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Water temperature variability within an Arctic stream; analysis and implications

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Arctic climate warming occurred at twice the global average over the last century and air temperature is predicted to increase by 7.5°C by 2099. Arctic river systems are hypothesized to be particularly vulnerable to warming due to their dependence on cryospheric water sources and thermal sensitivity of biotic communities. However, research is very limited on hydroecological response of Arctic rivers to a changing climate. This paper addresses this research gap and aims to investigate links between thermal dynamics and benthic communities for a river basin in Swedish Lappland.

The Kårsavagge is located ∼200 km north of the Arctic Circle and contains a small temperate glacier and two lakes. The Kårsa River drains into the Abisko River (∼ 25 km from the valley head). The region experiences marked seasonality with average monthly air temperature ranging from +10 to -10°C.

In June 2008, three gauging stations (1 - close to glacier snout, 2 - above first major extra glacial tributary and 3 – between the lakes and confluence with the Abisko river) were installed to record water temperature, riverbed temperature (at 0.05m, 0.20m and 0.40m depth), electrical conductivity, river stage, precipitation and turbidity. On top of these, twenty loggers recorded water temperature between gauging stations and across a braided reach located ∼ 1.5km downstream of the glacier snout.

Diurnal water temperature cycles were found at all sites; but average temperature increased downstream from 1.7°C near the glacier snout to 10.6°C before the Abisko River confluence. Sites immediately downstream of the lakes displayed moderated thermal variability.

Bed temperatures in the upper catchment (lower) were higher (lower) and less variable that temperatures in the overlying water column. The degree of parity between water column and stream bed temperatures varied among sites with site 3 showing the greatest difference and site 2 showing the least. This implies a variable degree of connectivity between the water column and bed sediments and/or variation in the extent and source water of upwelling. Average temperature across the braided reach ranged from 2.8°C in the main glacier fed (kryal) channel to 8.8°C in a snowmelt (nival) channel sourced from north-facing slopes, reflecting the differential impact of solar heating on water from these two distinct sources.

Chironomidae (non-biting midges) dominated the benthic communities in the upper catchment where maximum water temperature did not exceed 4.4°C. As distance from the glacier and water temperature increases other taxa appear (e.g. Plecoptera, Simulidae), with species richness and diversity peaking between the two lakes.

Longitudinal changes in thermal regime are associated with shifts in the benthic invertebrate community. Work is ongoing to evaluate whether the observed lateral variation, which is close to that observed down the 25km longitudinal profile has similar implications. This lateral variability may be important in providing thermal refugia and therefore increasing biota diversity in the upper catchment. This work has highlighted the potential extent of longitudinal, vertical and lateral temperature variation within Arctic river systems. In combination with invertebrate distribution this could be used to identify communities at high risk from changes in thermal regime and further, identify species which can act as indicators of the changing Arctic climate.