

DEVELOPING JUVENILE SALMON ASSESSMENT METHODS FOR SCOTLAND



Background

The Conservation of Salmon (Scotland) Regulations 2016 were introduced to manage the killing of Atlantic salmon in inland waters based on annual assessments of the conservation status of stocks. Current assessments are based on estimates of returning adult numbers. However, there is increasing interest in the potential of juvenile data to provide a complementary assessment.

Electrofishing surveys are undertaken by fisheries managers, scientists and regulators to capture and count juvenile fish. Where electrofishing is performed according to carefully defined standards and combined with appropriate statistical analyses, it is possible to estimate the number of fish in a particular section of a river, river catchment or region.

Juvenile electrofishing data are not currently used to assess the status of salmon stocks at a national level because (1) it is hard to determine how many fish there should be in a “healthy” river and (2) until 2018, there was no strategic national annual electrofishing survey from which to determine current salmon numbers.

To address these challenges, Marine Scotland has implemented a research and monitoring programme to develop a juvenile assessment

method that can be used to determine the status of salmon populations each year.

How many salmon should there be?

In 2019, Marine Scotland published a paper describing a new national juvenile salmon density model for Scotland (Malcolm *et al.*, 2019). The study was based on data collected by 25 organisations between 1997 and 2015, and involved >3800 site visits.

Using this model, it was possible to predict the average numbers of salmon that should be found in Scotland's rivers based on their environmental

characteristics, excluding the effects of environmental pressures (Fig. 1). The resulting predictions, which vary spatially across the river network, are known as ‘Benchmark’ densities and can be compared to observed salmon densities to assess the status of rivers.

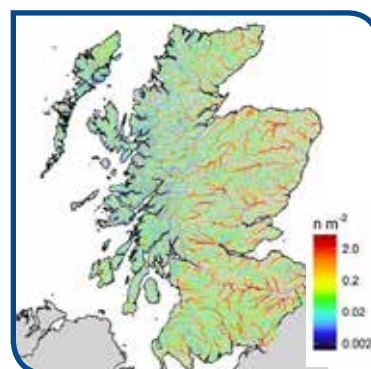


FIGURE 1
BENCHMARK DENSITIES FOR
SALMON FRY IN SCOTLAND

How many salmon are there?

The National Electrofishing Programme for Scotland (NEPS) was established to obtain a spatially balanced, representative, unbiased estimate of the number of salmon in Scotland's rivers (Fig. 2).

NEPS was designed by scientists from Marine Scotland. Sampling is undertaken locally by District Salmon Fishery Boards and fisheries trusts with financial support from Marine Scotland, Crown Estate Scotland, SEPA and SNH.

NEPS is a statistical survey, generated using a stratified, unequal probability, generalised random tessellation stratified (GRTS) survey design.

This ensures that the sampling is approximately equally distributed over the area of interest (rivers fishable by wading), while maintaining randomness at smaller scales. NEPS includes the following design features:

- Only rivers that are likely to be fishable by wading are included in the design.
- Rivers above impassable barriers are excluded.
- Rivers expected to have greater salmon densities (based on the juvenile density model) have a higher probability of being sampled.
- Stratified into 27, similarly sized, geographic regions with one or more rivers per region.
- 30 sites in each region, in each year, split across a 3 panel design that balances spatial coverage and trend detection.
- 10 3-pass sites and 20 1-pass sites per region.
- Replacement sites provided where sampling is not possible.

Assessing Status

By comparing Benchmark densities to those obtained from the NEPS survey it is possible to assess the status of individual sites. By up-scaling the Benchmark and NEPS survey data to catchment, regional or national scales, it is possible to obtain assessments appropriate to national fisheries management.

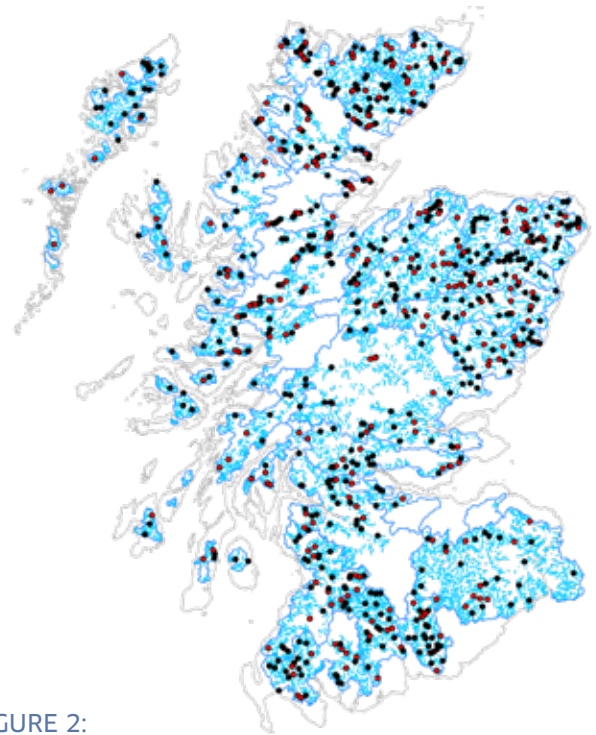


FIGURE 2: SITES INCLUDED IN 2018 NEPS SURVEY DESIGN. BLACK DOTS ARE 1 PASS SITES, RED DOTS ARE 3 PASS SITES. BLUE LINES ARE RIVERS INCLUDED IN THE DESIGN.

Future work

Outcomes of the juvenile assessment work will be compared to adult based methods for Conservation Regulations. Future work will consider options for combining the outcomes of the adult and juvenile assessment approaches into a single assessment.

Further Information:

<https://www2.gov.scot/Topics/marine/Salmon-Trout-Coarse/Freshwater/Monitoring/ElectrofishingProgramme>

R Shiny App: <https://scotland.shinyapps.io/sg-national-electrofishing-programme-scotland/>

Malcolm IA, Millidine KJ, Glover RS, Jackson FL, Millar CP, Fryer RJ. 2019. Development of a large-scale juvenile density model to inform the assessment and management of Atlantic salmon (*Salmo salar*) populations in Scotland. *Ecological Indicators* 96: 303–316 DOI: 10.1016/J.ECOLIND.2018.09.005

Malcolm, I.A. Millidine, K.J. Jackson, F.L. Glover, R.S. and Fryer, R.J. (2019) Assessing the status of Atlantic salmon (*Salmo salar*) from juvenile electrofishing data collected under the National Electrofishing Programme for Scotland (NEPS). *Scottish Marine and Freshwater Science* Vol. 10 No. 2.

