# Aquatic Invertebrate Monitoring at Effigy Mounds National Monument, 2008

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# Abstract

The National Park Service (NPS) began monitoring water quality and invertebrate community structure in Dousman Creek at Effigy Mounds National Monument (EFMO) in 2008. Dousman Creek is a Class "B" coldwater stream that supports a trout population and is listed among the Outstanding Iowa Waters. The purpose of this report is to summarize baseline aquatic invertebrate monitoring data collected during July 2008. Data are currently insufficient to fully characterize the integrity of Dousman Creek. Preliminary indications based on invertebrate community structure, water quality and physical habitat suggests Dousman Creek is largely unimpaired. All benthic samples were dominated by a moderately intolerant mayfly (*Pseudocloeon*) and Chironomidae were poorly represented in samples. Because large numbers of Chironomidae are often associated with disturbance, their low density in Dousman Creek is particularly notable. Taxa richness and EPT richness were lower than expected for this outstanding stream, but the reason for this is unknown. Several intolerant and uncommon taxa were represented in samples. Water quality data also suggest this stream is not disturbed. Future invertebrate sampling events at Dousman Creek should include a composited multihabitat sample that will allow investigators to calculate the IOWATER Advanced Benthic Macroinvertebrate Indexing Methods. Using this index to evaluate future benthic collections from Dousman Creek will allow site managers to directly compare its invertebrate community structure relative to Iowa reference streams in addition to assessing long-term trend in this resource.

# Acknowledgments

# Introduction

Aquatic invertebrates are an important biological tool for understanding and detecting changes in stream ecosystem integrity, and they can be used to reflect cumulative impacts that cannot otherwise be detected through traditional water quality monitoring. The National Park Service (NPS) began monitoring water quality and invertebrate community structure in Dousman Creek at Effigy Mounds National Monument (EFMO) in 2008 (Bowles et al. 2008). Dousman Creek is a Class "B" coldwater stream that supports a trout population and is listed among the Outstanding Iowa Waters (Iowa Department of Natural Resources, 2010a). The monitoring objectives of this study, as described by DeBacker *et al*. (2005), are: 1) determine the status and trends of invertebrate species diversity, abundance, and community metrics, and 2) relate the invertebrate community to overall water quality through quantification of metrics related to taxa richness, abundance, diversity, and region-specific multi-metric indices as indicators of water quality and habitat condition. The purpose of this report is to summarize baseline aquatic invertebrate monitoring data collected during July 2008.

# Methods

Methods and procedures used in this report follow Bowles *et al*. (2008), Monitoring Protocol for Aquatic Invertebrates of Small Streams in the Heartland Inventory & Monitoring Network. Samples were collected at one reach of Dousman Creek on July 7, 2008 (Figure 1).

Three successive riffles were sampled with three benthic invertebrate samples collected at each riffle, resulting in nine samples. A Surber stream bottom sampler (500 μm mesh, 0.09 m$^2$) was used to collect the samples. Samples were sorted in the laboratory following a subsampling routine described in Bowles *et al*. (2008). Taxa were identified to the lowest practical taxonomic level (usually genus) and counted. Metrics calculated for each sample included genus richness, Shannon diversity index, EPT (Ephemeroptera, Plecoptera, Trichoptera) richness, EPT ratio (EPT density/(EPT density + Chironomidae density)), genus evenness (where 0 = minimum evenness, 1 = maximum evenness), and Hilsenhoff biotic index (HBI) (Bowles et al. 2008). For details on calculating and interpreting metrics used in this report refer to Bowles et al. (2008). The preferred response of all metrics is an increase except for HBI where smaller values are the desired response. An increase in HBI is undesired because that would reflect increasing tolerance of the community to disturbance.

For each sample, current velocity (meters/second) and depth (cm) were recorded directly in front of the sampling net frame. Qualitative habitat variables (embeddedness, periphyton, filamentous algae, aquatic vegetation, deposition, and organic material) were estimated within the sampling net frame as percentage categories (0, <10, 10-40, 40-75, >75). Habitat data were analyzed as midpoints of each category. Dominant substrate size from the area within the sampling net frame was visually assessed using the Wentworth scale (Wentworth 1922). Stream discharge was measured upstream of the sampled riffles. Seven water quality readings were recorded hourly using a calibrated YSI 6920 data logger. The water quality and habitat data presented in this report represent only a snap-shot of the broad temporal range of conditions and should be cautiously interpreted. They are intended to describe the prevailing conditions that influence the structure of invertebrate communities, and they may help explain variability between samples,

but they should not be used as an analytical tool in the strictest sense (Bowles *et al*. 2008). Due to the limitations of using water quality data obtained with data loggers, the invertebrate community is used here as a surrogate of the long-term water quality condition of Dousman Creek.

The intent of this study is to monitor community condition within a site over time and not make comparisons within the site (Bowles et al. 2008). Because sample size presently is small (n=1 year), a rigorous statistical analysis of the data cannot be accomplished and only summary statistics are presented in this report.
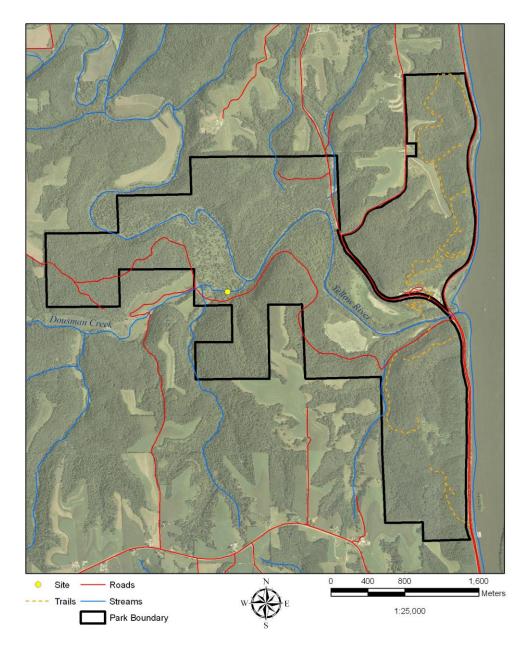


**Figure 1**. Map showing the approximate lower sampling reach boundary (yellow dot) for Dousman Creek, Effigy Mounds National Monument.

# Results

Genus and EPT richness values for Dousman Creek were lower than those expected for regional reference streams (Wilton 2004). Mean genus richness across riffles was 10.11 (range=9.0-11.3) and roughly one fourth of those taxa were EPT (Table 1). Among taxa represented in samples, the mean tolerance value (TV) was 5.4 (range 0-10 with 10 being most tolerant). Roughly one-fourth of all taxa collected were sensitive having tolerance values of 3 or less. Sensitive taxa present in samples included the caddisfly (Trichoptera) genera *Brachycentrus, Glossomsoma* and *Neophylax,* the riffle beetle *Optioservus* (Coleoptera), and the cranefly larva *Dicranota* (Diptera) (Appendix). Although EPT taxa were poorly represented among samples, the dominant taxon among all taxa in every sample was the mayfly (Ephemeroptera) genus *Pseudocloeon* (TV = 4.4). Other common taxa represented in samples were black fly larvae (Diptera: Simulium), and the Crustaceans *Lirceus* (Isopoda) and *Gammarus* (Amphipoda), with tolerance values of 4.4, 7.7., and 6.9, respectively. The relatively high EPT ratio for Dousman Creek (0.89) indicates that the dipteran family Chironomidae did not represent a substantial portion of the benthic community among samples. The percentage composition of Chironomidae in the total benthic community was low and ranged from 3.76% to19.11% (mean=8.18%). Shannon index among samples was relatively low ranging from 1.12 to 1.48 (mean=1.26). Shannon's index accounts for both abundance and evenness of the species present and index values are more robust when all taxa in a sample are equally abundant or have high evenness. The dominance of a few taxa among samples, particularly *Pseudocloen*, is reflected in the low Shannon Index values reported here. Genus evenness ranged from 0.49-0.61 (mean=0.55). HBI was relatively low among samples with scores ranging from 4.60-4.85 (mean=4.70). Because HBI scores can range from 0 to 10 with ten indicating the most disturbance, the relatively low HBI scores for Dousman Creek indicate the water quality condition for that stream is good.

All water quality parameters measured in this study compared favorably to Iowa surface water standards and to regional reference streams (Tables 2 and 3). The mean water temperature of about 15 $^o$C indicates Dousman Creek is a coldwater stream (Wilton 2004). The Iowa surface water quality standard for dissolved oxygen is that the minimum dissolved oxygen levels shall not be less than 5.0 mg/l during any 24-hour period (Iowa Department of Natural Resources 2010b). Dissolved oxygen levels in Dousman Creek clearly surpassed this standard. Stream discharge at the time of sampling was 0.42 m$^3$.

Habitat among riffles was uniform (Table 4). Riffles were shallow (mean= 16.89 cm) with moderate current velocity (mean=0.54 m/sec). Substrate among riffles consisted primarily of small to large pebble with size ranging from 14.33-14.67 (mean= 14.44, or 32-45 mm) on the Wentworth scale (Bowles 2008). Embeddedness and deposition were relatively low (means= 25% and 26.39%, respectively). Mean periphyton was 18.33% and did not exceed 25%. No aquatic vegetation or filamentous algae was present in samples. Percent organic material in samples also was low ranging from 5-25% (mean 13.89%).

**Table 1**. Summary statistics for invertebrate samples collected from Dousman Creek, Effigy Mounds National Monument, 2008.

| Statistic | HBI | Genus Richness | Shannon's Index | Genus Evenness | EPT Richness | EPT Ratio |
|---|---|---|---|---|---|---|
| Mean | 4.70 | 10.00 | 1.26 | 0.55 | 2.11 | 0.89 |
| Standard Error | 0.07 | 0.69 | 0.11 | 0.03 | 0.11 | 0.02 |
| Minimum | 4.60 | 9.00 | 1.11 | 0.49 | 2.00 | 0.86 |
| Maximum | 4.85 | 11.33 | 1.48 | 0.61 | 2.33 | 0.93 |
| N | 9 | 9 | 9 | 9 | 9 | 9 |

**Table 2**. Water quality data for Dousman Creek, Effigy Mounds National Monument, 2008. Data were collected hourly with calibrated data loggers.

| Water Quality Statistic | Temperature (°C) | Specific Conductance (µS/cm) | Dissolved Oxygen (mg/liter) | pH | Turbidity (NTU) |
|---|---|---|---|---|---|
| Mean | 15.21 | 562.43 | 10.52 | 8.05 | 3.2 |
| Median | 15.40 | 562.00 | 10.39 | 8.07 | 2.9 |
| Standard Deviation | 1.38 | 2.99 | 0.44 | 0.05 | 1.16 |
| Minimum | 12.97 | 560.00 | 10.03 | 7.94 | 2.00 |
| Maximum | 17.00 | 569.00 | 11.33 | 8.08 | 5.10 |
| Count | 7 | 7 | 7 | 7 | 6 |

**Table 3.** Statistical ranges of water quality parameters sampled at 98 candidate reference sites from 1994-1998 (from Wilton 2004).

| Parameter | Minimum | 25th Percentile | 50th Percentile | 75th Percentile | Maximum |
|---|---|---|---|---|---|
| Temperature (°C) | 8 | 14.6 | 18.6 | 21 | 26.8 |
| Dissolved Oxygen (mg/l) | 4.7 | 7.7 | 8.4 | 9.5 | 12.6 |
| pH | 6.5 | 7.4 | 7.7 | 8 | 8.6 |
| Conductivity (µmhos/cm) | 340 | 518 | 625 | 733 | 1200 |
| Turbidity (NTU) | 1 | 8 | 16 | 26 | 80 |

**Table 4.** Summary statistics for habitat variables associated with benthic samples collected from Dousman Creek, Effigy Mounds National Monument, 2008.

| Habitat Parameter | Mean | Standard Error | Minimum | Maximum | N |
|---|---|---|---|---|---|
| Depth (cm) | 16.89 | 3.39 | 10.67 | 22.33 | 9 |
| Current velocity (m/sec) | 0.54 | 0.11 | 0.33 | 0.69 | 9 |
| Substrate (Wentworth Scale) | 14.44 | 0.11 | 14.33 | 14.67 | 9 |
| Embeddedness (%) | 25 | 0 | 25 | 25 | 9 |
| Vegetation (%) | 0 | 0 | 0 | 0 | 9 |
| Filamentous algae (%) | 0 | 0 | 0 | 0 | 9 |
| Periphyton (%) | 18.33 | 6.67 | 5 | 25 | 9 |
| Deposition (%) | 26.39 | 5.09 | 18.33 | 35.83 | 9 |
| Organics (%) | 13.89 | 5.88 | 5 | 25 | 9 |

## Discussion

Data are currently insufficient to fully characterize the integrity of Dousman Creek. Preliminary indications based on invertebrate community structure, water quality and physical habitat suggests Dousman Creek is largely unimpaired. All benthic samples were dominated by a moderately intolerant mayfly (*Pseudocloeon*, tolerance value 4.4) and Chironomidae were poorly represented in samples. Wilton (2004) noted that the number of mayfly (Ephemeroptera) taxa in wadeable streams typically exceeds the number of taxa representing the other aquatic insect orders (≤36%), so the dominance of *Pseudocloen* in Dousman Creek should not be considered unsual. Because large numbers of Chironomidae are often associated with disturbance, their low density in Dousman Creek is particularly notable. Taxa richness and EPT richness were lower than expected for this outstanding stream (Iowa Department of Natural Resources, 2010b, Wilton 2004), but the reason for this is unknown. Wilton (2004) reported taxa richness values for reference streams that were generally greater than 20 taxa with about one-third of those being EPT taxa. Several intolerant and uncommon taxa were represented in samples. Water quality and habitat data also suggest this stream is not disturbed. Future invertebrate sampling events at Dousman Creek should include a composited multihabitat sample as described in Wilton (2004). A multihabitat sample in addition to the methodology described in Bowles et al. (2008) will allow investigators to calculate the IOWATER Advanced Benthic Macroinvertebrate Indexing Methods. Using this index to evaluate future benthic collections from Dousman Creek will allow site managers to directly compare its invertebrate community structure relative to Iowa reference streams (Wilton 2004) in addition to assessing long-term trend in this resource.

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**Appendix**.  Aquatic invertebrate data collected from Dousman Creek, Effigy Mounds National Monument, 2008. FFG= functional feeding group, TV= tolerance value.

| Phylum | Class | Order | Family | Genus | Feeding Group | Tolerance Value | 1 L | 1 M | 1 R | 2 L | 2 M | 2 R | 3 L | 3 M | 3 R |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nematomorpha | | | | | | 5 | | | | | 2 | | | | 1 |
| Annelida | Oligochaeta | | | | | 8 | | | | 4 | 10 | 5 | 3 | | 28 |
| | Hirudinea | | | | | 10 | | | | | | | | 1 | |
| | Hirudinea | Rhynchobdellida | Glossiphoniidae | *Glossiphonia* | | 7 | | | 1 | | | | | | |
| Arthropoda | Arachnoida | Hydracarina | | | Pa, Pr | 5.7 | | 2 | | 1 | 3 | | | | 1 |
| | Entognatha | Collembola | | | | 10 | | | | 1 | | | | | 3 |
| | Insecta | Ephemeroptera | Baetidae | | C | 4 | 13 | 20 | | | 3 | | | 30 | 9 |
| | | | Baetidae | *Pseudocloeon* | C | 4.4 | 116 | 147 | 138 | 185 | 181 | 114 | 178 | 104 | 85 |
| | | Trichoptera | Brachycentridae | *Brachycentrus* | F | 1 | | | | | | | | 1 | |
| | | | Glossosomatidae | *Glossosoma* | C, Sc | 1.5 | | | | | 1 | | | | |
| | | | Hydropsychidae | | C | 4 | | | | | 1 | | | | |
| | | | Uenoidae | *Neophylax* | Sc | 1.6 | | | 1 | | | | 1 | | |
| | | Coleoptera | Elmidae | *Optioservus* | C, Sh | 2.7 | | 1 | | 2 | | | | 1 | 1 |
| | | | Dytiscidae | *Agabus* | Pr | 5 | | | | | | | | 1 | |
| | Insecta | Diptera | unknown | | | | | | | | 1 | | | | |

**Appendix**. Continued.

| Phylum | Class | Order | Family | Genus | Feeding Group | Tolerance Value | 1 L | 1 M | 1 R | 2 L | 2 M | 2 R | 3 L | 3 M | 3 R |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Chironomidae | | | 6 | 8 | 12 | 14 | 23 | 21 | 19 | 41 | 13 | 39 |
| | | | Muscidae | *Limnophora* | Pr | 7 | | | | | | | 1 | | |
| | | | Tipulidae | *Dicranota* | Pr | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 4 | 1 | 5 |
| | | | | *Tipula* | C, Sh | 7.7 | | | | | | | | 1 | |
| | | | Simuliidae | *Simulium* | F | 4.4 | 53 | 101 | 58 | 34 | 81 | 70 | 158 | 74 | 18 |
| | Crustacea | Amphipoda | Gammaridae | *Gammarus* | C | 6.9 | 8 | 3 | 3 | 2 | 2 | 3 | 11 | 2 | 8 |
| | | Isopoda | Asellidae | *Lirceus* | C | 7.7 | 1 | 2 | 3 | 1 | | 6 | 10 | 3 | 5 |
| Mollusca | Gastropoda | Bassommatophora | Physidae | *Physa* | Sc | 8 | | | | 1 | | | | | 1 |
| TOTAL | | | | | | | 213 | 289 | 220 | 255 | 304 | 220 | 407 | 232 | 204 |