

**COLLABORATIVE RESEARCH:
HOW DOES CHANGING SEASONALITY AFFECT THE CAPACITY OF ARCTIC STREAM
NETWORKS TO INFLUENCE NUTRIENT FLUXES FROM THE LANDSCAPE TO THE OCEAN?**

Intellectual Merit: Stream networks are intimately connected to the landscapes through which they flow and significantly transform nutrients and organic matter that are in transport from landscapes to oceans. In previous research we studied several arctic headwater streams to determine how the seasonal development of the thaw basin (thawed sediments under streams) interacts with the hyporheic zone (a layer of surface sediments that contains water which exchanges continuously with water in the open channel). During this study we measured significant rates of net N and P regeneration from (or uptake by) the hyporheic zone during the mid-summer. In many cases this regeneration was important relative to, for example, the amount of N and P required to support primary production in these streams. However, our research raised a number of important questions. First, how important is hyporheic regeneration relative to other important ecosystem or landscape fluxes (e.g. hyporheic mineralization, throughflow, lateral flow)? Second, how does the interaction among these processes differ over the extreme arctic season? During the “shoulder seasons” in the arctic (spring and fall) the extent of sub-stream thaw basin controls the extent of the hyporheic zone, while during the summer the thaw basin is generally deeper than the hyporheic zone. This creates a situation – unique to the arctic – in which the hyporheic zone and its influences on stream biogeochemical processes change seasonally from being non-existent in the early spring and late fall to being fully formed and functional in the summer. Simultaneously, important terrestrial ecosystem characteristics and processes that affect stream function also vary seasonally (e.g., snowmelt, vegetation influences, DOM quantity and quality, microbial activity). The interaction of these seasonally-changing processes and their effects on key in-stream processes – specifically primary production and respiration - is poorly understood. Furthermore, as the arctic region warms in the future the synchrony among these processes may change in important ways. These aspects of arctic seasonality are important because the net effect of these interacting processes is what ultimately controls the flux of carbon, nitrogen, and phosphorus from the arctic landscape to the Arctic Ocean via river networks. **We propose to quantify the relative influences of throughflow, lateral inputs, and hyporheic regeneration on the seasonal fluxes C, N, and P in an arctic river network, and determine how these influences will shift under seasonal conditions that are likely to be substantially different in the future.** This objective is a logical extension of our earlier work and is directly relevant to the ARCSS *Changing Seasonality in the Arctic System* RFP. In this proposal we will focus on seasonal dynamics at different river reach scales (1st to 4th order streams) and will lay the groundwork for a whole river network model to integrate the influences of throughflow, lateral inputs, hyporheic regeneration, and in-stream metabolism on C, N, and P fluxes through an entire river network.

Broader Impacts: This research directly addresses the mission of the Office of Polar Programs Arctic Systems Science program to support interdisciplinary research that focuses on “uniquely arctic processes...that provide hypothesis testing required to produce the understanding needed to develop predictive tools based on first principles.” Our proposed research is also directly relevant to the *Changing Seasonality in the Arctic System* RFP and is consistent with the missions of other important Arctic initiatives, including the Study of Environmental Arctic Change (SEARCH), the Hydrologic Cycle and its Role in Arctic and Global Environmental Change (CHAMP), and the recently completed International Polar Year. Given that rivers are the conduits that link land to the ocean, processes within streams that modify material transport are critical to understand how runoff from land affects oceans. Furthermore, if climate change affects the rate or extent of in-stream processing, then there may be important impacts on the transport of materials from land to the ocean, which this research would address directly. These studies are essential therefore, to provide data and knowledge that will be of use to other scientists, policy makers, and resources managers. This project will directly engage 3 graduate students and several undergraduate students in research that is part of a larger integrated program of research centered at the Toolik Field Station (TFS) in Alaska. As a part of this project, we propose to develop a networked, upper undergraduate and graduate level seminar on the ecology of arctic river networks. The seminar will initially serve as a means to create interactions among the students and co-PIs on this project. However, in the second year we propose to open this seminar to students from any institution. The opportunity to participate in the 2nd year and beyond will be advertised through the many Arctic-related research and education groups already established.