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Salmon farming in the North

Regulating societal and environmental impacts

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Report

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Summary:

Salmon farming is a rapidly growing industry in the North and its sustainable development depends on adequate governance. We have assessed the governance systems for salmon farming in four northern countries, Canada, the Faroe Islands, Iceland, and Norway. In all the countries, the industry is marked by controversies, linked to the environmental and societal impacts of its activities. The question raised is how the authorities address these challenges - what instruments are deployed to achieve a sustainable salmon industry? We have identified both commonalities and differences. The farming of salmon is to a large extent organized in similar ways, with net-pens in the ocean as the dominant production form. In general, the regulations pertaining to the industry have a lot in common. All countries require a license to produce, there are environmental monitoring regimes in place, and the producers are required to report on the same parameters, such as biomass, sea lice counts, disease management, and a range of other statistics. A major difference is the polycentric character of the governance systems in Canada and partly Norway. Still, despite differences in production volume and contextual factors, we see that fairly similar regulatory toolboxes are used to control aquaculture activities.

Summary in Norwegian:

Lakseoppdrett er en næring i vekst i nord. En bærekraftig utvikling av næringen er avhengig av en forvaltning som ivaretar både miljømessig og samfunnsmessige hensyn. Rapporten gir en analyse av fire lands forvaltning av næringen, Canada, Færøyene, Island og Norge. Tross store forskjeller i produksjonsvolum, er utfordringene i stor grad de samme. Forvaltningsverktøyene som benyttes er i hovedsak like, men med noen særegne tilpasninger. Blant annet har landene noe ulik tilnærming til områdeforvaltning og regulering av vekst. Den største forskjellen er likevel den polysentriske innretningen på forvaltningssystemet i Canadas føderale system og kommunenes planmyndighet i Norge.

Preface

The project "Governing environmental and social aspects of salmon farming in four northern countries" (FourSalmon) has been funded by the Fram Centre Flagship MIKON. We would like to thank all informants and participants at workshops in Canada, Faroe Islands, Iceland, and Norway.

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1 Introduction: Governing salmon farming in the North

Aquaculture has become a major part of the global food production. It is at present the fastest growing food-producing industry in the world (FAO, 2020)[1]. In Northern and Arctic areas, intensive aquaculture is a relatively new industry. It has become important for regional development in many rural areas. There is also a general expectation of further growth.

Salmon farming makes up most of the aquaculture industry in the north. If the intensive salmon farming industry is to grow further, it is dependent on an ability to develop sustainably (Hersoug *et al.,* 2019). Today the industry is controversial, with frequent accusations of not operating in a sustainable manner (Osmundsen & Olsen, 2017). Challenges relate to the industry's impact on wild stocks and species, degradation of habitats, rural futures and economic restructuring, and rights to marine areas and resources (Young & Matthews 2010). Nature conservationists, nearby residents, and sports anglers (wild salmon, trout, char, and other wild fish species) argue that intensive fish farming is not sustainable due to negative environmental impacts. Area conflicts are becoming more visible, often with other interests (fisheries, recreational, tourism, etc.) and local/indigenous peoples, in addition to disagreements in relation to issues of power and control (Solås, 2014). An increasing number of local communities maintain that they receive too little in return for offering their most valuable areas to the intensive aquaculture industry (Hersoug *et al.,* 2019; Sandersen & Kvalvik, 2015), leading to debates about area taxes or resource rents.

There are controversies related to salmon farming in all the Northern countries, linked to both the environmental and societal impacts of the industry. Even though their expression is different in many regards, the fundamental challenges of environmental and social impacts are common (Young *et al.,* 2019). How the different governments respond to these challenges can be seen in how they design the governance systems to achieve an environmentally, socially and economically sustainable salmon industry. To date there have been few comparisons of the regulation of salmon farming. Identifying commonalities and differences in the regulation of aquaculture across environmental and social contexts can be useful when assessing and developing new policies and concrete regulations to govern the industry. In this project, we have assessed the governance systems for salmon farming in four northern countries, Canada, the Faroe Islands, Iceland and Norway.

Table 1 Salmon production in the four countries

Year 2018	Canada	Faroe Islands	Iceland	Norway
Annual production Atlantic salmon (1)	123 184 t	86 423 t	13 500 t	1 282 003 t
Value (Million EUR)	708	449	66	6 483
Salmon share of national export		41.7%	1.5%	6.8%
Number of production licenses		22	12	1 041
Number of production sites		33	26	1 015
Direct employment (2)		1 258	213	11 150
Employment in supporting industries		n.a.	265	30 000

(1) These are based on national statistics. There may be differences in the countries' conversion rate when calculating from slaughtered weight to whole fish equivalent; (2) Employment at hatcheries, smolt farms, sea farms and at harvest facilities

[1] http://www.fao.org/aquaculture/en/

Even though the countries differ noticeably in size and population, they are also similar in many respects. All are advanced democracies with strong export-oriented resource sectors, and long history of resource governance. They are also maritime countries with significant coastal populations and powerful commercial fishing lobbies. When it comes to salmon farming, however, these countries are quite different, both in production volume and in the industry's importance to the national economy, as shown in Table 1. As a rapidly growing industry, salmon farming is representative of the current intensification of industrial activities in the northern and Arctic regions. Long-term sustainable utilization of marine resources depends on adequate management, policy, practices, and technology (FAO, 2018). In other words, adequate *governance.*

1.1 Governmentality: the art of governing

Governance can be understood as interventions taken to solve societal problems and create social opportunities. Governance can further be regarded as the interactions between a governing system and a system-to-be-governed (Jentoft, 2007). These interactions produce and process knowledge that is converted into a system of regulatory practices that can contain specific instruments (Johnsen *et al.,* 2009), such as licenses or biomass regulations. The design of the governance systems sets conditions for the industry and how industrial activities will affect local communities and interests, for instance through general political expectations, specific regulations, or public-private contract agreements. This varies considerably between the salmon producing countries.

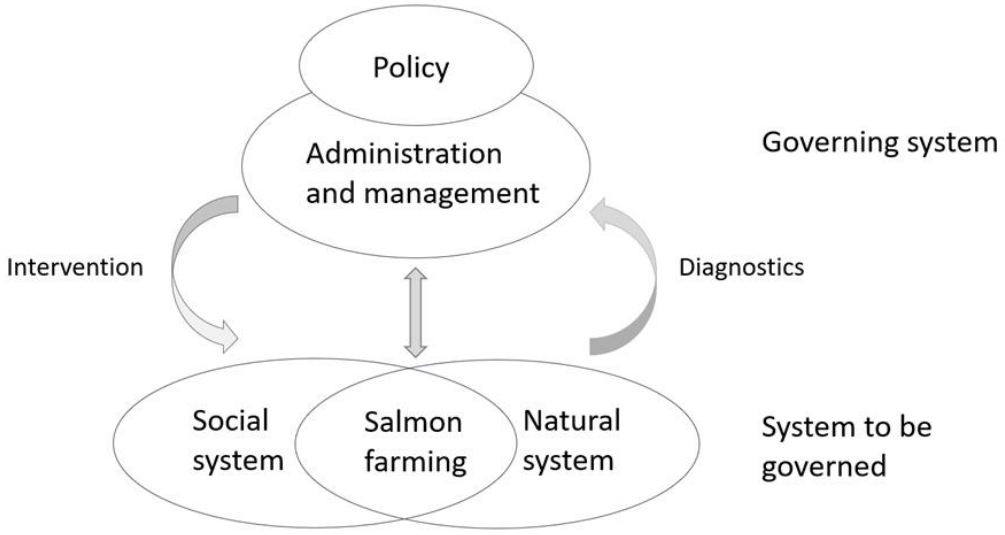

Figure 1 Model for analysing governance of salmon production (Solås et al., 2015, based on Nielsen & Holm, 2007).

Figure 1 represents this conceptual understanding of governance as a dynamic system that includes policymaking, administrative decision-making and management, and the natural and social interactions and feedbacks. On the right-hand side, there is a technical and scientific information system for monitoring the effects on the natural system. Based on the diagnostics, the effects on the system are modelled and fed back to the governance system. The left side in the model depicts the intervention mechanisms, i.e. regulatory instruments such as licenses, zoning plans or limits on allowed biomass or number of fish.

Countries have designed different regulatory instruments, and hence have different governing systems. A major issue is how environmental and societal concerns are accounted for in the aquaculture governance. Hence, the main question in this report is how governing of quite similar activities is conducted in the different countries and what kind of instruments are deployed to regulate the aquaculture actors' behavior. In this way, we assess the countries' regulatory toolboxes for aquaculture. We explore and answer this question by use of Foucault's concept of governmentality in combination with mappings of how concerns for environmental and social impacts of salmon farming are incorporated into the policies, rules, and regulations in the four countries.

Governing systems can be hierarchic and monocentric, with the state as the controlling center for governance, or they can be more polycentric, with less top-down control. Although contemporary governance studies point towards more polycentric models, there are monocentric elements in use in many governance systems (Termeer et. al, 2010). With reference to figure 1, we see the governing system, governing processes and the system-to-be-governed as mutually constructed through the interactions that stem from the effects and responses to instruments in use.

Governability has been understood as the overall capacity for governance (Kooiman & Bavinck, 2013). In our understanding, this is not a stable system property, or a simple question about the capacity of a governing system to govern a system-to-be-governed. Rather, it is the outputs of the strategic use of governing instruments and the reception and response to this use. Thus, governability is the wanted outcome of governing – the ability to control actors.

In a complex world, both the governing system and the-system-to-be-governed will develop in concert, and both will continuously evolve due to response and feedbacks (Rhodes, 1996). Hence, governing is a complex art, according to Jessop (1997). New instruments raise new concerns, and new concerns require new instruments. Our dynamic perspective is inspired by Michel Foucault's (1978a) studies of the history and genealogy of governing institutions and practices. "The State is a practice, not a thing' (Foucault, 1978: 277), and in this report we study how the different regulatory practices are organized to govern aquaculture. Foucault calls this "governmentality" or the "the art of governing" (Lemke, 2015). Hence, this comparative study explores how the four countries have organized the scene for conduction of the "art of aquaculture governance". In this report we focus mainly on how the processes are organized, or the practices that make up the governance.

This report builds on the work in the AquaLog and FourSalmon projects. Methodologically the project was performed using case-study methods (Yin, 2009), which are well suited for investigating complex phenomena from a qualitative standpoint. The main methods have been document studies and interviews with key stakeholders in government, industry, and local communities. Several workshops have been arranged, where the researchers met with managers, industry, and local community representatives from the host nation. The first workshop was held in Tromsø, Norway in 2015 as part of the AquaLog project, which also arranged a second workshop in Vancouver, Canada, in 2017. As part of the FourSalmon project, a workshop and a series of meetings was undertaken in Iceland in October 2019. The planned Faroese workshop was cancelled due to Covid-19. Partners in each of the countries have assessed the regulatory framework for salmon production in their respective countries, by conducting document analysis of relevant Acts and regulations, as well as applying national statistics and scientific literature.

2 Salmon farming in Canada

2.1 Production of farmed salmon in Canada

Canadian governments, both federal and provincial, have been actively supporting aquaculture development since the early 1980s (Keller & Leslie, 1996). These governments have seen aquaculture as an important tool for rural development, particularly as employment in fisheries and coastal forestry have declined, and have been eager to capitalize on natural assets such as the country's vast coastline and favourable climate for rearing coldwater species (Young & Matthews, 2010).

The Canadian aquaculture industry is diverse, with substantial production of both marine and freshwater finfish and shellfish species. Salmon aquaculture represents approximately 65% of Canadian production by volume, and 70% of the industry by value (DFO, 2015). Nevertheless, salmon production is modest by international standards, as Canadian production is only 10% of Norway's by volume. Approximately two-thirds of salmon production in Canada occurs in the province of British Columbia on the Pacific coast, with the remaining third occurring in the Atlantic provinces of New Brunswick, Nova Scotia, and Newfoundland and Labrador (DFO, 2018). Salmon aquaculture operations are mostly foreign owned, with international giants Grieg, Cermaq and Mowi accounting for the vast majority of production. The largest Canadian firm, Cooke Aquaculture, operates mostly on the Atlantic coast and has recently expanded internationally with sites and facilities in Scotland and Chile. A smaller Canadian company, Creative Salmon, operates exclusively in British Columbia growing chinook salmon.

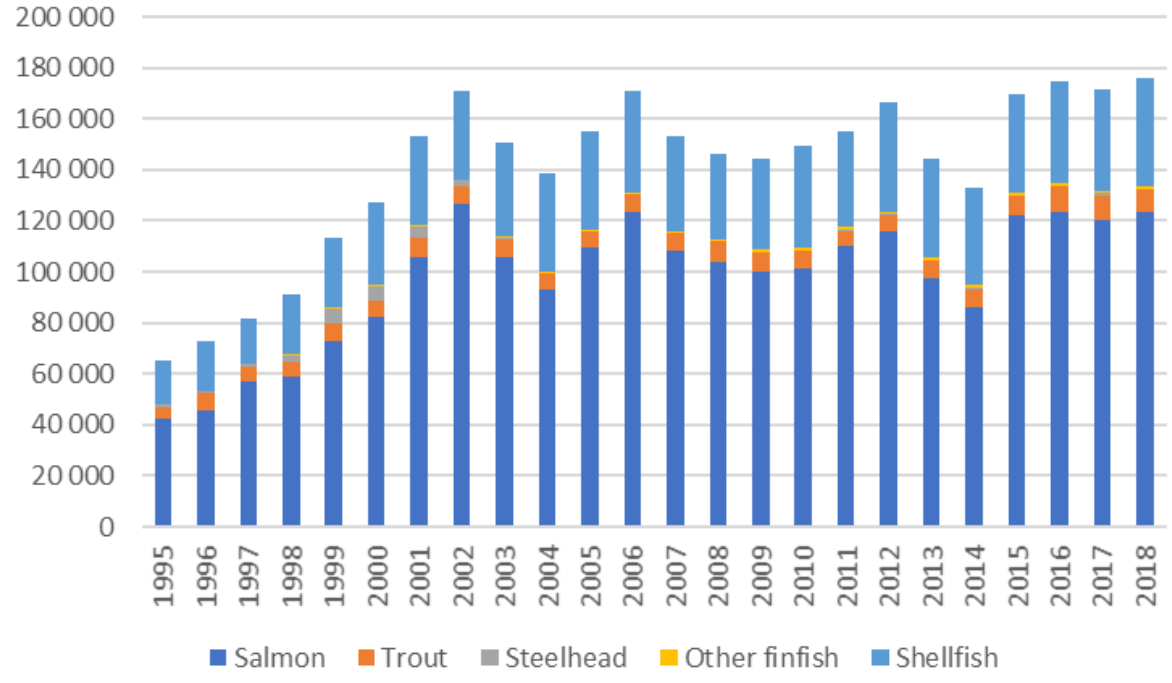

Figure 2 Aquaculture production volume in Canada (Statistics Canada. Table 32-10-0107-01 Aquaculture, production and value).

The latest available statistics (DFO, 2018) show that Canadian salmon production is modest compared to the largest salmon farming nations, totaling 123,184 tonnes, with a value of $1.1 billion CAD (approximately 708 million EUR). Production is concentrated in British Columbia (87,010 tonnes),

followed by New Brunswick (28,289 tonnes), Newfoundland and Labrador (15,000 tonnes, although this figure includes steelhead and trout production) and Nova Scotia (7,885 tonnes). As Figure 2 illustrates, salmon farming production in Canada has fluctuated year over year in the past decade with only modest overall growth. From 2008 to 2018, for example, production grew by an annualized rate of 1.6% (Statistics Canada, 2018). This is due to ongoing challenges with on-site grow out operations, as well as difficulty securing new tenures and site licenses in many regions of the country.

2.2 Aquaculture policy

Despite enjoying strong support from all levels of government, salmon aquaculture has been controversial in Canada since the 1980s. Concerns about environmental impacts have been the most consistent theme in the Canadian controversy, particularly with respect to disease and pathogen transfer among cultured and wild species (Krkošek *et al.,* 2007). On Canada's Atlantic coast, several critically endangered wild stocks of Atlantic salmon (*Salmo salar*) migrate through waters of intensive aquaculture production, raising concerns about interactions. On Canada's Pacific coast, farmed Atlantic salmon are an exotic species that some see as a colonization threat (Keller & Leslie, 1996). The Pacific region is home to significant wild salmon stocks and migrations that support a large commercial fleet, an extensive recreational fishing sector, and numerous First Nation (indigenous) fisheries. The wild salmon harvest has tremendous cultural and economic importance to First Nations people in the province of British Columbia. The rights of First Nations people across Canada are subject to ongoing political and legal challenges, and some see the siting of aquaculture operations without the consent of First Nations communities as a violation of traditional territories and a threat to subsistence activities such as clam harvesting (Young & Matthews, 2010). Interactions with other coastal industries have also spurred conflict, particularly with the lobster fishery in Atlantic Canada, and tourism in the Pacific region.

Support and opposition to the salmon farming industry are strong in Canada's rural coastal communities (Young & Matthews, 2010). The Canadian salmon aquaculture industry has developed partnerships with some First Nations groups and communities on the Pacific and Atlantic coasts, including agreements on local employment and enhanced environmental monitoring. However, many other First Nation groups and communities remain opposed to salmon aquaculture. There have been a number of instances in recent years of First Nation and non-First Nation activists boarding and occupying grow-out sites in British Columbia, forms of direct action that have increased tensions between supporters and opponents of the industry.

2.3 Regulation of salmon farming

Canadian federalism and the Constitutional division of powers between the national and provincial governments complicate aquaculture governance and regulation. The Government of Canada has jurisdiction over marine fisheries and oceans, while provincial governments have authority over natural resources and business licensing (Howlett & Brownsley, 2008). This means that aquaculture is regulated by both levels of government simultaneously – a situation that has frustrated both proponents (who see many regulations as overlapping and redundant) and opponents (who see significant regulatory gaps and inconsistencies across jurisdictions). At the federal level, Canada has never enacted an Aquaculture Act or similar legislation specific to aquaculture, relying on fisheries, marine usage, and environmental assessment law to regulate the industry (Doelle & Saunders, 2016).

In response to political pressures, provincial and federal governments have initiated several public inquiries over the past several decades to hear testimony from citizens and experts (Cohen, 2012). The result has been intermittent moratoria on aquaculture licensing, including a current ban on salmon aquaculture expansion into the northern half of British Columbia.

A major schism in Canadian aquaculture policy occurred following a British Columbia Supreme Court decision in 2009 in the case of Morton et al. v. The Attorney General of British Columbia. Morton, a long-time activist, successfully argued that the province of British Columbia was making regulatory and policy decisions regarding licensing and environmental regulation that are in fact the jurisdiction of the federal government. The court ordered the federal Department of Fisheries and Oceans to take primary responsibility in these spheres beginning in 2010. However, the ruling applies only in British Columbia, meaning that Canadian policy and regulations are now quite different on the Pacific Coast (where the federal government is the lead agency) and the Atlantic coast (where the individual provinces are the lead agencies). Functionally, this means that the Canadian regulatory and policy framework is highly fragmented. Importantly, the province of British Columbia continues to exert control over site licensing and tenures (leases) via the BC Lands Act, and the provincial government declared in 2018 that tenures will not be renewed without explicit consent from First Nations in whose traditional territories a farm is located (Laanala, 2018).

Canadian federalism means that each province has different rules governing salmon aquaculture licensing. Figure 3 provides a simplified illustration of this. In British Columbia, the federal government plays the lead role (following the 2009 Morton decision described above). Federal licenses are granted for up to 6 years and are conditional on the submission and maintenance of plans for environmental management and reporting of biomass, mortality, disease management, sea lice counts, and a range of other statistics. The licenses are also contingent on following set procedures and best practices for escape prevention, wildlife management, and protection of water quality (see DFO, 2020). On the Pacific coast, the province of British Columbia is responsible for issuing tenures under the BC Land Act (which also covers nearshore waters). This is highly relevant for siting of salmon farms, as without a tenure, a license cannot be enacted. This ensures a strong provincial mandate in salmon aquaculture licensing. For example, in 2018 the province announced that, effective June 2022, tenures would only be granted to salmon farm operators that have satisfied the federal DFO that their operations will not adversely impact wild salmon stocks, and who have negotiated agreements with the First Nation(s) in whose territory they propose to operate. The province also requires a license for any land-based operation linked to aquaculture production, such as a processing plant (BC, 2020).

In the Atlantic provinces, licensing decisions and requirements are determined primarily by the relevant Ministries of the provinces. The provinces of New Brunswick and Newfoundland and Labrador have both passed Aquaculture Acts to regulate salmon farming and issue licenses to operate. Nova Scotia relies primarily on a Fisheries and Coastal Resources Act to do the same. The Atlantic provinces of Quebec and Prince Edward Island (PEI) do not presently have salmon farming operations. PEI is a unique case, if it were ever to host salmon farming, it formally defers to the federal licensing system run by DFO. Provincial licensing requirements for the three Atlantic provinces that currently host salmon farming generally align with those of the federal government on the Pacific coast, requiring the submission of plans and reporting of biomass, mortality, disease management, environmental conditions, and sea lice. Some provinces have developed specific requirements for licensing, such as the appointment of an attending veterinarian responsible for designated sites in New Brunswick (e.g., New Brunswick, 2009). While the federal Department of Fisheries and Oceans is not directly involved

in licensing in the Atlantic region, salmon farms are required to adhere to federal legislation such as the Fisheries Act and the Navigable Waters Act.

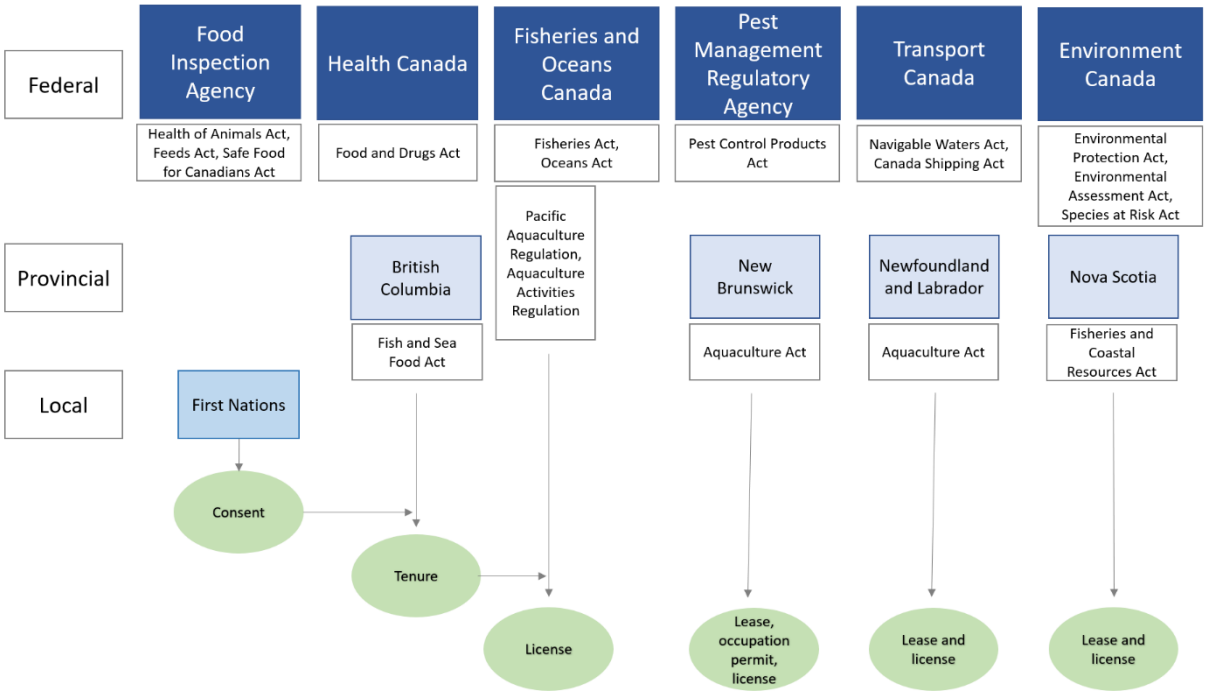

Figure 3 *Main authorities and legislation for aquaculture in Canada. Only sector-specific legislation is included, i.e. authorities and legislation pertaining to e.g. work safety are excluded.*

In summary, the governance system for Canadian salmon aquaculture is best described as a patchwork of multiple jurisdictional authorities. This is in part a consequence of Canadian federalism and the division and sharing of powers determined in the Canadian constitution. Areas of shared authority and responsibility are particularly murky. For instance, environmental regulation and coastal zone management are areas of shared responsibility between the federal and provincial governments. Regulation and legislation in these areas will always be complex and challenging to coordinate. However, the current governance patchwork is also the result of specific decisions. The federal government has, to date, elected not to draft or pass an Aquaculture Act, choosing instead to regulate aquaculture using a range of different legislative tools and standards intended to cover fisheries, environmental assessment, food quality, and marine transportation. The provincial approaches are also varying, with Aquaculture Acts in place in only two of the main four producers of farmed salmon. For salmon aquaculture producers, this means navigating numerous regulatory systems within the same country. Such complexity surely adds an administrative and compliance burden to firms. It is possible that aquaculture legislation and regulation will be streamlined and rendered more consistent as the industry matures. However, it is equally possible that future court decisions will push in the opposite direction, towards fragmentation and fracture of governance regimes, as has happened in British Columbia. Opposition to salmon farming remains strong in Canada, and court cases are regularly heard. Federal and provincial court rulings are made more unpredictable by the absence of a federal Aquaculture Act. Without a unifying legal framework, the future of aquaculture governance in Canada is uncertain and tenuous.

3 Salmon farming in the Faroe Islands

3.1 Production of farmed salmon in the Faroe Islands

Aquaculture in the Faroe Islands may be dated back to 1886 when a 10-year license was granted to farm oysters, and in 1887 an application was submitted to the local parliament, Løgtingið, for financial support to send a person to Denmark to study new tools for hatching sea trout (Jacobsen, 2011). However, little is known about these early attempts. Rainbow trout are natives in Faroese rivers, but not salmon. Starting in 1947 salmon fry from Iceland was introduced to some rivers to establish a local stock by enthusiasts, who later founded the Faroese Anglers Association, which today supports a catch of 400-600 fish each year In the early 1950s attempts were made to farm trout in ponds on land following practices in Denmark, and experimental farming at sea inspired by the development in Norway started by a private enterprise in 1968, which in 1970 was taken over by the government and become the Aquaculture Research Station of the Faroes (Michelsen, 2006; Jacobsen, 2011).

The 1970s were largely experimental, while licenses during the 1980s largely were granted as a supplement income to farmers and coastal fishers as part of a rural district policy. This resulted in a large number of small farms spread over the country and by 1989 permits for 19 hatcheries and 69 sea production sites were granted to nearly the same number of companies. This structure flavored conditions for diseases, and in addition the Faroes was hit by a severe economic drawback in the early 1990s causing bankruptcies in the industry (Dam, 2020). The production peaked at 17,970 tonnes in 1991 and then declined to 8,260 tonnes in 1995 (see Figure 4).

In the subsequent reconstruction the number of companies was reduced to 20. The companies were in severe need of capital, and the first foreign investment was seen in 1994. In 1997 foreign investors bought for the first time the majority of a company. This caused the authorities to stipulate an upper limit of 33 % foreign ownership of a company in 2001, and further that one company could not control more than 25 % of the licenses in the country (Act 51/2001). In the proceeding years production increased steadily, where it reached 65,210 tonnes in 2003 (Figure 4; Dam, 2020).

The appearance of the Infectious Salmon Anemia (ISA) disease, which was detected for the first time in year 2000, had devastating consequences for the industry (Figure 4, Figure 5 and Figure 6) and the production bottomed at 16 860 tons in 2006. This led to a second major reconstruction of the industry, and to a revised Aquaculture Act (No 83/2009). The maximum share allowed to be controlled by a single company was now limited to 50 %. The limitation on foreign ownership was dropped in 2004 (Act 25/2004) but reappeared in 2009 with a maximum of 20 % owned by a single non-Faroese interest. However, five foreign units with no interconnections may together control a Faroese company 100 %. These limitations are preserved in later amendments (128/2012; 50/2018; 65/2020). In the wake of the ISA drawback the number of companies first declined to 6, which were later merged into the 3 still existing companies: Luna, which is a 100% local family-owned enterprise, MOWI Faroes, which is 100 % owned by the Norwegian/international mother company, and Bakkafrost, which is own by Faroese and foreign investors.

From the ISA drawback production increased steadily to about 78,000 tonnes in 2014, when it flattened out (Figure 4) mainly due to challenges with sea lice, but also because all traditional available sites are fully exploited. The chosen strategy for increased production is massive expansion of the land facilities. This reduces the time in the sea and reduce the impact of sea lice, in addition to optimizing

the available sea sites. The grow out period in sea for an average 5.4kg sized salmon is this way shortened from 17.8 months in 2015 to 15.8 months in 2019 in average for the industry, while the total grow out period for both the land and sea phase has remained constant (Dam, 2020). In 2019 the production reached the record of 86,420 tonnes (Figure 4) and is now representing more than 40% of the total export value from the Faroe Islands (Figure 5).

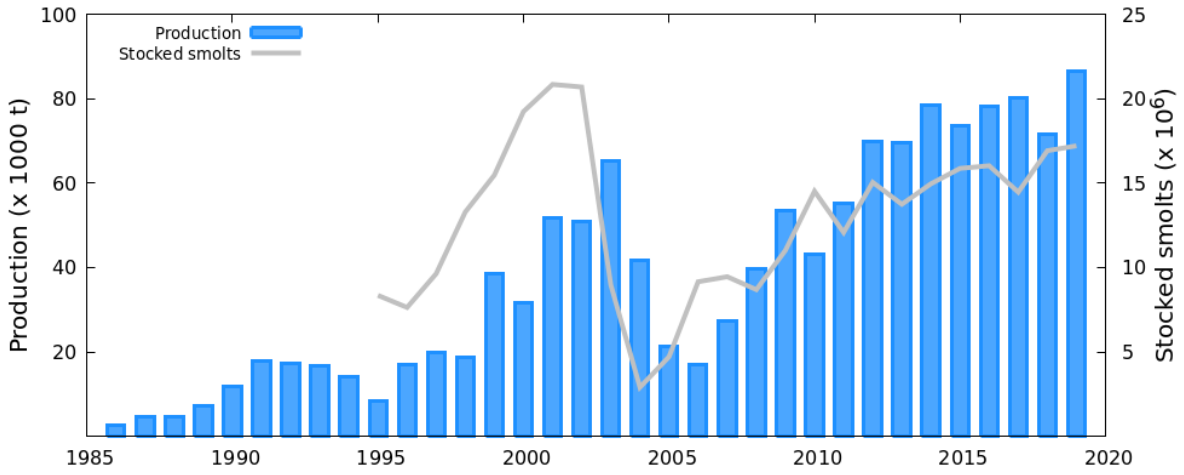

Figure 4 *Total production (x 1000 tonnes wfe) and number of smolts stocked into the sea cages in the Faroe Islands. (Sources: Dam, 2020, and Statistics Faroe Islands)*

The number of persons earning their wages working in the industry at the hatcheries, sea farms and harvesting has varied largely proportional to the production and is currently involving near 1200 persons, corresponding to about 4% of the work force in the Faroe Islands (Figure 6). In addition, there is a relatively large industry supplying services and equipment to the fish farming industry both locally and abroad.

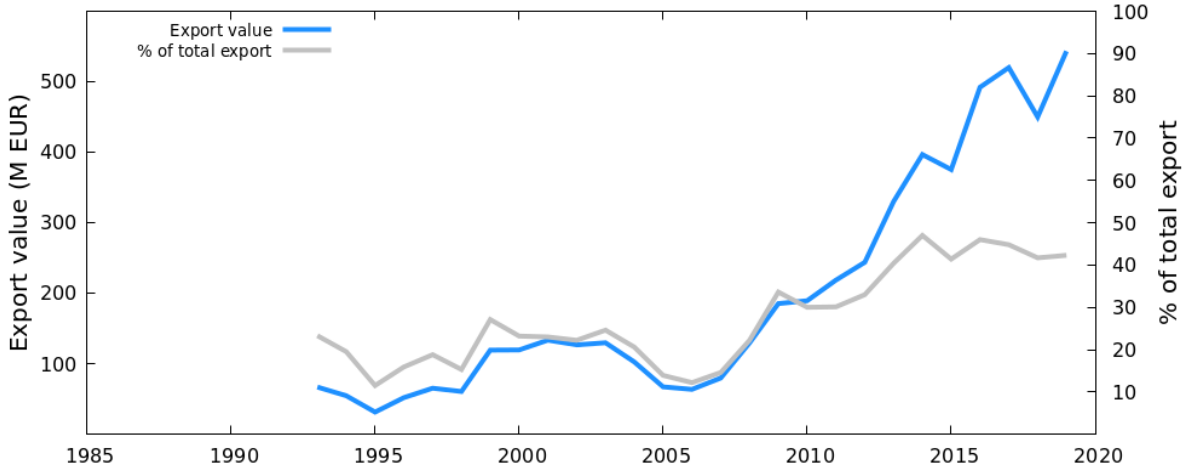

Figure 5 *Total export value of salmonids and its share of the total export value from the Faroe Islands. (Source: Statistics Faroe Islands)*

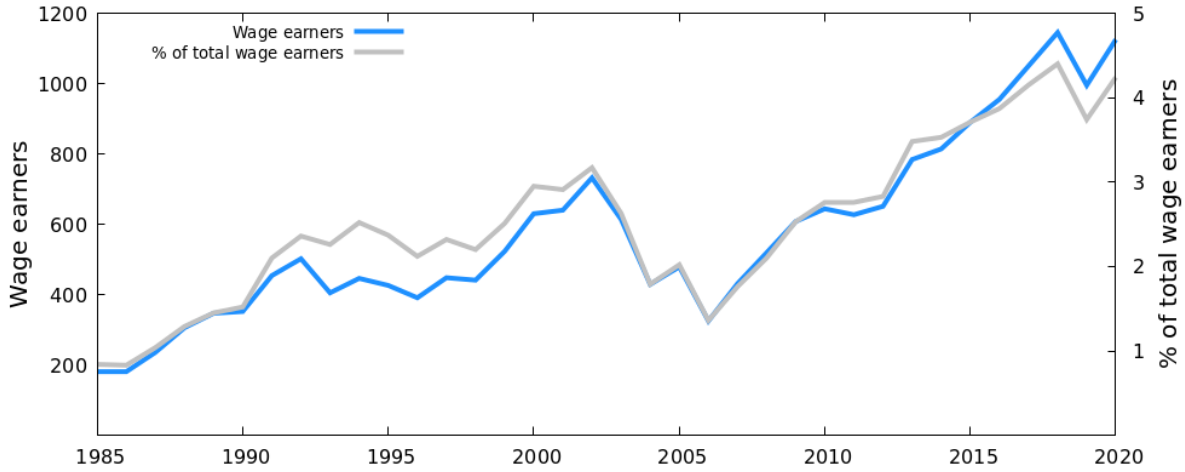

Figure 6 *Number of persons receiving their wages from aquaculture, including hatcheries, sea farms and harvesting, and its fraction of total number of wage earners in the Faroe Islands. (Source: Statistics Faroe Islands)*

3.2 Aquaculture policy

The political ambition of setting up the Aquaculture Research Station in 1970 was to initiate fish farming as a supplement income to farmers and coastal fishers, but when this became an industry the legal framework was not in place. A permit committee was formed in 1981 to advise the fishery minister on license permissions and technological matters, which later was replaced by an aquaculture council. The years 1984-85 may be considered the start of aquaculture as an industry, when the total production more than doubled from 500 tons to 1200 tons.

The first law regulating aquaculture was enacted in 1988, and in the following years some regulations were enforced to minimize the impact on the environment. However, a characteristic of this period is that the development of the legal framework was not able to keep up with the expanding industry. The crises due to the ISA disease in the early 2000s caused a complete revision of the regulations resulting in the present law, first enacted in 2009 (No 83), and revised in 2012 (No 128), 2018 (No 50) and 2020 (No 65), where the main goal is to ensure a profitable and compatible industry within a sustainable biological framework.

3.3 Regulation of salmon farming

Aquaculture in the Faroe Islands is under the jurisdiction of the Minister of Industry and Commerce and administered by the Food and Veterinary Authorities (FVA). Like most public agencies in the Faroe Islands, FVA includes several units, which may be compared to independent institutions in larger systems. Within FVA it is the Aquaculture Administration department, which is administrating licenses and permits related to aquaculture, while the inspection and certification is done by the veterinary and food safety departments. FVA also hosts the National Veterinary, which is the authority in questions on animal welfare and diseases. The department of environmental protection in the Environment Agency (EA) is responsible for certification and monitoring according to Environmental Act. Questions of environmental conservation are to be directed to regional committees, which are led by the local sheriff (Sysselman). The decisions of the regional committees can be appealed to a superior committee chaired by the judge. The EA has traditionally been managed by the Ministry of

Industry and Commerce, but under the political coalition in the period 2014-18 EA was placed under the Ministry of Health to separate the responsibilities of the aquaculture industry and environmental protection. Figure 7 provides a simplified illustration of the governance system of aquaculture in the Faroe Islands.

The main changes introduced with the Aquaculture Act No 85/2009 is the introduction of management zones (MZ) (Figure 8). A MZ contains one or more geographically limited areas, with room for several fish farms. Originally a MZ was geographically limited to a particular fjord or distinct part of a strait, but later most of the MZ's are geographically extended to also include the area outside the fjord or strait. Within a MZ, a minimum two-month fallowing is required before the outset of a new year class of salmon. In addition, minimum distances between sites within a MZ and two sites in neighboring MZ are introduced, as well as coordination of all activities like stocking, medical treatments, and harvest. The act from 2009 and later amendments also includes strict veterinary and environment monitoring regulations, which are specified in the acts of environment protection, fish welfare and food safety.

When the MZs were introduced in 2009, some of them hosted several farms operated by different companies. However, agreements between the companies and the authorities, and through merging of companies, only one company is now operating in each MZ.

In the act from 2009 it was said that no company could control more than 50% of the permits, but lack of specification of type of farming to be included in the total caused some discussions on how this regulation should be practiced. The update of the act in 2018 provides some clarification, defining 22 specific salmonid farming MZs, in addition to one broodstock zone, and 7 zones allocated for other type of farming or as development areas (Figure 8). For Bakkafrost and Mowi the share of licenses and foreign ownership, respectively, are above the caps in the most recent regulation, but transitional provisions in the Aquaculture Act secure that the obtained shares can remain. However, these companies cannot expand their activities with additional sea licenses, but they can apply for development licenses and expansion on land.

A prerequisite for salmon farming within a MZ is a production license, which is granted for a period of up to 12 years. In addition, the company needs different authorizations on operations, equipment, disease management, safety measures, reporting, etc. specified in Regulation No 80, 2019, based on the Aquaculture Act (83/2009, 65/2020), Veterinary Act (16/2001) and on the Animal Welfare Act (49/2018), and on requirements in the Environmental Act (134/1988). These authorizations are valid for a period of 5 years. Further the planned operations should not have negative impact on protected natural areas and follow town planning of the related municipality and plans for the sea area by the government (Act 83/2009). These issues are clarified through hearings from the respective stakeholders. The applicant also needs to document sufficient competence and experience. New in the amendment of the aquaculture act in 2018 was that available licenses may be awarded through auction.

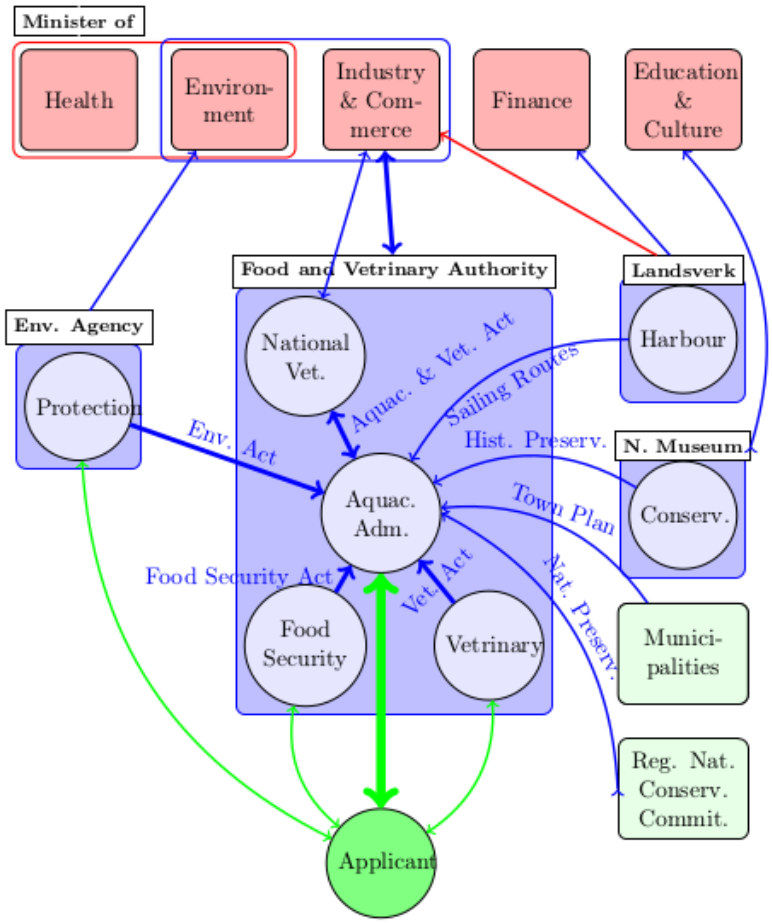

Figure 7 *Main authorities and legislation for aquaculture in the Faroe Islands. Only sector-specific legislation is included, i.e. authorities and legislation pertaining to e.g. work safety are excluded.*

Authorizations according to the acts of food safety, animal welfare and environment protection are required for keeping and renewal of a license. The authorizations are valid for 5 years but are continuously extended if the conditions are not broken or changed. Further, production plans for at least two production cycles should at any time be outlined, and the operator need to submit a detailed plan for a production cycle on a site no later than 5 months before the planned new stocking, which must be approved by the authorities no later than a week after the last harvest of the preceding production cycle (Reg. 80/2019). The issued production cycle license includes detailed specifications on allowed number of fish, and requirements on veterinary and environmental assessments. In the legislation there is no limitation on number of fish nor biomass, but the allowed number of fish in a new stocking is set before the approval of the production plan, and is based on the performance of earlier production cycles, including the disease situation, environment investigations, need of chemical treatments, and since 2016 also on the sea lice situation. Thus, if a company is not capable to comply with the approved production plan, including the terms in the production cycle approval or the specifications in the authorizations, then this will affect the approval for the next cycle.

The number of fish in each MZ currently varies from 300 000 to 2 800 000 (HFS.fo). In the regulation a minimum frequency of internal veterinary inspection, sea lice count, and environment monitoring are specified. Additional measures may however be included by the authorities through the approval process of the production plan. Benthic investigations are mandatory at maximum biomass, but its

extent and possible additional monitoring relies on the results in previous production cycles. Counting sea lice started in 2009. It was performed by the Aquaculture Research Station as an independent body on the behalf of the companies, and since 2016 this is mandatory. The current minimum requirement is bi-weekly count of all cages (Reg. 75/2016; 106/2019). Harvest and processing are regulated through the Food Safety Act (58/2010; 102/2017).

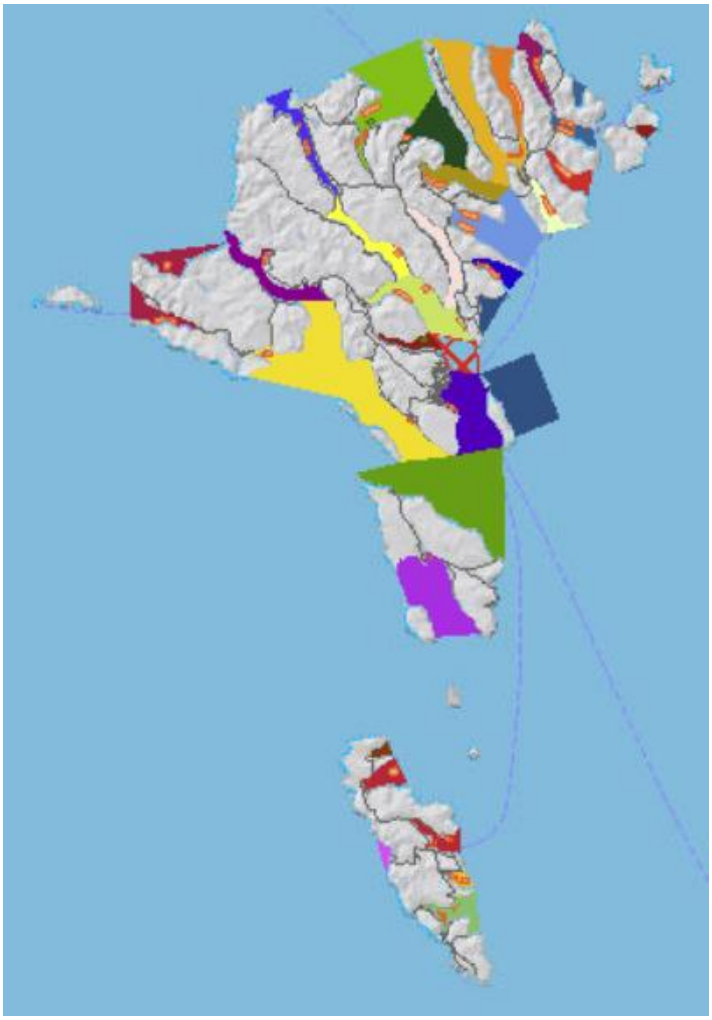

Figure 8 *Management zones, salmonid fish farming sites (Orange areas with red boundaries) and seaweed farming areas (Green squares). Shown in orange is the site areas, wherein a farm may be placed (Source: kortal.fo)*

Monthly inspections by either an internal or external veterinary is required for sea farms holding more than 1,000,000 fish, otherwise every second month as a minimum (Reg. 80/2019). In addition, the Veterinary department at FVA conduct physical inspections typically every three months. Benthic investigations are required by the EA before farming is starting up in an area, and at estimated maximum biomass during the production cycle. EA has a guideline of the minimum extent of the monitoring, which generally is written as a requirement in the production permit, but it is up to the companies to submit an investigation protocol for each area for approval at EA. In case of breach of a given threshold of the given parameters, extended and/or additional assessments may be required. An approval of the production plan is required prior to starting the grow out phase in sea, as mentioned above, where additional conditions may be incorporated based on the experience from the preceding production cycle. Each farm is required to keep a production diary, which is submitted to FVA weakly.

Information on the number of fish, average sea lice number and chemical treatment is publicly available on a webpage at FVE (hfs.fo).

In summary, the governance system for salmon aquaculture in the Faroe Islands can be described as adaptive and rather predictable. The Faroe Islands is a small, fisheries dependent country, with a well-organized national governance regime, where the aquaculture legislation and regulation is continuously updated. In responses to crises, such as the ISA outbreak, the government made fundamental changes in its regulation, introducing a strict area zoning which in turn restructured the entire industry. The process involved both (public) regulatory and (public-private) voluntary changes. As a result, the number of companies was reduced to 3, leaving the country with very few companies to govern.

4 Salmon farming in Iceland

4.1 Production of farmed salmon in Iceland

Aquaculture in Iceland has been expanding, with salmon farming taking the lead in the past few years. Other species currently farmed are mainly Arctic charr, Rainbow trout and Senegal sole (Statistics Iceland). In 2019, 34,000 tonnes of fish were farmed in Iceland, thereof 27,000 tonnes Atlantic salmon. Looking at figures for salmon farming in particular, as by far the largest part of Icelandic aquaculture, production increased from 13,500 tonnes in 2018 to 27,000 tonnes in 2019. The export value went from ISK 8.5 billion to ISK 18.5 billion (Statistics Iceland). The total export value of all aquaculture products was ISK 13.1 billion in 2018, doubled in 2019 and increased further in 2020, reaching more than 10% of the total export value of the fisheries sector, which is one of the three main pillars in the Icelandic economy. The total export value of the fisheries sector was ISK 239 billion in 2018, 40% of the total export from Iceland. While Icelandic fisheries have been quite stable in recent years around 250,000 -280,000 tonnes, there are expectations of further growth in aquaculture.

Figure 9 shows the development in aquaculture production since 2008. The main increase is in salmon farming and the land-based farming of Arctic charr has increased steadily, in 2019 reaching 6,300 tonnes. The farming of rainbow trout increased in 2016 and 2017 up to 4,628 tonnes when the two main rainbow trout companies changed their production to salmon and the rainbow trout production dropped to 300 tonnes. Land-based farming of Senegal sole was introduced in 2013 (Ragnarsson, 2014) using effluent water from Reykjanes geothermal power plant to heat the farming water to appr. 20°C. The annual production of Senegal sole is approximately 400 tonnes (Statistics Iceland).

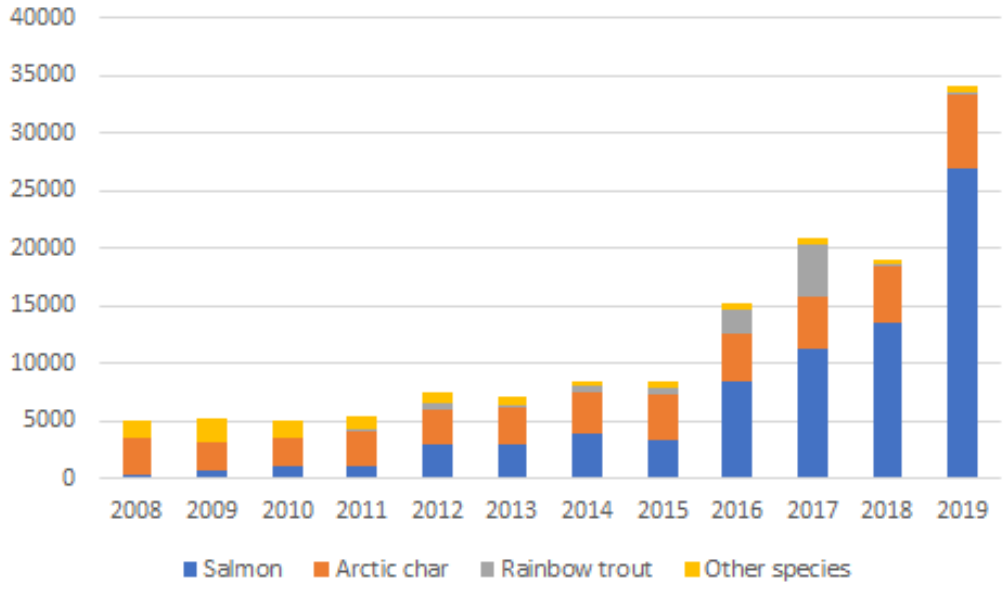

Figure 9 Aquaculture production in Iceland 2008-2019 (Statistics Iceland)

The growing aquaculture industry has resulted in job creation, especially in remote and scarcely populated areas. Since 2008 the number of direct employments is estimated to have increased from 166 to 457, mainly due to the salmon farming in sea cages, see Figure 10.

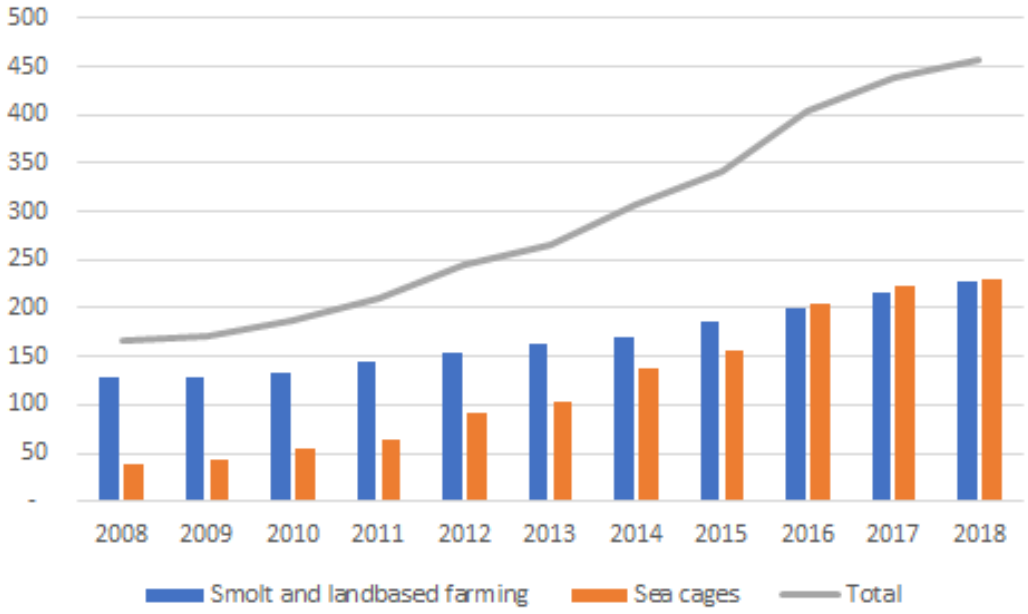

Figure 10 The direct employment in aquaculture in Iceland from 2008 to 2018 (radarinn.is).

The first aquaculture experiments in Iceland began in the 1950s in small land-based ponds and tanks and with the first sea cages of Atlantic salmon. The production volume was rather limited during the first years. Land-based aquaculture was early on located close to geothermal water. In 1961 a state-owned salmon hatchery was started in Kollafjordur with the objectives to produce salmon fry and smolt for rivers as well as for rearing to market size. During this period and until the 1970s only 10-15 small fish farms were operating (Bjarnason & Magnusdottir, 2019).

In 1978 land-based tanks with pumped seawater were introduced and in the 1980s salmon farming increased mainly with export of juveniles. The plan was to expand and increase the production of salmon (up to 2 kg fish) and large investments were made in the salmon industry in the years 1984-1990, while the price of salmon was relatively high. With the drop in salmon prices in 1992 most of the companies went bankrupt and the production dropped. New initiatives around the turn of the millennium resulted in the production of almost 7 000 tons of salmon in 2006, but due to unfavorable exchange rates this dropped to 292 tonnes in 2008. Since then salmon farming has been increasing again as can be seen in Figure 9. In 2019, operating licenses issued for salmon farming in sea cages in Iceland amounted in total to approximately 60,000 tonnes (Bjarnason & Magnusdottir, 2019) and now in late 2020 the total amounts to approximately 80,000 tonnes. The main Icelandic salmon farming companies are Arnarlax, Arctic Fish, Fiskeldi Austfjarda (Icefish Farm), Laxar fiskeldi and Islandsbleikja. Arnarlax and Arctic Fish are operating in the Westfjords, Fiskeldi Austfjarda and Laxar fiskeldi in the Eastfjords and Islandsbleikja has a land-based salmon farm in North Iceland. The four major companies in the industry are majority owned by Norwegian investors and Norwegian salmon farming companies.

Arnarlax in Bildudalur is the largest salmon farming company in Iceland after the merging of Arnarlax and Fjardalax in 2016. The major owner is the Norwegian company SalMar with 59% shares. The company has licenses to produce 23,700 tonnes. Arctic Fish started farming of rainbow trout in Dyrafjordur in 2012 but has since 2016 farmed salmon. Arctic Fish has three subsidiaries, Arctic Sea Farm, Arctic Smolt and Arctic Oddi and is owned by Norway Royal Salmon, Bremesco Holding and Novo. The company has licenses to produce 25,300 tonnes. Laxar fiskeldi started salmon farming in

Reydarfjordur in 2017. The company is owned by the Norwegian company Måsøval Fiskeopdrett AS and several others. The company has licenses to produce 10,000 tonnes. Fiskeldi Austfjarda (Ice Fish Farm) started rainbow trout farming in Berufjordur in 2013 and as Arctic fish they changed to salmon farming. The company has licenses to produce 20,800 tonnes. The company was owned by MNH Holding AS and the Icelandic founder, but recently Måsøval became the majority owner of the company and according to press releases they do not exclude merging the two companies operating in the Eastfjords. Finally, Islandsbleikja has five stations in Reykjanes, Ölfus and Öxarfjordur. Salmon is farmed in a land-based flow-through station in Öxarfjordur and the smolt is produced in Ölfus. The company also produces Arctic charr. Islandsbleikja is owned by Samherji and is licensed to produce 3,000 tonnes salmon and/or Arctic charr in Öxarfjordur. Export of salmon eggs by the company Stofnfiskur is also worth mentioning. Stofnfiskur is globally one of the biggest producer of salmon eggs with a yearly production capacity of 200 million eggs. The broodfish farm has been operating since 1991.

The growing aquaculture industry in Iceland has seemingly had a positive impact on the local communities in the rural areas. The total population has been declining in recent decades both in the Westfjords and Eastfjords due to the decreasing fisheries. Young people have tended to move to the capital area where the job opportunities are broader. Now when the growing aquaculture companies and supporting industries offer new jobs in different sectors, this development changes resulting in a steady increase in population in these areas (see Figure 11). This impacts on the local infrastructure such as municipality services and schools, providing new jobs in the servicing sectors as well. The establishment of Arnarlax in 2009 with the main premises in the village Bildudalur clearly illustrates this.

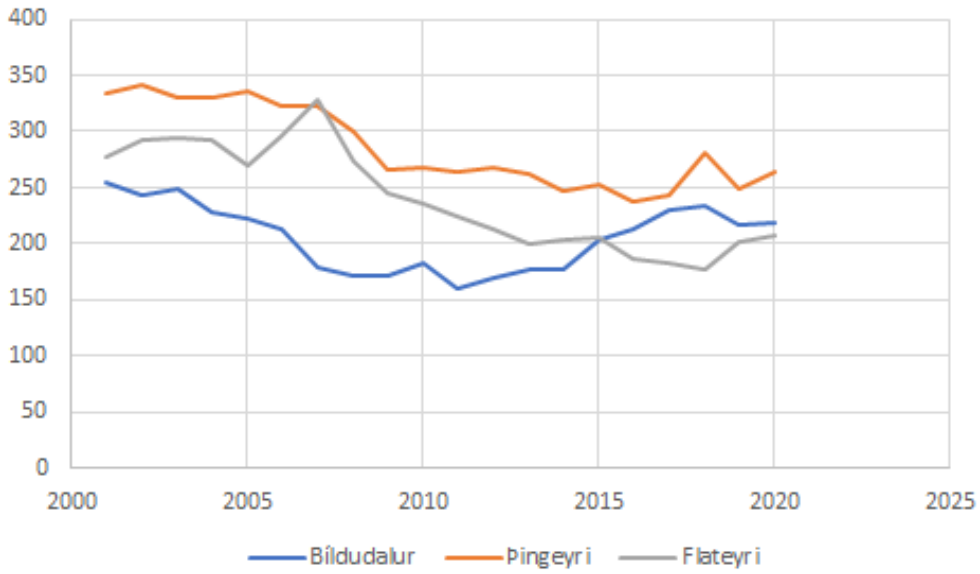

Figure 11 The graph shows the development of the population in three villages in the Westfjords; Bildudalur, Thingeyri and Flateyri 2001-2020 (Statistics Iceland). Arnarlax with the main premises in Bildudalur was founded in 2009.

4.2 Aquaculture policy

The Icelandic government supports the development of the aquaculture industry and see fish farming as a growing industry providing opportunities for greater employment, but requires that the industry

must be developed with the utmost caution not to threaten biological diversity (Agreement, 2017). The growing salmon industry supports the development of the remote areas in the Westfjords and Eastfjords and provides a new pillar to the Icelandic economy. However, much controversy exists not least concerning environmental and ecological effects.

The ecological and environmental impacts of salmon farming in sea cages has been debated by owners of salmon rivers, environmental protection groups, sport anglers and landowners. The main concerns involve possible escapes of farmed salmon and the impact on wild salmon stocks, sea lice issues, eutrophication, and alteration of natural habitats for other species. Moreover, the visual effect of sea cages has been debated.

The natural conditions for sea cage rearing are considered fairly good in Icelandic fjords, even though rough weather conditions and ice have caused problems on a few occasions. However, to protect salmon rivers and the wild salmon only certain specified coastal areas are open for salmon farming, mainly in the Westfjords and Eastfjords. This decision was made in 2004 with advertisement no. 460/2004, see Figure 12. The coastline in South Iceland is not suitable for aquaculture. Remaining areas in West and North Iceland have not been open for salmonid aquaculture due to the salmon rivers in these regions.

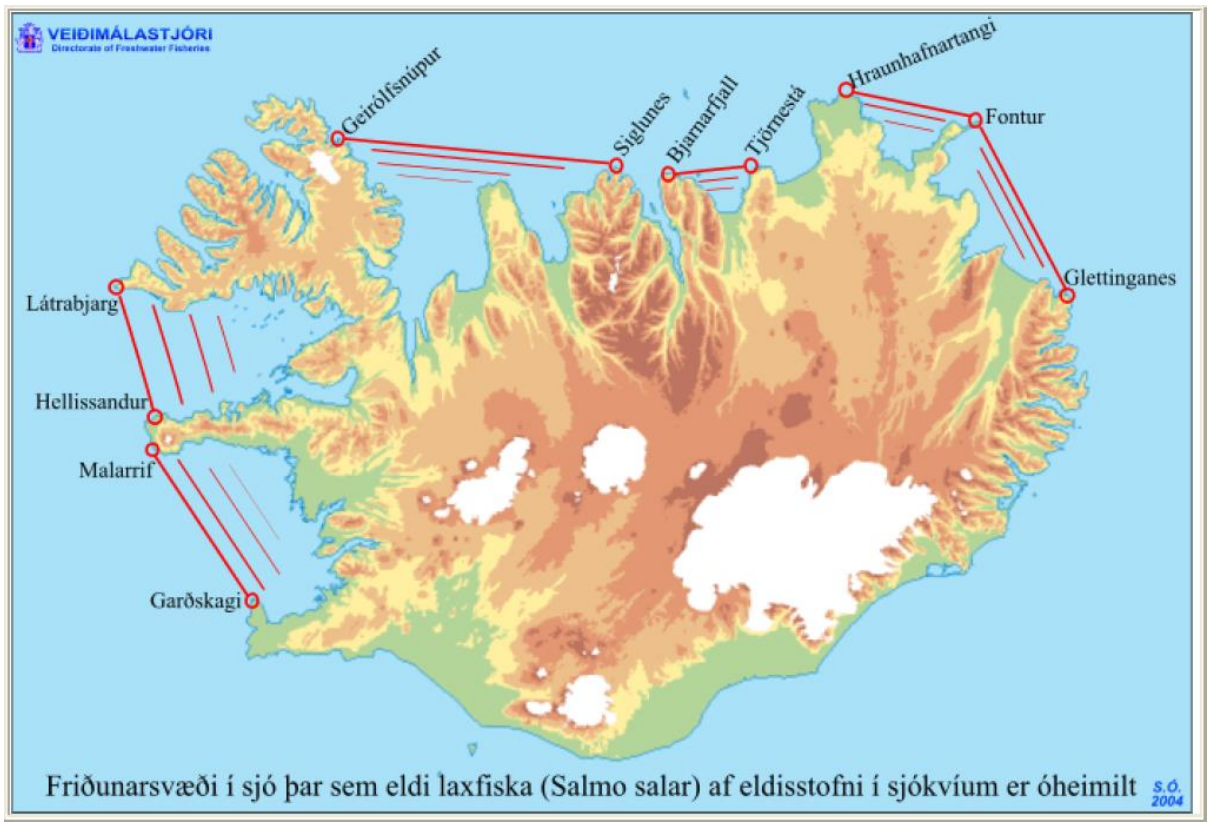

Figure 12 Salmon farming in sea cages in Iceland is only allowed in the Westfjords and the Eastfjords. Areas marked with red are closed to salmon farming (Advertisement no. 460/2004).

The Marine and Freshwater Research Institute (MFRI) is responsible for estimating the carrying capacity of the fjords designated for salmon farming, to ensure that the salmon production is environmentally responsible. The carrying capacity is mainly based on calculation of the risk of genetic deterioration of the wild salmon populations (Olafsdottir *et al.,* 2017). The MFRI recommended in 2017

that a maximum of 71 000 tons of fertile salmon should be farmed in Iceland seawaters, thereof 50 000 tons in the Westfjords and 21 000 in the Eastfjords (Johannsson, *et al.,* 2017). This was increased in 2020 to 106 500 tons, 64 500 in the Westfjords and 42 000 in the Eastfjords (Advertisement no. 562/2020).

4.3 Regulation of salmon farming

The salmon farming in Iceland is governed by the Ministry of Industries and Innovation and the Ministry for the Environment and Natural Resources. The main authorities are the Marine and Freshwater Research Institute (MFRI), the National Planning Agency (NPA), the Icelandic Food and Veterinary Authority (FVA) and the Environment Agency of Iceland (EAI). Figure 13 gives a simplified illustration of the main authorities and legislation.

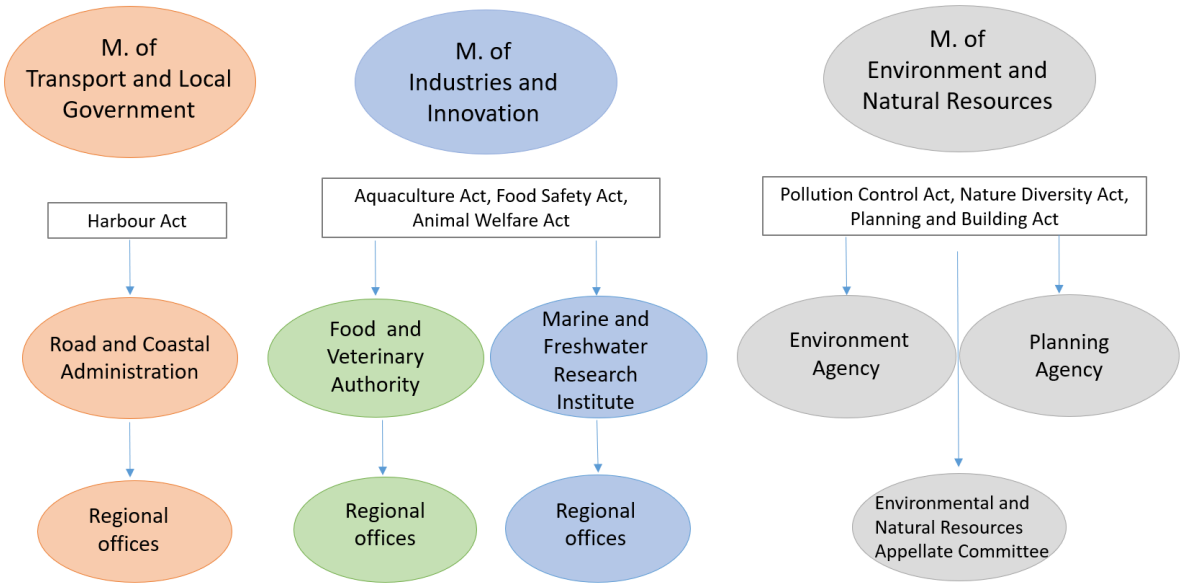

Figure 13 Main authorities and legislation for aquaculture in Iceland. Only sector-specific legislation is included, i.e. authorities and legislation pertaining to e.g. work safety are excluded.

The main legislation, the Act on fish farming no. 71/2008 is from 2008. The Act has been amended in recent years because of the growing salmon industry and several changes have been made not least since 2018. The changes have been on allocation of production sites, the carrying capacity assessment of the fjords, risk assessment of genetic impact on wild stocks, internal control, publication of information and tariffs. The related regulation on fish farming no. 1170/2015 has been changed four times since 2016. The changes have mainly been related to insurances, certification of production facilities, production sites and their distance from salmon rivers.

Other legislation concerning aquaculture in Iceland are: Act on Health and Pollution Control no. 7/1998 and related regulation no. 941/2002; Act on protection against fish diseases no 60/2006 and related regulation no. 300/2018; Act on handling, processing and distribution of seafood products no. 55/1998; Act on the organization of ocean and coastal areas no. 88/2018; Act on environmental Impact Assessments no. 106/2000, regulations no. 660/2015 and no. 713/2015 about assessment of environmental impacts; Act on hygiene and pollution control no. 89/2018; and Act about the Appellate Committee on Environment and Natural Resources no. 130/2011. The latter grants all those who have

legitimate interest, the right to appeal the decisions previously made by the NPA and FVA, involving the granting of environmental and operating licenses. Therefore, government decisions such as licenses and disputes regarding other issues in the field of environment and natural resources can be appealed to the Appellate Committee on Environment and Natural Resources. The Appellate Committee is independent in its work.

Due to appeals, the Appellate Committee decided in September 2018 to withdraw two issued operation licenses in Patreks- and Talknafjords affecting the farming plans of Arnarlax and Arctic Sea Farm in the Westfjords. The decision was made due to a lack of alternative plans in the companies´ environmental assessment reports that had been accepted by the Planning Agency. In this case the juvenile production was ready to be put out in the sea cages based on the issued licenses. The Icelandic Parliament decided in October 2018 on amendments to the Act on fish farming no. 71/2008 allowing the Icelandic Minister of Fisheries and Agriculture, to grant a temporary operation license for a maximum of 10 months, during which fish farming companies are supposed to take appropriate measures to correct shortcomings in their initial operation license. The companies added alternative plans to their environmental assessment reports and received new licenses for Patreks- and Talknafjords in 2019. Without the amendment the withdrawal would have been very costly for the companies, and of public concern as they had received the necessary licenses. This example illustrates the need to improve the licensing procedure to ensure that appeals are put forward earlier in the process to prevent costly mistakes.

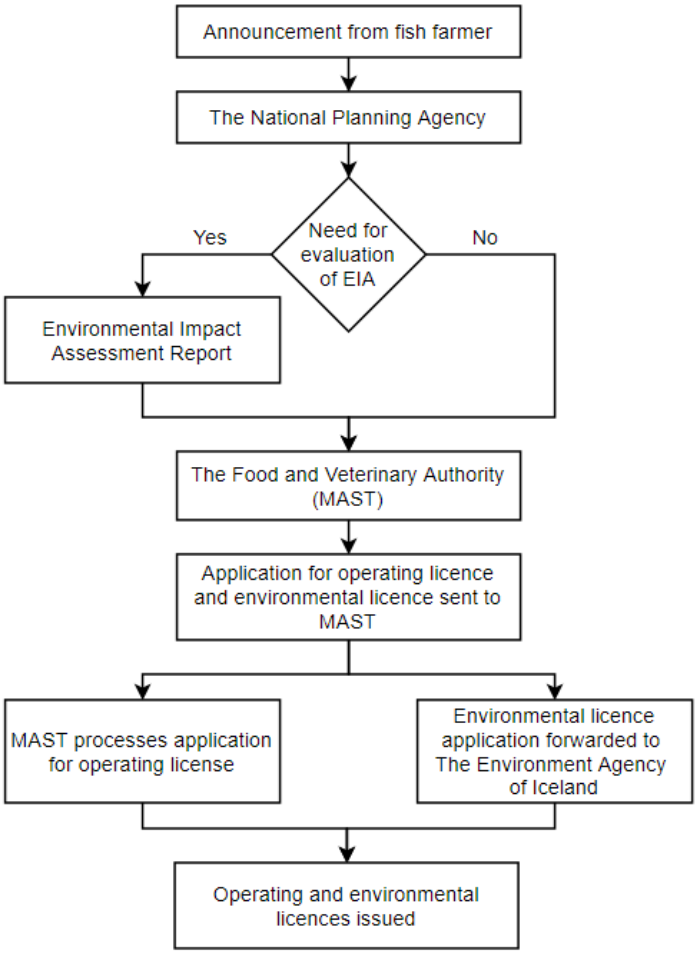

Figure 14 The procedure for salmon farming licensing in Iceland. (Figure: Bjarnason & Magnusdottir, 2019)

MRFI is responsible for carrying out the carrying capacity assessment and for research and development projects and advice. NPA is responsible for decisions regarding the companies´ announcements and reports regarding planning of new fish farms and their expansions together with their environmental impact assessment reports. Two types of licenses are required to establish and run fish farms in Iceland, an operating license from FVA and an environmental license issued by UST. After the notification process and if necessary, the environmental impact assessment report being accepted by NPA, the companies can apply for the operating and environment licenses, respectively. Figure 14 shows the procedure for licensing. The salmon farming license process is described in more details by Bjarnason & Magnusdottir (2019).

According to the regulation on fish farming no. 1170/2015 there are strict requirements about insurances and financial capacity of the fish farming companies. Before putting up a new site at sea, a site assessment must be carried out which complies with requirements made in the Norwegian standard NS 9415:2009. All equipment shall fulfill the standard. A site audit shall be carried out by an accredited inspection body. This is also required when inspections and repairs are made. If fish escapes from the farm this shall be reported immediately and the company shall proceed according to its contingency plan. The minimum distance between production sites of different companies is in general 5 km. The fallowing period is minimum 90 days.

The use of vaccines and antibiotics is not permitted without the approval from FVA and a diagnosis must be made by a veterinarian or an approved laboratory before treating farmed animals with antibiotics. The official national fish health monitoring program is responsible for the surveillance and screening of salmonid brood fish to prevent the vertical transmission of pathogens and control the process when diseases are found in farmed fish.

The control and monitoring operations include the internal control of the companies on all aspects of the production chain; production, losses, feed, use of chemicals and drugs, waste, failures, complaints, monitoring environmental parameters, fish health, quality and security of equipment, security and health of workers, training of employees and social responsibilities. The national environmental control is carried out by EAI and FVA is responsible for the animal health control and the annual control to secure the farms have fulfilled the requirements according to laws and regulations.

In summary, salmon farming in Iceland is a new industry, with a limited production and few companies. It is however a fast-growing industry, and government policy is directed at balancing the desire for increased production with environmental caution, particularly related to interference with wild salmon. The governance system is developing fast, continuously adapting to new issues and improving the application and operation procedures, as illustrated by the introduction of temporary licenses as a measure to give companies a chance to improve shortcomings in their original license. By only allowing production in a few dedicated fjord systems and a preset limit for production in each fjord, the regulation of production growth is predictable, for both the industry and its opponents.

5 Salmon farming in Norway

5.1 Production of farmed salmon in Norway

The Norwegian salmon farming had its breakthrough in the 1970s, both when it comes to production technology and commercialization. Yet, the roots can be found much earlier. There are several examples of attempts to farm salmon and sea trout in marine waters before the 1900s, and in the years after there were several try-outs of pond-based trout farming (Møller & Haaland, 2014a). The Norwegian production of anadrome fish was 200 tonnes in 1962, and less than 1 000 tonnes in 1969. Around 1970, the first sea-based net-pens were introduced, leading to successful attempts at farming Atlantic salmon, which in 1978 surpassed rainbow trout by volume (Møller & Haaland, 2014b). In 1980, the total production of farmed fish was 8 000 tonnes, which increased to 150 000 tonnes in 1990, mainly as a result of new licenses being granted; technological development, improved feeds; and better supply of fry (Kolle, 2014). The early 1990s were characterized by financial down-turns and many bankruptcies, which in turn led to a concentration in ownership and restructuring of the industry (Hovland, 2014). This was followed by heavy industrialization of the industry, resulting in an increasing number of larger corporations listed on the stock market in the 2000s (Hersoug, 2014a; 2014b).

The yearly production of salmon increased steadily, until stalling around 1.3 million tonnes from 2012 due to challenges with sea lice and regulatory responses to these challenges. Still, in volume salmon represents almost 95 % of the total aquaculture production (see Figure 15). In 2018, the export value of salmon and trout was 67.5 billion NOK (5.9 billion EUR). This constituted more than 70 % of the value of the total seafood exports, which also includes wild caught marine fish (NDoF, 2017).

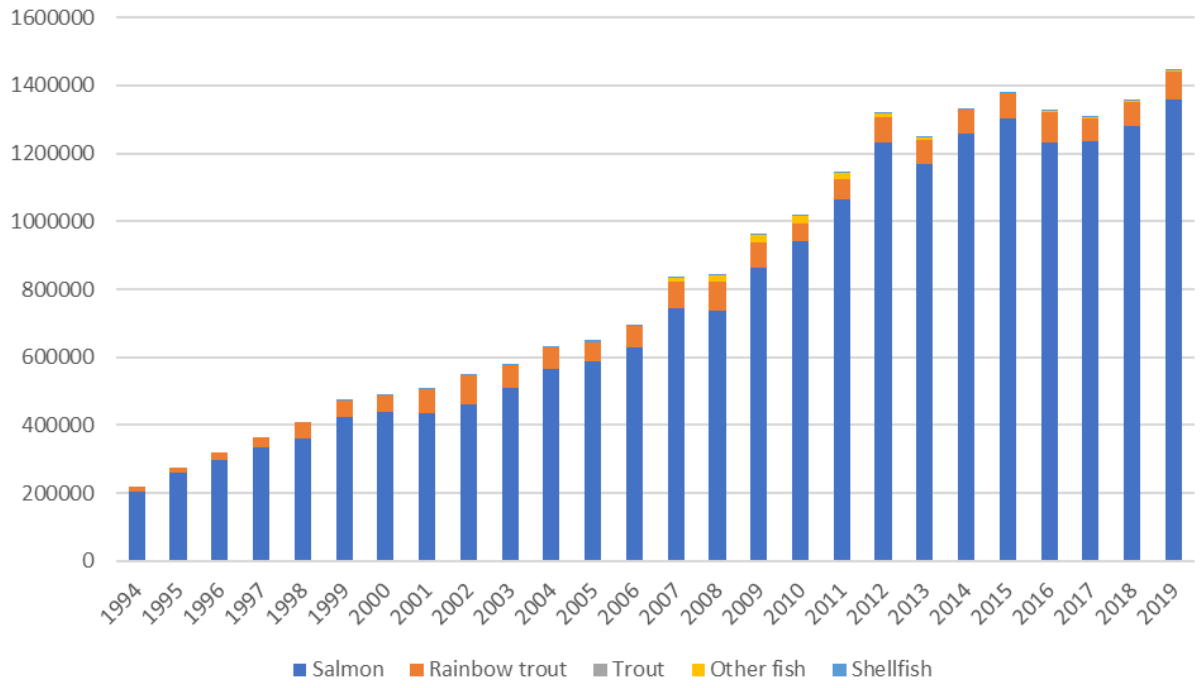

Figure 15 *Changes in aquaculture production volume (metric tonnes) in Norway. Salmonid species (salmon, rainbow trout and trout) constitute roughly 99% of the production volume. Other fish include cod, arctic char, halibut, and other species. For shellfish, the dominating specie is blue mussels, but the category also includes other mollusks, crustaceans, and echinoderms. In addition, smaller amounts of macro algae are grown, varying between 50 and 178 tonnes the last five years (NDoF, 2020).*

The salmon farming industry has seen heavy restructuring the last decades. The small-scale family-owned businesses that was expected to provide local employment when the coastal fisheries were declining, has developed into a high-tech industry, dominated by national and multinational corporations. Today, there are about 100 companies that farm salmon or trout in Norway, owned by 80 different actors (NFD, 2018). Even though quite a few companies are still locally owned and operated, companies listed on the stock exchange now control most Norwegian salmon farms, illustrating that this has become a capital-demanding industry. In 2019, the ten largest enterprises controlled around two thirds of the production volume (NDoF, 2020). Figure 16 shows the share of production capacity for each of the ten largest companies by the end of 2017. In addition, several of the largest companies own shares less than 50 % in other companies.

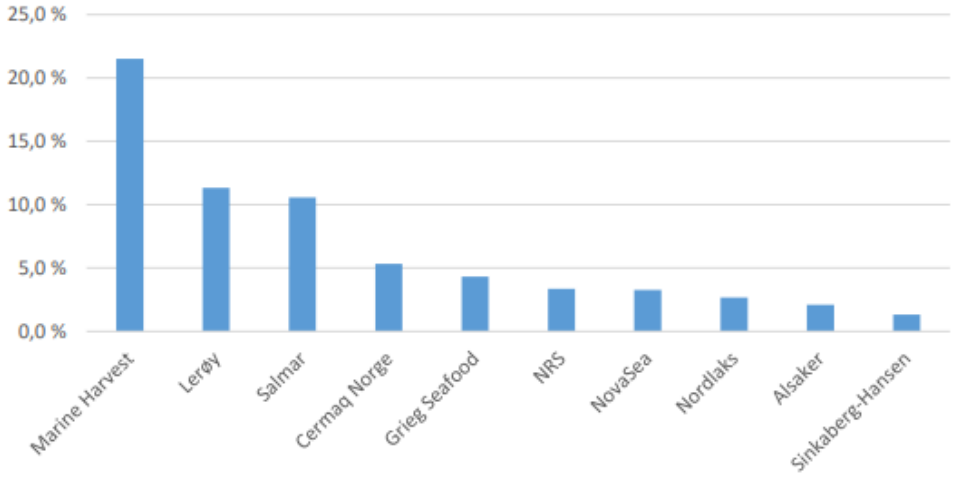

Figure 16 Share of production capacity for the ten largest companies by end of 2017. Marine harvest is now Mowi. (Source: The Ministry of Trade and Fisheries)

With the concentration of ownership, as well as technological innovations in the industry, the structure of the production siting has been altered as well. Production is taking place along the west coast from the south all the way to the northeastern border. The last decades, the number of sites for grow-out production has been reduced from around 1 500 to about 1 000. Due to fallowing requirements, around 600 are in use at any given time (NFD, 2018). As the number of localities has been reduced, the production at each site has increased. This development has led to a growing need for relocating fish farms to areas suitable for production of larger biomasses. As municipal spatial plans are central in this matter, this has in turn has led to a demand for updated local plans.

5.2 Aquaculture policy

From its beginning, salmon farming was believed to be important for the development of rural areas, which means that aquaculture has at times been particularly the subject of political interest. The stated purposes of each act and regulation give an impression of what considerations prevailed when the laws were passed. Roughly speaking, the first regulations focused on *who* should be allowed to farm and *where* the operation should take place, and the chosen measure to be used was licensing, combined with limited production volume (Hersoug, 2015).

Production licenses are limited and were earlier granted in special license allocation rounds, where producers would have to apply for a license based on stated selection criteria. The shifting political

ambitions for the salmon farming industry can be seen in these criteria. In the 1970s, the licensing system operated liberally and more like a registration system (Hersoug *et al.,* 2019), but since the 1980s licenses have been allocated infrequently and with varying criteria for receiving a license. For instance, in 1989, 30 licenses were granted, but only in North-Norway. Between 1985 and 2002, there were no ordinary licensing rounds. The five following allocation rounds all had different criteria to be fulfilled, as categorized by Hersoug *et al.* (2019), who identify a marked change over time: While the first four rounds were concerned with who should obtain a license and where, the 2013 round was much more concerned with environmental sustainability, or *how* the operations were to be performed. Figure 17 illustrates the different concerns addressed in these allocation rounds.

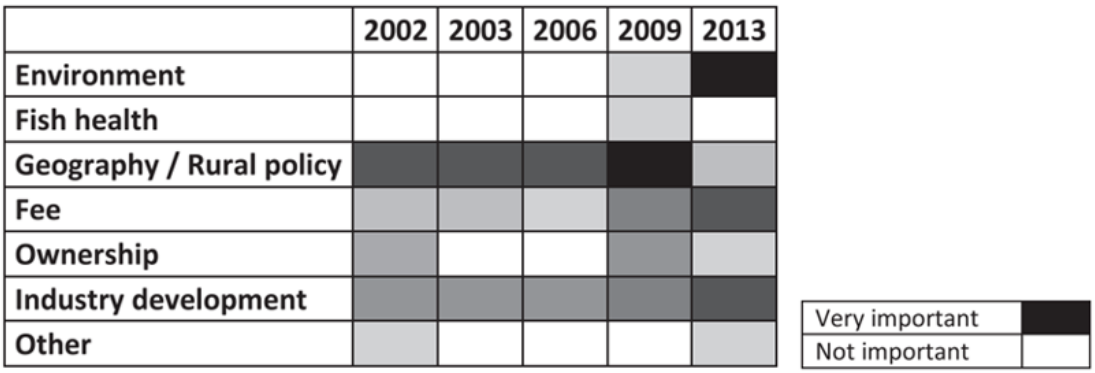

Figure 17 The main concerns addressed in the most recent license allocation rounds. (Figure: Hersoug et al., 2019)

After 2013, environmental concerns have received even more attention in policy documents. Arguing that the system with license rounds led to less predictability, because the criteria would be different in each round, the Government started the development of a new system for controlling industry expansion. The 2015 White paper on predictable and sustainable growth in Norwegian aquaculture states that environmental concerns will be the most important criteria for the authorities when deciding if further growth will be allowed, and that as a general rule, other concerns will not be given emphasis (NFD, 2015). The main tool in the new system are production areas and environmental indicators, as described below.

5.3 Regulation of salmon farming

The first aquaculture regulations date back to 1973, when the first preliminary Aquaculture Act was enacted, to be followed by the first permanent Aquaculture Act in 1981. Today, the aquaculture legislation in Norway is quite comprehensive. The Aquaculture Act of 2005 sets the premises for all aquaculture activities, while the Pollution Control Act, The Food Safety Act, the Animal Welfare Act and the Harbour and Fairways Act are all among the important sector acts. The Nature Diversity Act places specific requirements on all public authorities making decisions that will have impact on nature. In addition, there are several more detailed formal regulations pertaining to specific areas of production, such as licencing, technical standards for salmon farms, running operations, or increasing production volume.

The production licenses grant the right to produce a certain amount. Production growth was earlier regulated by issuing new licenses at irregular intervals. Now, a new system with production areas

determines increase or decrease in production based on environmental performance, which is to be assessed every two years. So far, the only indicator determining production growth or decline is salmon lice, which are deemed one of the biggest threats to wild salmon in Norway. In 2020, two of the 13 production areas (see Figure 18) had to reduce production. In nine areas, producers could apply for increased production volumes, while in the last two, the production was to be held at the current level. If production can be increased, the Ministry can announce new production licenses or offer increased volumes for existing licenses. In both cases, producers will have to pay for the right to increase production.[2] These revenues will then be redistributed by the Aquaculture Fund to municipalities and counties with approved aquaculture sites at sea. From 2016 – 2019, the municipalities received 80 % of the revenues from the sale of production capacity. This will change from 2022, when the new production fee will be introduced, and the municipalities will receive 40 % of the sales revenues and a share of the production fee paid by the industry.[3] As such, the Aquaculture Fund is an answer to calls for a larger share of the benefits to the local communities where salmon farming takes place.

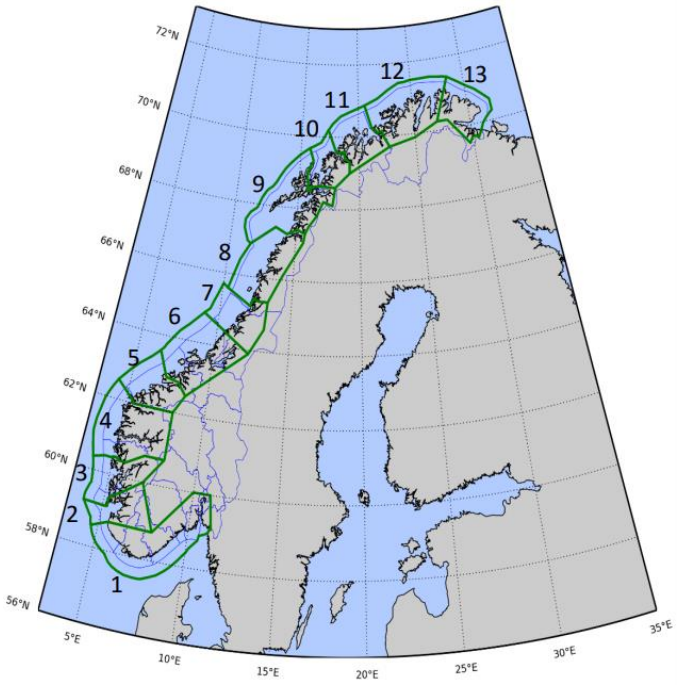

Figure 18 The Norwegian coast is divided into 13 production areas. (Image: The Ministry of Trade, Industry and Fisheries).

The governance of the aquaculture industry is quite specialized. Figure 19 provides a simplified overview of the ministries and underlying agencies, as well as planning authorities, which are involved in various ways in the governance of the aquaculture industry. The figure also shows the most central laws that the various administrative authorities are responsible for making decisions according to.

[2] Regulation on production areas for aquaculture (FOR-2017-01-16-61).

[3] The Norwegian Directorate of Fisheries: https://www.fiskeridir.no/Akvakultur/Nyheter/2020/0920/Utbetalinger-fra-Havbruksfondet [Payments from the Aquaculture fund]. Accessed 22. December 2020.

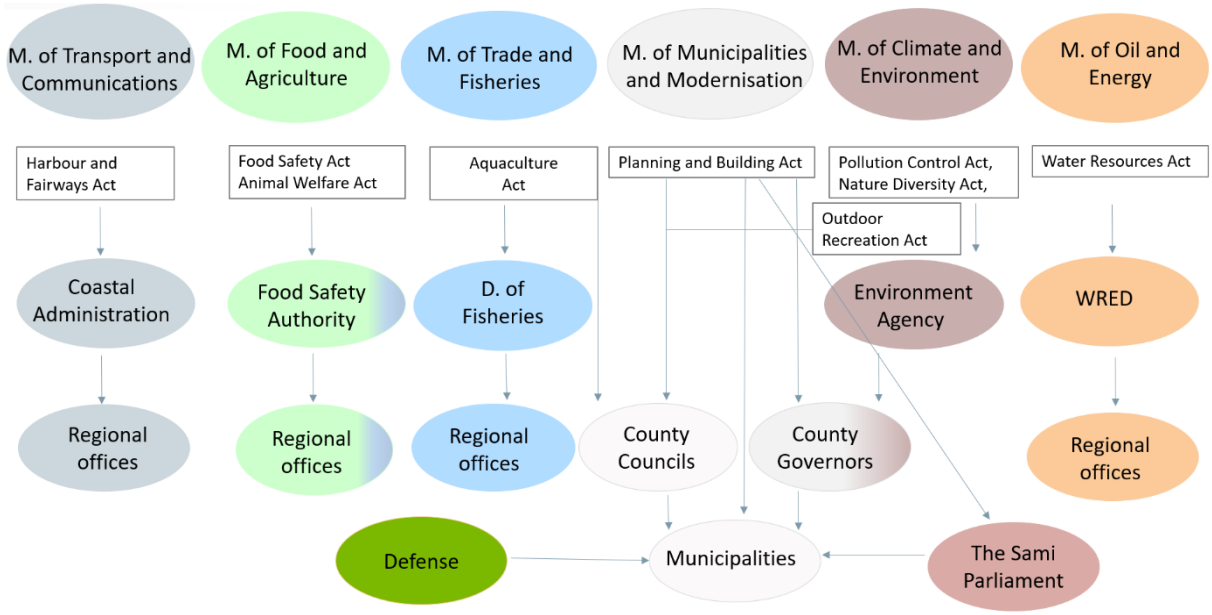

Figure 19 *Main authorities and legislation for aquaculture in Norway. Only sector-specific legislation is included, i.e. authorities and legislation pertaining to e.g. work safety are excluded.*

When it comes to licensing, the Norwegian management of aquaculture is based on a two-step system. The first step is acquiring a license to engage in salmon farming, or a *production license* (formerly termed a concession). There are two ways of getting a production license, either by applying to the Norwegian fisheries authorities for a new licence when these are allocated, or by buying an existing one from another producer. This production license will then subsequently become a part of the *site license*, i.e. the right to produce a given amount at a specific site. The site licensing involves several state sector agencies as well as both regional county and local municipal authorities.

The County Authorities, who have been delegated the authority to grant site licenses pursuant to the Aquaculture Act, coordinate the application process and functions as a one-stop-shop, as illustrated in Figure 20. However, the Aquaculture Act requires that an authorization has been granted in accordance with the Food Safety Act, the Pollution Control Act, the Harbour and Fairways Act and the Water Resources Act, before a license can be granted under the Aquaculture Act. In practice, this gives the sector authorities (the Norwegian Food Safety Authority, the County Governor, the Norwegian Coastal Administration and the Norwegian Water Resources and Energy Directorate) a de facto "veto right" when it comes to aquaculture site licenses.

According to the “Regulation on coordination and time limits in the processing of aquaculture licence applications”,[4] the processing of licence applications should take maximum 22 weeks. Time limits are specified for each stage in the process. For instance, there is a twelve-week time limit for public hearings and comments from the host municipalities, after which the state sector authorities have a four-week deadline to make their decisions pursuant to the relevant sector legislation.

Currently (October 2020), there is a public hearing regarding suggested changes to the licensing regulations on pollution control. The suggested change involves replacing the requirement of a

[4] FOR-2010-05-18-708

separate discharge permit pursuant to the Act on Pollution Control with a list of requirements that need to be fulfilled before a site license can be granted.

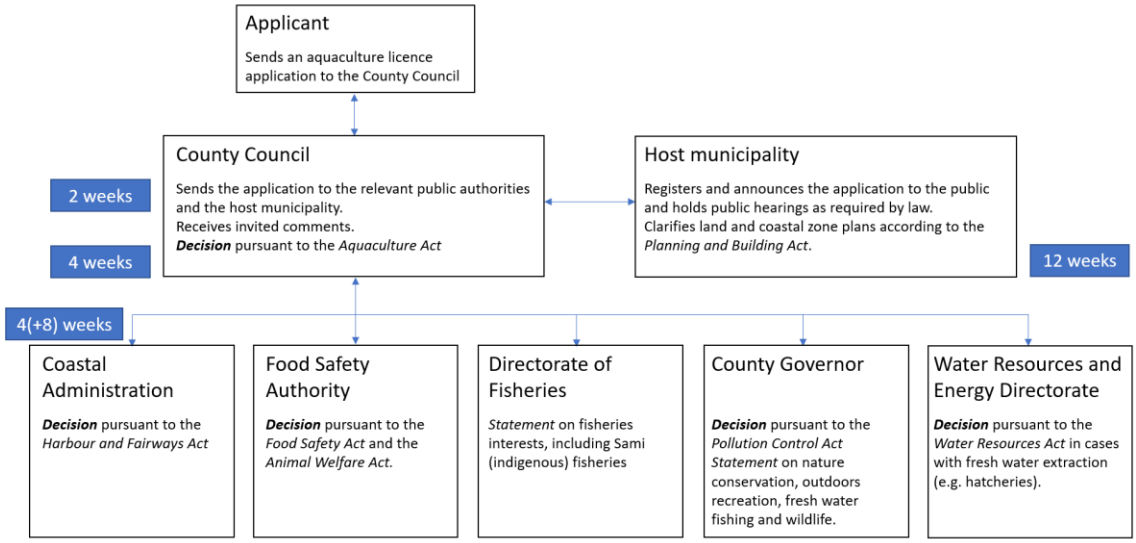

Figure 20 Illustration of the site licensing process in Norway.

The Aquaculture Act states that site licenses may not be granted in contravention of adopted conservation measures relating to nature conservation or cultural heritage, or adopted land use plans pursuant to the Planning and Building Act, unless the conservation or planning authority gives its consent. This gives the Norwegian local municipalities an important role in siting aquaculture, as they are the planning authority for near shore sea space (within 1 nautical mile from the base lines). The question of prioritizing aquaculture or not in municipal spatial planning, is largely a local political issue. The local authorities are in principle free to facilitate aquaculture should they choose to, and they are free to choose not to (Myklebust, 2016).

The operation phase is regulated pursuant to among others the Aquaculture Act, the Food production Food Safety Act, the Animal Welfare Act, the regulation on operating aquaculture plants,[5] and the regulation on requirements regarding technical standard for floating aquaculture plants.[6] In addition, some requirements may be found in the individual licenses or permits, mostly in the discharge permits granted by the County Governor (Mellbye, 2018).

The main requirement for the running of fish farms, is for the operations to be *responsible* in technical, biological, and environmental manners, and in aspects pertaining to animal health and welfare.[7] This general requirement implies that it is not enough for the companies to satisfy the concrete regulations in force at any given time, they also need to consider the consequences of their actions and if their practices satisfy the requirement of responsibility in all of the five regards mentioned (Mellbye, 2018).

[5] FOR-2008-06-17-822

[6] (NYTEK-forskriften): FOR-2011-08-16-849

[7] Aquaculture Act § 10, FOR-2008-06-17-822 § 5.

Important instruments to ensure responsible operations, are found in the regulation on internal control systems for aquaculture.[8] The monitoring and control system is based on a combination of industry self-reporting and formal inspections by the supervising authorities. A monthly report needs to be submitted on stocking of fish, biomass, slaughter, mortality, and feed consumption. Out of these parameters, the biomass is the most important when it comes to the authorities' supervision, as the licences are based on maximum allowed biomass, both for each production licence and for each site. In addition to the biomass restrictions, there are requirements regarding density and number of fish. Density of fish needs to be responsible and adapted to water quality, the behavioural and physiological needs of the fish, health status, mode of operation and feeding technology,[9] but there is no method for calculating the density of fish, nor any rules on sanctions related to these requirements. The number of fish per production unit, on the other hand, is clearly specified: The maximum allowed number of fish per net pen is 200 000 (ibid.).

Traditionally, one of the main challenges in the Norwegian salmon farming has been escapes of fish. Therefore, the regulations emphasize the operators' obligations to prevent escapes, to immediately report escapes to the Directorate of Fisheries, and to recapture fish within 500 meters from the farm. Requirements to prevent escapes is further elaborated in a separate regulation which aims to prevent escapes by securing a satisfactory technical standard on the fish farms.[10]

Regarding sea lice, the companies bear the main responsibility to control their own farms and make sure that they do not exceed the lice limits. The regulation on sea lice abatement[11] requires weekly reporting on sea lice counts. The reports must contain sea temperature and the number of adult female salmon lice, and if relevant, treatments against sea lice, the active substances used and their amounts, and results of sensitivity analyses and suspicions of resistance.

In summary, the governance system for Norwegian salmon production is complex. It has a long history, dating back to the 1970s, and has seen both incremental and more radical changes to the regulatory toolbox. Today, the industry is made up of a mix of small, locally owned companies and large, transnational corporations. Production is taking place from the south to the northeastern coast of the country, and new production technologies are introduced (both on land and out at sea) as a response to governance interventions to ensure the environmental sustainability of the industry. Compared to the other countries, the most striking feature of the Norwegian system-to-be-governed, is the huge production volume, while the role of the municipalities in siting aquaculture is a distinct feature of the governance system.

[8] Forskrift om internkontroll for å oppfylle akvakulturlovgivningen (IK-Akvakultur): FOR-2004-03-19-537

[9] Forskrift om drift av akvakulturanlegg (akvakulturdriftsforskriften): FOR-2008-06-17-822

[10] Forskrift om krav til teknisk standard for flytende akvakulturanlegg (NYTEK-forskriften): FOR-2011-08-16-849

[11] FOR-2012-12-05-1140

6 Discussion

What are the lessons we can learn from this comparison? Sea-based cage aquaculture for salmon is to a large extent organized in similar ways in the four countries. The knowledge and technology are to a high degree the same. There is also a pattern that the bigger Norwegian aquaculture companies are owners or part owners in aquaculture companies in the other countries. Another similarity is that in Canada, Iceland, and Norway there are political controversies related to aquaculture, in particular when it comes to environmental effects and aquaculture's impact on wild salmon stocks, which is not an issue in the Faroes. In Canada and Norway, the controversies also have a strong social dimension related to local and indigenous rights and sharing of benefits.

The aquaculture activities are strictly regulated in all the countries. All the countries acknowledge uncertainty and govern based on risk consideration and risk management. In addition, a considerable burden of proof has over the years been transferred to the industry.

Despite the similarities there are differences in the aquaculture governance in the four countries, yet with some striking system similarities among the two most complex governance systems, Canada and Norway, in the sense that both have elements of multi-level governance and polycentrism. In Canada and Norway, the governing systems must deal with complex systems-to-be-governed, while in the Faroe Islands and Iceland the systems-to-be-governed are less complex. The way national systems have structured and organized the aquaculture governance systems reflects both national traditions, different concerns, the scale of the industry and the power of the conflicting interests.

Canada, as a federal state, has in this respect the most complex aquaculture governance system, that also deals with a complex system-to-be-governed. In Canada, both the federal and provincial level govern aquaculture, with differences between provinces. In Pacific Canada, for example, it is a controversial aspect that the salmon farms use an alien species, while in Atlantic Canada the farmed salmon may mix with the local wild stocks if escapes occur. The relationship to First nations and environmental impact are urgent issues to be dealt with. Due to the complexity, the Canadian aquaculture governance system can be labeled as polycentric (Carlisle & Gruby, 2017). The federal organization can also be regarded as nested, with its multi-level character where independent authorities at different levels are operating within a hierarchy (Wyborn & Bixler, 2013). A characteristic of polycentric systems is that decision-making can take place in different autonomous bodies, more or less coordinated and integrated. With respect to Canada, the scale and the organization of aquaculture governance at federal and provincial levels on two different coasts with rather different challenges may indicate that coordination and integration has to take place on a provincial, political level and not so much on the federal and bureaucratic level. However, how much coordination that is required may depend on the scale of the industry.

Norway share some of these traits. As the illustration of the governance structure indicate, there is an element of polycentrism in Norway, with autonomous bodies making decisions according to specific sector laws, but due to the fact that the country in a unitary state with one legislator body (Parliament) there is also specific sector polices in place that guide the regulatory actions. The specific aquaculture policy coordinates and sets ambitions, but there will be both political and administrative tradeoffs, between the different authorities. The decision-making on siting is nested, with municipalities and counties involved, in addition to the sector authorities. In particular, the Norwegian use of municipal coastal zone plans, where the municipality can decide whether (and where) to designate areas for

aquaculture production, stands out from the other countries. From the industry's point of view the polycentrism and nested institutions may be seen as negative, but due to the scale of the industry and that the activity is spread along the coast, the polycentric structure can also be considered a strength, as it makes it possible to make adaptations according to different needs on a regional and local scale.

Iceland and the Faroe Islands are in comparison more monocentric. Partly due to much less complexity and fewer conflicts, the field is easier to handle. Although the problems related to the industry are quite similar to the ones in Canada and Norway, fewer interests are in conflict, and the industry becomes governable in the less complex governance structures in the two countries, also because the scale of the industry is smaller.

The main traits of the governance interventions also have a lot in common. All countries require a license to produce, there are environmental monitoring regimes in place, and the producers are required to report on the same parameters, such as biomass, sea lice counts, disease management, and a range of other statistics. Still, there are differences in the countries' toolboxes, which is a result of the interaction between the governance system and the system-to-be-governed in the different countries, with their different societal and environmental conditions. Table 2 summarizes some of these similarities and differences in the instruments applied. For instance, Canada, Iceland, and Norway are regulating the production volume though Maximum Allowed Biomass (MAB), while the Faroese have a more dynamic approach based on the veterinary and environmental performance of the companies on production sites. The new Norwegian system for regulating growth, however, has a more dynamic and performance-based approach, though on a bigger scale (within the 13 production zones, rather than site-based).

While Canada, the Faroe Island and Iceland have time limited licenses, there are no time limits in Norway. Still, in the Faroe Islands, the licenses are more or less automatically extended if performance is good. As such, the time limit provides the farmers with somewhat predictability in planning their production, as long as the set conditions are fulfilled. In Canada, on the other hand, the time limits also represent a source of great unpredictability to the farmers, who have experienced that strong opposition towards salmon farming have resulted in the non-renewal of the tenures.

In Iceland, the regulatory response to the opposition towards sea-based salmon farming, was to adopt instruments to reduce the risk of interference of farmed salmon with wild salmon. This is done by only allowing salmon farming in a few designated areas with little to no adjacency to wild salmon rivers, and to estimate the carrying capacity in each of these areas. This is a rather recent regulation, adopted for a new industry, hence a similar intervention could not have been introduced to govern the established industry in Canada, or in Norway with its 1000 existing production sites all along the coast. On the other hand, in the Faroe Island, a fundamental change with the establishment of 22 management zones and a one-company-one fjord approach was introduced as a response to the ISA disease, involving both regulatory and voluntary changes. This illustrates the willingness of the system-to-be-governed to accept radical government interventions in a situation of crisis, and as such the governmentality of the Faroese system.

The instruments to control the production of the companies are rather similar across all countries, but in the Faroese system, there is a stronger link between the performance under one production cycle and what the authorities allows in the next.

Table 2 Main instruments in governing of salmon production in four countries

	Canada	Faroe Islands	Iceland	Norway
REGULATORY RESPONSIBILITIES				
National	Policy making Regulatory (BC) Licensing (BC)	Policy making, Develop regulations Licenses and production sites	Policy making, Develop regulations Licenses and production sites	Policy making Develop regulations Announce and grant production licenses
Regional	Policy making Regulatory Licensing Tenure granting	None	None	Coordinate and grant site licenses Sectoral authorizations and "veto"
Local	None	None	None	Coastal zone planning/dedicating area for aquaculture SEA
GOVERNANCE INTERVENTIONS				
Licenses				
Duration	5-20 years	Max 12 years	10-15 years	No time limit
MAB	Yes	No, dynamic	Yes	Yes
Environmental tools	Planning, reporting and audits Environmental assessments	MZ No new licenses Environmental baseline assessments and subsequent assessments	No-go-zones (wild salmon) Designated production fjords, with MAB based on carrying capacity EIA Public consultation	No-go zones (wild salmon) Production zones with environmental indicators Environmental assessments
Societal tools	Occasional public consultations and feedback, particularly for environmental assessments	Public consultation Limitation on foreign ownership	Public consultation, particularly for environmental assessments	Occasional processing requirements, local and Sami ownership in license allocation rounds Incorporated in CZ plan Public consultation in CZ plan and site licensing Aquaculture Fund
Operations				
Environmental tools	Reporting and audits	Technical standards Production plans Sea-lice counts by third party Self-reporting procedures Audits	Technical standards Self-reporting procedures Audits	Technical standard Self-reporting procedures Environmental assessments Audits
Societal tools	HSE reporting	HSE reporting	HSE reporting	HSE reporting

The table above illustrates that despite of different ecological and social systems-to-be-governed and differences in the governance systems, we see fairly similar toolboxes used to regulate a rather similar activity. A question for further research is whether the use of similar tools to regulate a similar activity

will result in conducting the art of governing differently. One hypothesis is that to deploy the toolbox in quite different contexts, may result in different configurations of the systems-to-be-governed, the governing systems and to different effects. In particular two major issues, scale and complexity, seem to be of importance. Therefore, a trivial, but still important lesson is that despite of the similarities there may be no blueprint for governance that can be used to govern. Governmentality requires local adaptations in relation to scale and complexity, which also is a result of the history of governing an industry.

In this study, we have mainly focused on the institutions and the public governing instruments. To get a full understanding of how the art of governing is conducted, there is need for future research on how the responses from those being governed have feed-backs effects on the governing system (Lemke 2015). The organization of the governing system, how governance is executed and the reception of the actions and feed-back from the stakeholders together constitute governmentality.

Still, this study clearly shows that the complex art of governing cannot be understood as a monocentric exercise of power from the state to the industry. The aquaculture governance systems we describe in this report are hierarchic, but also participatory and flexible. The art of governing seems to unfold in the mutual construction of governing systems and systems-to-be-governed, where the particularities in both systems contribute to the different governing practices. In this respect, how an industry should be governed is not a technical, but a social and political issue.

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