EXECUTIVE COUNCIL

PUBLIC

Title:	Aquaculture Development: A review of international best practices and regulatory options.
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Portfolio Holder:	MLA Teslyn Barkman
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Previous papers:	153/18: Fish Farming Proposal 156/19: Aquaculture Development
List of Documents:	Appendix A Falklands Salmon Farming – Best Practice Recommendations Appendix B Falklands Salmon Farming – Legislative Review Appendix C Summary Report for Salmon Farming in the Falklands

1. Recommendations

Executive Council discussed the report and confirmed that they were not minded to agree the recommendations in the report.

It was therefore resolved that:

A. there would be no ban on all aquaculture activities.
B. they were not minded to agree to any large-scale fish-farming in the Falkland Islands.
C. they were not minded to approve any fish–farming that involve the introduction of further new species to the Falkland Islands.
D. any licences issued under the Fish Farming Ordinance 2006 will be subject to a condition limiting the maximum annual production to 50 metric tonnes.
E. the outstanding consultation and policy development exercise was not to be completed in the form described in the report.
F. a robust legislative framework be developed and implemented.
G. officers are asked to report back to Executive Council on options to implement the above policy decisions.

~~Honourable Members are recommended to approve:~~

~~(a) That the outstanding consultation and policy development exercise is completed (Section 5.1).~~

~~(b) That a robust legislative framework is developed and implemented (Section 5.2).~~

~~(c) That a cap on annual production of 20 mt is set for any licensing under the Fish Farming Ordinance 2006 (Section 5.2).~~

~~(d) That a ban on all aquaculture is not implemented (Section 5.3).~~

2. Additional Budgetary Implications

2.1 None

3. Executive Summary

3.1 FIG was first approached in 2017/2018 about the possibility of establishing large-scale salmon farming in the Falkland Islands. This led to reports to Executive Council in September 2018 and November 2019, which sought to allocate resource to investigate the technical, policy and regulatory requirements, which would be required to support a well-managed aquaculture industry.

3.2 MacAlister-Elliott & Partners (MEP) were subsequently commissioned to carry out a number of tasks the result of which were expected to provide FIG with clear information to enable a policy and legal framework within which large-scale salmon aquaculture could be established in the Falkland Islands.

3.3 Three key areas of work were identified:

3.3.1 A review of international best practice

3.3.2 A review of regulatory frameworks in other jurisdictions as well as a review of the Fish Farming Ordinance 2006 and other Falkland Islands legal powers linked to aquaculture.

3.3.3 An island-wide consultation process and the development of a policy framework.

3.4 A review of international best practice is appended to this report at Appendix A. A legislative review is appended at Appendix B. A possible first of its kind in the world, "platinum model", is appended at Appendix C as a summary report for what large-scale salmon farming in the Falkland Islands could look like in terms of having high minimum standards.

3.5 Whilst there has been much community discussion of the subject, the island-wide stakeholder consultation and policy development task has not been completed. DNR considered that ExCo should be appraised of the project outcomes thus far and request approval for next steps, following the clear public and political concerns that were raised during the hustings and following the recent general election.

3.6 In order to ensure that appropriate governance around policy development is delivered, this paper recommends the completion of the consultation and policy development task with regards to this project. Completing this work does not preclude the government from making a final policy decision to ban large-scale aquaculture.

3.7 In order to allow the current small-scale aquaculture operation to continue it is recommended that the existing regulatory framework is strengthened to ensure FIG have the appropriate powers to ensure these activities are carried out to high environmental standards.

3.8 As a precautionary measure and to ensure aquaculture activities are limited to an acceptable level until further regulatory and policy tasks are completed, it is recommended that licensing under the Fish Farming Ordinance is capped at 20 mt per annum.

3.9 A complete ban of all aquaculture is not recommended at this time due to the negative and financial impacts that it will have on the industry. Additionally, at this point in time, there is no clear evidence that this operation is causing any harm.

4. Background

4.1 In 2017 the Falkland Islands Government were approached by a Danish company F-Land, who were interested in developing an Atlantic Salmon (*Salmo salar*) farming project in Falkland Island Waters. In 2018 following consideration of report 153/18 by Executive Council, FIG entered into a "letter of intent" with F-Land. The letter indicated that FIG was positively disposed to the establishment of an aquaculture industry, but first wish to appraise the conditions necessary for the production of 50,000 tonnes of Atlantic salmon, considering both the potential benefits and risks around the establishment of that industry. The letter did not, however, commit FIG to approve the establishment of such an industry, nor did it seek to pre-judge the regulatory framework which would be applied.

4.2 F-Land then partnered with FI company Fortuna Ltd to create Unity Marine.

4.3 During 2018 and 2019 a number of studies were carried out by F-Land to create a baseline understanding of the activities and impacts on the Falkland Islands of potential salmon farming activities. FIG officers reviewed these reports and concluded that there was sufficient information to demonstrate feasibility, but not enough to green light a project.

4.4 DPED and DNR considered that the potential benefits of large-scale aquaculture are significant, and experience from multiple jurisdictions demonstrates that there can be equally significant risks associated with a weak regulatory environment. As a potential frontier environment for salmon farming and possibly other near-shore aquaculture, the Falkland Islands has an opportunity to learn from global experience and implement policies and regulations that will result in a sustainable, best-in-class aquaculture operation. It was therefore critically important for the Falkland Islands to conduct its own assessment of requirements and potential impacts, independent of any particular industry proposal.

4.5 Given FIG does not have in-house capacity or subject matter knowledge in this area, independent consultants, MacAlister-Elliott & Partners, were commissioned to carry out a review of international best practice and regulatory frameworks, in order to inform any future policy development and/or regulatory improvements.

4.6 There is existing, smaller-scale aquaculture already in operation in the Islands, and a basic regulatory structure.

4.7 In 2013, Fortuna Limited applied for a license (under the *Food and Environment Protection Act 1985*, the *Environment Protection (Overseas Territories) Order 1988* and the *Environment Protection (Overseas Territories) (Amendment) Order 1997*) to install two floating fish-cages at Shell Point, Fitzroy, East Falkland for the purpose of rearing Brown Trout (*Salmo trutta*).

4.8 A license was granted for a period of two years expiring on 30th September 2015, for two cages and a maximum production of 15 mt per annum. A number of conditions were included within the license and were contained within the Environmental Impact Statement which formed part of the planning application 89/12/P.

4.9 In 2018, Falklands Fish Farming Ltd (50% owned by Fortuna Ltd, and 50% owned by CFL) applied for planning permission to install two additional cages with a maximum production of 15 mt. Lifetime planning permission was granted and thus far has not been commenced. The planning permission will lapse if it is not commenced within 5 years of being granted (prior to 20 February 2023).

4.10 In order to modernise our legislation and to facilitate a fish farming industry, the Falkland Island Government developed and passed the Fish Farming Ordinance 2006, however, this did not commence until 2016. Whilst this ordinance provides a reasonable high-level framework, no detailed regulations have been developed in order to ensure robust controls. Additionally, there has not been any work carried out to ensure that other regulatory measures are put in place and are all aligned.

4.11 As of the beginning of March 2021, Falklands Fish Farming Ltd have no license to operate fish farming for the two cages that are currently deployed at Shell Point, Fitzroy.

4.12 Falklands Fish Farming Ltd have applied for and have been awarded planning permission for the existing fish cages at Shell Point, Fitzroy (Annex A 11.21.P), and the terms and conditions of that permission are broadly aligned to those with the 2018 permission.

4.13 In order for the Falkland Islands Fish Company Ltd to continue their fish farming operations they now require a license for production. DNR has requested that a full EIA be carried out and a monitoring programme developed which can be considered as part of the application. There is currently a delay whilst the survey work is carried out. It is expected that the application will come to ExCo for consideration in the third or fourth quarter of 2022.

4.14 Whilst it is unfortunate that this process has been far from perfect with regards to the operator holding the correct permissions and licenses at all times since 2013, it is a key objective under the 2018-21 Islands Plan to support the growth and expansion of our local industries and businesses; Falklands Fish Farming Ltd has been working towards developing a sustainable small-scale fish farming business for the Falklands Brown Trout, approval of their license application subject to appropriate conditions is required for the business to continue to operate.

4.15 The original planned project supported a number of Islands Plan 2018-2022 objectives, it is expected that it would continue to support a number of objectives in the 2022-26 Islands Plan, but this cannot be confirmed at this point in time. Objectives that this project would support include:

- creating long term, coordinated strategies that ensure our economy remains sustainable and benefits everyone
- ensuring responsible marine management
- promoting opportunities for individuals and families to live in Camp
- developing science and technology capabilities for the Islands
- Augmenting economic development in Camp

5. Options and Reasons for Recommending Relevant Option

5.1 Consultation and policy development task: this is the third and final piece of work that ExCo tasked DNR to complete prior to any final policy decisions regarding large-scale aquaculture. This task has not yet been completed as a result of clear public and political concerns that were raised during the hustings and following the recent general election. DNR considered that ExCo should be appraised of the project outcomes thus far and request approval for next steps.

5.1.1 Complete this task:

5.1.1.1 Benefits: ExCo will be able to consider a full project plan inclusive of objectively informed stakeholder feedback. ExCo then have the option to either support the development of large-scale aquaculture or not, but regardless they will have a robust mandate. The government will have a "project on a shelf – ready to deploy" if in the future large-scale aquaculture is desired. This may also provide a more robust policy that can regulate the current activity.

5.1.1.2 Risks: Could give the general public the impression that the elected Government supports large-scale aquaculture. Could indicate to industry that the government supports large-scale aquaculture, when they may just complete the task without then implementing it.

5.1.2 Don't complete the task:

5.1.2.1 Benefits: ExCo will consider they have achieved a political mandate they believe they have following the general election.

5.1.2.2 Risks: the government cannot be sure that the public has had the opportunity to be objectively informed about the risks and rewards of large-scale aquaculture. The government will be sending a clear message to industry that they will not facilitate the development of this potential new industry and that will result in a loss of investment in collection of environmental baseline data which could have helped inform any future decision about whether to implement large-scale aquaculture.

Recommendation: complete the consultation and policy development exercise.

5.2 Implementation of a robust legislative framework that enables sustainable aquaculture to take place.

5.2.1 Complete this task to ensure protection of "small-scale", existing aquaculture operations

5.2.1.1 Benefits: this will protect the existing business, whilst strengthening the environmental controls (requirement for a full EIA and monitoring programme), including the introduction of a cap on annual production at 20 mt per annum.

5.2.1.2 Risks: Completing this task so that only small-scale aquaculture can be facilitated in the future will send a clear message to industry that FIG does not wish to facilitate large-scale aquaculture of any species.

5.2.2 Complete this task to control all aquaculture including large scale aquaculture

5.2.2.1 Benefits: this will not only protect the existing business and introduce stronger environmental controls; it will also provide FIG with a legal framework to establish large-scale aquaculture of any species in the future with a shorter lead-in time should the need arise (economic diversification).

5.2.2.2 Risks: Could give the general public the impression that the elected Government supports large-scale aquaculture. Could indicate to industry that the government supports large-scale aquaculture, when they may just complete the task without then implementing it.

5.2.3 Do nothing

5.2.3.1 Benefits: Allows the continuation of existing small-scale aquaculture with no changes.

5.2.3.2 Risks: Does not ensure best practice systems can be appropriately implemented as legal powers will not be sufficient. By not establishing an annual production cap any interested company can apply for a license for any amount of production and it would have to be considered by DNR.

Recommendation: complete the task of building a robust legislative framework to ensure sustainable small-scale aquaculture, with a production cap of 20mt per annum

5.3 A final option that needs to be considered is an island-wide ban of any and all aquaculture activities in the Falkland Islands. Considering some of the public and political feedback regarding the potential environmental risks associated with aquaculture, it might be considered that intensive farming practices within our nearshore marine environment should be prevented from happening anywhere. This can be achieved by making this policy decision and then repealing the current ordinance.

5.3.1 Benefits: Protects the Falkland marine environment from any form of aquaculture activity no matter how big or small, by removing the legal framework that facilitates these activities.

5.3.2 Risks: Significant cost to industry that will need to be mitigated for. Results in longer lead in time for FIG should they wish to implement large-scale aquaculture in the future as the relevant legal framework would need to be started from a baseline of nothing.

Recommendation: That a ban on all aquaculture is not implemented.

6. Resource Implications

Financial Implications

None

6.1 Human Resource Implications

None

6.2 Other Resource Implications

None

7 Legal Implications

7.1 REDACTED.

7.2 REDACTED

7.3 REDACTED

7.4 REDACTED

7.5 REDACTED

7.6 REDACTED

7.7 REDACTED

8 Environmental & Sustainability Implications

8.1 Environmental implications of aquaculture are a key consideration that inform the options laid out in this paper. As pointed out, there are environmental risks associated with an aquaculture industry, particularly where there is insufficient regulation and control in place, as global case studies evidence.

8.2 In addition to describing approaches to reduce environmental impacts and considering the current status of both sustainability and organic certification schemes within the salmon sector, the appended reports provide a detailed overview of the environmental impacts of salmon farming and how these have been experienced by other countries.

8.3 As a currently existing industry in the Falkland Islands albeit it at a small-scale and one where there is commercial interest to expand, robust policy and legislation to ensure sustainable practices that minimise environmental impact are key to safeguarding the future of our natural environment, as envisioned under the Falkland Islands Environment Strategy 2021 – 2040 (ExCo 161-21). The attached recommendations and analysis could form a first step towards developing appropriate policy and legislation, and provide information on environmental risks of salmon farming, which will help to inform decision-making.

8.4 This paper implements the Environment Strategy's action to "*conclude investigations of potential environmental impacts of aquaculture, including large-scale aquaculture*."

8.5 This paper and any future work stemming from the options considered, will help contribute to achieving the strategic objectives of the Environment Strategy, including "*to have healthy, functioning and robust marine and coastal ecosystems in the Falkland Islands through protections and management.*" and "*to ensure that future generations can benefit from marine and coastal ecosystems and the goods and services they provide by sustainably managing human activities which impact our oceans and coasts.*"

8.6 A consultation on Marine Managed Areas (MMAs) is due to be launched on 21 April, and it is likely that responses will include comments on whether aquaculture should be a permitted activity in the proposed sustainable multi-use zones (which include most of the Islands' inshore waters)

9 Camp Implications

9.1 Whilst small scale aquaculture is likely to have limited positive economic impact on camp, large-scale aquaculture has the potential to provide significant opportunity to camp, in terms of employment, service provision and potential use of waste as fertiliser. These would be clarified in more detail if a large-scale aquaculture project was ever sanctioned.

10 Significant Risks

10.1 REDACTED

10.2 Economic risks: by not pursuing this project, FIG are not exploring the opportunity of economic diversification (growing our economic resilience) and potential significant increases to government revenues.

11 Consultation

11.1 There has been no proper island-wide stakeholder consultation on this project. MLAs believe they have a clear mandate from the public to cancel this project at the point it has reached. It is recommended that a full and proper consultation exercise is carried out, using the objective best practice and legislative review information as a basis (Section 1a).

11.2 The reports appended to this report will be made public at the point this paper is published.

12 Communication

12.1 Following the consideration of this paper DNR will communicate the recommendations and content to:

- 12.1.1 Falklands Fish Farming Ltd
- 12.1.2 F-Land ApS
- 12.1.3 Unity Marine Ltd
- 12.1.4 Wider public

12.2 It will be desirable for this communication to the general public to take place during the consultation window for Marine Managed Areas, so that responses can be informed by the latest and most complete information.

Salmon Farming in the Falklands – Industry Impacts, Solutions & Best Practice Recommendations

REPORT FOR DEPARTMENT OF NATURAL RESOURCES, FALKLAND ISLAND GOVERNMENT




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Table of Contents

1. Executive Summary

Aquaculture production has seen a remarkable growth in production over the past three decades, partly in response to wild capture resources reaching capacity and the need to feed an ever-growing global population. Within the sector, the production of Atlantic salmon *(Salmo salar)* is placed 9th in all major finfish (both freshwater and marine) species produced in world aquaculture in 2017 - at a 4.5 percent share or 2.43 million MT (FAO, 2020). In the Western world it has become the dominant production species, especially when considering the value of the product produced globally. In terms of countries, Norway is the dominant market leader, accounting for 1.4 million MT live weight in 2018. This is followed by Chile at 887,000 MT live weight and the UK third at 169,000 MT live weight (FAO, 2020). The Chilean production figure is even more incredible when it is considered that the Atlantic Salmon is not even a native species to the country (it lives naturally in the Northern Atlantic only).

This rapid growth in production has come with a host of challenges, both environmental and social which have raised concerns as to the sustainability of production. These concerns include the pollution of the surrounding water column (with increased nutrient loading, creation of anoxic benthos and high levels of chemical release), the escape of farmed salmon (and potential to degrade wild genetic stocks or create new non-native stocks), interaction with wildlife (including the lethal control of seals), the development of increased antibiotic resistance and the proliferation of high sea lice levels in wild stocks (as a result of outbreaks in farmed populations). Since the farming of salmon has started, reports of widespread disease outbreaks and mortality events (Chile), changes in wild genetic characteristics of natural stocks (Norway) and reduced returns of wild salmon to spawn in European rivers have been reported. The blame in many of these cases and others has been laid at the door of salmon farming, sometimes fairly and sometimes with little evidence.

It is also true that the location of these cage farms are often in areas of outstanding beauty which are widely regarded as tourism and wildlife hot spots and so do not sit well with intensive farming methods.

All the above has led to a recent groundswell in criticism of the industry by many NGOs and commentators (often with hidden agendas it must be stated). Currently, this does not seem to of affected sales of the species in its dominant markets but the general public are starting to ask more and more questions about salmon farming.

However, it is also true that the salmon industry has brought significant employment opportunities and revenue generation to many of the major producing nations. In Scotland alone it is estimated that the industry supports around 8,000 jobs, has an annual turnover of £1 billion and generates £216 Million in total tax revenue which is not insignificant to the country.

Currently, the Falklands Island Government (FIG) are considering the option of commencing commercial salmon farming operations in the Islands. Previous interest in the idea has been received from some commercial outfits who see the country as suitable for production. However, the NGO and local communities are expected to be quite hostile to this idea with the experiences of Chile often cited as a reason not to allow it to occur in the Falklands. What's clear is that any salmon farming which is completed will need to be done in line with the best environmental and social practices to ensure it is as sustainable as possible. Ensuring this will be the job of the countries regulatory policies and framework and so it is important that the FIG draws on the current best practices employed in other countries.

In general, the strength of a countries regulatory system is based on a strong licensing system and maintained with regular monitoring and assessment. Most licensing systems are based on standard planning permission systems and require the completion of detailed Environmental Impact Assessments (EIAs) and stakeholder engagements. Backing up this regulatory system, most countries have developed a range of environmental parameters which planning decisions can be based on. These create trigger points at which development is or is not considered acceptable. In Norway, it is generally accepted that onshore farming has reached the capacity limit and so no new licences are currently issued. Instead, they are now refining the current system to provide monitoring parameters which allow for the reduction or increase of biomass production in specific areas depending on outcomes (for example the traffic light system for sea lice numbers).

For major producing countries, a move to local management areas are also being seen, with, for example, a single loch system being treated under one set of determining rules. This reflects the idea of cumulative capacity (i.e they may be individual farms, but they are all based in the same area and have a cumulative effect which should be treated as such).

However, the strength of the salmon sector is invariably driven by the performance of the individual farms with some naturally showing greater stewardship than others. The regulatory system though is designed to ensure a minimum standard which no operator can fall below (whether for managing escapes, controlling environmental waste or the health management of the fish). The level at which this minimum standard is set is the role of the regulator and requires a balance between promoting an industry and ensuring sustainable production.

A recent development in the sector has been the proliferation of sustainable certification or eco-labelling. This has been led by the Aquaculture Stewardship Council (ASC) and Global Aquaculture Alliance Best Aquaculture Practice (GAA BAP). Both provide a standard against which operators can be audited to show they are meeting best international practices. However, these schemes are voluntary and should be viewed as such (i.e. the regulatory system should help operators achieve certification and not demand it as a condition of licensing).

An alternative option of organic farming is also considered in this report as a sustainable method of production for the Falkland Islands (i.e. the potential of making the Falklands an ‘organic only’ production zone). This though appears unfeasible as organic certification is generally not permitted for non-native species (as would be the case here).

The FIG has a strategic decision to make in the first place about what level of farming it wishes to see in its shores (none, some but below carrying capacity, or as much as carrying capacity will allow). All have disadvantages and advantages which need careful consideration. It is also true that should any salmon farming be permitted in the Islands, some negative environmental consequences will need to be accepted even if the best management practices are implemented (although these could be very small). A robust regulatory system will need to be implemented to ensure that the highest standards can be achieved. Furthermore, this report does not consider the economic and financial viability of operators setting up farms in the Falklands. This is clearly an area which will require further consideration as without an understanding of the interest and what is possible for the sector in the country it is hard to know what the vision for the industry might be capable of looking like.

2. Introduction

This report has been compiled by Macalister Elliott and Partners Ltd (MEP) on behalf of the Falklands Government (FIG). MEP is a UK based fisheries and aquaculture consultancy which has been operating since 1977.

The Falkland Islands are considering the potential for commercial scale salmon farming operations in the future. The waters of the Falklands are considered well suited to salmon farming and approaches have been made to the authorities by interested parties previously.

The potential for commencing commercial salmon farming would create additional revenue for the government and create jobs for islanders. However, the negative impacts that may exist because of these operations on both the natural environment and the social fabric of the community need careful consideration prior to any further steps being taken.

This report represents an initial assessment of the impacts of salmon farming. The report aims to provide a detailed overview of what the negative impacts of salmon farming are and how these have been experienced by other countries in the develop of the sector. It also provides a consideration of what current best practices have been or are being introduced to mitigate these impacts. The report also considers the current status of both sustainability and organic certification schemes with the salmon sector and the impacts these may have.

The overriding aim of the report is to present the current best practices globally and make initial recommendations on how the FIG might move forward with development within the sector. In making these initial recommendations and following initial discussions with the FIG, MEP has put ‘best practice’ at the forefront of its considerations. In doing this we have aimed to create a position in which any future salmon aquaculture industry in the Falklands could be considered the ‘global benchmark’. This is considered vital in ensuring that the Falklands maintains a pristine environment for now and future generation but with the potential for sustainable salmon farming within its shores.

3. Salmon Farming – Brief History and Current Status

The history of salmon farming is relatively short; until the early 1960s, salmon was only a wild capture industry, but due to the exponential growth of the aquaculture sector during the last 50 years, it has transformed into a global industry.

Farmed salmonids, or species of fish in the family Salmonidae, include the Pacific salmon coho (*Oncorhynchus kisutch*) and chinook (*O. tshawytscha*), the Atlantic salmon (*Salmo salar*) and the rainbow trout (*O. mykiss*), also known in seawater facilities as the steelhead (Figure 1). Production of salmonids is mainly based around the production of eggs and juveniles in freshwater facilities on land and grow-out of adult fish in floating cages or pens in semi-sheltered coastal bays, sea lochs or fjords.

The mid-19th century saw the establishment of freshwater salmonid hatcheries in UK and North America producing parr to enhance natural populations, however, it was in the 20th century that the concept of fish farming developed. Initially the culture of salmonids started on an experimental level during the 1950s, with the first farms established in Scotland and Norway in the 1960s. By the end of the 1980s, commercial salmon farming was well established in many temperate countries globally, *i.e.* Scotland, Ireland, the Faroe Islands, Canada, the North Eastern Seaboard of the US, Chile and Tasmania (Australia), with minor production in New Zealand, France, Spain and Japan.

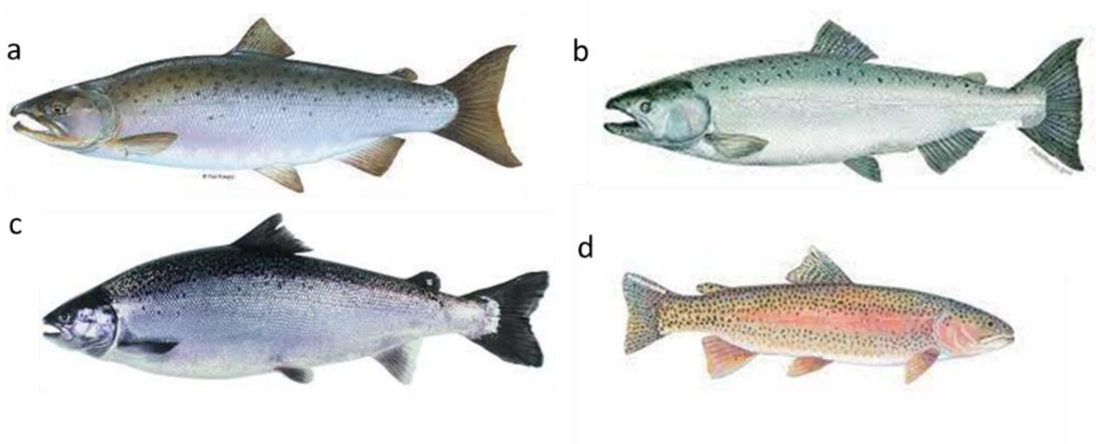

Figure 1: Common Species of farmed salmon

a) coho (Oncorhynchus kisutch) and b) chinook salmon (O. tshawytscha), the Atlantic salmon c) (Salmo salar) and d) rainbow or steelhead trout (O. mykiss).

The Food and Agriculture Organisation of the United Nation's (FAO) 'State of World Fisheries and Aquaculture' (FAO, 2020) report that global food fish consumption has increased at an average annual rate of 3.1 percent from 1961 to 2017, greater than that of all other animal protein foods, *i.e*. meat dairy milk *etc*., with per capita fish consumption growing from 9.0 kg (live weight equivalent) in 1961 to 20.5 kg in 2018 (FAO, 2020).

In 2018, total global capture fisheries production reached the highest level ever recorded at 96.4 million metric tonnes (MT) – an increase of 5.4 percent from the average of the previous three years. This increase is mainly driven by marine capture fisheries, however marine fishery resources, based on FAO's long-term monitoring of assessed marine fish stocks, has continued to decline; the proportion of fish stocks that are within biologically sustainable levels decreased from 90 percent in 1974 to 65.8 percent in 2017 (FAO, 2020).

Global fish production (which includes fish, crustaceans, molluscs and other aquatic animals, but excludes seaweeds and other aquatic plants) is estimated to have reached around 179 million MT in 2018, with a total first sale value estimated at USD 401 billion. Of this, 82 million tonnes or 46 percent, valued at USD 250 billion, came from aquaculture production (Figure 2) (FAO, 2020). Indeed, world aquaculture production of farmed aquatic animals has grown, on average, 5.3 percent per year in the period 2001-2018 (FAO, 2020) and aquaculture is currently the fastest growing of the animal food producing sectors.

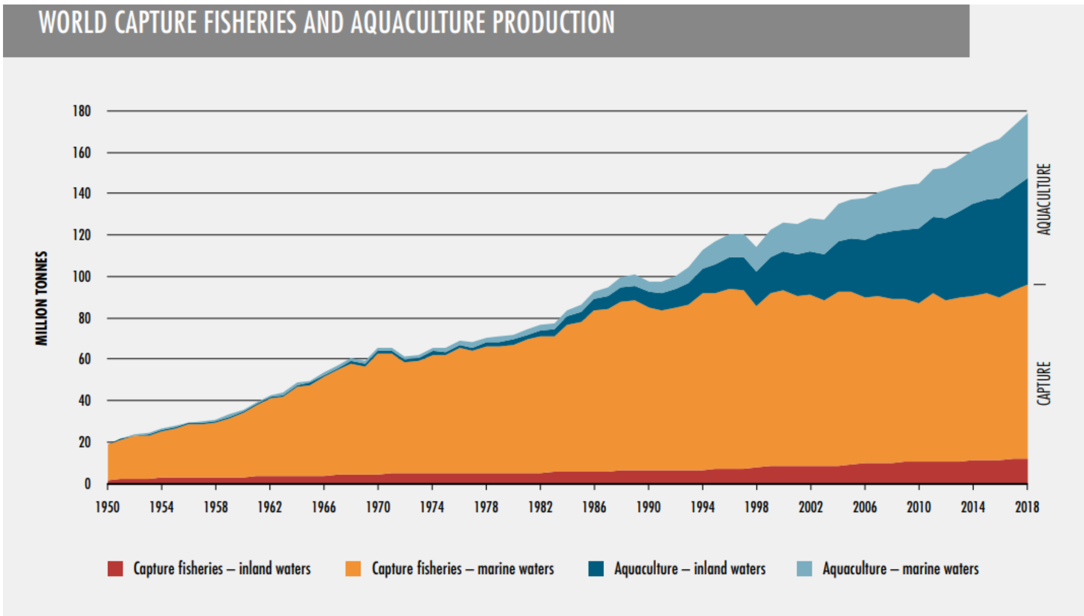

Figure 2: World capture fisheries and aquaculture production (1950 - 2018)

Source: FAO, 2020 The State of World Fisheries and Aquaculture

Aquaculture production is dominated by finfish, *i.e.* 54.3 million MT, which can be broken down according to environment to 47 million MT from inland aquaculture and 7.3 million MT from marine and coastal aquaculture. Marine aquaculture or mariculture is conducted in a marine environment and includes the culture of anadromous fish species, *i.e.* species that rely on seed production from hatchery and nursery facilities in freshwater with mariculture representing the 'grow-out' or 'on-growing' phase of the production cycle, such as salmonids. There is clearly a great diversity of aquaculture species raised, both in the freshwater and marine environment; climatic and environmental conditions will determine the species choice, however global marine aquaculture production by volume is dominated by a small number of 'staple' species or species groups (FAO, 2020). The Organisation for Economic Cooperation and Development (OECD) member countries, *e.g.* Norway, Chile, Japan, the United Kingdom of Great Britain and Ireland, Canada and Greece dominate the production of these 'staple' mariculture finfish species.

Atlantic salmon (*S. salar*) has become an increasingly popular seafood item that is driven by a strong customer demand and is now the largest single fish commodity by value (FAO, 2020). Indeed, the markets for Atlantic salmon (*S. salar*) account for the largest proportion of export revenue compared to the other farmed salmonid species, *e.g.* coho (*O. kisutsch*), chinook (*O. tshawytscha*) and rainbow trout (*O. mykiss*). The Atlantic salmon is currently placed 9th in all major finfish (both freshwater and marine) species produced in world aquaculture in 2017 - at a 4.5 percent share or 2.43 million MT - and is currently the major mariculture species produced (FAO, 2020) (Table 1). Norway currently ranks first amongst the major global salmonid producers, accounting for 1.4 million MT live weight, Chile second at 887.2 thousand MT live weight and the UK third at 169.6 thousand MT live weight in 2018 (FAO, 2020) (Figure 3).

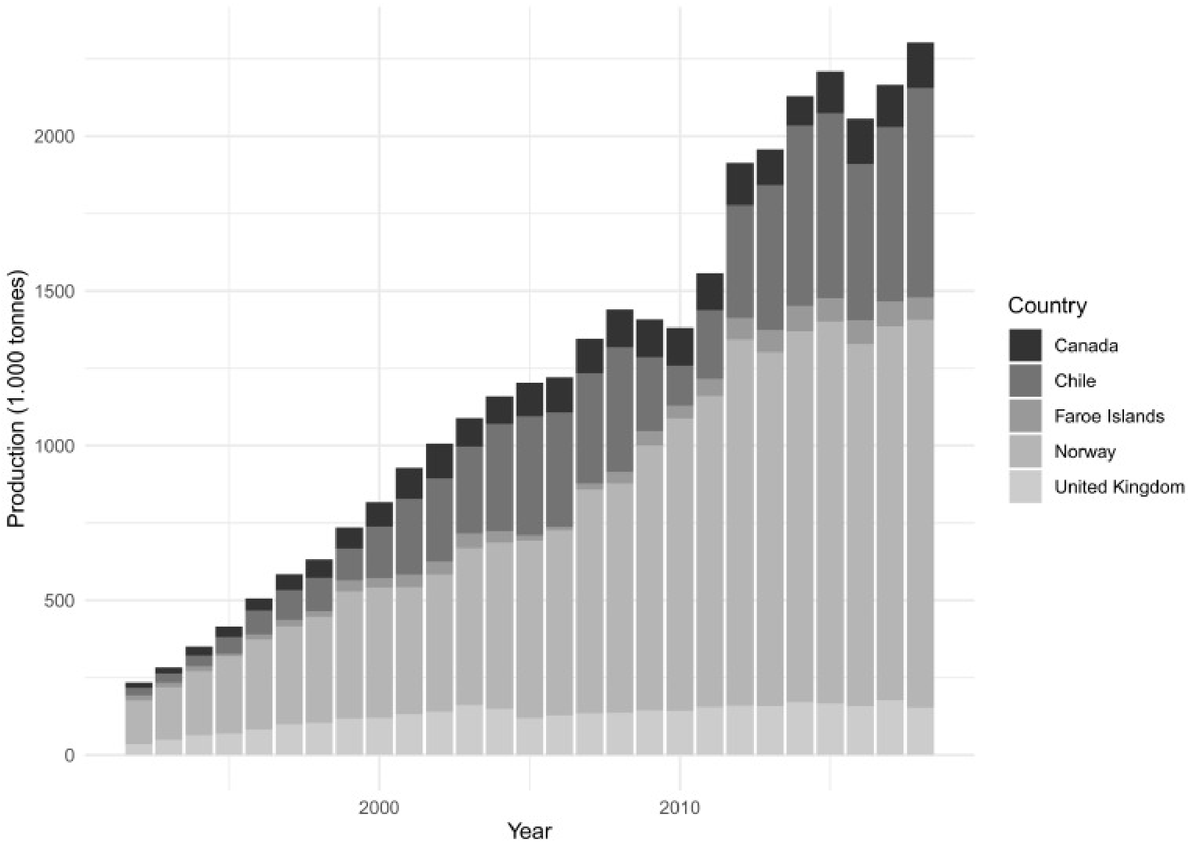

Figure 3: Atlantic salmon production in the five largest producer countries

Source: Kontali Analyse AS; taken from Iversen et al., 2020. Production costs and competitiveness in major salmon farming countries 2003-2018. Aquaculture, 522: 735089).

Table 1: Major finfish species (freshwater and marine) produced in Global Aquaculture

MAJOR SPECIES PRODUCED IN WORLD AQUACULTURE

	2010	2012	2014	2016	2018	2018 share
	(thousand tonnes)					(percentage)
Finfish						
Grass carp, *Ctenopharyngodon idellus*	4 213.1	4 590.9	5 039.8	5 444.5	5 704.0	10.5
Silver carp, *Hypophthalmichthys molitrix*	3 972.0	3 863.8	4 575.4	4 717.0	4 788.5	8.8
Nile tilapia, *Oreochromis niloticus*	2 657.7	3 342.2	3 758.4	4 165.0	4 525.4	8.3
Common carp, *Cyprinus carpio*	3 331.0	3 493.9	3 866.3	4 054.7	4 189.5	7.7
Bighead carp, *Hypophthalmichthys nobilis*	2 496.9	2 646.4	2 957.6	3 161.5	3 143.7	5.8
Catla, *Catla catla*	2 526.4	2 260.6	2 269.4	2 509.4	3 041.3	5.6
Carassius spp.	2 137.8	2 232.6	2 511.9	2 726.7	2 772.3	5.1
Freshwater fishes nei,[1] Osteichthyes	1 355.9	1 857.4	1 983.5	2 582.0	2 545.1	4.7
Atlantic salmon, *Salmo salar*	1 437.1	2 074.4	2 348.1	2 247.3	2 435.9	4.5
Striped catfish, *Pangasianodon hypophthalmus*	1 749.4	1 985.4	2 036.8	2 191.7	2 359.5	4.3
Roho labeo, *Labeo rohita*	1 133.2	1 566.0	1 670.2	1 842.7	2 016.8	3.7
Milkfish, *Chanos chanos*	808.6	943.3	1 041.4	1 194.8	1 327.2	2.4
Torpedo-shaped catfishes nei, *Clarias* spp.	343.3	540.8	867.0	961.7	1 245.3	2.3
Tilapias nei, *Oreochromis* (=Tilapia) spp.	472.5	693.4	960.8	972.6	1 030.0	1.9
Rainbow trout, *Oncorhynchus mykiss*	752.4	882.1	794.9	832.1	848.1	1.6
Wuchang bream, *Megalobrama amblycephala*	629.2	642.8	710.3	858.4	783.5	1.4
Marine fishes nei, Osteichthyes	467.7	567.2	661.0	688.3	767.5	1.4
Black carp, *Mylopharyngodon piceus*	409.5	450.9	505.7	680.0	691.5	1.3
Cyprinids nei, Cyprinidae	639.8	601.1	628.0	596.1	654.1	1.2
Yellow catfish, *Pelteobagrus fulvidraco*	177.8	233.7	302.7	434.4	509.6	0.9
Other finfishes	6 033.9	6 869.3	7 730.0	8 217.1	8 900.2	16.4
Finfish total	**37 745.1**	**42 338.2**	**47 219.1**	**51 078.0**	**54 279.0**	**100**

Source; FAO, 2020 The State of World Fisheries and Aquaculture

4. Key Environmental Impacts of Salmon Farming

Over the last 50 years, scientific developments have led to a greater understanding of the functioning of aquatic ecosystems and a global awareness of the need for sustainable management of these precious resources. The worldwide increase in reliance on aquaculture production, due to depletion of wild fish stocks and a growing population, has understandably triggered concerns. Aquaculture, by its very nature, has an impact on the aquatic environment; fish are in direct contact with their environment over which there is less control.

The intensive production of salmon, especially in their marine phase, results in the release of solid wastes into the environment, either as unused inputs, *i.e.* residual feed, or by-products such as faeces, dissolved wastes, *i.e*. by-products of feed metabolism containing major components such as nitrogen (N) and phosphorus (P) (Boyd and Massaut, 1999) and chemical inputs, *i.e.* chemotherapeutants, disinfectants and antifoulants. However, it would be true to say that there is a restricted ability to manage waste products in the same way as in terrestrial farming systems. Of particular concern is the release of pathogens originating from cultured salmonids, many of which are able to survive long-term without a host and which spread at faster rates than in terrestrial systems, with their dispersal aided by a lack of barriers in a highly connected aquatic system (McCallum, Harvell and Dobson, 2003).

Environmental interactions of aquaculture operations vary in their nature and extent depending on species farmed, farming system, as well as the level of intensification, however such rapid growth of the salmonid aquaculture sector, whose production system is one of the most profitable and technically advanced in the world, has resulted in several environmental challenges. Ecosystems have a remarkable capacity for resilience, however, once inadequate management fails to correctly manage environmental impacts, irreversible environmental degradation will inevitably result.

Below will be discussed, in an historical context, the main environmental sustainability concerns and constraints to the development of the global salmonid production, including both the production of eggs and juveniles in freshwater facilities on land and the on-growing phase in open cages in the sea.

4.1 Use of Freshwater

Salmonids are diadromous species (*i.e.* they migrate between freshwater and seawater) and more specifically anadromous species *(i.e*. they are born in freshwater, spend most of their lives in seawater and return to freshwater to spawn). Wild Atlantic salmon (*S. salar*) usually spend around four years in deep-sea feeding grounds, feeding on pelagic fish species, and, at the onset of maturation, cease feeding and return to their rivers of origin to spawn (October to January). Following spawning, fertilised eggs settle in riverine gravel beds or 'redds' to incubate for approx. 500 degree days before hatching. The larvae or alevins live off their large yolk-sac reserves for a further 300 degree days, and then actively begin to feed as they pass through the fry and parr stages for approx. two years, until physiological changes known as the smoltification or seawater adaptation process takes place, and they migrate downstream (normally in May and June) and enter the sea to on-grow.

Production of smolts for on-growing in sea cages is carried out in land-based hatcheries (smolt farms). Broodstock are selected from sea site production stocks and moved to freshwater facilities a few months prior to stripping. Eggs are manually stripped dry, fertilised with stripped milt, and laid down in trays to incubate, usually at around 10 ºc. Following hatching and yolk-sac absorption, fry are on-grown in tanks fed with artificial feed until they are moved to larger tanks or lake-cage systems to mature into smolts, usually in the spring of the year following hatching and are known as S1 smolts, prior to stocking at sea.

There are three principle hatchery systems–smolt farms, based on the level of technology and water management (Fivelstad *et al.,* 2004);

> A) Single-pass flow-through systems with oxygenation: According to regulations for licensing of Norwegian hatcheries (Norwegian Department of Fisheries), the lowest allowable flow limit in single-pass flow-through farms is 0.3 L/kg min.
>
> B) Partial reuse systems, *e.g.* aeration, oxygenation and particle removal, partial recirculation, lowest allowable flow limit 0.15 L/kg/min.
>
> C) Recirculating aquaculture systems (RAS), *e.g.* biofiltration, fully recirculated water, with lowest allowable flow of 0.02-0.04 L/kg/min (Fivelstad *et al.,* 2003) (Figure 4).

The traditional single-pass flow through systems or partial reuse systems have a number of constraints which include i) limitations in available freshwater resources, especially during dry periods of the growing season, ii) poor water quality of inlet water, *i.e.* low alkalinity, iii) threat of ingress of disease-causing pathogens and the requirement for disinfection, *i.e.* UV irradiation or ozone, iv) high CO_2 levels in ground water that requires stripping, and v) the need to regulated inlet water temperature (Kristensen *et al.,* 2009).

There is therefore considerable interest in the growth potential of land-based, intensive recirculating aquaculture systems (RAS) as a means to mitigate these problems. Not only do intensive RAS systems decrease water consumption, they also allow essential water quality parameters *e.g.* temperature, dissolved oxygen, carbon dioxide, ammonia, nitrite, nitrate, pH, salinity and suspended solids to be continuously monitored, hence optimising rearing conditions in terms of fish health and welfare, food conversion ratios *etc*. In addition, smolts raised under controlled conditions can be ready for moving to sea sites throughout the year. There is also currently interest in the production of larger more robust smolts, *i.e.* 250-1000 g, as this reduces the overall production time at sea mitigating the problems such as risk of exposure to sea lice infestation (Bergheim *et al.,* 2009).

Figure 4: A model of a large RAS system

Freshwater Requirements

The hatchery production process for salmon is completed in freshwater in land-based systems. This process requires large quantities of freshwater to be available and this raises concerns for the use of what is now a globally precious resource.

The current solution is a move towards RAS based systems which allow for the recirculation of freshwater and hence reduce the quantities required and help reduce potential harmful outputs. In some countries (Norway) the use of RAS land-based systems is being incentivised to encourage use (for example, licensing costs are reduced and pollution permits made easier to achieve for these systems).

4.2 Infectious diseases

'Aquatic animal disease is one of the most serious constraints to the expansion and development of sustainable aquaculture.'

(FAO, State of World Fisheries and Aquaculture. Sustainability in Action, 2020).

Infectious diseases, *i.e*. bacterial, viral and parasitic, have historically, and indeed still do, represent a major and concerning limiting factor for the expansion of the aquaculture industry; it is certainly true to say that the aquatic environment imposes '*a constant and omnipresent risk of pathogen exposure to resident hosts'* (Stentiford *et al.,* 2017). With the intensification of aquaculture there has been a concomitant proliferation and spread of pathogens resulting in direct costs that includes not just that of lost production from mortalities, but also a reduced growth and feed conversion ratio (FCR), associated expenditures for therapeutic treatment and disinfection of associated facilities and equipment (Pillay and Kutty, 2005), as well as temporary or permanent closure of aquaculture facilities.

It has been estimated that 10 percent of all cultured aquatic animals are lost because of infectious diseases, amounting to > 10 billion USD in losses annually on a global scale (Evensen, 2016). Regarding infectious disease in salmon aquaculture, there is a wealth of literature regarding disease epidemiology, transmission, impact and treatment options *etc*., clearly indicating that disease is a top priority for the industry and a potential impediment to its growth (Lafferty *et al*., 2015; Stentiford *et al.,* 2017).

The diseases affecting farmed salmonids tend to vary by country and production area over time and seasonal patterns have emerged for different disease challenges. It is revealing that The World Organisation for Animal Health's (OIE*) 'Diseases, infections and infestations in force in 2021'* (OIE, 2021) lists 10 notifiable finfish diseases, four of which affect farmed salmonids, *i.e.* Infectious Haematopoietic Necrosis (IHN) a viral disease caused by the Infectious Haematopoietic Necrosis Virus (IHVN), Pancreas disease (PD) (caused by a salmonid alphavirus (SAV), infestation by *G. salaris* (an ectoparasitic monogenean fluke) and Viral Haemorrhagic Septicaemia virus.

A summary of commonly occurring diseases in salmonid aquaculture are listed below;

<u>Viral diseases</u>*:* Viral diseases currently represent a significant problem in salmonid aquaculture; the most frequently reported viral diseases include Infectious Pancreatic Necrosis (IPN), Pancreas disease (PD), Heart and Skeletal Muscle Inflammation (HSMI), Cardiomyopathy Syndrome (CMS), Infectious Haematopoietic Necrosis (IHN) and Viral Haemorrhagic Septicaemia virus (VHS). The main reason for the dominance of viral diseases is the lack of effective vaccines.

<u>Bacterial diseases</u>: These may include Furunculosis (*Aeromonas salmonicida*), Vibriosis (*Vibrio* spp.), salmon rickettsial syndrome (SRS) or Piscirickettsiosis (*Piscirickettsia salmonis*) and bacterial kidney disease (*Renibacterium salmoninarumon).* In recent years there have been fewer outbreaks of bacterial diseases, reflecting the efficacy of currently available bacterial vaccines (Austin and Austin, 2007).

<u>Parasites</u>: The main parasitic threats to salmonids include parvicapsulosis, due to the myxosporean *Parvicapsula pseudobranchicola* and the microsporidian *Paranucleospora theridion*. The free-living amoeba *Paramoeba perurans,* the causative agent of Amoebic Gill

Disease (AGD), is now a devastating problem in worldwide salmonid producing areas. Sea lice, considered the greatest disease challenge in salmonid aquaculture, will be considered separately below.

Transmission from infected to potential susceptible hosts is strongly dependant on environment, therefore, in a highly intensive aquatic (fluid) environment, transmission patterns vary considerably to those in terrestrial systems (McCallum *et al*., 2004); not only does transmission occur between individuals due to close proximity, but also water currents will allow the spread of free pathogens, impacting populations located some distance from the source. Infectious disease also pose disease risks for wild fish (discussed in more detail later in this report).

Chemotherapeutants or chemical treatments are used both prophylactically (to prevent) and therapeutically (to treat) within the global salmonid industry, however there is a clear trend towards treating outbreaks using a 'best practice' approach, that includes such measures as improved biosecurity, sanitation and disinfection, alternative non-chemical treatments, *e.g.* freshwater treatments for AGD, thermoclining or using heated water to remove sea lice, better husbandry practices, site fallowing, vaccines, functional aquafeeds and immune modulators (pre- and probiotics) and phytochemicals or botanical products.

Infectious Diseases

Salmon farming has had significant issues with infectious diseases which have led to a variety of direct consequences including mass mortality and lower FCRs (not to mention te indirect effects which are discussed directly).

The production of any species in confined areas at increase densities is likely to result in a higher risk from infectious disease. To combat these diseases a range of treatments (prophylactic and therapeutic) have been created. However, current best practices are focusing on reduced the use of these and improving preventative measures through better vaccination, increased biosecurity and non-chemical treatments. This area is driven more by industry requirements than government regulation, although limits on chemical and treatment uses do exist. As an example, Norway is reported to of reduced its antibiotic use (for example) by 99% since the late eighties (mainly as a result of successful vaccination regimes).

4.3 Sea lice

Infestation of farmed Atlantic salmon by sea lice is considered such a significant barrier to the expansion of the industry that it will be dealt with here separately.

Sea lice is the generic name given to a group of ectoparasitic copepods from the family Caligidae, (Burka *et al*. 2012; Torrissen *et al*. 2013) that attach to and live on the skin of marine and anadromous fish species. They affect farmed and wild salmonids in their marine phase causing severe skin damage and are currently considered to be the most economically significant parasites to worldwide salmonid industry (Gallardo-Escarate *et al.,* 2019).

The sea lice species affecting farmed Atlantic salmon (*S. salar*) and rainbow trout (*O. mykiss*) in northern hemisphere salmon farming countries, *e.g.* Norway, Canada, Maine (USA), Ireland, Scotland, Ireland and the Faroe Islands, is the native species *Lepeophtheirus salmonis* (Costello, 2006; Burka *et al.,* 2012; Torrissen *et al.,* 2013) (Figure 5) , and, to a lesser degree, *Caligus elongatus* (Costello, 2006), whereas the species of concern in Chile is the native, southern hemisphere species *C. rogercresseyi* (Gonzalez *et al.,* 2000; Gonzalez and Carvajal, 2003) (Figure 5). Transmission of sea lice to fish hosts occurs during the copepodid, free-living or planktonic life stages when the larvae are dispersed by water currents (Figure 5) (McKibben and Hay, 2004; Brooks, 2005; Costello, 2006; Penston *et al.* 2008; Amundrud and Murray, 2009; Krkosek *et al.,* 2010; Molinet et al. 2011).

A high susceptibility to infection by the sea lice *C. rogercresseyi* (Figure 5) has been reported for farmed non-native or introduced salmonids in Chile, *e.g.* Atlantic salmon (*S. salar*) and rainbow trout (*O. mykiss*), however the Coho salmon (*O. kisutch*) is considered to be a resistant species (Zagmutt-Vergara *et al.,* 2005). Historically, *C. rogercresseyi* infestation had been reported in the coastal waters of northern Patagonia (40°15′S to 49°16′S) (Regions X and XI), where close to 90 percent of salmon farms are located, however, in 2017, this species was detected for the first time in farmed Atlantic salmon (*S. salar*) in the Magallanes region (Region XII) (south of 49°16′S) **(**Figure 6) and is currently considered the most economically important parasitic disease for the Chilean salmon industry (Arriagada *et al*., 2019). This spread was attributed to the migratory behaviour of the native rock cod *Eliginops maclovinus,* a natural host for *C. rogercresseyi* (Carvajal *et al.,* 1998; González *et al.,* 2000; Boxshall and Bravo, 2000; Bravo, Boxshall and Conroy, 2011). Indeed *C. rogercresseyi* has a broad fish host range and is known to infest a number of other native South American marine fishes, *e.g.* the Patagonian blennie (*Eleginops maclovinus*), the Peruvian silverside smelt (*Odontesthes regia*), the small-eye flounder (*Paralichthys microps*) (Carvajal *et al*., 1998; Boxshall and Bravo, 2000). Of concern is that the rock cod *Eliginops maclovinus* is endemic to southern Chile, southern Argentina and the Falkland Islands and although reports of infestation have not yet been reported on the eastern coast of South America this fish could potentially act as a vector for the rapid dispersal and geographic spread of this parasite.

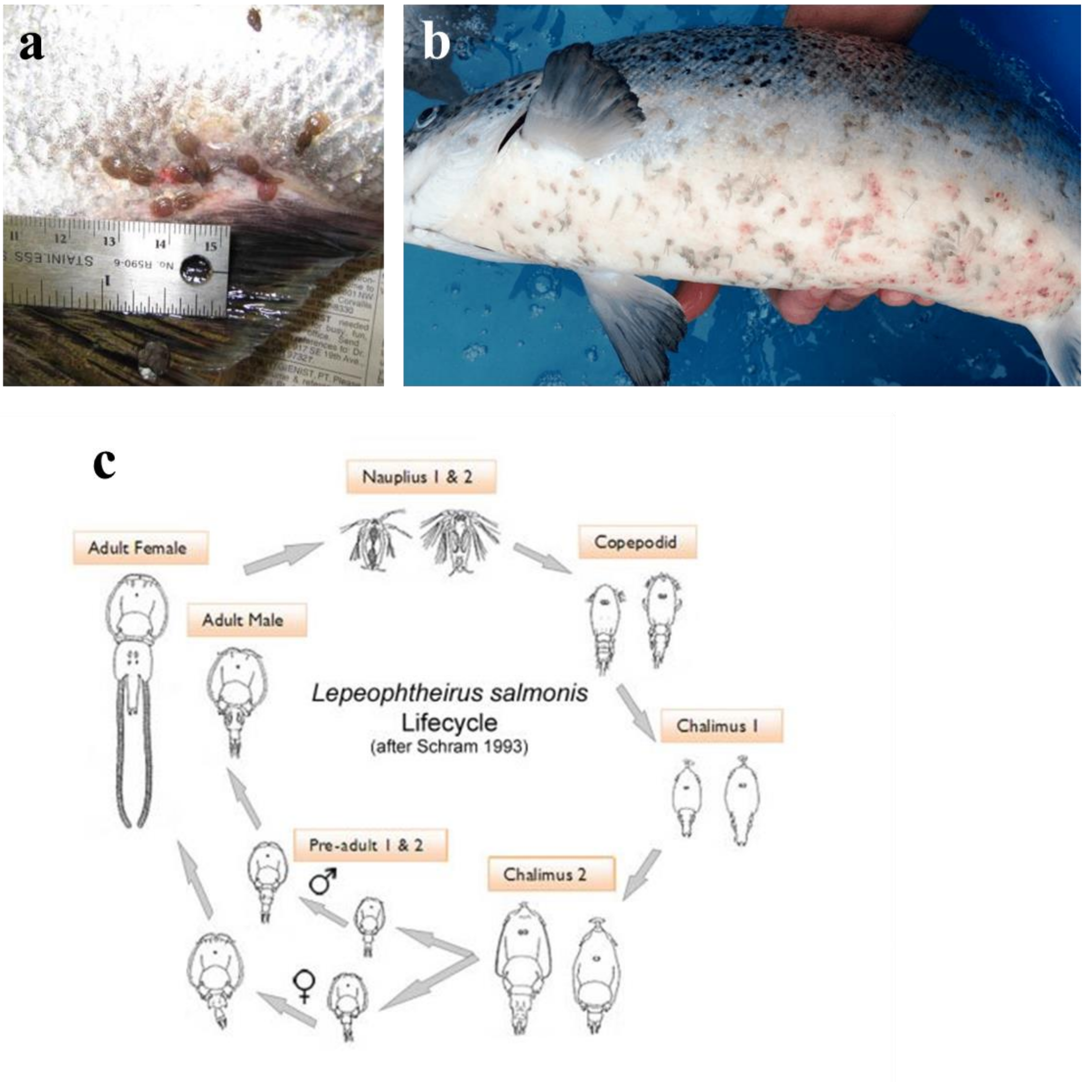

Figure 5: a) Lepeophtheirus salmonis infestation on farmed Atlantic salmon; b) Caligus rogercresseyi infestation on farmed Atlantic salmon in Chile; c) life-cycle of L. salmonis.

Figure 6:Incidence of reported *Caligus rogercresseyi* infestations in South America (dotted Lines)

NOTE: *Regions X, XI and XII are important salmonid producing areas (Taken from Bravo, Boxshall and Conroy, 2011).*

Heavy sea lice infestation causes severe skin damage, resulting in chronic osmoregulatory stress, reduced growth and feed-conversion efficiency (González and Carvajal, 2003; Johnson *et al*., 2004; Rozas and Asencio, 2007; Revie *et al*., 2009; Gonzalez *et al*., 2015). The economic burden of this disease is not only due to mortality and reduced marketability from unsightly skin lesions (Costello, 2009; Liu and Bjelland, 2014), but also the high associated costs of therapeutic treatments. Data from Norway estimate that lice parasitism caused losses of US$ 480 million in 2011 (Abolofia *et al.,* 2017).

In addition, the impact of sea lice from salmon farms is well recognised as a hazard to wild anadromous salmonids (Serra-Llinares *et al.,* 2014). Intensively farmed salmon produce huge amounts of planktonic larval stages of lice that spread via water currents; hydrodynamic modelling combined with biological data show that salmon lice can be transported up to 200 km over a 10-d period, although most dispersed 20 –30 km (Asplin *et al.,* 2011; Serra-Llinares *et al.,* 2014). These can infect migrating wild Atlantic salmon post smolts and other susceptible fish species, *i.e*. sea trout (*S. trutta*) and Arctic char (*Salvelinus alpinus*) (Jones and Beamish, 2011). With the expansion of the industry, the risk of wild salmonid population being exposed and infected by salmon lice larvae is greatly increased; it has been estimated in Norway, the largest producer of farmed Atlantic salmon, in 2014 that the worst case releases of larval lice originating from the farmed stocks in Norwegian farms are more than one billion larvae a day (Taranger *et al.,* 2014).

Over the years, a range of treatment and preventative measures have been employed for sea lice. Probably the most effective (and most controversial) has been the use of chemicals. These can be administered through a range of methods. Originally, this was done with the use of tarpaulins which are placed in-side the cage to form an enclosed water body around the fish. The chemical is then added to the water (usually Hydrogen Peroxide, although many others also exist) and left for a set period. The effect of this is the removal of sea lice but subsequently if the water is not properly oxygenated, high mortalities can be seen in the fish as well. Once finished, the water is then released into the environment (which creates another host of environmental concerns).

A secondary method for the treatment in sea lice is much more recent and uses the addition of chemicals to the feed. These chemicals can vary but include avermectin; emamectin, flubenzurons; teflubenzuron and diflubenzurons and all work in different ways.

The final two treatments for sea lice are not chemical related and are linked to the creation of physical barriers and the presence of competing predators. With barriers, an impermeable skirt can be added around the cage and since sea lice live in the very top part of the water column this can reduce interactions. The additions of cleaner fish (lumpfish and wrasse) is often gaining popularity with both found to eat the sea lice directly of the salmon once attached.

All the above methods are discussed in more detail in the country specific analysis sections further down in this report.

Sea lice

Sea lice is currently one of the main threats to salmon farming with significant environmental and economic concerns resulting from infections. The problem has been experienced in all nations farming salmon and is not limited to specific locations.

The treatment of sea lice has developed greatly in recent years. It commenced with the use of bath style immersions in chemicals but has recently moved more to the use of additives in feed (which is more targeted and less risky for the fish). A growing number of natural treatments are also forming part of best practice guidelines with the use of physical barriers and cleaner fish growing in popularity.

The control of sea lice represents a significant focus point for regulatory systems in key producing nations. In Norway, for example, a traffic light system is being employed which requires the reduction of biomass in areas of high sea lice numbers. Similarly, lower areas can increase biomass accordingly. These, and other best practice approaches are discussed in more detail further down in this report.

4.4 Climate change on disease emergence and spread

In the current times, it is particularly relevant to discuss the impact of global climate change on the salmonid industry.

It is well established that the potential for disease outbreaks within aquaculture production systems can be mediated by changes in global climate patterns (Leung and Bates, 2013). Karvonen *et al.,* (2010) noted that epidemiological issues associated with aquaculture would be exacerbated by climate change and, indeed, extreme weather events have become more frequent since that time and an upsurge in pathogen outbreaks and severe environmental challenges has been reported; increases in sea temperatures and precipitation have favoured the extension of seasonal windows of existing pathogens (Altizier *et al.,* 2006), as well as the introduction of pathogens to new geographical regions by producing environmental conditions that favour certain pathogen growth and transmission (Harvell *et al.,* 2002). A severe Harmful Algal Bloom (HAB) event in the Los Lagos region in Chile in 2016 raised awareness that climate change related sustained elevated sea temperatures and rainfall deficits were affecting salmon productivity and threatening the security of the Chilean salmon sector (Soto *et al.,* 2019).

4.5 Pathogen transfer from farmed salmon to wild fish

For most aquatic animal pathogens, any clear evidence for transmission from farmed to wild fish is limited (Raynard *et al.,* 2007). Most of the diseases currently reported in salmonid aquaculture are enzootic, *i.e.* regularly affecting wild populations in a particular district or at a particular season, suggesting that these infections occur or occurred in the past in wild stocks at undiscernible levels and were transmitted to the farmed population (Taranger *et al.,* 2015). An example is the southern hemisphere sea lice *C. rogercresseyi* who, due to its low host specificity (Carvajal *et al*., 1998), readily infected the first introduced salmonids in Chile by probable transmission from naturally infected native fish species (Carvajal *et al*., 1998). Since then, it has rapidly spread and *C. rogercresseyi* can be found along the southern Pacific coast of Chile (41°S) and was recently reported in the far south (51°S) (Arriagada *et al*. 2018).

There are, however, two serious and devastating documented cases in which exotic pathogens have been introduced due to farming activities, that have impacted wild Atlantic salmon populations in Norway;

1) The ectoparasite *Gyrodactylus salaris* (Monogenea) was first detected in Norway in 1975 (Johnsen *et al.,* 1999) and, by 2005, had been detected in 45 rivers and 39 freshwater farms (Mørk and Hellberg, 2005). A high mortality of Atlantic salmon parr in rivers was reported, with a reduction in numbers 50–99 percent (Johnsen *et al.,* 1999).

2) *Aeromonas salmonicida*, the causative agent of Furunculosis, was first reported in a single farm in Norway in 1964 that received rainbow trout from Denmark and spread to neighbouring farms and wild fish stocks. Following a second introduction in 1985, connected to an import of Atlantic salmon smolts from Scotland, the disease spread rapidly and in 1992 a total of 550 salmon farms and 74 river systems were affected (Johnsen and Jensen, 1994). Mortality in farmed fish was high, reaching 50 percent, but the disease was first controlled by antibiotics and subsequently effectively with oil-based vaccines (Sommerset *et al.,* 2005; Johansen, 2013).

Pathogen transfer from farmed to wild salmon

Current scientific evidence suggests that most pathogens reported in farmed salmon actually move from wild populations to farmed populations , rather than the other way around (although a few examples do exist which have been seen from the introduction of farmed species).

Maybe of greater concern, however, is the propensity for farms to act as areas of increased infections which can then promote higher levels in wild populations. It is this effect rather than the risk of introduced diseases being spread directly which provides probably the greatest concern.

4.6 Transboundary aquatic animal diseases

In recent years, reports of previously unreported pathogens causing the introduction of exotic aquatic diseases that have spread rapidly both within countries and across national borders and major aquaculture production losses have emerged (FAO, 2019). This is due to the increase in global trade and movement of live aquatic animals and their products; live aquatic organisms, *e.g.* eggs larvae fry and adults, have become food commodities and, when adequate national biosecurity is missing, pathogens may be transferred simultaneously. These transboundary aquatic animal diseases are usually caused by viruses, however occasionally the causative agent may be a bacterium or a parasite.

The concept of 'biosecurity' is therefore key in the prevention of these disease emergences within the aquaculture industry. A lack of knowledge of pathogens, *i.e.* pathogenicity and transmission routes and their potential susceptible hosts, *i.e.* species, life stages *etc*. is often lacking, as are appropriate diagnostic testing methods for identification. A lack of aquatic animal health management also limits the application of effective biosecurity measures. Risks lie in weak regulatory frameworks, enforcement and implementation of standards at farm, sector and national levels and also insufficient capacity for response to disease emergencies.

4.7 Escaped farmed Atlantic salmon

Fish escapees from farms has historically been a challenge and the salmonid industry was certainly no exception. Unintentional escapement of farmed Atlantic salmon, either through regular, low-level 'leakage' or through major escape events, can occur as a result of mechanical damage to containment units, *e.g.* tears in cages or nets pens due to harsh weather conditions, *e.g.* storms, surges *etc*., predatory marine mammals, *e.g.* seals or otters or simple daily wear and tear. Escapes can also occur during routine husbandry activities or disease treatment procedures, *i.e.* transferring between fish between cages, grading, towing of cages, movement to well boats *etc.* Whilst a decrease in the number of escapees has been observed since the mid-1990s, due to the development of more secure and robust sea pen and cage systems, improved predator control measures and vigilance in husbandry methods, escapes of domesticated Atlantic salmon still represent a threat to the sustainability of the industry and a number of large-scale escape events have been reported in recent years (see **Figs. 7 & 8**).

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

Figure 7: Largest reported Atlantic salmon escapes worldwide

Source; IntraFish, Feb. 2019; accessed 31/03/2021: https://www.intrafish.com/aquaculture/here-are-the-largest-recorded-farmed-atlantic-salmon-escapes-in-history/2-1-388082

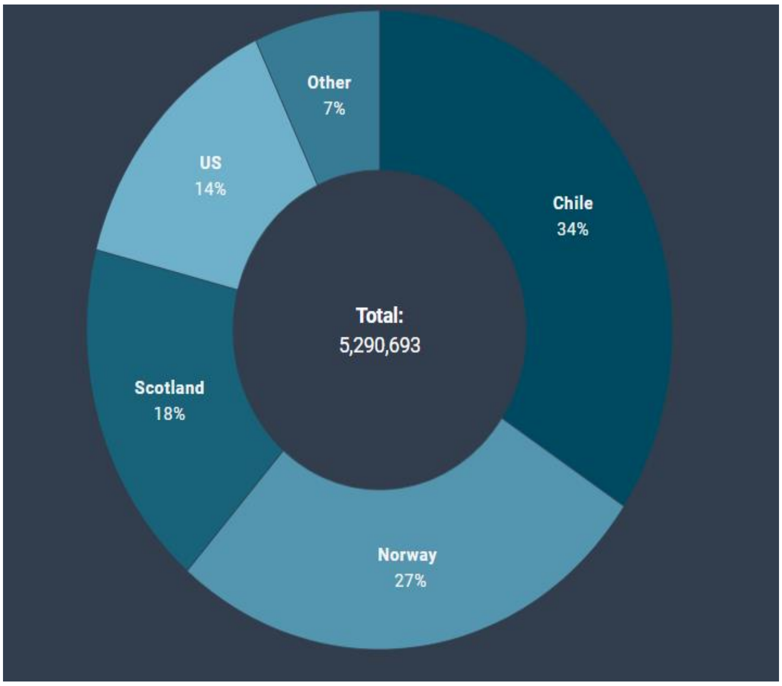

Figure 8: Escape events of over 100,000 farmed salmonids

NOTE: *Chile and Norway account for > 60 percent of the largest escape events*

Source; IntraFish, Feb. 2019; accessed 31/03/2021: https://www.intrafish.com/aquaculture/here-are-the-largest-recorded-farmed-atlantic-salmon-escapes-in-history/2-1-388082).

From a global perspective, the Atlantic salmon (*S. salar*) is now farmed not only within its native range, *e.g.* northern Europe and eastern North America, but also beyond, *e.g.* western North America, Chile and Tasmania. There have been documented escapes both in South America (Soto *et al.*, 2001) **(**Figure 7**)** and on the west coast of North America where, worryingly, Atlantic salmon have been documented in more than 80 rivers in British Columbia and are reproducing in some areas (Volpe *et al.,* 2000).

Interaction of escapees with native species raises a number of concerns that include competition for habitat and food resources, predation and the introduction and spreading of diseases and parasites (Forseth *et al.,* 2017), however it is the hybridisation or breeding of escaped farmed stock with indigenous populations of Atlantic salmon that is currently of the greatest concern and has been outlined as the most important contemporary challenge to wild salmon populations (Forseth *et al.,* 2017). In Norway it has been recently documented that 51 of 109 Norwegian Atlantic salmon populations showed significant genetic introgression (the movement of genes from one species to another) from farmed salmon (Karlsson *et al.,* 2016).

Breeding programmes for the domestication of Atlantic salmon was initiated in Norway in the early 1970s and has now approached 15 generations or more for several strains (Gjedrem, 2010). Currently there exists a range of worldwide breeding programmes that expedite improvements of key production traits in Atlantic salmon (Glover *et al.,* 2013; Wringe *et al.,* 2018; Naval-Sanchez *et al.,* 2020). As a consequence, domesticated salmon now display a wide range of phenotype and behavioural differences to wild salmon (Glover *et al.,* 2017) that include disease resistance (Gjedrem *et al*., 2012; Gutierrez *et al.,* 2014, 2016), improved growth rate (Thodesen *et al.,* 1999; Glover *et al.,* 2006, 2009; Solberg *et al.,* 2013a, b), stress tolerance (Solberg *et al.,* 2013a) and behavioural and life history traits, *e.g.* reproductive seasonality (Einum and Fleming, 1997). Results from modelling have indicated that where genetic introgression is high enough, life-history and demographic changes are expected in recipient wild populations (Castellani *et al.,* 2018). Most concerning is that interbreeding of escapees with wild populations can result in a less genetically variable hybrid population which is maladaptive for life in their natural environment (Ferguson *et al.,* 2007). These impacts of long-term and widespread escapes from aquaculture facilities seen in wild salmon include as a lowering of reproduction rates which cascades into a reduced smolt production and adult returns to the sea (Fleming *et al.,* 2000) as well as reduced sea survival (McGinnity *et al.,* 2003).

Another area for concern is 'biological contamination' or the introduction of exotic or non-native indigenous species into the marine environment, which can displace native species through completion for space and food and introduce new and potentially fatal diseases to endemic populations (Shelton and Rothbard, 2006).

The above discussion is clearly of vital importance to FIG since the introduction of salmon farming to the islands would represent the introduction of a non-native species. As reported, this has been practised in a variety of other countries/regions including Chile and Alaska (to name a few) and the evidence now shows that wild Atlantic salmon populations are present in the environment as the result of escapes. This position has changes somewhat with previous scientific opinion suggesting that Atlantic salmon were unable to survive outside their natural range. It must also be mentioned here that a difference exists between a species being present and breeding freely. Although evidence exists that breeding can occur, it remains the general scientific consensus that although escapees may be able to survive in the wild to some degree, but that active breeding is much less common (although it is acknowledged to occur).

For FIG to agree to the commencement of salmon farming in the Falklands requires the following key points to be fully understood;

1. That they will be introducing a new non-native species to the waters of the Falklands and that despite best efforts, escapes will occur at some point.
2. That the effects of these escapes on the Falklands environment may result in Atlantic salmon populations become established around the islands (either through breeding or simply through survival) and that this may have some direct or in-direct detrimental effects on the environment.

Other than the use of good management practices at the farm level (regular maintenance etc…) one further option does exist for reducing the risks of escapes in the form of using triploid fish.

A triploid fish is one which has three sets of chromosomes rather than the normal two. This is completed by exposing salmon eggs to high pressure. This process prevents early sexual maturation and results in a sterile fish. This sterility is clearly a positive from the perspective of ensuring that salmon escapes do not reproduce. Unfortunately some evidence of physical deformations have also been linked to the use of triploids (jaw deformities, heart deformities etc..) (Sadler et al 2001, Amoroso et al 2016) and they are known to be more sensitive to temperature changes.

In Norway, the Food Safety Authority grants special licences for growth of triploid salmon. These require farm sites to meet temperature and oxygen benchmarks to accommodate for triploids increased sensitivity to high sea temperatures and low oxygen levels.

It must also be pointed out that the triploid process is not absolutely 100% successful and so does result in the occasional breeding fish (although numbers are very low).

Very few hatcheries currently product triploid fish globally and insisting on its use in the Falklands would clearly reduce the chance of escapees forming new populations to very low levels. However, it would also raise welfare concerns about the fish themselves plus the consideration of genetic modification which can be very unpopular with public opinion.

Farmed Salmon Escapes

All farms at some point will have escapes which occur and for the FIG this is a vital consideration as the species is not native to the islands. Evidence shows that in other countries which have introduced the non-native Atlantic salmon, they have found to survive in the wild and even in some cases to breed. This brings obvious concerns around the dilution of genetic stock and additional and new competition with native species.

Best practices are generally not to introduce non-native species but should it be decided that the benefits are greater that the possible negatives then it would be suggested that a more detailed risk assessment is completed on this specific area.

Although much can be done to limit escapes, they are inevitable in some form from cage farming operations. One option is to insist on the use of triploid (sterile) fish in farming operations in the Falklands. This is likely to greatly reduce the risks associated with the escapes of a non-native species but does have other negative considerations associated with it (not to mention the practical aspects of sourcing triploid fish).

It is our opinion that this represents one of the main areas for further discussion by the FIG and a significant point of concern for future salmon farming operations in the islands.

4.8 Negative impacts on predators

The expansion of the marine finfish aquaculture industry over the last 30 years has resulted in increasing conflict with marine top predators such as birds and cetaceans (marine mammals), particularly pinnipeds, *i.e.* seals (Northridge *et al.,* 2013; Quick *et al*., 2004). Interaction takes the form of damage by predators to fish within the cages (seal strikes) and also to aquaculture infrastructures themselves, *i.e*. tearing nets, which may result in large scale fish escapes. In order to mitigate these problem interactions, different predator control measures have been used that include lethal methods such as shooting individuals, *i.e.* sea lions in Chile (Gaitán-Espitia *et al.,* 2017) or culling programmes, as well as the use of non-lethal deterrence devices such as physical barriers (secondary nets placed around the cages) and Acoustic deterrent devices (ADDs, also known as Acoustic harassment devices (AHDs)) (Quick *et al.,* 2004).

Whilst non-lethal approaches are preferred they can also have an impact on local wildlife; additional nets can cause unintentional death by entrapment (Tecklin, 2016). ADDs are used to mitigate seal depredation on aquaculture sites, a particular problem in the cage based Atlantic salmon industry, through the emission of loud and pervasive noise within the hearing range of the target species (pinniped underwater hearing range 50 Hz to 86 kHz; National Marine Fisheries Service, 2016), with the aim of deterring them from approaching and damaging the pens or the fish themselves (Coram *et al.,* 2014; Götz and Janik, 2013; Jacobs and Terhune, 2002; Quick *et al.,* 2004). In Scotland, they were first introduced in the mid-1980s (Coram *et al.,* 2014) and a widespread uptake of ADDS was seen in the 1990s; they were reported to be used at 52 percent of 195 aquaculture sites in 2001 (Quick *et al.* 2004). They are deployed underwater, attached to the cages, and can run continuously or only at times when seals are observed close to the nets (Northridge *et al.,* 2013), however data suggests that ADDs are a chronic and widespread source of underwater noise pollution as their frequency ranges have the potential to cause physical harm and behavioural effects on foraging, resting and reproductive behaviour on both target and non –target species (Brandt *et al.,* 2013; Coram *et al.,* 2014; Harris *et al.,* 2014; Morton and Symonds, 2002; Findlay *et al.,* 2018).

Interactions with pinnipeds is expected to be a similar area of concern in the Falklands with seals and penguins prevalent in the islands. Possible interactions with whales and entanglement have also been recorded in British Columbia.

<u>Negative Predator Impacts</u>

Seals, penguins and dolphins are all naturally attracted to salmon farming cages as it offers a source of available food. This can result in damage to cages and resulting escapes. To control this, a variety of methods have been used including lethal control, additional netting and acoustic deterrents.

Current best practices have greatly reduced the need for large scale lethal control, but it is still often required in most farms at some point (and is allowed in all regulatory systems in the world albeit with strict controls and licensing).

Predator interaction and control is likely to be a similar concern in the Falklands and so will need careful consideration.

4.9 Use of Fishmeal and Fish oil

Global non-fed aquaculture production has shown a clear downward trend over the last 20 years and now fed aquaculture production has outpaced the non-fed subsector in world aquaculture; (FAO, 2020). Intensively farmed salmonids rely entirely on industrially compounded aquafeeds, in the form of pellets at the marine on-growing phase, for their provision and supply of nutrients.

Energy, protein, and lipids in aquafeeds can be derived from crops and crop by-products, wild fisheries, *i.e.* forage fish, and fish and livestock processing by-products from the processing of fishery products for human consumption (Naylor *et al*., 2009). Atlantic salmon are carnivores and have a dependency and a high requirement for fish meal and fish oil in their diet. It is this reliance on fish meal and fish oil and the consequences for wild fish stocks that has received the most attention in recent years (Ytrestoyl, Aas and Asgard, 2015) and is often used as an argument against the sustainability of salmon production, *e.g.* Duetch *et al.,* 2007; Naylor *et al.,* 2000; Tacon and Metian, 2008.

As the global salmon industry has grown, the demand for fish meal and fish oil has increased concomitantly. The availability of small pelagic fish for aquafeeds, at prices that allow the feed industry to remain economically viable, has declined as many stocks are still overexploited and as more fish are consumed directly by humans for nutrition and pharmaceutical purposes (Ytrestoyl *et al.,* 2015). As a result, the use of fish processing wastes as a prime ingredient in aquafeeds is becoming more prevalent and will be a critical factor in augmenting net food supplies from aquaculture (Klinger and Naylor, 2012; Troell *et al.,* 2014; Ytrestoyl *et al.,* 2015). In addition, in order to reduce the components of marine origin (fish meal and fish oil) in salmonid aquafeeds, significant progress has been made in recent years identifying alternatives, *i.e*. products of plant origin and/or by-products of insect origin (Rumpold and Schluter, 2013; Shephard *et al.,* 2017).

It is clear that salmon feed composition has changed considerably during the relatively short history of intensive salmon farming; in 1990 around 65 percent of Norwegian salmon aquafeed was composed of ingredients of marine origin, whereas in 2013 it had reduced to *c*. 20 percent (Figure 9). However there are a number of caveats; not only may worldwide supplies of crop based feeds be threatened in the future due to changing climactic conditions (Troel *et al.,* 2014) but also the use of vegetable alternatives to replace marine based-protein sources could alternatively be used as high-grade food for human consumption (Troell *et al.,* 2014; Troell *et al.,* 2015; Cashion *et al.,* 2017; Fry *et al*., 2018). A further concern is the fact that, by replacing the marine components of the salmon feed with terrestrial products, the content of omega-3 fatty acids, notably eicosapentaenoic acid [EPA; 20:5n-3] and docosahexaenoic acid [DHA; 22:6n-3] in salmon may be reduced (Sprague *et al.,* 2016). This could have an important negative impact as neither humans nor salmon can synthesize omega-3 fatty acids and therefore must obtain them from their diet (Cadillo-Benalcazar *et al.,* 2020).

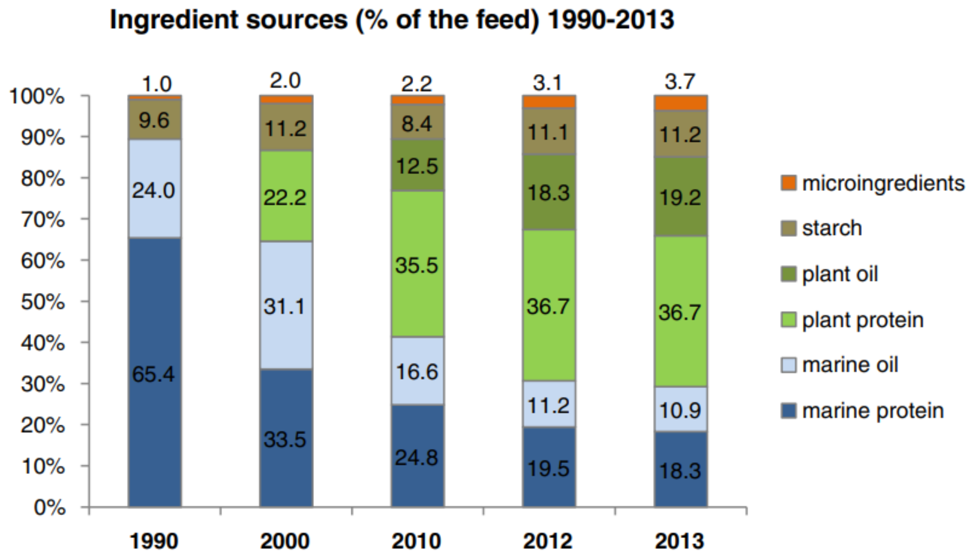

Figure 9: Nutrient Source in Norwegian salmon farming from 1990 to 2013.

Source: *Ytrestoyl, Aas and Asgard, 2015*

Sustainable Fish feeds

The salmon farming sector has made great strides in reducing its reliance on fishmeal and fish oil over the past two decades but concerns do exist over its sourcing and indeed the sourcing of its substitutes (from a sustainability perspective).

The issue of feed is not readily one that is addressed through regulation and is more the responsibility of sustainable certification initiatives which are discussed further on in this report.

4.10 Effects of Associated Wastes on the Marine Environment

As has already been discussed, salmonid farming is an intensive monoculture system and farmed salmonids are wholly dependent on the input of external feed (Folke, Kautsky and Troell, 1994) which, in open sea cages, will result in the release of organic and inorganic effluents, in the form of waste feed, faeces and metabolic by-products, directly into the surrounding aquatic marine environment without any form of treatment or recycling. (Carroll *et al.,* 2003; Holmer *et al.,* 2005; Strain and Hargrave, 2005). With the historical, exponential growth of the salmonid industry, there has been an increased awareness of the risks associated with increased discharges of wastes originating from salmon farms and a higher scrutiny of their environmental impacts (Taranger *et al*., 2021a).

The extent of nutrient enrichment and eutrophication is dependent on a number of factors, *i.e.* the size of the farm and fish biomass, the ambient environmental conditions, *i.e*. existing hydrodynamics (current velocities), water depth, wave exposure, topography and substrate type, as well as husbandry and management practices of the individual site (Holmer *et al.,* 2005; Carvajalino-Fernandez *et al.,* 2020).

Inorganic waste

Salmonids are carnivorous fish and are fed a protein-rich diet hence they excrete large amounts of dissolved metabolic by products mainly from their gills into the environment, in the form of dissolved inorganic nitrogen (**DIN**), i.e. $NH_3{}^{+}$ (ammonia) and dissolved inorganic phosphorus (**DIP**), i.e. $PO_4{}^{3-}$ (phosphate) and dissolved inorganic carbon (**DIC**) as **CO_2** through respiration (Wang et al., 2012) **(**Figure 10**).** These different nutrient components have the potential to influence different parts of the marine ecosystem, however the potential impact of inorganic or dissolved waste generated by fish farms is difficult to determine because of dilution and uptake by microorganisms in the water column (Quinones et al., 2019).

Benthic organic enrichment

The particulate fraction of the waste generated from salmon cages or Particulate Organic Matter (POM) is considered the largest source of negative impact upon the neighbouring benthic (the lowest level of a body of water such as the sea bed) communities at aquaculture sites, with up to 70–80 percent in the form of faecal material (Cubillo et al., 2016; Riera et al., 2017). Sedimentation of waste products can result in increased sediment organic matter (OM), i.e. particulate organic carbon (**POC)**, particulate organic nitrogen (**PON**), particulate organic phosphorus (**POP**) (Wang et al., 2012). Dissolved organic C, N and P (**DOC, DON** and **DOP**, respectively) are generated through dissolution of particulate organic fractions (Olsen & Olsen 2008) (Wang et al., 2012) **(**Figure 10**)**. In addition, dissolved 'free' pore water sulfides (Σ S2–, HS^{-} and H_2S) (S), particulate acid-volatile sulfides (AVS) and bottom coverage by white sulphur bacterial (Beggiatoa spp.) mats (Hargrave, 2010) will result in the generation of hypoxic (a deficiency of oxygen), anoxic (an absence of oxygen) or, potentially, azoic (devoid of life) conditions in areas that are in close proximity to the farm (Brooks et al., 2002; Hall-Spencer and Bamber, 2007; Keeley et al., 2012) in which macrofauna cannot survive (Haya et al., 2001). In recent years there has seen a movement of salmon fish farms to more dispersive locations which results in a greater horizontal transport of POM thus widening the potential zone of impact (Broch et al., 2017).

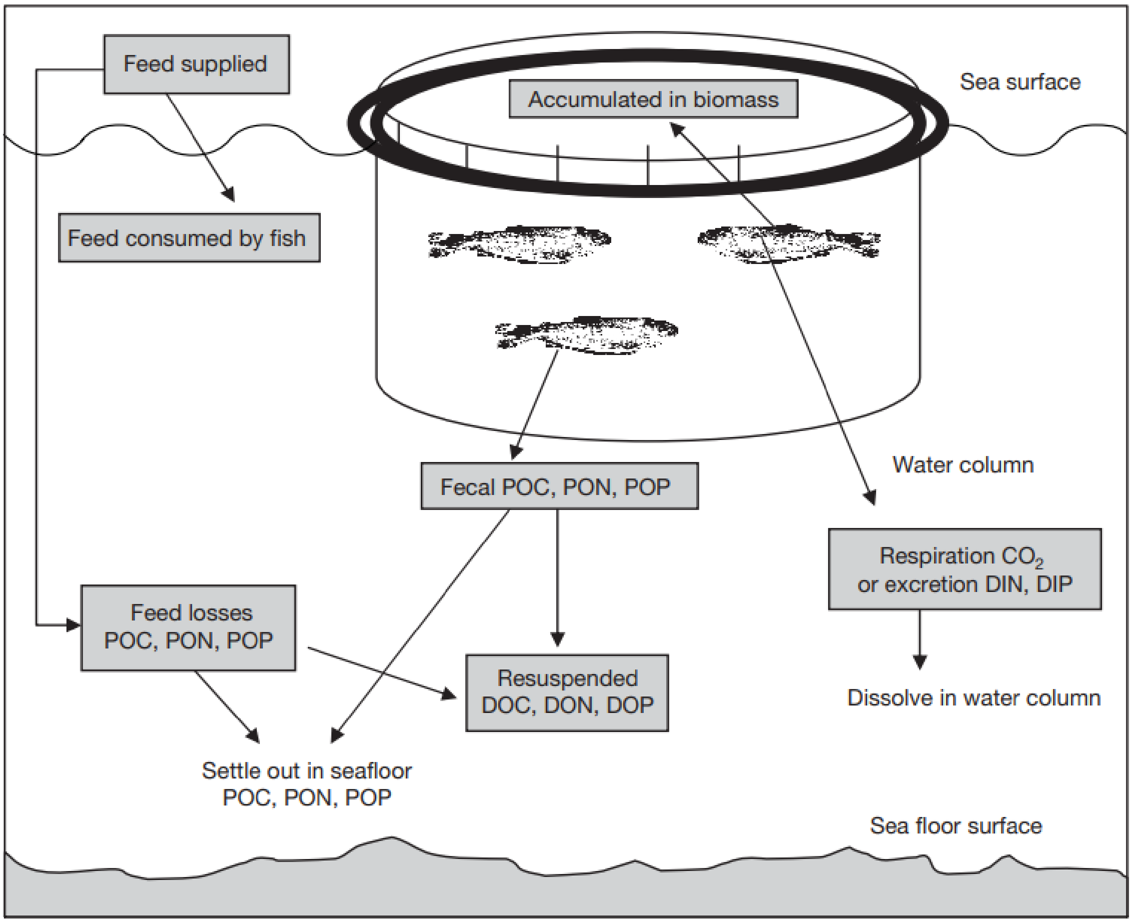

Figure 10: The flow and fate of nutrient components from a salmon cage system

Effects of chemical discharge from salmon farms

Infections by bacteria, parasites, fungi and viruses are frequent causes of morbidity and mortality in salmon aquaculture with important negative effects on production and profit (Dresdner et al., 2019). (See Section 3.1.1. Infectious Diseases). As is the case in any intensive animal food production system, it is often necessary to treat farmed salmon against diseases.

It would be true to say that aquaculture management practices have evolved over the past 20 years, and fish husbandry has greatly improved, resulting in a reduction in the use of some chemicals, particularly the use of antibiotics in most jurisdictions (See Section 3.1.5.2. Antibiotics), however, the industry still relies on the use of chemo-therapeutants to combat bacterial infections and infestations of ecto-parasites as well as disinfectants to manage the spread of diseases (Haya et al., 2005).

Disease management of salmonid production systems will result in the release of chemical inputs to the surrounding aquatic marine environment and those issues of most concern will be discussed below.

Parasiticides

Parasitic diseases have been a serious problem for salmon aquaculture industries for a number of years, especially infestation by sea lice.

Compounds used to treat infestations of sea lice are applied under veterinary prescription and are, as discussed above, ultimately released to the aquatic environment. These chemical parasiticides have historically been identified as a major environmental concern (Nash, 2003). The classes of therapeutants currently used to combat sea lice infestations include; avermectins, pyrethroids, hydrogen peroxide and organophosphates (Haya et al., 2005; Bravo et al., 2005; Lees et al., 2008). These compounds may be classified into two groups based on their route of administration, bath treatments, i.e. pyrethroids, hydrogen peroxide and organophosphates and in-feed additives, i.e. avermectins (Burridge et al., 2010).

In general, anti-lice treatments lack specificity and have the potential to negatively impact sensitive non-target organisms, specifically crustaceans, by altering the population structure within the immediate surroundings (Johnson et al., 2004). Of further concern is that historically sea lice have shown a remarkable adaptability to develop resistance to chemical treatments; it can take only a few years for evidence of resistance to appear following a new treatment with a new chemical. One solution has been to switch between different treatments methods, but the problem of resistance seems to be hard to overcome, and multi-resistance has emerged rendering them useless. The treatment of the sea lice problems also involves costs to the industry; Abolofia et al. (2017) estimated that the cost of sea lice treatment constituted production costs ranging from 0.12 to 0.67 US$/kg, or in the range of 2.27 to 13.10 percent of yearly revenues.

Antibiotics

Antibiotics have been used in veterinary medicine since the 1940s (Lozano et al., 2018) and in aquaculture for more than 50 years (Shamsuzzaman and Kumar 2012). Indeed they are currently amongst the most applied chemicals in the aquaculture industry (Sapkota et al., 2008). They are used as therapeutic agents in the treatment of bacterial infections (Alderman and Hastings, 1998; Angulo, 2000; Sørum, 2000, 2006; Pillay, 2004; Silbergeld et al., 2008) and work by either killing (displaying bacteriocidal activity) or inhibiting the growth of (displaying bacteriostatic activity) pathogenic bacteria and are usually administered to farmed fish through medicated feed (Smith et al., 2009; Rico et al., 2013; Wang et al., 2015). Antibiotics can also be applied to promote growth (Chowdhury et al., 2009),

A number of antibiotics have historically been used to treat bacterial infections in salmon aquaculture;

- Amoxicillin: a broad-spectrum antibiotic effective against gram positive and gram negative bacteria and used to treat fish with Furunculosis (causative agent: Furunculosis salmonicida).
- Florfenicol: a broad spectrum antibiotic used also to treat Furunculosis.
- Tribrissen (sulfadiazine: trimethoprim (5:1): a broad-spectrum antibiotic used to treat gram negative bacteria causing Furunculosis and Vibriosis (Vibrio anguillarum)
- Oxolinic acid and flumequin: quinolone antibiotics used to treat gram negative bacteria causing Furunculosis, Vibriosis and Piscirickttsia salmonis
- Oxytetracycline: a broad spectrum antibiotic effective against Furunculosis and Vibriosis (Powell, 2000).
- Erythromycin: effective against gram positive and non-enteric gram negative bacteria causing Bacterial Kidney Disease (BKD) (Powell, 2000).

Antibiotics are stable chemical compounds that are not broken down by the host (Capone et al., 1996; Hektoen et al., 1995; Boxall et al., 2004; Aarestrup, 2006; Sørum, 2006) and a significant percentage are released into the environment through unconsumed feed, or excreted in urine and faeces (Cabello et al., 2013; Miranda et al., 2018). Therefore these antibiotics and their metabolites end up in the surrounding environment (Boxall et al., 2004; Sørum 2006). Residues can accumulate in sediments, causing changes in microbial species composition and biogeochemical function of the benthic community (Contanzo et al., 2005; Tamminen et al., 2011) as well as in the culturing or adjacent waters affecting wild fish and shellfish which can be collected for human consumption, therefore potentially affecting capture fishery product safety and human health (Chen et al., 2015, 2018b; Lulijwa, Rupia and Alfaro, 2020). The consequences of human consumption of antibiotic residues include adverse drug reactions (ADR) and development of antibiotic resistance (AMR) for clinically important bacterial pathogens (Liu et al., 2017) (see Section 3.5.3. Antibiotic resistance).

Antibiotic usage in some major salmon producing countries has reduced in recent years due to vaccination against many economically important bacterial infections, i.e. infectious haematopoietic necrosis (IHN), salmon anaemia virus (ISAV), and improved husbandry practices, i.e. fallowing of sites after production cycles (Lillehaug et al. 2003; Burridge et al., 2010; Chuah et al., 2016), however therapeutic or prophylactic antibacterial therapy still remains the last option to combat bacterial infections in aquaculture (OSPAR, 2009; Lulijwa, Rupia and Alfaro, 2020).

Looking at global antibiotic usage in salmonid production, variations in the amount of antibiotics used during production cycles globally are clearly evident (Figure 11); historically Chile had and still does have the highest rate of antibiotic usage in salmon production in the world, mainly due to treatment of infection by the bacterial pathogen Piscirickettsia salmonis, a facultative, intracellular bacterium and the causative agent of Piscirickettsiosis, against which vaccines have proven unsuccessful (Miranda et al., 2018; Figueroa et al., 2019). Data from 2017 shows that, during the on-growing marine phase in Chile, 94.7 percent of the antibiotics used were for Piscirickettsiosis, 4.5 percent for Bacterial Kidney Disease (BKD) and 0.73 percent for other diseases (SERNAPESCA, 2017).

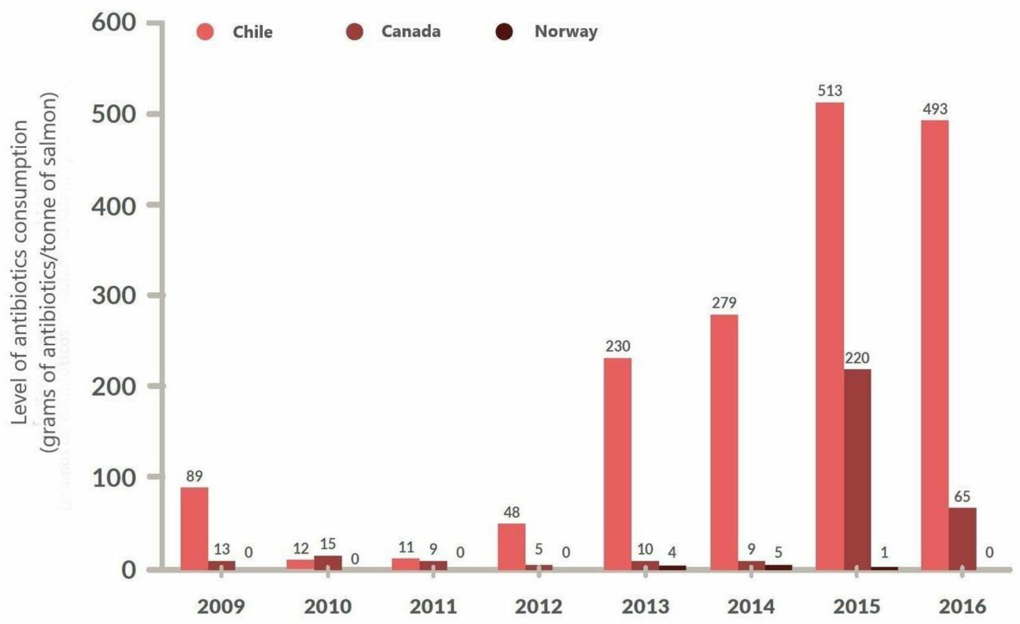

Figure 11: The amount of antibiotics used by Cermaq in Chile, Canada and Norway for one tone of production (2009-2016)

Source: *Design by ONG Oceana based on Cemaq's reports in 2011, 2012 and 2016 (Sustainability and GRI reports). Image accessed 10/03/2021.*

Antimicrobial resistance (AMR)

Antibiotic or antimicrobial resistance (AMR) is considered by the World Health Organisation to be one of the greatest threats to global health, food security and development (WHO, 2021) and will be dealt with here separately.

AMR results from the selection of spontaneous mutants and horizontal gene transfer between different species and genera (Alonso et al., 2001; Hastings et al., 2004; Sørum, 2006; Aarestrup, 2006; Welch et al., 2007; Baquero et al., 2008; Silbergeld et al., 2008; Martinez, 2009) causing the development of a disease-causing microbe to subsequently survive exposure to an anti-microbial agent, i.e. an antibiotic, and is well documented in the aquatic environment. In an aquaculture context, AMR can result from both short-term, low dose administration of antibiotic compounds, and, more so, from prolonged, high dose administration (Rezk et al., 2015; Chuah et al., 2016; Monteiro et al., 2016); in other words, the more antibiotics that are used in the aquaculture industry, the greater the risk of emergence and spread of AMR, with the result that the drug becomes increasingly useless against its target.

The first reports of AMR against fish bacterial diseases came from farmed aquaculture species in Thailand (Reungprach and Kesomchandra, 1983), however the problem soon became global; from 1990 to 2007 a total of 29 studies on AMR in aquaculture reported 100 incidences across 13 of the 15 top aquaculture producers (Lulijwa, Rupia and Alfaro, 2020). Although, unsurprisingly China - as the world's largest producer of aquaculture products - is currently leading globally in reports of AMR in farmed fish (Liang et al., 2013; Su et al., 2017; Chen et al., 2018a; Marti et al., 2018) there is also cause for concern within the salmonid industry. Chile is the second-largest global producer of salmonids after Norway and, as has been seen above, Chile currently leads in antibiotic usage amongst salmon producers (Fig. 11); in 2016, Norway used a total of 201 kg (EMA, 2016) of antibiotics to produce 1.3 million tons of salmon (0.01 g/ton) (Luthman, Jonell and Troell, 2019) however in the same year, Chile used 382,500 kg of antibiotics to produce 727,812 tons of salmon, and 334,100 kg of antibiotics were reported for 2019 (500 g/ton) (SERNAPESCA, 2020), indicating the continuous excessive antibiotic use in Chilean salmon farming, which threatens to cause environmental and health issues.

Regulators have got better at determining the risks of associated wastes in aquaculture over the past decade and most now require some form of 'plume modelling' to be completed as part of the licensing processing. In Scotland, a modelling platform called DEPAMOD is used for this purpose and allows regulators to determine the movement of nutrients and other residues from a specific site. Using this, regulators can then perform regular monitoring to ensure that farms are maintaining levels in line with those predicted (and regulated).

Associated Wastes

Salmon farms produce an array of both solid and dissolved associated waste products during operation. This includes uneaten fish feed, and fish waste (both solid fecal matter and dissolved nutrients). In significant quantities these can lead eutrophication of the water body of the build up of anoxic seabed conditions. Furthermore, other chemicals including antibiotics and pesticides can form high levels around cage farms if not carefully managed.

The control of these associated wastes has improved dramatically through beter regulation and licensing. Most farms require modelling of associated waste at the planning phase and these must show levels which are inline with accepted regulatory requirements. Once approved farms are also often required to complete seabed and water column monitoring to ensure that levels are maintained as predicted (and this is often backed up by direct testing and sampling by the authorities).

5. Social Economic Impacts of Salmon Farming

5.1 Public attitudes towards salmonid aquaculture

Fish farming has long been a topic of debate. With the growth and expansion of the global aquaculture, currently the fastest growing food sector in the world, the industry, especially salmonid production, has witnessed considerable negative public perceptions (Bacher, 2015; Hargreaves, 2017).

This debate is particularly visible in the mass media which has an important role in how people interpret information, thus shaping public opinion. The process known as 'media framing', i.e. highlighting some aspects of an issue while ignoring others (Iyengar, 2015) has often omitted important issues regarding aquaculture, e.g. technological advances in production methods and systems, reduction in usage of marine resources in feed fish, scientific advances in health management, e.g. vaccines and optimised husbandry practices, improvements in fish welfare, certification schemes etc. Media acts as an important intermediary for scientific information reaching the public, particularly in the food sector (McCluskey et al., 2015) and, in recent years, a seemingly increasingly hostile media coverage as well as global awareness of the precariousness of the sustainability of global aquatic resources seems to have steered public opinion. The public's views and opinions about of the social, economic and environmental aspects of aquaculture can exert a substantial influence on the industry's ability to retain and/or expand its access to production sites (Chu et al., 2010; Olsen and Osmundsen, 2017), as well as its success in selling farmed seafood products to consumers (Hall and Amberg, 2013; Verbeke et al., 2007; Whitmarsh and Palmieri, 2011).

Although the production and markets for salmon continues to expand, it is also clear that the debate on salmon farming is becoming louder with more parties taking to social media to vilify the practice (and often with an already set agenda). In the UK, for example, the wild fishery for salmon is particularly vocal and blames the aquaculture sector directly for reducing returns of fish to the rivers to spawn (which is an inescapable scientific fact, although the reasons are not so clearly understood).

This public debate is expected to be strong in the Falklands for several key reasons;

- The NGO community is strong in the region and has already publicly stated its position against farming in the islands
- The islands are considered a pristine environment and this is something that the local community are very passionate about
- The closest example of commercial salmon farming is in Chile and historically it is also probably the worse (leading to further negative perceptions)

It will be important to ensure that public debate forms a key pillar of future legislation and planning for any development of salmon farming in the country. This must be both at the national planning level (through stakeholder engagement processes) but also at the individual licensing level, should it occur (usually through the Environmental and Social Impact Assessment process).

5.2 Conflicts

'Actors' or those individuals or groups who are in opposition to the establishment or expansion of local fish farms are a diverse group and can comprise local populations, small-scale fishermen and women, environmental NGOs, tourism sector representatives, local or regional administration, researchers, fish consumers energy sector representatives, producers of different aquaculture species and recreational users, e.g. involved in sailing, diving or recreational fishing.

Conflicts around salmonid aquaculture can specifically relate to concerns about;

Environmental degradation or the irreversible consequences of generated wastes on the environment due to high nutrient loading, chemical use, antibiotic usage as discussed above (see Section 3.2.1. The impact of diseases on salmonid aquaculture & Section 3.2.5. Effects of chemical discharge from salmon farms).

Escapes, i.e. concerns about the impact of escaped farmed fish on wild salmon stocks through disease transmission and genetic interactions.

Actors in this debate are, as previously mentioned, usually wild salmon anglers and river owners and small scale commercial fisher people claiming decline in wild stocks, restriction in their fishing area and competition with cheaper aquaculture products.

Use of space, i.e. conflict between salmon farming and other resource users of the coastal areas, e.g. local populations who use the marine area for recreational purposes.

Impact on local tourism; the local tourism sector, e.g. angling, diving, sea safari and wildlife tours, is reported to perceive aquaculture as a risk due to the negative impacts of aquaculture infrastructure, i.e. noise, smell, unsightly/visual impact etc. and also conflict of space (see above).

Food safety concerns, i.e. concerns that farmed fish is unsafe to eat due to high chemical and antibiotic residues and genetic modifications.

The voices of these actors has certainly grown in recent years with increased use of social media and to many it appears that the fish farming sector is being held to far higher standards and requirements than other food production systems. Often, opinions are expressed with little evidence to back them up and false or historic claims are still regularly expressed.

Dealing with these conflicts is likely to be a difficult task in the Falklands where passions on this subject are already known to be high.

5.3 Advantages of Salmon Farming

The rapid growth of the salmonid industry worldwide has brought socio-economic benefits to a number of peripheral areas. Looking specifically at Scotland it can be seen that the salmon farming industry is an important source of employment to rural local communities and data on the number of employee directly involved with the salmon industry, including veterinarians, harvesting and maintenance staff and administrative staff but not including processing or marketing staff, has shown an overall increase from 1979 (Figure 12).

Aquaculture has the potential to offer more stable jobs when compared to seasonal fishing and can help to stabilise community structures and drive secondary industry and services (Neiland et al., 1991). The Scottish Salmon Producer's Organisation (SSPO) states on their website (2021) estimates that the industry supports around 8,000 jobs - Scottish Salmon Producers Organisation.

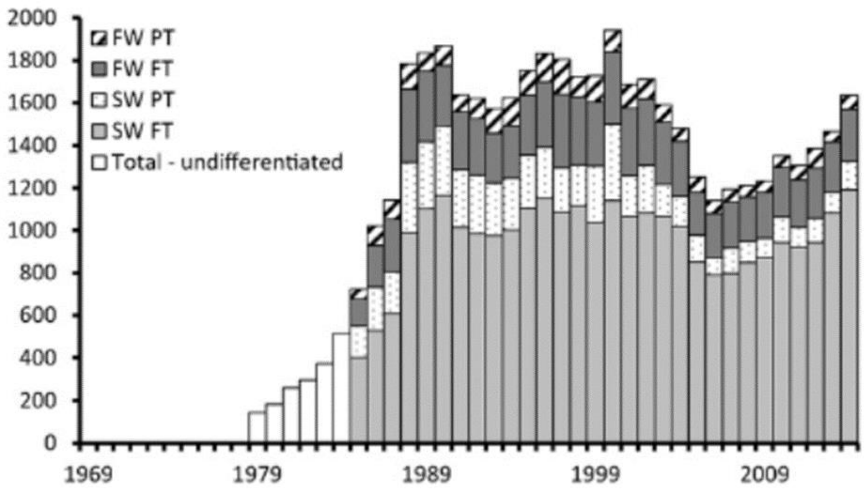

Figure 12: Full Time (FT) and Part Time (PT) employees in Scottish salmon industry

***Source**: Ellis et al., 2016*

Aside from job creation, the contribution to a countries GDP cannot be underestimated as well. Independent research by the SSPO suggests that the industry in Scotland has an annual turnover of £1 billion and generates £216 Million in total tax revenue which is not insignificant to the country.

It is fair to say that this positive story is one that is often lost amongst all the negative publicity that circulates about salmon farming. Ensuring this good news story is fully understood is vital to improving the acceptance of salmon farming, certainly at the community level where employment and wealth creation are often directly experienced.

5.4 Mitigation measures against potential conflict

Closer interaction and listening to voiced opinions and concerns of local communities who are expressing concern about the impacts of proposed aquaculture developments can help alleviate the worries to perceived problems. By informing about the proposed developments i.e. updating them about planning regulations and environmental impact assessments before initial site selection, is vital. Salmon farming in Scotland is tightly regulated and monitored by a framework of control measures (Henderson and Davies, 2000). The present approach in Scotland comprises i) control on fish farm location (via a Crown Estate lease), ii) control on effluent discharges (via a Scottish Environmental Protection Agency discharge permit) and iii) monitoring of the environmental impacts (via the relevant agency or by self-monitoring). Other requirements include the need for an environmental impact statement (EIA) for new farms or farm developments above a threshold size (100 tonnes production), plus controls on the sale and marketing of pharmaceutical products and pesticides (Whitmarsh, 2006).

In addition, transparency about planned farm husbandry procedures, including stockings, harvesting, treatments etc. can prevent conflicts. Industry transparency with data, such as mortalities, sea lice counts etc. can also encourage a feeling of involvement and understanding of the processes.

It is also a strong recommendation that all farms should introduce a complaints system to allow them to deal with issues in an efficient and effective manner as they arise.

Finally, ensuring a fair promotion of the positive aspects is an important mitigation strategy and ensures that discussion do not get overtaken by negative issues only.

Socio-Economic Considerations

The salmon sector globally has received increasing volumes of negative commentary from a host of actors. Often these opinions are not well informed or are based on hidden agendas (the wild rod and line capture sector for example) although this is not to say that criticism is not at all justified at times (as shown with the issues identified in this report).

The result of this negative criticism though is that public opinion may begin to be moved in an anti-salmon farming direction and the development of new activities could result in heavier criticism from local communities and NGOs alike.

In many ways, salmon farming consent is like house building in that many people accept it needs to happen, but few want it near them. Dealing with these socio-economic arguments can only be done through dialogue and transparency while using the wealth of scientific data which now exists. It is also vital that the positives of salmon farming are clearly spelt out to communities (job and revenue generation) so they understand the reasons that sustainable growth of the industry may benefit them and their communities directly.

6. The Salmon Industry: Lessons learnt and mitigation strategies

In 1995, the Food and Agriculture Organisation of the United Nations' (FAO) 'Code of Conduct for Responsible Fisheries (the Code)' **- whose aim was to** set international standards of behaviour for responsible practices for both fisheries and aquaculture with a view to ensuring the effective conservation, management and development of living aquatic resources - was adopted by all FAO members. It set out globally agreed principals and standards for the use of fisheries and aquaculture resources with the overreaching aim of ensuring the 'sustainable use of aquatic-living resources in harmony with the environment' (FAO, 1995)

Therefore it can be seen that the sustainability of the aquaculture industry, that is to say its long-term viability, has historically been a key factor of consideration. Considerable focus has been turned towards the development of best management practices, codes of conduct and aquaculture certification programmes etc. in order to promote more environmentally and socially responsible sustainable aquaculture farming practices (Quinones et al., 2019). This is certainly the case for the economically valuable and intensively farmed salmon industry.

As has already been seen, the scale of the impacts of salmon farming can vary depending on the geographical location and hosting ecosystem, the scale of production, management practices etc. The way that historical issues, that have been discussed above may vary, and mitigation measures that have been taken to address these issues reflect these differences. These will be explored below in the context of the two main global salmon producing countries, i.e. Norway and Chile.

6.1 Norway

6.1.1 A brief history of the Norwegian salmon industry

Norwegian salmon farming has grown exponentially over the last 50 years, and is continuing to grow. It has historically and continues to rank first amongst the major global salmonid producers, accounting for 1.4 million MT live weight in 2018 (FAO, 2020). It constitutes 74 percent of total seafood export value from Norway, thus by far surpassing the traditional fisheries (Hersoug, Mikkelsen and Osmundsen, 2021).

Salmon production began in Norway in the late 1960s as a diversification of small-scale farmers supported by the government, with little or no regulation (Olaussen, 2018). It was in 1973 that the first law on concessions in salmon aquaculture were introduced with permissions required to set up a fish farm (Aarseth and Jakobsen, 2009), and, in 1985, the first specific aquaculture related law was issued. However this did not cover concessions to set up a hatchery, with the result that overproduction of smolts reduced salmon prices and the industry faced allegations of dumping in the US market. It was only in 2005 that key environmental issues were addressed, with a new law focussing on the sustainable production and growth of an already significant and environmentally impactful industry, which will be explored below.

6.1.2 Key constraints to the growth of the Norwegian salmon industry

It seemed clear that the rapid expansion of the industry meant that management guidelines and targets to address potential negative effects had generally not developed in pace with growth. Therefore, there was a need for more coordinated efforts to identify hazards related to open sea cage farming and evaluate environmental risks. In 2009, the Norwegian government identified 5 key Goals or areas of environmental concern that threatened the sustainability of the Aquaculture industry that required to be addressed in the 'Strategy for an Environmentally Sustainable Norwegian Aquaculture Industry' (Anon, 2009b) and which are set out in Table 2.

Table 2: The five primary goals for the future development and sustainability of the Norwegian aquaculture industry (Norwegian government, 2009)

Goals	Threat	Process of concern	Endpoint concern	Management goal
Goal 1: Disease	Salmon lice	Salmon lice from fish farming affects wild fish	Salmon lice from fish farming significantly increase the mortality of wild salmonids	Disease in fish farming will not have a regulating effect on stocks of wild fish, and as many farmed fish as possible will grow to slaughter age with minimal use of medicines.
	Viral diseases i.e. PD, IPN, HSMI, CMS	Disease transmission from fish farming affects wild fish	Viral transmission from fish farming significantly increase the mortality of wild salmonids	Disease in fish farming will not have a regulating effect on stocks of wild fish, and as many farmed fish as possible will grow to slaughter age with minimal use of medicines.
Goal 2: Genetic interaction	Escapes of farmed salmon	Farmed escaped salmon successfully interbreed with wild salmon populations	Changes observed in the genetic characteristics of wild salmon populations	Aquaculture will not contribute to permanent changes in the genetic characteristics of wild fish populations
Goal 3: Pollution and discharges	Discharges of organic material: local effects (ii) regional effects	Emissions of organic materials to the surrounding environment	(i) Unacceptable change in sediment chemistry and faunal communities in the production zone; (ii) Significant change in bottom communities beyond the production zone—regional impact	All fish farming locations in use will maintain an acceptable environmental state and will not have higher emissions of nutrient salts and organic materials than the receiving waters can tolerate.
	Discharges of nutrients: local effects regional effects	Emissions of nutrients to the surrounding environment	(i) Nutrients from fish farms results in local eutrophication; (ii) Nutrients from fish farms results in regional eutrophication	All fish farming locations in use will maintain an acceptable environmental state and will not have higher emissions of nutrient salts and organic materials than the receiving waters can tolerate.

Goal 4: Zoning				The aquaculture industry will have a location structure and zoning which reduces impact on the environment and the risk of infection.
Goal 5: Feed and feed resources				The aquaculture industry's needs for raw materials for feed will be met without overexploitation of wild marine resources.

6.1.3 Pollution and discharges

During the marine phase of intensive salmonid culture, the cage or net pen rearing systems are situated in a large body of water and solid organic wastes, i.e. waste feed and faeces, passes thorough the bottom of the cage and settle in the surrounding area. The most severe impact has been associated with poor currents and water circulation, where general conditions and benthic fauna are negatively impacted mainly because of the lack of oxygen in the sediment after high bacterial respiration (Soto and Norambuena, 2004). In an optimal situation, the farm should be located at a site with high water currents, which aid organic matter dispersal and prevent accumulation below the cages. In addition, moving the cages and the fallowing of sites between production cycles avoids the build-up of solid wastes. (See Table 2; Goal 3).

Requirements before new farms can become operational that include an Environmental impact assessment of new farms (Table 3). In general terms, an EIA requires an operator to set out what it intends to do, determine a baseline for the site (for example what the current environment looks like) and then determine what potential impacts that these activities will have on this baseline. Once this is done, the operator will tend to suggest mitigation measures when possible to reduce the impacts to as 'low as practically possible'. The results of this EIA are then opened up to public and regulatory consultation and approval so that improvements can be suggested and/or issues raised. A finalised EIA is then usually attached to planning consent and further informs the final decision making process (basically asking regulators to agree if the potential impacts are acceptable). Finally, the EIA process usually requires the operator to put forward a monitoring program to allow for the continuous assessment of the impacts of the operation over time.

Table 3: Regional requirements before farms can become operational

Region	Requirements before receiving a license to farm salmon
Norway	Each farm must provide either the shire or Fiskeridirektoratet with an Environmental Impact Assessment (including size of the farm, biomass, potential effects on wildlife and environment), as well as management plans for escaped salmon, jelly fish invasions, algae blooms and predatory attacks. Furthermore, the farmer must provide a retention plan for escapes and a diploma or certificate that they are allowed to farm salmon (Aquaculture course level-II).
Chile	A license will not be issued unless an Environmental Impact Assessment is accepted by the Undersecretary or Sub-Secretariat for Fisheries or the Undersecretary or Sub-Secretariat for Marine Affairs. The assessment should include information about; potential risks for human health from effluents or discharges, significant alterations on renewable resources such as soil, water or air, if communities would have to resettle, if the environment would be seriously altered or if other resources or settlements would be affected, if tourist attractions, scenic areas or culturally important monuments or locations would change.

6.1.4 Sea lice

The levels of sea lice infestation on farmed salmonids, a historical problem in Norway, has been closely regulated on farms since 1997 in order to reduce the harmful effects on wild and farmed fish (Heuch et al., 2005). Indeed effective methods of controlling the impact appeared to be critical for sustainable expansion of Atlantic salmon production (Jevne et al., 2021).

From 2000 to 2013, the legal lice infection thresholds, enforced by the Norwegian Food Safety Authority (NFSA), were set to 0.5 adult female lice per fish, or 3 lice per fish of other mobile stages, i.e. adult males or pre-adult mobiles, during the period spanning Jan 1st –Aug 31st, and 1 adult female or 5 other motile stage per fish during the wild smolt migration period. However, in 2013, the threshold for taking action were significantly reduced to 0.2 lice per salmon on average in week 16–22 (wild smolt migration period), and less than 0.5 lice per salmon in remaining season. If thresholds are exceeded, it is mandatory for the farmer to treat or slaughter their fish within two weeks. The NFSA also requires farmers to count sea lice in their pens weekly if water temperatures are > 4 °C, bi-weekly if < 4 °C (Table 2; Goal 1).

In October 2017 The Norwegian Department of Fisheries and Aquaculture introduced the new and somewhat controversial 'Traffic light system' (Vollset et al., 2017; Myksvoll et al., 2018); the Norwegian coastline was divided into 13 production zones, each with an environmental indicator to determine whether the sea lice threat is low (green), medium (yellow) or high (red) based on regularly monitored sea lice counts of wild sampled salmon, thus allowing the salmon industry to grow (green), freeze production (yellow) or reduce production (red). This gauge is used as an indication of production status, i.e. growth of farmed stock within the respective production zone (Myksvoll et al., 2018). This system that relies on the principal that sea lice pressure on wild fish is key to growth has attracted criticism as it does not take account of other external factors, e.g. nutritional status, health status and immune competency, etc.

With the emergence of chemical resistance by sea lice and the associated reduction in the use of chemical based treatments, there has been considerable research and development carried out in Norway to explore alternative delousing methods, with varying degrees of success. Based on the premise that sea lice are more prevalent in the surface layers of the water, snorkel cages (a fine mesh net ceiling preventing fish from swimming in the surface waters of the cage) (Fig. 7 a), and skirts (fine mesh nets around the upper parts of cages) (Fig. 7 b) are being trialled to prevent sea lice attaching to farmed salmon (Stien et al., 2016, 2018; Grøntvedt et al., 2018). Mechanical and thermal delousing methods, i.e. flushing salmon with clean sea water at ambient temperature or elevated temperatures (28-34 ºC) have also been recently introduced and, although they are stressful and potentially lead to elevated salmon mortality rates post-treatment (Gismervik et al., 2019; Nilsson et al., 2019; Overton et al., 2019), they are, at present, the most common whole cage lice removal method currently applied in Norway.

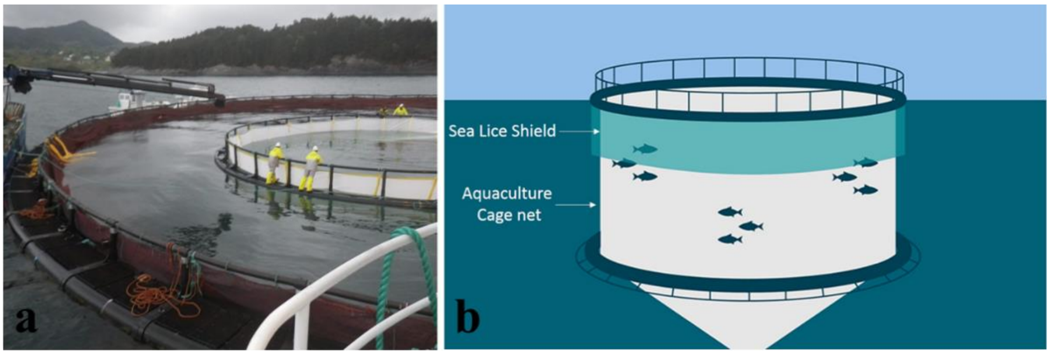

Figure 13: a) Photo of a large circular salmon cage with centre 'snorkel', i.e. tube in the net ceiling allowing fish to access the surface to fill swim-bladders; b) representation of a lice skirt or shield around a marine cage

Over the last ten years or so concern has prompted investment in biological control methods that have minimal welfare impacts upon salmon, specifically the use of 'cleaner fishes', i.e. lumpfish (Symphodus melops) (Fig. 8), ballan wrasse (Labrus bergylta), goldsinny wrasse (Ctenolabrus rupestris) and cuckoo wrasse (Labrus mixtus) that eat attached pre-adult and adult lice stages directly off salmon (Imsland et al., 2015, Powell et al., 2018). The use of cleaner fishes as biological control agents of salmon lice began in the late 1980s (Bjordal, 1991, Torrissen et al., 2013) and in Norway increased rapidly from 2012, (Overton et al., 2019); by 2018, 49 million cleaner fish were stocked in Norway, with 65 percent of farms using them (wrasse: 18 million; lumpfish: 31 million; Norwegian Directorate of Fisheries, 2019). Recent research has shown that efficacy is minimal and high losses of cleaner fish and incidence of disease do not fulfil fish welfare requirements (Overton et al., 2020).

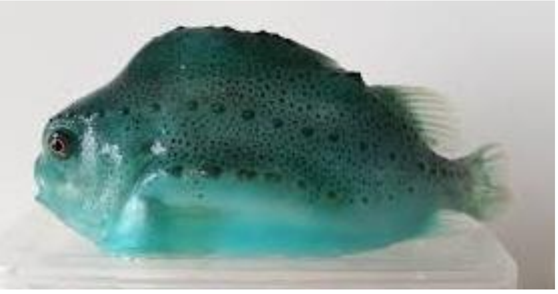

Figure 14: Lumpfish or lumpsucker (Cyclopterus lumpus)

6.1.5 Infectious diseases

Vaccines are recognised as critical tools for the prevention and control of fish diseases especially for Atlantic salmon, for which they are used routinely and recognised as an essential route to the reduction in use of antibiotics within the aquaculture industry and have been seen to significantly reduce antibiotic usage in salmonid aquaculture in Norway (Fig. 11).

Vaccination is a process by which protective immune response is induced in animals through the administration of preparations of antigens derived from pathogens and made non-pathogenic by means of heat or other ways and stimulate fishes' immune response and increase protection against diseases. The fish vaccination programme was initiated in 1942 with the first commercially available vaccine against Aeromonas salmonicida (Roar and Van Muiswinkel, 2013; Ayalew and Abunna, 2018); Ingunn et al., 2005) and since that time advances in biotechnology and immunology has led to development and commercialization of many other fish vaccines like DNA vaccines, Nano vaccines, subunit vaccines, genetically modified vaccines and polyvalent or multivalent vaccines (Dadar et al., 2017); Plant and La Patra, 2011). There are currently 24 licenced fish vaccines for some economically important fish species for treating bacterial and viral diseases and 18 for salmonids (Shefat, 2018; Adams and Subasinghe, 2019; Adams, 2019) (Table 4).

Table 4: Commercially available vaccines against major bacterial and viral infections for salmonids

Name of vaccine	Species vaccinated	Targeted disease
Arthrobacter Vaccine	Salmonids	Columnaris disease
Vibrio anguillarum-Ordalii	Salmonids, Rainbow trout	Vibriosis
Aeromonas salmonicida Bacterin	Salmonids	Furunculosis
Yersinia ruckeri Bacterin	Salmonids	Yersiniosis
Listonella anguillarum Vaccine	Salmonids seabass, yellowtail	Vibriosis
Vibrio salmonicida Bacterin	Salmonids	Coldwater Vibriosis
Vibrio anguillarum-salmonicida Bacterin	Salmonids	Vibriosis
Moritella viscosa Vaccine	Salmonids	Winter ulcer or Wound Disease
Enteric Red Mouth (ERM) Vaccine	Salmonids	Enteric red mouth disease
Pasteurella Vaccine	Salmonids	Pasteurellosis
Aeromonas hydrophila Vaccine	Salmonids	Motile Aeromonas Septicemia
Piscirickettsia salmonis Vaccine	Salmonids	Piscirickettsiosis
Flavobacterium psychrophilum Vaccine	Salmonids, FW species	Flavobacteriosis
Renibacterium salmoninarum Vaccine	Salmonids	Bacterial Kidney Disease

Infectious Hematopoietic Necrosis Virus Vaccine	Salmonids	Infectious hematopoietic necrosis
Infectious Pancreatic Necrosis Virus Vaccine	Salmonids	Infectious pancreatic necrosis
Infectious Salmon Anaemia Vaccine	Salmonids	Infectious Salmon Anaemia
Pancreas disease Virus Vaccine	Salmonids	Pancreas Disease

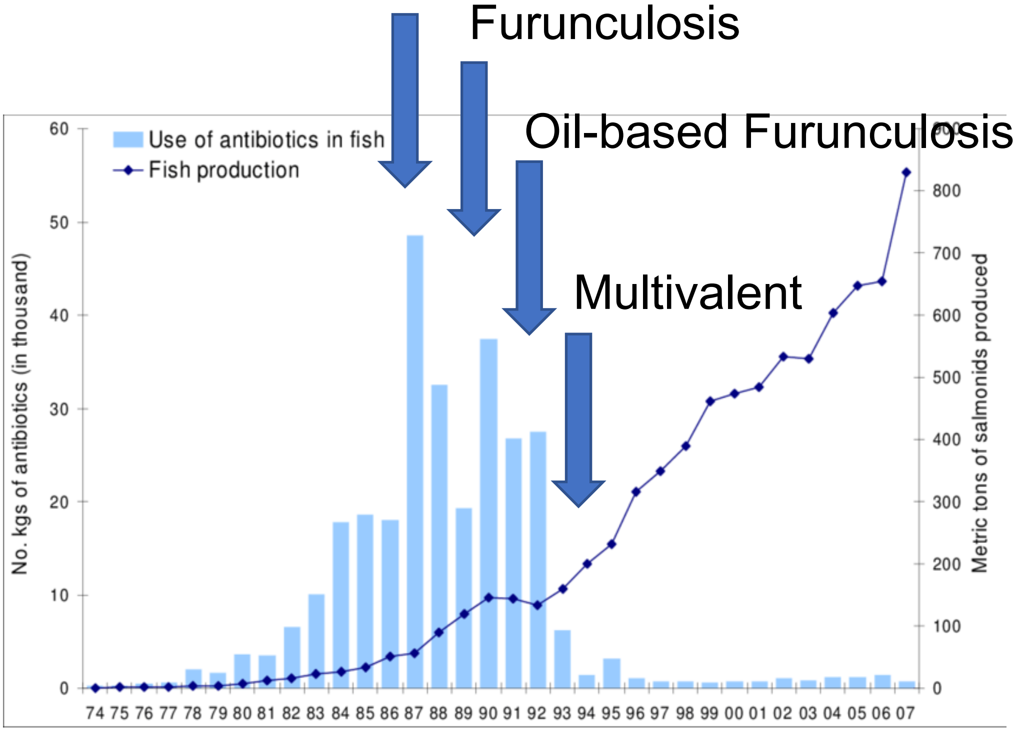

Figure 15: Yearly use of antibiotics used for the treatment of farmed salmon in Norway against MT salmon produced from 1974-2007 showing impact of vaccines

6.1.6 Escapees

Fish escapees from farms has historically been a challenge in Norway and raises a number of concerns. The proportion of escapees from fish farm facilities against the average total wild adult Atlantic salmon returning to spawn in rivers in Norway between the years 1993-2016 is shown in Fig. 10. Worryingly, the accuracy of this data has been called into question; the analysis of catch statistics and tagging studies suggests that the numbers of escapees in Norway was 2-4 times higher in the years between 2005-2011 (Skilbrei, Heino and Svasand, 2015). Of further concern is the fact that 90 percent of the global wild stocks of Atlantic salmon live in the north-eastern Atlantic Ocean, i.e. Norway, Iceland, Scotland and Ireland, and 85 percent of these stocks are listed as vulnerable, endangered or critical (Aquaculture and Fisheries (Scotland) Act, 2007).

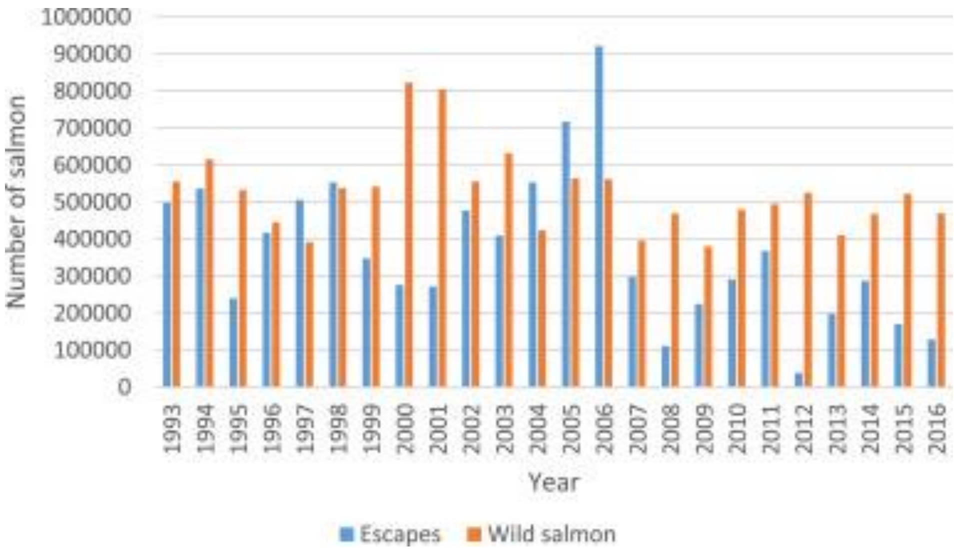

Figure 16: Yearly escape of salmon from fish farms and inflow of wild salmon to Norwegian rivers.

Source: *Fiskeridirektoratet, 2016; Anon, 2017). Taken from Olaussen, 2018.*

Norway aims to have zero escapes from salmon farm sites and requires that farms have trained personnel and a retention plan in place (European Commission, 2012), not just because potentially negative impacts on wild stocks, but also because of the economic loss that escapees implies (Luthmann, Jonel and Troel, 2019) however there is currently no escape cap in Norwegian legislation (Table 2). In 2019, a new approach to the risk assessment of Norwegian aquaculture was established (Grefsrud et al., 2019), specifically to address the challenge of escapees and genetic interactions of domesticated escapees in wild populations in the future. However, as many wild populations in Norway are already introgressed with domesticated escapees (Glover et al., 2013; Karlsson et al., 2016), the assessment of risk of introgression was defined as the assessment of risk of further introgression of domesticated escapees in wild populations.

6.1.7 Feed and feed resources

As has already been seen that salmon feed composition has changed considerably during the relatively short history of intensive salmon farming; in 1990 around 65 percent of Norwegian salmon aquafeed was composed of ingredients of marine origin, whereas in 2013 it had reduced to c. 20 percent (Fig. 9). However, this does not form part of Norwegian legislation requirements but is driven by the market (farmers do not want to spend money on expensive fishmeal if it can be avoided).

6.1.8 Norway Conclusions

Norway currently ranks first amongst the major global salmonid producers, accounting for 1.4 million MT live weight in 2018 (FAO, 2020); it was only in 2005 that key environmental issues were addressed, with a new law focussing on the sustainable production and growth resulting in the development of a valuable industry. It is not fair to say though that the Norwegian regulatory environment is the strongest in the world with a significant change in focus towards sustainable development. Indeed new licenses are now extremely limited and often only to RAS based systems. Companies wish to expand current production are currently only able to do this through auctioning of existing biomass permits.

6.2 Chile

6.2.1 Specific issues in the Chilean salmon industry

The history of the salmon farming industry in Chile is a very interesting case study on resilience.

Chile currently ranks 2nd amongst the major global salmonid producers, accounting for 887.2 thousand MT live weight of farmed salmonids in 2018 (FAO, 2020). The main farmed species is the Atlantic salmon (S. salar), but also rainbow trout (O. mykiss) and coho salmon (O. kisutch) are farmed, with the marine, on-growing phase carried out in the austral or southern regions of the country, i.e. in the Patagonian fjords and channels of Los Lagos, Aysen and Magallanes (Regions X, XI and XII, respectively) (Quinones et al., 2019).

The Chilean salmon industry began in the mid-1970s and, by 2007, was viewed to be amongst the most competitive in the world (Asche et al., 2009). This success can be seen to be due to a number of factors, i.e. rich natural and environmental resources, a supply of domestic fishmeal, as well as a business and political environment that clearly favoured the development of export-oriented industries (Barton 1998; Bjørndal & Aarland 1999; Bjørndal 2002; Barton & Murray 2009; Asche & Bjørndal 2011). Key also were the low costs of labour and hence lower production costs; by the end of the 1990s, Chilean-produced salmon was around 50 cents per dollar per kilogram cheaper than the salmon produced in Norway (Bjørndal & Aarland 1999; Bjørndal 2002).

As the industry grew and production intensified, epizootics or disease outbreaks occurred, however it was the ‘ISA Crisis’ in 2007 that dealt a devastating blow to the Chilean salmon industry. Infectious Salmon Anaemia (ISA) is a serious and highly contagious viral disease affecting farmed Atlantic salmon, caused by the Infectious Salmon Anaemia virus (ISAV), with reported mortality rates of up to 100 percent in the worst cases (Asche et al., 2009; Fischer, Guttormsen, and Smith, 2017; Quezada and Dresdner, 2017). Compounded by the appearance of the sea lice (C. rogercresseyi) and the bacterial disease Piscirícketsiosis, Chile’s aquaculture production, which had reached c. 700, 000 MT in 2007, was seen to dramatically drop in 2009, reaching an all-time low in 2010 (Asche et al., 2018) (Fig. 11). The disease not only had devastating effects on productivity but also caused a social crisis due to job losses (c. 20,000), particularly in the Los Lagos and Aysen Regions (Iizuka and Katz 2011; Iizuka and Zanlungo 2016).

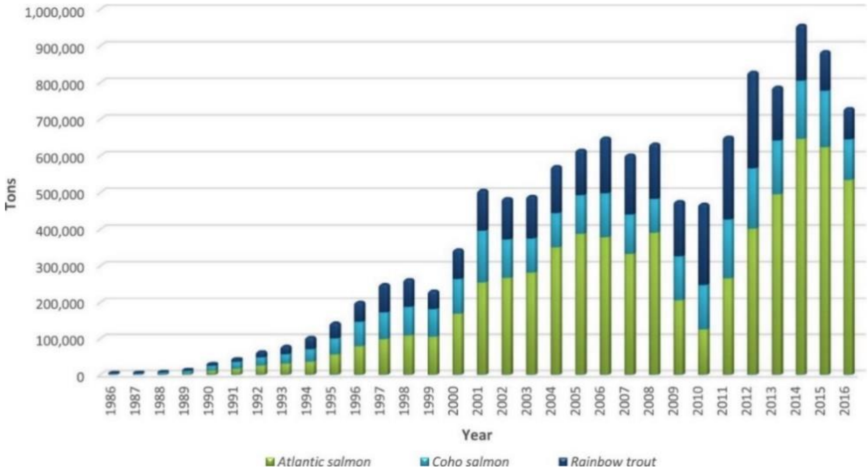

Figure 17: Evolution of Chilean salmon industry production between 1986 and 2016

Source: Lhorente et al., 2019.

It may well be that 'the fast growth and lack of control of the Chilean salmon industry' (The Norwegian Veterinary Institute, 2016) was responsible for the ISA catastrophe in 2007. What is clear however is that the Chilean salmon industry, as susceptible as it was to environmental and disease events, showed a remarkable resilience and has shown a rapid rebound since that time. It is important to note that, due to the importance of salmon farming to the Chilean economy, the Government was particularly responsive (Alvial et al., 2012). The rapid response to this crisis resulted in significant changes to the Chilean production model of salmon farming (Iizuka and Jorge Katz 2015; Hosono et al., 2016; Chavez et al., 2019), which now appears to have evolved to include many of the international recommended best practices (Fuentes and Engler, 2016; Alvial, 2017).

6.2.2 Changes to the existing regulatory framework

Following the crisis, dramatic modifications, both short term and more long term, were made and reforms were refined and incorporated into the General Law of Fisheries and Aquaculture (GLFA) (Chavez et al., 2019). (See Annex 1).

The strengthening of the legal regulatory framework for aquaculture production was achieved by addressing such key issues such as marine spatial planning, environmental protection and sanitary measures (biosecurity) and the current framework now includes;

- Requirements before new farms can become operational that include an Environmental impact assessment of new farms (Table 3);
- Renewal of existing aquaculture leases subject to strict compliance with environmental regulations (see above);
- Defining of geographical areas for monitoring and surveillance;
- Protocols to prevent escape and to recover escaped fish; there is no maximum escape cap (as in Norway) – note Atlantic salmon, Coho and rainbow trout salmonids are potentially invasive species in Chile (as they would be in Falklands).
- New, more stringent production standards, e.g. a mandatory fallow period between production cycles, reduction in stocking densities (cage biomass) and reducing the concentration of farms within a given area and moving farms to new production areas

especially Aysen and Magellanes regions (Iizuka and Zanlungo, 2016). (Note farms had been concentrated around Puerto Monte and Chiloe Island in the Puerto Monte area);

- Regular monitoring of the environmental conditions of the water column and the benthos and the development of tools to measure sediment aerobic conditions as an indicator compatible with the potential carrying capacity of the water body;
- The initiation of the ‘barrio’ (neighbourhood) or ‘group of concessions’ system for farms located within a similar geographical, oceanographic and epidemiological area, requiring that all farms must follow synchronised production cycles and collectively monitor and manage their health and disease status resulting in better control of disease transmission and reduction in disease outbreaks;
- Most critically, strengthening existing sanitary regulations with the introduction of a new self-reporting system for both health status and environmental information, with most importantly the implementation of sanctions if breached (Iizuka and Katz, 2015).

6.2.3 Knowledge gaps of the Chilean ecosystem

It is important to note that the huge geographical area and heterogenous nature of Chilean Patagonia, where the farms are located, impose a major challenge in terms of the generation of scientific knowledge and understanding of the marine ecosystem and environment, including biodiversity, trophic interactions, populations and community connectivity, biogeochemical cycling and circulation patterns etc. (Quinones et al., 2019). This knowledge is important in understanding the impact that farming activities have and how best to mitigate these issues.

However, in the last 10 years, there has been an increase in research efforts focused on Chilean Patagonian ecosystems, with new centres of research funded by the State, i.e. Center for Research in Ecosystems of Patagonia, CIEP; Center of Oceanographic Research COPAS Sur-Austral; Interdisciplinary Center for Aquaculture Research, INCAR; Center for the Study of Multiple Drivers on Marine Sociological Systems, MUSSELS; Millennium Nucleus of Invasive Salmonids, INVASAL; Research Center Dynamics of High Latitude Marine Ecosystems, IDEAL), either located in universities or linked to Regional Governments, e.g. CIEP (Quinones et al., 2019). In addition, the government has allocated funding for specific programmes to strengthen the institutional capacity of the Fisheries Development Institute (IFOP) in monitoring and research in areas such as HABS and oceanographic modelling and environmental modelling and pathogen interaction through the Fund for Strategic Investment, administered by SERNAPESCA.

6.2.4 Chilean Conclusion

In the years following the crisis, the Chilean salmon market has remained competitive, taking advantage of the northern hemispheres off-season salmon production for export (Asche et al., 2018), diversifying and adding value to salmon products as well as opening up 'new' markets, e.g. Latin America and Europe (Banco Central de Chile 2017). In spite of a new drop in production in 2016 due to a severe harmful algae bloom (HAB) outbreak (Montes et al., 2018) and the fact that Chile is still facing the usual problems, e.g. escapees, disease outbreaks, precarious infrastructure in remote locations in southern regions of country and higher related transport costs, lower levels of Research and Development, Chile still ranks 2nd amongst the major global salmonid producers (FAO, 2020).

In summary, it is fair to say that Chile went through an extremely dark period of salmon farming which it now has emerged from. However, the issues it has experienced appear to of been learnt from to some degree and legislation and regulation have dramatically improved in recent years. This said, some people would still question the sense of having the second largest production of a species in a country for which it is not even native to its waters.

7. Certification in the Salmon Industry

A recent development in the aquaculture sector has been the growth in so-called sustainability standards or eco-labelling, led by increased sustainability requirements by mainly western retailers. Today, virtually all retailers in developed nations have some form of 'sustainable procurement policy' which covers the purchasing of aquaculture products globally. The need for this sustainable procurement has been strongly promoted by the very active environmental NGOs in the Western world (the WWF, PEW Charitable Trusts and Greenpeace to name a few) and at first, retailers were responding from criticism from this sector. In the past five years this has changed somewhat with retailers now actively promoting their sustainability credentials to customers with the hope of increasing sales. In summary, sustainability is now a key part of most Western retailers buying and marketing approaches for aquaculture products.

Proving that your aquaculture supply chains are sustainable has mainly been done through third-party certification schemes. These are programs which use an independent auditor to verify the sustainability of your product against a set of pre-defined rules. Several different schemes exist in the aquaculture sector with the main ones being as follows;

Aquaculture Stewardship Council (ASC): The ASC was first founded in 2004 through a series of aquaculture dialogues (multi-stakeholder roundtables for best production practices in aquaculture species). It was founded directly on the back of the successful wild fisheries eco-label, the Marine Stewardship Council (MSC). Due to its importance as a sector, salmon was one of the first species to be targeted and a standard was developed and became live in June 2012.

Global G.A.P Aquaculture: Global G.A.P. was set up by European retailers in 1997 to develop independent certification systems for Good Agricultural Practice (G.A.P.). It has now developed into the world's leading farm assurance program with certificates in over 135 countries. It expanded into Aquaculture in 2004 and now runs a third-party certification program like the ASC but with one difference being it has a single standard which covers all finfish species (salmon included).

Global Aquaculture Alliance (GAA) Best Aquaculture Practices (BAP): The GAA was founded in 1997 in the United States and was dedicated to the advocacy, education, and leadership of responsible aquaculture. As part of this process, they developed the BAP standards which includes a Salmon Farm standard, and which has proven especially popular in North America.

Friend of the Sea (FoS): FoS was founded in the 1990s commencing with the creation of standards for wild capture fisheries. In 2013, they released a Marine Aquaculture standard which has limited uptake in the salmon industry (proving more popular for the bass and bream, industry). Due to its lack of market penetration for salmon it is not considered in greater detail in this review below.

7.1 Aquaculture Stewardship Council (ASC)

As previously set out, the first Salmon standard was developed and became live in June 2012. It is now on its third iteration and has developed significantly since its start.

The ASC works by providing a 'Species Standard' which sets out a series of Principles (in the case of Salmon, eight). Within each Principle are multiple Criteria which define specific outcomes to achieving the overriding aim of the Principle in question. To do this, each Criterion has one or more specific indicators which allows it to be measurable and subsequently, auditable.

To become ASC certified a company (or group of companies) must apply to a Conformity Assessment Body (CAB) which is accredited to perform audits against the specific standard. This accreditation is provided by the ASCs Accreditation Body, Accreditation Services International (ASI), who are basically responsible for making sure that the CABs are properly qualified to audit against the standard and perform the job to the required standard.

Once the client has chosen a CAB to complete the assessment, they will complete an audit against the standard, using the predefined checklist developed by the ASC. The auditors must complete a site visit at the farm (or farms) in question and will go through each of the Criterion to determine if they are met or not. In doing this the auditor will mark each one as Compliant (meets the requirement) or will issue a 'Non-Conformity'. Three types of Non-Conformity can be issued;

Minor Non-Conformity: The Criterion is mostly met however some small areas require further work. A deadline of one year is usually provided for resolution of these.

Major Non-Conformity: The Criterion is partially met but has some major areas that still require addressing for full alignment. A deadline of three months is usually provided for resolution of these.

Critical Non-Conformity: The Criterion is not met. A Critical Non-Conformity would result in the farm failing its ASC assessment.

Following the audit, a client is either recommended for Certification or is Failed. Should it be recommended, then a Draft Certification Report is uploaded to the ASC website and a period of fifteen days provided for any stakeholders to object. If after the fifteen days no objection is received, then the Farm is Certified and will receive a certificate which is valid for three years. The farm will also be required to complete yearly surveillance audits during this period to ensure certification is being maintained (and to check progress against any Non-Conformities). At the end of the three-year period a farm would be required to complete a full re-assessment against the standard.

In addition to the ASC Farm Standards, a traceability scheme or Chain of Custody standard is also run. This is designed to audit the product that is being or will be sold as certified and ensure it is being correctly identified and sold at all stages right through to the consumer. To sell product as ASC certified, the company in question (whether farm or processor or retailer) will require ASC Chain of Custody certification as well. Again, CoC Certificates are issued for three years and have regular audits (scheduled depending on the risk of the business).

7.1.1 The ASC Salmon Standard

Above we have set out how the ASC scheme works in principle. In this section we will consider the ASC Salmon Standard in more detail and the requirements it sets.

The Salmon Standard consists of Seven principles and one separate Section relating to the supply of Smolts. Prior to audits being completed though, a client needs to be confirmed as eligible under the scope requirements.

For salmon, a client is eligible for ASC certification if it is farming a species belonging to the Genus, *Salmo* or *Oncorhynchus* in any marine location using any farming production system. In summary, this would cover any cage-farm or land-based RAS system that is using predominantly seawater (although one using predominantly freshwater would not be covered). For smolt production, which is done in freshwater, certification is done under the Fresh Water Trout Standard.

The ASC is also currently developing a new RAS Module which is anticipated to become a 'bolt on' to the current Salmon standard and will better define and tighten requirements for these systems.

The ASC also operate a Group certification scheme which allows for 'groups of farms or farmers' to be certified under one certificate. The requirements for Group certification are beyond the scope of this report but would allow a salmon farm with multiple cage locations (for example) to receive a single certificate. In return they would receive a sampled audit (the CAB would not visit every farm) but would also need to introduce a program of internal audit to show conformity for all the sites.

With the above in mind, we will now consider the specific principles and how they generally apply to a classic 'cage-based' salmon farming operation.

Principle 1: Comply with all applicable National laws and local regulations.

Principle 1 is relatively straight forward and requires farms to simply produce evidence that shows that they are meeting all national and local regulations. This is likely to require evidence of licences and permits.

Principle 2: Conserve natural habitat, local biodiversity and ecosystem function

Principle 2 covers the major environmental impacts of salmon farming, specifically around water quality and maintaining ecosystems and biodiversity.

Under Criterion 2.1 the Standard considers the effects of cage farming on benthic biodiversity. It requires farms to take measurements for sulphide or Redox potential outside an Allowable Zone of Effect (AZE) defined in as an area of 30 metres around the site (and through a credible modelling system). These measurements must show zero of greater Redox potential or less than 1,500uMol/l of sulphide. At the same time, a faunal index sample must be obtained which shows that the sediment outside the AZ is of ahigh ecological quality and that over two of the abundant taxa are not pollution indicator species.

Criterion 2.2 covers water quality requirements and requires weekly Dissolved Oxygen levels to be above 70% saturation (when completed against a defined methodology) and that readings under 2mg/l represent less than 5% of the weekly samples

Criterion 2.3 deals with the release of nutrients directly through the fines of feed (which must be less than 1% of the weight of the feed.

Criterion 2.4 requires the farm to complete an assessment of potential impacts on biodiversity against specified components in the standard. It also specifies that the farm cannot be confirmed as present in a Protected or High Conservation Value Area (HCVA)[1].

Criterion 2.5 relates to interactions with wildlife (and specifically predators). It requires no use of Acoustic Deterrent Devices and states that the farm cannot be responsible for any deaths in red-listed or endangers species. It also sets rules relating to the use of lethal force (no more than 9 lethal incidents every two years and evidence that other methods have been tried first).

Principle 3: Protect the health and genetic integrity of wild populations

Principle 3 aims to avoid harm to wild salmon populations from the farming activity. Criterion 3.1 deals with the introduction and amplification of parasites and pathogens and specifically sea lice. It requires the farm to develop and Area-Based Management (ABM) scheme for disease treatment. IT then specifies that regular sea lice testing is completed and sets some levels for on-farm lice levels. Interestingly, the ASC are currently completing a public consultation on these requirements which will toughen then considerably[2].

Criterion 3.2 requires that a farm does not introduce a non-native species. In this case this means that the salmon species being farmed must be a native species (or evidence is provided to show why it is as good as native species already).

Criterion 3.3. Outlaws the ability of transgenic fish to be certified (i.e. Genetic modification is not allowed under the ASC certification system). This would include the use of triploid fish which may be of importance to the Falklands.

Finally, Criterion 3.4 deals with escapes and provides an upper maximum limit of 300 in the most recent production cycle (unless shown to be outside the farms control) and that systems for checking and confirming escapees' numbers are in place.

Principle 4: Use resources in an environmentally efficient and responsible manner

Principe 4 deals with the use of other resources in farming so specifically feed and chemicals.

Criterion 4.1 requires all raw materials in feed to be traceable (as demonstrated by the feed producer).

Criterion 4.2 sets out a Fishmeal and Fish Oil Forage Dependency Ratio (FFDRm and FFDRo) of less than 1.2 and 2.52 respectively. This effectively means that the farm should try to reduce the amount of fishmeal from wild fish that it uses in its feed.

[1] *This is an important consideration for the Falklands since it would potentially mean that no farm could be certified if located in an MPA.*

[2] *This is in response to increased public concern on the interaction of sea lice with salmon farms and wild populations.*

Criterion 4.3 has created numerous issues since the standard was created by the ASC. Effectively the original requirement was that all fishmeal was to come from a certified scheme (for example the MSC) within 5 years of the publication of the Salmon Standard (so by June 2017) . However, the availability of certified fishmeal in 2017 made meeting this target impossible. The ASC therefore released an interim measure which basically removed the time requirement on this and replaced it with a requirement that a lower standard was met in the meantime. Currently the ASC is also developing a new Feed Standard which aims to replace these requirements and is aimed directly at the feed manufacturers.

Criterion 4.4 requires non-marine raw materials to be from a responsible sourcing policy and that all Soya derived ingredients are certified against the Roundtable for Responsible Soy (RTRS).

Criterion 4.5 sets out requirements for the treatment or disposal of non-biological waste. The requirements are not specific but need to show that the waste is not being disposed in an irresponsible way and that recycling occurs when it is possible.

Criterion 4.6 deals with the release of greenhouse gases by farms and requires an energy assessment to be completed and to be repeated annually. It does not currently set any requirements for the reduction in greenhouse gas emissions though.

Criterion 4.7 provides requirements relating to the use of non-therapeutic chemicals. This mainly focuses on requirements for copper treated nets and ensures that cleaning is done with effluent treatment and that Cu measurements are taken from the sediment and are not seen to be present in high levels (above 34mg Cu/kg).

Principle 5: Manage disease and parasites in an environmentally responsible manner

Principle 5 covers the management of disease and parasites in the farmed fish (while Principle 3 considered it from the view of wild populations).

Criterion 5.1 sets out the need for a farm to have a Fish Health Management Plan and to receive regular (four times a year) by a designated veterinarian. The farm is also required to remove and dispose of 100% of its mortalities and to record them all. The farm must not experience mortality because of viral diseases in more than 10% of the fish from a recent production cycle and unexplained mortalities should be less than 40% of all mortalities seen on the farm (over two production cycles).

Criterion 5.2 covers the use of therapeutic treatments and effectively bans the use of a variety of antibiotics and chemicals (which are already outlawed in most major salmon producing countries). When treatments are allowed they must be overseen by a veterinarian and are limited in use (for example, antibiotic treatment is only allowed 3 times in a production cycle).The use of prophylactic antimicrobial treatments is also not allowed.

Criterion 5.3 attempts to deal with the development of resistance in parasites, viruses and bacteria by requiring rotation of treatment regimes and the use of bio-assay analysis to determine if and when resistance might be forming.

Criterion 5.4 sets out the requirements for a functioning biosecurity plan. This includes the notification of diseases, the use of single year class salmon and actions to take in the case of a disease outbreak.

Principle 6: Develop and operate farms in a socially responsible manner

Principle 6 covers the social compliance areas of the ASC standard, these are wide ranging but include areas such as freedom of association, child labour, forced labour, working hours, discrimination, fair pay and health and safety.

The requirements of Principle 6 are usually assessed by a separate trained social auditor and are of particular importance for some of the farm assessments competed in higher risk countries (for example some parts of Asia).

They still require assessment for salmon farming but since most farms are in relatively well-developed countries, issues are seen less regularly than for some of the other species' standards (shrimp, tilapia etc…)[1].

Principle 7: Be a good neighbour and conscientious citizen

Principle 7 aims to address broader social impacts associated with salmon farming and specifically in relation to interactions with local communities.

Criterion 7.1 requires the farm to engage in regular and meaningful consultation with community representatives and to have a suitable policy in place to deal with complaints. It also has a specific requirement for farms to place notices if they are to use therapeutic treatments (due to the potential human health risks).

Criterion 7.2 deals with the need for farms to consult with indigenous and/or aboriginal groups to try to develop a protocol agreement. In essence, it is attempting to remove some of the previous issues that have arise in Alaska with local people and farming operations.

Criterion 7.3 seeks to ensure that farms do not remove or restrict access for local communities to local resources. While it is accepted that some restriction is likely (for example an area of water is no longer open to vessels) this must not be deemed as unacceptable.

Section 8: Requirements for supplier of Smolts

Section 8 sets out some requirements for farms to meet with regards to the supply of salmon smolts. Basically, a farm can either buy from a certified smolt producer (under the Freshwater Trout standard) or they must prove the smolt producer meets a host of the Salmon standard requirements directly through evidence.

[1] *This is not to say issues do not arise in the salmon sector. However, they are usually minor in nature and certainly less common.*

7.1.2 Current uptake of the ASC Salmon Standard

The Salmon standard went live in 2012 and now has 431 live certificates for Atlantic Salmon *(Salmo salar).* These are summarised by Company and Country of Location in Table 5 and Figure 18.

Table 5: ASC Salmon Certifications in 2021

Company	Country of Location										
	Norway	Chile	UK	Ireland	Canada	Faroe	Iceland	Denmark	Australia	Poland	TOTALS
Mowi	78	20	10	5	22	1					136
Leroy	43										43
Cermaq	23	6			11						40
Salmar	34										34
Grieg Seafood	16				6						22
Nova Sea	19										19
Bakkafrost						17					17
Norway Royal Salmon	15										15
Empresas Aquachile SA		13									13
Salmones Camanchaca		12									12
Acuimag S.A.		8									8
Invermar S.A.		7									7
Australis Mar SA		7									7
Arnalax							6				6
Flakstadvag Laks AS	5										5
Kvaroy Fiskeoppdrett	5										5
Salmones Blumar		5									5
Productos Del Mar		5									5
Nova Austral		5									5
BluRiver SPA		5									5
Hofseth Aqua AS	4										4
Tassal Operations									4		4
Multiexport Patagonia S.A.		3									3
Nordlaks Oppdrett AS	2										2
Edelfarm	2										2
Wenberg Fiskeoppdrett	2										2
Ocean Farming A.G.	1										1
Fredrikstad Seafoods AS	1										1
Danish Salmon								1			1
Jurassic Salmon										1	1
Pure Salmon Poland										1	1
Country Totals	**250**	**96**	**10**	**5**	**39**	**18**	**6**	**1**	**4**	**2**	

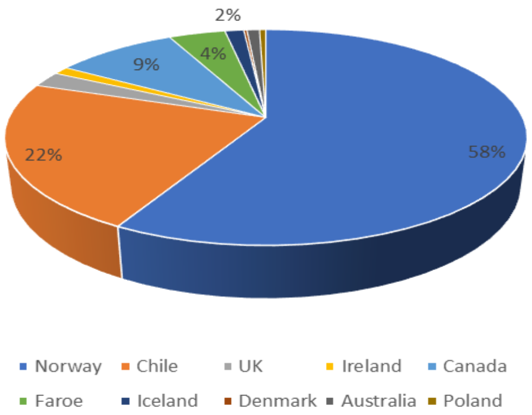

Figure 18: ASC Certifications in 2021 by Country

The data above shows us that the ASC push in the salmon sector is dominated by Norway (58% of certificates), Chile (22% of certificates) and Canada (9% of certificates). This is clearly not that surprising since they also represent the three biggest producers globally. In terms of producers again the worlds biggest producer, Mowi, are also the biggest holder of certificates with 136 across the globe (they have committed to becoming 100% ASC certified but no timescale has been given). The next three, Leroy, Cermaq and Salmar follow and again, unsurprisingly they are also next in terms of global revenue. All have also committed to a varying timescale for ASC certification across all their sites.

7.2 Global G.A.P Aquaculture

As previously mentioned, Global G.A.P. moved into the aquaculture certification world in 2004 and operate a general certification system which is similar in many ways to the ASC but with a few general exceptions.

1. Global G.A.P. does not operate an independent accreditation body as the ASC does with ASI. Instead, they rely on the use of so-called 'international accreditation bodies'. These are usually country based (for example in the UK, it is the body called UKAS) and they are responsible for the accreditation of CABs against the main ISO Accreditation Standards. In short, this means that a CAB has to be accredited against ISO 17065 by the international accreditation body in that country to be approved by Global G.A.P. but is not specifically accredited against their rules (as they are by ASI for the ASC accreditation process).
2. Global G.A.P. operate a single standard which covers all aquaculture operations together. The ASC have separate standards for each species.
3. A Global G.A.P. certificate is only valid for one year (not three as for ASC).
4. Finally, as will be seen below, the Global G.A.P. standard touches on areas which the ASC does not including food and Health and Safety.

The audit process is relatively similar to that for ASC, however CABs are required to determine if each condition is either 'Met' or 'Not Met'. If 'Not Met' is applied, then the farm is not eligible for certification until this is rectified (i.e. it does not operate a Major/Minor Non Conformity System as the ASC does).

Finally, Global G.A.P. also operate a separate chain of custody standard as the ASC do which it required by all farms to allow for the sale and use of the logo.

7.3.1 Global G.A.P Aquaculture Standard

The Global G.A.P Aquaculture standard consists of two separate modules, the Farm Module and the Aquaculture Module. The Farm Module is the same that is used across the terrestrial farming standards and covers generic requirements (across sixteen separate principles) which are considered good practice for virtually all farming enterprises (water or land based). In summary, the main areas covered are as follows;

Record Keeping: This is a very general requirement which expects all required records to be maintained for a period of at least two years (unless longer is specifically required). It also requires all certified farms to complete a yearly self-assessment against the Global G.A.P. Standard and record any non-conformances and corrective actions taken.

Hygiene: The farm shall have a hygiene-based risk assessment in place and a documented hygiene procedure, which includes the provision of annual training for staff in relation to hygiene. This is an area which differs from the ASC (who do not cover food hygiene areas in the standard but only hygiene relating to bio-security requirements).

Health and Safety: As previously mentioned, the coverage of H&S is something that differs from the ASC requirements. Here farms are required to have a written H&S policy based on a risk assessment and to provide training to staff as required. They must also have a clear accident and emergency procedure, provide first aid kits and PPE (as required) for staff use.

Waste and Pollution Management: The farm requires a documented waste management plan which identifies sources of waste and the processes that are completed to dispose of it suitably. It also requires that the farm specifically composts organic wastes (if no risk exists from the waste product).

Conservation: the farm must have a Wildlife and Conservation Management Plan which identifies the environmental impacts of its activities and considers how to enhance the environment whenever possible. It also requires the farm to monitor is energy use and recommends (this is not a requirement) that the plan leads to improvements in energy efficiency and makes use of non-renewable energy sources.

Complaints: The farm needs to have a system for dealing with complaints and ensuring they are properly followed up on (identical to the ASC).

Recall Procedure: A system for recalling product from the marketplace if required, needs to be in place.

Traceability and Segregation: The farm needs an effective traceability system in place and one that always ensures the segregation of certified and non-certified products.

Mass Balance: The Mass Balance test requires a producer to be able to record all inputs and outputs by weight and through the use of agreed conversion ratios account for all products sold through this method. The idea is that the mass balance ensures that the product being sold as certified can be shown to of originated from a corresponding amount of certified source product. In principle, this is fine for processing facilities but is very hard to complete accurately at the farm level.

The aquaculture module provides the more specific requirements for fish farming which need to be met. It covers sixteen separate principle areas and these are now discussed in more detail below (areas that are not relevant to Salmon farming are not considered).

Site Management: The site management requirements under the Aquaculture Module are very similar to those put forward by the ASC as well. Firstly, they require a farm to be able to prove that it is meeting required country legislation (licensing, registered etc..). This needs to be backed up with proper maps and locational information on the farm(s) locations.

Secondly a management structure with defined organisational responsibilities must be in place.

Finally, farms must also be able to demonstrate that they have been meeting the standard requirements for the past three months. This is an area that differs from standard to standard with some requiring a previous full period of production under requirements and others no historical time requirement at all.

Reproduction: The reproduction component requires all broodstock to be obtained from a breeding program or if from the wild, through an ecologically managed fishery. GM farming techniques are prohibited (as with ASC). This would include the use of triploid fish which may be of importance to the Falklands.

The Global G.A.P. standard provides more specific requirements than the ASC one on specific area requirements for hatchery management. Of importance for salmon farming are the following;

- Fish stripping must be done under anaesthetic (which must be approved for use by the competent authority).
- Fingerling transportation must be done at densities and water oxygenation levels that are suitable for the species (although these are not specifically provided).

Chemical Compounds: Global G.A.P. provide extremely prescriptive requirements on the use and storage of chemicals. These are mainly procedural and aimed at reducing the risk of spillage and or human health implications.

Occupational Health and Safety: These requirements build on the farm module requirements already discussed above. Of particular interest to salmon faring is that diving operations are covered by a specific health and safety risk assessment (this it not really covered by the ASC).

Fish Welfare, Management and husbandry: The requirements on fish health and welfare are relatively similar to the ASC. They require the farm to have a suitable Health Plan which is signed of by a recognised veterinarian. They must notify authorities of disease outbreaks, maintain records of stock numbers and average weights, monitor health indicators and mortalities collected, recorded and the causes investigated.

Treatments are not allowed for products banned under the FAO/WHO Codex Alimentarius list and all must be approved by a vet. Antibiotics can only be used to treat infectious diseases (although not limits on the number of treatments I made).

The farm mut have a bio-security plan which covers all areas of operation including the sterilisation of equipment, people and inputs (feed and seed).

Finally, specific husbandry requirements are set out for the use of fish nets. These are not allowed to touch the seabed, must be well maintained and considered suitable in terms of location and net mesh sizes etc…They must also be well marked with navigation aids.

In summary, the requirements here are similar to the ASC but are less prescriptive or specific to salmon farming.

Feed Management: The feed requirements state that all fish stocks should receive a compound feed diet which is suitable to the species and that it must be obtained from a recognised source. Specifically, this means that the source needs to be certified against the Global G.A.P. feed standard, another benchmarked standard or against another accredited scheme. Global G.A.P. face many of the same issues that the ASC do with feed management and sustainability concerns.

Pest Control: Farms are required to maintain a pest control system which prevents the risk of infestation. To be clear, this is dealing with pests and not predators and is normally met by the installation of baits and traps by an external pest control company.

Environmental and Biodiversity Management: This principle covers most of the key requirements for salmon farming and are based on very similar principles to those outlines in the ASC standard (although they are less prescriptive). Once again, the farm cannot be located in an area of High Conservation Value and must be developed in line with a full Environmental Impact Assessment (EIA) program. A sampling program needs to be set up for monitoring benthic sediment (although unlike the ASC, how this is done is not prescribed).

Predators need to be excluded whenever possible and lethal force must be a final solution and cannot be completed on endangered (IUCN) species.

The farm must have a plan in place for avoiding and dealing with any escapes that may occur.

In general, these requirements are aimed more at mangrove habitats than those faced by salmon farms. They are also less prescriptive than the ASC (although generally cover the same areas).

Water Usage and Disposal: This area really deals with the abstraction of water and so is only relevant to smolt production facilities. It attempts to ensure that local communities still have access to drinking water, fishing areas and that water abstractions is only undertaken in line with consents.

Harvesting and Crowding Facilities: This is an interesting area of divergence from the ASC which does not specifically cover harvesting in detail. The requirements here are mainly hygiene related (temperature requirements and clean equipment etc…).

Slaughter Activities: Again, an interesting area of divergence. Global G.A.P. provide specific requirements on the slaughter of fish. Firstly, all must be ‘effectively stunned’ prior to bleeding (if used). It does not specifically state that certain methods may not be used but that these must ‘consider fish welfare’.

Social Criteria: Social requirements are assessed under the GRASP (Global Risk Assessment on Social Performance) Module (a separate social module is required to be completed). The requirements are similar in many ways to the ASC Social Standard requirements.

7.3.2 Current uptake of the Global G.A.P. Aquaculture Standard

Obtaining data on certificates by species from Global G.A.P. is difficult due to the complex system they use to report (the Global G.A.P database). However, an estimate is made that Global GAP currently has around 100 live certificates for Salmon related producers.

Of these 100, the majority appear to be located in Norway, with other producers in Australia and the UK. Interestingly, it appears that many of the producers represent Smolt production units only (i.e. Global GAP may be chosen for smolt facilities and not on-growing in some cases).

What is clear though is that Global G.A.P. is a much less significant player in the salmon sector that either the ASC or GAA BAP.

7.3 Global Aquaculture Alliance (GAA) Best Aquaculture Practices (BAP)

The Global Aquaculture Alliance (GAA) was founded in 1997 in the USA and is a NGO which dedicates itself to the advocacy, education and leadership of responsible aquaculture practices. In 1999, the GAA set out a Code of Practice for Responsible Shrimp Farming which has since led to the creation of the Best Aquaculture Practices (BAP).

BAP is part of the GAA group but is run as a separate certification scheme on its own. The certification scheme is run along similar principles to the ASC one.

The audits are completed by third-party CABSs which in turn are approved by GAA. To become recognised as a CAB they must show experience in aquaculture, accreditation to a national certification body (as explained under the Global G.A.P. requirements), and must complete specific GAA training courses.

A company that wants to be certified against the BAP Standards must first complete and submit a self-assessment form to ensure they are prepared for the full audit. Once completed, they select a CAB to complete the on-site audit and the audit is completed.

CABs will go through all the requirements of the Farm Standard and will raised Minor, Major or Critical non-conformities (as described in the ASC section). The company must present Corrective Actions to these NCs within 35 days to the CAB to then be recommended for certification.

The certificate lasts for a maximum of one year with a follow up audit required before the anniversary to maintain the certification.

BAP have developed the standards they employ considerably over the past decade and now have a combination of generic and species-specific standards which apply. For salmon farming specifically, the BAP Salmon Farm Standard is used and applies to salmonids raised in net pens in marine waters. A separate standard (the BAP Hatchery and Nursery Standard) applies to smolt production facilities. For farms that are producing salmonids in land-based grow-out systems (for example RAS), the BAP Farm Standard applies.

7.3.1 GAA Best Aquaculture Practices (BAP) Salmon Standard

The BAP Salmon Farm Standard is for all cage based marine operations and covers 12 separate principles. Each principle is briefly considered below.

Area 1: Community - Property Rights and Regulatory Compliance

In comparison with the other standards considered here this requires companies to be able to prove they are compliant with national legislation (water use, operating licences, environmental requirements etc…). It also includes a requirement to show that farms are compliance with any specific area management agreements that they may of agreed to.

Area 2: Community - Community Relations

The farms relationship with the community is assessed here. It seeks to ensure local inhabitants are not blocked from access to fishing areas or other public resources (and if they are it is justified and well signed). The farm must also demonstrate interaction with the local community to help avoid and resolve conflicts/ It must have a system for recording complaints and deadline with them in a fair and effective manner.

Separately the farm is required to cooperate with other BAP certified farms in an area of up to 5km radius on stocking, fallowing and biosecurity (effectively the creation of an Area Management Agreement).

Area 3: Community - Worker Safety and Employee Relations

Area 33 covers health and safety specific areas and employee relations (in effect the social requirements for the farm). The requirements under this area are quite detailed and in-line with the social compliance requirements of the other standards (although maybe not quite as detailed). However, it does provide additional requirements in relation to diving operations and PPE requirements.

Area 4: Environment - Sediment and Water Quality

The farm is required to monitor sediment and water quality, but this is done in line with 'local standards' (i.e. it refers to country requirements and does not set specific levels as the ASC standard does). When a country does not require sediment monitoring, the farm is required to implement a process which is in line with 'generally accepted methods'.

For water quality sampling, data is required to be collected and it is specified that this may be required to be submitted to the BAP database for future research (again though, no limits are set).

This area provides one of the biggest differences between BAP and ASC. The ASC is far more prescriptive on what is required while BAP tends to rely on the countries on water quality standards and basically confirms that these are being met.

Area 5: Environment - Fishmeal and Fish Oil Conservation

Farms are required to source feed from a BAP-certified feed mill (or one that declares its compliance with BAP feed mill standards). They must be able to demonstrate traceability of feed and display records of feed used.

The facility must also calculate an FCR for each year class and achieve a fish in: fish out ratio of 1.5 or less for each year class harvested.

Area 6: Environment – Control of Escapes

Escape controls are like those of the ASC with requirements for an escape prevention plan to be in place. The farm must also complete an analysis of its actual harvest biomass to confirm it is not more than 3% different from the predicted biomass (i.e., escapes have occurred without knowledge).

Again, the farm cannot be in an area of critical or sensitive habitat. The use of transgenic fish is banned and fish species must be approved for production in the country.

Area 7: Environment – Predator and Wildlife Interactions

The requirements here are virtually identical to the ASC. However, the use of acoustic harassment devices can be permitted if supported by independent expert opinion (the ASC have an outright ban).

Lethal controls must be reported but no limits are placed on farms (although the frequency should aim to decrease over time).

Area 8: Environment – Storage and Disposal of Farm Supplies

Requirements here require the safe storage of feed, fuel and lubricants to avoid spillage and the proper disposal of garbage (under national legislations). A written waste reduction plan must be in place for the farm and compliance must be demonstrated.

Specific requirements for the cleaning of copper treated nets are also provided in this section.

Area 9: Animal Health & Welfare – Health and Welfare

The fish welfare must be overseen by a fish health professional and fish should be inspected daily (when weather allows). Dead fish should be recorded, and stocking densities should be below 25kg per m^3 on average for the production cycle.

Interestingly, the BAP standard requires all fish to be stunned prior to slaughter (no other standard requires this).

Area 10: Animal Health & Welfare – Biosecurity and Disease Management

The requirements for disease management and biosecurity are very similar to the ASC but generally less prescriptive. The rules require strict reporting and processing of disease treatments (by a qualified health professional) but they do not ban any specific treatments. Instead, they state that treatments must be conducted within national regulations.

Area 11: Food Safety – Control of Potential Food Safety Hazards

This section is different to the ASC (who do not audit against food safety). It requires producers to provide documented proof that antibiotics have not been added to feed. It also requires fish to be checked for traces of contaminants, should a contamination incident occur within 5 kilometres of the farm. Finally, it requires all ice to be made from potable water or water that has been disinfected to an equivalent standard.

Area 12: Traceability – Record Keeping Requirement

Area 12 is rather generic and simply requires standard records to be kept relating to each production cycle for a minimum of 12 months (or the expected shelf life of the product if longer).

7.3.2 Current uptake of the GAA BAP Standard and Issues

The BAP Salmon standard has 432 live certificates for Atlantic Salmon *(Salmo salar).* These are summarised by Company and Country of Location in Table 6 and Figure 19.

Table 6: GAA BAP Certifications in 2021

Company	Country of Location							
	Norway	Chile	UK	USA	Canada	Australia	New Zealand	TOTALS
Acuimag S.A.		6						6
Aguas Clara S.A.		2						2
AquaChile S.A.		9						9
Australis Mar S.A.		10						10
Aysen SPA		2						2
Bluriver SpA		3						3
Caleta Bay Mar SpA		4						4
Cooke Aquaculture Chile S.A.		4						4
Cooke Aquaculture USA					10			10
CERMAQ Chile		27						27
CERMAQ Canada Ltd		6						6
Cultivos Yadran S.A.		3						3
Empresas AquacChile S.A.		23						23
Exportodora Los Fiordos		37						37
Finger Lakes Fish Inc.				1				1
Granja Marina Tornagaleones S.A.		5						5
Grieg Seafood Ltd					17			17
Invermar S.A.		9						9
Kelly Cove Salmon Ltd					55			55
Kvara Fiskeoppdrett AS	2							2
Mount Cook Alpine Salmon Ltd.							3	3
Mowi Canada					41			41
Mowi Chile S.A.		14						14
Multiexport Patagonia S.A.		2						2
Northern Harvest Sea Farms Ltd					1			1
NovaAustral S.A.		1						1
Petuna Aquaculture Pty. Ltd.						3		3
Producto del Mar Ventisqueros S.A.		7						7
Salmones Antartica S.A.		2						2
Salmones Australes S.A.		12						12
Salmones Aysen S.A.		2						2
Salmones Blumar S.A.		7						7
Salmones Camanchaca S.A.		7						7
Salmones De Chile S.A.		4						4
Salmones MultiExport S.A.		26						26
Sanford Ltd							1	1
Scottish Salmon Company Ltd			40					40
Skretting ARC Pargua		1						1
Superior Fresh LLC				1				1
Tassal Operations Pty. Ltd.						9		9
The New Zealand King Salmong Co. Ltd							9	9
Van Diemen Aquaculture Pty. Ltd.						1		1
Wester Ross Fisheries			2					2
Yarra Valley Caviar						1		1
Country Totals	2	235	42	2	124	14	13	432

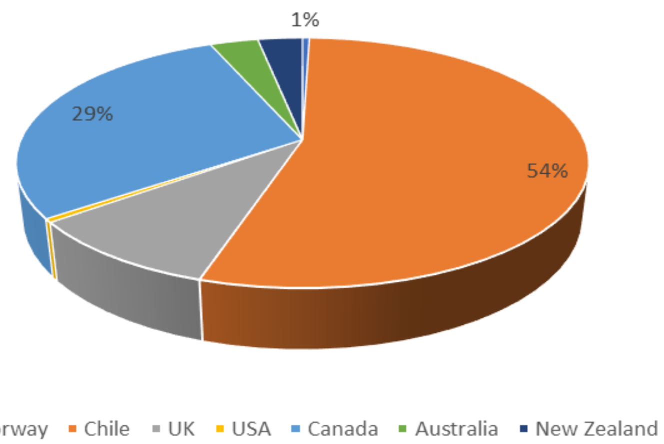

Figure 19: GAA BAP Certifications in 2021 by Country

As is clear from this data, the main areas of uptake for BAP have been Chile, Canada and the UK, with Norway having relatively few certificates (the reasons for this are discussed later in this report).

7.4 Organic Salmon Production

The term 'Organic' can be considered one of the most confusing and misunderstood in modern day food production and this is no different in fish production. In reality, defining something as Organic has no set criteria and can cover a host of different requirements and considerations which vary from location to location. Interestingly, during recent consumer surveys in the UK, the term organic was most clearly linked to the 'absence of pesticides'.

Within the salmon farming sector, the production of 'organic salmon' has been going since the 1990's. Determining what is required to determine that a salmon is organic though remains open to interpretation and varies greatly between countries. For example, in the UK and EU, the use of tanks is forbidden in organic production but in the US it is not. For this discussion though we will focus on the UK/EU system which is considered by many to be the best developed.

Defining the term Organic through the development of a certification standard was a job that was pioneered in the UK by the Soil Association. It was them who first developed a standard for organic farming in the 1960s and this was followed by an aquaculture standard in the early 2000's. However, to somewhat confuse matters, the EU decided to create its own rules for organic products. For aquaculture, these rules were developed in 2007 through EU Regulation 834/2007. By setting these rules the EU were stating that any product that entered its jurisdiction had to have proof that the requirements of 834/2007 were being met to be called 'Organic'. As a result of this and some adjustments by the Soil Association the two standards then became aligned, and the Soil Association effectively became a Certification Body for the EU and the UK standard they had developed. Since Brexit however, the situation has changed again but the detail of this is beyond the scope of this report and we will simply consider the Soil Association requirements below. However, it is important to note that when exporting organic product, it is the country into which the product enters who defines what organic means (and so a producer needs to know what organic market it is targeting and then produce under those specific rules).

With regards to the Soil Association/ UK requirements, certification activities are completed by Soil Association Certification or SAC (a separate entity which completes audits) who are accredited under ISO 17065 by UKAS. SAC will complete the initial audit against the organic requirements, and this must be followed by a yearly audit to maintain the certification. As with other standards, SAC will raise Minor, Major or Critical non-conformances depending on any issues which are found.

Below we have set out the 'key requirements' for organic salmon farming under the Soil Association standard.

<u>Environmental Assessments</u>: If producing more than 20 Tonnes of product per year then the farm is required to draw up an environmental assessment (in most cases an EIA is used).

<u>Sustainable Management Plan</u>: The farm is required to develop an SMP which sets out perceived risks and mitigation measures. This should include areas such as waste management, predator control etc….

Non-Native Species: The standard states that locally produced species should be used which is believed to exclude species that are non-native (or at least not already grown in the region).

GMO Products: Unsurprisingly, the production of Genetically modified product is not allowed. It is also not allowed to use products from GMO origins in areas such as feed (for example, soy protein) and you must have statements to confirm this is the case from suppliers. Importantly, the use of triploids is also not allowed under organic farming principles.

Site Suitability and Separation: Organic farming operations are required to be operated in areas which are free from pollution or pollutants that would effect the organic integrity of the product. A classic example here would be another non-organic fish farm. No specified distances etc… are provided but you need to provide evidence that they are 'adequately separated'.

Furthermore, it is possible to produce non-organic and organic product under the same company but the production units will need to meet the requirements for separation specified above.

Stocking Density: The regulations specify a specific maximum stocking density in cage farms of 10 kg/m^3. This is the maximum it can reach (at maximum biomass) and so normally levels will be much lower. This is probably one of the key differences between organic and 'normal' salmon farming.

Feed requirements: This is another major areas of difference in organic production. Basically, feed sources that are allowed are from organic products themselves, products derived from trimmings from human consumption in sustainable fisheries or whole fish sources derived from sustainable fisheries. This presents a very similar problem to the other certification standards but due to the lower quantities involved it is possible to achieve.

Other feed requirements include the need for astaxanthin to be sourced from organic crustacean shells, and for only certain permitted minerals and additives (a long list is provided in the standard) to be included.

The result is that all organic salmon producers will buy an 'organic pelleted feed' which has been specially formulated to meet the above requirements (and is subsequently much more expensive). As an example, the feed producer Aller Aqua produce an organic salmon feed (https://www.aller-aqua.com/feed-products-and-concepts/organic-feeds).

Slaughter Techniques: All farmed fish must be stunned before killing and killing must use an effective and efficient method (not ice, CO_2 or suffocation).

Fallowing: It is a recommended requirement that after every production cycle, cages are cleaned and left fallow for a period of time (to allow seabed regeneration). This though is not an actual requirement and is rarely practised.

Disease Treatment: This is probably one of the most controversial areas of organic salmon farming with many people incorrectly believing that the use of treatments would be banned in organic farming.

Organic farming allows for the use of homeopathic remedies, plant and plant extracts and trace element and authorised probiotics. However if this is not found to solve the problem a range of allopathic (drug) treatments are permitted up to two times per year.

Specifically, for the treatment of parasites, you can use chemical treatments a maximum of two times per year (but prior approval from the Certification Body is required). The use of biological controls (cleaner fish) is preferred however.

So, in summary, organic production allows the same treatment of disease and parasites as normal production but with limits on the treatment amounts allowed in a year.

Cleaning Methods: Removal of bio-foul is only allowed by physical means (no use of copper in nets is allowed for example).

Disinfection of equipment is allowed but a list of prescribed products is provided for this purpose.

7.3.3 Current Organic Salmon Production

Data is not available on the global status of organic salmon production with organic requirements so different from region to region making comparison difficult. However, certain areas or countries are known to have organic salmon production occurring and these are discussed in more detail below.

Ireland: Although a small producer, Ireland is one of the main producers of Organic salmon with 95% of its production certified. Current Irish organic salmon production is estimated at around 11,000 Tonnes in 2019 and has actually fallen in recent years. The vast majority of this product is exported to France and other European markets.

Production in Ireland is mainly based in the North (around 50%), followed by the Atlantic coast. The exact reason that Organic salmon farming has dominated in Ireland is not entirely clear. However, the licensing process in the country is known to be incredibly slow (with licenses taking over 10 years in some cases for approval).

The main producer of Organic Salmon is Mowi Ireland (sold through trading name The Irish Organic Salmon Company) which has been producing since 1996.

Scotland: Scotland was estimated to have five production sites for organic Salmon in 2018 producing around 4,200 Tonnes per year. Considering the country produced 156,000 Tonnes in 2019 this represents only 2.7% of the total production.

Until recently, production has been dominated by Cooke Aquaculture from there organic base in the Orkney Islands. This year however, Mowi began harvesting from a newly certified initiative on Loch Ewe (unsurprisingly marketed under the trading name 'The Scottish Organic Salmon Company').

Norway: Despite being the biggest producer of salmon globally, Norway is only estimated to produce around 18,000 Tonnes of organic product a year. This represents 1.5% of the 1.2 Million salmon produced in the country in 2020.

Major producers in the country are Leroy (eight sites) and Salmar (five sites in central Norway).

7.5 Summary and Discussion on Certification in the Salmon industry

The analysis above has shown how the use of sustainable certification schemes has grown dramatically in recent years within the salmon sector. Three schemes, ASC, BAP and Global GAP are responsible for virtually all third-party certifications across the globe. Each has been analysed and above and although many similarities exist, some generic differences have been identified;

ASC: Considered the most environmentally robust of the three standards. It sets its own specific requirements (rather than relying on national legislation for example). It does not though cover areas such as H&S and Food Safety in as much detail (or at all) as the others). The ASC Standard has gained the most traction amongst the salmon industry and leads the way in terms of certificates and up take, particularly in Norway.

BAP: The second most popular standard in the industry. Although quite detailed, the standard is less robust than the ASC one with many requirements being based on local legislation (rather than setting actual levels). The standard does cover other areas such as H&S, food safety and human slaughter however. The standard has been particularly popular in Chile and has also gained some traction in the UK.

Global GAP: The standard is very similar to BAP but has failed to gain the same traction (despite being the first on the scene). It is now generally only used for specific clients or for smolt operations and is not considered a major player in the salmon sector anymore.

So what has driven the different uptake rates of these three standards? The answer lies in multiple reasons but the most important has been stakeholder acceptance. In short, the farms are keen to meet the requirements which will give them the greatest purchasing power but are, at the same time, as easy to achieve as possible. For most, the ASC is the highest level and so this is the one that many Western retailers are requesting. It is though the most difficult to achieve and so is not taken lightly. The ASC standard has received major backing through the support of the Global Salmon Initiative (GSI). The GSI was set up in 2013 by a group of major salmon farming companies who realised a joint approach to issues such as sustainability would be better. It now represents around 40% of global salmon production and has all the major players included, except for Mowi (the biggest). The GSI has committed to the ASC as its 'standard of choice' and aims to achieve 100% certification amongst all its members (although no date is set). At the same time, Mowi has also set the ASC standard as its preferred standard of choice and is aiming for 100% certification (although again with no date set). When you add the commitment of GSI and Mowi together you are covering around 50-60% of production, so it is easy to see why the ASC standard is proving the most popular.

The BAP standard though has also gained traction in Chile. The reasons for this are partly due to it being easier to achieve but also because of the US market which Chile is more active in supplying. GAA BAP is a US based standard and so has much better presence in this market than the European one.

It is also true that some companies have decided to simply take on both certifications to cover all options! For some, it is the case that certain retailers are requiring BAP and others are requiring ASC. Although efforts have been ongoing to benchmark these standards to avoid the need for multiple certification standards this is still developing and so some companies still adopt the multiple certification approach.

How the use of these certifications may play out in a future Falklands industry now needs some consideration. Firstly, it is important to understand that no country has yet placed a sustainability standard as a 'requirement for licensing'. Instead, the schemes are voluntary and driven more by the industry and public opinion with the regulatory process being separate. That said, it is true that many regulatory systems are becoming closer and closer aligned to the requirements of the standards. What is not desirable is a regulatory system in which the requirements are substantially different from the standard requirements a this can create problem for the standard setters who will struggle to argue that companies should be doing something different to the law[1].

Considering the above, it is our opinion that future regulatory requirements should consider the requirements of the main standards carefully and ensure at least alignment whenever possible. However, we do not think that legislation should place an absolute requirement of farms being certified against specific certification requirements. In this regard, the legislation and regulatory framework can be seen as setting the right environment for allowing operators to achieve third party certification.

Despite the above though, one specific area is likely to create a major problem for any farm wishing to become certified against any of the standards specified above and this relates to the fact that salmon (coho or Atlantic) are not native species to the Falklands or currently introduced in the Islands. The wording in relation to this is set out for each standard below in Table 7.

Table 7: Standard requirement wording in relation to non-native species use

ASC	3.2.1 If a non-native species is being produced, demonstration that the species was widely commercially produced in the area by the date of publication of the ASC Salmon Standard. Exceptions shall be made for production systems that use 100 percent sterile fish or systems that demonstrate separation from the wild by effective physical barriers that are in place and well-maintained to ensure no escapes of reared specimens or biological material that might survive and subsequently reproduce. 3.2.2 If a non-native species is being produced, evidence of scientific research completed within the past five years that investigates the risk of establishment of the species within the farm's jurisdiction and these results submitted to ASC for review
Global GAP	None found
GAA BAP	6.8: The applicant shall provide documents that prove the species of salmon farmed is approved for farming in that country and that the stocked fish are not transgenic. Where the species farmed is not native or not already farmed, further documents shall be provided to demonstrate that approval for farming is based on the 2005 ICES Code of Practice on Introductions and Transfers of Marine Organisms.

The above wording suggests that it may be possible for a farm to be ASC certified for salmon production in the Falklands providing it uses 100% sterile fish (we presume this includes the use of triploids) or if they are grown in a land based closed containment system only. For BAP, the wording is less clear but following discussions with BAP staff it appears that the production would need to be reviewed on a case by case basis and would require approval from the BAP

[1] A good example here might be that a country makes certain treatment requirements for salmon law but that this then goes against the standard. In this case the farmer has an impossible choice between breaking the law or meeting the certification requirements. It is therefore important that the two do not contradict each other whenever possible.

committee first. Either way, achievement of certification in the Falklands is not likely to be a straight forward process at all.

The other area that we have considered in the analysis above is that of 'organic salmon farming'. While it is noted that the principles of what is organic can vary considerably, a growing industry in the EU for organic salmon still exists. To date, no country has set the precedent of requiring all salmon farming operations to follow organic requirements as part of licensing requirements. As mentioned, Ireland is currently producing salmon virtually 100% organic, but this is not a regulatory requirement but simply a result of company policy making and slow licensing by the Government.

It would certainly be an option for the FIG to develop its future salmon farming industry based on 'organic production' and this would represent a 'world first'. A few key points are raised at this stage which require further consideration;

- The idea of 'organic only' would most likely be better received by the NGO and local community than traditional salmon farming.
- Having a whole region classed as organic would make the process of certification easier and would avoid issues linked with 'cross contamination'.
- The legislation would have to specifically link to the key organic requirements to ensure that it is clear
- What is classed as 'organic' though would need careful consideration and is partly linked to the market that producers would supply
- Whether a market and business model exist which would make it attractive to operators is not clear. Certain specific issues (such as sourcing organic feed in the Falklands) would need to be overcome and it is noted that the current major markets for Organic are considerable distance from the Falklands.
- It does not though appear that non-indigenous species can be grown under the organic requirements (although the wording is not very clear) and this would require further confirmation.

8. Summary of Findings & Key Conclusions

In this report we have set out the key issues which have been shown to affect the salmon farming industry and current best practices which are being implemented to resolve these issues. In the table at the end of this section we have further attempted to summarise these risks and mitigation solutions for the reader.

It is though true that the commencement of any salmon farming in the Falklands Islands will result in some negative environmental outcomes, however small they may be or well controlled the system is. MEP considers it a vital first step for the FIG to develop a vision on how it wishes to move forward with the potential salmon farming in the Islands. It is our opinion that this vision can fall into one of four options which are set out below along with the strengths and weaknesses of each approach.

Option 1: No salmon farming in the Falkland Islands	
FIG takes the decision that the financial benefits of salmon farming (employment and GDP) are not strong enough to warrant the environmental risks that exist from the activities (even is managed through best practices).	
Advantages • NGOs will be happy • Local community concerns will not be realised • Falklands environmental reputation is not jeopardised by potential salmon farming activities	**Disadvantages** • No revenue generated • No employment generates

Option 2: Commercial salmon farming takes place and is limited only by the carrying capacity of the environment.	
FIG takes the decision to allow salmon farming and to limit by the carrying capacity of the water system (as done in Norway). Licensing will be completed always using best available management practices but will allow development up to capacity limits as determined by the regulatory system (and with potential reduction reference points built in for areas such as sea lice for safety).	
Advantages • GDP and employment generation can be maximised	**Disadvantages** • Likely to be highly unpopular with NGOs and some of local community • May tarnish environmental reputation (whatever the outcome) • Highly likely to be issues of disease etc.. even despite the use of best management practices (no system is perfect).

Option 3: Commercial salmon farming takes place but is limited well below the carrying capacity of the environment.
FIG takes the decision to allow salmon farming but to limit the licensing volumes to well below anticipated carrying capacity (either through a carrying capacity assessment or using

the precautionary principle approach). Best management practices will still be employed for all licenses which are granted.	
Advantages • Some GDP and employment generation • Can appease NGOs by showing precautionary approach and limited licensing • Potential to increase in future if process proves successful	**Disadvantages** • Some activity still unlikely to fully appears NGOs and local community concerns • Likely that some negative outputs may still occur from licensed facilities • Requires development of high quality management and regulatory systems but for limited GDP/employment generation

Option 4: Commercial salmon farming is allowed but through niche methods such as 'organic production'	
FIG decides to allow only niche salmon farming production through the creation of an 'organic only' approach. All licenses will only be issues to companies who agree to becoming organically certified. Best management practices (in line with organic requirements) will still be employed for all licenses which are granted.	
Advantages • Some GDP and employment generation • Creation of a 'niche industry with strong environmental credentials' • May help appease NGO and community concerns	**Disadvantages** • Unlikely that a non-native species such as Salmon could be produced in Falklands under Organic requirements. • Unclear if it would be financially viable for commercial operations • Likely that some negative outputs may still occur from licensed facilities

Of the four options above, it is likely that Option 3 represents the most likely path forward for FIG. It provides a compromise between the commencement of some commercial activities while also maintaining caution through the limitation of licensing activities. What scale those limited activities should be is dependent on the capacity that could be supported on the Islands and at what level FIG considers farming to be 'acceptable'.

To implement Option 3 (and 2 and 4 for that matter), a well-defined regulatory environment covering all areas of best practice highlighted in this report will need to be developed in the country. The rough outlines and structure of this system (in Scotland) is presented in Annex 2 of this report and shows just how complex and intertwined the process often is!

It must also be stated that his report makes no assessment of the economic potential which companies may see in farming opportunities in the Falklands Islands. If restrictions are placed which are economically prohibitive, then the result will be no commercial enterprises will want to invest in salmon farming on the Islands in the first place. Furthermore, the isolated location of the Falklands clearly presents some specific infrastructure and market supply considerations which are likely to only add costs to the process. It is also important that FIG consult with the wider commercial producers to understand what may or may not be feasible.

Creating a regulatory environment which would not allow any profitable commercial activity would be considered counter intuitive.

In summary, this report has presented the variety of issues which have and continue to be faced by the global commercial salmon farming industry. Should the FIG decide to begin the licensing of farming operations on the island, it is inevitable that some of the issues described in this report will be experienced at some point, even providing that the best available management measures are implemented. Clearly these negative associations will need to be outweighed by the positives which developing this sector will bring (in employment and GDP). In this approach, caution is seen as the most sensible option and it would be recommended that farming is started on a single pilot scale basis to provide the NGOs and community with an opportunity to get used to the new sector and make improvements and refinements to the regulations and policies prior to additional licensing being agreed.

With good management and strong regulatory framework, it should be possible to reduce the impacts of the negative outfall (both real and perceived) from salmon farming in the Islands to low levels. Furthermore, the semi-autonomous and relatively simple legislative structure should present additional advantages to the islands as it develops its policies and regulations.

Source	Impact	Best Management Practices
Interaction with endemic wildlife		
Use of non-native species *(Salmon salar)*	• Development of wild stocks of non-native species • Interaction with existing food chain	• Do not introduce non-native species • Possible use of Triploidy species (noting issues however)
Farmed fish escapes	• Development of wild stocks of non-native species • Interaction with existing food chain	• Possible use of Triploidy species (noting issues however) • Limited biomass production (reduces risk) • Predator netting system (to avoid escapes) • Locations of farms in protected areas (to avoid escapes) • Escape Management Plans at farm level (legal requirement) including staff training
Predator interaction	• Farmed fish escapes • Loss of revenue and farm mortality • Harm to protected marine mammals and seabirds	• Use of predator netting • Use of Acoustic Deterrent Devices (ADDs) (limited and approved) • Strict legal process for authorising lethal action
Disease		
Infectious diseases (bacterial, viral and parasitic)	• Transmission of pathogens to wild species	• Aquatic animal health management plan in place on all farms • Regular veterinary checks (Norway: 4-6 times annually, depending on the size of the farm) • Farms to have a location structure and zoning to reduce the risk of disease transmission. • Advanced vaccination programmes in place • Optimised biosecurity (legal requirements) • Use of functional feeds and immune modulators etc. • Improved husbandry methods to reduce stress • Fallowing
Sea lice	• Transmission of sea lice to wild species in greater numbers • Loss of revenue and farm mortality	• Caps on maximum sea lice threshold (Norway: 0.2 lice during wild salmon migration period, otherwise 0.53 motile lice per salmon always, Chile: 3 motile lice per salmon at all times) • Potential reference points for reduction of biomass production (like traffic light system) • Use of treatments allowed but under strict regulatory approval • Encouragement of alternative measures (skirt nettings, lumpfish)

Pathogen transfer and transboundary aquatic animal diseases	• Transmission of pathogens to wild species	• Adequate biosecurity • Quarantining • Use of pathogen free stocks
Chemical discharge		
Chemotherapeutants/parasiticides	• Residual effects on wild species	• Use of chemotherapeutants only after consultation and prescription by a licensed veterinarian • Improved biosecurity • Functional feeds and immune modulators etc.
Antibiotics	• Residual effects on wild species • Immunity to antibiotics	• Minimal use of antibiotics and strict use control and approval • Vaccination programmes • Functional feeds and immune modulators etc.
Feed		
High dependency on fish resources in feed	Over exploitation of wild marine resources.	• Production of organic certified fish only? • Encouragement of certification schemes
Waste control		
Benthic flora/fauna	• Emissions of organic materials to the surrounding environment both local and regional resulting in unacceptable changes in sediment chemistry and faunal communities	• Environmental Impact Assessment (EIA) before site licence given • Location of site in area of high-water currents, aiding organic matter dispersal and prevent accumulation below the cages • Optimised management, e.g. moving the cages and the fallowing of sites between production cycles • Benthic monitoring system around farms implemented by the FIG with specific requirements on changes in faunal communities • Use of RAS in hatchery systems through incentivisation.
Inorganic waste	• Local and regional emissions of nutrients to the surrounding environment resulting in eutrophication	• Environmental Impact Assessment (EIA) before site licence given (and to include predictive inorganic waste modelling (DECAPOD) • Location of site in area of high-water currents, aiding organic matter dispersal and prevent accumulation below the cages • Optimised management, e.g. moving the cages and the fallowing of sites between production cycles • Use of RAS in hatchery systems through incentivisation.
Freshwater Use		
Significant freshwater use at hatchery level	• High use of freshwater which is an important resource (although maybe not limited in the Falklands)	• Use of RAS in hatchery systems through incentivisation.

Social-Economic Considerations		
Negative response from NGOs and community	• Negative feedback and ill feeling to industry	• Public consultation in the regulatory phase • Public consultation at the individual licensing phase • Regular feedback on process and responses to points raised • Identification of benefits of industry to islands • Initial pilot phase
Complaints and Issues arising after licenses provided	• Negative feedback and ill feeling to industry	• Licensees required to have a functioning complaints procedure • Regular stakeholder workshops to discuss issues

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Annex 1: Chilean Regulatory Aquaculture Framework

Box 1: General regulatory framework for aquaculture in Chile

- The **General Law of Fisheries and Aquaculture (GLFA, 1991)** provides the general national framework for aquaculture;

- The **Ministry of Economy, Development and Tourism** includes;

    - The **Undersecretary of Fisheries and Aquaculture (UFA)** which is the regulatory authority for fishing and aquaculture activities
    - The **National Fisheries and Aquaculture Service (SERNAPESCA)** which is in charge of monitoring and enforcing the regulations
    - A number of other regulatory agencies with both regulatory and enforcement responsibilities in specific aquaculture related matters, *e.g.* environmental and fish health and disease related regulations, use of marine space and farm siting, *etc*.

- There are also other forms of self-regulatory initiatives by the **private sector** including voluntary agreements for clean production, integrated management system, *etc*. (Chavez *et al.*, 2019), mainly coordinated by Salmon Chile A.G. , an association of the **major private companies** in the salmon farming industry, along with public institutions, including regional governments, the UFA, the Ministry of Health and the National Environmental Commission (currently the Ministry of Environment) (Chavez *et al.*, 2011).

Annex 2: Overview of Regulations required for Aquaculture

National Frameworks and Policies

Strategic Framework for Aquaculture: In most countries, the first step of developing an aquaculture sector is the development of a strategic framework. This framework aims to set out the potential options and subsequent advantages and disadvantages of each. This is done at a National level and requires a large amount of stakeholder interaction. In essence it sets out the vision for the aquaculture industry usually for the next decade.

In Scotland, a new strategic framework was published in 2009, entitled 'A Fresh Start[1]'. This document provides an overriding vision for aquaculture in Scotland which is focused on sustainable growth. To achieve this, it identifies a variety of strategic objectives (for example 'Smarter', 'Wealthier' and 'Greener') which it requires future development and policy making to focus on.

National Marine Plan: A national marine plan aims to develop a joined-up policy which considers all uses of the marine environment (including aquaculture). The aim is to develop a policy which can then feed into national and local planning requirements and ensures that a fair and agreed process, which targets growth areas is being achieved. In simple terms this plan determines how difficult or easy it is for aquaculture facilities to gain planning consent!

National Legislation

Marine Act: The Marine act sets out the rules and regulations associated with all areas of marine use. For aquaculture, this usually covers the requirements for a marine licence and so ensuring safe navigation in marine waters.

Aquaculture Act: An aquaculture act covers the general rules and regulations associated with aquaculture. This includes enforcement requirements and general legal requirements for operators. Often this is combined with wild capture fisheries in a joint Fisheries and Aquaculture Act (but not always).

Water Environment Regulations: In most countries, specific water environment regulations have been developed which deal with issues such as acceptable discharges from aquaculture facilities. In Scotland, these are covered by The Water Environment (Controlled Activities) (Scotland) Regulations 2011. It is these regulations which form the basis of the CAR licensing process set out below.

Aquatic Health Regulations: Regulations are required to cover the health and welfare of fish species. Part of this requires the establishment of a competent authority who are responsible for health licensing and inspections on farms. In Scotland, this is covered by the Aquatic Animal Health (Scotland) Regulations 2009.

[1] https://www.gov.scot/publications/fresh-start-renewed-strategic-framework-scottish-aquaculture/

Licensing Requirements

Usually, a host of licensing requirements need to be in place before the business can begin production. In Scotland, this would include the following;

Seabed Lease: In Scotland, the seabed (up to 12 Nautical Miles) is effectively 'owned' by the Crown Estate (as determined by the Crown Estate Act) and they have a statutory duty to 'obtain a return for any area of seabed or foreshore within its ownership'. As a result, usually the first step for an operator is to agree to a lease of the seabed which it is considering placing its farm on. To allow an operator the time to develop a potential area (and jump through all the other regulatory hoops required) it is normal for a Lease Option Agreement (LOA) to be granted. This lasts for three years with the condition that relevant planning is submitted within two. If all required licences are obtained within the three years, they the Crown Estate will convert the LOA to a full seabed lease. In this regard the Crown Estate has the unique situation of determining on licensing requirements at both the beginning and end of the process.

Controlled Activity Regulation (CAR) Licence: The issuing of a CAR licence in Scotland is completed by the Scottish Environmental Protection Agency (SEPA). The licence is issued to confirm that the operator is not likely to be exceeding site specific limits on the amount of fish in the cages, the amount of medicines and chemicals that it can use and the dispersal of nutrients. To do this the operator needs to collect baseline data from the site (water current speed, depth etc…) which is then fed into a modelling system (Scotland uses AutoDepomod) which makes predictions on the disbursement of chemicals around the site. This modelling is then analysed to ensure that statutory requirements are not likely to be breached. If all is in order, then a CAR is issued. It should be noted that although it is a requirement that a notification is publicly made of an application for a CAR no specific consultation process occurs in Scotland. The granting of a CAR usually takes around 16 weeks and is completed after an LOA is made but before planning permission is commenced.

Planning Permission: This is required for all salmon farming activities in Scotland and is overseen by the Local Authority (LA). It is governed by the Town and Country Planning Act (the Planning Regulation).

Planning is a vital and time-consuming part of the licensing consent process and gives the commercial activity permission to develop a farm on the site identified (although it does not grant permission to actually start farming).

In Scotland, the planning process usually takes around 2-3 months from commencement to sign off. Large scale applications involve a Pre-Planning Application (effectively a screening activity) requirement which lengthens the process considerably.

The process involves the submitting of an application followed by a period of open consultation (usually around three weeks). It is then considered at the council level (who decide based on national planning regulations and guidelines but also local consultation outcomes). A determination is then made and consent either approved or denied.

Environmental Impact Assessment (EIA): The completion of an EIA really forms part of the planning permission process. Again it is covered by the Town and Country Planning Act in Scotland and follows a set template developed by the Scottish Authorities. The process has many steps but in simple terms, requires the company to set out its activities and identify any environmental impacts that might be incurred. It then provides mitigation and monitoring strategies to minimise these impacts. This process results in the development of an

Environmental Statement which is attached to the planning application and forms part of the public consultation process.

Marine Licence: The granting of a marine licence is more to do with ensuring the navigational safety associated with the presence of a floating structure. In Scotland, it is required for all cages and moorings. In Scotland, it is governed by the Marine Scotland Act and requires the completion of a single application form and it has a target timeframe for completion of 14 weeks. The process also involves a period of open consultation with stakeholders.

Authorisation to operate an Aquaculture Production Business (APB): An APB is issued in Scotland by the Marine Scotland Science Fish Health Inspectorate (MSS-MHI). The licence is in relation to animal health requirements only and issued when the operator will not lead to 'an unacceptable risk of spreading disease'. The requirements which inform this decision-making process are set out in the Aquatic Animal Health Regulations (2009) in Scotland. One of the main requirements under this is for the occurrence of regular fish health inspections of farms by the authorities. During these inspections, areas such as Health Management, Biosecurity and the general health of the fish are checked. The authorities have the regulatory power to suspend farming activities at any time if they feel it is required. The licence application process usually takes around three months to complete.

MACALISTER ELLIOTT & PARTNERS LTD

Salmon Farming in the Falklands – Legislative Review

REPORT FOR DEPARTMENT OF NATURAL RESOURCES, FALKLAND ISLAND GOVERNMENT




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Table of Contents

1. Executive Summary

This report has been compiled by Macalister Elliott and Partners Ltd (MEP) on behalf of the Falkland Islands Government (FIG). The Falkland Islands are considering the potential for commercial scale salmon farming operations in the future and have commissioned a series of studies to determine the best practices and legislatory requirements for a successful and sustainable salmon farming industry.

The first report commissioned for the FIG focused on understanding the environmental and social effects of salmon farming in greater detail. This second report focuses on the best global regulatory practices used in the industry with the aim of making potential legislatory recommendations for future adoption in the Falkland Islands.

Currently a relatively simple regulatory system exists in the Falklands for aquaculture development, and this is a reflection on a lack of activity in the sector. The Falklands Development Plan does though identify aquaculture as a potential area for growth and this is supported by approaches to FIG from commercial organisations who see salmon farming as having potential in the islands. The current system is controlled through a general planning system and two key pieces of regulation, the Fish Farming Ordinance, and the Fishery Products Ordinance. The general process for significant aquaculture developments is currently untested but would involve an application for planning, the completion of an EIA and then the provision of a Fish Farming licence with conditions raised, as seen as applicable by FIG. One area that is currently not understood in the Falklands is the ownership (and potential leasing requirements) of the seabed, a process controlled by the Crown Estate directly in the UK.

To provide regulatory comparisons for the Falklands, the current systems employed in Scotland and the Faroe Islands were considered in detail.

Scotland currently produces over 200,000 Tonnes of Atlantic salmon per year. The farming of salmon has been ongoing in Scotland for some time and so a complex and often over bureaucratic system has developed involving hundreds of separate pieces of legislation. The system though is based on the planning system, with all farms required to obtain planning permission before operations can commence. Additionally, applicants must first lease the seabed required from the Crown Estate. Then they are required to complete an Environmental and Social Impact Assessment (ESIA) and to apply for a Controlled Activities Regulation (CAR) licence which effectively models the anticipated discharge of the planned operation and decides if it is within parameters which are environmentally acceptable. In addition, a farm is also required to obtain a Marine Licence and an Aquaculture Production Business (APB) authorisation. In recent years, the system has become increasingly complex and a target for environmental (and other) campaigners and stakeholders alike. This has led to a situation in which current planning applications can take up to two (2) years to be approved. Interestingly, the Scottish National Party (SNP) have recognised that the current system is too burdensome and made a manifesto pledge to simplify it under one statutory authority (a process which has just recently commenced).

In contrast, the Faroe Islands is a relative newcomer to commercial salmon farming but now has production of around 90,000 Tonnes per year. It has also developed a reputation for 'best practice' within its regulatory system which has been borne out of significant initial issues with Infectious Salmon Anaemia (ISA) in the 90's and a subsequent rewriting of the legislation. The

system in the Faroe's is also based on a planning system but with one key piece of legislation (the Faroese Veterinarian Act) providing the key rules and regulations for farming. The country has split its coastline into so-called Marine Zones (MZs) which are areas of similar water mixing. Within these MZs only one farming company is allowed to operate, providing clarity on what happens and who is responsible. Furthermore, the country operates an all in- all out policy for each MZ meaning that fish must all be stocked and then harvested before any further fish can be added. Between each restocking or production run a significant period of fallowing and equipment disinfection is also required. These rules, along with a variety of other controls have seen a strong regulatory system develop in the Faroe Islands resulting in generally less environmental concerns and issues than are seen in other major salmon producing nations. The similarities between the Falklands and Faroes also make it an ideal case study and we believe a model for future development by the FIG.

A further area that is seeing strong development in the Faroes is around the stocking of much bigger smolts into sea cages. Typically completed at an average size of 200g, some companies in the Faroe's are now growing smolts on-land to 600g. This has the effect of reducing the cage-based time and limiting risks associated with disease (in particular, sea lice). Although not a requirement under law, this is seen as a win-win situation with reduced risks for the farmers and better environmental outcomes for all.

MEP has considered the current legislation in place in the Falkland Islands and has made a series of recommendations and improvements which we believe takes the best parts of other global regulation to produce a 'best in class' system which could be adopted should future development of salmon farming be approved. Some of the key requirements which have been put forward are as follows;

A maximum biomass limit: Should farming be approved, we think a maximum biomass should be set for salmon farming in the Falkland Islands, above which no further farming licences will be approved. We have tentatively set this at 40,000 Tonnes. However, it must be noted that this is not based on environmental assessment. To do this, a carrying capacity assessment would need to be completed for the Islands which would be an expensive and timely undertaking. Instead, we would suggest an approach based on the precautionary principle is taken. This would see a low initial biomass being agreed which could then be assessed at regular intervals and then increased if felt appropriate (although we would still suggest setting an absolute maximum limit for the Islands to provide concerned stakeholders with some comfort on the overall aims of development).

Sterile fish only: A major area of concern in the Falklands is that the farming of Atlantic salmon will represent the introduction of a non-native species which can bring about significant risks. For this reason, we are suggesting that farming is only completed using sterile fish that cannot breed in the environment should they escape.

Currently, the only commercial method of producing sterile fish is through triploidy inducement. This process does have some remaining concerns which are currently undergoing significant research but we believe the benefits of such use will significantly outweigh any negatives.

Certification as a requirement: All farms should be required to meet the ASC certification requirements. These are considered the highest standard globally and would ensure that farms are operating at the highest possible levels.

Some concerns do exist around the use of triploidy fish under ASC certification (and whether this will prove possible or not). For this reason, it is recommended that legislation requires all farmers to be able to show they meet the ASC requirements which are applicable (and to not necessarily be certified) until this is clear.

The potential to insist on organic production only was considered in detail but was not seen as possible since the standards do not allow for the use of non-native species unless they have been produced in the country for over ten (10) years (which is clearly not the case in the Falklands).

Marine Zoning, all in-all out and significant fallowing: The best parts of the Faroe Islands legislation have been used to attempt to reduce the concerns specifically around sea lice. These have proven successful in the Faroes and would be well employed in the Falklands.

Minimum Smolt size: We are recommending that a minimum size limit of 400g is set in the regulations for a smolt stocking size to cages in the Falklands. A clear trend is being seen globally in the production of larger and larger smolts in land-based systems. However, no country has introduced regulatory size limits around this, something we think that should start in the Falklands.

Some key next steps are required and are summarised by the four key recommendations set out below.

Recommendation 1: FIG Agreement on Approach: A general agreement is first required from FIG on the approach and way forward. MEP has set out its suggested approach and recommends this is discussed with FIG and a broad level of agreement set as a starting point[1].

Recommendation 2: Faroe Island Visit: MEP sees significant synergies between the Falklands Islands and the industry which has developed in the Faroe Islands. The two states are very similar in many ways and the Faroes has attempted to maintain 'high standards' within its sector. Despite the obvious complication of organising a visit to the Faroe Islands, we do believe that this would be highly beneficial for key members of the FIG. It would allow the processes employed in the Faroes to be seen first-hand and for discussions to be held directly with key legislators in the country. MEP would be able to help organise such a visit should it be agreed as a good next step.

Recommendation 3: Stakeholder Discussion and Review: The decision to allow or not allow future salmon farming in the Falklands is clearly one that needs to involve discussions with stakeholders. Firstly, the island residence will need to be consulted and concerns and questions addressed. Once the proposed approach set out in the document is agreed in FIG, MEP would suggest that we attend such stakeholder meetings in the Falklands.

Also, of importance though is that the potential industry stakeholders are also consulted on the potential changes (specifically, Unity Marine). The introduction of new rules for potential salmon farming in the Falklands would be pointless if no commercial organisation would be prepared to undertake farming because the rules are too onerous or cannot be achieved.

Following a period of stakeholder consultation with all parties it is likely that key amendments would need to be made to the suggested legislation and processes which are set out here.

Recommendation 4: Development of Policy and Legislation: Should agreement be made on the policy and legislation and a decision made to move forward with salmon farming, then the

[1] *This does not mean that agreement is required on whether to allow salmon farming but that the possible approach should it be allowed is generally accepted.*

next stage would be the development of the specific ordinance and frameworks required under the Falklands legal system.

Finally, it must be stressed that this report is not designed to advocate either for or against the commencement of large-scale salmon farming in the Falkland Islands. As with virtually any anthropogenic activity, salmon farming will produce negative outcomes (as well as positive outcomes) which some stakeholders find acceptable, and others do not. The final decision on whether these outcomes are acceptable or not will need to be taken by the FIG (following consultation). However, this report has attempted to set out a potential regulatory system which would present a ‘best practice’ approach to cage-based salmon farming within a relatively small archipelago and acknowledging what could be a small (globally) but significant industry for the Islands.

2. Introduction

This report has been compiled by Macalister Elliott and Partners Ltd (MEP) on behalf of the Falkland Islands Government (FIG). MEP is a UK based fisheries and aquaculture consultancy which has been operating since 1977.

The Falkland Islands are considering the potential for commercial scale salmon farming operations in the future. The waters of the Falklands are considered well suited to salmon farming and approaches have been made to the authorities by interested parties previously.

The potential for commencing commercial salmon farming would create additional revenue for the government and create jobs for islanders. However, salmon farming globally has also seen some significant environmental concerns raised.

This report represents the second provided to the FIG in relation to salmon farming operations in the Islands. The first (Best Practice Recommendations) provided an initial assessment of the impacts of salmon farming and included a detailed overview of what the negative impacts of salmon farming are and how these have been experienced by other countries in the development of the sector. It then presented some recommendation on potential development options within the Falkland Islands.

This report focuses on the legislative process of salmon farming with the aim of providing recommendations on how this could be improved/developed in the Falklands to ensure the highest standards of production could be obtained (should it be decided to move forward with commercial aquaculture production in the Islands). To inform this legislative review, two case studies have been considered for production in Scotland and the Faroe Islands. Both these countries have shown significant growth in salmon farming in the past two decades but operate quite different legislative requirements. The final part of the report makes recommendations on how current Falklands legislation could be developed to allow for best practices to be adopted in the future.

Finally, it is important to state from the outset that no aquaculture production of farmed salmon is entirely without impact on the environment. As with any anthropogenic process, it is inevitable that some negative impacts may occur within the environment. However, the aim of this review is to provide approaches which can minimise and mitigate these negative outcomes to the greatest degree possible but within the context of allowing a commercial salmon farming industry to develop (albeit at a controlled level).

3. Current Legislative System in the Falklands

3.1 National Vision and Policy

Since aquaculture is not currently a significant industry in the Falklands (only one producer of trout currently) it is not really a surprise that the country has a limited strategic framework or masterplan in relation to it.

The Falklands has developed the Falklands Islands Development Plan (2015) which aims to provide a 'structure' for the future spatial development of the Islands. Under this plan, aquaculture development is covered by SP8: Rivers, Coastal Areas and Territorial Sea. Here it states;

'Both marine and freshwater aquaculture proposals, together with any associated proposal on land, will;

1. *Be considered against the impact on marine ecology, biodiversity and heritage resources, water quality and catchment and visual amenity and landscape/coastal quality; and*
2. *Only be supported where they demonstrate no significant adverse impact on the environment and how any structures are to be removed and the land reinstated if/when no longer in use.'*

Under Point 5.25 a further discussion on aquaculture is included and mentions that aquaculture is a possible growth area to help diversify the economy of the Falkland Islands. However, the remaining discussion relates mainly to the environmental concerns of aquaculture and states that;

'The primary objective therefore is to ensure that the development of marine farming can be undertaken sustainably with no undue impact on native species.'

It is therefore clear from the FIDP that aquaculture is seen as a potential area of economic development but that if it does occur it must be done 'sustainably' and with no 'undue impact' on native species.

This aside however, no real Government policy exists for the development of aquaculture in the Falkland Islands. In fairness, this is recognised by the FIG and is one of the reasons this work has been commissioned. If aquaculture was to be developed it would be considered wise for this 'framework for aquaculture development' to be further expanded to recognise what the FIG classes as sustainable and not creating undue impact. After all, it is the basis of this development plan which will create the basis for decision to be made under the planning process.

3.2 The Legislative framework for fish farming

Step 1: Seabed ownership and lease

In most countries that have cage-based aquaculture, it is a requirement for the applicant to first rent the planned seabed site from a national agency which is responsible for its control and development. In the UK this is the Crown Estate (see Section 4 below on the Scottish salmon legislatory system).

Unsurprisingly, the ownership of the seabed in the Falklands is not clear and no current licences have been required to lease the seabed. Clearly, the situation around this will need to be confirmed and developed before any further licensing occurs.

Step 2: Planning Permission (& EIA)

The planning process is the main tool used globally for the issuance of aquaculture licenses and this is currently also the case in the Falkland Islands.

The process of Planning Permission on the Falkland Islands is governed by the Planning Ordinance 1991. This document sets out the process for applying for planning, how it is considered and the outcomes, appeals and enforcement actions which exist. The actual planning process is overseen by the Falkland Islands Government Planning and Building Services (PBS).

Fish farming activities are specifically covered under the Planning Ordinance under Section 26 (Meaning of 'Development'). Here it is clearly stated that the *'placing or assembly of any tank, cage, frame….for the purpose of fish farming'* should be considered as development which requires planning permission to be granted. In consideration of this, it is clear that all salmon farming activities would need planning permission to be granted under the Planning Ordinance 1991.

The planning system in the Falklands is currently operated through a facebook page on which all forms, requirements and applications are placed. A single application form currently exists for all planning types and was updated in 2021. No specific form exists for an aquaculture application, but this is by no means surprising since only one application has been made to date (that by the Falkland Islands Fish Company). Reviewing this previous application confirms that the standard form was completed for this purpose (although it is also true to state that this application form really is not fit for purpose for major fish farm applications to be made in the future).

With a planning application form a fee is also required to be submitted. These fees are also published on the facebook page and a specific cost for aquaculture planning requests is stated of £103 per application.

Decisions on planning applications are made based on the current Falkland Islands Development Plan which was adopted in 2015 and has already been discussed above (it has limited direction for planning in relation to sustainability and no undue impact at present).

The other requirements on seeking planning permission are relatively standard with requirements on publicising plans in advance and ensuring all representations are considered.

No specific requirements are made in relation to aquaculture, except for the acknowledgement in Section 39 which states that;

"Subject to the following subsections, an application for planning permission for exploration for or winning and working of minerals or an application for planning permission for fish farming must be determined by the Governor."

In essence this places aquaculture development on a similar level to mineral extraction in the islands and requires approval at the highest level of the FIG.

The Planning Ordinance though does specify that planning permission may require the completion of an Environmental Impact Assessment (EIA). The requirements on what is required under this EIA are very broad and simply allow the authorities to vary the requirements as they see fit. Although it is not specifically stated, it is clear that applying for planning for a salmon farming operation would require an EIA to be completed in-line with the planning process. As will be seen in the example below for what is required in an EIA for an operation setting up in Scotland, it is common practice to provide quite prescriptive requirements on what the EIA should cover within the legal regulations. This is something that will need to be developed within the Falklands regulations.

Step 3: Fish Farming Ordinance

In 2006, a new piece of legislation was passed in relation to aquaculture, called the Fish Farming Ordinance (Ordinance No. 20 of 2006). This regulation aims to set out the rules and regulations in connection with aquaculture production in the Falkland Islands. It includes requirements on who and what can apply for a fish farming licence, what pre-requisites are required (i.e. planning), and some other generic requirements.

In general, the ordinance provides some important general legislative rules which are required to manage any aquaculture sector. For example, the ability to provide, invoke and suspend licences, to enforce and inspect requirements and what happens when licences are cancelled (to name a few). The requirements though do not provide any technical legislation on what is and isn't allowed for fish farming activities in the Falkland Islands.

Some key points of the Fish Farming Ordinance are as follows

1. That a licence can only be issued to a qualifying company (a company which has 25% or more of its share capital invested in a company or person(s) which have legal status in the Falklands).
2. That Planning permission is a pre-requisite that is required before any licence will be issued.
3. That submitting an application should include;
    a. A map of the waters for which the licence is sought
    b. Details of the operation being completed
    c. Any equipment to be used
    d. A business plan
    e. Information on the source of financing and beneficial owners
4. The licence will run for an indeterminate period (no specific period is provided)
5. That any licence must result in the commencement of activity within five (5) years
6. That conditions may be imposed on the licence as seen fit by FIG

7. That the licence holder may have to pay royalty licences as may be prescribed (no specific rates for royalties are provided).

As previously mentioned, the requirements set out under the Fish Farming Ordinance cover many of the basic requirements for enforcing aquaculture legislation in the Falklands. They though are not clearly integrated into the full approval system and miss significant technical requirements which would form the backbone of sustainable production in the Falklands. This is discussed in more detail in Section 6 of this report.

Stage 4: Fishery Products Ordinance

The Falklands bought legislation into force in 2006 relating to fishery products (the Fishery Products Ordinance (Ordinance No 21.). These regulations are mainly relating to the production of shellfish but do also provide general rules relating to permission to discharge and the control of disease which are poignant and require further consideration here.

Permission to Discharge

The regulations forbid persons from discharging effluent or sewage into controlled water areas. However, a licence permitting this may be applied for and must be supported by relevant evidence (we presume an EIA). Since salmon farming will naturally release effluent into the water, we can only presume that this legislation would be appropriate and would require any salmon farm to receive a consent to discharge.

The process set out here is the same basic one that is governed by the CAR process in Scotland (effectively providing permission to pollute). However, the legislation is not really set up to deal with salmon farming and so would require additions to make it fit for purpose.

Control of Disease

The regulations require any person who observes abnormal mortality in fish or shellfish to notify the authorities as quickly as possible. Should the authority have reasonable grounds for suspecting disease, the regulations then give them the ability to prohibit the sale and if required, instruct the destruction of the contaminated/infected fish/shellfish.

The above are important requirements within any regulatory environment for ensuring that only healthy fish enter the market and are removed as required to avoid the spread of further infection. However, this is very much the most basic level of disease control that can exist and we make much stronger regulatory recommendations specifically for salmon farming in Section 6 of this report.

Live Fish Introduction

Section 28 place a prohibition on the introduction of live fish or eggs into the Falklands unless accompanied by documents confirming they are form an area free from disease. This will be an important factor if salmon eggs are to be imported initially.

In general terms, the fishery products ordinance provides quite basic regulatory requirements covering both fisheries and aquaculture and a wide plethora of requirements from water classification to hygiene and quarantine requirements. However, its relationship with the fish farming ordinance is less clear and will need further consideration as the legislation is developed.

4. Case Study 1 – Scottish Salmon Farming

4.1 National Vision and Policy

National Vision for Aquaculture

The vision for aquaculture development in Scotland is set out in the new strategic framework which was published in 2009, entitled 'A Fresh Start[1]'. This document provides an overriding vision for aquaculture in Scotland which is focused on sustainable growth. To achieve this, it identifies a variety of strategic objectives (for example 'Smarter', 'Wealthier' and 'Greener') which it requires future development and policy making to focus on.

The framework makes it clear that the aquaculture sector is and will remain an important industry for Scotland and that the Government is committed to sustainable growth of the sector. However, alongside this it recognises the need to improve the health of fish, make the licensing system better and improve containment (reduce escapes).

In short, Scotland is committed to trying to increase production through aquaculture while improving the practices of the industry and reducing environmental concerns associated with it. To implement this, Scotland has introduced a range of new plans and policies which are discussed below.

National Policy

A National Marine Plan aims to develop a joined-up policy while considering all uses of the marine environment (including aquaculture). The aim is to develop a policy which can then feed into national and local planning requirements and ensures that a fair and agreed process, which targets growth areas is being achieved. In simple terms this plan determines how difficult or easy it is for aquaculture facilities to gain planning consent!

In Scotland, the National Marine Plan[2] was last updated in 2015 and deals specifically with Aquaculture in Chapter 7. It sets out seven key objectives for aquaculture planning in Scotland of which the most important are;

1. Create an aquaculture industry which is sustainable, diverse, competitive, economically viable and contributes to food security while minimising environmental impact.
2. Aim to increase marine finish production to 210,000 Tonnes per year
3. Create a proportionate and transparent regulatory framework

These objectives are in line with the national vision already set out (increased production but in a more sustainable way). Probably the most import point to understand from the Scottish Marine Plan is that it specifically commits to increasing finfish production to a level of 210,000 Tonnes per year.

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[1] *https://www.gov.scot/publications/fresh-start-renewed-strategic-framework-scottish-aquaculture/*

[2] *https://www.gov.scot/publications/scotlands-national-marine-plan/*

To achieve this and help planners make decisions on what areas can and cannot be developed for aquaculture, the Scottish Government have completed a variety of Marine Spatial Planning exercises which provide further guidance.

National Legislation

To support the strategic framework and plans of the Scottish Government, a vast array of national legislation exists in the country.

Marine Act: The Marine Act sets out the rules and regulations associated with all areas of marine use. For aquaculture, this usually covers the requirements for a marine licence and so ensuring safe navigation in marine waters.

Aquaculture Act: The Aquaculture Act covers the general rules and regulations associated with aquaculture. This includes enforcement requirements and general legal requirements for operators. Often this is combined with wild capture fisheries in a joint Fisheries and Aquaculture Act (but not always).

Water Environment Regulations: In most countries, specific water environment regulations have been developed which deal with issues such as acceptable discharges from aquaculture facilities. In Scotland, these are covered by The Water Environment (Controlled Activities) (Scotland) Regulations 2011. It is these regulations which form the basis of the CAR licensing process set out below.

Aquatic Health Regulations: Regulations are required to cover the health and welfare of fish species. Part of this requires the establishment of a competent authority who are responsible for health licensing and inspections on farms. In Scotland, this is covered by the Aquatic Animal Health (Scotland) Regulations 2009.

Upcoming Changes

In 2021, the Scottish National Party (SNP) made a manifesto pledge for a new approach to the way fish farming consents are handled. As is discussed below, the current process requires four different regulatory bodies to oversee the consenting process with each one acting as a statutory consultee on the process handled by the others (i.e., each will comment on each other's procedural areas). This process is considered cumbersome and so the pledge aims to introduce a single authority with responsibility for the licensing process.

The first stage of this change was announced in August 2021 with the announcement of the appointment of Professor Russel Griggs to lead the review into this reform process. This review and manifesto pledge have been broadly welcomed by the current industry in Scotland.

This planned change needs to be kept in mind during the following discussion on the current regulatory system in Scotland.

4.2 The Legislative framework for fish farming

Step 1: Seabed Ownership and Leasing

In Scotland, the seabed (up to 12 Nautical Miles) is effectively 'owned' by the Crown Estate (as determined by the Crown Estate Act) and they have a statutory duty to 'obtain a return for any area of seabed or foreshore within its ownership'.

As a result, usually the first step for an operator is to agree to a lease of the seabed which it is considering placing its farm on. To allow an operator the time to develop a potential area (and jump through all the other regulatory hoops required) it is normal for a Lease Option Agreement (LOA) to be granted. This lasts for three years with the condition that relevant planning is submitted within two. If all required licences are obtained within the three years, they the Crown Estate will convert the LOA to a full seabed lease. In this regard the Crown Estate has the unique situation of determining on licensing requirements at both the beginning and end of the process.

The process of obtaining an LOA is completed directly with the Crown Estate and requires the completion of an application form which needs to be accompanied with a plan of the area to be leased and a brief outline of the business/production plan for the site in question. The Crown Estate will consider the application to decide if the required resources (technical and financial) are available and that the applicant is following best practices for production.

An LOA is free to apply for, although it is possible to extend the time of LOA from three to five years at a cost of £1,000.

Should all the required licensing requirements be met and the full seabed lease is provided, the Crown Estate will charge a flat rate of £27.50 per tonne of salmon (net gutted weight). A 10% reduction is provided for the Outer Hebrides. Orkney and Shetland to reflect the higher operational costs.

Further information on the leasing process can be found at the following link: https://www.crownestatescotland.com/what-we-do/marine/asset/aquaculture/section/applying-for-and-managing-your-lease

Step 2: Environmental Social Impact Assessment (ESIA)

Once an LOA has been received, the applicant is now free to commence the regulatory application process. Usually, the first step is to complete an Environmental Social Impact Assessment (ESIA) which aims to provide a systematic assessment of the likely environmental effects arising from a proposed development.

In Scotland, the requirements of completing an ESIA are covered by the Town and Country Planning (Environmental Impact Assessment) (Scotland) Regulations 2017. The key points from this are as follows;

EIA Threshold Level: Any farm which will produce more than 10 Tonnes of dead fish weight per year or is designed to hold a biomass of 100 tonnes or greater or will extend to 0.1 hectares or more of the surface area of the marine waters are required to complete an ESIA.

Form of the ESIA: The form of the ESIA is not specified directly (i.e. no template is provided) but the 2017 regulations do require certain items to be included;

1. A description of the development, including in particular:
    a. description of the location of the development;
    b. a description of the physical characteristics of the whole development;
    c. a description of the main characteristics of the operational phase of the development (in particular any production process), for instance, energy demand and energy used, nature and quantity of the materials and natural resources (including water, land, soil and biodiversity) used;
    d. an estimate, by type and quantity, of expected residues and emissions (such as water, air, soil and subsoil pollution, noise, vibration, light, heat, radiation and quantities) and types of waste produced during the construction and operation phases.
2. A description of the reasonable alternatives (for example in terms of development design, technology, location, size and scale) studied by the developer, which are relevant to the proposed project and its specific characteristics, and an indication of the main reasons for selecting the chosen option, including a comparison of the environmental effects.
3. A description of the relevant aspects of the current state of the environment (the "baseline scenario") and an outline of the likely evolution thereof without implementation of the development as far as natural changes from the baseline scenario can be assessed with reasonable effort on the basis of the availability of relevant information and scientific knowledge.
4. A description of other factors likely to be significantly affected by the development: population, human health, biodiversity (for example fauna and flora), land (for example land take), soil (for example organic matter, erosion, compaction, sealing), water (for example hydro morphological changes, quantity and quality), air, climate (for example greenhouse gas emissions, impacts relevant to adaptation), material assets, cultural heritage, including architectural and archaeological aspects, and landscape.
5. A description of the likely significant effects of the development on the environment resulting from, inter alia:
    a. the construction and existence of the development, including, where relevant, demolition works;
    b. the use of natural resources, in particular land, soil, water and biodiversity, considering as far as possible the sustainable availability of these resources;

c. the emission of pollutants, noise, vibration, light, heat and radiation, the creation of nuisances, and the disposal and recovery of waste;
d. the risks to human health, cultural heritage or the environment (for example due to accidents or disasters);
e. the cumulation of effects with other existing and/or approved projects, taking into account any existing environmental problems relating to areas of particular environmental importance likely to be affected or the use of natural resources;
f. the impact of the project on climate (for example the nature and magnitude of greenhouse gas emissions) and the vulnerability of the project to climate change;

6. The description of the likely significant effects should cover the direct effects and any indirect, secondary, cumulative, transboundary, short-term, medium-term and long-term, permanent and temporary, positive and negative effects of the development. A description of the forecasting methods or evidence, used to identify and assess the significant effects on the environment, including details of difficulties (for example technical deficiencies or lack of knowledge) encountered compiling the required information and the main uncertainties involved.
7. A description of the measures envisaged to avoid, prevent, reduce or, if possible, offset any identified significant adverse effects on the environment and, where appropriate, of any proposed monitoring arrangements (for example the preparation of a post-project analysis).
8. A description of the expected significant adverse effects of the development on the environment deriving from the vulnerability of the development to risks of major accidents and/or disasters which are relevant to the project concerned.
9. A non-technical summary of the information provided under paragraphs 1 to 8.

To complete this, the applicant will be required to appoint a specialised company to perform the ESIA and will be required to collect relevant baseline data at the site. Once the ESIA has been completed it is sent to the relevant authorities as part of the planning process (as set out in the next step below).

Step 3: Planning Permission

As with the Falklands, planning has been required in Scotland for all fish and shellfish farms since April 2007 under the Town and Country Planning Act (the Planning Regulation). The process is overseen by the Local Planning Authorities (LPA) of which six are relevant in Scotland (Argyll and Bute Council, Highland Council, Orkney Council, Shetland Council and Comhairle Council).

Each LPA has a slightly different application process but for the benefit of this report, we have used the Argyll and Bute Council system.

Pre-Application Process

A relatively new development in planning is the 'pre-application' process. This is basically a 'pre-assessment' which allows the developer to discuss the details of the project with the council team and get a feel for how the project would be received and what steps are required to ensure the smooth process of full planning. The process is charged for by the council at £1,000 each.

Full Application Process

Whether or not a pre-application is completed, the full planning process commences with the submitting of an application form[1]. This must be accompanied with the following documents;

a. Location plan and admiralty chart showing application site
b. Plans of the cages/cultivation equipment to be used
c. Evidence of lease holding for relevant seabed area
d. Environmental Impact Assessment (ESIA)
e. Landscape and Visual Impact Assessment
f. Design Statement
g. Water Quality Report (usually forms part of the ESIA)
h. Appropriate Fee (Planning applications for aquaculture are charged at £183 for each 0.1 hectare of the surface area of the marine waters to be used in relation to the placement or assembly of any equipment for the purposes of fish farming and £63 for each 0.1 hectare of the seabed to be used in relation to such development subject to a maximum of £18,270)

The planning process is handled by the 'Major Applications Team' at Argyll and Bute Council. Upon receipt of the application documents the council has a guideline of providing a decision on the application process within four (4) months (two (2) months if no Environmental Statement is required). However, it is common for the decision-making process to take much longer than this. An example of a planning application is provided in the following link[2].

During this period the council will seek stakeholder opinions from both the public and relevant statutory authorities. The Statutory authorities who are invited to comment directly include the Scottish Environmental Protection Agency (SEPA) and Marine Scotland Science (MSS).

This process is triggered by the release of a Planning Application Statement which is published on the councils website and in local press sources. The statement sets out the planning application details, including the fact that it has been accompanied by an EIA, and invites

[1] https://www.argyll-bute.gov.uk/sites/default/files/marine_fish_farm_planning_application_form_1.pdf

[2] https://publicaccess.argyll-bute.gov.uk/online-applications/applicationDetails.do?activeTab=summary&keyVal=QE8MP8CH0I300

interested stakeholders to comment in writing within 4 months of the date of the notice. However, due to the public 'interest' in schemes of this type, it is common for the council to receive high numbers of often detailed responses and requests for further information. Many stakeholders also request significant periods of extension to the process to allow them to submit further supporting information for the process. As an example of this, in the Kilbrannon farm example linked above, a total of 285 public comments and 12 consultee comments have been received to date (of which 237 are objections). Following requests from public stakeholders and the applicant, the decision-making process has been extended to allow further comments to be received until the end of July 2021 (despite it originally meant to be finished in December 2020. In reality, this process involves significant back and forth between objectors and the applicant with the latter attempting to appease the former with additional information prior to the council finally making a final planning decision[1].

The actual decision-making process for planning taken by the council is further guided by supplementary planning guidance on aquaculture development (SG AQUA 1) which is developed by each of the different councils in the context of the National Marine Plan and Scottish Planning Policy. This guidance sets out nine separate Development Criteria (DC) areas against which the planning application will be considered. These are considered in more detail below;

DC1 Landscape/seascape and visual amenity: DC1 has an overriding principle of trying to ensure that the proposed facility will be 'satisfactorily integrated' within the existing landscape. This is often completed through a Landscape and Visual Impact Assessment (LVIA). Some important areas for consideration under DC1 are as follows;

- *National Scenic Areas (NSAs):* In Argyll and Bute, seven NSAs have been designated due to highly varied and valuable landscapes. Although it is not impossible for planning to be granted in these areas it is likely to have significantly more constraints than areas outside the NSAs.
- *Areas of Panoramic Quality (APQs):* These are a lesser designation but still have 'enhanced' landscape considerations.
- *Cumulative Impacts:* Multiple developments in an area are likely to have a cumulative impact which should be considered under DC1.

Some specific recommended development guidelines are also provided here to help mitigate the effects under DC1;

- Long, regular coastline areas may offer better opportunities for larger sized development by creating a sense of big space
- Dark vegetation and/or steep landform which casts shadows across the water for the large part of the day can help to mitigate the visual effects (by making the farms harder to see).
- Landscape which is less removed and accessible is considered more desirable for development
- Areas already characterised by activity (for example regular maritime traffic) are also considered favourable.

[1] *The applicant will be keen to mitigate as much of the negative comments from the public as possible prior to a planning decision being taken to hopefully improve the chances of a positive decision being made.*

DC2 Isolated coast and wild land: Following on from the final two points above, areas of Isolated Coast and Wild Land have been mapped by the council and are considered less suitable for development.

DC3 Historic or archaeological sites & their settings: Aquaculture development should not compete with iconic or important coastal features either visually or in terms of direct impact (for example, wreck sites).

Key Ancient Monuments, listed buildings, conservation areas and points of marine interest are all designated and mapped in the region and should be avoided for marine aquaculture siting.

DC4 Priority habitats/species and designated sites for nature conservation: Scottish planning policy requires the planning authorities to take account of effects on the seabed and that protected or important marine habitats should be specifically considered.

With regards to habitats, In Argyll & Bute, eight (8) RAMSAR sites, ten (10) Special Protection Areas (SPAs) for bird, five (5) Marine Protected Areas (MPAs) , fourteen (14) Sites of Special Scientific Interest (SSIs) and two (2) National Nature Reserves are in existence.

In simple terms, any planning applications which are likely to negatively affect the qualifying features which give the areas their designation are unlikely to receive permission.

Considering priority species, this is mainly focused on the European Protected Species (EPS) but also required consideration of wild migratory salmonids and also areas of rare benthic habitat.

Again, locations which are unlikely to significantly disturb wildlife, avoids vulnerable benthic habitats and have good mitigation measures in place to reduce the risks will be favoured.

DC5 Ecological status of water bodies and biological carrying capacity: The biological carrying capacity of the water body is obviously a key concern but is really covered in significant detail in the ESIA process and the provision of a CAR license. Should it be considered to be unsuitable loading levels for the surrounding water body then it is doubtful that a CAR licence or planning would be granted.

One recent development though under DC5 has been the creation of location guidelines for sea lochs specifically. Here Marine Scotland used nutrient modelling to determine areas which could support additional biomass (Category 2 and 3) and those that couldn't. (Category 1). For Category 1, any increase I production biomass is ruled out straight away (so providing further limitations on areas which cannot be considered for aquaculture development)./

DC6 Commercial and recreational activities: Again, Scottish marine planning requires that other marine interests are considered when a new farm is being planned. These include commercial fishing, tourism, recreational activities and Ministry of Defence activities (if appropriate).

The aim is not to exclude aquaculture in areas that these other activities take place (as this would probably cover everywhere!) but to identify what the potential impacts could be and propose mitigation measures accordingly. This should include careful consideration of public safety considerations and avoiding the impeding of access to the foreshore.

DC7 Economic impact: The positive and negative economic impacts are considered under DC7. Aquaculture is likely to create jobs but could for example, result in losses from commercial fishing grounds.

If the new facility is likely support Economically Fragile Areas, then additional weight is given to this in the planning process.

DC8 Management areas: Management Areas are a relatively new concept within the aquaculture sector. They require groups of farms who are located within the same hydrographic areas (often linked to tidal flow) to manage risks in a coordinated manner (in an effort to mitigate any cumulative impacts). These are commonly used for the control of sea lice in particular.

On this basis, any new farm within an overlapping tidal excursions area will be required to operate in accordance with the existing sites.

DC9 Operational Impact (waste, noise, light and odour): Finally, the planning system takes account of these additional areas. Noise and light are considered on a case-by-case basis (with more remote sites likely to be more of an issue as they have much lower existing noise and light pollution). Farms may have to show how they will mitigate against this (lights directed down, silent generators used etc…).

All farms will need to develop a waste management plan to show how they will handle the inevitable waste that will occur from the farm.

A planning decision is made by weighing up all of the above considerations, including all stakeholder feedback and applicant responses to make the final decision. In all cases planning will either be granted with conditions or rejected (it is possible for permission to be granted without conditions, but this never happens).

As an example of what conditions are often attached to a granted planning application, the Eilean Grianain (Carradale) Salmon Farm is used[1]. This was granted with eight (8) conditions which can be summarised as follows;

Condition 1: Farm can only be permitted in accordance with the specific plans provided

Condition 2: Within nine (9) months of first being stocked with fish, the operator needs to submit a strategy on monitoring and managing the interaction between the farm and the wild fish environment. The strategy should cover containment breaches (escapes) and sea lice control and should specifically;

a. Define a monitoring regime for sea lice infestation monitoring sites up to 30km from the site
b. Define sea lice infestation levels at which additional mitigation measures must be imposed

[1] https://portal360.argyll-bute.gov.uk/civica/Resource/Civica/Handler.ashx/Doc/pagestream?cd=inline&pdf=true&docno=21318666

c. Define what these mitigation measures shall be
d. Identify a minimum threshold for escape events, above which further monitoring will be completed to further knowledge of genetic impacts of escapes.
e. Provide for a periodic review of the strategy.

This strategy must be approved by the planning authority before implementation.

Condition 3: Requires the removal of any unused associated equipment (not used for three years) to lesson any visual amenity.

Condition 4: Commitment to remove any damaged and/or stranded equipment by the operator.

Condition 5: All lighting to be directed downwards by shielding and extinguished when not required.

Condition 6: Al equipment above the water surface should be non-reflective and finished in a dark muted colour (unless required otherwise for navigational purposes).

Condition 7: Provision of details on any Acoustic Deterrence Devices (ADDs) to be used at the site and approval in advance by the Planning Authorities.

Condition 8: Details of any non-productive species (i.e. cleaner fish) to be submitted and approved by the Planning Authorities in advance of use.

Step 4: Controlled Activities Regulation (CAR) Licensing

Since April 2006 it has become a legal requirement for aquaculture operations to receive a CARs license. This licensing process is completed by the Scottish Environmental Protection Agency (SEPA) and is used to control impacts on the water environment. For fish farming, this mainly relates to the release of nutrients and chemicals into the water column. In effect, the CAR license provides the operator with a 'licence to pollute' on the basis that it has been considered as unlikely to create a significant impact on the environment. It is common for CAR licences to be issued with conditions which set site specific condition limits for which the operator (or operators) are responsible for maintaining.

In 2019, the framework related to the CAR licensing process underwent a significant overhaul with significant new additions put in place (in response to mounting criticism). These new requirements are considered in more detail below under the CAR licensing process.

Stage 1 - Pre-Application Proposal: the applicant is required to submit a pre-application form to SEPA. This form provides key details including the location of the farm, intended biomass, feeding rates and sea lice treatment plans. SEPA then register this on the 'SEPA Registry', allocate a lead office and launch the following stages.

Stage 2 - Screening Modelling and Risk Assessment: SEPA produce a screening modelling exercise and risk identification reports within six (6) weeks of receipt of the pre-application proposal. This report is provided to the applicant who has twenty-one (21) days to comment. Following this, the report is published on the SEPA website until the point that the application is fully determined. An example of a Screening and Risk Identification Report can be found here[1].

Stage 3 - Engagement Meetings: A period of engagement with SEPA, the applicant and local communities now follows. In practice though this normally occurs at the same time as the engagement which is undertaken for the Planning Permission process set out below. Following this engagement process, any required changes to the Screening and Risk Identification Report are made by SEPA within four (4) weeks.

Stage 4 - Modelling Method Statement: The applicant is now required to propose a modelling method statement which aims to address the risks identified in the above process. SEPA have provided guidance on how best to do this in the following document[2]. SEPA will provide responses to the Method Statement within two (2) weeks of receipt and the aim is to finalise the method statement as soon as practically possible.

Stage 5 - Modelling Data Collection Report: For a period of ninety (90) days the applicant is then required to collect a variety of physical and environmental data from the site (including current and water depths). These are then sent in pre-agreed templates to SEPA who then will confirm if the data collected is acceptable to continue within two (2) weeks.

Stage 6 – New DEPOMOD Modelling Report: The applicant is now required to complete specific base modelling and scenario analysis which will result in the completion of a NewDEPOMOD modelling report (DEPOMOD is a specific modelling program often used in the aquaculture sector).

[1] https://www.sepa.org.uk/media/463071/example-screening-modelling-and-risk-identification-report.pdf

[2] https://www.sepa.org.uk/media/450278/regulatory-modelling-process-and-reporting-guidance-for-the-aquaculture-sector.pdf

Stage 7: Conclusion of Modelling: At this point SEPA brings together all the Modelling data and outputs and creates a Modelling Summary Report. If all is considered in order, then the applicant can move to the Baseline Survey stage.

Stage 8 – Baseline Survey & Planning: So far, the process has been reliant on some relatively limited data collection and modelling to determine key risks. Now a Baseline Survey is required to be completed by the applicant. The first step in this is to determine a survey plan. SEPA will provide advice on what, when and how this will need to be collected[1].

Stage 9 – Baseline Survey Completion & Reporting: The applicant now completes the agreed baseline survey and sends the results in a pre-defined template for review by SEPA. SEPA review the baseline survey and informs the applicant of any amendments or issues.

Stage 10 – Baseline Summary Report: SEPA will produce a Baseline Summary Report and make it publicly available.

Stage 11 – Environmental Monitoring Plan (EMP): The final step in pre-application is for the applicant to devise an EMP setting out how they intend to continue to monitor the site following the introduction of fish and to ensure validation of the modelling outputs.

Stage 12 – Validation of Permit Application: With the pre-application process now complete, the more formal (but shorter) validation process can commence. Here the first step is to submit the full application form to SEPA for approval[2]. As part of this application process, all relevant documents already supplied during the pre-application process must be resubmitted and referenced. A Fish Production Plan (FPP), Medicine Minimisation Plan (MMP) and Seabed and Water Quality Monitoring Plan (SWMP, as agreed in the pre-app) must also be supplied at this stage.

Stage 13 - Consultation on Permit Application: The full application then needs to pass a further period of consultation. This includes placing an advert in the national and local press and contacting relevant statutory authorities. All groups/individuals who were contacted during the pre-application are also recontacted at this point. All stakeholder responses must be provided within twenty-eight (28) days.

Stage 14 - Final Permit Determination: SEPA will then move to determining a final decision on the CAR application. If this is successful then a Draft Permit is created and sent to the applicant, statutory consultees and relevant third parties. The applicant can appeal a decision if it feels the outcome or conditions are unreasonable. Similarly other parties can request that the application be 'called-in' for determination by Scottish Government Ministers.

A CAR Permit is then issued to the applicant. To help standardise this process, SEPA have developed a draft permit template which provides standard conditions of use which are often included for the farm's operation (although others may also be added if required). These standard conditions are set out in the table below with a description of the justification behind each.

[1] https://www.sepa.org.uk/media/433428/baseline-survey-and-monitoring-plan-design.pdf

[2] https://www.sepa.org.uk/media/433430/mpff-app-form.pdf

<u>Fish Species:</u> Only one species may be farmed at the site at one time (with exceptions for cleaner fish) *<u>Justification:</u> Although not common to mix species on site it is commonly a requirement that this is not allowed. The only exception to this is in the use of cleaner fish.*
***<u>Maximum Weight of Fish</u>*: A maximum weight of fish to be held at the site at one time will be set.** *<u>Justification:</u> This is a standard licence requirement for any fish farm pretty much anywhere. A maximum biomass is agreed for the farm based on the outcome of all the other investigative work and as determined as suitable by SEPA. This biomass is the amount that cannot be exceeded on the farm (i.e., a maximum biomass not an average one).*
<u>Fallow Period:</u> A minimum period of 42 consecutive days fallow period must be used between every production cycle during which no fish shall be kept on the site. SEPA must be notified within 14 days of a site being stocked and fallowed. *<u>Justification:</u> The use of a fallow period has become a more and more common regulatory requirement in salmon farming. The aim of it is to break the life cycle of the sea lice and help in reducing infection rates. The 42-day period is considered a minimum time to allow this to happen and is used as a standard fallow period. However, SEPA can increase or decrease this as they see fit.*
<u>Pen Configuration:</u> An agreed configuration of pens is agreed in the licence and specific locational points are stated (National Grid References). A maximum distance is specific from which the pens can deviate from these NGRs (taking account of tide, currents etc…). *<u>Justification:</u> This condition is added to ensure the farmer cannot add or move the cages from the agreed locations. With the NGRs set in the licence it is easy for a SEPA official to check the location using a handheld GPS unit.*
<u>Medicine Minimisation:</u> All reasonable steps must be taken to minimise the discharge of medicine residues *<u>Justification</u>*: This condition helps to ensure the protection of the water environment through sustainable water use.
<u>Medicines & Chemical Use:</u> Only medicines and chemicals specifically authorised in this permit may be discharged into the water environment. *<u>Justification</u>*: This conditions ensures that only permitted and authorised chemicals are allowed to be discharged by the farm (and specifically lists what these are as part of the permit).
<u>PSL and PSWP</u>: All medicines named in the Permitted Substance List (PSL) or Permitted Substance Working Plan (PSWP) must be used in accordance with the limits specified. *<u>Justification:</u> Ensures that farms only administer approves substances at approved levels and using approved techniques.*

<u>Bath Sea lice medicines</u>: Provides detailed requirement on the use of bath sea lice medicines including the quantity and types permitted, number of pens to be treated at once etc.. *<u>Justification:</u> Strict conditions on use of these chemicals is to avoid any impacts on the natural environment to the best extent possible.*
<u>In-feed sea lice medicines</u>: Similar to the above but for in feed treatment. Includes a limit of 50 micrograms per kilogram of treatment per day (or 60mg per kg if approved by a vet). The current EPQ requirements also effectively mean that new farms are only able to treat the fish once every five years. *<u>Justification:</u> Strict conditions on use of these chemicals is to avoid any impacts on the natural environment to the best extent possible.*
<u>Notification of Medicines Use</u>: Requires SEPA to be informed at least two (2) working days prior to a treatment being carried out (for bath medicines) or five (5) working days for in-feed medicines. *<u>Justification:</u> Required to ensure strict environmental levels are not likely to be exceed by the farms use.*
<u>Biological Seabed Standards</u>: Requires the seabed at any point immediately under the outer edge of any pen to contain a minimum of two (2) species of re-worker polychaete worms with a combined abundance of more than 1,000 individuals per square metre. *<u>Justification:</u> Required to ensure strict environmental levels are not likely to be exceed by the farms use.*
<u>Chemical Seabed Standards</u>: Requires Emamectin benzoate concentrations to not exceed 12 ng/kg (dry weight) in the seabed at the boundary of the mixing zone *<u>Justification:</u> Chemical used in in-feed treatments and aims to ensure that excreted quantities do not build up to toxic levels in the seabed around the farm.*
<u>Seabed and Water Monitoring Plan</u>: Monitoring to be carried out against the approved SWMP (submitted at the CAR application stage). Monitoring activities should be notified to SEPA fourteen (14) days in advance *<u>Justification:</u> Ensures that the farm is meeting its SWMP requirements properly.*
<u>Notification of environmental event</u>: SEPA to be informed of any event which could cause an adverse impact to the water environment or human health, or is a breach of the CAR permit within 24 hours of identification. *<u>Justification:</u> Pretty clear justification.*
<u>Management of environmental event</u>: All reasonably practicable measures should be taken to stop an event and to minimise and/or mitigate its effects. *<u>Justification:</u> Clearly important that the farm attempts to deal with an event to the best degree possible.*

<u>Reporting of environmental event</u>: Within fourteen (14) days of any event a report must be submitted to SEPA setting out the reasons for the event, actions taken to minimise its impacts and actions taken to prevent it recurring. *<u>Justification:</u> Important to learn lessons from incidents as and when they occur.*
<u>Data Recording & Reporting:</u> All key records must be maintained for six (6) years and key information (as specified by SEPA) should be submitted every quarter. *<u>Justification:</u> Record keeping is a vital part of monitoring and so it is important that the farm maintains the records and submits important data regularly to the authorities.*

Step 5: Marine Licence Approval

Any process which involves the placing of obstacles or objects into the sea or onto the seabed is required to be issued with a marine licence by Marine Scotland and is governed by the Marine Scotland Act. Clearly salmon farming in cages falls into this category.

A Marine licence application cannot be determined without valid planning permission already being provided[1]. For this reason, it is completed as a separate step after planning.

The Marine Licence is applied through an application form[2] which must be completed and accompanied by clear charts showing the location of all planned structures (including specific lat/long co-ordinates). This must also be accompanied by an application fee which is calculated based on the capital expenditure for the project (ranging from £150 to £10,000). Marine Scotland aim to make all Marine Licence decisions within fourteen (14) weeks from receipt of fee and application form. Once made, an application must also be advertised in a selection of papers or media outlets for a period of forty-two (42) days minimum. Marine Scotland will then also carry out a twenty-eight (28) day consultation with both statutory and non-statutory consultees (SEPA, MCA, RYA for example…). If granted, the licence remains valid for up to six (6) years at which point it must be re-applied for.

In practice, the marine licensing step is somewhat of an unnecessary step in that it repeats many of the other processes already undertaken through the EIA and planning permission process.

[1] *A marine licence can be applied for prior to panning being granted but cannot be awarded.*

[2] *https://www.gov.scot/binaries/content/documents/govscot/publications/advice-and-guidance/2020/02/marine-licensing-applications-and-guidance/documents/applications/finfish-and-shellfish-farm-application-form/finfish-and-shellfish-farm-application-form/govscot%3Adocument/Finfish%2Band%2Bshellfish%2Bfarm%2Bapplication%2Bform.pdf*

Step 6: Aquaculture Production Business (APB) Authorisation

Usually the final step in licensing for a new fish farm in Scotland is the issuance of an Aquaculture Production Business (APB) authorisation. An APB is issued in Scotland by the Marine Scotland Science Fish Health Inspectorate (MSS-MHI). The licence is in relation to animal health requirements only and issued when the operator will not lead to 'an unacceptable risk of spreading disease'.

The requirements which inform this decision-making process are set out in the Aquatic Animal Health Regulations (2009) in Scotland. One of the main requirements under this is for the occurrence of regular fish health inspections of farms by the authorities. During these inspections, areas such as Health Management, Biosecurity and the general health of the fish are checked. The authorities have the regulatory power to suspend farming activities at any time if they feel it is required.

The process commences with the completion of an application[1] and Aquatic Animal Holding Form[2]. The form requires the farm to detail its biosecurity measures and site practices (including fish movement control, mortality recording and disposal etc…). The aim of this assessment is to confirm that the farm is capable of meeting the following key requirements;

a. Recording the movement of animals into or out of the farm
b. Recording of mortalities
c. Recording outcomes from health surveillance assessments
d. Follow good biosecurity practices
e. Comply with surveillance requirements from the Fish Health Inspectorate

The licence application process usually takes around three (3) months to complete but is one of the easier parts of the licensing process. Farms will usually apply for this at the same time as the marine licence (or at least when planning is drawing to an end).

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[1] https://www.gov.scot/binaries/content/documents/govscot/publications/form/2020/02/aquaculture-production-business-apb-forms-and-guidance/documents/apply-to-authorise-apb-and-site/application-for-authorisation-of-an-aquaculture-production-business-apb/application-for-authorisation-of-an-aquaculture-production-business-apb/govscot%3Adocument/Application%2Bfor%2Bauthorisation%2Bof%2Ban%2BAquaculture%2BProduction%2BBusiness%2B%2528APB%2529%2B.pdf

[2] https://www.gov.scot/binaries/content/documents/govscot/publications/form/2020/02/aquaculture-production-business-apb-forms-and-guidance/documents/apply-to-authorise-apb-and-site/guidance-on-completing-aquatic-animal-holding-site-details-form/guidance-on-completing-aquatic-animal-holding-site-details-form/govscot%3Adocument/FHI%2B054G%2BAquatic%2Banimal%2Bsite%2Bdetails%2Bguidance.pdf

5. Case Study 2: Faroe Islands Salmon Farming

Our second case study considers the situation in the small North Atlantic archipelago of the Faroe Islands. Located 200 miles to the Northwest of Scotland and about halfway between Norway and Iceland, the development of a Salmon farming industry is a relatively new thing in the country. Although some salmon farming was reported in the country in the 1970's it was not until the 1990's that production really began to increase significantly. On the face of it, the reasons are clear with the country blessed with clean temperate oceanic waters, strong currents and significant fjord inlets which are ideal for salmon farming operations. In 2020, it was estimated that the Faroe Islands produced 90,000 Tonnes of Atlantic Salmon, not an inconsiderable amount (Scotland produced around 200,000 Tonnes in the same year).

Today, the Faroe Islands is considered by many to represent the 'gold standard' of salmon production and has worked very hard to maintain an image of a high quality, well managed industry. This though was not always the case and between 2004 and 2006 the industry was decimated by Infectious Salmon Anaemia (ISA). Since then, the government has rewritten the legislation and management which supports the industry with the aim to be 'best in class' and this has proven relatively successful to date.

With this in mind and considering the relative similarities between the Faroes Islands and the Falkland Islands (they are both distant archipelagos with small populations and a reliance on the natural environment for much of their income), this is seen as a key case study for consideration.

In the below review, the key salmon farming requirements as set out by the Faroe Islands are presented. It should be noted that the full system for planning is not reviewed here as it is relatively similar to that already set out for Scottish farming above. However, it is some of the specific requirements which are most relevant for this review.

The current key regulation for aquaculture is the Faroese Veterinarian Act which was first created in 2003 and has been amended several times since. The Faroese Ministry of Trade (FMoT) is the government authority responsible for the policy and maintains the legislative framework. It is also responsible for the issuing of farming licences.

The FMoT is supported in this role by the Faroese Environment Agency (FEA) and the Faroese Food and Veterinary Authority (FFVA). The FEA are responsible for the granting of an environmental approval to each farm. This is the equivalent process completed by SEPA in Scotland in the issuing of a CAR.

The issuing of licences to salmon farming operations in the Faroe Islands is strictly controlled and has been developed through the creation of specific Management Zones around the country. In Figure 1 below, these MZs are shown and in most cases these are identical to a single fjord or bay separated by areas with well mixed waters due to strong tidal currents. Within each of these MZs the authorities have set a significant number of rules and requirements which aim to reduce disease risks and mixing.

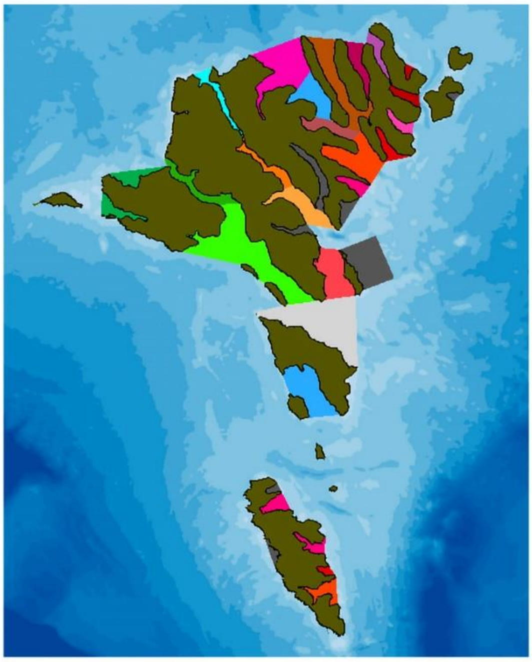

Figure 1: Salmon Management Zones in the Faroe Islands

Rule 1: All in/ all out rule: Each MZ is allowed only a single generation at one time, meaning that all fish are stocked at the same point and also harvested together. This is often referred to as the all in/ all out policy and helps ensure no mixing of generations can occur in the Faroe Islands (the same year class is only ever being produced).

Rule 2: Single company per MZ: To help with this, it is also required for each each MZ to be controlled by a single company as well (this also helps with legislatory control as any breaches in an MZ are the responsibility of only one company (no one else can be blamed!). In Figure 1 above, the blue zones are operated by MOWI, the green zones by Luna and the red/orange/pink by Bakkafrost.

Rule 3: Fallowing: Once the fish have been removed from an MZ, a period of forced fallowing is required (i.e. a period when no fish are added to the MZ). This must be for a minimum period of two (2) months but can be extended if disease was detected by the authorities. During this fallow period, all nets must be removed from the water before being cleaned and disinfected on land (only when the nets are removed does the fallow period commence). Furthermore, the cage structures must also be disinfected at sea with the whole process and chemicals used approved first by the FFVA.

Rule 4: Updated Operational Plan: It is a requirement that a new Operational Plan is submitted for each new restocking activity (following the required period of fallowing) and approved by the authorities before any new fish can be added to the water. Furthermore, the specific requirements of what must be included in these operational plans are dictated by the authorities.

Rule 5: Biomass Approval: No specific rules exist on the total quantity of fish that can be produced in a set MZ, although rules do exist on maximum biomass levels within cages specifically, of between 15kg and 25 per m^3 (rising with the average fish size from 2kg to 3kg or over). Instead though, the authorities operate a more practical approach which considers how past production has gone. Should a previous production have experienced disease or mortality issues, then the authorities will reduce anticipated biomass. However, if performance has been good, biomass can be maintained or even in some cases, increased.

Rule 5: Distance from farms: All farms must be at least 2.5 km apart in the same MZ.

In addition to the above rules which are specific to the MZ operations, the authorities have also introduced other significant legislative requirements on farms in the country. The key ones are set out below.

Health Inspections: A registered veterinarian must be associated with each farm and must complete regular inspections of each site at set intervals. For on-growing farms producing more than 1,000,000 fish, twelve (12) inspections a year are required. This is reduced to six (6) inspections for farms of less than 1,000,000 fish. What is required during each inspection is also specifically set out by the authorities within the legislation and includes requirements for dissection of mortality.

Fish Kill Disposal: Farms are required to have the capacity to dispose of at least 1% of the maximum biomass on a daily basis. This should include the ability to collect, grind, convert to silage, temporarily store and then have collection completed. This requirement can be provided by a sub-contractor agreement, but this must be signed and in place in advance. The aim of these requirements is to avoid dead fish being left for significant periods and creating a disease/health risk to the remaining stock (or other farms).

All the above requirements which have been discussed are set out in the Faroese Veterinarian Act for Aquaculture and more specifically the Executive Order on the establishment of and disease-prevention in aquaculture facilities.

With regards to actual licensing, the Faroe Islands has a similar system although not as detailed, as has been set out in Scotland. However, the country has determined that no additional licences are possible within its MZs and so the opportunity for new players to join simply does exist. This has led though to the industry considering how it could possibly increase production in the country. The main approaches which are now being considered are reducing cage based on-growing time and also the use of deep-sea sites. Both of these are discussed in more detail below.

Reducing Cage Grow Out Time: The Faroe Islands has been somewhat of a pioneer in attempting to reduce cage grow-out periods. It is widely recognised that the longer salmon spend in cages the greater the risks associated with significant sea lice infestations. To counter this, the industry has been working on the use of land-based system which grow ‘smolts’ to much larger sizes than was previously the case. Traditionally, salmon are transferred to cage systems at around 200 grams. However, several companies in the Faroes Islands have increased this to 500g using intensive RAS based land systems. In turn, this can reduce the time required to reach market size from 18 to 12 months. The company, HiddenFjord actually report an even more impressive stocking size of 650 grams currently.

Above this though, the land systems required are seen as prohibitive currently, but this has not deterred HiddenFjord with trialling new systems to reduce this further. This includes the trialling of floating closed containment systems which are designed to hold the fish until the reach 2kg and can then be transferred to traditional open cages for 4-6 months only.

What is clear is that the Faroe Islands is leading the way in maximising land production and so providing the largest smolt sizes possible for stocking to cages. This is seen as sensible all round as it reduces the risks considerably. In response, the authorities have also ensured that the legislation is in place to deal with these land-based facilities effectively. Currently, no specific legislatory requirement on smolt stocking sizes is in place in the Faroes Islands but this may well form a consideration in the future.

Deep Sea Production: In recent years, the Faroe Islands legislation was updated to allow sites outside of the MZs (and in deeper more exposed locations) to be licensed for production in the future. This is certainly not a new situation with many countries and producers considering the possibility of deep-sea aquaculture for salmon.

The use of such sites has clear advantages and disadvantages. On the plus side, the water depths and currents make disease and sea lice infestations much less likely. Also, the effects on benthic habitats and nutrient loading in the water column are greatly reduced. However, the systems used are under significant stress from increased wave action and are more likely to break in significant storms (essentially an engineering problem). Indeed, storms have already caused fish losses to occur in the Faroe Islands in recent years for traditional inland sites[1] and so the risks of using these more exposed sites are clear to see. Still though, this is tactic that the company Bakkafrost clearly sees as the future for expansion in the Faroe Islands[2].

[1] https://www.fishfarmingexpert.com/article/bakkafrost-fish-may-have-escaped-in-storm/

[2] https://www.fishfarmermagazine.com/news/bakkafrost-plans-move-to-offshore-farming/

6. Specific Considerations

6.1 Use of Triploids

One of the key areas of concern for the introduction of salmon farming in the Falklands will be the fact that Atlantic Salmon *(Salmo salar)* is not a native species. As was set out in our earlier report (Best Practice Recommendations), this represents some potential risks for native species and ecosystems should escapees begin to breed or compete in the waters surrounding the islands.

Two potential mitigation systems exist on this basis, namely the use of closed containment systems (land-based facilities) or the use of triploidy fish.

The use of land-based facilities presents a clear mitigation by avoiding the fish mixing with the environment in the first place. However, the potential for land-based farming of Atlantic salmon in the Falklands seems counter intuitive (one of the advantages of land-based farming is that it can be located near to major markets to reduce transport costs, and this is clearly not the case in the Falklands). It is the ideal environment for cage farming which would make the waters around the Falklands attractive to the prospect of cage farming specifically. For this reason, we do not see the potential for developing on-grown land-based salmon farming in the Falklands as worthwhile for significant consideration (although smolt production on land should definitely be encouraged).

The second approach is the use of so-called 'sterile fish' which are unable to breed in the wild and so naturally mitigate the risks of interaction with native species and ecosystems. In salmon the most common and accepted method of achieving sterile fish is through the process called 'triploidy'. Triploid fish are those which have three sets of chromosomes (two from the female and one from the male) and so rendering the salmon sterile. To achieve this process of triploidisation it is common to expose newly fertilised eggs to hydrostatic pressure (Benfey and Sutterlin, 1984). This process has been relatively well developed over the last few decades and has even become a requirement in certain juristictions (Tasmania, parts of Norway etc…).

Triploidy though is not without its issues and is still undergoing research and development. The key issues presented by the process are as follows;

Success Rate: The process of creating triploid eggs is around 99.5% effective when performed correctly. However, it is not necessarily 100% effective and so it is still possible for diploid salmon to exist within triploid batches, which if they escape, present the same risks for standard farming. Clearly though the risks are much reduced within triploid production[1].

Skeletal Issues: Evidence does exist that triploid salmon are more prone to skeletal deformities than standard diploid ones (Amoroso et al. 2016; Benfey 2001; Sadler, Pankhurst, and King 2001; Sutterlin, Holder, and Benfey 1987). The reasons for this have been researched quite extensively and appear to be linked to different nutritional requirements, particularly phosphorous (Fjelldal et al. 2016; Sambraus et al. 2020; Smedley et al. 2016, 2018). This has led to feed producers actually creating specific feeds for triploid fish (https://www.biomar.com/en/uk/products--species/salmon/triploider/).

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[1] *It should also be pointed out that the evidence for mixing of wild and farmed salmon population is relatively weak. Some evidence does exist but this is limited.*

Mortality Rates: Evidence exists that mortality rates in triploid fish are higher than those experienced in standard production systems. Madaro, A *et al.* (2021) found increased mortality in triploid production when compared to that of diploidy on the same farms with most interestingly linked to periods around delousing (indicator that the fish may be less able to withstand stress). In total this research showed an increase in mortality of triploid over diploid production of 4% which could be quite significant in a commercial setting.

Emaciation and Meat Quality: The incidence of emaciation has been seen to be a more common occurrence in triploid production than diploid. Again this is also linked to a lower meat quality performance with experiments showing a lower prevalence of 'superior' meat quality in triploid production over that of diploid (Madaro, A *et al.* (2021)) of 5%.

'Genetic Enhancement': Triploid production is not a form of genetic modification but often the public fail to make this distinction and can become concerned about the process of 'triploid production'. Few people are aware of its common use in agriculture already (bananas are virtually all produced through triploid use) and so a program of education is often required for the public. This is likely to be a potential area of concern in the Falklands (as is the effects of escapes of a non-indigenous species).

A combination of the above issues has seen the use of some triploid farming being phased out in Norway recently while a better understanding of the welfare issues is determined. However, currently it really remains the only commercial method for creating sterile species and so research is likely to continue to improve these welfare concerns over time. We believe that the benefits of triploid product would outweigh the potential impacts of escapes in the Falklands[1].

[1] *Interestingly, it is noted that the proposal for farming put forward by Unity Marine stated a plan to use 'sterile fish' in the Falklands (although little detail was provided).*

6.2 Product Certification

The use of third-party standards to certify the best practices of salmon farms has been discussed at some length in the previous report prepared by MEP (Best Practice Recommendations).

The idea of requiring all farms to produce certified salmon if farming in the Falklands is clearly an attractive idea and would help to guarantee that best standards are being met. However, two significant concerns were raised in the previous report relating to non-indigenous species and sterile fish use and how these may affect the ability of certification being achieved. MEP has sought some clarifications on these issues and presents the key findings below for the two main options considered, Aquaculture Stewardship Council (ASC) and Organic Certification.

Aquaculture Stewardship Council (ASC): The use of non-native species is not allowed under the ASC standard accept with certain exceptions:

1. *The species has a history or production in the area*: This is not the case in the Falklands for Atlantic salmon.
2. *The species is being produced in closed containment systems:* Already discussed and not likely to be the case in the Falklands for Atlantic salmon.
3. *100% Sterile salmon are being used:* This follows on from the discussion above around triploid use. The ASC do not define which methods are classed as producing '100% sterile salmon'. Following clarifications with the ASC, they state that the onous is on the producers to show they 100% sterile to the certification body at the time of assessment. However, they also noted during discussions that the ASC Salmon Steering Group were currently uncertain if any technology was capable of producing 100% sterile salmon. Unfortunately, this is a rather typically unhelpful position for the ASC to adopt in that they seem to suggest that it is not possible but that the final decision is based on the assessment body reviewing the evidence provided. MEP is currently reaching out to the ASC to determine if any farms are currently operating using sterile fish under the program[1].

Organic Certification: Two issues exist for the production of organic certified fish in the Falklands;

1. *Non-Indigenous Species:* The EU Organic standard states that 'locally grown species shall be used'. 'Locally grown' are then defined as species which are neither alien nor locally absent. Rather confusingly though, certain species that are non-indigenous are allowed to be certified, such as pacific oysters in Europe (as an example). Following clarification, it appears that the EU have accepted species which have been present or produced for a significant period of time in the local environment (although they don't specify what they see as 'significant'). The current interpretation currently used is that the species needs to of been produced for at least 10 years in the country with no significant issues. Since no salmon is currently produced in the Falklands it is not considered possible that it could be certified as Organic in the next ten (10) years at least.

[1] *At the time of completing the report, the ASC were still not sure if any farms using sterile fish were certified under the Salmon Standard.*

2. *Triploidy Use:* The use of sterile fish has been recommended as a licence requirement elsewhere in this report as a way of mitigating escapes from a non-indigenous species. However, this is specifically not allowed under the EU Organic standard.

Based on the above, it is not considered possible for EU organic certification to be obtained for salmon produced in the Falklands.

Following the outcomes above, it is our recommendation that any future production is required to become ASC certified as part of its licensing agreement in the Falkland Islands. This would help maintain the highest production standards and provide confidence that any company is operating to the highest standards possible. This though comes with the uncertainty over whether an ASC farming system can be certified with triploidy use. In our opinion, if this is not deemed possible then the use of triploidy should take precedence over the ASC certification process. To counter this possibility, we would suggest that the regulatory wording is made to state that the farm meets all the requirements of the ASC standard which are possible under Falklands legislation. This means that a farm would not need to be necessarily certified against the ASC standard but would need to show (probably through a third-party audit) that it does meet all the requirements of the standard other than those which do not allow it under Falklands legislation.

7. Suggested Reforms to Legislative System

In this report, we have set out the current legislation for fish farming in the Falklands and then provided example case studies from Scotland and the Faroes Islands for comparisons. We have also raised some specific issues or areas which we see as specifically important to salmon production in the Falkland's (Sterile fish and product certification). In this Section, we now attempt to pull all of this together to make recommendations on how to reform the Falkland's legislation, so it is line with the best practices possible. Most of this review is based on the Fish Farming Ordinance since this forms the basis for legislation in the Falkland's. While we have not specifically rewritten this, we have clearly set out areas for inclusion in the ordinance below. When legislatory requirements outside of the ordinance are required, these are specifically discussed below.

7.1 Step 1: Seabed Ownership and Leasing Process

The current situation around seabed ownership and required leasing is not fully understood in the Falklands and will need to be clarified. If it is determined that the seabed is owned by the Crown Estate then a similar system to that set out in the discussion for Scotland above.

If the seabed does not have jurisdiction under the Crown Estate then the exact situation needs to be clarified.

It is though important to note that the leasing of the seabed is not a valued licensing process but merely an administration and revenue generated mechanism (i.e. it is not the leasing process that should determine whether a licence should be granted. Instead, it should rely on the main licencing system to make this determination and support the decision which is reached).

7.2 Step 2: Developing the Current Planning Systems

The current planning system in the Falklands is relatively simple but offers a good base from which fish farming planning can be considered. Some significant changes should though be made to help better inform the decision-making process for fish farming applications specifically

1. *Application Form:* All planning applications in the Falklands use a single application form which is clearly not suitable for the consideration of a major fish farming operation. We would recommend that a specific form is created for fish farming applications. This could be based on ones currently developed by the different councils of Scotland (for example, Argyll and Bute) and would ensure better initial information is collected at the commencement of the process.
2. *Planning Policy Development:* Currently, the Falklands has not specific planning policy development which can be used to support the process of approving/ rejecting the planning applications which may be made for fish farming. While a lot of the discussion and recommendations in this report detail the processes which we believe should be included to ensure that best practice is undertaken, it does not deal with what level or locations of farming is right for the Falklands. This is not necessarily a scientific discussion point but often more of a social one[1]. Defining this through a set of planning policies is going to be crucial (including the potential use of spatial planning). Some suggestions around this are as follows;
    a. *Designated Aquaculture Areas:* One system is to define species areas which are 'approved' for fish farming activities. This could be based on the assessment of the areas and a decision that they represent the best locations for both environmental and social reasons (i.e. they are not sensitive habitats, are not areas of outstanding beauty etc.…). The advantage here is that the areas are pre-determined and so the planning process is more about determining if the development is of a scale and quality to be suitable for approval.
    b. *Case by case approach:* Here applications are determined on a case-by-case basis with no pre-determined locations either approved or rejected in planning policy. In locations with few applications (such as is likely in the Falklands) this can be a workable approach. However, if multiple applications are being received it can soon become unworkable.
    c. *Combined Approach:* One option is to have a case-by-case approach which is combined with other 'general limitations'. Most commonly, these limitations will be spatial (i.e. areas which are considered unsuitable for aquaculture development for a variety of reasons) and quantitative (a limit on biomass either within areas or on a wider scale are set).

    The approach, which is to be taken in the Falkland Islands, should it be agreed to permit some fish farming, clearly needs further discussion. To commence this process, we have made an initial recommendation on what we think would constitute a suitable planning policy for fish farming development in the Islands as follows.

[1] *The point being raised here is that a system can be implemented which reduces the environmental impacts to as low as possible but that does not make the graining of fish farming planning applications socially acceptable to the community at large. The planning framework policy needs to attempt to achieve this by setting out clear rules on what and what is allowed.*

1. Fish farming planning applications shall be considered on a case by case process through the planning process and Fish Farming Ordinance requirements.
2. Areas of designated protective status (as identified through a geo-spatial survey) will not be permitted to allow fish farming development under any circumstances[1].
3. Within the Falkland Islands, no more than 40,000 Tonnes[2] of harvestable biomass may be produced on a yearly basis in cage farming operations. No additional licensing applications will be considered beyond this yearly harvestable biomass.

In summary, we are recommending a planning policy which considers new application on a case-by-case basis but with development in certain areas prohibited and a cap on the total biomass allowed for cage farming in the islands determined in advance. Once agreed, it will be important for this to be included in the Falkands Development Plan (or within a separate development plan for aquaculture).

Environmental Social Impact Assessment (ESIA) Requirements

The current Falklands legislation does specify that an ESIA is required for certain projects. Although it is not specifically stated that this is a requirement for fish farming activities it does seem that this is likely to be the case. We would recommend though that specific legislation is added requiring any application for a fish farm which will produce more than 5 Tonnes of dead fish weight per year to avoid confusion.

The Falklands legislation does not seem to currently provide specific requirements on what is needed to be completed in the ESIA. To avoid doubt or confusion, we believe that some specific requirements for an ESIA should be included in the legislatory system (either through separate legislation or through inclusion in current Ordinance). In Annex 1, we have provided a recommended minimum contents requirement for an ESIA being submitted on behalf of a fish farming application. In reality, the completion of ESIAs will often follow a set process and so none of the requirements are likely to be controversial. However, we do recommend that the modelling of pollutant dispersal from the farming operation is undertaken using suitable software (for example, DEPOMOD). Within the Scottish regulation, this is a requirement of the CAR licensing system, however we do not think an additional process should be added here as it will overcomplicate the system in the Falklands (see the discussion below under Step 3).

The process for completing, submitting and approving the ESIA is also not defined but clearly needs to include a period of stakeholder comment and discussion before a final approval is made. This can be included in the planning process to avoid the need for separate and duplicating processes to be ongoing at the same time.

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[1] What constitutes an area not permitted for development of fish farming clearly needs further debate and agreement. However, we believe that it would be sensible for certain areas of the Falkland Islands to be designated as not suitable for development.

[2] This figure is an initial suggestion and needs further discussion. It should be significantly low enough to avoid the reaching of any carrying capacity issues in specific water bodies (otherwise a full carrying capacity assessment would need to be completed).

7.3 Step 3: Developing a CAR licensing system?

The CAR system which has been outlined for the Scottish regulations is the process by which a farm is given permission to discharge into the environment. To determine this, the farm is required to model its discharges, and these are determined against the baseline to determine the risk and to set maximum limits of discharge which may be considered acceptable within a licence (or may not as the case may be).

This process should form part of the ESIA and has become very complicated and burdensome in the Scottish system with multiple periods of stakeholder feedback, analysis and reporting.

For the Falklands, considering the simplicity of the regulatory system is likely to be an advantage (noting the current review in Scotland to reduce the regulatory authorities involved) we would not recommend the creation of a new and separate CAR licensing system. Instead, we would suggest that the process requires the inclusion of relevant information relating to modelling within the ESIA process and this is considered at this stage. The licensing for the facility is therefore still achieved through the obtaining of a fish farming licence through the Fish farming ordinance bill and a separate CAR licence is not therefore required (See Section 7.4 for an overview of how this system is seen as working in the Falklands).

7.4 Step 4: Amending & Developing the Fish Farming Ordinance

The current Fish Farming Ordinance provides a good basis on which to develop the aquaculture legislation which we believe is necessary to ensure Best Practices for the industry.

During this review we have taken some of the best practices which are currently occurring globally (with particular emphasis on the Faroe Islands) and which we think would benefit from inclusion in the Fish Farming Ordinance requirements. Below we set out the significant additions which we would recommend adding into the ordinance

Marine Zones: We are suggesting that the FIG implements a system of Marine Zones around the Falklands which are based on areas of mixing water bodies, similar to that employed in the Faroe Islands. These MZs will then allow for the control of single fish classes within them.

Suggested Ordinance Text:

Requirements 1: Marine Zones shall be determined by the FIG for all waters around the Falkland Islands

Requirement 2: The licensing of fin fish aquaculture shall only be allowed within the approved Marine Zones

§§§§

Protected Status Zones: It is recommended that the FIG decides on areas around its coast which should not be allowed for aquaculture development (specifically fin fish aquaculture). These areas should be ones considered of scientific or social importance. We believe that some mapping work has already been completed in this context and could be used to guide these decisions.

Suggested Ordinance Text:

Requirement 1: The licensing of fin fish aquaculture shall be prohibited in 'protected status zones'

§§§§

Biomass Limitations: MEP is recommending that a maximum yearly harvestable limit of cage-based fin fish is set in regulation. This level is not set based on carrying capacity estimations and so needs to be precautionary and designed to provide residence with the reassurance of an upper limit. The exact amount is clearly open to further discussion but has initially been set at 40,000 Tonnes per annum

Suggested Ordinance Text:

Requirement 1: Only 40,000 Tonnes of cage based harvestable fin fish biomass shall be permissible in Falklands Waters annually

§§§§

Licensing Process: As a general comment, the current Fish Farming Ordinance is not particularly clear on how it fits within the general application process for fish farming. It does mention the requirement for planning permission to be determined but this is not specifically clear.

Our recommendation is that a potential farmer should be required to apply for a 'Fish Farming Licence' at the same time as planning permission is commenced. This process should involve the completion of an application (including all areas covered in section 4 (and as specified below). The licence though cannot be granted until the planning permission has been granted for the facility[1].

Suggested Ordinance Text:

No specific text is specified here but the ordinance needs to be made clearer on how it fits into the overall process. This could be aided by a separate flow diagram for the whole approval process (once developed) in the Falkland Islands.

§§§§

Application Requirements: The current Fish Farming Ordinance includes requirements for what needs to be provided as part of the licence application process (Section 4). We would recommend the inclusion of the following additional requirements.

Suggested Ordinance Text:

Requirement 1: An initial Emergency Response Plan (including a biosecurity plan)

Requirement 2: Evidence of the proposed Internal Control System for the facility, including, but not limited to, health inspection processes, water quality monitoring and operational planning systems.

Requirement 3: An initial Operational Plan for the facility.

§§§§

Operational Plan & Logbook: It is standard practice for a farm to be required to maintain and operational plan for its stocking operations. We are recommending that this forms part of the approval process following every fallowing period (i.e. a new operational plan is submitted each time). The requirements of what should be included in an operational plan are also specified here in Annex 2 of this document.

On top of an operational plan, the farm should also maintain a day-to-day operational logbook. This is a record of all the daily activities which are being completed on the farm and should be

[1] *This appears to be the case under the current ordinance but the process is not specifically made clear.*

available (completed) to review by the authorities at any time. Again, the suggested requirements of the Operational Logbook are provided in Annex 3.

Suggested Ordinance Text:

Requirement 1: The licence holder must maintain a continuous operation plan for its aquaculture facility.

Requirement 2: For operations requiring periods of fallowing (cage-farming operations), an updated operational plan must be submitted to the authorities a minimum of six (6) months prior to any new proposed stocking activity for prior approval.

Requirement 3: For operations with continuous production during the year, an operational plan should be submitted by the end of January each year to the authorities.

Requirement 4: The licence holder shall also maintain an operational logbook with, as a minimum, the information maintained in Annex 3. The logbook must be always maintained up to date.

§§§§

Hatchery Supply: The production of smolt should be completed in land-based facilities in the Falklands to allow for vertical control of the process. All should be approved by the FIG for supply. The one exception to this will need to be the import of eggs (at least in the short term) since none currently exist in the Falklands.

Suggested Ordinance Text:

Requirement 1: On-growing farms may only be supplied smolt from hatcheries operating in the Falklands and approved for such operations by the FIG.

Requirement 2: Eggs may be imported from external suppliers but must be approved in advance by the FIG and inspected and quarantined on arrival.

Requirement 3: All hatcheries operating in the Falklands must use modern Recirculating Technology (RAS).

§§§§

Smolt transfer size limit: One of the most significant areas of change which is currently occurring in the salmon industry is the extending of land based growing periods for salmon. The reasons for this are discussed in the report but focus on reducing the time required in the cage system. In the Faroe Islands, this practice has been particularly well developed with some companies now growing fish to 500g on land prior to stocking on sea.

We recommend that an aggressive target is set here to encourage as much land-based production as possible and to limit the cage time to a minimum, hence an average target weight of 500g for cage stocking is provided.

Suggested Ordinance Text:

Requirement 1:Fish (except for broodstock and/or cleaner fish) may only be transferred to a cage farm at an average size of 500g and no smaller.

Requirement 2: The authorities may reduce the size requirement in Requirement 1 at there discretion.

§§§§

Emergency Response Plan (ERP): All farms should operate an ERP which sets out the processes that should occur in certain emergencies, specifically fish escapes, mortality events, disease outbreaks etc...

Suggested Ordinance Text:

*Requirement 1:*All licence holders must maintain an Emergency Response Plan (ERP) which identifies all key hazards and the measures to be taken in the event of accidents or specific events.

Requirement 2: The ERP should be approved in advance by the authorities (prior to the granting of a licence).

Requirement 3: If the ERP is to be changed, it should be re-submitted to the authorities for prior approval.

§§§§

Single Year Class in MZs: This rule has been developed in the Faroes and has been well received and shown to be effective for reducing sea lice transmission. We would recommend its inclusion in the Fish Farming Ordinance to ensure that only fish from the same year class came be produced in a single Marine Zone at any one time***.***

Suggested Ordinance Text:

Requirement 1: All farms operating cage-based operations within the same Marine Zones may only farm fish of the same year class at the same time.

Requirement 2: No new year class may be stocked into a farm in the same Marine Zone until all the farms have been emptied of existing fish (and any required fallow period completed).

Requirement 3: Different year classes may be allowed at land-based facilities provided it is split into different production units for this purpose. This must receive the approval of the authorities in advance of operation.

Requirement 4: Cleaner fish are exempt from the requirements in Requirement 1 meaning that different year classes of these fish may be stocked in one production cycle.

§§§§

Use of sterile fish: It is our recommendation that only sterile fish can be farmed in the Falkland Islands due to the risk of introducing non-indigenous species. For this process, we anticipate that the use of triploid fish will be the standard approach employed and although these do come with some welfare concerns, we feel the positives of using sterile fish outweigh this. However, other methods of producing sterile fish may become available and so the wording is left to allow these to be considered on a case-by-case basis.

For all farms producing non-native species, a requirement to monitor the potential impacts of the species is included.

Suggested Ordinance Text:

Requirement 1: Only fish approved as sterile by the authorities may be used for cage based on-growing operations in the Falkland's.

Requirement 2: The use of triploidy is encouraged for developing sterile fingerlings. However, other methods may be considered by the authorities on a case-by-case basis.

Requirement 3: All farms producing non-native species in the Falklands must implement and maintain an approved monitoring plan to determine any potential interaction effects of the species with native species and the ecosystem at large.

Requirement 4: For cleaner fish, only native indigenous species may be used in fish farming operations.

§§§§

Certification Requirement: To ensure the highest possible standards are maintained at any farming facility in the Falklands, we are recommending that it is a requirement of any licence holder to becomes certified against the Aquaculture Stewardship Council (ASC) requirements. It is considered that a time period will need to be provided from the commencement of activities and have suggested that this is set at three (3) years from the first stocking of fish into cages.

In recognition that it is currently unclear whether the use of sterile (triploidy) fish is possible under the ASC standard currently, the wording has been left to allow a farm to show it is in line with the requirements (but not necessarily certified).

Suggested Ordinance Text:

Requirement 1: All cage-based farming operations are required to receive and maintain ASC certification for their operations within three (3) years of the first stocking of fish into the cage systems.

Requirement 2: In the case that ASC requirements do not correspond fully to the FIG licensing requirements, a farm may be able to demonstrate that it meets all applicable ASC requirements through the completion of a third-party audit and review on a yearly basis.

Requirement 3: The suspension or termination of a farms ASC certification (or evidence that it meets all applicable ASC requirements) may result in the suspension of the company's fish farming licence. The final decision shall be at the discretion of the authorities and will be considered on a case-by-case basis.

§§§§

Updated Operational Plan: It is recommended that a new Operational Plan is submitted for each new restocking activity (following the required period of fallowing) and approved by the authorities before any new fish can be added to the water.

Furthermore, the authorities should be provided with the opportunity to require a reduction in biomass if previous production runs have encountered issues.

Suggested Ordinance Text:

Requirement 1: Prior to any restocking of fish into a cage farm system (following a period of fallowing), a new Operational Plan must be submitted to the authorities and approval received for each activity.

Requirement 2: The authorities reserve the right to request a reduction in biomass for a new stocking activity into cages based on previous negative performance (for example, disease issues, regulatory breaches etc..).

§§§§

Distances between farms: It is good practice to maintain a minimum distance between farms All farms must be at least 2.5 km apart in the same MZ.

Suggested Ordinance Text:

Requirement 1: All farms must be at least 2.5 km apart in the same MZ

Requirement 2: The measurement shall be taken from the closest surface-based structure of the two farms in question.

§§§§

Maximum Biomass: A maximum biomass should be maintained on the farm (kg/m3) to help reduce disease incidents. It should be noted that this is the maximum permissible level and not the average (i.e., it should never go higher than this).

Suggested Ordinance Text:

Requirement 1: All cage-based farms shall always maintain a maximum fish biomass of no more than 25kg per m3.

§§§§

Requirement for Fallowing: We are recommending an enforced period of fallowing be introduced for any future cage operations in the Falklands. We are setting this at two (2) months but with a notice that this can be extended by the authorities (as required).

Suggested Ordinance Text:

Requirement 1: All cage-based farming activities must observe a two (2) month fallowing period in between production cycles. This period will commence from the day the nets are removed from the water.

Requirement 2: The Authorities reserve the right to extend this fallowing period should it be deemed necessary and on presentation of the reasoning to the licensee.

§§§§

Equipment Disinfection During Fallowing Period: As is practiced in the Faroe Islands, we believe an enforced period of equipment disinfection should be stipulated in the legislation as part of the fallowing period. This should include the removal of all nets on to land and the cleaning of all equipment in the sea as required. The plan for this should be approved in advance and should follow specific requirements on chemical use and wastewater treatment (which are dealt with further down in these recommendations.

Suggested Ordinance Text:

Requirement 1: All cage nets must be removed during a period of fallowing and disinfected on land.

Requirement 2: Any floating equipment which cannot be removed from the sea during a period of fallowing must be washed and disinfected at sea.

Requirement 1: Prior to a fallowing period commencing, a plan for the cleaning and disinfection of the equipment (as specified above) must be presented and approved by the authorities.

§§§§

Fish Lice Inspections & Treatment: Fish lice represents one of the biggest issues in salmon farming and so strict controls are necessary to identify infections quickly and treat them in an effective but environmentally sensitive manner. To aide the FIG in monitoring sea lice infestations it is suggested that a requirement to report infestation numbers at regular intervals is made a condition of licensing for cage operations.

Suggested Ordinance Text:

Requirement 1: Sea lice numbers are to be counted and reported to the FIG for all cage farming activities. This shall be completed once every two weeks in the summer months and once every month during the Winter months.

§§§§

Health Inspections: Health inspections are a vital part of maintaining vigilance against disease and ensuring early detection. They should be completed by a qualified veterinarian and we suggest presenting prescribed levels as set out below.

Suggested Ordinance Text:

Requirement 1: All aquaculture facilities incorporating fish must have an approved veterinarian who is responsible for the completion of animal health inspections

Requirement 2: This veterinarian must be registered with the authorities and any changes notified in advance

Requirement 3: Health inspections must be completed at the facility (nursery, broodstock or on-growing facility) once every month as a minimum.

Requirement 4: A facility may request a reduction in these inspections to six (6) per year following the first year of operation and based on the farms risk assessment and previous performance. Granting of this reduction will be at the discretion of the authorities.

Requirement 5: Fish health inspections should include, but not be limited to;

a. The dissection of a sample of slaughtered fish
b. The dissection of a sample of any fish which have died from unknown causes
c. A visual inspection of the operational units
d. A review of the operational logbook

Requirement 6: After every fish health inspection, an inspection report should be produced and maintained by the licence-holder.

§§§§

Fish Mortality Disposal: It is important that a farm is capable of dealing with fish mortality in an efficient and effective manner. This helps avoid potential disease issues and helps increase biosecurity. As such, we recommend the setting of specific capacity requirements around this.

Suggested Ordinance Text:

Requirement 1: All farms must have the capacity (either directly or through a sub-contractor agreement) to dispose of at least 1% of the maximum farm biomass on a daily basis.

Requirement 2: This capacity should include the ability to collect, grind, convert to silage, temporarily store the fish and to finally dispose of it.

§§§§

Chemical and Medical Use: These requirements are simply added to ensure farms are not using chemicals or medicines which are not approved.

Requirement 1: Any chemicals to be used at aquaculture facilities must be approved by the authorities

Requirement 2: Any medicines to be used at aquaculture facilities must be approved in advance by the authorities.

§§§§

Humane Slaughter: The use of humane slaughter techniques is growing in popularity around the world and in our opinion should be included as a legislative requirement for farms operating in the Falklands.

This can either require the use of instant slaughter methods or the use of sedation first in other cases.

Suggested Ordinance Text:

Requirement 1: All fish must be sedated prior to slaughter or disposal, so that the fish lose consciousness before they are killed.

Requirement 2: The requirement for sedation shall not apply if fish are slaughtered using a method that ensures the fish die instantly on commencement of the process.

7.5 Step 5: Provision of a Fishery Products Licence

Having reviewed the Fisheries Product Ordinance, we are unclear if a system for licensing and aquaculture facility exists under its requirements.

In most countries, an aquaculture company will need a secondary licence which is issued by the Fish health inspectorate. This licence is specifically related to the health of the fish and ensuring veterinary practices are being followed. This often extends to ensuring that the final product meets consumer regulations once entering the market (for example its free of antibiotic residue etc…).

It appears that the majority of this is covered by the Fisheries Product Ordinance but some of the requirements have been included in Section 7.4 above under changes to the Fish Farming Ordinance.

Two options now exist for the Falklands. Firstly, these requirements could instead be included in the Fishery Products Ordinance and a second separate licence provided under this. The advantage here is that the authorities would have the ability to stop a farm from selling/ moving its products by suspending this licence specifically (but without effecting its general aquaculture licence).

Alternatively, all fish health requirements could be included under the Fish Farming Ordinance and only a single licence provided. This maintains a relatively simple system which can also be advantageous.

For the benefit of our recommended regulatory system , as summarised in Section 7.6 below, we have presumed that these will correspond to two separate licences (a fish farming licence and a fisheries product licence).

7.6 A brief overview of the proposed approval system

In Annex 3 of this report, we have provided a visual representation of the licensing system and how we see it working within the Falklands. Below we summarise this process and highlight the documents/requirements that will be needed for the process to move forward at each stage.

1. Firstly, an applicant must apply for a Lease Option Agreement (LOA) from the Crown Estate. This process provides the applicant with the basis to move forward with the consenting process[1].
2. Once an LOA is in place, the applicant may commence the collection of baseline data from the site which will be used to inform the ESIA. The ESIA can now be prepared in line with the requirements set out in Annex 1.
3. Once the ESIA is completed, the applicant should now apply for planning permission. This process requires the completion of a specific Fish Farming Application Form (to be developed) and should be accompanied by the completed ESIA.
4. Upon receipt of notification of the planning application, the applicant can now apply for a fish farm licence (under the Fish Farming Ordinance). To do this, the applicant must again submit a Fish Farming Licence Application Form (to be developed) and provide a host of relevant information including the ESIA, a Business Plan, an Operational Plan (OP) and an Emergency Response Plan (ERP). The information provided must show that the applicant will be operating in-line with the requirements specified in the Fish Farming Ordinance (to be updated).
5. At the same time, the applicant may also apply for a fishery products licence (under the fishery products ordinance) which will provide the farm with permission to sell its product on the market.
6. The Planning Application will now proceed through the set process with a period of stakeholder comment and discussion included. During this, in person meetings will be assembled to allow any stakeholder the chance to present questions to the applicant. The FIG will then collate all questions and responses from the applicant before raising any specific comments they have on the planning application.
7. Following all comments and feedback to the applicant, they will be requested to update all documentation (as required) and re-submit for final approval (or rejection).
8. The FIG will then make a final planning decision with the application either rejected or approved.
9. Upon Planning approval, the FIG will also provide a Fish Farm Licence which shall include all licence conditions that will need to be met by the farming operation.
10. At the same time the FIG will provide the Fishery Product Licence which will give the farmer permission to commence selling their products on the market.
11. Upon receipt of the Fish Farm Licence and Fishery Product Licence the applicant may then request the receipt of a full lease agreement from the Crown Estate. This marks the last step in the consent process.
12. Once a Lease Agreement is received, farming operations may commence and will be subject to all conditions and regular inspections from the authorities.

[1] It is not completely clear if the Crown Estate has jurisdiction on the seabed in the Falklands. Here we have presumed that it does but should it be found that a different system exists then this will need to be further updated.

7.6 Capacity Requirements within the FIG

The commencement of a commercial salmon farming sector would represent a significant new industry in the Falklands. Furthermore, our recommendations in this report suggest it is done with the highest environmental sustainability standards possible.

The licensing of such operations is clearly going to require a level of expertise within the FIG which does not currently exist. Should it be decided that commercial salmon farming should be undertaken in the Falklands then it will be imperative that the FIG recruits a new individual (or possibly individuals) with a strong background and previous experience in Salmon farming (and ideally within the regulation of salmon farming).

Furthermore, the commencement of a new industry is likely to require additional capacity in several additional areas including the fisheries health department. It will be necessary for any new farms to be regularly inspected by the authorities and this will need qualified and trained individuals located in the Falklands.

For some of these tasks it is likely to be possible to sub-contract some of operations required but this will not be possible for all. The FIG will need to be prepared to recruit new staff to handle the application, processing and monitoring of any new salmon farming licences.

7.7 Revenue Generation Considerations

Although not a key consideration for this project, it is worth briefly considering the revenue generation methods that exist within the legislation and could be employed in the Falklands. This is an important consideration since clearly, the production of additional GDP is a key positive for the development of salmon farming in the environment.

Globally, revenue is generated through salmon farming through several mechanisms. The most common significant revenue generator for Governments is through the standard tax system. This can vary greatly from country to country but essentially, the collection of tax through sales (VAT or Royalties) or profits (Corporation Tax) are used. The Fish Farming Ordinance does hint at the use of royalties but no further details are provided. In most cases this is the most effective and efficient method of ensuring that revenue is collected.

However, it is also common for cost recovery to occur throughout the licensing process (the process can be expensive to run for any Government). Key places were this is completed area as follows;

Seabed Lease: The Crown Estate will lease the seabed to the farmer. Generally, the process of obtaining an LoA is free of charge but one a lease is agreed it is charged. In the UK this is done at a rate of £27.50 per tonne of harvested fish (net gutted weight). This is not only a cost recovery method though but also generates direct revenue for the government. Should the Falklands reach 40,000 Tonnes of Salmon per year, this would represent a not inconsiderable yearly revenue of £1.1 Million (although who benefits from this would need to be confirmed!).

Planning Process: Commonly, a fee is charged for submitting a planning application. In the UK a salmon planning application is charged at a higher fee than a standard housing application due to the additional complexity. Currently the charge is set at £183 per 0.1 Hectare of seabed surface area and £63 per 0.1 Hectare of seabed. This is capped at a maximum cost of £18,270.

On average, most salmon farms in Scotland will pay around £10,000 for a planning application process to the council. In the Falklands, a standard charge of £103 is levied for all planning applications. Clearly this will need to be increased for salmon farming applications in the Falklands.

CAR Process: The CAR process in Scotland is charged through set scheme fees which are dependant on the size of the farm. For farms which are smaller than 50 Tonnes, an application cost of £3,371 is charged followed by a yearly fee of £4,902. For farms over 50 Tonnes, this increases to £4,494 and £11,332 respectively.

MEP is not recommending the setting up of a CAR based licensing system in the Falklands but the review and approval of licensing requests under the Fish Farming Ordinance will incur significant costs for the FIG which will need to be recharged to the farmer.

Marine Licence: A Marine licence in Scotland is chargeable at a set fee depending on the capital expenditure involved. For example, for a capital investment of £5-10 Million, a yearly licence fee of £14,175 is payable.

A Marine Licence is not specifically required under the suggested or current Falklands regulatory system.

Aquaculture Production Business (APB) Licence: The application and receipt of an APB licence is not currently chargeable. It is not known if charges are applicable under the Fisheries Product Ordinance.

8. Conclusions & Recommendations

This report has set out the current legislatory framework for future salmon farming in the Falkland Islands and made potential recommendations for changes which would allow it to be conducted under best practices. To help in determining what these best practices are, the report has also considered both the current legislative system in Scotland and the Faroe Islands.

The current legislation for aquaculture in the Falklands is relatively underdeveloped. This is not a surprise since little aquaculture exists but should large commercial scale salmon farming be permitted in the country it will clearly need to be developed.

In developing the legislation, MEP has attempted to amalgamate the best parts of other countries systems with a specific focus on the Faroes Islands which is clearly a very similar case study. At the same time, the Falklands will not be developing an intricate and highly complex system to base the planning process on as it is unlikely to be a sensible use of resource. As an example, a carrying capacity assessment could be completed for the Falklands which could define how much salmon farming could be completed without significant environmental impact occurring. This though would be an expensive undertaking and not necessarily in line with future plans (i.e., it would be trying to maximise the industry that could be achieved rather than creating a sustainable one based on best practice). For this reason, MEP is of the belief that the process should instead be precautionary in approach with, for example, a slow build up in biomass providing the opportunity to review progress at every stage before moving any further.

MEP has made some key legislative suggestions which it thinks would help ensure the best possible practices in the industry while also helping to mitigate the concerns of stakeholders and in particular residents. Specifically, these include;

A maximum biomass limit: Should farming be approved, we think a maximum biomass should be set for salmon farming in the Falkland Islands, above which no further farming licences will be approved.

Sterile fish only: A major area of concern in the Falklands is that the farming of Atlantic salmon will represent the introduction of a non-native species which can bring about significant risks. For this reason, we are suggesting that farming is only completed using sterile fish that cannot breed in the environment should they escape.

Currently, the only commercial method of producing sterile fish is through triploidy inducement. This process does have some remaining concerns which are currently undergoing significant research but we believe the benefits of such use will significantly outweigh any negatives.

Certification as a requirement: All farms should be required to meet the ASC certification requirements. These are considered the highest standard globally and would ensure that farms are operating at the highest possible standards.

Marine Zoning, all in-all out and significant fallowing: The best parts of the Faroe Islands legislation have been used to attempt to reduce the concerns specifically around sea lice. These have proven successful in the Faroes and would be well employed in the Falklands.

Minimum Smolt size: Globally, a significant move is currently being seen to increase smolt sizes through land-based farming operations and hence decrease the time required for salmon to spend in cages at sea. In the Faroe Islands, some companies have moved to smolt sizes as high as 600g. No country though has limited the size of smolts which are allowed to be stocked in sea cages through legislation (mainly due to the vast array of different producers that already exist). We are recommending that a size limit of 400g is included in any further Falkland's legislation and believe this would represent a significant industry leading approach to salmon farming.

The following recommendations and next steps are suggested for the further development of salmon farming in the Falkland Islands.

Recommendation 1: FIG Agreement on Approach: A general agreement is first required from FIG on the approach and way forward. MEP has set out its suggested approach and recommends this is discussed with FIG and a broad level of agreement set as a starting point[1].

Recommendation 2: Faroe Island Visit: MEP sees significant synergies between the Falklands Islands and the industry which has developed in the Faroe Islands. The two states are very similar in many ways and the Faroes has attempted to maintain 'high standards' within its sector. Despite the obvious complication of organising a visit to the Faroe Islands, we do believe that this would be highly beneficial for key members of the FIG. It would allow the processes employed in the Faroes to be seen first-hand and for discussions to be held directly with key legislators in the country. MEP would be able to help organise such a visit should it be agreed as a good next step.

Recommendation 3: Stakeholder Discussion and Review: The decision to allow or not allow future salmon farming in the Falklands is clearly one that needs to involve discussions with stakeholders. Firstly, the island residence will need to be consulted and concerns and questions addressed. Once the proposed approach set out in the document is agreed in FIG, MEP would suggest that we attend such stakeholder meetings in the Falklands.

Also, of importance though is that the potential industry stakeholders are also consulted on the potential changes (specifically, Unity Marine). The introduction of new rules for potential salmon farming in the Falklands would be pointless if no commercial organisation would be prepared to undertake farming because the rules are too onerous or cannot be achieved.

Following a period of stakeholder consultation with all parties it is likely that key amendments would need to be made to the suggested legislation and processes which are set out here.

Recommendation 4: Development of Policy and Legislation: Should agreement be made on the policy and legislation and a decision made to move forward with salmon farming, then the next stage would be the development of the specific ordinance and frameworks required under the Falklands legal system.

[1] *This does not mean that agreement is required on whether to allow salmon farming but that the possible approach should it be allowed is generally accepted.*

9. References

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Annex 1: EIA Requirement Recommendations

The below represent the key requirements for inclusion in an EIA supporting a fish farm planning application in the Falkland Islands.

1. A description of the development, including its specific location, the physical characteristics of the development and how it will operate.
2. An outline of the potential environmental areas of concern anticipated for the development.
3. A baseline assessment considering the current state of the environment (the 'baseline scenario') and any natural changes which are anticipated (as may be relevant).
4. A consideration of the likely environmental effects (positive and negative) on the development from construction through to operation. This should include (but is not limited to);
    a. Anticipated release of pollutants into the water environment. This should include the use of suitable modelling software to show dispersion effects from the facility.
    b. Any other anticipated releases of pollutants into the environment (land or air)
    c. Anticipated impacts form the facility relating to noise, vibration, light, heat or radiation.
5. A consideration of any human health risks
6. A consideration of any risks to cultural heritage or architecture.
7. A consideration of all likely socially effects (positive or negative) as a result of the facilities development and operation.
8. A consideration of all the effects considered above from that of a cumulative impact (considering other operations/ facilities or existing environmental issues which might be relevant)

a. the impact of the project on climate (for example the nature and magnitude of greenhouse gas emissions) and the vulnerability of the project to climate change;

9. The description of the likely significant effects should cover the direct effects and any indirect, secondary, cumulative, transboundary, short-term, medium-term and long-term, permanent and temporary, positive and negative effects of the development.
10. A risk-based assessment of all the impacts identified by the EIA and the mitigation measures to be used to avoid, prevent, reduce or, if possible, offset them.
11. A proposed monitoring arrangement for the facility during the operation and ensuring that the effective implementation of mitigation measures can be measured
12. Specific consideration of any significant adverse risks which might exist, particularly around accidents or natural disasters, and the mitigation which has been implemented to this regard.
13. A non-technical summary of the information above

Annex 2: Operational Plan Requirements

An Operational Plan should include the following requirements at a minimum.

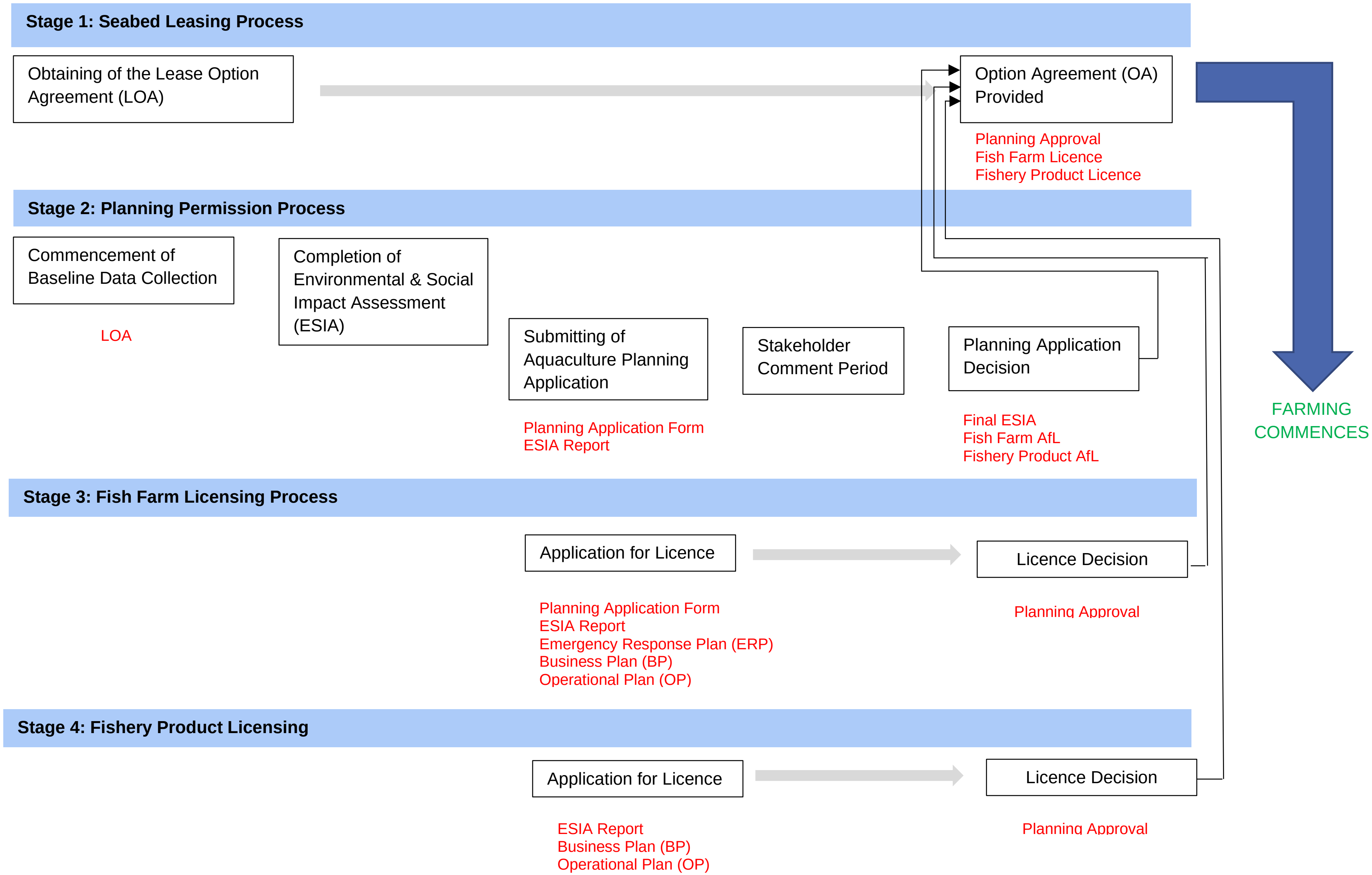
1. Relevant starting and finishing dates for the operation plan
2. Production process flowchart including details of all individual processed being undertaken (reception, grading, harvesting, transport, sale etc…)
3. Projected number and quantity of fish at the commencement of each process
4. Projected number and quantity of fish at the completion of each process
5. Highest projected biomass during production cycle
6. Highest project density (kg/m3) during production cycle
7. Planned monitoring to ensure planned levels are being met (and not exceeded) during the production cycle
8. Any other information as may be deemed appropriate to provide a detailed breakdown of activities being undertaken during the production cycle

Annex 3: Operational Logbook Requirements

All farms are required to maintain an Operational Logbook which should include the following as minimum requirements.

1. Daily Biomass Calculations to include;
    a. Date
    b. Live number of fish at the end of each day
    c. Average weight of fish at the end of each day
    d. Daily Observed Mortality at the end of each day (fish number and weight)
    e. Total Biomass at the end of each day
2. Daily Feed Calculations to include;
    a. Daily feed used per cage unit
    b. Details of feed used on a daily basis
    c. Feed Conversion Ratio for current fish batches
3. Daily Water Quality recordings to include (but not limited to) and covering a representative sample of all licensed farming operations;
    a. Oxygen levels
    b. Carbon Dioxide levels
    c. Ph levels
    d. Salinity levels
    e. Temperature levels (DegC)
4. Stocking and Harvest Records to include;
    a. Date of each stocking and harvesting activities
    b. Volume and number of fish stocked harvested
    c. Location of fish stocked and harvested
    d. Information on provider or purchaser of stock
5. Grading Records to include;
    a. Date and location of grading activities
    b. Any movement of fish (numbers and biomass)
6. Mortality Records
    a. Daily volumes of mortality
    b. Evidence of post mortem results for mortality sampling
    c. Disposal records for recovered mortality
7. Disease Records (in case of outbreaks) to include
    a. Date when disease was first suspected
    b. Date when farm's veterinarian was call
    c. Data when FIG was contacted
    d. Any treatments approved including start and end date, name of treatment
    e. Any withdrawal periods for products or follow up treatment/diagnosis
8. Parasite Records (as required under licensing requirements) to include;
    a. Dates and sampling activity details
    b. Number of ovigerous sea lice found per fish during sampling
9. Escape Records to include;
    a. Date of any escape events
    b. Number and weight of fish escaped
    c. Cause of escape
    d. Follow up actions completed under ERP
    e. Any lessons learnt and implemented mitigation

Annex 3: Overview of Suggested Falklands Approval Process



MACALISTER ELLIOTT & PARTNERS LTD

Summary Document Outlining the Potential Options and Opportunities for Salmon Farming in the Falkland Islands

Since the 1960s, global aquaculture production has been rapidly increasing. The industry is projected to accommodate for two-thirds of the world's fish for direct human consumption by 2030, for which it currently accounts for over half of this global market. The Falkland Islands are considering the potential for commercial scale salmon farming operations in the future and have commissioned a series of studies to determine the best practices and legislative requirements for a successful and sustainable salmon farming industry. Where appropriately managed, aquaculture production could offer positive economic impacts for the Falkland Islands. However, it is also true that aquaculture can also have negative environmental impacts under certain conditions. Therefore, to make informed decisions when weighing economic considerations against environmental concerns, understanding the total economic impacts of aquaculture in the country is necessary.

With aquaculture's growth, several high-profile concerns have arisen, including pollution, feeding practices, disease management and antibiotic use, habitat use, non-native species, food safety, fraud, animal welfare, impacts on traditional wild fisheries, access to water and space, market competition, and genetics. The level to which these concerns can be managed is partly dependent on the objective of the enforcing state. For some, the focus is on commercial development, while for others, maintaining the best possible practices (and subsequently reducing the negative aspects) is key. However, it is also true that whatever path is taken, the outcome must present an economically viable opportunity for the industry (otherwise no farming will happen).

Aquaculture has been identified as an area of potential growth by the Falklands Development Plan and commercial organizations have already expressed an interest in commencing operations with the region. It has been made clear to us though, that any future development of salmon farming within the Falklands will need to be undertaken using the very best levels of best practice from around the world (to help minimize potential impacts). To inform what such development would look like, a review of current regulatory systems in Scotland and the Faroes Islands (selected as case studies) was undertaken.

In the Falklands, aquaculture is presently controlled through a general planning system and two key pieces of regulation: the Fish Farming Ordinance, and the Fishery Products Ordinance. The general process for significant aquaculture developments is currently untested but would involve a planning application, completion of an Environmental Impact Assessment (EIA) and then the subsequent provision of a fish farming license with conditions raised, as seen as appropriate by the Falkland Islands Government (FIG). This regulatory process, while covering most bases, would require significant development for larger scale aquaculture development.

By comparison, aquaculture in Scotland is based on a complex planning system, whereby all farms require planning permission before operations can commence. Applicants must first lease the seabed from the Crown Estate (something that remains unclear in the Falklands) and are then required to complete an Environmental and Social Impact Assessment (ESIA). Applicants must also apply for a Controlled Activities Regulation (CAR) licence which effectively models the anticipated discharge of the operation and decides if it is within environmentally acceptable parameters. In addition, farms must acquire a Marine Licence and an Aquaculture Production Business (APB) authorisation. The system is incredibly complex, bureaucratic and requires companies to spend significant amounts of money with no clear guidance on the likelihood of success. Even despite this increasingly complex system, Scotland has become a target for environmental (and other) campaigners and stakeholders alike in recent years. Many of these campaigners believe that salmon farming is responsible for the decline in wild salmon numbers in Scotland, with elevated sea lice levels being the most common reason for these concerns. This has resulted in planning applications taking up to two (2) years to become approved in recent cases.

Despite this complex approval system and stakeholder concerns, Scotland currently produces over 200,000 tonnes of Atlantic salmon per year, with the aquaculture sector directly employing 6,260 people in 2018. Overall, the aquaculture sector contributed around £885 million Gross Value Added (GVA) to the Scottish economy and generated 11,700 jobs. Salmon production was responsible for 66% of the 2018 GVA impact. The impact of the salmon production's supply chain was even larger, responsible for around 86% of the total supply chain impact, contributing around £310 million GVA. This makes it a significant contributor to the Scottish economy, generating £14 million per year in National Insurance contributions alone for the government. In summary, Scotland has developed an important commercial industry through salmon farming which provides significant income to the economy. However, despite often best intentions, the licensing system has been convoluted and, in some cases, outdated. When combined with a highly active stakeholder community (many of whom simply want all salmon farming banned) this has created a difficult environment for any further expansion within the sector and significant negative publicity.

In contrast to Scotland, the Faroe Islands are relative newcomers to commercial salmon farming but now produce around 90,000 Tonnes of salmon per year. This growth has been rapid and now accounts for 40% of the total export value of the Faroe Islands. This makes the country the world leading salmon producer measured relative to the population, with 1.5 Tonnes per capita. Similarities between the Falklands and Faroes make it an ideal case study from which the FIG can model future development of the salmon farming industry. Much like the Falklands, the geographical position of the Faroes is ideal for farming Atlantic salmon. Its remote location is complemented by pristine clear waters, cool steady sea temperatures, strong currents and accessible fjords. The Faroese aquaculture industry is well consolidated both horizontally and vertically, with vertical integration allowing producers to have full control over the quality of the salmon from feed and smolt (young salmonid fish) to export. In recent years (and after a 'rocky start' to production in the 1990's), the country has developed a reputation for 'best practice' within its regulatory system which is relatively new and follows the latest scientific knowledge and principles.

The Faroe Islands use a planning system with one central piece of legislation (the Faroese Veterinarian Act) that governs the rules and regulations for farming. The country's coastline is split into so-called Marine Zones (MZs) which are areas of similar water mixing. Within these MZs, only one production company is allowed to operate, providing clarity on what happens and who is responsible. Furthermore, the country operates an all in-all out policy for each MZ meaning that fish must all be stocked and then harvested before any further fish can be added. Between each restocking or production run, there is a significant period of fallowing and equipment disinfection. These rules, along with a variety of other controls, have seen the development of a strong regulatory system in the Faroe Islands, resulting in fewer environmental concerns and issues than are seen in other major salmon producing nations. The Faroes have also started stocking much larger smolts into sea cages than the global average. Typically, fish of around 200g are stocked, though some companies in the Faroes are now raising smolts up to 600g at their on-land facilities. This results in a reduced cage-based time and limits some risks associated with disease (in particular, sea lice). This can be viewed as a win-win situation, reducing risks for farmers and providing better environmental outcomes for all in the country.

The contribution of salmon exports to the Faroese economy has already been shown to be significant, at 40% of the country's export value (around £183 Million GVA per annum). The industry directly employs an estimated 2,500 people (5% of the population) and generates estimated tax revenues of around £70 Million per annum. In summary, the Faroes Islands have managed to develop a hugely important commercial sector in salmon farming. This has been done within a sensitive environmental situation through the development of best practice regulatory processes which help to limit the potential negative impacts of the industry (although, does not remove them entirely).

To develop a salmon production industry in the Falklands, it would therefore seem sensible to adopt the principles and practices of the Faroe Islands as a starting point for future regulation. However, one additional and significant area of concern exists in the Falklands (which is not an issue in the Faroes) in that the farming of Atlantic salmon will represent the introduction of a non-native species. This can bring significant risks and issues which clearly need to be considered in any future farming operations.

In Table 1 (at the end of this document), we have set out some of the key policy recommendations which we believe would provide a system for potential development of best practice farming operations in the Falklands. A description as to the reason for each measure is also provided to show how this mitigates a specific risk which is seen in salmon farming. In summary, the recommended actions would see a biomass limit for the islands, the use of sterile fish only, single cohort farming, periods of fallowing, minimum stocking sizes for juveniles and a requirement for certification. Should these rules all be implemented, it would be fair to say that the Falkland Islands would have the most stringent salmon farming regulations of any significant producer in the world.

The benefits of moving forward with salmon farming in the Falklands would be both economic and social (mainly employment). Although it is hard to determine quantitatively exactly what these benefits may look like, we can make estimates based on the figures from the Faroes Islands. Here, the salmon industry has generated around £200 million of exports from the country per year and is responsible for the employment (direct and indirect) of 2,500 people. The targeted production of 40,000 Tonnes in the Falklands is under half of the Faroese production. Therefore, it is estimated that salmon farming could bring around £50-80 million of exports per year for the Falklands and has the potential to employ between 500-1,000 people (almost a third of the population).

The decision to allow or not allow future salmon farming in the Falklands is clearly one that needs to involve discussions with stakeholders. The island residence will likewise need to be consulted, with concerns and questions addressed prior to any decision to proceed. Finally, it must be stressed that this report is not designed to advocate either for or against the commencement of commercial salmon farming in the Falkland Islands. As with virtually any anthropogenic activity, salmon farming will produce negative outcomes (as well as positive outcomes) which some stakeholders find acceptable, and others do not. The final decision on whether these outcomes are acceptable or not will need to be taken by the FIG (following consultation). However, this report has attempted to set out a potential regulatory system which would present a 'best practice' approach to cage-based salmon farming within a relatively small archipelago. Importantly, we acknowledge what could be a small (globally) but significant industry, of economic benefit for the islands.

Table 1: Key Regulatory Recommendations for Falkland Islands Salmon Production

Regulatory Recommendation	Justification for Regulation
Biomass Limit: Only 40,000 Tonnes of cage based harvestable finfish biomass shall be permissible in Falklands Waters annually	We believe an overriding upper limit should be set for cage biomass production in the Falklands. Since no carrying capacity assessment has been undertaken, this figure is set on the basis of a precautionary approach.
Sterile Fish Only: Only Atlantic salmon approved as sterile by the authorities may be used for cage-based on-growing operations in the Falkland's. The use of triploidy is encouraged for developing sterile fingerlings. However, other methods may be considered by the authorities on a case-by-case basis. All farms producing non-native species in the Falklands must implement and maintain an approved monitoring plan to determine any potential interaction effects of the species with native species and the ecosystem at large.	The farming of non-native species represents a significant concern in the Falklands. To overcome most concerns with this we are recommending that only sterile fish are farmed in the country. It is important to note that triploid salmon are not genetically modified salmon.
All In, All Out: All farms operating cage-based operations within the same Marine Zones (which will be designated) may only farm fish of the same year class at the same time. No new year class may be stocked into a farm in the same Marine Zone until all the farms have been emptied of existing fish (and any required fallow period completed).	This rule has been developed in the Faroe Islands and has been well received and shown to be effective for reducing sea lice transmission. It effectively means that a farm can only farm one year class at a time and no new stocks can be added until this one has been fully harvested.
Fallowing: All cage-based farming activities must observe a two (2) month fallowing period in-between production cycles. This period will commence from the day the nets are removed from the water.	An enforced period of fallowing in cage farming operations has been shown to significantly reduce the impacts of sea lice and so is recommended here. This is often well received by stakeholders who can equate it to fallowing operations in normal agriculture.

Certification: All cage-based farming operations are required to receive and maintain ASC certification for their operations within three (3) years of the first stocking of fish into the cage systems. In the case that ASC requirements do not correspond fully to the FIG licensing requirements, a farm may be able to demonstrate that it meets all applicable ASC requirements through the completion of a third-party audit and review on a yearly basis.	To ensure the highest possible standards are maintained at any farming facility in the Falklands, we are recommending that it is a requirement of any license holder to become certified against the Aquaculture Stewardship Council (ASC) requirements. In recognition that it is currently unclear whether the use of sterile (triploidy) fish is possible under the ASC standard currently, the wording has been left to allow a farm to show it is in line with the requirements (but not necessarily certified).
Juvenile Sourcing: The production of smolt should be completed in land-based facilities in the Falklands to allow for vertical control of the process. All should be approved by the FIG for supply. The one exception to this will need to be the import of eggs (at least in the short term) since none currently exist in the Falklands.	The production of all juveniles in the Falklands and in land-based farms would allow for greater control of the process by the FIG (as well as promoting greater economic advantages for the Islands).
Minimum Cage Stocking Weight: Fish (except for broodstock and/or cleaner fish) may only be transferred to a cage farm at an average size of 500g and no smaller.	A general move in the industry is seeing larger and larger smolt sizes being stocked to cages. This reduces the time fish send in cages which reduces environmental effects and reduces the risks to the farmer. We recommend that an aggressive target is set here to encourage as much land-based production as possible and to limit the cage time to a minimum, hence an average target weight of 500g for cage stocking is provided.