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Cold Regions Hydrological Indicators of Change for Assessment of Environmental Flows and Climate Change in the Arctic

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Hydrological regimes of the Arctic have been of focal interest due the region's susceptibility to climate variability/change and resource development (eg, oil and gas, hydropower). Not only are the timing and magnitude of hydrological processes affected by cold-region processes that are thermally sensitive (snow, ice, permafrost), especially in a warming climate, but large-scale alterations of flow regimes via damming of rivers have been shown to potentially be significant disruptors of natural flow regimes and related aquatic ecosystems of Arctic rivers.

The natural flow paradigm established explicit linkages between the flow regime and lotic ecosystem structure, function, and diversity. Riverine communities have adapted to variability in magnitude, timing, and predictability of key hydrograph components, such as high- and low-flow periods. Previous research has explored the significance of these and other key variables for hydro-ecological research and environmental flow needs (EFN) recommendations. EFN research historically focused on protection goals of maintaining minimum instream flows to sustain fish species of interest. It has become clear that this approach may fail to protect all components of the river and floodplain ecosystem. This is especially true for cold-climate countries where flow regimes are typically characterized by winter low flows during the ice-covered period, extreme water levels generated with the influence of ice jamming during the spring ice breakup, followed by high spring/summer flows during the open-water period.

In light of increasing development pressures and projected climate change impacts on water availability, both timing and magnitude, there is a growing need to incorporate environmental flows into water sustainability frameworks for cold regions of the globe in order to sustain ecosystems. The goal of this paper is twofold: present an overview of environmental flows for the Arctic region, with a focus on North America; and ii) present the novel Cold-regions Hydrological Indicators of Change (CHIC), which can provide the basis for the assessment of EFN and climate change assessments in cold-region river ecosystems.