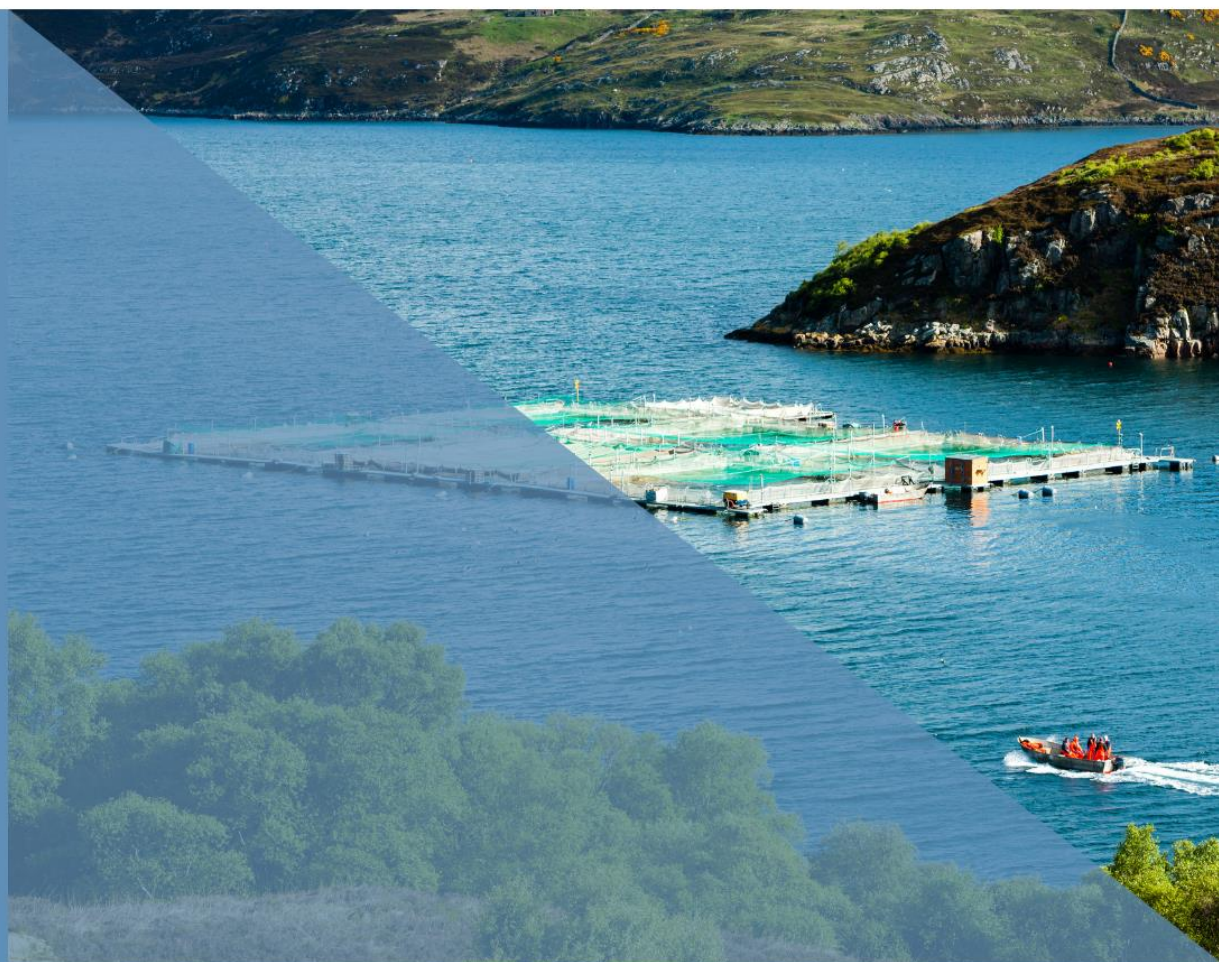


A global comparative study of present transparency and information databases on salmon farming



Prepared by Fidra
March 2022



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About Fidra and our Best Fishes project

This report is published by Fidra as part of our Best Fishes project. Fidra is an environmental charity who aims to achieve pragmatic solutions to environmental issues using the best available science working in collaboration with the public, industry, and government. Visit www.bestfishes.org.uk to find out more about Scottish salmon farming and www.fidra.org.uk to learn about Fidra's other projects.

Cover Image: Salmon farm, Loch a Chairn Bhain, Highlands, Scotland
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Executive summary

Introduction

Worldwide the farmed salmon industry, particularly Atlantic salmon farming, has grown substantially since the 1970's. Atlantic salmon farming accounts for 70% of the market with 2.6 million metric tons (t) produced globally in 2019¹. Despite this, the industry is inconsistent with its position on transparency across the world. Legal requirements to make information available to the public varies widely between individual countries, this often leaves the decision on information availability down to companies within the industry. The Aquaculture Stewardship Council (ASC) is currently the only certification scheme that requires a high level of transparency from companies².

The current global state of transparency across the industry

This study explored global data availability of information on Atlantic salmon farms. As a minimum the Food and Agriculture Organisation (FAO) produce annual yearbooks providing information on all aquaculture production, by species and country, or area (metric tons)¹. Norway is the world leader across the industry and have set a benchmark for transparency in aquaculture. The establishment of BarentsWatch³ 10 years ago has made real time data available for salmon farms across the country. Although the general consumer may need a level of understanding of the sector to navigate confidently across the portal, Norway salmon products are the most transparent on the global market.

The Australian government and companies working across Tasmania have recognised the issues within the sector and have increased the accessibility of data substantially in recent years⁴. Whilst the sheer volume of data seen on BarentsWatch³ is not available across any platform/dashboard, the Australian data is set up on a sustainability dashboard⁴ in an easily digestible format, where anyone, regardless of prior knowledge of the industry is able to navigate across any of the portals. The current dataset only spans from 2019-present. It is unclear if this limited data availability is linked to the resilience from the sector to provide information or if the data collection changed in 2019 and it was only easier hereafter to digitise this information.

Across Scotland, like Norway, all environmental data is publicly available. However, this data is significantly less accessible. Firstly, the data available is shared across four main platforms in different ways: Scotland Aquaculture website⁵; Scotland Environment website⁶; Marine Scotland Fish Health Inspectorate (FHI)⁷; and SEPA FOIs⁸. However, it is difficult to get a full overview on an individual farm's performance. This removes accessibility, leaving only experts able to navigate through available data. However, what is important to note is

that all information available is provided at a farm level, which is a more detailed level of information than in most other salmon farming nations.

Across the rest of the global aquaculture arena, access is considerably more sparse and less accessible to local communities and the public. In areas where there have been concerns over the impacts of sea lice to the environment and wild salmon, there is more publicly available data, for example Ireland produces annual sea lice reports⁹ and the British Columbia Region of Canada now has an online tool with information on environmental parameters¹⁰. Aside from this, information is not always available in English and the Faroe Islands do not have any publicly accessible data post-2012¹¹. In most countries, if it is not a requirement of government regulation to have data publicly available, companies are left to decide what they want to provide to local communities and consumers, with the result that data can be limited and hard to access.

In light of the findings of this report, Fidra believe now is the right time for a Scottish dashboard and total transparency in the sector and makes the following recommendations:

- 1. Scotland has an extensive amount of data publicly available, but it needs to be more accessible.**
- 2. A dashboard providing environmental parameters at farm-level is fundamental to hold the industry accountable.**
- 3. Scotland's 'Vision for a Sustainable Aquaculture' must include a real commitment to transparency to ensure the environment is kept at the forefront of decisions, particularly with the expected expansion of the industry¹².**
- 4. Retailers must listen to the public. The public want easier access to information on Scottish salmon products they purchase, 83% of consumers support having the name of the farm on the label of Scottish salmon products¹³. Labelling products with farm name and providing accessible information through a dashboard would put Scotland and the UK at the forefront of the global industry, which in turn could increase market performance locally and globally.**

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1. Introduction

Across the Atlantic salmon farming sector, transparency varies significantly on a global scale. Legal requirements to make information about the industry available to the public varies widely between individual countries, with the result that the information available is often controlled by the companies. The Aquaculture Stewardship Council (ASC) is the only certification scheme that currently requires a high level of transparency from companies²; however, the accreditation standards may not be met by all the farms owned by a company. Therefore, the level of transparency may vary within a company down to the farm-level.

In Scotland

Fidra's position paper on certification of Scottish salmon farming¹⁴ provides a detailed summary of the criteria used by certification schemes in Scotland. The paper indicated that only two certification schemes, the ASC² and the Soil Association¹⁵, require any information on the salmon farms accredited to be publicly available. Of the two schemes, the Soil Association only lists the farms that meet its certification standards, while by contrast, the ASC publishes its audit reports for individual farms online.

In Scotland, salmon farms are required to have a Controlled Activities Regulations (CAR) licence from the Scottish Environmental Protection Agency (SEPA) in order to operate. A farm must monitor several environmental parameters and submit the data to SEPA to show it is meeting its licence conditions. It is also required to submit monitoring data on fish health, such as diseases present and treatments used to the Fish Health Inspectorate (FHI), which is part of Marine Scotland. Much of this data is available to the public; however, it is held in different databases and usually organised by topic rather than farm. Therefore, finding out information about an individual farm's environmental performance from publicly accessible data is extremely difficult. This is covered in more detail by a desk study on the accessibility of farm-level data from the Scottish salmon farming industry carried out in 2020 by Fidra¹⁶.

The role of retailers

Retailers and/or their suppliers can actively choose the farm or company they want their salmon to be supplied from. However, at least in the UK, this information does not have to be available to the consumer. Fidra's 2020 desk study on the accessibility of farm-level data from the Scottish salmon farming industry focussed on a single UK retailer that provided the name or location of the salmon farm on their own brand products¹⁶. Despite having this information, the study found it was prohibitively difficult to find measurable environmental information on the salmon farm, which could have aided a consumer's decision during product selection.

Study aim

This study aims to explore the availability of information on Atlantic salmon farms globally. There are 12 main countries where Atlantic salmon is currently farmed; Norway, Chile, Scotland, Canada, Australia (on the island state Tasmania), New Zealand, the Faroe Islands, Iceland, Ireland, the Russian Federation, Denmark and Poland. Three main questions will be addressed:

1. What data is available in the public domain on salmon farms worldwide;
2. What data is available from the most commonly used certification schemes;
3. How accessible and comprehensive is Scottish salmon farming data in comparison to other countries?

This desk-based study provides global information on the transparency within the Atlantic salmon industry.

2. Accessibility of information

Data is available to the public across all countries that farm Atlantic salmon. As a minimum, the Food and Agriculture Organisation (FAO) produce annual yearbooks providing information on all aquaculture production, by species and country, or area (metric tons)¹. Often the accessible data is not always comprehensive, in one place, or up to date. Furthermore, there is a lack of responsibility to share data as most countries' regulations do not require the information to be made publicly available, particularly on environmental parameters.

Levels of transparency

'Transparency' is often used interchangeably with 'traceability'; however, they mean very different things when striving for environmentally sustainable aquaculture practices. Traceability is specific to information on the origin of a product and the movement of this information through a supply chain. Retailers who provide this information on their packaging rely upon data being available elsewhere, for example, through an information database such as BarentsWatch³ or an accreditation scheme such as ASC². Transparency is the provision of this additional information to identify the credibility of a salmon farm. Traceability is, therefore, essential to transparency.

Traceability is important, but it shouldn't be an alternative to transparency

In an environmentally sustainable aquaculture setting, transparency is the practice of sharing information with a wider audience. Fidra's position is to encourage retailers to ask for

transparency from industry to demonstrate and align with sustainability objectives and to help customers have better access to this information on a farm-by-farm basis. Traceability alone would limit access to key information that Fidra believe should be publicly available (Table 1). Companies that voluntarily opt to disclose data to a wider audience are seen to be taking a leading role in an industry where transparency is not a mandatory requirement. Concerns over competition and commercially sensitive data have been at the forefront of the agenda when transparency has been discussed alongside certification schemes. By comparison, retailers' main resistance to transparency is that consumers do not desire or need this data, and therefore 'farm name' is rarely included on the packaging of salmon products¹⁷. However, disclosing environmental data associated with individual farms should be common practice¹². It will increase trust in an industry already under scrutiny due to its impacts on the environment and the negative media attention it has received because of this. It will also demonstrate progress towards sustainability commitments.

Transparency schemes

Several schemes have been developed which aim to increase transparency around wild-caught and farmed seafood. There are three that are largely used by UK retailers, which increase the information available on several aspects of their farmed Scottish salmon products. This information ranges from details of salmon farming practices to what is printed on labels. The transparency schemes include The Ocean Disclosure Project¹⁸; The Sustainable Seafood Coalition¹⁹; and Sustainable Fisheries Partnership²⁰.

In particular, 'The Sustainable Seafood Coalition', established by Client Earth, requires members to adhere to its Labelling and Sourcing Codes of Conduct¹⁹. The labelling guideline's Voluntary Code of Conduct on Environmental Claims aims to "create harmonised seafood labelling that will provide consumers with accurate information on the provenance and sustainability of the fish or seafood". The sourcing code's Voluntary Code of Conduct on Environmentally Responsible Fish and Seafood Sourcing is designed to "ensure that consumers have confidence that the seafood they are buying meets or exceeds minimum standards of responsibility". The best practice outlined in the codes are seen as the minimum required level of transparency by Fidra, and we hope that retailers aspire to be fully transparent with consumers.

Table 1 Updated table of environmental criteria for optimal transparency for relevant audiences²¹

Environmental criteria	Detail required	Audience		
		General public/local communities	NGO's	Retailer's
Sea lice counts; other diseases	Real-time data	Essential	Essential	Essential
Mortality	Rates, causes and mitigation	Essential	Essential	Essential
Benthic survey details	Reasons for 'unsatisfactory' results, action taken	Essential	Essential	Essential
CAR license	Compliance, breaches, enforcement	Essential - Low level of detail	Essential	Essential
Wildlife interactions	Seal, otter and bird mortalities	Essential - low level of detail	Essential	Essential
Acoustic Deterrent Device use	Numbers, types and positioning	Essential - low level of detail	Essential	Essential
Medicine use	Medicine, application method and dosage	Essential - low level of detail	Essential	Essential
Chemical use	Chemical, application method and dosage	Essential - low level of detail	Essential	Essential
Planning applications	Details of company, site, biomass, EIA	Essential	Essential	Essential
Escape events	Reasons, recovery and mitigation	Essential - low level of detail	Essential	Essential
Production tonnage	From farm to country level	Essential - low level of detail	Essential	Essential
Plastic/other litter	Mitigation policies or guidelines	Desirable	Desirable	Desirable
Climate change	Carbon footprint, mitigation policies	Desirable	Desirable	Desirable
Feed Conversion Ratio (FCR)	By site	Desirable	Desirable	Desirable
Accreditation	Accreditation held, including audits	Desirable	Desirable	Desirable

In addition to these transparency schemes, there is an initiative called the Global Salmon Initiative²² (GSI), which has a long-term goal of improving sustainability across salmon farming. Its members currently represent 40% of the global farmed sector. This includes a commitment from thirteen members and eight associate member companies across eight operating regions, eighteen of which farm Atlantic salmon. The GSI is driving environmental sustainability through the ASC accredited certification; currently, 65% of GSI members are ASC certified, which equates to 244 farms²².

By actively promoting ASC certification over all others, the GSI indicates that full farm-level transparency could directly link to improved sustainability. There is risk with any initiative and relying upon GSI membership for traceability alone has its limitations. Firstly, the GSI is reliant on members to submit their own reports. It is unclear if a farm cannot meet the ASC certification what, if any, consequences the GSI member is subject to. Secondly, if the farm has not met the ASC certification requirements farm level information is then not provided through any other means via the initiative. Nonetheless, the uptake of the GSI is evidence of some desire for transparency across the sector.

Transparency across the global salmon farming industry

Australia

Across Tasmania, there are currently 16 freshwater farms and 47 licensed salmon marine farming leases; current production is estimated to be 56,989t^{1,23}. Three main companies operate in Tasmania: Tassal²⁴ and Huon²⁵ have their own sustainability dashboards, whereas Petuna (Van Diemen Aquaculture) produces annual sustainability reports and refers website visitors to use the Tasmanian Government dashboard for salmon farming data⁴. At a regulatory level, the Australian government provides summarised information through the dashboard⁴. The Australia-wide sustainability dashboard includes environmental and chemical information, since 2019. The information is split by location first and then company. However, if a company owns multiple farms in an area, the information is not further categorised by farm. Further to this, it is unclear if historic data will be added to this database in future.

Canada

Canada is the world's fourth largest Atlantic salmon producer (118,630t¹). Atlantic salmon farming is split into two main regions in Canada, British Columbia and the east coast provinces, with seven operating Atlantic salmon farming companies. In British Columbia, concerns over the impact of Atlantic salmon farming on wild salmon has resulted in the launch of an online tool¹⁰ in 2020 via the British Columbia Salmon Farmers' Association (BCSFA). The tool uses eleven indicators of the industry's environmental, economic and social performance. The data is held for a five-year reporting period and is very broad. Whilst there is an interactive map²⁶ of where the farms are located, you cannot explore any of the indicators on a farm or even region level. There is a more comprehensive online 'Deeper Dive' tool which was launched at the same time as the performance tool, which enables users to click on specific topics of interest and access more detailed data, but this is also not at a farm level. Fifty-one of the seventy-nine farms across the British Columbian region are ASC certified²⁷. Across the east coast, information is less accessible and more difficult to find. This is likely to be due to provinces and territories managing their finfish regulations

separately. The only central platform for east coast aquaculture information is through a membership-driven association known as the Atlantic Canada Fish Farmers Association (ACFFA). There is no online tool, but the ACFFA produce general annual reports²⁸ and a lice management report²⁹ over a 10-year period, which are all publicly accessible. However, these annual reports do not provide any data on performance or any environmental indices at a farm level.

Chile

Across Chile, 32 large companies operate in the salmon farming industry. Approximately 1,000 marine farms operate throughout the country, producing 25% of the world's supply³⁰ (701,984t¹), making it the second largest Atlantic salmon producer globally. Of these farms, ~12% are ASC certified²⁷. Information on certain environmental data appears to be available on a few company web pages; however, most information (bar the websites home pages) is in Spanish and therefore inaccessible to non-Spanish speakers. There is also a portal, 'SalmónChile', through the Chilean Salmon Industry Association, which provides sustainability reports for individual companies³¹, although it does not include all companies which operate in the region and it is unclear what information is accessible without being able to read Spanish. Further to this, eight companies across Chile are a part of the GSI³².

Denmark

It is unclear how many salmon farms operate across Denmark, but in 2019 Denmark's environment minister announced no future open pen fish farms would be approved³³. The move to land-based fish farms is linked to the country's desire for 'greener' fish farming where issues with sea lice and salmon escapes are completely removed from the equation. The scale of Atlantic salmon farming is significantly smaller than all other countries (1,463t¹), but regulations are driving traceability in the sector. Hazard Analysis and Critical Control Point (HACCP) inspection reports are available for salmon farms in the country; however this information is not available in English³³.

Faroe Islands

Outdated information on Atlantic salmon farming appears on the Faroe Fish Farmers Association (FFFA) webpage¹¹, the page was last updated in 2012, making it redundant. The FFFA claims all feed has full traceability, but limited online information is available. Only three companies appear to be exporting salmon, these are Bakkafrost, Mowi and Hiddenfjord. Bakkafrost is the only company whose Faroe farms are all ASC certified²⁷ (Table 3). There is limited online data and no information on environmental parameters across the Government³³, FFFA or individual websites available for Mowi or Hiddenfjord.

Iceland

This nation has a long and turbulent relationship with aquaculture due to the naturally rough weather conditions, with sea temperatures often reaching extremely low levels³⁴. As a result, the production of Atlantic salmon was relatively low until 2015, which saw production more than double from its previous year¹. Over 46,000 metric tons of salmon were produced last year³⁵, an increase of 46% since 2010 (1,068t) and an increase by a factor of 1.7 from 2019 (26,957t)¹. As a result, aquaculture is one of the fastest-growing industries across the country. Furthermore, as arctic charr is increasingly moving to large-scale land-based systems, more companies are also expected to increase Atlantic salmon aquaculture systems on land³⁶, though most recently, these numbers have declined³⁵. Individual companies operating in Iceland produce their own sustainability reports³⁷, but publicly available data does not appear to be enforced by the government, and there is no portal or dashboard available.

Ireland

Ireland is a small producer of farmed Atlantic salmon (11,333t¹). Ireland's government website provides details on all finfish farm licenses³⁸ and annual sea lice data reports via Ireland's Marine Institute are publicly available, with summary sea lice tables split by company and farm level⁹. However, companies are responsible for benthic environment reports³⁹, which do not appear to be publicly available. Only six farms are ASC certified farms (Table 2).

Norway

As the largest producer of farmed Atlantic salmon (1,364,042t¹), Norway has 1712 aquaculture sites, 1341 of which are marine. Norway also has an extensive and long-established sustainability portal called BarentsWatch³. The portal was established in 2012 to provide a centralised database with a wide range of available open data content. The online portal is considered the 'gold standard' across the industry. It provides information in real-time, at farm level, on a wide range of environmental indices, which no other country provides in such an accessible way. Around 20% of Norway farms are ASC certified, with 278 farms across 21 companies meeting the accreditation criteria.

Poland

Uniquely, Poland only has land based Atlantic salmon farms. Atlantic salmon is not widely farmed in Poland. However, in 2020 Pure Salmon Poland became the first land-based Atlantic salmon farms to receive Aquaculture Stewardship Council (ASC) certification⁴⁰. The FOA fishery yearbook does not provide species specific production tonnage for Poland¹.

Russian Federation

Since the first Russian decree prohibiting import bans on certain EU, US, Canadian, Australian, and Norwegian products, including fish⁴¹, the country's aquaculture industry has expanded. Across the Russian Federation, between 2014-2019, Atlantic salmon production increased by a factor of 1.7, though similar to Iceland, sea water temperature is likely to be the explanation for inconsistent values of Atlantic salmon produced annually^{1,42}. In 2020, the country's Atlantic salmon and trout farms produced 116,000t, and it is anticipated to continue to increase production levels to 150,000 by 2030⁴². Companies are not required to disclose actual production figures; therefore, it is unclear how many farms there are or their actual production figures. There is no data available in English, if this data is available, on the sustainability of Russian salmon or any environmental metrics and the country does not have any farms ASC certified (Table 2).

Scotland

Scotland is the third biggest Atlantic salmon producer globally (190,500t¹). Eleven companies operate across 232 sites. Of these, 14 farms are ASC certified²⁷ within one company (Table 3). Data is publicly available on annual production collected by the Scottish Government's Marine Scotland Directorate through surveys⁴³ and monthly mortality rates are published by Salmon Scotland (the industry body formerly known as Scottish Salmon Producers' Organisation of SSPO)⁴⁴. Though neither report publishes this information by farm. Additional environmental data submitted to the regulators SEPA and FHI is available within the public domain at farm level.. This data is accessed via the following locations:

- Scotland Aquaculture website⁵
- Scotland Environment website⁶
- Marine Scotland Fish Health Inspectorate (FHI)⁷
- SEPA FOIs⁸

However, as this information is held in different databases and usually organised by topic rather than farm. For example, on the Scotland Aquaculture website information is accessed by selecting a category and can be filtered by date, fish type, site ID, site name and operator and sometimes local authority depending on the type of data⁵. Therefore, finding out information about an individual farm's overall environmental performance is extremely difficult.

Table 2 Total number of Atlantic salmon marine farms which are ASC certified by Country²⁷.

Country	No. of marine farms
Australia	4
Canada	25
Chile	121
Denmark	1
Faroe Island	16
Iceland	3
Ireland	6
Norway	278
Poland	2
Russian Federation	0
Scotland	14

Summary of current limitations of available data

- Data available is inconsistent across countries or companies. As a result, the public living near or purchasing salmon products are not in a position where they can access information on the differences in salmon products across multiple countries and are instead left to try and navigate across multiple resources, where available, to export information on the sustainability of the salmon product they wish to purchase.
- Data is often split in different incomparable arbitrary ways, including by region or summarised by company.
- Data is not all available in one place. If it is, this is typically presented in a 'company-wide' overview of all operations, so it is unclear how individual farms are performing. This makes it very inaccessible to the public, consumers, and communities local to salmon farms.
- There are clear gaps in data that could be solely down to the general public's limitations to speak an array of languages.
- Chile, the Faroe Islands and the Russian Federation have the least accessible data available to the public on marine based operations, except where ASC certification has been achieved.

3. Data availability across certification schemes used by the Scottish salmon farming industry

Certification schemes have become a fundamental feature in the salmon farming industry. UK retailers rely upon them to make informed decisions about the products they stock and consume. Eight main accreditation schemes are discussed in depth in Fidra's position paper on certification¹⁴. All certification schemes promote varying degrees of 'environmental

sustainability' through different indicators and have different 'thresholds', and the importance of sustainability varies. All the schemes are voluntary and for a farm to acquire certification it is often costly, without the guarantee of product prices increasing or better access to the market. Despite the eight main schemes being a central focus in the industry, Fidra's 2021 consumer survey¹³ found that retailers' own labels/certification logos were deemed as a more important factor for a consumer when selecting which salmon product to purchase, followed by the Royal Society for the Prevention of Cruelty to Animals (RSPCA) Assured certification. By contrast, retailers and transparency initiatives such as the GSI see the ASC certification scheme clearly demonstrating that the farm is committed to transparent practices.

The Aquaculture Stewardship Council certification scheme

As previously recognised by Fidra's position paper on certification¹⁴, the ASC certification scheme has the strictest criteria for environmental impacts, disease, social responsibility and transparency than any other scheme. The ASC², unlike government and company data portals, requires companies to make data available for each individual farm, arguably making data more accessible than most individual countries' authorities. Further to this, the ASC is the only scheme supported by the GSI, that is striving for ASC certification across all farms. Currently 470 farms globally are certified through ASC²⁷. No other scheme makes data as accessible. A list of fish farm sites certified by the Soil Association¹⁵ is available on their website, but it is hard to find and does not provide any additional information. Other certification schemes do not even offer that level of information¹⁴.

The ASC provides accessible data in a universal way for all consumers. However, the ASC farm audit reports do not provide detailed information on the quantity or frequency of chemicals used on individual farms. The ASC is an important starting point for fish farms to achieve a higher level of transparency, but without regulatory bodies pushing for open access of information, the public is unlikely to be provided with enough information to make informed choices. Relatively few Scottish salmon farms are ASC certified when compared to other countries (Table 2).

Other schemes

The low uptake of the ASC certification by Scottish salmon producers is in some cases linked to the opposing criteria of other certification schemes. For example, Label Rouge certification⁴⁵ does not assess environmental or animal welfare criteria, has no standards regarding sustainability and requires a high marine content in feed⁴⁶. Further, detailed information on the certification is only accessible to retailers and consumers in French⁴⁶. The Label Rouge logo is highly valued because it puts a farm in a more favourable position

in France, which is an important market for Scottish salmon. However, the short-term gain for farms through access to a wider market should not be considered more important than the long-term future of the farm and its impacts on the surrounding and wider environment.

Global G.A.P have developed a portal that provides what they refer to as 'farm information' via a barcode on packaging⁴⁷. However, this is in fact company level information and therefore has limited detail. Further to this, transparency across certification schemes is a minority practice. As previously mentioned, only the ASC and the Soil Association certification schemes provide any publicly accessible information on individual farms and therefore until this is normalised and not seen as a competitive concern to companies, other certification schemes are unlikely to follow suit.

Table 3 A summary of ASC certified farms by country and company²⁷ (data across all farm types included).

Country	Company	ASC Certified	Initial Audit	Expired	Failed application	Suspended	Cancelled	Withdrawn
Australia	Tassal	4						
	Huon Aquaculture							3
Canada	Cermaq	5	1	3			5	1
	Greig Seafood BC Ltd.	8					1	
	Mowi Canada West	12		2			4	5
Chile	Acuimag S.A.	11	1		1			
	Australis Mar SA	14	3		1		6	
	Cermaq chile	11	3		3		7	
	Cooke Aquaculture Chile	3			1		1	
	Empresas AquaChile S.A	13	7	1	2		8	
	Invermar S.A	5	1	2	3		1	
	Multexport Patagonia S.A.	3					2	
	Mowi Chile	18	1		2	2	7	1
	Nova Austral	5	1		1		3	10
	Productos del Mar Ventisqueros	6		1				
	Salmones Blumar S.A.	9	2				4	
	Salmones Blumar Magallanes SpA	8	1					
	Salmones Camanchaca	12	1		3		12	
	Salmones Multiexport Foods	1	2					
	Trusal S.A.	2						
	Granja Marina Tornagaleone S.A.		1					
Salmones Porvenir Spa		1						
Ventisqueros S.A.						1		
Faroe Islands	Mowi Faroes		1	1				
	P/f Bakkafrost Farming	16	2	1				

Norway	Astafjord Smolt AS		1					
	Ballangen sjofarm AS *	3						
	Bremnes Seashore	1	3					
	Cermaq Norway	27		2		1	3	1
	Edelfarm	2						
	Fidra Sjoframer AS *		2					
	Flakstadvag Laks AS *	1	2				1	
	Frdrikstad Seafoods AS	1						
	Grataglaks AS		1					
	Grieg Seafood Finnmark AS	18						
	Grieg Seafood Rogaland AS		3					
	Hofseth Aqua AS	4						
	Kvaroy Fiskeoppdrett	5						
	Leroy Aurora AS *	20	1					
	Leroy Midt AS *	30	1				1	
	Lingalaks AS	2	1					
	Mowi ASA	11	3					
	Mowi Norway	63		1		3	5	9
	Masoval Fiskeoppdrett AS*			1				
	Nordlaks Oppdrett AS	6						
Norway Royal Salmon	16		1					
Nova Sea AS	21							
Ocean Farming AG	1							
SalMar ASA	42	8				7		
Salkas AS	2	1						
Wenberg Fiskeoppdrett	2							
Scotland	Mowi Scotland	14	9					
	Scottish Sea Farms		2					
Denmark	Danish Salmon A/S	1						

	Atlantic Sapphire Denmark A/S							1
Iceland	Arctic Sea Farm	1						
	Amarlax	2						
Ireland	Mowi Ireland	6						
Poland	Jurassic Salmon	1						
	Pure Salmon Poland Sp. Z.o.o	1						

4. Scottish farmed salmon: a comparative summary

Norway is perceived as not only the largest stakeholder in the industry, but also world-leading in transparency due to the extensive online portal BarentsWatch³. Despite the Scottish salmon industry providing a wealth of information online, as previously stated, this is not shared from one central point. Herein lies the problem, as unlike Norway or Australia, the public are not able to access this data easily, even if it is extensive. Data across all platforms is provided as exportable information by parameter, for example, all the data for the sea lice treatments used on salmon farms in Scotland are in one area of the Scotland Aquaculture database, while data for sea lice in-feed treatment residues and results of environmental monitoring surveys are in other areas. Separate areas, therefore, need to be visited to get an overview of a single farm. As a result, it is difficult to assess or understand the performance of an individual farm, making any analysis or comparison very time-consuming and inaccessible to many.

The role of retailers

Retailers recognise the need for global industry standards for seafood traceability. Major retailers, including Lidl, Tesco, Sainsburys, Co-op and Aldi, were amongst the companies and organisations that drafted the Global Dialogue on Seafood Traceability (GDST) standards⁴⁸. These standards focus on traceability over transparency; therefore, at most, they are designed to meet operational business needs and do not commit to transparency. Transparency will provide accessible data on a broad range of environmental criteria that should be available if retailers intend to use them to make informed decisions on the products they stock. Currently, no farmed Atlantic salmon companies are adopting the GDST standards⁴⁹. The first imperative and straightforward step towards transparency is for retailers to strive for traceability of all their salmon products, not just premium or own branded products. Consumers need to be able to identify the supply chain from farm to fork, and this would put pressure on all to operate under best practices. A longstanding belief amongst the industry, particularly retailers, is that consumers do not care enough. Therefore, adding this information would be unnecessary and potentially time-consuming and costly.

Why is it important to have transparency of data in the public domain?

Fidra have conducted two independent surveys via survey monkey, and whilst they never explicitly asked 'why is it important for full transparency to the public', there is undoubtedly interest for more information on the origin of salmon products. Consumers overwhelmingly want this information to be accessible via food packing, as evidenced by ~70% of respondents¹³. Even though the main influences of a consumer's decision during product selection are found to consistently be freshness, price and colour, there is an increase in demand for information on whether the product was responsibly sourced and sustainable¹³.

Even though consumers rate retailer sustainability assurances the highest, retailers should provide an appropriate level of information to support consumers' purchasing decisions.

There is a rise in consumer demand for more information on responsible sourcing and sustainability to be available on Scottish salmon product labels.

Consumer requests for transparency are most likely to peak when there is substantial negative media attention on the industry, whether through documentaries⁵⁰, reports⁵¹ or news outlets⁵²⁻⁵⁴. We are in a pivotal position in society where there is an increasing awareness of the impact of agriculture and aquaculture practices on the environment¹². For a large proportion of the public, being concerned about the environment is a privilege that some cannot afford; however, transparency should be available to all, not only to those who can 'afford' to care and therefore pay the premium price for this information^{55,56}.

Traceability programmes

One of the current points of resistance to supply chain traceability on farmed salmon products lies with the retailers. Not only are they unable to see an appetite for this information from consumers, but retailers also argue that it would be a costly addition to packaging, which they deem to be already overcrowded with information. The digitisation of the reporting processes would significantly contribute to improved transparency across the sector and could resolve some of the retailers' concerns over the introduction of salmon farm or location being added to their packaging. For example, the IBM Food Trust platform⁵⁷ uses QR codes on packaging to make information available to the end-user on the product. This programme or similar schemes including Global G.A.P's barcode initiative⁴⁷ could be used to label products at the point of sale, for example on shelf, with information including farm name and farm certification information.

5. Working towards sustainable aquaculture

Despite the known environmental implications of salmon farming, aquaculture is viewed as one of the most eco-efficient forms (a management strategy used to move to more efficient practices within the supply chain to improve components of the industry) of protein production^{58,59}. Half of all seafood eaten worldwide comes from aquaculture³². The industry is continuing to expand, and best practices need to be adopted and upheld. A longstanding issue with farming finfish, regardless of species, is the lack of consistent long-term monitoring of local marine environments to assess the true impact of finfish aquaculture. Despite the salmon farming industry's long history in Scottish waters, studies on environmental impacts have been sporadic, as illustrated by a 2018 report indicating

medicinal treatments can have a severe impact on Scotland's seabed^{60,61}. Waste restrictions have been tightened to control organic waste deposited, and operators expect significant investments into monitoring. However, it is difficult without detailed historic monitoring to know the extent of harm inflicted across Scotland on the habitats and marine life around fish farms from long-term chemical use before further restrictions were implemented⁶².

Offshore fish farms

Offshore farms have long been seen as a potential alternative to the already crowded north and west coastlines of Scotland and in other areas of the world⁶³⁻⁶⁵. However, there are large knowledge gaps, so any expansion of marine farms to offshore locations needs to be approached with caution^{66,67}. For example, offshore farms may inadvertently pose threats to wild Atlantic salmon migratory routes and there is a potential for increased escapes and mortality rates due to the increased likelihood of storm events⁶⁷. Further to this, economics associated with damage and accessibility are unclear as there are so few active offshore sites at present. Perhaps the most important factor for long-term sustainable aquaculture, regardless to the farm's location (i.e. coastal or offshore) is the Environmental Carrying Capacity (ECC)^{66,68}. The ECC is defined as environmental characteristics (including bathymetry conditions, physical-chemical characteristics of water and substrate, trophic status and colonising capacity (fouling)) of the environment, which help determine the discharge load (i.e., dissolved and particulate organic matter, chemicals) that might be assimilated by the affected ecosystem⁶⁹. Norway is the largest farmed salmon producer in the world and has developed a sustainably led best practice in aquaculture linked to the carrying capacity of the ecosystem⁷⁰. However, without adopting an ECC approach they are in a position where individual farms may meet criteria to be within a carrying capacity, but the wider area comprised of multiple leases may still have damaging impacts on the marine ecosystem due to sea lice presence and therefore not guarantee long-term sustainability⁷¹.

British Columbia farmed salmon: Have lessons been learned?

There is an ongoing issue with ignoring the welfare of wild salmon and marine life and solely focusing on farmed stocks. The continued battle between British Columbia's government and its aquaculture industry shines a light on potential future issues across Scottish aquaculture if further legislation is not introduced to protect wild salmon from wild-farm interactions⁷². Concerns over sea lice from farmed salmon populations endangering wild salmon stocks were brought to the attention of the Canadian Government in 2020⁷³, with a particular emphasises on sea lice data being underreported⁷⁴. This led to the announced closure of 19 salmon farms on the Discovery Islands and a federal court case overturning the decision due to the lack of consultation and evidence. This occurred despite building evidence showing a link between farm-intensive areas and the spread of salmon lice to wild

Atlantic salmon worldwide⁷⁵⁻⁸⁰. Even though Norwegian data on salmon lice-induced mortality of wild Atlantic salmon where the source of lice is farmed salmon⁸⁰ have faced criticism over model choice resulting in overestimating mortality of wild salmon^{80,81}, there is now no doubt that the link exists and should be addressed. If the Scottish Government continue to support industry to double productivity across aquaculture by 2030⁸² without sound scientific knowledge on the impacts this expansion could have on marine ecosystems, there will not be enough measures in place to mitigate this.

6. Recommendations and concluding remarks

From the research that Fidra has conducted into transparency across the Atlantic salmon farming industry at a global scale, much more needs to be done. The level of data, where available, can differ within a country and is often controlled at a regional and company level. Legislation would be the most efficient way to ensure open access of data on environmental parameters within the industry. However, legislation would not necessarily lead to publicly accessible farm-specific information being in a comprehensive format.

True farm to fork transparency would require both comprehensive farm-specific information to be accessible, and the ability to identify which farms retailers sourced from, for example by providing the farm name on product packaging. A commitment from retailers to adhere to the three main transparency schemes is important to encourage the adoption of best practice measures in terms of transparency. Retailers could make a substantial increase in transparency by labelling all their own -brand salmon products with the farm name that the salmon was produced on, or providing that information through a QR code or barcode on pack or on shelf.

Why now is the right time for a Scottish dashboard and total transparency in the sector

The Scottish Government is currently developing a 'Vision for Sustainable Aquaculture' to be published by the end of 2023⁸³. A commitment to the inclusion of more accessible data for all levels of expertise would show a real commitment to the protection of the environment. Fidra recommends a dashboard with portals and/or information tailored to separate users such as retailers and consumers/local communities (Table 1). Unlike other countries, Scotland's finfish aquaculture continued development on one fish species, Atlantic salmon. Therefore, **public perception of the potential environmental, as well as social impact is highly relevant with the expected expansion and continued operation of this industry**¹². The public want **easier access to information** on Scottish salmon products they purchase¹³. Labelling products with farm name and providing accessible information through a

dashboard would put Scotland at the forefront of the global industry, which in turn could increase market performance locally and globally.

Fidra's summarised recommendations

1. **Scotland has an extensive amount of data publicly available, but it needs to be more accessible.**
2. **A dashboard providing environmental parameters at farm-level is fundamental to hold the industry accountable.**
3. **Scotland's 'Vision for a Sustainable Aquaculture' must include a real commitment to transparency to ensure the environment is kept at the forefront of decisions, particularly with the expected expansion of the industry¹².**
4. Retailers must listen to the public. The public want **easier access to information** on Scottish salmon products they purchase, **83% of consumers support having the name of the farm on the label of Scottish salmon products¹³**. Labelling products with farm name and providing accessible information through a dashboard would put Scotland at the forefront of the global industry, which in turn could increase market performance locally and globally.

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