# Seasonality of Nutrient and Organic Matter Export from the North Slope of Alaska to the Beaufort Sea

J.W. McClelland[1], A. Townsend-Small[2], R. M. Holmes[3], M. Stieglitz[4], F. Pan[5], B. J. Peterson[6]

[1]University of Texas, Austin; [2]University of California, Irvine; [3]Woods Hole Research Center; [4]Georgia Institute of Technology, Atlanta; [5]University of North Texas, Denton; [6]Marine Biological Laboratory, Woods Hole

## Introduction

Fluxes of nutrients and organic matter from watersheds to the coastal ocean are tightly coupled with climate variables that control the water balance as well as biological and geochemical activity. This poster focuses on nutrient and organic matter export from the Sagavanirktok, Kuparuk, and Colville rivers to the Alaskan Beaufort Sea (Figure 1). Together these three rivers drain most of the land area on the North Slope of Alaska. While the USGS measures water discharge near the mouth of the Kuparuk River, there are no gauging stations at downstream locations on the Colville or Sagavanirktok rivers. Water discharge was therefore modeled to support estimates of export from these two rivers (Figure 2). Water chemistry was measured at downstream locations on all three rivers (Figure 1) during intensive field efforts in 2006 and 2007. The river export estimates provide a basis for considering runoff contributions to productivity in coastal waters of northern Alaska. Changes in climate are likely to alter the timing and magnitude of river export from the North Slope. This, in turn, will impact productivity in coastal waters of the Alaskan Beaufort Sea.

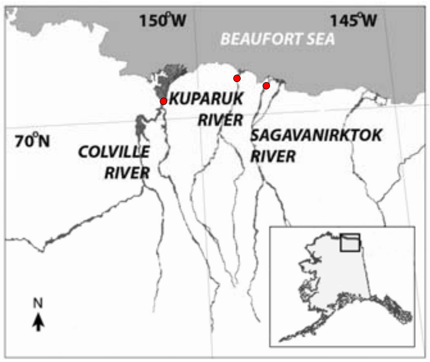



**Figure 1.** The three largest rivers draining the north slope of Alaska. Red points mark sampling locations.

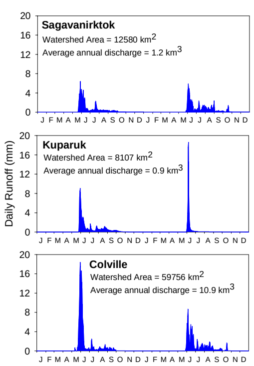
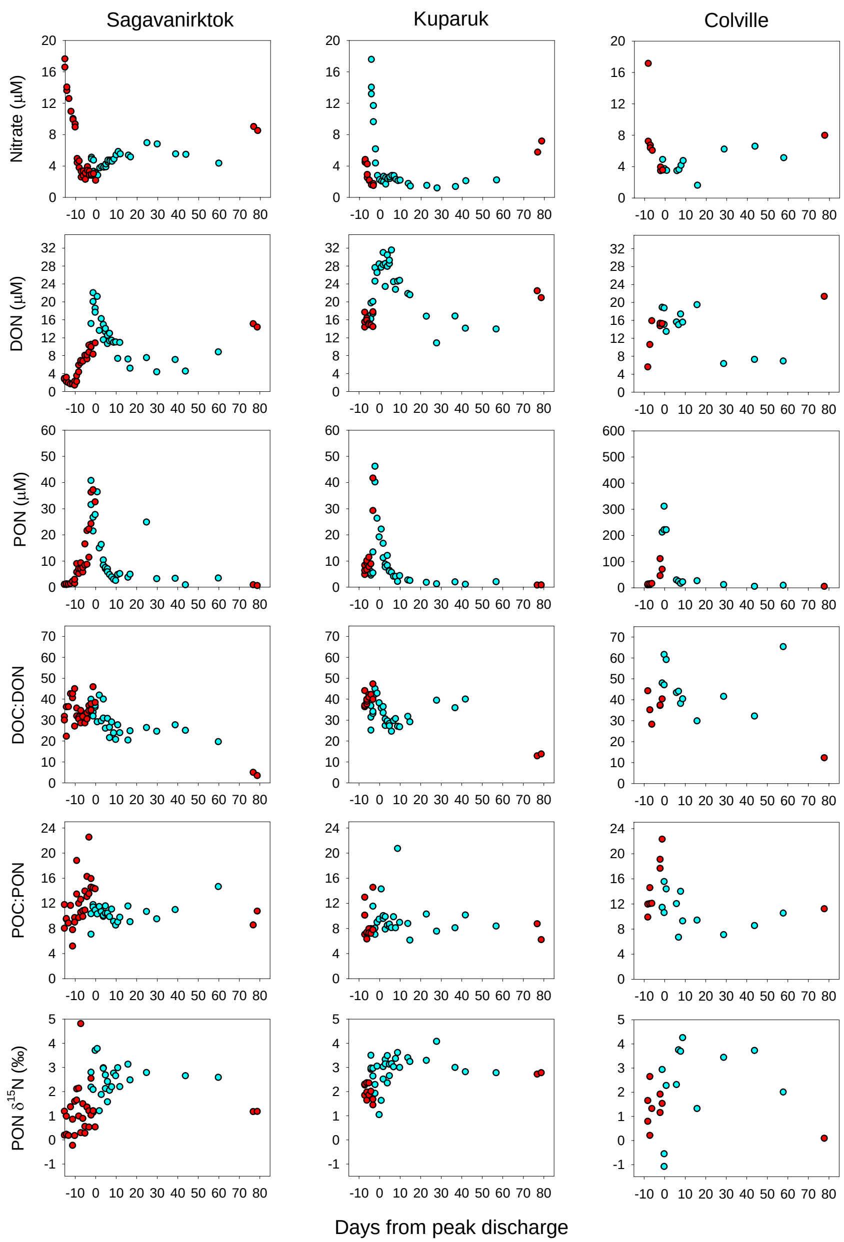



**Figure 2.** Daily runoff from the Colville, Kuparuk, and Sagavanirktok watersheds during 2006 and 2007. Data from the USGS gauge at Deadhorse were used to calculate runoff from the Kuparuk watershed. Runoff from the Sagavanirktok and Colville watersheds was estimated using a version of the NASA Seasonal to Inter-annual Prediction Project Catchment Based Land Surface Model. Model output was compared to measured discharge during the spring freshet. Modeled hydrographs were shifted to match dates of measured peak discharge at each river.




**Figures 3.** Temporal variations in nitrogen concentrations and organic matter quality (as indicated by C:N and $\delta^{15}N$) in the Sagavanirktok, Kuparuk, and Colville rivers. Data from 2006 (blue) and 2007 (red) are plotted relative to the timing of peak discharge (day 0) for each year.

**Table 1.** Constituent export (metric tons / year) and yield (mg / square meter / year) from the Colville, Kuparuk, and Sagavanirktok River watersheds. Values are averages for 2006 and 2007.

| | Colville | Kuparuk | Sagavanirktok |
|---|---|---|---|
| **POC** | | | |
| metric tons / year | 153485 | 1320 | 2220 |
| mg / m$^2$ / year | 2569 | 163 | 177 |
| **PON** | | | |
| metric tons / year | 12977 | 163 | 220 |
| mg / m$^2$ / year | 217 | 20 | 18 |
| **DOC** | | | |
| metric tons / year | 88339 | 8343 | 5103 |
| mg / m$^2$ / year | 1478 | 1029 | 406 |
| **DON** | | | |
| metric tons / year | 2771 | 296 | 275 |
| mg / m$^2$ / year | 46 | 37 | 22 |
| **SRP** | | | |
| metric tons / year | 108.6 | 5.2 | 7.2 |
| mg / m$^2$ / year | 1.8 | 0.6 | 0.6 |
| **Ammonium-N** | | | |
| metric tons / year | 159.4 | 4.5 | 5.0 |
| mg / m$^2$ / year | 2.7 | 0.6 | 0.4 |
| **Nitrate-N** | | | |
| metric tons / year | 843.5 | 41.5 | 137.7 |
| mg / m$^2$ / year | 14.1 | 5.1 | 10.9 |

## Results and Discussion

Large temporal variations in constituent concentrations and organic matter quality are evident in the Colville, Kuparuk, and Sagavanirktok rivers (Figure 3). These variations are most pronounced surrounding the spring freshet. Increased organic matter concentrations during high flow amplify organic matter export during this period. Ammonium and soluble reactive phosphorus (daily data not shown) exhibit similar patterns to those observed for dissolved organic nitrogen. In contrast, dilution of nitrate during high flow diminishes relative export of nitrate during the spring freshet. Annual constituent export from the Colville River watershed is much larger than annual constituent export from the other two watersheds (Table 1) as a consequence of much greater river discharge (Figure 2) . However, constituent yield (mg/m$^2$/y) is also higher in the Colville.

Overall export of inorganic nitrogen from the three watersheds has the potential to support ~7.9 kilotons ($10^9$g) of new organic carbon production in the coastal ocean each year. Organic matter export could support an additional 110 kilotons of new production if all of the organic nitrogen were remineralized. However, the extent to which terrigenous organic matter is broken down after entering the marine environment is not yet well constrained. We know that dissolved organic matter exported from these rivers during the spring freshet is more labile than dissolved organic matter exported later in the summer (Holmes et al., 2008). However, we do not know how much terrigenous organic matter is broken down during its residence time in Arctic coastal waters nor how much nitrogen is conserved within the bacterial community.

Changes in vegetation, microbial activity, and surface/subsurface hydrology as a consequence of changes in climate on the North Slope are likely to alter constituent export from these rivers in the future. Indeed long-term data from the upper Kuparuk River suggest that nitrate export may already be increasing (McClelland et al., 2007). The timing of export is also likely to change (i.e. earlier snowmelt). Such changes have potentially important, yet poorly understood, implications with respect to productivity in coastal waters of northern Alaska.

## Acknowledgements

We thank Breton Frazer, Chad Wagoner, and Jorge Noguera for assistance with field work. This project was funded by NSF-OPP grant #0436118