The South Saskatchewan River in Winter

It's almost winter, and the South Saskatchewan River is well into the seasonal changes shared by cold-region rivers worldwide. River ice is an essential component of the South Saskatchewan's flow regime and plays a critical role in its hydrological, ecological, and chemical processes. The annual cycle of cooling in the fall, initial freeze-up, extended ice cover, and spring break-up can produce low flows or floods, modify channels through erosion or deposition, and influence aquatic and riparian habitats. River ice can also have social and economic implications for river-based recreation and floodplain or river corridor development.

As temperatures drop in early fall, the temperature of surface water drops as well. How quickly and how much freezing occurs at the water surface is a dynamic balance between air temperature and streamflow. It takes a relatively high amount of energy to cause a change in water temperature, so deep water, buffered from below against freezing, is warmer water. Fast-moving energetic water is also warmer because movement prevents it from losing enough heat to freeze. Cool air temperatures, combined with shallow water and slow flow, can lead to a quick freeze, however, and the formation of river ice in various forms. Ice types range from frazil ice to anchor ice or static ice or icings. And ice cover can vary from stationary to moving or suspended or pressure related. (Prowse and Gridley (1993) provide a good description of the characteristics and environmental aspects of river ice.)

As temperatures continue to drop, life in and around the river changes. While a cover of ice suggests dormancy, under that cap of ice, water still flows, and life carries on. There are varying degrees of cold hardiness, and aquatic and semi-aquatic life shift into survival mode with strategies that range from remaining active to slowing down or hibernating. Depending on species and habitat, general adaptations include the shift to winter foods, increased range of foods, prolonged development, and life cycles that respond to environmental cues. Harsh conditions can also be avoided by a movement for the winter to terrestrial habitats, to less severe aquatic habitats, or different parts of the same habitat, or by the construction of shelters.

Conserving energy is critical for fish survival through the winter. They survive by changing their behaviour, metabolic processes, habitat preference, and everyday interactions with their surrounding environment. Physical adaptations to winter conditions include a significantly slowed metabolism and slowed swimming abilities. As winter sets in, fish change habitat preference and are more likely found in undercut banks, under rocks, or in root-wads and other covers. They also shift to more overall activity at night, mainly to avoid daytime predation, but also to escape the possibility of being trapped in their hiding places by the overnight formation of ice on the riverbed. Groundwater seeps and springs entering streams can also provide a refuge for fish and other organisms from the severe cold. The groundwater temperature is usually equal to the air temperature above the land surface; thus, areas where groundwater seeps into streams can provide temperatures well above surface water temperature in winter.

Fish must also find winter habitats with a sufficient supply of oxygen. Oxygen becomes a component of river water through the turbulence that occurs with wind and waves, waterfalls, riffles, springs, and rapids. Aquatic plants produce oxygen too. When wintry weather changes surface water to ice, oxygen will continue to be supplied if there is some open water, wind-driven waves, or turbulent flow. If the ice is widespread and complete, there might not be enough oxygen to support fish through the winter in that location.

Some aquatic organisms survive winter by spending months at the bottom of streams and ponds protected from the harsh temperatures near the surface. Many invertebrates burrow in the mud or leaves for the winter. Insects often secrete a fluid that is like antifreeze to withstand the cold. Others, such as toads, frogs, or snakes, hibernate under decaying logs or in stone piles or burrows. Several semi-aquatic mammals also overwinter in and along the South Saskatchewan. Beavers construct mud and wood lodges – with living areas above the water line – to keep them warm and dry when not swimming. Otters and muskrats also stay for the cold weather. River otters are primarily nocturnal but become more active during the day in winter.

Like freeze-up, river ice break-up is sensitive to both temperature and flow conditions. In a *thermal* break-up, "the ice experiences a protracted period of thinning and mechanical deterioration before being easily flushed away by the prevailing flow". In contrast, "*dynamic* break-ups are characterized by rapid and large runoff leading to fracturing and fragmentation of the ice cover" (Prowse et al., 2007).

The break-up of winter ice cover is a short but important event in the annual cycle. Ice jams can occur when floating river ice accumulates at a natural or artificial feature that slows or blocks the downstream progress of ice. Spring break-up ice jams can have a damming effect, significantly reducing the river's flow and causing extreme upstream flooding events with considerable impacts on riverside communities, aquatic life, infrastructure, navigation, and hydropower generation. According to the Committee on River Ice Processes and the Environment (CRIPE), the most severe impacts of river ice occur during ice-jam flooding that can result in loss of property and human life. Evacuations, and even relocations, of entire communities, are often prompted by ice jams. It has been estimated that such events are responsible for annual damages of nearly one hundred million dollars for Canada.

Physical, chemical, and biological processes are adapted to an ice regime, but ice is being lost as the climate warms. There's evidence indicating that the extent and duration of river ice will shift as winters warm – under a warming climate, increased summer heat and delayed autumn cooling would delay river freeze-up. There are still a lot of unknowns about the ecological and physical effects this may have on the rivers such as the South Saskatchewan. However, we know that climate changed induced shifts in ice cover will not be uniform within watersheds, between watersheds, or across the globe.

References and further information:

A Look Under the Ice

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River-Ice Ecology I: Hydrologic, Geomorphic, and Water-Quality Aspects

River-Ice Ecology II: Biological Aspects

Streams in Winter

The ecology of river ice

The Importance of Ice

Winter Season waterways