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Dear Anne,

Thank you for meeting representatives of The Friends of the Sound of Jura and CROPMACH on 5th April and for saying that you want to listen to our concerns. It was interesting to learn that SEPA finds that community groups are usually less forthcoming than other stakeholders, hence less often heard from.

We represent west coast communities concerned about the potential loss of sustainable jobs, biodiversity and our quality of life, all of which depend on an unpolluted sea. We are concerned that the expansion of fish farming, the locations chosen for new farms and the increases in size/biomass of the farms could cause this kind of harm to our communities.

As much of our meeting was taken up with the interesting presentation about advances in modeling and with discussing industry regulation, we did not manage to ask you many of our more specific questions. We have included them below.

It may be helpful if we summarise our understanding of the current situation, as per the meeting and your letter to FoSoJ, of 29th January 2018.

Please correct this summary if any part of our understanding is wrong:

In order to better assess the impact of solid waste and associated chemicals from salmon farms there has been a change in how SEPA models and assesses the dispersion and deposition of this material. A new local depositional model (NewDepomod, which has a 2x2km maximum modelled area) will completely replaced the earlier AutoDepomod as soon as your final draft guidance on modeling for aquaculture is finished.

A new hydrodynamic model can also be used to predict the larger scale adverse impacts of solid organic waste deposition. SEPA has already used this to model the cumulative impact of multiple farms in certain areas (eg around Fetlar and Shuna) and field work is planned to validate its deposition predictions by monitoring the seabed in those areas. This model is not yet being used for assessing individual aquaculture licence applications.

The changes in modelling have been explained to the industry but not much more widely. Fish farming companies are already submitting CAR licence applications to SEPA that include predictions made using NewDepomod (eg Muck and Shuna/Poll na Gille). The Muck application is for a 3500 tonne farm, breaking the 2500t previous

biomass cap. We note that the CAR applications for Muck and Poll na Gille include both NewDepomod and AutoDepomod modeling reports. An application to expand a fish farm at Shuna to 3500 tonnes has been submitted to Argyll and Bute council and similar plans are in discussion for N Carradale. Despite these changes the public have not been allowed to see SEPA's new final draft guidelines for modelling the environmental impacts of farms of this or any other size.

Your letter confirms that SEPA has ignored and continues to ignore the dispersion and impact of solid waste outside AutoDepomod's modelled area of 1x1km. Mr A'Hearn's recent reply to Mr Dey (convenor of the ECCLR Committee - letter on the ECCLR committee salmon inquiry webpage) shows that SEPA is confident that this exported waste does not adversely affect the seabed elsewhere, because:

'The basis of our current approach is to:

...b) prevent impacts occurring beyond the allowed zone of impact in vicinity of the cages.'

However, a significant revelation of SEPA's latest large-scale hydrodynamic modeling is that areas of seabed very far from fish farms are being adversely impacted by the cumulative waste from multiple farms. Clearly the present regime of monitoring and data analysis has been inadequate to pick this up.

The present consenting regime takes no account of these impacts.

The paucity of SEPA's monitoring data is striking in other respects too:

It is clear from the *SAMS NewDepomod Final Report* that SEPA's routinely collected environmental data (mostly self-monitored by fish farms) has proved inadequate for testing NewDepomod. Only 6 sites had the extra data this required.

The SARF098 PAMP2 study also showed that the routinely collected 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 some sites in Shetland made this possible.

An internal SEPA emamectin benzoate *Options Paper* (D. Sinclair), released under FOI, also makes it clear that SEPA has not routinely analysed the monitoring data it does hold on EMB use and animal abundance and diversity on the seabed, to spot large scale patterns of change. It said:

*'SEPA is justifiably proud of the approaches which have been developed to model the likely effects of sea louse medicines to enable them to be released while ensuring environmental protection and generally. To date effects such as those described in SARF098 have not been evident, indeed, as discussed above, the original PAMP report demonstrated no detectable effects from the use of these medicines. **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.***

Many existing fish farms were consented using Autodepomod. Even with its conservative limits, the widely-acknowledged flaws in this model and the observed real-world evidence of adverse impacts on the seabed must make the safety of the licensed biomass questionable for many farms, especially at exposed sites, sites where the seabed is not flat, sites with high flow and sites with multiple farms. We appreciate that you say this model was never intended to make accurate predictions, only safe predictions, but we believe there is ample evidence that the model, and

the regulatory framework within which it is used, often has not and still does not even manage that.

We were glad to hear that compliance with CAR licence terms is improving. Even so, the public record shows that seabed impacts of waste and EMB very often breach these licensed levels. 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 EMB EQS levels among Scotland's c. 225 active salmon farms, and that when biomass was reduced at 42 of them, 20% have been 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 also still be doing harm.

Some operators seem to overstock cages on purpose (eg at Poll na Gille) and we have seen allegations that at least one company keeps two sets of books in order to hide its real stocking levels and chemical use from SEPA and FHI.

Indeed the EMB *Options Paper* suggests that SEPA also suspect this may be happening: '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.**'

Yet self-monitoring is still relied on and apparently will be in future, since Mr A'Hearn's letter to Graeme Dey shows that SEPA is considering backing down on doing all its own monitoring, under the DZR scheme. The reason given for this seems to be that moving monitoring equipment between farms would pose an infection risk, yet that is exactly what the industry's wellboats, thermolicer etc do at present.

There has been a leap in chemical usage, because disease is increasing and sea lice are evolving resistance (SAMS report and EMB *Options Paper*). At least one SEPA aquaculture specialist (EMB *Options Paper*) seems to believe that all aquaculture chemicals need to be reviewed. We are glad that SEPA is reviewing azamethiphos and hydrogen peroxide.

In addition to these impacts, the ECCLR committee's report makes it clear that sea lice from fish farms cannot be allowed to continue to impact wild salmonids. SEPA has a legal biodiversity duty here and a duty to apply the precautionary principle.

For these reasons we agree with ECCLRC that the existing regulatory regime is not working properly, so we were pleased to read in your letter and to hear at the meeting that SEPA plans to address some of these things in its new Sector Plan. In particular it is welcome news that SEPA will review every CAR licence.

However the industry's ambitious plan for expansion is well underway. New fish farm and expansions are being granted rapidly, with more proposed every week. We do not feel that the existing regulatory framework is fit for the purpose of assessing or limiting the environmental impact of this expansion.

The SAMS report highlights how little is known about the impact of fish farm waste and chemicals on Scottish marine species and habitats. The ECCLR committee report highlights 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 Mark Harvey of H&IC 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'*.

At our meeting you explained that any knowledge gap regarding the location of sensitive animals and habitats is SNH's and Marine Scotland's problem and that if they cannot supply accurate spatial information then the applicants must. This does not address the issue of the sensitivity of Scottish species, including mobile ones, to fish farm waste and chemicals.

The likely timescale for SEPA to do anything about these impacts is too long. If SEPA manages to review 80% of fish farm licences in the first year (perhaps 2019), then instigates enhanced monitoring where there are concerns, over the two year salmon production cycle, then analyses all the results; at least four years will have passed before there can be any changes to biomass or chemical use as a result of this review. By this time much of the sector's expansion will have been consented, including 3500 tonne and perhaps even larger farms. Meanwhile existing fish farms will be able to operate as before, and to expand under their existing licences, consented using AutoDepomod's inaccurate analysis of dispersion of waste and chemicals, while still allowing unlimited waste exports from their modelled domains.

It is clear from the recent SAMS report that the industry is polluting the sea as well as harming wild fish with sea lice, disease and gene introgression, and that it does not have the means to mitigate these problems at its existing size, let alone as it expands. For these reasons we believe it is irresponsible for SEPA to allow such rapid expansion of this industry when so little is known about the location of rare animals and habitats or about the thresholds for biological harm.

You explained that SEPA does not like the idea of a moratorium, presumably taking this to mean a halt to all fish farm production. You said a moratorium would preclude limiting the biomass of the most damaging existing farms.

However, given that the Parliamentary Inquiry has yet to report and that there is a clear need to be precautionary, a moratorium on expansion seems both necessary and responsible. Such a moratorium need not prevent SEPA from taking action on farms that are polluting already, as demonstrated by Mr A'Hearn's letter to Mr Dey, which shows that biomass reductions can be applied now, as they have been to 42 licences in the most recent three-year period.

At the meeting we had hoped to be able to ask you specific questions about the following subjects:

- Why aquaculture seems to be subject to different conditions to other industries, regarding pollution.
- Modelling and consenting.
- Why there are such high levels of adverse impacts and so many breaches of

compliance to licence terms.

- Why it has been hard for SEPA to detect emerging problems in the past.
- Why applications are already being considered by SEPA for 3500t farms. We dispute the assumption that more exposed sites will always be offshore.
- More about how SEPA fulfills its biodiversity duty and applies the precautionary principle to wild salmonids, commercial shellfish, MPAs, fixed and mobile PMFs, and elsewhere.
- What SEPA will do now.

There are a large number of questions below. Our iessincerely believe that a great deal rests on this. We are not trying to waste your time, but are asking in good faith, with a genuine concern about the answers.

We trust that you and your team will take our concerns seriously when answering these questions, as you have done to date.

Thank you, on behalf of the Friends of the Sound of Jura and CROMACH

Section 1 Why aquaculture seems to be subject to different conditions to other industries, regarding pollution.

Public trust in SEPA as a regulator of pollution depends on the transparency with which it carries out its duties and on the parity of treatment between industries. 'Polluter pays' is Scottish Government policy, recently reiterated by the Environment Secretary. At the moment the polluters in aquaculture are not paying to clean up the pollution they release into the sea, which is a shared resource.

We do not think this is right and were pleased to hear that the aquaculture Sector Plan and other modernisations (eg in modelling) may address this. However, you did say that aquaculture is treated identically to other industries, in that all industries need CAR licences to pollute, yet there do seem to be some significant differences:

At present aquaculture is treated differently to other industries regarding the discharge of organic waste; for instance Mr A'Hearn's letter makes this comparison to the discharge of human sewage ('urban waste water').

'The difference between the regulation of fish farms and urban waste water discharge relates to the permitted zone of impact. There is no direct equivalent for urban waste water discharges beyond an initial mixing zone of the waste effluent. This is because sewage solids are settled out as sludge prior to discharge.' (A'H letter to GD):

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 it seems that only aquaculture is permitted to adversely impact the seabed with its waste.

Q 1.1 Are aquaculture sites treated in exactly the same way as the end-of-pipe pollution sources of other industries, regarding the particulate and other organic waste it releases into the sea?

Q1.2 Is any other industry in Scotland permitted to impact seabed biodiversity at more than 200 locations, with its organic and chemical pollution, in Allowable Zones of Effect, such that the Infaunal Trophic Index (ITI) reaches 'degraded' or 'very degraded' quality?

Q1.3 Are the impacts of aquaculture's discharges modelled in the same way as other industries' end-of-pipe impacts, using hydrodynamic models to assess the cumulative impacts from multiple sources, and of other types of pollution, on a scale of many square kilometres, rather than just within a 1 or 2 km of the source?

The SAMS report cites *Heath et al* (2002), saying that aquaculture is already responsible for c. 80% of the nutrients entering the sea in some places on the west coast. Expansion plans would double this by 2030.

Q1.4 To date, how has SEPA assessed the effect of these nutrients on the wider marine ecosystem, at the scale of water bodies?

Aquaculture also seems to be treated differently regarding the discharge of biocidal chemicals.

'Fish farming is unique in that it is a sector which is allowed to discharge substantial quantities of biocides ...' (D. Sinclair - SEPA Internal Options paper on EMB/PAMP2 (FOI))

Q1.5 Are any other industries allowed to discharge 'substantial quantities of biocides' into the sea?

In the same EMB Options Paper, Mr Sinclair also wrote:

'...the sea louse populations appear to have developed resistance to all of the actives available to fish farm operators. Control of sea louse infestations is difficult to achieve and in some cases seems to involve almost continual use of Slice and other products through the growth cycle, particularly in the summer months when water temperatures and louse reproduction rates are high.'

'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 bath medicines in use in Scotland have been authorised using environmental standards that are essentially MACs. The pattern of use of these products is however generally not intermittent but often highly repetitive, this would seem at odds with the way in which the products have been licensed.'

'... MACs are used where releases of pollutants are occasional or intermittent - perhaps once or twice per year. The original vision for Slice was that it would be used once or twice per year but currently the reality is that it is used in many sites 5 to 7 times per year.

This fact added to the reality that residues have a half life in excess of 200 days would suggest that rather than a MAC, an Annual Average (AA) approach to an environmental standard would be more apt.'

'The arena in which these products are deployed has however changed, resistance in sea lice to the available actives is not freely admitted by the sector but is evident from patterns of medicine use.' ...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.'

'If SARF098 had not been published the nature of use of these products would have led to a requirement for SEPA to review the means of authorisation of sea louse medicines. That it has been published merely makes such a review, both for Slice and the other active ingredients all the more necessary and urgent.'

SEPA has already said that it plans to reassess how Azamethiphos and hydrogen peroxide are used, which is welcome news.

Q1.6 Given the recommendations above, will SEPA also review the means of authorisation and the use of the other sea louse medicines, including moving to an Annual Average environmental standard?

Section 2 Modelling and consenting

We welcome the improvements in NewDepomod but we believe that the current depositional model, AutoDepomod, is not fit for purpose and its use should be discontinued immediately. We are also concerned that many of the CAR licences issued using AutoDepomod include unsafe seabed impact assessments and fish biomass calculations.

SEPA acknowledges that AutoDepomod is not capable of accurately modelling pollution dispersion in many real-world situations, except in a narrow range of locations where there is low flow and a flat seabed. The agency has known about these limitations since Depomod was first used for consenting, as shown for instance by the notes in a 2006 SEPA/SNH/Marine Scotland study on the impact of fish farming on maerl (*Commissioned Report No. 213 - Investigation into the impact of marine fish farm deposition on maerl beds*).

We have listed many references to AutoDepomod's limitations at the end of this document (Annex A), including: the small size of its modeled domain, the exclusion of particles once they have left the domain, that particles cannot be re-suspended after 4 days on the seabed, its failure to model complex seabeds, to account for movements down slopes, or cumulative impacts, or multiple chemical treatments and that it uses only 15 days of field data to model a whole year's flow.

The essence of it, as Andrew Berkeley told us, is that 'if the sensitive receptor is 500-1000m away, you cannot use AutoDepomod to assess the impact on it'.

In your letter to FoSoJ you say that, instead of using AutoDepomod to predict impacts with spatial accuracy, it has been deliberately used as a risk-assessment tool with conservative assumptions, ie, it produces a worst-case scenario by being biased to show more deposition under the cages than is expected to happen in reality. You say it was, '*intended to produce safe outcomes, not necessarily accurate ones.*'

Never-the-less, on p 38 the *NewDepomod Final Report* says:

*'Previous use of AutoDEPOMOD in Scotland has generally followed a highly prescriptive approach, developed by SEPA, in which a default model configuration together with 14 days of flow data are used to define modelling scenarios **which are taken as a more or less definitive expectation of how the site will function.***'

This and a number of other such references we can supply if you wish, support our conclusions that the outputs of this model have not just been used for risk-screening, but that its dispersion maps have also been used when making consenting decisions, as if they were accurate spatial predictions.

We understood from the meeting that AutoDepomod is no longer being used to assess CAR licence applications, yet the current set of aquaculture CAR applications on the SEPA website include deposition modelling using AutoDepomod.

Q 2.1 Why is AutoDepomod still being used to assess CAR applications when its acknowledged flaws should disqualify it from being able to assess any but a small subset of Scottish fish farming sites?

Q 2.2 Why do some CAR applications, such as Poll na Gille and Muck, includes an AutoDepomod assessment and a NewDepomod assessment?

We understand why AutoDepomod's deposition assumptions have been set to be conservative regarding deposition below the cages, but this has an unfortunate consequence: By conservatively over-estimating deposition below the cages, the model must be under-estimating how much waste will leave the modelled domain to pollute the wider environment.

This has not troubled SEPA before because the model and regulatory framework in which AutoDepomod's results are assessed have always ignored the organic material that leaves its 1x1km domain. Now the new hydrodynamic modelling results show that this exported material does not vanish, but that much of it is deposited further away. This can no longer be ignored.

Q 2.3 When AutoDepomod flags a higher than average risk (for instance at Dounie it predicted that 99% of organic waste would leave the grid) what process would these predictions trigger, in order for SEPA to decide on a safe biomass to license?

Q 2.4 If AutoDepomod is effective at flagging risks and setting the biomass conservatively, in order to avoid adverse seabed impacts, how do you account for the 105 breaches of seabed impact limits in the most recent 3 year period, at farms whose biomass was set using AutoDepomod, and for the 42 farms that had to be asked to reduce their biomass as a result?

Q 2.5 Why did the rest of the farms involved in these breaches not have to reduce their biomass as a result?

AutoDepomod also fails to account properly for the impact of EMB outside its modelled domain, because EMB dispersion is modelled by using organic waste as a proxy, so the conservative dispersion model must also under-estimate EMB dispersion and deposition away from the cages. This under-estimation, compared to real-world measurements, is apparent from the *NewDepomod Final Report* and many other sources.

The CAR regulation framework, including AutoDepomod, has never allowed for the possibility that the exported emamectin would be anything other than uniformly diluted across very large areas (with a precautionary average concentration allowed for the total quantity of EMB exported, as if it were spread uniformly over 10 km²). The new hydrodynamic models show that this is nowhere near the truth. Particulate pollution (including bound-in emamectin) is not necessarily diluted by the sea - the models show that these pollutants are sometimes concentrated at locations far from their source.

Q 2.6 Andrew Berkeley says that c. 1.15% of seabed is predicted by the hydrodynamic model to be adversely impacted in the Shuna area. What was the percentage of seabed adversely impacted in the Fetlar area?

Q 2.7 Do these totals include the existing AZEs, and what proportion do the AZEs contribute to that total?

In your letter to FoSoJ you said that, even though accumulation of material like this was found to happen away from the farms around Shuna, during a SEPA study there, the study did not find any places where EMB was above the far field EQS.

However, the SEPA Shuna study *Briefing Note* also said:

*'Mass balance calculations also show that, given the relatively high frequency and magnitude of treatments 18 months to 2 years prior to the survey, **peak concentrations exceeding the sampled results by a factor of approximately 2.5 may have occurred around the start of 2014.** This, combined with the fact that no farm treated with their maximum consented quantities suggests that **concentrations significantly higher (greater than 5 times) than those found may have been possible.**'*

And that:

'At some locations, sediment from all six farms outside Loch Melfort is predicted to deposit.

This inter-connectivity illustrates the importance of considering the cumulative impact of SLICE treatments, and also highlights the potential for transport and mixing connections between farms.'

*'It is clear that **there is a knowledge gap** in the understanding of the dispersion of contaminated sediment from Aquaculture sites, **particularly in reasonably dynamic sea areas like Shuna Sound.**'*

We know from the PAMP2 study that EMB is likely to be much more toxic than previously assumed - it is for this reason that SEPA has applied a reduced EQS inside qualifying MPAs, as a precaution - so the old EQS is a poor measure of possible harm. Shuna is inside an MPA for the critically endangered (IUCN) flapper skate, whose egg case and crustacean prey may well be harmed by emamectin benzoate and other fish farm chemicals, according to Dr James Thorburn of St Andrew's University who is studying the skate.

Q 2.8 How much of the Shuna area modelled by the SEPA study would have had EMB levels above the reduced precautionary EQS for Marine Protected Areas?

Q 2.9 How can you be sure that AutoDepomod's conservative settings and the associated regulatory framework around the model, have not resulted in SEPA failing to account for widespread harm being done to seabed biodiversity, by the EMB and organic waste that leaves the immediate area of fish farms?

Q 2.10 How is SEPA assessing the harm done by the waste and emamectin that accumulates in hotspots away from the cages?

Q 2.11 How does is this assessment used to limit biomass at any farms causing this effect?

Q 2.12 How can it be right to continue to believe that the waste from the biomass of fish in multiple farms, individually assessed as safe by AutoDepomod modelling, is not having a cumulative effect on the seabed away from the farms?

Some sites are less dispersive than modeled. The *NewDepomod Final Report*, p 42:
'Several sites which have failed their cage edge intensity standards in the past are awarded more biomass in the new model under conditions of full flow. This can be interpreted to mean that the actual conditions on site are less dispersive than those implied by the sampled dataset and under which the site was originally modelled and licensed.'

Q 2.13 Have these 'several sites' since had their biomass reduced when empirical field sampling showed deterioration of the seabed?

Q 2.14 How many fish farms have received CAR licences on the basis of AutoDepomod predictions since it was introduced?

Q 2.15 How many existing fish farms, licensed using AutoDepomod, are sited close to steep seabed slopes?

Q 2.16 How many are in lochs with sills preventing effective flushing of waste?

Q 2.17 In how many locations does the distribution of waste from multiple farms overlap, leading to a reasonable assumption that it will impact the seabed?

Q 2.18 How many existing fish farms, licensed by using AutoDepomod, are inside MPAs or within the distance of them that waste might be expected to travel, or sited close to Priority Marine Features that are not inside MPAs, including mobile PMFs?

Q 2.19 How many fish farms are in higher energy sites than AutoDepomod is capable of modelling, where a significant proportion of their particulate waste and emamectin are exported from the modeled domain and subsequently ignored?

Q 2.20 How many existing sites' licences have ever been reviewed for the reasons above?

We believe that many aquaculture consenting decisions made using AutoDepomod are unsafe. If SEPA's seabed impact monitoring was more comprehensive, systematic in collecting consistent types of samples and able to processes and analyse many more samples, on a much wider scale, it might be possible to operate adaptive management within a realistic timescale to mitigate ever case of harm to the marine environment, but this does not seem to be the case at present.

For these reasons we urge you to review all CAR licences now, not on the likely 4-year timescale of the new Sector Plan.

We also urge you to accept that these uncertainties mean that existing farms should not be allowed to expand on the basis of their existing licences, or AutoDepomod assessments.

NewDepomod

'The revised version of the depositional model coupled with hydrodynamic modelling and more extensive monitoring provide us with the necessary confidence to remove the cap.' (on biomass)

(A'H letter to GD)

Presumable SEPA is hoping that communities like ours will place their trust in your ability to regulate the environmental impact of fish farms, and that we too will have confidence in the modelling you use and the monitoring you do. If so then transparency is everything, yet the *NewDepomod Final Report* states that one of the developers' goals was to produce a model: *'That supports industry expansion'*. You can imagine the effect that reading this has had in our communities.

In order to trust any new modelling and monitoring regime we would need to know:

- How accurate the new models are, spatially and in magnitude of deposition.
- Whether we can trust those who influence and interpret their results, when the depositional models have not been peer-reviewed.
- Why the modelling does not incorporate storms, gravity flows of sediment or the action of seabed animals.
- What the biological impacts are of the predicted deposition.
- What the impacts of this material would be if it settles on the seabed for too short a time to register in averaged plots, then moves to settle elsewhere. This means understanding the effect of short but concentrated impacts on animals, some of which can move, while others are sessile.
- How uncertain the results will be, if the two new types of model are not validated per site. It seems that NewDepomod is especially likely to be unrepresentative if it is unvalidated, while the hydrodynamic models may be more easily checked against short runs of existing tidal measurements.

NewDepomod is a very complex, flexible model that can be configured in a wide range of ways. As with all computer models these settings will have a profound effect on its outputs.

NewDepomod's parameters need subjective 'tuning' by hand because, according to the *NewDepomod Final Report*, p 31:

*'Hindcasting scenarios were run for the 6 test sites using a range of parameter configurations.'...but...'**No single model configuration was seen to demonstrably provide close agreement with empirical residue concentrations across all of the sites.**'*

'... the scenarios using different flow datasets show quite different impact zones....'

We are not suggesting that any dishonest 'tuning' has happened but the temptation for unscrupulous operators to do so will be strong, with large profits at stake.

In order to convince the public that it can make accurate impact predictions, you need to persuade us that NewDepomod has not been and will never be 'tuned' to produce outcomes tailored to supporting industry expansion.

Q 2.21 Who will make these tuning adjustments to the model and how will their impartiality be assessed? Will this process be open to public scrutiny?

In your letter to FoSoJ you say that a future requirement will be that tide-only modelling is used with NewDepomod, in order to predict dispersion conservatively, but this is not the case in Marine Harvest's current CAR application for Muck, for instance, which includes a NewDepomod report, to justify exceeding the previous 2500 tonne biomass limit.

(https://www.sepa.org.uk/media/349033/1109999_newdepomod_modelling_report.pdf)

Q 2.22 Why does the NewDepomod report in the Muck application show full-flow modelling results, as well as tide-only, and recommend licensing a quantity of EMB that only achieves a pass with full-flow modelling?

NewDepomod's tide-flow modelling at Muck did not pass a sufficient quantity of EMB to even treat every fish once, and the full-flow model only just manages one treatment. At many farms, sea lice are treated with EMB several times during a production cycle, sometimes as many as 5-7 times (*EMB Options Paper*). This would clearly be impossible at Muck and it will produce sea lice as a result.

Muck is only 10 km from the Ardnamurchan Burns SAC and 20 km from the Mingary Burn SAC, both for pearl mussels and both of which are in unfavourable condition because of insufficient populations of wild salmonids; fish which are directly affected by high sea lice numbers in fish farms.

With full-modelled flow at Muck, 85% of the particulate waste would be exported to unknown fate. 62% would be exported under tide-only modelling.

It is because of the need for trust and transparency that the ECCLR committee asked SEPA about peer review. In his reply, Mr A'Hearn said that SEPA, '*only subjects proposed changes to the scientific basis for things like environmental standards to peer review.*' In our view, a new model that will be used for making all the particulate waste/EMB predictions for consenting CAR licences, is a change to the scientific basis of what SEPA does and should be peer-reviewed accordingly, as AutoDepomod was.

Transparency matters: NewDepomod was produced by SAMS, an organisation heavily dependent on aquaculture contracts. SAMS recently removed the *NewDepomod Final Report* from public scrutiny by taking it off its website. FoSoJ has had to resort to FOI to obtain a copy.

Q 2.23 Why can NewDepomod not be peer-reviewed, in order that the public can have faith in its outcomes and the uses they are put to?

Q 2.24 Is NewDepomod a hydrodynamic model of the same accuracy and quality that SEPA requires of other end-of-pipe industries?

Q 2.25 When will AutoDepomod be retired and NewDepomod modelling be required for consenting of all new sites and existing site expansion?

One requirement of NewDepomod modelling is a much longer, site-specific data set.

From the *NewDepomod Final Report*:

'The model output is highly sensitive to the flow dataset used, with 14 day samples proving inadequate for representing the longer-term conditions under which impacts were formed.'

And on p 38.

'...comprehensive calibration dataset(s), including long-term (>6 months) current meter data together with concurrent seabed impact data would be a significant improvement on this exercise and invaluable for validating the model.'

Q 2.26 Why then, will only 90 days validation data will be required per site, when the Final Report says that >6 months would make a significant improvement?

Public bodies, including Local Authority planning departments and committees that use, but do not fully understand the limitations of these models are likely to act on their predictions as though they are facts, in particular the maps. Models are only as good as the data and assumptions entered. These must be available for public scrutiny.

SEPA (in response to FOI) said that no information on NewDepomod's limitations had been received from SAMS. By contrast the SAMS *NewDepomod Final Report* shows that the model has the following limitations:

- It requires subjective manual tuning to fit data, for instance, only after this tuning was done:

'By virtue of the use of Z_0 as a tuning parameter, the model is able to produce footprints at both low and high flow sites.'

In the hindcasting trials, 'tuning' the model with a conveniently responsive parameter (bed roughness or Z_0), allowed it to fit the field data, but only by changing this value a great deal. The required alteration was very large, eg at Noster Z_0 ,S had to be tuned from 0.02 and 0.00003 to fit the 2005 and 2015 flow data.

p 44. *'...we have chosen to fix most of the levers and adjust model predictions against empirical data using the seabed roughness parameter Z_0 .'*

And:

'The new model is sensitive to idiosyncrasies in sampled flow data. Anomalies associated with the magnitude of sampled flow data can be mitigated to some extent using a combination of astronomical scaling and Z_0 tuning.'

Q 2.27 Does Z_0 'bed roughness' still represent a real physical parameter that varies on the seabed by such a large amount as the adjustments in the model suggest, or has it just become a handy 'lever' to help to produce results that 'support industry expansion'?

If it is the latter, then the model is opaque, subjective and does not accurately represent the processes happening in the sea, unless perhaps it were to be validated by >6 months of real-world calibration at each site.

The *Final Report* describes other tuning experiments (*Shear modified settling velocity, Vertical dispersion coefficient, Erosion function and Bed Model*) where the model's parameters, which are included because they are intended to model empirically measured real-world physics, have either been turned off, or 'tentatively' assigned values in order to better fit observed data.

Time is a costly constraint, so, instead of exhaustive testing, 'some judgment has been exercised'. Such judgments are inevitably subjective.

- Domain size sets limits on the accuracy of predictions of impacts.

NewDepomod's domain size could have been larger than 2x2km, which would have allowed more accurate modeling of the impact of the significant proportion of waste that otherwise 'vanishes' from the larger domain, but larger domains require more computation and more site-specific sampling, so they cost more. It is not possible to assess cumulative impacts on larger scales without using larger domains.

Q 2.28 How many km² does the waste from all the farms currently around Shuna cover, compared to the 2x2km grid that NewDepomod would model for each one?

- Using limited flow data makes NewDepomod much less accurate.

'Discrepancies between observed impacts and those produced by the model must, however, be considered in the context of the highly limited flow data' (ie 14 days) 'which does not closely represent the conditions under which the observed impacts arose both in terms of long term flow magnitudes and the predominance of flow directions.'

p 44. 'The (NewDepomod) model remains **highly sensitive to the hydrodynamic data inputs**. In Scotland, at present, these are generally restricted to **15 days** at multiple depths and **this constitutes a major source of error in model predictions.**'

- Data is gathered at just one point, limiting accuracy away from that point.

Q 2.29 Can NewDepomod accurately model turbulent flow, using so little validation data, and that gathered at one point, just where the fish farm is?

- What about cumulative impacts?

The 2x2km domain is not large enough to assess these and the model is incapable of it anyway, since exported material is not allowed to reenter the model's domain.

Q 2.30 How does SEPA model cumulative impacts?

Q 2.31 If SEPA uses hydrodynamic modelling to model cumulative impacts, are these predictions be used to limit biomass at all the contributing farms?

- Extreme events are not included in either type of model.

In order to cover EMB's active life on the seabed, SEPA needs to model a 4.5 year time series, yet the flow data collected plays down the influence of infrequent high-magnitude events, some of which would occur during that time. Climate change is making powerful storms more frequent.

Q 2.32 Why are large re-suspension events, such as storms, not factored into NewDepomod?

- Gravity flows of sediment on the seabed, are not modelled. This under-represents how much material will move away from the source.

Q 2.33 Why are movements of material on the seabed not included in NewDepomod?

- Temporary and permanent hotspots.

It is not just the chronic, average concentration of waste and harmful chemicals across large areas, that harm rare or sensitive animals and habitats. Acute 'hotspots' of deposition also matter, even if they occur fleetingly.

Q 2.34 How much flow data does NewDepomod need to accurately predict where such hotspots will occur, even fleetingly, throughout a 2x2km domain?

The waste moves around on the seabed. Averaging snapshots of different distribution across a long period may not capture the impact of that waste on sensitive animals during shorter exposure. A month of being buried or exposed to EMB may be enough to kill some species.

Q 2.35 How will SEPA and others be able to use NewDepomod to assess the impact on marine species of intense but fleeting exposure to waste, rather than average levels?

- Burrowing animals.

NewDepomod makes no allowance for the reworking and re-suspension of sediment caused by burrowing animals. This is a major factor on the seabed.

Q 2.36 How has SEPA quantified how much sediment is reworked, exhumed and re-suspended by burrowing animals? Why is this not included in NewDepomod?

- Spatial accuracy.

NewDepomod Final Report p 38.

'These experiments did show that the model can produce approximately "correct" (relative to the empirical data) magnitudes of impact, however, if not the precise seabed positions of these impacts.'

Q 2.37 When NewDepomod has not been site-validated, its predictions are spatial imprecise. How will SEPA use them to deal with sensitive receptors such as maerl beds, flapper skate or other PMFs, or the spread of chemicals into MPAs, where lower EQS levels are required?

Q 2.38 How will SEPA prevent others (eg local councils, fish farmers) from relying on these predictions as if they are as precise as they appear on the output maps, as seems to have been the case when using AutoDepomod to judge fish farm applications?

Q 2.39 In your letter to FoSoJ you say that there will be, 'an option to calibrate and validate NewDepomod in order to provide demonstrably accurate model scenarios'. What does this mean and why is it optional?

Establishing the extent of the limitations of the model is another reason why NewDepomod should be independently reviewed.

Your letter also mentions that there will be a 'requirement for numerical hydrodynamical modeling in cases where perceived risk warrant it'.

Q 2.40 Given that large-scale, cumulative impacts around some clusters of fish farms has already been revealed by hydrodynamic modeling, how will you judge the 'perceived risk' at other sites, without doing this kind of modeling first?

As we recall, the hydrodynamically modelled area around Fetlar covered about 100km². It seems unlikely that SEPA will already have site-specific validation data for many other areas as large as this.

In its absence, Andrew spoke about checking the model's tidal and flow predictions by using the 15-day flow data that was collected to consent each fish farm in the area. These data sets can check the model's flow predictions, but they were collected to deliberately exclude extreme events like storms, and they can tell us nothing about the accuracy of the hydrodynamical model's deposition predictions.

Modelling the transport, settlement and re-suspension of particles is what NewDepomod has been designed to do. These are really complex things to model. Larger scale hydrodynamic models aren't suitable unless they have all the necessary physics built in.

Q 2.41 Is the MIKE hydrodynamic model capable of making such fine-scale predictions about particle transport, deposition and re-suspension as NewDepomod?

Q 2.42 Have the results of both models been compared at the 2x2 km² scale? If so, how spatially accurate are the hydrodynamic model's predictions of deposition?

Q 2.43 Could you apply the MIKE flow data predictions to NewDepomod, in order to overcome NewDepomod's reliance on 90-day of flow data, which, by being collected at a single point, compromises the precision of its predictions towards the edge of the domain?

Q 2.44 Is it correct that at present the hydrodynamic model is not used at all when considering licence applications? When will it start to be applied to actual licensing decisions?

There is clearly a vital need for long-term field validation data, potentially measured years apart, without which detailed spatial predictions are not reliable.

Q 2.45 Will SEPA allocate more resources to gathering this long-term data in all fish farming areas, wherever there are large or multiple farms and complex flows?

We understand that SEPA intends to use NewDepomod to assess development sites

which have not been validated. Mr A'Hearn's letter to Mr Dey explains that the unvalidated model's inevitable errors will be acknowledged:

'The validity of the simplifications and assumptions in the models are tested by comparing model predictions with environmental monitoring results.

This testing tells us how much potential error and hence uncertainty there is in the predictions. Knowing this allows us to apply the appropriate level of precaution when using model results to inform our decisions about development proposals.'

Q 2.46 How would you quantify the uncertainty implicit in using NewDepomod in this conservative mode, without any site validation, when its predictions may be more or less correct for magnitude but not spatially precise?

Q 2.47 How would you use the quantified uncertainty to set an appropriate biomass for a fish farm?

Q 2.48 NewDepomod did not make accurate predictions 'out of the box' for any of its six test sites. Will SEPA apply the model to proposals for expanding fish farms to 3500 tonnes or more, where its predictions have not been validated by >6 months of flow data, and unless those predictions have been compared to 'more than usually detailed contemporaneous environmental impact data' (both as per the NewDepomod *Final Report*)?

Q 2.49 Have the sites of any existing applications for new or expanded farms already been validated to this extent?

Section 3 Why there are such high levels of adverse impacts and so many breaches of compliance with licence terms?

The impact of emamectin Benzoate

At our meeting, Mike Montague said that the SARF-funded PAMP2 study (including its final part, published in 2017: '*SARF098C PAMP2 Refreshment Study - The association between emamectin benzoate use and crustacean assemblages around Scottish fish farms*') had only shown a weak impact on crustaceans.

In fact it's conclusions were that:

'...the evidence indicates a wide scale cumulative impact and incomplete recovery between successive emamectin benzoate treatments....'... 'the ecosystem consequences of the observed reduction in crustacea are not known, but crustacea include important fishery species such as crabs and lobsters...'

'...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.'

The study strongly implicates emamectin benzoate in the reduction of crustacean diversity and abundance very far from fish farm cages, by an average of c.60%. Here are some parts of the 2017, crustacean-specific part of that report:

'...the data presented here suggest an approximate halving of mobile crustacean abundance in association with chronic and heavy use of EMB at reference stations.'

'The analysis indicates that, at average conditions, high EMB treatment will be associated with a halving of mobile crustaceans, at Reference stations in Shetland (following exclusion of scavenging/social species). These data are observational and it is possible that any association is not indicative of a causal relationship.'

'The model (outliers removed) indicates that the effect of 300 g EMB usage (total per site and the approximate maximum total within the Shetland Islands) would be to reduce mean mobile crustacean abundance from approximately 18 to 7 (with a lower and upper 95% confidence interval of 3 and 15) at average current speed and depth.'

(NB: a mean reduction from 18 to 7 is more than the halving mentioned above. Extreme reductions in abundance from 18 to 3 are not ruled out).

'These data were unlikely to be observed if there was no association between EMB (or correlated variables) and the abundance of crustacean families.'

'Multivariate analysis ... identified all the environmental variables assessed (EMB, particle size, sample depth and current speed) as being influential in determining the patterns of abundance of families at the Ref station.'

'These analyses indicate that EMB is associated with changes in crustacean taxa, at Reference stations in Shetland. However, these relationships are complex.'

'Mobile taxa had a clear relationship with EMB use ...'

Subsequently SARF commissioned peer review for the PAMP2 report. Astonishingly this was conducted by 5 out of 6 reviewers appointed by the manufacturer of Slice.

This study also highlights how little is known about the effect of EMB, saying that:

- EMB might affect crustaceans by killing animals <1mm, not included in the grab sample analysis but eaten by larger animals, however:
'...the consequences of any associated change to the macrobenthos, and whether such changes cause meaningful change to ecosystem function and services remain unknown'
- *'There are currently no systematic data on the inter-species variation in sensitivity to EMB, at least in relation to the crustacean species recorded in the SEPA database or any assessment of susceptibility of different life-stages within a given taxa'*
- *'The direct effects of EMB (mortality, altered fitness, escape) which are largely unknown, will combine to give a complex assemblage-level responses to EMB that are likely to change with the degree and timing/duration of EMB exposure. The apparent (measured) response as estimated as part of SEPA-consent monitoring (i.e. as generating the data analysed here) may be highly influenced by the timing of the sampling event with respect to the last and previous treatment (timing and amount) and this is likely to be influenced by the nature of the receiving environment (e.g. current exposure, particle size) among other factors.'*
'Modelling such complicated interactions/interrelationships requires a very large and well-balanced data set and that was not available in the current analysis.'
- *'Nothing is known about the rapidity, or extent, of crustacean-defaunation following EMB exposure and the rate of return of mobile taxa including macro-crustaceans.'*

The PAMP2 study is filled with these 'largely unknown', 'inadequate data' and 'needs further study'. In the light of the uncertainty SEPA have asked for a review of the EQS for EMB and made interim reduction in EMB EQS in qualifying MPAs.

Q 3.1 Given so much uncertainty, why does the EMB EQS reduction apply only in qualifying MPAs and then only to new farm proposals, rather than to existing farms or proposals for their expansion?

Q 3.2 With so many acknowledged unknowns, where is SEPA applying the precautionary principle to protect commercially valuable species and others that occur outside MPAs?

The impact on commercially valuable crustacean species

Sustainable jobs are very important in small coastal communities such as ours. Many of these are in the creel fisheries for crustaceans, which employ more people in coastal communities than fish farming and generate a huge amount of income for Scotland. We are deeply worried that SEPA's EMB *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'

Norwegian prawn fishermen are reporting the same fall in prawn or shrimp catches around fish farms, and so are fishermen in Wester Ross and the Hebrides.

The study mentions that: *'Langford et al. (2014) concluded that EMB use in Norway might pose a risk to shrimp and any other species undergoing a moulting cycle'*. A number of other papers, such as this from 2017, show that the chemicals used in aquaculture affect the larvae of commercial crustaceans, for instance the crab *M. edwardsii* zoea I, which is commercially-fished in Chile:

'Cypermethrin, deltamethrin, and azamethiphos affected 100% 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 larval M. edwardsii zoea I, repeated exposure to azamethiphos increased mortality, but did not affect zoea I developmental time, and chronic exposure to hydrogen peroxide had a lethal effect on larvae.'

(http://www.centroideal.cl/wp-content/uploads/2018/02/2017-Gebauer_PASCHKE_PARDO_etal-Chemosphere.pdf)

Q 3.3 What information does SEPA have about possible impacts on the crustacean fishery?

Q 3.4 How is the precautionary principle being applied to these important species?

Q 3.5 Is SEPA leading or commissioning research into the effects of chemicals on commercially and ecologically important animals, such as *Nephrops*, lobsters and crabs, separately and through a 'cocktail' effect? If not, why not?

The PAMP2 analysis deals only with medium to small animals. This may have to do with the size of the sampling grabs. The study says:

'Different farm-operators use different grab-sizes (0.02, 0.045 and 0.1 m²) and SEPA require different numbers of replicates depending on the grab size (5, 3 and 2) giving combined grab area of 0.1, 0.135 and 0.2 m² respectively.'

The largest (0.1m²) grab represents a square of 30cm on each side, which is quite small if you wish to sample larger crustaceans. You'd be very unlikely to catch an adult lobster or brown crab with such a grab. Prawns burrow in mud but the other commercially important species are often found on hard substrates where grabs would not work anyway.

Q 3.6 Why does SEPA not routinely sample in ways that would include these commercially important animals around fish farms?

Q 3.7 Are commercial crustaceans represented at all in the benthic biological samples collected for and by SEPA, for the purpose of assessing the impacts of pollution?

Q 3.8 Will SEPA now look for evidence of reductions in crustacean biodiversity (including of the commercial species), where the hydrodynamic models predict adverse impacts on the seabed due to solid waste, much of which contains EMB?

Q 3.9 Will SEPA also look for such an effect in areas where such modelling has so far not been done?

Compliance

We feel that SEPA should make more rigorous and unannounced inspections (written evidence to ECCLRC shows that in 2017 just 9% of 160 visits were unannounced). We understand that there are access, safety and biosecurity considerations, but this would help to counter the sense that there is too much reliance on fish farms to self-report, when self-reporting their environmental harm could affect their profits. More licences should be modified when required. Public trust in the regulator suffers when there is a failure to revoke licences and to successfully prosecute persistent offenders. This failure has become more apparent in the last decade.

You mentioned that compliance has improved recently but in the three years to the end of 2017 there were still 105 breaches of either seabed or EMB EQS levels among Scotland's c. 225 active salmon farms, according to Mr A'Hearn's letter to Mr Dey. Sometimes both may have occurred at the same farm, or perhaps multiple times at the same farm, but the minimum number of areas of seabed affected is 76, which means that these breaches seem to have happened, at best, at 1 in 3 farms and perhaps more. Of the 42 farms that had to reduce biomass only 10 were confirmed to have recovered. Eight (20%) have not shown seabed quality improvement. A similar number had become fallow as part of the usual cycle, and not surprisingly the seabed under those has improved, but is likely to be damaged again when production restarts, and a further 15 farms (ie >1/3) have yet to submit their latest survey results, so some of those may not have improved either.

Q 3.10 Do you agree that this is an unacceptable proportion of farms to be causing adverse environmental impacts?

Q 3.11 How do these percentages compare to the proportion of terrestrial farms generating adverse environmental impacts on land?

Q 3.12 Do these breaches of environmental standards count as non-compliance with the CAR licence terms? Or is that only when the farms fail to take action to rectify their adverse impact on the environment?

Q 3.13 Have any farms ever had their CAR licences revoked by SEPA for persistent breaches of licence terms?

Q 3.14 Have any operators been fined for breaching their licence terms?

Q 3.15 Have there been any successful prosecutions for persistent breaches?

Q 3.16 If not, why not?

Q 3.17 Are these breaches due to modelling problems resulting in over-generous biomass limits, or the breaking of safe biomass limits, or other factors? If so what are the other factors?

Q 3.18 Is SEPA's reluctant to revoke licences or to prosecute for EQS/AZE breaches because it knows that its modeling/consenting framework, using AutoDepomod, is not accurate enough to predict whether the permitted biomass will impact the seabed adversely?

Q 3.19 Does self-reported monitoring data become ineligible as evidence in court, as self-incrimination is not allowed?

Honest self-monitoring

Q 3.20 What is 'quality assured monitoring data' in Mr A'Hearn's letter to Mr Dey? How is it assured?

Q 3.21 What percentage of environmental monitoring is self-reported by the industry?

Q 3.22 What safeguards are there to prevent a fish farm operator from sampling the seabed further from the cages than they are supposed to?

We have seen the following allegations that at least one company overstocks its pens on purpose and keeps two sets of book, one with false figures to show the inspectors, while a second, accurate set is hidden during inspections:

'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.'

Q 3.23 How do inspectors assess biomass when looking at a pen full of fish? Do they just look at the books kept by the fish farmer?

Q 3.24 Likewise, how could an inspector tell whether extra chemicals were being used to treat sea lice, if their use was not recorded?

Q 3.25 Has SEPA considered that the soaring quantities of chemicals found on the seabed may be a consequence of higher than permitted biomasses of fish being treated?

Here is one example of overstocking, at Poll na Gille:

From October 2012 to July 2014 there was a cycle with very significant overstocking. The site was licensed for a maximum of 1500 tonnes from November 2012 but by early 2014 the cages were holding roughly 50% over the permitted level. There were

significant mortalities. The current cycle started in November 2016, with permitted biomass of 1500 tonnes at commencement, but figures published on the Scotland's Aquaculture database show that stocking reached 2207 tonnes in October 2017.

The later breach, in 2017 seems to have occurred because Marine Harvest re-stocked the farm in November 2016, in anticipation of being granted an application to increase biomass from 1500 to over 2000 tonnes. That application was not even advertised until the end of November 2016, with an end date for public comment of 19th December 2016. Permission to increase biomass to its current level was not granted until March 2018. The most recent emamectin residue sampling at Poll Na Gille, carried out on 18th January 2016, shows breaches of the current far-field EQS (at 100m from the farm), 110 days after the last use of emamectin on the farm.

At Poll na Gille the benthic surveys show six 'Borderline', six 'Unsatisfactory' and two 'Not Accepted' since the farm was established.

Q 3.26 Given this record, why did SEPA permit the two earlier increases in biomass at Poll na Gille?

If there are no fines, no successful prosecutions and no revoking of licences there is no disincentive to avoid overstocking and adverse impacts like these.

Q 3.27 Were Marine Harvest prosecuted for these biomass breaches and the consequent impact on the marine environment? If not, why not?

The NewDepomod report submitted to SEPA for CAR approval for further biomass increase at this site (CAR/L/01000800) shows no distribution of waste away from the cages at all, despite their being sited above a sloping seabed. No waste is predicted to be exported from the modeled domain.

Q 3.28 Why is there such a large discrepancy between NewDepomod's predictions and what the hydrodynamic modelling suggests normally happens around Shuna.

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

Q 3.29 Does SEPA know whether these farms also have exceeded their CAR biomass limits?

Q 3.30 Since NewDepomod and especially the hydrodynamic models, show the dispersion of waste across a larger area than previously, the amount remaining in the area that's currently assessed by SEPA will inevitably be reduced. Does this make it easier for fish farms to achieve a pass for their impact on the environment?

Section 4 Why has it been hard for SEPA to detect problems in the past?

Insufficient seabed monitoring

The NewDepomod Final Report, p 26, 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.'

SEPA only had sufficient data to test its own models by hindcasting at 6 sites. This is part of a broader failure to collect enough meaningful/useful seabed impact data. The PAMP2 study struggled with the same problem.

NewDepomod Final Report, p 30:

*'Although SEPA have good EMB residue data available for 6 sites, **contemporaneous flow data is not available for the periods relating to those impacts. Therefore hindcast modelling has been performed using relatively small samples of flow data which may be non-representative of the actual flow conditions experienced when the impact was being created.'***

And:

*'A more robust test of the model, **and more accurate approach to model-site calibration would be to use flow data collected through the time period over which a measured impact has formed.'***

Q 4.1 Will the collection of contemporaneous flow and seabed impact data now be a standard requirement or all fish farms?

There is clearly a need for large-scale monitoring of the seabed away from farms

Q 4.2 Will more data be gathered in the far field and will it be analysed routinely for emerging patterns across the sector as well as per farm, as appears not to have happened previously?

Q 4.3 How often will it be analysed? Once every 13 years or so (PAMP1 to PAMP2) is clearly not often enough.

Q 4.4 Where will the results be published?

This will be a lot of work and the sector is planning to double in size. Charging for monitoring at individual fish farms may not cover the cost of this general monitoring.

Q 4.5 Are SEPA allowing extra resources for this?

Section 5 Applications already for 3500t farms

SEPA seems to assume that more exposed, dispersive sites will always be offshore. Dispersing particulate waste might work far offshore in very deep water, but close to shore this kind of pollution is not diluted to oblivion.

Fish farm operators will find near-shore locations much more convenient, so it is no surprise that one of the first 3500 tonne farms being proposed (and now being considered by Argyll and Bute council) is close to the mainland shore.

In the light of the trial hydrodynamic modelling results around Shuna it is clear that, in complex shallow coastal areas such as this, even with high flow rates, the waste moves further from the farms and much of it then accumulates elsewhere, increasing the chance of cumulative effects with other farms.

It would be irresponsible to permit such large farms while the effects of the accumulated chemicals and the waste on Scottish species are unknown, and irresponsible to permit the doubling of production of farmed fish without first gathering this information.

The as-yet unapproved new DZR system aims to 'promote the use of tidal locations' (or 'exposed, more remote locations with strong tides' as Mr A'Hearn put it to GD). We are very skeptical of that. The Sound of Jura has fast tides but it is not far offshore, so fish farms here, and in many similar coastal location with strong tides, would be sited close to homes and businesses that rely on the sea being unpolluted, close to valuable creel fisheries, salmon migration routes, wild salmonid breeding rivers and sea trout coastal feeding habitat.

It is not true, as stated in Mr A'Hearn's letter to Mr Dey, that farmed fish in coastal sites like this will be located '*...where the risk of diseases and hence medicine usage are also likely to be lower*'. Nor is it true that in all exposed locations '*...the risk of infection with sea lice and other diseases can be less*'.

There would not be fewer sea lice at sites in the Sound of Jura or near Shuna - their sea lice reporting areas have some of the worst figures in Scotland and treating lice is a major cause of the increased use of biocidal chemicals. SEPA must take its share of responsibility for increasing sea lice numbers, as a direct result of permitting larger farms.

Despite being inshore, these are extremely exposed sites. The proposed farm at Dounie would have been only 50m from a rocky lee-shore, anchored on the edge of a 200m underwater cliff and exposed to an 8 km fetch.

We agree with SEPA that, at present, there is inadequate consideration by Marine Scotland of the extreme conditions that new large farms in similar locations will have to survive. The SAMS report shows that large numbers of escaping salmon have a profound effect on the wild salmon population. Hundreds of thousands already escape from farms in sheltered locations every year. Siting larger farms in more exposed places make this more likely. Siting them near the shore would be irresponsible.

Mr A'Hearn's letter to Mr Dey says: *'The improved risk assessment process will be applied to all proposals for new farms and expansions to existing farms, irrespective of location.'*

Q 5.1 By this does he mean by this that NewDepomod and hydrodynamic modelling will be applied to all new and existing farms?

Mr A'Hearn also wrote that: *'The updated deposition model and hydrodynamic models used for DZR will also be used for all proposals to discharge emamectin benzoate'*

Q 5.2 Would this apply even if the detailed site-specific validation of NewDepomod has not been done at every such site? What would the results mean under those circumstances?

Mr A'Hearn also wrote that:

*'The improved capabilities of the new risk assessment system will allow some of the precaution (e.g. the 2,500 tonne maximum biomass limit) in the current system to be appropriately reduced. That precaution had been incorporated to account for gaps in understanding but was producing the perverse effect of creating disincentives for farms to locate **where the environment is best able to accommodate them.**'*

Q 5.3 If the objective of the new system is to encourage farms to relocate to areas where the environment is best able to accommodate them, why are Marine Harvest looking to have their first 3500t farm near Shuna, where there are at least 6 farms already?

Q 5.4 Is the Shuna fish farm one of the new government approved 'innovation sites'?

Q 5.5 Unless SEPA has seen satisfactory hydrodynamic modelling results at the time of any planning consultation, how can the agency advise a local authority whether a proposal will do harm across a large area, and perhaps combine its impacts with the waste from other fish farms or other sources of particulate pollution outside NewDepomod's modelled domain?

Q 5.6 Now that it is possible to do such modelling, but in its absence, aren't SEPA and the local authority obliged to conclude that there is a possibility of such harm occurring?

Q 5.7 Under the DZR proposals, doesn't allowing a 50ha AZE (larger than most AZEs under the current system), directly contradict DZR's stated aim of doing less harm to the seabed?

Section 6 SEPA's biodiversity duty and the precautionary principle, the impact on protected sites and species

'Regarding revoked or adjusted licences, 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.' (SEPA written update to ECCLR Committee 2018)

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

Q 6.1 Is this inability to identify any farms as having compromised protected sites because, according to SEPA's updated written evidence to the ECCLR committee:

'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.'?

Q 6.2 How many protected sites established in areas with pre-existing fish farms have been checked, to make sure the farms are not compromising the protected features of the sites?

Q 6.3 How much other data has SEPA sought on impacts within protected areas, distant from farms, given what is now known about the very widespread nature of fish farm waste deposition?

Q 6.4 Does Mr A'Hearn's statement above rely solely on routine fish farm grab and sediment chemical monitoring at two fixed distance locations per farm?

Soon after a fish farm was established at Scarba, northern sea fans disappeared at the site. They are a PMF. This was documented photographically, before, during and after by local diver David Ainsley.

The definition of 'relevant protected area' given in WAT-PS-17-03 includes:
*'- 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'*

Q 6.5 Given that 'relevant protected areas' are not only inside MPAs but also include places 'where a Priority Marine Feature has been identified', and places 'in which the conservation interest may be susceptible to the effects on the area of emamectin Benzoate', how does SEPA identify the areas outside MPAs which are eligible for the lower EMB EQS?

Q 6.6 Has the lower EMB EQS been applied in all these cases, to new and existing farm licences?

Q 6.7 With regard to the interim lower EMB EQS, and given that there is no information on the sensitivity of Scottish species to EMB, or to organic waste, how does SEPA determine whether a 'conservation interest' will be affected?

Q 6.8 How is the precautionary principle applied to these decisions?

Q 6.9 Does the more stringent EMB EQS apply throughout the protected area or only in certain parts of it? If the latter, how does SEPA determine which parts?

Q 6.10 Has SEPA reassessed any EMB licences for the farms that are now inside MPAs that were created after the farms were licensed?

Q 6.11 Why is it considered safe for existing farms in MPAs to continue to operate and even to expand, without modifying their EMB EQS downwards?

Given that:

- The 'safe' biomass for these farms was established by AutoDepomod, which deliberately under-estimates the export of organic material and EMB from the modeled area around the farms.
- Hydrodynamic modelling shows that this material can accumulate far from the farms, and that multiple farms add to the quantities, increasing EMB concentrations at those locations.
- Emamectin seems to have profound effects on seabed animals, especially crustaceans, at levels below the limits of detection, according to the PAMP2 study.

Q 6.12 What assessment do SEPA use for the cocktail effect of more than one fish farm chemical being used at the same time, especially as EMB is excreted by farmed fish for months and that it persists on the seabed for many years, and given that (*SAMS report*): '*Bath treatment chemical plumes can extend up to 8 km*' (*Page & Burrige, 2014*)?

Impact on the broader environment

'We regulate waste emissions from all marine cage farms in a way designed to prevent damage to the marine environment beyond a permitted footprint of impact on the sea floor around the cages. We do this by setting limits on fish biomass and on medicine usage.

The limits are calculated with the aim of ensuring that concentrations of pollutants beyond the permitted zone of impact do not exceed levels at which damage to biodiversity could result.

These safe levels are defined by environmental standards. We use a combination of monitoring data provided by operators and the results of our own monitoring and investigative surveys to check that the standards are being met.' (A'H letter to GD):

Q 6.13 The hydrodynamic modeling you showed us demonstrates that pollutants and waste are accumulating and having an adverse impact on the seabed outside the permitted footprint of farms. What is SEPA doing to ensure that the standards in the depositional areas away from farms will be met?

We were pleased to hear that SEPA are, 'currently developing large-scale spatial

standards for waterbody-scale issues, including overlapping impacts. This may lead to limitations of biomass to reduce cumulative impact of solid waste as indicated by hydrodynamic modeling.'

Q 6.14 What is the scientific basis for your calculation of the west coast's total assimilatable amount of solid and dissolved waste, and of fish farm chemicals?

Q 6.15 What is an acceptable amount of organic material to lose from a modeled domain to 'fate unknown'? 82%, as NewDepomod predicted at Dounie? 99%, as AutoDeopomod predicted?

Q 6.16 How will you assess the amount of deposited material to which mobile Marine Priority Feature species are exposed?

Q 6.17 In the absence of such information, how will you apply the precautionary principle?

We understood from the meeting that when a pre-existing farm in a more recently created MPA (with qualifying features), asks for permission to expand, that SEPA would advise them not to apply to expand, if the modelling suggested the farm's waste would impact the sensitive features of the MPA. If the operators chose to press on with their application they might find that the extra monitoring/modelling would oblige them to reduce biomass instead.

Q 6.18 Is that correct and does it apply to all applications for expansion inside qualifying MPAs and other protected areas now?

SEPA's biodiversity duty

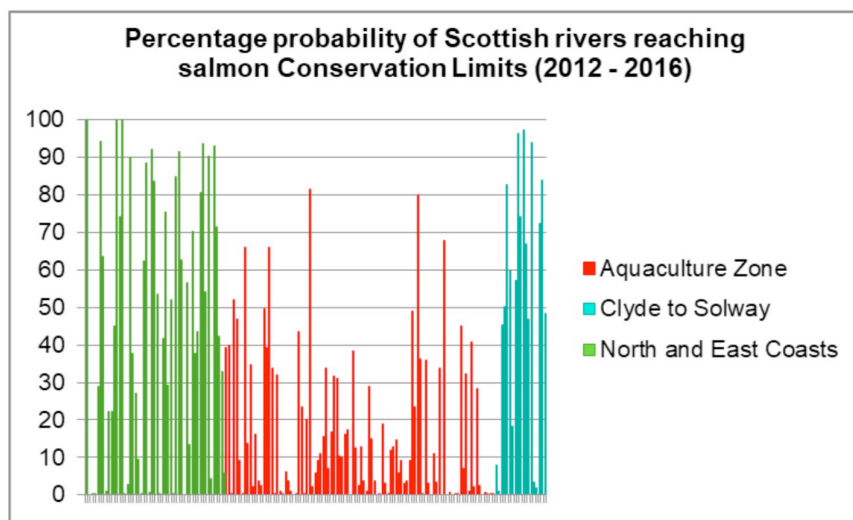
At the meeting we discussed SEPA's legal duty to protect biodiversity and agreed that this is unavoidable, since all Scottish public bodies must take direct responsibility for the environmental impacts of their actions: as the Explanatory Notes to the Nature Conservation (Scotland) Act 2004 state,

*'...public bodies have a legal obligation to further the conservation of biodiversity in the course of carrying out their functions ... The new duty is not intended to be narrow or prescriptive, but **the purpose of it 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.**'*

Indeed SEPA's Biodiversity Duty Report talks about exercising its duty to protect designated features of conservation sites, but it says nothing about mobile PMFs such as salmon and sea trout.

You mentioned that wild salmonids are also declining in the east of Scotland, where there is no fish farming. The SAMS report for ECCLR was very clear on this: Scotland's wild salmonid populations are declining for a number of reasons, but, as the graph

below (using rod catch data in the public domain) shows very clearly, the decline is most pronounced in the west coast aquaculture zone.



We explained that the biomass of fish in farms is the main factor affecting how many sea lice are encountered by wild salmonids in the coastal zone.

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.'

In the face of evolving resistance to chemicals and the growing problem of sea lice infestation of farmed fish, the only mechanism available to further the conservation of salmon and sea trout (both of which are Scottish Government PMFs) is to limit sea lice in fish farms by limiting biomass.

In your letter to FoSoJ you said:

'SEPA has a significant role in regulating fish farm developments under the provisions of the Water Environment (Controlled Activities) (Scotland) Regulations 2011, but these regulations are not appropriate to address the issue of containment and sea lice. These pressures are more appropriately addressed through the Aquaculture and Fisheries (Scotland) Act 2007 and the Town and Country Planning (Scotland) Act 1997, regulated by Marine Scotland and the local authorities respectively.'

At the meeting we explained that SEPA is the only agency with the necessary power to alter farmed fish biomass and therefore control sea lice numbers. Neither Marine Scotland (ie the Fish Health Inspectorate), nor local authorities, are able to make farms modify their biomass for wild fish reasons, once they have planning permission. FHI are only legally concerned with farmed fish.

Since our meeting Argyll and Bute Council has released a consultation document on their response to RECC, with a draft written submission to RECC at the end ([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](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))

It makes clear why local authorities are unable to control sea lice numbers:

'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...

'...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, even if CoGP standards are met on individual farms.

'More farmed fish present an increased incidence of sea lice in the marine environment, even where control measures enable CoGP standards to be met.'

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

'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.'

*'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.**'*

'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.'

And the local authorities are ill-equipped:

'In terms of technical knowledge and scientific expertise neither officers, nor councillors are best placed to address wild fish issues'

and they are unable to assess the cumulative impacts of multiple farms:

'...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.' (From A&B Council's supplementary written evidence to ECCLR Committee: http://www.parliament.scot/S5_Environment/Inquiries/003_Argyll_and_Bute_Supp.pdf)

There seems to be little evidence that applicants comprehensively assess the cumulative impact of new farms, as required by law.

In addition, not all fish farms need EIAs, and extensions to existing farms do not require them, as Mr Kerr wrote to FoSoJ 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 the A&BC written submission to the ECCLRC he went on:

'In other cases there is no express requirement for the applicant to provide cumulative information, although we would expect Marine Scotland in their consultation response to provide advice on likely cumulative effects upon wild fish interests.'

However the minutes of the A&BC Aquaculture Liaison Committee show that the same council planning department is frustrated by the non-committal advice they routinely receive from Marine Scotland on wild fish impacts.

The A&BC's written submission to the ECCLRC continues:

*'...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' and '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.'

'The new Fish Health Inspectorate (FHI) regime only considers the health and welfare of the farmed fish and therefore is not considered to adequately mitigate the risk to wild salmonids from sea lice on salmon farms.'

In your evidence to the RECC on the 18th April you explained that a working arrangement drawn up in 2010 had defined which agencies would deal with which aspects of fish farm impacts. You said that Marine Scotland do marine assessments and therefore they had the responsibility for interactions with wild fish. This agreement between government departments cannot be of the same legal standing as every Scottish public agency's biodiversity obligation.

Q 6.19 SEPA is obliged by law to conserve biodiversity. If it uses the CAR Regulations to set biomass in farms that exceed levels at which sea lice can be properly controlled, resulting in harm to wild salmonid populations (an effect accepted by Marine Scotland, the SAMS report and the ECCLR committee), then why would SEPA not be in breach of its biodiversity duty?

Acceptance of this responsibility was apparent in SEPA's Fish Farm Manual of 2005:

'in certain instances to protect important wild salmonid stocks, SEPA will limit the biomass to that which can be treated at the site using an authorised sea lice medicine.' and
'...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.

Q 6.20 If SEPA could limit biomass in 2005, to protect important wild salmonid stocks, please could you show us which parts of the subsequent legislation makes this no longer the case?

We appreciate that SEPA's stance on this may change and we note that Mr A'Hearn's letter to GD suggests a willingness to do so, saying that the new Sector Plan will include:

*'supporting action to protect wild fish', and that,
'..we are open to taking account of the risk posed to wild fish in assessing the appropriateness of farm locations in our advice to local planning authorities and in our permitting process'.*

Section 7 What will SEPA do now?

The ECCLR Committee concluded that it,

'is not convinced SEPA (or any other agency) is effectively monitoring the environmental impact of salmon fisheries...', and that

*'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)*

We await the new aquaculture Sector Plan with interest. You explained that you are open to (eventually) revoking licences, if the Sector Plan's review + enhanced monitoring and analysis shows there is a need to do so.

Meanwhile fish farm expansion will be forging ahead, as we pointed out.

It is clear that there are problems with aquaculture's impact on the environment - the hydrodynamic models show this, PAMP2 shows it, SEPA's Shuna study shows it, the EMB *Options Paper* acknowledges it.

The Sector Plan licence review is going to be too slow to address many of these long-standing problems. In the interim it is surely appropriate to have a moratorium on expansion, until the REC committee's recommendations have been published and acted on, your Sector Plan has been published, the necessary licence reviews, chemical EQS reviews and field validation for NewDepomod and the hydrodynamic model have been completed, and other essential data has been gathered (eg on the sensitivities of Scottish species).

Even under these circumstances you are against a moratorium, saying that it would lock in the current biomass of those farms causing the greatest impacts. However, Mr A'Hearn's letter to Mr Dey shows that 42 biomass reductions were applied to CAR licences during the three-year period to the end of 2017.

Q 7.1 Please could you explain why a moratorium on expansion while CAR licence reviews are undertaken and essential data is collected and analysed, would necessarily have the effect of locking in the biomass of the most damaging farms?

Annex A - Autodepomod's limitations

In the *NewDepomod Final Report* p 11:

'Mayor et al. (2010) published a statistical analysis of SEPA's fish farm monitoring benthic data and concluded that, "...in isolation, current speed, water depth, and farm size are not necessarily good predictors of benthic impact"'

This was published eight years ago yet these continued to be the measured data used by AutoDepomod to make predictions that form the basis of all biomass consenting.

Specifically, AutoDepomod cannot:

(page numbers refer to '*NewDepomod Final Report*' SAMS):

- Model large scale dispersion (Anne Anderson's letter to FoSoJ, 29 Jan 2018)
- Identify specific transport pathways and sensitive receptors (AA's letter)
- Deal with cumulative impact of several farms (or other interacting discharges) (AA's letter)
- Model how material will move once on the seabed or whether it would damage sensitive areas. (Andrew Berkeley p. comm)
- It uses current measurements taken only at the fish farm site. (AB p. comm)
- Current measurements are taken for only 14 days, then repeated until they add up to a year. *NewDepomod Final Report* p 45.
'In Scotland, at present, these' (15-day hydrodynamical inputs) ... constitute a major source of error in model predictions.'
- The 1x1km grid is too small and skews the dispersion results because particles are not readmitted once they leave the modeled domain. (AB p. comm)
- p 37. *'Isolated experiments with domain size showed that the use of a 1 km domain caused, in some cases, an export bias.... The use of larger domains...'* (ie by the improved model) *'...caused not only the overall mass balance to be larger, but also the EQS footprint to be larger.'*
p 37. When using a larger grid: *'At all sites an impact was observed, even in those cases with sufficiently fast flow (e.g. Ardgour, Noster (2015)) that no impact would have been produced in the original version of the model.'*
(ie AutoDepomod's predictions allow too much organic waste to 'vanish' from the domain, never to return. At Dounie 99% of particles were predicted to leave this area in this way, after which they vanish to 'fate unknown'.)
- Particles are locked down once they've rested on the seabed for 4 days, never resuspended. (AB p. comm)
- There is no allowance for storms or other infrequent events that can resuspend particles. (AB p. comm)
- There is no allowance for burrowing animals to bury, expose or resuspend the sediment, which happens all the time, in all soft seabeds.
- The seabed is treated as flat, yet (p 28 *NewDepomod Final Report*):
'Bathymetry plays an important role in determining the extent and locations of impacts. In the improved model footprints (are) not elliptical – as they typically, approximately were in the original version...'

Depositing material on steep gradients in the improved model now,

- '... causes the footprints to become extended in one or more directions, and considerably larger than in the original model.'*
- p 43. *'... it was concluded that 30 day run times (of the model) are prohibitively short...'*
 - p 10. *'The original DEPOMOD work was calibrated at only 2 sites (Cromey et al., 2002a) which may not be representative of the large variety of sites that are currently in use or proposed in Scotland.'*
 - p 9. *Even so, 'These dispersion data were used to parameterise the resuspension component of the model...'*
 - p 26. *'...the theoretical decay rate of EMB indicates that discharged quantities reduce to <1% of their original mass during a period of 4.5 years....'*
 - Yet, p 27. **With AutoDepomod the longest possible run was 233 days.**
 - p 27. *'...multiple (EMB) treatments cannot be simulated in the original model...'*, even though multiple EMB treatments are the norm.
 - p 27. *Also unrealistically, '... the original model could only accept a single, constant feed rate...' and '... The original model could also only accept 1 hour flow data resolution'*
 - AutoDepomod is not good at predicting impact dispersive sites:
 - p 10. *'An analysis of the relationship between modelled organic solid loading and predicted benthic response (using ITI) has shown that **there is in general a tendency for DEPOMOD to over predict impact at quiescent sites and under predict impact at more dispersive sites.***
 - p 10 *'In addition there is a considerable degree of variation between predicted and actual values of ITI over a range of sites.'*
 - p 28. *'... Other anecdotal evidence suggests that in some cases – typically with very fast flow - footprints are observed despite none being predicted by the original AutoDEPOMOD....*
...this implies that the original model can, in some (or perhaps most) cases, be too depositional, but in other cases too dispersive.'
 - p 27. *'The general pattern indicated by the residue samples are for **concentrations to be much lower at cage edge locations in comparison with model predictions ... but generally higher than predicted by the model further out ... especially at the farthest, "EQS", locations where the model under-estimates actual concentrations in many cases, including some which exceed the EQS.***
 - p 28. *'The occurrence of cage edge concentrations which fall considerably short of modeled predictions (often by an order of magnitude) is consistent with routine (but patchy) monitoring data seen by SEPA.*
This suggests that there is an inherent tendency in the original model to accumulate mass beneath the cages that does not correspond with reality.'