



A Report by Fidra:

The impacts of Scottish salmon farming on the benthic environment

Fidra's Best Fishes Project

The survey was conducted as part of Fidra's Best Fishes project which aims to minimise the environmental impact of Scottish salmon farming www.bestfishes.org.uk. Fidra welcomes further discussion on seabed impacts and compliance, please contact Dr Clare Cavers for further information clare.cavers@fidra.org.uk.

Fidra's mission is to address specific environmental issues by developing pragmatic and proportionate responses through collaborative dialogue with the public, industry and government to ultimately achieve targeted and effective solutions. Fidra currently works on several projects relating to the environment, details of which are available on our website www.fidra.org.uk.



Salmon farm on Loch Fynne. ©Fidra

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Executive Summary

As a science-based environmental charity, Fidra has been examining the impacts that the Scottish salmon farming industry has on some of Scotland's most remote and unique ecosystems through its [Best Fishes](#) project. From the research Fidra has conducted, we have concerns about the implications of long-term and intensive salmon farming on the loch floor and seabed, also referred to as the 'benthos'.

This benthos directly and indirectly supports all life forms present in these ecosystems providing safe havens for a variety of plant and animal species to live and breed in, hide from predators, and feed from. Data on the health of the benthos is collected via benthic surveys that are conducted by farms as part of their licence conditions set out by the [Scottish Environment Protection Agency \(SEPA\)](#) [1], which regulates Scottish aquaculture. From data sourced via [Scotland's Environment](#) [2] and [Scotland Aquaculture](#) [3] websites, as well as [SEPA's Compliance Assessment Scheme](#) (CAS) [4], Fidra has examined the impact of the Scottish salmon farming industry on the benthos, as shown through these benthic surveys.

As part of this study, Fidra looked closely at the benthic survey results for two groups of farms:

- The full list of farms owned by one Producer which a major UK retailer sources all their salmon from;
- All farms that received a 'Very Poor' or 'Poor' compliance assessment result from SEPA in 2018 (the most recent publicly accessible data).

The farms analysed as part of this study ranged in size and age and included those in designated Marine Protected Areas (MPAs) [5].

In the second group, case study two, we looked at the 32 farms that received a 'Very Poor' or 'Poor' standard through SEPA's CAS in 2018, and therefore were deemed not compliant with regulation and expectation. The majority of these assessment reports, 24, highlighted benthic survey results as a key reason for non-compliance. The other reasons included one or more of the following: breaches of discharge limits (11), error in cage configuration (2) and fault in operation and management (1). Closer analysis of these 24 sites showed that just 5 of the 24 farms received a 'Satisfactory' benthic result in the last 5 years and this number dropped to just 1 farm in the last 3 years.

The benthic survey data from all farms with a 'Very Poor' or 'Poor' compliance assessment results, demonstrates that poor performance has been present for over a decade, begging the questions: why are these farms still in operation and what are regulators doing to end this pattern of non-compliance?

In light of the findings in this report, Fidra offer the following recommendations:

- 1 A clear limit of 3 consecutive failed or non-compliant assessments needs to be set after which a fallow period or site closure ought to be enforced.**
- 2 In areas where several poorly performing salmon farms are closely situated, further aquaculture development should cease unless, and until, performance of the farms can be improved and sustained to limit the damage to that area's benthic environment.**
- 3 No additional salmon farms should be granted in Scotland's Marine Protected Areas (MPAs) and consideration should be given to moving those that are presently in MPAs.**

[1] <https://www.sepa.org.uk/>

[2] <https://www.environment.gov.scot/data/data-analysis/marine-fish-farm/>

[3] <http://aquaculture.scotland.gov.uk/>

[4] <https://www2.sepa.org.uk/compliance/default.aspx>

[5] <https://www.gov.scot/policies/marine-environment/marine-protected-areas/>

With regard to the availability of information and transparency, Fidra makes the following further recommendations:

- 4 Benthic survey reports should be made available online, including subsequent requirements set by SEPA such as biomass reduction, or actions taken by producers.**
- 5 A 'Borderline' benthic survey result produced automatically by assumption and not due to actual survey results should not equate to a 'Good' CAS standard, if preceded by 'Unsatisfactory' or 'Not assessed' results. CAS assessment should then not be completed until a benthic survey has been undertaken.**

The recurrence of 'Unsatisfactory' benthic surveys, and 'Poor' and 'Very Poor' CAS assessments, indicates that the enforcement of present regulation should be stronger, or new regulations may be required. **Fidra therefore makes the following regulatory recommendations:**

- 6 Stricter enforcement ought to be in place to ensure farms genuinely limit their biomass after an 'Unsatisfactory' benthic survey result.**
- 7 Farms that receive an 'Unsatisfactory' result should have more frequent benthic surveys conducted.**
- 8 Monitoring should be established to indicate how salmon farm waste interacts with other pollution streams.**

The Scottish salmon farming industry is a significant player in Scotland's economy, and the biggest contributor to Scottish aquaculture which brought in over £1.8 billion in 2016. The Scottish Government is supportive of the Scottish salmon farming industry's ambition to double by 2030, predicted to bring in around £3.6 billion and generating up to 18,000 jobs.

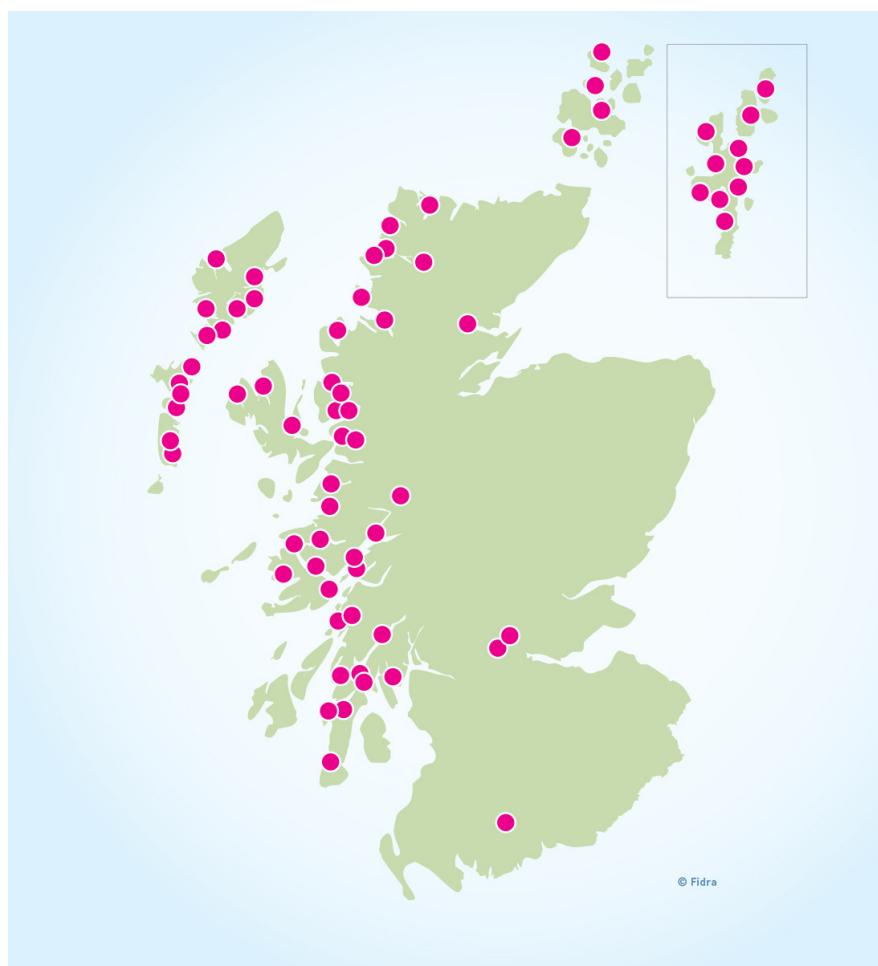
The prospect of the industry, and as a result any negative impacts, being doubled over the next decade with little to no change in industry practices and regulation provides a very worrying situation for the health of Scotland's coasts and waters.

Background

The salmon farming industry in Scotland has grown steadily since the 1970s and is the main contributor to Scottish aquaculture, which brought in over £1.8 billion to the Scottish economy in 2016. Scotland is the third largest producer of Atlantic salmon, behind Norway and Chile.

This expansion has offered Scotland the opportunity to be a world leader in the industry, creating employment opportunities and contributing to exported trade. Yet, the environmental impacts from this industry can be significant and vast.

Scottish Government has made a commitment to support the Aquaculture Industry Leadership Group's growth strategy [6] to double the economic contribution of Scottish aquaculture to £3.6 billion and double the number of jobs to 18,000 by 2030. There are significant concerns that salmon aquaculture negatively impacts the environmental integrity of some of Scotland's most remote communities and unique habitats (Figure 1 highlights the locations of salmon farms in Scotland); and whilst this continues to be the case it is difficult to envisage sustainable growth of this sector.



The economy of such areas is heavily reliant on tourism, of which the natural environment is a key asset [7]. To avoid conflict between nature-based tourism and the aquaculture industries, organisations must work together to ensure these spaces are developed in a sustainable manner. Vital to this is minimising environmental impacts and having social acceptance.

Fidra's Best Fishes [8] project seeks to engage with the current environmental concerns associated with Scottish salmon farming. The tailored website (www.bestfishes.org.uk) outlines the challenges facing the industry, which include the use of chemical treatments, the risk of escaped, domesticated species and the incubation of diseases and parasites with potential to infect wild fish.

Figure 1. Location of Atlantic Salmon farms in Scotland. © Fidra

The overarching aim of the project is to bring attention to these issues by working with industry, regulators, retailers, consumers and other NGOs to implement best practice and limit the level of environmental harm being inflicted on local habitats. To achieve this, Fidra looks to work with a variety of stakeholders in the following ways:

- Assist and facilitate the development of an online 'Sustainability Dashboard' which will present detailed yet clear information on the environmental impacts of individual salmon farms in Scotland.
- Work with UK retailers to encourage improved transparency throughout the sector by increasing the level of information presented on the packaging, for example listing the name of the farm so customers can look up the performance on a suggested Sustainability Dashboard.
- To inform consumers about the known environmental impacts of salmon farming and allow them to choose salmon with the least negative effects.
- Liaise with salmon producers to implement best practice processes, reduce impacts on the local environment and increase transparency on farms through the proposed Sustainability Dashboard.
- Continue dialogue with government and regulators to adopt robust legislation based on best practice, supported by strong regulations and effective enforcement.

The purpose of this report is to outline Fidra's concerns regarding the environmental impacts that Scottish salmon farming has on surrounding habitats, with a focus on the benthic environment of the loch floor or seabed.

[6] <https://aquaculture.scot/>

[7] <https://www.nature.scot/sites/default/files/2019-07/Valuing%20nature%20based%20tourism%20in%20Scotland.pdf>

[8] <https://www.bestfishes.org.uk/>

Environmental impacts of Scottish salmon farming

The open net pens of salmon farms in Scotland can hold tens of thousands of salmon, with most farms having a license which permits them to have a maximum of 2,500 tonnes of salmon at a time. The actual biomass will vary between farms and production cycles.

With this amount of salmon being farmed in one place, it is inevitable that it will have a number of impacts on immediate and surrounding ecosystems. The most prominent environmental impacts are shown in Figure 2 below.

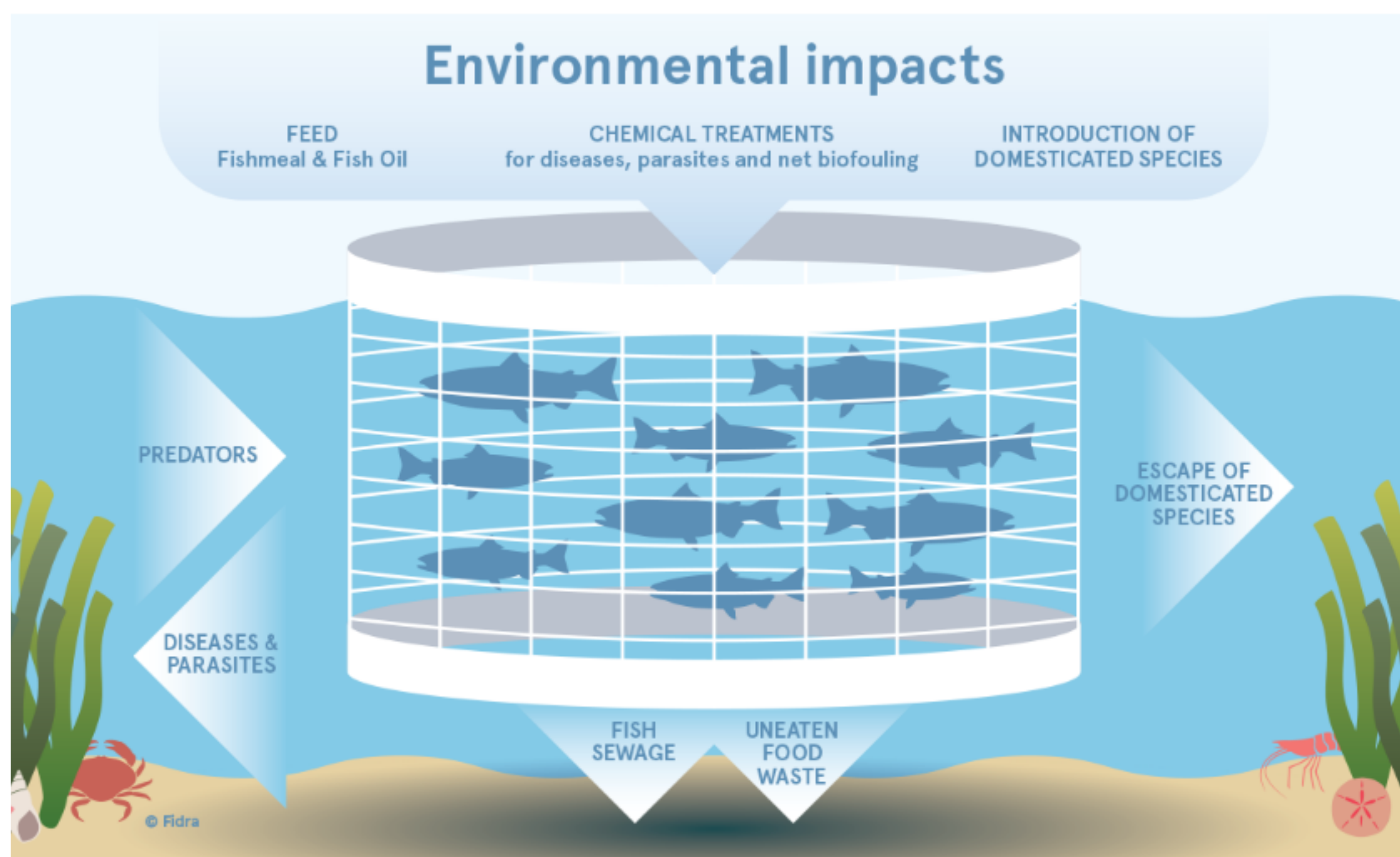


Figure 2. Environmental impacts of open net cages used for salmon farming. © Fidra

Waste

Waste from uneaten food and fish faeces enters the aquatic environment surrounding open net pens, with a concentrated amount being deposited directly under the farm structures [9].

The deposition of this waste can lead to excessive amounts of nutrients such as nitrogen and phosphorus in the water column. Both are essential for plant growth, but excess can lead to 'eutrophication', which is accelerated algal growth that can lower water quality and produce toxic blooms potentially harmful to people, marine species, and birds [10].

Fidra are particularly concerned about the impact of waste deposited on aquatic habitats under and surrounding salmon farms.

[9] Navarro, N. et al., (2008), *Effect of salmon cage aquaculture on the pelagic environment of temperate coastal water: seasonal changes in nutrients and microbial community*. Marine Ecology Progress Series, 361, pgs.: 47-58.

[10] Wilson, A. et al., (2009), *Review of environmental impact assessment and monitoring in salmon aquaculture*. In FAO. Environmental impact assessment and monitoring in aquaculture. FAO Fisheries and Aquaculture Technical Paper. No. 527. Rome, FAO. pgs.: 455-535.

In the sediments the waste can result in organic enrichment with high carbon levels, leading to sediments becoming 'anoxic' (low or no oxygen) and changes in the composition of species living in the seabed. A Norwegian study based on production levels of 1.3 million tonnes of salmon estimated releases in the region of 60,000 tonnes of carbon, 34,000 tonnes of nitrogen and 9,750 tonnes of phosphorus annually [11]. With Scottish production figures of 163,000 tonnes of salmon recorded in 2016 [12], releases of the same nutrients from Scottish salmon farms are likely to be about a 10th of this. While seabed conditions near farms are regularly monitored, there is no recent synthesis of the data, or recent research into acceptable deposition levels for different sediment types, following periods, or long-term changes in the seabed habitats with anthropogenic organic inputs.

The input of chemical treatments, fish sewage and uneaten food waste can all impact on the health of the seabed directly below and surrounding fish farm open net structures.

Chemical treatments

Numerous chemical and non-chemical treatments are used to combat diseases, parasites and build up on farm nets. Infectious diseases represent a major problem in fish farming despite successful development and application of vaccines against a range of pathogens.

One of the main issues for the salmon farming industry is infestations of sea lice. These parasitic crustaceans can breed rapidly in the concentrated populations of salmon, both in the wild and in open net farming pens. Sea lice can be transferred between wild and farmed populations of salmon if they come into contact through escapes or when wild species migrate past farms.

To target sea lice specifically, there are three main solutions: (i) preventing their attachment to salmon through the development of medicines added to salmon feed, (ii) dissolving therapeutants in a bath treatment, or using warm water rinses, and (iii) introducing various 'cleaner fish' species, which eat the sea lice without causing harm to the salmon.

The chemicals used in bath treatments for sea lice include hydrogen peroxide, synthetic pyrethroids, and organophosphates; yet it is evident that sea lice are becoming more resistant to existing medicinal treatments [13]. Systemic (in feed) treatments tend to be more efficient but are becoming less effective; of these, only emamectin benzoate is currently used in Scotland. Because of the design of these chemicals, they are non-discriminatory and persist in the environment. Therefore, they will affect populations of non-target organisms, such as crabs, for as long as they are present.

There are concerns over the use of emamectin benzoate, which takes many years to break down in the environment, as studies have shown it slows growth, impacts egg production, and changes life cycle patterns in aquatic invertebrates [14]. Due to these findings the regulatory body in Scotland, Scottish Environment Protection Agency (SEPA), is currently reviewing the recommended levels, known as Environmental Quality Standards (EQS) [15]. SEPA recognises an 'Allowable Zone of Effect' (AZE) as a designated area of seabed or volume of receiving water body, in which some exceedance of relevant Environmental Quality Standards (EQSs), or some damage to the environment, is allowed [16].

[11] Taranger et al., (2015), *Risk assessment of the environmental impact of Norwegian Atlantic salmon farming*. *Ices Journal of Marine Science*, 72, pgs.: 997-1021. doi:10.1093/icesjms/fsu132

[12] <https://www.gov.scot/publications/scottish-fish-farm-production-survey-2016/pages/5/>

[13] Aaen, S.M. et al, (2015), *Drug resistance in sea lice: a threat to salmonid aquaculture*. *Trends in Parasitology*, 31, 72-81. <https://doi.org/10.1016/j.pt.2014.12.006>

[14] Bloodworth, J.W. et al, (2019), *Negative effects of the sea lice therapeutant emamectin benzoate at low concentrations on benthic communities around Scottish fish farms*. *Science of the Total Environment*, 669, 91-102. <https://doi.org/10.1016/j.scitotenv.2019.02.430>

[15] <https://www.sepa.org.uk/regulations/water/aquaculture/medicines-and-chemicals/>

[16] SEPA, (2005), *Regulation and Monitoring of Marine Cage Fish Farming in Scotland*. Annex H: Methods for Modelling In-feed Anti-parasitics and Benthic effects. <https://www.sepa.org.uk/media/113511/fish-farm-manual-annex-h.pdf>

Why the concern over the seabed, or 'benthos'?

The term 'benthic' refers to the lowest ecological area in a body of water, known as the 'benthos'. This habitat is essential for marine life because all species rely, directly or indirectly, on it to feed, rest or reproduce [17]. Benthic surveys completed in relation to salmon farming provide an indication of the health of the loch floor or seabed directly underneath and surrounding the farm. Information from measurables such as oxygen levels, the animal and plant species, types and quantities of chemicals present is used to assess the condition, or 'quality status', of the benthic habitat. This in turn reflects the combined effects of all the pressures to which it is subject.



Figure 3. Benthic habitat of a Scottish seabed. © Scottish Natural Heritage.

A Scottish salmon farm's Controlled Activity Regulations (CAR) licence issued by SEPA requires each farm to carry out benthic surveys to indicate the impact the farm may be having on nearby habitats and species [18]. As waste from fish farms is deposited onto the benthic environment, it can lead to the creation of an anoxic environment, as described above. Researchers describe this process as the amount of waste "[exceeding] the carrying capacity of the environment" as the benthos is unable to process the waste successfully [19]. This directly impacts the inhabitant plant and animal species by limiting the likelihood for survival and recovery, specifically directly underneath open net pens and within the AZE.

SEPA have acknowledged that the presence of aquaculture will have an impact on the floor of the water bodies that support salmon farms, and state that the regulations and licensed limits that they set for each farm are at a level where the local environment would be able to survive with the farm at maximum operation.

[17] <https://oap.ospar.org/en/ospar-assessments/intermediate-assessment-2017/biodiversity-status/habitats/condition-of-benthic-habitat-defining-communities/common-conceptual-approach/>

[18] <https://www.sepa.org.uk/regulations/water/pollution-control/>

[19] Riera et al., (2017), 'MACAROMOD: A tool to model particulate waste dispersion and benthic impact from offshore sea-cage aquaculture in the Macaronesian region', *Ecological Modelling*, 361, pgs.: 122-134.

What are benthic surveys like in Scotland?

Fish farm operators usually conduct benthic surveys at least once per growth cycle, with the survey results then submitted to SEPA for assessment and classification. The benthic surveys should be taken within the month after the maximum biomass of the farm is reached. Samples of 0.02 square metres are taken from 2 stations along the line of the predominant current direction, with one station at the edge (within 5m) of the pens, and the other 25m from the pens, currently the edge of the AZE. Samples are also taken from 2 reference stations, remote from the open net pens, between 500m and 1km away. All samples are then analysed to identify any animals present and to assess the health and quality of the benthos [20].

Surveys are evaluated by SEPA and classified as 'Satisfactory', 'Borderline' or 'Unsatisfactory'. While 'Borderline' is taken to mean satisfactory it does still indicate stress on the sea bed.

It is important to note that the industry regulations changed significantly in 2006, and SEPA are now in their third iteration of the regulatory process, so data gathered before 2006 cannot be directly compared to that collected after and is not considered here. In addition SEPA is presently transitioning to new protocols under the new Finfish Aquaculture Sector Plan [21].

Fidra acknowledge the importance of benthic survey results to understand the wider impacts that farms are having on the immediate ecosystems supporting Scotland's aquaculture industry. As a result, Fidra has looked closely at the benthic survey results for two groups:

1. **Case Study One:** The full list of farms that one major UK retailer sources all their salmon from.

This list consists of 42 farms managed by the same operating body.

2. **Case Study Two:** All 24 farms that received a 'Very Poor' or 'Poor' compliance assessment result from SEPA in 2018 (the most recent publicly accessible data), which explicitly stated that poor benthic survey results contributed to this outcome.

This list makes up 12% of all 207 active salmon farms in Scotland in 2018. Overall, 32 farms (15%) were deemed non-compliant by SEPA's CAS. Fidra feel that 15% non-compliance is too high, especially given the longevity of some of these poor results.

By addressing poor benthic survey results the compliance of Scotland's salmon farms could be significantly improved.

[20] Health of the benthos is measured using the physio-chemical parameters: redox (Eh), organic carbon and particle size analysis (PSA). A visual description of the sediments is also required.

[21] <https://sectors.sepa.org.uk/finfish-aquaculture-sector-plan/>

Case study one

Fidra were offered the full list of farms that a major UK retailer sources their salmon from. In total, there are 42 farms which are all owned by the same operator.

Whilst the results from all the farms were interesting to analyse, for this report Fidra have focused on the information gathered from 4 specific farms to clearly depict circumstances and issues we have observed from across the industry.

These examples demonstrate incidences where farms have been granted a ‘Good’ or ‘Excellent’ compliance assessment from SEPA, the regulating body, despite consistently poor benthic survey results. In addition, a couple of the examples below, beg the question why farms are still permitted to be in production despite repeatedly receiving ‘Poor’ compliance results from the regulating body.

Benthic survey data was accessed via the Scotland’s Environment website and included results from 21/05/1996 to 26/09/2019 [22]. Analysis of the benthic survey data available from the 42 farms showed that 155 results were marked as ‘Satisfactory’, 72 ‘Borderline’, and 91 as ‘Unsatisfactory’.

Fidra compared benthic survey data against the results of the SEPA Compliance Assessment Scheme (CAS) to gain some wider context for each farm. The CAS information that is currently available dates from 2014 to 2018 and gives an overall compliance standard for farms. In the interest of confidentiality, the names of the salmon farms have been removed but all of the data presented is correct and publicly accessible.

Farm A

The limitations in transparency and context around the data provide a confused picture and highlight discrepancies, as presented for Farm A in Table 1.

Farm	Date of benthic survey	Biomass (T)	Result of benthic survey	Year of CAS	Result of CAS
Farm A	25/03/2019	0	To be evaluated		
				2018	Excellent
				2017	Good
	12/04/2016	1,418	Borderline	2016	Poor
	06/09/2015	887	Unsatisfactory	2015	Excellent
	02/04/2015	1,264	Unclassified		
				2014	Excellent
	08/12/2013	1,599	Satisfactory		
	27/04/2011	1,119	Borderline		
	02/05/2009	1,620	Unsatisfactory		
	13/06/2007	678	Unsatisfactory		

Table 1. Benthic survey data & CAS results for Farm A.

Farm A shows a very clear example of Fidra’s concern regarding discrepancies between the benthic survey data, which only received one ‘Satisfactory’ survey result, and the CAS standards awarded as this farm has mostly been assessed as ‘Excellent’.

[22] <https://www.environment.gov.scot/data/data-analysis/marine-fish-farm/>

According to SEPA the benthos is surveyed at around 75% of the production cycle, when farms are presumed to have the greatest impact, without impacting the harvesting process [23]. If a farm receives an ‘Unsatisfactory’ benthic survey result at this point, the following year – year one of the following production cycle – a ‘Borderline’ result is automatically given to accommodate the expected decreased output due to the harvest of the previous stock. Farms may also put processes in place to rectify these concerns and improve performance. Such processes may be at SEPA’s request or carried out voluntarily by the farm. There is no information publicly available on the processes being used, instead it is available through a Freedom of Information (FOI) request.

SEPA equate a ‘Borderline’ benthic result to a ‘Good’ CAS assessment. Fidra see this to be a flawed process which classifies a farm as having a ‘Good’ level of compliance, in spite of gaining an ‘Unsatisfactory’ benthic survey result. In the case of Farm A the CAS assessment moved from ‘Poor’ in 2016 to ‘Good’ in 2017 and ‘Excellent’ in 2018, despite the most recent benthic surveys being ‘Unsatisfactory’ in 2015 and ‘Borderline’ in 2016 with no subsequent surveys completed before the CAS ‘Excellent’ assessment in 2018.

SEPA equate a ‘Borderline’ benthic result to a ‘Good’ level of compliance. Fidra see this to be a flawed process.

In addition to this, after an ‘Unsatisfactory’ result farms are often required to reduce their biomass in the following cycle and/or spread the biomass across more cages. The results in Table 1 show that after the ‘Unsatisfactory’ result received on 06/09/15, the biomass of Farm A’s production actually increased by a considerable amount. There is no available information to explain this or put it into context.

Farm B

Table 2 shows data for Farm B. As is shown, this farm has only ever been deemed ‘Poor’ through SEPA’s CAS, yet it continues to be in production. Although the first two benthic results were ‘Not Accepted’, no explanation is available to the public about why this was.

Farm	Date of benthic survey	Biomass (T)	Result of benthic survey	Year of CAS	Result of CAS
Farm B	30/01/2019	0	Unsatisfactory		
				2018	Poor
	07/05/2017	1,481	Borderline	2017	Poor
				2016	Poor
	29/04/2015	1,939	Not Accepted	2015	Poor
				2014	Poor
	16/11/2013	0	Not Accepted		

Table 2. Benthic survey data & CAS results for Farm B.

[23] SEPA personal communication.

Such data needs to be accompanied by context and greater transparency throughout the aquaculture industry.

SEPA have stated that Farm B is not sited in the exact location for which planning permission and the subsequent CAR licence were given. This was due to rocky substrate and the presence of a maerl bed [24], previously undetected. Maerl beds constitute a Priority Marine Feature (PMF) [25], protected by the UK's Biodiversity Action Plan [26] and listed as one of OSPAR's threatened and declining habitats [27]. As a result of the farm being sited in a different position, it is not performing in the way that was predicted through the current modelling system.

From conversations that Fidra have had with SEPA, it is understood that, regardless of poor environmental performance, there are not many circumstances under which a farm would be closed and that all other options would be exhausted first. This is despite SEPA's websites specifically stating that fish farmers are "legally required to apply for a Controlled Activities Regulations (CAR) licence, which can be withdrawn if they fail to meet water control standards" [28].

Farm C (South) and C (North)

The final example in this case study looks at the data from Farms C (South) and C (North). Farm C (South) has recorded consistently poor benthic survey data (Table 3). Given the requirement for farms to reduce their biomass after 'Unsatisfactory' results, we would expect to see the biomass of this farm to decrease after each result.

Farm	Date of benthic survey	Biomass (T)	Result of benthic survey	Year of CAS	Result of CAS
Farm C (South)	07/03/2019	1,581	Borderline		
	01/11/2018	2,494	N/A	2018	Good
	31/01/2017	2,289	Unsatisfactory	2017	Poor
				2016	Broadly compliant
	15/05/2015	1,879	Unsatisfactory	2015	Poor
	04/10/2013	2,500	Unsatisfactory		
				2014	Poor
	11/08/2011	2,204	Unsatisfactory		

Table 3. Benthic survey data & CAS results for Farm C (South).

However, this has not happened even after 4 consecutive 'Unsatisfactory' benthic surveys. The lower biomass of 1,581 tonnes recorded with the benthic survey on 07/03/2019 is deceptive as just a few months earlier the biomass was 2,494 tonnes, showing no decrease in biomass from previous years. It is unclear how the farm then received a 'Good' CAS assessment in 2018 despite never performing well on benthic assessment. We assume that a 'Borderline' result was inferred as described previously.

[24] <https://www.nature.scot/landscapes-and-habitats/habitat-types/coast-and-seas/marine-habitats/maerl-beds>
[25] <https://www.nature.scot/professional-advice/safeguarding-protected-areas-and-species/priority-marine-features-scotlands-seas>
[26] <https://jncc.gov.uk/our-work/uk-bap-priority-habitats/>
[27] <https://www.ospar.org/work-areas/bdc/species-habitats/list-of-threatened-declining-species-habitats>
[28] <https://www2.gov.scot/Topics/marine/Fish-Shellfish/18716/car>

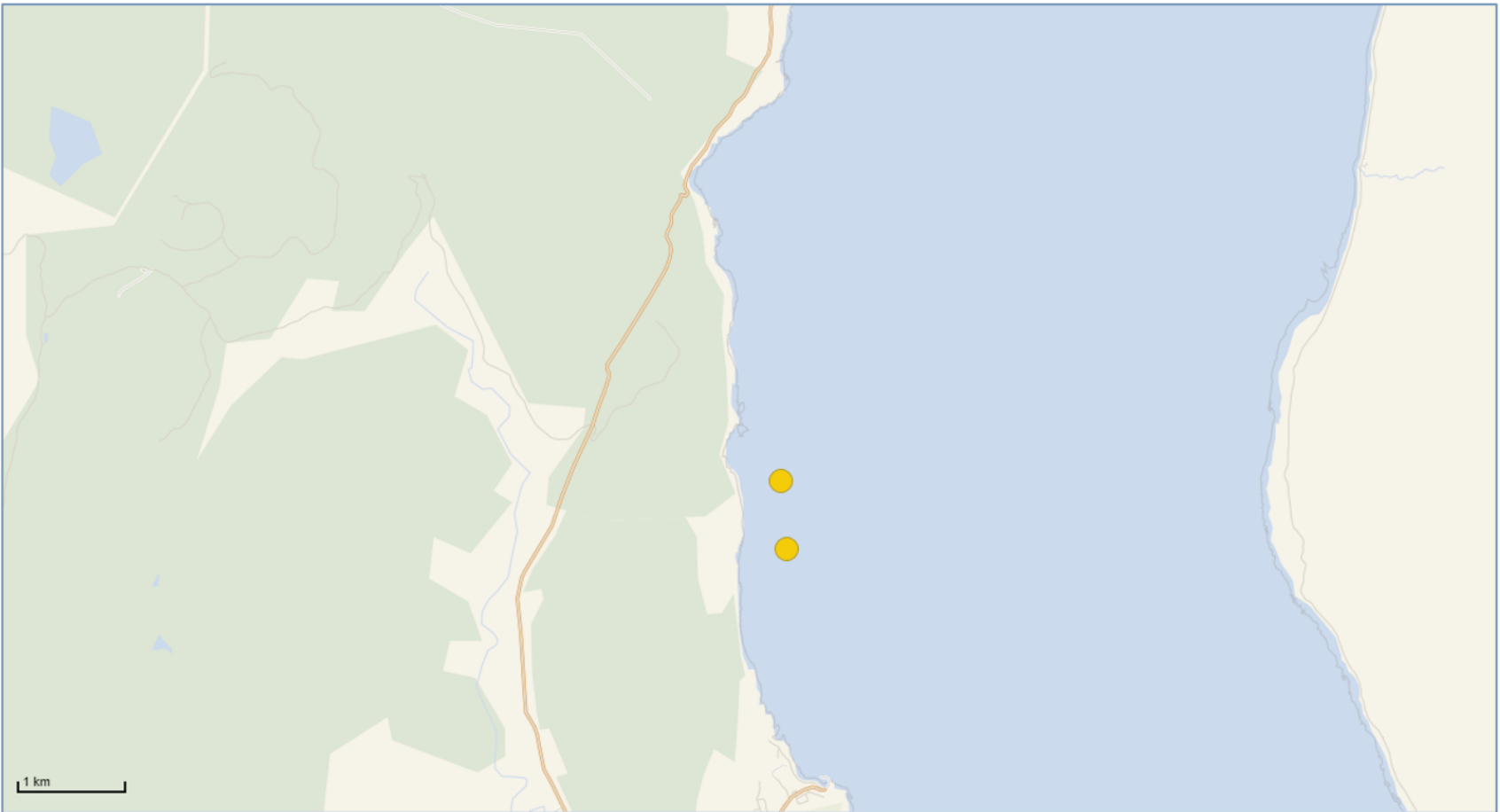


Figure 4. Image from [Scotland's Environment website](#) showing the close proximity of Farm C (south) and (North). Accessed 28th July 2020.

Farm C (South) is directly neighboured by Farm C (North). They are registered as separate farms, but they are directly next to one another (Figure 4).

Benthic results for Farm C (North) are 'Unsatisfactory' and 'Borderline' in 2017 and 2019 respectively (Table 4). SEPA's CAS rated this site as 'Excellent' in 2016, 'Poor' in 2017 and 'Good' in 2018.

Farm	Date of benthic survey	Biomass (T)	Result of benthic survey	Year of CAS	Result of CAS
Farm C (North)	07/03/2019	892	Borderline		
	01/01/2019	2,415	N/A	2018	Good
	31/01/2017	2,213	Unsatisfactory	2017	Poor
				2016	Excellent

Table 4. Benthic survey data & CAS results for Farm C (North).

Given both the poor results and the proximity of these two farms, Fidra feels that there ought to be greater information about (a) why Farm C (North) was developed, and (b) the accumulated impacts on the already 'Unsatisfactory' benthic performance.

Case study two

As described above, this group of farms were specifically selected for analysis as they were all assessed as 'Very Poor' or 'Poor' under SEPA's CAS and included a note that stated this was at least in part due to poor benthic performance.

To reiterate, 32 farms were deemed as 'Very Poor' or 'Poor' by SEPA's CAS in 2018 and are therefore not compliant with regulations. The majority of these, 24, specifically highlighted benthic results as a key reason for non-compliance. The other reasons included breaches of discharge limits (11), error in cage configuration (2) and fault in operation and management (1).

Our analysis showed that only 5 of these 24 farms received a 'Satisfactory' benthic result in the last 5 years, which was often stand-alone, and this number dropped to just 1 in the last 3 years.

It was important to note the locations of these sites to understand whether there are concentrations or geographical locations where farms are non-compliant. Further details and specific locations are available on a map [29] developed by Fidra, shown in Figure 5.



Figure 5. Locations of fish farm sites rated as non-compliant by SEPA in 2018.

The benthic data from these farms shows that regular poor performance has been present for over a decade. This begs the question why they are still in operation, causing greater degradation to the immediate and surrounding environments.

[29] Map of farms deemed 'Very Poor' and 'Poor' by SEPA's CAS, Fidra

Fidra compared the aforementioned non-compliant sites with neighbouring farms to understand whether the location was particularly detrimental. From this exercise, we were able to see that there was a significant number of sites in the north of Shetland that did not perform well.

Of the 32 farms, 13 are on Shetland clustered between Hascosay and Uyea, or Billister and Collarfirth; and 13 on the west coast between Oban and Mallaig, and out to the west coast of the Isle of Mull. Fidra are concerned that many of these farms fall into Marine Protected Areas (MPAs), shown in Figure 6.

Scottish MPA Network

The Scottish Government has a vision of clean, healthy, safe, productive, and biologically diverse marine & coastal environments. The creation and maintenance of the Marine Protected Area (MPA) network is an integral part of that vision.

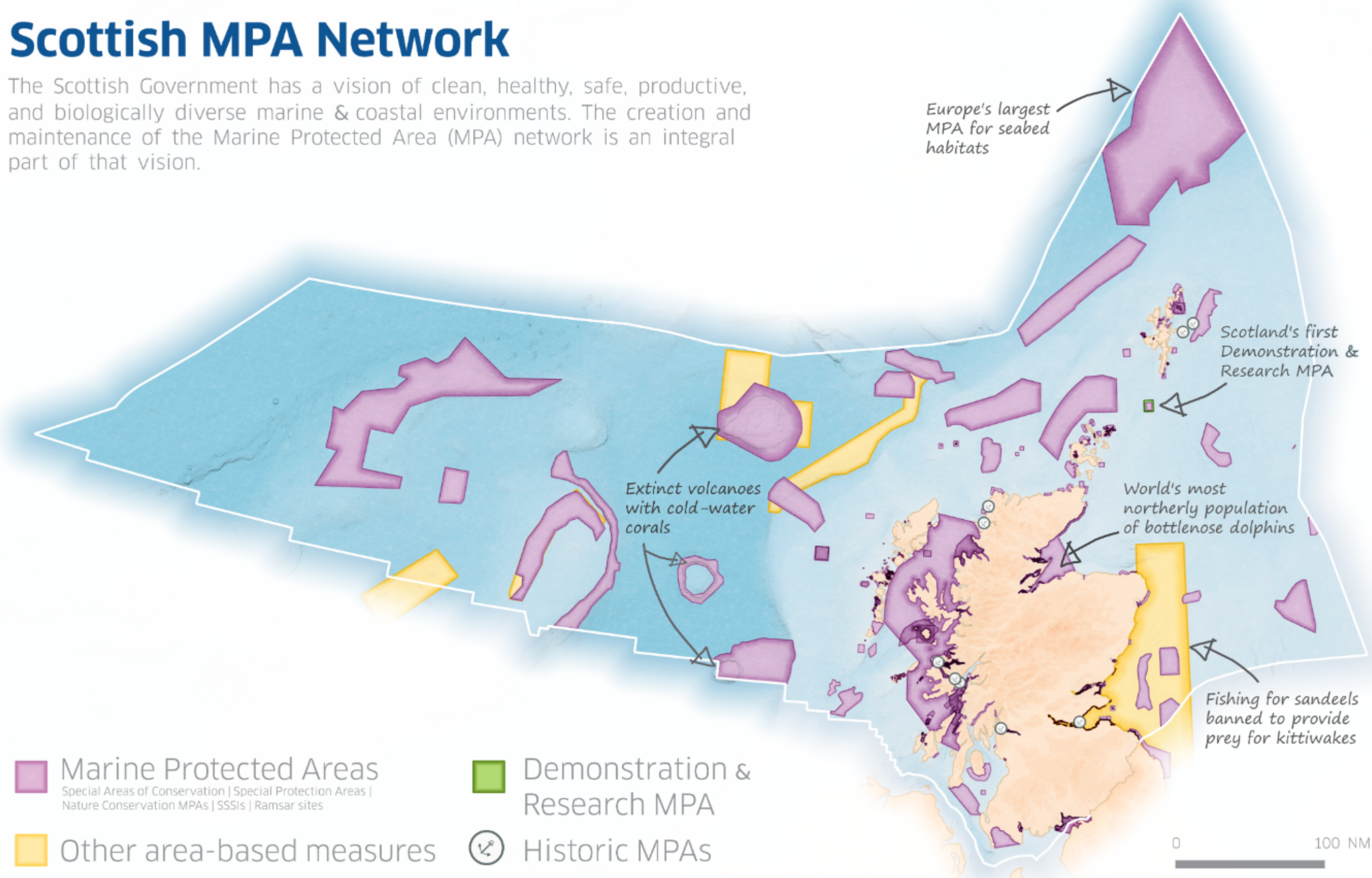


Figure 6. Scottish MPA Network, Marine Scotland, Scottish Government, 2018. [30]

[30] <https://www2.gov.scot/Resource/0054/00544746.png>

Recommendations and concluding remarks

From the research that Fidra has conducted into benthic survey results and the performance of farms based on their CAS assessments, it is evident that the present regulatory system is enabling waste emissions from salmon farms that have a significant negative impact on the benthic environment. Retailers and processors who source Scottish salmon from these farms rely on compliance as indicating good performance, but this report shows that CAS does not always mean that.

SEPA currently regulates emissions from salmon farms under a CAR licence, granted through the Water Environment (Controlled Activities) (Scotland) Regulations 2011 [31] which require authorisations for all discharges to groundwater and surface waters. Pollution from other industries falls under the Pollution Prevention and Control (Scotland) Regulations 2012 (PPC 2012) [32]. 'Best Available Techniques' (BAT) guidance has been developed for each sector controlled by Integrated Pollution Prevention and Control (IPCC) throughout Europe and are outlined in BAT reference documents (BRefs). The PPC 2012 regulations place emphasis on the BRef documents including the requirement for an installation to be compliant within 4 years of any BRef and the resulting BAT conclusions being published. As the Controlled Activities Regulations (CAR) is an equivalent system applying to other pollution sources, there is a strong case to develop BATs and BRefs for sectors authorised under CAR licencing.

An inquiry was held in 2018 by the Scottish Parliament's Environment, Climate Change and Land Reform (ECCLR) Committee into the environmental impacts of salmon farming, for which a review of the scientific evidence relating to the environmental effects was produced [33].

The final report of the ECCLR Committee stated that further sustained and long-term research is needed in a number of areas, including:

- how waste is recycled in inshore areas;
- the relationship between waste and pathogenic organisms;
- the cumulative effect of fish farms, including in inshore areas, which have different hydrodynamics to lochs and voes;
- environmental impacts in freshwater environments;
- acceptable levels of sediment loading for different sediment types;
- resolving lack of recently synthesised data on the conditions of the benthos near fish farms [34].

The ECCLR Committee report fed into a subsequent inquiry into salmon farming by the Rural Economy and Connectivity (REC) Committee. In giving evidence to the REC Committee, SNH called for: **"a greater emphasis on collaborative analysis of post consent surveys and monitoring to develop understanding of benthic impacts, particularly focusing on Priority Marine Features and protected features, including those outside the modelled impact zone"** [35].

The REC Committee's report proposed 65 recommendations, the second of which was that "urgent and meaningful action needs to be taken to address regulatory deficiencies as well as fish health and environmental issues before the industry can expand" [35]. It further recommended that the issue of waste collection and removal be given a high priority by the industry, the Scottish Government and relevant agencies, as a main impact on the environment that needs addressing as a matter of urgency.

[31] <http://www.legislation.gov.uk/ssi/2011/209/made>

[32] <https://www.sepa.org.uk/regulations/pollution-prevention-and-control/>

[33] Tett, P. et al (2018) *Review of the Environmental Impacts of Salmon Farming in Scotland*. 024688 0001, Issue 01, 24/01/2018. pgs.: 196.

[34] Environment, Climate Change and Land Reform Committee (5th March 2018) *Report to the Rural Economy and Connectivity Committee on the Environmental Impact of Salmon Farming*. Retrieved from: http://www.parliament.scot/S5_Environment/Inquiries/20180305_GD_to_Rec_salmon_farming.pdf

[35] Rural Economy and Connectivity Committee (2018) *Salmon farming in Scotland, 9th Report* (Session 5).

Written evidence to the REC Committee inquiry from the University of Plymouth Marine Institute highlighted that "Locating fish farms above maerl habitats is not consistent with UK conservation targets and alternative sites should be sought when licensing new farms." The ECCLR Committee inquiry report stated that it "remains deeply concerned that it appears a precautionary approach has not been, and is not being, applied to the development of fish farms and in particular to farms in MPAs or in the vicinity of a PMF" [36].

The REC Committee inquiry report in turn states that: "the Scottish Government should, as a matter of priority, initiate a spatial planning exercise with a view to developing strategic guidance specifying those areas across Scotland that are suitable or unsuitable for siting of salmon farms. This work should take full account of existing strategic documents such as the Marine Plan and incorporate an assessment of the potential impact of salmon farms on MPAs and PMFs and the species which inhabit them." Marine Scotland is developing heat maps to identify areas suitable for farmed salmon expansion, which might inform a wider spatial planning exercise. The REC Committee further recommended there should be "immediate dialogue with the industry to identify scope for moving existing poorly located farms".

In light of the findings of both inquiries and in relation to the specific case studies in this report, Farm B should be close in this location and relocated. In addition, **Fidra offer the following recommendations:**

- 1 A clear limit of 3 consecutive failed or non-compliant assessments needs to be set after which a fallow period or site closure ought to be enforced.**
- 2 In areas where several poorly performing salmon farms are closely situated, further aquaculture development should cease unless, and until, performance of the farms can be improved and sustained to limit the damage to that area's benthic environment.**
- 3 No additional salmon farms should be granted in Scotland's Marine Protected Areas (MPAs) and consideration should be given to moving those that are presently in MPAs.**

Developing recommendation 1, Fidra feel that allowing farms three production cycles to implement improvements and monitor the outcomes is realistic and fair. Following three consecutive compliance assessments, if a farm is still performing poorly then we recommend that production is ceased until performance is improved and sustained.

Furthermore, Fidra understand that the Code of Good Practise (CoGP) [37] advises that fallow periods ought to last a minimum of 4 weeks, at the end of each production cycle. The Scottish Salmon Producers Organisation (SSPO) [38] report that whilst the recommended minimum is 4 weeks, the average fallow period for Scottish farms is closer to 20 weeks. Academic research indicates it is not until the 6 month mark that macrofauna even begin to show partial recovery [39]. A survey of biological structures in Scotland concluded a fallow period of over 2 years is required to recover, especially where maerl beds are present [40]. Finally, the ECCLR committee report states that research into the optimal length of fallowing "is required" [41]. Fidra support this statement given the variation in the aforementioned recommended time frames and would meanwhile encourage a longer time frame of at least 6 months be adopted as a precautionary principle.

Recommendation 2 is of particular relevance to farms in Shetland, as evidenced by a recent study conducted by SEPA to trial new methods for measuring benthic impact, which examined benthic surveys from 8 fish farms [42]. The results indicated that the impacts of farms may extend beyond their immediate vicinity, therefore where farms are closely situated there is likely to be a cumulative effect on the surrounding environment.

[36] http://www.parliament.scot/S5_Environment/Inquiries/20180305_GD_to_Rec_salmon_farming.pdf

[37] http://thecodeofgoodpractice.co.uk/wp-content/uploads/2015/02/cogp_overview.pdf

[38] <https://www.scottishsalmon.co.uk/facts/faqs/environment/what-is-a-fallowing-period-in-salmon-farming>

[39] Zhulay et al., (2015), *Effects of aquaculture fallowing on the recovery of macrofauna communities*. Marine pollution bulletin, 97, pgs. 381-390

[40] Nickell et al., (1998), *The recovery of the sea-bed after the cessation of fish farming: benthos and biogeochemistry*. ICES CM. 1998 V:1.

[41] http://www.parliament.scot/S5_Environment/Inquiries/20180305_GD_to_Rec_salmon_farming.pdf

[42] *Fish Farm Survey Report: Evaluation of a new seabed monitoring approach to investigate the impacts of marine cage fish farms*, SEPA, October 2018.

The limited information available on the Scotland Aquaculture and Scotland Environment websites make it difficult to understand the full context of the impacts and subsequent action taken, if any, by both regulators and producers in the case of 'Unsatisfactory' benthic surveys and 'Poor' or 'Very Poor' compliance. There is therefore an urgent need to increase the information flow and transparency around these, for example through a combined, more detailed database or Sustainability Dashboard. The Norwegian portal developed by Nofima, SINTEF Ocean and BarentsWatch is a good example of how such information could be put into wider context [43]. Indeed one of the final suggestions from the REC Committee report was that "a key part of any improvement in the enforcement of regulation should be the introduction of mechanisms to provide more open and transparent reporting of regulatory breaches".

With regard to the availability of information and transparency, **Fidra makes the following further recommendations:**

- 4 Benthic survey reports should be made available online, including subsequent requirements set by SEPA such as biomass reduction, or actions taken by producers.**
- 5 A compliance assessment should not be completed until a benthic survey has been undertaken. A 'Borderline' benthic survey result produced without a survey being completed should not equate to a 'Good' compliance standard.**

The recurrence of 'Unsatisfactory' benthic surveys at sites, and of 'Poor' and 'Very Poor' CAS assessments indicates that the enforcement of present regulation should be stronger, or new regulations may be required.

Fidra makes the following regulatory recommendations:

- 6 Stricter enforcement to ensure farms genuinely limit their biomass after an 'Unsatisfactory' benthic survey result.**
- 7 Farms that receive an 'Unsatisfactory' result should have more frequent benthic surveys conducted.**
- 8 Monitoring should be established to indicate how salmon farm waste interacts with other pollution streams.**

Any expansion of the Scottish salmon industry at present will be at the expense of Scotland's unique ecosystems. The economy of rural areas where salmon farms are located often relies heavily on tourism, for which the striking natural environment of Scotland is key. It is therefore vital that the aquaculture industry ensures it is operating with minimal environmental impact, so that both it and the tourism industry continue to be sustainable.

Benthic environments support the majority of marine species, directly and indirectly, through nutrition and security. The data detailed in this report shows clearly that farms across Scotland are repeatedly damaging this environment, with no clear vision for recovery of these sites. There is therefore an urgent need for increased enforcement and implementation of the new SEPA FinFish Aquaculture Sector Plan on existing farms.

Retailers also have a responsibility to consider benthic surveys and ensure they are not sourcing their products from farms that repeatedly perform poorly. This may be challenging for those retailers that source from various suppliers, in which case greater transparency of the supply chain, for example with farm names added to packaging, and a well-structured database such as a Sustainability Dashboard, would enable this information to be accessed easily.

Fidra will continue to work with a variety of stakeholders, including retailers, government, regulators, industry and NGOs, to ensure that the aquaculture sector is held to account, and environmental sustainability is considered and prioritised.

[43] <https://www.barentswatch.no/en/havbruk/environmental-studies>

Acknowledgements

Fidra would like to take the opportunity to thank SEPA and members of the salmon farming industry for engaging with us throughout our work on Scottish salmon farming and the process of writing this report.

Fidra recognise that there is a significant amount of research and innovation occurring within the aquaculture industry, both in Scotland and internationally, which will allow for standards to continue to improve. We endeavour to be part of this process by holding relevant bodies accountable for environmental harm and encouraging stakeholders to continue to communicate about how current momentum can be maintained to limit further degradation.

Fidra would like to see a model in Scotland where the aquaculture industry invests some of their profits into further Research and Development, similar to current practices in Norway. This would ensure that all stakeholders are able to keep up with the best available science and technological advancements, resulting in an efficient and premium level of performance.

It is important to state that the available data shows that some salmon farms in Scotland have performed consistently well during their production lifetime; however, Fidra do not feel that these sites require further interrogation at this time. Regardless, Fidra continue to call for context to be provided around all data for greater clarity.

