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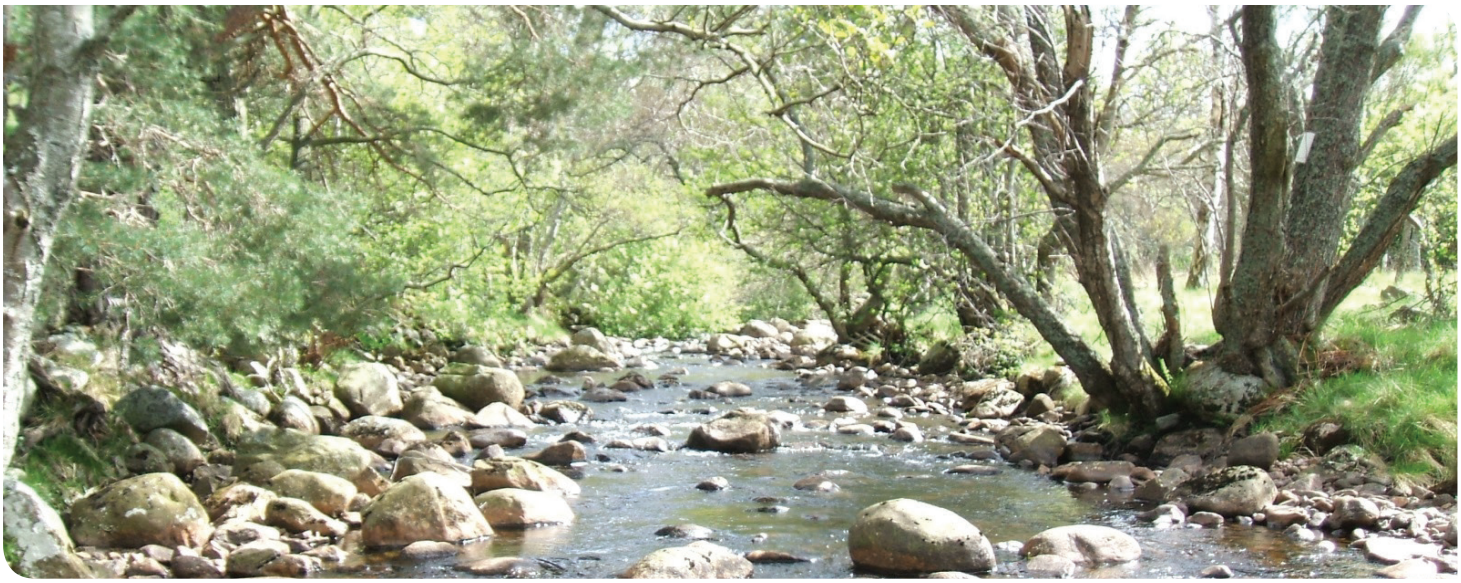
WHERE SHOULD WE PLANT TREES TO PROTECT RIVERS FROM HIGH WATER TEMPERATURES?



Background

River temperature (Tw) influences the feeding, growth and productivity of freshwater fish and extreme high Tw (e.g. >29°C and >32°C for trout and salmon juveniles) can kill fish in as little as 10 minutes. Under climate change Tw is expected to rise, with potential consequences for Scotland's valuable salmon and trout populations.

Bankside trees can reduce Tw, however, their effect varies depending on the characteristics of the rivers (such as width, channel orientation, speed) and their surrounding landscapes (such as tree density, landscape shading).

Fisheries and river managers are increasingly interested in planting bankside trees to protect rivers from high water temperatures. However, they often lack the necessary information to determine where planting would deliver the greatest benefits.

Can models help inform tree planting strategies?

Marine Scotland and the University of Birmingham have recently developed tools and advice to help river managers decide where to plant trees to reduce maximum daily river temperatures and mitigate the effects of climate change.

These tools include two types of complimentary models which are applied depending on the spatial scale at which decisions are being made:

1. Statistical models describe large scale (>km) Tw variability and climate sensitivity

2. Deterministic models identify the processes controlling Tw and the effects of management actions (including shading by trees) at finer spatial scales (metres to kilometres).

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Large-scale statistical models

Statistical models are supported by data from the Scotland River Temperature Monitoring Network. Two of the main outputs from these models are maps of:

- maximum river temperatures
- climate sensitivity (the increase in Tw that would be expected for a 1°C increase in air temperature).

These outputs are available online through NMPi (see further information), allowing river managers to prioritise management actions to the parts of river catchments that are most likely to be negatively impacted by climate change.

Fine-scale deterministic models

Deterministic models can be used in "virtual experiments" to assess the importance of different controls on river temperature. For example, it is possible to assess the effects of different densities of bankside trees (shading), the direction that a river flows (orientation) and the speed that it flows at (Fig 1).This information can be used to inform precise planting locations.

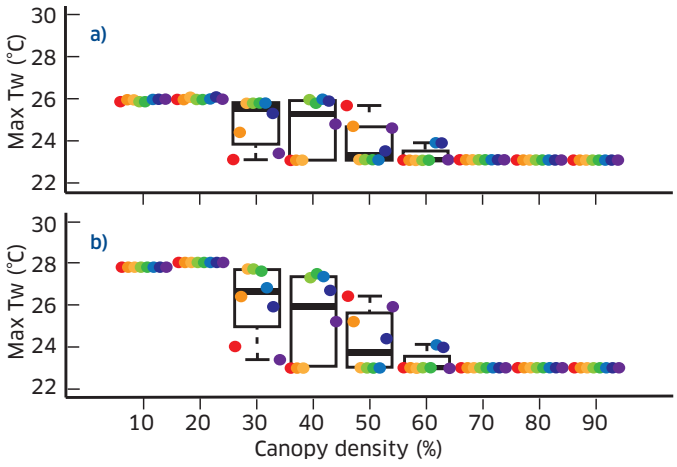

FIGURE 1.
THE EFFECTS OF TREE CANOPY DENSITY AND CHANNEL ORIENTATION ON PREDICTED RIVER TEMPERATURE UNDER CONDITIONS OF (A) HIGH AND (B) LOW WATER VELOCITY. POINTS ARE COLOURED BY CHANNEL ORIENTATION FROM NORTH-SOUTH (RED) TO NORTH WEST- SOUTH EAST AT 45 DEGREE INTERVALS.
Figures reproduced from: Garner et al. (2017) The role of riparian vegetation density, channel orientation and water velocity in determining river temperature dynamics

How should we use these to inform tree planting?

To use these models to inform tree planting, some of the things to consider are:

- Identify general locations for planting using mapping outputs from the statistical models (NMPi)
- Where a southerly bank is available, then less tree cover is needed to reduce Tw
- Where a southerly bank is not available, then higher density, overhanging trees are required
- Planting has a greater effect in slower flowing rivers
- The benefits of planting are greater in medium sized rivers that are shallow and wide

Further Information:

SRTMN web page:

http://www.gov.scot/Topics/marine/Salmon-Trout-Coarse/Freshwater/Monitoring/temperature

SRTMN topic sheet:

http://www.gov.scot/Topics/marine/Publications/TopicSheets/tslist/SRTMN

NMPi maps:

http://marine.gov.scot/information/scotland-river-temperature-monitoring-network-srtmn-predictions-river-temperature-and