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The case of hydrological and biogeochemical process-understanding for predicting stream biota across scales

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The linkage between the terrestrial watershed, the riparian interface and stream water is fundamental for our understanding of surface water ecosystems. While hydrology is the key to explaining the physical linkage between different soil compartments and surface waters, the biogeochemistry of the hydrologically-connected soils provides the basis for understanding variability in the hydrochemical signature. By combining a hydrological and biogeochemical process-understanding we can better appreciate the natural variability in stream water quality. This understanding will also provide the basis for models for predicting water quality effects from land-use changes and climatic warming. This in turn, can help anticipate how aquatic ecosystems are likely to respond to changes in water quality across temporal and spatial scales.

One example of where a hydrological and biogeochemical process-understanding has been successfully related to stream ecology across scales is at the interdisciplinary, multi-scale Krycklan Catchment Study in northern Sweden. This study has combined detailed soil transect investigations, synoptic sampling of 60 stream sites and 15 intensively monitored sub-catchments ranging over three orders of magnitude in size, from 3 ha to 6780 ha, since 2002. The process-understanding comes from a cocktail of solutes (pH, DOC, inorganic monomeric Al, major anions and cations, Hg and other metals) and isotopic tracers (^{18}O, D, ^{14}C, ^{13}C, ^{15}N, ^{34}S, $^{206/207/208}$Pb, ^{226}Ra, ^{230}Th,$^{234/238}$U,) that have been measured in combination with hydrometric analyses, electro-fishing surveys, fish survival experiments, studies of macroinvertebrate

taxa richness and species assemblages, diatom species composition and microbial utilization of DOM. The results from this work suggest that water quality is an important determinant for species assemblages and biodiversity of stream biological communities in the boreal landscape. For example, streams of low pH provide a natural boundary for some organisms, notably brown trout (*Salmo trutta*), but have little effect on macro-invertebrate species diversity in the Krycklan catchment. At the same time modeling results suggest that the spatial extent of acid-sensitive organisms throughout the catchment is sensitive to small changes in biogeochemistry, especially during the spring snowmelt period.