

K eeping 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.

salmon and trout. Warmer waters affect reduction, too.

he recent mild weather has embryo and juvenile survival rates, the provided us with enjoyable timing of smolt runs, adult migration fishing conditions, but patterns - and thus abundance and it hasn't been quite as distribution patterns. Declining fish happy going for the fish. Warmer stocks have been associated with air temperatures mean warmer increasing amounts of fine sediment, water temperatures: and this has a for example, but water temperature detrimental impact on the lifecycles of may play a significant part in this

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

Riparian woodland has a doublewhammy 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









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

pressures, it poses something of a challenge

share several similarities, but there are also strong contrasts between the two rivers, and a comparison will help us to understand the key controls on water temperature.

Since 1990, the Environment Agency (EA) has taken monthly spot-check measurements of water temperature at a handful of locations on both rivers. These data show increases in mean annual temperature of between 0.7 and 1.9°C per decade. As a result of change in sampling times, the absolute increases are probably less, but warming trends are found at all EA monitoring locations on the rivers. Intriguingly, the rate of warming since 1990 is greater for water temperature than it is for air temperature recorded at the closest national climate monitoring site (in Buxton).

The detailed insight gained from our continuous monitoring of air and water temperatures should reveal the scope for water temperature management on the Dove and Manifold. Our data will show variation in temperatures at and between all 35 sites, and within and between the seasons, to demonstrate not only absolute differences in temperature between warm sites and cool sites, but also how different sites respond to warm and cool periods. Short term and extreme temperature events affect the physiology, behaviour and movement patterns of salmon and trout - and are not detected by monthly spot-check measurements. The findings of our study will also be transferable to other rivers that have similar natural characteristics and physical properties. On the basis of associations between these features and the strength of the air-water temperature relationship, it will be possible to identify sites vulnerable to warming, and evaluate how any change to the local physical environment at a

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.