ESG Risks and Opportunities in Aquaculture

Contents

This report is based on data and analysis from the Coller FAIRR Protein Producer Index 2020, released on 11 November 2020.

Jeremy Coller Foundation is a registered charity number 1163970 and a company limited by guarantee, registered in England number 9696841.

Executive Summary

Aquaculture is a fast-growing industry: production volumes grew by 527% between 1990 and 2018, and farmed fish provides a growing proportion of the world's seafood. Yet, over the same period, global capture fisheries production has only increased by 14%, due to the exhaustion of global wild fish stocks.[1]

Aquaculture is widely regarded as a more sustainable alternative to livestock production. It is considered to be an essential part of the food system, providing for the growing demand for protein while minimising environmental impacts. However, value in this sector is still heavily impacted by environmental, social and corporate governance (ESG) issues. Fish farming is heavily dependent on environmental conditions and ecosystem services – in some ways more so than chicken and pork, as the latter are mostly raised in controlled, indoor environments.

The Coller FAIRR Protein Producer Index assesses ten 'pure-play' aquaculture companies, all of which predominantly produce salmon, and six multiple protein producers that engage in aquaculture production. Given the dominance of salmon producers in the company universe, our analysis focuses on salmon farming.

In this report, we examine the results of the 2020 assessment of these companies and provide an overview of broad trends impacting this sector.

Disease management is a highly material issue that every animal producer must manage, including salmon producers, as animal mortalities constrain production. This has been a particularly prevalent issue in Chile, where salmon production has been troubled by outbreaks of Salmon Rickettsial Syndrome (SRS). This disease is commonly treated with antibiotics, explaining Chile's extremely high antibiotic use versus other salmon-producing countries, but vaccine trials and improvements to broodstock may help mitigate this issue.

Climate change presents a long term systemic risk to salmon farmers. It exacerbates the risk of diseases that impact salmon, and impacts both the availability of soy and marine raw material inputs and the suitability of certain areas for salmon farming. However, FAIRR's research has found that only one of the salmon-producing companies has conducted a climate scenario analysis.

We also tackle the thorny question of whether farmed salmon is more sustainable than meat. We then look forward to consider whether new land-based recirculating aquaculture systems (RAS) can address the sustainability challenges in this sector. While RAS present an opportunity to reduce greenhouse gas (GHG) emissions for products exported to distant markets in East Asia and parts of the US, the high capital expenditure and teething problems with this new technology mean it is not likely to fully meet expected demand for salmon in the future.

Finally, we assess how new regulations in Chile may drive environmental improvements among salmon producers.

1. Industry Overview

Sector Context: Aquaculture Production

In 2018, global farmed fish production reached approximately 82.1 million tonnes, with a value of $250.3 billion, up from $238 billion in 2017. Major producers such as China, India, Indonesia, Vietnam and Bangladesh contribute to Asia producing 89% of the world's aquaculture production.[2]

China is by far the world's top producer, accounting for nearly 60% of global production by value, followed by India, Indonesia, Chile, Vietnam and Norway, each of which account for between 3% and 6% of global production. In 2017, farmed and wild-caught fish accounted for about 17% of all animal proteins consumed.[3]

Aquaculture is a diverse industry that includes the farming of hundreds of species of fish, crustaceans, molluscs and other aquatic animals. Many of these species are specific to certain parts of the world.

In terms of global volume, the most important cultured seafood species in 2018 included carp, miscellaneous freshwater fish and tilapia. The most important species by value differ somewhat from those that are the most harvested. In addition to carp and miscellaneous freshwater fish (which rank highly because of their high volume), shrimp, freshwater crustaceans and salmonids derive the highest economic value.

Figure 1: Top aquaculture-producing countries by volume, 2018[4]

Rank	Country	Aquaculture production, millions of tonnes (excluding aquatic plants)
1	China	47.56
2	India	7.07
3	Indonesia	5.45
4	Vietnam	4.13
5	Bangladesh	2.41
6	Egypt	1.56
7	Norway	1.35
8	Chile	1.27
9	Myanmar	1.13
10	Thailand	0.89

Figure 2: Top aquaculture-producing countries by value, 2018[5]

Rank	Country	Aquaculture production value, $ millions (excluding aquatic plants)
1	China	145,005,018
2	Vietnam	14,460,784
3	India	13,178,432
4	Indonesia	12,011,584
5	Chile	10,446,268
6	Norway	8,342,301
7	Bangladesh	5,894,683
8	Japan	4,072,117
9	Ecuador	2,799,442
10	Thailand	2,701,065

Figure 3: Top farmed atlantic salmon-producing countries by value, 2018[6]

Rank	Country	Farmed Atlantic salmon production value, $ millions	Percentage of global production value
1	Norway	7,932,577	46%
2	Chile	5,586,619	33%
3	United Kingdom	1,240,241	7%
4	Canada	859,823	5%
5	Faroe Islands	499,793	4%
6	Ireland	135,298	3%
7	Russian Federation	102,830	<1%
8	Iceland	73,964	<1%
9	United States of America	67,327	<1%
10	Australia	63,660	<1%

Figure 4: Farmed shrimp-producing countries by value, 2018[7]

Rank	Country	Farmed shrimp production value, $ millions	Percentage of global production value
1	China	15,757,668	41%
2	Vietnam	6,044,420	16%
3	Indonesia	4,432,841	12%
4	India	3,534,024	9%
5	Ecuador	2,652,000	7%
6	Thailand	1,776,660	5%
7	Mexico	607,455	2%
8	Bangladesh	498,257	<1%
9	Philippines	484,805	<1%
10	Saudi Arabia	448,800	<1%

Like other animal proteins, aquaculture production uses different farming environments depending on the maturity of the animal:

1. **Hatchery**: In this stage, the focus is on developing the fry (recently hatched young fish). Given their vulnerability at early stages of life, strong technical competence is essential to achieve good survival rates. Vertically integrated aquaculture companies may own their own hatcheries, whereas others will purchase fry from external hatcheries.

2. **Nursery/smolt facility**: Fish and shellfish are transferred to a nursery once they reach an appropriate size. This production stage is seeing wider adoption in an attempt to increase survival rates in the final grow-out phase. Historically, fish have been transferred straight from hatchery to grow-out.

3. **Grow-out**: The final and longest farm phase, where fish and shellfish are transferred to a farm to reach their full size for harvest.

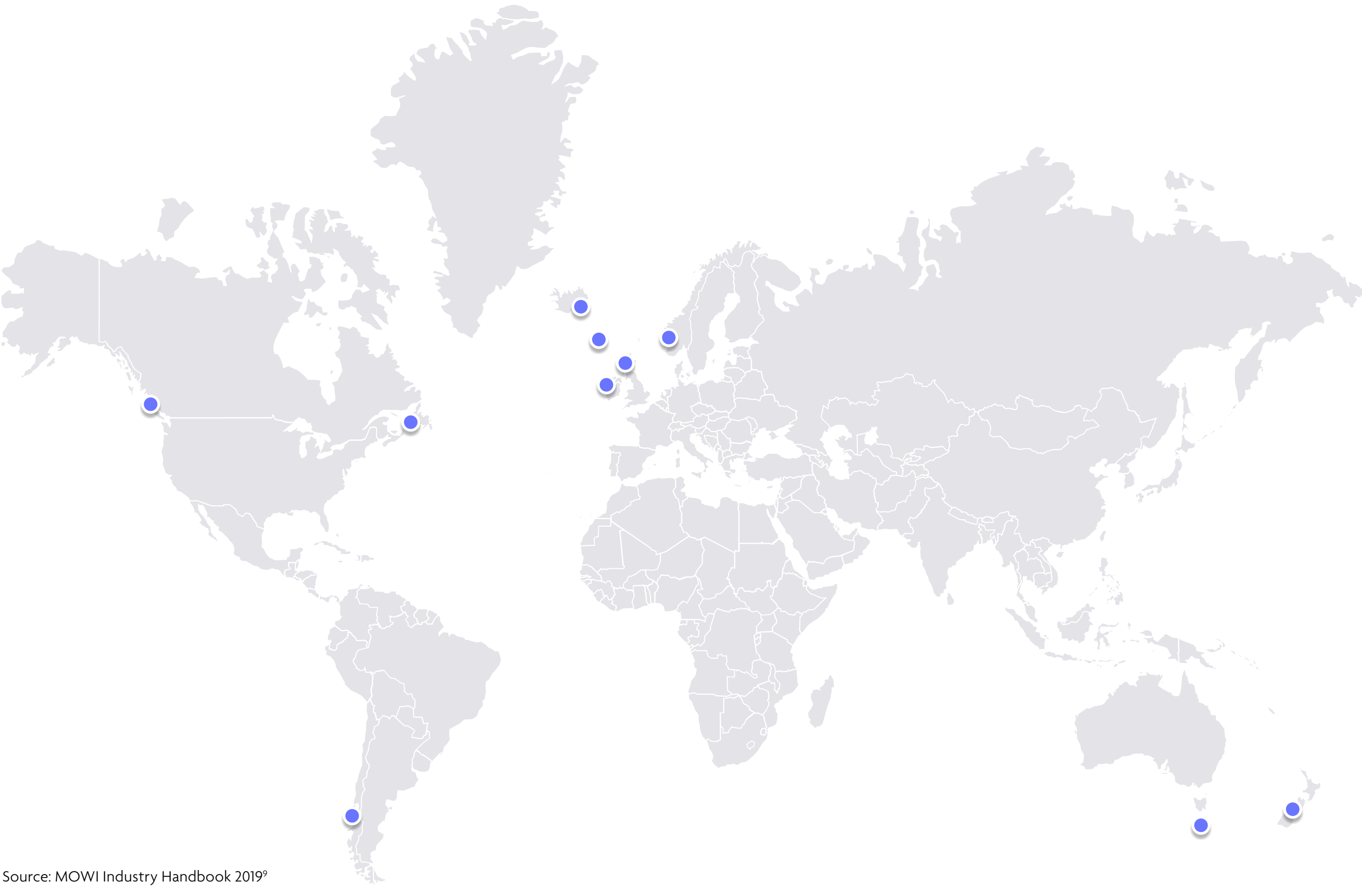
Figure 5: Duration of production phases for farmed salmon and shrimp[8]

Species	Hatchery	Nursery	Grow-out
Salmon	3–4 months	6–12 months	12–24 months
Shrimp	1 month	2 months	3 months

Salmon Aquaculture's Unique Industry Structure

The farmed salmon industry displays unique characteristics compared with other land-based meat producers – most notably recently its high and sustained returns on capital. This is largely due to the logic of supply and demand. Since its infancy, the industry has been constrained within specific locations that have the right conditions for growing salmon. These include sea temperatures limited to between 6 and 14 degrees Celsius, and deep waters with freshwater currents that reduce salinity and carry away effluent waste. The most important salmon-producing regions are the Norwegian and Chilean fjords, followed by Scottish and Canadian loch systems.

Figure 6: Farmed salmon locations worldwide



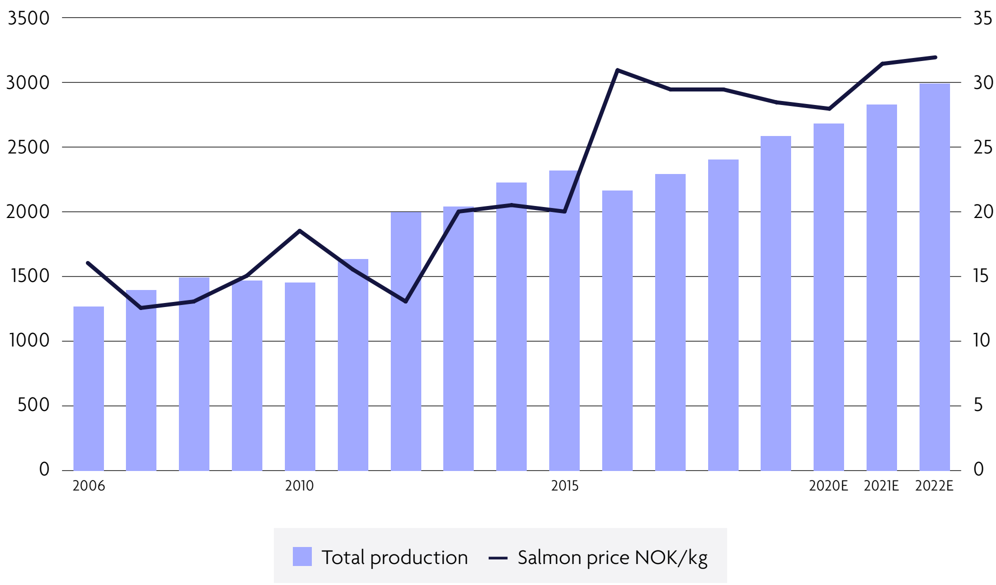
Source: MOWI Industry Handbook 2019[9]

Alongside this fundamental limitation, government restrictions in producing countries constrain production. Only by purchasing a licence can an operator farm salmon – up to the licence's 'maximum available biomass' and subject to conforming with the rest of its terms. Stricter regulation and fewer new licences in Chile and Norway to protect local ecosystems have meant the industry has not been able to achieve more than mid-single-digit supply growth. As demand has continued to rise at a higher rate, only one thing could square this circle – a sustained higher price for salmon.

Global Salmon Supply and Pricing[10]

Increasing licence restrictions on supply caused farmed salmon profits to rise, and company valuations rose with them. But as returns increased dramatically over the last five years, biological and ESG challenges facing the industry grew too.

Figure 7: Global salmon production vs salmon price 2006-2022



2. Aquaculture Companies in the Index

Sixteen companies in the Index produce aquaculture products. These companies contribute a total of $65.82 billion in revenues (19% of the total 2019 revenues for all 60 Index companies). They have a market capitalisation of $51.25 billion (15% of the total). Ten of these companies are pure aquaculture players, while six also produce other proteins. For these six companies aquaculture generates an estimated $6.05 billion in revenue, or just 14% of their total revenues.

The ten pure aquaculture companies are assessed on eight factors and 21 key performance indicators (KPIs). The companies that produce aquaculture and other proteins are assessed on all ten factors and 30 KPIs. These include five aquaculture-specific KPIs that capture information specific to marine animal production.

The best-performing risk factors are antibiotics and working conditions, which both score 42%. The relatively higher scores on these factors are primarily driven by some of the pure aquaculture companies. While the quality of companies' GHG inventories is generally high, scores relating to quality of emissions-reduction targets is lower. The KPI on Scope 3 targets remains the worst-performing KPI for aquaculture companies for the second year in a row. Disease management is far better among pure-play aquaculture producers than companies that produce other proteins, with the two groups scoring 35% and 3% respectively on this KPI.

Figure 8: Five Aquaculture-Specific KPIs

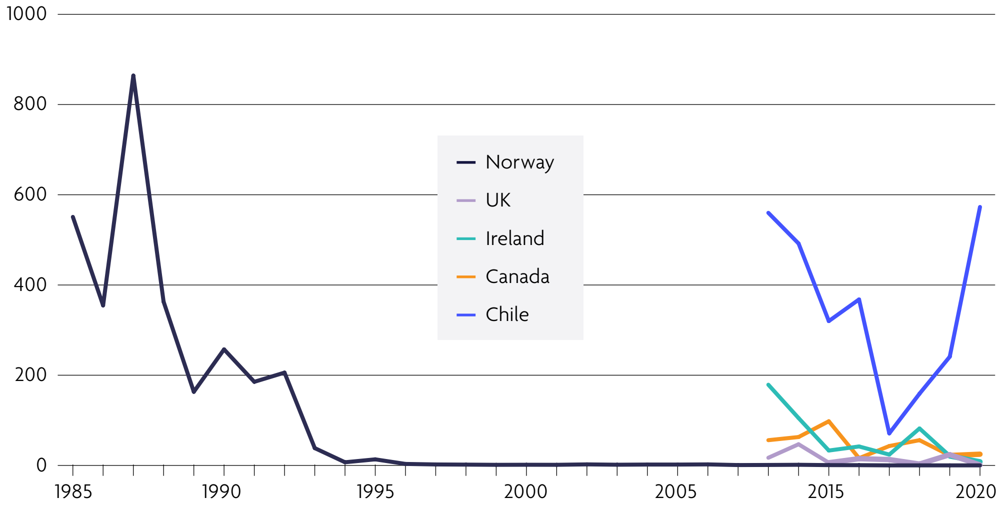
Deforestation and biodiversity	Aquatic animal welfare
1. Aquaculture certification	1. Aquatic animal welfare
2. Feed ingredients and conversion	
3. Disease management	
4. Ecosystem impacts	

Disease Management: Salmon Rickettsial Syndrome

The types and magnitude of disease that impact fish farms depend very much on regional and local conditions. In 2018, disease cost the Chinese aquaculture sector $401 million,[11] accounting for 6.2% of total production value. Sea lice management costs in Norwegian salmon production are rising, causing damages equal to 9% of revenues.[12] In addition to production losses, disease outbreaks can cause indirect losses through: temporary or permanent closure of production facilities; employment losses on farms and upstream and downstream industries; decreased market access due to export bans; and loss of domestic sales due to public concerns over the safety of consuming seafood.[13]

In Chile, salmon producers are battling with the bacterial disease Salmon Rickettsial Syndrome (SRS). This is one of the most common diseases in Chilean salmon production. One estimate suggests it costs the sector $300 million each year[14] – representing 5.4% of Chilean Atlantic salmon production in 2018. Historically, SRS has been controlled by antibiotics. While Norway has managed to reduce antibiotic use to minimal quantities, Chile's use of antibiotics has risen sharply since 2012. In 2016, 89% of all antibiotics used in Chilean salmon farming were for managing SRS.[15] The disease continues to have a significant financial impact on producers. Multiexport Foods reports that Q2 2019 provided only 15% of its annual profits despite yielding 54% of production. It reports that this was due to a sharp drop in international salmon prices and SRS outbreaks, which reduced the quality of the biomass harvested and increased farming costs.[16]

Figure 9: Antimicrobial use in salmon farming 1985-2015



Source: Henriksson, P. J., et al. (2018)[17]

However, solutions are in development. Salmones Camanchaca reports that in 2018 it vaccinated 100% of its salmon with an SRS vaccine. The company reports that this strategy has been one of several reasons why it has reduced its 12-month rolling mortality rate from 17.8% in 2016 to 2.8% in 2018.[18] It is also conducting research and development into genomic selection for SRS-resistant fish.[19] The Pincoy Project, a collaboration led by aquafeed producer Skretting that aims to reduce antibiotics used in aquaculture, has developed a salmon egg that is resistant to SRS.[20] Salmon farmers operating in Chile must be cognisant of new developments in this area to mitigate the impacts of SRS and reduce antibiotic use.

Disease Management: Algal Blooms Risk

Harmful algal blooms (the rapid increase of algae in a marine or freshwater environment) have devastated the salmon industry in Norway and Chile in the past. As algae develops, it consumes the dissolved oxygen in the water and starves other animal and plant life of oxygen. It can also irritate farmed salmons' gills and lead to respiratory issues. In 2016, Chile suffered from algal blooms that caused an estimated $800 million in damage by killing nearly 27 million fish (20% of the country's salmon production that year).[21] In 2019, Norway suffered from its worst algal bloom in 30 years. According to industry experts Kontali Analyse, the bloom is estimated to have killed around 2% of total biomass, rising to around 22% of annual production for affected companies. It cost the industry NOK 2.1–2.4 billion in lost sales and NOK 1.6–1.7 billion in other direct and indirect costs, such as clean-up and fish handling.[22]

Several factors can cause and exacerbate algal blooms. Their incidence is difficult to predict. These factors include flush rates, oxygen levels, marine nutrient pollution and high seawater temperatures. Algal blooms, parasites and diseases are key risks to salmon farming that can have a detrimental impact on production. A Planet Tracker analysis found that farmed salmon growth forecasts to 2025 may be overestimated by 6% to 8%, based on reported fish losses impacting annualised production forecasts for ten publicly listed salmon producers between 2010 and 2019.[23]

In the Protein Producer Index 2020, FAIRR introduced criteria looking at disclosure of algal bloom management plans for the first time. Our analysis found that six of the ten pure-play aquaculture companies do not disclose information on how they monitor the risk of algal blooms and their management plan in the event of a bloom occurring. Grieg Seafood and Mowi were the top performers on these criteria. Mowi uses a system to monitor plankton that aims to reduce losses associated with algal blooms. In Chile, Canada, Scotland, Ireland and some regions in Norway it uses seasonal monitoring protocols, ensuring that surveillance is carried out on a daily basis during high-risk periods. In the event of a harmful algal bloom, Mowi uses measures such as aeration systems, reduced surface feeding to encourage fish to swim away from the algae, and steering fish to safer depths using deep lights.[24] Grieg Seafood is developing a big-data program to help predict when harmful algal blooms may occur. The company already uses a program informed by satellite monitoring and on-site microscopes to monitor potential algal blooms in British Columbia, Canada and plans to roll out this system in Scotland and Norway.[25]

Companies operating in Chile will be required to disclose several environmental metrics that may be used to inform algal bloom monitoring, which may improve their scores on these criteria going forward. See the section below, '**Changing regulatory environment: increased environmental monitoring requirements and stronger farm infrastructure in Chile**' for more information.

Climate-Related Risks in Salmon Production

Similar to the livestock industry, salmon farming operations are exposed to climate risk. The final (and longest) stage of production takes place in the sea, making salmon production highly dependent on environmental conditions. In some ways, fish farming is more dependent on environmental conditions and ecosystem services than chicken and pork, as the latter are mostly raised indoors. Deteriorating biology in warmer seas such as those off the coasts of Southern Norway or Scotland have shifted the value of operations in various production regions to favour colder northern regions of Norway, or the Faroe Islands.

Climate risk impacts salmon producers in several different arenas. However, the exact nature, likelihood and timelines of these impacts are not yet well understood:

- Higher seawater temperatures can make some marine areas less suitable for salmon production if they exceed the 6–14°C temperature range, and increase the risk of heat stress. Conversely, this can make colder areas more suitable for salmon production. In October 2019, Mowi suffered a loss of around 2.6 million fish in its East Canadian operations – nearly half the company's salmon at sea in the region – due to high seawater temperatures.[26] Consequently, the company had all its licences in Newfoundland, Canada suspended and Q3 operational earnings before interest and taxes were down 29%, from €207 million to €148 million over 2018–19.[27]
- Higher temperatures also increase the likelihood of some diseases impacting farmed salmon, such as furunculosis, vibriosis and francisella. However, academics note that further research is required in this area.[28] Sea lice are also known to thrive in warmer water. Huon Aquaculture, an Australian salmon producer, suffered from high mortalities due to higher-than-average temperatures and a disease outbreak that was prolonged by the warmer conditions. As a result, the company cut its forecasted profits, and its eventual net profit after tax fell 26% from AUD 26.4 million in 2018 to AUD 9.5 million in 2019.[29]
- Extreme weather events can disrupt the fishmeal availability (a key ingredient in salmon and shrimp feed). In 2014, warming waters caused a reduction in anchovy yields in Peru, the world's top fishmeal exporter. As a result, fishmeal prices surged to $2,400 per tonne, compared to the average of $1,600 per tonne.[30] Considering that feed costs make up 30–50% of salmon production costs, and fishmeal typically makes up around 15% of feed input, price shocks can have a significant impact on producers' margins.
- Like other producers, salmon companies are exposed to the risk of a carbon tax or increased energy costs – particularly as they begin to transition more production to land-based systems.

Climate Risk Management by Index Aquaculture Companies

Most (13 out of 16) aquaculture companies acknowledge climate risk as a material issue for their businesses. Most of the Asian aquaculture producers, many of which also produce livestock products (Japfa, Charoen Pokphand Foods, Great Wall Enterprise, Maruha Nichiro, Nissui and QL Resources), acknowledge the materiality of climate risk to their operations. The only companies that do not discuss climate risk are Salmones Camanchaca, Thai Union and NH Foods. Tassal reports more detail on how it manages climate risk relative to most other aquaculture companies, as Australian salmon farmers have to date seen more climate impacts materialise than peers in Norway, Chile and the UK.

The only aquaculture company to disclose that it has completed a climate-scenario analysis is Mowi. It recognises that climate change could impact the business in numerous ways. These include: causing damage to fish farming facilities; disrupting production activities; and affecting the severity of weather, sea levels and temperatures, the frequency of algae blooms, and the availability of the raw materials for fish feeds. To mitigate these risks, the company is reducing its carbon footprint by achieving its science-based target, sourcing more resilient farming equipment and exploring the use of alternative feed ingredients.[31]

Is Farmed Salmon More Sustainable Than Meat?

It is clear that salmon production, while a well-managed industry relative to livestock production, faces a number of ESG risks that constrain production. However, does salmon have a lower environmental footprint than meat?

Salmon is commonly thought to be significantly more environmentally-friendly than chicken and pork, but academic literature suggests this depends on the particular environmental factor considered. In terms of water use, salmon offers some advantages over land-based proteins. When looking at feed consumption, the picture is less clear. Salmon has a lower kilo-for-kilo feed conversion ratio. But once we consider the higher calorific content of the feed for salmon (approximately 30% fishmeal and fish oil), the calorie and protein retention looks less impressive (28% and 25% respectively for salmon, versus 37% and 27% for chicken). As salmon only retains 25% of the proteins it requires in its feed, it does not produce protein more efficiently than chicken.

Figure 10: Environmental impacts of salmon and animal protein products

Protein	Salmon	Poultry (chicken)	Pork	Beef
GHG emissions, kg CO_2 per kg edible meat[32]	7.9	6.2	12.2	39.0
Freshwater consumption, litre per kg edible meat[33]	2,000	4,300	6,000	15,400
Feed conversion ratio, edible meat per 100kg feed[34]	56	39	19	7
Calorie retention[35]	28%	37%	21%	13%
Protein retention[36]	25%	27%	16%	7%

The GHG emissions accounting of individual seafood species varies considerably, yet the science is less developed than for livestock proteins. However, the latest research suggests that GHG emissions for farmed salmon are somewhere in-between chicken and pork. A recent SINTEF report pointed to emissions from farmed salmon at 7.9kg CO_2eq as edible meat versus 6.2kg for chicken, 12.2kg for pork and 39kg for beef.[37] A Swedish study also found that farmed salmon's climate impacts were greater than chicken yet less than pork.[38]

The incremental demand for farmed salmon has also come from further afield, including the Far East and America. Given that farm production could not be moved from Norway or Chile, and given the customer's strong preference for a fresh product, servicing these markets involves air transport. Salmon travels either in the bellies of passenger planes or in specialist cargo planes. A flight from Oslo is 7,500 km to Miami and 7,000 km to Beijing. On a calculated GHG per km air travel, this would add an extra 10 kg CO_2-eq per kg (including approximately an extra 25% for conversion into edible meat).[a] This means that a salmon product in Beijing would have emissions of 18 kg CO_2-eq per kg versus just 8 kg CO_2-eq for the same product served in Oslo. This matters because China is the fastest-growing market for Atlantic salmon, with demand increasing by 9.7% between 2018-2019.[39]

a 1.13kg CO_2-eq per km per tonne * 7,000-7,500 / 1,000 kg = 8 kg CO_2.eq * 1.25 = 10 kg CO_2-eq per kg https://ourworldindata.org/carbon-footprint-food-methane

New Production Systems: Can They Address the Sector's ESG Challenges?

As discussed above, producers in Norway and Chile have had to face increasingly difficult sea conditions for raising salmon. However, over the next decade, things may be set to change with the emergence of commercial-scale land-based salmon recirculating aquaculture systems (RAS). These systems aim to raise salmon from hatchery to grow-out without placing them in the sea.

The industry has always relied on land-based production for broodstock, hatcheries and smolt production that mimics the freshwater early salmon lifecycle. Recently, some operators have been transferring smolt to sea at larger sizes (up to 500 g) to increase their resilience to sea lice and other risks. But now producers aim to raise salmon economically without the fish ever entering the sea. Moving towards land-based systems also means that salmon production is freed from requiring the highly specific environmental conditions found along the Norwegian, Chilean, British and North American coastlines. And producing salmon in facilities located near to end markets means avoiding the added GHG footprint of air travel.

The proponents of this technology are touting land-based RAS salmon as more sustainable in other areas too. One advantage is that the facility has total control over conditions such as temperature, which may allow operators to achieve a better feed conversion ratio (i.e. <1.1x vs 1.3x due to no winter low-growth periods).[40] Also, the absence of external risks such as sea lice, disease or algal blooms may enable land-based operators to achieve higher harvest weights and lower mortality – both helping to improve GHG footprint. Waste can be removed from the water in the system and disposed of safely (and even used as fertiliser), rather than disseminated into local ecosystems. There will also be no potential for escapes affecting the wild salmon population.

Land-based systems do have some significant disadvantages, however. Due to the high capital expenditure costs, many producers report using stocking densities up to three times higher in marine net pens to improve margins, presenting reputational and welfare risks.[41] In terms of energy use, RAS is much more demanding than net pen farming: it uses significant energy to provide current for fish to swim against, and to recirculate and treat water. One study suggests that when comparing emissions from salmon production (excluding post-production emissions), RAS emits more than twice the emissions of marine net pens.[42] Also, despite improvements in filtration technology, which allows over 90% of water to be recirculated, freshwater use per kg will be higher than open-net salmon production. The efficiency and reliability of the filtration systems used is of paramount importance in RAS systems, as without them water cannot be recirculated. Some facilities use backup flow-through systems that allow water to enter and exit the system without being filtered and recirculated in case problems arise with the filter. Lastly, raising salmon in completely closed systems may prevent marine pollution, disease and antibiotic use, but if an error occurs in production, all the salmon raised in the system will likely be lost.

Other unknown risks may yet exist. Issues involving odd taste, skeletal formation and even the impact of nearby construction activity forcing emergency harvests[43] has affected land-based operations. Before the evidence of scale output over multiple cycles, we cannot yet be sure of either the biological or environmental metrics, nor the economics of land-based aquaculture. What seems likely is that land-based aquaculture will be able to supply demand in places like Miami and Beijing with a better environmental impact then if supplied out of Norway and Chile.

Financially, with 840,000 tonnes of land-based salmon predicted over the next decade,[44] there seems to be room for both systems to exist without destroying returns. Even with this incremental supply, sea-based salmon production will still have to grow at 4% per year to meet a 6% increase in demand.[b] If salmon prices fall much below 60 NOK/kg, land-based returns on investment are unlikely to be high enough to justify new land-based facilities.[45] Therefore, this new technology looks set to cap revenues around current levels.

b ((3 million tonnes * 1.06^10) – 840k) ^ (1/10).

Changing Regulatory Environment: Increased Environmental Monitoring and Stronger Farm Infrastructure Requirements in Chile

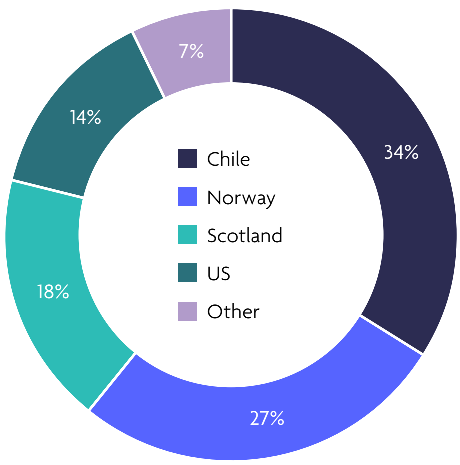
In August 2020, two new regulatory changes impacting salmon farmers were announced by various Chilean government bodies.

First, salmon farmers in Chile will now have to implement continuous monitoring systems that track dissolved oxygen in the water column and temperature and salinity at 5 metre and 10 metre depths – and report these to the Superintendency of the Environment (SMA). The new regulation stipulates that salmon farmers must set up the technology to report directly into SMA systems, meaning farms without such technology in place will have to invest in new systems to ensure compliance.[46] Salmones Camanchaca, Multiexport Foods and Mowi all operate salmon farms in Chile and will need to ensure they are compliant with the new regulations. The aim of the new rules is to use real-time information to better detect potential environmental challenges that may impact the marine ecosystem.

Second, Chilean salmon farms will also be subject to stricter standards on quality of farm infrastructure to prevent farm collapses and escapes. Farms must be inspected every six months and independently audited annually against a standard published by the Undersecretariat for Fisheries and Aquaculture (Subpesca). The standard defines key safety metrics that farms must be built against to ensure they can withstand harsh storms and currents. It also requires farmers to have a traceability or monitoring system in place for the farm infrastructure to prevent the use of exhausted materials. As of August 2020, a timeline had not been announced for companies to comply with the new rules. But Subpesca indicated that the new standard would be "gradually implemented" to allow companies to adapt.[47]

The Chilean salmon farming sector has suffered from many large escape events. According to an industry media report from February 2019, of the ten largest Atlantic salmon escape events, 34% of fish lost were in Chile and 27% in Norway, despite Norway producing 53% of the world's Atlantic salmon, and Chile making up 27%.48 In August 2020, Mowi Chile announced it would appeal against a CLP 5.3 billion ($6.7 million) fine issued by SMA – the highest fine the agency has issued – for an escape of 690,000 fish in July 2018.

Figure 11: Atlantic salmon escapes



Company	Country	Year	Number of fish	Cause
AquaChile	Chile	2013	787,929	Damaged cages due to bad weather
Marine Harvest Chile	Chile	2018	680,000	Wind
Marine Harvest	Norway	2005	496,000	Strong wind and electricity
Cypress Island Inc.	USA	1997	369,000	Unknown
Meridian Salmon Farms	Scotland	2011	336,470	High tides
Sjølaks Norway	Norway	2008	307,356	Unknown
Scottish Sea Farms	Scotland	2000	258,000	Weather
Grieg Seafood Shetland Scotland	Scotland	2002	238,420	Unknown
Australis Chile	Chile	2016	173,156	Displacement of modules due to strong underwater currents
SalMar	Norway	2011	173,156	Unknown

Source: Intrafish[49]

Changing Regulatory Environment: NGOs Win Legal Push for Antibiotic Use Disclosure in Chile

As we have seen above, antibiotic use is extremely high in Chilean salmon production due to the presence of SRS on many farms. Consequently, NGOs have been pressing companies to disclose their antibiotic use for several years. In August 2020, Oceana Chile won an appeal against Sernapesca, the Chilean and fisheries and aquaculture regulatory body, forcing the agency to deliver disaggregated information by company on the use of antibiotics and total biomass in tons during 2018, and antiparasitic treatments per farm and annual production between 2015 and 2019. The information has been granted in line with the country's transparency law, which enables access to information that is in the public interest.[50]

Oceana Chile has requested this information from the Chilean authorities since 2014. The Council for Transparency denied its first request, which was only granted through a court appeal,[51] but approved it for the first time in 2018.[52] Of the 19 companies that Oceana Chile has requested information from, 14 have opposed disclosing it (as of August 2020): Mowi Chile, Australis Mar, Multiexport, Cultivos Yadrán, Cermaq Chile, Cooke Aquaculture, Ventisqueros, Salmones Camanchaca, Salmones Blumar, Empresas AquaChile, Salmones de Chile, Salmones Austral, Salmones Aysén and Caleta Bay.[53]

While the law does not yet specifically require farmers to disclose this information, the fact that it is now disclosed on request without an appeal signals a change in attitude on the part of government bodies. Considering the Chilean regulatory changes announced in August 2020, it is possible that the government may move towards a stronger stance on antibiotic use disclosure in the future.

4. Impact of Covid-19 on the Salmon Sector

Coronavirus has caused huge disruption to the global meat industry. As an employee-intensive sector, the loss of human capital and closure of meat-processing facilities has impacted a significant portion of the global foodservice industry, affecting revenues and profits. It has exposed companies to reputational, legal and financial risks that may exacerbate the significant disruptions already felt by the industry.[54] The immediate effects of COVID-19 impacted both foreign and domestic salmon demand as foodservice markets collapsed, with dining out ending following introductions of national lockdowns worldwide. Foodservice sales account for approximately 30–40% of the global salmon market. The industry has subsequently shifted massive volumes of supply from foodservice to retail. The industry has faced the added strain of losing routine transport and logistics timetables to export salmon, as well as lower exports to China after traces of COVID-19 were detected on seafood packaging.[55]

However, the salmon sector has been relatively resilient to these shocks. In 2020, salmon prices largely followed seasonal trends, albeit with notable dips during periods of national lockdowns. Following three consecutive years of strong supply growth, and a record year in 2019 with a 7% increase in total global production, salmon only saw falls in pricing during March to May and October to December 2020.

Implications on Production

The most pronounced effects of the pandemic on production have been on reduced logistics and delayed harvesting. With passenger flights mostly halted, air freight – on which the supply of salmon heavily depends – was limited, meaning salmon producers had difficulties exporting salmon to foreign markets.

At the farm level, the uncertainty of the pandemic has led to the postponement of harvests worldwide in the hope of an imminent return to normality. This has resulted in farms seeing a higher proportion of large fish in pens as fish approach their maximum harvest weight. Pens have therefore become more cramped, raising the potential of jeopardising fish health. The increased fish in pens has also meant reduced stocking. In addition, production capacity during the pandemic has been affected by additional health and safety measures, necessitating a reduced workforce and labour mobility throughout the supply chain.[56]

According to Rabobank, salmon supply is expected to remain fairly flat in 2021, with growth of just 0.5–2%. Yet analysts expect salmon demand will recover this year, with the gradual reopening of foodservice and hospitality industries.[57]

Norway

The Norwegian salmon export market has been fairly resilient to COVID-19 impacts. Despite the challenges posed by the pandemic, continued international demand for salmon saw export volumes fall by just 1% in 2020, while export price per kilo was down 7% compared with 2019.[58]

Figure 12: Price and weight of Norwegian fresh and chilled salmon exports, 2019-20

Source: Statistics Norway[59]

Chile

Chile's salmon export market has faced more difficulties than Norway as a result of the pandemic. In the first quarter of 2020, 192,000 tonnes of Atlantic salmon were harvested, a 5.9% increase on 2019 volumes.[60] Over 2019–20, export volumes increased by 7%, but the combination of strong harvests, lower demand and distribution issues led to the average export price per kilo falling by 20%.

Figure 13: Price and weight of Chilean salmon and trout exports, 2019-20

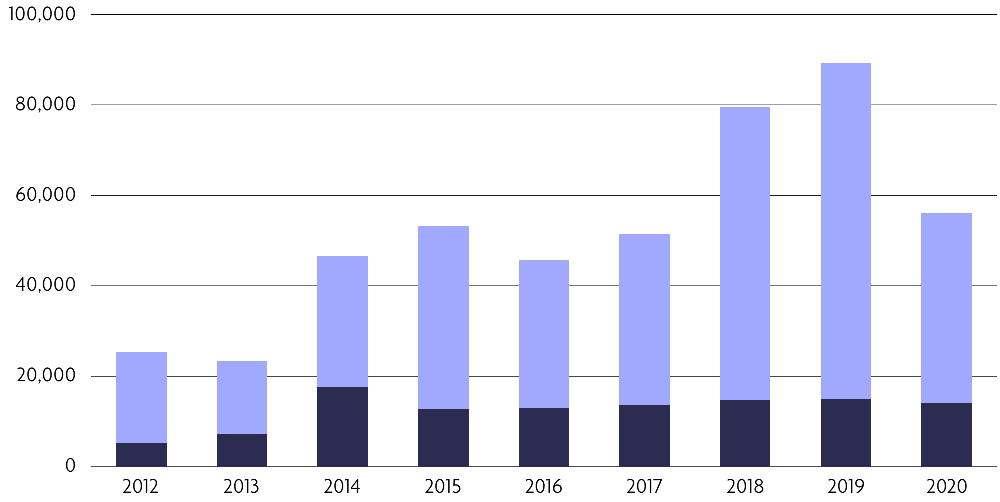
Source: Government of Chile, Customs Service[61]

Reduced Demand from China

China is a large, rapidly developing market for salmon exporters. Between 2012 and 2019, the volume of Atlantic salmon imported into China had a compound annual growth rate of 19%.[62] Reduced demand from China therefore presents a threat to salmon producers' growth. Considering that China's foodservice industry accounts for 90% of the country's total consumption of salmon, the fall in Atlantic salmon imports of 30% between 2019 and 2020 is perhaps lower than expected. Following the country's national lockdown and the detection of COVID-19 in a seafood market in June, the second half of the year saw China's salmon imports plummet by 62% compared with the same period in 2019. As in other popular salmon markets, Chinese salmon consumption is now shifting from foodservice to retail.[63]

Despite suspending the import of European salmon after the discovery of the virus at a seafood market, Norwegian salmon increased its proportion of China's market share (from 36% in 2019 to 42% in 2020), although absolute import volumes fell. Chilean salmon imports, meanwhile, saw their market share in China fall from 35% to 20%.[64]

Figure 14: China's Atlantic salmon imports



Source: Norwegian Seafood Council, cited in Undercurrent News (2020)

The Future of Salmon Production

Supply growth is expected to tighten in 2021, with less fish stocked in 2020 due to postponed harvests, and an oversupply of salmon stored in freezers as foodservice's hoped-for recovery hangs in the balance. Predictions for Chilean supply in 2021 range from between 608,000 and 706,000 tonnes, or a year-on-year drop in harvest volumes of between 3% and 15%.[65]

The outlook for salmon production is more promising in the long term, with signs indicating continued growth for the sector. The implications of the shift to retail is seen by many as a positive for future growth,[66] with Mowi predicting that the surge in retail demand will offset losses from foodservice.[67,68] As foodservice becomes more dynamic through online channels and deliveries, so demand for salmon through foodservice will become more important to the sector.

Indeed, the FAO[69] has advised the seafood industry to continue to innovate and adapt products, distribution channels and marketing campaigns to reflect the new market landscape, as we continue into uncertainty this year.

Endnotes

1 FAO. 2020. 'State of the World Fisheries and Aquaculture 2020' (interactive story). http://www.fao.org/state-of-fisheries-aquaculture

2 FAO/Fisheries Global Information System (FIGIS). Global Aquaculture Production 1950–2018 (fisheries statistics, aquaculture). http://www.fao.org/fishery/statistics/global-aquaculture-production/query/en

3 FAO, 'State of the World Fisheries and Aquaculture 2020' (interactive story).

4 FAO/FIGIS.

5 Ibid.

6 Ibid.

7 Ibid.

8 Lucas, J. S., Southgate, P. C. and Tucker, C. S. 2019. Aquaculture: Farming aquatic animals and plants. As quoted in O'Shea, T., Jones, R., Markham, A., Norell, E., Scott, J., Theuerkauf, S., and T. Waters. 2019. Towards a Blue Revolution: Catalyzing Private Investment in Sustainable Aquaculture Production Systems. http://encouragecapital.com/wp-content/uploads/2019/05/Towards-a-Blue-Revolution-TNC-and-Encourage-Capital-FINAL-5-5-2019-for-email.pdf

9 Mowi ASA. 2020. Salmon Farming Industry Handbook. Available to download at: https://mowi.com/investors/resources.

10 NASDAQ Salmon Index (https://salmonprice.nasdaqomxtrader.com/public/report;jsessionid=7BCE1A446C4FCF0BC287E3E8B-FA5ACB8?0) and Pareto Securities AS Equity Research. 3 August 2020. 'Seafood Weekly.'

11 FAO. 2020. State of the World Fisheries and Aquaculture. http://www.fao.org/3/ca9229en/online/ca9229en.html

12 Abolofia, J. and Wilen, J. E. (2017) The Cost of Lice: Quantifying the Impacts of Parasitic Sea Lice on Farmed Salmon.

13 FAO. 2020. State of the World Fisheries and Aquaculture. http://www.fao.org/3/ca9229en/online/ca9229en.html

14 Andrews, S. 2017. 'A simple solution to Chile's SRS epidemic'. https://thefishsite.com/articles/a-simple-solution-to-chiles-srs-epidemic

15 Lozano, I., Díaz, N.F., Muñoz, S., and Riquelme, C. 2017. 'Antibiotics in Chilean Aquaculture: A Review' in Antibiotic use in animals. https://www.intechopen.com/books/antibiotic-use-in-animals/antibiotics-in-chilean-aquaculture-a-review

16 Multiexport Foods. 2019. Annual Report, 6–7.

17 Henriksson, P.J.G., Rico, A., Troell, M. et al. 2018. 'Unpacking factors influencing antimicrobial use in global aquaculture and their implication for management: a review from a systems perspective.' Sustain Sci 13, 1105–1120. https://link.springer.com/article/10.1007/s11625-017-0511-8

18 Salmones Camanchaca. 2018. Sustainability Report, 5, 17.

19 Ibid, 111.

20 Proyecto Pincoy. 5 May 2020. 'Pincoy implementa el uso de ovas homocigotas' (video). https://www.youtube.com/watch?v=-GiFDw_ZBwtY&feature=emb_title

21 FAO/GLOBEFISH. 6 June 2016. 'Algal bloom mortalities in Chile have salmon prices climbing even higher.' http://www.fao.org/in-action/globefish/market-reports/resource-detail/en/c/415527/

22 FishFarmingExpert. 6 November 2019. 'Cost of Norway's algal bloom was around NOK 4 billion.' https://www.fishfarmingexpert.com/article/cost-of-norways-algal-bloom-calculated-at-around-nok-4-billion/

23 Planet Tracker. 2019. Salmon feels the heat: capital at risk from investor concentration in the salmon aquaculture industry. Available to download at: https://planet-tracker.org/tracker-programmes/oceans/seafood/.

24 Mowi ASA. 2019. Integrated Annual Report, 54. https://corpsite.azureedge.net/corpsite/wp-content/uploads/2020/03/Mowi_Annual_Report_2019.pdf

25 Grieg Seafood. 2019. Annual Report, 62.

26 The Guardian Canada. 15 November 2019. 'Death of 2.6 million salmon in Newfoundland reignites debate over fish farming.' https://www.theguardian.pe.ca/business/local-business/death-of-26-million-salmon-in-newfoundland-reignites-debate-over-fish-farming-376777/

27 Mowi ASA. 2019. Q3 earnings report. https://ml-eu.globenewswire.com/Resource/Download/d3435070-65f4-4580-8ccf-4a3eced7c792

28 Troell, M., Eide, A., Isaksen, J. et al. 2017. 'Seafood from a changing Arctic.' Ambio 46, 368–86.

29 FishFarmingExpert. 29 August 2019. 'Jellyfish and warm water blamed as Huon profits plunge by 64%.' https://www.fishfarmingexpert.com/article/jellyfish-and-warm-water-blamed-as-huon-profits-plunge-by-64/

30 Financial Times. 12 November 2015. 'El Niño threatens fishmeal prices.' https://www.ft.com/content/cc36ed98-8933-11e5-90de-f44762bf9896.

31 CDP. 2019. Mowi CDP Climate 2019. https://www.cdp.net/en/responses/11366

32 SINTEF. 2020. Greenhouse gas emissions of Norwegian seafood products in 2017. https://www.sintef.no/contentassets/25338e561f1a4270a59ce25bcbc926a2/report-carbon-footprint-norwegian-seafood-products-2017_final_040620.pdf/

33 Mekonnen, M., and Hoekstra, A. Y. 2010. The green, blue and grey water footprint of animals and animal products. https://research.utwente.nl/en/publications/the-green-blue-and-grey-water-footprint-of-animals-and-animal-pro

34 Mowi ASA. 2020. Salmon Farming Industry Handbook.

35 Fry, J. P., Mailloux, N. A., Love, D. C., Milli, M. C., & Cao, L. 2018. 'Feed conversion efficiency in aquaculture: Do we measure it correctly?' Environmental Research Letters 13(2). https://doi.org/10.1088/1748-9326/aaa273

36 Ibid.

37 SINTEF. 2020. Greenhouse gas emissions.

38 Hallstrom et al. (2019) Combined climate and nutritional performance of seafoods

39 Mowi ASA. 2019. Integrated Annual Report, 29.

40 Vinci, B., Summerfelt, S., Rosten, T.W., Henriksen, K. and Hognes, E.S. 2020. 'Land Based RAS and Open Pen Salmon Aquaculture: Comparative Economic and Environmental Assessment.' (Presentation, The Conservation Fund). https://ccb.se/wp-content/uploads/2015/11/Freshwater-Institute_Brian-Vinci_day2.pdf

41 FAIRR Initiative. 2019. Shallow Returns? ESG Risks and Opportunities in Aquaculture. https://www.fairr.org/article/shallow-returns-esg-issues-in-aquaculture/

42 Liu, Y., Rosten, T. W., Henriksen, K., Hognes, E. S., Summerfelt, S., and Vinci, B. 2016. 'Comparative economic performance and carbon footprint of two farming models for producing Atlantic salmon (Salmo salar): Land-based closed containment system in freshwater and open net pen in seawater.' Aquacultural Engineering 71, 1–12. https://www.sciencedirect.com/science/article/pii/S0144860916300036

43 Intrafish. 29 July 2020. 'Atlantic Sapphire initiates emergency harvest of close to 200,000 land-based salmon.' https://www.intrafish.com/aquaculture/atlantic-sapphire-initiates-emergency-harvest-of-close-to-200-000-land-based-salmon/2-1-849410

44 Intrafish. 2 July 2020. 'Skretting: 1 million metric tons more feed needed to meet land-based aquaculture demand.' https://www.intrafish.com/feed/skretting-1-million-metric-tons-more-feed-needed-to-meet-land-based-aquaculture-demand/2-1-833648

45 Vinci, B., et al. 2020. 'Land Based RAS and Open Pen Salmon Aquaculture'.

46 Superintendencia del Medio Ambiente Gobierno de Chile. 18 August 2020. 'Tras Aprobación de Instrucción General para Centros de Engorda (CES): SMA instruye a sector regulado implementar Sistema de Monitoreo Continuo y en Línea.' https://portal.sma.gob.cl/index.php/2020/08/18/tras-aprobacion-de-instruccion-general-para-centro-de-engorda-ces-sma-in-

struye-a-sector-regulado-implementar-sistema-de-monitoreo-continuo-y-en-linea/
47 Subpesca. 21 August 2020. 'Nueva reglamentación de Subpesca obligará a salmoneras a certificar sus jaulas de cultivo una vez al año.' http://www.subpesca.cl/portal/617/w3-article-108504.html
48 FAO/FIGIS.
49 Intrafish. 1 February 2019. 'Here are the largest recorded farmed Atlantic salmon escapes in history.' https://www.intrafish.com/aquaculture/here-are-the-largest-recorded-farmed-atlantic-salmon-escapes-in-history/2-1-388082
50 Consejo para la Transparencia. 7 August 2020. 'Consejo para la Transparencia ordena entrega de datos sobre uso de antibióticos y producción de salmoneras.' https://www.consejotransparencia.cl/consejo-para-la-transparencia-ordena-entrega-de-datos-sobre-uso-de-antibioticos-y-produccion-de-salmoneras/
51 Intrafish. 21 September 2015. 'Oceana wins antibiotics case against Chilean gov't.' https://www.intrafish.com/news/oceana-wins-antibiotics-case-against-chilean-govt/1-1-647818
52 International Aquafeed. 14 August 2018. 'Chile's Council for Transparency orders salmon producers to reveal amount of antibiotics used.' https://aquafeed.co.uk/entrada/chile-s-council-for-transparency-orders-salmon-producers-to-reveal-amount-of-antibiotics-used--18666/
53 Oceana Chile. 6 August 2020. 'Decisión inédita en Consejo para la Transparencia: Ordena a salmoneras entregar datos de antibióticos y producción.' https://chile.oceana.org/en/press-releases/decision-inedita-en-consejo-para-la-transparencia-ordena-salmoneras-entregar-datos-de
54 ICCR. 2020. Investor Statement: Recommendations for Meat Processors During COVID-19 . Available at: https://www.iccr.org/sites/default/files/page_attachments/investorstatementoncovid19riskstomeatsectorworkerswsig_05.21.20.pdf
55 Intrafish. 27 November 2020. 'Beijing's largest wholesale market pulls seafood from sale on COVID-19 concerns.' https://www.intrafish.com/markets/beijings-largest-wholesale-market-pulls-seafood-from-sale-on-covid-19-concerns/2-1-920331
56 OECD. 2020. Fisheries, aquaculture and COVID-19: Issues and policy responses. Available at: http://www.oecd.org/coronavirus/policy-responses/fisheries-aquaculture-and-covid-19-issues-and-policy-responses-a2aa15de/
57 Feed Navigator. 27 November 2020. 'Rabobank's view: Very tight salmon supply expected in 2021, all eyes on RAS developments, bullish forecast for shrimp prices, and higher demand seen for fishmeal.' https://www.feednavigator.com/Article/2020/11/27/Rabobank-s-view-Very-tight-salmon-supply-expected-in-2021-all-eyes-on-RAS-developments-bullish-forecast-for-shrimp-prices-and-higher-demand-seen-for-fishmeal
58 Undercurrent News. 6 January 2021. 'Norway hit second-highest seafood export value ever in 2020.' https://www.undercurrentnews.com/2021/01/06/norway-hit-second-highest-seafood-export-value-ever-in-2020/
59 Statistics Norway. Available at: https://www.ssb.no/
60 FAO/GLOBEFISH. 9 September 2020. 'Widespread disruption in the salmon sector.' http://www.fao.org/in-action/globefish/market-reports/resource-detail/en/c/1306829/
61 Gobierno de Chile, Aduanas. Available at: https://www.aduana.cl/exportacion-por-productos/aduana/2020-04-02/091449.html.
62 Undercurrent News. 8 January 2021. 'China's salmon imports fell by third in 2020, estimates NSC.' https://www.undercurrentnews.com/2021/01/08/chinas-salmon-imports-fell-by-third-in-2020-estimates-nsc/
63 Ibid.
64 Ibid.
65 Undercurrent News. 4 December 2020. 'Breaking down 2021's global farmed salmon supply outlook.' https://www.undercurrentnews.com/2020/12/04/breaking-down-2021s-global-farmed-salmon-supply-outlook/
66 FAO/GLOBEFISH. 9 September 2020. 'Widespread disruption in the salmon sector.'
67 Undercurrent News. 24 November 2020. 'DNB's Sletmo: COVID-19 is positive for salmon market long-term.' https://www.undercurrentnews.com/2020/11/24/dnbs-sletmo-covid-19-is-positive-for-salmon-market-long-term/
68 Undercurrent News. 14 September 2020. 'Mowi CEO predicts retail demand could entirely offset foodservice salmon losses.' https://www.undercurrentnews.com/2020/09/14/mowi-ceo-predicts-retail-demand-could-entirely-offset-foodservice-salmon-losses/
69 FAO/GLOBEFISH. 9 September 2020. 'Cautious economic reopening as COVID-19 continues to dominate outlook.' http://www.fao.org/in-action/globefish/fishery-information/resource-detail/en/c/1306843/

Coller FAIRR Protein Producer INDEX

The findings of the Coller FAIRR Protein Producer Index are available online at **www.fairr.org/index**, an interactive website assessing 60 of the largest listed global meat, dairy and aquaculture companies against ten environmental, social and governance factors.

See FAIRR's research and engagement resources on the aquaculture sector at **www.fairr.org/engagements/sustainable-aquaculture**

CONTACT

Aarti Ramachandran

Director, Research and Engagements
Aarti.Ramachandran@fairr.org

Faazi Adam

Manager, Research and Engagements
Faazi.Adam@fairr.org

Sumye Fung

ESG Analyst
Sumye.Fung@fairr.org