrost is owned by over 3,000 different shareholders in 22 different countries and is by far the largest company on the islands. After recent communication with the Minister of Trade and Foreign Affairs, Poul Michaelsen, this regulation is in a transition of change and companies with 100% foreign ownership are expected to be allowed permission in near future (Marine Harvest, 2018; Michaelsen, 2019; Moylan et al., 2017).

Faroe Islands have the optimal weather conditions with respect to temperature and wave heights similarly to Ireland, but the Faroe Islands have a government which indicates more support and commitment to a project like “Octopus”. Additionally, there should be a common interest in getting a better market for the tourism on the islands which are small and hidden in the Atlantics, along with increasing export products.

4.5 A brief conclusion

A conclusion in this chapter summarize some of the factors that strengthens and weakens the feasibility of Octopus in each country. The main concerns taken into consideration in the conclusion is temperature, wind, waves and climate, license regime and different incentives from the country to change and / or upgrade current technology and increase production. Attached as “Appendix A” is a comparative overview of essential information about the four different countries and Norway for comparison. I make reservations that it may be more accurate or updated information available. There are e-mails sent to the authorities in each country in order to provide the best information and some answers have been given. Nevertheless, there is probably more information to collect if the timeframe and resources were adequate.

Starting with Iceland, the sea temperature on the island is generally too low and even though it reduces the risk of salmon lice and other diseases and lays in the Gulf Stream, it still needs additional heating to reach a suitable temperature for farming salmon. When the temperature increases, the number of salmon lice will probably increase too. On the other hand, Iceland is recently granted permission for expansion of the production, which is certainly fit for the “Octopus” project. However, there is a limited infrastructure since the whole island is not easily connected by roads or boats along with a significant risk of high waves that may damage “Octopus”. The roads often get closed due to weather during the winter season and drifting ice can cause greatly damage on the Octopus since it is placed exposed and offshore. The possibility of the drifting ice floes presents an unnecessary risk which will most likely apply additional time or costs to the planning and operation. The licensing process is also too demanding and time consuming for a project that is eager to be tested.

Scotland is a country which is a part of UK and EU which leads to complex regulations and processes. To get an application through a system requires time and this may be particularly relevant for a new type of farming as “Octopus” which may do not go under the standard application process. The infrastructure and legal system in Scotland are clearly qualified in terms of quality since its responsible for 2/3 of the fish production in the UK. Even so, Scotland have a well driven aquaculture industry and several other possibilities when it comes to export production which may lead to a decreasing interest in investments regarding new and up-coming technology. When it comes to the water replacement, the geographical location may not be optimal in the Irish Sea. Ireland works like a shelter, making large parts of the Scottish coast acting like fjords and is not that exposed. Additionally, as Scotland is one of the windiest countries in Europe does not seem like an advantage for "Octopus" with respect to operational conditions in strong winds.

The island west of UK, Ireland, is also a potential candidate due to the small difference in the summer- and winter temperature and is positioned strategically in terms of the Gulf Stream. The exposed environment and rapid water replacement, temperature and positioning make this island to a fish farming nation. However, along with the perfect positioning, the depressions from the Gulf Stream also present significant strength of the gusts which can be challenging for "Octopus" due to operational limitation on the facility in strong winds. Even though Ireland have experimented with offshore farming in the past, due to politics and economy it died out or was put on hold. Additionally, the cooperation and support from the government does not seem adequate according to the Irish Farmers 'Association. This gives an indication of small interest from the government and that the funding's is not adequate. Ireland is also a part of EU which makes the application process as complex as Scotland with the regulations and standards required. The process is not likely to have any faster timeframe and the application is required to go through many approvals. Additionally, as mentioned, together with increased intensity of fish farming comes the increased spreading of salmon louse.

The Faroe Islands is a very isolated group of islands right in the middle of the Gulf Stream. Firstly, the isolation is beneficial in terms of spread of disease and in case of challenges, the insolation makes it easier to control and treat. However, isolation can cause a delay if there is a need of particular services which is not provided on the islands. Politically speaking, the Faroe Islands is adaptable due to the self-governing system arrangement and is not controlled by standards and requirements from the EU. This probably simplifies the application process and allows the government to monitor and control the farming facilities to a greater extent. Even though the regulation says that a company cannot be owned 100% by a foreign owner, this is in transition and the new regulations is most likely allowing foreign companies to apply for licenses. Additionally, most of the export from the Faroe Islands is seafood, which gives an impression of passion and commitment to the industry. It can also give an indication of commitment due to the lack of other resources.

Based on the brief overview discussion over the four countries in this chapter, I will conclude with the Faroe Islands as the country best suitable for the handling and execution of "Octopus". This is mainly because of the licensing regime which is not restricted by the EU or have a major complex process with applying for a license. The Faroe Islands have also a long history of fishing that ensures experience and knowledge within the field. The most convincing factor is the Faroe Islands dependency on fishing. When between 90 to 95% of all export is related to the fish industry, the government is forced to pay attention to this area and cooperate both financially and politically.

5 PESTEL analysis of the Faroe Islands

In this PESTEL analysis, I will try to elucidate the factors and effects that may affect Roxel Aqua AS and "Octopus" if the Faroe Islands become an area of interest. As mentioned earlier, a PESTEL analysis consists of an assessment of external factors such as political, economic, social, technological, environmental and legal. In this chapter I will present some of the factors that may have an impact on an establishment of “Octopus” on the Faroe Islands.

5.1 Political

The political factors are all about how and to what degree a government intervenes in a certain industry. Basically, all the influences that a government has on a business could be classified here. This can include government policy, political stability or instability, corruption, foreign trade policy, tax policy, labour law, environmental law and trade restrictions. Furthermore, the government may have a profound impact on a nation’s education system, infrastructure and health regulations. These are all factors that should to be taken into account when assessing the attractiveness of a potential market.

As earlier mentioned, the Faroe Islands are a self-governing nation with a high degree of autonomy encompassed by the external sovereignty of the Kingdom of Denmark and their political system is considered as a parliamentary democracy. Løgting, the legislative assembly, is one of the oldest parliaments in the world which consists of 33 elected members chosen for a period of four years. Føroya Landsstýri, the executive government, is headed by the Prime minister and has the executive authority on the islands. There are eight departments that the prime minister chose the composition of. Additionally, two Faroese representatives are elected to the Danish Parliament in Copenhagen. The islands do not have independent embassies in other countries but have representatives within some of the Danish embassies (Føroya landsstyri).

Therefore, the Foreign Policy Act gives the Faroe Islands the exclusive right to legislate and govern independency in a wide range of areas. Nevertheless, The Kingdom of Denmark is still the head of state and Denmark’s local representative at the islands is the National Ombudsman. The Faroe Islands’ inner autonomy has gradually been extended to all areas, except for the state constitution, citizenship, supreme court, foreign-, security- and defence policy and currency- and monetary policy. Some of the important areas regarding the fish farming industry are the conservation and management of living marine resources within the 200-mile fisheries zone, protection of the environment, trade, education, industrial relations, taxation and customs, transportation, communication etc. Although Denmark does not have authority in all areas of the Faroe Islands, the Faroe Islands still have influence and participation in foreign and security policy in Denmark (Føroya landsstyri).

The Faroe Islands is a large producer of high-quality Atlantic salmon with an annual production of around 70,000 tonnes and export it globally. According to Poul Michelsen, the aquaculture industry is responsible for over 50% of the total export from the Faroes which makes the industry a major part in political decisions (Michaelsen, 2019; Visit Faroe Islands).

As a third country in relation to the EU, the Faroes have a cooperation agreement within fisheries, trade and research with the EU. Recently, they entered into a treaty with Iceland, known as the Hoyvik Agreement, that created a single economic area that involves both of the countries with free movement of goods, services, capital and persons. The Faroe Island have according to the Department of International Trade in UK (2019), newly signed a continuity agreement with the UK securing mutual exchange between the two islands when UK leave the EU (Department of International Trade et al., 2019; Føroya landsstyri).

Along with Iceland, UK and the EU, the Faroe Island have free trade agreements with both Greenland, Norway and Switzerland and a similar agreement with Turkey is underway. According to the global newspaper Reuters (2018), the Faroe Islands seek a free trade deal with Russia in order to stay as their biggest foreign supplier of fish. The Faroes seek opportunities for agreements with the countries worldwide and is considered as a free trader (Føroya landsstyri; Matzen & Gronholt-Pedersen, 2018).

Political decisions and any political changes at the Faroe Islands will significantly affect the fishing industry, mainly due to the extreme isolation on this archipelago. Since the Faroe Islands have their own government and are, unlike Denmark, not part of the EU, they can theoretically decide how this industry should work and any necessary changes are easier and faster to implement. According to the operational manager in Mowi, Finnur Johannesen, the government is supporting to the local aquaculture, and the industry is a part of any major decisions within the field (Johannesen, 2019).

The general taxes for the companies on the Faroes are divided into two parts. One that annually is paid to the state and one tax that is paid to the municipality depending on which areas the company operates in. For the aquaculture, there is an additional fee representing the loan of the fjords, the farming licenses, which depends on the annual turnover, normally 5%. According to Finnur Johanessen, the aquaculture companies present on the island, Bakkafrost, Hiddenfjord and Mowi, are operating in several municipalities. Therefore, they can choose which of the municipalities their tax should go to. Finnur Johanessen stated that Mowi is dividing the tax equally between all the municipalities they are operating in regardless of the amount of production or employees in each area. He expressed that this contributes to a balance in the politics when it comes to the aquaculture industry (Johannesen, 2019).

Bakkafrost has an annual municipal tax of approximately 120 million which makes the distribution important for the affected municipalities. The operating manager at Mowi expressed a concern with the way Bakkafrost distribute their taxes. Bakkafrost distributes the taxes according to the number of employees they have in each municipality. As an example, in the main office of Bakkafrost is in the municipality known as Glyvrar, there are between 300-400 employees and therefore the largest portion of their taxes goes to Glyvrar. Nevertheless, Bakkafrost has between 40-50 fish farms around the islands that do not have as many employees and thereby gets a significant smaller portion of the taxes. Finnur Johanessen revealed that this is a possible way for the companies to influence the politics in the local community. As an example, the politicians can be bribed by being promised a larger portion of the taxes if one gets adhesion in specific decisions. This is referred to as corruption and even though there is no evidence to whether this happens or not, there is a genuine concern in relation to the size difference and the impact force distributed among the companies on the islands (Johannesen, 2019).

On another side, Bjarní Larsen (2019), the farming optimiser in Bakkafrost, believe that the government gradually takes “a bigger portion of the cake” and that they sometimes work towards the industry. He gives an example with different paperwork that needs approval before Bakkafrost is allowed to get started with a specific operation can take an unnecessarily long time to get signed and approved. However, Poul Michaelsen answered that this as an act of intention to ensure a more detailed review and evaluation of all of the operations in the aquaculture industry. He points out that the consequences for quick assessments and approvals will be significant if the requests are not carefully considered, especially with respect to nature. It is also considered as a counteract so that the largest company does not outgrow the others, as this creates division and disagreement within the industry (Larsen, 2019; Michaelsen, 2019).

Providing a framework for the creative industries in the Faroes to thrive and develop further is according to Michaelsen a high priority for the Faroese government. As described in chapter 4.4, the licenses for aquaculture on the Faroe Islands are only available for companies where a minimum of 80% is owned by citizens of the Faroe Island. This regulation was initially a tool to keep the Faroese industry to the Faroe Islands to preserve traditions, local labour and the local environment. This particular regulation is, according to Michaelsen, in change. He has expressed a rather long wish for a change like this in the aquaculture industry to make the Faroes available for foreign newcomers and that it opens up greater opportunities for international cooperation. The regulation is in the last phase of the implementation process and will, according to the director of industry and trade at the Faroe Islands, Pól Edvard Egholm, be ready in June 2019. Since it is Bakkafrost, Hiddenfjord and Mowi that stands for the production in the aquaculture industry on the islands, it may be wise to have a fresh breath of new companies (Egholm, 2019; Michaelsen, 2019).

Bakkafrost has the largest total production of salmon along with their recent purchase of the local fish feed producer Havsbrùn. According to Michaelsen, there is currently too much domination from Bakkafrost than what is desired compared to Hiddenfjord and Mowi. Both Signar Pæturssonur Dam, biological developer at Hiddenfjord, and Finnur Johannesen, operating manager at Mowi, have stated that in such an isolated and small society, it can often be an advantage to know the right people in the right positions. Even though this can result in good communication and mutual understandings in various scenarios, it can often be related to corruption (Dam, 2019; Johannesen, 2019).

Poul Michaelsen have expressed some concern regarding the political direction the aquaculture industry have. Producers have become greedy regarding the production levels and the intrusion it causes to the nature when certain choices may be made based on hasty conclusions rather than taking a step back to assess the possible consequences of each opportunity. As a consequence, it may lead to unnecessary risks regarding personal safety of operations and environmental sustainability along with disagreements leading to split in the cohesion of the islands (Michaelsen, 2019).

When it comes to the infrastructure on the islands, the transportation and digital networks on the islands are highly advanced connecting over 95% of the community by either bridge, ferries, helicopter or subsea tunnels. The road system is constantly developing better ways to connect the islands. There is an ongoing construction of a 11 kilometres long subsea tunnel that will make the travel time between Tórshavn to Runavík go from 64 minutes to 16 minutes. The transport system is developed to modern standards and the cooperation between different mean of the transport sector is of high quality, this results in a quick access to necessary needs from abroad and/or export of goods and services aboard. The Faroes Airline, Atlantic Airways and the ferry company Smyril Line ensures connection with the rest of the world such as Iceland, Scotland, England, Denmark and Norway. Media communications and rapid web association over the entire nation additionally gives a good base to keeping up the financial, social feasibility of remoter networks (Føroya landsstýri; Michaelsen, 2019; Visit Faroe Islands; Visit Faroe Islands).

5.2 Economic

Fishing has been the main source of income for the Faroe Islands since the late 19th century. Fish and fish-products including farmed fish, represent between 90 and 95 percent of the total export value, and around 20 per cent of the gross domestic product (GDP). Farmed salmon in particular is a vital part of the Faroese economy, representing half of the country´s export value and providing valuable jobs for communities around the islands. The Faroese salmon is exported to six continents. In fact, the employment directly connected to the aquaculture industry consists of over 1,000 jobs, which is results in employment of over 2 % of the entire population. In Figure 31, different departments within the salmon farming industry is viewed to illustrate the opportunity this marked provide to the society (Visit Faroe Islands).

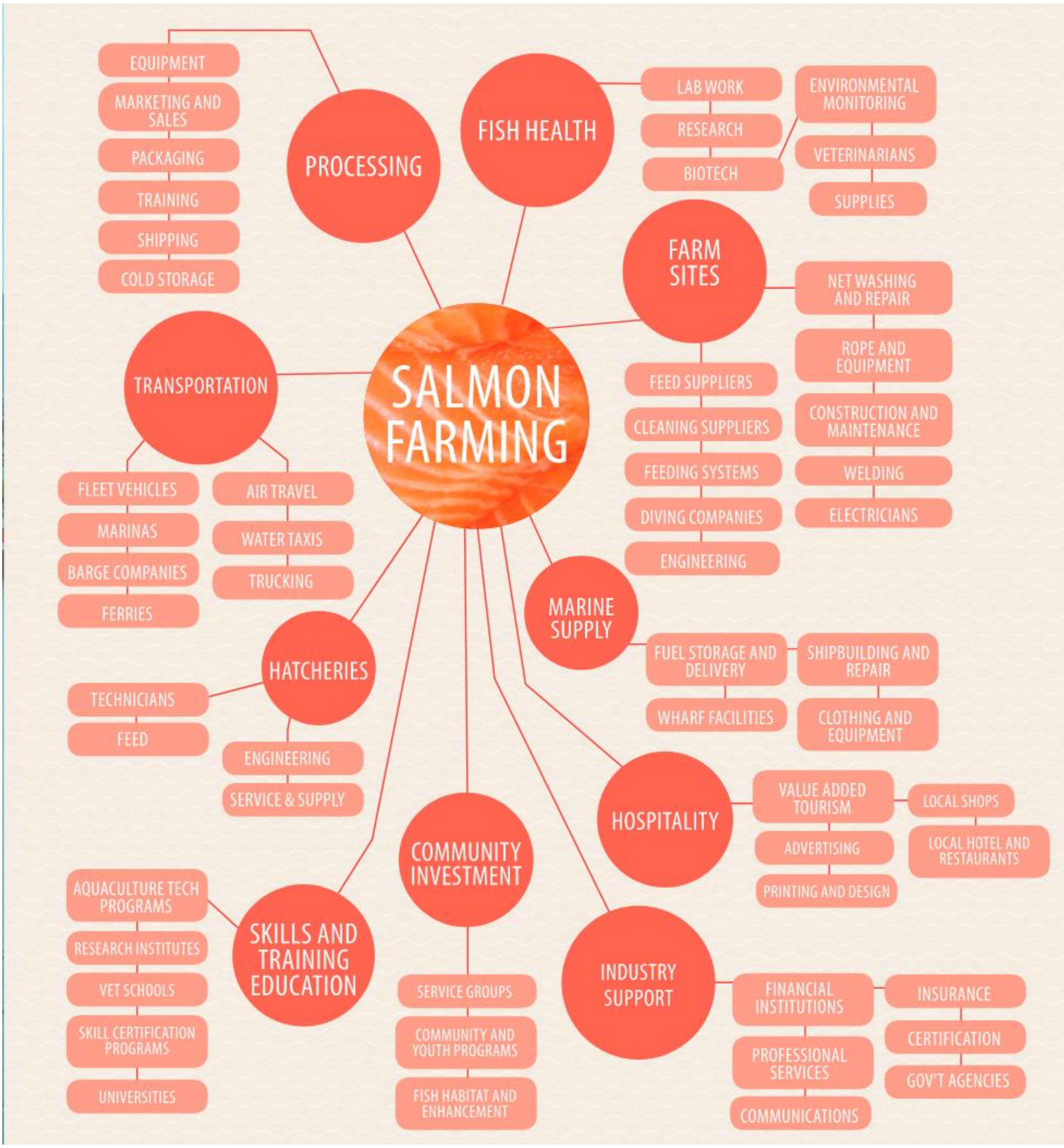

Figure 31: A view of the departments associated within the salmon farming industry (International Salmon Farming Association, 2018).

As mentioned in chapter 5.1, the aquaculture companies on the islands pay taxes to the state and the municipalities. According to Michaelsen, the taxes to the municipalities depends on the turnover for each of the companies, while the tax going to the state is set at 18% (Michaelsen, 2019).

However, as mentioned in chapter 1.5, the financial part is a very comprehensive and demanding analysis that is recommended to do as a further research. This section should cover all costs associated with operating on the Faroe Islands, including shipping of equipment, installation, employees, any fees associated with start-up and operation, along with some models calculating all possible future revenues. A future research should include highlights in a wide range of economic issues, both of a business and economic nature. It involves analyses of profitability, liquidity, financial structure and solidity. In order to conduct such an analysis, significant additional time and resources is required.

5.3 Social

The social factors affecting a business are the social and cultural changes along with the development in a society. It is vital for a company to be familiar with the trends, patterns and concerns surrounding the potential market. Be prepared and knowing how to handle and communicate with the locals, will make the entering into the new market easier.

One of the most important industries on the Faroe Islands are the tourism. A traveller survey made by the National Geographic Traveler (2007) resulted with the Faroe Islands being ranked as the top of the 111 islands that participated. It was described as authentic, unspoiled and likely to remain so. The Faroe Islands is a small community where the citizens are committed and feel especially responsible for their island. Therefore, it is an important priority to keep the Faroe nature intact. According to a statement in The Guardian (2019) by the director in Visit Faroe Islands, Guđriđ Højgaard, the investment in tourism has increased including maintenance and a new target for 2020 is that the overnight stays should be doubled and thus increase revenues in this sector (Ecott, 2019; Tourtellot, 2007).

Firstly, the fact that the Faroe Islands are a part of the global salmon market contributes to market the islands as a tourist destination. It also contributes to global food security and supply in the world market with high-quality products which results in sustainable livelihoods and welfare for the citizens of the Faroe. Additionally, like any other country, the tourism is an important part of society and is greatly appreciated. This creates jobs outside the salmon industry that values tradition and history (Føroya landsstyri; Michaelsen, 2019).

In connection with traditions, there is not many countries that is as dependent on the ocean and its assets as the Faroe Islands. The Faroes have built up the abilities and mastery important to make the most out of the resources found in the North Atlantic. As the fish industry culture is well established and developed, the knowledge in relation to fish is considerably high. There is a broad focus on the safety of the marine environment and develop sustainable ways to use the resources on and surrounding the islands, which probably makes the islands open but still critical to new developments involving the nature (Føroya landsstyri).

Secondly, according to Bjarní Larsen, the Faroe Islands, such as Norway, have developed a resistance movement towards salmon farming, with an emphasis on this way of processing the fish is non-natural process and is hurting the natural marine environment. Artificial conditions are created for the salmon where the it is manipulated as the producers' desire. The living conditions of the fish are seen as captivity and the well-being is questionable. Placing tens of thousands of fish in a net cage with limited space along with an intense feeding program, is seen by many as on the border of animal cruelty (Larsen, 2019).

According to the interviewees at the aquaculture companies on the islands, Hiddenfjord, Mowi and Bakkafrost, they believe that this dissatisfaction with farmed salmon comes from a lack of knowledge about salmon farming. Most of those who express their opinions regarding the welfare of the fish are aware of the salmon needs and whether it thrives or not in different environments. The local companies regularly measure the stress level, how much they eat and mortality of the fish. They have stated that a vision of honest and open communication with the citizens will ensure more acceptability in the years to come (Dam, 2019; Johannesen, 2019; Larsen, 2019)

Global coordinated effort is fundamental to the nature of Faroese research and development. Most of the research teams on the Faroese are parts of an international research community and the research on the islands is to a substantial degree tied down in worldwide partnerships. There is a flourishing and developing exploration culture in the Faroe Islands with a few organizations, labs, galleries and privately-owned businesses taking a shot at unique research ventures. Additionally, there are a few Faroese researchers living as foreign researchers abroad, that are occupied with research issues identified with the Faroe Islands, which indicates a curious community with an interest in development (Føroya landsstyri).

5.4 Technological

As offshore aquaculture is a relatively new way of operating a fish farm, it is therefore also limited knowledge of experience within the field. The theoretical technological advantages of "Octopus" are discussed in chapter 2.2.

Nevertheless, according to Øystein Patursson, a former researcher in Fiskaaling at the Faroe, an aquaculture of approximately a depth of 50 metres has been tested. This was initiated by a collaboration between the fishing industry and the research industry, but due to limited resources, the project was put down. Øystein Patursson stated that the research department on the islands is annually granted an economic delegation of 6-7 million DKK, which leads to a prioritizing that may not benefit the aquaculture industry (Patursson, 2019).

Nonetheless, as stated by Øystein Patursson, Norway is careful when it comes to start with completely new projects, since neither the consequences, the risk or the effects of the project are known. As an example, Norway does not import new medicines until they have been extensively tested and have a documented effect. In the Faroe Islands, on the other hand, they are more willing to try new things and methods but prefer to use equipment and technology that already exist at the islands due to financial challenges. Even though this may lead to small amount of expertise in some areas, it will lead to a considerable knowledge of several areas. Additionally, Øystein Patursson states that it is not the same consequences in case of failure at the Faroe Islands compared to Norway, where it is given fines and other forms of punishment (Patursson, 2019).

The development of technology in the Faroe Islands is characterized by the isolation. Although companies like Mowi are experimenting with technology regarding exposed fish farming , these projects will automatically be linked to Norway where Mowi originates. According to Poul Michaelsen, the government on the Faroe Islands is open and supportive of experimenting with new ideas. There have in fact been several technology solutions developed lately, both offshore farming, pull-down and cages hanging after a boat in motion, but they are still early in the development phase and is expected to require testing before it will be able to enter the market. The internal research and development within the Faroe Islands are, according to Øystein Patursson, not sufficient compared to other neighbouring countries mostly due to lack for funding and knowledge of new technology. Although the technology itself is not significantly outstanding in the Faroe Islands, the industries are determined to use equipment and other services available on the islands before it is received from abroad (Dam, 2019; Johannesen, 2019; Larsen, 2019; Patursson, 2019).

Recently, according to Bjarní Larsen, a farming optimizer in Bakkafrost, Bakkafrost has developed a genetic family of salmon at the Faroe Islands. The result is proven to be positive and they are excited to introduce the second generation of the salmon in 2020 (Larsen, 2019).

As stated by Ragnar Joensen, there is a new technology within particle simulation that is ongoing on the islands. This is a tool to track the travel patterns of the particles around the Faroe Islands so that it can be predicted which areas that may be affected by diseases or other similar challenges if such is detected nearby. In this way, the various fish farms can be prepared for a wave of salmon lice, for example, and treat the fish accordingly. Another thing Ragnar Joensen emphasizes is that even lice adapt and become resistant and therefore new methods must be continually assessed (Joensen, 2019).

5.5 Environmental

According to Hauge Aqua fish health and welfare is the status of the fish, such as its ability to withstand infection, the pressure and stress inflicted in the stock and in which environment the fish is farmed. As stated in the BBC news (2019), the salmon swim around in a circle for around two years before it is harvested and ends up on our dinner plates. In the two years of "freedom" in the nets at the sea, they get processed feed with additives that are supposed to ward off diseases and infestations. This is a common perception of the aquaculture industry around the world as well as on the Faroe Islands. If it is to be interpreted in black and white, this is also a part of the reality. The salmon is forced to swim in a circle, it does get feed with additives to keep diseases away and they do end up at our dinnerplates (Adams, 2019; Hauge Aqua).

However, in 2003, there was a major change in the aquaculture legislation on the Faroese due to the ISA crisis earlier in 2000. In 2004, there was only one fjord left with salmon as the ISA disease had forced most companies down to their knees and the banks would no longer fund the salmon. Infectious salmon anaemia is a virus which is inhabits the red blood cells from carrying oxygen usually resulting in death. The change in the legislations in 2003, which will be presented in more detail in sub-chapter 5.6, would ensure a strict compliance with the highest level of fish welfare and environmental protection as possible. This exclusive veterinary prevention programme has been so effective that farmed salmon from the Faroe Islands are completely free of antibiotics (Roos et al.;Faroe Fish Farmers Assciation, 2011).

Additionally, the ISA crisis in the 2000s and the empty fjords led to an unexpected side effect. It was then the discovery of great smolt took place according to the experienced long-timer in the aquaculture industry Ragnar Joensen. The smolts that were in the big fine hatchery plants were not allowed to be released into the sea and the fish had to be removed and tossed. When the salmon farmers finally got funding to release the fish in 2005, they were only allowed to release a small number of smolts, and they could be held on land longer than usual and grew thereby bigger. When the fish was slaughtered in 2006, the results were very good in terms of quality and health, and since then the development and interest of large smolts have continued on the Faroe Islands (Joensen, 2019).

The Faroe Island is a member of several environmental organisations in order to preserve the natural environments on the islands, such as Nordic Council of ministers which represents cooperation between the Nordic countries in Europe, the International maritime organisation (IMO) which is a specialised agency of the United Nations responsible for regulating shipping, and the Food and Agriculture organisations (FAO) that specialises in defeating the words hunger. There are several other organisations that the Faroe Islands is a member of as well which indicates that the Faroes have a sincere interest in protecting and preserving the environment, not only on their own islands but worldwide (The Government of the Faroe Islands).

The geographical positioning of the Faroe Islands is perfect for premium salmon production. The islands are surrounded by pristine clear waters, cool steady sea temperatures, strong currents and accessible fjords. Therefore, it can create a bad atmosphere with the locals and the authority if the operation of the fishing industry is pushing the natural environment by keep intruding into the nature. The most important measure a company can take to ensure that they are not violating any of the nature preservations is to get certified licenses. These licenses are a certificate that prove the companies' ability to preserve the surrounding nature while operating. Examples of some environmental certifications associated with the aquaculture industry are the Aquaculture Stewardship Council (ASC) which is a certification program for responsible aquaculture, GLOBALG.A.P. which ensures responsible hold of agriculture, animal husbandry and aquaculture and Best Aquaculture Practices (BAP) which puts a standard for all seafood (Laksefakta, 2018a).

The Faroe Islands are at the top when it comes to production of renewable energy. Over 50% of all electricity consumed on the islands is renewable. Heating of the houses still comes mainly from fossils fuels that also drives the transportation and the fish industry on the islands. However, the goal for the Faroes is to reduce and eventually be independent of fossil fuel in near future, where a goal of 100% green electricity consumption by 2030 is set by the government and the national electricity company. On the Faroes the possibilities are many for the production of renewable energy; hydropower, tidal power and wind power. Thereby, if all heating and transportation on the islands can be done by electricity, the reduction of fossil fuel will be significant (Minesto AB, 2018).

Even though there are resistance movements for salmon farming on the islands, this has not been a major problem so far, as farming probably being one of the most important ways to provide food with minimal intrusion into the nature. Since wild salmon is naturally found in nature around the islands and live parallel to the farmed salmon in the free, the impact will be minimal. By minimal, it means that there are certain influences that can damage the wild stock. As mentioned earlier, the Faroe Islands have an exclusive fishing zone that stretches over 200 miles off the coast. Within this zone there are regulations on the number of lice per fish, feeding and other parameters that will ensure that the farmed salmon together with the wild salmon will live in "harmony". Nevertheless, the area outside may experience various diseases such as salmon lice. Even though the fish are trapped in cages, the parasites and diseases are welcome to come and go and let significant amounts of tons of waste into the surrounding water. The difference is that the wildlife outside this limit will not receive the same follow-up and monitoring as the farmed salmon. It is not necessarily the case that this often happens, but it is still important to continuously evaluate these impacts in the aquaculture industry (Larsen, 2019).

According to the International Salmon Farmers Association, salmon are feed conversion champions, since it can be fed with approximately 1 kg of food and turn into 1 kg of salmon. That is not the case with for example chicken and beef. To make 1 kg of chicken, the chicken needs around 2 kg feed and to make 1 kg of beef, at least 10 kg of feed for the cow is required. In Figure 32, an overview of salmon, chicken, pork and beef is presented. As seen, is salmon the food source with most protein retention with 31%, which stands for protein retention efficiency and describes the quality of the protein.

Protein Retention	31 %	21 %	18 %	15 %
Energy Retention	23 %	10 %	14 %	27 %
Edible Yield	68 %	46 %	52 %	41 %
Feed Convertion Ratio (FCR)	1.1	2.2	3.0	4-10
Edible Meat pr 100 kg fed	61 kg	21 kg	17 kg	4-10 kg

Figure 32: Overview of a resource efficient production with respect to salmon, chicken, pork and beef (International Salmon Farming Association, 2018).

In the graph below in Figure 33, the biggest producers of salmon in the world is listed showing the biological feed conversion ratio, BFCR. BFCR is a measurement that shows how many kilos of feed it takes to produce one kilo of salmon. The graph indicates that Faroe Islands have the best BFCR of all of the world´s top producers of salmon, and therefore also the sustainability, with an approximate average of 1.10.

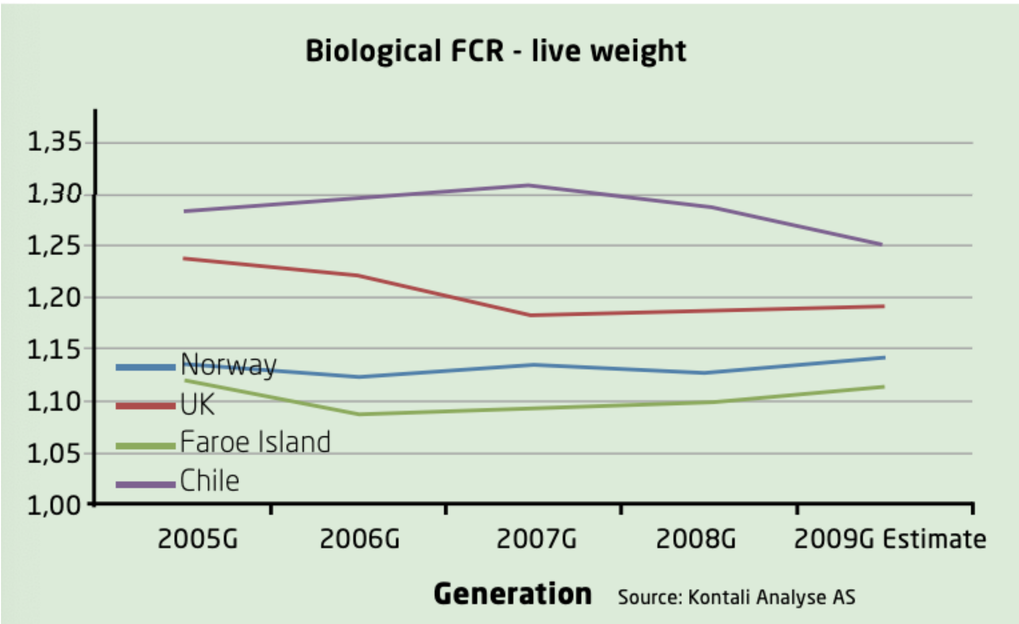

Figure 33: BFCR of live weight salmon in Norway, UK, Faroe Islands and Chile (Faroe Fish Farmers Assciation, 2011).

However, according to a report done by Changing tastes (2019), the Americans prefer farmed fish from offshore farms. They refer to how the fish is produced and about half of the respondents in a survey believed that offshore farms produce a higher quality fish that is cleaner and free of antibiotics, pesticides and other chemicals. They also believe that such production is better for the environment, has a smaller impact on the wildlife and is gentler compared to other aquaculture methods (Changing tastes, 2019).

A concern expressed by Finnur Johanessen is a louse referred to as “scotchlice”. Twenty years ago, there was an event where almost all locations were affected by this type of lice, but two months later it was completely gone. There was also a serious incident in 2012 where almost all the salmon that had just been released into the sea was infected by this "scotch" louse, indicating an unusual pattern for a louse. The concern that this "new" type of lice may cause additional challenges in the future is real at Mowi (Johannesen, 2019).

Salmon lice are normally treated with different methods such as additives in the feed known as slicer, temperature treatments, known as termalicer where the fish are exposed to very low and / or very high temperatures and by mechanical treatments, known as neutraliser, where the fish bath in high pressure water. However, according to researcher Øystein Patursson, the access to fresh water for these treatments can be developed into a future problem due to the limited access of fresh water on the islands (Larsen, 2019; Patursson, 2019).

To reduce the number of lice in the Faroe Islands, Øystein Patursson had a proposal in relation to offshore aquaculture. Since the salmon lice are unable to hold onto the salmon in strong currents, especially the new-born lice, it may be beneficial to put out a lot of fish right away. If these fish are infected with lice beforehand, there will be a large number of lice at the start before the lice "fall off" and the lice stock on the fish decreases. Almost like a treatment, but with less pressure and stress on the fish. Another suggestion given by Ragnar Joensen is to approach the louse before it is sexually mature, in this way the amount being reproduced is likely to fall, big parts of the new-born will not be able to stay on the fish in the exposed environment offshore and it may be possible to reach a zero vision on the islands (Joensen, 2019; Patursson, 2019).

The big smolt that the Faroe Islands have been recognized for in recent years has an important factor in relation to the environmental sustainability in the industry. The fact that the smolt is larger, i.e. weighs more, when it is released into the sea, means that the time it needs to be in the sea to reach desired weight will be shortened. The mortality of smolt that has either not finished the smoltification or for other reasons does not survive after the release into seawater have decreased. Signar Pæturssonur Dam, biological developer in Hiddenfjord, stated that

Hiddenfjord has, with recent measurements, an average weight of 680 grams on each of the generations of salmon they release, which causes the salmon to be slaughtered within approx. six months. They have had smolts up to a weight of 1.2 kg and the average target is 800-900 grams, which will lead to 8-9 months in the sea before harvesting. Optimally according to Pæturssonur Dam, there should be a stage between the hatchery and the discharge to the sea, a kind of "habitat" where the fish can get used to the salty water and grow bigger. As the growth immune system of the fish is "slightly inhibited" in hatchery plants, it could have been a solution to have a place of residence where the growth system is set a little more cautiously. As an example, the smolts grown in the hatchery could have a weight of approximately 500 grams before being transported to a closed plant with saltwater for approximately two months until the weight is around 1-2 kilograms, and then released into the sea for eight months. These would probably have an enormous final weight of up to 10 kg. This is an investment that would cost significantly more than conventional aquaculture operation, an estimated cost of 15 times more than conventional aquaculture according to Signar Pæturssonur Dam. There is also not enough knowledge and experience related to the field yet, but the biologist utter a wish about trials in this field in the future (Dam, 2019).

Additionally, the salmon feed usually contains soy and although soy production itself is certified and environmentally approved, but the consequences of this cultivation are noticeably negative both on the ecosystem, the people who live in the forest areas it is grown on and the climate emissions that accompany the production. Rainforests, grass areas and savannas are the areas that are particularly hit hard as this production requires constant development and expansion. The increasing of the production is expected to continue as soy produces more protein per hectare than any other cultivating crops in the world (Laksefakta, 2018b).

5.6 Legal

The legally required licensing process is an important aspect to consider when entering a new market in a foreign country. This may impact both time and resources due to the evaluation time of the application and costs related to the license itself, rent or taxes that follows when a license is granted.

Initially in the 1970's, the licensing regime on the Faroe Islands was poor and uncoordinated which resulted in numerous problems within the fish health sector leading to many sick fish and a significant portion had to be slaughtered. As earlier mentioned, one of the most severe complications occurred when the ISA virus hit the Faroes. The production went from around 60,000 tonnes to approximately zero. That caused the government to revaluate the licensing process resulting in an implementation of a comprehensive and demanding aquaculture veterinarian regulatory regime in 2003 (Johannesen, 2019; Michaelsen, 2019).

By a more comprehensive and demanding regime, means that the industry has to strengthen its emphasis on training the employees of the fish farm and the overall knowledge of aquaculture. This should prove to be the start of an industry with clearer and more coherent objectives and a significant improvement in the fish health. The stress level in the fish decreased, there were less diseases and the mortality rate went down causing the industry to be able to eliminate the use of antibiotics (Moylan et al., 2017).

One of the new regulations was introduced based on an "all in, all out" principle, where it was not allowed to transfer fish between sites after the release into the sea, and that it should be one breeder per fjord. By having the one fjord-one company policy, the main focus is on controlling sea lice levels to preserve the environment of the wild fauna and flora. Additionally, two months of fallowing of each site between each release, so that the fjords and the seabed could get a “break”. If the facility was part of a common area where the distance to another breeder was too small, one month of common fallowing was required (Moylan et al., 2017).

The law on the Faroe Islands says that the release should not be based on biomass, but rather on the number of smolt allowed according to the environmental conditions at each specific site, along with the maximum allowable density of fish in each cage being 25 kg/m^3. The number of smolt depends on the sites environmental sustainability and is to be assessed in between each generations of release as well as regular samples of the seabed. The idea is that the breeders then put out the biggest and healthiest smolt that has the best conditions for living in the seam which have resulted in a lower mortality rate (Egholm, 2019; Michaelsen, 2019).

The licensing process present on the Faroe Islands requires a zoning of the area that is concerned in advance of any application. As mentioned, it is the Food and Veterinary Authority who is in charge of issuing the licenses. According to the Faroese Food and Veterinary Authority (2019), there are currently 34 licenses within aquaculture available, where 20 of them is reserved to salmon fish farming. There are currently only three companies qualified to hold these, Bakkafrost, Mowi and Hiddenfjord. There is a 12-year license awarded from the Faroese government with subject to renewal if regulatory requirements are met. The tax associated with the license are, as mentioned earlier in the thesis, a harvesting royalty of 5% of the market value determined by FishPool at harvest. If the market prices fall, the royalty will fall accordingly, to typically 2.5% and 0.5%. New commercial salmon farming licenses are likely to be sold e.g. in auction (Faroese Food and Veterinary Authority, 2019).

To get an approval for a license, the organization have to prove their ability to operate and maintain the aquaculture farm by presenting evidence of experience and scientific knowledge as well as presenting a contingency plan for escapes and diseases. It is The Food and Veterinary Authorities on delegation from the Ministry of Foreign Affairs and trade to award licenses on the Faroe Islands (Moylan et al., 2017).

First, the application and the documents presented is carefully evaluated and peer reviewed. These applications must gain approval by the Environmental agency, the Chief Veterinary Officer and municipalities. To get an approval from the environmental agency, the application should inform about what kind and how much chemicals that is going to be used, daily procedures, emission estimation, how they are going to handle dead fish etc. The Faroe Islands have national environmental standards which they generally align to EU standards by choice. The application must not infringe on zoning regulations and other preservation measures e.g. nature/environment and cultural heritage. All interested parties are heard in the process; industrial interest in the area e.g. fishing or lobster catchers and other relevant environmental organizations. Every operating farmer on the Faroe Islands is required to have an independent veterinary advisor who monitor and reports how the facility is driven. The licensing process takes between three to six months to evaluate (Egholm, 2019; Michaelsen, 2019; Moylan et al., 2017).

According to Pól E. Egholm, older licenses required a distance of 2.5 kilometres between each facility, but the newer licenses are required a distance depending on site specifications and the variety of farming in the area. As two aquaculture farms in different aquaculture fjords needs to have a distance of minimum 5 km, the distance between two aquaculture farms in the same fjord is not required more than 2.5 km. Aquaculture farms within the same company should hold a distance of 1 km (Egholm, 2019).

The biggest differences in the licensing process on the Faroes compared to Norway are the limitation in biomass. In Norway, the licenses are limited to 200,000 smolt per cage and a permission to release a certain ton of fish, but on the Faroes, this is not a restriction. According to Poul Michaelsen, aquaculture farms have a restriction that is consistent with the industry practices in terms of biological and technical manner. The restriction should not negatively impact the conditions in the water or the welfare of the fish. Pól E. Egholm gave this restriction of fish density at sea-based aquaculture farms shall not exceed:

Average weight of the fish in the cage	Fish Density
< 1 kg	10 kg/m^3
1-2 kg	15 kg/m^3
2-3 kg	20 kg/m^3
> 3 kg	25 kg/m^3

The limitation on the Faroes is the density of the salmon referred to above and a number of smolt per cage depends on the size of the cage and the density restriction. There is a preferred limitation of 120,000 smolt per release among the farmers, but this is not an absolute maximum, but rather an incentive to get the freshest smolt released resulting in a low mortality rate. Usually there is only the 15 m of the upper layer that are counted when calculating the density in the cage. Low density is considered as a tool to ensure quality over quantity. The Faroes regulatory regime is based on the allocation of specific smolt numbers to each farm (Egholm, 2019; Moylan et al., 2017).

The cages are monitored, and parameters are constantly recorded and reported. Dead fish are gathered and counted daily and registered in a database. The average weight and biomass of the dead fish is also registered. According to Finnur Johanessen, some of the other daily recordings required are:

- Date
- Number of live fishes at the end of the day
- Average weight of live fish at the end of the day
- Biomass of live fish at the end of the day
- Feed consumption
- Type of feed

Additionally, counting lice is required as a daily routine. This is usually done by the farmers themselves along with a mandatory regular count performed by an external on the behalf of the authorities (Moylan et al., 2017).

According to Poul Michaelsen, there is a system for enforcing the legal requirements is implemented as a penalty point system which decides the numbers of smolt each facility is allowed to release into the sea each year. Violations of defined parasite loading or of the fish health protocols will result in a possible reduction in the number of smolt allowed to be released next year. Every time the number of sexual mature sea lice per salmon exceeds 1.5 generates a point. E.g. a count of 1.5 lice per salmon gives one point, while 4.5 lice per salmon gives three points. If chemical treatments are necessary, each treatment count as two points. Depending on the severity of the violation, the facility is given these points. Points can also be generated if the seabed survey reveal unsatisfactory conditions with too high levels of waste (Egholm, 2019; Joensen, 2019; Michaelsen, 2019).

According to the director of Industry and Trade at the Faroe Islands, Pól Edvard Egholm, if a facility exceeds the 20 points limit within a year, it has to reduce the number of smolt release next year. If they have between 10 and 20, they are according to regulations capable of handling the amount of smolt they released that year. Less than 10 clips qualify to increase the number of smolt release next year if desired, presuming the other requirements are met. If a fish farm is supposed to go beyond the 20-over three-fold limit in one year, this will lead to emergency slaughter and a fish-free site for three months. This penalty point system is expected to also apply for offshore facilities (Egholm, 2019; Joensen, 2019).

According to Poul Michaelsen, a new regulatory framework is under development and that in the future they may be moving towards auctioning fish farms quotas as it has been done a few times in Norway. As mentioned initially in chapter 4.4, it is currently illegal to possess more than 50% of the salmon licenses on the Faroe Islands. Bakkafrost recently had to resign one of their licenses due to this particular limitation and this license is now considered to be given as a development license. The license can, geographically, either be used on land-based or on exposed/offshore basis. If the license is given for land-based site, the area will be unavailable for offshore site and vice versa. The depth of the location this license includes is under 100 meters, but the licenses are expected to be available on deeper water and/or create brand-new test licenses. These development licenses may have a shorter duration than regular farmed licenses, even so, a renewal of a license is unproblematic if all the guidelines are followed. As stated in chapter four, it is only companies that are registered at the Faroe Islands where majority of the board and 80% of the ownership are qualified to receive a salmon license. The license that Bakkafrost had to resign back to the Faroese government, are primarily the license that is going to be available when the change of regulation is complete. The regulation it is referred to is the forthcoming permit where companies with more than 20% foreign ownership is allowed to apply for licenses on the Faroe Islands (Poul Michaelsen, 2019).

6 Discussion

6.1 Political

The Faroe Islands are undoubtedly in a very special political situation. There are not many countries in the world that accept their own autonomy for part of the country as Denmark does. That is precisely why I also believe that the community on the islands work well the way they do. In such a geographically small society with relatively few residents, it is theoretically easier to involve and fulfil any wishes than in a country that has such large areas that special considerations must be taken to all different areas within the country. By the fact that the Faroe Islands are geographically small, it will also indicate that the conditions around the islands are also quite similar, making it predictable.

However, in this small archipelago where the authorities come close to generally everything that happens both industrially and privately, and this will probably also increase the interest and attention each company or organization gets. This can be regarded as something that can create tensions in the companies, a fear of doing something wrong and that they can get the feeling of having to operate at "tiptoe". Although this will, from the outside, be a good way to ensure that all production goes according to plan and regulations, it is also important to show confidence in the production companies.

Additionally, by keeping an eye on everything that is happening within the aquaculture industry, the three companies, Bakkafrost, Mowi and Hiddenfjord, all mentioned in their interview that they got a sense of being taken care of and being heavily involved when it came to decisions and changes to be made politically.

To be able to implement and experiment with a project like “Octopus”, cooperation from the authorities is absolutely essential. To put it somewhat extremely, if it were to be assumed that the project was tested out in a place where the authorities were not cooperative, Roxel Aqua could risk investing large amounts of time and resources into a project that was doomed to not succeed from the start because they may be opposed by the authorities. That is harshly enough the importance of political acceptance.

In the Faroe Islands I have been in a personal interview with the Minister who is responsible for ensuring that the fish farming industry on the islands functions as optimally as possible, namely Poul Michaelsen. He expressed with great confidence that it will in the near future be open to 100% foreign owned companies to apply for licenses for fish farming. This pre-announced message gives Roxel Aqua a unique opportunity to continue investigating sites on the islands to find optimal placement and prepare for any application before any competitors.

This amendment is a great indication of a positive welcome to Roxel Aqua and other foreign companies from the Faroese authorities. At the same time, it could be a relief for the smaller companies on the islands, Hiddenfjord and Mowi, as there is a clear consensus among them and the minister that Bakkafrost has too much power in terms of size and dominance on the islands. Nevertheless, it will be in Roxel Aqua's best long-term interest to enter the market with respect and good communication with all the existing companies on the islands.

In addition, it should also be mentioned that the Faroe Islands are fairly neutral when it comes to conflicts and disagreements. An example, despite the fact that there are some conflicts between Russia and the EU, exports between Russia and the Faroes are unaffected. Denmark can of course deny access through Denmark's national borders and ports and exports must thereby find another way, but exports in themselves remain unaffected by political disagreements. These long and safe agreements with the Faroe Islands with countries globally contribute to a very stable export, which is very reassuring for the producing companies on the islands. If Roxel Aqua enters these agreements, it can help create a network that can also be used outside the aquaculture industry, as Roxel has several departments such as offshore, construction, technical and infrastructure.

6.2 Economic

Economically speaking, the Faroe Islands will be an excellent start for a project such as "Octopus". According to the regulations presented, the cost of licensing and approvals is not significant in relation to the investment required by "Octopus" itself. The costs associated with the investment in the "Octopus" itself had taken place irrespective of location, but by a possible location in the Faroe Islands may contribute to the cost of the license itself being less than initially assumed, since the license is not purchased but rented for a certain percentage of the annual turnover.

However, as previously mentioned, this is an analysis that should be carried out in a further study as there are far too many factors that need to be considered.

6.3 Social

Since the Faroe Islands are a relatively remote area compared to other large parts of Europe in terms of both industry, buildings and tourism, this means that the population who have settled on these islands has probably lived there for several generations and hence is a very complex society. Introducing a high-tech foreign concept such as "Octopus" can thus seem daunting and the enthusiasm of most people may not be great at first. Even though some researchers and enthusiasts within technology and aquaculture finds it exiting, most of the habitants will most likely remain sceptical. Therefore, it is important that if Roxel Aqua chooses to enter the market on these islands, that they educate the inhabitants about the concept and give them knowledge of what is happening. I myself come from a small local community and am very proud and protective of the traditions I grew up with, which I also believe is the case on the Faroe Islands. By informing and continually maintaining good communication with the local community is something I think is absolutely essential form Roxel Aqua to be able to have a long-term operational opportunity on the islands.

At the same time, it will also benefit Roxel in a positive way to involve and increase the enthusiasm of the locals since, after all, they come from generations of fishing and farming all the way back to the 1960s. Experienced people also become less sceptical about new things if one is allowed to participate, which can provide good and knowledgeable workforce to Roxel while creating jobs for society.

On the other hand, a newcomer from abroad will help develop the market opportunities for tourism in the Faroe Islands. As Roxel has several departments that carry out jobs worldwide, this network can be the key to more people being aware of the opportunities that the Faroe Islands can offer in both tourism and other industries.

6.4 Technical

Since "Octopus" is an offshore installation, offshore quality is also required for the equipment used. For an offshore installation to withstand waves with H_s of 30 metres and a wind of up to 45 m/s, certified equipment is required that can withstand these loads so that the use of equipment from the petroleum industry is a good indicator that the installation will be able to stand welcomes weather and wind better than the traditional fish farms. When it comes to stability, an installation which is in constant contact with the seabed will also be more stable than a float such as, for example, the food barges used in conventional farming. Since the installation will be semi-automatic, it will also help to ensure that employees are not exposed to more risks than necessary. Normally, such indicators in a safer workplace will be a good start to convince citizens and the authority that “Octopus” is a good solution for the future.

As we know, conventional fish farms work relatively well in fjords and less exposed areas. With "Octopus" the entire facility is laid offshore and will hopefully eventually prove that this is a better way of farming. Most likely, “Octopus” it will initially be tested out in parallel with conventional farming and should anything unexpected happen while operating with "Octopus", it can be shut down temporarily, do some changes and try again. All new technology must be tested before one can determine whether something works better or not in relation to the existing solution. The point is that the testing of this new type of technology does not harm the way farming is already working, it will at best be a conviction that there are better ways to farm. It is not like jobs and existing technology are forced out of the market, on the contrary, it can be a good strategy to cooperate to eventually merge ideas to find the most optimal.

Since the Faroe Islands do not have a strong commitment to research, an implementation of "Octopus" can lead to revelations with respect to innovation and technology can be useful in the years to come.

6.5 Environmental

Jack-up rig is no longer commonly used by the Norwegian petroleum industry as today's production is often in deeper water, which is not optimal for that type of jack-up rig. This means that it is a number of these that are on hold and are not currently in use. The fact that "Octopus" will apply these relates to reuse of products and if the project becomes a success, several of these jack-up rigs will most likely also be used instead of rusting and deteriorate.

The isolation this local population has been a part of can be a challenge for Roxel Aqua when tradition and well-known routines are highly appreciated. It is therefore important that Roxel Aqua provides recognized environmental certifications so that they can reassure residents that "Octopus" will not harm the local environment on the islands or in the marine environment. Simply provide all local acquaintances with knowledge and requirements that are set for the project.

Mentioned on the Faroe Islands' websites, the islands have a goal that all electricity will be produced by sustainable green energy by 2020. It can then be an advantage for the Faroe Islands to get a company like Roxel on the track when they have other departments that probably have experience and knowledge that can be shared and applied in order to reach the target.

Environmentally, it will also be beneficial to take production out of the fjords in order to give the marine life inside these fjords a break. Even though the conventional fish farms are required to have a break between each discharge, it is not unlikely that this is not enough to maintain the natural marine environment that has been built up over thousands of years. "Octopus" which is installed in deeper water may give the seabed and life that live there a new chance for development in peace and quiet.

The Faroe Islands, as earlier mentioned, have also been recognized as manufacturers of large-scale smolt with an average weight of approximately 280 grams, but have in recent years been up to 650 grams. For a salmon to survive on deeper water in exposed areas immediately after discharge, it must have a larger size than what is normal. The fact that the Faroe Islands have come a long way on this front gives a good starting point for the smolt size required for "Octopus".

6.6 Legal

This new law that will be introduced sends from the authorities that foreign owned companies are soon warmly welcome to apply for licenses in the Faroe Islands. Regarding the licensing process in the Faroe Islands, there is not that much to discuss. It usually takes around half a year to get an application response, the renewal is guaranteed as long as all the rules and requirements are met, and the authorities is largely cooperating with the aquaculture industry. Theoretically, that seems like the perfect legal circumstances for “Octopus” to be developed.

However, even though the authorities may be able to make changes and new implementations rapidly, does not mean that this will always be in Roxel´s favor. Therefore, it is important for Roxel to stay updated and involved in all political decisions involving the aquaculture industry. It should also be kept in mind that the authorities are not thrilled when a company dominates and have too much power, therefore it should be made an internal strategy for the development on the Faroes.

7 Conclusion and recommendations

7.1 What are the advantages/disadvantages of "Octopus" compared to conventional aquafarming?

"Octopus" is a new solution within the aquaculture industry that may contribute to less pollution of the marine environment, less diseases, safer operations and an increase in the production of Atlantic salmon with respect to the welfare of the fish. Even though there are going to be challenges such as equipment and methods that may not work as predicted, the installation is providing a feasible solution for an increase in the salmon production.

The jack-up rig is able to be placed anywhere as long at the depth preferences fit, it creates a stabile base in terms of safety of the fish and staff during waves and harsh weather due to its legs which are standing on the seabed. The stability is also enhanced due to the suction anchor that prevents relocation of the fish cages. The installation will be semi-automatic, which means that there is less risk associated with operations that is former performed by employees.

By keeping the facility offshore contributes to less pollution of the seabed due to more rapidly replacement of water and have more available locations to operate the farm since it does not need fjords or sheltered areas which are already in use. The different modules available on the jack-up rig on the site may contribute to less mortalities due to stress and scraping caused by transportation.

By being able to submerge the fish cages under the water obtains a more optimal temperature for the fish along with pulling the fish below the "licebelt" resulting in a possible reduction of lice infections. Additionally, it will prevent the fish from getting seasick as the wave strength decreases with depth.

After a review of all the possible advantages by having an offshore fish farm, I realised that the installation can give the industry the solution it needs to keep up with the world´s demand without jeopardising the conventional aquaculture.

7.2 Which country in Europe would be the most suitable location for "Octopus" and why?

As stated in the conclusion in chapter 4.5, there were several advantages with all of the countries assessed but the Faroe Islands were the only one that satisfied several of the required areas. Iceland was a feasible location with respect to temperature and commitment but had a comprehensive and long process for getting a license along with the risk of drifting ice or icing of equipment. Scotland is already a big supplier of salmon and have a history with farming, nevertheless, the country is a part of UK which is currently a part of the EU creating a demanding process along with a reputation of being the windiest country in Europe. As Ireland is a good candidate with respect to the environmental conditions, the authorities were not that supportive of former offshore innovation projects which gave an impression of lack of commitment and enthusiasm.

When the Faroe Islands are able to provide a licensing regime with a timeframe of six months, a cooperative government, a curious society and optimal weather conditions, there is also the best suitable location for "Octopus".

7.3 By running a PESTEL analysis of the country settled in the question above, what are the main factors to consider if one wants to establish in the current market in this country?

If Roxel Aqua decides to enter the Faroese salmon market, there are a few things that they should be aware of beforehand.

As the Faroe Islands is an autonomous country, the opportunities are great, but such a small society can make quick decisions that may affect the business. Hence, to be active and conscious of the politics at all times is recommended in order to keep up with possible changes and be a part of the decision.

Since Denmark is a member of the EU, there are situations that may affect the Faroe Islands even though it is not a member. Denmark have the upper influence and is able to make changes if absolutely necessary in certain conditions such as in case of war. Even though Faroe Islands have their own government, it is not an independent country.

While the Faroes are opening up for foreign companies, Roxel Aqua should be aware of the possible competition in the future. There are probably going to be other companies that find the Faroe Islands as a suitable location for salmon production.

As Bakkafrost have succeed on the islands, it has also been recognised as dominant and on the edge of corruption with respect to local politicians. This is not well received with the authorities and they have thereby opposed Bakkafrost in some cases.

Due to the passion for traditions at the islands, it is important that Roxel Aqua enters the market with an open communication about the project, both how it works and how it affects the environment. In that way, the knowledge of the industry may prevent scepticism and resistance movement. Should also go to acquisition of certificates as a documentation of operations in accordance with sustainable development.

In relation to the penalty point system, Roxel Aqua should be prepared to treat salmon lice and work with the system. Even though the possibility of salmon lice is less in exposed areas and in cages in pulldown state, it is still a significant problem that needs to be carefully considered.

7.4 Recommendations

At the end of this thesis I will present some recommendations for further research. As initially stated, a further analysis of the economy factor should be conducted in order to see what kind of financial benefits and challenges that can arise in the Faroese market. Nevertheless, there should have been a more thorough analysis of each of the factors within the PESTEL analysis. Due to the timeframe and resources on this thesis that comprises most of the factors, it is just a glimpse of all the relevant information which is presented.

8 References

About Roxel. Retrieved 01.06.19 from https://roxel.no/about/

Adams, L. (2019, 20 may 2019). Is there a problem with salmon farming? *BBC News*. Retrieved 20.05.19 from https://www.bbc.com/news/uk-scotland-48266480

Aquaculture Stewardship Council. (2019). *ASC Salmon Standard Version 1.2* Retrieved from 04.06.19 The Netherlands: https://www.asc-aqua.org/wp-content/uploads/2019/04/ASC-Salmon-Standard_v1.2.pdf

Asche, F., Guttormsen, A. G., & Nielsen, R. (2013). Future challenges for the maturing Norwegian salmon aquaculture industry: An analysis of total factor productivity change from 1996 to 2008. *Elsevier, 396-399*, 43-50.

Atlas, W. (2016). Faroe Islands Map and map of Faroe Islands information page. Retrieved 26.04.19 from https://www.worldatlas.com/webimage/countrys/europe/faeroe.htm

BarentsWatch. (2016). Salmon lice. Retrieved 05.06.19 from https://www.barentswatch.no/en/articles/Salmon-lice/

Barrett, C., & Hegarty, J. (2018). Population and Migration Estimates Retrieved 03.03.19 from https://www.cso.ie/en/releasesandpublications/er/pme/populationandmigrationestimatesapril2018/

Bazilchuk, N. (2018). World´s highest waves from west of Norway. *Science Nordic*. Retrieved 09.06.19 from http://sciencenordic.com/world%E2%80%99s-highest-waves-form-west-norway

BioMar. What are salmon lice? Retrieved 20.05.19 from https://www.biomar.com/en/uk/articles/products/cleaner-fish/what-are-salmon-lice/

Blaalid, G.-E., & Jensen, P. M. (2019, 22.03.2019). Island åpner for stor produksjonsøkning. *kyst.no*. Retrieved 10.05.19 from https://www.kyst.no/article/island-aapner-for-stor-produksjonsokning/

Bleasdale, A. (2014). *Biodiversity Priorities for Ireland (2014-2020)*. Retrieved 05.05.19 from https://www.epa.ie/pubs/reports/research/sustainableenvironmentresearchplanningworkshop2013/Natural%20Capital%20-%20NPWS%20Presentation.pdf

Böðvarsdóttir, A. R., Guðmundsdóttir, H., Þóroddsson, Þ. F., & Marteinsdóttir, G. (2004). Aquaculture in Iceland: Licensing Process, Monitoring and Environmental Impact Assessment. Retrieved 30.04.19 from https://notendur.hi.is/runam/annaposter.pdf

Business to you. (2016). Scanning the Envionment: PESTEL analysis. *Business to you(September 18)*. Retrieved 29.04.19 from https://www.business-to-you.com/scanning-the-environment-pestel-analysis/

Changing tastes. (2019). *Aquaculture Mariculture: US Market Insights and Opportunities*. Retrieved 10.04.19 from https://static1.squarespace.com/static/5b212fceb27e39c4ff9c8493/t/5c8671fd7817f7cf02cded8d/1552314880242/Changing+Tastes+Mariculture+Insights+March+2019.pdf

CIA, C. I. A. The World factbook:Iceland. Retrieved 04.03.19 from https://www.cia.gov/library/publications/the-world-factbook/geos/ic.html

Creswell, J. W. (2014). *Research design: qualitative, quantitative and mixed methods approches* Los Angeles: SAGE.

Dalen, M. (2004). *Intervju som forskningsmetode: en kvalitativ tilnærming*. Oslo: Universitetsforlaget.

Dalland, O. (2007). *Metode og oppgaveskriving for studenter*. Oslo: Gyldendal.

Dalland, O. (2017). *Metode og oppgaveskriving*. Oslo: Gyldendal.

Dam, S. P. (2019). [Interview on Faroe Islands 10.04.19].

Department of International Trade, Hollingbery, G., & Eustice MP, G. (2019). *UK and Faroe Islands sign trade continuity agreement*. GOV.UK Retrieved 15.03.19 from https://www.gov.uk/government/news/uk-and-faroe-islands-sign-trade-continuity-agreement

Dey, G. (2018). *Environment, Climate Change and Land Reform (ECCLR) Committee report on the environmental impacts of salmon farming*. Retrieved 25.03.19 from https://www.parliament.scot/parliamentarybusiness/CurrentCommittees/107588.aspx

Divingglore. (2015). UK Depth Chart. In: Divingglore.

Ecott, T. (2019, 8th May 2019). Sustainable tourism: why the Faroe Islands closed for maintenance. *The Guardian*. Retrieved 10.03.19 from https://www.theguardian.com/travel/2019/may/08/faroe-islands-closed-maintenanace-voluntourists-conservation

Egholm, P. E. (2019). [Communication via email].

European Commission DG ENV. (2011). *Fish farm pollution dmages seabed ecosystems*. Retrieved 07.03.19 from Bristol: http://ec.europa.eu/environment/integration/research/newsalert/pdf/232na6_en.pdf

Faroe Fish Farmers Assciation. (2011). *Salmon from the Faroe Islands*. Retrieved 13.04.19 from Tórshavn: http://salmon-from-the-faroe-islands.com/myfiles/files/Salmon%20from%20the%20Faroe%20Islands.pdf

Faroe Fish Farmers Association. The history of aquaculture in the Faroe Islands. Retrieved 02.03.19 from http://salmon-from-the-faroe-islands.com/history.html

Faroese Food and Veterinary Authority. (2019). Aliloyvir - ymiskar leitingar. Retrieved 23.04.19 from https://www2.hfs.fo/webcenter/portal/HFS/aling/page1612/page1456?_adf.ctrl-state=1712l71lx2_1&_afrLoop=35320621707289568#!%40%40%3F_afrLoop%3D35320621707289568%26_adf.ctrl-state%3D1712l71lx2_5

Fish farming expert. (2019). Chilean Atlantic salmon harves grew 8.6% in 2018. *Fish farming expert*. Retrieved 10.05.19 from https://www.fishfarmingexpert.com/article/chilean-atlantic-salmon-harvest-grew-86-in-2018/

Fjeldstad, H.-P. (2012). *Atlantic salmon migration past barriers.* (Doctoral thesis), Norwegian University of Science and Technology, Trondheim. Retrieved 20.02.19 from https://brage.bibsys.no/xmlui/bitstream/handle/11250/242176/538854_FULLTEXT02.pdf?sequence=2&isAllowed=y

Fon, M. (2019). *Annual report 2018*. Retrieved 02.05.19 from https://exposedaquaculture.no/wp-content/uploads/EXPOSED-Annual-report-2018-web.pdf

Fontaine, P. (2017, September 04, 2017). Fish Farming: New Oppotunities, Ols Dangers. *The Reykjavík Grapevine*. Retrieved 28.03.19 from https://grapevine.is/news/2017/09/04/fish-farming-new-opportunities-old-dangers/

Food and Agriculture Organization of the United Nations (Fisheries and Aquaculture Statistics). (2019). Global aquaculture production: Atlantic salmon. Retrieved 19.05.19, from Fisheries and Aquaculture Department www.fao.org/fishery/statistics/software/fishstatj/en

Foras na Mara Marine Institute. (2019). Locations of Salmonid Farms. Retrieved 28.03.19 from https://www.marine.ie/Home/site-area/areas-activity/aquaculture/locations-salmonid-farms

Føroya landsstyri. Government & Politics. Retrieved 26.04.19 from https://www.faroeislands.fo/government-politics/

Føroya landsstýri. A Dynamic and Resilient Economy. Retrieved 24.05.19 from https://www.faroeislands.fo/economy-business/economy/

Føroya landsstýri. Interconnected. Retrieved 28.05.19 from https://www.faroeislands.fo/people-society/infrastructure/

Gíslason, G. Location & logistic. Retrieved 14.05.19 from https://icefishfarm.is/locationlogistic/

Gíslason, G. (2019). [Personal communication with Chairman of IceFishFarm].

Gjedrem, T. (1993). *Fiskeoppdrett : vekstnæring for distrikts-Norge*. Oslo: Landbruksforlaget.

Goddard Space Flight Center. (2004). North Atlantic Currents. In N. A. Currents (Ed.). Wikipedia. Retrieved 13.05.19 from https://no.m.wikipedia.org/wiki/Fil:North_Atlantic_currents.svg

Guide to Iceland. (2019). East Iceland. Retrieved 14.05.19 from https://guidetoiceland.is/travel-iceland/drive/east-iceland

Guttormsdóttir, A. B. (2018). *Status of Aquaculture in Iceland*. Retrieved 29.05.19 from Reykjavik: https://www.vannportalen.no/globalassets/nasjonalt/engelsk/harmonisation-and-implementation-of-the-wfd-in-the-northern-countries/8th-nordic-conference/workshops/wg-5---aquaculture-in-iceland.pdf

Hall, A. (2009). Fish get seasick, scientist “proves”. *The Telegraph*. Retrieved 20.04.19 from https://www.telegraph.co.uk/news/newstopics/howaboutthat/5193278/Fish-get-seasick-scientist-proves.html

Hallenstvedt, A. (2015). Fiskeoppdrett. In *Store norske leksikon*. Retrieved 12.03.19 from https://snl.no/fiskeoppdrett

Hart, C. (1998). *Doing a Literature Review: Releasing the Social Science Research Imagination*. London: SAGE Publications.

Hart, C. (2001). *Doing a Literature Search: A Comprehensive Guide for the Social Sciences*. London: SAGE Publications.

Hauge Aqua. Fish health and welfare. Retrieved 10.04.19 from http://www.haugeaqua.com/environment/

Holmyard, N. (2017). Irish seafood industry booming Retrieved 23.04.19 from https://www.seafoodsource.com/news/supply-trade/irish-seafood-industry-booming

Hoyle, A. (2017). Scientists shed light on blindness in salmon. *Fish farming expert*. Retrieved 20.03.19 from https://www.fishfarmingexpert.com/article/scientists-shed-light-on-blindness-in-salmon/

Icelandic Meterological Office. (2008). Icelandic climate. Retrieved 23.03.19from https://en.vedur.is/weather/climate_in_iceland/

Ingebrigtsen, O. (1982). *Akvakultur Oppdrett av laksefisk*. Matredal: NKS-Forlaget.

Innovation, T. M. o. I. a. Aquaculture. Retrieved 14.03.19 from https://www.government.is/topics/business-and-industry/fisheries-in-iceland/aquaculture/

International Salmon Farming Association. (2018). *Salmon Farming: Sustaining communitites and feeding the world*. Retrieved 10.03.19 from https://sjomatnorge.no/wp-content/uploads/2018/06/ISFA-Report-2018-FINAL-FOR-WEB.pdf

IntraFish. (2019). Intra Sea Lice Report. *IntraFish*. Retrieved 21.09.19 from https://www.intrafish.com/aquaculture/1712400/report-the-salmon-farming-industrys-biggest-problem

Ireland´s Seafood Development Agency. (2018). *BIM Annual: Aquaculture Survey 2018*. Retrieved 15.03.19 from http://www.bim.ie/media/bim/content/publications/aquaculture/BIM-Annual-Aquaculture-Survey-2018.pdf

Irish Farmers´ Associasion. (2019). Government inaction leads to 21% drop in aquaculture production. Retrieved 20.02.19 from https://www.ifa.ie/79763-2/

Joensen, R. (2019). [Interview on the Faroe Islands 08.04.19].

Johannesen, F. (2019). [Visit at Mowi in the Faroe Islands].

Jóhannesson, H., & Sigurbjarnarson, V. (2012). *Icelandic Road Infrastructure and Policymaking*. Retrieved 21.03.19 from University of Akureyri Reseach Centre: https://www.rha.is/static/files/Rannsoknir/2012/R12038SAM-Trans_tourism-skyrsla_RHA-final.pdf

Johnson, G., Whittington Sir, R., Angwin, D. D., Regner, P., & Scholes, K. (2014). *Exploring strategy: text & cases* Harlow: Pearson.

Jørstad, J., Pihl, R., & Skatvik, F. (2018). Skottland. In R. Pihl (Ed.), *Store Norske Leksikon*. Store Norske Leksikon: Store Norske Leksikon. Retrieved 10.03.19 from https://snl.no/Skottland

Kenyon, W., & Davies, D. (2018). *Salmon Farming in Scotland*. Retrieved 20.03.19from https://sp-bpr-en-prod-cdnep.azureedge.net/published/2018/2/13/Salmon-Farming-in-Scotland/SB%2018-12%20rev.pdf

Komjáti, V. (2018). A Complete Guide to the Weather in Iceland. Retrieved 03.05.19 from https://www.extremeiceland.is/en/travel-guide/weather-iceland

Laksefakta. (2018a). Miljøsertifiseringer for oppdrettslaks. Retrieved 02.03.19 from https://laksefakta.no/laks-og-miljo/miljosertifiseringer-for-oppdrettslaks/

Laksefakta. (2018b). Soya og lakseför *Laksefakta*. Retrieved 18.03.19 from https://laksefakta.no/hva-spiser-laksen/soya-og-laksefor/

Larsen, B. (2019). [Interview of Bakkafrost].

Lew, J. (2017). 10 of the windiest places in the world. *Mother Nature Network*. Retrieved 13.02.19 from https://www.mnn.com/earth-matters/climate-weather/photos/windiest-places-world/windiest-europe-scotland

Lie, Ø., & Osland, A. B. (2018). *Roxel Aqua AS - avslag på søknad om utviklingstillatelser*. Fiskeridirektoratet Retrieved 09.02.19 from https://www.fiskeridir.no/content/download/23800/330050/version/40/file/Roxel%20Aqua%20AS%20-%20avslag%20p%C3%A5%20s%C3%B8knad%20om%20utviklingstillatelser.pdf

Lilledahl, G., & Hegnes, A. W. (2000). *Sosiologi Hovedfag UiO: Kvalitativ metode - forelesningsnotat*. Retrieved 10.04.19 from Universitetet i Oslo: http://www.giaever.com/sosiologi/KM.htm

Lundal, S. O., Paus, M., Phil, R., Ryste, M. E., Skatvik, F., Smørgrav, I., & Thuesen, N. P. (2019). Island. In *Island*. Store Norske Leksikon: Store Norske Leksikon. Retrieved 23.03.19 from https://snl.no/Island

Marine Harvest. (2018). *Salmon Farming Industry Handbook 2018*. Retrieved 20.02.19 from http://marineharvest.no/globalassets/investors/handbook/2018-salmon-industry-handbook.pdf#page=21&zoom=auto,-113,227

Marine Scotland. (2015). *Scotland´s National Marine Plan: A single framework for managing our seas*. Retrieved 28.03.19 from https://www.gov.scot/binaries/content/documents/govscot/publications/strategy-plan/2015/03/scotlands-national-marine-plan/documents/00475466-pdf/00475466-pdf/govscot%3Adocument/00475466.pdf

Matzen, E., & Gronholt-Pedersen, J. (2018, June 12 2018). Small fry: Faroe Islands seek fish pledge with Russia trade deal *Reuters*. Retrieved 28.05.19 from https://www.reuters.com/article/us-faroes-fish-russia/small-fry-faroe-islands-seek-fish-export-pledge-with-russia-trade-deal-idUSKBN1J81XA

Meade, J. W. (1989). *Aquaculture management*. New York, N.Y: Van Nostrand Reinhold.

Met éireann. The wave climate of Ireland: From averages to extremes. Retrieved 01.06.19 from https://www.met.ie/science/marine-meteorology

Michaelsen, P. (2019). [Interview at the Faroe Islands].

Minesto AB. (2018). Faroe Islands - tidal energy to go 100% renewable by 2030. Retrieved 20.05.19 from https://minesto.com/projects/faroe-islands

Moylan, M., Ciennéide, L. Ó., & Wheland, D. K. (2017). *Review of the Aquaculture Licensing Process*. Retrieved 15.02.19 from http://www.fishingnet.ie/media/fishingnet/content/ReviewoftheAquacultureLicensingProcess310517.pdf

Mustad, J. E., & Thuesen, N. P. (2019). Irland. Retrieved 19.04.19 from https://snl.no/Irland

Natural Scotland. Scotland´s Aquaculture. Retrieved 03.04.19 from http://aquaculture.scotland.gov.uk/our_aquaculture/our_aquaculture.aspx

Norges Geotekniske Institutt. Ekstrem forankring på dypet. Retrieved 06.03.19 from https://web.archive.org/web/20140323164338/http://www.ngi.no/no/Innholdsbokser/Forside-innhold/Feature-root/Ekstrem-forankring-pa-dypet/

Nosowitz, D. (2018). Thousands of Farmed Salmon Escape Into the Wild. *Modern Farmer*. Retrieved 19.05.19 from https://modernfarmer.com/2018/08/thousands-of-farmed-salmon-escape-into-the-wild/

Olsen, S. (2019). Ice Fish Farm gets greenlight to triple production in Iceland. *SalmonBusiness*. Retrieved 03.05.19 from https://salmonbusiness.com/ice-fish-farm-gets-greenlight-to-triple-production-in-iceland/

Patursson, Ø. (2019). [Interview on the Faroe Islands 10.04].

Peta.). Aquafarming. *People for the Ethical Treatment of Animals* Retrieved 17.03.19 from https://www.peta.org/issues/animals-used-for-food/factory-farming/fish/aquafarming/

Roos, G., Krogh, G. v., Roos, J., & Boldt-Christmas, L. (2013). *Strategi: En innføring*. Bergen: Fagbokforlaget.

Rosenbrock, K. (2015). Salmon: A powerful superfood for every type of athlete. *The Active Times*. Retrieved 13.03.19 from https://www.theactivetimes.com/salmon-powerful-superfood-every-type-athlete

Roxel Aqua AS. (2018). Norway Patent No. Roxel Aqua As. Retrieved 02.03.19 from https://roxel.no/aqua/solution/

Roxel Aqua AS(Tord Ludvigsen) (2019). [Personal communication regarding "Octopus".].

Rusten, G., & Aarset, B. (2007). *Havbruk : akvakultur på norsk*. Bergen: Fagbokforl.

Scotland, N. Marine Finfish Aquaculture. Retrieved 10.03.19 from http://aquaculture.scotland.gov.uk/our_aquaculture/types_of_aquaculture/marine_finfish.aspx

Scottish Governemnt. (2019). Scotland´s aquaculture map. Retrieved 04.04.19 from http://aquaculture.scotland.gov.uk/map/map.aspx

Sjømatråd/Sjømat Norge. (2016). Salmon Lice. Retrieved 24.04.19 from https://salmonfacts.com/salmon-and-environment/salmon-lice/

Smith, O. (2018). Revealed: The snowiest, coldes and windiest places in Britain. *The Telegraph*. Retrieved 29.04.19 from https://www.telegraph.co.uk/travel/destinations/europe/united-kingdom/articles/uk-extreme-weather/

Statistics Norway. (2019). Aquaculture. Retrieved 19.05.19 from https://www.ssb.no/en/fiskeoppdrett

Sveier, H. (1996). *Havbruk* (Vol. 2). Oslo: Landbruksforl.

Teknologirådet. (2012). *Fremtidens lakseoppdrett*. Retrieved from 14.05.19 https://teknologiradet.no/wp-content/uploads/sites/105/2018/04/Rapport-Fremtidens-lakseoppdrett.pdf

The Government of the Faroe Islands. The Faroe Islands in the international community. Retrieved 07.06.19 from https://www.government.fo/en/foreign-relations/the-faroe-islands-in-the-international-community/

Thuesen, N. P., & Phil, R. (2019). Færøyene. In *Store Norske Leksikon*: Store Norske Leksikon. Retrieved 10.03.19 from https://snl.no/F%C3%A6r%C3%B8yene

Tikkanen, A. (2008). Atlantic salmon. *Encyclopædia Britannica.* Retrieved 13.03.19 from https://academic.eb.com/levels/collegiate/article/Atlantic-salmon/10105

Tjora, A. (2012). *Kvalitative forskningsmetoder i praksis*. Oslo: Gyldendal akademisk.

Tourtellot, J. B. (2007). 111 islands. *National Geographic Traveler*. Retrieved 20.05.19 from https://www.nationalgeographic.com/traveler/pdf/nd07placesratedislands.pdf

Tvenning, H., & Bachmann, F. (1991). *Fiskeoppdrett* (4. utg. ed.). Oslo: Aschehoug.

Utdanningsdirektoratet. (2015). Akvakulturfag. Retrieved 05.03.19 from https://utdanning.no/studiebeskrivelse/akvakulturfag

Visit Faroe Islands. Aquaculture. Retrieved 26.03.19 from https://visitfaroeislands.com/meetings/why-the-faroe-islands/our-distinctions/aquaculture/

Visit Faroe Islands. By Air. Retrieved 27.03.19 from https://visitfaroeislands.com/plan-your-stay/transport/getting-to-the-faroe-islands/by-air/

Visit Faroe Islands. Getting to the Faroe Islands. Retrieved 26.03.19 from https://www.visitfaroeislands.com/plan-your-stay/transport/getting-to-the-faroe-islands/

Vøllestad, A. (2018). Laks. *Store Norske Leksikon.* Retrieved 02.03.19 from https://snl.no/laks

Wennevik, V. (2016). Atlantisk laks. *Havforskningsinstituttet.* Retrieved 13.05.19 from https://www.imr.no/filarkiv/2016/03/laks.pdf/nb-no

Yin, R. K. (2009). *Case study research: design and methods* Thousan Oaks, CA: SAGE Publications.

9 Appendix

9.1 Appendix A

		Norway	Iceland	Ireland	Scotland	Færøyene
4	**Maximum number of smolt per cage**	200 000	200 000	N/A	N/A	Unlimited (avg. 120 000)
5	**Maximum density of fish [kg/m3]**	25	25	N/A	N/A	25
6	**Maximum allowable biomass [tons]**	780 (945 in the North)	No regulation. Based on volume vs. Density	N/A	Depends on envionemental conditions at site: between 100-2500	depending on environmental sustainability like seabed conditions and lice
7	**Lease or owned**	Owned	Lease	Lease	Lease	Loan/Lease
8	**Timeframe application process**	< 6 months	7 years	Between 87-216 months	6-12 months for Planning Permission + 4-6 months for environmental discharge license	3-6 months
9	**Duration of license**	Unlimited	10 years	10 years (duration can be up to 20 years)	25 years	12 years before renewal is required
10	**Licenses available [development and production]**	1015 (2017)	Approximately 110	282	45	22
11	**Cost per license**	Auction (last auction 152 MNOK)	No cost, but costs related to research and license application. Annual fee is based on tons of license active.	€ 6.35 (62.41 NOK) /ton. Foreshore rental fees € 63.49 (624 NOK) for up to and including 5 hectares: additional hectare up to 10 € 31.74 (312 NOK): addtional hectare >10 € 63.49 (624 NOK)	Annually: Environmental discharge license: 9 000 GBP (102 788 NOK). 22.50GBP (257 NOK)/ton harvested for Mainland sites: 20.50 GBP (235 NOK)/ton harvested for Western Isles site: 1 000 GBP (11420 NOK) f no harvest. 2000 (22 840 NOK) GBP if dormant. + planning permission fee of 63 GBP (720 NOK)/0.1 hectare of seabed + SEPA environmental licnese 4 202 GBP (47 990NOK) (for a new site).	12 000 DKK (15 798 NOK) per licence + harvesting royalty of 5% (depending on market value at FishPool)
12	**Government framework**	Directorate of Fisheries Regional Office, County Governor, Norwegian Food Safety Authority, Norwegian National Coastal Administration, Municipality, Norwegian Water Resources and Energy Directorate (NVE) Regional Offices	Veterinary and Food Authority, The Directorate of Fisheries	Processing - The Aquaculture and Foreshore Management Division (AFMD), Environmental Impact Assessment (EIA),The Marine Engineering Division (MED) - site mapping and technical advice, The Marine Institute - scentific advice. Other advices - Appropriate Assessment (AA), Bord Iascaigh Mhara (BIM), Sea fisheries Protection Authority (SFPA)	Planning permission - local regional Council, Marine License - Marien Scotland, Discharge license - Scottish Environment Protection Agency (SEPA)	The Food and Veterinary Authority , The minister of trade and foreign affairs
13	**Annuall production [tons]**	1 236 353 (2017	11 265 (2017)	19 305 (2017)	189 707 (2017)	71 172 gutted weight (2017)
14	**Annuall revenue**	61,635 BNOK (2017)	19 BISK (1,36 BNOK) (included landbased)(2017)	141,2 MEUR (1,39 BNOK) (2019)	1 050 976, 780 £ (12 BNOK) (2017)	
15	**Employment (salmon farming)**	5 761 (2017)	435 (2017)	Approx. 200 (2017)	1 431 (2017)	1018 (2018)
16	**Distance to other farms**	5 km	5 km			5 km

9.2 Appendix B

Interview guide for the interviews conducted on the Faroe Islands.

1. What do you see as the biggest advantages for salmon farmers at the Faroes compared to other regions? Do you see this change in the coming years?
2. How has the change in the regulations in 2003 impacted the aquaculture industry in the Faroes?
    a. and how has it changed the daily operations? Larger smolt etc?
    b. quality of the salmon
    c. growth of the salmon
3. What are the main challenges to operate in the aquaculture industry at the Faroes Island?
4. What are the largest challenges related to fish health? Lice / diseases / predators such as seal / other?
5. What are the costs related to lice and disease (per kg) (on the facility / in general)?
6. What is the expected outlook of the salmon farming industry on the Faroes?
    a. Expected growth in biomass
    b. Will the growth come from landbased, sheltered, exposed or offshore?
    c. What do you look upon as the advantages/disadvantages of exposed / offshore farming?
    d. Do you expect the same players as today, or do you expect/welcome new players?
    e. What are the biggest threats for the industry to grow?
    f. What are the government doing to help the industry grow in the coming years?
    g. Do you have any plans to implement development licenses, similar to the Norwegian program for development licenses?
    h. Do you see a need for a larger upgrade of the infrastructure to grow further in the aquaculture industry? (Smolt, wellboats, harvest facilities, different work force etc?)
    i. Do you usually import technology or use technology developed at the Faroes?
    j. Do you expect the technology to allow for more autonomous farming than today?

7. What is the willingness to invest in new projects for further growth in the aquaculture industry?
8. Some specific questions about your regulations:
    - Criteria for determining the amount of maximum allowed biomass / number of smolt
    - Distance to other farms
    - Fallowing regime (will this change if the sea farm is exposed / offshore)
    - Number of smolt per cage
    - Density of the salmon
    - How is mortality counted?
    - Are the other important parameters?

9. The penalty point system:
    a. how does this work?

b. Is it related to the company or the facility? In Norway we have zones which is treated as “one” and is directly related to the biomass each facility is granted. As an example, if there is much lice in one of the facilities in a zone, the other facilities in that zone is also affected.
c. Will this also apply to landbased or exposed / offshore farming?

10. If you could change anything in the way aquaculture is done today, what would it be?