



Managing Interactions Aquaculture Project:

Locational Guidance Model

Public Briefing Paper

November 2013

1. The Managing Interactions Aquaculture Project

Since April 2011, Rivers and Fisheries Trusts of Scotland (RAFTS), on behalf of member fishery trusts and with partner district salmon fishery boards and the Association of Salmon Fishery Boards (ASFB), has implemented the Managing Interactions Aquaculture Project (MIAP). This project is funded by the Scottish Government, and is focused on interactions between salmon aquaculture with wild salmonids on Scotland's west coast, from Argyll to West Sutherland and the Outer Hebrides.

The need for this project is due to the potential negative impacts poorly managed aquaculture can have on native wild salmon and sea trout populations. An accumulation of the parasitic sea louse, *Lepeophtheirus salmonis*, within salmon aquaculture cages can lead to the release of many thousands of sea lice into the aquatic environment, where they potentially infect wild salmonid fish, causing harm and death to the infected fish. The effects of poorly managed aquaculture have been shown to have negative population level effects from studies conducted in Ireland and Norway, with strong circumstantial evidence that a similar effect occurred in Scotland (Whelan 2010). The most comprehensive recent review of the literature concerning interactions between aquaculture and wild fish concluded that the weight of evidence is that sea lice of farm origin can present a significant threat to wild salmon stocks (Revie et al. 2009). More recently, Krkosek et al. (2013), demonstrated that sea lice caused around a one-third loss of overall adult recruitment in Atlantic salmon, and concluded that parasites can and, in this case [Ireland], did have a large effect on fisheries recruitment, irrespective of apparent changes in overall marine mortality over time. These findings have important implications for the management and conservation of wild salmon stocks.

MIAP is made of three component parts:

1. An annual programme of sea-trout post smolt sweep netting and reporting of this;
2. A programme of wild fish sampling and subsequent genetic analysis to assess levels of introgression of aquaculture / Norwegian strain genetic materials in wild fish. sampling for this project took place in 2011;
3. Development of a locational guidance model to support fishery trust and district salmon fishery board representations to aquaculture development planning consultations to seek to better protect wild fish populations from inappropriate development.

The results of 1. and 2. are reported separately on the RAFTS website¹

This paper provides a non-technical summary of the current position in respect of the development and outputs of the Locational Guidance aspect of the project.

A technical project report of this work designed to accompany the Locational Guidance is also available.

The Locational Guidance work within MIAP has been the subject of much debate and publicity. However, now that v1 model outputs are available and can be made public, an informed consideration of the work can begin. This process of consideration, review and consultation with others is active in 2013/14.

2. Locational Guidance Model

The Locational Guidance model (LG) provides information on factors relevant to wild salmonids when considering planning applications for new aquaculture sites. The LG model is a risk sensitivity analysis that provides contextual information on the status of wild salmonid populations in proximity to the proposed location of the fish farm. The Rivers and Fisheries model focuses on the status of the rivers with regard to salmonid populations and quality of habitat, using a combination of data from public bodies and fisheries trusts. The LG model also provides information on the Coastal and Transitional waters; sea lice are transported in the sea primarily by surface winds, but also by tides and currents; knowledge of these factors provides further information to take into account when considering an application for a new aquaculture site.

The outputs of the Locational Guidance work are Geographical Information System (GIS) map layers and not hard copy maps. Map layers have been prepared in relation to "River and Fisheries" and "Coastal and Transitional Water" areas.

2.1 River and Fisheries

A large area, 13,757km², of the west coast of Scotland is included in the model and information has been collated against a total of seven criteria to populate it:

1. Designations and Features
(Natura Special Areas of Conservation for Atlantic salmon and freshwater pearl mussel)
2. Water Framework Directive Classification
(see http://www.sepa.org.uk/water/river_basin_planning.aspx for details)
3. Value of fisheries
(Rod and line fisheries on rivers are valued (the Rateable value) based on the number of salmon and sea trout caught and assessed by Local Authorities' District Assessors)
4. Nature / type of fishery
(value of angling lets/availability of angling opportunities)
5. Catchment accessibility
(presence of man-made barriers to fish migration preventing access to all of the naturally accessible catchment)

¹ <http://www.rafts.org.uk/aquaculture/>

6. Juvenile salmonid populations

(fisheries trusts collect data on the health of juvenile salmonids, and can calculate how many salmonids should be present versus what actually is present)

7. Habitat quality

(fisheries trusts assess the quality of the river habitat for salmon and sea trout, noting where the habitat has degraded due to human activity such as agriculture or forestry)

For a catchment or river to be included in the model a minimum of five of the seven criteria must have information against it. Catchments or rivers with insufficient information to fulfil this criterion are not included in the model.

The information required to populate the model is provided from a mixture of both public and private sources.

Public:

Designations and Features, Water Framework Directive (WFD) Classifications and Value of Fisheries are held and controlled by Scottish Natural Heritage, Scottish Environment Protection Agency and Local Authorities respectively. The information used to populate these criteria has been provided directly from these sources.

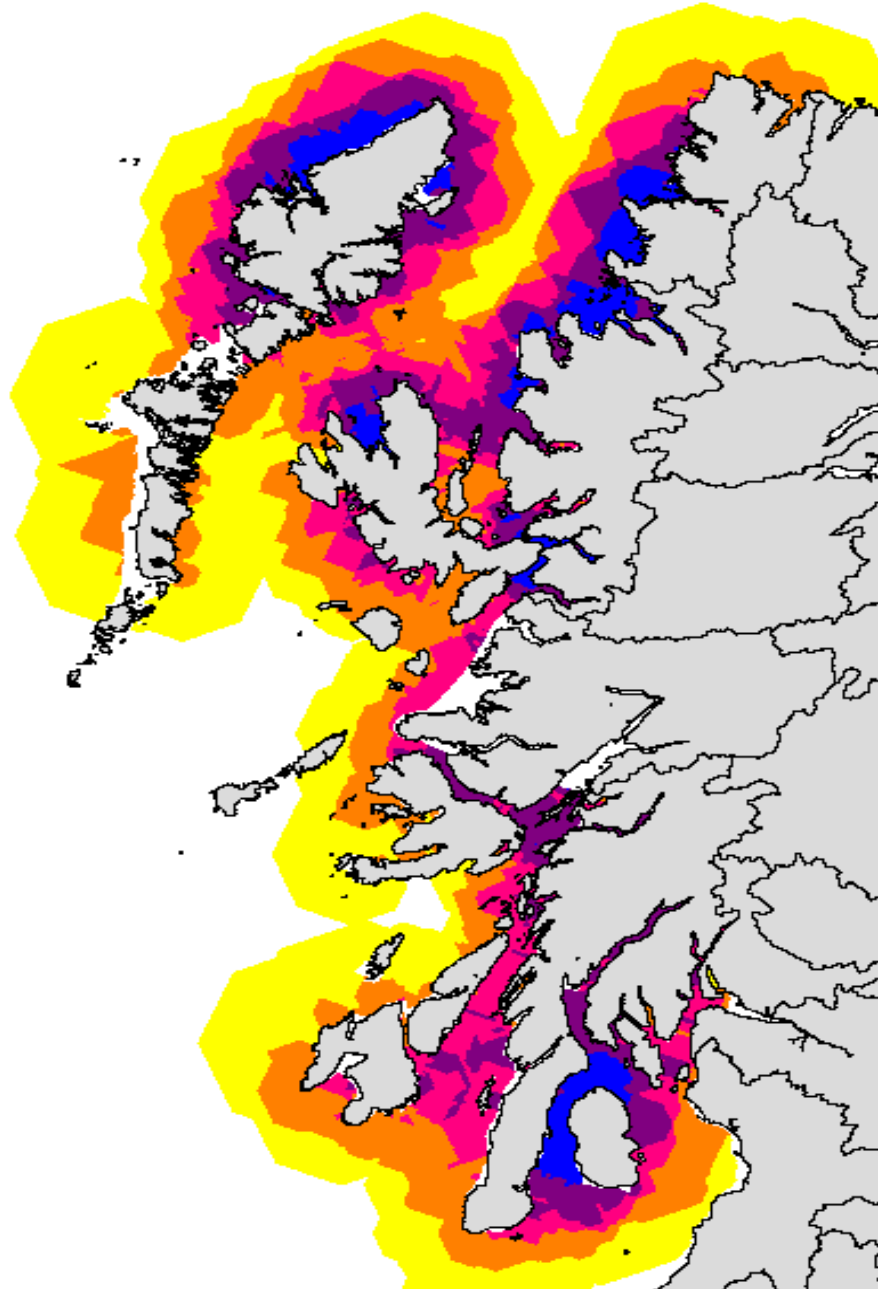
Private:

Five fisheries trusts (Outer Hebrides, Skye, Argyll, Wester Ross and West Sutherland) have provided information to the model in respect of the Nature / Type of Fishery, Catchment Accessibility, Juvenile Salmonid Populations and Habitat Quality derived from records and data held by them.

Lochaber Fisheries Trust opted not to participate in the Locational Guidance component of MIAP in January 2013. An alternative approach has been developed for Lochaber catchments using publicly available information only to ensure that waters in other trust areas bounding Lochaber are fully represented in the sensitivity analysis. Waters solely in Lochaber are excluded from the model and available maps. Statistical assessments of this approach have been undertaken to confirm that this analysis approach is appropriate and reasonable.

2.1.1 Outputs:

The v1 output of the model has been prepared (see **Map 1**). This has been provided to participating trusts in GIS map layer format and the map presented is simply an image of this entire layer. The model generates a 5 class sensitivity assessment of coastal waters which is a function of the combined river scores of all rivers and their intersections with each other at 1km, 5km, 15km and 31km distances from each river mouth. There is no ranking of individual rivers available or generated and scores from all rivers are combined into an overall sensitivity of the receiving coastal waters. The 31km distance was selected following analysis of post smolt sea trout sweep netting data (component 1 of MIAP) undertaken by Marine Scotland Science (Middlemas et al. 2012). This analysis detected a relationship between harmful levels of sea lice on wild sea trout and the distance to the nearest salmon fish farm, with harmful lice levels found on sea trout up to 31km from the fish farm. (It is recognised that there is uncertainty regarding the 31km, and that this figure may be revised when more data are collected and analysed.)



Map 1: v1 Output of River and Fisheries Locational Guidance

A summary of this analysis is provided in **Table 1**. This shows that the large majority of the waters included in the analysis are in the lower sensitivity scores 1 and 2 (65%) (largely a function of the large areas of offshore water included in the assessment by running the model to 31km from each river mouth) with the higher sensitivity scores 4 and 5 making up 19% of the total area. When the map is viewed it is clear that the most sensitive areas are largely inshore areas with multiple rivers draining to these and, often, with protected sites amongst the catchments.

Table 1: Summary of sensitivity scores by area and of % of total area

Colour Code	Sensitivity Score	Area km ²	Area %
Yellow	1	11479	39
Orange	2	7585	26
Pink	3	4625	16
Purple	4	4009	14
Blue	5	1569	5

The v1 map output can also be considered in relation to the location of current aquaculture developments. When an analysis is completed on the location of fish farm sites in relation to the sensitivity areas (**Table 2**) it is clear that a high level of current aquaculture developments operate in the areas identified as most sensitive to wild salmonids from the model analysis. A total of 57% of all aquaculture operates in the 19% of most sensitive waters identified.

Table 2: Showing distribution of aquaculture sites in sensitivity score categories (Lochaber area excluded)

Colour Code	Sensitivity Score	Area km ²	Area %	Active Farm	% Active Farm
Yellow	1	11479	39	5	4
Orange	2	7585	26	24	18
Pink	3	4625	16	28	21
Purple	4	4009	14	53	39
Blue	5	1569	5	24	18

The system of locational guidance is specifically designed to allow Fishery Trusts and DSFBs the flexibility to incorporate local knowledge and information in order to provide local context to the output of the models. For this reason, fishery catch statistics are not included in the model, but instead will provide important contextual information. It is important to understand that the models are based solely on a risk assessment from a wild fisheries perspective and there has been **no** attempt to assess the potential or suitability for aquaculture development on the West Coast of Scotland. On that basis it is quite possible that there are legitimate reasons for significant issues to be raised in areas which from the output of the model alone may appear to be 'low' risk. It is vital that planners, decision makers, stakeholders and the industry understand this point.

Therefore, in addition to the model analysis outputs context information (analysis of catch statistics per fishery district) will be provided to and prepared for the project partners. This work is ongoing and will allow fishery boards and trusts to represent the local context of the individual river catch trends to support their position in any overall planning representation.

2.1.2 Next steps:

A large majority (88%) of the study area is already included in the model analysis. Additional areas where new data would best be collected by trusts to support v2 of the model have been identified. In addition, desirable data and information inputs from "boundary trusts" in Clyde, Ayrshire and Loch Lomond have been identified and quantified. The standard analysis and presentation of catch statistics (salmon and sea trout) for each fishery district is to be completed.

2.1.3 Summary Conclusions:

- This is work in progress but offers a way to consistently represent fish and fisheries in the aquaculture development and planning processes.
- It **does not** highlight individual rivers as more or less important than another as priorities are combined and applied to coastal waters.
- It allows and supports the flexible use of context information by trusts and boards to reflect local circumstances and priorities.
- It **does not** prevent trusts or boards highlighting additional factors or information to planners if they wish.
- Presentations are being scheduled and delivered to groups including Scottish Natural Heritage, the Crown Estate, Local Authority Planners in 2013/14 to show the current work to these parties as well as Boards and Trusts in the MIAP area.
- It would be desirable to include information such as smolt migration routes within the model. However, these data do not exist. This is likely to be the case for many years.
- The model has been designed to allow new relevant information and data (including smolt migration routes) to be incorporated in future versions of the GIS layer.

2.2 Coastal and Transitional Waters

A large area, 12,855km², of the west coast of Scotland is included in the model and information has been collated against a total of four criterion to populate it:

1. Type of Loch System
2. Orientation of Loch System
3. Flushing Rate Of Loch System
4. Monitoring Data (from post smolt sweep netting)

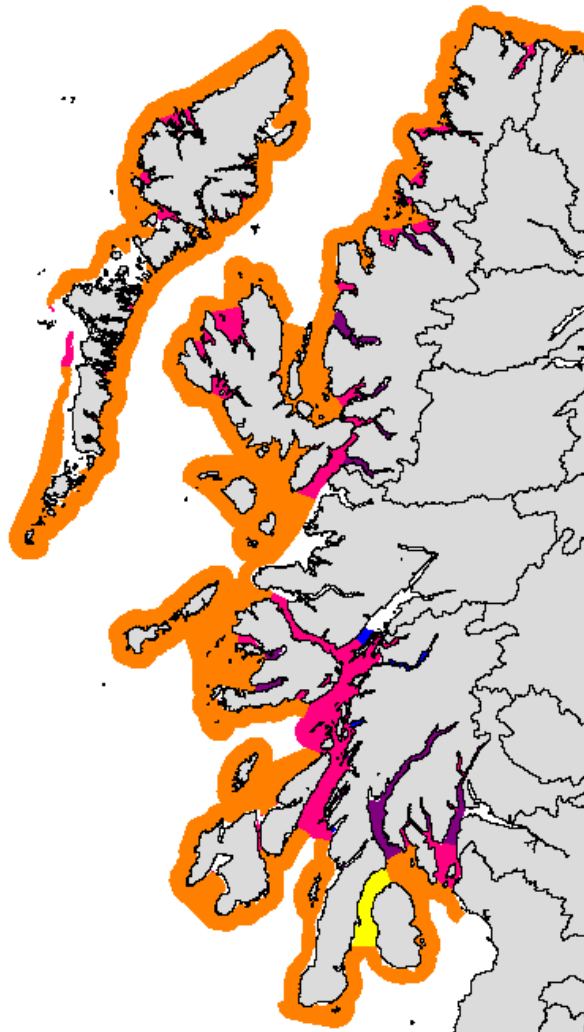
The Coastal and Transitional Model input information is all publicly available (criteria 1-3) or available through the reporting of the sweep netting results by the overall MIAP project (criterion 4).

WFD water bodies are used in this model as opposed to the distance rings or arcs from river mouths used in the rivers and fisheries model. All water bodies identified have been fully included in the

model analysis. These criteria are all, essentially, related to the sensitivity of the coastal and transitional waters to sea lice related risks.

2.2.1 Outputs

The v1 output of the model has been prepared (see **Map 2**). This has been provided to participating trusts in GIS map layer format and the map presented is simply an image of this entire layer. The model generates a 5 class sensitivity assessment of coastal and transitional waters.



Map 2: v1 Output of Coastal and Transitional Waters Locational Guidance

A summary of this analysis is provided in **Table 3**. This shows that the large majority of the waters included in the analysis are in the lower sensitivity scores 1 and 2 (84%) (largely a function of the orientation and type of coastline along much of the study area) with the higher sensitivity scores 4 and 5 making up only 4% of the total area. When the map is viewed it shows that the most sensitive areas are largely made up of fjordic, south west facing sea lochs which often have low flushing rates.

The v1 map output can also be considered in relation to the location of current aquaculture developments. When an analysis is completed on the location of fish farm sites in relation to the sensitivity areas (**Table 3**) it is clear that a high level of current aquaculture developments operate in the areas identified as most sensitive from the model analysis. A total of 24% of all aquaculture

operates in the 4% of most sensitive waters identified, whereas only a small percentage of aquaculture activities (22%) are found in the 84% of waters identified as least sensitive. Some 54% of aquaculture operates in the middle sensitivity analysis banding which represents 12% of the area included in the model.

Table 3: Showing summary of sensitivity areas and % and distribution of aquaculture sites in sensitivity score categories (Lochaber area excluded)

Colour Code	Sensitivity Score	Area km ²	Area %	Active Farm	% Active Farm
Yellow	1	172	1	1	1
Orange	2	10664	83	28	21
Pink	3	1584	12	72	54
Purple	4	395	3	26	19
Blue	5	40	1	7	5

In addition to the model analysis outputs, further contextual information (WFD Classification, Marine Scotland Science Aquaculture Waterbody Characterisation and SNH Marine Conservation Areas) has been prepared and is available to participating partners. This context information can be used by fishery boards and trusts to support their position in any overall planning representation.

2.2.2 Next steps:

This is a more straightforward model to re-run and this will take place annually using revised WFD Classification and sea-trout post smolt survey information available each year.

2.2.3 Summary Conclusions:

- This is work in progress but offers a way to consider, essentially, sea lice risks and sensitivities in the aquaculture development and planning processes.
- It allows and supports the flexible use of context information by trusts and boards to reflect local circumstances and priorities.
- It **does not** prevent trusts or boards highlighting additional factors or information to planners if they wish.
- Presentations are being scheduled and delivered to groups including Scottish Natural Heritage, the Crown Estate, Local Authority Planners in 2013/14 to show the current work to these parties as well as Boards and Trusts in the MIAP area.
- It would be desirable to include data and information on sea lice dispersal models within the model. These data do not exist in anything other than local and incomplete coverage areas. This is likely to be the case for many years.
- The model has been designed to allow new relevant information and data (including sea lice dispersal) to be incorporated in future versions of the GIS layer.

4. Summary

1. The v1 Locational Guidance outputs of the MIAP have been run for both "Rivers and Fisheries" and "Coastal and Transitional Waters" and these sensitivity maps are available in GIS format.
2. These models seek to make best and ordered use of the information which does exist and is available to the fisheries sector to support representations to aquaculture development planning processes.
3. Desirable information on smolt migration routes and lice dispersal models does not currently exist and so cannot be included. However, were such or other information to become available the design of the model allows the inclusion of new data sources within the current structure.
4. There is significant interest in this work within Local Authority planners, the Crown Estate and others who consider that this approach may allow them to better consider responses from fishery trusts and boards to aquaculture development applications (new development or expansions); particularly if a more consistent approach to such application responses is adopted by the fishery trusts and boards.
5. Significant proportions of current aquaculture activities take place in areas identified by the model to be most sensitive to aquaculture development. The Locational Guidance may provide a basis both to protect these areas from inappropriate future development within the planning process and to begin dialogue on the potential for relocation of production from particularly sensitive locations, or at least changes in management regimes, if political and industry support for this is generated.
6. In the longer term the movement of aquaculture production offshore and/or to closed containment is the stated policy objective of RAFTS and ASFB to better protect wild fish stocks from the impacts of sea lice and aquaculture escapes in particular. In the meantime, the Locational Guidance model is one mechanism designed to allow Fishery Trusts and District Salmon Fishery Boards to better inform the planning system to ensure that detrimental effects on wild fish are minimised.