

SUMMER 2018 RIVER TEMPERATURES



Background

River temperature is important for growth and survival of freshwater fish. There are concerns that increasing river temperatures could have a detrimental effect. Atlantic salmon exhibit thermal stress at ca.23°C with mortality at ca.33°C. Brown trout die where maximum temperatures exceed ca.30°C.

The summer of 2018 was characterised by unusually high air temperatures (Fig 1) and low river discharges (Fig 2). However, recent UKCP18 projections suggest that the chances of experiencing summers as warm as 2018, could be as high as 50% by 2050. The data collected during summer 2018 therefore provides insights into the effects of temperature extremes on salmonid populations under current climate and the likely prevailing effects under climate change.

The Scotland River Temperature Monitoring Network (SRTMN) provides quality controlled data from a strategically designed network of >200 sites. When combined with spatial statistical river network models it is possible to understand and predict temperatures across all Scotland's rivers.

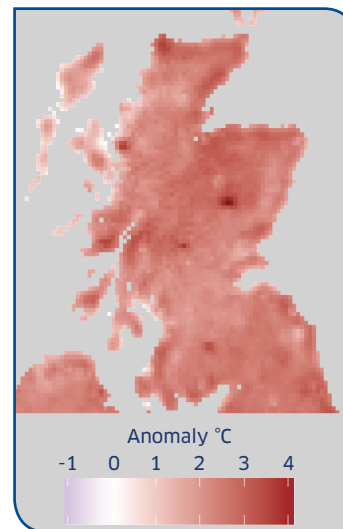


FIGURE 1
MEAN MAXIMUM DAILY AIR TEMPERATURE ANOMALIES FOR SUMMER 2018. POSITIVE VALUES INDICATE TEMPERATURES WERE WARMER THAN AVERAGE OVER THE PERIOD 1981-2010.

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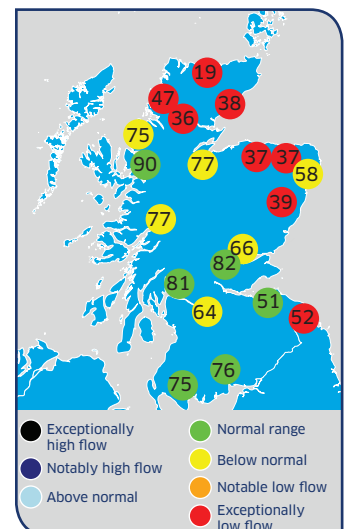


FIGURE 2
RIVER FLOWS (SUMMER 2018) RELATIVE TO A 30 YEAR BASELINE (1981-2010). NUMBERS INDICATE THE % OF BASELINE FLOWS OBSERVED DURING 2018. COLOURS INDICATE THE RANKING RELATIVE TO BASELINE YEARS.

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Objectives

1. Map predicted maximum river temperatures for summer 2018
2. Illustrate where maximum river temperatures exceeded important temperature thresholds for salmon and trout.

Statistical Models

In 2018, Marine Scotland and the University of Birmingham published a daily maximum river temperature model for Scotland using data from 2015-16 (Jackson et al., 2018). This model was “re-fitted” to data from 2018 and used to predict maximum daily river temperatures across the country using daily air temperature data from the UK Met Office.

Summer maximum river temperatures were mapped and the number of days exceeding the temperature threshold for thermal stress in salmon were summarised (Fig. 3a, b).

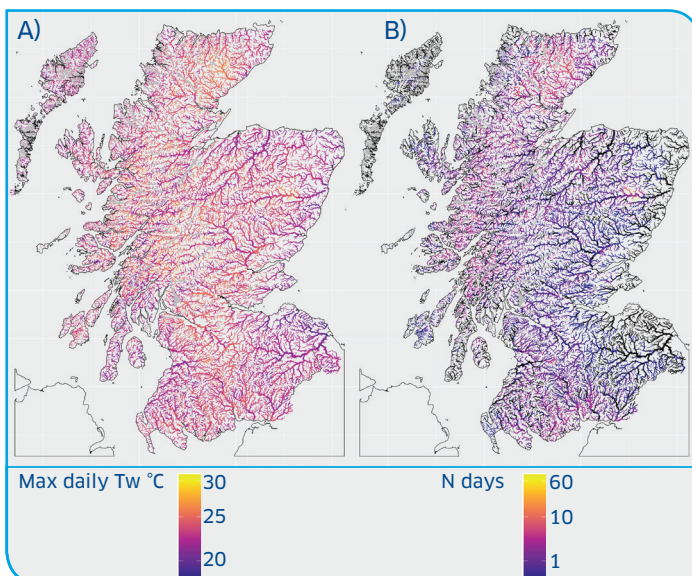


FIGURE 3
A) PREDICTED MAXIMUM RIVER TEMPERATURE AND B) NUMBER OF DAYS EXCEEDING THE THRESHOLD FOR THERMAL STRESS IN JUVENILE ATLANTIC SALMON (23°C). GREY DENOTES LOCHS. BLACK DENOTES 0 DAYS ABOVE THRESHOLD.

Results and future work

The temperatures recorded during the summer of 2018 show that 69% of Scottish rivers experienced temperatures that cause thermal stress for salmon on one or more days (Fig. 4). 0.01% of Scottish rivers experienced temperatures above the lethal limit for trout. No rivers experienced temperatures that would be lethal for salmon. Under climate change, high temperature events such as those seen in 2018 are expected to become more common and extreme.

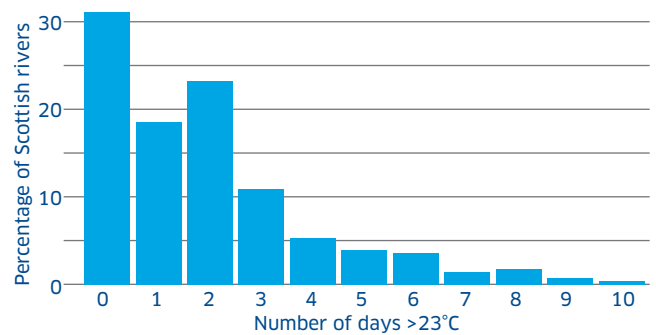


FIGURE 4
THE PERCENTAGE AND DURATION OF SCOTTISH RIVERS EXCEEDING THE THRESHOLD FOR THERMAL STRESS IN JUVENILE ATLANTIC SALMON (23°C). EXCLUDES STRAHLER RIVER ORDER 1.

In certain circumstances bankside trees can mitigate high temperature extremes. Marine Scotland has produced a suite of tools for managers to plan and prioritise tree planting to help manage river temperatures.

Further Information:

- 🌐 <https://www2.gov.scot/Topics/marine/Salmon-Trout-Coarse/Freshwater/Monitoring/temperature>
- 🌐 R Shiny Application: <https://scotland.shinyapps.io/sg-srtmn-data/>
- 🌐 Model: 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.
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