Breaking the ice:
effects of ice formation and winter floods on vegetation along streams

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Akademisk avhandling

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Abstract
Streams in cold regions are characterized by unique hydrological processes that control flow regime and water levels. One of the most important processes is the formation, growth and melting of different types of ice in and around the stream channel during winter. River ice controls major hydrologic events such as winter floods with magnitudes and frequencies often greater than those created by open-water conditions. While river management in northern countries has already recognized high risk of ice damages, the focus of the risk assessment has been mostly aimed towards the local economy; the ecological role of river ice has been less acknowledged. Along rivers in boreal Sweden, riparian vegetation has developed specific zonation with height and age of the plants increasing the further away they are from the stream channel. On lower levels the vegetation is often comprised of short-lived plants, such as annuals and biennials whereas more permanent woody vegetation is found at higher levels. This zonation has most often been explained by the resilience of different growth forms to the inundation regimes, such as the spring flood in northern systems. Within this framework, I investigated which factors drive the ice formation and how ice and ice-induced floods affect riparian and in-stream vegetation. A 3-year survey was conducted of ice formation and vegetation along 25 stream reaches and a set of experiments were used to evaluate ice as a disturbance agent. Reaches far away from lake outlets which had a low input of groundwater and a high velocity and stream power were most prone to form anchor ice, but many other factors also influenced ice formation. Streams with anchor ice experienced more frequent flooding of the riparian vegetation during winter. Our findings suggests that ice and winter floods favour diversity and create habitat heterogeneity for riparian species. On a community level, woody plants such as evergreen dwarf shrubs are eliminated when flooded during winter, opening up patches for other species to colonize, creating a dynamic riparian understory community. Significant changes in river ice conditions could develop with projected changes in climate which would have important geomorphologic, ecological and socio-economic impacts. One implication of climate change could be less ice disturbance and consequently a riparian vegetation in cold regions that slowly changes from forb to dwarf-shrub dominated with a subsequent decrease in species richness. Changes in species diversity and abundance of groups of species related to changes in ice formation could potentially cascade into riparian and in-stream processes such as nutrient cycling, litter decomposition and organism dispersal.

Keywords
anchor ice, climate change, in-stream, riparian, river ice, streams, vegetation