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Biotic and geomorphic patterns in a naturally disconnected stream network— longitudinal variations in channel width and riparian vegetation communities in a northern stream-lake system

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Ecological and geomorphic theory assumes longitudinal connectivity within a stream network. Biotic communities show predictable downstream patterns of increased richness and similarity to proximal upstream and downstream communities, sediment transport connects reaches and increasing downstream flows cause channel geometry to change predictably downstream. These biotic and geomorphic adjustment processes are partially based on the idea of predictable longitudinal changes in a stream network, as described by the concepts of downstream hydraulic geometry and the river continuum concept; although, recent concepts (e.g., serial discontinuity concept and process domain concept) have noted exceptions to the idea of continuous downstream changes. These basic concepts of continuous longitudinal changes in a connected stream system were developed and tested largely in alluvial streams with high levels of connectivity. Here, we test whether these concepts are applicable in a naturally disconnected stream network with numerous mainstem lakes and coarse glacial legacy sediment with low sediment transport levels.

In two medium-sized catchments in northern Sweden, which contain three process domain types (rapids, slow-flowing reaches and lakes), we determined downstream hydraulic geometry relationships for channel width and we inventoried riparian vegetation in each new process domain reach along a continuous $\sim$10 km segment. We found that hydraulic geometry relationships (power regressions of width vs. drainage area, derived from 2m DEMs) were very weak (R2 values: 0.04-0.5) and with mostly low coefficients (α-values < 1) and large variation in exponents (β-values: 0.2-0.7), even when lakes were excluded. This indicates that although channel width does increase in the downstream direction, there is very high local variation in width, within and among process domains. Riparian vegetation richness did not increase markedly downstream as would be expected in a connected stream network, and our data suggest very weak relationships between similarity in riparian vegetation composition among reaches and distance between reaches, indicating that hydrochory plays a small role in metacommunity organization. These biotic and geomorphic results show that these catchments are highly fragmented and that local factors, such as variations in glacial deposits and local seed banks, likely steer geomorphic form and biotic organization. With weak downstream hydraulic geometry relationships, traditional stream ecology concepts, which assume increasing width as discharge and thus drainage area increases, may not apply. These results have implications for stream restoration and recovery in that passive ecological recovery, through recolonization by hydrochory, or geomorphic recovery, through channel adjustment based on the current flow regime, may not be possible. Therefore, in disconnected systems, manual planting of riparian vegetation and physical channel manipulation should play a larger role in stream restoration. Furthermore, even though disconnected fluvial systems with abundant lakes are relatively understudied systems, they may be analogous to pre-anthropogenic stream networks that contained abundant log jams and beaver dams, which create various degrees of natural disconnectivity.