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Thermal regimes in a large upland salmon river: a simple model to identify the influence of landscape controls and climate change on maximum temperatures.

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Stream temperature is a key physical water quality parameter influencing biotic and abiotic dynamics in aquatic systems. These processes include solubility and exchange of gases, decomposition of organic matter, and community metabolism of aquatic ecosystems. The complex feedbacks between these processes regulate carbon and nutrient fluxes between the terrestrial system and the oceans. Furthermore, temperature determines thermal habitats, influencing all aquatic organisms. In the light of climate change, which will likely affect stream temperature, the aims of this study are to (i) identify catchment characteristics which control stream temperature at the large catchment size, (ii) identify temperature sensitive zones in a large scale stream network and (iii) use different scenarios to explore possible effects of riparian land use change and climate change on the temperature sensitive zones.

Temperature observations at 25 sites in the 2000 km2 Dee catchment in NE Scotland were used, in conjunction with GIS analysis, to identify dominant landscape controls on mean monthly maximum stream temperatures. Maximum winter stream temperatures are mainly controlled by elevation, catchment area and hill shading, while the maximum temperatures in summer are driven by more complex interactions, which include the influence of riparian forest cover and distance to coast. Multiple linear regression was used to estimate the catchment wide distribution of mean weekly maximum stream temperatures for the hottest week of the two year observation period. The results suggested the streams most sensitive to high temperatures are small upland streams at exposed locations without any forest cover and relatively far inland, while lowland streams with riparian forest cover at locations closer to the coast exhibit a moderated thermal regime. Under current conditions all streams provide a suitable thermal habitat for the dominant native fish species, Atlantic salmon and Brown trout. Using two climate change scenarios assuming 2.5°C and 4°C air temperature increases, respectively, temperature sensitive zones of the stream network were identified which could potentially have an adverse affect on the thermal habitat of Atlantic salmon and Brown trout. Analysis showed that extension of riparian forests into headwater streams has the potential to moderate changes in temperature under climate change.