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The Influence of Riparian Woodland on Stream Temperatures: Implications for juvenile salmonids

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Stream temperature is an important variable affecting the performance of juvenile salmonids with extreme high temperatures ($>$27 degrees C) causing outright mortality. Temperatures are controlled by energy (heat) inputs to and losses from the watercourse which are reported elsewhere at this conference. These energy exchanges are, in turn, influenced by spatial factors which include: aspect; channel and riparian morphology; substrates; and the location of tributary and groundwater inflows. Temporally, controls include: annual solar cycles and seasonal changes in hydrology, wind speed, humidity, air and water temperature. In recent years that has been considerable interest in the affects of riparian trees on stream temperatures due to their potential to mitigate against extremes: an issue thought to be of increasing relevance to climate change impacts. Previous work in N. America, primarily in relation to commercial forestry, has generally focused on maximum temperatures and many studies have been of short duration (1year). In the United Kingdom, there is increasing interest in the use of natural riparian woodland in stream restoration, although the impacts on stream temperature and subsequent affects on freshwater ecology are largely unknown.

The Girnock Burn is a 30 km^2 catchment in the North East of Scotland where stream temperatures and salmon population dynamics have been studied for over 30 years. In recent years, spatially distributed temperature measurements have been combined with intensive repeat electrofishing surveys in order to assess (1) the influence of riparian woodland on the temporal and spatial variability of stream temperatures in

a small upland spawning stream and (2) assess the influence that this has on juvenile salmonid performance. Stream temperature was measured at five locations on the Girnock stream network, 2 sites were located above the riparian woodland in an area of open moorland, while the remaining 3 sites were located within the woodland at approximate distances of 0.75, 1.5 and 2km downstream. Intensive repeat electrofishing was carried out at the uppermost open moorland site and at the furthest downstream woodland site where differences in stream temperature would be expected to be greatest. Inter-site differences in thermal regime varied at a range of temporal scales from inter-annual to diel. Maximum differences were observed during summer months when mean daily temperatures varied by up to 2.3 degrees C and maximum daily temperatures varied by up to 5.8 degrees C. Winter temperatures were similar between sites, reflecting low inputs of shortwave radiation and the reduced importance of shading. Differences in juvenile salmonid performance detected between sites were consistent with the spatial variability in thermal regime with slower growth rates observed at forested sites. However, exact mechanisms are confounded by inter-site differences in juvenile densities and potential differences in food availability. This study indicates that riparian land management has the potential to mitigate against extreme stream temperatures that may result from climate change. However, further work is required to understand more subtle impacts on juvenile salmonid performance.