



Mini Cases

Sea-farmed Salmon: Assessing the Impact of a Growing Industry

A Strategy Consultant, looking at the issue of fish farming in Iceland, noted that everyone, it seems, had an opinion on the issue. While the sea-farming of fish had a long history in Iceland it was only recently that huge investments were made – by foreigners – to grow and harvest salmon in Iceland's fjords. It was early 2022 and the Consultant had been asked to assess the advantages and disadvantages of this rapidly growing industry. What were the short-term and long-term impacts, importantly, how could the benefits and the cost of stewardship could be shared?

In 2008, about 232 tonnes of salmon were farmed. In 2021, Iceland was producing 46,000 tonnes, a third more than in 2020. Two fish farms in the Westfjords and Eastfjords accounted for the production, with Arnalax being the largest producer at 23,600 tonnes and Arctic Fish at 23,400 tonnes.¹ Already Iceland's second most valuable fish export, the intent was to increase salmon production to 200,000 tonnes a year in the future. The planned increase in salmon production from 13,000 tonnes a year to 200,000 tonnes a year brought with it the prospect of hundreds of new jobs, a welcome piece of news for the rural Westfjords economy. In 2017, the salmon farming industry employed 435 people in Iceland, mainly in Westfjords and Eastfjords. These rural regions had experienced declining populations over the past few years because of the lack of jobs. Westfjords alone had lost 1,000 residents in the past 20 years.²

The main players in the Icelandic sea-farmed salmon industry were Norwegian companies who held fish farming license of up to 16 years.³ While the sea-farmed salmon industry in Iceland was growing rapidly, Norway had stopped issuing new licenses for open net farms. This was because Norway's native wild salmon population had declined by 50% in two decades as a result of interbreeding with escaped fish from Norwegian farms. It was estimated that 200,000 salmon escaped from Norwegian farms each year and salmon in more than two-thirds of Norway's rivers had interbred with these escapees.⁴

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“Statistically speaking, for every tonne of farmed fish, one is likely to escape. 130,000 tonnes to be farmed in Iceland could mean 130,000 escaped fish. The total wild stock of Icelandic salmon is 35-40,000, and each river has a localised supply. While Norway has banned so-called “open pens” for aquaculture, these are precisely the types of pens that the developers of aquaculture in Iceland intend to use.” Iceland had an estimated 80,000 wild salmon and each river had a population that was genetically different because of the unique environmental conditions present. “Iceland’s Marine Research Institute projects that for every tonne of farmed fish, one will escape, meaning that an extra 70,000 Norwegian escapees each year could soon mix with Iceland’s population of 80,000 wild salmon.” “Local fly fishers say they can identify the river a salmon has come from by its features. In a carnival of biodiversity, each river has its own small population.”⁵ A negative impact on Iceland’s wild salmon stocks could have an impact on the country’s pole and fly fishing industry, a source of income for about 1,500 people.⁶

In addition, farmed salmon populations were susceptible to disease (Amalax lost 200,000 salmon at its Laugardalur pen in 2019 due to bacterial kidney disease)⁷, sea lice, and produced waste. A farm that produces 3,000 tonnes of salmon a year could produce “as much effluent as a city of 50,000, according to the Norwegian Pollution Control Authority, and eutrophication problems¹ may follow.”⁸

In Iceland, the environmental impact of fish farming was overseen by the Environment Agency of Iceland, the Marine Research Institute, and the Food and Veterinary Authority. See Exhibit 1 for information on how aquaculture is governed in Iceland. “However, remember that aquaculture is still relatively new to the country. These institutions might have trouble

¹ „Eutrophication is the process by which an entire body of water, or parts of it, becomes progressively enriched with minerals and nutrients, particularly nitrogen and phosphorus. It has also been defined as "nutrient-induced increase in phytoplankton productivity". <https://en.wikipedia.org/wiki/Eutrophication>



assessing what to look out for, and it's with this and many other points that Jón Kaldal, a journalist who has been openly critical of the burgeoning enterprise, takes issue.”⁹ The government earned a levy – between 0.5% and 3.5% - of the value of the salmon being farmed (see Exhibit 2).

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Exhibit 1 – Government of Iceland – Aquaculture

“On 19 June 2019 the Icelandic government passed a legal bill regarding an act on a levy for fish farming in the sea and a fish farming fund before the Icelandic Parliament. The Act, which is no. 89/2019, main topics are as follows:

History of Aquaculture

Initially based on the on-rearing of salmonids for release into rivers, aquaculture efforts in Iceland gradually developed into larger-scale rearing of fish for the consumer market. While the history of fish farming in Iceland stretches back more than a century, the industry has until recently been struggling in finding its way forward.

Health and welfare

The first aquaculture experiments in Iceland began in the 1950s in small ponds and land based tanks as well as experiments with ocean ranching of Atlantic salmon. Hatcheries are generally located in areas with ample cold spring water free of fish pathogens. Early on aquaculture prospects in Iceland were linked with the use of geothermal water to create optimal growth conditions. In hatcheries for Atlantic salmon geothermal water is used to reach optimal water temperature and thereby shorten the process from egg to smolt to one year. Land based tanks with pumped seawater were first used in 1978. In this way optimal temperature and salinity conditions were indeed created. With a high market price for salmon at the time a number of such land based salmon farms were built in the late 1980s. However, as the price of salmon went down, this production method proved too expensive due to the high construction costs and the high energy cost for pumping large amounts of water into the tanks.

...

Iceland has taken pride in the fact that some important fish diseases are not found in Icelandic farmed fish. Therefore, all reasonable precautions are taken to prevent introduction of new fish pathogens to the Icelandic aquatic environment. Existing pathogens that live in the natural environment can cause havoc when introduced into the fish farming environment. A special



monitoring program has been in place in Iceland since 1985 to confirm the absence of exotic and other serious diseases. This surveillance program forms the foundation of targeted initiatives by the authorities for controlling diseases in farmed fish and is also a fundamental basis for the international recognition of the disease-free salmon eggs that are exported all over the world from Iceland.

The Icelandic regulations for fish health and welfare include measures such as tie-ups, slaughtering, leaving waters unstocked (fallowing) as well as restrictions on transportation and the sale of fish. The official national monitoring program documents the absence of exotic and other serious diseases for all Icelandic fish farms. The surveillance covers the screening of salmonid brood fish to prevent the vertical transmission of certain pathogens. This helps to gain an important overview of diseases found at any given time and subsequently underpins targeted public initiatives for controlling diseases in farmed fish.

Official quality control is the responsibility of the Icelandic Food and Veterinary Authority (MAST) under the Ministry of Industries and Innovation. A government-appointed Fish Disease Committee advises MAST on all fish disease issues. The Fish Disease Laboratory is a National Reference Laboratory that offers applied veterinary research, health control and diagnostic services for aquatic animals.

Exhibit 2 – Legislation and Levies

Scope and objective of the legislation

The act for example applies to the determination, imposition and collection of a levy for the production of fish through fish farming in the sea, for salmon- and rainbow trout farming. The levy is, according to the act, based on the fact that holders of operating licenses for fish farming have limited rights to utilize natural resources of Iceland. This provides an advantage for the operations, which have the opportunity to generate higher profits compared to other sectors of the Icelandic economy. Another objective of the imposition of the levy is to recognize that the acquisition of work facilities is a part of a company's operating cost, but to this day no levy has been charge for the holding of an operating license. The act takes into account that the income that will be derived from the collection of the levy, can be allocated to research for the benefit of aquaculture, to the cost of reinforcement of the administration and for the empowerment of the community where the effects of aquaculture activities are felt. The main amendments according to the act According to the act a holder of an operating license shall pay a levy to the Icelandic Treasury, for his production of fish through fish farming in farming areas in the sea. Until passing of the bill, aquaculture companies did not pay any special levy for the production but only the levy (fixed amount) in accordance with its operation license as previously mentioned. The imposition and collection of the production charge is subject to the factual production of the Licensees of operating licenses.

Licensees of operating licenses, issued by the Food and Veterinary Authority, for farming of salmon and rainbow trout in the sea, shall pay the levy as stated in the act. Other fish farming is excluded from paying the levy. That includes the farming of cod and arctic char, which are the other species of fish currently or previously being farmed in Iceland.

The charge shall be determined annually by the Directorate of Fisheries (Fiskistofa) before 1 December in accordance with the following, as laid out in the act:



1. The levy's amount per kilogram of produced salmon shall be based on the average of the international market value on the Atlantic Ocean salmon between August-October before the decision date (1 December each year) and amount to the proportion of the base as follows:
 - a. 3.5% when price is EUR 4.8 per kilogram or higher,
 - b. 2% when price is EUR 4.3 per kilogram or higher,
 - c. 0.5% when price is lower than EUR 4.3 per kilogram.

2. The levy's amount per kilogram of produced rainbow trout shall be half of the above mentioned amount of produced salmon.

3. The levy's amount per kilogram of produced infertile salmon or salmon which is produced in sea area with closed farming equipment shall be half of the above mentioned amount of produced salmon. a. This levy does not start until with slaughtered fish from 1 January 2029.

<https://assets.kpmg/content/dam/kpmg/no/pdf/2020/02/KPMG-Taxation-of-Aquaculture-2020-a-country-overview.pdf>

Exhibit 3 – Aquaculture in Iceland

The number of employed persons in aquaculture was 435 in 2017 and the overall revenue in the field was 19.3 billion ISK. The net worth of aquaculture companies has increased significantly in the last few years.

Table 2 Selected items from financial income statements (billion ISK)

Item	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
0-2-0 No. of employees	164	173	163	217	241	268	306	339	406	435
1-1-0 Operating income	2,995	3,447	3,960	4,466	6,220	6,654	9,328	9,588	14,391	19,303
1-2-2 Labour costs	-666	-706	-804	-1,103	-1,375	-1,576	-2,169	-2,316	-3,203	-3,689
1-3-0 EBIT	539	456	929	664	496	206	153	-889	-1,719	924
1-8-0 Net profit	-643	131	705	293	44	-83	-378	-1,263	-1,609	-1,534
2-1-0 Fixed assets	2,076	2,140	2,820	3,609	5,699	8,554	11,084	11,087	15,266	20,634
2-2-2 Stock	2,048	1,845	2,599	3,792	4,742	6,574	8,756	11,222	11,465	13,178
2-3-1 Long-term liabilities	3,756	2,154	3,599	3,417	4,377	6,278	9,154	10,773	10,707	11,990
2-3-2 Short-term liabilities	1,489	2,097	1,476	3,397	4,209	4,374	2,972	4,654	8,795	9,783
2-4-0 Equity	143	1,025	2,060	2,691	5,020	7,684	11,808	11,761	17,398	22,193

The export value of farmed fish has increased sevenfold in the last 10 years, from 2 billion ISK in 2008 to 13.7 billion ISK in 2017. According to preliminary export data for 2018, the export value may have reduced by 0.7 billion ISK from 2017. In 2018, 95% of salmon was exported whole, 4% as fillets and the rest as live fish and juvenile fish. Of trout, arctic char and rainbow trout, 45% was exported whole and 55% as fillets.

Table 3 Export value of aquaculture 2008-2018 (tonnes/billion ISK)

Species	Unit	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018*
All species	Quantity	2,129	1,983	1,809	2,289	4,011	3,754	4,504	5,555	9,692	14,765	14,087
	Value	1.8	2.7	2.8	3.3	4.7	4.9	5.4	7	9.6	13.7	13.1
Salmon	Quantity	232	364	380	462	1,791	1,192	1,621	2,089	5,526	8,691	9,636
	Value	0.5	1.1	1.1	1.2	2.4	2.3	2.5	3.3	5.6	8.3	8.8
Trout	Quantity	1,837	1,598	1,361	1,720	2,006	2,355	2,814	3,306	3,602	4,795	3,037
	Value	1.2	1.6	1.5	2	2.2	2.5	2.9	3.6	3.6	4.5	3.4
Other species	Quantity	60	20	67	107	213	206	69	160	563	1279	1412
	Value	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.5	0.9	0.8

In comparison with other European countries, the Icelandic aquaculture production was small in 2016. Salmon production is significantly more in France, Ireland, Norway and the UK, while Iceland is the biggest producer of arctic char and Sweden is the next in line.



The Ocean
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Table 4a Salmon farming in Europe 2008-2016 (tonnes)

Country	2008	2009	2010	2011	2012	2013	2014	2015	2016
UK	128,744	144,663	154,633	158,310	162,547	163,518	179,397	172,146	163,135
Denmark	11	2	3	..	0	..	394	420	1,279
Ireland	9,218	12,210	15,691	12,195	12,440	9,125	9,368	13,116	16,300
Iceland	292	714	1,068	1,083	2,923	3,018	3,965	3,260	8,420
Norway	737,694	862,908	939,575	1,065,975	1,232,095	1,168,324	1,258,356	1,303,346	1,233,619
Poland	43	18	0	0	4	272

<https://static.eis/publications/news-archive/fisheries/aquaculture-in-iceland/>

Exhibit 4 – Fish Farming

Fish Farming

Iceland's qualities make energy-intensive food production such as fish farming a cleaner, less costly process with a top level result.

Iceland's clean waters and plentiful sources of environmentally friendly energy, including surplus geothermal water from power plants, make it an excellent environment for high-quality fish farming.

Reasons to choose Iceland:

Pure geothermal water

- Icelanders have been working with aquaculture for over a century.
- Using the natural resources available enables farms to produce high-quality fish in a pure environment.

Energy that is clean, green and competitively priced

Iceland's [environmentally friendly energy](#) presents a unique opportunity for a production process that has:

- No carbon footprint
- Less business cost

An exciting mix of experience and opportunity

- Iceland is already the main aquatic farmer of Atlantic Char and also a major producer of Atlantic cod, Atlantic salmon, and other species.
- As of 2008 there were 50 registered fish farms in Iceland, mostly dealing with salmonid. They are a mixture of:
 - Farms that produce juveniles
 - Sea cage farms
 - Land-based farms
 - Mussel farms
 - Research stations

Icelandic aquaculture companies that are already using natural energy resources:

- [Matorka](#) uses natural geothermal water and other natural resources in their production of Arctic Char.
- [Stolt Sea farm](#) is producing Senegalese sole on Reykjanes, using water from Reykjanes geothermal power plant.

<https://www.invest.is/key-sectors/fish-farming>

¹ <https://aquaculturemag.com/2022/02/16/iceland-reaches-record-salmon-production-in-2021-with-35-more-than-a-year-earlier/>

² <https://grapevine.is/news/2017/09/04/fish-farming-new-opportunities-old-dangers/>

³ <https://www.icelandreview.com/news/bill-proposes-eliminating-indefinite-fish-farming-licences/>

⁴ <https://www.theguardian.com/environment/2019/apr/19/huge-plans-to-expand-icelands-fish-farms-risk-decimating-wild-fish-populations>

⁵ <https://www.theguardian.com/environment/2019/apr/19/huge-plans-to-expand-icelands-fish-farms-risk-decimating-wild-fish-populations>

⁶ <https://grapevine.is/news/2017/09/04/fish-farming-new-opportunities-old-dangers/>

⁷ <https://www.theguardian.com/environment/2019/apr/19/huge-plans-to-expand-icelands-fish-farms-risk-decimating-wild-fish-populations>

⁸ <https://www.theguardian.com/environment/2019/apr/19/huge-plans-to-expand-icelands-fish-farms-risk-decimating-wild-fish-populations>

⁹ <https://grapevine.is/news/2017/09/04/fish-farming-new-opportunities-old-dangers/>