

# Mapping Pressures on Wild Atlantic Salmon in Scotland

Guidance for District Salmon Fishery Boards and  
Rivers/Fisheries Trusts



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## Introduction

The purpose of this project is to provide fisheries managers with a common platform for identifying and quantifying the primary factors limiting wild Atlantic salmon production in Scotland.

Ultimately, outputs from this process will be available for use by local managers to inform and target management action and also to provide important evidence for policy development at a national level. The two main outputs from this process will be colour coded maps for local catchments showing the extent and impact of key salmon pressures and summary information showing the river length and wetted area affected by each pressure for each catchment.

In order for this process to be successful and for outputs to be comparable between regions, it is vitally important that information is presented in a consistent manner. The purpose of this guidance document is therefore two-fold:

1. To set out a clear framework and guidance within which local managers undertake the required assessments across Scotland;
2. To provide technical assistance in the use of the web-based salmon pressures mapping process.

Further to providing a framework for gathering local knowledge, effort is made to provide links to useful external sources of information to help inform contributions. A range of potential sources of supporting evidence which should be considered in advance of starting this process is set out below. These include national assessments on the status of salmon populations (juvenile and adult) and where available, specific information relating to pressures. The guidance below places a particular emphasis on ensuring that where pressures are assigned with high confidence that the source of evidence used to make such assessments is also provided.

Fisheries Managers may contribute information on up to 40 individual pressures which were identified by Marine Scotland and Fisheries Trust biologists through the Salmon Liaison Group.

In recognition that the amount of information available to fisheries managers will differ between areas, and for different pressures, the salmon pressures mapping process is designed to be flexible and will allow contributions to be made at varying spatial scales. This will allow fisheries managers to assign pressures to individual river reaches. However, pressures may also be rapidly assigned to entire catchments.

In some cases, juvenile and/or adult surveys may indicate a problem, but it may be difficult or impossible to attribute this impact to a specific pressure. As you will see below, there is a specific option to identify impacted parts of catchments to unknown pressures. This is also very valuable information and may reveal key knowledge gaps. **Users should err on the side of caution by attributing impacts to unknown pressures and marking their severity as unknown if there is uncertainty about their cause and/or significance.**

This is the first application of such a tool in Scotland. It is intended that the process will be refined and improved over time.

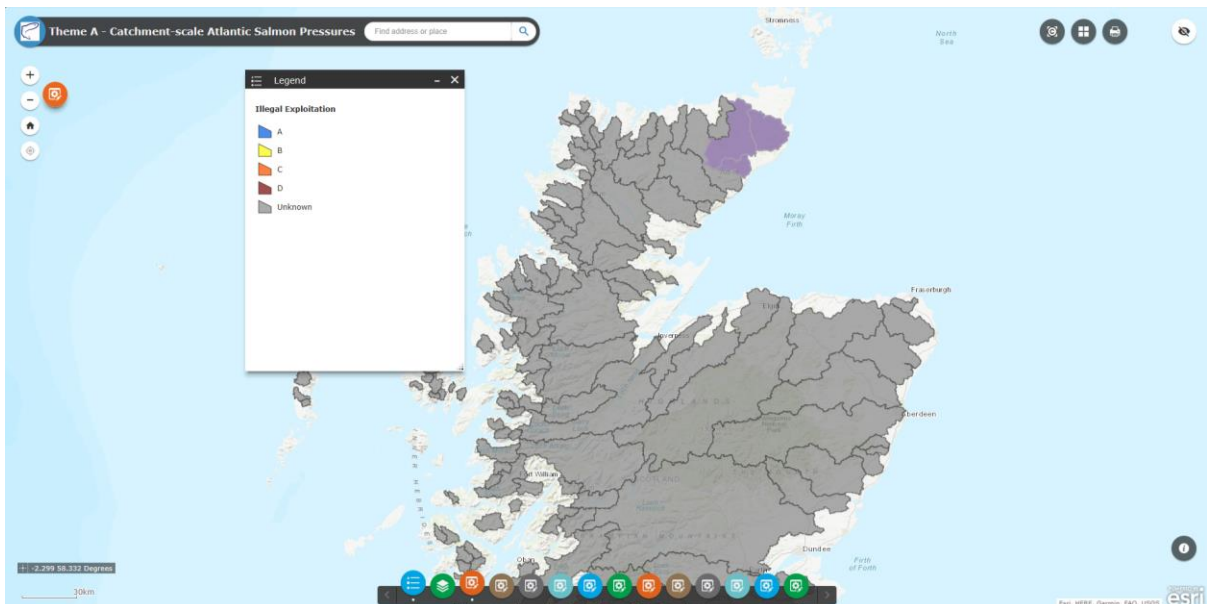
## Salmon Pressures Mapping Process

In order to enable all fisheries managers in Scotland to contribute within one common framework, a web-based approach has been deployed. This will allow you to access the salmon pressures mapping tools via a secure login. Access is via any internet browser, but use of a large screen, and mouse will make the process easier.

Contributions can be revised and updated throughout the process and a secure backup of all data provided across Scotland will be taken weekly (on a Friday) and stored by Fisheries Management Scotland for the duration of the project. The mapping software behind this project is provided by Earth Systems Research Institute (ESRI) and is long-established, secure and reliable. Data contributed on salmon pressures will not be publicly visible during the data gathering phase.

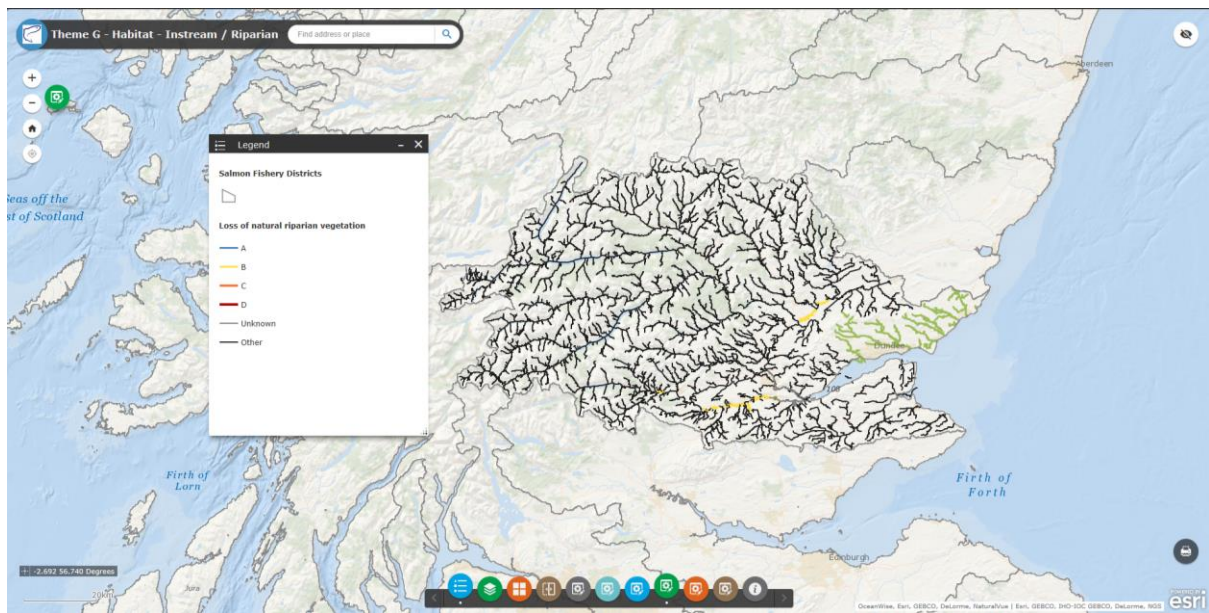
After the data gathering phase is completed, in February 2020 contributions will be collated and checked to ensure a broadly consistent approach has been taken between different regions. It is our intention to host summarised outputs and national-scale salmon pressure maps on the Fisheries Management Scotland website after project completion (April 2020).

### Atlantic salmon pressure tool for contribution of pressures at whole-catchment scale



**Map 1.** Example image taken from the tool that enables salmon pressures to be assigned to whole catchments. In this example the illegal exploitation pressure is being assigned rapidly by selecting 3 catchments in North East Scotland.

## Atlantic salmon pressure tool for contribution of pressures recorded at river segment scale



**Map 2.** Example image showing salmon pressures being assigned at river segment-level. In this example loss of natural riparian vegetation pressure is being assigned to a number of small coastal burns within the Tay district.

### Supporting Information

Fisheries Managers are asked to consider the status of salmon populations before beginning to attribute impacts to specific pressures. These include juvenile and adult salmon status assessments undertaken at both a national and local level.

#### Salmon status

##### Juvenile salmon status

In addition to local salmon assessments, a range of new applications have been made available to help reveal areas where juvenile production is less than should be expected. Marine Scotland have developed two applications which allow you visualise information on the status of juvenile salmon populations.

The first [application](#) allows you to explore data collected under the National Electrofishing Programme for Scotland. This application allows you to map data from the relevant region / catchment to assess whether the observed juvenile numbers are as expected for a healthy salmon population given local river characteristics. This is achieved by comparing observed salmon numbers to a “benchmark” (an indicator of what should be present). The NEPS application is able to show either differences from the benchmark or the percentage of benchmark for individual sites or regions. Where outputs indicate that local populations are lower than would be expected (less than the benchmark), this may indicate that pressures are acting locally.

You may also wish to consider the second [application](#), which allows you to use juvenile data collected for local management purposes in the same way as above, provided that these data were collected to the same scientific standards. The outputs are the same as the first application (above).

##### Adult salmon status

The outputs from the national conservation regulations have also been included in a further [application](#). For any given assessment area, the application allows you to display river grades for the 2020 fishing season, catch data and an assessment of performance for the past 5 years.

## Atlantic Salmon Pressure Definitions






Having gathered all relevant information relating to the status of Atlantic salmon stocks (see above), the next step is to attribute (where possible) specific pressures to these impacts. The importance of any given pressure is a function of the severity of the pressure and the spatial extent over which that pressure acts. For example, a relatively small impact which takes place over an entire catchment may be more important than a severe impact on a small section of river (unless that section relates to a specific sub-population).

For each individual pressure added to the map, you are also asked to assign a severity, status and a confidence level. It is important to remember to categorise all sections of river where there is no recorded impact, rather than leaving the entry blank. The easiest way to do this is to either select the whole catchment with the freehand selection tool.

The definition of each of these categories is included below. Should any catchments or river segments be left blank with no **Severity or Status** rating at the end of the exercise, for data collation and reporting purposes these will be considered as **Severity = Unknown and Status = No Value (Null)**.

### Severity

Severity relates to the impact of the pressure on salmon production. It is recognised that the precise impact of a specific pressure is difficult to quantify accurately, therefore four broad categories (labelled A-D) are set out below.

<b>A:</b> Production is as expected – no impact	 <b>A</b>
<b>B:</b> Between 51% and 95% of natural production remaining due to this pressure	 <b>B</b>
<b>C:</b> Between 20% and 50% of natural production remaining due to this pressure	 <b>C</b>
<b>D:</b> < 20% of natural production remaining due to this pressure	 <b>D</b>
<b>Unknown</b>	 <b>Unknown</b>

Pressures should only be assigned to category C or D where there is clear evidence (perhaps through significantly depressed juvenile or adult numbers) of a major impact.

Where you consider that the pressure is acting on the catchment, but cannot assign a specific severity rating, the severity should be marked as **Unknown**. This is still valuable information and may help to identify key knowledge gaps at a national level. For any catchments or river segments left with no Severity rating provided at the end of the exercise, these will be considered as **Severity = Unknown**.

To make the process as user-friendly and intuitive as possible, as soon as contributions are made, the colour of the map will change automatically based on the severity, as set out below.

### Status

Status relates to the amount of time during the year in which the pressure is acting on salmon production and also covers historic and emerging pressures. In the case of river segment pressures, the following categories relate to the entire calendar year. At the catchment-scale a pressure may extend over a shorter period but may still be chronic if that period corresponds to a key life stage (e.g. smolt run, or adult migration).

**Chronic:** pressure is currently present for more than 50% of the calendar year

**Episodic:** pressure is currently present for less than 50% of the calendar year



**Historic:** pressure has now been removed but has lasting effect on salmon

**Emerging:** pressure is increasing and thought likely to have a greater impact in the future

The user also has the option to mark the status as **not applicable**. This would only be used where severity is recorded as 'none' (in circumstances where it was clear that this could not be an emerging pressure) or severity is recorded as 'unknown'. **Not Applicable** is the default output where no data has been entered. For any catchments or river segments left with no Status rating provided at the end of the exercise, these will be considered as **Status = No Value (Null)**.

### **Confidence**

The default (pre-entered) value for all pressures in the salmon pressures mapping project is '**Low**'. '**Low**' refers to pressures where data-driven evidence is not readily available to show the impact on salmon populations. Users are requested only to assign pressures with '**High**' confidence where there is data and evidence to back up this assessment. This could be locally collected data or information drawn from elsewhere.

### **Sources of Evidence**

To complement the map-based aspects of this process, users are also provided with the opportunity to contribute a brief summary of the sources of evidence used. This may be a brief list of available evidence sources -for example juvenile survey data or smolt emigrant data or other survey data- or links to online reports where more detail can be found.

Rather than attempt to gather text directly within the salmon pressure mapping tools, an online form has been created to enable this. For each individual salmon pressure, up to 500 characters (~150 words) may be provided. Please note that for any individual pressure marked with '**High**' confidence, sources of evidence must be provided. For any individual pressure marked with '**Low**' confidence, provision of sources of evidence is optional.

<https://www.surveymonkey.co.uk/r/salmonpressures>

One response from each district is requested and the form may be accessed and revisited at any time, so long as the same computer is used.

## Pressures on Atlantic salmon

The Scottish Government, along with Fisheries Management Scotland and other partners have identified 12 [high-level pressure groups](#) impacting on Atlantic salmon in our waters and further afield which are broadly comparable with the broad themes identified in the salmon pressures mapping project.

The same list of pressures that may be faced by Atlantic salmon forms the basis for this project, as set out below. These pressures have been grouped into broad themes, some of which should be recorded at a catchment scale, whilst others should be recorded only for the appropriate parts of the river catchment upon which the pressure is acting. These pressures are listed below, along with some basic guidance as to how these might be considered.

1. Those which can be considered as acting on whole catchments – these relate to Theme A (see below);
2. Predation-related pressures (Themes A and B) may also be recorded at both catchment-scale (extent of impact on wider salmon population) and river segment-scale (specific in-river location of predation events).
3. The remaining pressures are to be recorded at a river-reach scale in Themes B-I. To allow information to be assigned rapidly across large rivers, data may be added to whole sub-catchments at once. In recognition that some pressures may be acting on very short sections of river it is also possible to record at fine scales.

The river network utilised within the process covers all of the main rivers in Scotland as mapped by Ordnance Survey. Please note that this includes areas above natural and man-made barriers to migration. Contributors are free to record pressures taking place above the limit of salmon distribution where these pressures have an impact further downstream on salmon.

The data entry process has been split into the following broad themes in order to simplify the process.

### Pressures to be recorded at whole-catchment scale

#### Theme A - [Catchment-scale Pressures](#)

##### Illegal exploitation

This would include 'poaching' but also any taking of fish within rivers designated as category three under the Scottish Government conservation measures. The 2019 salmon status assessment map is available within the layer list.

##### In River and Estuarine Net

This relates to legal operation of fisheries which are not affected by the Scottish Government conservation measures. It may also relate to historic impacts of fisheries which have now been closed.

##### Rod and line

This relates to the effect of killing fish within the rod and line fishery, assessed at a whole-catchment-scale. Please take into account the Scottish Government conservation measures approach here.

### **Seals**

The effect of seal predation on adult returns at a catchment-scale. You have the option to view relevant mapping layers relevant to seals directly.

### **Piscivorous birds**

The effect of predation by piscivorous birds on salmon smolts at a catchment-scale.

### **Piscivorous fish**

The effect of predation by piscivorous fish on salmon smolts at a catchment-scale.

### **Disease**

The effect on adult spawner numbers at catchment-scale.

### **Sea lice**

- Whilst there is a significant body of work developed in Norway and Ireland, it is recognised that currently there is little Scottish-specific information on the impact of sea lice from aquaculture on wild salmon (as opposed to sea trout). Unless you are able to supply good evidence to the contrary (i.e. sweep netting data collected during the Atlantic salmon smolt run) it is suggested that the severity of impact from sea lice should be marked as 'unknown'. However, in assessing relative pressures arising from sea lice, current data from Norway and Ireland (which shows an average impact of 20%) will be taken into account.
- [Scottish Salmon Producers Organisation – Monthly sea lice reports](#)
- [MSS Summary of information relating to impacts of salmon lice from fish farms on wild Scottish sea trout and salmon](#)

### **Farmed Escapees**

Please use any relevant information on the extent of genetic introgression or direct effects through competition etc.

- [Fish Escapes – Scotland's Aquaculture](#) (Please note that an escape in the marine environment is only likely to lead to impacts on wild salmon if the escaped fish enter rivers).

### **Coastal Nets**

There continues to be a prohibition on coastal netting of salmon so the status of this pressure should only be marked as 'historic', if applicable.

### **Marine Development**

Estimated effect on marine survival as a result of any marine developments, including harbour developments, marine renewables, but not aquaculture. A range of different marine development mapping layers may be switched on using the layer list directly in the tool.

- Various mapping layers related to marine developments are available in the layer list.

### **Other Catchment-scale Pressure**

Free-text field to record any additional pressure of any type that cannot be captured elsewhere in the process. This field is limited to 100 characters.

## **Pressures to be recorded at individual river scale**

### **Theme B - [Predation & Stocking](#)**

#### **Piscivorous birds**

Specific location of piscivorous bird predation events, recorded at river segment-scale.

#### **Piscivorous fish**

Specific location of piscivorous fish predation events, recorded at river segment-scale.

#### **Other Predation**

Free-text field with a character limit of 100. Specific location of any predation event which cannot fit in any other category.

#### **Stocking**

Stocking has been undertaken across Scotland with a range of objectives. In recent years, scientific studies have shown that where inappropriate stocking is undertaken (e.g. the introduction of fish of domesticated (aquaculture) origin, or translocation of fish without suitable local adaptations) this can have detrimental effects on wild salmon production. Please identify areas where stocking activities have had a detrimental effect on local wild salmon production.

### **Theme C - [Invasive Non-Native Species \(INNS\)](#)**

Please see further information on the water environment hub below in relation to these pressures.

- [SEPA Water Classification Hub](#) – Alien Species assessment
- [UK Technical Advisory Group classification of aquatic alien species according to their level of impact](#)
- [Aquatic alien species and the WFD: proposed list of ‘locally non-native’ species and guidance on its interpretation](#)

#### **Crayfish**

Specific location(s) of invasive crayfish species impacts within the catchment. The Water Framework Directive (WFD) assessment of Alien Species status is also available within the map. Please also refer to Annex A below.

#### **Fish**

Where fish species are introduced outside their native range, this can have negative effects on Atlantic salmon populations. Please indicate parts of the catchment where negative impacts occur.

#### **Other**

Free-text field with a character limit of 100 for noting the spatial extent of any other invasive non-native species impacts on salmon production.

## **Theme D - [Habitat - Water Quality](#)**

Assessments that may be applicable across the pressures in this theme include the [SEPA Water Classification Hub](#) – overall chemistry and ecology assessments, benthic invertebrates, biological elements and ecological indicators assessments. These assessments can be chosen and viewed using the navigation panel on the left hand side of the Hub.

### **Acidification**

Rivers where salmon production is known to be impacted by acidification. This could be from current sources or historic sources such as acid rain. Please also refer to Annex A below.

- SEPA Water Classification Hub – macroinvertebrates, Acidity, ANC and PH assessments

### **Point-source pollution**

River segments where salmon production is known to be impacted by point-source pollution including septic tanks or licensed discharges. There is a further option available to record at fine (metre length) scales.

### **Diffuse pollution**

Rivers where salmon production is thought to be impacted by diffuse pollution, including sedimentation, high nutrient concentrations, pesticides etc.

### **Eutrophication**

Rivers where salmon production is thought to be impacted by excessively high nutrient levels. Please also refer to Annex A.

- SEPA Water Classification Hub – aquatic plants, dissolved oxygen and soluble reactive phosphorous assessments

### **Other - Habitat - Water Quality**

Free-text field (with a character limit of 100) to note the spatial extent of any additional water quality-related pressure that cannot be captured elsewhere.

## **Theme E - [Habitat - Water Quantity](#)**

Assessments applicable to general water quantity include the [SEPA Water Classification Hub](#) – overall hydrology, hydrology, low flows.

### **Abstraction**

Rivers where salmon production is thought to be impacted by a reduction in water quantity through abstraction. Please also refer to Annex A below.

### **Flow regulation**

Rivers where salmon production is thought to be impacted by changes in water quantity through flow regulation from industries such as hydro power.

### **Upland / agriculture / land-use and drainage**

Rivers where salmon production is thought to be impacted by land-use-mediated impacts on water quantity.

### **Changing rainfall patterns (floods)**

Rivers where salmon smolt production is thought to be significantly impacted by extreme high flow events. Please consider effect on smolt output only rather than impacts on individual cohorts of fry and parr.

- [SEPA Water Classification Hub – Hydrology](#) –medium/high flows.

### **Other - Habitat - Water Quantity**

Free-text field (with a character limit of 100) to record any additional water quantity-related pressure that cannot be captured elsewhere.

## **Theme F - [Habitat - Thermal](#)**

Due to the complex relationships between water temperature and salmon production, assigning a severity category may be challenging or impossible. In these cases, severity should simply be marked as none or unknown. Where evidence clearly suggests a significant impact on salmon production, this would normally be assigned to category B. Under current conditions it is unlikely that water temperature-related pressures would be assigned as category C or D.

For further information on river temperatures in Scotland please view the outputs of the [Scotland River Temperature Monitoring Network](#). These layers are available directly within the layer list. A new [application](#) also allows metrics such as salmon stress to be mapped for catchments where temperature loggers are currently installed.

Scottish Forestry mapping layers (such as the [Native Woodland Survey of Scotland](#)) have also been included directly within the salmon pressure mapping tool.

### **Loss of shading**

Rivers where an increase in water temperature due to loss of shading by trees has an impact on salmon production. Further option available to record at fine (metre length) scales.

### **Over-shading**

River segments where over-shading by trees is thought to have an impact on salmon production. Due to the lack of evidence available on this topic, severity should routinely be recorded as unknown. There is a further option available to record at fine (metre length) scales.

### **Changing temperature patterns**

Rivers where climate warming is thought to have an impact on salmon production. This pressure encompasses both effects on adult spawners and juveniles. Status would routinely be recorded as emerging for this pressure as climate warming is predicted to have an increasing impact on salmon in future. Maps showing climate projections such as increase in summer air temperature are available directly within the pressure mapping tool.

### **Thermal discharge**

River segments where anthropogenic warm water discharge (such as that from whiskey distilleries) is occurring. As it is challenging to link warm water discharge to impacts on salmon production the severity for this pressure should routinely be recorded as unknown. There is a further option available to record at fine (metre length) scales.

### **Hydro modification**

This relates to changes in the thermal regime relating to large impoundments.

### **Other - Habitat - Thermal**

Free-text field (with a character limit of 100) to record any additional water temperature-related pressure that cannot be captured elsewhere.



## **Theme G - [Habitat - Instream & Riparian](#)**

Due to the complex nature of instream and riparian habitat dynamics and the relationship to salmon production, assigning a severity category may be challenging or impossible. In these cases severity should be marked as unknown or none. Where evidence clearly suggests a significant impact on salmon production, this would normally be assigned to category B. For many of the habitat-related pressures in this section, it is unlikely that severity would be assigned as category C or D.

Various layers have been included, including the Habitat Map of Scotland and Forestry Scotland layers.

### **Loss of sediment transfer**

River segments where loss of sediment transfer (for example below dams) has an impact on salmon production. Please refer to the SEPA obstacles to fish passage dataset.

### **Lack of large woody debris**

River segments where a lack of woody debris/habitat has an impact on salmon production. There is a further option available to record at fine (metre length) scales.

### **Canalisation / dredging/boulder removal**

River segments where instream works have an impact on salmon production. There is a further option available to record at fine (metre length) scales. Please also refer to Annex A below.

- [SEPA Water Classification Hub](#) – morphology.

### **Loss of natural riparian vegetation**

River segments where the loss of natural riparian vegetation reduces habitat quality and salmon production. There is a further option available to record at fine (metre length) scales.

### **Conifer afforestation**

River segments where commercial non-native forestry activity reduces salmon production. This includes effects on in-stream productivity and food availability for salmonids but does not include acidification or effects on river temperature (see relevant sections above). There is a further option available to record at fine (metre length) scales.

National Forest Estate layer is included.

### **Other - Habitat - Instream & Riparian**

Free-text field (with a character limit of 100) to record any additional instream and riparian pressures that cannot be captured elsewhere.

## **Theme H – [Obstacles to Fish Passage](#)**

Please note that the maps include some areas above natural and man-made barriers to migration. Contributors are free to record pressures taking place above the limit of salmon distribution where these pressures have an impact further downstream on salmon. Please refer to the SEPA obstacles to fish passage layer available within the salmon pressures mapping tool. You may also want to make use of available barrier impact resources from Marine Scotland including the barrier impact analysis included within the Marine Scotland [application](#). If you have any new information on obstacles to fish passage please forward to [dominic.habron@sepa.org.uk](mailto:dominic.habron@sepa.org.uk)

### **Upstream passage**

Please record river segments upstream of man-made obstacles (and partial obstacles) to fish passage where salmon production is impacted. Please note that areas above natural barriers to migration should not be considered. Please also refer to Annex A below.

### **Downstream passage**

River segments below barriers where losses (smolt or adult) occur as a direct or in-direct result of man-made obstacles to downstream salmon passage.

### **Other Obstacle-related Pressure**

Free-text field (with a character limit of 100) to record any additional barrier-related pressures that cannot be captured elsewhere.

## **Theme I - [Unknown Salmon Pressures](#)**

To be utilised where evidence points to a decline in salmon production but the pressure causing the reduction is unknown. Severity and status may also be recorded for unknown pressures.

## Annex A

### Integration of available information from the Water Framework Directive

Users are encouraged to draw upon a wide range of information sources to assist with the gathering of salmon pressure information. Data on a range of river environment pressures is available via the SEPA [Water Classification Hub](#). From the hub you may view maps and access data on the status of the surface waters, ground waters and protected areas in Scotland, classified under the Water Framework Directive (WFD) scheme. This includes a range of potentially useful information relating to the physical condition, water quality, access for fish migration, water flow and levels and INNS. At the top of the classification hub web page there is a link to user help pages.

For a total of 6 individual pressures, the salmon pressure mapping tools have been pre-populated (using 2018 data) in order to flag river segments where the WFD status may be assessed as less than *good* status (*moderate, poor or bad* status). These river sections are coloured pink on the map.

For these areas fishery managers are asked to make their own assessment specifically for salmon. This should be undertaken in exactly the same manner as for all other pressures. In practice this involves selecting these rivers and assigning severity (A, B, C, D, or Unknown), status and confidence ratings exactly as done elsewhere in the process. At the end of the project all rivers which were initially coded as “WFD status less than good” should have been changed to one of the Atlantic salmon severity categories.

Please note that WFD information has only been pre-populated for the following six individual pressures; Upstream passage, crayfish, acidification, eutrophication, abstraction, canalisation / dredging / boulder removal.

Please note that due to data transfer constraints information may not appear exactly as it does in the Water Classification Hub. For up to date information on all WFD pressures please view the [Water Classification Hub directly](#).