Scottish
Aquaculture
Research
Forum

Project Number:	Completion Date:
SARF098	18th December 2015

Project Title:
PAMP Refreshment Study – final report. A statistical analysis of sea-lice medicine use and benthic monitoring at Scottish marine salmon farms (2002 – 2014).

1. In your view have the scientific objectives been achieved. If not, does this need to be addressed by SARF?

Objective 1. A literature review considering the effects of sealice medicines on benthos to include both published and grey literature.

> ➢ Yes, this objective has been achieved.

Objective 2. A review of SEPA database to determine a sub-set of sites with relatively high sediment medicine concentrations in monitoring or audit. Data will be examined statistically to establish any relationships between medicine use or residues and environmental factors e.g. current speed, sediment type, in order to determine whether any types of site are inherently more at risk of breaking EQS.

> ➢ This objective has been attempted, with achievement of it constrained by the quality of the database and the use of only one statistical modelling approach.

Objective 3. At case study sites, determine whether there is any evidence of effects on the benthos specifically from medicine usage that can be distinguished from impacts of organic enrichment e.g. as evidenced by particular impacts on crustaceans.

> ➢ Again, this objective has been attempted, with achievement of it constrained by the quality of the database and the use of only one statistical modelling approach.

Objective 4. To provide expert advice on whether present regulations and practices provide good protection of the Scottish benthic ecosystem and to advise on any specific studies that might be required to reduce uncertainties and to improve the prospects for continued sustainable growth of the Scottish salmon industry in line with government and industry targets. Recommendations for further research programmes, that address knowledge gaps identified within the work proposed here, will also be made.

> ➢ Advice and recommendations for further work have been provided by the authors, but these are based on what I, and several other previous reviewers, regard as an overly strong set of inferences. It would be better to ensure first that the weight of evidence from currently available experimental data and modelling approaches supports the authors' conclusions.

2. Comment on the overall results of the project, including their significance for SARF.

I was one of the five reviewers (Reviewer 2) of an earlier draft of this report (dated 1 July 2015). The authors have made some revisions to the report in the light of these reviews, especially by including an analysis of reference sites in section 8.7. However, I do not think that the authors have responded adequately to what seems to be a quite consistent message from these earlier reviewers. This message is that the modelling approach used by the authors may not be capturing a real signal from exposure to emamectin benzoate from amongst the noise of the data.

In their responses to earlier reviewers the authors appear to hold a particularly strong view of what a model, including a statistical model, actually is, and therefore what it can achieve. In my view a model is just a simplified version of reality which, we hope, allows us to understand (and sometimes to predict) important aspects of that reality. To do this most effectively we need to include in the model aspects of that reality which we know are important. If we cannot do this then that does not mean that we cannot make some inferences on the basis of the data that we do have, but it does mean that we need to be rather cautious about the strength of those inferences.

The authors acknowledge that the SEPA database is constructed in a way that "…disadvantages the analysis" (their reply to reviewer comment 90). The cliché "garbage in, garbage out" should therefore have been at the forefront of their minds during the analysis. The database that they used reports values from sampling which was often not synoptic and did not include important variables, such as measured concentrations of emamectin benzoate. It is therefore far too strong an inference for the authors to state in the Executive Summary that: *"Whilst it is possible that the modelled reductions in crustacea were attributable to factor(s) that were associated with EMB use, rather than directly caused by EMB, this is unlikely given the range and nature of the co-variables included in the models."*

It may be the case that emamectin benzoate is responsible for declines in crustacean richness and abundance at reference sites. However, when assessing the current weight of evidence this seems at least questionable on the basis of other available experimental and monitoring data. The authors' analysis seems to show that something quite interesting might be going on in these ecosystems, and I would be very happy with this report if the results were couched in such terms. However, much uncertainty remains. For example, it is intriguing and perhaps a little odd that their analysis shows that at reference sites MaxBio is positively associated with both EMB and crustacean abundance, yet EMB is negatively associated with crustacean abundance. Why would this be? Does higher MaxBio lead to some organic enrichment of reference sites? But if this is the case, wouldn't we then expect concentrations of emamectin benzoate associated with organic material at these reference sites also to be higher?

My main criticism is therefore that the results of a "hypothesis/question generating" study such as this are described as if they are the results of a "hypothesis testing" study, despite assertions to the contrary by the authors in their responses to the earlier reviewers. For example, they state the following in the second sentence of the Discussion: *"There was strong evidence that both crustacean richness and abundance were lower in sites that had been treated with EMB, that this effect extended beyond the farm boundary to the Reference stations and was not attributable to site-specific differences and/or covariables including depth, sediment texture, current exposure or sampling methodology."* I don't see how the results of a correlational study based on, frankly, rather poor data, can possibly be described as "strong evidence."

3. Is there a need for further work? If so, explain.

Yes, there is need for some further work. As I stated in my earlier review I believe that the most important first step is to analyse the data using a different model to see if it produces similar results. I suggested quantile regression as one approach, but the more the merrier! This would show the extent to which the conclusions drawn by the authors are model-dependent.

The authors' recommendations for further work should be considered only if alternative analyses show similar trends to those the authors found (i.e. a very large decline in crustacean richness and abundance at reference sites, which is associated with emamectin benzoate use at nearby farms).

Overall marking
1 - outstanding results
2 - results significantly above expectation
3 - satisfactory results (the statistical analysis is satisfactory)
4 - results below expectation (the interpretation of results is below expectation)
5 - poor results

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Signature	Print Name	REF01	Date	5 February 2016

Please indicate whether you wish to receive payment (Yes/No)   No

Additional Comments**:**