OFFICIAL REPORT
AITHISG OIFIGEIL

Rural Affairs and Islands Committee

Wednesday 5 June 2024

Session 6

The Scottish Parliament
Pàrlamaid na h-Alba

Wednesday 5 June 2024

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RURAL AFFAIRS AND ISLANDS COMMITTEE
16th Meeting 2024, Session 6

CONVENER

*Finlay Carson (Galloway and West Dumfries) (Con)

DEPUTY CONVENER

*Beatrice Wishart (Shetland Islands) (LD)

COMMITTEE MEMBERS

*Alasdair Allan (Na h-Eileanan an Iar) (SNP)
*Ariane Burgess (Highlands and Islands) (Green)
Rhoda Grant (Highlands and Islands) (Lab)
*Rachael Hamilton (Ettrick, Roxburgh and Berwickshire) (Con)
*Emma Harper (South Scotland) (SNP)
*Emma Roddick (Highlands and Islands) (SNP)
*Elena Whitham (Carrick, Cumnock and Doon Valley) (SNP)

*attended

THE FOLLOWING ALSO PARTICIPATED:

John Aitchison (Coastal Communities Network)
Sean Black (Royal Society for the Prevention of Cruelty to Animals)
Dr Annette Boerlage (Scotland's Rural College)
Sarah Evans (Marine Conservation Society)
Professor Simon MacKenzie (University of Stirling)
Professor Sam Martin (University of Aberdeen)
Edward Mountain (Highlands and Islands) (Con)
Rachel Mulrenan (WildFish)
Dr Helena Reinardy (Scottish Association for Marine Science)
Professor Lynne Sneddon (University of Gothenburg)

CLERK TO THE COMMITTEE

Emma Johnston

LOCATION

The Mary Fairfax Somerville Room (CR2)

Scottish Parliament

Rural Affairs and Islands Committee

Wednesday 5 June 2024

[The Convener opened the meeting at 09:10]

Decision on Taking Business in Private

The Convener (Finlay Carson): Good morning, and welcome to the 16th meeting in 2024 of the Rural Affairs and Islands Committee. We have received apologies from Rhoda Grant. I ask everyone to ensure that all electronic devices are switched to silent.

Our first item of business is to decide whether to review in private the evidence that we take as part of our follow-up inquiry into salmon farming today and at future meetings. Do we agree to do so?

Members *indicated agreement.*

Salmon Farming in Scotland

09:10

The Convener: The next item of business is to commence our follow-up inquiry into salmon farming in Scotland by hearing from two panels of witnesses. This is the first of a number of evidence sessions that we will hold over the coming months. Our inquiry follows the Rural Economy and Connectivity Committee's extensive inquiry in session 5. In 2018, that committee produced its report, which included 65 recommendations for the Government, its agencies and the aquaculture industry to take forward in order to improve salmon farming.

I make it clear from the outset that, through our work, we do not intend to reopen the various debates on salmon farming in Scotland that were explored in depth during that committee's inquiry. Our inquiry quite simply involves assessing the level of progress that has been made in implementing the recommendations that were agreed by our predecessor committee.

With that disclaimer out of the way, I am pleased to welcome our first panel of witnesses, who are representing environmental and animal welfare non-governmental organisations. We are joined by John Aitchison, from the Coastal Communities Network's aquaculture group; Sean Black, senior scientific officer for aquaculture at the Royal Society for the Prevention of Cruelty to Animals; Sarah Evans, aquaculture policy officer at the Marine Conservation Society; and Rachel Mulrenan, Scotland director of WildFish.

I also welcome Edward Mountain, who is attending today's meeting. I will bring you in after members have completed their questions. Do you have any interests to declare?

Edward Mountain (Highlands and Islands) (Con): As I did during the REC Committee's inquiry in the previous session, I will make a full declaration of my interests. I am a partner in a salmon fishery on the east coast of Scotland that employs three full-time employees and provides numerous other jobs for people in the area through the tenants we bring in. The fishery generates income, and all those details can be found in my entry in the register of members' interests.

The reason why I do not think that my taking part in today's meeting represents a conflict of interest is that there are, I believe, no fish farms that affect salmon fisheries on the east coast. All the fish farms are located on the west coast, and the salmon from the River Spey, which is where I have my interest, migrate up the east coast and then head north, so they cannot be affected by

those fish farms. However, there should be no doubt that I have an interest in wild fisheries management, which I have been undertaking for about 45 years.

The Convener: Thank you.

We have about 90 minutes for questions, and I will kick off. It has been estimated that salmon farming was worth approximately £760 million to the Scottish economy in 2021, and it provides more than 1,500 full-time jobs. In your view, does salmon farming bring economic and social benefits to Scotland? If so, how could those benefits be improved?

Rachel Mulrenan (WildFish): Thanks for having me today. On the economic question, we recognise the need for high-quality future-proof jobs on the west coast of the Highlands and Islands region—that is beyond dispute—but WildFish does not think that there is a place for salmon farming in that future. We can look at the proportion of jobs that salmon farming represents in the Highlands and Islands. In the past 30 years, between 1990 and 2020, out of the total of 22,100 new jobs that were created in the region, 465 were in salmon farming, so salmon farming represents only 2 per cent of the jobs that were created in the Highlands and Islands, and it comes at a huge cost to the environment.

09:15

The Scottish Government has never done an analysis of the net benefit of the salmon farming industry by balancing the positive economic contributions of the industry against the negative impacts, including the potential impacts of other economic contributions that could be viable in a different environment. In 2020, we commissioned three economic experts to evaluate the economic contribution of open-net salmon farming, and they concluded that the Scottish Government needs to address the matter as a priority and should conduct a cost-benefit analysis.

Sarah Evans (Marine Conservation Society): Thank you for having me here today. The Marine Conservation Society does not take a position on the economic benefits of salmon farming; we take a purely environmental perspective. One of the recommendations in the REC Committee's report was about the need for a social licence in salmon farming communities. We support that and think that that needs to happen.

The Convener: We are looking at something like a £66 million positive impact in relation to employment, so that is not to be sniffed at in a rural area.

Sarah Evans: I agree.

Sean Black (Royal Society for the Prevention of Cruelty to Animals): We very much take the same view. First and foremost, the RSPCA is an animal welfare charity, so we do not have an official position on the impact of salmon farming on the economy.

John Aitchison (Coastal Communities Network): I live in a coastal community on the west coast, up from Argyll. The jobs in salmon farms are important—all jobs are important—but they do not depend on how the salmon farming is done. If salmon farming was done better, the jobs would still be there, and if it was done even better than that, there could be more jobs. The processing jobs, which are a big part of the industry, can be dependent on the supply of fish, and those fish can be produced well or not well—there is a separate question about how we produce the fish.

It is worth noting that, according to the Government's figures, there were 1,508 jobs on the farms in 2022—only 3 per cent more than the figure for direct employment in 2018—and the figure has actually fallen in Argyll, with 17 per cent fewer jobs now than there were in 2018.

My point is that there has been automation and that farms have consolidated into bigger units with fewer people. There are, on average, seven people on each farm—if you divide the number of people employed by the number of active farms, you find that there are about seven people directly employed on each farm.

The Convener: Economic considerations might not be your primary interest, but every type of food production has a potential impact on biodiversity, the climate and animal welfare. Given the sector's huge economic benefit—£760 million a year—to the Scottish economy, is there not a place for a well-managed fish industry in Scotland, given that every activity that we undertake has some sort of impact? Is the output not proportionate to the potential impacts on the environment and animal welfare?

Rachel Mulrenan: I do not dispute that there is a place for aquaculture in the Scottish economy. That is clear. However, in our minds at WildFish, salmon farming is not the only type of aquaculture, and the production of a carnivorous fish—a fish that takes in more wild-caught fish than it produces—is not a sustainable food system at all. There is a place for aquaculture, but we are looking in the wrong places in relation to the type of aquaculture that we are promoting in Scotland.

Sarah Evans: We need to recognise that salmon farming is a food production system and that all such systems have impacts. There can be a place for salmon farming in Scotland's future, but there need to be changes before the industry

can grow. In particular, we need to recognise that we are in a nature and climate crisis, which needs to be addressed or else there will not be an industry, given the impact of climate change. If we do not take action, what we are talking about will not really matter, because there will not be an industry to argue about.

John Aitchison: I completely agree with that.

The figure that the convener has quoted excludes any impact costs; it takes into account only the benefits. If the lost opportunity costs to fishermen and so on are subtracted, the figure goes down quite a lot.

The Convener: Thank you. We will move to questions from Emma Roddick.

Emma Roddick (Highlands and Islands) (SNP): The Griggs review, in 2022, recommended a social contract in the consenting process that recognises the local community and its needs. I have constituents complaining that they see the impact of the farms but they do not necessarily see a benefit. When they look at the profits that are made at these farms, they feel that there should be more benefit to them and their communities. Do you think that that has improved recently? What more could be done to ensure that?

John Aitchison: You mean financial benefits.

Emma Roddick: I assume financial benefits, but there certainly could be others.

John Aitchison: Yes. The Government has a vision for sustainable aquaculture, but the Scottish aquaculture council does not include any community voice at all apart from the Convention of Scottish Local Authorities. So, the councillors are there.

As I understand it, the arrangement is that the councils will receive payment from the industry and they will decide where it goes. Separate to that, the companies sometimes give money to individual islands, particularly island communities such Colonsay. I think that it is £10,000 or £20,000 a year from profits of many millions of pounds per production cycle. There are some financial benefits and they have helped a bit by putting some money into some affordable housing for their own staff on Colonsay. They have also put a bit of money in for the community, which is genuinely helpful.

In a broader sense, we have to be careful that offering money in exchange for putting up with the status quo, which is the situation because the farming has not improved very much, is not a kind of bribe. There is a risk that, in advance of communities deciding how they feel about a consenting decision, they are offered money to say yes and they do not get the improved form of aquaculture but they are paid to put up with the existing dirty form.

Rachel Mulrenan: Anecdotally, at WildFish I am contacted almost weekly by people who live in coastal communities who are concerned about applications that have gone in for new farms or for extensions to existing farms. From our perspective, the only tangible thing that has come from the Griggs review, which is the streamlined consenting pilot, is really detrimental to communities being able to feed into the planning process, because it speeds up the process and gives people in local communities less time to get to grips with a complex subject. We have groups that have gone from having no knowledge of salmon farming to knowing enough to have a degree in salmon farming within months, but it takes a toll on people in the community. Streamlining the process cuts down the amount of time available for people to feed in and voice their concerns.

Emma Roddick: On the consenting process, what would you like to see more as standard from growth and expansion in a particular community?

John Aitchison: I am here for the Coastal Communities Network Scotland, which is a group of 21 communities around the whole coast. I live in a coastal community and there are others nearby. Some have farms and some do not have farms. From the community perspective, I have some notes here of what people have told me in advance of this meeting and over the years.

The general gist is that a community cannot make any difference. If a big industrial corporation with a lot of money comes along and wants to put a farm in a particular place, the only thing that will stop it happening is if it contravenes a rule. If it will affect the national population of a priority marine feature, for instance, it might be turned down or it might not. A big farm west of Gigha is being proposed at the moment, and the majority of people surveyed by the community council have said that they do not want it. The decision has not been made yet, but the council is not obliged to take that as a material consideration. It can listen to them, but it will not make any difference to the decision; it never does.

The biggest thing is if a community really does not want a farm and it is being foisted on them by an external big company. The community ought to have the final say. It is not national infrastructure; it is not a power station. It is a private company wanting to impose an industrial farm on a place, and some places are unsuitable.

One of the reasons for a farm being unsuitable is that the community does not want it for practical reasons—not just because it is ugly, but for practical reasons such as because they use that

place. The Clyde Fishermen's Association has said:

"It all feels very undemocratic. I really do not think we can continue in this vein."

The Scottish Creel Fishermen's Federation has stated:

"We object in principle to the insidious creep of this industry, rendering ever increasing areas of waters unfishable."

That is ignored by people in the planning system. They hear it but they do not take any notice.

Emma Roddick: That is interesting, because it has been identified that other fishing is going on in the area, and the impact on that is assumed to be negative. Is there a way of balancing that through the consenting process?

John Aitchison: No. It is just that the farm will make more money. That is the way it is balanced. Will the farm make more money, and can the community fish somewhere else? That is the assessment. The fishermen say they cannot fish anywhere else, because the sea bed is not uniform. The Clyde Fishermen's Association says, "This place is where we go in the winter. It might not look very busy in the summer time, but it is a safe place in the winter. When it is stormy outside and we cannot go to the usual summer places, we have to go to this place." But that is dismissed—it just does not count.

Rachel Mulrenan: The way in which the planning process works at the moment is that there are statutory consultees, which are the regulatory bodies and various other bodies, but the community does not have that statutory position in the consenting process.

The Convener: That is not unique to the salmon farming industry. If you searched and replaced "fish farm" with "wind turbines" or "commercial forestry" you would see that it is not specific to aquaculture. It is an issue with the ability of communities to influence planning decisions and what may be in the wider, broader community's interest or the national interest. The same argument could apply to commercial forestry, wind turbines and solar farms. Are you indicating that there is an issue generally with community voices on planning issues?

John Aitchison: That is probably true, but, on the specifics of aquaculture, Salmon Scotland has a community engagement charter, which says:

"It is in our interest to work with community as part of the inherent natural asset of a place. We will always work to communicate why we are keen to see a site develop ... where relevant, we will engage communities in a vote to allow the local people to have a direct say in what is happening. Consider putting the decision to a community vote—it is the ultimate test of whether the case has been made for a site and has the support of the wider population."

That is the industry saying, "If they say no, we should back away," which Mowi has done. I think that only Mowi has done it, but only for islands such as Coll and Eigg, for instance. That is outside the planning system.

The Convener: Again, we often hear that argument about what a community is. Is the community those who live in the area or those who feel that they are stakeholders or opinion holders? Then there are the interests of the wider community and the wider nation.

John Aitchison: You quoted national figures, did you not? Yes, it is in Scotland's interests, but it is only in Scotland's interests if we do not trash something else that is also valuable. In the long run, we do not want to damage the renewability, the regeneration and the sustainable use of the sea or other people's sustainable use of it for a less sustainable use.

Sarah Evans: I want to circle back to the point about the Griggs review and what we think can go further. One of the points it raised was about the ability of a salmon farm to give up its licence for a site when it is no longer suitable or when our knowledge has improved and we do not think it is a suitable site any more, so that it can be used for shellfish or seaweed farming or even returned to nature. We have not seen the uptake of that, but we support that recommendation and think it should go ahead.

Emma Roddick: Is it likely that any farms would be interested in doing such a thing?

Sarah Evans: The review made the point that, in order to encourage the industry to do that, there would need to be a presumption of ability either to scale up in another area, so that the farm would not leave biomass or, if we had effective spatial planning in place, to say to the farm that, although it had a licence for a certain amount of biomass, that was not the area that it needed to grow it in, presuming that a farm in another location would be given the go-ahead because there were likely to be fewer environmental impacts.

Sean Black: On the point about new farm developments, at no point in the recommendations is there any mention of animal welfare—the welfare of the fish. If we are moving to offshore farms, which might be a reasonable thing to do, we need to consider the welfare of the farmed fish. There is a lot of tidal movement in those locations and the weather can be quite bad, which needs to be part of the consideration. We should not do it without considering the effect on the animal of removing it to exposed locations. That needs to be quite high on the agenda. There is no reference to

it in the recommendations, but it needs to be considered.

09:30

Ariane Burgess (Highlands and Islands) (Green): I am interested in understanding whether you think that sufficient progress has been made in the implementation of the previous RECC inquiry's recommendations on the environmental impacts of salmon farming. In particular, I would like to hear your thoughts about climate change and spatial planning.

John Aitchison: No, there has not been sufficient progress. I took part in the Environment, Climate Change and Land Reform Committee hearings six years ago, and it will be six years in November since the REC Committee published its recommendations. The second recommendation was:

"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."

There has been very little change since then, and the status quo is still pretty much the same. About 50,000 tonnes of new biomass has been consented and given planning permission since the 2018 inquiry published its report, and another about 50,000 tonnes is in screening and scoping or pending decisions. That is a lot. That is the opposite of that recommendation.

The changes that have come about in that time have been quite minor. The Scottish Environment Protection Agency's sea lice framework is probably the biggest change, and it has just been applied this year and only to new farms.

In that time, mortality on the farms has got very much worse. It has gone from roughly 4 million or 5 million fish dying in the sea stage each year, when the inquiry took place, to about 17.5 million in 2022. That is taking the weights reported to SEPA and converting them into figures of individual fish using the fish health inspectorate individual fish to weight ratio. Having 17.5 million dead fish in one year is not an improvement in fish welfare. It is not "urgent and meaningful action". Whatever action has been taken, it has not made a difference.

To answer your specific point about climate change, we are all aware that it has got warmer in the past couple of years. It is not unique and it is an indication of what the near future will be like all the time. In the past year, the north Atlantic sea surface temperature was 2°C above the average, and, if the sea does not get below 8°C in the winter, the pathogens from the previous year pass on through, affecting the fish, and mortality goes up. The jellyfish are worse, algal blooms are worse—everything is bad for the fish. There is less oxygen in the water. That is why mortality is spiking. If we do not recognise that climate change will be doing this increasingly, we are not being realistic. Climate change is a given and it is not going away.

Salmon are a cold-water animal. They do not mind the warm water, but all their pathogens love it. We are potentially consenting farms in places such as west Gigha and in Argyll, where I live. It is too warm in Argyll to humanely farm fish. These mortality levels are inhumane. Unnecessary suffering is being caused in these farms and we are just promoting more and more of it—50,000 tonnes since 2018. It is completely ridiculous that that is not part of the planning process. Marine Scotland, the marine directorate, ought to be advising local authorities on that, but it is not doing it.

Rachel Mulrenan: Climate change is definitely playing a role in the industry. A peer-reviewed report that came out earlier this year attributed the rising mortality on salmon farms, which is a trend across the world and has been seen over the past 10 years, to two things. The first is the impact of climate change, but there is also the increased reliance on technology; it is important to remember that. Technology will not take us away from the issues associated with climate change, because they seem to be contributing to larger mass mortality events.

In the past six years, we have seen a trend of what is called innovation within the industry, but it is basically problem solving and trying desperately to fix problems. For instance, warmer waters mean there is a greater proliferation of sea lice on the fish in the farms. That necessitates more chemical treatment to rid the fish of sea lice, because of the negative impacts on migrating wild salmon. Resistance to the chemicals being used is rising, which means that the industry has increasingly been running the fish through physical treatments to remove the sea lice. That weakens the fish, which means that weaker, compromised fish are going back into water that is warming, and disease can proliferate on the farms in warmer water.

We are seeing that kind of cycle, which is exacerbated by climate change. It is not solely explained by climate change, but it is definitely playing quite a negative role.

Sarah Evans: I agree that a lot more work needs to be done on climate change and spatial planning. As we have heard, climate change is driving mortality. There was a recommendation in the RECC report and in the draft climate adaption plan for a specific aquaculture climate adaptation plan. We have not seen that come to fruition either from the Government or the industry.

The big point for us is that spatial planning is not achieving what it needs to achieve. We would like to see the development of national marine plan 2 as quickly as possible. Additionally, we need to see the regional plans happen as quickly as possible. The Clyde and the Shetland regional plans, in particular, have been delayed for years, and that cannot be allowed to continue.

With spatial planning, we need to have an understanding of key impacts across all farms in an area, but also across all industries or all activities that are happening in an area, until we understand the cumulative impact on the receiving water body. Spatial planning is not currently effective.

Ariane Burgess: What is holding up the regional marine plans?

John Aitchison: They are quite difficult to agree. There is so much competition for space that it becomes a very toxic environment between all the different competing users of the sea. It is very hard to make an agreement on bottom-contact fishing, for example, as it is one of the most contentious issues. There is also spatial loss—fishermen hate the farms because they are losing ground to them. There are a lot of competing issues.

Sarah Evans: The Shetland regional marine plan has been sitting in draft form since 2021, and it might need updates by this point. The fact that it never had approval to get past the draft stage is a problem, and we need to understand why that hold-up happened.

John Aitchison: Could I add one thing about regional planning? The Scottish Government wrote a research paper in 2020, I think, which was an analysis of mortality against temperature and biomass. Government scientists found that 81 per cent of the variation in mortality can be predicted by the previous minimum winter temperature and the biomass of fish. If you raise the temperature of the water and you increase the biomass, the mortality goes up. It is 81 per cent of the variation and is very predictable. If you look at the temperatures where I live in Argyll and compare them to temperatures in Shetland, you see that it is much warmer in the south and west. The Western Isles and Argyll have warmer water than Shetland and Orkney. In the most recent mortality figures in the Government's Scottish fish farm production survey, Argyll had 32 per cent, the Western Isles had 38.8 per cent, Shetland had 18.1 per cent, the north-west had even less than that and Orkney had a bit more than Shetland.

Let us not forget that those figures are way above what Norway has. There was outrage in Norway this year. One of the unions that represent fish vets threatened to strike because the mortality in Norway was 16.7 per cent for the year. In Scotland, the Government will tell us that a production cycle mortality rate of 25 per cent is fine because it is not varying. That is not annual mortality, but it is way worse than Norway's and the fish vet union in Norway said it should be 5 per cent. Fish vets in Norway will strike if the Government does not have a plan for bringing it down to 5 per cent within five years. We are sitting at 80 per cent mortality in some farms—2,000 tonnes of fish dying in a 2,500 tonnes farm. That is a lot of fish.

Emma Roddick: I want to come back to fish welfare but, if we can, focus on the environmental impact for a moment. John Aitchison mentioned that the SEPA framework is showing good indications. How long does that need to bed in before we know whether it is enough, and what more needs to be done?

John Aitchison: Do you mean the new sea lice framework? Salmon are declining for lots of reasons, and the reasons are probably different in different places. There are no farms on the east coast, as Edward Mountain said, so the decline there will be because of a different set of reasons from the decline in the west coast, where there is aquaculture. One of the things that is affecting the wild fish is sea lice from the farms. That is pretty well established, although it is not the only reason by any means. The only thing that is causing that aspect of the decline is existing farms. New farms do not exist yet, so they cannot be making a difference.

SEPA's new rules have started to apply, but they apply only to new farms to start with. SEPA has decided that it will implement what it calls a "no further deterioration" condition, which is the maximum that it says it can do. It will assess, by modelling, whether each new farm will have an impact and then it will set a threshold on the farm, depending on where it is. If a farm is on its own in a place where there are no other farms and no wild salmon—it should be sea trout as well—SEPA will not set any limits on it. If a farm is in a place where modelling has shown that most of the capacity for harm has been used up or exceeded even, SEPA will strictly control it or may even say that the farm cannot go there.

That is just for new farms. "No further deterioration" assumes that you have to stop the existing harm that existing farms are causing at the moment. SEPA has said it will freeze the lice levels on the existing farms only in the worst places—19 farms out of 210—to cap the amount of harm. However, if the wild salmon population is declining and the numbers of lice are capped at existing levels, the worst farms will stay bad. They can have high lice levels, like they have had previously, and the decline will carry on. "No

further deterioration" will not freeze that at all. How long will it take to bed in? I do not know, but it could take many years.

Rachel Mulrenan: Bringing it back to the recommendations that were made in 2018, fundamentally, sea lice levels on farms have not changed since 2018, because SEPA is still developing the framework. However, the framework will not apply to any existing farms, including, as John Aitchison said, 19 farms that have already presented a risk factor to wild migrating fish. SEPA has also said that it does not expect to take any enforcement action on farms for at least five years, which will be more than 10 years since the original recommendations.

The Convener: You quoted an astonishing figure of over 80 per cent mortality. Where does that figure come from? What does that actually relate to?

John Aitchison: It comes from Salmon Scotland, which collects a monthly self-declared mortality figure from each farm and tallies them up at the end of the production cycle. The production cycle could be a year and a half, and the cumulative mortality over that period is a farm's total mortality for a production cycle.

Two farms that are next to Gigha—so they fit the pattern of warmer waters being less good for the fish—both had 82 per cent in two production cycles. One had 80 per cent mortality in the previous production cycle as well. They were the worst two in Scotland in that set of production cycles, but 40 were above—

Rachel Mulrenan: Salmon Scotland is saying that the same company has an application in for a new farm at the same location. There was a recommendation not to consent to expansion at existing sites with high mortality, and we argue that that should be extended to companies operating in areas with high mortality rates. We should not even be considering consenting to a new farm in an area where the same operator has had 80 per cent mortality.

John Aitchison: The Rural Economy and Connectivity Committee's report recommended that urgent action should be taken on high mortality and new farms should not be consented if mortality is very high, but that has not happened.

Emma Harper (South Scotland) (SNP): Good morning, everybody. Rachel Mulrenan, you mentioned chemicals and the environment. I do not want to impose on my colleagues' questions about welfare that might be coming up, but I am interested to hear your thoughts on the progress towards use of medications and chemicals having minimal impact on the surrounding environment.

09:45

Rachel Mulrenan: Unfortunately, again, there has not been an improvement since 2018. Chemical use per tonne of salmon produced has remained quite consistent since 2018, but in absolute terms chemical use has increased on the farms as the biomass has increased. For instance, emamectin benzoate use has increased by 14 per cent since 2018 to 2023, azamethiphos use has increased by 33 per cent and deltamethrin use has increased by 35 per cent. Those three chemicals are known to be toxic to the surrounding environment. We have not seen any decreasing impacts on the surrounding environment since 2018.

It is also worth saying that impacts vary by producer. For instance, Mowi, the largest producer, more than doubled its usage of azamethiphos from 2018 to 2023, and Scottish Sea Farms, the second-largest producer, doubled its use of emamectin benzoate from 2018 to 2023. It is definitely a concern.

Emma Harper: Okay. I know that the Global Salmon Initiative is working to look at non-medicinal approaches to managing sea lice, and there is continuing research and development. That is part of the process of research and development as we move forward. Are more chemicals and more types of antibiotics being used? Is that a concern?

Rachel Mulrenan: The chemicals that I mentioned are not antibiotics, and the absolute volume of chemicals used has increased. As I mentioned, per tonne of salmon produced, the figure has remained fairly consistent since 2018. The recommendations in 2018 were intended to improve the industry's environmental performance, but we have not seen any improvement since then.

To go back to what I was saying earlier, physical treatments also have problems associated with them. When you run fish through physical treatments, you have welfare issues and you also weaken the fish and put compromised fish back into the water, which contributes to rising mortality. It feeds into the cycle.

From our perspective, innovation is not moving us anywhere. It is just creating more and more problems for the industry.

John Aitchison: The industry can discharge all its pesticides into the sea. That is what happens, and it is allowed to do that. The quantity allowed per farm for a period of time is limited—that is how it is capped. If you have more farms, you have more pesticide discharges. There is nothing mandatory that is driving a reduction in pesticide discharges into the sea from fish farms. It is the biggest polluting industry of the sea in Scotland

and the Government has not set a target that it should go down—it is entirely voluntary. Actually, because the sea lice have evolved to be resistant to the chemicals, chemical use is going up.

Non-medicinal things, as Rachel Evans said, have problems. For example, cleaner fish such as wrasse and lumpsuckers are put into the farms to pick lice off the salmon, and they are all killed at the end of the production cycle. One farm, BDNC, which is near where I live in Argyle, put in 182,000 lumpsuckers and 31,000 wrasse, and they all died. That happened in just one production cycle—a year and a half, basically. It did not report 100,000 of the deaths; it reported 86,000. Some 100,000 went unreported because the farm did not know what had happened to them. That was a consequence of not using the medicines or trying not to, a bit.

The medicines do not work anyway. Either you have to increase the quantity of medicines to make them stronger or you have to use something else, but that then kicks into this other welfare nightmare for the fish.

Emma Roddick: I have a question for Sarah Evans on the environmental impact. What more could be done now on enforcement, without creating new legislation or powers, to mitigate pollution and the impact on the marine environment?

Sarah Evans: I think that it is recognised that SEPA needs more resources for enforcement. At the moment, a lot of the industry is reliant on self-reporting and self-monitoring, and we would like SEPA to be able to do more of the testing.

In order to evaluate the industry's environmental impact properly, there needs to be an increase in data transparency. SEPA's new aquaculture website would help with that push, but we understand that the building of that website has been delayed. That would allow farm-level information to be provided in a much more timely fashion than is the case currently. Until that data is accessible, we cannot truly evaluate the industry's impact on the environment. We are particularly concerned about farms in and around marine protected areas and priority marine features. More needs to be done in that regard.

The Convener: I will bring in Alasdair Allan.

Can you make sure that you are not muted, Alasdair?

Alasdair Allan (Na h-Eileanan an Iar) (SNP): Thank you, convener. Can you hear me?

The Convener: Yes.

Alasdair Allan: In 2019, SEPA put in place revised arrangements for monitoring, particularly for finfish aquaculture. I realise that the witnesses have expressed their concerns, but are the revised arrangements that have been in place since 2019 any better from an environmental point of view?

John Aitchison: The point of those changes was to try to encourage farms away from more sheltered places where the water flow is poor and the waste is more likely to accumulate under the farm—and it is the solid wastes, which include emamectin benzoate, that the fish have swallowed. That is the only part of the pollution that it is dealing with.

In its analysis, SEPA provided something like 10 early-stage examples of how the changes had made a difference. The changes had not decreased the biomass on any farm, but they had slowed the rate of increase by about a third, according to our calculations. People will not get permission for a big farm in sheltered water, because the exchange of water is too low, so people were nudged to build bigger farms offshore.

Concurrent with those changes was the change away from the maximum size of a farm being capped at 2,500 tonnes, which was to do with modelling capacity. If two of the biggest farms were put next to each other, they would be 5,000 tonnes. There are two such farms in the country, as well as some 4,000-tonne farms. They are not further from the shore but are in faster-flowing places.

Have the changes made a difference? SEPA is supposed to do a bit more monitoring of the sea bed, but the changes have probably not made very much difference, to be honest. The farms are just in different places. At present, out of 210 farms, SEPA has 72 submitted sea bed survey results, mostly from 2023, that have not been assessed, and some of those farms have been restocked. SEPA does not even have the capacity to assess those results, so providing it with more information is not really helping. It is not able to do its job properly.

Alasdair Allan: You have mentioned what you see as shortcomings in this situation, and you have talked about resources for SEPA. Are you advocating a change in its powers or simply a change in the way that it operates?

John Aitchison: It depends. SEPA's approach is extremely slow; changes happen very slowly. SEPA has no duty to make improvements—it can freeze things as they are, but it has to be instructed to make improvements by legislation and by ministers. That would be how to do it.

If a business was trying to improve something, it would get good data, as Sarah Evans said, on mortality, pollution and sea lice counts. Data on all of that is badly lacking; we do not have good-quality data. The business would set a key

performance indicator to show what it was aiming for. It would set a date for a review and its data would be used for that—it would carry out good surveys to ensure that that data was good. If the business did not hit its target, it would be penalised, but it would be incentivised, too.

None of that is happening. Under the legislation, the Government has no intention of improving things as they stand.

The Convener: I will round off this section. Do you believe that SEPA operates a robust enforcement system—yes or no?

Rachel Mulrenan: In relation to sea lice, which is our area of expertise—

The Convener: I am talking about regulation and enforcement generally. Do you believe that SEPA operates a robust enforcement system?

John Aitchison: I will give an example. Distilleries were fined millions of pounds for breaking SEPA's rules, but fish farmers do not get fined at all, as far as I can tell.

Sarah Evans: There has been improvement, but the system is not as robust as we need it to be.

The Convener: Okay. Thank you.

Beatrice Wishart (Shetland Islands) (LD): Some of the witnesses have alluded to welfare standards. Have welfare standards on fish farms improved since the REC Committee's inquiry?

John Aitchison: No, because mortality, which is our only KPI, has doubled—17.5 million fish died in the sea in 2022. That figure is extrapolated from weight, because SEPA reports mortality in kilograms. We should not measure welfare in kilograms; we should be talking about individual fish. Using figures from the fish health inspectorate—although its reporting is partial, because it does not get all the death reports—we can extrapolate the number of fish based on SEPA's figures for weight, which cover all deaths. That gives the figure of 17.5 million fish dying at sea in 2022. The year before that, the figure was, I think, 11 million; the year before that, it was about 8 million; the year before that, it was 8 million; and the year before that, it was about 5 million. Things are not improving at all; they are going the opposite way.

Sean Black: Are you talking about welfare or mortality?

Beatrice Wishart: I am talking about welfare.

Sean Black: On welfare, I disagree with John Aitchison. Fish welfare is improving, but our knowledge is still developing. We do not know enough about positive welfare for fish. For a fish, what is a good life that is worth living ? I know that the committee will hear from Lynne Sneddon later.

Mortality is a very crude indicator of welfare, but we are trying to drive forward welfare standards. We have developed welfare standards to try to push things forward in relation to how people look after fish and the responsibility that people take for live animals that are under their care. We have moved forward in that regard. Since the REC Committee made its recommendations, two new sets of welfare standards for Atlantic salmon have been introduced. We have, I think, more than 700 standards, so we are trying to push things forward, but mortality has not improved.

John Aitchison: How do you measure welfare?

Sean Black: It is incredibly difficult to measure welfare. We have to use things such as fin scores as individual indicators for fish, but it is difficult because that requires the sampling of fish, which involves removing them from the water and anaesthetising them. To get a representative sample, hundreds of fish would have to be caught every day, which would not be possible under the current standards.

That leaves us with reporting and record keeping. What are people able to do? What can they adhere to? On that front, we have seen a push forward. The fish welfare standards that the RSPCA has created are still regarded as the highest in the world, and we are about the only ones with salmon-specific standards. We are trying to push forward those standards, and the industry is trying to do that with us.

We acknowledge that mortality has not got better. If anything, it has probably got worse.

John Aitchison: It has got massively worse.

Sean Black: I think that we can all agree that the reporting and presentation of data is pretty poor, because we still talk about tonnage of fish—these are individual fish, and they should be treated as such, so we should know the numbers. In relation to mortality, the average weight has probably increased, which distorts some of the figures, but we have no idea of the actual number of fish that die on farms. I think that fish welfare has got a little bit better, but we acknowledge that mortality has not improved.

Rachel Mulrenan: I would like to voice a concern. As I stressed to the clerks before the meeting, it is important to note that the RSPCA is financially involved in the salmon farming industry—

Sean Black: That is not true. The RSPCA is not—

Rachel Mulrenan: RSPCA Assured—

The Convener: Please direct your comments through the chair.

Rachel Mulrenan: Sorry. As I said, I raised a concern ahead of the meeting, and I would like to raise it again. I struggle to believe that the RSPCA can be impartial on improvements to fish welfare considering that, through the RSPCA Assured certification scheme, it is financially incentivised to certify salmon farms as having high welfare standards. That conflict of interest should be noted.

Sean Black: The RSPCA and RSPCA Assured are separate charities. They have different charity numbers and operate in completely different ways—

10:00

Rachael Hamilton (Ettrick, Roxburgh and Berwickshire) (Con): Could you repeat that, please? I did not hear what you said.

Sean Black: The RSPCA and RSPCA Assured are completely separate charities. They have different charity numbers and different structures. I work in the RSPCA's farmed animals department, and my sole aim is to improve the lives of farmed fish.

The assurance scheme certifies farms, but it is separate from the RSPCA and is not represented today. I do not speak on its behalf; I am here as a representative of the RSPCA. We do not take any money from the salmon industry.

John Aitchison: Convener, could we clarify something? Could you ask Sean Black how much RSPCA Assured takes from salmon farmers and whether it ever turns down any farms?

The Convener: We will stick to committee members asking the questions, or it will turn into a debate, which is not the purpose of today's meeting.

Beatrice Wishart: I will go back to animal welfare and the inquiry from five or six years ago. Can you specify which recommendations have not been met?

Sean Black: On welfare?

Beatrice Wishart: Yes.

Sean Black: There was not much on welfare. It was all about health and mortality. The health of the fish and the welfare standards are quite separate. Very few recommendations on mortality have been met in any way that we accept as going far enough.

The recommendations mentioned accreditation schemes, but we have not seen those pushed forward enough. I would need to see the exact recommendations about welfare standards.

John Aitchison: I have them here if you want them. They state:

"urgent and meaningful action needs to be taken to address ... fish health";

"no expansion should be permitted at sites which report high or significantly increased levels of mortalities, until these are addressed to the satisfaction of the appropriate regulatory bodies";

"The Committee welcomes the statement in the Scottish Government's Fish Health Framework that ambitious targets should be agreed 'to achieve a significant and evidenced reduction in mortality for salmon and trout'".

They also state that there must be "high levels of transparency" about "the causes" and

"where early harvesting has been carried out because of a disease outbreak"

and that mortality reporting should be mandatory.

On gill health, we are told:

"The Committee ... has difficulty understanding how expansion of the industry can reasonably occur if this issue is not satisfactorily resolved."

We are also told that one of the primary factors contributing to the increase of gill diseases is "rising sea temperatures"

and that

"sea temperature may ... become a discussion point around the location of salmon farms".

Sea lice trigger levels should be

"challenging and set a threshold that is comparable with the highest international industry standards",

and there should be no voluntary sea lice reporting—it should be mandatory and so should compliance. Enforcement action following breaches

"must be robust, enforceable and include appropriate penalties",

and the Scottish Government should fund Marine Scotland to monitor and enforce sea lice regulations. The data provided should be fit for informing the regulatory regime and not the industry's choice of data, and the industry should pay for a better and "comprehensive" presentation of data.

Sean Black: I would say that very few recommendations on mortality have been pushed forward far enough.

Beatrice Wishart: You are saying that the salmon industry has not done anything at all.

Sean Black: I am not saying that it has not done anything at all, but it has not gone far enough. The mortality data is publicly available, but it could do with more detail. We would like to see more about what caused the mortality. "Gill disease" is super vague—it is like saying you have

a lung infection. There could be more detail. The recommendation was that the farmed fish health framework should develop 10 mortality causes, and that information could be made public.

The Norwegian Veterinary Institute produces a robust report every year that looks at the drivers of mortality and at what the people on site feel are developing issues. That is the kind of thing that the Scottish Government should look to have every year. It should be transparent. Every farming industry should be transparent about what mortality happens on farms—salmon farming more so, because of the concerns. People should be open and honest about what is coming. Working with other stakeholders, we can tackle and push forward on these issues only if we know what they are.

More needs to be done. Compared to some other areas, movement on the recommendations around mortality has probably been slower.

Beatrice Wishart: I find it surprising, because I know fish farmers who care deeply about the welfare of their fish.

Sean Black: Sure. When we talk about mortality levels, it is worth noting that some farms have a mortality rate of less than 10 per cent for their whole production cycles. It is possible. Not every farm has a 25 per cent mortality rate. We try to tease out what separates the farms that John Aitchison mentioned from those that have a mortality rate of 5 or 10 per cent, and we understand that other stakeholders try to do that. If we could find out what that was, we would ask for it in our welfare standards.

John Aitchison: The committee said that we should shut the ones that have a high mortality rate if they cannot be controlled. Time after time, it constitutes unnecessary cruelty.

The Convener: Can I ask a simple question? What are the indicators of fish welfare when you decide whether welfare is good, poor or otherwise? Surely, mortality and health are the key indicators.

Sean Black: Sure. Mortality can be the end indicator of poor welfare, but mortality can occur without poor welfare before. They are not intrinsically linked all the way through.

In our new welfare standards, we are starting to ask farms to score their individual fish on welfare indicators such as fin scores, scale loss and wounds. For a larger group on a farm or in a pen, we would look at the behaviour of the fish and their feed intake, but it is still quite blunt. Of course, one problem with fish is that, because they live in the water, it is difficult to understand their natural behaviour.

The Convener: This is not a new industry. This is not an innovative way to farm fish. This has been around for a long time. Surely, you should be in a position to say, in general, given the indicators you have suggested, whether fish welfare at Scottish fish farms is either improving or declining. What is your view on that right now?

Sean Black: We are still building up the database. We do not have historical data on that kind of stuff, because it has not moved forward fast enough.

The Convener: I am sorry, but I must press you on this. You have no indication whether animal welfare on fish farms is improving or declining because you do not have the data.

Sean Black: I can tell you what I think but, no, we do not have KPI data. Our welfare standards are 20 years old, so we still have a lot to do.

Emma Harper: I have a quick question. Some information from the University of Victoria says that fish mortality on fish farms has increased in Norway, Canada, the United Kingdom, Chile, Australia and New Zealand. What work is being done to learn lessons? I want to highlight that it is not just a Scottish problem but a global issue. What work is being done to join up all the scientific knowledge?

Sean Black: We speak to experts from around the world about what goes on in other countries and what they do to drive forward and tackle some of the issues.

There are also larger, tri-nation scientific meetings every other year in different countries to talk about the current issues, such as gill health and heart health, and we, as stakeholders, are still learning a lot about what drives a lot of this. Those meetings go on and we have those discussions. Maybe there is a better way to have joined-up thinking. We are talking about mortality data and we do not have a good enough understanding of that because the reporting is still messy. A lot can still be learned, and conversations are going on all the time between different parties.

John Aitchison: Could I add something to that about what the industry would say?

The Convener: I am conscious of the time. A few members still want to ask questions.

John Aitchison: That is fine.

The Convener: Can I bring in Rachael? I beg your pardon—we have another Rachel with us today. Rachael Hamilton wants to come in on the back of this. Do you want to ask your questions now?

Rachael Hamilton: I will develop this line of questioning, convener. Rachel Mulrenan might get an opportunity to answer.

As we know, salmon farms are legally required to report weekly sea lice counts, but Sean Black said that the reporting is messy. Can you categorically say whether the reporting of sea lice and mortality has improved in recent years?

Sean Black: Yes, because at least it is happening, but a lot of the data lives on the Scotland's Aquaculture website, which is quite convoluted to use. Taking the data out of it is not particularly easy. At least the reporting has been done, but it needs to be better. Norway has a good system that I think is called BarentsWatch. It is much more up to date and much easier to use. The Scotland's Aquaculture website is messy and clunky, but at least the data is coming in, which is an improvement on what was happening six years ago.

Rachel Mulrenan: Since April 2021, salmon farms have had to report to Scottish Ministers their weekly sea lice counts, which are published in arrears on the SEPA website. We did a little bit of analysis of those figures before coming here today, and almost 20 per cent of submitted counts since 2021 have been no counts, which is a data gap. So, we have a data gap of almost 20 per cent in sea lice reporting. It is also worth reiterating that the counts are self-reported and unverified, which is significant because SEPA bases its sea lice framework on that data. We struggle to see how it can do that with such a big data gap and without verifying the counts that come in from the farms.

Rachael Hamilton: In your opinion, do those who operate the farm assurance scheme have any input into the data gathering, so that the farms that should be giving information are doing so and it is then followed up? When I looked on the site at some of the circumstances in which no counts were registered, the reasons given included "weather", "withdrawal period prior to harvesting", "vet advice" and "site recently stocked". What input do the assurance scheme providers have in ensuring that salmon farms provide that information?

Rachel Mulrenan: That is an interesting question. I am not sure, to be honest.

Rachael Hamilton: Maybe Sean Black could answer that.

Sean Black: Sure. At the moment, we default to the fact that they should be doing it in line with the legislation. I guess there might be scope to improve that as we go forward. The issue of no counts is convoluted because, although the fish health inspectorate accepts it as legitimate, we see weeks going by without counts.

What you described are legitimate reasons for not being able to catch fish. During a withdrawal period, you would probably have to cull those fish, because you could not put them back into the pen and they could not go to market with anaesthetic on them.

Farm assurance standards and schemes could be better at pressing the farms on it, but it feels like something for the Government to be harder on than farm assurance schemes. Our schemes and standards are voluntary, and that seems like something that the Government should be doing.

John Aitchison: A big farm has a huge number of fish in it, with a lot more lice coming out into the wild to affect wild fish and fish health compared with a small farm. The effort put into the counting has to be scaled to the biomass of the farm, but it is not. The number of fish counted for lice is incredibly small compared to the number in a big farm. Counting the lice on 50 fish in a farm that has a million fish in it is meaningless. The data is worthless. You need thousands of fish counted each week to give a meaningful, relatively statistically accurate figure for lice in a farm.

Rachael Hamilton: That is really interesting. What would make that exercise more practical and meaningful?

John Aitchison: The only way to do it is to photograph the fish and count the lice on them. If you had a lot of people with frames, you could do it. As the fish passed by an underwater camera, they could count the lice. Artificial intelligence could do it. The Norwegians are developing AI for counting lice on fish in situ, without handling them.

Rachael Hamilton: Emma Harper quoted that some of the welfare and mortality figures are similar to those in Scotland, but the figures that I have seen comparing Scotland with Norway show that that is not the case.

John Aitchison: It used to be much better in Scotland than in Norway but, as Sean Black said, the data published by the Government is atrocious. The fish health inspectorate data has lots of exceptions. A farm does not have to report less than 1 per cent mortality at a given event. It does not have to report in the sea. It does not have to report for the first six weeks when the fish are in the water, because so many die when they are first put in salt water. Those figures are not included in the fish health inspectorate's data. The fish health inspectorate will show you how many individual fish have been reported, but a larger number have actually died, and you can get access to that information only through SEPA, and it is provided in kilograms. You can tally up how many kilograms of fish or tonnes of fish have died, but you do not know how many individuals have died. SEPA used to collect that data until the cyberattack, and now, for some reason, it has decided that it does not want it, so it collects the information just in kilograms.

10:15

Rachael Hamilton: SEPA has tried to make its life a little easier, because it does not have the capacity to gather that data.

John Aitchison: No—it is reported by the farms. SEPA does not gather it.

Rachael Hamilton: To be clear, it does not have to be gathered under statute and reported to the Scottish Government.

John Aitchison: No. It is statutory to provide the overall figure but not the number of individual fish that have died.

Rachel Mulrenan: Mortality incidence above 1 per cent on a farm has to be reported to the fish health inspectorate.

John Aitchison: So does an average of 4 per cent over four weeks.

Rachael Hamilton: Okay, so if this committee asked RSPCA Assurance to come in and given evidence, it would be able to disclose that information.

Sean Black: Through the standards, we ask that the same data comes back that the Government asks for. We ask producers to report weekly mortality above certain thresholds so that we can go in and perform—

John Aitchison: In kilograms.

Sean Black: It is a percentage—we do not get a full data set. Nobody has a full data set.

John Aitchison: It does not exist.

Sean Black: I do not know whether Salmon Scotland has a full data set.

Rachael Hamilton: Okay. My last question on this particular issue is for Sean Black. Do you have regular meetings with the Scottish Government about severe welfare issues and mortality?

Sean Black: The RSPCA has regular meetings with lots of people, including the Scottish Government, but we do not discuss individual farms or cases. It is more about the general work that is going on across both organisations, so that we are not so much aligned with as aware of the Government's intentions and so that it is aware of what we are doing.

We have those meetings with lots of stakeholders—we do not just exist in our own sphere. We want to push forward on things. We do not discuss individual cases, but we would discuss any big welfare issue that existed in the industry, such as gill health, plankton or jellyfish. I guess that RSPCA Assured might discuss a welfare abuse case, but I do not know that for certain. It would probably fall into the Animal and Plant Health Agency's remit.

John Aitchison: It is responsible for enforcing the Animal Welfare Act 2006.

It is worth pointing out that nobody sets an upper limit for mortality. There is no figure for the maximum acceptable mortality. The Government will say that farms should work towards the lowest possible figure. In Druimyeon Bay, where it was 82 per cent, that was the lowest possible figure, so that is apparently acceptable to the Government and to RSPCA Assured. There is no KPI that gives a maximum mortality rate. Mortality has to come down—we all agree with that—but there were no sanctions for having an 82 per cent mortality rate.

The Convener: I am conscious that we are halfway through and nearly completely out of time. I must ask the panel to try to keep their answers specifically to the questions they are asked. The next question comes from Alasdair Allan.

Alasdair Allan: Thank you, convener. Can you hear me?

The Convener: Yes.

Alasdair Allan: It is a question for the RSPCA. How were you—and possibly other agencies that you know of—involved in revising welfare standards for farmed Atlantic salmon? How were those standards developed? Did you find your involvement in them adequate?

Sean Black: I can tell you how we develop our standards revise them. I cannot speak for other groups such as the ASC.

We try to revise our standards every two years. In the intervening period, we take in feedback from different stakeholders, including RSPCA Assured's assessors, about the issues to progress. We then speak to wide groups of stakeholders to work out what development in this area looks like and how we can push forward on welfare output assessments and the best indicators to develop. We then take that to our standards technical advisory group, to get feedback on how it can be implemented on farm. We take that feedback away and write the standards, which go off to an accreditation board under the SCI—supply chain insight—scheme. It is more of an RSPCA Assured thing, but I can provide the details. We write the standards and develop all of them in-house, and we aim to do that biennially.

Alasdair Allan: I should know this, but I will ask this question for the benefit of people watching, because I am sure that you are asked this regularly. The Scottish Society for the Prevention of Cruelty to Animals operates in Scotland and the RSPCA is often advertised as operating in England and Wales. Can you explain how that

point becomes relevant when we are talking about salmon?

Sean Black: The welfare standards that the RSPCA writes can be used, in theory, for farm animals anywhere in the world. They are not Scotland-specific, United Kingdom-specific or England and Wales-specific. We operate in that realm as we develop the welfare standards as part of our role, and they can be used anywhere.

We come into play within Scotland because we work with Scottish farmers, as the RSPCA Assured assurance scheme is UK-wide. It does not operate outside the UK. We work closely with the SSPCA and I have regular meetings with it to chat about issues and what is going on.

Beatrice Wishart: On that point, I am looking at a news article that says:

"The RSPCA received £700,000 in membership and licence fees in 2022 from salmon farmers and producers as part of its RSPCA Assured scheme."

Can you comment on that?

Sean Black: I have already answered that. That is a lie. The facts have been misconstrued by whoever has written that article. RSPCA Assured will have received that money, but none of it comes to the RSPCA.

Beatrice Wishart: Okay. How do your standards go above and beyond legal standards for the quality of products in Scotland? Organisations such as Quality Meat Scotland and some of the supermarkets go above and beyond them. How does your organisation do that?

Sean Black: Scotland has no species-specific legislation for the welfare of fish. Fish are not even covered by the legislation in the UK or Scotland around welfare at the time of killing. There is almost nothing in that regard, so the fact that our standards even exist is going above and beyond. We have standards around the maximum time that fish can be out of water, around stun and slaughter and around how to handle fish. None of those issues are covered by legislation, so everything within the standards is above and beyond the legislation.

Beatrice Wishart: Are your standards required by regulation?

Sean Black: I do not quite understand.

Beatrice Wishart: Should there be some kind of regulation around the standards that you use for your assurance scheme?

Sean Black: There should—100 per cent—be regulation in Scotland for farmed fish welfare, and the scheme and the standards that exist can be used by those who want to go above and beyond, as is the case with Quality Meat Scotland and the other organisations for farmed animals. There are regulations around cattle, sheep, chickens and other farmed animals, and, if people want to go above and beyond, they can sign up to RSPCA Assured. The situation should be exactly the same for fish. The welfare of fish should not be left to a voluntary set of standards and schemes; it should—100 per cent—be in legislation.

Beatrice Wishart: In terms of how the scheme operates, I understand that announced visits are made to fish farms. Is that correct?

Sean Black: Visits are announced and unannounced. Unannounced visits tend to take place in response to either a complaint or a concern, or if the farm is under special measures. If RSPCA Assured has had a previous concern that it had not been able to sign off, the farm might be subject to unannounced visits in the future. Unannounced visits are tricky, because you have to get a boat out to the farm, so it is not as though you turn up and are there, but they are as unannounced as they can be.

Beatrice Wishart: That happens only if you have had some kind of complaint. You do not go and visit a fish farm that you have had no complaint about.

Sean Black: I believe that RSPCA Assured would not do that as a matter of course.

The Convener: Elena Whitham will ask the next two questions.

Elena Whitham (Carrick, Cumnock and Doon Valley) (SNP): Good morning. I am interested in the interaction between farmed salmon and wild salmon populations, and the potential risks around that.

The Rural Economy and Connectivity Committee recommended that a proportionate approach should be taken to minimise that risk. The panel members have already spoken a little bit this morning about the risk from sea lice, and I am thinking about introgression of genetic material as well. John Aitchison, has a precautionary approach been applied?

John Aitchison: In a minimal way. One major precaution is a presumption against having salmon farms on the north and east coasts of Scotland, in order to protect migratory fish. That has been Government policy for a long time, so the risk from aquaculture is recognised.

The precaution in the SEPA regulations is the so-called no-deterioration condition that it imposes on sea lice numbers in specific water bodies. In the CCN's opinion, that approach will not result in no deterioration, because it locks in high numbers of lice on farms that had high numbers of lice—it does not limit those in existing farms—so, decline, if caused by sea lice, will continue.

The precaution does not apply to smaller fish. The rule is that, if a post-smolt salmon of 75g passing through an enclosed body of water gets more than two lice on it, SEPA will say that that is not acceptable, because it can harm that fish and the population of those fish. SEPA has set a level of density of sea lice that those fish might encounter over 24 hours, and, if that is exceeded, SEPA will say that water body has a problem, but, unless it is presented with hard evidence, it will not do anything about it for four or five years, as Rachel Mulrenan said, even if modelling evidence shows that there is likely to be a problem. However, the precautionary principle does not work like that; it is supposed to be the other way around, so that you apply a precaution even if you do not know how bad a known risk is. The number of lice on all farms should be capped, as it is in Norway, where there is a cap of 0.2 lice on every fish during the spring on every farm, with mandatory slaughter if that is exceeded when the wild fish are passing by. We should have done that here.

Elena Whitham: I have another question. [*Interruption*.] Sorry—the dog walker has just brought my dog home. You can see it walking on the back of the couch.

Does anybody want to comment on the issue of escaped farmed salmon's interaction with the wild salmon population? It is a multifaceted situation.

The Convener: I will bring in Rachel Mulrenan, who wants to address some of the points from your first question.

Rachel Mulrenan: I can talk about escapes as well, briefly. First, however, I wanted to reiterate what John Aitchison said about the SEPA sea lice framework being far from precautionary. The premise is that SEPA feels that it needs to collect evidence of harm being caused by specific farms before it will take any action against those farms, such as biomass reductions. SEPA estimates that it will take five years to collect that evidence. That is the opposite of precautionary.

We also see that at a local planning level. In the past six months, two new farms in areas with known migratory fish routes—one in Shetland and one in Kilbrannan—have been given planning consent, which shows that the precautionary principle is not being enacted at a local level.

On escapes, there has not been any significant progress since 2018. The wild salmon strategy that was published by the Scottish Government outlines plans to consider introducing penalties for escapes, but nothing more concrete than that has been produced. More than 52,000 were reported to have escaped in 2022, and a 2021 Scottish Government study found evidence of genetic introgression at 23.2 per cent of its survey sites. It is definitely an issue, and it has not been addressed since 2018.

Elena Whitham: The committee is aware that WildFish and the Coastal Communities Network have submitted a complaint to Environmental Standards Scotland about SEPA's sea lice regulatory framework, which has already been touched on. Would you like to add anything about why you have submitted that complaint and what your key concerns are?

Rachel Mulrenan: We submitted that complaint to Environmental Standards Scotland because we do not feel that the proposals by SEPA comply with the relevant regulations. We do not feel that they take a precautionary approach to sea lice and the impact on wild fish populations.

We will submit our complaint as evidence after this session, because it would probably be helpful to the committee to see it.

10:30

John Aitchison: SEPA is correct in saying that it cannot act to improve things without being instructed to do so by ministers. As it says, it can only freeze things as they are. However, by allowing existing farms to have the lice levels they previously had in high-risk areas, it has failed to freeze things as they are.

The Convener: As no one else wants to respond to Elena Whitham's questions, we will move on to questions from Ariane Burgess. Ariane, part of your question about escapes has been answered. Do you have a supplementary?

Ariane Burgess: I do. Yes, the issue has been touched on. Rachel, you mentioned that the Scottish Government is looking at introducing proportionate penalties. If penalties were introduced for fish farm escapes, do you think that that would be sufficient, or should there also be penalties for breaches of licence conditions, such as the use of controlled chemicals, significant mortality events or breaches of sea lice levels?

Rachel Mulrenan: Yes—in our opinion, there should be penalties for breaches of all those conditions on farms. As John Aitchison said earlier, limits should be set on farms, and those should be enforced.

We have looked again at how many sea lice counts have been submitted that have been above the limit of two sea lice or six sea lice per fish. Since 2021, 1,391 counts above two sea lice per fish have been submitted, but the fact that there have been no prosecutions as a result of that indicates that there needs to be proper enforcement on such matters.

Ariane Burgess: What would be a proportionate penalty? Where should the revenue from those penalties go?

John Aitchison: The fines are capped, so there will never be large fines. Financial penalties are not effective. A penalty that reduced the biomass that a farm could farm next time would be substantial. If it ramped up with second and third breaches in such a way that the biomass went down, the financial hit would be extremely strong. Below a certain size, farms become unviable.

If you were to ask SEPA, you might find that, informally, it makes farms have less biomass when they have fouled the sea bed and cannot do anything about it, but it then allows them to creep back up in size and to keep testing. Because SEPA changed the rules in 2019, some farms that were non-compliant before became compliant without there being any change to the pollution.

Ariane Burgess: Can I clarify something? When you talk about a reduction in biomass, you are talking about a reduction in the number of fish. If that keeps getting reduced, at some point it becomes economically impossible for a farm to operate. Is that right?

John Aitchison: Yes. You could do that with mortality, with sea lice counts, with pollution or with pesticide discharges. That would be the only effective method.

Ariane Burgess: The opening questions were about the economic and social impact of salmon farming. You pointed out that, although salmon farming brings in a great amount economically, the environmental impact is not balanced against that.

John Aitchison: It is called externalising costs. The costs on the environment are not included in the costs to the fish farm. The polluter does not pay. One of the environmental guiding principles is to tackle the source of the pollution at source and to make the polluter pay. The polluters are not paying. The cost is externalised on to other people and on to the sea.

Beatrice Wishart: Regulation on the use of acoustic deterrent devices has been tightened. Has that addressed the welfare concerns in relation to cetaceans? What effect has it had on the stress factors on salmon that are caused by predators around the cages?

Sarah Evans: I can comment on that only briefly. The MCS was very supportive of the tightening of the regulations around ADDs. We do not have a specific viewpoint on the matter, although given our membership of Scottish Environment LINK, I could certainly talk to other members who have the expertise to answer that question properly after this session.

John Aitchison: CCN was instrumental in that happening, in that we pointed out to the Government that it was not licensing the ADDs when they were disturbing cetaceans. That coincided with the American Marine Mammal Protection Act coming into force for countries that export seafood to America. It would not allow any of the existing ADDs. The ADD ban was on that type of ADD. Acoustic startle devices are now being developed—NatureScot is trialling them in Shetland rather quietly. The devices are not quiet, but the trial is being done rather quietly. There is a high risk that the new devices also frighten cetaceans, so they need to be properly tested before they are deployed.

If you take a lot of fish and put them in a place where there are seals, you can expect the seals to be very interested in the fish. They will come up and look at the fish through the pen nets and bite them; sometimes, they even get inside the pens. The industry is getting bigger pens so that the centre is further from the edge. That means that the fish are in the middle and the seals cannot stress them so much. However, it is true that stressed fish get diseases more often, and constant seal attention makes them sicker.

Sean Black: Since we have had the ban on the use of ADDs with seals, the impact on farmed fish has been talked about a lot but it has not been quantified, because nobody has the data. It would probably be a worthwhile exercise to find out what that impact has been. We could perhaps quantify that if the mortality reporting was a little bit better. Issues such as the extent to which stress on the fish leads to other diseases is unknown, but it would be worth doing work on that, because such data does not seem to exist. Nobody seems to have exact numbers as regards the impact on the farmed fish. That gets forgotten when we talk about seals. Those fish are being predated on.

Emma Roddick: I have a brief question for Rachel Mulrenan. Fish escapes vary wildly year on year. What should be done to prevent that? Can you give us an indication of what the demonstrable impact of escaped fish is?

Rachel Mulrenan: Escaped fish have two impacts on wild salmon populations: competition and hybridisation. They compete for resources, and they breed with the wild fish and compromise its genetic integrity. I mentioned the 2021 Scottish Government survey that found genetic introgression at 23.2 per cent of the sites that were surveyed. Around a quarter of the rivers that were surveyed had indications of genetic introgression.

I do not know how escapes could be prevented. By its nature, open-net salmon farming involves an open-net structure. Increasingly—for good reason—farms are located away from shallow coastal waters and in more exposed waters,

where they are subject to more severe weather. We saw that in 2020, when 50,000 salmon escaped from a farm in Carradale because of bad weather. In addition, the industry is increasingly looking to go offshore because of the environmental impacts of the industry on the coastal waters. There is an increased risk of fish escapes in offshore locations because the weather conditions are more turbulent.

Sarah Evans: I have a quick point to add on offshore sites. Will one of the potential solutions come with climate change? Innovation in this area is potentially a good thing, but it needs to be assessed properly. The upcoming review of technical standards for infrastructure and equipment for salmon sites is a great opportunity. If we are looking to move to more active sites with rougher weather, we must ensure that we look further ahead, not at what the equipment needs to do now in order to handle bad weather but at what standards we should have in place then.

John Aitchison: In a recent presentation, a scientist from the Scottish Association for Marine Science said:

> "On high-exposure sites, mortality increased more steeply at temperature extremes compared to less-exposed sites, while there was an increase in lice infestations at high temperatures and stronger co-incidence of sea lice and amoebic gill disease."

His thinking is that wave exposure is greater in exposed sites, and that stresses the fish. It does not kill them, but it makes them more likely to be affected by disease. If, in addition to that, the water temperature is higher, which, of course, is happening, and the storms are stronger, because of global warming, that will make things worse. Mortality goes up.

The Convener: Last but not least, Edward Mountain has some questions.

Edward Mountain: I think that one of my questions could best be dealt with by letter. I am slightly concerned that I do not understand the difference between the RSPCA and the RSPCA Assured scheme. The articles of association say that the RSPCA can appoint the chair of the assurance scheme and members of the trustees, and that they share the uses. It might be helpful for that to be clarified, because I am confused by that. I do not want to argue about it.

The RECC report made 65 recommendations, 64 of which I stand by and one of them I do not stand by. Recommendation 3 stated:

> "The Committee notes calls for a moratorium on new salmon farm development and expansion of existing sites, it considers that there is insufficient evidence to support this."

Was the committee wrong or right? A yes or a no will do. I will ask each member of the panel.

Rachel Mulrenan: I think that there was sufficient evidence for a moratorium then, and there is sufficient evidence for one now.

Sarah Evans: I think that a moratorium would be too strong, but more work needs to be done before there is significant expansion.

Sean Black: I agree—I think that a moratorium would be too strong, but we should not run headlong into expansion, because there are still a lot of issues that need to be sorted.

John Aitchison: If I am correct in thinking that a moratorium means a temporary pause rather than a permanent stop, it should have happened. There was evidence for one then, and there is now.

Edward Mountain: I have a final question. I was corrected by the industry: between 2017 and 2021, antibiotic use went up by 168 per cent. It dropped back in 2022, but deaths continued to rise—there were 36,000 tonnes of deaths in 2022. I have not yet collated all the 2023 figures. Have you heard of antibiotic resistance and lice treatment resistance? Does it concern you? That question is for Sean Black and Rachel Mulrenan, in particular.

Sean Black: Yes, we have heard of it, and, yes, it is a cause for concern, as is the existence of any antibiotic-resistant bacteria in any type of farming. As the issue relates to salmon, the answer to both questions is yes.

Rachel Mulrenan: Yes, the rising use of chemicals, which I mentioned earlier in the session, is a concern, both from the point of view of the environmental impacts and because the industry is looking to other solutions, such as cleaner fish. That is an issue that we have not touched on today. Those are wild-caught fish that are taken into salmon farms from the wild and culled at the end of production. Therefore, the industry's ecological footprint grows as its chemical resistance grows.

Edward Mountain: Thank you, convener. I could go on all morning, but I will spare you and the committee that. Thank you for indulging me.

The Convener: Thank you, Mr Mountain. I certainly agree with you on that point.

I thank Rachel Mulrenan, Sarah Evans, Sean Black and John Aitchison very much for their evidence, which has been most helpful.

I will briefly suspend the meeting until 10 to 11, to allow for a changeover of witnesses.

10:42

Meeting suspended.

10:52

On resuming—

The Convener: We will now hear from our second panel of witnesses, which is made up of aquaculture scientists. I welcome to the meeting Professor Simon MacKenzie, who is head of the institute of aquaculture at the University of Stirling; Professor Sam Martin, who is the director of research in the school of biological sciences at the University of Aberdeen; and Dr Helena Reinardy, who is a lecturer and teaching fellow at the Scottish Association for Marine Science. Joining us remotely are Dr Annette Boerlage, who is a research fellow in aquatic epidemiology in the school of veterinary medicine at Scotland's Rural College, and Professor Lynne Sneddon, who is the chair in zoophysiology in the department of biology and environmental sciences at the University of Gothenburg.

I am glad that I got my lips around all of that. We have approximately 90 minutes of questions, and I will kick off with a fairly straightforward one.

The Scottish Science Advisory Council's report on the use of science and evidence in aquaculture concluded that science on aquaculture is "not sufficiently visible". Do you consider public understanding of the salmon farming industry to be based on reliable information?

Professor Sam Martin (University of Aberdeen): Are you asking whether we think that the public view of the salmon industry is based on scientific evidence?

The Convener: Yes.

Professor Martin: No, it is probably not. Whenever we do our research, we try to disseminate our results as best we can. Often, that is through scientific literature and at conferences. We all work closely with the salmon industry on its problems, but the number of good stories that get out to the public is quite limited. In the UK, we all realise that salmon farming has negative connotations with the media. It is quite difficult to rectify that with the public, although there are a lot of improvements. We do a lot of research. Whether enough of that gets to the general public is hard to know.

Dr Helena Reinardy (Scottish Association for Marine Science): I agree. It is quite challenging to communicate the current status of the industry and the research around it. We do our best through various outlets, but I agree with Sam Martin's comments.

The Convener: There is a public perception of aquaculture, and views on it can be quite polarised, as are so many topics these days. Is the public understanding based on accurate and reliable information? The job of the committee in the piece of work that we are doing is to see whether there has been progress in the past five years. It is important that we base our decisions on accurate information. Professor MacKenzie, is the information that the public have reliable and sufficient for them to make up their minds on aquaculture?

Professor Simon MacKenzie (University of Stirling): I concur with my colleagues on the overall understanding. The contextualisation of that information is important. In specific regional areas, where salmon farming is part of the fabric of communities, there is a much stronger understanding of how it is done.

This space has two different themes. One is the plans and the consenting process, which people do not understand. The other theme is health and welfare. Those streams of information are different. When you do that type of dissemination into the public sphere and public perception, you have to talk to different groups across your society. At an educational level, there is a lack of understanding of farming. Salmon is a part of that process, if we consider that to be food security and how our society understands what food security is. On the other hand, different voices seem to have different impacts, which is probably about how you deliver the information. Sorry—my voice is not very good today because I have been travelling. Anyway, it is not an open playing field.

Dr Annette Boerlage (Scotland's Rural College): I agree with those opinions. I often find that the information that the public have might already be a little bit outdated, because improvements in industry and new science might not always get to the public in a timely manner. That is sometimes lacking.

Professor Lynne Sneddon (University of Gothenburg): Sorry—I had a problem with unmuting there. I hope that you can hear me. Thank you very much for asking me, and I apologise for not being there in person.

The public are pretty clued up on the welfare of animals. They see images and films of sea cages and the way that the animals are slaughtered. They see substantial problems that are associated with the salmon welfare industry.

The aquaculture industry needs to tackle those problems because the numbers do not lie. Having 17 million fish die in a year is not good for business or for public consumption of that animal. The public sees these quite shocking videos, and you cannot dispute the poor state of the fish in the videos. It could have been a bad day when the person filmed, but the evidence is growing. Scientists are commenting on the significant welfare issues in the aquaculture industry. There are, of course, scientists who are trying to tackle

that, but the problems are not new, and I do not see that anything has improved over the past six years.

The public is aware of the problems, which is why, over the past 12 months or so, aquaculture businesses use words such as “welfare” and say that they care about the fish, which is good.

11:00

The Convener: One of the statements that you just made illustrated the issue that we have. You quoted the mortality of X million fish, but you did not contextualise that or provide any information about whether that is proportionate or acceptable. We continue to hear that message. We are not sure whether 1.5 million fish dying is reasonable or can be accepted. Understanding the context is one of the issues that the committee has. For example, a 1 per cent mortality, or more than that, in a beef herd might be significant, but a 5 per cent mortality in the aquaculture industry might not be significant compared with other types of farming. With situations like that, does the public get enough information to make educated decisions on whether aquaculture is making progress?

Professor Sneddon: We heard this morning that the industry accepts a 25 per cent mortality rate and that farms report anything up to 80 per cent. However, in the terrestrial farming industry—beef, dairy, sheep and so on—the aim is 5 per cent with a maximum of 10 per cent. Why do we allow such huge numbers of fish to suffer and die? For me, no percentage is acceptable. We should aim to keep all the animals as healthy as possible. Of course, I am realistic and pragmatic. If the animals get disease, there will be some level of mortality, but I see no ethical reason why we cannot apply the same legislation and acceptable levels to fish that we apply to farmed mammals and birds.

The Convener: Thank you. That is a good place to start. I move to a question from Ariane Burgess.

Ariane Burgess: I will introduce the theme of environmental impacts. The committee has heard about continuing concern regarding the environmental impact of salmon farming. I am interested to know whether current scientific understanding supports those concerns. Also, in the previous session of Parliament, the Rural Economy and Connectivity Committee welcomed the UK technical advisory group’s recommendation that there should be a new environmental quality standard for the toxic sea lice insecticide emamectin benzoate or, as it is often called, Slice. Six years later, that new standard still has not been applied to existing farms, which have carried on discharging the chemicals at the same levels. Is there scientific evidence on the damage that that and other medicines that are used in salmon farming cause? Should their environmental impact be assessed? I put that to Lynne Sneddon first.

Professor Sneddon: Those chemicals that are used to treat salmon have quite a negative effect on their welfare. Of course, we balance that with the positive aspects of treating diseases and ensuring the animals are disease free.

Some salmon farms are positioned near ancient maerl beds and there is a lot of evidence that the chemicals have a negative impact on the maerl beds and the animals that live within them. We are contaminating environments that are important nursery grounds for fishes, for wild animals and for the animals that they eat. That significantly impacts the environment around the sea cage; it is not only the fish in the sea cage that are affected. I have seen quite a lot of reports showing the complete death of maerl beds in proximity to sea cages. Those are important for our biodiversity, for conserving wild species and for ensuring that we have sustainable stocks of fish to catch in the sea, because those are important nursery grounds for commercially caught fish.

There is a lot of evidence, but other experts on the panel can probably answer that question better than I can.

The Convener: Would anybody like to come in? Sam Martin?

Professor Martin: I will talk a little bit about drug use and chemotherapeutics. I will not answer specifically about sea lice treatments; that is not my area of expertise.

Other drugs that are given to fish, such as antibiotics, are used for controlling bacterial infections, and their use has increased, but we must remember that most bacterial pathogens are controlled well with vaccination, which has helped us to keep the use of antibiotics down compared with what it was in the 1980s and 1990s, before good vaccines were generated.

We need to remember that sea lice are controlled not just by drugs but by an integrated pest management procedure. A lot of other approaches are used in combination to keep lice levels lower, and we know that there is a push to reduce the amount of chemotherapeutics in lice management. It is an on-going issue.

Fish do not die from lice. We have to keep lice numbers down because we do not want particular levels of gravid lice on the fish. However, the issue is the management of keeping down lice numbers when fish might have other issues that can compromise them. We might come on to that later

on. Using drugs is only one part of lice management.

The Convener: Would anybody else like to come in on that?

Dr Reinardy: Yes. The sea lice issue is a challenge for the industry, but we are seeing quite an expansion in the work to find a range of alternative solutions. Using chemical therapeutants is one tool in quite a wide range of management tools, and quite significant research is being carried out to compare the benefits.

The fate of chemical therapeutants in feed or in a bath is often to end up in the benthic footprint below the cage, but that is quite heavily regulated and companies are under severe pressure to keep residue levels below the regulatory levels.

There is increasing research—particularly through the new sea lice regulatory framework—to identify better tools to support the industry and to gain better understanding of how to control sea lice and minimise the impact on wild fish.

One of the tools that is under development takes account of the dispersal characteristics of sea lice and is based on better understanding of the biology of sea lice. It seeks to break the life cycle through management methods and to better understand the black box of the life stages of the sea lice—the early larval stages in the water column where they are dispersed.

We are seeing an increase in the number of tools that are available to tackle sea lice in order to reduce the use of chemical therapeutants. As I said, there is increasing research in that area.

Professor MacKenzie: This is quite a complex area, where many different streams of aquaculture work intertwine. I agree 100 per cent—I think most stakeholders would agree—that the environmental protection of specific marine protected areas is fundamentally important. There is a body of scientific evidence that suggests that we need to consider how we will do that in specific locations and how that will work, which ties into planning and consent, which is a different type of conversation.

On the use of chemotherapeutants, I do not have the data for Scotland, but the use of those in Norway, for example, has reduced by 60 per cent over the past few years, for various reasons.

Ariane Burgess: Will you explain what chemotherapeutants are?

Professor MacKenzie: Emamectin is an example. Let me change that wording to medicines. If you look at the use of medicines, there has been a reduction of about 60 per cent over the past three to four years in Norway. That is what was alluded to earlier. It has been replaced by non-medicinal treatment—that is, by husbandry and operational routines—which aims to reduce the sea lice load and disease burden on the fish.

There is divergence and a move towards less use of chemotherapeutants, with resistance against those chemotherapeutants and how those are being developed. I do not work in that area, so I cannot talk about what has happened in the past six years and I do not know the answer to your initial question.

Ariane Burgess: I have a supplementary question about that. Sam Martin, I liked how you described physical treatments as “integrated pest management”. I had only previously heard that term in relation to my garden. I understand that those treatments—washing off sea lice and that kind of thing—lead to welfare issues and weaken the fish, so I am wondering about that aspect. Are we tracking the wellbeing of fish when that practice is used?

Also, I have seen images of sea lice eating fish alive, but you said that sea lice do not kill fish. Seeing sea lice on fish looks horrific. I can imagine that they would certainly weaken the fish. Do we have any scientific process for measuring and tracking that?

Professor Martin: This comes back to public perception. Various bits of video footage are always being played on YouTube, the news and “The One Show” or whatever. However, to my mind, they are not representative of what is going on in aquaculture on a day-to-day basis. For whatever reason, there are always extreme cases in a company. Sometimes, things go wrong—there is no question about that. The video footage that you will have seen is terrible, but it is not representative of what is going on generally. Quite often, you will not see very many lice on a fish at all.

Ariane Burgess: How do you know that?

Professor Martin: I do extensive research on sea cages up and down the whole of the west coast, including Shetland and Orkney.

Ariane Burgess: What does that extensive research entail?

Professor Martin: We sample fish, though not for sea lice. Mostly, we are working on gill health. We routinely sample at various times of the year and carry out repeat sampling on the same cages. I have not experienced any scenes like the ones that you would see on television. I am not saying that that never happens, but it is not the norm by any means.

Ariane Burgess: Does anybody else have any experience of that or on the weakening of fish through the use of physical treatments?

Dr Reinardy: Companies are obliged to publish their sea lice counts regularly, and there is a commitment to improving the timeliness of the release of that data and the counting of sea lice. That obligation is seen as a move forward in respect of improving sea lice counting. Having looked at the public data on the levels of sea lice, I would agree that those extreme cases are not representative of the population of farmed fish. The numbers of sea lice are quite low.

I point to the fact that welfare is an intrinsic value for the companies. It affects their bottom lines, so there is huge interest in maintaining good welfare in order to sell the fish that they are farming. It is in companies' best interests to develop a wide range of practices.

Some of the alternative treatments—you mentioned the Hydrolicer treatment—can use fresh water or warm water. Every sea lice treatment has drawbacks but also benefits. My understanding of sea lice treatments—I am not an expert in this area—is that they can have quite a narrow window of efficacy and, if companies get the treatment slightly wrong, there can be welfare issues. However, if they get the treatment right, they can be quite efficient at removing sea lice.

There is a range of treatment options. We see a trend of introducing cleaner fish—those are another species—into cages, which feed off the sea lice.

We are seeing an increase in the number of available options and the use of combinations of different practices and solutions. As my colleague said, it is in companies' interests to reduce the levels of sea lice, so that you do not see gravid—pregnant—females in the farm and you do not have the full life cycle within the farm. That is the aim.

Ariane Burgess: Convener, Lynne Sneddon has indicated that she wants to come in.

Professor Sneddon: I want to comment on the other treatment methods on the welfare of the fish. Other methods include swimming the fish backwards through jets of water to knock off the sea lice. You have to remember that fish pain receptors are sensitive to less than 0.1 gram, so swimming them backwards through jets of water is likely to be painful. Another option is the Thermolicer, which uses high temperatures. You are effectively putting the fish into temperatures that scald the skin and burn off the sea lice or they do not like it and they drop off. The temperatures that are used—above 29°C—are above the threshold for pain in salmon.

11:15

I wrote to the Scottish Parliament, the UK Animal Welfare Committee and RSPCA Assured in 2019 to point out that that treatment causes pain to the animal. I have spoken to people in the industry who tell me that the animals do not feed for several weeks after thermal treatments, so they are, in effect, weakened or in a poor welfare state. We should not allow such treatment, because it causes pain and it significantly impairs their behaviour and welfare. They also do no feed for quite a long time afterwards.

Those other treatments are associated with significant problems.

Professor Martin: I will not comment on pain—that is Professor Sneddon's expertise—but I want to come back on the weakening of the fish due to lice treatments.

Another way of looking at this is that, if the fish are already weak or in any way physiologically compromised by any problem, they cannot deal so well with treatments, particularly physical treatments that require moving fish about, such as moving them into a wellboat for fresh water or warm water treatments. If fish are in any way physiologically compromised by having bad gills or other underlying conditions, they cannot deal as well with the treatments.

I would not think that the sea lice treatments are causing terrible damage—not terrible damage but compromising the fish—but, if they have other underlying conditions, the treatments may exacerbate what is going on. I hope that that makes sense to you.

Ariane Burgess: It makes sense. However, having just heard what Lynne Sneddon said about the pain threshold of fish, I find the situation even more concerning.

Professor Martin: The then Scottish Aquaculture Innovation Centre funded a project that looked at welfare indicators following treatment with a Thermolicer, which Lynne Sneddon has described. I was only part of that project. I was looking at gill health following treatment through a Thermolicer. We had all the different controls, and we did not see any obvious differences in the gills after that treatment. The project did not have anything to do with researching pain, but we did not see anything very negative happening from the welfare indicators that we used. That does not mean that the treatment is perfect.

Professor MacKenzie: That is an excellent question. In the past five years, there has been change in what is happening in the industry, and that is related to what we talked about earlier in connection with chemical or medicinal treatment

versus non-medicinal treatment and how the process of farming is impacting the animals.

The evidence is very clear, and Lynne Sneddon put that across quite clearly. There is no doubt that over 29°C is beyond the pain threshold of the animal. Current information is a bit fragmented, but they are also saying in Norway that they will stop that form of treatment if there is enough evidence.

As everyone knows, the Thermolicer treatment is the most used technique at the moment. Multiple mechanical techniques are being used—Optilice, Hydrolicer and so on—and the industry is using combined techniques. There are stories about combinatorial methods.

What we have seen in the past five years—what has definitely been brought to the fore—are changes to mortality rates and to operational routines as they have tried to bring methods together to understand optimal ways of doing things. There are, obviously, some issues with trying to understand that.

There are a series of things to understand. One is a very specific methodology—the Thermolicer—which provides a temperature shock. There are definitely ethical issues around the use of that method. There are also other mechanical treatments and combinations of those treatments.

If we look at what is happening at the moment, mortality is being considered, and Sam Martin spoke about high mortality rates. If we take the burden of disease in the animals, the key issue is when you can use a method and when you cannot use a method. The body of evidence and science that is available now shows that it is very difficult to measure when you can use a method on the animals versus when you cannot used a method on them. That is what is causing the threshold problem. There is an issue there, and across the scientific community, I think. I am sure that my colleagues can speak to that point.

Most of our research—certainly in my team—is aimed towards that space and trying to understand how that operates with the animals. It is called allostatic loading—I am sure that Lynne Sneddon is very used to looking at that. That is about risk management and benefits. The issue is that, if you cannot understand where the fish is at, because you do not have the tools to understand its health and welfare status, understanding any of those technologies is complicated. You are pumping, crowding and stressing the fish, which is not a positive welfare situation. Therefore, I would suggest that it is more to do with how the fish recover and how much time they have to recover after that process.

The Convener: Would any other members of the panel like to comment? If not, Rachael Hamilton has a supplementary question.

Rachael Hamilton: My question is for Professor Martin. If an animal that is destined for the food chain experiences stress, consuming its meat not a pleasurable experience. In this industry, at what point is a fish discarded if it has experienced poor health? You are saying that you have not noticed severe welfare issues to do with sea lice, but we know that there must be a threshold. What happens if, for example, a fish has been through all these processes and perhaps does not eat? Does it still go into the food chain?

Professor Martin: What does and does not go into the food chain? If fish were compromised by certain diseases, they would not go into the food chain. If they were to die on the farm, they would not go into the food chain.

Here and in other countries, if fish look like they are compromised in some way, they might be harvested earlier. Farms anticipate by looking at signatures of health that might indicate that fish are going towards a poor health or welfare status and harvest them early. That has happened in the past. The farmers do not want to do that, but sometimes they need to. It is better than letting a fish get to a worse state. Do they go into the human food chain? It depends on what is wrong with the fish. People do not want to eat animals that have come from a bad welfare situation; obviously, it is not ethical.

The biggest problem with fish welfare, as I see it, is probably to do with compromised gill health. Gills in fish are where they get their oxygen and how they breathe. There are lots of parasites in the water—we might come on to this—such as micro-jellyfish, plankton and so on, which can damage the gills. If their gills are damaged, fish are under more physiological stress. It would be like us trying to run if we have asthma; we cannot do it. If fish have in any way compromised gills, you cannot use the physical treatments to treat them for lice. There is then a balance in how you are going to treat your animals if they have compromised gills or if they have a low-lying chronic virus, which also can compromise a fish's physiological capacity to undergo physical treatments. A combination of things coming together can cause welfare issues, and maybe you cannot treat for one particular problem if there is also another problem present. Although I say that the lice themselves will not kill the fish, they will eventually cause secondary infections to occur, but that is not generally what happens. That will happen only when things go very badly wrong.

Emma Harper: I am thinking about what Ariane Burgess said about stress in salmon. I am assuming that using biological methods or cleaner

fish might be less stressful for the salmon. In the previous panel, it was said that the cleaner fish—the wrasse—were all wild caught, but I understand that the lumpfish are farmed, and work is being done and millions of pounds are being invested to look at breeding and husbandry programmes for other specialised cleaner fish. How does that all that link with improved welfare and reduced stress for the salmon?

Professor MacKenzie: You are absolutely right. Previously, wild caught fish were being used, and that has caused some issues with the ecological impact of using wild animals. There has been a significant push in the industry space to produce those animals within a closed cycle—aquaculture of the cleaner fish per se—and that is moving forward at a fairly significant pace. Being able to closed-cycle some of those animals has had a very positive impact in removing the ecological impact on wild animals. There is no doubt about that.

At the moment, the evidence on the efficacy of using cleaner fish is a bit contradictory. What percentage of individuals actively feed on sea lice and how are they responding? Also, how do you look after the welfare of cleaner fish within salmon operation routines, which are not designed for that purpose? They are designed for the salmon and not so much for the cleaner fish, so the impact on the cleaner fish is important.

The original question, if I understand it rightly, of whether using cleaner fish decreases stress for the salmon is an interesting one about interspecies interaction and how that is working. It may well make a difference. It depends on the health status of the fish and how they are behaving in that context. I think that Lynne Sneddon is more of a specialist than I am in that space, but I would suggest that it is debatable.

Professor Sneddon: I have just written a review on lumpfish welfare. It is an area that needs far more research. In no other production system would we think that it was acceptable to catch a vertebrate sentient animal to grow another vertebrate sentient animal. It is a very strange approach to go out into the wild and catch all these fish, or even to farm lumpfish, in order to be able to produce another species of fish. There is a big gap in our knowledge about the welfare of the lumpfish and cleaner wrasse. Something like a third of them die within the first few weeks. Only about a third or so feed on the sea lice. The effectiveness seems to vary from farm to farm. In some farms, it is not effective at all; in some farms, it works quite well. However, these are animals. They are animals that we could eat. If you think of them as units of protein, there is a massive loss, and we are not doing very much to ensure the welfare of these animals. Like salmon, they are fish. Why are we using one fish to produce another fish when we are still using other treatments—chemical and physical—to get rid of the salmon louse problem?

Emma Roddick: Last session, the committee did not feel that there was enough evidence to pursue certain other recommended routes. Some of the recommendations were about addressing the data and analysis gaps, particularly around the discharge of medicines and chemicals into the natural environment. Do you think that those gaps have been addressed? Have they been addressed to the extent that we can be confident about the environmental impact of fish farms?

Professor MacKenzie: My opinion is no, probably not. The availability of the information and access to it is still fragmented. I think that the information is out there; the problem is with the co-ordination and funding of the work to be done in that space and with bringing the agencies together to make it happen.

This has been a decades-long story of where you get the data from, how you get the data and how you process it. I do not know how colleagues feel about this, but I feel that access to the data in the Scottish community—the ease of getting it and being able to analyse it—has not been particularly clear and has not been very well funded. There is a structural issue there rather than an issue with the analysis of the data per se. The data may well be there, but having a final valid, objective approach is something else. The problem is with the way in which we manage our data.

11:30

Emma Roddick: So, the data may be held centrally by various bodies, but external organisations cannot get anything from it.

Professor MacKenzie: Absolutely. Do not get me wrong, though. I am not talking just about the aquaculture industry here. You could talk about data as a general thing. It is a challenge within food production systems. It is a challenge to get that data, and I do not think we have been doing a good enough job.

Emma Roddick: Do we know what the environmental impact of salmon farms is?

Professor MacKenzie: As a global objective, that is a difficult conclusion to come to from where we are right now.

Dr Boerlage: On the question of data—it is quite challenging to do this work correctly because, as you can understand, there is so much going on on the different farms that we need quite large amounts of data, and different types of data, especially if we are looking into preventive measures such as cleaner fish for sea lice. It is

very hard to measure something that will not happen because we are preventing it. There is a huge challenge there and it is important to make sure that there is adequate access to data. It is an important way of evaluating what is going on, but it is also very challenging.

The Convener: Emma Harper wants to ask about comparisons.

Emma Harper: Our papers talk about comparisons between regulations in Norway and Scotland. The Norwegian industry has been established for a long time and seems to have not a condensed system but a quite straightforward system. In Scotland, however, it has been noted that the system is a wee bit disjointed. What do you think about that? What could Scotland do differently with regulation?

Professor MacKenzie: This is an on-going theme. We have been talking to this theme for several years, starting with the Griggs report and consenting. The outcome of the Griggs report was very clear that the situation in Scotland is very fragmented and that that represents an obstacle to what we as Scottish society are trying to achieve, which is to understand the global impact. Do we know how it works? On consenting and planning, are there sites that we should not be using or going to any more? Can we consent to make that happen in a different way? That is a significant barrier and there is a lot to be done in that space—100 per cent.

Emma Harper: Do you mean in terms of regulatory bodies, the marine directorate, SEPA, Government? Is that what makes it a wee bit disjointed?

Professor MacKenzie: That was recognised by the Scottish Science Advisory Council when we did that work with Griggs—the piece that was done around consenting. That gives some very good ways to go forward with that process and how we should do it and bring all the stakeholders together in the right space. However, we should also consider what happens in Norway and look at some of Norway's regulatory approaches. Take Norway's traffic light system and the way it looks at sea lice. It is a green-amber-red scenario that regulates what you can grow and produce on different sites. It is based on a sea lice count, which is set and which then determines what percentage of the animals you can or cannot grow there. There are caveats about some of the ways in which that is done, and maybe Scotland could take a look at that system and come up with better guidelines in that area. Certainly, there is a lot to be done with the capability and regulatory process on top of that.

Emma Harper: So, we do not need more regulation; we just need to make it work better and condense the structure.

Professor MacKenzie: My point of view is very similar to what I said when we were talking about data. There is a lot of co-ordinating work to be done to get everybody into the right space, so we know what we are doing, as Annette Boerlage was saying about data. There is a difficulty. There is a challenge in accessing data and getting people around the table to make it work. Yes—100 per cent.

Emma Roddick: I would like to move on to fish welfare, Professor Martin, and pick up on some of your earlier comments.

The Convener: We are still on regulation and enforcement.

Emma Roddick: Okay. I had moved on.

The Convener: We are looking at environmental impacts. If you do not have a question, I have one and then we can move on to the next one.

Emma Roddick: I have covered my question on that theme.

The Convener: To conclude this section, I want to put it into perspective. As a former farmer, I remember that we used to inject our calves with selenium to give their immunity a little boost. We used to give them an infectious bovine rhinotracheitis injection, or they would get bovine viral diarrhoea, and, on the back of that, there was quite a high use of antibiotics. We were treating conditions that were the result of various infections. Over time, however, the livestock industry has reduced the use of antibiotics quite significantly—for instance, as a prophylactic treatment for dry cows with mastitis. We have seen a dramatic drop in the use of antibiotics in other types of farming and food production. Are we seeing the same progress in aquaculture?

This inquiry and the report that we will be doing are all about progress and whether we are making progress. In agriculture, the advances in the area of inoculations and vaccinations have had the knock-on effect of reducing the use of antibiotics. Are we seeing the right direction of travel in aquaculture? Are we on the right path to reducing the use of antibiotics—not Ivermectin, which is a wormer for cattle, but the one that is used for fish? Are we seeing progress leading to the reduction in the use of these types of chemicals?

Professor Martin: Antibiotics work against bacterial pathogens. In Scotland, every salmon that goes to sea is vaccinated against at least four or five different bacterial pathogens and a number of viral pathogens. About 60 million animals are vaccinated every year. The major pathogens are

furunculosis and vibriosis, which almost wiped out the salmon aquaculture industry in the 1980s and 1990s. Vaccines were produced against them.

If there has been a slight increase in the use of antibiotics in the past couple of years, it will have been to do with complex unspecified bacterial infections, possibly linked to poor gill health or other emerging pathogens. When new pathogens arrive, researchers have to take the time to develop new vaccines. We work with some of the multinational vaccine companies trying to understand how vaccines provide protection. As I understand it, there is no prophylactic use of antibiotics such as you might get in the livestock sector; there is no prophylactic use at all in aquaculture. Currently antibiotics are used only in emergencies.

The thing about salmon farming and aquaculture in general is that farmers want to keep their fish in good health. A vet can look at a herd of sheep or cows, see one sick animal and treat it. If you see one or two fish sick with a virus or a bacterial infection in a cage with 100,000 fish, you will realise that you have a big problem. Therefore, the idea is to keep the pathogens out, especially viruses and bacteria, and to control them with vaccinations and biosecurity. Once your fish get sick from an infective agent, it is difficult to control it.

The Convener: My question comes down to whether the aquaculture industry is making fast enough progress. Is it comparable with agriculture? We talk about all the medicines that are used in aquaculture and it is one of the big issues. Are they comparable to the medicines that we use in other types of food production? Antibiotics are very important in the poultry industry, for example. Are we seeing the same progress in reducing the amount of medicine in aquaculture through the use of better animal husbandry? Are we making enough progress? Is progress being made at the same pace as in the agriculture and other food production sectors?

Professor Martin: I do not know what the pace of progress is in the other sectors. I am not an expert in that area. I cannot comment on the difference between chickens and fish—I do not know.

The Convener: So, is it your perception that the industry is making enough progress quickly enough to address these concerns?

Professor Martin: We are in a sort of arms race against the changing environment, the changing fish and the changing pathogens, and we are trying to keep pace with new challenges that are coming along.

Professor MacKenzie: There is a fundamental difference, because you are looking at fish on the one hand, and, on the other, at mammals or birds. The biology of their immune systems is very different, and there will be different ways of vaccinating a fish compared with vaccinating a mammal or a bird.

In a mammal, the gold standard is lifelong protection and memory. That is the standard for all of us—it is how biomedicine functions. For fish, though, it is unclear whether you can get lifelong protection. You can have protection induced by vaccination, but that is not the same story. You cannot apply the same logic to fish as you would to mammals such as cows and pigs, because the underlying science and the organisation of their systems are very different.

I am not an expert on terrestrial animals, but, if we are looking at the development of solutions, I would say that chickens do not provide a good comparison, because the production cycle is a lot shorter for a chicken than it is for salmon. Moreover, there are different environments to deal with; with salmon, it is fresh water and sea water, while with chickens you are looking at a more stable environment.

Overall, I think that there has been a huge amount of progress. We just need to look at what has happened in aquaculture over the past 30 years—and not just for salmon but worldwide—and at how the technology has developed. There has been massive development. Indeed, as Sam Martin has said, every salmon that goes into the sea is vaccinated. Previously, that would have been almost unheard of.

The word “antibiotics” is on everybody’s lips right now, because—and this is your key story sitting in the background—we are all talking about antimicrobial resistance and the requirement to reduce the use of antibiotics to an absolute minimum. In that respect, I would highlight the new and emerging technologies that have already been commercialised for yersiniosis, for example; I am talking about bacteriophages, which are viruses that kill bacteria very specifically and do not generate any form of resistance in them. That has already happened in the salmon aquaculture industry, and it is a first in terms of the numbers of animals involved.

So, in one respect, there is, no doubt, a lot of drive to create sustainable solutions in the health space, and a lot of innovation is happening there. We are just not focusing on it enough.

The Convener: That leads me nicely to my last question. What do you believe are the main challenges for the industry with regard to environmental impact?

Dr Reinardy: I am happy to come in here.

We have been studying the environmental impacts for decades, so we understand the main areas of impact. The fallout from a cage within a sea loch system, for instance—both particulate and dissolved wastes and the benthic footprints thereof—has been a major area of development and research. Another area of very active research is how infections and parasites might be dispersed in the marine environment and the concern about the possibility of their interacting with other salmonid populations in the wild. Then there are welfare issues around animal production itself, the susceptibility to diseases, how the conditions in which fish are kept are maintained and how their growth and production can be optimised.

Those are the main areas of environmental concern, and they have been the focus of research and, indeed, the regulations, too. We have seen real developments in the monitoring of a lot of these conditions—for instance, in the monitoring of the footprint on the benthos and the chemicals in the sediments around where the deposited waste ends up. We are seeing a lot of activity in those areas. I note that there is nobody here today from the regulatory or veterinary side of things who would do that monitoring, but I can tell you that we do have some good processes in place.

In some areas, we need to develop the tools to better measure impacts, because a lot of this is very challenging to measure and quantify in what is a very complex marine system. Arguably, a terrestrial field or a shed is a somewhat simpler environment compared to the very complex hydrodynamic environment of, say, a coastal sea loch. It is hard to measure some of these things, and for that reason we need to do research. We, in Scotland, are uniquely placed, because a lot of research is quite collaborative. There are only a few of us, and we try to work together, but often we are hampered by lack of funding or opportunities to do the research and develop the tools.

On your original question, we are and have been aware of the major environmental impacts of aquaculture. We are getting a grip on how to measure them and regulate against them, but huge areas need further investment to understand them better and develop them more.

11:45

The Convener: Thank you. I call Beatrice Wishart.

Beatrice Wishart: Good morning, panel. It has been a really interesting discussion, and it is good to hear from the scientific community on this issue.

How has the scientific understanding of fish welfare needs developed in recent years? Do you think that current welfare standards reflect the evidence? I think that we have touched on some of that already, but I would be interested in hearing your thoughts. Who wants to go first?

The Convener: Who is keen to respond?

Professor MacKenzie: I am happy to do so.

I would suggest that advances in fish welfare have been significant over the past 20 years, at least, but I think that there are two different things to take into account here. It all depends on whom you are talking about as far as certifications are concerned and whether the certification body is the RSPCA or the Aquaculture Stewardship Council.

Points were made earlier about sentience in vertebrate animals and how we have to deal with that. How should that sort of thing—and, indeed, the issue of cleaner fish—be managed in the salmon production industry? We have a good idea of some of those things and of some of the more ethical problems or issues that we want to discuss. On the other side is the biological context of what welfare means, the dissociation with regard to health and welfare and what that means for the animals within a culture system.

There has been some significant progress in the past 10 years, if we think about where we are now and how we are trying to move forward. With the body of evidence that we have and the science per se, we are in a very good moment with regard to welfare. Things have advanced a lot, and I think that the science can give a lot into this space. It is a fundamental pillar of how we need to approach the aquaculture universe—if we can call it that. It is fundamentally important.

Going back to the comments that were made on environmental impact, I would say that there are two streams in salmon aquaculture at the moment. There is on-land aquaculture, in which the animals are removed from their natural environment, and a series of in-betweens with regard to how you produce the animals. The welfare context is central, and although we do not have all the tools in that space yet, I think that there has been a lot of advancement in that area.

Beatrice Wishart: So, there has been progress.

The Convener: Annette Boerlage, would you like to come in?

Dr Boerlage: Yes, thank you. I just want to add that we are getting into a very exciting time. When we looked at fish welfare before, we were really dependent on taking the fish out of their environment. Now, we have a lot of tools such as underwater cameras that, combined with new AI development, can recognise and see things and

make it a lot easier to get a better idea of what is happening under the water without having to touch the fish. There has been a lot of development in that area, and I think that, in the near future, we will have a lot more information with which to monitor fish welfare. We will develop that further, and it will bring a lot of advantages for welfare in the near future.

Emma Roddick: I would like to pick up the issue of fish welfare. Professor Martin, you drew a distinction earlier between pain and welfare, and I want to explore that a bit more. If a fish is in pain, can its welfare be described as being at a high level?

Professor Martin: I would imagine not, but I am not an expert in pain—that would definitely be a question for Lynne Sneddon. My perception is that we do not want animals to be in pain, but there is also a balance to be struck between what is and is not acceptable. That said, I do not think that I am in a position to comment on pain thresholds.

The Convener: Lynne, would you like to comment?

Professor Sneddon: Yes. If an animal is in pain, it is definitely experiencing poor welfare. Quite a lot of work on salmonid species has shown that they are capable of experiencing pain, that pain is an important event for them and that it has a detrimental effect on their behaviour, physiology and neurobiology.

Going back to the previous question, I would point out that we have operational and laboratory welfare indicators. In 2018, Chris Noble and colleagues produced a set of welfare indicators for decision making—I am sure everybody is aware of it—but whether those welfare indicators are being implemented is up for debate. One of the key aspects of improving welfare is that we do have a set of very clear indicators or thresholds against which we can judge the welfare of fish, and more specifically salmon.

The fact is that we do not have the legislation in place, so we have to rely on certification schemes, most of which really focus on environmental impacts and sustainability. The Aquaculture Stewardship Council has recently started to consult on implementing animal welfare standards, so I hope that the future is bright and that we will have a series of indicators and key parameters that a farm must meet to ensure the welfare of the animals.

Emma Roddick: Do you think that there is an easy route to getting agreement among the community on what welfare looks like for fish? Is there an understanding of how a happy fish acts and what it looks like, which could lead to key recommendations being made and the setting of criteria that must be met within a farm?

Professor Sneddon: A lot of research out there shows quite clearly how the animal's welfare is affected by different experiences during the production cycle, and there is lots of research on stocking densities, water quality parameters and species interactions. Of course, we have experts on the health side here today.

It will require very careful management to get the right people in a room and get them to come up with very clear and easily implementable welfare standards that are transparent and open. However, these things also need bite. When you ask RSPCA Assured or other certification schemes whether they have ever thrown any farms off their scheme, they will generally not answer. There needs to be bite. In other words, if farms are not meeting those welfare standards, action needs to be taken. Typically, that will happen through legislation, but it could be incentivised through certification schemes. It will require quite a lot of management of different stakeholders and ensuring that what we come up with is achievable, practical and acceptable to the industry, the public and the Government.

Emma Roddick: I note that most of the welfare-focused recommendations made by the previous committee in the last parliamentary session looked at mortality. That is understandable, because that is easy to collect data on, but what other indicators do we need to achieve that overview of fish welfare that that committee also asked for? What would be the key indicators beyond mortality that you would want fish farms to look at?

Professor Sneddon: Certainly, you could look at behavioural indicators. Are the fish feeding normally? Do they have a reasonable rate of food intake? Are there no signs of aggression between animals? Do the animals swim normally? Are they using the cage space in a normal way? Can we see that the animals are not sustaining any damage and do not have, say, lesions, missing gill covers or damage to the eyes or fins?

There are lots of morphological indicators that we can use. We can subsample the fish and look at key physiological traits or we can do pathology and look for any signs of disease or parasitism in the fish; in other words, you can subsample a very small number at random and look at more laboratory welfare indicators.

There is certainly a wealth of information out there that needs to be brought together to ensure not only that we meet the needs of farmed salmon, that they are living a good life and that their health is being maintained throughout the process, but that action will be taken if, say, 10 per cent of the fish start exhibiting signs of aggression. What will the industry do about that?

Emma Roddick: I have one final small question. At the moment, do we have a good overview of fish welfare in salmon farming?

Professor Sneddon: Numerous studies have investigated various aspects of salmon behaviour such as salmon feeding rates, salmon growth and reproduction, and we can use those to come up with indicators of good health and welfare. My answer, therefore, would be yes. We just need to put that information together and get agreement and buy-in from the industry.

Ariane Burgess: I want to come in on the back of Emma Roddick's questions. Professor Sneddon mentioned wrasse and lumpfish—or what we collectively call cleaner fish. We have been focusing on the welfare of salmon, but will you describe the welfare of lumpfish and wrasse when they are in salmon cages? Do you have any concerns about them?

Professor Sneddon: Those animals are caught in fisheries, taken from a wild situation and transported to the salmon cages, which is a very artificial environment, and there are moves now to farm lumpfish for that very purpose—I know that there are now many facilities in the UK that do that.

On taking animals from the wild, perhaps it would be ethically more acceptable to farm them instead of going out to catch them and disturbing wild populations. There has been quite a big public outcry about that in Sweden over the past week. Swedish lumpfish are being caught to be taken to Norway to sit in salmon cages and eat salmon lice. Those animals are, usually at a certain size, put in cages and then, in effect, left to fend for themselves. They have to learn to feed off the salmon.

As I have said, around a third of them perish within the first few weeks. They simply do not acclimatise or adapt to the new environment. Perhaps that is because of the stress of being taken from the wild or because they simply have not fed on any of the salmon lice, so they starve to death.

There is supplementary feeding on some farms. They add food for the lumpfish. The fish are then typically left there to the end of the production cycle, and they perish because they are not used for any other purpose.

There has been some improvement in their welfare. Some farms put in environmental enrichment. There are ropes or fake seaweed fronds. Lumpfish, in particular, have a sucker on the bottom of their body and they like to suck on to stones or other substrates to rest. The provision of such enrichment has reduced the mortality rate of lumpfish. They have been given some space to suck on to, as that is a behavioural need for them.

Overall, very few studies are looking at what happens to individual lumpfish or wrasse when they go into sea cages, and there seems to be quite high mortality. Once they reach a certain size, they stop feeding on sea lice. They sit in the cage, and it is likely that they will be exposed to treatments—whether that is chemical or physical treatments—for salmon lice. They will, of course, be affected in the same way as the salmon are by those treatments. However—

The Convener: I am sorry, but I am going to interrupt you. Your points are valid, but we need to not go into too much detail. We need to concentrate on, for example, the recommendations that have been made.

We will move on to a question from Rachael Hamilton.

Rachael Hamilton: SEPA figures indicate that, in Scotland, 17 million farmed salmon died last year. That indicates that mortality rates on fish farms remain high. Is there a scientific consensus on the key causes of that? If so, how is that data recorded? Is it aggregated and published?

12:00

Professor Martin: The industry has made big efforts, through Salmon Scotland, to publish all the mortality data monthly for every site in Scotland. I look at that data regularly out of interest to see what the reported mortalities have been caused by. If you go through that, you will see that nearly all the major fish mortality rates are recorded as being from gill health or a virus or from a combination of both. As I have said, it is very rarely a matter of sea lice.

A number of viruses affect fish, and the terminal tissue that the viruses go to is the heart. If a virus in the heart is causing a pathology in the heart—the heart muscle maybe has some kind of histopathology in it—that will weaken the fish's capacity to pump blood around its body. If a fish has compromised gills, which might result from micro jellyfish or microscopic parasites that attach on to its gills, there is a double issue—there is a poor heart and there are poor gills. If people try to use a treatment, potentially for lice, for example, or move the fish about, the fish can succumb to the physiological stress. That is what the mortality results from most of the time. Multiple factors come together.

The salmon lifecycle is very complex. Salmon spend the first year in fresh water, mostly in recirculation hatcheries, in which the water is reused. That is a very pristine and clean environment. They are then transferred to marine cages in a stage called smoltification. They go from fresh water to salt water. That is a very vulnerable stage for the fish, as they have to

change their osmoregulatory ability. We call them post-smolts. We know that their immune system is decreased and that they can become very susceptible to new pathogens. They are vaccinated in fresh water and transferred to salt water in which they are exposed to multiple agents that can be not good for them. Particularly in the past couple of years, when we have not had cold winters, a lot of parasites have not been cleared out with cold water temperatures.

Normally, we would see that mortality is cyclical and that the highest mortalities would be at the end of the summer, in the autumn, and going into winter. Those mortalities would drop off dramatically at the end of the winter and into the spring. With a cold winter, the water pretty well cleans itself out, and the cycle will happen again. Because we have had much warmer winters over the past couple of years, the water temperature has not really had a chance to go down, and there has been an on-going gill health issue with other compromising factors that have resulted in high mortalities.

The mortalities are far too high. No farmer or researcher wants to see high mortalities—that is simply not where we want to go. If you look at the public data from Salmon Scotland, you will see that that is where most of the mortalities are.

Rachael Hamilton: Okay. Thank you.

Professor MacKenzie: Annual mortalities of 17 million fish in Scotland and 65 million fish in Norway is not a sustainable practice. The targets that need to be set and even the aspirations of what are acceptable mortalities in that food production system have to be debated. As Lynne Sneddon suggested, the approach needs to have some bite behind it, otherwise change will not happen.

I agree that all stakeholders in the system do not want to see such mortalities. If you look at the trajectory over the past 10 to 15 years, you will see that it is a complex scenario. Everybody will always say that it is quite complex, but a consensus is emerging to do with the husbandry operation, what people are doing to the fish, where they are doing it, and the sites. That is about consenting and where the sites are being put. Are they good or bad sites?

Data integration is happening—Annette Boerlage talked about that. Gains have to be made, and the only way in which they can be made is by integrating the research, knowledge and culture in the industry. That has several drivers. It involves multiple things, such as policy and regulation, but it has to be based on the science that is evidenced as we go forward.

If you look at the amount of data that we get now compared with what we had 10 years ago, you will see that it is massive—it is orders of magnitude higher than it was. A lot of the time, it is about decision-making processes and how we make them work. A lot of data exists, but setting up the structures that act on them is the key.

Rachael Hamilton: Does the salmon farming industry work with the universities and pay them to do that type of work? What kind of producer wants to have welfare issues and such mortality rates? The situation is affecting profits, and I presume that it also affects worker welfare and coastal communities, because why would anyone want to see discarded fish or lorries leaving fish farms with dead fish? Does the industry work with universities to try to establish—

Professor MacKenzie: Absolutely. As all the scientists you have here will agree, you do not do aquaculture science unless you are working in that space. It might be production companies or it might be pharmaceutical or environment or ecology issues. We work across a huge range and diversity in that space—there is no doubt about that.

If we look at what we are doing in our nation compared to other competing nations in the salmon world, we find that we are underinvesting hugely and that we rely a lot on what happens in other countries to bring the information together. That is not a positive state of affairs for Scotland in the great scheme of things. Scotland is very different from the other competitor nations, if we look at it like that.

Rachael Hamilton: To develop that, I asked whether there is scientific consensus on why mortality rates are increasing. Professor Martin talked about the situation with micro jellyfish and, obviously, the waters are warming, but nobody has mentioned the increase in the number of salmon being produced and whether that is having an impact, or the use of technology. Perhaps the risk is greater using the technology, even though some people have said that it is helping. You are the scientists. Where is the scientific consensus about tackling mortality rates?

Professor Martin: I will just say—

The Convener: Before you come in, I will bring in Annette Boerlage, who indicated that she would like to come in some time ago.

Dr Boerlage: Thank you. I wanted to point out that we are in a fortunate position that all the data is public. I am an epidemiologist, and my colleagues work a lot in other sectors where that is not always the case. It is therefore actually relatively easy to see where the problems are at the moment. As a scientist, you always want to find out what the problems will be in five years, because you want your research to be a little bit advanced when the problems get bigger, because

they need solving at that moment. That is a very challenging thing to do, but we are trying all the time.

I just wanted to point out that the data is there and that we have access to it, so we know that we need to focus on gill health and viruses, as Sam Martin alluded. Those are the major problems right now. I totally agree that no one in the industry wants to see these high numbers. In Scotland, we are a lot smaller, so we rely quite a bit on what happens in Norway. They have exactly the same problems with mortality, which ideally needs to come down. There are similar challenges, so we are trying to work together to find out how we can solve the problems to reduce that mortality today but also to anticipate what is coming. Having access to some open data is very important and makes that more possible than if that were not the case and we had to pull all those resources together to start with.

Professor Martin: In previous reports that were generated, there was discussion about moving sites to areas that were perhaps regarded as higher energy sites. We work with the industry and the industry knows that the fish do not generally perform as well in some locations as they do in other sites. As I understand it, there was a wish to move sites to areas that were predicted as being better for fish health—and, of course, health is welfare.

This is outside my research area, but I understand that it is very difficult to get permission and licences to go to areas that are thought to be healthier or even expand into those areas and then move the fish away. Companies have their licences, which might go back to the 1990s when the industry was just starting, and they are still farming there because they cannot put the fish anywhere else. Looking forward to the next few years, if it was possible to do something about that, you could mitigate some of the issues.

Professor MacKenzie: I would like to highlight one important point. In order to evaluate technologies, you need to have the research infrastructures to do that. We have to work within the size and scale of the research infrastructures in the UK. Recently, the national aquaculture technology and innovation hub has been set up in Stirling, but there remains one huge gap, which is very relevant to what everybody is talking about: we do not have any sea cage facilities in Scotland that can be run for research. We have to use production sites, so we are generally chasing our tails when we look at different types of technology. You go to different sites with different environmental conditions, and the variables make it very difficult to come to a scientific consensus.

If you do not have an integrated infrastructure where scientists can measure approaches, it is very difficult to come to conclusions, because sites A, B and C will all have different characteristics. That makes it very difficult for us to pinpoint the issues. For example, with a mechanical technology, we could measure it again and again, make the effect clear and make a call to use that, but we do not have that capability in the UK. There is a gap when it comes to sea cage facilities.

That takes me to the point about planning and how you get research licence sites and that sort of thing. In Norway, that capability is there. In Scotland, we do not have that capability, which holds us back a lot because our environmental conditions are very different from those in other countries. It is quite difficult for us to generate a global view or a consensual view for Scotland, as we rely on data from other places.

Rachael Hamilton: Why can we not get those research licence sites?

Professor MacKenzie: That is not within my gift to say, I am afraid.

The Convener: Is that research capability available in other parts of the world? Is it just Scotland where there is an issue?

Professor MacKenzie: Yes.

The Convener: Okay—that is helpful.

One of the report's recommendations was for

"coordination with the data ... and comprehensive overview of all fish health, welfare and treatment issues across the sector".

Have we made improvements over the past five years to ensure that there is co-ordination of fish health data? Is it better than it was five years ago?

Dr Reinardy: I would say that it is better than it was five years ago, but we are—

The Convener: It is still not there.

Dr Reinardy: We are still not there yet. There have been some efforts to create the Scotland's aquaculture website, where the data can be compiled and presented in one public place. We are getting there. There are efforts to bring together the data and improve the reporting. There is a huge amount of data out there and the producers are investing huge amounts in measuring and monitoring. A lot of that data is kept in commercial confidence, so accessing it is a huge challenge. We have made improvements, but we are not yet at a place where we can easily access the data.

The Convener: Thank you. Emma Harper has a question.

Emma Harper: I think that it has been answered. It was about sea cage research sites

elsewhere on the globe. What is the barrier to Scotland having those? Is it just cost?

Professor MacKenzie: Yes—cost is a significant factor. There are probably stakeholders—industry partners—who are willing to do that sort of thing, so it is just about cost and making it happen. It has to be a national resource, because these things lose money. Research infrastructures lose money—there is no doubt about that. They do not make a profit, but they are a fundamental piece of our story, or our puzzle, and how we want to work in that space. It is about having the right stakeholders and the will to make it happen.

Emma Roddick: Earlier, we heard some uncertainty around what can be done to prevent fish escapes. How can the recommendation to take a precautionary approach be met by farms, if it is unclear what can be done to prevent escapes from occurring in the first place?

12:15

Professor Martin: The worry about salmon escaping is that they might breed with the wild salmon population. Twenty years ago, there were probably many more fish escaping relative to the number of fish that were being farmed than there are now. Escapes happen due to storm damage and seal damage of cages. Those are the two ways that fish will escape.

The fish that are farmed now are very different from wild salmon. There have been eight generations of very heavy selection towards growing fast and having massively reduced stress response. If you keep wild salmon in a tank and farm salmon in another tank beside them, you will find that they have completely different behaviour. If the farm salmon escape, they will not do very well—they will be selected against very strongly compared to fish with wild genes. However, if there is saturation—if there are many of them—that will, of course, cause a long-term impact.

A fish farmer tries to prevent escapes. They do not want to lose fish, because they lose money. Escapes used to be a big concern in the west of Scotland, and there were a lot of escaped fish in the west of Ireland as well. On what fish farmers can do to reduce escapes, they continually try to improve the quality of the nets and to prevent escapes. That is not my expertise. Simon MacKenzie might know a bit more about escapes than I do.

Professor MacKenzie: I am afraid that I do not, although I know that there are some nice technologies out there that tell you in real time when there is a breach in the net so that the operators can go straight there. That is linked into the internet so that you can map across all your cages, see when they are open and get in there faster. That is a mitigation context for escapes.

Emma Roddick: The great variation in numbers of escapes in Scotland in different years suggests that there is no clear way of entirely preventing salmon from escaping. Therefore, I would like to be clearer on how people can meet that ask of taking a precautionary approach to escapes.

Professor MacKenzie: You would have to have a land-based system to make that happen. Some of the new technologies that are being used in Norwegian waters, for example, involve closed containment systems or whatever.

Emma Roddick: But that recommendation cannot have been met—

Professor MacKenzie: The issue of escapes opens a door to discussions about genetic integration and impact on wild populations, which have to be taken in context. How much of that is happening, and what does it really look like? Others know more about the science on that than I do, but let us say there is some debate in that area.

Emma Roddick: So, since 2018, that recommendation has not been met, largely because it could not be met?

Professor MacKenzie: I cannot answer that question. I do not know the answer to it.

Dr Reinardy: The industry is tackling escapees mainly through improved technology and the construction of the cages. I heard recently that double netting seems to be a really effective method. It is in producers' interest not to have escapees, as that is money out the net, so they have been investing in the technology. The technology around the nets is quite incredible. The monitoring of the nets and the construction of the pens have undergone huge development and investment. We do not have the same farms that we had 20 years ago. I cannot speak on the data on the escapees, as that is not my area.

Dr Boerlage: That is also not my area of expertise, but Emma Roddick is right that the fact that the data is so variable is an issue. If it was a constant amount, you could do something about it. There are incidents, and all that you can do is try to understand what happened and do things better. It is good that escapees always have to be registered. Because people can see where the escapes are, that is an incentive for farms to ensure that it does not happen.

The Convener: The Rural Economy and Connectivity Committee reported, or identified, a lack of scientific data into the interactions between farmed and wild salmon. Can you tell us whether the research for that has developed over the past six years since that committee's

recommendations, and is there still a knowledge gap? Whoever feels most qualified to answer should answer.

Professor Martin: I do not do that work: marine directorate science staff would be the lead researchers on that. They are working on farmed and wild salmon interactions, mostly at their labs at Pitlochry. That goes beyond the work that we do.

Professor MacKenzie: Absolutely. Our focus with wild fish is more on conservation aquaculture, which is a different story that is about not interaction but how to support the populations.

Alasdair Allan: This subject has been touched on already. We have mentioned the interaction between farmed salmon and wild salmon. Can you say a little about the data on that? More specifically, in your view, are regulations keeping up with issues around that interaction?

The Convener: The response to that might be very similar to the response to my question, unfortunately. If nobody feels that they can offer a view on the interaction between wild and farmed salmon, we will leave it there.

Dr Reinardy: I could comment. The new sea lice risk assessment framework seeks to protect wild salmon. That regulatory framework links presumed sources of lice in aquaculture to impacts on wild salmon. There is a bit of a disconnect in that we have various communities of researchers and interest groups that work on one side or the other. Getting the two sides to work together is challenging but the new framework is trying to do that.

It is not easy to monitor how an industry affects a complex species that has very complicated routes of migration and behaviour in the water. From my expertise, I do not think that we are addressing the matter as directly as we could, because we are all in different communities.

Professor MacKenzie: I do not want to talk specifically but will mention something related to that. There is a red, amber and green traffic-light system used in Norway, which is based on sea lice numbers and wild smolts—the 10 per cent, 30 per cent story. There is quite strong evidence showing that, in order to keep to those levels, there have been increases in the use of non-medicinal treatments on farms, which impacts and drives mortality on the other side. It is a critical issue and all stakeholders need to be brought to the table to talk about it. Mortality in aquaculture is being artificially driven at the same time, so it is a very sensitive and critical issue.

The Convener: Thank you. That is helpful.

Beatrice Wishart: The Scottish Animal Welfare Commission considers that there is a need for more research on alternatives to acoustic deterrent devices in order to reduce risks to cetaceans. Can you say anything about the research on that? Are there research gaps in that or in relation to stress on salmon from seals outside cages?

Dr Reinardy: I can comment. It is not my area of expertise, but I collaborate quite closely with colleagues who work on the sea mammals side. As far as I am aware, acoustic deterrent devices are now banned. On the aquaculture side, that is a bit of a loss, because acoustic deterrence was a useful tool in deterring seals, reducing escapes and reducing damage from and mortality among fish.

There are some very interesting developments in seeing whether targeted acoustic deterrents could be used specifically for the problem of seals, which would not have the generalised impacts of previous devices. That is an area of active research. As far as I am aware, at the moment we do not have other tools; there is just research on finding replacements or solutions to deter problematic seals.

Emma Roddick: I will be very quick. In terms of the risk to cetaceans, are there alternatives to the ADDs that also pose threats to cetaceans?

Dr Reinardy: I am not familiar with such alternatives.

Edward Mountain: I want to drill down into something that Sam Martin said. You said that sea lice do not kill fish, but 15 minutes later you said that if they are not treated sea lice allow in other diseases that could kill the fish. It is a bit like saying stage 1 cancer does not kill you, but the follow-on cancers will. Is that not right? Sea lice do kill fish.

Professor Martin: In the farm situation, if sea lice are left to proliferate beyond the level to which they should be allowed, the fish will succumb to secondary infections and will die. On a wider scale, we do not, in the farm situation, see fish being killed at high levels by sea lice. The treatment to keep the lice numbers down to very low levels can cause mortality because of the secondary problems that we have mentioned already.

Edward Mountain: Okay. Salmon Scotland says on its website that it must control sea lice for the simple reason that, if it does not, other infections will come in and, because the sea lice have disturbed the balance of the salmon's skin, another infection will kill them.

Professor Martin: The reason why lice numbers are kept down is the code of practice that says that we do not want, on the farmed fish, more than X number of gravid females, which is less

than wild salmon would have. Wild salmon all have sea lice on them.

Edward Mountain: I will come to wild salmon. I am trying to identify whether, if sea lice get on a fish in sufficient numbers, they will compromise that fish by allowing in other diseases that could kill them, such that sea lice do kill fish.

Professor Martin: Yes, in that case.

Edward Mountain: On that basis, that would be right. When salmon farmers put out juvenile fish they treat them before they do so because they are particularly susceptible to disease when they move out, including being susceptible to sea lice, because their skin is particularly thin and liable to be affected by them. Is that not right?

Professor Martin: Quite often they get the Slice treatment drug post-transfer, when they go out.

Edward Mountain: That is because they are particularly vulnerable when they are juveniles.

Professor Martin: The numbers can get up to the point at which the sea lice must be treated. When sea lice numbers get up to a certain level, the salmon farm will be allowed to go to the vet and say that they need to give an additional treatment. Within a site, the farm is allowed to give only a certain amount of treatment per tonne. I am not sure what the numbers are.

Edward Mountain: So, if we are going to deal with the issue—which is that wild fish interests believe that sea lice affect the juveniles going out to sea—the only way that we are going to be able to prove whether sea lice kill them is by trapping them after they have gone through a heavily sea-lice-infected area to see whether they do. To say that there is no evidence that they do not die is based on no research at all.

Professor Martin: I was not talking about wild fish. I was talking about—

Edward Mountain: I am looking for you to agree or disagree.

Professor Martin: In Ireland, there were quite a lot of experiments a while ago at hatcheries for wild fish, which were treated before they went to sea, then the treated and non-treated ones were monitored coming back. There were no very strong conclusions from that because of heterogeneity within the experiments. Of course, they were hatchery fish, not wild fish. Hatchery fish that are released into the wild do very badly compared with naturally produced wild smolts.

Marine Scotland, or whatever the marine directorate calls itself now, was doing a lot of experiments to understand the survival of smolts going out in the west of Scotland. I understand that the numbers of fish that they were able to get in the traps were never high enough to make a proper statistical inference.

I know quite a lot about wild fish, as I am an angler. There is concern about fish swimming past the cages picking up lice and what happens to them. We do not know—it is a very difficult area on which to do research. As you say, we would have to catch wild fish after they go past cages, but it is very difficult to know where they go, and there are not as many wild salmon as there were 30 or 40 years ago.

12:30

Edward Mountain: Anecdotally, one of the reasons why the fish farm at Loch Ewe has moved is that some sea trout that were returning were smolt sea trout that had gone out to sea and were coming back before they had spent any time at sea because they had absolutely no fins left on them. The fins were destroyed. They were effectively dying in the river trying to get back into fresh water because, for some reason, they knew that fresh water would get rid of the lice. Do you accept that there could be a serious problem?

Professor Martin: If there are very high levels of lice on animals, yes.

Edward Mountain: Thank you. Convener, I would like to go to Annette.

The Convener: We need to stick to what the inquiry is about—the RECC recommendations that you are very familiar with—and not do a deep dive into too many specifics. That would be helpful.

Edward Mountain: I am absolutely not deep diving, convener, and I will stick to the points, but if evidence is given to the committee that I think is fundamentally flawed, I must challenge it, otherwise it will not be on the official record.

Annette, I hope you are in Inverness in that wonderful centre that I visited the other day. I want to probe on antibiotic resistance and chemical resistance. Antibiotic use leads to antibiotic resistance. Are we seeing that in salmon farming, and is that a factor of increased use of chemicals or is it something that we should not worry about?

Dr Boerlage: Antibiotic resistance is something that we should always worry about. I have not worked with any data on that for fish, so I cannot be any more specific than that about whether we should worry about it in this specific case. The subject is very important especially for the human population but also for animal populations, because we want to be able to treat them in the future, so we need to keep a very close eye on the matter. Beyond my having a general understanding, I have not been looking at any data on that.

Edward Mountain: I share your concern. If oxytetracycline was being used as an antibiotic—it is used in humans and there is resistance being built up—that would cause me concern.

Professor MacKenzie: I will just make a quick comment about antimicrobial resistance in aquaculture systems. Right now, we are working on a very large European project called Circles. We have been working on that for the past seven years. It is on all salmon farming systems across Europe, terrestrial plus aquatic. I would say that we will, in six months' time, be able to provide and map AMR data right across the system. We are not too far away from that at this moment.

Edward Mountain: I am sorry, convener—can I follow up on that particular matter?

The Convener: Yes, certainly.

Edward Mountain: If you are going to give us data in six months' time, you might have some thoughts on how things are progressing at the moment. Is AMR of concern?

Professor MacKenzie: There is AMR presence. I need to contextualise this. Let us look at the northern European AMR context versus the Thailand or Vietnam context with pangasius aquaculture, for example, in which there is huge use of antibiotics. There, it is very easy to pick up AMR and the proliferation and movement of AMR across different bacterial communities, because that is what you are looking at. You are looking at transfer of that capability and we are not finding that hugely in Norway, Scotland or Ireland.

Edward Mountain: But fish can build up AMR.

Professor MacKenzie: No, it is not fish that build it up. It is bacteria, generally—

Edward Mountain: Sorry, but can the diseases that affect fish pick up AMR, or are you saying—

Professor MacKenzie: No.

Edward Mountain: Are you saying they cannot?

Professor MacKenzie: You are referring to tetracycline resistance. That is what you were saying before.

Edward Mountain: Yes.

Professor MacKenzie: Under the right conditions, it is possible, but whether those conditions exist is a moot point.

Edward Mountain: I will have to wait to read your report.

Professor MacKenzie: It is a really nice piece of work, because there are a lot of teams in there.

Edward Mountain: I would love to see it, if you could send it to me.

Rachael Hamilton: My colleague Edward Mountain now has my cogs working on the gill health and sea lice interaction. The Government has brought in the new regulatory obligation for fish farms to meet on the threshold for sea lice. The ways in which we are controlling sea lice are clearly impacting on fish health—specifically, gill health. We have brought in something and created a new problem. Does the committee need to look at whether sea lice control is being done in the correct way? It could be, as Professor Martin said, the reason why mortality levels have increased so dramatically.

Professor Martin: To reword that a bit, what you said was that lice treatments are causing gill health issues. The fish have gill health issues first and, if it is bad, they go into the sea lice treatment, which can compromise the fish. Lice treatments are not causing the gill health issues. The gill health issues are environmental challenges for the fish from pathogens, micro-jellyfish, storm damage and naturally occurring plankton. If the gills are damaged, the fish are less able to withstand the procedures that are used to remove the lice. It is not the other way around.

Gill health must be good. One of the big areas for our research team is in trying to understand the mechanisms and the causes of poor gill ill health in order to have early warning indicators so that farms can say—on the basis of X, Y and Z—that the gills are becoming compromised. Therefore, we will advise that they do whatever procedure to look after the lice problem.

If the gills are at a particular level of damage and farms are to do this themselves all the time, now that we are trying to speed the process up, they would make an informed decision based on what their health managers say about treatment.

Of course, we want to bring things forward and give them better warnings. The University of Stirling, the University of the Highlands and Islands and the University of Aberdeen are working on joint and separate projects to understand the causes of gill ill health, which will give the fish farmers knowledge on how they might deal with other things. It happens that way round.

The Convener: We have no further questions, so I thank you all for your attendance this morning. Once again, the evidence has been hugely helpful in our inquiry. That concludes our business in public.

12:37

Meeting continued in private until 12:59.

Published in Edinburgh by the Scottish Parliamentary Corporate Body, the Scottish Parliament, Edinburgh, EH99 1SP

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