Bugs in the System:
A Comparison of Invertebrate Biodiversity between Two Rivers in Western Massachusetts

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INTRODUCTION. Humans have a long history of altering environments. Farm runoff, mill construction on rivers, deforestation, and reforestation are examples of factors that affect stream and river biodiversity. In this study, we compared invertebrate diversity between the Mill River and Jimmy Nolan Brook in Western Massachusetts. First, we wanted to establish a baseline to begin to examine biodiversity trends and patterns in time and space. Second, we wanted to assess stream health and quality using invertebrate species as bio-indicators.

METHODS. Hester-Dendy samplers were used to sample stream invertebrates in the Mill River and Jimmy Nolan Brook (Figs. 1 & 2). Along with the samplers, 4 Hobo temperature data loggers were submerged at each of the sampling sites. A total of 6 Hester-Dendy samplers were set out on 24 October 2008 in the Mill River near Smith College, Northampton, MA. Three were submerged downstream, 30 m south of the athletic bridge. The other 3 samplers were submerged upstream, 965 m west of Paradise Pond. Six Hester-Dendy samplers were also submerged in the Jimmy Nolan Brook on 26 October 2008. Three were submerged 40 m northeast of Jimmy Nolan Road (upstream), where there was fast-moving water. Three samplers were submerged 30 m southeast of Jimmy Nolan Road (downstream). Samplers were collected at each site after 3 weeks and preserved in 70% ethanol. All organisms in each of the 24 samples were identified using dissecting microscopes and taxonomic guides (Lehmkuhl 1979 & Voshell 2002). For each sample, the number of organisms per family was counted. Shannon Diversity Indices were computed and 2-way analysis of variance (ANOVA) models were used to test for differences between streams or between the upper and lower locations within the streams (Magurran 1988).

Figure 1: Photo documentation of Mill River site.

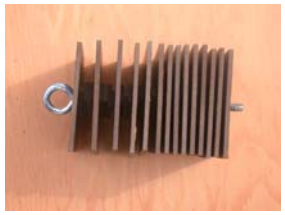

Figure 2: Hester-Dendy sampling gear.

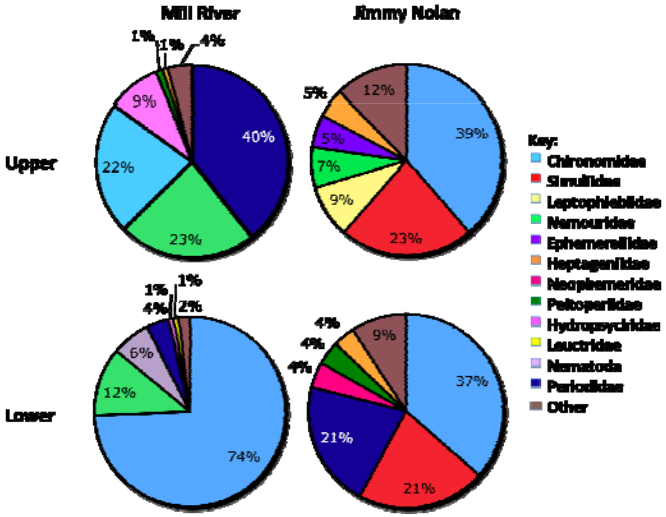

Figure 3: Diversity of major invertebrate groups per site and location. The 6 most abundant families for each are shown; the rest are pooled into the category "others". (A) Mill River Upper, (B) Mill River Lower, (C) Jimmy Nolan Upper, and (D) Jimmy Nolan Lower.

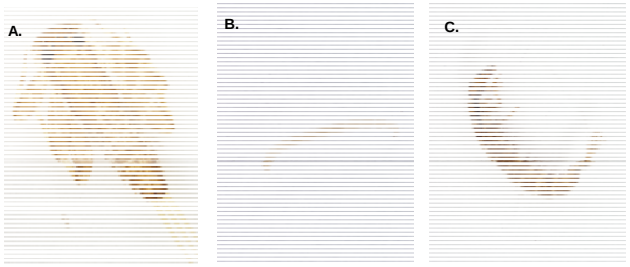

Figure 4: Representative stream invertebrates from the Mill River and Jimmy Nolan Brook. (A) Flatheaded Mayfly (Ephemeroptera, Heptageniidae), (B) Midges (Diptera, Chironimidae), (C) Common Caddisfly (Trichoptera, Hydropsychidae).

RESULTS. Invertebrate composition: The composition and relative abundance of freshwater invertebrates differed between the Mill River and Jimmy Nolan Brook and between locations within sites (Fig. 3). Our samples consisted almost entirely of larval and nymphal stages of insects (Fig. 4). Small fly larvae in the family Chironomidae (Fig. 4 B) composed the largest percentage of individuals at 3 of the 4 stations (Fig. 3 B, C, D). Two other families of stoneflies, Nemouridae and Perlodidae, also showed high relative abundance. The Mill River had a relatively high percentage of Hydropsychidae (caddisflies) (9%, Fig. 3 A), while Jimmy Nolan had a high percentage of Simuliidae (black fly larvae) (Fig. 3 C, D).

Total abundance: The total numbers of invertebrates collected in our samplers were not consistent between locations at each site (S x L interaction, p = 0.0122) (Fig. 5). In the Mill River, the total number of invertebrates was significantly higher at the lower location (391.3) than at the upper location (115.6) (Fig. 5). In contrast, there was no significant difference in total number between the upper and lower locations at Jimmy Nolan Brook.

Diversity (Hs): Jimmy Nolan Brook had significantly higher family diversity than the Mill River (p = 0.0231) (Fig. 6 A). Family diversity did not differ between the upper and lower locations at either site.

Evenness (J): Jimmy Nolan Brook had significantly higher evenness than the Mill River (Fig. 6 B) (i.e., abundances were more evenly distributed among families). At both sites, the upper locations displayed higher evenness than the lower locations.

Water temperature: Water temperatures were higher in the Mill River than in Jimmy Nolan Brook by 1˚C.

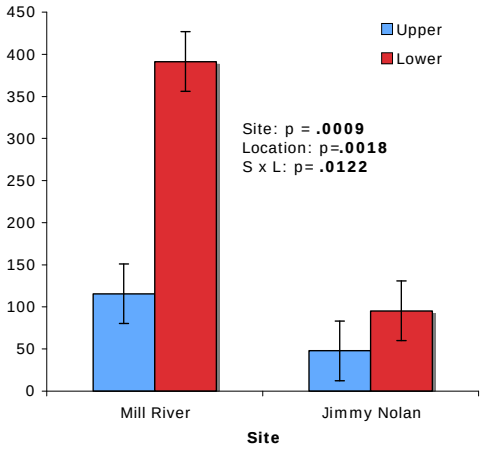

Figure 5: The total number of organisms by site (Mill River or Jimmy Nolan) and by location (Upper or Lower). Error bars ± 1 S.E.M.

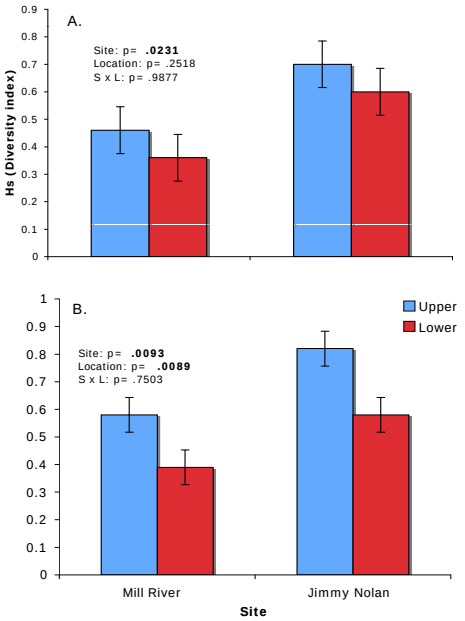

Figure 6: (A) The Hs (Shannon Diversity Index) and (B) evenness of the upper and lower locations of Mill River and Jimmy Nolan Brook. Error bars, ± 1 S.E.M.

DISCUSSION. Overall, Jimmy Nolan Brook displayed greater invertebrate diversity and evenness than the Mill River. The composition and relative abundances of insect families were more similar between upper and lower locations at Jimmy Nolan Brook (e.g. 58-62% chironomids and simulids) than at the Mill River. This is not surprising because upper and lower locations at Jimmy Nolan Brook were closer together and more similar in topography and flow rates than at the Mill River. Highest total abundances were recorded in the lower Mill River, perhaps reflecting high water flow and greater oxygen or nutrient content just below the dam at Paradise Pond. The underlying reasons for differences in taxonomic composition and diversity between rivers will require further study. The rivers differ in a number of respects. For example, the Mill River was wider and had greater water volume and higher water temperatures than Jimmy Nolan Brook. Invertebrates are often used as bio-indicators of water quality and overall stream health (Macroinvertebrates 2009). We found representatives of the Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies) in both rivers. All of these insect families are sensitive to pollution and their presence in both systems suggests good water quality. Finally, our study establishes a baseline for comparing trends in invertebrate stream diversity and abundance with future environmental changes.

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