

Spring 2015

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AQUATIC MACROINVERTEBRATE DIVERSITY WITHIN AN URBANIZED GRADIENT



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Introduction

Urbanization leads to reduced ecosystem functioning and biological diversity of streams^{1,2}. However, catchment level effects may also be critical in understanding variation in this relationship². Rock Island and Moline, IL are experiencing substantial growth in population and impervious surfaces (Fig. 1), resulting in less natural infiltration and higher amounts of flow, debris, and pollutants in stormwater streams. Even low levels of development (upstream percent impervious surface levels of 5-10%)³, can eliminate or reduce many pollution intolerant macroinvertebrates. Aquatic invertebrates families are sensitive to water quality and can present a more integrative picture of overall water quality.

Research Questions:

- 1) How do macroinvertebrate communities vary across a gradient of urbanization?
- 2) How does observed variation relate to water quality?

Methods

- 11 watersheds were identified and mapped using GIS (Fig. 2).
- 30 access points to the watersheds were chosen based on access to the headwater, ravine, and confluence.
- Macroinvertebrates were collected at all sites⁴ (Fig. 2).
- 2013: samples were collected approximately once per month May-September.
- 2014: a standardized unit effort was established: 10 pool/10 riffle dip net samples and a fixed 30 minute effort.
- The Family Biotic Index (FBI=tolerance value x frequency) was calculated for each site⁴ (Fig. 3).

Number of organisms per Watershed

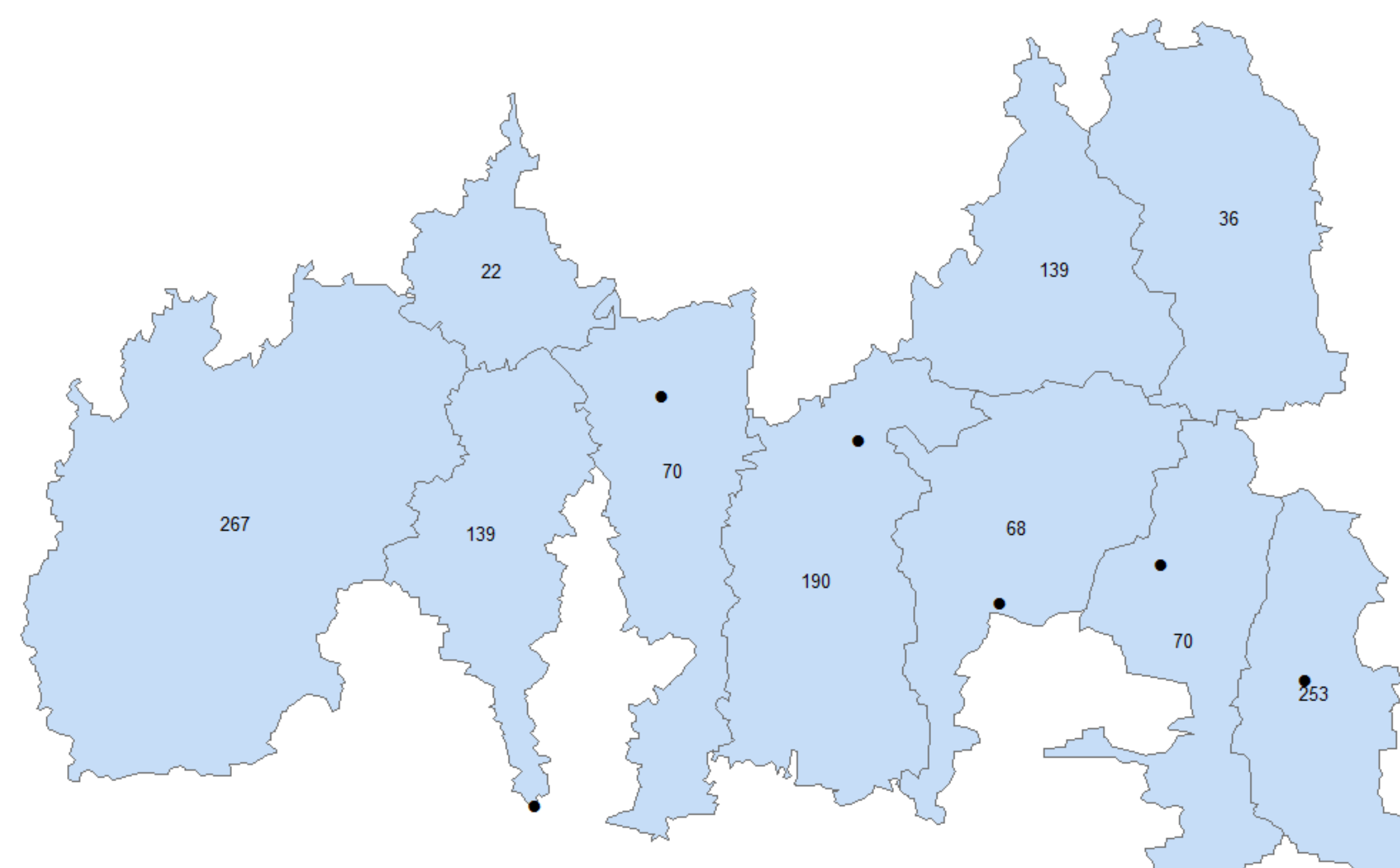


Figure 2: The number of organisms collected per watershed. The markers indicate sampling sites at which no organisms were collected..

- The mean imperviousness (%)⁵ for each area was calculated using GIS polygons previously delineated for the head water, ravine, and confluence areas (Fig. 1).
- NO₃ was measured using an Orion ion selective half-cell with reference electrode.
- NH₃ (Salicylate method) and reactive phosphorus (ascorbic acid method) were measured on a Hach DR850 colorimeter.
- Temperature, pH, specific conductance, turbidity, dissolved oxygen, and dissolved solids were measured using YSI Professional-Plus Multi-parameter Instruments

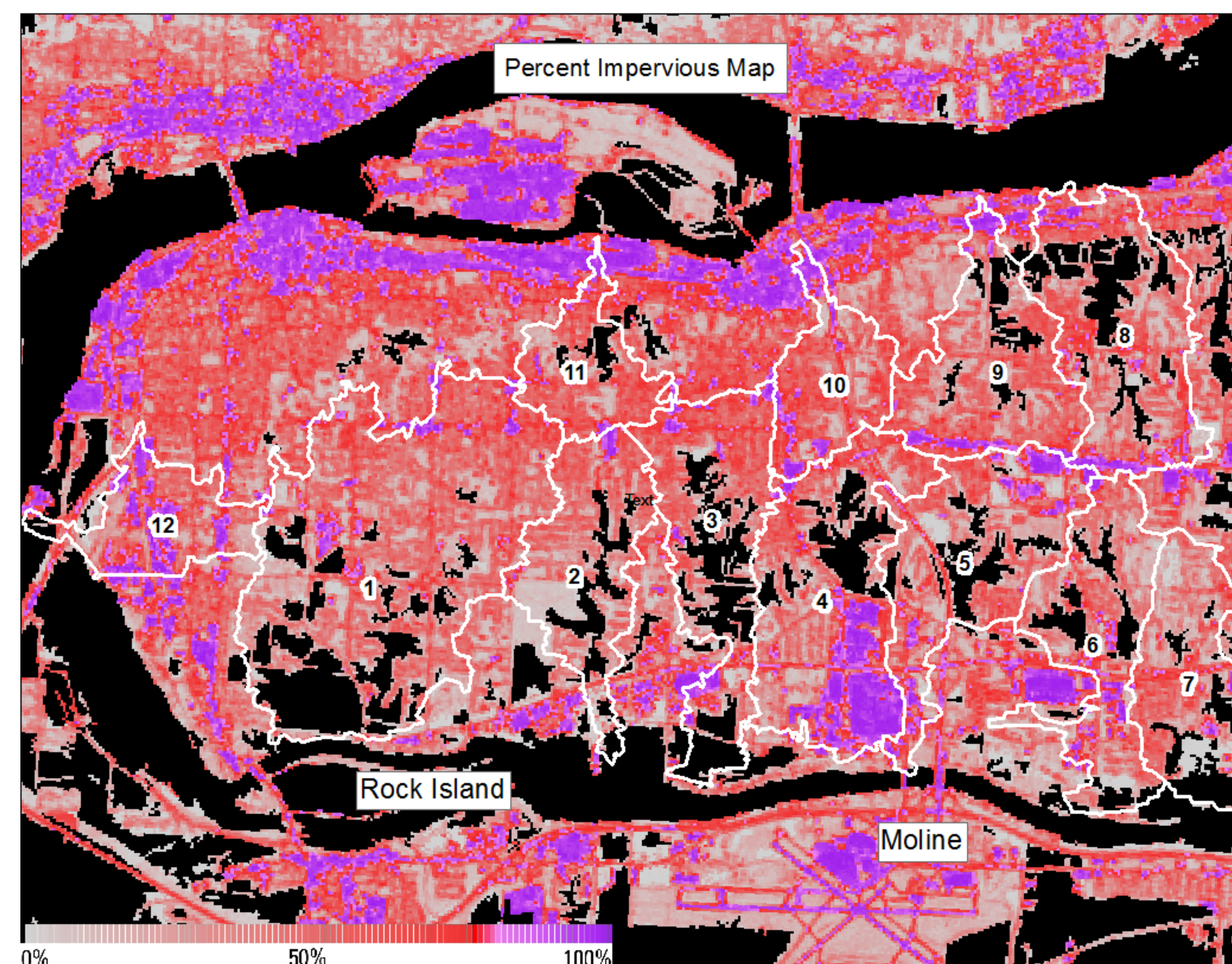


Figure 1: percent impervious in sampled watersheds.

Results

- The sites varied significantly from one another.
- The percent impervious of the surfaces around the sampling sites varied greatly, ranging from 25% to 60% impervious (Fig. 1 and 2).
 - Nitrate:: range: 0.35-25.66 mg/L; overall mean: 6.49 mg/L
 - Ammonia:: range: 0.00-0.60 mg/L; overall mean: 0.13 mg/L
 - Total Dissolved Solids:: range: 3.64-1715.0 ppm; overall mean: 661.66 ppm
 - In general, headwater sites experienced higher nitrate and ammonia levels than Ravine sites, while TDS levels remained the same in both headwater and ravines for most watersheds.

- There was significant variation across the 13 sampling sites in FBI (average FBI ranging 4-8.16)(Fig. 3), however, we found almost no reliable predictors of FBI, with the exception of a weak negative relationship between dissolved oxygen levels and FBI in 2014 (regression, p-value = .035; R² = 0.298).
- The relationship between FBI and upstream imperviousness was weak (regression, p-value = 0.247, R² = 0.034).
- Chironomidae were numerically dominant at most sites (mean 37%, range 0-100%), while Ephemeroptera and Trichoptera were rare (mean 3.9%, range 0-86%).

Discussion

- Our findings provide insights into the integrity of the macroinvertebrate community within an urbanization gradient
- No macroinvertebrates were collected in almost 20% of our sites despite extensive collecting effort (Fig. 2), suggesting severe impairment
 - Findings are consistent with those of other studies showing that high levels of urbanization can homogenize communities: Chironomidae dominate within urban settings while Ephemeroptera and Trichoptera, insect Orders that are highly sensitive to changing water conditions and poor water quality, were found in extremely low abundances.
 - Measured water quality parameters and percent imperviousness do not drive observed patterns in FBI.
 - The lack of observed impact may be due to watershed specific effects such as fine scale land use variation throughout the sampling area, as well as variation in water level and flow.

Average FBI by Site

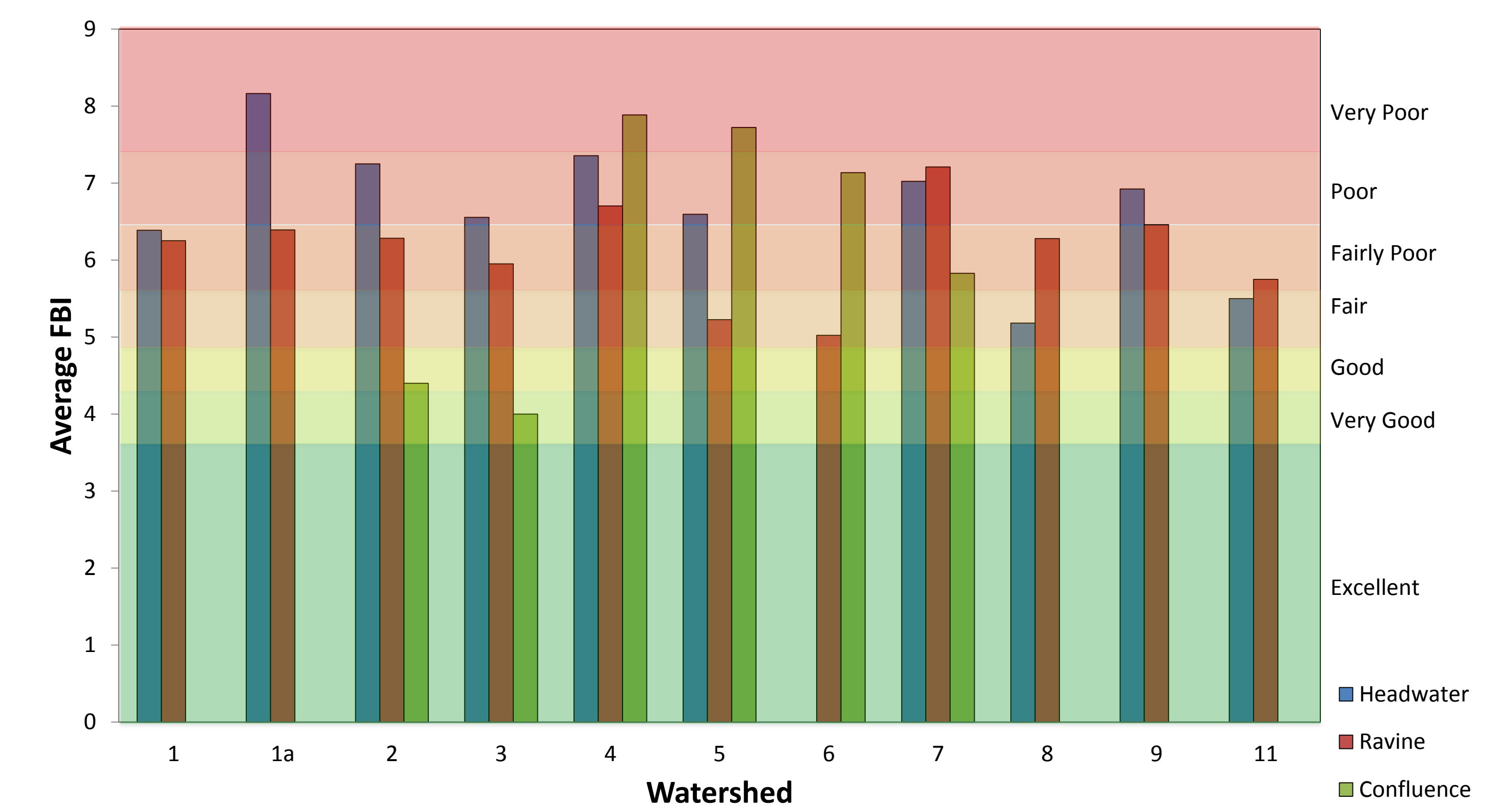


Figure 3: The average Family Biotic Index score for each sampling site.

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