Response of the Coastal Communities Network Scotland to SEPA's Proposals for a risk-based framework for managing interaction between sea lice from marine finfish farm developments and wild Atlantic salmon in Scotland
https://consultation.sepa.org.uk/regulatory-services/protection-of-wild-salmon/

4. Do you think that there are important areas for wild salmon post-smolt migration that we have not identified as wild salmon protection zones?

Yes

5. If yes, please identify these areas, explaining why they should be protection zones and the evidence to support this.

The risk posed to wild salmon by sea lice is a consequence of the density of infectious-stage sea lice (copepodids) in the sea, and of the time that salmon spend exposed to that lice density. Larger fish can tolerate more sea lice than smaller ones, while spending more time exposed to higher densities increases the risk of harm. For this reason, SEPA's rational is to protect wild salmon smolts in areas constrained by the land (in lochs, sounds and areas around the mouths of listed salmon breeding rivers), where they cannot reduce their exposure time by quickly swimming to the open sea.
This is a reasonable basis for making an initial selection of areas where wild salmon smolts are at risk from sea lice but this should be seen as a provisional list. These other types of area also ought to be included:

- Areas where sea lice accumulate outside the proposed wild salmon protected zones, on likely smolt migration routes. Hydrodynamic sea lice modelling must be done to map these areas. Additional areas are also likely to need protection, as the understanding of smolt migration routes improves.
- Areas around the proposed wild salmon protected zones, and in the gaps between them, where lice densities may exceed the threshold for likely harm, and through which migrating wild salmon are likely to pass.
- Areas around rivers where wild salmon used to breed but which are not included in Marine Scotland's list of salmon rivers with conservation ratings.
- Areas of importance to sea trout.
- Additional areas of importance to freshwater pearl mussels, where wild salmon are absent but sea trout are present.

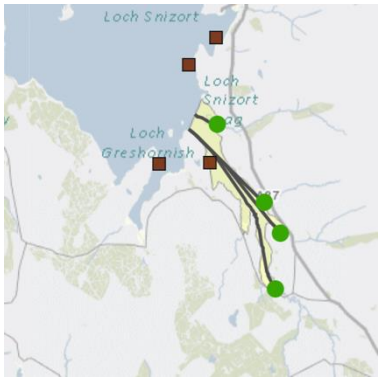
Areas away from the proposed protected zones but within likely migration routes, where hydrodynamic modelling shows that sea lice will accumulate
Water movements can disperse sea lice copepodids more than 30km from the farms where they originate. Observations at sea and hydrodynamic modelling confirm that tidal, temperature and salinity features in the sea can concentrate copepodids from multiple farms at high densities, far from their source. The proposed wild salmon protection zones should be reviewed in the light of hydrodynamic modelling of virtual lice particles, to predict where the lice will accumulate. If these high copepodid density areas are outside SEPA's proposed protected zones and on likely migration route for wild smolts, then the zones should be extended. (See the Firth of Clyde example below, Fig.17)
It is essential that lice from all existing and proposed farms are included.

Areas around the edges of proposed protected zones and in the gaps between them
SEPA proposes to assess the risk to wild smolts in the proposed wild salmon protection zones, based on their average swimming times through geographically confined areas, along the shortest route from the mouth of the furthest breeding river to open sea boundaries designated by SEPA.
Subjective decisions have been made in choosing the seaward boundaries of these areas.
These choices make a profound difference to where wild fish will be protected.
For instance: In a number of places there are small, non-sensical gaps between different protection zones. In other cases, the chosen boundaries of several small zones are inside large bays which have a more natural seaward boundary that must be crossed by all the migrating smolts from the zones inside it.

Choices have also been made between designating rivers as opening onto open coasts, or opening into enclosed waterbodies. This makes a significant difference to the size of protected areas, as the seaward boundaries of enclosed waterbodies are straight lines, while the zones around open-coast river mouths have a curved boundary of 5km radius.
There is more detail on these boundaries below, with the changes that we think are needed.

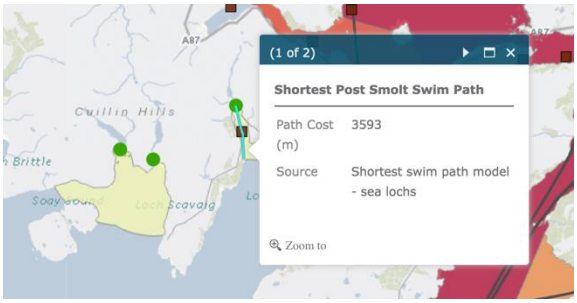
The choice of seaward boundaries is important because SEPA's assessment of the risk to wild fish ceases at the edge of the protection zones, while the risk to wild fish does not necessarily stop there.

Changes that should be made to the proposed Wild Salmon Protection Zones
Some of the constrained waterbodies that SEPA has designated as separate wild salmon protection zones are extremely small, resulting in less protection for smolts than if an area of 5km radius had been drawn from the river mouths.



There are several examples in the Hebrides, for instance the River Hinnisdal on Skye (upper green dot in Figure 1), where the shortest swim to 'open sea' is only 1270m. The Hinnisdal flows into Loch Snizort, which SEPA could have designated as a constrained waterbody. Alternatively, it could have designated the River Hinnisdal as opening onto an open coast. Instead, the river has been lumped with three other rivers, in a small waterbody called Loch Snizort Beag. The longest minimum swim of 10km in this waterbody means this zone has the lowest risk rating. In fact, the whole of Loch Snizort is constrained, and it contains several salmon farms. It should be designated as a protection zone in its entirety

Figure 1 - *River Hinnisdal (upper green dot)*



There are other small protection zones on Skye, for instance the River Ant-Statha Mhoir, which has a shortest swim of 3595m - substantially less that the 5km radius assigned to the two rivers to its west (Fig. 2).

Figure 2 - *River Ant-Statha Mhoir (right hand green dot)*

To be consistent, the Ant-Statha Mhoir and others with short minimum swim distances, should be treated in the same way as rivers that open onto open coasts - an additional radius of 5km should be

added offshore. Sometimes adjacent 5km zones would touch, representing the realistic risk that smolts from one such river will have to swim through a similar area offshore from an adjacent one.

In the Outer Hebrides there are several small zones, with minimum swim distances less than 5km, that ought to be extended in this way, for instance Camas Uig (Fig. 3), Loch Erisort (Fig. 4), Stornoway Harbour (Fig. 5), and Loch Fleòideabhagh, Loch Stocinis and Loch Fhionnsabhaigh (Fig. 6), whose 5km zones would merge off shore.

Figure 3 - *Camas Uig (left hand dots)*

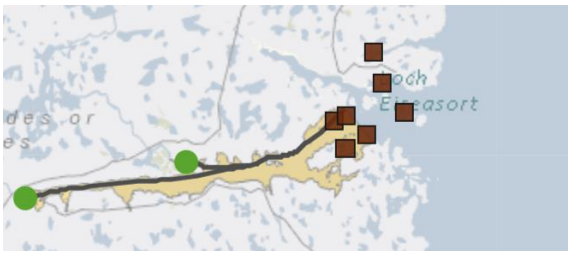


Figure 4 - *Loch Erisort*

Figure 5 - *Stornoway Harbour (lower dot)*

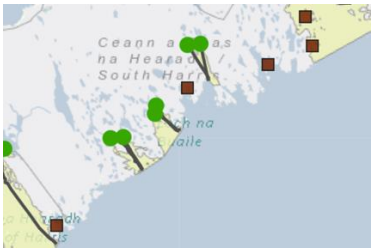
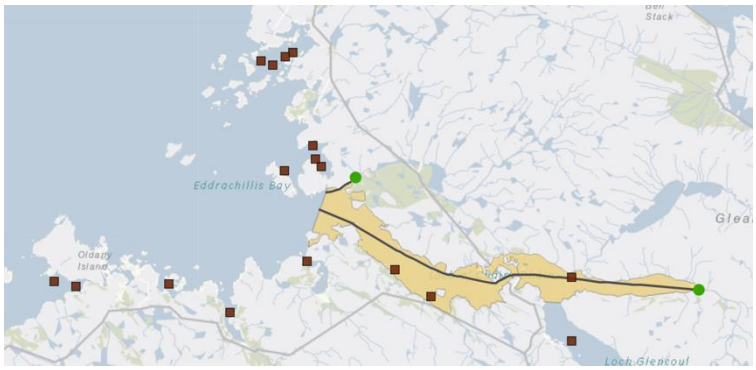


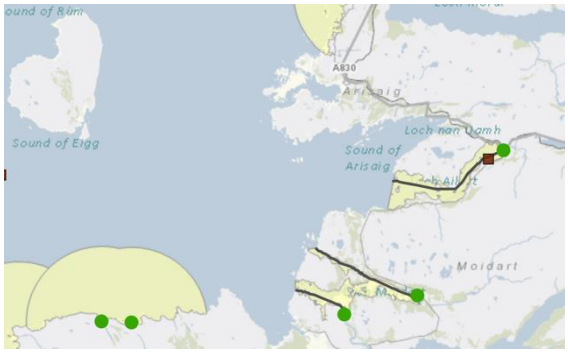
Figure 6 - *Lochs Fleòideabhagh, Stocinis & Fhionnsabhaigh (six central dots)*

In some cases, SEPA has chosen seaward boundaries that are too far inland.



The open sea boundary between the designated Loch a' Chàirn Bhàin waterbody and Eddrachillis Bay (which has no designated waterbody name in the interactive map) (Fig. 7) should extend further into the bay. There are a number of farms there whose lice pose a risk to migrating smolts (brown squares).

Figure 7 - *Loch a' Chàirn Bhàin waterbody (orange zone)*

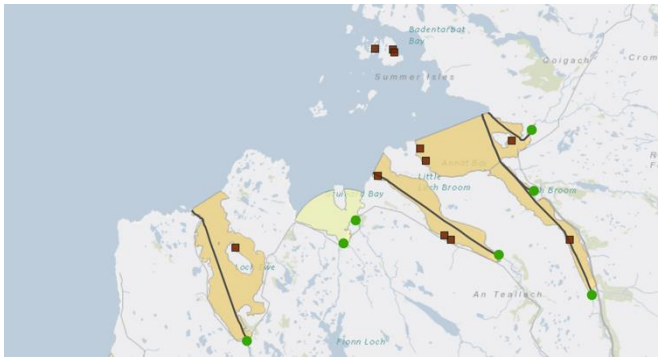


Similarly, the outer edge of the Sound of Arisaig should be the seaward boundary for a zone including the Loch Ailort and Loch Moidart waterbodies (Fig. 8). Adding 5km radius half circles to each waterbody would achieve this, while representing the realistic risk to smolts offshore.

Figure 8 - *Loch Ailort and Loch Moidart (encompassing the three right hand green dots)*

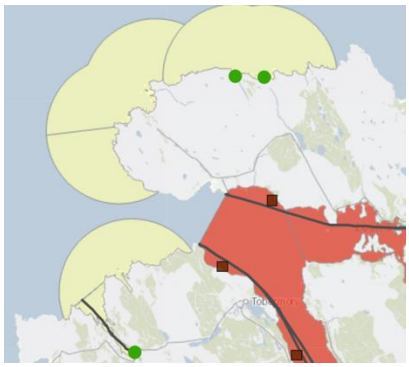
The gap between Loch Laxford and Scourie should be closed (Fig. 9)

Figure 9 - *Loch Laxford (lower left) and Scourie*



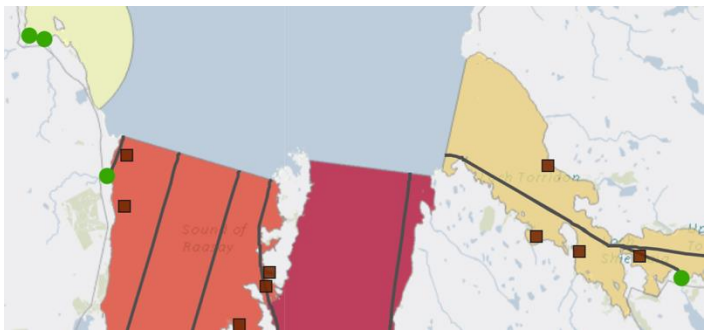
It is extremely unlikely that smolts leaving each of the separately-defined Loch Ewe, Gruinard Bay, Little Loch Broom and Annat Bay/Loch Kanaird waterbodies will not swim past some of the adjacent zones, and the farms at the Summer Isles (Fig 10). The gaps between these waterbodies should be closed and the whole bay, including the Summer Isles designated as one zone.

Figure 10 - *Loch Ewe, Gruinard Bay, Little Loch Broom and Annat Bay/Loch Kanaird*



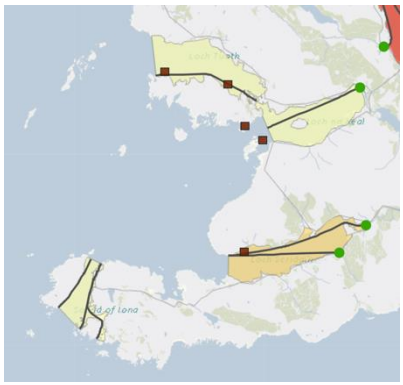
The gap at the mouth of the Sound of Mull should also be closed, as most of the smolts leaving that area must swim through it (Fig. 11)

Figure 11 - *The mouth of the Sound of Mull (left of the red zone, sandwiched by yellow zones)*



The gaps between the North Skye, Sound of Raasay, Inner Sound and Loch Torridon zones should also be closed, rather than three of them ending with straight edges that do not meet (Fig. 12).

Figure 12 – North Skye, *the Sound of Raasay, the Inner Sound and Loch Torridon*

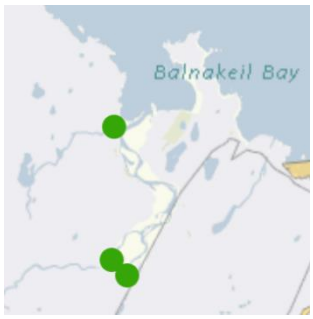


The west of Mull is also awkwardly subdivided (Fig. 13), with Loch Tuath and Loch na Keal treated separately despite being interconnected at Ulva Ferry. This makes a much longer swim more likely than the marked straight line from the River Ba.

Fish from Loch Scridain are quite likely to swim through these other zones as well. The three zone should be merged.

Figure 13 - *Loch Tuath and Loch na Keal (uppermost pale yellow areas) and Loch Scridain (orange area)*

There are a few more anomalies:
The upper part of Loch Kishorn has not been given any grading but it ought to match the zonation of adjoining Loch Carron. Similarly, Loch Ainort should be graded the same as Broadford Bay, Gare Loch should be the same as the Clyde Estuary - Outer, Loch Long (North) should be the same as Loch Long (South) and Loch Striven should be the same as the Kyles of Bute.
Smolts do not necessarily take the most direct route and may use these areas.



The Daill, Grudie and Dionard rivers seem to lack any designation, despite being marked as Salmon Conservation Regulations River Mouths (Fig 14).

Figure 14 - *The Daill, Grudie and Dionard rivers*

The shortest path concept has some limitations as there is no guarantee that smolts will choose the most direct route to the open sea. For instance, most salmon smolts migrating around Vancouver Island in British Columbia choose a longer route and pass more salmon farms than they need to. The size and shape of the proposed wild salmon protection zones, and whether they join up, should reflect this uncertainty, as well as the lack of choice of migration routes.
For instance, migrating smolts are likely to have to swim through gaps between the proposed protection zones in the Firth of Lorn area south of Oban (Fig. 15), the Firth of Clyde, between the Small Isles and Skye, along the northwest highlands coast (e.g. the Wester Ross MPA) and on the east coast of the Outer Hebrides.

Figure 15 - *The Firth of Lorn, a gap between proposed wild salmon protection zones*

It is likely that fish from the separate Loch Spelve, Loch Feochan, Sound of Shuna and Sound of Jura (North) zones will swim through this gap, and onward through the Sound of Mull.
Sea lice from the many farms in Loch Linnhe, Loch Shuna and the Sound of Mull will be present in the gap, as well as in the proposed zones. The risk they pose in this area ought to be assessed by designating the 'Firth of Lorn South' as a wild salmon protection zone.

The Firth of Clyde (Fig. 16) also has a significant gap between zones, where wild fish would receive no protection from sea lice under SEPA's proposals.

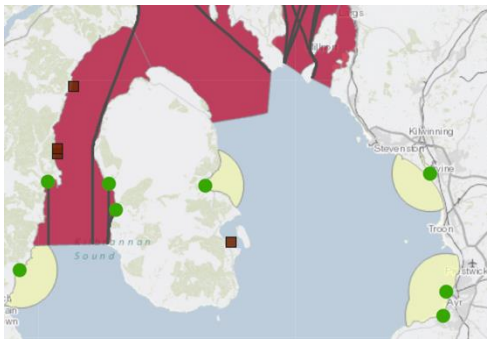
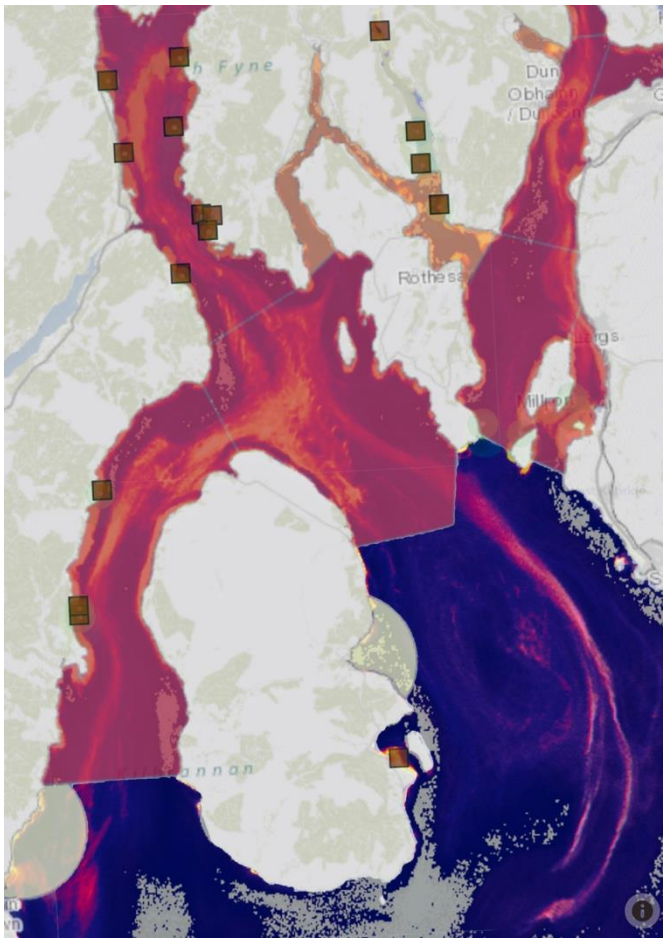


Figure 16 - *SEPA's proposed wild salmon protection zones in the Firth of Clyde*



Hydrodynamic modelling commissioned by local groups (Fig. 17) shows that sea lice will accumulate outside the proposed protection zones.
The distribution shown is a 14-day average of copedpodids originating from 18 farms, with all farm biomasses in the 2nd year of production except for St Molios/Lamlash Bay, which is managed out of phase.
Lice from the four farms proposed by Dawnfresh and the North Kilbrannan proposal are included.
Sea lice densities in large areas are likely to be above the proposed threshold of harm, including in areas outside SEPA's designated zones (red). Many salmon smolts swimming down the Clyde and from other rivers in the area will be unable to avoid the high-density area south of Bute/the Cumbraes and east of Arran and east of Campbeltown.

Figure 17 – *The Firth of Clyde and Arran, with SEPA's proposed wild salmon protection zones (red) superimposed on copepodid sea lice density modelling*

During its second year of production, the St Molios/Lamlash Bay farm would contribute significant numbers of sea lice to the area east of Arran (not included in this map).
Rather than the Firth of Clyde (Inner) – Cumbraes and Sound of Bute waterbodies ending close together, with straight line boundaries that do not join up, the wild salmon protection zones should be extended to the south, into the 'Seamill and Ardrossan', 'Firth of Clyde Middle – Offshore' and 'East Arran' waterbody areas (named in the Proposed Wild Salmon Protection interactive map).
The Kilbrannan Sound protected zone should be extended to the south as well, to include the area of modelled high lice density accumulation there.

Salmon smolts are known to follow haloclines while they adjust to salt water. It seems highly likely that smolts leaving the many short rivers of the northwest highlands and the Outer Hebrides will not immediately head offshore. They are more likely to swim close to the shore for some time, passing through multiple, small proposed protection zones. In the Outer Hebrides it would be precautionary to combine the following waterbodies from the Proposed Wild Salmon Protection interactive map, to form a near-coastal protection zone for migrating smolts:
Sound of Barra, Rubha Roiseal to Sgeir a Mhill, Flodaigh Beag to Rubha Roiseal, North Uist, Sound of Harris (part of), Eilean Glas to Rubha Reinis (part of), Gob Rubh Uisinis to Eilean Glas, Rubha na Creige More to Gob Rubh Uisinis, Rubha Raerinis to Rubha na Creige More, Gob na Greige to Rubha Raerinis (part of) and Meall Geal to Gob na Greige.

An equivalent passage zone to protect smolts migrating from rivers in the northwest highlands would include the following near-coastal waterbodies:
The Minch - South East, The Minch – East, Gruinard Bay, The Minch - North East, Scourie and Cape Wrath.

Cumulative exposure when passing through multiple wild salmon protection zones
The total risk for smolts is determined by their overall exposure to sea lice copepodids during their whole migration journey, not just the period they spend inside a single protection zone.
They may swim through several geographically constrained areas on their journey north, and pass a large number of fish farms. The total passage time for fish that travel through multiple zones (for instance the Sound of Jura, the Firth of Lorn, the Sound of Mull, and perhaps then also the Sound of Sleat and the Inner Sound) will be much longer than it would take smolts to swim through any one of these zones. SEPA's Figure B2 indicates that the passage time in some lochs and sounds is in excess of 8 days. Modelling conducted by MOWI for lice larvae emanating from their farms in the Small Isles has shown that copepodids are likely to be found in infectious concentrations over 100 km to the north, in the Minch. A smolt leaving a river at the end of Ardnamurchan will still be in the infection zone from farms in the Small Isles for several days after it has left the 5km zone around its river mouth. Modelling commissioned by CCN member groups also shows that lice accumulate far from farms.
The cumulative risk of harm from sea lice must be assessed overall but it is unclear how SEPA proposes to make this assessment.

Restoration of wild salmon to rivers where they no longer breed
SEPA's plans should be consistent with the Scottish Government's stated intention to conserve and restore biodiversity. Using only Marine Scotland's list of river gradings will not help to restore salmon and sea trout to rivers where they used to breed. Those rivers should also be included in wild salmon protection zones, to encourage the return of breeding fish.

Sea Trout
We are unconvinced by the statement in Section 9.2, that 'catches [of sea trout] appear to have stabilised or even increased'. SEPA highlights the fact that sea trout are more likely to be impacted by sea lice than salmon, because they spend much more time in coastal waters. Marine Scotland Science accepts that sea trout have suffered severe impacts from salmon farms.

We disagree strongly with SEPA's proposal to defer including sea trout in the new sea lice risk assessment process. This is not in line with the Scottish Government's response to the SIWG's recommendations. Sea trout are a Priority Marine Feature and the National Marine Plan commits the Scottish Government to protecting their national population.
We understand that it is more difficult to make a regulatory framework for sea trout, but their urgent need for protection is a significant gap in SEPA's plans. This needs to be addressed now.

Dealing with salmon first and deferring the protection of sea trout until some unspecified point in the future will inevitably result in continuing damage to sea trout populations. Formulating a system that protects sea trout will also protect migrating salmon. The reverse is not true.

We do not agree that the transitional arrangements for protecting sea trout from harm should rely on the *status quo* and be undertaken by local authorities. Local authorities do nothing to ensure their protection and they are incapable of monitoring sea trout populations.
It is not justifiable to say that sea trout can mitigate the impact of sea lice by returning to freshwater, as doing so repeatedly has a high physiological cost for the fish.
It is essential that SEPA takes a precautionary approach, and designates protection zones for sea trout in areas where wild salmon are not likely to be present.

Freshwater Pearl Mussels
SEPA's interactive map of proposed wild salmon protection areas also shows Special Areas of Conservation for freshwater pearl mussels. It excludes one of the main freshwater pearl mussel populations in Scotland which is not in an SAC. Freshwater pearl mussels should be protected wherever they occur. They cannot reproduce without salmonid fish. Some rivers in pearl mussel SACs lack wild salmon but do have sea trout - Ardnamurchan is an example. As SEPA's framework currently includes no protection for sea trout, it is unable to protect freshwater pearl mussels in these rivers. When sea trout-only rivers contain freshwater pearl mussels, SEPA should apply the same criteria it uses for protecting salmon.

6. Do you think that any of areas we are proposing as wild salmon protection zones should not be so identified?

No.

8. Do you have any scientific evidence that should be considered to ensure the sea lice exposure threshold is effective in protecting wild salmon populations? This includes any evidence for a refinement of the threshold.

The Norwegian state determines when wild salmon smolts face an unacceptable risk of harm due to sea lice infestation, using the 0.7 copepodid.day/m^2 cumulative exposure threshold that SEPA is proposing. This threshold is based on the best available science. In Norway, the consequences for salmon smolts of spending time at this copepodid sea lice density have been thoroughly validated against the sea lice infestation rates of smolts in sentinel cages. The Norwegians have also validated modelled sea lice densities against copepodid densities measured in the field. All the research has been published in peer-reviewed journals, and forms the basis of the Norwegian Government's Traffic Light System (TLS), for protecting wild salmon populations from being harmed by sea lice from fish farms.

No doubt the Scottish fish farm industry will criticise SEPA's use of the same thresholds, most likely on the basis of a recent evaluation of the scientific basis of the Norwegian TLS.[1]
It is important to appreciate that this evaluation report states that the TLS, '…is probably the most sophisticated salmon risk assessment in operation around the globe … In general, the overall risk assessment process in the TLS follows good scientific practice and tradition in these types of assessment.' 'Individually, and taken as a whole, the modelling systems represent a state-of-the-art network approach to simulate the impact of sea lice in the area of coastal salmon farms. The different methodologies of the modelling systems provide the ExpGrp [the Norwegian Government's

[1] An Evaluation of the Scientific Basis of the Traffic Light System for Norwegian Salmonid Aquaculture. Evaluation Committee. Research Council of Norway. 2021

Expert Group] with independent metrics that can be counted as an important, added value dimension to the decision-making process.'

The evaluation report also points out, correctly, that, '…the mortality threshold values are the single most important source of dependence between the assessment end points', and that expert judgement is required to assess the consequences of sea lice densities and infestation rates for wild fish mortality. This hardly a surprise.
Quite reasonably, the report recommends that the Norwegian authorities should be clear about when expert judgement has been exercised.

The evaluation report concludes, 'we consider it essential that the mortality thresholds must be the focus of sensitivity analyses for overall TLS performance. The TLS is very sensitive to assumptions made in this part of the process, and yet empirical data appear to be largely unavailable. This represents a significant weakness in the TLS and its assessment end points'; and, 'as recently as 2019 the ExpGrp [the Norwegian TLS Expert Group] pointed to shortcomings in the methods used to determine the threshold values and recommended they be reviewed and evaluated again.'

This is also not a surprise. The mortality thresholds are bound to affect the outcomes of the TLS, but it is quite a stretch for the Evaluation Committee to take the view 'that a solid empirical basis for the thresholds has not been provided to date and that such is required to underwrite key assessments arising from the TLS', because the Norwegian TLS Expert Group was clear that 'a solid empirical basis for the thresholds' has been provided. The Evaluation Committee's report says so itself:
'In 2019 a subgroup of the ExpGrp reviewed available data to determine whether there were grounds for changing the thresholds. **They concluded that there was no basis for changing the limits proposed by Taranger *et al***. (2011 and 2012) and recommended further research including trials in nature.'

Science can always refine and improve its conclusions, and more research would certainly be valuable, to fine tune the mortality consequences. It is difficult in the field to assess the mortality of wild fish due to sea lice, so much of the research has been done in the lab., but the Norwegian science base (including Taranger's thresholds) is still the best available basis for assessing the risk that sea lice will harm wild salmon. It would be wrong to conclude from the TLS evaluation report that the same threshold should not be used in Scotland, where there is no system in place to assess this risk at present, and without an alternative peer-reviewed and properly validated threshold for harm.

The evaluation report does not recommend rejecting Norway's use of the existing TLS thresholds. On the contrary, it says, 'it is difficult to envisage an empirical study that could provide any data allowing the effect of lice on wild smolts to be modelled more effectively'. The minimal degree to which it is concerned is clear from its moderate and sensible recommendations:

> **'R5** We recommend that the appropriateness of the mortality thresholds be reassessed regularly in light of new information, with careful consideration around sensitivity analysis, as part of regular system performance reviews.'
> **'R6** We recommend that studies should be undertaken and peer reviewed, to provide data on *in situ* effects of sea lice infestation on wild salmon at an individual and population level.'

Incidentally, we do not agree with the part of the TLS evaluation report concerning validation:
'…importantly, while the models themselves are state-of-the-art, model products are heavily reliant on calibration data, some of which demonstrate high levels of variability and uncertainty (e.g. sentinel cages). This reliance on calibration data potentially impairs the quality of model products.'

The TLS models' predictions have been shown to be accurate through field validation/calibration. Sophisticated statistical methods (developed for weather forecasting) are used to manage the patchy nature of sea lice aggregations and an ROC method is used to reduce the system's reliance on exact density predictions, by converting the predicted copepodid densities into the TLS's red, yellow and green risk assessments. An expert panel then assesses the outputs.

Norway's Traffic Light System seems to be a proportional, robust and science-based system that is fit for purpose. The threshold levels should be open to improvement, should new information become available. Further research is likely, in Norway and Scotland, on how environmental copepodid densities relate to infestation rates, and how infestation relates to individual fish mortality rates and population impacts.

SEPA's risk assessment system must be precautionary, in the face of the known risk that sea lice can harm wild salmon and sea trout. SEPA is right to base its approach on the Norwegian approach, and to use the 0.7 copepodid.day/m^2 threshold, rather than setting its own.

In 2021, a number of salmon farming companies (including Mowi and Scottish Sea Farms' owners Lerøy) asked a Norwegian district court to examine the scientific basis of the TLS modelling and its validation methodology. The fish farmers lost. An appeal court hearing has just finished but it seems unlikely to alter the 0.7 copepodid.day/m^2 threshold value.

9. Which groups and organisations do you think we should include on technical advisory groups to assist us with the development of the detailed working arrangements and methods needed to implement the framework?

The technical advisory group should of course include regulatory agencies and industry representatives but it must also include environmental organisations, such as CCN and Salmon & Trout Conservation Scotland, and representatives of the District Salmon Fisheries Boards and Trusts. The NGOs have acquired significant technical expertise and have legitimate interests in the detail of this work. The inclusion of experienced Norwegian scientists and modellers from Scotland and Norway would be beneficial too.

10. Do you have relevant expertise or experience that you would be happy to share with us during implementation planning to help us develop modelling protocols?

Yes

11. If yes, please tell us about your area of expertise:

Several members of CCN have worked with the hydrodynamic modelling company MTS-CFD, to develop sea lice models in a number of areas on the west coast. This work closely follows the Norwegian IMR modelling protocols. CCN is now working with the company on a wider area model, and liaising with the Marine Scotland Science SPILLS team. This kind of modelling will be crucial to achieving good results within SEPA's proposed framework.
CCN has a good understanding of the underlying biological science, the practicalities of developing, validating and using 3D hydrodynamic models and of using integrated sea lice biological models, including the most widely-used protocols and parameters for sea lice behaviour. It is well versed in the important issue of how the results of this modelling should be analysed and presented, to help decision-makers and communities understand them.

12. If you would like to be involved, are you happy for us to contact you by the email address you have provided?

Yes

13. Do you have any suggestions for how SEPA could most efficiently and effectively assess compliance?

The primary requirement is that information must be collected to a higher standard than it is at present and published in a genuinely timely fashion. This is crucial, given that the proposed framework is concerned with a relatively short timetable of smolt passages.
Counts of adult female lice per fish (not gravid females, as suggested) are already reported at weekly intervals. Adult female lice per fish should be counted in all the cages in every farm, as happens in Norway (see the Norwegian regulations on the control of salmon lice in aquaculture facilities: Appendix 1 - Requirements for routine counting of salmon lice[2]).
The number of fish present at the farm, their average weight and the sea temperature at 3m depth should also be reported weekly, to enable accurate modelling.
Independent monitoring is essential to ensure the accuracy of the reported data. Canadian research shows that sea lice counts roughly doubled when done independently.[3]
Farming companies should pay for this independent monitoring through a licence fee, as recently recommended by the Griggs review. In the long term, all monitoring of finfish farms should be done independently, financed by the farm operators.
Details of all steps taken to reduce lice numbers should be reported on the same timescale, including physical treatments, well boat, freshwater and Hydrogen Peroxide treatments, which are not currently published.

17. Are there other types of information that you think could usefully inform the adaptive development of the proposed framework?

Hydrodynamic modelling of sea lice concentrations is essential, as mentioned elsewhere. The wild salmon protection zones should include all modelled high-density areas.

In Norway, the state modellers produce weekly lice forecasts. Crucially, they also produce an annual hindcast. This is of higher quality, as late-reported farm data can be included. The hindcast is vital for informing the next year's Traffic Light ratings and farm management practices. This ought to be part of SEPA's plan and is one reason why its sea lice modelling capability must not be limited to simple screening modelling, such as its modelling of the cumulative impacts of bath chemicals.

Note that in Norway the ceiling for adult female lice during the smolt migration period is an average of 0.2 per farmed fish. (See Norway's Regulations on the control of salmon lice in aquaculture facilities – section 8: Limits for salmon lice and measures'[4]), and that 'measures shall be implemented to ensure that the amount of salmon lice does not exceed the limits in the first and second paragraphs, **including, if necessary, the culling of fish**.'
Scotland's Fish Health Inspectorate's current farm lice reporting and intervention levels are far higher than this. FHI has no remit to limit sea lice impacts on wild fish.

18. Do you think the design of the proposed framework, or how it is implemented, could affect your community or business interests?

[2] https://lovdata.no/dokument/SF/forskrift/2012-12-05-1140/%C2%A71#%C2%A71
[3] https://esajournals.onlinelibrary.wiley.com/doi/abs/10.1002/eap.2226
[4] https://lovdata.no/dokument/SF/forskrift/2012-12-05-1140/%C2%A71#%C2%A71

Yes, with both positive and negative effects.
CCN represents 21 coastal communities, all of which exist to protect and improve the environment in which they operate. Many of them have salmon rivers in the areas they care for. Wild salmon are an iconic Scottish animal and a keystone species, affecting and linking marine, fresh water and terrestrial ecosystems.

Knowing that you live in a country that is taking action to preserve its biodiversity for the future is worth a great deal to Scottish people, but action on the biodiversity crisis needs to match political rhetoric. This will depend on how the framework is implemented, monitored and enforced. Negative effects will follow lax implementation – please see answer to question 19 below.

Effective protection for wild salmon and trout will increase salmon populations, restoring many of the jobs in recreational angling that have been lost on the west coast and in the Hebrides.

19. Do you have suggestions how any potential negative effects could be reduced or avoided without compromising the environmental protection purpose of the proposed framework?

SEPA is right to bring forward plans for the regulation of interactions between wild fish and lice from fish farms. The success of these plans will depend on how they are implemented.
The proposed framework is a static model of an essentially dynamic situation - it seems to presume that there is a fixed level of sea lice pressure associated with each farm and that lice numbers can be effectively and quickly controlled in all cases. The weekly published data shows that sea lice levels on a farm can vary considerably and rapidly.
Paragraph C13, which stipulates demonstration of access to 'control measures', is worryingly weak. Sea lice are not always under control: Medicines cannot be applied without limit, thermolicers are not always available quickly enough, cleaner fish are not always readily to hand and they do not always work. Farmers also withold treatments for commercial reasons, for instance when poor gill health would result in large numbers of fish dying due to the sea lice treatments.

This is a risk-based framework and, as such, it leaves open the possibility of harm, not least because it is based on a number of assumptions about fish behaviour and biology. If these assumptions are slightly wrong then the framework could give the green light to further rapid expansion of farmed biomass, which eventually proves devastating to wild salmon.

It is not enough to 'protect wild salmon populations against harmful increases in infective-stage sea lice concentrations', if the reference point is the current unnaturally high sea lice concentration. SEPA's plans must be designed and implemented to prevent impacts in the first place.

To do so, the new framework must be robust, transparent, enforceable and enforced, as specified by the Salmon Interactions Working Group and it must deliver Scotland's NASCO commitment that '100% of farms to have effective sea lice management such that there is no increase in sea lice loads or lice-induced mortality of wild salmonids attributable to the farms'.

The framework must assess and control the effects of lice from all existing farms, as specified by the SWIG, and it must protect sea trout, as the SIWG also specified.

The framework must cover the whole period when wild salmon are vulnerable to sea lice.

Impacts can only be prevented by setting an exposure threshold for infectious-stage sea lice in the sea. To prevent this threshold being exceeded, there must be strict, farm-specific ceilings on sea lice numbers on farmed fish, with an obligation on operators to control lice numbers on the farms

before wild fish are affected. These farmed-fish lice thresholds must be absolute ceilings, as they are in Norway, rather than just thresholds for triggering sea lice treatments. These lice ceilings must not be exceeded and must be rigorously enforced. They may vary from area to area.

The regulators of fish farming favour adaptive management over the precautionary principle.
For adaptive management to work, there must be no significant knowledge gaps, so high quality and frequent environmental and on-farm monitoring is essential, supported by excellent modelling of sea lice dispersion and density, to determine which areas pose the highest risk, and the necessary on-farm ceilings. The modelling must be based on much better and more timely data, independently checked and transparently published.
The weekly lice-risk forecasts published by the Norwegian authorities are especially important in the run up to the wild smolt migration period, when urgent action must be taken to drive down lice numbers on farms. The same thing should happen here.

As well as doing continuous modelling and independent monitoring, SEPA will need to enforce rapid feedback to effective farm management as soon as problems are detected. This must include biomass reductions and meaningful penalties for breaches.

In 2018 the REC Committee reported that: '…***if the industry is to grow, the "status quo" in terms of regulation and enforcement is not acceptable***…***urgent and meaningful action*** *needs to be taken to address regulatory deficiencies as well as fish health and environmental issues* ***before the industry can expand****.'*
Around 75,000 tonnes of new biomass have been consented since then. These consents are being granted under the existing framework, which is incapable of protecting wild fish from harm. It is deeply worrying that SEPA intends not to implement these proposals for another year. We urge SEPA to develop and deliver the new framework more quickly.

There should be a pause in the consenting of new biomass in areas near salmon rivers and on migration routes, until the new framework is in place and the existing farms have been assessed. This pause should include all currently open applications which SEPA is determining, or on which it is currently being consulted as a statutory consultee. SEPA should state that in the light of current knowledge, the potential risks are too great to recommend approval of increased biomass.

All CAR licences, including any recently awarded, must be subject to amendment when the new framework is introduced.

20. Do you have any suggestions how potential positive effects delivered or enhanced without compromising the environmental protection purpose of the proposed framework?

The only potential positive effects of the framework are those which support environmental protection. The forthcoming ten-year Vision for Scottish Aquaculture should give the fish farming industry a route map, with deadlines for moving to closed-containment in all sensitive areas. Closed containment farms have far fewer sea lice. Zero sea lice impact on wild fish should be a non-negotiable outcome.

21. Do you have any additional feedback on the proposed framework?

We welcome SEPA's acknowledgment that harm can be done to wild salmonids by finfish aquaculture, and the intention of these proposals to reduce that harm. We have some significant reservations about the brief given to SEPA and we believe that the success of this framework will lie in the detail of how it is implemented.

We urge SEPA to provide more detail on how its proposals will work in these respects:

- When a new development is being assessed, how will the contribution of existing farms be incorporated in the total infective-stage sea lice concentration within the wild salmon protection zones?
- Will the new farm discharges permits apply to existing farms as well as new ones and if so, when?
- How will the regulatory framework work in practice, to ensure that infectious-stage sea lice (copepodid) levels remain below the at-sea exposure threshold?
- If the infective-stage sea lice exposure threshold is breached in an area, how will responsibility for reducing the density of infectious-stage sea lice in the sea be apportioned to multiple farms and farm operators?
- How quickly will feedback from sea lice monitoring and modelling affect management, to bring sea lice numbers down on farms?
- Sea lice have a patchy distribution in the sea and their density may be very high in some areas. Migrating fish will be unable to avoid high-density areas that span the width of geographically constrained waterbodies so they may quickly receive a fatal infestation of sea lice. Averaging the sea lice density over the large areas of many of SEPA's proposed zones will not fully capture the risk to smolts that swim through these areas. How will SEPA assess the varying risk of exposure during the smolts' migration journeys?
- According to early results from the West Coast Tracking Project, many smolts pass through several wild salmon protection zones. How will this cumulative risk be assessed?

SEPA's Brief

That SEPA has been instructed to create this framework is a clear indication that finfish aquaculture poses a significant risk of harm to wild fish, through the impact of sea lice. This risk is significant and has existed for several decades. Harm has already been done and continues to be done by the existing farms. Under these circumstances, it makes no sense to apply this framework only to new and expanded farms. Sea lice from all the farms in an area exert a cumulative impact on wild fish. It is essential to examine the dispersion and impact of lice from all existing farms, to understand where harm is already occurring. In paragraph 6.3 of the consultation, it is made clear that the Government wants consenting of new and expanded farms to be a priority, in contrast to 1.1, which clearly includes all existing risk. This ambiguity must be resolved as soon as possible.

Be precautionary while more information is gathered

Section 6.3 states that more information is required to enable an accurate assessment of whether existing finfish farm operations are causing a hazard to wild salmonid populations. In contrast, Marine Scotland Science's March 2021 update of its Summary of Information web page[5] shows that there is no doubt about this: 'The body of scientific information indicates that there is a risk that sea lice from aquaculture facilities negatively affect populations of salmon and sea trout on the west coast of Scotland.'

In a situation of seriously deficient knowledge, it is vital that SEPA takes a precautionary approach. The implementation of the new framework must be designed to ensure that any information gaps are addressed, but it must proceed on the basis that harm is already occurring.

The precautionary principle should be applied to all increased biomass when they might affect wild salmon, as the REC Committee recommended in 2018:

[5] https://www.gov.scot/publications/summary-of-information-relating-to-impacts-of-salmon-lice-from-fish-farms-on-wild-scottish-sea-trout-and-salmon/

RECOMMENDATION 40: *…although there is a lack of definitive scientific evidence of the various factors that are contributing to the decline of wild salmon stocks, the Committee is nevertheless of the view that a precautionary approach should be taken which will seek to minimise the potential risk to wild salmon stocks wherever possible*,
RECOMMENDATION 46: *…the Committee is of the view that a similar precautionary approach must be taken in Scotland to assist in mitigating any potential impact of sea lice infestation on wild salmon*
RECOMMENDATION 48 *…the Scottish Government should provide strong and clear leadership in ensuring that the precautionary principle is applied, producing appropriate policy and guidance documents as necessary.*

Adaptive management is the opposite of precaution and is inadequate in this situation. We believe that due attention should be given to the Continuity (Scotland) Act 2021 and what is likely to follow in the way of Environmental Principles, currently in development.

Migration routes and minimum passage times
The lack of knowledge of the behaviour of salmon smolts and post smolts is a crucial gap, particularly their migration routes. It is not sufficient for SEPA to ensure that risk thresholds are not exceeded, on the basis that fish will take the shortest route to the open sea. Smolts will not always choose the route which is in their own best interests. In Canada, the Fraser river smolts' migratory route decisions seem to depend on the genetics associated with their tributary of origin.

Minimum passage times on the shortest possible route are not the best way to assess the risk, as the average minimum times are far shorter than the longest, and the longest exposure represents the highest risk to individual fish and populations. In its response to this consultation, FMS has included preliminary results from the West Coast Tracking Project.
The fastest smolts took 1.26 days to swim from the mouth of the River Lochy to the Sound of Mull, while the slowest took 18.87 days. To base the need for protection on the minimum passage time, or even the average time of 5.14 ± 3.85 days, would underestimate the risk to slower, smaller fish.

As mentioned earlier, wild smolts are likely to travel through more than one protection zone.
A smolt from the river Add, in the south, may be affected by lice from 14 farms before it emerges past Seil. In the quite likely event that it then travels through the Sound of Mull, it will pass at least 8 more farms before it reaches the Small Isles, where it will pass two more farms. The cumulative effect on its survival will be immense. It could continue on a coastal route, passing many more farms east of Skye.
Rather than assessing the risk of taking shortest path, any path which might realistically be taken by a smolt ought to be assessed. These may take them through many protection zones.

When to protect wild salmon
Sea lice levels in the sea should be maintained below the exposure threshold at any point when sensitive life stages of Atlantic salmon are present. Only applying this framework during April and May is not sufficient to protect migrating fish. The industry's own 'Code of Good Practice' reduces the target level for farm sea lice between 1st February and 30th June and some existing Environmental Management Plans include a year-round sea lice threshold to protect wild fish.
SEPA's protected period should be lengthened, to allow for annual and local variations in salmon smolt behaviour. Additionally, smolts passing through more than one protection zone may still be near the shore well after the end of May.
Mature salmon returning to their home rivers also suffer from the effects of sea lice, so lice numbers should be well-controlled at all times, not just for two months in the Spring.

As an interim measure, sea trout could also be protected by extending the protection period from February to June, in line with the industry's Code of Good Practice for salmon. Sea trout are present in coastal waters for most of the year, so only a year-round protection threshold will help to halt their decline.

LPAs and EMPs
Robust interim guidance for Local Authorities is needed, to ensure that they fulfil their duty to protect biodiversity. This guidance must cover the cumulative risk to salmon and sea trout of sea lice from proposed and existing farms, and the risk to freshwater pearl mussels.

LPAs should be told that they must apply the precautionary principle when they lack sufficient information to make a safe decision in the face of a known risk. They are extremely reluctant to do so at present, saying that the Scottish Government has already applied the precautionary principle to protect Scotland's salmon population through its presumption against fish farm development on the north and east coasts, in order 'to protect migratory fish', i.e. wild salmon. This is nonsense, as the planning presumption clearly shows that the same risk applies to west coast salmon, which remain largely unprotected by the LPAs responsible for their safety in those areas.

The proposals say that during the transition, local authorities 'will remain the lead bodies for considering the risk posed to wild salmonids from marine finfish farm developments', but local authorities have no role in managing interactions between wild fish and most fish farms because very few farms have EMPs. When farms do have EMPs, the plans are not fit for purpose because they do not allow for rapid feedback to farm management, and local authorities cannot monitor wild fish impacts or enforce the planning conditions. EMPs do not allow councils to apportion responsibility for making farm management changes to multiple farms, when they contribute lice to the overall density in the sea. LPAs routinely ignore threats to sea trout.
Conditions for the management of sea lice in the new CAR licence should replace all EMPs.

Allowing for mitigation
SEPA should regulate infectious-stage sea lice densities on the basis that they must always be below the exposure threshold for risk to wild fish. Farm operators must deliver this outcome by adjusting their actions and farm biomass. This may include adopting innovations to reduce lice numbers, but these methods must not be accepted uncritically, as being effective mitigation. Fish farm companies must regularly demonstrate that the claimed benefits are really reducing lice densities below the threshold level. Any allowance that CAR licences make for innovations must be reviewed whenever the exposure threshold for risk to wild fish is exceeded.

Modelling
Mathematical models are crucial to the implementation of this plan. Models vary in their quality and underlying assumptions. Their parameters can easy be chosen or adjusted to achieve particular outcomes, without this being obvious. Results can be presented in ways that might mislead non-specialists, for instance by using log scales and averaging sea lice densities over long periods or large spatial areas.
For these reasons, sea lice modelling must be standardised. Relying on the industry to do its own modelling is to invite bias, so SEPA should set all the modelling protocols and do the modelling itself, as happens in Norway. This should be paid for by a levy on the developers.
SEPA's modelling should not just be limited to screening. As mentioned above, it should include annual hindcast modelling of lice from all farms, to inform the next year of production.

Monitoring, enforcement and penalties

Transparency and fairness are the only way to rebuild public trust in the regulatory system and in the industry's good faith. Fish farming companies must be treated in the same way as other businesses, with regard to sea lice and other environmental standard breaches.

SEPA has recently fined Diageo £1.2m for failing to report climate emissions at three of its sites, saying: 'These penalties should serve as a warning to not only the company involved, but all others in Scotland, that we will take the appropriate action to ensure compliance'.[6]

This is in contrast to SEPA's treatment of Scottish Sea Farms, which failed to report pesticide discharges into the sea at 25 of its farms, over three years.[7] It received two warning letters but no fine or enforced changes to its CAR licences.

The penalties for breaching lice thresholds (set out in CAR licence terms) must be greater than the economic benefits of doing so, and they must be rigorously and transparently enforced.

SEPA's fixed monetary penalties for breaching CAR licence terms are around £600. Withdrawing licences or compulsory biomass reductions are more effective penalties than fines, but we are not aware of SEPA forcing any compulsory reductions in biomass. Variable monetary penalties are now available to SEPA but they do not seem have not been used much.

Unannounced audit inspections will also help to build trust in the new framework. The results should be published immediately. Enforcement actions and penalties must also be published within weeks, rather than around two years later, as happens at present.

Lice numbers and fish numbers on farms must be published in real time. It takes far too long for data to be published on Scotland's Aquaculture website and Scotland's Environment Web

Implementation group

It is our hope and expectation that CCN will be part of the implementation group for the new framework, particularly as it has significant expertise in sea lice modelling.

[6] https://theferret.scot/diageo-fined-climate-breaches/

[7] https://theferret.scot/salmon-firm-misreporting-pesticide/