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Scotland river temperature monitoring network (SRTMN)

Background

Water temperature (Tw) is critical for the growth, production and survival of ecologically and economically important freshwater fish including Atlantic salmon and brown trout. Salmon and trout tend to do best when temperatures are in their mid-teens and struggle much above 20°C.

In 2018, it is estimated that around 70% of Scotland's rivers experienced temperatures that would cause thermal stress in juvenile salmon (greater than 23°C), with similar conditions expected every other year by 2050. As a result there are growing concerns over the future availability of suitable thermal habitat for species adapted to living in cool water.

Under certain circumstances, bankside trees can reduce high temperatures providing management options. However, fisheries and river managers need information on where rivers are hottest, where temperatures will increase most and, where bankside tree planting would be most beneficial to target management actions.

It is possible to produce this information, but it requires carefully planned and managed temperature data collection and novel statistical models to map current and future river temperatures. As a result the Scotland River Temperature Monitoring Network (SRTMN) was established in 2013 as a scientific collaboration between Marine Scotland Science and the University of Birmingham, supported by District Salmon Fishery Boards and fisheries trusts.

Objectives

- Develop models to understand and predict river temperatures across Scotland under current and future climate
- Produce maps to show where rivers are hottest, will change the most under climate change and where trees can reduce river temperature
- Provide information on inter-annual variability and trends in river temperature

Designing the network

The monitoring network was designed to include sites across a wide environmental and geographic range to allow statistical models to be developed. Temperature dataloggers (automatically recording temperature sensors) were deployed between the summers of 2014 and 2015 following stringent quality control procedures (*see* SRTMN webpages). The base monitoring network is shown in Figure 1a and summary data is available through the SRTMN R Shiny App.

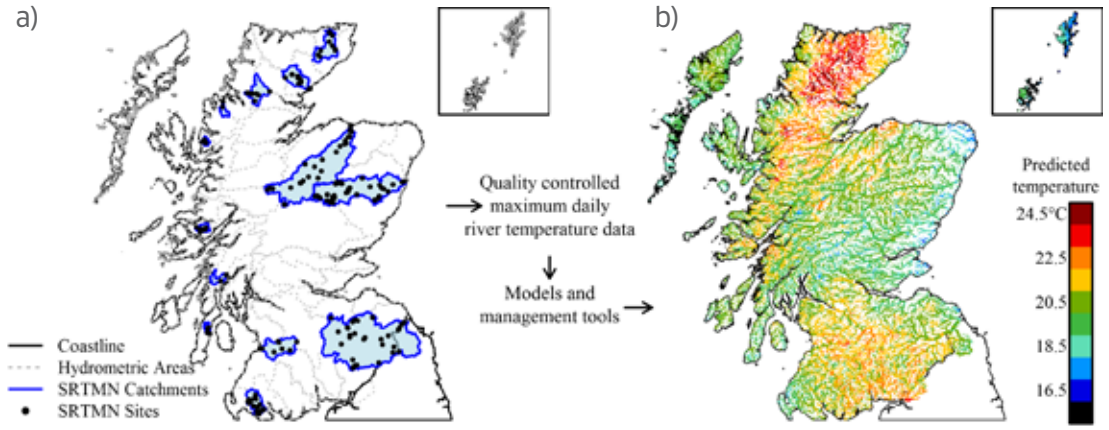

Figure 1
a) SRTMN sites
b) National maximum river temperature predictions for the hottest day of the 2015/16 study (DoY 182).

Figures reproduced from; Jackson, F.L., Fryer, R.J., Hannah, D.M., Millar, C.P., & Malcolm, I.A. (2018) A spatio-temporal statistical model of maximum daily river temperatures to inform the management of Scotland's Atlantic salmon rivers under climate change. Science of The Total Environment, 612, 1543-1558.

Since 2015, additional short term temperature deployments have been undertaken to improve understanding of river temperature in unmonitored catchments. These deployments follow the same quality control standards as core SRTMN deployments.

Statistical models

Since it was established, a number of management models have been developed using data from SRTMN. An example of one such model is shown in Figure 1b, where Tw was predicted for the hottest day of 2015 / 16

This models provides information on:

- maximum Tw (where is hottest)
- climate sensitivity (how much Tw will change for a given change in air temperature)

Predictions of Tw can be made for any river location, on any day of the year using information on air temperature, location in the country (region), location on the river network and the characteristics of the river (elevation, bankside woodland and channel orientation).

Interactive maps of maximum river temperatures and climate sensitivity are available online to help fisheries, river and land managers plan for the future to protect Scotland's rivers and fisheries from the detrimental effects of climate change. Further information on how to use SRTMN resources to help decide where to plant trees to protect rivers from high temperatures is available in topic sheet 91 (*see* SRTMN tools webpages).

Future work

Monitoring will continue to provide important information on changing river temperatures in Scotland and to underpin improvements to Tw and juvenile salmonid assessment models. Work is under way to explore opportunities for adding real-time monitoring to the network and for assessing the influence of natural and man-made standing waters on Tw.

Further information:

SRTMN tools web page: https://www.gov.scot/publications/scotland-river-temperature-monitoring-network-srtmn/pages/outputs-and-tools/

Jackson, FL, Fryer, RJ, Hannah, DM, Malcolm, IA. Predictions of national-scale river temperatures: A visualisation of complex space–time dynamics. Hydrological Processes. 2020; 34: 2823– 2825.

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