



Keeping our rivers cool

Julia Toone from the Department of Geography at Loughborough University offers advice on how to protect fish stocks from rising water temperatures.

The recent mild weather has provided us with enjoyable fishing conditions, but it hasn't been quite as happy going for the fish. Warmer air temperatures mean warmer water temperatures: and this has a detrimental impact on the lifecycles of salmon and trout. Warmer waters affect

embryo and juvenile survival rates, the timing of smolt runs, adult migration patterns - and thus abundance and distribution patterns. Declining fish stocks have been associated with increasing amounts of fine sediment, for example, but water temperature may play a significant part in this reduction, too.

Amid increasing air temperatures, river water temperatures across England and Wales have risen by an average of 0.3°C per decade since 1990 (Orr et al., *Hydrological Processes, under review*). Similar trends have been observed in many countries, not just throughout the UK, and are set to continue into the future.

So what can be done to protect our fish stocks from this warming?

Given the strong relationship between air and water temperature, there is ample evidence that shade provided by bank-side trees and overhanging vegetation maintains cooler water temperatures, and limits extremes in temperature range at a site. This effect has been particularly noted in North America by studies of pre- and post-

tree harvesting conditions, and in catchments subject to different land uses. But is planting trees the universal answer?

Riparian woodland has a double-whammy advantage of both providing shade and limiting bank erosion at the same time. But trees are not always welcomed by landowners, or anglers, either. Not everyone is happy to have trees planted along their river banks, citing problems such as river access, shading of agricultural fields and even increased flood risk. So what is a suitable alternative to trees when they are not wanted, or maybe not even the most appropriate remedy?

River banks and valley sides also provide shade. Incised narrow channels, such as the upper part of the River Dove in Derbyshire, are entrenched within the valley bottom, often beneath several steep former floodplain terraces, and high valley walls. In places, the shading afforded by the natural landscape of the river channel overrides that provided by bank-side trees. In these locations, planting trees would have less effect, and is arguably not the best use of limited resources.

Where should we buffer water temperatures? Can we identify, literally, hot spots along our rivers? Which sites are more vulnerable to warming than others - and at which sites should we prioritise our efforts? Conversely, where is management least likely to be effective?

To get a handle on some of these questions, the Department of Geography at Loughborough University is currently monitoring air and water temperatures at 35 different sites along the Dove and the Manifold Rivers. We are particularly interested in how the relationship between air and water temperature is influenced by physical channel characteristics, such as channel slope, bed sediment size, bed and bank shape, inflow from tributaries, geological changes, and the amount of bank-side shade.

The Dove and Manifold drain the Upper Dove catchment, of which 60 per cent lies in the Peak District National Park. Thanks to Isaak Walton and Charles Cotton, the Dove in particular is an iconic fishing river. But by way of its natural history and contemporary

pressures, it poses something of a challenge to its fish population.

The Dove and Manifold are complex river systems: their upper parts are relatively unconstrained, draining a landscape underlain by silt-rich mudstones and sandstones. In contrast, their lower parts are confined by narrow limestone gorges, and old artificial within-channel weirs and stone-wall channel banks. In terms of their physical channel properties, the Dove and Manifold

site might influence local water temperature. In turn, it is hoped that this information can be used by local environment and conservation officers who want to predict how temperatures will change at different locations on their rivers, and target areas for remediation.

We would like to thank the Wild Trout Trust for their financial support, which enabled dataloggers to be purchased; and the local anglers who keep watch on our kit.



A completely exposed river with no shade at all



With very little shade, this river is prone to increased water temperatures



In addition to trees, river banks and steep valleys can provide shade



Ample shade provided by a combination of valleys and trees