

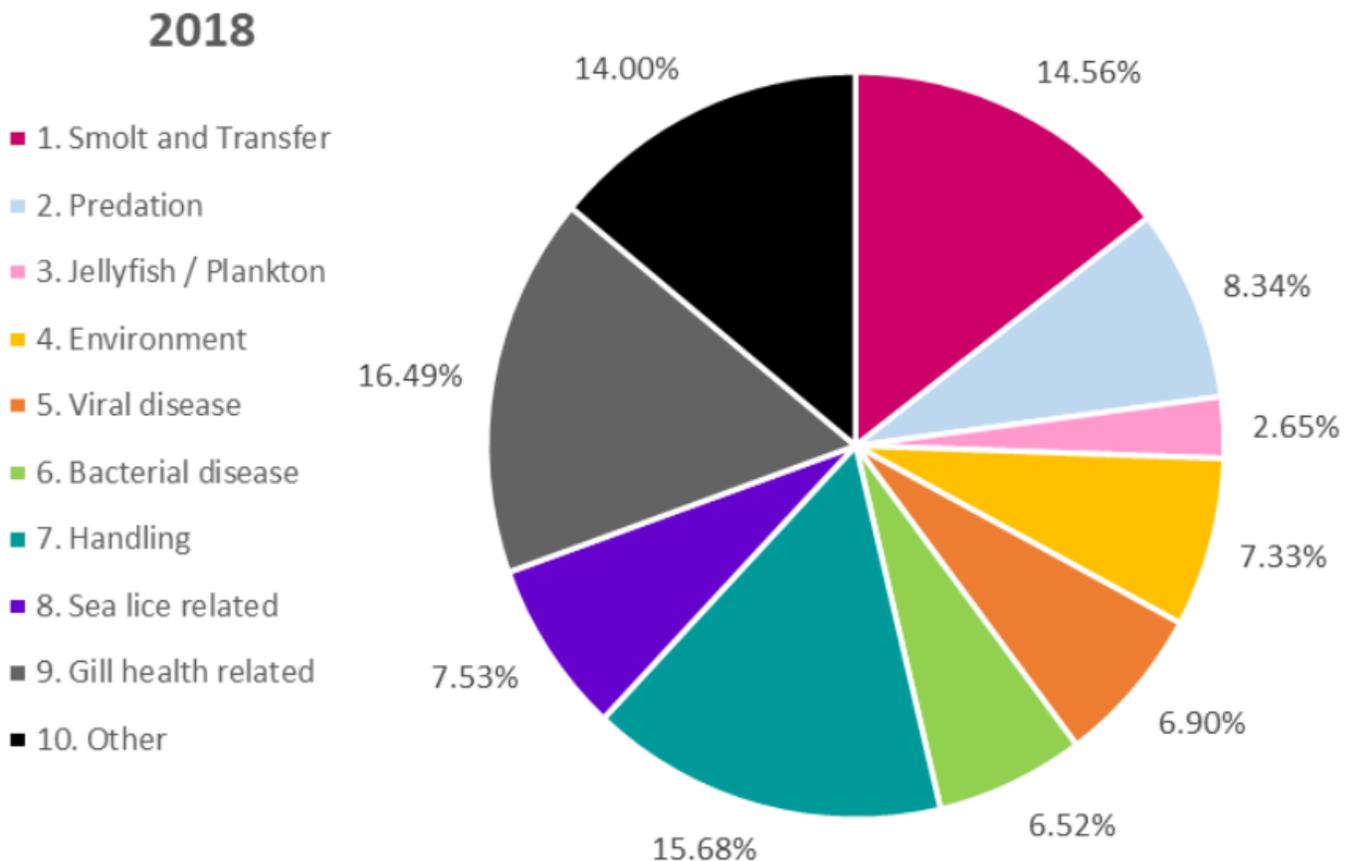
Scamon Scotland, 20 October 2023

Microjellies suffocating Scottish salmon to death

- FOI from Scottish Government turns up heat on Scotland’s ‘Silent Sting’
- Warming waters & UK heatwave signal end of salmon farming in Scotland
 - Soaring death rates on salmon farms eat into company profits
 - Jellyfish, parasites & disease could “empty the deepest of pockets”

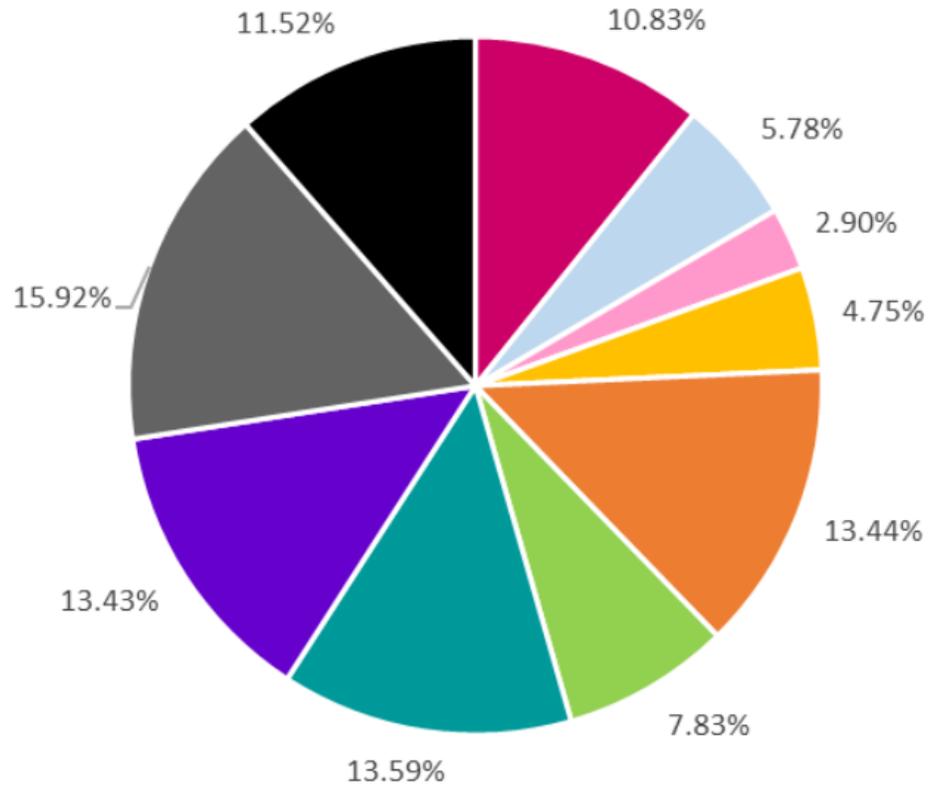
A Freedom of Information (FOI) disclosure by the Scottish Government turns up the heat on deadly Scottish salmon farms plagued by swarms of jellyfish and ‘microjellies’ [1].

One document - [An Analysis of the Causes of Mortality: Scottish Salmon Sector 2018-2020](#) – disclosed by the Scottish Government on 11 October 2023 details “a high-level analysis of the causes of mortality in marine grown salmon and trout” which will “help inform future activities within the Farmed Fish Health Framework”. In each year from 2018 to 2020, the leading cause of mortality was “gill health related” with ‘Jellyfish/Plankton’ (defined as “Physical or toxic algal damage and jellyfish stings inc. those impacting gills where jellyfish damage is the primary cause of mortality”) more than doubling in importance from 2.65% in 2018 to 6.7% in 2020:



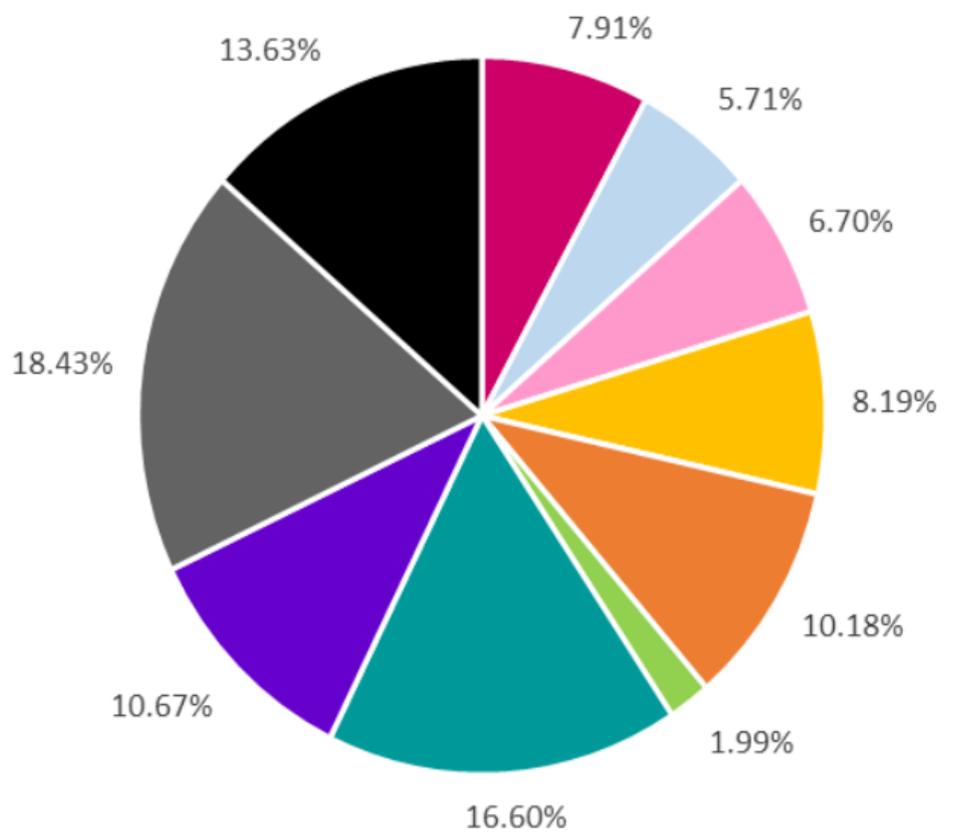
2019

- 1. Smolt and Transfer
- 2. Predation
- 3. Jellyfish / Plankton
- 4. Environment
- 5. Viral disease
- 6. Bacterial disease
- 7. Handling
- 8. Sea lice related
- 9. Gill health related
- 10. Other



2020

- 1. Smolt and Transfer
- 2. Predation
- 3. Jellyfish / Plankton
- 4. Environment
- 5. Viral disease
- 6. Bacterial disease
- 7. Handling
- 8. Sea lice related
- 9. Gill health related
- 10. Other



The [FOI reply letter from the Scottish Government dated 11 October 2023](#) refused disclosure with respect to some internal communications of a First Minister’s Questions (FMQ) briefing document prepared by a Marine Directorate Policy Officer. “We recognise that there is a public interest in disclosing information as part of open, transparent and accountable government, and to inform public debate,” stated Kate Webb (Marine Directorate FOI/EIR Adviser). “However, there is a greater public interest in allowing a private space within which officials can provide free and frank advice and views to Ministers in briefing for FMQ answers. It is clearly in the public interest that Ministers can properly answer Parliamentary questions and robustly defend the Government’s policies and decisions. They need full and candid advice from officials to enable them to do so. Disclosure of this type of information could lead to a reduction in the comprehensiveness and frankness of such advice and views in the future, which would not be in the public interest.”

The Scottish Government’s FOI disclosure (11 October 2023) included [an email to Caroline Cowan from another Scottish Government official \[name redacted\] in June 2023](#) which cited “higher mortality rates in salmon aquaculture when winters are milder”:

From: [Redacted]
To: [Cowan C \(Caroline\)](#); [Redacted]
Cc: [Redacted]
Subject: RE: Cabinet Secretary TNZJT - Briefing for Committee
Date: 19 June 2023 13:26:00

Hi all,

I think [REDACTED] has already given a good overview on marine heatwaves from MCCIP.

A few other points to note:

- There is also a warm record in the wider North Atlantic, so this signal in the coastal seas could have been transported in along the ocean current pathways, but it could also be due to local atmospheric processes (the recent warm weather). Most likely it’s a combination of both.
- We still know very little about these short-lived, extreme events: both in terms of their extent through the water column (or whether only a near-surface phenomenon) and how they impact marine species, habitats and ecosystems.
- Examples of the impacts of ocean warming more generally include changes to fish body size in wild capture fish species and higher mortality rates in salmon aquaculture when winters are milder.
 - Baudron, A.R., Needle, C.L., Rijnsdorp, A.D. and Tara Marshall, C. (2014), Warming temperatures and smaller body sizes: synchronous changes in growth of North Sea fishes. *Glob Change Biol*, 20: 1023-1031. <https://doi.org/10.1111/gcb.12514>
 - Moriarty M, Murray AG, Berx B, Christie AJ, Munro LA, Wallace IS. Modelling temperature and fish biomass data to predict annual Scottish farmed salmon, *Salmo salar* L., losses: Development of an early warning tool. *Prev Vet Med*. 2020 May;178:104985. doi: 10.1016/j.prevetmed.2020.104985. Epub 2020 Apr 6. PMID: 32289615.

- Australia is at the forefront of research on the impact of marine heat waves globally. Scientists there have reported reductions of kelp forest, jellyfish bloom occurrences and coral reef loss due to marine heatwaves.
- We anticipate warming temperature to continue to grab headlines this year: forecasts suggest a shift to El Nino conditions by late 2023 (with significant impacts in the Pacific and usually higher global average temperatures), and the warming in the Atlantic mentioned above means there is now a significant “hurricane generation region” (the seasonal forecast has already been adjusted from “near normal” in May, to a “above average but more unpredictable” this past week by one weather forecaster).

The above email cited the scientific paper – ‘[Modelling temperature and fish biomass data to predict annual Scottish farmed salmon, *Salmo salar* L., losses: Development of an early warning tool](#)’ – published in the journal Preventative Veterinary Medicine in May 2020.

Another undated and unattributed document disclosed by the Scottish Government on 11 October 2023 addressed ‘[Marine Heatwaves](#)’ citing ‘international evidence’ suggesting a variety of possible impacts “including algal blooms, deoxygenation of water column, jellyfish blooms, impacts on fish size and increased mortality risk for marine species including at aquaculture sites”:

Marine heatwaves

19 June: VARIOUS MEDIA REPORTS ([BBC](#), [Guardian](#)) - UK Met office climate scientists and US National Oceanic and Atmospheric Administration (NOAA) warning of a marine heatwave concentrated around the UK and Ireland, impacting Scotland’s coastal seas (to the west of Scotland and in the North Sea).

Above average temperatures have been recorded for the time of year, and may be four degrees above the long-term average. The region has been categorised as being hit by category 4 (extreme) marine heatwave (most severe on scale). The exact cause of the heatwave is being investigated but a combination of natural variation in weather patterns and climate change are factors. Further study marine observation data is needed to confirm the magnitude and extent of this current warming event.

The implications for Scotland’s marine ecosystems remain unknown at this stage. Evidence of the impacts of marine heatwaves in the UK is limited as this is a rare event but international evidence suggests a variety of impacts are possible including algal blooms, deoxygenation of water column, jellyfish blooms, impacts on fish size and increased mortality risk for marine species including at aquaculture sites.

We anticipate ocean temperatures and the role of the ocean in the global climate to continue making global news headlines in the coming months. Forecasts suggest a shift from neutral to El Niño conditions by late 2023 and ocean temperatures globally are above average.

‘Top Lines’ identified in the Scottish Government’s [Marine Heatwaves](#) document included:

TOP LINES

Scotland’s seas are experiencing an unprecedented, extreme, marine heat wave due to a combination of factors including climate change, illustrating the importance of not only Scotland but all nations taking climate action and building an effective pathway to net zero.

- Marine Heatwaves are an increasing risk in Scottish waters but are currently poorly understood due to limited targeted monitoring, it is therefore important we maximise learning from this event to understand the risks and resilience of Scotland’s marine environment.

The Scottish Government is monitoring this event through our marine monitoring programme on ocean climate and in collaboration with international partners and will assess the various risks to marine species and potential risks to human health.

- Scotland has an established ocean climate monitoring programme. This helps us to understand both these short-lived extremes and the long term changes in the ocean climate which occur because of natural variability and global warming.
- Scotland’s marine environment monitoring is also helping us to understand wider impacts of climate change and ocean acidification.
- Marine heatwaves can influence the potential for Harmful Algal Blooms. Food Standards Scotland monitoring will identify any potential risk to human health.

The Scottish Government’s [Marine Heatwaves](#) document included a ‘Background Briefing’ which cited how “previous analyses have, for example, linked milder winter temperatures to higher mortality in Scottish salmon aquaculture”:

Background Briefing

Scotland’s coastal seas (to the west of Scotland and in the North Sea) are experiencing anomalously warm sea surface temperatures. A marine heatwave occurs when sea water temperatures are anomalously warm for five days or more compared to the long-term average. This is similar to the definition of heatwaves in the weather. The US National Oceanic and Atmospheric Administration (NOAA) is categorising the region as being hit by a category 4 (extreme) marine heatwave (most severe on scale). Although further study of high resolution, sustained ocean observations is needed in order to confirm the magnitude and extent of this current warm event and place it in context. Marine Directorate scientists continue to monitor research outputs and will also investigate further from our own monitoring data.

The Atlantic Ocean surface waters have been warming extremely fast in recent weeks. These warm waters could have been transported along the known ocean current pathways into Scottish waters, thus being the source of these extreme warm sea surface temperatures. Local sunny and calm weather may also have contributed. The reason for this warm event still needs to be investigated. The exact reason for the extreme warm sea surface temperatures in the Atlantic are also still being investigated, but weaker than average winds, reduced input of Saharan dust and atypical weather patterns over North America may all play a role. Colleagues will continue to monitor this event in our own sustained observations of ocean climate and in collaboration with partners.

The implications for Scotland's marine ecosystems remain unknown at this stage. Evidence of the impacts of marine heatwaves in the UK is limited. Marine heatwaves have been associated globally with blooms of gelatinous plankton (such as jellyfish), coral reef loss and mass mortality events across marine organisms (these are often linked to knock-on environmental influences and/or cascading effects across species). Previous analyses have, for example, linked milder winter temperatures to higher mortality in Scottish salmon aquaculture, and warmer sea temperatures have been linked to a tendency towards smaller adult fish in the North Sea on average.

We anticipate ocean temperatures and the role of the ocean in the global climate will continue making global news headlines in the coming months. Forecasts suggest a shift from neutral conditions to El Niño conditions by late 2023: this change in the prevailing weather patterns of the subtropical Pacific has repercussions for the local ocean climate and strong El Niño events have been known to impact marine ecosystems, as well as have severe weather impacts on land. Global mean temperatures in the year following an El Niño are often higher and the period 2023-2027 is predicted to be between 1.1 °C and 1.8 °C warmer than the 1850-1900 average (World Meteorological Organisation; global mean temperature in 2022 was 1.15 °C above 1850-1900 mean).

Reaction

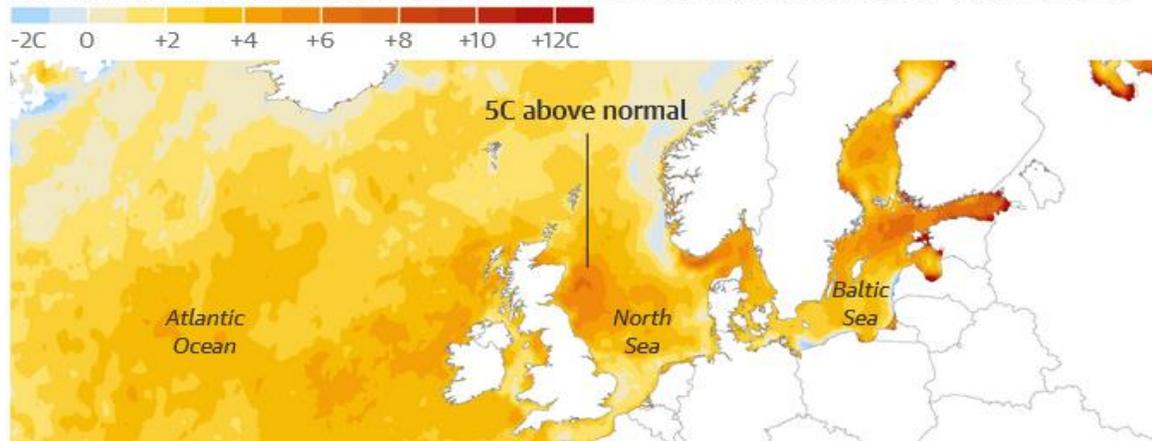
- **Professor Kim Cobb, earth sciences at Brown University.** *"The combination of El Niño and global warming will bring a stepwise decline in marine ecosystem capacity..... not steady and gradual, it's a cliff that species and ecosystems fall off.....It does not bode well for ecosystems around the world.....This is an important year for monitoring and identifying ways to assist species through these next couple of decades"*.
- **Dr Dan Smale from the Marine Biological Association** *"Current temperatures are way too high but not yet lethal for majority of species, although stressful for many ... If it carries on through summer we could see mass mortality of kelp, seagrass, fish and oysters"*.

Scamon Scotland [reported via ‘Scottish Salmon’s Silent Sting’ on 4 October 2023:](#)

Temperatures in Scotland – as [published by the Scottish Government’s Fish Health Inspectorate](#) – have reported temperatures in excess of 14 degrees C with [14.8 degrees C reported at Bakka Frost’s East Tarbert Bay salmon farm off the Isle of Gigha in August 2022](#); [16.8 degrees C off Islay in August 2022](#); [14.3 degrees C in Loch Broom in August 2022](#) and [14.2 degrees C in Loch Kanaird in August 2022](#). Data for the summer of 2023 – to be published [online here](#) - may report even higher temperatures in view of an [“unheard of” marine heatwave](#).

Sea temperatures around the UK are several degrees above normal

Sea surface temperature anomaly on 17 June compared with long-term average for the time of year



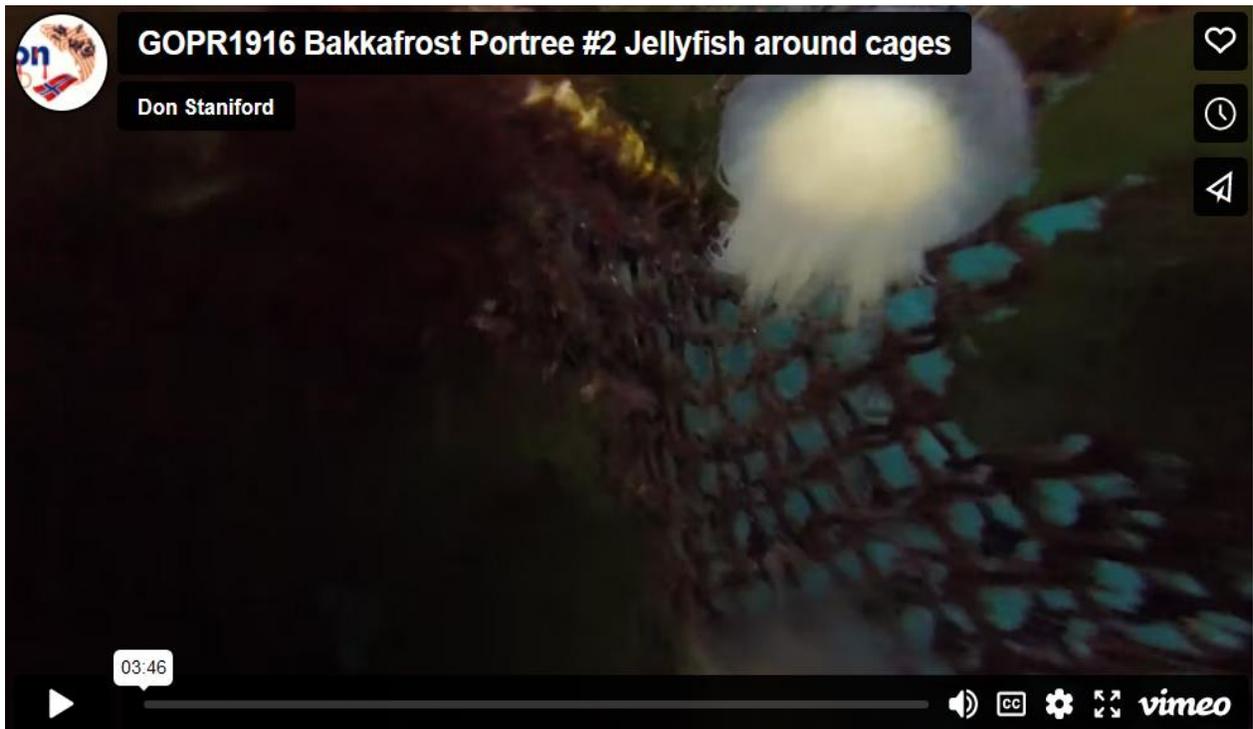
Video evidence of jellyfish attacking salmon farms is stacking up as water temperatures crank up the heat. When Scamon Scotland visited Fishnish salmon farm operated by Scottish Sea Farms (Norskott Havbruk) in the Sound of Mull in August 2023 we found Lion’s Mane jellyfish swarming outside a cage and their stinging tentacles encroaching inside the net:



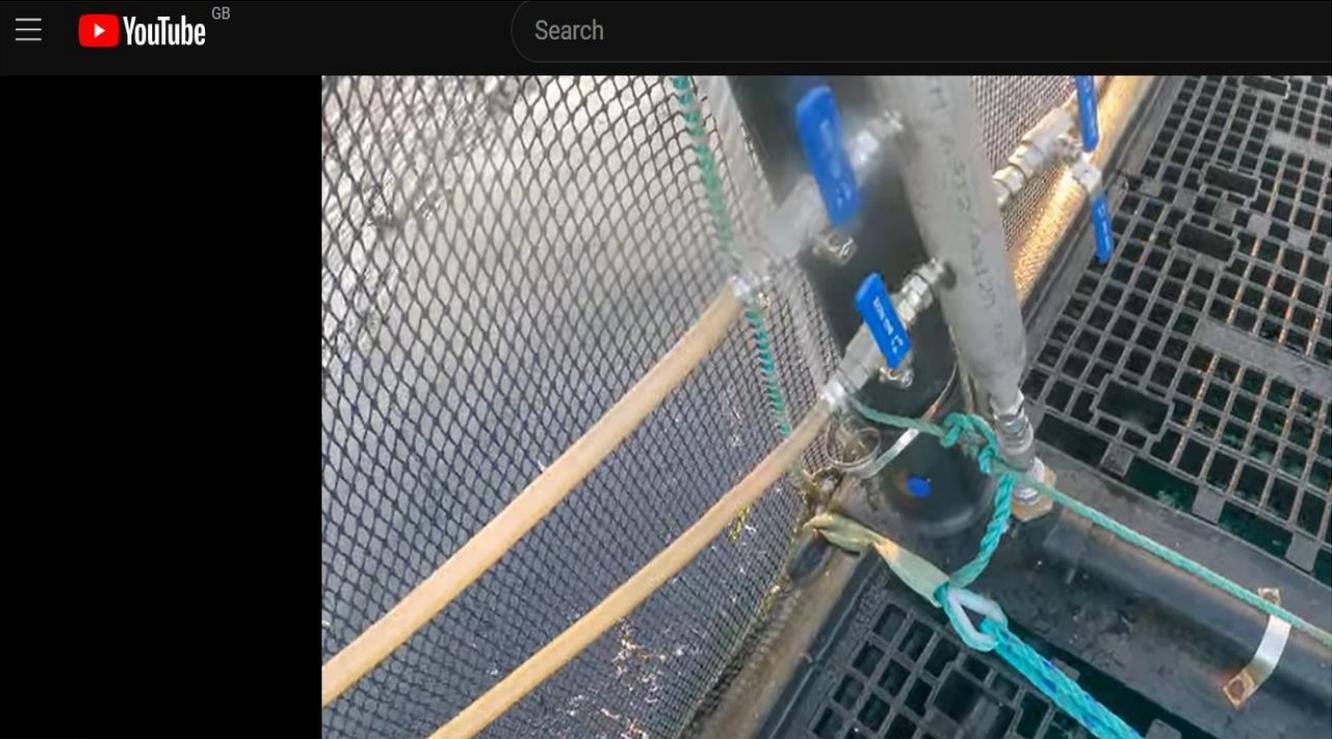
Video footage shot at Scallastle Bay salmon farm operated by Scottish Sea Farms (Norskott Havbruk) in the Sound of Mull in June 2023 shows jellyfish stuck on the outside of the net and a toxic soup of microjellies and zooplankton:



In this video footage shot at Bakkafrost's Portree salmon farm off the Isle of Skye in late June 2023 you can see jellyfish congregating outside the salmon cage with the tentacles of one medusa reaching out into the net where the farmed salmon are swimming:



When \$camon \$cotland visited Bakkafrost's Geasgill salmon farm in Loch Na Keal off the Isle of Mull in late June 2023 we found swarms of jellyfish and a toxic soup of microjellies and zooplankton with oxygen being pumped into the cages:



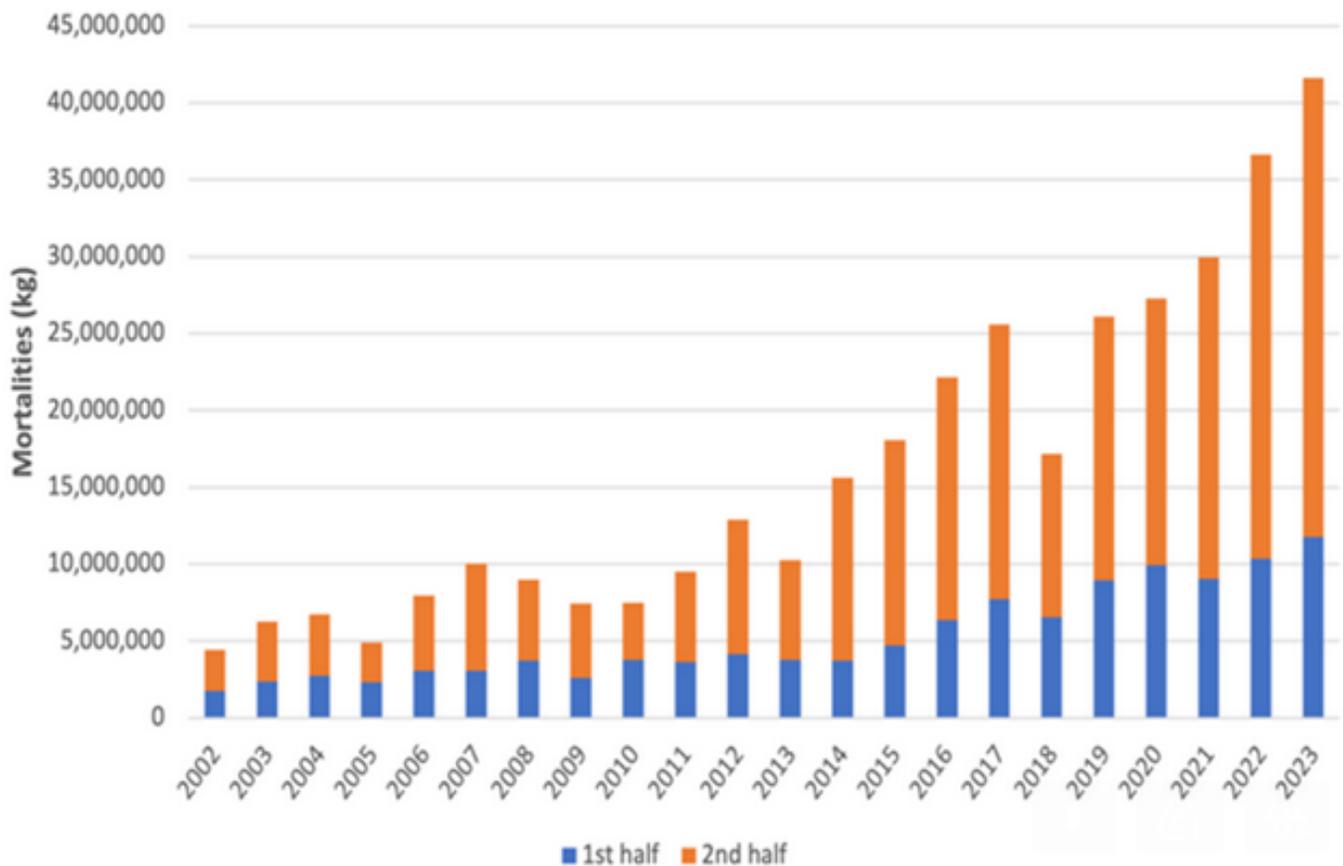
When Scamon Scotland visited Bakkafrost's Gometra salmon farm in August 2023 we captured evidence of microjellies inside and outside the cages along with dead fish floating on the surface:



[Note the Scottish Government's Fish Health Inspectorate [reported on 2 October 2023](#) that Bakkafrost's Gometra salmon farm suffered "gill damage the result of microjellies" with "large numbers of jellyfish reported" and 14,994 dead fish in late August 2023]



Mortalities on salmon farms in Scotland in 2023 are [shaping up to be the worst ever with a record 11,761 tonnes of morts reported in the first six months of this year and 41,623 tonnes predicted by the end of 2023](#).



Read more via: [Scottish Salmon is Dead in the Warming Water!](#)

Mass mortalities at Scottish salmon farms – and jellyfish blooms - could increase even further during 2023 if the marine heatwave has accelerated mortality ([satellite data from the European Space Agency in June 2023 showed sea surface temperature more than 5°C higher than the average during this time of year](#)).

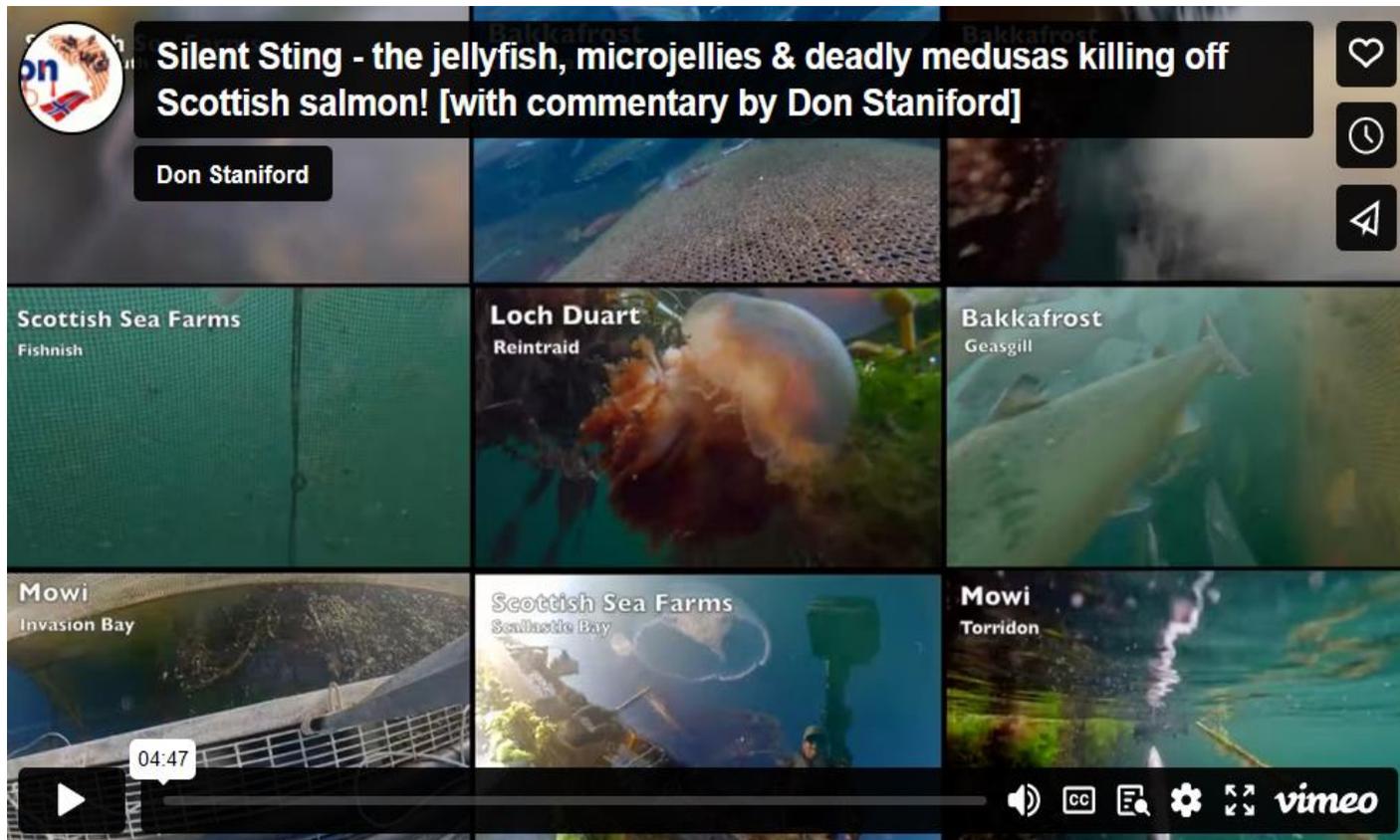
Increases in mortalities on salmon farms have been correlated with rising water temperatures. “At salmon farms, a strong link between milder winter temperatures, disease and increased fish mortality has been identified,” reported a ‘Marine Climate Change Impacts Partnership’ paper co-authored by Marine Scotland Science and the Institute of Aquaculture in Stirling [published in November 2022](#). “We have statistical evidence of an existing association of salmon mortality with milder winters and evidence of the emergence of amoebic gill disease in UK waters in association with warm summers and persistence with mild winters.”

Read more via a Freedom of Information disclosure by the Scottish Government in September 2023 [2].

Media Backgrounder: Scottish Salmon is Dead in the Warming Waters (October 2023)

The Silent Sting of the Sea:

Earlier this month (4 October), Salmon Scotland [published video footage](#) showing jellyfish and microjellyfish swarming around salmon farms operated by Mowi, Scottish Sea Farms, Bakkafrost and Loch Duart:



In [video footage shot between May and August 2023](#), larger jellyfish species such as Lion’s Mane and Moon Jellyfish are clearly visible with their tentacles stinging through the nets. Microscopic jellyfish – dubbed ‘microjellies’ by salmon farmers - are by definition much more difficult to see. A jellyfish expert has identified *Pleurobrachia pileus* (sea gooseberry) – which can clog the gills of farmed salmon and *Pandeidae* – it has bell-shaped medusa and threadlike tentacles – from the video footage. ‘Mortality Event Reports’ and ‘Case Information’ [published by the Scottish Government](#) has cited *Obelia*, *Muggiaea Atlantica*, *Solmaris* and *Sarsia tubulosa*.

Increasing Deaths Caused by Jellyfish:

14 cases [reported by Salmon Scotland for August 2023](#) (published in October 2023) cited jellyfish/plankton as the reason(s) for mortalities headed by 38.2% monthly mortality at Bakkafrost’s Lamlash salmon farm off the Isle of Arran, 29.8% at Bakkafrost’s Greanamul

(which reported 56.4% cumulative mortality) and 28.7% monthly mortality at Bakkafrost's Geasgill off the Isle of Mull:



Monthly Mortality Rate: August 2023

Published: October 4th, 2023

DOWNLOAD 

Company	Farm	Monthly mortality (%)	Notes	Cumulative mortality over full production cycle (%)
Bakkafrost Scotland	Lamlash	38.2	Jellyfish / plankton, Viral disease	In production
Bakkafrost Scotland	Greanamul	29.8 (Farm followed in Aug.)	Jellyfish / plankton, Viral disease	56.4
Bakkafrost Scotland	Geasgill	28.7	Jellyfish / plankton, Viral disease	In production
Bakkafrost Scotland	Maragay Mor	26.0 (Farm followed in Aug.)	Jellyfish / plankton, Viral disease	33.5
Scottish Sea Farms Ltd	Kishorn C (West)	23.5	Jellyfish / plankton, Gill health related	In production
Bakkafrost Scotland	Gravir Outer	23.1	Jellyfish / plankton	In production
Bakkafrost Scotland	Maaney	21.7 (Farm followed in Aug.)	Jellyfish / plankton, Viral disease	35.0
Bakkafrost Scotland	Portree	19.6	Jellyfish / plankton	In production
Scottish Sea Farms Ltd	Kishorn A (South)	17.7 (Farm followed in Aug.)	Jellyfish / plankton, Gill health related	40.5
Scottish Sea Farms Ltd	Kishorn B (North)	17.6	Jellyfish / plankton, Gill health related	In production
Scottish Sea Farms Ltd	West of Burwick	15.4 (Farm followed in Aug.)	Viral disease	37.1
Mowi Scotland Limited	Camas Glas	15.0	Bacterial disease	In production
Mowi Scotland Limited	Loch Hourn	10.7	Gill health related	In production
Mowi Scotland Limited	Rum	10.7 (farm followed in Aug.)	Gill health related	6.1
Scottish Sea Farms Ltd	Langa	10.0	Viral disease	In production
Bakkafrost Scotland	Kyles Vuia	9.9	Bacterial disease	In production
Bakkafrost Scotland	Gometra	8.9	Jellyfish / plankton, Viral disease	In production
Mowi Scotland Limited	Greshornish	8.1 (Farm followed in Aug.)	Jellyfish / plankton	19.0
Scottish Sea Farms Ltd	Setter	7.1	Viral disease	In production
Bakkafrost Scotland	West Strome	6.6	Jellyfish / plankton	In production
Mowi Scotland Limited	Bagh Dall Nan Cean	6.5	Gill health related	In production
Scottish Sea Farms Ltd	Score Holms	6.1	Viral disease	In production
Cooke Aquaculture (Scotland)	Carness Bay	5.9	Predation, Gill health related	In production
Scottish Sea Farms Ltd	North Papa	5.8 (Farm followed in Aug.)	Viral disease	41.3
Scottish Sea Farms Ltd	Westerbister	5.7	Environmental	In production
Mowi Scotland Limited	Ardnish	5.3	Jellyfish / plankton	In production

[Data for September 2023 is expected to be [published by Salmon Scotland](#) in early November 2023]

Data [published by Salmon Scotland for July 2023](#) (published in September 2023) cited 10 cases where jellyfish/plankton – along with gill health and viral disease - caused mortalities at salmon farms (by comparison with the same time last year, there were [no mortality incidents citing jellyfish in July 2022](#)):

Monthly Mortality Rate: July 2023

Published: September 1st, 2023



Company	Farm	Monthly mortality (%)	Notes	Cumulative mortality over full production cycle (%)
Bakkafrost Scotland	Geasgill	23.7	Jellyfish / plankton, Gill health related, Viral disease	In production
Bakkafrost Scotland	Gravir Outer	22.6	Jellyfish / plankton, Gill health related, Viral disease	In production
Scottish Sea Farms Ltd	Kishorn C (West)	16.2	Jellyfish / plankton, Gill health related	In production
Scottish Sea Farms Ltd	Kishorn A (South)	15.2	Jellyfish / plankton, Gill health related	In production
Bakkafrost Scotland	Lamlash	13.8	Jellyfish / plankton, Gill health related, Viral disease	In production
Scottish Sea Farms Ltd	Kishorn B (North)	11.3	Jellyfish / plankton, Gill health related	In production
Scottish Sea Farms Ltd	Lober Rock	9.5	Jellyfish / plankton, Gill health related	In production
Bakkafrost Scotland	Gometra	4.6	Jellyfish / plankton, Gill health related	In production
Scottish Sea Farms Ltd	Hunda	4.1	Jellyfish / plankton, Gill health related	In production
Scottish Sea Farms Ltd	Westerbister	3.9	Jellyfish / plankton, Gill health related	In production

No jellyfish-related mortalities were [reported by Salmon Scotland between January and June 2023](#) (the [previous citation of jellyfish was in November 2022](#)). The salmon farming industry has [published monthly data on mortalities since January 2021](#) – including 22 cases in 2022 where ‘jellyfish’ are cited as a cause of mortality (spiking in [September 2022](#) with 13 cases including 56% mortality at Loch Duart’s RSPCA Assured Loch Carnan salmon farm and 38% mortality at Mowi’s RSPCA Assured Stulaigh salmon farm) and 9 cases in 2021. The month of May was the earliest report of jellyfish problems in any year with the month of September accounting for 16 of the 22 cases in 2022 and 2021.

Read more via: [Silent Sting](#) and [Media Backgrounder - Dead in the Warming Water Addendum](#)

Warming Waters Threaten Salmon Farming in Ireland & Scotland:

The Irish Times [reported \(19 October\)](#) on the ‘climate crisis’ and the ‘impact of warmer seawaters’: “The current marine heatwave encapsulates one of the most pressing technological challenges for aquaculture in Irish waters, according to both operators and groups like Friends of the Irish Environment (FIE). Warmer waters, jellyfish, parasites and disease could ‘empty the deepest pockets’, according to FIE’s Tony Lowes”.

Bakkafrost Scotland is Dead in the Water:

“The Bakkafrost Scotland third quarter harvest will be down by almost half the total of last year, a trading update from the company has revealed,” [reported Fish Farmer \(5 October\)](#) via an article titled: ‘Near 50% drop in Bakkafrost Scotland harvest’. “The company continues to battle various biological issues in Scotland”.

Bakkafrost’s [2021 Annual Report](#) – published in October 2022 - references the “deadly cocktail” of micro-jellyfish and reduced gill health:



ANNUAL REPORT 2021

In Scotland, we had severe mortality in Q3 and Q4, with a total of 262 mDKK in exceptional mortality costs. The underlying issue was linked to the reduced gill health the fish develops due to the extended growth cycle in the marine environment, up to 22 months, due to the small average smolt size on release. The fish are exposed to hazards that impair their gills during this period. Late in Q3 and into Q4, there was a significant bloom of hydrozoans and micro-jellyfish, which deteriorated the gill health even more and led to very high mortality across several sites. In short, the micro-jellyfish bloom on top of reduced gill health was a deadly cocktail.

Biological ‘Risks’ & ‘Problems’ Reported by BBC Scotland in August:

“Some of Scotland's biggest salmon farms have reported significant and continuing ‘biological’ problems,” [reported BBC Scotland’s business and economy editor \(23 August\)](#). “That often refers to sea lice or disease and there has also been a challenge from exceptionally high sea temperatures, bringing more jellyfish. Leroy, the Norwegian firm that owns half of Scottish Sea Farms, said April to June was ‘extremely challenging’Scottish Sea Farms have revised their estimated full-year output to 27,000 tonnes, having produced 38,000 tonnes over the whole of 2022.”

“Scottish Sea Farms cuts harvest estimate by 10,000 tonnes,” [reported Fish Farming Expert \(23 August 2023\)](#). “Company made £10.6m operating loss in Q2”. The Q3 2023 financial results from Scottish Sea Farms (co-owned by SalMar and Leroy under the company name Norskott Havbruk) will be [published on 15 November 2023](#).

“High temperatures caused some feeding issues due to the challenges of storing and handling feed in such high air temperatures,” [reported BBC Scotland \(23 August\) in relation to Mowi Scotland](#). “These also led to more challenging environmental conditions related to increased presence of plankton, algae and jellyfish.”

Salmon Farming in Scotland is Cooked:

Fish Farming Expert [reported \(19 October\)](#): “Like other salmon producers Cooke was affected by the micro jellyfish blooms that occurred in Scottish waters, but the impact was restricted to some of its Orkney sites, with its sites in Shetland untouched.”

Cooke Aquaculture Scotland’s ‘Strategic Report’ for 2022 – [published on 17 October 2023](#) – flags up the ‘market risks’ of “changes to environmental conditions, resulting in increasing numbers of plankton, algae’s and, in extreme case, micro jellyfish, which negatively affects gill health. Cooke cites “a severe biological issue with the impact of micro-jellyfish that affected the whole Scottish industry” [3].

Loch Duart Warns Investors of ‘Changing Climate’ Risks:

“Risks in relation to fish health and mortality levels are inevitable in aquaculture,” reported Loch Duart in a ‘Strategic Report’ [published in December 2022](#). “The changing climate, with recent warm dry summers, has changed the underlying risk levels and will require innovation in farming practice to cope” [4].

Mowi is Feeling the Heat:

‘[Mowi projects EUR 37 million earnings drop in Q3](#)’ reported Seafood News (19 October) on a financial update for the world’s biggest salmon farmer. Mowi’s Q3 2023 report will be [published on 8 November 2023](#).

“Over the summer, temperatures have been high and biology challenging,” said Pareto Securities analyst Sander Lie in an article - ‘[Should weaker results outside of Norway be a concern for Mowi?](#)’ - published by Salmon Business (18 October 2023).

“The update was disappointing, and will probably lower expectations for the next quarter,” analyst Wilhelm Roe at Danske Bank [told IntraFish \(18 October 2023\)](#). “The company mentions that Canada has had challenges with algae that have affected both profit and volume, but in general Chile, Canada, Scotland and Iceland have all come in weaker than expected. This is probably due to both lower price achievement and higher costs than expected, and it has been somewhat more challenging biology than expected.”

“There was probably some problematic biology in both Scotland and Chile, as well as Canada,” said another financial analyst in the Intrafish article titled: [Shares in world's largest salmon farmer Mowi sink after disappointing profit setback](#).

Mowi’s Q2 2023 report – [published in August 2023](#) – flagged up “higher than normal” seawater temperatures and the “increased presence of plankton, algae and jellyfish” which could reduce production later this year:

“Biological performance was relatively stable in Scotland whilst seawater temperatures were higher than normal throughout the quarter which may impact biological performance in the second half of 2023.” (p5)

“Biological performance in the quarter was relatively good, especially taking into consideration the record-high seawater temperatures. However, the high temperatures caused some feeding issues due to the challenges of storing and handling feed in such high air temperatures. The high temperatures also led to more challenging environmental conditions related to increased presence of plankton, algae and jellyfish.” (p10)

Mowi’s Q4 2022 report – [published in February 2023](#) – cited “significant issues with micro-jellyfish in the aftermath of a record warm summer” and “relocation to inshore sites during the jelly fish bloom”:

“Harvest volumes in Scotland dropped slightly compared with the fourth quarter of 2021, which was below guidance. Supply was negatively impacted by adverse biological issues related to SRS following significant issues with micro-jellyfish in the aftermath of a record-warm summer.” (p5)

“Salmon which were relocated to inshore sites during the jelly fish bloom, recovered well and were harvested at the end of the fourth quarter, with some stocks being deferred for harvesting into the first quarter.” (p10)

Mowi’s Q3 2022 – [published in November 2022](#) – cited how “micro-jellyfish impacted growth and harvest volumes” leading to relocation to other sites and “accelerated harvesting”:

“Harvest volumes in Scotland dropped slightly compared with third quarter of 2021, which was below guidance. Biological issues related to gill health and effects from micro-jellyfish impacted growth and harvest volumes.” (p5)

“Non-seawater costs were significantly impacted by incident-based mortality of EUR 7.6 million (EUR 1.5 million), or EUR 0.52/kg, related to micro-jelly fish blooms around Skye and the Western Isles causing elevated mortalities in some of our farms. As a response to these challenges several fish groups were relocated to other sites with good results.” (p10)

Mowi’s [Q3 2022 report](#) cited “elevated mortality costs in Scotland and Ireland caused by issues with micro-jellyfish”:

“Results within Farming were good in the quarter due not only to strong prices and record-high volumes, but also relatively stable farming costs compared to the previous quarter, despite elevated mortality costs in Scotland and Ireland caused by issues with micro-jellyfish.” (p20)

Mowi’s Q2 2022 report – [published in August 2022](#) – cited in relation to Scotland:

“Incident based mortality losses in the quarter amounted to EUR 2.8 million (EUR 1.5 million) mainly related to gill issues, treatment mortality and predators. In addition to the issues related to

stocks grown from externally sourced eggs, the biological situation has been negatively impacted by gill issues, including AGD, algae and jelly fish.” (p10)

Mowi’s ‘Salmon Farming Industry Handbook 2023’ – [published in July 2023](#) – included (p99):

Salmon Farming Industry Handbook 2023



Risk Factors

12.2 Most important health risks to salmon

Gill Disease (GD): GD is a general term used to describe gill conditions occurring in sea. The changes may be caused by different infectious agents; amoeba, virus or bacteria, as well as environmental factors including algae or jellyfish. Little is known about the cause of many of the gill conditions and to what extent infectious or environmental factors are primary or secondary, how they interact, and causes of disease.

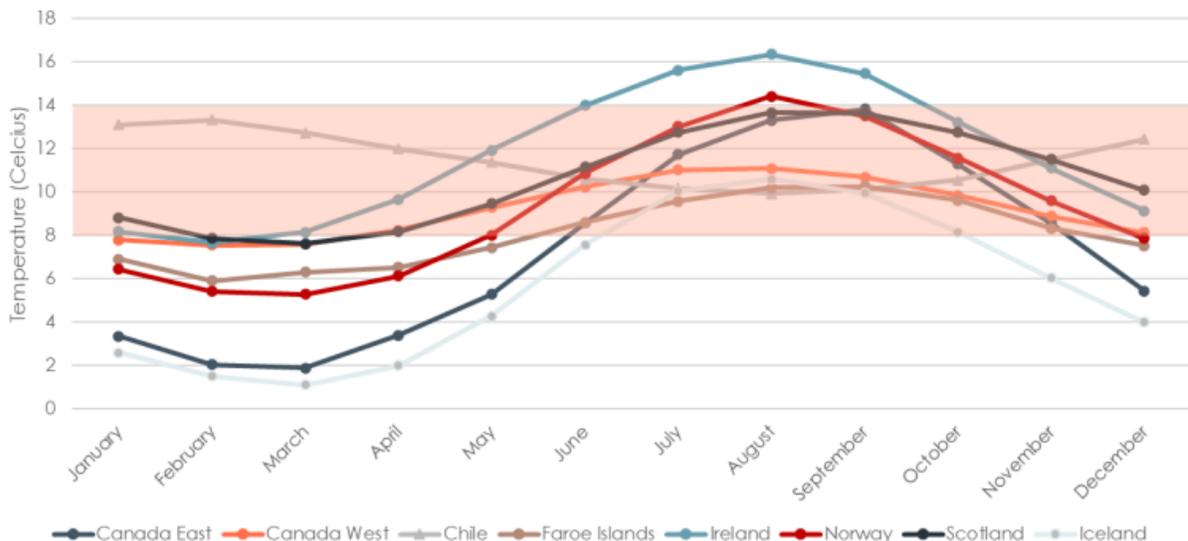
Mowi’s ‘[Salmon Farming Industry Handbook 2023](#)’ includes (p28):

“The optimal temperature range for salmon is between 8 and 14 degrees C”.

Mowi’s ‘[Salmon Farming Industry Handbook 2023](#)’ includes (p54):

Salmon Production and Cost Structure

8.3 Influence of seawater temperature

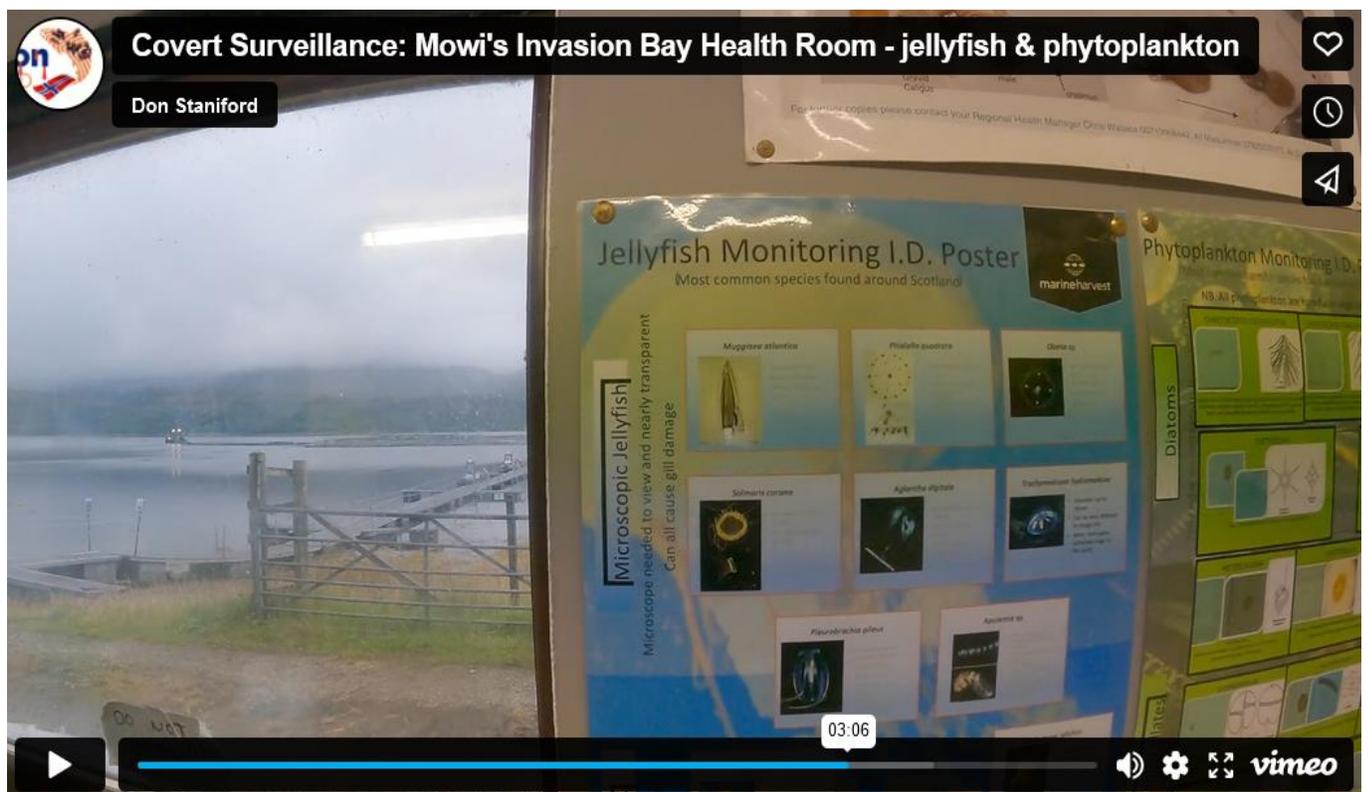


Seawater temperatures vary considerably throughout the year in all production regions. While the production countries in the northern hemisphere see low temperatures at the beginning of the year and high temperatures in autumn varying by as much as 10°C, the temperature in Chile is more stable varying between 10°C and 14°C. Chile and Ireland have the highest average temperature of 12°C, and the four other regions have an average temperature of about 10°C, except from Iceland which have the lowest average temperature of 6°C.

As the salmon is a cold-blooded animal (ectotherm), water temperature plays an important role in its growth rate. The optimal temperature range for Atlantic salmon is 8-14°C, but they thrive well from 4-18°C. Temperature is one of the most important natural competitive advantages that Chile has compared to the other production regions as production time there has historically been shorter by a few months.

With high seawater temperatures the risk of disease increases, and with temperatures below 0°C, mass mortality becomes more likely, both of which cause the growth rate to fall.

When Scamon Scotland [visited Mowi's Invasion Bay salmon farm in Loch Sunart in August 2023](#) we saw warnings of jellyfish, microjellies and plankton on the walls of the 'Health Room':



Salmon Scotland’s big problem with microscopic jellyfish & “a tiny bunch of critics”:

Writing in the [October 2023 issue of Fish Farmer magazine](#), Salmon Scotland’s Chief Executive Tavish Scott said:

“This time last year, we faced a significant increase in microscopic jellyfish blooms, which affected the survival of farm-raised fish. As we said at the time, 2022 production was down – and that is reflected in annual data now being published by government following the usual time-lag....While there are a tiny bunch of critics who want to close us down, the simple reality is that global climate change risks mean that we must lead the world in growing healthy, sustainable salmon for decades to come.” [5]



Reaction from Don Staniford, Director of \$camon \$cotland:

“Salmon farming in Scotland is dead in the warming water. A deadly cocktail of rising temperatures, swarms of jellyfish, toxic algal blooms, plagues of parasites and gill diseases is the death knell for Scottish salmon. This lethal industry is losing so much \$almoney that shareholders in Norway must be crying into the fjords. Mass mortalities are leaping so fast that salmon farming in Scotland may not even last the decade. Feedlots must be closed down now as a matter of urgency to end the welfare nightmare for millions of suffering salmon. Shame on RSPCA Assured, the Soil Association and the ASC for greenwashing Scottish salmon.”

Read more via [Media Backgrounder - Dead in the Warming Water](#)

‘End Salmon Farming’ digivan tours UK supermarkets from Halloween:

[Join the Scottish Salmon Boycott - 'Digivan' Tour from London to Edinburgh \(31 October to 6 November\)](#)

Contact:

Don Staniford: 07771 541826 (salmonfarmingkills@gmail.com)

Notes to Editors:

[1]

MARINE DIRECTORATE
Corporate, Strategy & Marine Planning



Scottish Government
Riaghaltas na h-Alba
gov.scot

T : Working from home please contact by email
E : kate.webb@gov.scot

Don Staniford
salmonfarmingkills@gmail.com

Our Reference: 202300376448

Your Reference: Request for Source Documents on Jellyfish inside and around salmon farms

11 October 2023

Dear Don Staniford,

REQUEST UNDER THE ENVIRONMENTAL INFORMATION (SCOTLAND) REGULATIONS 2004 (EIRs)

Thank you for your request dated 15 September 2023 which you made as part of your request for a review of our response to your original EIR case reference number 202300372264.

Your request

You asked for us to: *"provide the source documents and the 'advice' cited above."*

For context, by "above", you are referring to wording contained within Annex A of our response to your previous EIR request handled under case reference number 202300372264.

As the information you have requested is 'environmental information' for the purposes of the Environmental Information (Scotland) Regulations 2004 (EIRs), we are required to deal with your request under those Regulations.

Response to your request

I enclose a copy of most of the information you requested. Please find PDFs 1, 2 & 3 enclosed.

While our aim is to provide information whenever possible, in this instance we are unable to provide some of the information you have requested because exceptions under regulation 10(4)(e) (internal communications) and regulation 11(2) (personal data of a third party) of the EIRs applies to that

Marine Laboratory, 375 Victoria Road,
Aberdeen AB11 9DB
www.gov.scot/marine-and-fisheries/



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We invest in people Silver



information. The reasons why these exceptions apply are explained in the Annex to this letter.

Your right to request a review

If you are unhappy with this response to your EIRs request, you may ask us to carry out an internal review of the response, by writing to Annabel Turpie, The Director of the Marine Directorate, Victoria Quay, The Shore, Edinburgh, EH6 6QQ or by emailing: directormarine@gov.scot

Your review request should explain why you are dissatisfied with this response, and should be made within 40 working days from the date when you received this letter. We will complete the review and tell you the result, within 20 working days from the date when we receive your review request.

If you are not satisfied with the result of the review, you then have the right to appeal to the Scottish Information Commissioner. More detailed information on your appeal rights is available on the Commissioner's website at:

<http://www.itspublicknowledge.info/YourRights/Unhappywiththeresponse/AppealingtoCommissioner.aspx>

ANNEX

REASONS FOR NOT PROVIDING INFORMATION

Exceptions apply

Regulation 10(4)(e) – internal communications in relation to SPQ background notes, Ministerial/media briefings, lines to take, etc.

An exception under regulation 10(4)(e) of the EIRs (internal communications) applies to some of the information you have requested because it is an internal communication of a First Minister's Questions (FMQ) Briefing document prepared by a Marine Directorate Policy Officer.

This exception is subject to the 'public interest test'. Therefore, taking account of all the circumstances of this case, we have considered if the public interest in disclosing the information outweighs the public interest in applying the exception. We have found that, on balance, the public interest lies in favour of upholding the exception. We recognise that there is a public interest in disclosing information as part of open, transparent and accountable government, and to inform public debate.

However, there is a greater public interest in allowing a private space within which officials can provide free and frank advice and views to Ministers in briefing for FMQ answers. It is clearly in the public interest that Ministers can properly answer Parliamentary questions and robustly defend the Government's policies and decisions. They need full and candid advice from officials to enable them to do so. Disclosure of this type of information could lead to a reduction in the comprehensiveness and frankness of such advice and views in the future, which would not be in the public interest.

Regulation 11(2) – applicant has asked for personal data of a third party

An exception under regulation 11(2) of the EIRs (personal information) applies to some of the information requested because it is personal data of a third party and disclosing it would contravene the data protection principles in Article 5(1) of the General Data Protection Regulation and in section 34(1) of the Data Protection Act 2018. This exception is not subject to the 'public interest test', so we are not

required to consider if the public interest in disclosing the information outweighs the public interest in applying the exception.

Yours sincerely

Kate Webb
Marine Directorate FOI/EIR Adviser



[Scottish Government FOI disclosure 202300376448 11 October 2023 #1](#)

[Scottish Government FOI disclosure 202300376448 11 October 2023 #2](#)

[Scottish Government FOI disclosure 202300376448 11 October 2023 #3](#)

[2] In August 2023, Scamon Scotland filed a Freedom of Information request with the Scottish Government; namely:

Your request

You asked for information on jellyfish inside and around salmon farms including:

- 1) any monitoring data on jellyfish inside and around salmon farms; data on mortalities on salmon farms attributed to jellyfish; welfare problems and disease problems caused by jellyfish on salmon farms; and any other information pertaining to jellyfish (including 'microjellies') and salmon farming.
- 2) any photos, videos, emails, letters, 'expert advice' provided by Marine Scotland Science and other information relating to jellyfish inside and around salmon farms.
- 3) information on any scientific research looking into salmon farming as a cause of jellyfish blooms or scientific research on salmon farms exacerbating jellyfish blooms.
- 4) information on warming sea temperatures and outbreaks of jellyfish at salmon farms.

A [FOI reply by the Scottish Government dated 14 September 2023](#) included:

Response to your request

A copy of some of the information you have requested is enclosed. In particular, this includes some summary information relating to mortalities attributed to jellyfish / plankton, along with some ministerial advice concerning mortality and welfare, and marine heatwaves. This information is provided in Annex 1 of this response.

Some of the information you have requested is available from the Scottish Government website. In particular:

- 1) Reports of aquatic animal health surveillance conducted by the Fish Health Inspectorate (FHI) where such reports relate to salmon farms and observational details relating to the presence of jellyfish on or near salmon farm sites have been recorded. Such reports may also detail welfare and disease problems caused by jellyfish in cases where this has been observed. Photographs where taken as part of an individual case are also published along with the case information:

<https://www.gov.scot/collections/publication-of-fish-health-inspectorate-information/>

- 2) Mortalities reported to the FHI in accordance with reporting requirements detailed within the industry code of good practice - Chapter 4, section 3.5:

<https://www.gov.scot/collections/publication-of-fish-health-inspectorate-information/>

- 3) Weekly plankton samples are collected and analysed by Scottish Government's Marine Directorate (SGMD) for the presence of gelatinous zooplankton at both Stonehaven and Loch Ewe – two sites in the Scottish Coastal Observatory (SCObs). SCObs data which have been quality flagged is available to download online:

https://data.marine.gov.scot/search/type/dataset?query=Scottish+coastal+observatory+&sort_by=changed&sort_order=DESC

Data which has yet to be quality flagged can be made available on request. Information on how to use the quality flag system when interpreting SCObs data can be found through:

<https://data.marine.gov.scot/dataset/scottish-coastal-observatory-1997-2013-parts-1-3/resource/e67e50ae-e526-4d1b-b4d9>

<https://data.marine.gov.scot/dataset/scottish-coastal-observatory-dataset-1997-%E2%80%93->

[2020/resource/dd3540f2-2e74-4682-a8d3](https://www.foi.gov.uk/2020/resource/dd3540f2-2e74-4682-a8d3)

4) Information relating to scientific research concerning jellyfish and salmon farms can be obtained through simple internet searches.

Under the terms of the exception at regulation 10(4)(a) of the EIRs (information not held), the Scottish Government is not required to provide information which it does not have. The Scottish Government does not have some the information you have requested because:

- 1) Excluding the information referred to in relation to SCObS the Scottish Government does not undertake monitoring or collect monitoring data relating to the presence of jellyfish in and around the cages of salmon farms
- 2) Excluding your own video footage, provided to us as part of this request, we hold no video footage relating to jellyfish inside and around salmon farm cages
- 3) SGMD are not currently involved in any research relating to salmon farms exacerbating jellyfish blooms

Annex 1 – Information released

The following information has been extracted from our records as being in scope of your query and so is being released to you:

On mortality associated with jellyfish:

- 1) Analysis of the cause of mortality within the Scottish salmon Sector from 2018 to 2020 revealed that in, 2018 - 2.65%; 2019 - 2.90%; 2020 – 6.70% of the total mortality experienced for each year was attributed to Jellyfish / plankton as a cause. This information was shared through the Farmed Fish Health Framework in April 2021. The mortality values do not differentiate between jellyfish or plankton but rather are linked together under the term: *Physical or toxic algal damage and jellyfish stings (inc. those impacting gills where jellyfish damage is the primary cause of mortality.*
- 2) Scottish Government recognises the rise in recent mortality figures – it can be attributed to an unusual bloom of micro jellyfish (*Muggiaea atlantica*) occurring out with its normally recognised range. It is premature to say if this will cause similar problems in future years. *Advice concerning mortality and welfare on fish farms to the First Minister from Marine Scotland 14 March 2023.*

On water temperature, climate change and jellyfish:

- 1) Evidence of the impacts of marine heatwaves in the UK is limited as this is a rare event but international evidence suggests a variety of impacts are possible including algal blooms, deoxygenation of water column, jellyfish blooms, impacts on fish size and increased mortality risk for marine species including at aquaculture sites.
Advice concerning marine heatwaves to the Cabinet Secretary for Rural Affairs Land Reform and Islands from Marine Scotland from communications dated 21 June 2023.
- 2) Australia is at the forefront of research on the impact of marine heat waves globally. Scientists there have reported reductions of kelp forest, jellyfish bloom occurrences and coral reef loss due to marine heatwaves.
Advice concerning marine heatwaves to the Cabinet Secretary for Transport, Net Zero and Just Transition from email communications dated 19 June 2023.

You may also find the attached publicly available information relevant to your request:

https://www.mccip.org.uk/sites/default/files/2022-11/Aquaculture%20Formatted_updated%20and%20returned%20by%20authors.pdf

[Scamon Scotland filed a FOI review to request to access further information]

The scientific paper – [“Climate change impacts on marine aquaculture relevant to the UK and Ireland”](#) – cited in the FOI disclosure above was published in November 2022 via the Marine Climate Change Impacts Partnership. The paper included:

KEY FACTS

What is happening

- In the UK, there have been no major changes to the types or locations of species farmed due to climate change.
- At salmon farms, a strong link between milder winter temperatures, disease and increased fish mortality has been identified.

What could happen

- Temperatures are expected to remain suitable for salmon growth until the end of the century, when aquaculture in Northern Ireland and the southwest of Scotland may experience seasonal declines due to warming.
- Warming conditions will lead to a rise in outbreaks including sea lice, fish diseases and shellfish pathogens, with subsequent increased mortality.
- The risk of mortality due to more frequent and intense heatwave events will increase in the future, highlighting the need for adaptive management.
- Offshore facilities may be more exposed to structural damage due to potential changes in storm events, with an increased risk of farmed species escaping.

Jellyfish blooms can be a significant cause of mortality for penned finfish (Luisetti *et al.*, 2018), mainly through exposure of gill tissue to the stingers resulting in direct traumatic damage, impaired function and triggering secondary diseases (Clinton *et al.*, 2021). Globally, most reports of jellyfish impact on aquaculture are on salmon in the North Atlantic (Bosche-Belmar *et al.*, 2021) with losses of up to \$1.3 million in Scotland and Ireland.

A strong statistical link between increased mortality in salmon farms with milder winter temperatures has been identified (Moriarty *et al.*, 2020).

Although complex environmental factors affect jellyfish blooms (Edwards *et al.*, 2020), increasing temperatures appear to be a key factor for many species (Kennerley *et al.*, 2021). Increasing temperatures may result in greater frequencies of blooming events within the natural long-term cycles of jellyfish populations, with greater numbers of days occurring where ocean temperatures fall within the optimum physiological tolerances of several native and non-native species (e.g., Collingridge *et al.*, 2014). However, there are significant knowledge gaps in species-specific physiological information in response to each of the environmental factors thought to influence jellyfish populations (Kennerley *et al.*, 2021).

A scientific paper [published in Preventative Veterinary Medicine in May 2020](#) included:



Preventive Veterinary Medicine

Volume 178, May 2020, 104985



Modelling temperature and fish biomass data to predict annual Scottish farmed salmon, *Salmo salar* L., losses: Development of an early warning tool

[M. Moriarty](#)  , [A.G. Murray](#), [B. Berx](#), [A.J. Christie](#), [L.A. Munro](#), [I.S. Wallace](#)

Abstract

Losses due to mortality are a serious economic drain on Scottish salmon aquaculture and are a limitation to its sustainable growth. Understanding the changes in losses, and associated drivers, are required to identify risks to sustainable aquaculture. Data on losses were obtained from two open source data sets: monthly losses of biomass 2003-2018 and losses of salmon over production cycles (numbers input minus output harvest) 2002-2016. Monthly loss rates increased, accelerating after 2010, while losses per production cycle displayed no trend. Two modelling frameworks were investigated to produce an early warning tool for managers about potential increases in losses. Both linear regression and beta regression showed that monthly losses related to biomass and minimum winter air temperatures with high precision and low bias. These relationships apply at both the national and regional levels where the beta regression best fit model explain 82 % and 69 % of variation in mortality, some regional differences apply, particularly for the Northern Isles. The lack of trend in losses per production cycle may have been due to shorter production cycles as more salmon were harvested earlier, and possibly increasing losses of larger salmon (which affects biomass but not numbers lost). In the long-term, the models predict that milder winters and increased biomass will be associated with increased mortality, which will need to be managed. In the short-term, given relatively little year-to-year variation in biomass, minimum winter temperature is a powerful early warning of the likely extent of losses in the Scottish salmon farming industry.

A limiting factor in maximum production potential is mortality (Aunsmo et al., 2010). There are a number of contributors to losses such as management, environmental factors, predation and disease (Soares et al., 2011). Monitoring trends in mortality may be used as an operational welfare indicator, as high mortality may be an indication of poor welfare (Ellis et al., 2012). About one third of production losses are attributed to diseases (Soares et al., 2011), the significance of different diseases has changed over time with viral diseases and sea lice increasingly becoming the focuses of research (Murray et al., 2016). Loss levels of Scottish salmon production have been relatively consistent at 10–20 % per production cycle for many years (Salama et al., 2016; Murray and Munro, 2018), however, loss rates above 20 % have occurred in recent years (Munro, 2019) and the emergence of gill diseases is an increasingly serious problem (Oldham et al., 2016; Hall et al., 2017). Changes in climate, particularly water temperatures has been linked to emerging marine diseases (Harvell et al., 1999), and may be an associated factor in increasing mortality on salmon farms (Thyholdt, 2014). Coastal sea surface temperatures around Scotland were, on average, between 0.2 °C and 0.4 °C warmer in the 2006–2016 period when compared to the longer-term average from 1981 to 2010 (Hughes et al., 2018). These temperature rises have been associated with changes in ecology and wild fisheries including salmon growth (Beaugrand and Reid, 2003; Todd et al., 2008). Temperature changes are likely to be associated with changes in aquaculture; as warming temperatures have positive effects that includes increases in growth rate (Calloway et al., 2012; Collins et al., 2020). However, warming temperatures also have negative effects that include increased prevalence and severity in diseases and parasitic infestations such as bacterial diseases (Thompson et al., 2006), sea lice (Rittenhouse et al., 2016) and particularly gill diseases (Oldham et al., 2016; Benedicenti et al., 2019).

The transmission of pathogens in aquatic environments is also likely to be associated with increased biomass. Many pathogens ability to transmit is enhanced as population densities increase (Anderson and May, 1979; Murray, 2009). Pathogens are often exchanged between aquaculture sites, the risk of transmission between sites is attributed to water movements and the distances between sites, and is related to number of sites and biomasses on sites (Salama and Murray, 2011).

A 'Journal Pre-Proof' copy of the scientific paper – obtained from lead author [Dr Moriarty of the Scottish Government's Marine Directorate](#) in September 2023 – included additional information not included in the [online version](#):

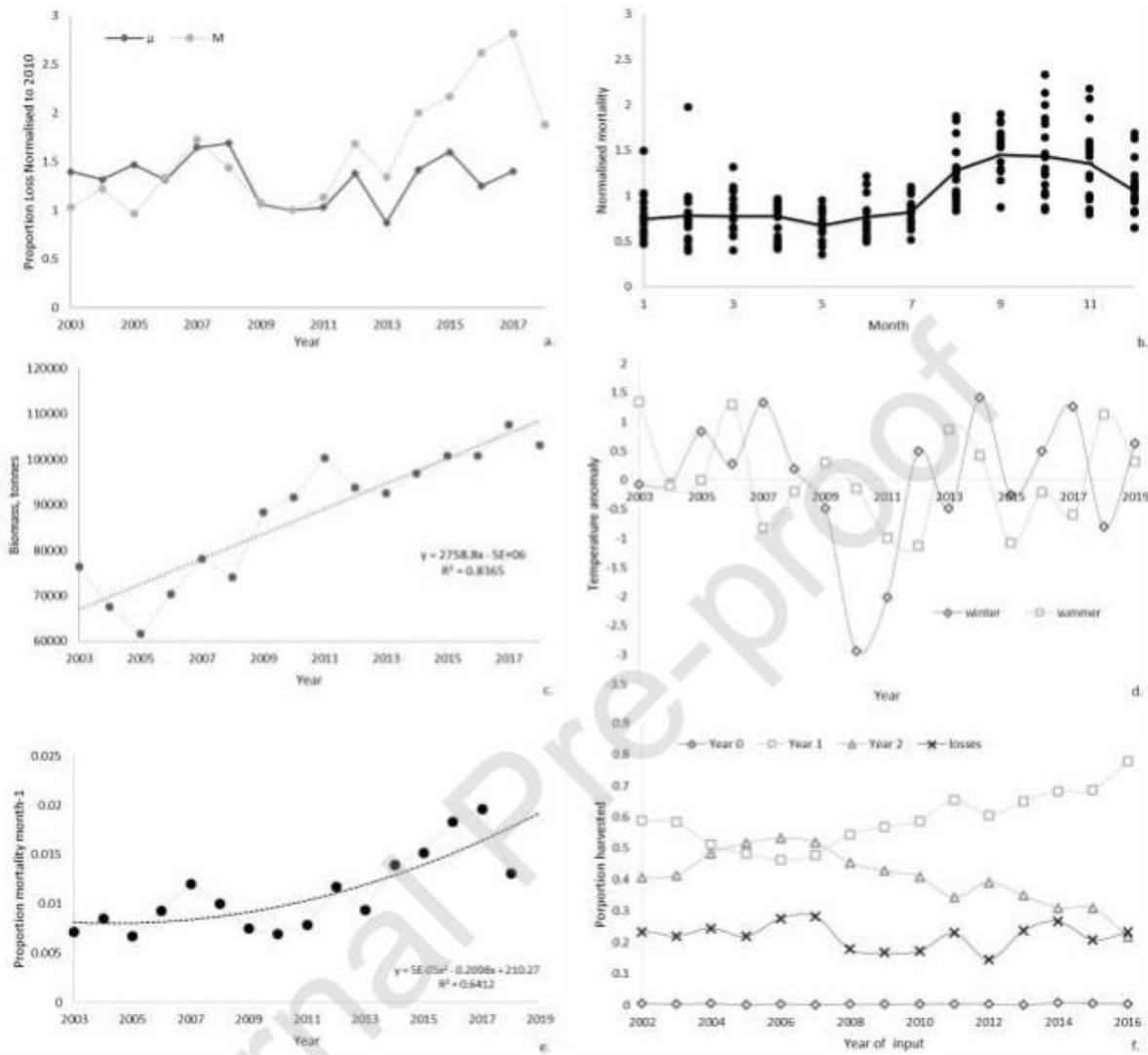


Figure 2 Provides details about the preliminary data exploration undertaken. (a.) Losses as proportion of biomass per month (M) for 2003–2018 and per production cycle (μ) input in preceding year 2002–2017, normalised to 2010 values. (b.) Monthly losses as proportion of biomass lost per month at national level 2003–2018, normalised to the average monthly mortality for the year, and mean loss (line). (c.) Average Scottish farmed salmon biomass by year (B) in tonnes for 2003–2018 and regression of 2759 tonnes per year increase. (d.) Temperature anomalies from mean air temperature 2003–2019 at the national level (e.) Proportion monthly biomass lost (M) by year 2003–2018, with a 2nd order polynomial fit (dash line). (f.) Proportion of salmon that are harvested in the year of input (year 0), a year later (year 1) or 2 years (year 2) after input, and proportion of salmon that are lost in the full production cycle (full production cycle: 2002–2016).

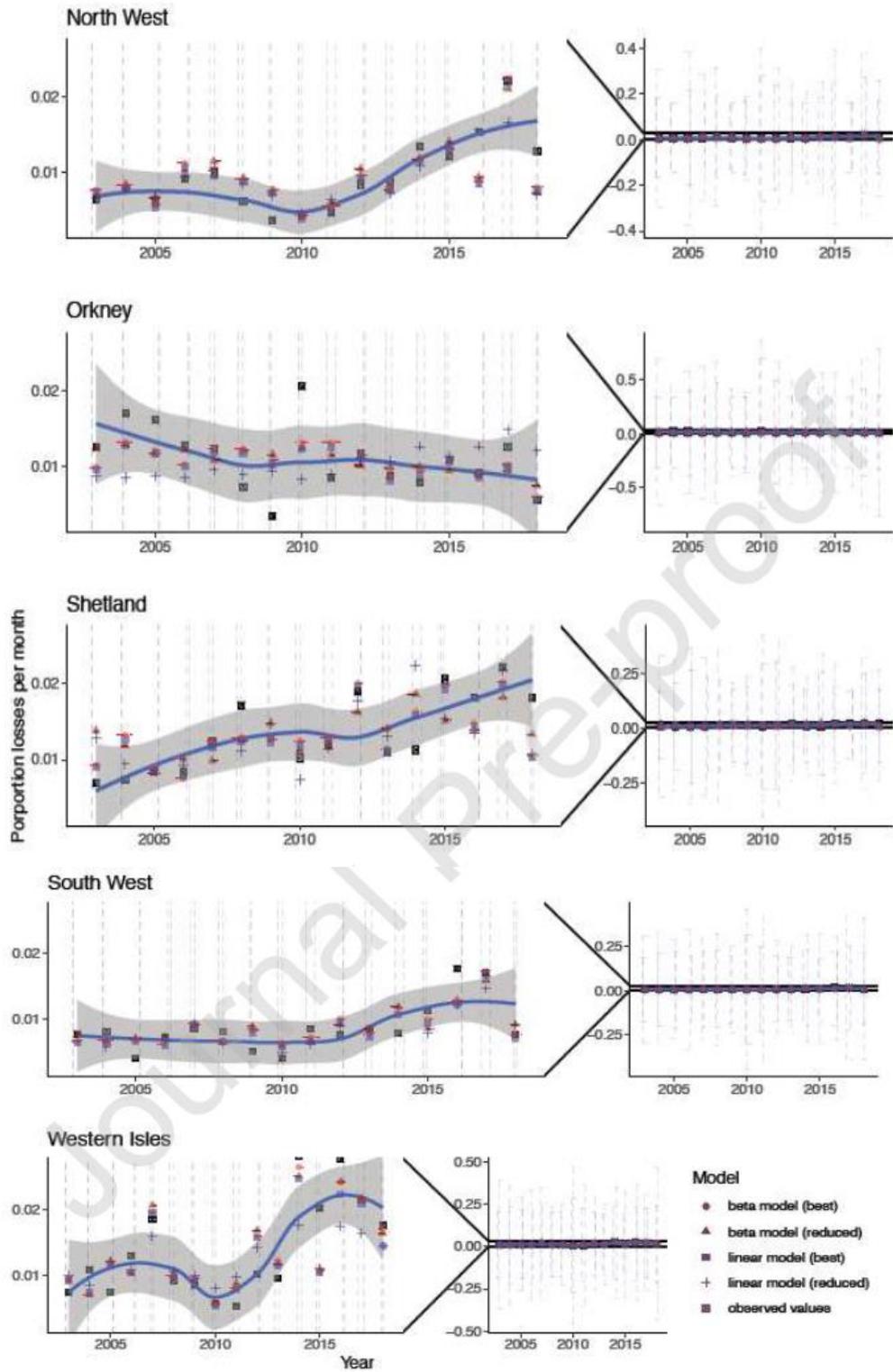


Figure 3. Plots of regional LOWESS curves for losses with time 2003-2018 indicate an increase in average monthly proportion loss rate after 2010 for most regions. The predicted values from each model summarised in Table 2 are shown. LOWESS curve is based on observed data, error bars show the 95% confidence intervals associated with each model.

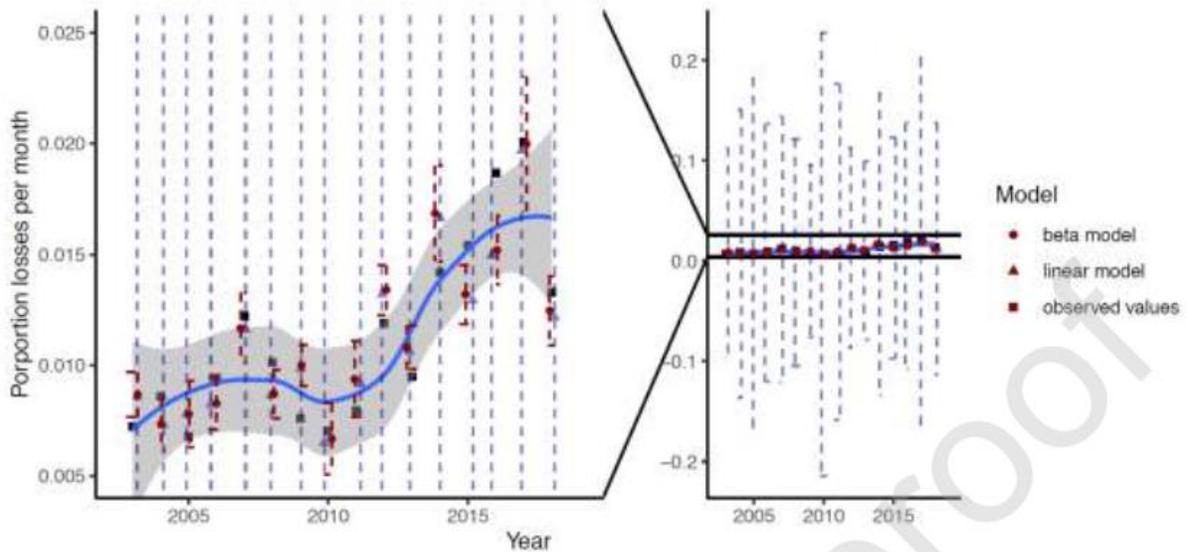


Figure 4. Plot of national losses over time 2003-2018 indicate an increase in average monthly proportion loss rate after 2010. The predicted values from each model summarised in Table 2 are shown; LOWESS curve is based on observed data, error bars show the 95% confidence intervals associated with each model.

Appendix 1: Monthly losses and biomass (SEPA)

A. Monthly loss as proportion of biomass.

YEAR	SCOTLAND	NORTH MAINLAND	ORKNEY	SHETLAND	SOUTH MAINLAND	WESTERN ISLES (EILEAN SIAR)
2003	0.007197	0.006466	0.012337	0.006811	0.007734	0.007277
2004	0.008527	0.007841	0.016649	0.007271	0.008135	0.010749
2005	0.006742	0.00613	0.015855	0.00829	0.004084	0.007329
2006	0.009339	0.009071	0.012545	0.008238	0.007282	0.012809
2007	0.012069	0.009865	0.012129	0.012209	0.008499	0.018105
2008	0.01003	0.006153	0.007246	0.016883	0.008068	0.009106
2009	0.007555	0.00374	0.003375	0.012721	0.00515	0.008313
2010	0.006987	0.004294	0.020127	0.010135	0.00405	0.005711
2011	0.007898	0.004684	0.008372	0.011955	0.008499	0.005334
2012	0.011753	0.008416	0.011493	0.018626	0.007656	0.010012
2013	0.009397	0.00866	0.008663	0.010921	0.008451	0.009421
2014	0.014001	0.013285	0.007849	0.011162	0.007802	0.02731
2015	0.015181	0.012015	0.01079	0.02022	0.011263	0.019701
2016	0.018343	0.015175	0.008953	0.017847	0.017363	0.026808
2017	0.019667	0.021658	0.012457	0.021681	0.016691	0.020905
2018	0.013120	0.012745	0.005562	0.017808	0.007594	0.017359

B. Monthly mean biomass tonnes by year.

YEAR	SCOTLAND	NORTH MAINLAND	ORKNEY	SHETLAND	SOUTH MAINLAND	WESTERN ISLES (EILEAN SIAR)
2003	76471	20401	2843	23867	15667	13691
2004	67529	23554	2397	18097	12523	10956
2005	61664	17759	1909	13832	13710	14452
2006	70427	24192	2009	15875	14628	13720
2007	78112	23062	3096	17848	16413	17691
2008	74022	23985	2948	20305	12678	14104
2009	88334	22118	4237	27224	20527	14226
2010	91687	24884	4730	25592	17584	18897
2011	100370	27023	5020	29749	19812	18765
2012	93843	24834	6380	27136	17053	18439
2013	92490	23375	6809	25920	18697	17686
2014	96968	23630	7464	27435	19007	19430
2015	100795	32624	7421	27079	18106	15564
2016	100791	23926	8971	23513	21594	22784
2017	107675	30004	9838	27128	22279	18425
2018	103194	24141	10127	23199	22220	23505

From: **Don Staniford** salmonfarmingkills@gmail.com

Date: Thu, Sep 21, 2023 at 9:36 AM

Subject: Re: PDF copy of your paper, pretty please?

To: Meadhbh.Moriarty@gov.scot

Dr Moriarty,

One quick question - when you write:

"Coastal sea surface temperatures around Scotland were, on average, between 0.2°C and 0.4°C warmer in the 2006 to 2016 period when compared to the longer-term average from 1981 to 2010".

Do you have updated data since 2016?

Don

From: Meadhbh.Moriarty@gov.scot

Date: Thu, Sep 21, 2023 at 12:03 PM

Subject: RE: PDF copy of your paper, pretty please?

To: salmonfarmingkills@gmail.com

Hi Don,

As written in the paper we downloaded these temperature data from the MET office website. Here is a link that will bring you directly to the Scotland mean temperature > [metoffice.gov.uk/pub/data/weather/uk/climate/datasets/Tmean/date/Scotland.txt](https://www.metoffice.gov.uk/pub/data/weather/uk/climate/datasets/Tmean/date/Scotland.txt)

It's best practise to go to the source for these data, as they are updated monthly by the MET office. For wider interest on other temperature data sets they collect have a look here > [UK and regional series - Met Office](#).

Kind Regards,

Dr. Meadhbh Moriarty
Senior Aquatic Epidemiological Modeller
 Marine Directorate| Scottish Government

e: meadhbh.moriarty@gov.scot
 w: <https://www.researchgate.net/profile/Meadhbh-Moriarty>

Here's the latest data from the MET Office website for Scotland:
<https://www.metoffice.gov.uk/pub/data/weather/uk/climate/datasets/Tmean/date/Scotland.txt>

Areal values from HadUK-Grid 1km gridded climate data from land surface network
 Source: Met Office National Climate Information Centre
 Monthly, seasonal and annual mean air temperature for Scotland
 Areal series, starting in 1884
 Last updated 01-Sep-2023 10:47

year	jan	feb	mar	apr	may	jun	jul	aug	sep	oct	nov	dec	win	spr	sum	aut	ann
1978	1.1	-0.1	4.1	4.5	9.5	11.1	11.7	12.3	11.0	9.4	5.9	2.4	1.69	6.00	11.70	8.75	6.94
1979	-1.1	-0.1	1.8	5.0	6.7	11.5	12.3	11.6	10.3	8.8	4.1	2.8	0.40	4.50	11.79	7.77	6.18
1980	1.1	3.1	2.4	6.7	9.1	11.2	12.0	12.7	11.6	6.4	4.4	3.8	2.30	6.05	11.99	7.45	7.04
1981	2.7	2.1	4.3	5.7	9.3	10.6	12.3	13.1	11.4	4.9	5.1	-1.1	2.87	6.46	12.00	7.14	6.73
1982	1.1	3.5	3.9	6.6	8.5	11.6	13.6	12.7	10.4	8.1	4.8	2.2	1.08	6.30	12.67	7.77	7.27
1983	4.1	0.7	4.6	4.1	7.5	10.7	14.6	14.2	10.1	7.7	5.6	4.3	2.37	5.39	13.21	7.82	7.40
1984	0.3	2.8	3.0	6.4	8.2	11.6	13.8	14.0	10.8	8.0	5.5	4.0	2.43	5.84	13.12	7.85	7.30
1985	-0.1	1.8	2.7	5.7	8.3	10.0	12.6	11.6	10.4	8.6	1.9	3.4	1.91	5.57	11.42	7.00	6.44
1986	1.3	-1.1	3.5	3.7	8.4	11.7	12.3	10.6	9.2	8.2	5.5	3.1	1.27	5.20	11.55	7.64	6.42
1987	0.4	1.9	2.2	7.1	7.8	9.5	12.9	12.3	10.3	6.5	4.8	3.6	1.84	5.70	11.60	7.21	6.65
1988	2.5	2.9	3.5	5.9	9.1	12.3	12.2	12.4	10.8	7.8	4.5	5.8	3.00	6.15	12.29	7.69	7.49
1989	5.7	3.6	4.1	4.5	9.2	11.0	14.4	12.5	10.5	8.7	4.6	1.6	5.08	5.96	12.66	7.96	7.58
1990	4.1	4.0	5.8	5.8	9.6	11.0	13.3	13.5	9.9	8.7	4.4	3.0	3.21	7.09	12.62	7.70	7.79
1991	1.6	1.0	5.1	5.9	9.0	9.6	14.6	13.9	10.9	7.7	4.7	3.8	1.90	6.70	12.73	7.77	7.37
1992	3.2	4.0	4.6	5.9	10.3	12.8	12.6	11.8	10.1	5.3	4.4	2.2	3.65	6.98	12.38	6.61	7.28
1993	3.2	4.7	4.4	6.6	8.3	11.5	11.7	11.4	9.8	5.9	3.2	1.7	3.33	6.44	11.52	6.29	6.87
1994	2.4	1.3	3.8	5.3	7.8	10.8	13.8	12.3	9.9	7.5	7.5	3.8	1.80	5.64	12.33	8.29	7.22
1995	2.0	2.9	2.5	6.0	8.5	11.6	14.3	15.2	10.9	9.9	5.8	0.3	2.92	5.64	13.72	8.86	7.51
1996	3.7	1.4	3.0	6.4	6.7	11.3	12.7	13.7	11.5	9.0	3.1	1.7	1.82	5.36	12.56	7.88	7.03
1997	2.0	3.7	5.9	6.8	8.5	11.0	13.9	15.2	10.9	7.9	6.8	4.2	2.46	7.07	13.40	8.50	8.09
1998	3.2	6.4	4.9	5.0	9.6	10.6	12.3	12.6	11.9	7.0	4.3	4.1	4.53	6.55	11.84	7.72	7.67
1999	3.0	2.8	4.7	7.0	9.6	10.8	13.8	12.9	12.5	8.6	5.7	1.9	3.32	7.08	12.49	8.94	7.80
2000	3.8	3.6	5.4	5.4	9.3	10.8	12.6	13.3	11.8	8.1	4.5	3.2	3.09	6.73	12.27	8.10	7.67
2001	1.3	1.9	2.4	5.4	10.1	10.7	13.0	13.0	10.7	10.6	5.9	2.4	2.14	5.97	12.25	9.09	7.32
2002	4.1	3.5	5.0	7.0	9.5	11.9	12.6	14.0	11.7	6.7	6.1	3.4	3.34	7.14	12.82	8.17	7.98
2003	2.7	2.6	5.6	8.0	9.2	12.9	14.8	14.4	11.4	6.7	6.3	3.2	2.92	7.59	14.05	8.14	8.18
2004	3.3	3.0	4.7	7.4	9.8	12.0	12.7	14.4	11.6	7.6	6.0	4.4	3.17	7.28	13.07	8.41	8.09
2005	4.3	2.9	5.5	6.6	8.2	12.3	13.4	13.1	12.0	9.7	4.6	3.7	3.91	6.76	12.96	8.76	8.06
2006	3.3	2.9	2.4	5.7	8.8	12.6	15.6	13.3	13.2	9.8	6.0	4.3	3.31	5.63	13.85	9.70	8.20
2007	4.6	4.0	5.1	8.9	8.7	11.9	12.7	12.5	10.6	9.3	5.9	3.3	4.31	7.56	12.40	8.64	8.16
2008	3.4	4.1	3.6	5.7	10.6	11.2	14.0	13.5	11.2	7.1	4.7	2.3	3.58	6.66	12.94	7.67	7.64
2009	2.5	2.9	4.9	7.8	9.2	12.1	13.8	13.5	11.8	8.9	5.4	0.5	2.55	7.31	13.14	8.70	7.80
2010	0.2	0.4	3.8	6.6	8.3	12.6	13.2	12.4	11.2	8.0	2.7	-1.7	0.36	6.23	12.75	7.33	6.51
2011	2.1	3.6	4.5	9.1	9.2	10.7	12.7	12.1	11.9	9.4	7.6	3.1	1.28	7.59	11.86	9.62	8.02
2012	3.2	4.3	7.1	4.9	8.6	10.4	12.2	13.5	10.3	6.1	4.5	2.3	3.50	6.89	12.04	6.94	7.29
2013	2.8	2.2	1.3	4.8	8.3	11.5	15.3	13.6	11.1	9.3	4.1	5.0	2.45	4.80	13.50	8.21	7.49
2014	3.5	3.8	5.4	7.9	9.7	12.8	14.5	12.2	12.4	9.1	6.4	3.1	4.11	7.69	13.18	9.29	8.43
2015	2.5	2.9	4.3	6.4	7.5	10.6	12.2	12.9	10.8	8.7	6.2	5.4	2.84	6.07	11.93	8.55	7.56
2016	3.1	2.2	4.6	5.1	9.7	12.2	13.1	13.3	12.7	8.4	3.4	5.6	3.57	6.49	12.89	8.14	7.80
2017	3.5	4.0	5.4	6.7	10.6	12.1	12.9	12.8	11.2	9.6	4.1	2.9	4.37	7.58	12.63	8.29	8.01
2018	2.1	1.6	2.3	6.6	10.7	13.0	14.9	12.9	10.4	8.0	6.2	4.1	2.21	6.53	13.62	8.19	7.77
2019	2.4	5.1	5.2	7.5	8.3	11.6	14.7	13.9	11.4	7.2	3.6	4.1	3.85	7.01	13.41	7.37	7.93
2020	4.8	3.1	4.2	7.1	9.7	12.6	12.3	13.5	11.0	7.9	6.6	3.4	4.03	6.97	12.81	8.47	8.02
2021	0.6	2.5	5.3	4.6	7.7	12.5	15.1	13.7	12.9	9.2	6.2	3.4	2.13	5.87	13.78	9.46	7.84
2022	4.7	3.9	5.2	6.7	10.2	12.5	14.2	13.9	11.9	9.7	6.9	1.6	4.00	7.40	13.57	9.53	8.49
2023	3.2	5.1	3.6	6.6	10.3	14.3	13.2	13.8					3.60	6.84	13.76		

The full reference for the Hughes et al 2018 report [cited in the 2020 Moriarty paper](#) is:

Hughes, S.L., Hindson, J., Berx, B., Gallego, A. and Turrell, W.R. (2018) Scottish Ocean Climate Status Report 2016. Scottish Marine and Freshwater Science Vol 9 No 4, 167pp. DOI: 10.7489/12086-1

The above report is available [online here](#)

marinescotland
INFORMATION

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Scottish Ocean Climate Status Report 2016

What is it:

The Scottish Ocean Climate Status Report 2016 described the status of the physical conditions in the seas around Scotland in 2016 and examined the variability and trends in the last decade, and further into the past.

This information page is part of the theme:

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[Ocean Climate](#)

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[Physical Characteristics](#)

[Clean and Safe](#)

[Healthy and Biologically Diverse](#)

[Productive](#)

[Climate Change](#)

[Monitoring](#)

[Administrative](#)

[Regions](#)

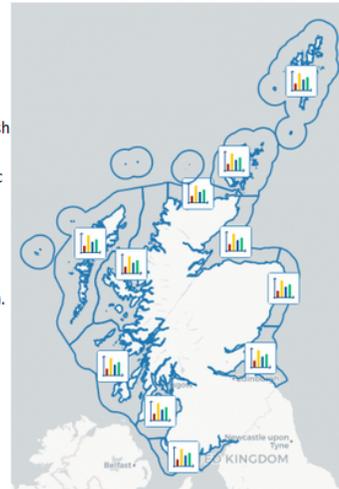
[National Marine Plan](#)

Figures showing time series of a number of variables were extracted from the report and added as tooltips to the the Scottish Marine Regions, the Charting Progress 2 Regional Seas, and four water masses (North Atlantic Water, NAW; Modified North Atlantic Water, MNAW; Fair Isle Current, FIC and Cooled Atlantic Waters, CAW).

These figures can be viewed using the links in the Maps table below (hover over the chart icon on the maps to view each figure).

Data originators:

[Scottish Government \(Marine Directorate\)](#)



Scottish Ocean Climate Status Report maps on NMPI (hover over the chart icon on the maps to view each figure) © Marine Scotland

The '[Scottish Ocean Climate Status Report 2016](#)' included:

Both air and sea temperatures around Scotland have warmed at a similar rate to the global pattern of century-scale warming as reported by the IPCC in 2014. At a multi-decadal scale, during the 1970-1980 to 2010 warming episode, air and sea temperatures across Scotland warmed at a rate faster than the global average.

- The period of 2006 to 2016 was, on average, warmer than normal in Scottish coastal waters, with sea surface temperatures between 0.2 and 0.4 °C warmer than the long-term average (1981–2010).

‘Scotland’s Marine Assessment 2020’ – [published online by the Scottish Government](#) includes:

What is already happening?

The global ocean has warmed continuously since 1970, and has taken up more than 90% of the excess heat in the climate system (Pörtner *et al.*, 2019). In line with the global warming trend (IPCC, 2014), Scottish waters (coastal and oceanic) have warmed by between 0.05 and 0.07 °C per decade (Figure 1), calculated across the period 1870 – 2016 (Hughes, Hindson, Berx, Gallego & Turrell, 2018).

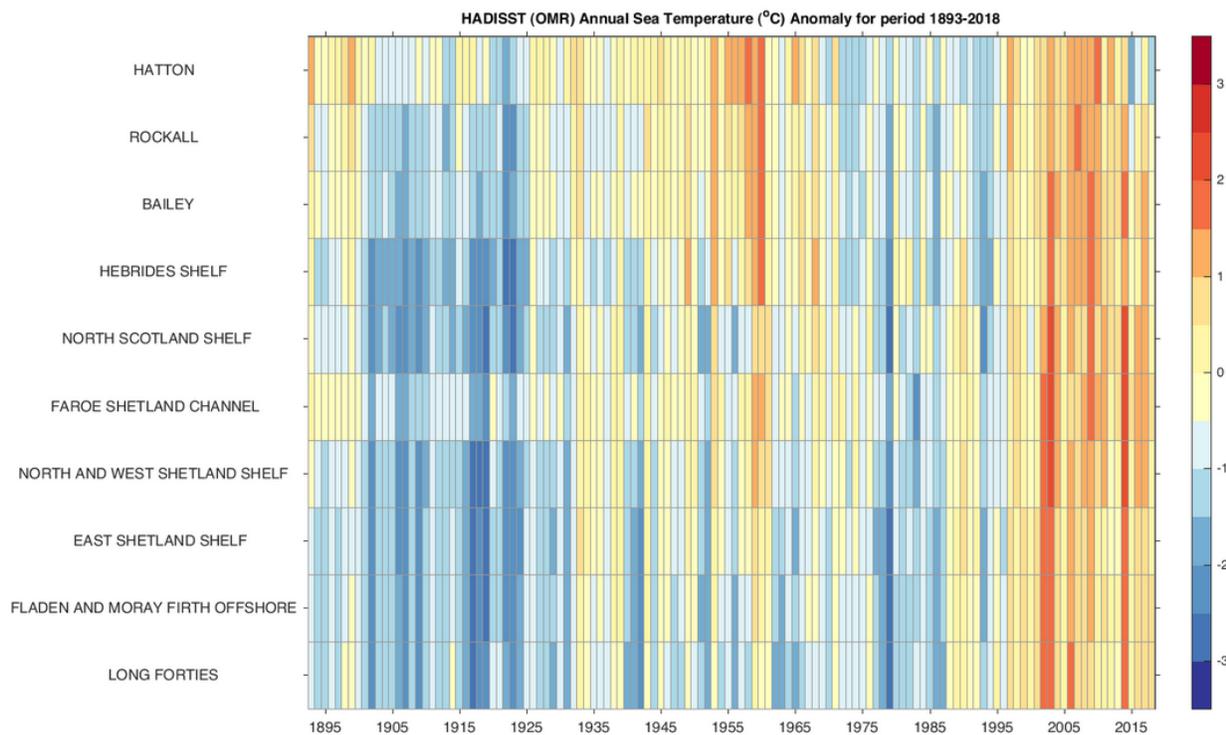


Figure 1: Annual Sea Surface Temperature anomalies relative to the 1981 - 2010 period by Offshore Marine Region (OMR) from an interpolated, combined in situ and satellite gridded product (HadISST 1.1; Rayner *et al.*, 2003). The use of these standardised values allows for easy comparison between regions which may have different variability. These anomalies have been normalised by removing the 1981 - 2010 mean and scaling by the 1981 - 2010 standard deviation for the region.

What is likely to happen in future?

Most climate projections for the end of the 21st century indicate, with medium confidence, warming of between 1 and 4 °C of the north west European Shelf seas. Exact confidence of these trends on regional scales is lower still (Tinker & Howes, 2020), as often future climate projections for these regions have not been subject to dedicated studies.

Links and resources

Literature and Data sources

Hughes, S.L. *et al.*, 2018. *Scottish Ocean Climate Status Report 2016*, Marine Scotland Science. Available at: <https://data.marine.gov.scot/dataset/scottish-ocean-climate-status-report-2016>.

IPCC, 2014. *Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. R. K. Pachauri *et al.*, eds., Geneva, Switzerland: IPCC. Available at: <https://epic.awi.de/id/eprint/37530/>.

Josey, S.A. *et al.*, 2018. *The recent Atlantic cold anomaly: causes, consequences, and related phenomena*. *Annual Review of Marine Science*, 10(1), pp.475-501. Available at: <https://www.annualreviews.org/doi/10.1146/annurev-marine-121916-063102>.

Pörtner, H.-O. *et al.*, 2019. *IPCC (2019): Special Report on the Ocean and Cryosphere in a Changing Climate*. Available at: <https://www.ipcc.ch/srocc/>.

Rayner, N.A. *et al.*, 2003. *Global analyses of sea surface temperature, sea ice, and night marine air temperature since the late nineteenth century*. *Journal of Geophysical Research: Atmospheres*, 108. Available at: <https://agupubs.onlinelibrary.wiley.com/doi/abs/10.1029/2002JD002670>.

From: **Don Staniford** <salmonfarmingkills@gmail.com>
Date: Fri, Sep 22, 2023 at 8:59 PM
Subject: Scotland's Marine Assessment 2021 or 2022?
To: <Barbara.Berx@gov.scot>

Dr Berx,

I was reading 'Scotland's Marine Assessment 2020': <https://marine.gov.scot/sma/assessment/sea-temperature>. Do you know if there is a 2022 version or an update?

From: <Barbara.Berx@gov.scot>
Date: Mon, Sep 25, 2023 at 3:01 PM
Subject: RE: Scotland's Marine Assessment 2021 or 2022?
To: <salmonfarmingkills@gmail.com>

Dear Don,

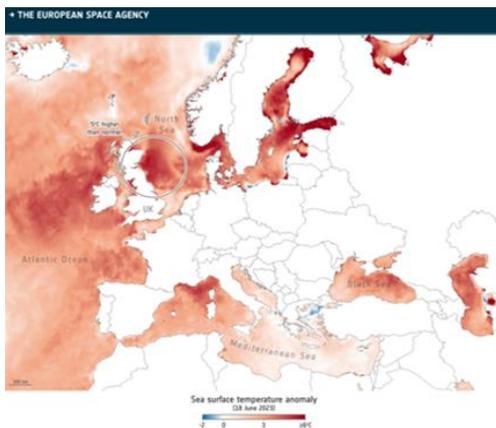
No, there has been no update to Scotland's Marine Assessment 2020.

Kind regards, Bee

From: **Don Staniford** <salmonfarmingkills@gmail.com>
Date: Mon, Sep 25, 2023 at 5:29 PM
Subject: Re: Scotland's Marine Assessment 2021 or 2022?
To: <Barbara.Berx@gov.scot>

Thanks - if an update is published a copy would be much appreciated. Do you have data on sea temperatures in Scotland?

The ESA reported in June:
https://www.esa.int/ESA_Multimedia/Images/2023/06/UK_suffers_marine_heatwave



Do you have data for the West coast of Scotland and salmon farming areas in the Western Isles, Orkney and Shetland?

From: Barbara.Berx@gov.scot
Date: Tue, Sep 26, 2023 at 8:00 AM
Subject: RE: Scotland's Marine Assessment 2021 or 2022?
To: salmonfarmingkills@gmail.com

Dear Don,

While we have looked at data from the recent heatwave through the products made available by NOAA in the USA, there is nothing further on this to share.

If we publish any updates to our time series, or assessments, I will be sure to let you know. At this stage, I can't help you any further with your questions.

Kind regards, Bee

Dr Bee Berx

Environment Monitoring and Assessment Programme
Oceanography Group
Physical Oceanographer / MSS Climate Change Lead

E-mail: Barbara.Berx@gov.scot



Marine Scotland Science, Marine Laboratory, 375 Victoria
Road, Aberdeen, AB11 9DB, UK

[3]

COOKE AQUACULTURE SCOTLAND LIMITED

STRATEGIC REPORT
FOR THE YEAR ENDED 31 DECEMBER 2022

Introduction

The directors present their Strategic Report for the year ended 31 December 2022.

Business review

2022 was a challenging year for the business but one in which we were still able to deliver an increase in the net profits up from £20.9m to £27.5m, an increase of 31%. Turnover increased 4% to £184m in the year, despite volumes sold being down 15%, mainly due to the record high salmon prices in the year. Cost of sales increased 1% to £134m in the year, despite the decrease in volumes sold. This was in the face of cost challenges with the increase in material costs, labour inflation and utility price increases, there was also a severe biological issue with the impact of micro-jellyfish that affected the whole Scottish industry. Whilst some of the Orkney sites were affected the overall impact to the company was reduced due to the sites in Shetland remaining untouched.

Operational and market risks

The Company's financial performance is significantly affected by the market prices obtained for the Company's fish and these are subject to price fluctuations due to a number of factors. These may include short-term over/under supply in the Company's market, changes in customer preferences, size of harvested fish and general economic factors.

Biological performance can be affected by changes to environmental conditions, resulting in increased numbers of plankton, algae's and, in extreme cases, micro jellyfish, which negatively affects gill health. Winter storms are also an increased risk as we move into more exposed locations.

[4]

LOCH DUART LIMITED

STRATEGIC REPORT (CONTINUED)

FOR THE YEAR ENDED 31 MARCH 2022

Principal risks and uncertainties

The group exports a significant percentage of its production and is therefore exposed to exchange rate movements. The group seeks to manage those risks via appropriate treasury management.

The geographic diversification spreads the group over many locations, sales markets and health & welfare issues. The ongoing pursuit of this diversification would normally reduce the operational, and hence financial, risk faced by the business.

The group has historically enjoyed good prices and been resilient to the more extreme market movements but remains exposed to price volatility around issues of supply in the wider market and changing consumer behaviour as adjustment to post-COVID 19 conditions. Given the ongoing challenges in the market and the potential volatility of both sales prices and input costs, management continues to monitor the implications for liquidity and cashflow. Operating cashflow has been sufficient to meet day to day operating obligations. However, developing the group's strategic plans has required and will require investor support. The company has a letter of support in place from the investor to allow the group to meet its obligations as they fall due.

Risks in relation to fish health and mortality levels are inevitable in aquaculture, but the group considers its husbandry and welfare practices are capable of minimising such risks to the extent that they can be addressed. The changing climate, with recent warm dry summers, has changed the underlying risk levels and will require innovation in farming practice to cope.

[5] Fish Farmer [reported in October 2023](#):



Farmers rise to the challenge

Despite natural environmental challenges, the hard work and dedication of farmers and production companies has maximised survival rates in 2023, writes Salmon Scotland Chief Executive **Tavish Scott**

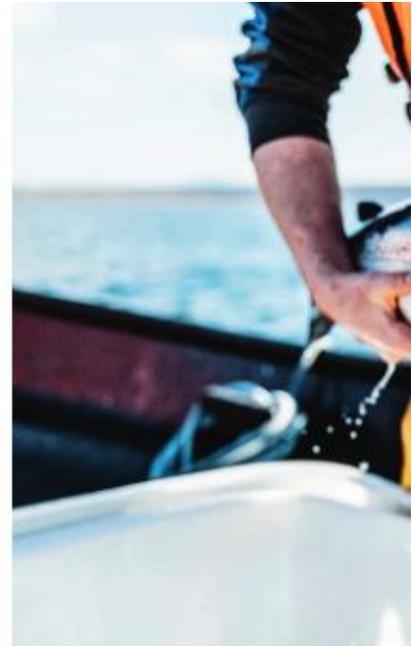
THIS July, the hottest seawater temperatures ever were recorded off the coast of Florida, where temperatures reached 38.4°C.

This phenomenon was not unique to the US, with water temperatures in some places here around four to five degrees warmer than average. This was notably the case on the UK's east coast.

Higher temperatures are not a direct issue for salmon, as they are within their natural range.

And given fish are cold-blooded, seawater temperature increases can actually encourage growth and allow harvest weight to be reached more quickly.

However, record seawater temperatures do contribute to an increase in naturally occurring organisms, which can reduce oxygen levels and also compromise the health of the salmon in areas such as the west coast of Scotland.



That's why the aquaculture sector is constantly innovating to overcome challenges. The sector has been deploying a range of short-, medium- and long-term solutions to maximise survival.

Mortality incurred in a natural environment is not an indicator of poor farming conditions, despite what uninformed activists might claim, but it goes without saying that the loss of livestock is devastating for farmers – just like when sheep farmers lose their lambs to poor weather or predation from foxes.

However, salmon are not like terrestrial livestock, which produce a relatively small number of young over their lives. When fish breed, they produce many thousands of eggs, which are fertilised outside the body.

In the wild, it's a reproductive strategy that acknowledges a high natural level of mortality, with the goal that just a small number of salmon will survive to breed.

Of course, in farming, we want to make

”
Climate
change
poses a
long-term
challenge
to all food



to all food sectors, including our own

Above: Scottish Sea Farms, Summer Isles salmon
Left: Scottish Sea Farms' Sólás Na Mara

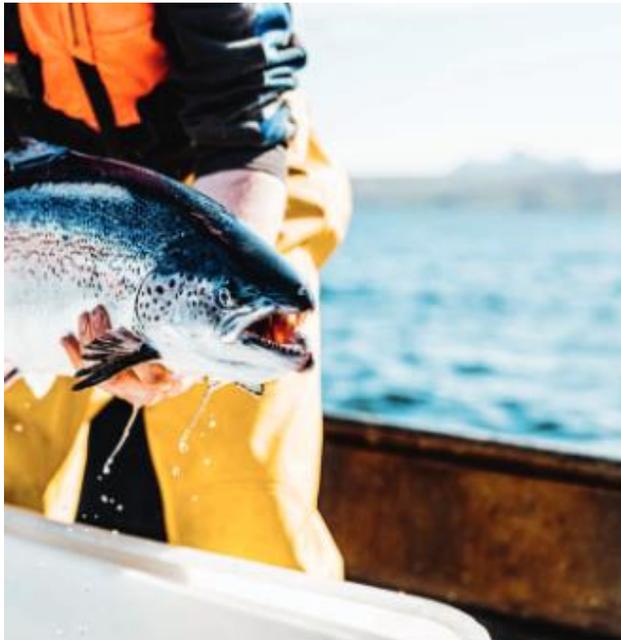
sure as many fish as possible survive. But all too often campaigners try to compare salmon to other livestock – and that's just not appropriate.

Tackling jellyfish blooms

This time last year, we faced a significant increase in microscopic jellyfish blooms, which affected the survival of farm-raised fish.

As we said at the time, 2022 production was down – and that is reflected in annual data now being published by government following the usual time-lag.

Better monitoring systems have since been put in place, along with a host of other mitigation measures.



Salmon farmers, supported by veterinarians and fish health experts, have done everything they can to maintain optimal conditions for the fish in their care.

Farms monitor sea conditions on a daily basis and have been oxygenating the water where appropriate to provide optimal fish welfare.

And a lot of work has gone into understanding the movement of micro jellyfish and other organisms, including daily monitoring and testing, with our producer companies sharing information and best practice.

bloom can badly affect one site without any interaction with a neighbouring site.

Many environmental issues are also predominantly a west coast issue, with salmon farms further north in Orkney and Shetland relatively unaffected.

But there's no question that climate change poses a long-term challenge to all food sectors, including our own. It also, more importantly, poses a threat to our very way of life.

Like all parts of the economy, we are exploring further options to mitigate the impact.

With larger fish being put to sea, "one summer" salmon could become more common – this reduces the amount of time they spend in seawater, helping to avoid contact with organisms that are harmful to our fish.

Rising seawater temperatures lead to faster fish growth, so we are able to drive that kind of innovation.

Offshore and semi-closed containment for the marine phase could also help to separate salmon from naturally occurring organisms that tend to hug the coast.

We have an incredibly talented expert workforce, who are exploring all the options.

And unlike other farming sectors, we aren't joining the queue for government subsidies to help us fund innovation – we are tackling the issues head-on ourselves.

I know that our sector can overcome any challenges, as it has many times before, and we will continue to farm as sustainably as possible.

Unlike other sectors, we'll also continue to be open and transparent about any challenges we face.

We pride ourselves on having the confidence to publish monthly survival data, sharing with customers and regulators contemporaneous farm-by-farm data on issues that arise.

Salmon farming sustains thousands of jobs here in Scotland and produces 850 million low-carbon, healthy, nutritious meals that are helping to feed a growing global population.

We want to produce even more fish, playing a full role in the

So, while 2023 has not been without its own challenges, the result is that there has been good progress in managing environmental challenges in the sea.

It is testament to the hard work and dedication of production companies that we have faced the warmest temperatures on record and yet managed to maintain survival so far, on average, above 98% a month.

September is typically the most challenging month for salmon survival, but provisional figures provided by our member companies for 2023 show that salmon survival was higher than the same time last year.

Let us not forget that the Scottish salmon sector takes a proactive approach to communicating issues. Scotland's salmon companies are the only farming sector in the UK that voluntarily publishes monthly mortality reports for individual farms.

The challenge of climate change

Our member companies have been investing millions on ways to protect their salmon from the harmful effects of climate change.

Mitigation measures include aeration/oxygenation of the water and feeding strategies, which minimise the time salmon spend near the water surface, where they are more likely to come into contact with jellyfish or algal blooms. We are also investigating other options, such as bubble curtains, which use air to create a barrier to prevent jellyfish and algal blooms from entering salmon pens.

We have also seen fish movements to remove salmon when the presence of micro-jellyfish is anticipated or detected, and farmers have been putting larger fish to sea.

Not all farms face identical challenges. Sometimes, a jellyfish

blue economy and meeting the pledges made at every level of government from Holyrood to the UN.

While there are a tiny bunch of critics who want to close us down, the simple reality is that global climate change risks mean that we must lead the world in growing healthy, sustainable salmon for decades to come.

With its low carbon footprint, Scottish salmon is exactly the sort of climate-friendly food we should be producing more of.

Once again, despite the natural challenges witnessed this year and last, I am always encouraged by the determination of our farmers and farming companies to deliver that progress.

Tavish Scott is Chief Executive of Salmon Scotland. ●



Cleaner fish online course with faiAcademy

An interactive online certificated course with 12 modules for farm, technical and health staff, and aquaculture students. Content includes biology, rearing, health and welfare, and farm deployment of cleaner fish.

More details at:

<https://fai.academy/aquaculture/cleaner-fish-biology-rearing-and-farm-deployment>