Event-scale dissolved oxygen dynamics in urban and peri-urban streams

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Introduction

Dissolved oxygen (DO) is an important parameter for ecological and biogeochemical processes and a crucial metric for assessing impact in urban streams. Many previous studies relate DO concentrations to temperature, biotic integrity, and amount of sewage input in urban streams. However, only a few have linked fine temporal scale DO data to meteorological parameters. Using time series of DO coupled with meteorological data, we attempted to link fine-scale dynamics in DO levels to meteorological patterns and watershed characteristics in a network of six urban streams in the Pittsburgh metropolitan region. After one year of data, our goals included the following: 1) quantify the diel range in DO levels across the urbanization gradient, 2) test whether or not diel patterns in minimum and maximum DO levels varied across an urbanization gradient, and 3) determine if DO ranges are affected by precipitation events

Methods

We deployed Precision Measurement Engineering DO sensors at each of the sites listed in the table below. Each recorded DO levels every 15 minutes over a year. Data from the U.S. Navy recorded times of sun rise and set every day for one year. Precipitation data, from 3 Rivers Wet Weather, was recorded at least twice a day or at a higher frequency during precipitation events. Stream characteristics were taken from USGS Stream Stats 4.

Stream	Drain Area (sq. mi)	Urbanization (%)
Breakneck Creek (BRCR)	0.042	5
Crouse Run (CROU)	3.74	69
Glade Run (GLRU)	0.27	0
Irwin Run (IRWI)	0.56	25
Montour Run (MONT)	4.83	15
Nine Mile Run (NMRU)	5.31	84

For each day of record, we quantified the minimum, maximum, and range of DO, the difference in range of DO between days, time frame when the minimum and maximums occurred, and total precipitation. Precipitation data were temporally aligned with DO data to link rain or snowfall events with DO dynamics.

Results

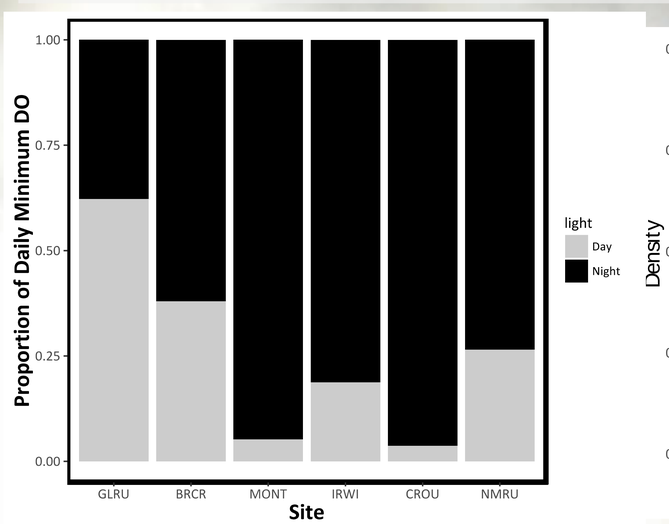

Figure 1 – Occurrence of daily minimum DO over one year.

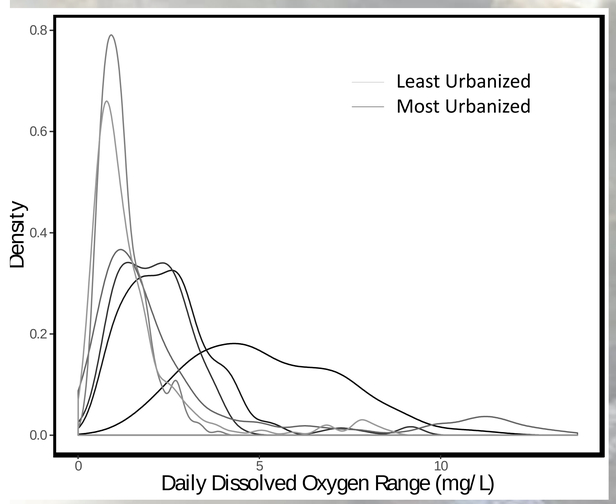

Figure 2 – Distributions of daily DO ranges by site.

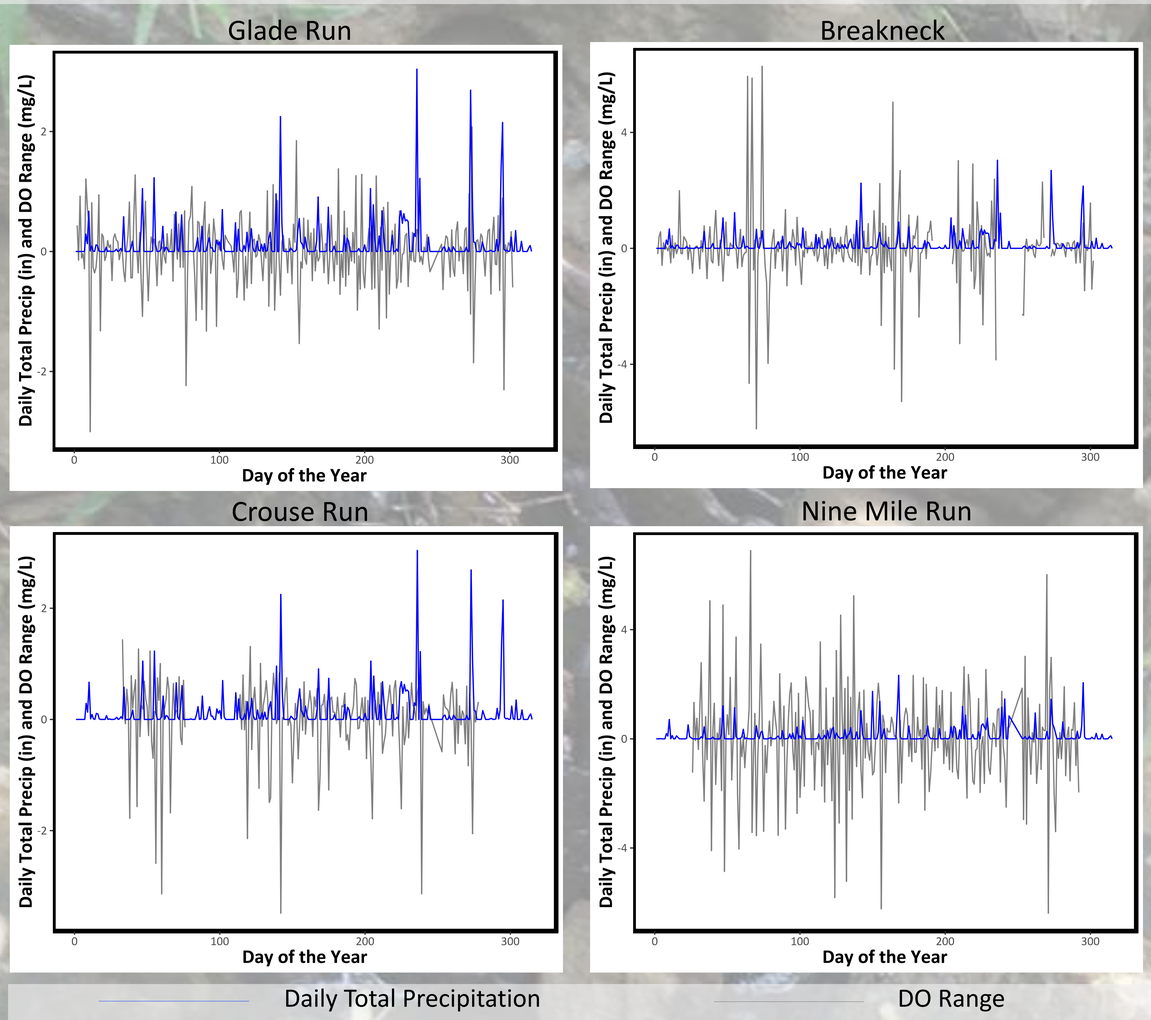

Figure 3-6 – Combines daily precipitation totals with changes in DO ranges. The DO ranges in these graphs are the differences in range between consecutive days. Positive values indicate the previous day had a greater DO range than the following while negative values indicate the opposite.

Discussion

Our findings demonstrated significant differences in daily DO levels across the urbanization gradient. Larger, more urbanized streams typically had minimum DO levels at night and greater daily ranges, while smaller, less urbanized streams had minimums during the day and less variable ranges. However, the most urbanized site behaved like a small, headwater stream in this regard. Streams in our network exhibited episodic, abrupt reductions in daily DO ranges associated with precipitation events. Future investigations will attempt to quantify the size of precipitation events needed to alter observed daily ranges in DO. Our findings show that some event-scale DO dynamics in urban and peri-urban streams depend on watershed size and degree of urbanization.

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