# Aquatic Macroinvertebrate Communities from the Portage River Watershed Headwater Streams (Wood County, Ohio)[1]

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**ABSTRACT. Macroinvertebrate communities in a transect of the Portage River watershed were quantitatively and qualitatively assessed. The emphasis was on identification and community structure of the macroinvertebrate biota resident in its smallest order streams and ditches. Hester-Dendy multi-plate samplers were used to assess the macroinvertebrate communities at 10 sites across the watershed in the summer of 2001. Dominant macroinvertebrates collected at greater than 70% of the sites were: *Caenis* sp., *Stenonema femoratum, Lirceus lineatus, Physella integra* 54 species from 11 major taxa were collected overall, with highest diversity in the smallest order tributaries. The central area of the transect yielded lower numbers of species and densities than the eastern or western drainage areas, and Shannon-Wiener Diversity Indices (SDI) illustrate this depressed community structure. Of the study sites, Rader Creek and the South Branch of the Portage were the most diverse, while Bull Creek was the least diverse. As was predicted from the physical appearance of the majority of the sites, the Portage River watershed macroinvertebrate communities were both depauperate and trophically simplistic. The Invertebrate Community Index (ICI is the principal assessment tool used by the Ohio EPA to monitor all free-flowing waters in Ohio) of the macroinvertebrate communities' resident suggest only poor to fair water quality at all locations throughout the summer. The impoverished state of the communities present in what is the most active time of the year suggests that steps to increase the health and complexity of the habitat would offer greater natural services to the watershed and drainage.**

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## INTRODUCTION

The Portage River watershed is 97 km long and covers an area of 1531 km$^2$ in Wood County, northwest Ohio. This watershed is an important drainage system for the Western Basin of Lake Erie. The Portage River watershed has an inherently low gradient and extensive areas of bedrock are characteristic (OEPA Technical Report 1995). Although 75% of the Portage River meets Ohio EPA standards, making it one of northwest Ohio's highest quality streams, there are some water quality problems (TMACOG 1997). A low gradient and residence in northwest Ohio's largely agricultural base are major contributors to those water quality problems. McCabe and Gotelli (2000) and Hackmoeller and others (1991) suggested that nonpoint source pollution and other human activities, combined with a low gradient, limit the ability for streams to support macroinvertebrate communities and therefore limit the natural ecosystems services they can provide.

Few streams retain their natural stream morphology in the Portage River watershed; the majority of the creeks and ditches that compose the drainage are channelized. Channelization creates highly erosional/depositional habitats, which negatively impact the diversity of the macroinvertebrate communities, while the simplified community structure and low numbers of organisms reduce the natural ability of these flowing systems to respond to the amount of nonpoint source material that runs off the drainage. Water scour and periodic high flow that occurs stress many macroinvertebrate species; the periodic flow reduction allows fine sediment to accumulate and limits hard surfaces for refuge and feeding. Streams that shift rapidly from highly erosional to highly depositional along much of their reaches allow only the best-adapted species to become established. This limits diversity and standing crop, as well as the establishment of other species. Streams and ditches that meander, as opposed to those that have straight morphologies, allow more structural diversity. Meandering waterways offer variety in feeding and refuge for macroinvertebrate species across taxa, due to the physical protection they provide from periodic scouring and flooding.

An Ohio EPA report (1995) indicated that in-stream cover was the single most influential factor in the estuarine portion of the Portage River watershed; silt and muck substrates negatively influenced aquatic assemblages. In the upper reaches of the drainage, in-stream cover was largely non-existent in the areas sampled. However, small depositional areas were present during times of low flow.

It is well documented that the structure of lotic macroinvertebrate communities depends on fluvial processes, and is also impacted by stream morphology, sediment size, quality of riparian habitat, and nonpoint pollution. To a lesser extent, urban influences are a contributing factor (Zuellig and Kondratieff 2001; OEPA Technical Report 1995; Tertuliani 1998; Laasonen and others 1998).

The area selected for this study was determined through a larger project examining the Portage River watershed located in Wood County. The full project is currently investigating several significant features, including fluvial processes of small drainage ditch features (Mecklenburg 2000), bench morphology, nutrient loads,

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flow rate, economic impacts of water management, and stream biota. The purpose of this study was to examine the macroinvertebrate composition of the headwater streams of the Portage River watershed in order to assess the status and health of the macroinvertebrate community across the drainage.

## MATERIALS AND METHODS

Hester-Dendy multi-plate samplers (Hester and Dendy 1962) were used to quantitatively assess aquatic macroinvertebrate communities at 10 sites in the Portage River watershed. Qualitative observations were made in the field by a variety of methods (dip net, visual examination, etc.).

The sites were selected based on a subset of overall sites selected as part of a larger Great Lakes Protection Fund (GLPF) project. For the characterization of macroinvertebrate communities, sites were chosen at locations in the watershed that offered a mid-reach transect (sites designated A), with some smaller order tributaries also selected (sites designated C) as focal points (Fig. 1).

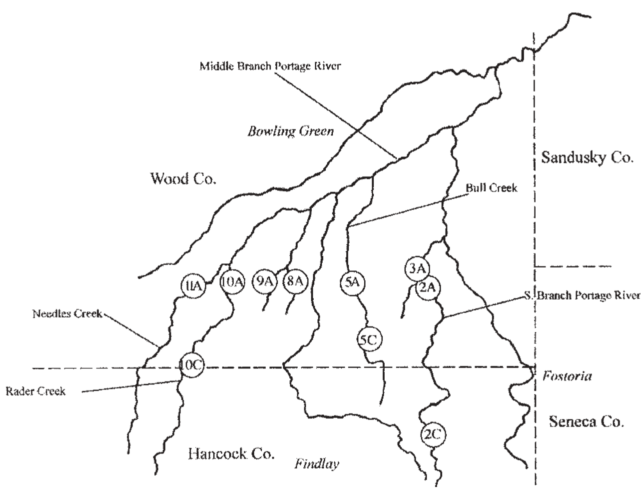



FIGURE 1. Portage River Watershed. Collection sites for Hester-Dendy samplers, May–August 2001.

Samplers were constructed of nine, 7.6 $cm^2$ Masonite™ plates (3.0 mm thick), separated by spacers, leaving a 3.0 mm space between plates (Hester and Dendy 1962). These artificial substrate samplers are used by the Ohio EPA for monitoring and assessment activities of Ohio's rivers and streams (DeShon 1995). The area sampled by each Hester-Dendy multi-plate sampler (HD) was 0.10 $m^2$. A sample consisted of six samplers placed at each of the 10 sites beginning 14 May 2001; final samples were retrieved 14 August 2001.

In the field, HD samplers were partially disassembled and macroinvertebrates removed and collected at approximately four-week intervals. Samples were preserved and identified to the lowest taxonomic level in the lab. The following references were used for taxonomic determinations: aquatic insects (Brigham and others 1982; Chapman 1998; Dillon and Dillon 1972; Bolton 2002; Glotzhober and McShaffrey 2002; Merrit and Cummings 1996; Peckarsky and others 1990; Peterson 1973; Randolf and McCafferty 1998; Stark and Armitage 2000), other macroinvertebrates (Burch 1989; Klemm 2002; Peckarsky and others 1990; Smith 2001; Rife 1993; Thoma and Jezerinac 2000).

Community parameters examined were: EPT/chironomid ratio (Hershey and Lamberti 2001), total number of taxa collected in the watershed, taxa collected per site, Shannon-Wiener Diversity Index (SDI) (Shannon and Wiener 1949), and Invertebrate Community Index (ICI) (DeShon 1995). The EPT/chironomid metric is calculated as a ratio of the aquatic insect larval groups Ephemeroptera, Plecoptera, and Trichoptera (indicators of good water quality), and the dipteran larvae of the family Chironomidae (indicators of poor water quality). EPT/chironomid ratios are a popular community level metric used in biomonitoring (Hershey and Lamberti 2001).

The ICI is a multimetric index developed by the Ohio EPA and has been used as its principal assessment and monitoring measure since 1973. The ICI values can be reliably scored despite the collection of often highly variable numbers of individual organisms. Crucial factors in the use of this index include: artificial substrate samplers used by the Ohio EPA, taxonomic identification according to the level routinely used by the Ohio EPA, and current speeds no less than 10 cm/s under normal summer-fall regimes in the streams sampled (DeShon 1995). The methods (sampler type, number of replicate samplers, and identification) and physical parameters of the sample sites in this study were suitable for the calculation of this metric (DeShon personal communication 2003). The ICI values can be used as a reliable indicator of water quality, and are calculated by using the following metrics: total number of taxa, number of mayfly taxa, number of caddisfly taxa, number of dipteran taxa, percent mayfly composition, percent caddisfly composition, percent tribe *Tanytarsini* midge composition, percent other dipteran and non-insect composition, percent tolerant organisms (as defined by Ohio EPA), and number of qualitative EPT taxa.

## RESULTS

Table 1 summarizes the HD sample data collected May - August 2001; it includes site locations, total number of species, densities, EPT/chironomid ratio metric, and Shannon-Wiener Index (SDI). Figure 2 illustrates the number of taxa, average density, and diversity (mean SDI, multiplied by a factor of ten for ease of illustration) for each site across the watershed.

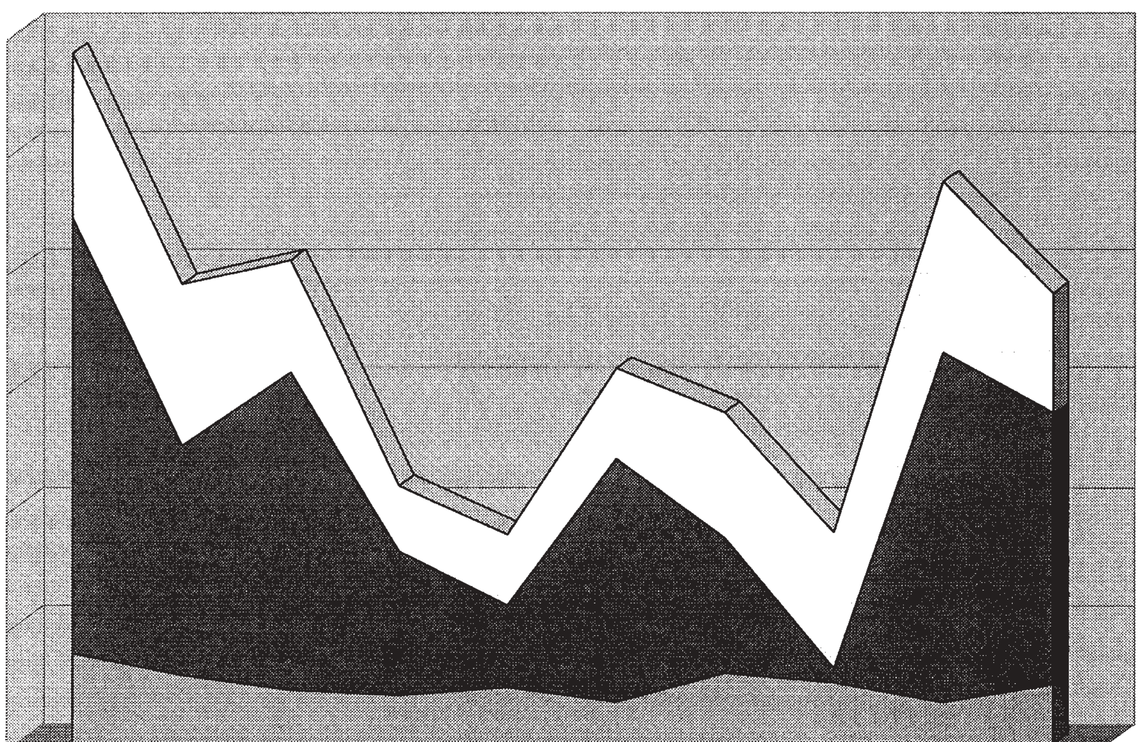
All species are tabulated in Table 2. Terrestrial isopods were listed, but not used as part of the aquatic community metrics as they are not part of the aquatic community proper. They were listed as they were collected from samplers that were not fully submerged due to low flow at collection time. Erosional/depositional species dominated each site (Merritt and Cummings 1996; Smith 2001), with the remaining species identified as typical of depositional or erosional habitats. Two species of mayflies (*Caenis* sp., *Stenonema femoratum*), an aquatic isopod (*Lirceus lineatus*), and

TABLE 1

*Site location, total number of species, density values, EPT/chironomid metric, and Shannon-Wiener Diversity Index (SDI) for Portage River transect, Summer 2001.*

| Stream Name | Location | North | West | N = * | D = | EPT: C | SDI |
|---|---|---|---|---|---|---|---|
| South Branch Portage | 2A | 41 14' 12" | 83 32' 09" | 23 | 12 | 3: 14 | 1.510 |
| South Branch Portage tributary | 2C | 41 07' 57" | 83 31' 09" | 22 | 8.33 | 3: 15 | 1.143 |
| Cygnet Ditch | 3A | 41 14' 11" | 83 33' 21" | 14 | 7.44 | 3: 3 | 0.886 |
| Bull Creek | 5A | 41 14' 24" | 83 36' 12" | 11 | 5.67 | 4: 0 | 0.801 |
| Bull Creek tributary | 5C | 41 12' 37" | 83 32' 43" | 11 | 3.44 | 3: 0 | 0.941 |
| B & O Ditch | 8A | 41 14' 28" | 83 40' 26" | 13 | 4.78 | 1: 4 | 0.692 |
| Middle Branch Portage | 9A | 41 14' 21" | 83 41' 56" | 19 | 7.33 | 4: 4 | 1.182 |
| Rader Creek | 10A | 41 14' 46" | 83 44' 22" | 15 | 8.56 | 4: 6 | 1.023 |
| Rader Creek tributary | 10C | 41 09' 31" | 83 46' 42" | 21 | 16 | 2: 13 | 0.692 |
| Needles Creek | 11A | 41 14' 39" | 83 45' 35" | 17 | 7.44 | 6: 8 | 0.996 |

*N = the total number of species collected; D = the average density of all organisms per 0.1 $m^2$ for June, July, and August; EPT = the total number of Ephemeroptera, Plecoptera and Trichoptera species collected at each site; C = the number of different species of midge fly larvae; SDI = the Shannon-Wiener Diversity index.



| | 2A | 2C | 3A | 5A | 5C | 8A | 9A | 10A | 10C | 11A |
|---|---|---|---|---|---|---|---|---|---|---|
| ☐ Species Richness | 28 | 27 | 19 | 11 | 12 | 15 | 21 | 23 | 29 | 20 |
| ■ Total Density | 73.35 | 38.7 | 53.41 | 24.38 | 13.8 | 41.05 | 22.83 | 2.4 | 58.67 | 45.7 |
| ▨ SDI x 10 | 15.1 | 11.43 | 8.86 | 8.01 | 9.41 | 6.92 | 11.82 | 10.23 | 6.92 | 9.96 |

FIGURE 2. Number of Taxa, Species Density, and SDI for Portage River Watershed Sites, May–August 2001

TABLE 2

*Taxonomic list of species surveyed by Hester-Dendy samplers in the Portage River transect, Summer 2001.*

| Collection Points | | 2A | 2C | 3A | 5A | 5C | 8A | 9A | 10A | 10C | 11A |
|---|---|---|---|---|---|---|---|---|---|---|---|
| EPHEMEROPTERA (mayflies) | | | | | | | | | | | |
| *Caenis* sp. | | X | X | X | X | | X | X | X | | X |
| *Stenonema femoratum* | | X | X | X | X | X | | X | X | X | X |
| *Stenacron* sp. | | X | | X | X | | | X | X | | X |
| PLECOPTERA (stonefly) | | | | | | | | | | | |
| *Perlesta* sp. | | | X | | X | X | | X | | | |
| TRICHOPTERA (caddisflies) | | | | | | | | | | | |
| *Heteroplectron americanum* | | | | | | | | | | | X |
| *Cheumatopsyche* sp. | | | | | | X | | | X | X | X |
| *Neotrichia* sp. | | | | | | | | | | | X |
| NEUROPTERA (alderfly) | | | | | | | | | | | |
| *Sialis americana* | | | | X | X | X | | X | X | | X |
| ODONTATA (damselflies) | | | | | | | | | | | |
| *Argia* sp. | | X | | | | | | X | X | X | X |
| *Lestes* sp. | | | | | | | | | | X | X |
| CRUSTACEA (sowbugs, scuds, crayfish) | | | | | | | | | | | |
| Peracaridea | | | | | | | | | | | |
| *Lirceus lineatus* | | X | X | X | X | X | X | X | X | X | |
| *Porcelio scaber* | | X | | | | | | | | | |
| *Trachelipus rathkei* | | | | | | | X | | | | X |
| *Gammarus lacustis* | | | | | X | | | | | | |
| Decapoda | | | | | | | | | | | |
| *Orconectes* sp. | | | | | X | | | | X | | |
| MOLLUSCA (clams, snails, limpets) | | | | | | | | | | | |
| *Corbicula flumimea* | | | | X | X | X | X | X | | X | |
| *Physella integra* | | X | X | X | | | X | X | X | X | X |
| *Planorbella truncata* | | | | | | | X | X | | | |
| *Planorbella* sp. | | | | | | | X | X | | X | |
| *Ferrissia* sp. | | X | X | | | | | X | X | X | |
| ANNELIDA (leeches and aquatic worms) | | | | | | | | | | | |
| *Erpobdella punctata* | | | | X | | X | X | X | X | X | |
| *Helobdella fusca* | | | | | | | | | | X | |
| *Helobdella stagnalis* | | | | X | | X | | | | | |
| *Placobdella parasitica* | | | | | X | | | | X | X | |
| *Placobdella ornate* | | | | | | | | | | X | |
| *Placobdella papillifera* | | | X | X | | X | | | | | |
| Unknown sp. | Oligochaeta | | | | | | X | | | | |
| COLEOPTERA (aquatic beetles) | | | | | | | | | | | |
| *Berosus* sp. | | | | | | X | | | | | |
| *Peltodytes* sp. | | | | | | X | | X | | | |
| *Enochrus* sp. | | | | | | | X | | | | |
| Hydrophilidae | | | | | | | X | | | X | X |
| *Stenelmis* sp. | | | | | | X | | X | | X | X |
| *Macronychus glabratus* | | | | | | | | | X | | |

TABLE 2 (*Cont.*)

*Taxonomic list of species surveyed by Hester-Dendy samplers in the Portage River transect, Summer 2001.*

| Collection Points | 2A | 2C | 3A | 5A | 5C | 8A | 9A | 10A | 10C | 11A |
|---|---|---|---|---|---|---|---|---|---|---|
| *Tropisternus* sp. | | | X | | | | | | | |
| *Dubiraphia* sp. | X | | | X | | | | | | |
| *Copelatus* sp. | | | | | | X | | X | | |
| *Laccophilus* sp. | | | | | | | | | | X |
| *Dineutus* sp. | | | | | | | | | | X |
| DIPTERA (chironimids) | | | | | | | | | | |
| *Ablabesmyia mallochi* | X | X | | | | X | | | | X |
| *Chironomus* sp. *C* | X | X | X | | | X | X | X | | |
| *Cladotanytarsus mancus* | X | | | | | | | | | |
| *Conchapelopia* sp. | | | | | | | | X | | |
| *Corynoneura lobata* | | | | | | | | | X | |
| *Cricotopus bicinctus* | | X | | | | | X | | | |
| *Cricotopus* sp. | | | | | | | | | X | |
| *Cricotopus tremulus* | | | | | | | | | X | |
| *Dicrotendipes neomodestus* | X | X | | | | | | | X | |
| *Dicrotendipes fumidus* | X | | | | | | | | | |
| *Glyptotendipes* sp. | X | | | | | | | | | |
| *Kieterrus Kiefferulus?* sp. | | X | | | | | | | | |
| *Labrundinia pilosella* | | X | | | | | | | | |
| *Microtendipes pedellus* | X | X | X | | | | X | X | X | |
| *Nanocladius minimus* | | | | | | | | | X | |
| *Nanocladius crassicrornis/rectinervus* | | | | | | | | | X | |
| *Paratanytarsus* sp. | X | X | | | | | | | X | |
| *Paratendipes albimanus* | X | X | | | | X | | | | X |
| *Paratendipes* sp. | X | | | | | | | | | |
| *Phaenopsectra obediens* | | | | | | | | X | X | |
| *Phaenopsectra flavipes* | | | X | | | | | X | | |
| *Polypedilum flavum* | | X | | | | | | | | |
| *Polypedilum illinoense* | | | | | | | | X | X | |
| *Polypedilum fallax* | | X | | | | | | | | |
| *Procladius bellus* | | | | | | | X | | | |
| *Rheotanytarsus* sp. | | X | | | | | | | X | |
| *Stichtochironomus* sp. | X | X | | | | | | | | X |
| *Tanytarsus glabrescens* | X | X | | | | | | | | |
| *Tanytarsus* sp. | X | X | | | | | | | | |
| *Tanytarsus guerlus* | | | | | | | | | X | |
| *Thienemanniella xena* | | | | | | | | | X | |
| *Tribelos jucundum* | X | | | | | | | | | |
| *Zavreliella* sp. | | | | | | X | | | | |

a gastrodpod (*Physella integra*) dominated in 70% of the sites (Table 2). Every stream had freshwater mollusks, and a variety of leech species were present across the watershed. Aquatic Coleoptera (13 genera) were spread across the watershed but most diverse in the middle and western drainage. The greatest species numbers were midge fly larvae (primarily of the family Chironomidae).

Table 3 indicates the ICI index and water quality designation for each sample collected.

## DISCUSSION

An overall picture regarding macroinvertebrate communities resident in the Portage River watershed can be presented with the EPT/chironomid ratio metric. EPT/chironomid ratios and community components for the watershed by individual streams showed decreased numbers and densities, as did the Species Diversity Index

TABLE 3

*Invertebrate Community Composition (ICI) indices and water quality designation for Portage River Watershed, 2001.*

| Collection site | June (ICI) | July (ICI) | August (ICI) |
|---|---|---|---|
| 2A | Fair (14) | Poor (10) | Poor (12) |
| 2C | Fair (17) | Poor (10) | Fair (14) |
| 3A | Poor (2) | Poor (8) | Poor (4) |
| 5A | Poor (0) | Poor (0) | Poor (8) |
| 5C | Poor (2) | Fair (14) | Poor (0) |
| 8A | Poor (8) | Poor (8) | Poor (8) |
| 9A | Poor (8) | Poor (8) | Poor (8) |
| 10A | Fair (16) | Poor (10) | Poor (10) |
| 10C | Fair (16) | No Samples | Fair (20) |
| 11A | Fair (18) | Poor (10) | Fair (30) |

(Tables 1, 2; Fig. 2). It is notable that tributaries of the larger-order streams were similar. The South Branch of the Portage River, located at the eastern edge of the watershed, and Rader Creek tributary at the western edge of the watershed, had both the greatest number of species and the highest densities per square meter of streambed (Table 1). The diversity at these sites was also the highest for the watershed (Fig. 2). The EPT/ chironomid community members compose over 50% of the communities in these two streams. Bull Creek, located centrally, had a significant reduction in community members of these important groups (27–31%) and no resident dipteran larvae. Total number of taxa and density of macroinvertebrates were depressed in the central area of the watershed at the sample locations (Bull Creek and B&O Ditch).

It was suspected (Michael Bolton personal communication 2002) that generally at least 20 species of chironomid larvae would be collected at each stream on HD samplers; our sites never yielded more than 15 species on any sampler, and generally were populated by much lower numbers of species. The ICI values for the sites ndicate that water quality is generally poor in the headwater streams and fair to poor in the smaller order streams. The physical features of the smaller order streams, based on qualitative observations, were more structurally diverse regarding the presence of a bench, aquatic vegetation, and meandering stretches.

In conclusion, the middle of the Portage River drainage has macroinvertebrate communities that differ from the eastern and western drainage. It is unclear if the difference is due to water quality, gradient or morphology characteristics, or a combination of these factors. It is clear that the erosional and depositional character of the watershed as a whole shapes the macroinvertebrate communities, but it is unclear which factors will negatively impact the communities to the extent that they cannot maintain the natural food web and decomposition activities they should provide. The low numbers for this watershed in densities and balance of community indicates a less representative macroinvertebrate community. This implies that the overall watershed could support improved communities. A focused effort to return streams in this watershed to a more natural morphology and water quality would clearly enhance ecosystem services that healthy macroinvertebrate communities can provide.

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