The Coastal Communities Network, Scotland - Aquaculture Sub Group

Information prepared for Roseanna Cunningham, Cabinet Secretary for Environment, Climate Change and Land Reform, regarding our concerns with Scottish aquaculture development

The CCN is a collaboration of locally-focused community groups, guided by the belief that coastal communities across Scotland can offer long-term solutions to ensure healthy, well-managed seas. The aim of the Network is to connect coastal communities across Scotland, share knowledge and expertise, and build community action on marine conservation. The Network represents members distributed all around the Scottish coast, from Wester Ross to Jura and from St. Abbs to Fair Isle - and it is growing at speed. Not all Network members share the same issues, but the Network supports members to speak with a shared voice where they do. These groups represent thousands of people in Scottish coastal communities. We care about representing our communities and we are here to stay.

Last November you said: *'My ambition is to carry through not just the letter of EU environmental law but also the underlying principles of precaution, prevention and rectifying pollution at source, as well as the 'polluter pays' principle'*

We welcome this and the Government's commitment in '*Developing an Environment Strategy for Scotland'* to *the four EU principles: polluter pays, preventative action, tackling pollution at source and the precautionary principle.'*

We also welcome the commitment to marine conservation in the latest Programme for Government, especially:

• the acknowledgment that *'our rich ecological capital and natural environment are powerful assets that can help create economic value for the country as a whole'*.

• the pledge to *'do more to safeguard our biodiversity, species and habitats for future generations to enjoy'.*

• the pledge to improve compliance with the biodiversity duty under the Nature Conservation (Scotland) Act 2004.

The PfG made no mention of the serious environmental problems facing the aquaculture industry, or any proposals to tackle them, yet, *'there is no other single sector making discharges to the water environment which have the same total cumulative extent of impacts as fish farms...*'

(Anne Anderson, Head of Compliance and Beyond at SEPA, 02/08/2018)

Aquaculture is in crisis. It is harming our environment and Scotland's international reputation for excellent seafood, wild landscapes, and responsible behaviour.

The *Farmed Fish Health Framework* 2018 says aquaculture '*must be delivered and developed sustainably, with appropriate regulatory frameworks which minimise and address environmental impacts',* but the Scottish coastal communities we represent are concerned that SEPA and Marine Scotland are not properly protecting the environment. MS seems mostly to be working to enable the industry to expand, while one stated aim of SEPA's NewDepomod software (in its '*NewDepomod Final Report')* was to *'support industry expansion'.*

We urge you to review and to greatly reduce the environmental impact of the aquaculture industry, to better protect the environment and our rural communities' sustainable jobs.

Scotland's National Marine Plan policy AQUACULTURE 14 states that: *'The Scottish Government, aquaculture companies and Local Authorities should work together to maximise benefit to communities from aquaculture development.'*

Contrary to this, the members of the CCN's west coast groups feel that the industry and government have emphasized the benefits to 'remote rural communities' without taking proper account of the risks posed by open-net fish farming to our existing jobs and to the environment in which we live, particularly in light of the industry's proposed doubling of capacity.

On 25th July we met Marine Scotland to put our concerns. MS replied in writing seven weeks later but did not answer most of these questions. This is unacceptable.

Your 2017 joint statement with Fergus Ewing, said that your aim is *'an aquaculture industry that is sustainable, diverse, competitive, economically viable and which contributes to food security whilst minimising environmental impact*.'

For us the key is in how much you are willing and able to minimise that impact. You have both written to us to confirm that the status quo is not an option, so please address the following questions and assure us that you will act on them.

Our concerns are laid out in more detail after the questions.

On behalf of the following Coastal Communities Network, Scotland, members:

Community Association of Lochs and Sounds (CAOLAS)
Community of Arran Seabed Trust (COAST)
Craignish Restoration of Marine and Coastal Habitat (CROMACH)
Fairlie Coastal Trust
Friends of Loch Etive
Friends of the Sound of Jura
Save Seil Sound
Sea Change Wester Ross
South Skye Seas Initiative
And supporters, Sealife Adventures

Save Seil Sound

Sea Change Wester Ross

Executive summary

- **The significance of the risk to wild salmonids**

  We believe that sea lice, disease and escapes of farmed fish pose a risk of significant harm to a nationally important population of wild salmonids in the 'aquaculture zone'.

  The Local Authorities tell us they will continue to approve fish farm proposals in wild salmonid areas until Marine Scotland advises them that this risk is significant.

  MS agrees that aquaculture has an impact on wild salmonids but says it does not know its significance. So there is a risk. We believe it is significant. Someone must make this decision. Will you? If not we believe that society should decide.

- **Apply the precautionary principle**

  The OSPAR Convention says:

  '*Preventive measures are to be taken when there are reasonable grounds for concern that human activities may bring about hazards to human health, harm living resources and marine ecosystems, damage amenities or interfere with other legitimate uses of the sea, even when there is no conclusive evidence of a causal relationship. A lack of full scientific evidence must not postpone action to protect the marine environment.*'

  MSP Mike Russell recently wrote to the Planning Minister *'I have been sceptical about some recent applications in my constituency and think the precautionary principle must play a major role in decision making on these matters.'*

  The ECCLRC inquiry's report agrees: '*further development and expansion must be on the basis of the precautionary approach.*'

- **The impact of pollution on PMFs and commercial crustaceans**

  We are concerned that the pesticides and large amounts of waste that fish farms are allowed to dump directly into the sea (an indulgence permitted only to this most marine-polluting of Scottish industries, according to Anne Anderson at SEPA) are harming PMFs and other species, including the crustaceans on which many sustainable jobs in our communities depend.

  We asked MS how it knows that PMFs and commercially important crustaceans are not harmed by cocktails of chemicals, including emamectin benzoate, shown by the SARF098 study to correlate with a 60% fall in crustacean abundance over wide areas.

  MS did not answer. Will you answer this question Minister?

- **Illegal disturbance of cetaceans by ADDs**

  It is illegal to disturb any individual cetacean. SNH says that the Acoustic Deterrent Devices used on many fish farms do disturb cetaceans.

- **The presumption against fish farms on E and N coasts - less risk on the west coast?**

  Argyll & Bute's Head Planner tells us that the presumption against fish farms on the north and east coasts *'to protect migratory fish',* shows that the Government believes the risk to wild salmonids from fish farming is smaller in the aquaculture zone.

- **SEPA is in breach of its biodiversity duty**

  SEPA is responsible for consenting the total biomass of all fish farms in Scotland, yet it takes no account of the local or cumulative effect of sea lice from these farms on wild salmonids, or of the impact of locating 3500t+ farms in the coastal areas used by wild fish, under DZR. This is a breach of its Biodiversity Duty as a public body.

  SEPA says that MS exercises this duty on its behalf, by giving advice, but MS's advice is non-committal on the impact of biomass increases.

- **The need for a Strategic Environmental Assessment**

  The economic case for expansion has been overstated and current fish farming methods threaten many existing sustainable rural jobs.

  There has been no Strategic Environmental Assessment of the Government's policies (in the National Marine Plan and Scottish Planning Policy) that support industry expansion. The 2013 NMP Sustainability Assessment did not address aquaculture expansion, as *'the spatial framework for the future development consent of individual projects was out with the scope of the National Marine Plan and subsequently, the accompanying SEA.*'

  (MS letter to CCN, 14/09/2018). The NMP will not be reviewed until 2023 but an SEA of public policies in support of expansion is needed now, and is a legal requirement.

- **Suspend expansion until it is proven to do no harm**

  We believe the industry's impacts on the environment and on our communities' jobs are so great that it should prove they have been solved before it is permitted to expand.

  To address these problems by 'Adaptive Management', while expanding, is irresponsible, as this approach has failed so far.

- **Move to closed containment**

  Open nets cause many of the industry's problems. All new farms in Norway receive a 'development licence' for closed containment methods. www.akvafuture.com has successfully operated such a farm for 6 years without any sea lice. It is hydro-powered and recycles its waste for biofuel. In 2017 it harvested 2000t of salmon. Scotland could do this too.

- **Give greater weight to community opinion**

  The consenting process largely ignores communities' opinions. One company (MH) says it will not push new farms on unwilling island communities, but many non-island communities do not want them either. These are not defence facilities to be pushed through in the national interest; they are privately-owned industrial farms, exporting their profits overseas while polluting our seas for free, because Scotland's regulations make it cheaper to farm here than in Norway. These polluters are not paying.

- **Triggering Harmful algal blooms**

  We believe that nutrient discharges from fish farms are responsible for significant Harmful Algal Blooms that close down shellfish fisheries and kill fish. They decimated Chile's coast in 2016 and become more likely here as our seas warm.

- ***Over-reliance on self-reported data***

  'The current level of non-compliance in the finfish sector is not acceptable' (Anne Anderson 02/08/2018). Despite this she adds: *'No marine cage fish farm licences have been revoked by SEPA for persistent breach of licence terms and there have not been any successful prosecutions of marine cage fish farm operators for non-compliance with licence conditions in the recent past.'*

  SEPA often seems unable to detect the deliberate over-stocking of farms and relies on self-reported environmental impact data, which is inadmissible as evidence in court.

- **Review of monitoring and publication of impact data**

  Transparency engenders trust. Norway does this better. An independent review is needed to explain why data on aquaculture's impacts is often hidden from the public and why SNH rarely comments on aquaculture's impacts on wild salmonids.

CCN questions to the Cabinet Secretary - please also answer these in writing

Please note throughout - we strongly contend that closed containment would solve most of the industry's problem.

1. Can you say with certainty that aquaculture, now and after doubling in size, poses no risk of significant harm to wild salmonid populations in the 'aquaculture zone'?

Solution: If you are not sure of the significance of this harm, will you apply the precautionary principle until this risk is proven to be insignificant?

2. How do you know that cocktails of fish farm chemicals and other waste are not harming PMFs and commercially important crustaceans?

Solution: Will you apply the precautionary principle until the facts are available?

Solution: Will you determine and then remove this threat to creel fishermen's jobs?

2.1. Is it consistent with the NMP that SEPA and SNH don't know where all PMFs are or whether their national status is being harmed by aquaculture?

Solution: Will you apply the precautionary principle until they do know?

3. The cumulative environmental impacts of expanding the industry, and its socio-economic impact on sustainable jobs are unknown.

Solution: Will you pause the industry's expansion until you have assessed them?

4. SHN gave advice to Ministers that ADDs can cause disturbance, displacement, and hearing damage in cetaceans. It is illegal to disturb cetaceans.

Solution: Will you act now to stop the illegal use of ADDS, ensure that ADDs can only be used if an EPS license is held, and refuse to allow the 3 EPS licensing tests to be weakened?

Solution: Will you ensure that only farms with farms double nets are licensed to shoot seals? This is best practice, as shooting seals then would really be a last resort.

5. The Local Authorities believe that fish farming poses a smaller risk to wild salmonids in the aquaculture zone than if it would to the same species on the east and north coasts

Solution: Does the Government believe this? If not will you tell the Local Authorities?

We appreciate that we may cover no more than this in our meeting. Please answer the following in writing.

6. Farming in open cages provides hosts for parasites and disease that transfer to wild fish.

Solution: Tell us the advice you've had on the epidemiological risks of open cage farming.

7. SEPA is not fulfilling its Biodiversity Duty to protect wild salmonids when consenting biomass, per fish farm and cumulatively, and at large DZR coastal sites.

Solution: Will you ensure that SEPA does fulfil its Biodiversity Duty in this respect?

8. Communities' opinions are not given equal weight to the pro-expansion bias in the planning and consenting system.

Solution: Will you ensure that communities' opinions are given equal weight?

9. Doubling the industry's waste discharges will make Harmful Algal Blooms more likely.

Solution: Will you apply the precautionary principle while you investigate this risk?

10. The regulator relies on self-reported data. It cannot be used to prosecute offenders.

Solution: Will you investigate and review why this is?

11. Many of the industry's worst problems would be solved by closed containment.

Solution: Will you make closed-containment obligatory for all new farms?

More on Solutions…

The ECCLR Committee said, *'further development and expansion must be on the basis of a precautionary approach and must be based on resolving the environmental problems.* ***The status quo is not an option****.'* (their emphasis)

Powerful images also show that Scotland's aquaculture industry is in trouble. Its reputation internationally and at home is in tatters. It promises new ways to control sea lice (to minimise its losses rather than to protect wild fish), but these are so far unproven. SEPA promises environmental improvements with DZR and its sector review, but it will take at least 4 years to review every aquaculture CAR licence, to monitor problem farms and then act to limit damage. By this time much of the sector's expansion will have been consented, including 3500+ tonne farms in coastal locations that threaten wild salmonids and the wider environment, including commercial shellfisheries. Meanwhile existing inshore, open-net fish farms will operate as before, and expand under their existing licences.

MS points out that even if sea lice are kept below industry CoGP levels, *'adherence to the suggested criteria for treatment of sea lice on individual farm sites stipulated in the industry Code of Good Practice may not necessarily prevent release of substantial numbers of lice from aquaculture installations.'*

Aquaculture firms are rushing to submit applications to Local Authorities and SEPA before the rules change. SEPA is struggling to finish its sector review. Mr A'Hearn has confirmed (16/09/2018) that the old system will still apply while this is happens. We are unclear whether SEPA will hold off from processing the applications it has received for farms larger than have ever been allowed before, in untried and dangerously exposed locations. If it does process them, SEPA may still use its outdated modelling software (autodepomod), despite acknowledging that it does not work in these situations.

We want to be positive: Rural jobs matter. We do not object to fish farming in principle; just to how and where it is being done at present.

The details of our arguments below support the following solutions:

The short-term solution is to fix all farms at their present size (or smaller if their impact is unsatisfactory now), and freeze applications for new farms until the problems are fully understand and solved. This breathing space would allow SEPA to update its regulatory framework and publish its sector review, to be scrutinised by parliament and stakeholders. By then it should be possible to review sea louse control with concrete data. Cleaner fish and physical treatments must be proven to keep sea lice numbers close to zero, indefinitely, as agreed with NASCO.

The next stage is to give up open nets. To encourage this, Norway fines heavily for breaches of environmental conditions and sea lice numbers. Licence fees are lower for farms using best practice. All new farms must use closed containment methods. For 6 years Akvafuture (www.akvafuture.com) has successfully operated such a farm, entirely without sea lice, by pumping deep fjord water into impermeable cages and capturing its waste to recycle for biogas, which powers it, alongside hydroelectricity. In 2017 it harvested 2000 tonnes of salmon.

Detailed Section - Contents

1. Sustainable jobs in our communities

In the communities we represent, fish farming using open-nets risks undermining the basis of many sustainable jobs - jobs that will last indefinitely without harming the marine environment. The aquaculture industry's version of 'sustainable' is very different - meaning only that it can sustain its profits as long as the marine environment around the farms does not completely collapse.

The *Farmed Fish Health Framework* says '*There has been a recognised deterioration (in the years to and including 2017) in farmed fish survival in Scotland'*. The death of c. 25% of farmed fish stock from disease, parasitic sea lice, from what the *FFH Framework* calls '*treatment losses',* and harmful algal blooms/jellyfish, show that the industry is not sustainable at present and is not using best available practice - all these could be solved or much reduced by not using open nets.

The industry's claims about its economic benefits are exaggerated. The industry's argument for expansion claims it supports around 18,000 jobs but fish farms directly employ only around 2000 people. The others are tallied by estimating indirect and induced jobs. The industry's economic analysis (*Aquaculture Growth to 2030*) even counts the £16.5m spent on pesticides in 2016 as an economic good - so having more diseases and parasites makes a stronger case for expansion. A socio-economic study of Wester Ross, submitted to the REC Committee's inquiry, shows that aquaculture can hit more sustainable jobs.

The SSPO pays lip service to respecting community views, in its *Community Engagement Charter*, (*'community support and endorsement is important for the farms to operate – a two-way relationship is needed.'* Communities should be given the, *'ability to influence size, scale and location of farms through local expert opinion',* and*, 'at the heart of our work is respecting, listening and responding appropriately to issues and concerns raised during the Community Engagement process'),* and Marine Harvest has said: *'We will not establish a new farm, unless we have community support. At the end of the day they're the people that are living there. If the community said they're not in favour of the salmon farm we wouldn't attempt to try and start one up'.*

(Steve Bracken, on BBC Radio 4 *Farming Today*, 12/08/2017), only to qualify this off-air, by saying that MH meant it to apply just to island communities.

But why just islands? <u>All</u> communities should be asked whether they want fish farms, <u>before</u> the companies bribe them with 'community sponsorship', such as free minibuses, as happened near NH's new feed plant at Kyleakin, for instance.

These are not power stations or defence facilities which must be pushed through in the national interest against objection; they are privately-owned industrial farms, run mainly by multinational companies that export their profits, expanding their operations here because our environmental requirements are less strict than the same companies face at home in Norway. It is cheaper to operate in Scotland because we allow our environment to absorb their pollution for free. Most communities are not asked whether they want fish farms. Some might want them, and if no harm would result to the natural environment, then go ahead. If others do not want them, the industry and Government policy should respect that too.

2. Aquaculture is in crisis

The Scottish Biodiversity Strategy Report to Parliament 2011- 2013 has the goal that, in accordance with the country's commitment to the UN's 'Rio' Convention on Biodiversity: *'By 2020 areas under agriculture, aquaculture and forestry are managed sustainably, ensuring conservation of biodiversity',* but instead Scottish salmon farming is unsustainable, with soaring fish mortality rates due to sea lice and disease outbreaks. It is damaging biodiversity by contaminating sea lochs with organic waste and pesticides, by causing declines in the west coast's wild salmonid populations and by illegally disturbing cetaceans with Acoustic Deterrent Devices. It also risks causing harmful algal blooms such as decimated marine life in Chile in 2016.

Despite this, National and Local Government planning policies are biased in favour of the industry's expansion.

The Community Empowerment Act and other policies are supposed to support *'our communities to do things for themselves, and to make their voices heard in the planning and delivery of services',* but the communities most affected by aquaculture are not being consulted properly about its planning and regulation, or being given sufficient information about its impacts to allow them to make good decisions.

The industry and its regulators are secretive, withholding information that casts aquaculture in a bad light.

The thousands of people we represent are increasingly aware of these problems and are losing faith in the safety and quality of Scottish salmon. A PR disaster is brewing for the industry, and for the Scottish Government, if it is seen to uncritically support industry expansion while these problems remain unresolved.

3. Harming Scotland's reputation

This failure is not going unnoticed. On 10th September, *The One Show* showed around 3 million TV viewers across the UK what has been happening on and around the SSC farms in Loch Roag, Lewis. They could see that salmon farming is in serious trouble, with sea lice infestations killing farmed and wild salmon.

People come to Scotland above all to enjoy our wild landscape and they like to buy the world's best seafood. We should be proud of this, but Scotland's reputation for producing seafood in its clean seas is being destroyed.

A Norwegian industry editorial in *Salmon Business* (05/09/2018) said:

'SSC, which has hired in PR consultants, has obviously not fathomed the gravity of the issue, which has prompted massive reader traffic. The grotesque and, to the highest degree, visual news has spread like wildfire, providing heaven-sent ammunition for the industry's opponents, thus causing the Scots' reputation to be decisively stomped in the mud – and mud sticks.'

'There can be no doubt that this is proof of such appalling practice, supplemented with weak judgment at several levels, which should necessitate appropriate consequences for the perpetrators.' 'Communication here must be crystal-clear: In no way, shape or form is this acceptable for us!' '...now is not the time to

pump "good-news" items about sustainability, new export records and sponsoring of age-specific soccer teams in sparsely populated rural districts. Now's the time to clean up the mess. To stand upright, and through action take responsibility, and provide credible assurances that this will not recur.' 'In this instance trust is a keyword. Trust equals hard currency.' 'The fact that the PR consultants and SSC's management don't see the connection here between reputation and trust from the authorities, is astonishing.' http://salmonbusiness.com/animal-tragedy-in-scotland-in-no-way-shape-or-form-is-this-acceptable/

We claim to be a Good Food Nation but if this lack of trust spreads, the harm being done internationally will go beyond Scottish salmon and risk harming our other food exports. It also risks harming our landscape and wildlife tourism businesses, which dwarf fish farming in value, as well as compromising the image of Scotland as a progressive, environmentally responsible country; one whose word you can trust.

Just look at the powerful international campaign to stop whaling in Iceland, a country that depends on whale-watching tourism.

As a nation we have pinned our hopes for soaring food exports on fish farmed in a damaging way. Salmon farming is harming the pristine seas it boasts about in its own adverts, but it does not need to be like this.

There is nothing intrinsically wrong with farming fish, as long as the welfare standards are high, and doing so would have a conservation benefit if it reduced the demand for wild-caught fish. The current problems are with how it is being done, where it is being done and how it is regulated and monitored.

When salmon are farmed in closed containers rather than open nets, they do far less harm to the environment. Scotland should make this transition. Instead SEPA licenses aquaculture to pollute the sea more than any other Scottish industry:

4. The regulator's treatment of aquaculture is unique

'There is no other single sector making discharges to the water environment which will have a same total cumulative extent of impacts as fish farms…'

(Anne Anderson, Head of Compliance and Beyond at SEPA, 02/08/2018)

4.1. Organic pollution

At present, aquaculture releases untreated sewage solids into the sea, equivalent to the sewage produced by about half of Scotland's human population (figures from the ECCLR SAMS report) at c. 225 active sites. In their point-source nature these sites are no different to the end-of-pipe pollution sources of other industries, yet only aquaculture is permitted to adversely impact the seabed with its waste, in Allowable Zones of Effect (AZE), such that the life in the seabed is either 'degraded' or 'very degraded'. This means it only needs to sustain '*a viable population*' of animals to aerate the seabed sediment. SEPA defines this most basic of animal communities as '*>2 species of enrichment polychaete at densities >1000 m-2*'. Many farms fail to achieve even this.

Anne Anderson tells us: *'The approach used by SEPA accepts that the zone where impacts may occur from fish farm discharges is generally very much larger than from discharges made from other industrial sectors.'* This is unacceptable.

Mr A'Hearn (CE of SEPA) wrote to Mr Dey (convener, ECCLR Committee: letter on the ECCLRC salmon inquiry webpage) to say that this AZE approach protects life on the seabed elsewhere, as: *'The basis of our current approach is to … prevent impacts occurring beyond the allowed zone of impact in vicinity of the cages.'*

But this is contradicted by SEPA's own large-scale hydrodynamic modeling of the areas around Shuna and Fetlar, which shows that areas of seabed miles from the AZE are also impacted by the cumulative waste from multiple farms, in places that SEPA and SNH do not survey for damage to biodiversity.

The present consenting regime takes no account of these impacts and SEPA's standard way of monitoring and data analysis cannot pick it up.

4.2. Dissolved nutrients and Harmful Algal Blooms

At the RECC hearings, harmful algae blooms were identified as sometimes killing farmed fish. This is not publicly reported, or how often is it happening.

The SAMS report, and its authors' at their ECCLRC session, suggested that HABs are entirely natural events, triggered by changes in nutrients far offshore, but the SAMS report also states that 5-10% of the dissolved nitrogen in the Minch is already derived from salmon farming, and (*Heath et al* (2002)) shows that nutrient inputs from aquaculture in parts of the west coast contribute more than 80% of land-derived inputs.

The SAMS report shows that the solid nutrient inputs alone will reach 500,000 tonnes by 2030 (more than the untreated sewage of half of Scotland's people), while the dissolved nutrients already total twice that much, and will have doubled by 2030. Pearson and Black's (2001) *'mass balance models …indicate that 50% of the nitrogen and 28% of the phosphorus supplied with the food is lost in the dissolved form'*, much of it as ammonia which promotes the growth of bacteria, in turn promoting HABs.

There are minimal terrestrial nutrient inputs from farming or sewage at Loch Roag, on Lewis, yet this summer harmful algae closed it to shellfish harvesting.

This is not an isolated example. The *Farmed Fish Health Framework*, 2018 says: *'Changes include increased plankton community variability and fluctuations in environmental conditions. In particular, fish farmers have experienced increased sea temperatures in successive years, and this can be linked to increased fish mortality. The characteristics of natural jellyfish and phytoplankton blooms are such that they lead to high mortalities in farmed fish. Climate change is set to continue. The combination of ocean acidification with sea temperature rise and deoxygenation is of particular concern.*'

Again there is an emphasis on 'natural phytoplankton blooms'.

The industry is worried enough about HABs to suggest the creation of '*real time monitoring of plankton and alert of the occurrence of potentially harmful phytoplankton species*' (*Farmed Fish Health Framework*) and in the light of climate change the *FFH Framework* also suggests the need to assess

'currently available environmental data from around fish farms, for example real-time temperature data'. The temperature around a fish farm is only one factor. The nutrients that harmful plankton need to bloom are another - the nutrients from fish farms, rather than the distant offshore natural sources that are being blamed for all HABs.

There seems to us to be a significant risk, coupled to our warming seas, that these nutrients will increase the occurrence of HABs, such as wiped out most marine life over a large part of Chile's coast in 2016, with dire economic and ecological consequences.

At present, uniquely among Scottish industries, aquaculture is not paying to clean up its pollution; instead it is using the sea, a valuable shared resource, to dispose of its animals' excrement and pesticides for free. This would be unacceptable on land and should not be acceptable in the sea. Closed containment would solve these problems.

The most insidious pollution is a consequence of treating diseases and sea lice.

4.3. Chemical pollution

'Fish farming is unique in that it is a sector which is allowed to discharge substantial quantities of biocides …' (D. Sinclair - SEPA Internal *SARF098 PAMP Refreshment Study – SEPA Response Options Paper* - FOI)

The pesticide emamectin benzoate is attached to the fish farms' solid waste.

The CAR regulation framework, including SEPA's previous autodepomod and its newdepomod modelling software, assumes that if any emamectin leaves the AZE, it will be uniformly diluted across a large area, but SEPA's hydrodynamic modelling around Shuna and Fetlar show that particulate pollution and its bound-in emamectin are not always dispersed by the sea - instead they can be concentrated and deposited far from their source.

These chemicals are dumped into the sea from wellboats too, a process currently not assessed by SEPA under the CAR licence system. Sea lice are becoming resistant to all current sea lice medicines and the Industry wants to *'encourage development of new medicines'* according to the *FFH Framework*.

5. The impact of fish farm pesticides on non-target species and crustacean fisheries

These are powerful toxins and there is ample research to show that all the licensed chemicals harm non-target organisms outside the farm cages.

Norwegian research, published this year in *Aquaculture Environment Interactions,* shows that even hydrogen peroxide, largely ignored by SEPA as benign, kills commercially-fished crustaceans at doses 1000 times lower than used in fish farms. https://www.int-res.com/journals/aei/aei-home/

A number of other papers (eg http://www.centroideal.cl/wp-content/uploads/2018/02/2017-Gebauer_PASCHKE_PARDO_etal-Chemosphere.pdf from 2017), show that the chemicals used in aquaculture affect the larvae of commercially-fished crustaceans: *'Cypermethrin, deltamethrin, and azamethiphos affected 100% of crab larvae at concentrations lower than used against sea-lice, hydrogen peroxide at the concentration used as an anti-sea lice treatment had lethal and sub-lethal effects on (crab larvae).'*

The Scottish Aquaculture Research Forum's SARF098 study showed a 60% average fall in abundance of crustaceans around Scottish fish farms using emamectin benzoate. (*'SARF098C PAMP2 Refreshment Study - The association between emamectin benzoate use and crustacean assemblages around Scottish fish farms*'), concluding that:

'...the evidence suggests that benthic crustacean may not be adequately protected by the current regulation of EMB use in Scottish salmon farms'*...'our results indicate that, even allowing for regional differences in the physical properties of the receiving environment, the use of EMB is associated with substantial, wide scale reductions in both the richness and abundance of non-target crustacea. Given the findings in this report* ***we believe there is an urgent requirement to... consider the likely ecosystem consequences of large scale reductions in crustacean richness and abundance at the scale of sea lochs****.' 'These data were unlikely to be observed if there was no association between EMB (or correlated variables) and the abundance of crustacean families.'*

Norwegian shrimp fishermen have reported falling catches around fish farms, and so have fishermen in Wester Ross and the Hebrides. Anne Anderson (02/08/2018) told us that she is aware of this but said that: 'SEPA *does not collect or produce data on crustacean fisheries or on the stocks that are pursued by fishermen. SEPA has been aware either through direct reports or through information provided indirectly - for example in media stories of a possible change in crustacean abundance which may have been anecdotally linked to the use of sea louse medicines such as emamectin benzoate.'*

SEPA knows that the evidence for the harm done by emamectin is more than anecdotal. Its own 2016 internal emamectin *Response Options Paper* says:

'...the waters in which salmon farming is practiced are usually the same waters in which Scotland's valuable crustacean fisheries are located.'

'Whatever conclusion is reached on the quality of such waters in terms of the WFD, it is not tenable for SEPA to adopt a position where commercial shellfish species are impacted by the day-to-day activities of fish farms, activities which SEPA will have knowingly authorised under CAR.'

'Indeed, one of the significant considerations and drivers of the authorisation process for all sea louse medicines has been the protection of commercial shellfish species, SARF098 reveals that there is a significant risk of failure to provide such protection.' 'To date effects such as those described in SARF098 (ie the PAMP2 study) have not been evident, ... In part though this is down to our not having been in a position to undertake analysis of the data that we hold and this could be seen as a significant failing on our part, especially in light of anecdotal claims of impacts on crustacean fisheries'

All the licenced pesticides are toxic to crustaceans. SEPA's emamectin *Response Options Paper* continues*: 'In addition to the concerns over the use, and over-use of Slice,* ***the current patterns of use of the other authorised medicines should be a matter of some disquiet to SEPA*** *... The pattern of use of these products is however ... often highly repetitive, this would seem at odds with the way in which the products have been licensed.' '...during each two year growth cycle, the use of 20 or more treatments is not unusual with each active ingredient being used 5 or more times.' 'The original vision for Slice was that it would be used once of twice per year but currently the reality is that it is used in many sites 5 to 7 times per year.'*

The SARF098 study is filled with 'largely unknown', 'inadequate data' and 'needs further study'. In the light of this uncertainty, a year ago SEPA asked UK TAG to review the EQS for emamectin benzoate/Slice and said it would make interim reduction in the EQS in 'relevant protected areas'. These apply beyond MPAs. WAT-PS-17-03 defines them as: *'- an area designated as a marine protected area for the protection of habitats and/or species; or where a Priority Marine Feature has been identified; and - in which the conservation interest may be susceptible to the effects on the area of emamectin benzoate'.*

SEPA has failed to apply the lower levels of emamectin to every such area and has not answered our question about how it identifies the areas outside MPAs that are eligible for the lower EQS. Given that there is no information on the sensitivity of Scottish species to emamectin benzoate, or to organic waste, it is not clear how SEPA determines whether a 'conservation interest' will be affected. SEPA has not answered that question either, even though we asked Anne Anderson both questions in April. She has not told us when UK TAG will report on emamectin either.

The *SAMS report* adds that *'Bath treatment chemical plumes can extend up to 8 km'*.

In Norway, the 'PestPuls' study is investigating the cumulative impacts of cocktails of pesticides. No similar public research is being done in Scotland. This is a serious issue, with many jobs at stake in rural areas.

The Scottish Government needs to commission such research as a matter of urgency, and should apply the precautionary principle where there is uncertainty about the significance of these impacts.

6. The impact inside MPAs and other areas protected for conservation

Our economy depends on productive seas. They need ecosystem-wide protection and better coordination and information sharing between MSS, SEPA and SNH.

Little is known about how species interact, the locations of nursery and spawning grounds, which support fisheries, and the habitats that supports their food chains. We can't just protect a few species as the whole system is interconnected.

The MPA network is Scotland's insurance against the loss of such ecosystems, and should provide some resilience against the impacts of climate change but public data, analysed by NTS in February 2018, show that 32% of active salmon farms are within protected areas. Astonishingly, SEPA says it has no information on whether existing fish farms inside MPAs are harming marine life away from the farm cages.

The large-scale impact of all salmon farms inside the MPA network needs to be assessed as a matter of urgency, along with the cumulative impact from farms near their borders. This is particularly important where MPAs were created to protect species that are highly sensitive to fish farm waste and the chemicals, such as maerl.

7. Failure to protect PMFs and the wider marine environment

We welcome the government's review of the protection of PMFs from mobile-gear fishing. The impact of aquaculture on the same PMFs has not been assessed, which is not consistent with the National Marine Plan's policy that: '*Development and use of the marine environment must not result in significant impact on the national status of Priority Marine Features'.*

Static species, such as northern sea fans, and mobile PMFs, including porpoises, flapper skate, seals and otters, are all affected by pollution or the other impacts of fish farms. PMFs also include the wild salmon and sea trout harmed by sea lice and diseases from farmed fish.

Maerl is damaged by fish farm waste far beyond a fish farm's AZE, and does not recover even after 2 years, but SEPA confirms that it does not know where the maerl beds are or whether they are impacted, so these statements it made to the ECCLRC are not reassuring:

'SEPA *has not had cause to reduce the permitted biomass at, or revoke the authorisation for, any fish farm for the purposes of ensuring the achievement of a protected area objective, including those for maerl.'*

'To date no existing fish farms have been identified as compromising the objective for a protected site' (A'H letter to GD)

'We do not hold information with which to assess whether farms authorised in the past (i.e. pre-dating the establishment of protected areas for maerl) affected the quality or extent of any maerl beds present around these farms.'

The cumulative effect of multiple farms makes these impacts worse, especially when they are added to the impacts of bottom trawling and dredging.

The Government know that aquaculture harms many of these species. How is it consistent with the NMP's commitment to protect their national status, if the agencies responsible for doing so do not know where they all are?

8. Illegal disturbance of cetaceans by Acoustic Deterent Devices

On 28th July 2017, the Head of Policy and Advice at SNH wrote to Marine Planning and Policy at Marine Scotland, with the following advice to Scottish Ministers:

'There is sufficient evidence, both empirical and modelled, to show that ADDs can cause disturbance and displacement of cetaceans'.

ADDs are designed to scare seals. They are even more efficient at disturbing cetaceans. They are so good at disturbing porpoises that they are used to protect porpoises from pile driving noise by displacing them.

One study[1] found that 96% of porpoises were excluded from stations 7.5 km from a single active ADD at a received sound level of 113dB re 1 µPa (RMS). Aquaculture ADDs output from 179-194 dB re 1 µPa (RMS). They are normally used in multiple arrays of between 4 and 20 ADDs per farm. Disturbance has been recorded by Kok, at 100dB re 1 µPa (RMS) and hearing injury at short exposures to 164 dB[2] and longer exposures at lower levels. A report to SNH[3] stated "*the risk that ADDs at Scottish aquaculture sites is causing permanent hearing damage to marine mammals cannot be discounted".*

The CCN Fairlie group's acoustic surveys suggest that porpoises in the Clyde are being embayed towards the top of loch Fyne. They think this is due to ADDs.

The latest research, published this year, was *'the first broad-scale measure of the acoustic footprint of ADDs used in the Scottish salmon aquaculture industry'* with 11 years of data (to 2016) from the west coast, much of it collected by the Hebridean Whale and Dolphin Trust. (*Mapping widespread and increasing underwater noise pollution from acoustic deterrent devices*. Findlaya et al. Marine Pollution Bulletin 135 (2018) 1042–1050.)

The study found that in 2015, 278 active ADDs were detected in its west coast survey area. It also found *'a steady increase in ADD detections … as well as substantial geographic expansion. This study demonstrates that ADDs are a significant and chronic source of underwater noise on the Scottish west coast with potential adverse impacts on target (pinniped) and non-target (e.g. cetaceans) species.'*

'…In Scotland, the deployment of multiple ADD transducers per fish farm (e.g. one per cage) is common (Northridge et al., 2010)'

'…despite being widely used as mitigation to seal depredation at aquaculture facilities, consistent long term effectiveness of ADDs in reducing depredation has yet to be conclusively proven…In contrast, there is considerable evidence for the unintentional effects of ADDs on non-target species'

'Given present knowledge of ADD signals' effects on species such as harbour porpoises, the widespread and increasing use of ADDs in Scottish waters could therefore have a range of negative impacts including causing chronic reductions in hearing thresholds (Götz and Janik, 2013; Lepper et al., 2014), and/or the potential for exclusion from key habitats, risking creating barriers to their movement (Johnston, 2002), all of which can have long-term fitness and population-level consequences.'

It is an offence *'to deliberately or recklessly disturb any dolphin, porpoise or whale*' under Habitats Regulation 39(2) as amended in Scotland. This law applies to individual cetaceans as well as at a species level, as established by the successful prosecution of a jet-skier who disturbed a small group of dolphins on a single occasion. It must therefore follow that it is an offence for a salmon farmer to disturb any individual cetacean, even once, with an ADD, and that it does not matter how large an area the disturbance or injury occurs in; it is still an offence under Habitats Regulation 39(2).

Given that there is scientific evidence demonstrating that ADDs do disturb and can injure cetaceans, MS should enforce Habitats Regulation 44, by requiring farms that might disturb cetaceans with ADDs

[1] Brandt, M. J., Höschle, C., Diederichs, K., Betke, K., Matuschek, R., Witte, S., Nehls, G. (2012c) Far-reaching effect of a seal scarer on harbor porpoises (Phoena phocoena). *Aquatic Conservation:Marine and Freshwater Ecosystems:1-11*
[2] Lucke *et al.* (2009) Temproary shift in masked hearing thresholds in harbour porpoise after exposure to seismic airgun stimuli. *J Acoust Soc Am 125:4060-70*
[3] Lepper, P.A., Gordon, J., Booth, C., Theobald, P., Robinson, S. P., Northridge, S. & Wang, L. (2014) Establishing the sensitivity of cetaceans and seals to acoustic deterrent devices in Scotland. *Scottish Natural Heritage Commissioned Report No. 517.*

to hold EPS licenses. It has not done so. A typical open cage salmon farm could not pass any of the 3 tests required before an EPS licence can be issued.

So far 9000 people have signed a Change.org petition to you, Ms Cunningham, on this subject (https://www.change.org/p/roseanna-cunninham-scottish-government-cabinet-secretary-for-the-environment-save-dolphins-porpoises-and-seals-from-scottish-salmon-farms).

Disturbance of cetaceans by unlicensed ADDs is subject to a complaint to the EU.

The ECCLR report said: '*The committee has significant concern about the use and operation of ADDs and their cumulative impact and considers all fish farms in Scotland should be required via legislative or any other appropriate means, to follow the position of the Aquaculture Stewardship Council in relation to ADDs. This ensures fish farms cannot use ADDs*'

Marine Scotland has failed to answer a number of questions on the illegal use of ADDs, posed by CCN members since January 2018. It still did not answer them at the July meeting, or in its written answers in September. This is unacceptable.

9. Seals

ADDs are used to deter seals, which may then be shot under licence as a last resort. The US Marine Mammal Protection Act will come into force in 2022, but requires countries to be working toward compliance by 2019. If Scotland fails to do so it will face an export ban. Seal shooting has to end and ADD use is illegal where it disturbs cetaceans. There is an effective solution, using double nets, correctly tensioned. Some companies already use them here, others use them abroad. They cost more but they represent best practice in this respect. Surely it is a simple thing for the Government to instruct the industry to make this change, which is in its best interests anyway. After January 2020 no seal shooting licences should be issued unless a farm has double-skinned anti-predator nets. Farms not using the best technology are not complying with the licensing condition to only shoot seals as a last resort. Closed containment would avoid this too.

The ECCLR report said: '*The committee considers the industry should manage the risk of predation through extension of the use of double skinned predator nets'.*

Harmful industries should be obliged to prove that they are doing no harm, rather than making an assumption that all is well until it is proven otherwise.

10. Depositional Zone Regulation

SEPA has described this as a minor change to the way it regulates aquaculture, when in fact a major change is needed. DZR is not a good solution for wild salmonids.

In order to reduce pollution in sheltered lochs, SEPA is encouraging fish farms to move to more exposed sites. As an incentive it plans to remove the 2500t cap on their maximum biomass. SEPA consulted on DZR last year but has not yet published the results, so DZR has not been scrutinised by Parliament or the public, yet the Local Authorities and the industry are acting as if it is a fait accompli.

For example, this month four farms in Loch Fyne applied to Argyll and Bute Council to *'delete their biomass limits'*, despite having poor environmental and sea louse records at their present sizes. Another proposal (now in screening with A&B Council) is for a farm holding 3300-4660 tonnes of fish at Corpach Bay on Jura.

Last month the same council gave planning permission for Marine Harvest's BDNC Loch Shuna farm to expand to 3500 tonnes - making it the largest farm in Scotland. The Argyll Salmon Fisheries Board opposed this expansion, as the farm is close to two salmon breeding rivers, in an area used by sea trout all year: larger farms mean more sea lice. Several farms in the area have a history of high sea lice numbers and SEPA's most recent seabed monitoring report for BDNC Loch Shuna (26/04/2018) was 'borderline' at its present size, but the council approved it anyway.

SEPA has also received applications for other 3500+ tonne farms. They are all sited in more exposed but still coastal waters that are used by wild salmonids.

SEPA must accept responsibility for the consequences of its actions in this respect.

11. Sea lice impacts of larger farms in exposed locations

Siting larger farms in exposed waters also increases the sea lice threat to wild fish. During the ECCLRC's inquiry, Mr A'Hearn wrote to Mr Dey (28/03/18), to explain that new farms should be located in *'exposed, dispersive environments where current speeds significantly reduce accumulation of waste on the sea bed'*.

He added '*...in practice, large farms would be limited to more exposed locations* ***where the risk of infection with sea lice and other diseases can be less'***.

But this is wrong. Many high tidal flow sites are close to mainland and island shores, such as in the Sound of Jura, where peoples' livelihoods depend on the sea not being polluted. The HIE's *Value of Aquaculture to Scotland Report* confirms that: *'From our consultations, producers' focus pre-2025 is on* ***near-shore****, more exposed sites...'*. These sites are easier to service with smaller vessels from existing shore bases, so they suit fish farming companies better than offshore sites.

MS has failed to publish sensitivity maps for wild salmonids, but what is certain from the SAMS report, the independent NINA report and research published this year from Skye (Moore et al, 2018), is that when the smolts of both species leave their natal rivers they spend time in coastal areas, where they are severely compromised by sea lice from fish farms. Sea trout live in coastal waters year-round, so farms in inshore exposed sites are in areas used by wild salmonids. These farms will not have fewer sea lice, as Mr A'Hearn stated - in fact the sea lice numbers in many of these reporting areas have been among the worst in Scotland.

Treating lice is a major reason for the increased use of biocidal chemicals, so siting larger farms in such places would release more chemicals, not fewer.

The strong currents at these sites may disperse pollution further from the farms, but they will also carry sea lice far and wide. The latest research shows that currents can sweep viable sea lice larvae from the mainland to the Outer Hebrides, while others can be carried back. (*Temporal variability in sea lice*

population connectivity and implications for regional management protocols. T.P. Adams *et al*. SAMS. Aquaculture Environment Interactions Vol. 8: 585–596, 2016)

Despite this, SEPA is already processing applications for Scotland's largest farms (>40% bigger than any others) in more exposed sites.

12. SEPA's Biodiversity Duty

SEPA refuses to take any responsibility for these consequences of its actions, saying that sea lice are not pollution, and ignoring its biodiversity duty as a public body, under the Nature Conservation (Scotland) Act 2004, '*to further the conservation of biodiversity so far as is consistent with the proper exercise of (its) functions.'*

As the Explanatory Notes to the 2004 Act states, the point of the biodiversity duty *'is to place the onus on public bodies* ***to take direct responsibility*** *for the impacts which their policies and operations may have on the natural environment.'*

SEPA clearly accepted this responsibility in its 2005 Fish Farm Manual:

'...in order to better protect wild salmonid stocks however, SEPA has adopted a Limiting Factor approach to consenting marine caged fish farms. SEPA may, in determining biomass limits for sites where proximity to important wild stocks is considered as a significant issue, impose a biomass limit equivalent to that biomass which can be effectively treated for sea lice infestations using an authorised sea lice medicine.'

Subsequent Acts of Parliament have not changed SEPA's biodiversity duty, but it no longer recognises the obligation to limit biomass to protect wild fish. Its latest Biodiversity Duty Report says nothing about salmon and sea trout.

The Fish Health Inspectorate is unable to limit farm biomass to protect wild salmonids, as it is only legally concerned with farmed fish. Once a farm has planning permission, neither Marine Scotland nor the Local Authority can modify its biomass for wild fish reasons. Only SEPA can do this.

The ECCLR Committee concluded that it, *'is not convinced SEPA (or any other agency) is effectively monitoring the environmental impact of salmon fisheries...'.*

13. Containment failures

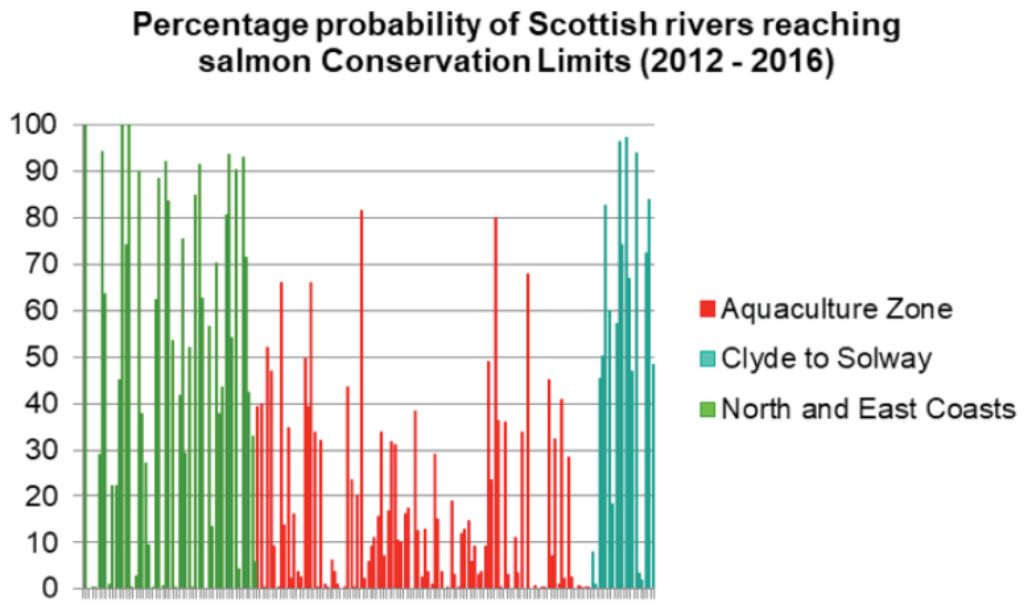
The SAMS report says that an average of 146,000 cultivated adult salmon are reported as having escaped from salmon farms each year in Scotland, many of them during storms. That's equal to half of the entire wild salmon population. Many more escape unnoticed. In Norway escaped salmon are deemed the greatest threat to wild fish. Placing millions of fish in ever-larger farms, in some of the most exposed locations on our coasts, increases the risk of escapes. This is not best practice.

MS is responsible for assessing the ability of farms to contain their fish, but at present it only requires the applicants and manufacturers to state that their equipment would survive a 1 in 50 year storm. This may satisfactorily pass legal responsibility for its failure onto the developer, but no fish farm could retain all its fish during 1 in 50 year storm on the west coast of Jura, where Kames Fish Farming has proposed its new 3300-4660 tonne farm. The farm and a 43m long feed barge would be anchored less

than 100 metres from a rocky shore, facing the open Atlantic. Closed containment farms would not have to be in such exposed places.

14. Who is responsible for protecting wild salmonids?

There are other pressures on wild salmonids, and their decline started before fish farming became such a large industry, but the on-going decline is worst in the 'aquaculture zone'.



The decline is mirrored in Ireland and Norway, where more thorough research has proven a causal connection.

This is the only impact on their lives that we can mitigate and, as their population's decline, the need to do so becomes ever more acute.

This is hindered because no agency takes responsibility for the impact of sea lice, disease and escapes on wild salmonids. This is a systemic failure and it seems to be deliberate.

The '*Aquaculture Working Arrangements*' document assigns the duty to consider wild fish to MS, but without the responsibility to do anything to protect them. This agency is the closest to the industry and has the least incentive to limit farmed fish biomass to protect wild fish.

Scottish Natural Heritage has been marginalised by the Aquaculture Working Arrangements and defers to MS about the status and protection of sea trout and salmon at sea, even though they are PMFs species, never offering public opinions on their national conservation status.

The salmon farming industry has been given considerable freedoms by the highest levels of Government, that many other industries would not be given, for example on the discharge of chemicals and the damage the industry causes to wild fish. It is clear that SNH has been warned off being critical of fish farming and Marine Scotland is soft on the industry. Why is this?

A new independent body is needed, with the authority and direct responsibility for protecting the national status of wild salmonids.

15. The significance of the impacts on wild salmonids - Marine Scotland's advice to Local Authorities

The Local Authority planning process is the only democratic part of the fish farm consenting system. Communities' opinions are a material consideration but the LAs' Planning Committees routinely dismiss informed public objections on the impact on wild salmonids. The Head Planner at Argyll and Bute Council tells us that these objections will continue to be outweighed by advice from Marine Scotland, until that advice says that aquaculture developments have a significant environmental impact on a nationally important population.

At present Marine Scotland's advice to the LPAs is non-committal on the significance of the impact on wild salmonids. Even the Aquaculture Industry Leadership Group has called for MS to give more detailed, site-specific advice (minutes of 5th AILG meeting).

CCN members met Marine Scotland in July and asked why it gives such inadequate advice to the LPAs, on the significance of the impact of aquaculture on wild salmonids, and on the LPAs' legal obligation to undertake Strategic Environmental Reviews of the cumulative impact of all the farms they consent, at a larger scale than individual water bodies. MS replied in writing 7 weeks later but still did not answer this question.

Even the industry acknowledges the risk of harm. Marine Harvest (29/05/2018) wrote to the Principal Planning Officer, Argyll and Bute Council: *'it is now the generally accepted position that uncontrolled sea lice levels on fish farms located in constrained water bodies can present a hazard to wild fish populations'*. Marine Scotland also accepts that sea lice from fish farms will impact wild salmonids.

The key question is about the significance. Marine Scotland says it cannot quantify this impact. SNH bows to MS, saying it lacks the information to make its own judgement. The councils' planners say they do not know, and point at the Government's presumption against fish farms on the E and N coast, *'as a precaution to protect migratory fish'*, saying this must mean that wild fish in the west coast 'aquaculture zone' face a smaller risk. Argyll & Bute Council referred us to Marine Scotland to address the truth of this but MS will not say who is supposed to assess the significance of the risk, although we asked the question many times, or whether the presumption against fish farms on the E and N coasts means that salmon on the west coast are less at risk from aquaculture, saying only that '*responsibility for policy on wild salmonids sits within the ACRE Division.'*

If no one will take responsibility for deciding the significance of the risk, then we think society should do so. This is consistent with Prof Tett's (SAMS) statement to the ECCLR Committee inquiry that: *'effect is value neutral, and impact requires evaluation of the effect. That evaluation will depend on the criteria that are applied, which are formal legal criteria and understandings of ecosystem health, but they also relate to societal concerns'*.

We represent thousands of the people in the communities that live closest to the impacted wild salmonids and we believe that the risk to these fish (the same species on all of Scotland's coasts) from the same parasites and diseases, is as significant on the west coast and in the Outer Hebrides as it is on the E and N coasts.

16. Apply the precautionary principle

In the face of such a significant risk, and in the absence of scientific certainty, there is a principle that all public bodies are legally obliged to apply.

The OSPAR convention, to which the UK is a signatory through the EU, states this precautionary principle as follows:

'*Preventive measures are to be taken when there are reasonable grounds for concern that human activities may bring about hazards to human health, harm living resources and marine ecosystems, damage amenities or interfere with other legitimate uses of the sea, even when there is no conclusive evidence of a causal relationship. A lack of full scientific evidence must not postpone action to protect the marine environment.*'

Argyll and Bute Council's Head Planner told us (02/05/2018) that it is *'generally accepted that lice produced on farms pose a threat to the health of wild fish and that this threat will increase with numbers of fish being farmed'*, but he also said that he has too little information to apply the precautionary principle:

'It would not be appropriate to routinely refuse applications on a precautionary basis ***simply because definitive information was not available****. To do so would impose an unjustifiable moratorium upon the fish farming industry.'*

This is extraordinary as it is in exactly these circumstances that the precautionary principle is supposed to apply.

He does understand this, as he later quoted the preamble to the 1992 UN 'Rio' Convention on Biological Diversity: '*where there is a threat of significant reduction of loss of biological diversity, lack of full scientific certainty should not be used as a reason for postponing measures to avoid or minimize such a threat.'*

He added: *'The Council's view is that wild fish issues would be best addressed on a water body wide basis, having regard to cumulative effects of the fish farm development',*

but he admitted that, *'the responsibility for wild fish interactions arising from marine fish farms is … not best placed with planning authorities given that consideration is only prompted at the time of planning applications being submitted, and in response to the details of the application at hand, without any opportunity to address issues associated with other operational sites in the same water body.'*

Despite the council's inability to assess these cumulative impacts, it has continued to issue planning permission for many fish farms. For each incremental expansion of existing farms it rarely even requests an EIA. The Argyll & Bute Planning Dept. told us last year:

'Generally the situation with fish farms is that we normally require EIA for new sites, but are less likely to do so for extensions or alterations to existing sites – unless they are in especially sensitive locations.' In its written submission to the ECCLRC the council added that: *'In other cases there is no express requirement for the applicant to provide cumulative information...'*

There is a risk that these developments will cause significant harm to wild salmonids and information is lacking, so why are the Local Planning Authorities not applying the precautionary principle?

We urge you to apply the precautionary principle, by halting the industry's expansion until MS, SNH and others have been able to provide solid evidence that this expansion will do no harm.

17. Sea Lice

We believe the industry's problems must be solved before any expansion takes place, yet the opposite is happening, in the optimistic belief that adaptive management can fix every problem as it goes along. This approach has manifestly failed so far, most obviously concerning sea lice, which the industry acknowledges as its most pressing problem. According to the *Farmed Fish Health Framework,* its solution is '*...a more balanced strategy, including the use of cleaner fish and physical removal, alongside the use of licensed medicines',*

But this '*...has brought with it a number of challenges related to biosecurity and welfare, primarily because it has increased the need for fish to be handled, which is a contributory factor in mortality*.'

The tragic events this summer in Loch Roag, where tens or hundreds of thousands of farmed salmon died due to sea lice infestation, and where wild fish have been eaten alive by up to 700 sea lice per fish, took place <u>before</u> the industry has doubled in capacity. What will prevent this type of event from becoming even more common after expansion?

The *Farmed Fish Heath Framework* says: *'The industry understands that it makes business sense to produce healthy fish and that doing so depends on the marine and coastal environment' ...'They also understand their responsibilities to uphold the highest standards of welfare in how they care for their fish.' 'In recent years changing coastal environmental conditions have contributed to the industry's challenges and it recognises the need for continuous improvement in its practices...'*

In Norway sea lice are spreading north as the sea warms. This is Scotland's future too, under climate change. The warm seas this summer probably contributed to the disaster in Loch Roag. As well as being an animal welfare disgrace and a terrible blow to the wild salmon population, this is also an economic disaster. The owner of the Garynahine Estate, where the wild fish were found dying, points out that their loss will have a significant impact on the livelihood of the 30 local people employed by his remote rural business, based on fishing for wild salmon.

The industry claims to have solutions for its sea lice problems, by using wrasse and lumpsuckers to eat them, and Thermolicer and Hydrolicer machines to remove them physically. The wild wrasse fishery is controversially depleting populations in the protected areas where they are caught. Cleaner fish can spread diseases so they are slaughtered after two years, with the farmed salmon. Wrasse can be farmed but they don't all learn to clean salmon. Recent photos show lumpsuckers infested by sea lice in salmon farms on Mull. The physical treatments continue to kill and maim farmed fish in numbers that the industry does its best to keep quiet. Official records from farms in Loch Fyne show that sea lice quickly resettle on farmed fish after these physical treatments. None of these treatments have yet been proven to fully control sea lice and the lice have evolved resistance to pesticides.

Even if the latest measures succeed in bringing lice numbers below the industry's Code of Good Practice levels, MS confirms that substantial numbers of sea lice will still be released by fish farms. Farmed fish

will continue to escape, and diseases will still spread from the open cages, all of which will harm wild salmonids.

Here is one example of the sea lice problem on a fairly typical fish farm, the SSF-owned Slocka Ronas Voe, in Shetland. Marks and Spencers sells its salmon as 'Lochmuir'.

In its last production cycle, lice numbers at Slocka Ronas Voe peaked at av. of 38 per fish (all life stages). The site was harvested early, due to high lice levels, and was restocked in 2017. 196,400 smolts died during that restocking, due to disease: *'Mort event form completed detailing; mortality of 196,400 (100%). - Inadequate osmoregulatory capacity by or implicated with fungus in FW leading to mortality event during wellboat transport with compromised fish health in the following days after discharge. Previous cycle of fish on site had high lice levels and gill issues so site was harvested earlier than initially planned.'*

Since then the farm's SSPO sea lice figures show an av. 3.37 adult female lice per fish in May, up from 2.27 in April and 0.67 in March and 0.74 in February. This year the farm has breached the new 3 and 8 sea lice trigger levels, with an average of 6.7 adult female lice per fish in wk 17, 5.55 in wk 21, 3.61 in wk 22 and 5.8 in wk 23. SEPA data shows no chemical treatments between January and June 2018. FHI last inspected a year and a half ago. At that time there were no cleaner fish. The farm has used a Thermolicer.

The last time Slocka Ronas Voe was below the Code of Good Practice sea lice level was in January 2018, so for at least 5 months this year sea lice larvae have been flooding out of the farm. Only SSF and the SSPO know what has happened since May, because they do not release their sea lice counts for many months.

18. Transparency. Secrecy breeds distrust

The SAMS report said: *'the legislative and voluntary frameworks that underpin the management of lice levels on farms are not transparent. They appear neither to be succeeding in controlling sea lice, nor capable of addressing the environmental effects of the lice.'*

The lack of public trust in this industry and its regulators is not helped by their secrecy. Here are some examples:

SARF delayed publication of its SARF098/PAMP2 emamectin study until several anonymous reviewers, employed by the manufacturer, had added their comments. The industry then lobbied to have SEPA's emamectin ban cancelled.

The industry withholds information from the public record: for instance last year the Scottish Salmon Company, in *Mortality Event Report MRT00577* (https://beta.gov.scot/publications/foi-18-01466/), declined to tell the regulators in writing what percentage of fish they had killed with the Hydrolicer, *'only that the figure is >1%'*. Report *MRT00577* says, *'figures collected during visit to office'* two months later. Local Authorities refuse to disclose their pre-application discussions.

This secrecy is made worse when data is self-collected, voluntarily, as then it belongs to the company, even when it is the only data about that company's impact on our shared environment. The Government

has lost multiple appeals to the Scottish Information Commissioner about its refusal to release information.

The FFHWG's published 'activities' include: *'Move to pro-active open site-level reporting of key statistics concerning fish health, including sea lice and mortality'* and '*… promote openness and transparency within the Scottish industry'*, so when will it publish its annual mortality rates, listed by cause?

When the industry and Government try to hide the problems, you lose our trust.

The Government should commission a systematic review, independent of MS (which collected the information from the Scottish Salmon Company two months later, perhaps to avoid FOI disclosure) of how this industry is monitored, how all the data is collected and made public, and publish the results in full. Norway does it better.

19. Disease transfer

The *Farmed Fish Health Framework* (2018) says *'Gill health has emerged as the key challenge to the farmed fish industry in the marine environment and is the most significant contributor to increasing marine mortality'* yet its 'objectives' do not mention the risk of amoebic gill disease, proliferative gill disease or any other diseases being transferred to wild fish. Disease transfer is acknowledged as a major risk in Norway but the SAMS report shows that it has hardly been studied in Scotland at all. This is a major omission. The precautionary principle should apply until more is known. Closed-containment would help.

20. Other knowledge gaps

The SAMS report also highlighted how little is known about the impact of fish farm waste and chemicals on Scottish marine species and habitats. The ECCLR committee report said that there seems to be little evidence that SEPA or other agencies are applying the precautionary principle in these circumstances.

At the RECC meeting on the 18th April, the Head of Planning at the Highlands & Islands Council said: *'Industry has set a challenge to double production but no-one knows the capacity of Scottish waters to absorb that much'*, adding: *'it feels that we are 30 years too late. In 2018 we should have the answers. We are nowhere near.'*

Asked whether anyone knew what the carrying capacity for fish farms is, SNH replied *'we are quite a long way from that'.*

The biological surveys of the seabed, submitted with fish farms proposals, are often of very low quality. It was only by luck that SNH spotted the northern sea fan PMF in a few video frames at Dounie for instance, which resulted in the proposal being withdrawn. The applicants had failed to mention their presence. SNH did not know the sea fans were there. Otherwise they would soon have died, smothered by fish excrement, and no one would have been any the wiser.

SNH admits that it does not know the location of many PMFs, yet SNH told the RECC inquiry that even inside MPAs it does not survey the areas around fish farms, as they are not 'typical'. SEPA does not survey areas away from the cages for PMFs either, saying that SNH deals with the wider environment. This gap in the knowledge of the distribution of rare and sensitive animals urgently needs to be closed.

Mobile PMFs are impacted by aquaculture too, for instance the critically endangered flapper skate (at greater risk of extinction than the giant panda) and of course sea trout and wild salmon, whose distribution has still not been accurately mapped by Marine Scotland, hindering the LPAs in making sound decisions. According to the Scottish Planning Policy, MS is obliged to explain its, *'locational policies when identifying areas potentially suitable for new development, and sensitive areas which are unlikely to be appropriate for such development'*.

There is an urgent need for this to happen.

In the meantime, when a public body knows there is an impact but does not know its significance, it is obliged to find out before approving the development. That is the precautionary principle.

21. Cumulative impacts and the need for a Strategic Environmental Assessment

The ECCLRC report and the SAMS report point out that there are large uncertainties about the impacts of aquaculture on marine life.

Under The Environmental Assessment (Scotland) Act 2005, the environmental impacts of all public plans for industries must be examined through a Strategic Environmental Assessment.

The National Marine Plan lays out the government's policies, plans and strategies to support aquaculture growth. A presumption in favour of expansion is also supported by the Scottish Planning Policy and has been promoted by the Cabinet Secretary for REC. The *Fishupdate* website reported that, at a reception organised by Seafood Scotland, Mr Ewing said:

'I am determined to give what leadership I can to make sure that no matter what challenges are thrown at it, you double growth.' 'Let's do it…let's go Scotland!'

https://www.fishupdate.com/minister-champions-salmon-sectors-growth/

Other proposals, such as mechanical kelp harvesting, are subject to very detailed SEA, but the environmental impacts of the Government's policy to support the expansion of aquaculture, or that expansion itself, have not been assessed at all.

The west coast of Scotland is one ecosystem, interconnected by the sea. The total biomass of farmed fish is determined by a single government agency, and farms are consented by a handful of Local Authorities - just two main ones on the west coast mainland. Their decisions control the total biomass of farmed fish across huge swathes of the coast, but the LAs insist that the planning process can only consider each proposal on its own merits, and neither SEPA nor the LAs make any assessment of the cumulative, large-scale environmental impact of their pro-expansion policies.

It is irresponsible to allow this industry to expand without knowing the environmental impacts of that expansion, or the socio-economic impacts on sustainable jobs.

We call on you to commission a detailed SEA of the industry, in order to determine the biological carrying capacity of the 'aquaculture zone' for marine fish farms, the cumulative impact of all the fish farms existing now and after the proposed doubling of capacity, on coastal and marine species and habitats, including wild salmonids. This SEA should also assess the socio-economic impact on local

communities and other users of the sea, and on existing sustainable jobs, including tourism and creel fishing, where fish farm pesticides can kill commercially valuable crustaceans.

22. Better monitoring is needed

Adaptive Management is the opposite of the precautionary principle.

Professor Tett (SAMS) told an ECCLRC session that its success depends on the quality of the monitoring, but SEPA and SNH have had their budgets cut so much that the ECCLRC has expressed concern about their ability to do their jobs. They lack the money to do significant amounts of monitoring. Both agencies have also had their missions changed to include supporting the economy.

In the past SEPA has sometimes moved the goalposts - for instance by making the AZE larger under the most polluting fish farms. Above all, the regulators save money by requiring the industry to monitor most of its own compliance with the rules.

The paucity of SEPA's monitoring data is striking:

The SARF098 study showed that the environmental data held by SEPA was inadequate for assessing the impact of emamectin benzoate on benthic animals. Only the existence of additional data collected at a few sites in Shetland made this possible. *The NewDepomod Final Report* also says: *'Seabed EMB residue data from routine monitoring undertaken in association with all treatments is held by SEPA. However, this data only comprises two sampling locations per site.* ***Such a sparse coverage of impact data is insufficient for adequately characterising the spatial extent and intensity of a seabed impact. Therefore this routinely collected data was considered inadequate for the purpose of assessing model performance.'***

An internal SEPA emamectin *Response Options Paper,* released under FOI, makes it clear that SEPA has not routinely analysed the monitoring data it holds, to spot large-scale patterns of change. It said: *'To date effects such as those described in SARF098 have not been evident… In part though* ***this is down to our not having been in a position to undertake analysis of the data that we hold and this could be seen as a significant failing on our part, especially in the light of anecdotal claims of impacts on crustacean fisheries.'***

23. Non-Compliance and the regulators' willingness and ability to enforce the rules

SEPA tells us that *'the current level of non-compliance in the finfish sector is not acceptable.'* (Anne Anderson 02/08/2018).

She adds that: *'SEPA has taken enforcement action against sites which fail to meet environmental standards by reducing the authorised biomass or the conditions relating to the use of medicines at such sites.'*

While Mr A'Hearn letter to Mr Dey shows that in the three years to the end of 2017 there were 105 breaches of either seabed or emamectin levels, among Scotland's

c. 225 active salmon farms, biomass was reduced at only 42 of them. Of these, 20% were slow to show signs of seabed health improvement, 20% more were fallowed anyway and may damage the seabed

again when production restarts, and c.33% have not reported yet, so may still be doing harm.

We have received the following allegation of deliberate fraud at one fish farming company:

'Several of their existing fish farms are currently producing above authorised levels. Reports of production levels, fish numbers and densities to the authorities are false. Site managers keep duplicate records. The real figures are never shown to auditors.'

At our meeting we will show you more details.

The emamectin *Response Options Paper* above suggests that SEPA also suspects that fraud may happen: *'Clearly something has changed, possibly the higher levels of use currently observed are leading to an accumulation,* ***or the data on use provided by farmers is incomplete such that sites with apparent light use are actually subject to higher exposure levels****.'*

Despite all this Anne Anderson confirmed that: *'No marine cage fish farm licences have been revoked by SEPA for persistent breach of licence terms and there have not been any successful prosecutions of marine cage fish farm operators for non-compliance with licence conditions in the recent past.'*

SEPA says that self-reported data may alert the regulators to problems, allowing the agency to collect its own evidence, but this will only happen with accidental breaches. If the cages are deliberately overstocked the environmental impacts would rise in proportion and pesticide use would rise also but it is very hard to tell how many fish are in a cage and, as SEPA's written evidence to the ECCLRC shows, in 2017 just 9% of 160 visits were unannounced.

No amount of self-monitoring data can reveal deliberate fraud, yet self-monitoring is still relied on and apparently will be in future, since Mr A'Hearn's letter to Mr Dey shows that SEPA is considering backing down on doing all its own monitoring under the DZR scheme, apparently because the industry says that moving monitoring equipment between farms would pose an infection risk.

Yet that is exactly what its own wellboats, Thermolicer etc do at present.

You have confirmed to Michael Russell that self-reported data cannot be used as evidence in court, which we believe helps to explain why there have been no recent successful prosecutions.

Breaching licence terms is not a barrier to expansion. Anne Anderson writes: *'It is not unusual for farms which have a poor compliance record to have an increase in biomass granted, if for example that change in the permitted biomass is associated with change in the configuration of the farm that may lead to a predicted reduction in overall impacts.'*

We see this as evidence that the relationship between the industry and its regulators is too close.

Sometimes overstocking is deliberate, but sanctioned by SEPA anyway. For instance, from November 2012, Poll na Gille, in Argyll, was licensed for 1500 tonnes. By early 2014 the cages were holding roughly 50% more fish. There were significant mortalities. The next cycle started in November 2016, still with a permitted biomass of 1500 tonnes. The *Scotland's Aquaculture* database shows that stocking was 2207 tonnes in October 2017. Marine Harvest had re-stocked the farm in November 2016, apparently expecting a biomass increase to 2000+ tonnes. Permission was not granted until March 2018.

The farm's benthic surveys show six 'Borderline', six 'Unsatisfactory' and two 'Not Accepted' since the farm was established. Emamectin residue sampling on 18th January 2016, showed breaches of the EQS at 100m from the farm, 110 days after its last use.

Argyll and Bute has just granted the farm a further increase in capacity, without an EIA, which is often the case for expansion, even though several incremental increases will result in a much larger biomass than was initially subject to EIA.

Fish farms in Loch Fyne have been applying for retrospective planning permission for larger biomasses. In the absence of sanctions for overstocking, this seems to be a way to expand production without delay or proper scrutiny.

Public trust in the regulator suffers when there is a failure to prosecute persistent offenders. This failure has become more apparent in the last decade.

24. The Local Authority planning process is not working

Local Authorities have been instructed to favour this industry, as long as the environment is protected. It disregards public opinion as a result.

Argyll and Bute Council's supplementary written evidence to the ECCLR Committee shows that *'any applications requiring Environmental Impact Assessment are required by the EIA Regulations to address cumulative impacts in association with other developments, so an applicant would be expected to address wild fish interactions on a cumulative basis.'* (http://www.parliament.scot/S5_Environment/Inquiries/003_Argyll_and_Bute_Supp.pdf)

However the council admits that it is unable, on its own, to fulfil this duty because: *'In terms of technical knowledge and scientific expertise neither officers, nor councillors are best placed to address wild fish issues'.*

Rather than accepting the Area Salmon Fishery Board's and members of the public's opinions, that expanding a fish farm would put wild salmonids at risk, councillors on the Argyll planning committee said at one recent planning meeting, *'we must trust the experts*. Their preferred experts are Marine Scotland. As discussed above, MS will not say whether the acknowledged impact of sea lice from farms on wild fish is significant or not. In private the council's planners say that MS's advice is ambiguous and unhelpful.

The Head of Planning at Argyll and Bute feels that the responsibility for wild fish impacts has been misplaced. His draft written submission to the RECC makes it clear why Local Authorities cannot control sea lice numbers. (https://www.argyll-bute.gov.uk/moderngov/documents/s125557/Final PPSL Committee - Rural Economy and Connectivity Committee - Salmon Inquiry - 27.04.18 3ML0.1.pdf):

'The most significant issue facing planning decision-makers in the case of salmon farms is the acceptability of developments in the light of anticipated interactions with the wild salmonid environment. Methods relied on in the past by fish farm operators for the treatment of sea lice by chemical means (bath treatments and in-feed treatments) are proving to be less effective as resistance increases...'

'Marine Scotland has recognised the severity of the sea lice issue in recent months by the introduction of its own standards for the incidence of sea lice on farmed fish, with mandatory trigger levels prompting action on the part of operators. Whilst these provide something of a backstop in terms of protecting wild fish interests they have been introduced to address fish health on the farm and have not been devised in response to wild fish interactions.'

'...even where (CoGP sea lice) thresholds prove capable of being adhered to, the trend towards larger production units with higher biomass levels than hitherto, presents additional hosts which result in more lice being present in the environment.'

'Planning applications can only consider the various means by which operators intend to mitigate the effects of their developments on wild fish interests. They cannot guarantee those measures will necessarily be effective, particularly given that there are off-site environmental factors which contribute to the incidence of sea lice, so levels may become elevated despite an operator's best endeavours.'

'Sea lice are an environmental wide issue presenting cumulative impact considerations, therefore ***their consequences are not best addressed by individual planning applications****, which present themselves on an ad hoc basis. The issue of sea lice requires an area wide water body response which cannot be delivered by EMP's associated with individual applications.'*

'Whilst new or expanded sites may become subject to EMP's, other long-standing sites, potentially with more biomass or a history of elevated lice levels, may not present a similar opportunity to deploy EMP's, simply because they are not subject to alterations requiring further planning permission.'

'Planning authorities do not receive operational data from fish farm companies and do not have any role in monitoring production activities on site.'

The council's written submission to the ECCLRC's inquiry adds that:

'...the Planning Authorities responsible for aquaculture are agreed that EMP conditions afford the only means open to them to monitor the effectiveness of an operator's response to the incidence of sea lice arising from the operation of a particular site, and present the only opportunity to require monitoring data or to introduce sanctions in the event that lice numbers after mitigation become significantly more prevalent than envisaged at the application stage. ***That does not, however, mean that EMP's are the best means of monitoring the impact of sea lice from multiple sources upon a given water body****.'*

Environmental Management Plans are*: '...not an appropriate means to provide an area wide response to the overall impact of sea lice'*, because

'many pre-existing sites (are) operating without EMP's, and without any prospect of such unless an application should be made to alter a farm in the future'.

'EMP's are resorted to by Planning Authorities given the lack of an overall area based approach to wild fish interests founded around cumulative impacts' ... 'providing a somewhat random and ad hoc response to an issue which is ongoing*...'*

'They are in effect a sticking plaster, not a systematic means of assuring well-being in the wider environment.'

There is a case for removing this responsibility from Local Authorities but to do so would remove the last democratic stage in the consenting process, and still no agency would be responsible for wild fish.

Communities' opinions need to be given greater weight in these decisions.

25. Tourism and landscape impact

In Visit Scotland's latest (2015-16) survey, visitors cite Scotland's landscape as its main attraction. Tourism is worth about £11bn to Scotland, rising to c. £23bn by 2025. It provides many jobs in small coastal communities like ours, and at least 100 times more Scottish jobs than those directly employed on fish farms. More than 10% of jobs in Argyll & Bute are tourism-related, the highest proportion in Scotland.

The impact of aquaculture on tourism is routinely dismissed by Local Authorities, on the basis of two SARF studies, funded by the industry and government, yet fish farm cages never feature in photos advertising Scottish tourism. Perhaps this reflects the findings of the SARF045 study (*Assessment of evidence that fish* farming impacts on tourism. F Nimmo. R Cappell. Aquaculture Research. 2011):

A quarter of people surveyed did not want to see an increase in the number of fish farms, over a third didn't want to see them get any bigger and 10% said they would be less likely to visit these locations again. 48% of respondents said the expansion of fish farming would negatively impact the scenery and 46% said it would negatively impact the natural environment.

The huge fish farm proposed for Corpach Bay on Jura is in one of only 20 Wild Lands Areas - a designation intended to protect the nation's wildest places. These designations are meaningless if an industrial fish farm can be sited there.

26. Feeding diseased fish back to farmed fish?

It is possible that salmon that have been killed by disease are being reprocessed into food for other farmed salmon. The BSE crisis showed what can happen when diseased animals are fed to others. Please investigate this.

27. Sustainability and carbon emissions

The industry claims that farming salmon in open cages is sustainable and that this way of producing protein has one of the lowest carbon footprints. The sustainability claim falls apart in the light of the industry's plans to double its capacity.

Farmed salmon are fed other fish, such as anchovies caught off Peru in a fishery that is already at its conservation limit, or other species caught more locally - such as sandeels; vital to puffins and other seabirds that are now in serious decline for lack of food. Soya and palm oil has been substituted for fish to the maximum extent the Scottish industry will support, before its customers complain that its products are unnatural. Soya or palm oil cannot be 100% certified as causing no deforestation. The industry now wants to feed fish GM canola with omega-3 producing genes inserted, and is turning increasingly to using Antarctic krill, adding enormous CO^2 emissions by unsustainably fishing down the food chain, halfway around the world.

Feeding locally-bred soldier flies or other insects to salmon would be much more sustainable than this.

This is not a low carbon industry. The following table shows how many units of CO^2- releasing fossil fuel energy are used by different farming methods to produce each unit of energy in edible food. (From *Salmon & Sustainability: The Biophysical Cost of Producing Salmon Through the Commercial Salmon Fishery and the Intensive Salmon Culture Industry*. PH Tyedmers, PhD Thesis. University of British Columbia. 2000)

Food production system	Amount of energy and carbon used per unit of edible food energy
Third world farmers	0.01
First world vegetable production	1 - 3
Commercially caught coho salmon (B.C.)	13.5
Milk (USA)	14.1
Swine (USA)	17.9
Commercial cod fishery (USA)	20.0
Chicken (USA)	26.3
Eggs (USA)	26.3
Lamb (USA)	50.0
Intensively cultured Atlantic salmon	**50.0**
Beef (USA)	52.6

Tyedmers' calculations show that the sea cage salmon farming system requires about 50 times more fossil fuel energy than is contained in the salmon, as edible food energy. This is less carbon and energy efficient than many other food production systems, except for some other intensive aquaculture systems and intensive beef production. It is definitely not the most efficient food production system.

Food energy calculations, using the Scottish salmon farming industries' production figures and fish feed manufacturer's feed composition data (cross-checked with data from the USDA, FAO and the UK governments food consumption surveys), show that in 2015 salmon feed contained 6.67 times the food energy contained in the harvested salmon. In 2016 it contained 7.40 times the food energy.

It would be c.7x more efficient for humans to eat the ingredients of the salmon food.

In its latest sustainability report, the salmon feed production company BioMar, which has a factory at Grangemouth, says it bought 19,400 tonnes of Antarctic krill and 19,500 tonnes of sandeels. In total it bought 304,000 tonnes of fish, for fish meal and oil, of which 77,000 were fish trimmings from other fisheries, so it used almost a quarter of a million tonnes of wild fish and krill to make salmon food that year.

The European salmon farming industry requires a marine support area for feed estimated at 40,000 to 50,000 times the area of cultivation and is equivalent to about 90% of the primary production of the fishing area of the North Sea (*Naylor et al., 1998)*.

BioMar also says that 1.6 tonnes of CO^2 are emitted for every tonne of feed it produces.

The industry's carbon footprint argument seems to be based on one 2011 paper: '*Marine Finfish: Super-Chickens of the Sea?*' O. Torrissen (Nordland Faculty of Biosciences & Aquaculture, Norway) *et al*. Reviews in Fisheries Science, 19(3):257–278, 2011. This paper gives these CO^2 equivalents, *'in terms of calculations based in relation to edible product': **'Atlantic salmon (farming) shows an emission comparable to wild-caught Atlantic cod and chicken** while substantially less than beef and pork'*

It also says that Scotland's salmon farming emits almost twice as much CO^2 as Norway's: *'1.78 kg CO^2 eq/kg (whole weight) for Norwegian-produced salmon, to 3.27 CO^2 eq/kg (whole weight) for fish produced in the United Kingdom (Pelletier et al., 2009), explaining this by 'the higher use of marine resources for fish produced in the United Kingdom*.'

The CO^2 emissions from salmon feed production must be added to those from running the farming operations, and should include the c. 25% of Scottish salmon that are fed but die before harvest, the 146,000 or so that escape each year, and the many more that are discarded at processing - according to the '*super-chicken'* paper this happens to 1.9 million fish pa in Norway, so perhaps to 400,000 in Scotland. Diseased fish grow more slowly too: *'substantial costs are also associated with poor growth rate'.*

Nor does the '*super-chicken'* paper account for the CO^2 emitted during distribution, which is enormous, because the fish are farmed so far from processing factories and their markets, increasingly in the Far East and USA. In 2017, 92,000 tonnes of salmon were exported, 53% of it outside the EU (*Scotland's 10 Year Farmed Fish Health Framework).* Research published in 2016 concluded that the *'carbon footprint of salmon produced in land-based closed containment water recirculating aquaculture systems, delivered to market in the US, is less than half of that for salmon produced in traditional open net pen systems in Norway that is delivered to the US by air freight.'*

(*Comparative economic performance and carbon footprint of two farming models for producing Atlantic salmon (Salmo salar): Land-based closed containment system in freshwater and open net pen in seawater*. Yajie Liu et al. Aquacultural Engineering Volume 71, March 2016, Pages 1-12)