Maryland Biological Stream Survey's Sentinel Site Network: A Multi-purpose Monitoring Program

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April, 2010

This study was funded in part by State Wildlife Grant funds provided to State wildlife agencies by the U.S. Congress, and administered through the Maryland Department of Natural Resources' Natural Heritage Program

ABSTRACT

Each year since 2000, the Maryland Biological Stream Survey, led by the Maryland Department of Natural Resources (MDDNR), Monitoring and Non-tidal Assessment Division, monitors several high quality reference streams in the Sentinel Site Network (SSN) to assess annual variability in stream conditions associated with natural factors. Data are collected on the biology, chemistry, physical habitat, water and air temperature, and land cover/use at each Sentinel Site.

The major goal of this report is to describe the temporal variability in conditions at 27 SSN streams based on 10 years of annual sampling, 2000 through 2009. The secondary goal of this report is to present biological indicators as parts in a tool box of assessment parameters that could be used to track climate change effects on Maryland's non-tidal streams, and to conduct exploratory analyses of SSN data from the 10-year baseline of stream conditions against which future climate influences can be assessed.

Between 2000 and 2009, drought conditions occurred in Maryland during 2001, 2002, and 2007. Conversely, the year 2003 was wetter than normal. Precipitation amounts and stream flows were near normal in the other six years. Biological indicator scores for benthic macroinvertebrates and fish responded to the 2001 and 2001 drought conditions at Sentinel Sites in only one of the four geographic regions: The Coastal Plain – western shore. Macroinvertebrate Index of Biotic Integrity (IBI) scores, fish IBI scores, and total numbers of individual fish collected decreased at Sentinel Sites in this region during 2003, following two years of drought, but returned to normal numbers in 2004. The aquatic biota at Sentinel Sites in this region also decreased slightly in 2008, a year after the 2007 drought. Stream biota did not appear to respond negatively to the relatively wet year, 2003, in any region, based on the parameters measured by the SSN. Neither the macroinvertebrate nor fish IBI scores varied significantly across years at Sentinel Sites in the Coastal Plain – eastern shore, Piedmont, or Highlands regions.

The percentages of coldwater-preference benthic macroinvertebrate taxa richness and percent brook trout (a coldwater-obligate) abundances were negatively associated with year, apparent decreases that were not statistically significant, at the 27 Sentinel Sites. We now have a list of coldwater taxa and a 10-year baseline of species composition data against which results of future Sentinel Site sampling can be compared. If coldwater taxa richness or abundance decreases significantly over time and water temperatures increase, these findings could indicate climate change impacts on Maryland streams.

Water temperatures collected by in-situ data loggers at all Sentinel Sites did not vary significantly between 2000 and 2009, at any spatial scale (site, region, or statewide).

Land cover/use (i.e., forest loss or urban increase) changed between 2002 and 2008 in the catchments of seven of the 27 Sentinel Sites. The site in the Mattawoman Creek watershed had the largest loss of forest cover (932 acres). The Sentinel Site in the Timber Run watershed experienced the largest increase in land cover/use (10 acres of urban land). Biological indicator scores were not significantly affected by the land cover/use changes at

these two Sentinel Sites, nor at the other five sites where smaller land cover/use changes occurred between 2002 and 2008.

None of the 27 Sentinel Sites drain catchments that are located entirely on protected lands. Therefore, several sites are vulnerable to urban/suburban development and other anthropogenic impacts in the future. It is critically important that the current 27 Sentinel Sites and their catchments are protected. It is also desirable that the SSN be expanded, that the SSN data be used by a diverse array of interested parties, and that we find ways to extend the current 10-year baseline period of record and continue the SSN for many decades. Implementation of recommendations that emerged from a workshop sponsored by the Maryland Water Monitoring Council in November 2009 (www.marylandwatermonitoring.org) could help achieve the goal of SSN expansion and persistence over the long run. In the coming months, MDDNR will seek funding and partners who can contribute resources and/or monitoring sites to an expanded SSN that could provide the framework for a long-term network, implemented statewide, to track climate change effects on Maryland's non-tidal waters.

INTRODUCTION

The Maryland Biological Stream Survey (MBSS), started in 1995 by the Maryland Department of Natural Resources (MD DNR), assesses the ecological condition of 1st through 4th order, non-tidal streams at statewide, basin, and watershed scales, by measuring key chemical, physical, and biological parameters. Spanning 15 years, the MBSS also provides an opportunity to document changes in stream condition over time and elucidate discernable trends. Each year since 2000, the MBSS has monitored several high quality, reference streams in the Sentinel Site Network (SSN), to assess natural annual variability in stream conditions (Prochaska 2005, Becker et al. 2007, Becker et al. 2008).

In streams relatively uninfluenced by anthropogenic disturbance, temporal trends in ecological condition should be attributable primarily to seasonal and annual variations in precipitation (and resultant droughts or floods) and temperature/dissolved oxygen regimes, as well as biotic interactions. Stress caused by these natural changes can have drastic effects on stream biota (e.g., benthic macroinvertebrates and fish), effects that should be detected by the biological indicators and ancillary chemical/physical measurements taken by the SSN. Therefore, monitoring a set of minimally-disturbed (more ideally, pristine) streams in places not likely to experience anthropogenic impacts (i.e., the SSN) offers the best means of discerning changes in biological indicator scores across years at stream sites sampled along the entire gradient of disturbance that are also being influenced by natural variability.

Although pristine streams no longer exist in Maryland, monitoring several of the best remaining streams, or those perhaps "mostly recovered" from past degradation (personal communication with R.P. Morgan II), is a useful approach for evaluating variability in stream conditions associated with natural influences. The SSN includes some of the best remaining non-tidal streams in Maryland, based on chemical, physical, and biological parameters measured by the MBSS. SSN sites represent all regions, 1st through 3rd orders, and are located in catchments that, hopefully, will not experience major anthropogenic disturbances in the foreseeable future.

The major goal of this report is to describe the temporal variability in conditions at 27 SSN streams based on ten years of annual sampling from 2000 through 2009.

The abundance and species composition of stream fish and invertebrate communities respond to seasonal and annual changes in biotic and abiotic conditions (McElravy et al. 1989, Grossman et al. 1990, Boulton et al. 1992, Poff and Allan 1995). Understanding natural variability is critical to the interpretation and application of stream assessments, including the designation of impaired waters and also documenting then adjusting stream assessment results to account for natural variability influences on stream condition, particularly the biota. Natural variability in lotic environments can be manifested in floods and droughts that, in turn, influence water quality and quantity, channel morphology, substrate composition, and habitat availability.

In addition to documenting changes in precipitation, temperature, and other factors at seasonal and annual scales, and then assessing the effects of this relatively short-term natural variability on stream biota, the SSN should also be useful for tracking long-term (i.e., multi-decadal) changes associated with climate change. Discriminating the effects of climate change on stream conditions from shorter-term variability in weather and anthropogenic influences, such as urbanization, will be difficult but essential for planning adaptation responses to climate change.

Global climate change has the potential to significantly impacts Maryland's aquatic ecosystems (MCCC 2008a, b; Pyke et al. 2008; Hayhoe et al. 2008; Najjar et al. 2009). Global mean surface air temperatures increased 0.74 C +/- 0.18 C over the last century (1906-2005). Based on climate change modeling, air temperatures are projected to continue increasing through the 21st century . Global mean surface temperature increases are related to greenhouse gas emissions, with low rates yielding a likely increase from 1.1 C to 2.9 C by 2100, while high emission rates may yield increases from 2.4 C to 6.4 C for the same time period. Anthropogenic releases of greenhouse gases, particularly carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_20), have increased significantly and are responsible for the increase in global average temperatures since the middle of the 20th century. In the last 250 years, CO_2 concentrations in the atmosphere have increased by 100 ppm (36%), with the fastest rate of increase occurring during the past ten years from1995 to 2005. Since 1750, methane and nitrous oxide have increased by 148 and 16 percent, respectively. The increase is CO_2 is due primarily to the burning of fossil fuels, while methane and nitrous oxide concentrations have increased primarily due to agriculture (IPCC 2007).

In Maryland, air temperatures are also projected to increase through the 21st century. Like global projections, the amount of warming in Maryland is dependent on greenhouse gas emissions. If emissions continue to increase unchecked (i.e., business as usual), the State is expected to see summer temperatures increase by 5 C and winter temperatures increase by about 4 C by 2100. In addition, heat waves (defined as three or more consecutive days above 90 F) are projected to increase three-fold (i.e., most summer days will exceed 90 F) and the number of days that exceed 100 F are projected to increase by a factor of five (MCCC 2008a). Overall, these projected changes in air temperatures will likely impact Maryland's aquatic ecosystems.

Mean annual precipitation amounts are projected to increase in Maryland by about 10%, mostly during winter and spring (MCCC 2008 a, b). Model projections forecast significant increases in precipitation intensity (i.e., more precipitation per event) and an increase in short-term droughts during summer and fall. Sea level in Maryland is projected to rise 0.7 to 1.6 M by 2100 (Pyke et al. 2008). More information on possible climate change effects on Maryland's water resources, including non-tidal streams, can be found in Becker et al. (2008) and Kaushal et al. (2008).

These projected climate changes are likely to have significant effects on stream biota, even though there is uncertainty about the timing and magnitude of any effects. Temperature is one of many factors restricting the distribution of species and is a key factor in aquatic habitat sustainability (Allan 1995). Thus, temperature changes that may occur over the next

century will likely alter the abundance and distributions of many of Maryland's stream species, especially those that prefer coldwater habitats. A considerable amount of research has examined the impact of increasing stream temperatures on suitable habitat for coldwater fishes. For example, trout species are extremely vulnerable to temperature increases, particularly in southern portions of the Appalachian Mountains where temperature already limits population viability at low elevations. Flebbe et al. (2006) predicted a loss of 53-97% of available trout habitat in the Southern Appalachians if mean annual air temperatures increased by 2.5 to 5.5°C, respectively. In Maryland, temperature increases of 2-4°C would completely eliminate brook trout from the State, except in portions of streams in the Highlands region of Garrett and Allegany counties (Meisner 1990). Temperature changes will not only affect coldwater (and cool water) species. Altered stream temperatures are also likely to hasten the spread of non-native species and make conditions more suitable for some pathogens.

Along with air temperature, average annual precipitation is projected to increase in Maryland, primarily in winter and spring. Most of this winter and spring precipitation will likely come in the form of extreme events, resulting in more frequent flooding of stream ecosystems. Increased flood intensity and frequency has the potential to substantially increase erosion and sedimentation, habitat degradation, nutrient loading, and concentrations of other pollutants, all of which are known to harm stream biota (MCCC 2008a, b).

With most of the precipitation increases coming during winter and spring, droughts are likely to occur more frequently during summer and fall. Depending upon severity, droughts can have significant negative effects on the biota of non-tidal streams. Low flow conditions reduce the quantity and quality of in-stream habitats available to stream species leading to increased inter- and intra-specific competition for resources such as food and shelter, more severe disease and parasite outbreaks, increased vulnerability to predation, and exposure to higher concentrations of toxic contaminants. Stream temperatures can increase during droughts, beyond the temperature increases already occurring due to increases in air temperature, thus exacerbating thermal impacts to stream biota. During severe droughts, streams may become completely dry, leading to mortalities and severe reductions of fish and benthic macroinvertebrate populations.

Because sea level is also projected to continue rising in Maryland (Pyke et. al. 2008), many coastal non-tidal streams and rivers will be inundated. Specific areas at risk include coastal swamps and black water streams which support many of Maryland's imperiled fish species. As brackish waters become barriers to fish movement, populations of freshwater fishes living in lowland, coastal streams are likely to become fragmented and more vulnerable to local extirpation.

Although the long-term effects of climate change on streams are likely to be profound, these changes will be gradual. Subtle annual changes may be difficult to detect until a long record of monitoring data is available and analyzed. Mitigating and adapting to climate change impacts on streams require a clear understanding of the specific factors affecting these habitats and their relative influences, no matter how subtle. However, because stream

conditions vary substantially across space and time in response to a range of human activities, as well as naturally-occurring phenomena, documenting the subtle effects of climate change will be challenging.

A multi-decadal time series of monitoring data, coupled with focused research and data-rich models, will be needed to detect and track climate change effects on Maryland streams. Long-term monitoring programs are key components of environmental science and natural resource management (Lovett et al. 2007). Palmer et al. (2009) recommended that populations at high risk from climate change effects or of special value should be monitored so appropriate management actions can be taken. DNR's SSN has a 10-year data base that could serve as the core monitoring program or framework for an expanded network of headwater stream sites established and regularly monitored to track the effects of climate change in Maryland. A recent study (Brooks 2009) and others (Poff et al. 2002, Grubin et al. 2009) concluded that headwater streams and ephemeral aquatic habitats (e.g., vernal pools) are especially sensitive to changes in precipitation patterns. Therefore, these places may be the first non-tidal ecosystems to respond to climate change.

The secondary goal of this report is to present biological indicators and species composition information that could be used to track climate change effects on Maryland's streams and to present exploratory analyses of SSN data from a 10-year baseline of stream conditions against which future climate change influences can be assessed.

METHODS

To track natural variability in stream chemical, physical, and biological conditions, the Maryland Biological Stream Survey (MBSS) established a long-term monitoring component, the Sentinel Site Network (SSN) in 2000. The Network consists of 27 of the highest quality, minimally-disturbed freshwater streams in the State. These streams represent all regions and stream sizes ranging from 1st through 3rd order. To minimize the potential for human-related impacts to the Sentinel Sites, they are located in catchments that would be least likely to experience future anthropogenic disturbances. Since 2000, the MBSS has collected chemical, physical, and biological data at all Sentinel Sites each year. This annual monitoring effort documents natural annual changes in water chemistry, physical habitat quality, and biological communities that occur in these minimally-disturbed streams. The SSN also provides one tool for detecting and tracking subtle changes to stream conditions over time that may be associated with climate change.

The methods and criteria used to select stream sites for inclusion in the SSN are described in detail in Prochaska (2005). The criteria were used to identify streams with minimal human alterations, thus limiting the potential for anthropogenic factors to confound attempts to document the effects of natural annual variability and climate change. The basic criteria used to select Sentinel Sites are:

- no evidence of acid mine drainage (AMD) in the site catchment;
- sulfate concentrations < 50 mg/l;

- pH > 6.0 or dissolved organic carbon concentrations (DOC) > 8.0 mg/l (i.e., pH could be < 6 if the stream is naturally acidic blackwater);
- nitrate nitrogen concentrations < 4.0 mg/l;
- forested land use > 50% of catchment area; and
- mean of the fish (FIBI) and benthic macroinvertebrate (BIBI) indices of biotic integrity > 3.0 (or a blackwater stream site).

Maps with the locations of MBSS Sentinel Sites in each of four geographic regions are shown in Figures 1-4.

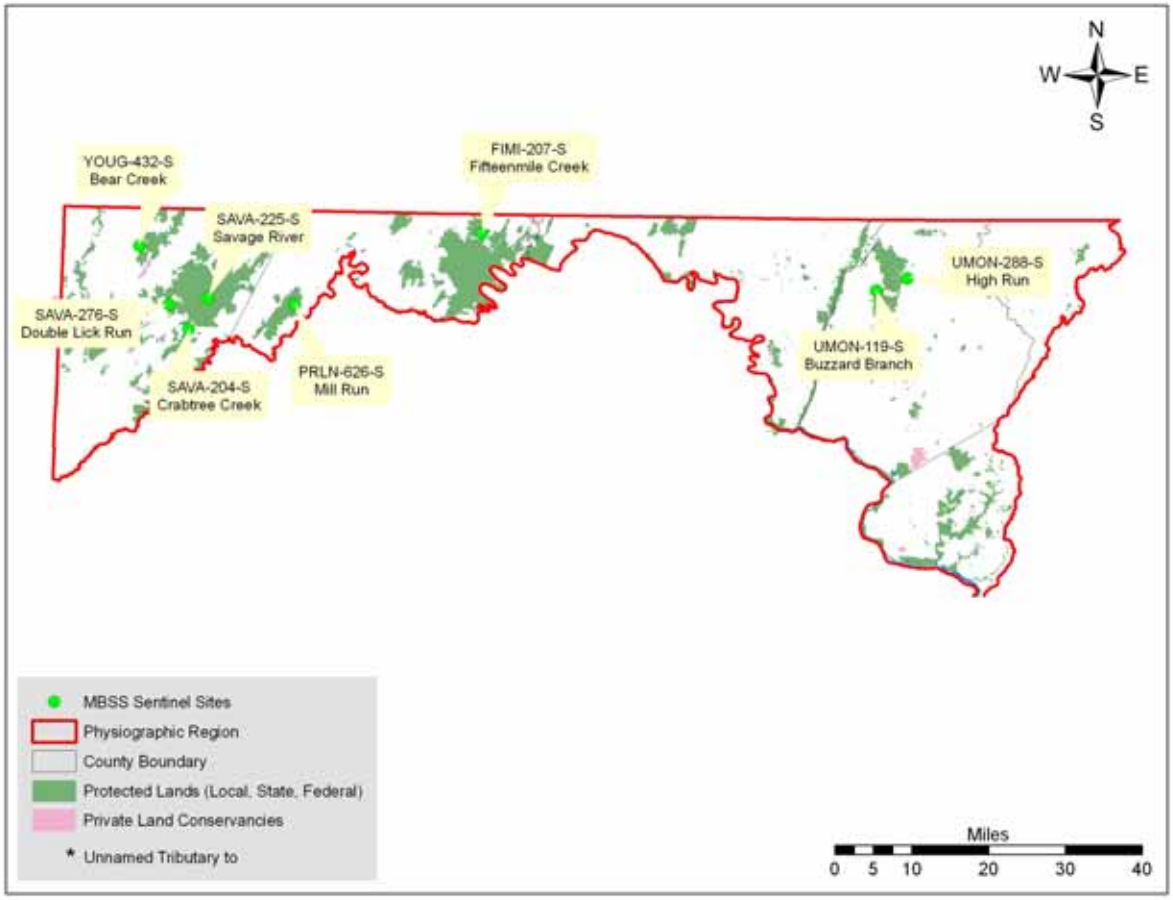

Figure 1 - Sentinel Sites in the Highlands Region.

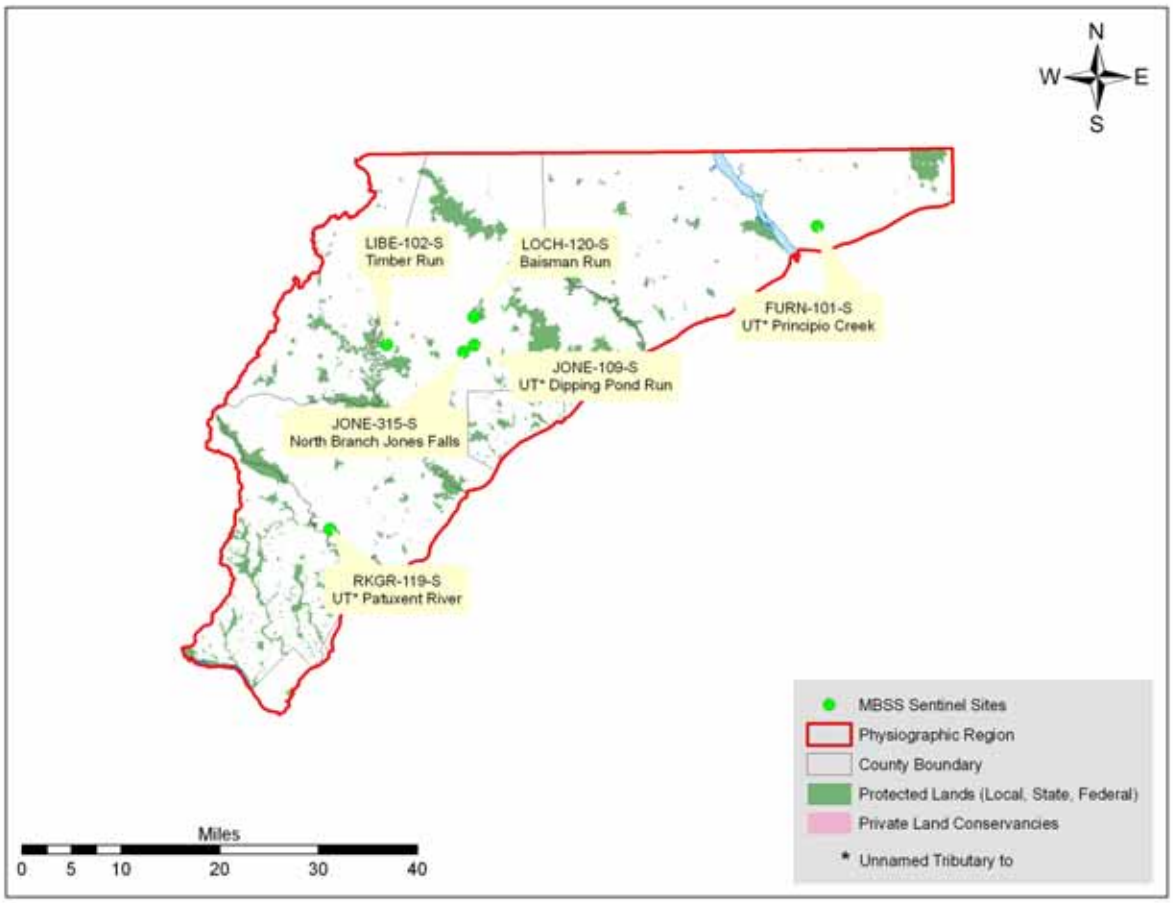

Figure 2 - Sentinel Sites in the Eastern Piedmont Region.

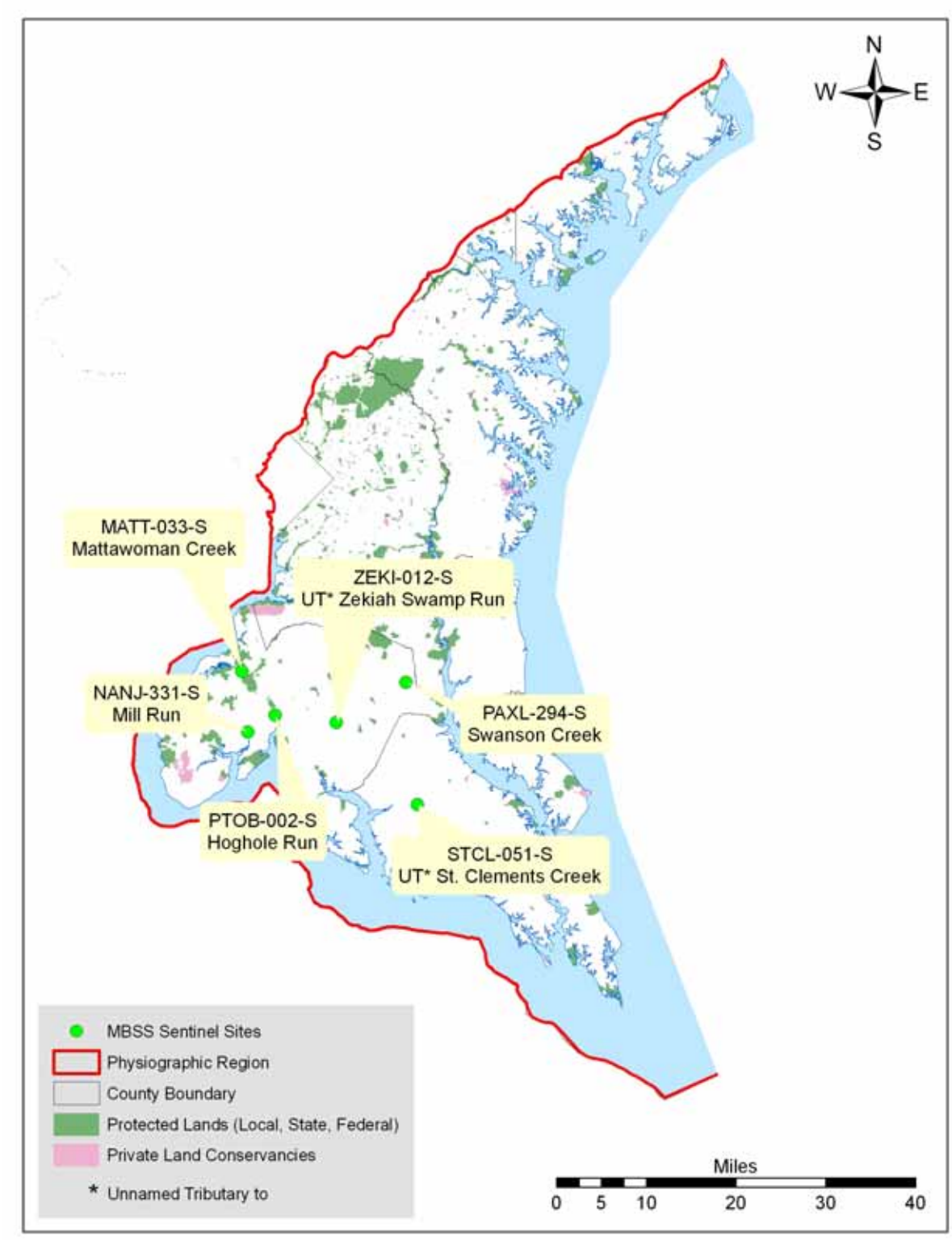

Figure 3 - Sentinel Sites in the Coastal Plain - Western Shore Region.

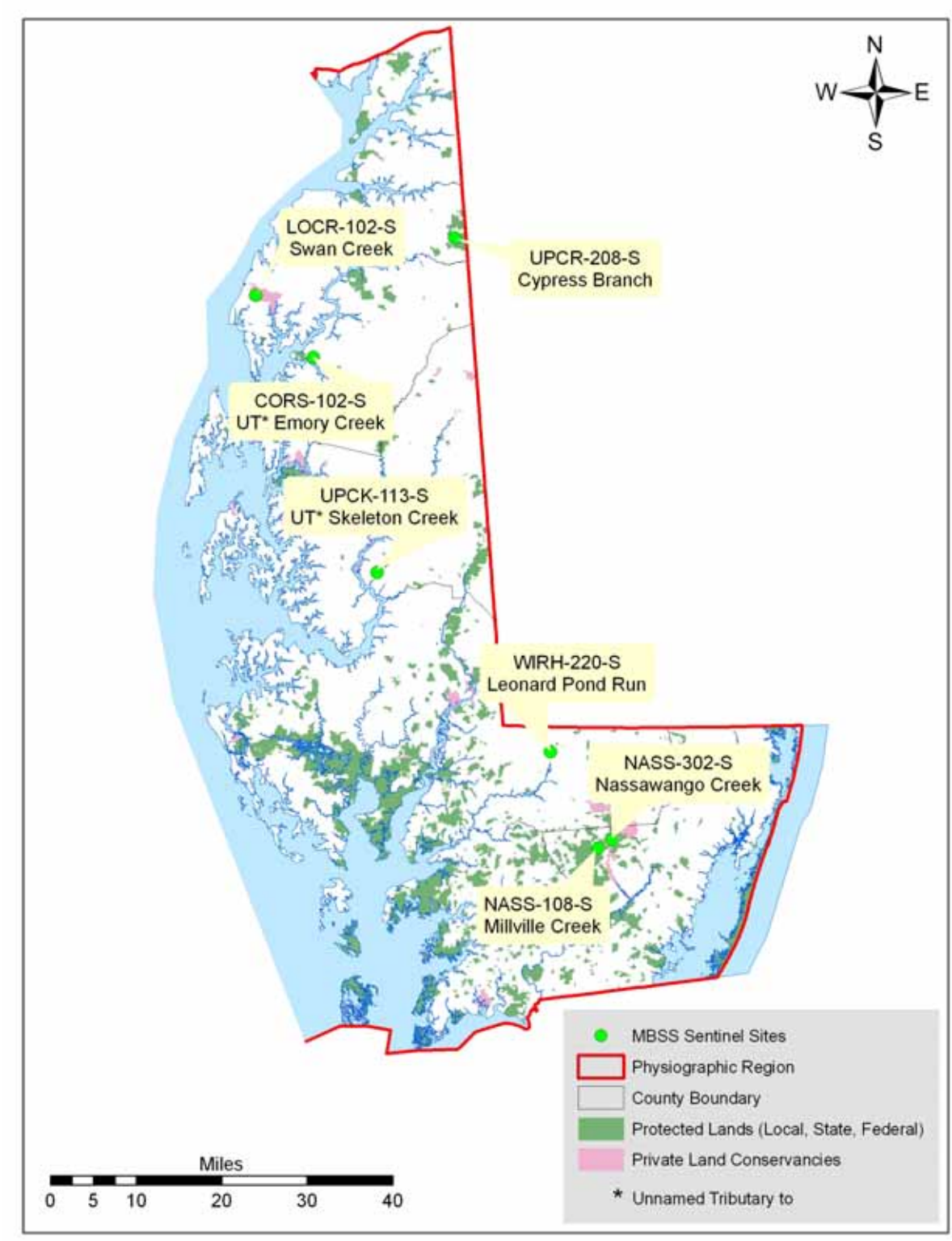

Figure 4 - Sentinel Sites in the Coastal Plain - Eastern Shore Region.

Biological, temperature, and catchment land use/cover data were collected annually at 22 Sentinel Sites from 2000 to 2009. Site access for sampling was not provided for at least one year during the 10-year period at the other five Sentinel Sites. All available data for all Sentinel Sites were used in the analyses presented in this report. In addition to these Sentinel Sites, data from 1,094 MBSS sites sampled once throughout Maryland over the same time period were used to establish "coldwater-preference" stream taxa (benthic macroinvertebrates and fish). A detailed explanation of sampling protocols used at these stream sites can be found in Stranko et al. (2009). A shortened version of the protocols used to collect site-specific biological, temperature, and land use/cover data follows.

Temperature

Air and water temperatures were recorded every 20 minutes during June – August using Onset^{TM} temperature loggers from 2000 through 2007. Beginning in March 2008, air and water temperatures are being recorded year round at all Sentinel Sites. Mean, maximum, proportion of readings greater than 20 ^{o}C, and proportion of readings greater than 24 ^{o}C taken from summer temperatures by site were graphed. A Spearman correlation analysis (with Bon Ferroni correction) was used to test for significant ($p<0.05$) temporal trends.

Biological Parameters

During spring (March-April) of each year, benthic macroinvertebrates were collected using 20, 0.093 M^2 samples of the best available invertebrate habitats found within each 75 M-long sites using a 500 micron mesh D-net. Backpack electrofishing with two passes and block nets in each 75 M-long site was used to collect fishes during summer months (June-August).

Indices of biotic integrity were calculated using the benthic macroinvertebrate (BIBI) and fish (FIBI) developed specifically for the MBSS (Roth et al. 1998, Southerland et al. 2005, Southerland et al. 2007). Analysis of variance (ANOVA) was used to test IBI scores for significant differences among years ($p<0.01$), by geographic region.

Using water temperature logger and biological data from the 1,094 one-time MBSS sampling sites, we identified fishes and benthic macroinvertebrates that prefer relatively cold water and looked for temporal trends in the proportion of these "coldwater-preference" taxa collected at the Sentinel Sites. Benthic macroinvertebrate and temperature data were analyzed using methods outlined by the Idaho Department of Environmental Quality (Grafe et al. 2002). For 490 benthic macroinvertebrate taxa (genera) collected in Maryland streams, summary statistics of average daily mean water temperature (C) and the 99% probability of the daily mean water temperature (C) distribution were calculated. Benthic macroinvertebrate taxa collected at fewer than 10 MBSS sites were removed from the analysis, leaving 216 taxa for our analyses. Coldwater-preference taxa were selected as those taxa with a 99% percent probability of being found where the daily mean water temperatures were below 24 C. This cut-off temperature was based on the maximum temperature tolerated by brook trout, a coldwater-obligate fish species (MacCrimmon and Campbell 1969, Meisner 1990, Eaton and Scheller 1996). Using the list of coldwater-preference macroinvertebrates, we calculated the percent coldwater taxa richness at the 27 Sentinel Sites. Trends in coldwater-obligate stream fishes were examined using brook trout, a native species found throughout Maryland, except

in all but one stream (Jabez Branch) in the Coastal Plain. Percent brook trout abundances at the 27 Sentinel Sites were calculated. Spearman correlation analysis (with Bon Ferroni correction) was used to test for significant temporal trends ($p<0.05$) in the proportion of coldwater-preference benthic macroinvertebrate taxa collected and brook trout abundance over the 10-year period at the 27 Sentinel Sites.

Land Use/Cover

Although Sentinel Sites were chosen in areas with minimal human impacts, none have upstream catchments that are completely protected from land alterations (i.e., the entire catchments are not contained within county, state, or federal park land, or on private land conservancies). The percentages of forest, agriculture, and urban land use/cover from the 2001 National Land Cover Database (NLCD; Homer et al. 2007) were extracted for the catchment upstream of each Sentinel Site. Catchment boundaries were drawn by hand using digital USGS 7.5 minute topographic quadrangle maps. Since even minor changes in land use/cover could affect Sentinel Site quality and confound our attempts to evaluate the effects of short-term, natural variability and also longer-term, climate change influences, it was important to understand land use/cover changes that occurred in Sentinel Site catchments since the 2001 NLCD was generated. To accomplish this task, we visually compared satellite images of each Sentinel Site's catchment from 2002 and 2008. Any catchment with a loss of forest or gain in urban land use/cover was hand digitized and the total area of losses and gains (in acres) was calculated for each Sentinel Site catchment.

Measures of climate, weather, and land use/cover change over time were acquired from appropriate sources. These data were used to help explain temporal variability in Sentinel Site-specific data. Since these are some of the factors likely to change as Maryland's climate continues to change, correlations between them and Sentinel Site-specific variables may be useful in predicting and documenting future changes to stream biology, physical habitat, and chemical conditions.

Precipitation

Monthly rainfall data were acquired from NOAA for the period 1999 through 2008 (NOAA 1999; NOAA 2000; NOAA 2001; NOAA 2002; NOAA 2003; NOAA 2004; NOAA 2005; NOAA 2006; NOAA 2007; NOAA 2008; NOAA 2009) for each geographic region in Maryland. We used average annual deviations from normal rainfall amounts, as defined by NOAA (www7.ncdc.noaa.gov/IPS/cd/cd.html).

Stream Flow

Active USGS gaging stations located near the Sentinel Sites were mapped (Figure 5) and daily flow data from those stations were summarized and analyzed. The mean summer (June-August) stream flow (discharge) in cubic feet per second (cfs) was calculated for each selected gaging station. Mean summer discharges were standardized by conversion from cfs to mean percentile. Mean percentiles were then averaged by geographic region (Coastal Plain – eastern shore, Coastal Plain – western shore, Eastern Piedmont, Highland) and by individual Sentinel Site.

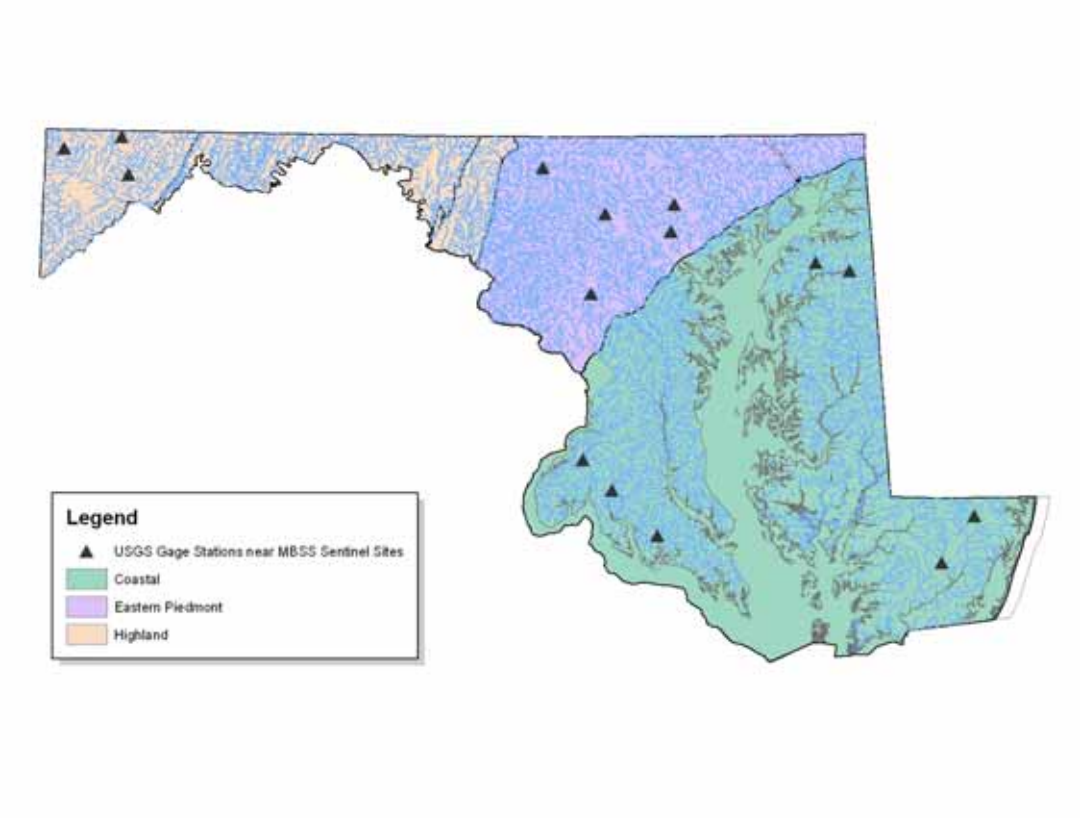

Figure 5. Map of USGS stream gaging stations in Maryland used for flow analyses.

Relating Site-Specific Data to Climate Variables
Potential relationships between Sentinel Site-specific data and climate variables (temperature, precipitation, flow) were tested using a Spearman correlation analysis, with Bon Ferroni correction. Correlations of biological and temperature data were conducted by site. Correlations of precipitation and stream flow with biological data were conducted using Sentinel Site data combined by geographic region and also statewide, to accommodate the spatial scales at which the climate data were available. The effects of land use/cover changes from 2002 to 2008 on patterns in the biological data were also examined.

RESULTS

The array of biological, chemical, and physical habitat-related information collected at each of the 27 Sentinel Sites (plus site photos) is presented in Appendices A through D.

Biological Parameters
Significant differences in IBI scores across years were observed in the Coastal Plain – western shore region (BIBI $p<0.0001$, FIBI $p = 0.003$). The lowest annual mean Sentinel Site IBI scores in this region were recorded during 2003: 1.25 (FIBI) and 0.73 (BIBI), lower than the mean annual IBI scores for this region during any other year from 2000-2009. The IBI scores are based on a condition scale that ranges from 1 (very poor) to 5 (good), with

scores below 3.0 indicating poor/very poor biological condition (Southerland et al. 2005). The year 2003 was the only time when the FIBI score was less than 3.0 and the only time the BIBI score was less than 4.0 (the threshold for Tier 2, high quality waters) in this region. No BIBI or FIBI scores were significantly different ($p<0.01$) at the Sentinel Sites across years in the Piedmont ($p=0.11$ for BIBI, $p=0.95$ for FIBI), the Coastal Plain - eastern shore ($p=0.82$ for BIBI, $p=0.99$ for FIBI), or the Highlands regions ($p=0.03$ for BIBI, $p=0.41$ for FIBI).

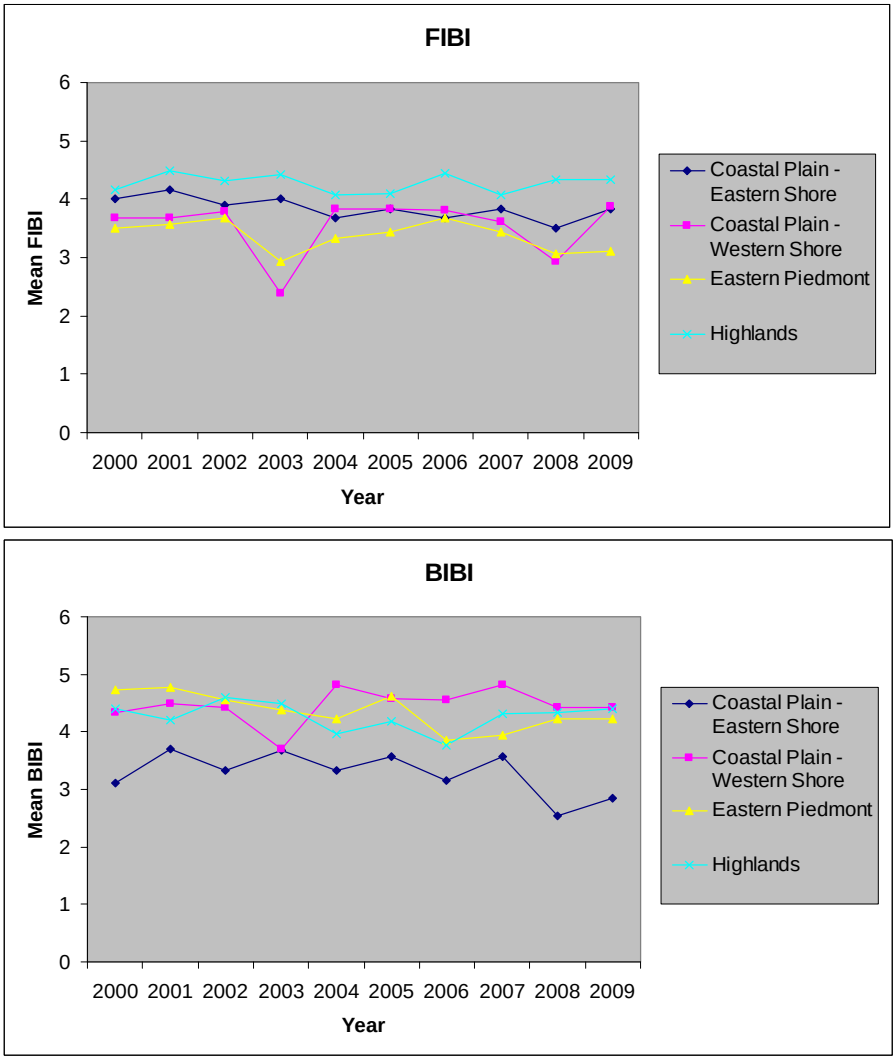

Figure 6. Mean annual FIBI and BIBI scores for the Sentinel Sites by geographic region.

A total of 16 benthic macroinvertebrate taxa were designated as coldwater-preference (Table 1) and one fish species (brook trout) was designated as a coldwater-obligate. Two stonefly genera (*Tallaperla* and *Sweltsa*) are likely coldwater-obligate species. All these taxa require relatively cold streams to flourish. Based on examining data from those Sentinel Sites (statewide) with average maximum daily water temperatures below 20.5 C (11 of 27 sites), the percentages of coldwater-preference benthic macroinvertebrate taxa in the

community at these 11 Sentinel Sites were negatively but not significantly correlated (r = -0.29, p=0.40) with year between 2000 and 2009 (Figure 7). The percentages of coldwater-preference macroinvertebrates varied from about 6.5% to 8.8% across this 10-year period of record. We have not yet determined if the coldwater preference and obligate macroinvertebrate proportions were significantly different across years at the smaller, geographic region scale. The Spearman correlation analysis showed a negative but not significant temporal trend in brook trout abundances at the Sentinel Sites (r = -0.15, p = 0.67). Percent brook trout abundance ranged from a low of 2.5% to a high of 5.7%, with a slight decrease visually evident between 2008 and 2009 (Figure 8). Further analyses with these cold water-preference taxa will be conducted at finer spatial scales in future reports. Data collected in the SSN from 2000 through 2009 have established a 10-year baseline for 16 coldwater-preference benthic macroinvertebrate genera and one coldwater-obligate fish species (brook trout) at the Sentinel Sites that can be used to look for shifts in these biological taxa in future years that may reflect climate change influences.

Currently, benthic macroinvertebrates collected at MBSS sites (random and targeted) and the Sentinel Sites are identified to the genus taxonomic level. Each of the 16 coldwater-preference macroinvertebrate genera could be comprised of only one to possibly as many as 15 or 16 species in Maryland streams. Information on the distribution and life history characteristics of the 16 macroinvertebrates listed in Table 1 is summarized in Appendix E. All but three of these 16 genera (*Bittacomorpha, Dixa, Prodiamesa*) are also pollution-sensitive taxa with tolerance values < or = 3.0. Two stonefly genera appear to be coldwater-obligates in Maryland streams, *Sweltsa* and *Tallaperla*. MDDNR will determine if we have the staff time and resources to identify all *Sweltsa* and *Tallaperla* collected at the Sentinel Sites to species level to, hopefully, enhance our ability to detect climate changes affects on these macroinvertebrates.

Table 1. Coldwater benthic macroinvertebrate taxa list and temperature statistics generated from temperature logger data.

Genus	Order	Average Daily Mean Temperature (°C)	Daily mean temperature (°C) below which there is a 99 percent probability of taxa being observed
Tallaperla	Plecoptera	16.53	21.37
Sweltsa	Plecoptera	16.95	21.66
Cinygmula	Ephemeroptera	16.79	22.57
Wormaldia	Trichoptera	17.25	22.75
Diphetor	Ephemeroptera	17.52	23.08
Bittacomorpha	Diptera	19.11	23.18
Prodiamesa	Diptera	17.91	23.41
Paraleptophlebia	Ephemeroptera	17.58	23.42
Dixa	Diptera	18.38	23.43
Habrophlebia	Ephemeroptera	19.31	23.53
Alloperla	Plecoptera	17.72	23.55
Diplectrona	Trichoptera	18.38	23.58
Epeorus	Ephemeroptera	17.59	23.8
Ephemera	Ephemeroptera	18.14	23.8
Leuctra	Plecoptera	18.20	23.88
Heleniella	Diptera	18.21	23.88

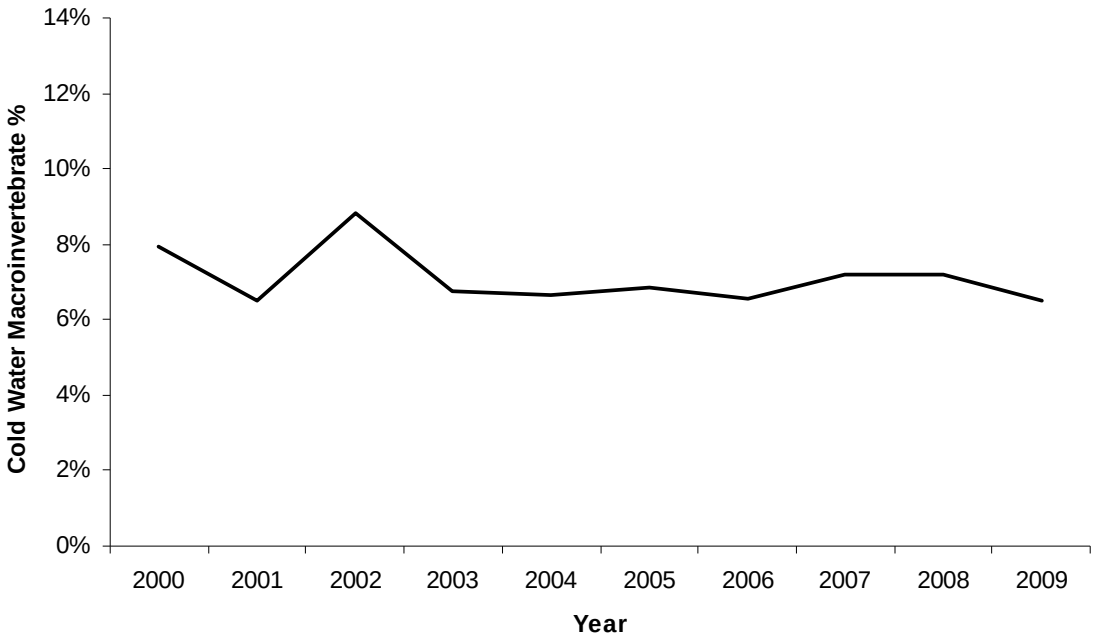

Figure 7. Percent coldwater-preference benthic macroinvertebrate taxa richness at 27 MBSS Sentinel Sites sampled between 2000 and 2009.

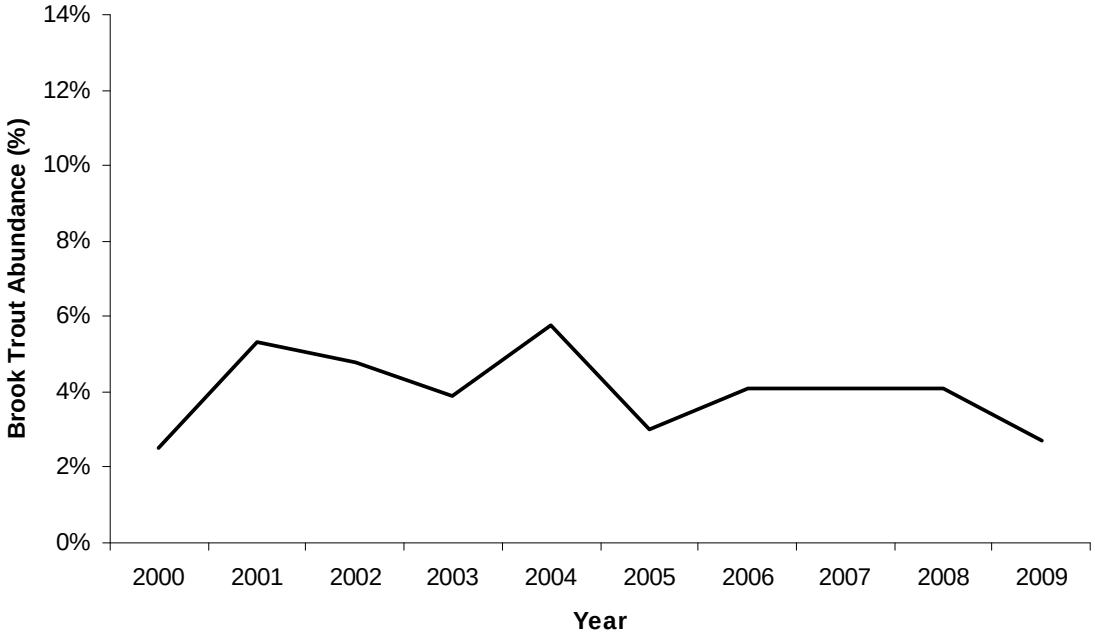

Figure 8. Percent brook trout abundance at 27 MBSS Sentinel Sites sampled between 2000 and 2009.

Water Temperature

Water temperature data (mean, maximum, proportion of readings greater than 20 ^{o}C, proportion of readings greater than 24 ^{o}C) collected by in-situ temperature loggers located at each Sentinel Site did not show any significant differences across years ($p>0.05$) during the 10-year period of record (2000-2009) at the site, region, or statewide scale.

Precipitation

In all regions, mean annual precipitation amounts were more than three inches below normal during 2001, 2002, and 2007 (Figure 9). During 2003, mean annual precipitation amounts were more than five inches above normal in all regions. Mean annual precipitation amounts were near the long-term normal in 2000, 2004-2006, and 2008.

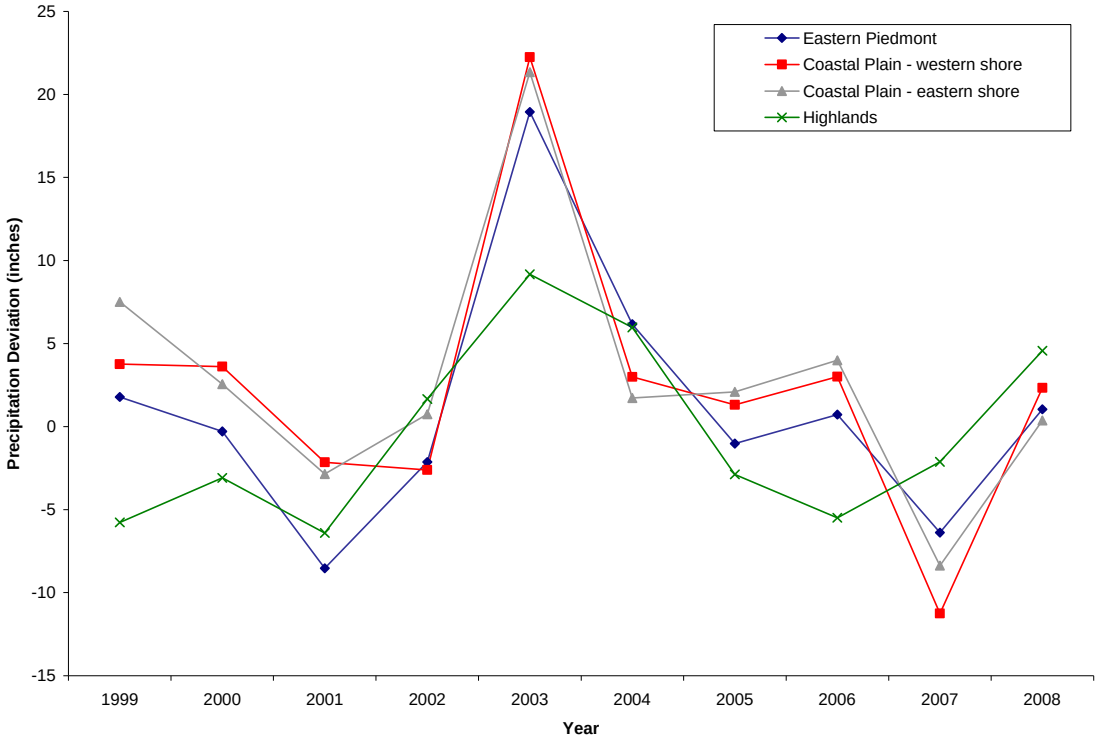

Figure 9. Graph of annual precipitation amounts (deviation from normal), by region, in Maryland from 1999-2008.

Stream Flow

During 2002 and 2007, streams in all regions (except the Highlands) experienced a large decrease in average flow (Figure 10). Mean summer flows for these two years in Piedmont, Coastal Plain – western shore and Coastal Plain – eastern shore streams were below the 10th percentile of flows from preceding years of available USGS gage data.

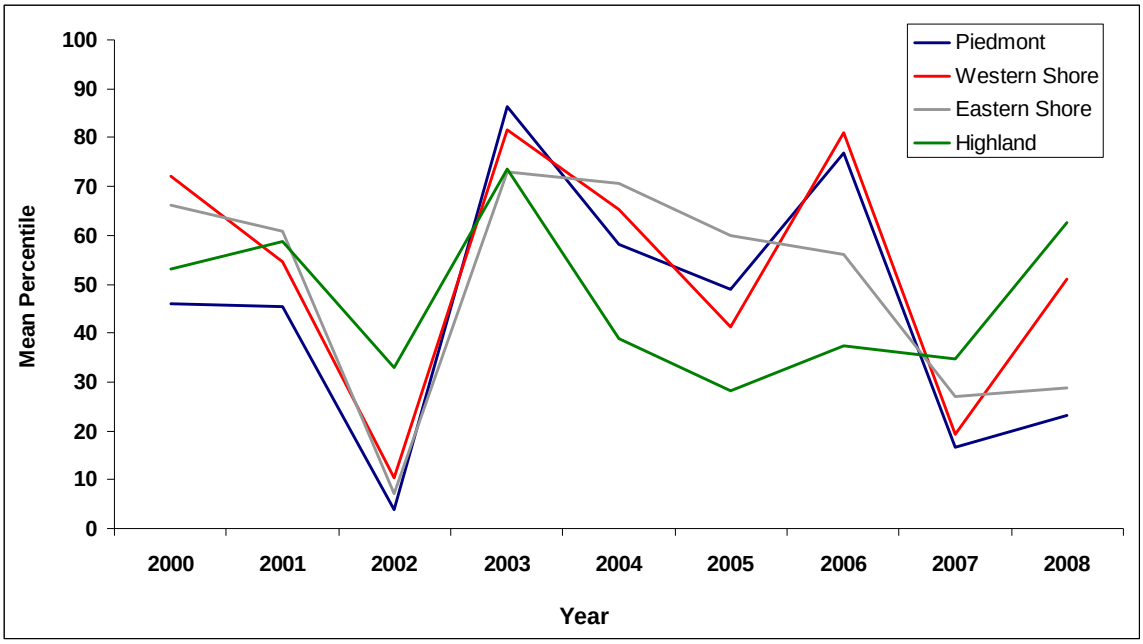

Figure 10. Plot of mean summer (June-August) stream flow percentiles, by region, at USGS gaging stations in Maryland between 2000 and 2008.

Land Use/Cover

We observed differences in land use/cover at seven of the 27 Sentinel Sites between 2002 and 2008 (Table 2). The largest forest cover loss was observed in Mattawoman Creek (932 acres; 2.4% of the watershed area). The largest proportional increase in urban land use/cover was observed in Timber Run (10 acres; 1.5% of the watershed area). Two other Sentinel Sites gained urban land use/cover of about 1.0 %.

Table 2. Forest land cover loss and urban land use/cover increase from 2002 to 2008 at the Sentinel Sites

Site	Forest loss (acres)	Forest loss (%)	Urban increase (acres)	Urban increase (%)
PTOB-002	0	0.0%	0	0.0%
STCL-051	0	0.0%	0	0.0%
ZEKI-012	0	0.0%	0	0.0%
NANJ-331	**15**	**0.3%**	0	0.0%
PAXL-294	**9**	**0.3%**	0	0.0%
MATT-033	**932**	**2.3%**	0	0.0%
UMON-288	0	0.0%	0	0.0%
UMON-119	0	0.0%	0	0.0%
SAVA-276	0	0.0%	0	0.0%
SAVA-204	0	0.0%	0	0.0%
RKGR-119	0	0.0%	0	0.0%
LOCR-102	0	0.0%	0	0.0%
CORS-102	0	0.0%	0	0.0%
NASS-108	0	0.0%	0	0.0%
LIBE-102	0	0.0%	**10**	**1.5%**
JONE-109	0	0.0%	0	0.0%
JONE-315	0	0.0%	0	0.0%
LOCH-120	0	0.0%	**4**	**1.0%**
YOUG-432	0	0.0%	0	0.0%
PLRN-626	0	0.0%	0	0.0%
UPCK-113	0	0.0%	0	0.0%
FURN-101	**12**	**1.6%**	0	0.0%
SAVA-225	0	0.0%	0	0.0%
NASS-302	0	0.0%	0	0.0%
**FIMI-207	0	0.0%	0	0.0%
WIRH-220	0	0.0%	**144**	**1.1%**
***UPCR-208	0	0.0%	0	0.0%

**About 3/4 of catchment in Pennsylvania - could not determine change in Pennsylvania
***About 3/4 of catchment in Delaware - could not determine change in Delaware

Relating Sentinel Site-Specific Data to Climate Variables

The only significant relationships ($p<0.05$) were IBI scores with summer stream flows. BIBI scores at four of six Sentinel Sites in the Coastal Plain – western shore region were significantly correlated ($p<0.05$) and positively with summer flow percentiles ($r= 0.67, 0.70, 0.73$, and 0.76). The lowest IBI scores in the Coastal Plain – western shore region occurred the year after the lowest flow year (2002). This was the only year with stream flow below the 10^{th} percentile of record for the available gage data. The same pattern observed with summer stream flows was also observed with precipitation. The lowest IBI scores in the

Coastal Plain – western shore region consistently occurred one year after the lowest rainfall year (2002).

Total fish numbers collected at Sentinel Sites in the Coastal Plain – western shore region showed the same pattern as the BIBI and FIBI scores, with the fewest total individuals collected during 2003, the year after the lowest recorded precipitation amounts and stream flows. The proportion of coldwater-preference benthic macroinvertebrates decreased slightly (but not significantly) between 2000 and 2009, and there were no significant relationships with water temperature or any variables other than stream flow. Although the abundance of the coldwater-obligate brook trout also decreased (but not significantly), their abundances were also not significantly correlated with any of the variables examined in this study.

The BIBI and FIBI scores did not appear to be related to any of the changes in land use/cover observed at Sentinel Sites between 2002 and 2008. However, brook trout have not been collected since 2003 at the Sentinel Site with the largest proportional increase in urban land use/cover (Timber Run).

DISCUSSION

The MBSS Sentinel Site Network (SSN) is a valuable monitoring tool for interpreting stream conditions in a given year, for evaluating the causes of stream condition changes observed over time, and for making informed decisions on water resource management issues. Throughout the 10-year period of record for the SSN (2000-2009), precipitation patterns varied from drought conditions (2001, 2002, 2007) to one extremely wet year (2003). Stream fish and benthic macroinvertebrate communities were influenced by natural variations in precipitation and flows more in some regions of Maryland than in others. Regional differences in geology and ground water availability may explain the dramatic responses of fish and benthic macroinvertebrates in the Coastal Plain-western shore region to the 2001-2002 drought, as discussed previously by Prochaska (2005). By comparison, stream biota in other Maryland regions responded much less dramatically to these drought conditions. Although the biotic response to the 2001-2002 drought was relatively severe, especially in the Coastal Plain – western shore regions, it was also temporary and the biotic communities appeared to recover quickly.

If droughts occur more frequently and with greater magnitude in response to climate change, fauna in Coastal Plain-western shore region streams may be the first to be affected. The influence of climate change on streams in this region that are also suffering from other stresses (e.g., urbanization, sand and gravel mining) could be much more severe than in other areas of Maryland.

Even small changes in land use/cover (like those documented in this report) may be sufficient to substantially change the biological quality of the State's streams and could confound our attempts to detect and track the effects of global climate change. The loss of brook trout at the Timber Run Sentinel Site was documented by Stranko et al. (2008), who showed that the last collection of brook trout from this stream occurred in 2003, after the start and just prior

to the completion of residential development in the watershed in 2004. Based on observations like these, supported by empirical evidence, we will examine land use/cover changes at finer temporal scales in future reports, as we continue to collect biological data at Sentinel Sites, to determine more precisely when landscape changes occurred. By tracking such alterations, we may be better able to document land use/cover changes that are coincident with ecological variability at these sites.

The decline of coldwater species has been widely forecast to result from global climate change predictions (e.g., Meisner 1990, Eaton and Scheller 1996, Mohseni 2003). The results of our study, described in this report, suggest declines in coldwater-preference benthic macroinvertebrate genera and cold-water obligate brook trout abundance over the 10-year period of record for the SSN (2000-2009) that were slight but not statistically significant. These 'suggested' declines in coldwater taxa, without a significant correlation with air or water temperatures or any other climate-related variable, make it difficult to infer climate change as an explanation for these observations. Coldwater-preference and obligate stream biota may be responding to minor climate change influences that are as yet too subtle to measure directly or that are related to changes in the timing of climatic events. Streams that warm more quickly than normal or experience base-flow conditions earlier in the year could become inhospitable to certain coldwater stream taxa. MDDNR will continue to carefully track taxa composition and abundance at the Sentinel Sites.

As the population of Maryland continues to grow and development converts more forests and farm land to houses, roadways, shopping centers, and other impervious surfaces, many Sentinel Sites and/or their catchments may be altered. Since climate change will add to and magnify stressors already present (Palmer et al., 2009), any disturbances caused by land use/cover changes in Sentinel Site catchments will make it difficult to quantify either short-term natural variability or the longer-term effects of climate change. Land use/cover changes that occurred at some Sentinel Sites between 2002 and 2008, as described in this report, emphasize the need to protect Sentinel Site watersheds. To continue to build a longer and more robust time series, the SSN should be protected, expanded and also continued into the foreseeable future.

To help achieve this goal, the Maryland Water Monitoring Council (in collaboration with MD DNR) sponsored a workshop focused on designing and implementing a climate change monitoring network in the State's non-tidal waters. The major goal of this November 17, 2009 workshop was to construct the framework for a long-term (multi-decadal) statewide monitoring network focused on ephemeral aquatic habitats (e.g., vernal pools) and headwater streams----a network that can be used to detect and track the effects of climate change. One outcome of this workshop was the formation of a Maryland Non-tidal Climate Change Monitoring Work Group that will design and find ways to implement this statewide monitoring network. Workshop attendees agreed that MD DNR's SSN should be expanded and continued to serve as the core or framework of a long-term monitoring network. A recent analysis (Becker 2009) selected 515 potential candidates for expansion of the MBSS SSN. This list was refined to the top 10 candidate sites in each of four geographic regions (Coastal Plain – eastern shore, Coastal Plain – western shore, Eastern Piedmont, Highlands) by giving highest priority to those sites that had all or a large portion of their catchments on

protected lands and were also located within a Stronghold Watershed. Three candidate Sentinel Sites will be sampled in 2010 for possible permanent addition to the SSN. Potential partners have been identified to help MDDNR staff sample two of these three potential new Sentinel Sites. Other interested parties will be encouraged to contribute additional monitoring sites and/or resources to this long-term network. Information coming from this collaborative network should help us document the predicted effects of climate change on non-tidal streams and aid in the development of adaptation strategies to protect ecosystem integrity.

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Appendix A
Sentinel Sites in the Coastal Plain – Eastern Shore Region

Cypress Branch (UPCR-208-S)
Unnamed Tributary to Emory Creek (CORS-102-S)
Leonard Pond Run (WIRH-220-S)
Millville Creek (NASS-108-S)
Nassawango Creek (NASS-302-S)
Unnamed Tributary to Skeleton Creek (UPCK-113-S)
Swan Creek (LOCR-102-S)

Cypress Branch (UPCR-208-S)

Site UPCR-208-S is located on Cypress Branch in the Coastal Plain – eastern shore region of Maryland. It is in the upper Chester River watershed in Kent County. This site was sampled in 2004 and 2008 to 2009. Its watershed is primarily forested (65%), with 34% agriculture.

Cypress Branch in spring 2009.

Water Chemistry

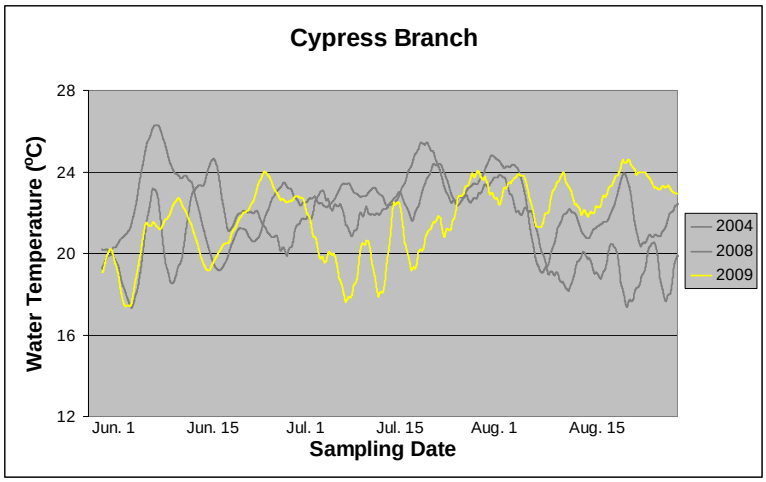
Summer water chemistry data collected at Cypress Branch (2004 and 2008 to 2009)

Parameter	*2004*	*2008*	*2009*
Field pH	6.3	5.9	6.2
Dissolved Oxygen (mg/L)	4.6	1.6	4.3
Conductivity (mS)	0.10	0.10	0.12
Turbidity (NTU)	19.2	16.8	11.8

Physical Habitat

Physical habitat measurements collected at Cypress Branch (2004 and 2008 to 2009). Scored parameters are on a 0 (worst) to 20 (best) scale.

Parameter	*2004*	*2008*	*2009*
Instream habitat (0-20)	13	12	18
Epifaunal substrate (0-20)	11	13	17
Velocity/Depth Diversity (0-20)	14	6	9
Pool Quality (0-20)	15	13	17
Riffle Quality (0-20)	16	0	16
Shading (%)	90	95	80
Embeddedness (%)	100	85	100
Discharge (cfs)	2.35	0.00	1.53



The graph above displays the temperature logger data for Cypress Branch for 2004 and 2008 to 2009.

Biology

Fish

Cumulative list of fish species (with abundance) collected in Cypress Branch by sampling year.

Species	*2004*	*2008*	*2009*
American eel	13	-	2
Bluegill	1	-	7
Bluespotted sunfish	4	-	2
Brown bullhead	-	2	-
Chain pickerel	-	1	-
Creek chubsucker	2	-	5
Eastern mudminnow	38	15	18
Golden shiner	11	-	8
Green sunfish	21	-	3
Largemouth Bass	-	-	3
Margined madtom	5	-	1
Mud sunfish	3	2	3
Pirate perch	18	10	5
Pumpkinseed	6	-	4
Redbreast sunfish	4	-	1
Redfin pickerel	16	28	26
Tadpole madtom	39	1	3
Tessellated darter	33	-	-
Yellow bullhead	10	1	1

Green indicates intolerant fish; blue are moderately tolerant; and red are tolerant.

Crayfish

Cumulative list of crayfish species (with abundance or presence {P}/absence {A} data) collected in Cypress Branch by sampling year.

Species	*2004*	*2008*	*2009*
Spinycheek crayfish *(Orconectes limosus)*		P	A
(*Procambarus sp.*)		P	8

Mussels

Cumulative list of mussel species (with abundance or presence {P}/absence {A} data) collected in Cypress Branch by sampling year.

Species
None Observed

Herpetofauna

Cumulative list of herpetofauna species collected in or near Cypress Branch.

Order (Common)	*Species*
Anura (Frogs and Toads)	American bullfrog, Eastern cricket frog, Fowler's toad, Gray treefrog, Cope's gray treefrog, Northern green frog, Pickerel frog, Southern leopard Frog, Wood frog
Caudata (Salamanders and Newts)	Marbled salamander
Squamata (Snakes and Lizards)	Eastern ratsnake, Northern watersnake

Benthic Macroinvertebrates

Cumulative list of benthic macroinvertebrates collected in the Cypress Branch by sampling year, RA = %Relative Abundance.

PHYLUM	*ORDER*	*FAMILY*	*GENUS*	*2004 RA*	*2008 RA*	*2009 RA*
Arthropoda	Amphipoda (Scud)	Crangonyctidae	*Crangonyx*	0.9	-	-
			Synurella	0.9	1	0.9
	Coleoptera (Beetle)	Gyrinidae	*Dineutus*	2.7	-	-
				-	-	-
	Diptera (True fly)	Chironomidae	*Conchapelopia*	2.7	-	-
			Diplocladius	-	-	3.6
			Hydrobaenus	-	1	8.1
			Kiefferulus	-	1	-
			Orthocladiinae	*0.9	*1	*2.7
			Orthocladius	1.8	-	3.6

PHYLUM	*ORDER*	*FAMILY*	*GENUS*	*2004 RA*	*2008 RA*	*2009 RA*
			Polypedilum	3.6	-	-
			Rheosmittia	4.5	-	-
			Stenochironomus	1.8	-	-
			Symposiocladius	1.8	-	-
			Tanypodinae	*0.9	-	-
			Tanytarsus	2.7	-	-
			Thienmannimyia Group	*10.8	-	-
			Tribelos	0.9	-	-
			Tvetenia	-	4.8	23.4
		Simuliidae	na	-	*22.9	-
			Cnephia	-	2.9	2.7
			Prosimulium	9	13.3	37.8
			Simulium	20.7	1.9	-
			Stegopterna	3.6	32.4	10.8
		Tipulidae	*Ormosia*	-	-	0.9
	Ephemeroptera (Mayfly)	Heptageniidae	*Stenonema*	0.9	-	-
		Leptophlebiidae	na	*0.9	-	-
	Isopoda (Aquatic Sow Bug)	Asellidae	*Caecidotea*	0.9	-	-
				-	-	-
	Lepidoptera (Moth)	na	na	*0.9	-	-
				-	-	-
	Odonata (Dragonfly/Damselfly)	Aeshnidae	*Boyeria*	0.9	-	-
				-	-	-
	Plecoptera (Stonefly)	Nemouridae	na	*5.4	-	*5.4
			Prostoia	5.4	11.4	-
		Perlodidae	na	-	*1	-
		Taeniopterygidae	*Taeniopteryx*	-	1	-
	Trichoptera (Caddisfly)	Hydropsychidae	*Cheumatopsyche*	10.8	-	-
		Limnephilidae	*Ironoquia*	1.8	2.9	-
		Phryganeidae	*Ptilostomis*	0.9	-	-
Mollusca	Veneroida (Bivalve)	Pisidiidae	na	-	*1.9	-
			Musculium	0.9	-	-

Green families are intolerant (family tolerance values from 0 to 3); blue are moderately tolerant (family tolerance values from 3.1 to 6.9); and red are tolerant (family tolerance values from 7 to 10).
* Taxa not identified to genus.

Unnamed Tributary to Emory Creek (CORS-102-S)

Site CORS-102-S is located on an unnamed tributary to Emory Creek in the Coastal Plain – eastern shore region of Maryland. It is in the Corsica River watershed in Queen Anne's County. This site was sampled from 2000 to 2009. Its watershed is primarily forested (84%), with 14% agriculture.


Unnamed tributary to Emory Creek in spring 2009.

Water Chemistry

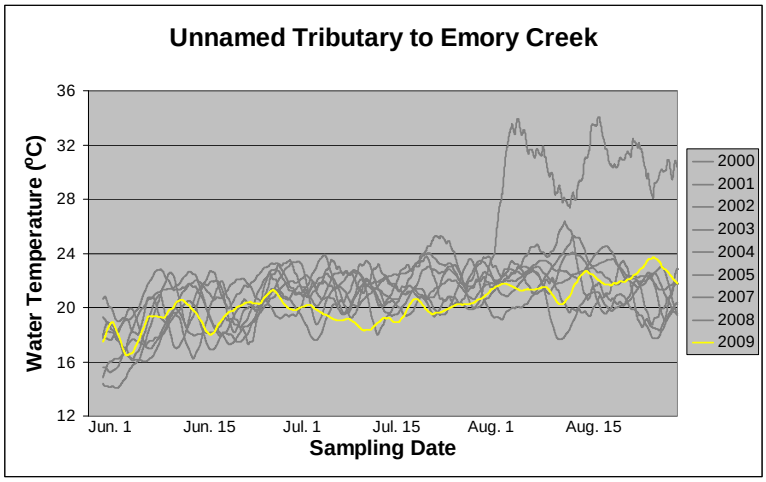
Summer water chemistry data collected at the unnamed tributary to Emory Creek (2000 to 2009).

Parameter	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
Field pH	6.4	7.2		5.8	6.8	6.4	6.3	6.1	6.3	6.4
Dissolved Oxygen (mg/L)	5.9	5.2	Not sampled in	7.3	5.7	5.1	5.1	0.8	3	7.8
Conductivity (mS)	0.09	0.13	summer (dry)	0.05	0.13	0.12	0.14	0.14	0.12	0.08
Turbidity (NTU)	11.0	10.7		9.6	13.9	6.0	7.7	13.9	5.1	5.3

Physical Habitat

Physical habitat measurements collected at the unnamed tributary to Emory Creek (2000 to 2009). Scored parameters are on a 0 (worst) to 20 (best) scale.

Parameter	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
Instream habitat (0-20)	10	8		14	8	7	12	10	6	14
Epifaunal substrate (0-20)	8	9		12	9	8	10	8	6	14
Velocity/Depth Diversity (0-20)	8	9		16	8	7	5	2	2	12
Pool Quality (0-20)	9	13	Not sampled in summer (dry)	16	11	11	10	6	8	12
Riffle Quality (0-20)	12	8		16	6	0	0	0	0	15
Shading (%)	80	92		95	93	95	95	70	80	70
Embeddedness (%)	40	60		20	20	25	70	100	100	100
Discharge (cfs)	0.58	0.02		4.13	0.02	0.00	0.00	0.00	0.00	0.88



The graph above displays temperature logger data for the unnamed tributary to Emory Creek during 2000 to 2009. In 2002, the tributary became dewatered during summer drought conditions.

Biology

Fish

Cumulative list of fish species (with abundance) collected in the unnamed tributary to Emory Creek by sampling year.

Species	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
American eel	3	-		1	-	-	-	-	-	4
Bluegill	-	-		-	-	1	-	11	-	1
Eastern mudminnow	37	168		23	33	227	7	66	7	8
Golden shiner	-	-	Not sampled in	1	-	3	2	5	2	-
Green sunfish	-	-	summer (dry)	-	-	-	2	2	-	-
Eastern mosquitofish	-	-		-	6	6	-	-	-	-
Pumpkinseed	-	-		-	-	-	-	2	-	-
Redfin pickerel	6	5		3	8	7	26	14	2	18

Green indicates intolerant fish; blue are moderately tolerant; and red are tolerant.

Crayfish:

Cumulative list of crayfish species (with abundance or presence {P}/absence {A} data) collected in the unnamed tributary to Emory Creek by sampling year.

Species	*2006*	*2007*	*2008*	*2009*
Devil crawfish (*Cambarus diogenes*)	A	P	P	A

Mussels

Cumulative list of mussel species (with abundance or presence {P}/absence {A} data) collected in the unnamed tributary to Emory Creek by sampling year.

Species
None Observed

Herpetofauna

Cumulative list of herpetofauna collected in or near the unnamed tributary to Emory Creek.

Order (Common)	*Species*
Anura (Frogs and Toads)	American bullfrog, Fowler's toad, Gray Treefrog, New Jersey chorus frog, Northern green frog, Northern spring peeper, Pickerel frog, Southern leopard frog, Wood frog
Squamata (Snakes and Lizards)	Common five-lined skink, Eastern garter snake
Testudines (Turtles)	Eastern snapping turtle

Benthic Macroinvertebrates

Cumulative list of benthic macroinvertebrates collected in the unnamed tributary to Emory Creek by sampling year, RA = % Relative Abundance.

PHYLUM	*ORDER*	*FAMILY*	*GENUS*	*2000 RA*	*2001 RA*	*2002 RA*	*2003 RA*	*2004 RA*	*2005 RA*	*2006 RA*	*2007 RA*	*2008 RA*	*2009 RA*
Annelida	Haplotaxida	Enchytraeidae	na	*0.9	-	-	*1.6	-	-	-	-	*0.9	-
		Naididae	na	*7.7	-	-	-	-	*0.9	-	-	-	-
		Tubificidae	na	*3.4	*0.9	*5.1	*1.6	-	-	-	-	*0.9	-
			Limnodrilus	-	-	-	-	-	0.9	-	-	-	-
			Spirosperma	-	-	-	-	-	0	0.7	-	0.9	-
	Lumbriculida	Lumbriculidae	na	-	*0.9	-	-	*1	*2.6	*1.4	-	*0.9	*1.7
Arthropoda	Amphipoda	na	na	-	-	-	-	-	*10.3	-	-	-	-
	(Scud)	Crangonyctidae	na	*10.3	-	-	-	*1.9	-	-	-	-	-
			Synurella	-	0.9	-	2.3	14.4	0.9	29.5	3.6	2.8	-
		Gammaridae	*Gammarus*	-	1.8	-	-	-	-	-	-	-	-
	Coleoptera	Dryopidae	*Helichus*	-	-	-	-	-	0.9	-	-	0.9	-
	(Beetle)	Dytiscidae	na	*1.7	-	-	-	-	*0.9	*9.6	-	-	-
			Acilius	-	-	-	-	-	0.9	-	-	-	-
			Neoporus	-	-	-	0.8	-	1.7	-	2.7	-	-
		Elmidae	*Stenelmis*	-	-	-	-	-	0.9	-	-	-	-
		Haliplidae	*Peltodytes*	-	-	-	-	-	-	-	0.9	-	-
		Hydrophilidae	*Hydrobius*	-	-	-	-	1	-	-	-	-	-
		Scirtidae	na	-	*0.9	-	*0.8	-	-	-	-	-	-
	Diptera	Ceratopogonidae	na	-	-	*0.8	-	-	-	-	-	-	-
	(True Fly)		*Culicoides*	-	-	-	-	-	-	-	0.9	-	-

PHYLUM	ORDER	FAMILY	GENUS	2000 RA	2001 RA	2002 RA	2003 RA	2004 RA	2005 RA	2006 RA	2007 RA	2008 RA	2009 RA
		Chironomidae	na	-	-	-	*0.8	-	-	-	-	-	-
			Ablabesmyia	-	-	-	-	-	6.9	-	-	-	-
			Chaetocladius	-	-	-	-	-	-	2.1	-	-	-
			Chironomini	-	*0.9	-	-	-	-	-	-	-	-
			Chironomus	1.7	-	-	-	-	-	1.4	-	-	-
			Conchapelopia	0.9	0.9	-	-	-	-	-	-	-	-
			Corynoneura	10.3	-	-	-	-	-	-	-	0.9	-
			Cricotopus	1.7	-	-	-	-	-	-	-	-	-
			Cryptochironomus	-	-	-	-	-	1.7	-	-	-	-
			Dicrotendipes	0.9	-	-	-	-	-	-	0.9	-	-
			Diplocladius	-	-	-	0.8	-	-	-	4.5	-	-
			Eukiefferiella	-	0.9	-	-	-	0.9	-	-	3.7	0.9
			Heleniella	0.9	-	-	-	-	-	-	-	-	-
			Heterotrissocladius	-	-	-	-	-	-	-	-	0.9	-
			Hydrobaenus	-	0.9	52.5	3.1	2.9	2.6	-	-	26.6	11.3
			Micropsectra	-	1.8	-	-	-	-	3.4	-	-	-
			Microtendipes	-	1.8	-	-	-	0.9	-	-	-	-
			Odontomesa	-	-	-	-	-	-	0.7	-	-	-
			Orthocladiinae	-	*3.7	-	-	-	-	-	-	-	-
			Orthocladius	-	-	22	3.1	10.6	2.6	4.1	0.9	7.3	5.2
			Parametriocnemus	-	5.5	-	-	1.9	0.9	-	-	-	0.9
			Paraphaenocladius	-	-	-	-	-	-	-	-	0.9	-
			Polypedilum	0.9	-	-	-	1	-	-	-	-	-
			Procladius	-	-	-	0.8	-	-	-	-	-	-
			Rheocricotopus	9.4	1.8	1.7	-	-	1.7	-	1.8	-	-
			Rheosmittia	-	-	-	-	-	0.9	-	-	-	-
			Sympotthastia	-	4.6	1.7	-	-	-	-	-	-	-
			Tanypodinae	-	*2.8	-	-	-	-	*0.7	-	-	-
			Tanytarsus	3.4	1.8	-	-	-	-	4.1	-	-	-
			Thienemanniella	13.7	-	-	-	-	-	-	-	-	-
			Thienemannimyia Group	-	-	-	-	*4.8	*6.9	-	*1.8	-	*0.9
			Tribelos	-	-	-	-	-	0.9	-	-	-	-
			Tvetenia	-	-	0.8	-	-	-	-	1.8	-	0.9
			Zavrelimyia	2.6	6.4	-	2.3	-	3.4	26	0.9	0.9	0.9
		Simuliidae	na	*1.7	*1.8	-	-	-	*0.9	-	-	-	-
			Prosimulium	1.7	29.4	0.8	13.3	1.9	-	-	1.8	-	17.4
			Simulium	1.7	-	-	-	-	-	-	-	-	-
			Stegopterna	5.1	13.8	-	46.1	5.8	1.7	-	2.7	10.1	3.5
		Tabanidae	*Chrysops*	-	-	0.8	-	-	-	-	-	-	-
			Tabanus	-	0.9	-	-	-	-	-	-	-	-
		Tipulidae	na	-	-	-	-	-	*0.9	-	-	-	-
			Tipula	-	0.9	-	-	1	1.7	-	1.8	0	-
	Ephemeroptera (Mayfly)	Ameletidae	*Ameletus*	2.6	-	-	-	-	-	-	0.9	-	-
		Baetidae	*Acerpenna*	-	-	-	-	1	-	-	-	-	-
		Leptophlebiidae	na	-	-	-	*0.8	-	-	-	-	-	-
			Leptophlebia	-	1.8	-	0.8	4.8	20.7	1.4	46.4	-	-
	Hemiptera (True Bug)	Corixidae	na	-	-	-	-	-	*0.9	-	-	-	-
				-	-	-	-	-	-	-	-	-	-
	Isopoda (Aquatic Sow Bug)	Asellidae	*Caecidotea*	5.1	-	-	0.8	1.9	3.4	2.7	-	0.9	-
				-	-	-	-	-	-	-	-	-	-
	Odonata (Dragonfly/ Damselfly)	Aeshnidae	*Aeshna*	-	-	-	-	-	-	0.7	-	-	-
		Cordulegastridae	*Cordulegaster*	-	-	0.8	-	-	-	-	-	-	-
		Corduliidae	*Neurocordulia*	-	-	-	-	-	-	-	-	0.9	-
			Somatochlora	-	-	-	-	-	1.7	2.1	-	-	-
	Plecoptera (Stonefly)	Capniidae	na	-	-	-	-	-	*0.9	-	*0.9	*3.7	-
			Allocapnia	-	-	-	-	-	-	-	-	-	8.7
			Paracapnia	-	-	-	-	-	-	-	*1.8	17.4	-
		Nemouridae	na	-	*0.9	-	*3.9	*8.7	-	-	*12.5	*6.4	*40.9
			Amphinemura	5.1	-	-	-	-	2.6	1.4	0.9	3.7	-
			Ostrocerca	-	-	-	10.2	-	-	-	-	-	-
			Prostoia	-	0.9	-	2.3	28.8	5.2	-	6.3	-	-
		Perlodidae	na	*0.9	-	-	-	-	-	-	-	*4.6	*1.7
	Trichoptera (Caddisfly)	Hydropsychidae	*Cheumatopsyche*	-	1.8	-	-	-	-	-	-	-	-
		Limnephilidae	na	*0.9	-	*0.8	-	*6.7	-	-	*0.9	-	*1.7
			Ironoquia	0.9	-	-	-	-	-	0.7	0.9	-	-
			Pycnopsyche	0.9	-	-	-	-	-	-	-	-	-
		Philopotamidae	*Wormaldia*	-	-	-	-	-	-	-	0.9	-	-
		Rhyacophilidae	*Rhyacophila*	-	-	-	-	-	-	-	-	-	1.7
		Polycentropodidae	*Polycentropus*	-	-	-	-	-	0.9	-	-	-	-
Mollusca	Basommatophora (Snail)	Physidae	*Physa*	1.7	3.7	2.5	-	-	0.9	2.1	1.8	0.9	-
		Planorbidae	*Menetus*	-	-	5.9	-	-	1.7	0.7	-	-	-
			Planorbella	-	0.9	-	-	-	-	-	-	-	-
	Veneroida	Pisidiidae	na	*0.9	-	-	-	-	-	-	-	-	*0.9

PHYLUM	*ORDER*	*FAMILY*	*GENUS*	*2000 RA*	*2001 RA*	*2002 RA*	*2003 RA*	*2004 RA*	*2005 RA*	*2006 RA*	*2007 RA*	*2008 RA*	*2009 RA*
	(Bivalve)		*Musculium*	-	-	-	-	-	6	4.8	-	-	-
			Pisidium	-	-	2.5	1.6	-	-	-	-	-	-
			Sphaerium	-	1.8	-	-	-	-	-	-	-	-
Nemertea	Hoplonemertea	Tetrastemmatidae	*Prostoma*	-	-	-	-	-	-	-	-	-	0.9

Green families are intolerant (family tolerance values from 0 to 3); blue are moderately tolerant (family tolerance values from 3.1 to 6.9); and red are tolerant (family tolerance values from 7 to 10).

* Taxa not identified to genus.

Leonard Pond Run (WIRH-220-S)

Site WIRH-220-S is located on Leonard Pond Run in the Coastal Plain – eastern shore region of Maryland. It is in the Wicomico River Head watershed in Wicomico County. This site was sampled in 1995 and 2000 to 2009. Its watershed is primarily agriculture (49%), with 38% forested, 10% urban, and 3% barren.


Leonard Pond Run in spring 2009.

Water Chemistry

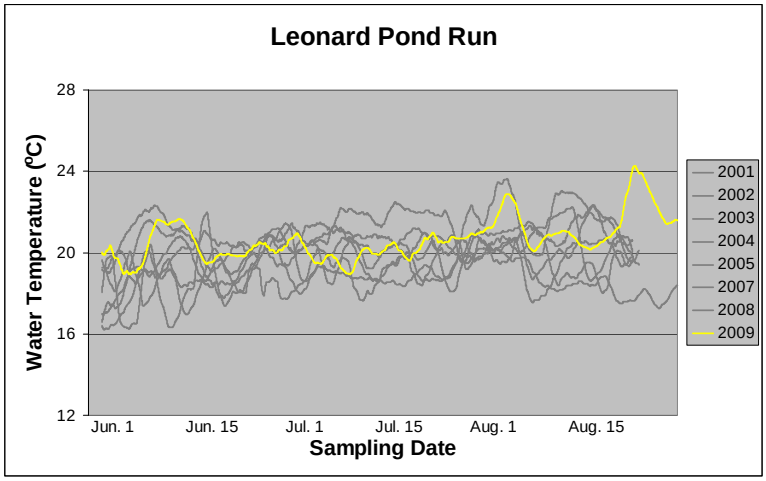
Summer water chemistry data collected at Leonard Pond Run (1995 and 2000 to 2009).

Parameter	*1995*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
Field pH	6.6	5.9	6.5	6.5	5.9	6.2	6.2	6.1	6.7	6.5	6.4
Dissolved Oxygen (mg/L)	6.7	7.5	7.3	9	6.7	7.6	6	8.6	7.3	7.5	5.8
Conductivity (mS)	0.11	0.14	0.13	0.14	0.12	0.13	0.13	0.16	0.17	0.17	0.16
Turbidity (NTU)	Not measured	1.8	2.9	2.3	7.1	3.1	7.4	2.8	3.6	2.5	4.1

Physical Habitat

Physical habitat measurements collected at Leonard Pond Run (1995 and 2000 to 2009). Scored parameters are on a 0 (worst) to 20 (best) scale.

Parameter	*1995*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
Instream habitat (0-20)	16	19	18	17	16	15	17	18	18	17	17
Epifaunal substrate (0-20)	10	16	16	13	16	13	12	16	14	14	17
Velocity/Depth Diversity (0-20)	17	18	19	15	17	13	14	11	8	9	9
Pool Quality (0-20)	14	17	17	17	16	16	16	17	19	18	17
Riffle Quality (0-20)	16	15	0	13	16	16	13	12	0	0	6
Shading (%)	60	87	85	60	80	78	80	85	85	85	80
Embeddedness (%)	100	100	100	100	100	100	100	100	100	100	100
Discharge (cfs)	9.07	39.23	20.77	13.82	31.74	18.07	39.53	12.66	12.45	9.14	11.59



The above graph displays the temperature logger data for Leonard Pond Run for 2001 to 2009. Maximum recorded temperatures occurred during August 2004. No data were available in 2006.

Biology

Fish

Cumulative list of fish species (with abundance) collected in Leonard Pond Run by year.

Species	*1995*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
American eel	9	5	7	15	3	10	1	8	15	17	19
Black crappie	-	1	3	-	-	-	-	-	-	-	-
Bluegill	12	27	37	9	31	32	16	9	23	9	52
Bluespotted sunfish	-	-	-	-	-	-	1	-	4	2	-
Brown bullhead	2	-	-	2	-	1	1	-	-	-	3
Chain pickerel	7	26	26	17	11	16	4	23	19	18	12
Creek chubsucker	-	12	6	1	-	2	-	-	1	-	-
Eastern mosquitofish	-	-	-	1	-	-	-	-	1	-	-
Eastern mudminnow	16	6	6	19	4	9	-	15	5	25	14
Golden shiner	-	-	-	-	-	4	-	-	-	-	-
Largemouth bass	1	2	6	1	2	8	3	-	2	5	-
Least brook lamprey	-	5	2	18	3	19	3	40	28	36	78
Margined madtom	2	1	1	4	4	5	1	4	1	3	3
Pirate perch	4	7	16	42	10	17	3	24	17	12	19
Pumpkinseed	3	1	-	-	17	5	6	14	8	5	2
Redfin pickerel	-	-	-	2	-	1	6	-	-	-	-
Tadpole madtom	-	1	4	8	1	3	-	1	-	1	-
Tessellated darter	19	70	93	220	47	119	21	87	78	128	49
White perch	-	2	2	-	2	-	1	-	-	-	-
Yellow bullhead	-	1	-	1	-	1	-	-	-	-	-
Yellow perch	-	1	-	2	9	8	12	5	9	4	1

Green indicates intolerant fish; blue are moderately tolerant; and red are tolerant.

Crayfish

Cumulative list of crayfish species (with abundance or presence {P}/absence {A} data) collected in Leonard Pond Run by sampling year.

Species	*2006*	*2007*	*2008*	*2009*
Spinycheek crayfish (*Orconectes limosus*)	P	15	P	25
(*Procambarus sp.*)	P	10	A	11
Devil crawfish (*Cambarus diogenes*)	A	P	A	A

Mussels

Cumulative list of mussel species (with abundance or presence {P}/absence {A} data) collected in Leonard Pond Run by sampling year.

Species	*2007*	*2008*	*2009*
Eastern elliptio (*Elliptio complanata*)	P	P	P
Northern lance (Elliptio fisheriana)	A	P	A

Herpetofauna

Cumulative list of herpetofauna species collected in or near Leonard Pond Run.

Order (Common)	*Species*
Anura (Frogs and Toads)	American bullfrog, Fowler's toad, Gray treefrog, Green treefrog, Northern green frog, Northern Spring Peeper, Pickerel frog, Southern leopard frog
Caudata (Salamanders and Newts)	Eastern red-backed salamander
Squamata (Snakes and Lizards)	Common five-linked skink, Southern ring-necked snake
Testudines (Turtles)	Eastern snapping turtle, Eastern box turtle

Benthic Macroinvertebrates

Cumulative list of benthic macroinvertebrates collected in Leonard Pond Run by sampling year, RA = % Relative Abundance.

PHYLUM	*ORDER*	*FAMILY*	Genus	*1995 RA*	*2000 RA*	*2001 RA*	*2002 RA*	*2003 RA*	*2004 RA*	*2005 RA*	*2006 RA*	*2007 RA*	*2008 RA*	*2009 RA*
Annelida	Haplotaxida	Enchytraeidae	na	-	-	-	-	*1.7	-	-	-	-	-	-
(Worm)		Naididae	na	-	-	-	-	-	-	-	-	-	-	*0.9
	Lumbriculida	Lumbriculidae	na	*1	-	*0.9	-	-	-	-	-	-	*1	-
	Tubificida	Tubificidae	na	-	-	*0.9	*1.1	-	-	-	-	-	*4	-
			Limnodrilus	-	-	-	-	-	-	-	-	-	1	-
Arthropoda	Amphipoda	na	na	*14.4	*6.1	-	-	-	-	-	-	-	-	-
	(Scud)	Crangonyctidae	na	*1.0	-	-	-	-	-	-	-	-	*2	-

PHYLUM	ORDER	FAMILY	Genus	1995 RA	2000 RA	2001 RA	2002 RA	2003 RA	2004 RA	2005 RA	2006 RA	2007 RA	2008 RA	2009 RA
			Crangonyx	-	-	0.9	-	-	3	-	-	0.8	1	2.8
			Synurella	-	-	-	-	-	-	-	-	0.8	-	-
		Gammaridae	*Gammarus*	6.2	0.9	2.6	3.2	1.7	10.9	7.1	1.8	4.2	1	7.5
		Hyalellidae	*Hyalella*	-	-	-	-	-	-	-	-	-	-	0.9
	Coleoptera	Dytiscidae	na	-	-	-	-	*0.9	-	-	-	-	-	-
	(Beetle)		*Neoporus*	-	0.9	-	-	-	-	-	-	-	3	-
		Elmidae	*Ancyronyx*	-	-	-	-	-	-	0.9	1.8	0.8	-	-
			Dubiraphia	-	-	-	-	-	-	-	1.8	-	-	-
			Macronychus	-	-	0.9	-	-	-	-	2.7	0.8	-	-
		Gyrinidae	*Dineutus*	-	-	-	-	1.7	1	-	-	-	-	-
			Gyrinus	-	-	-	-	1.7	-	-	-	-	-	-
	Decapoda	Cambaridae	*Procambarus*	-	-	-	-	-	-	-	-	-	-	0.9
	Diptera	na	na	-	-	-	-	*1.7	-	-	-	-	-	-
	(True Fly)	Ceratopogonidae	na	-	-	-	*1.1	-	-	-	-	-	*5	-
			Probezzia	-	-	-	-	-	-	-	3.6	-	1	-
		Chironomidae	na	-	-	-	-	*2.6	-	-	-	-	*2	-
			Ablabesmyia	-	-	-	-	-	-	0.9	3.6	-	-	0.9
			Apsectrotanypus	-	-	-	-	-	-	-	0.9	-	-	0.9
			Brillia	-	0.9	-	-	1.7	-	1.8	-	3.3	4	-
			Chaetocladius	-	-	-	-	-	-	-	-	1.7	1	-
			Cladopelma	-	-	-	-	-	-	-	-	-	-	0.9
			Cladotanytarsus	-	-	-	3.2	-	-	-	-	-	-	-
			Clinotanypus	-	-	-	-	-	-	-	3.6	-	1	-
			Conchapelopia	-	2.6	-	-	-	-	-	-	-	-	-
			Corynoneura	-	-	-	1.1	-	-	-	0.9	-	2	-
			Cricotopus	-	-	-	6.3	-	-	-	-	3.3	3	0.9
			Cryptochironomus	-	-	-	1.1	-	1	-	-	-	-	-
			Diplocladius	-	-	-	-	0.9	-	-	-	-	-	-
			Endochironomus	-	0.9	-	-	-	-	-	-	-	-	-
			Eukiefferiella	-	-	0.9	-	-	-	-	-	-	-	-
			Heterotrissocladius	-	-	-	-	-	-	-	-	-	-	0.9
			Hydrobaenus	-	-	-	-	0.9	-	-	-	-	-	-
			Labrundinia	-	-	-	-	-	-	-	0.9	-	-	-
			Micropsectra	-	-	-	-	-	-	-	-	-	1	-
			Natarsia	-	-	-	-	-	-	-	0.9	-	-	-
			Orthocladiinae	*13.4	*8.7	*5.1	*1.1	*0.9	-	*1.8	-	-	-	*0.9
			Orthocladius	-	-	0.9	2.1	9.5	13.9	1.8	4.5	5.8	4	2.8
			Paracladopelma	1	-	-	-	-	-	-	1.8	-	-	-
			Parakiefferiella	-	-	-	1.1	-	5	-	-	-	-	-
			Parametriocnemus	1	0.9	0.9	-	-	-	0.9	-	1.7	-	4.7
			Paraphaenocladius	-	-	-	-	27.6	-	-	-	-	16.8	-
			Paratanytarsus	7.2	13	12	-	-	-	-	-	-	-	-
			Paratendipes	-	-	-	-	0.9	-	-	-	-	3	0.9
			Phaenopsectra	-	-	-	-	-	-	-	-	-	2	0.9
			Polypedilum	1	15.7	5.1	18.9	6.9	18.8	6.2	2.7	5.8	1	43
			Potthastia	-	-	-	-	-	-	-	-	-	-	1.9
			Procladius	-	-	-	-	-	-	-	2.7	-	1	-
			Pseudorthocladius	-	-	-	-	3.4	-	-	-	-	-	-
			Rheocricotopus	3.1	0.9	1.7	8.4	4.3	1	1.8	4.5	-	4	14
			Rheosmittia	-	-	-	7.4	3.4	3	19.5	4.5	5	-	-
			Rheotanytarsus	-	-	-	-	-	-	-	-	-	-	3.7
			Stempellinella	-	-	-	-	-	1	-	3.6	1.7	-	-
			Symposiocladius	-	-	-	-	-	-	-	-	-	1	-
			Tanypodinae	-	-	-	-	-	-	-	-	*0.8	-	-
			Tanytarsus	2.1	-	3.4	7.4	1.7	-	-	0.9	-	-	-
			Thienemanniella	5.2	-	2.6	-	6	-	-	2.7	0.8	1	-
			Thienemannimyia Group	-	-	*0.9	-	*1.7	*7.9	*4.4	*12.7	*3.3	*5.9	*1.9
			Tribelos	-	-	-	-	-	1	-	4.5	-	1	-
			Tvetenia	-	0.9	3.4	6.3	3.4	2	5.3	3.6	7.5	1	-
		Empididae	*Chelifera*	1	-	0.9	-	-	-	-	-	-	-	-
			Hemerodromia	-	-	-	1.1	-	-	-	-	-	-	-
		Ephydridae	na	-	*0.9	-	-	-	-	-	-	-	-	-
		Sciomyzidae	na	-	-	-	-	*0.9	-	-	-	-	-	-
		Simuliidae	na	-	-	*0.1	*1.1	-	-	-	-	-	*8.9	-
			Simulium	15.5	17.4	-	-	-	-	3.5	-	5.8	-	1.9
		Tabanidae	na	-	-	-	*1.1	-	-	-	-	-	-	-
			Chrysops	-	-	-	-	-	1	-	-	-	-	-
		Tipulidae	na	-	-	-	-	-	-	-	-	-	*1	-
			Hexatoma	-	-	-	-	0.9	-	-	-	-	-	-
			Tipula	-	-	-	-	0.9	-	-	-	-	-	-
	Ephemeroptera	Baetidae	na	-	-	-	*1.1	-	-	-	-	-	-	-
	(Mayfly)		*Acentrella*	-	2.6	-	-	-	-	0.9	-	-	-	-
			Plauditus	-	-	-	-	-	-	-	-	10	-	-
		Ephemerellidae	*Eurylophella*	4.1	15.7	24.8	12.6	2.6	1	1.8	1.8	9.2	6.9	-

PHYLUM	ORDER	FAMILY	Genus	1995 RA	2000 RA	2001 RA	2002 RA	2003 RA	2004 RA	2005 RA	2006 RA	2007 RA	2008 RA	2009 RA
		Heptageniidae	na	-	-	*10.3	-	*0.9	-	-	*4.5	-	-	-
			Maccaffertium	-	-	-	-	-	-	-	-	-	1	-
			Stenonema	8.2	4.3	-	7.4	-	8.9	12.4	-	10.8	-	-
		Leptophlebiidae	*na*	-	*0.9	*0.9	-	-	-	-	*2.7	-	-	-
				-	-	-	-	-	-	-	-	-	-	-
	Isopoda	Asellidae	*Caecidotea*	3.1	1.7	0.9	-	-	-	4.4	1.8	0.8	-	-
	(Aquatic Sow Bug)			-	-	-	-	-	-	-	-	-	-	-
	Megaloptera	Corydalidae	*Nigronia*	-	0.9	-	-	-	-	-	-	-	-	-
	(Dobsonfly/	Sialidae	*Sialis*	-	-	-	-	-	-	-	0.9	-	-	-
	Fishfly)			-	-	-	-	-	-	-	-	-	-	-
	Odonata	Aeshnidae	*Boyeria*	-	-	-	-	-	1	-	-	1.7	-	-
	(Dragonfly /	Calopterygidae	*Calopteryx*	-	-	-	-	1.7	1	-	1.8	-	-	0.9
	Damselfly)	Coenagrionidae	*Argia*	-	-	-	-	-	-	-	-	-	-	0.9
		Gomphidae	*Hagenius*	-	-	-	-	-	-	0.9	-	-	-	-
	Plecoptera	Leuctridae	na	-	-	-	-	-	-	*0.9	-	-	-	-
	(Stonefly)	Perlidae	na	*1	-	-	-	*1.7	-	*0.9	-	-	-	-
			Perlesta	-	-	-	-	-	-	-	-	0.8	-	-
		Perlodidae	na	-	-	*3.4	-	-	*1	*0.9	-	-	-	-
			Isoperla	-	2.6	4.3	4.2	3.4	9.9	2.7	0.9	1.7	1	-
		Pteronarcyidae	*Pteronarcys*	-	-	-	-	-	-	0.9	-	-	-	-
		Taeniopterygidae	*Taeniopteryx*	1	-	-	-	-	-	-	-	-	-	-
	Trichoptera	Brachycentridae	*Brachycentrus*	-	-	-	-	-	-	-	0.9	-	-	-
	(Caddisfly)	Hydropsychidae	*Cheumatopsyche*	1	-	2.6	1.1	0.9	3.0	10.6	2.7	2.5	1	0.9
			Diplectrona	-	-	-	-	-	-	-	-	0.8	-	-
		Lepidostomatidae	*Lepidostoma*	-	-	0.9	-	-	-	1.8	-	6.7	-	-
		Leptoceridae	na	-	-	-	*1.1	-	-	*0.9	-	-	-	-
			Ceraclea	-	-	-	-	-	-	-	-	-	1	1.9
			Oecetis	-	-	-	-	-	-	-	5.5	-	-	-
			Triaenodes	-	0.9	-	-	-	-	-	0.9	0.8	-	-
		Limnephilidae	na	*1	-	-	-	*0.9	-	*0.9	-	-	-	-
			Hydatophylax	-	-	-	-	-	-	0.9	-	-	-	-
			Pycnopsyche	-	-	-	-	-	1	-	-	-	-	-
		Polycentropodidae	*Polycentropus*	-	-	-	-	-	1	-	0.9	-	-	-
		Psychomyiidae	*Lype*	-	-	-	-	-	1	1.8	0.9	-	2	-
Mollusca	Basommatophora			-	-	-	-	-	-	-	-	-	-	-
	(Snail)	Lymnaeidae	*Pseudosuccinea*	-	-	-	-	-	-	0.9	-	-	-	-
		Physidae	*Physa*	4.1	-	-	-	-	-	-	-	-	-	-
	Veneroida	Pisidiidae	na	*3.1	-	-	-	-	-	-	*0.9	-	-	*0.9
	(Bivalve)		*Musculium*	-	-	-	-	-	1	-	0.9	-	-	-

Green families are intolerant (family tolerance values from 0 to 3); blue are moderately tolerant (family tolerance values from 3.1 to 6.9); and red are tolerant (family tolerance values from 7 to 10).
* Taxa not identified to genus.

Millville Creek (NASS-108-S)

Site NASS-108-S is located on Millville Creek in the Coastal Plain – eastern shore region of Maryland. It is in the Nassawango Creek watershed in Worcester County. This site was sampled in 1997 and 2000 to 2009. Its watershed is primarily forested (75%), with 17% agriculture, 6% barren, and 1% urban.


Millville Creek in spring 2009.

Water Chemistry

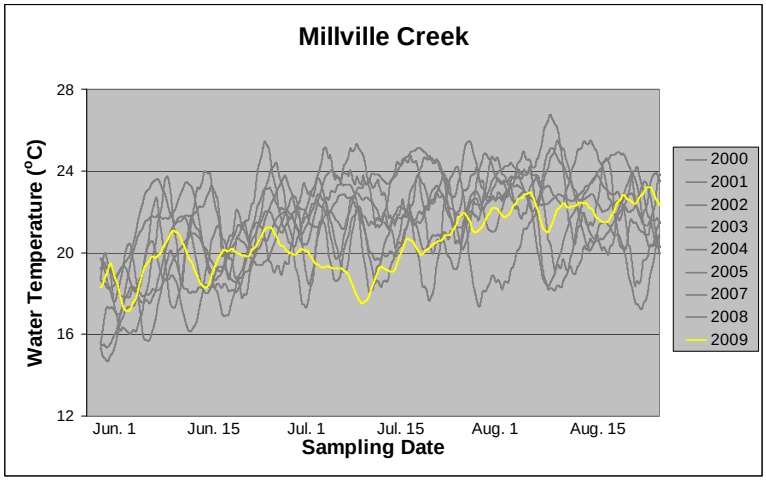
Summer water chemistry data collected at Millville Creek (1997 and 2000 to 2009).

Parameter	*1997*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
Field pH	4.4	4.2	5.1	4.5	4.2	3.9	5.1	4.62	4.53	4.2	4.21
Dissolved Oxygen (mg/L)	1.5	2.8	1.1	4	1.6	3	3	4	1.6	1.8	0.8
Conductivity (mS)	.05	0.08	0.06	0.08	0.07	0.07	0.057	0.079	0.109	0.076	0.072
Turbidity (NTU)	Not measured	2	24	2.1	2.1	3.4	1	3	8.1	1	3.7

Physical Habitat

Physical habitat measurements collected at Millville Creek (1997 and 2000 to 2009). Scored parameters are on a 0 (worst) to 20 (best) scale.

Parameter	*1997*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
Instream habitat (0-20)	17	17	6	12	11	12	7	15	1	11	14
Epifaunal substrate (0-20)	16	16	6	7	10	13	9	11	2	12	17
Velocity/Depth Diversity (0-20)	2	14	3	7	7	8	5	6	1	6	9
Pool Quality (0-20)	18	14	7	11	15	13	7	15	2	13	15
Riffle Quality (0-20)	0	0	0	0	0	0	0	0	0	0	0
Shading (%)	80	99	93	92	90	90	95	98	95	98	90
Embeddedness (%)	100	100	100	100	100	100	100	100	100	100	100
Discharge (cfs)	0.00	0.92	0.00	0.00	0.57	0.71	0.00	0.17	0.00	0.05	0.07



The graph above displays the temperature logger data for Millville Creek for 2000 to 2009. No data were available in 2006.

Biology

Fish

Cumulative list of fish species (with abundance) collected in Millville Creek by sampling year.

Species	*1997*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
American eel	-	1	-	-	-	-	-	-	-	-	-
Banded sunfish	50	6	-	-	1	10	30	2	-	-	-
Bluespotted sunfish	1	-	-	-	-	-	-	-	-	1	-
Eastern mudminnow	370	136	1005	181	165	194	2184	55	-	41	25
Mud sunfish	2	-	1	-	4	-	3	1	-	1	-
Pirate perch	18	9	10	5	7	12	79	-	-	3	3
Redfin pickerel	38	45	8	16	41	8	42	10	-	1	8

Green indicates intolerant fish; blue are moderately tolerant; and red are tolerant.

Crayfish

Cumulative list of crayfish species (with abundance or presence {P}/absence {A} data) collected in Millville Creek by sampling year.

Species	*2006*	*2007*	*2008*	*2009*
Devil crawfish (*Cambarus diogenes*)	A	A	A	2
Digger crayfish (*Fallicambarus fodiens*)	A	A	A	8
(*Procambarus sp.*)	P	A	A	8

Mussels

Cumulative list of mussel species (with abundance or presence {P}/absence {A} data) collected in Millville Creek by sampling year.

Species
None Observed

Herpetofauna

Cumulative list of herpetofauna species collected in or near Millville Creek.

Order (Common)	*Species*
Anura (Frogs and Toads)	American bullfrog, Fowler's toad, Gray treefrog, Northern green frog, Pickerel frog, Southern leopard frog, Wood frog
Squamata (Snakes and Lizards)	Eastern fence lizard
Testudines (Turtles)	Eastern snapping turtle

Benthic Macroinvertebrates

Cumulative list of benthic macroinvertebrates collected in Millville Creek by sampling year,

RA = % Relative Abundance.

PHYLUM	*ORDER*	*FAMILY*	*GENUS*	*1997 RA*	*2000 RA*	*2001 RA*	*2002 RA*	*2003 RA*	*2004 RA*	*2005 RA*	*2006 RA*	*2007 RA*	*2008 RA*	*2009 RA*
Annelida	Lumbriculida	Lumbriculidae	na	*4.2	-	*1	*1.8	*1	-	*0.9	*0.9	*0.8	-	-
(Worm)	Haplotaxida	Enchytraeidae	na	-	-	-	-	-	-	-	-	-	-	*0.9
	Tubificida	Tubificidae	na	*1	-	-	-	-	-	*0.9	-	-	-	*0.9
			Spirosperma	-	-	-	-	-	-	-	-	0.8	-	-
Arthropoda	Amphipoda	na	na	-	-	-	-	-	-	-	-	*4.2	-	-
	(Scud)	Crangonyctidae	na	-	-	-	-	-	-	*3.5	-	-	-	-
			Crangonyx	2.1	17.9	2.9	-	-	28.3	-	0.9	1.7	1	10.1
			Synurella	-	-	3.9	-	1.9	6.2	1.8	2.8	-	-	2.8
	Coleoptera	Dytiscidae	na	-	-	-	-	-	-	-	-	-	*1	-
	(Beetle)		*Neoporus*	-	-	-	-	-	2.7	-	2.8	-	-	-
		Hydrophilidae	*Berosus*	-	-	-	-	-	0.9	-	-	-	-	-
	Collembola	Isotomidae	*Isotomurus*	-	-	-	-	-	-	0.9	-	-	1	-
	(Springtail)			-	-	-	-	-	-	-	-	-	-	-
	Diptera	Ceratopogonidae	na	-	-	-	-	-	-	*1.8	-	-	*3	-
	(True Fly)		*Bezzia*	1	-	-	-	-	-	-	-	-	-	-
		Chironomidae	*Chironomus*	-	-	1	-	-	-	-	-	-	-	-
			Conchapelopia	-	-	-	-	-	0.9	-	-	-	-	-
			Corynoneura	2.1	-	1	-	17.1	-	-	-	-	-	1.8
			Cricotopus	-	-	-	-	-	-	-	-	0.8	-	-
			Dicrotendipes	-	-	-	-	-	-	-	-	0.8	-	-

PHYLUM	ORDER	FAMILY	GENUS	1997 RA	2000 RA	2001 RA	2002 RA	2003 RA	2004 RA	2005 RA	2006 RA	2007 RA	2008 RA	2009 RA
			Heterotrissocladius	-	-	-	2.7	-	-	-	-	-	-	-
			Orthocladiinae	*4.2	*14.2	*3.9	-	*4.8	-	*0.9	-	-	-	*1.8
			Orthocladius	-	-	-	-	-	1.8	-	4.6	-	10.9	-
			Parachironomus	-	-	5.9	-	-	-	1.8	-	-	-	-
			Parakiefferiella	-	-	-	-	2.9	-	17.5	-	-	-	-
			Phaenopsectra	-	-	-	-	-	-	-	-	2.5	-	-
			Polypedilum	3.1	1.9	-	-	-	-	1.8	-	0.8	-	0.9
			Psectrocladius	1	9.4	-	-	-	-	-	-	1.7	-	-
			Stenochironomus	1	-	-	-	-	-	-	-	-	-	-
			Tanytarsus	-	-	-	-	-	-	0.9	-	-	-	-
			Thienemannimyia Group	-	-	-	-	-	*0.9	-	-	-	-	-
			Tribelos	-	-	1	2.7	-	7.1	3.5	-	-	-	0.9
			Tvetenia	-	0.9	5.9	9.8	2.9	-	-	9.3	-	42.6	2.8
			Zalutschia	-	-	43.1	82.1	22.9	15.9	12.3	62	2.5	-	12.8
			Zavrelmyia	-	-	1	-	-	-	-	-	-	-	-
		Simuliidae	na	-	*2.8	-	-	-	-	-	-	-	-	-
			Simulium	-	-	2	-	7.6	-	36.8	-	0.8	-	-
			Stegopterna	17.7	-	20.6	-	-	0.9	-	5.6	1.7	3	5.5
		Tabanidae	*Chrysops*	-	-	-	-	-	-	-	-	0.8	-	-
		Tipulidae	*Hexatoma*	-	0.9	-	-	-	-	-	-	-	2	-
			Ormosia	-	-	-	-	-	-	-	-	-	-	0.9
	Isopoda (Aquatic Sow Bug)	Asellidae	*Caecidotea*	19.8	47.2	2	-	1	30.1	12.3	8.3	79	17.8	16.5
				-	-	-	-	-	-	-	-	-	-	-
	Plecoptera (Stonefly)	Nemouridae	na	-	-	*2	-	*18.1	*4.4	-	*2.8	-	*16.8	-
			Prostoia	39.6	3.8	-	-	18.1	-	1.8	-	-	-	41.3
	Trichoptera (Caddisfly)	Limnephilidae	na	-	-	*2.9	*0.9	-	-	-	-	-	*1	-
			Ironoquia	2.1	-	-	-	1	-	0.9	-	0.8	-	-
		Polycentropodidae	*Polycentropus*	-	0.9	-	-	1	-	-	-	-	-	-
Platyhelminthes	Tricladida (Flatworm)	Dugesiidae	*Cura*	1	-	-	-	-	-	-	-	-	-	-

Green families are intolerant (family tolerance values from 0 to 3); blue are moderately tolerant (family tolerance values from 3.1 to 6.9); and red are tolerant (family tolerance values from 7 to 10).

* Taxa not identified to genus.

Nassawango Creek (NASS-302-S)

Site NASS-302-S is located on Nassawango Creek in the Coastal Plain – eastern shore region of Maryland. It is in the Nassawango Creek watershed in Worcester County. This site was sampled in 2001 to 2009. Its watershed is primarily forested (61%), with 33% agriculture, 5% barren, and 1% urban.

Nassawango Creek in spring 2009.

Water Chemistry

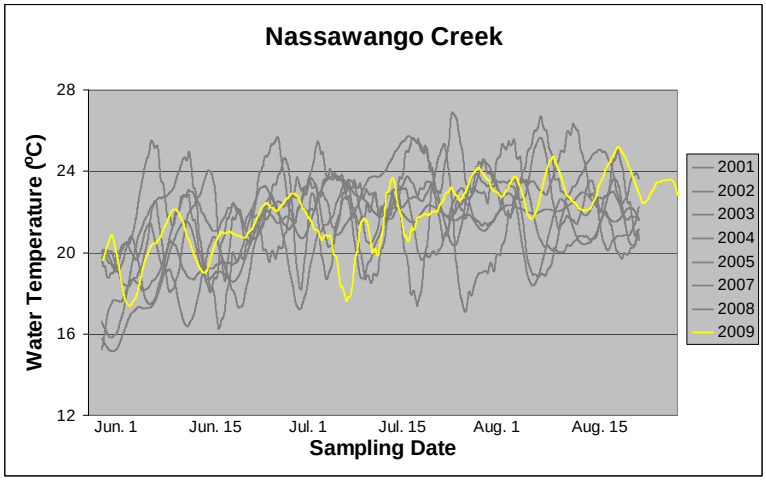
Summer water chemistry data collected at Nassawango Creek (2001 to 2009).

Parameter	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
Field pH	6.4	6.5	5.2		6.3	6.2	6.1	6.1	6.4
Dissolved Oxygen (mg/L)	5.1	5.7	3.9	Not sampled	4.9	6.8	3.1	3.4	2.8
Conductivity (mS)	0.09	0.08	0.07	(high flow conditions)	0.06	0.07	0.10	0.08	0.10
Turbidity (NTU)	8.5	16.8	12.5		15.0	13.6	46.0	44.5	70.6

Physical Habitat

Physical habitat measurements collected at Nassawango Creek (2001 to 2009). Scored parameters are on a 0 (worst) to 20 (best) scale.

Parameter	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
Instream habitat (0-20)	19	16	16		17	18	17	14	14
Epifaunal substrate (0-20)	18	14	13		12	12	16	15	14
Velocity/Depth Diversity (0-20)	8	10	8		9	10	6	8	7
Pool Quality (0-20)	19	17	17	Not sampled (high flow conditions)	18	19	17	17	18
Riffle Quality (0-20)	0	0	0		0	0	0	0	0
Shading (%)	80	89	85		80	75	80	65	70
Embeddedness (%)	100	100	100		100	100	100	100	100
Discharge (cfs)	8.91	0.87	12.88		23.94	2.74	0.31	0.00	1.01



The graph above displays the temperature logger data for Nassawango Creek for 2001 to 2009. Maximum recorded temperatures occurred during July 2005. No data were available in 2006.

Biology

Fish

Cumulative list of fish species (with abundance) collected in Nassawango Creek by sampling year. Fish were not sampled during 2004 due to high flow conditions.

Species	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
American eel	31	58	52		18	37	102	41	27
Banded sunfish	11	7	35		34	35	21	2	1
Black crappie	-	-	1		-	-	-	-	-
Bluegill	1	8	3		-	-	-	5	1
Bluespotted sunfish	17	12	4		3	25	17	6	9
Brown bullhead	-	2	1		4	12	11	8	7
Chain pickerel	17	6	10		1	9	5	5	4
Creek chubsucker	16	18	35		19	24	23	23	39
Eastern mudminnow	25	60	9		18	8	10	9	29
Golden shiner	117	88	96		69	67	132	51	60
Largemouth bass	-	-	1		-	-	-	-	1
Longnose Gar	-	-	-	Not sampled (high	-	-	-	1	-
Least brook lamprey	-	1	5	flow conditions)	-	-	-	-	-
Margined madtom	-	1	1		1	1	20	5	6
Pirate perch	35	68	35		9	46	59	49	90
Pumpkinseed	7	14	9		9	12	18	3	12
Redbreast sunfish	1	1	6		1	-	-	-	3
Redfin pickerel	17	12	34		32	5	18	20	51
Swamp darter	-	-	-		-	1	19	11	11
Tadpole madtom	7	9	-		-	17	24	8	2
Tessellated darter	1	4	-		-	1	5	4	2
White crappie	-	-	-		-	-	1	-	-
Yellow bullhead	1	1	-		1	5	7	4	3
Yellow perch	15	33	7		4	9	36	17	8

Green indicates intolerant fish; blue are moderately tolerant; and red are tolerant.

Crayfish

Cumulative list of crayfish species (with abundance or presence {P}/absence {A} data) collected in Nassawango Creek by sampling year.

Parameter	*2006*	*2007*	*2008*	*2009*
Spinycheek crayfish (*Orconectes limosus*)	P	2	A	1
(*Procambarus sp.*)	P	1	A	5

Mussels

Cumulative list of mussel species (with abundance or presence {P}/absence {A} data) collected in Nassawango Creek by sampling year.

Species
None Observed

Herpetofauna

Cumulative list of herpetofauna species collected in or near Nassawango Creek.

Order (Common)	*Species*
Anura (Frogs and Toads)	American bullfrog, Eastern American toad, Fowler's toad, Gray treefrog, Northern green frog, Northern spring peeper, Pickerel frog, Southern leopard frog
Squamata (Snakes and Lizards)	Common five-lined skink, Northern black racer
Testudines (Turtles)	Eastern box turtle, Eastern snapping turtle, Stinkpot

Benthic Macroinvertebrates

Cumulative list of benthic macroinvertebrates collected in Nassawango Creek by sampling year, RA = % Relative Abundance.

PHYLUM	*ORDER*	*FAMILY*	*GENUS*	*2001 RA*	*2002 RA*	*2003 RA*	*2004 RA*	*2005 RA*	*2006 RA*	*2007 RA*	*2008 RA*	*2009 RA*
Annelida	Haplotaxida	Enchytraeidae	na	*3.8	-	-	-	-	-	-	*9.8	-
(Worm)	Lumbriculida	Lumbriculidae	na	*12.3	-	-	-	*1.1	-	*2.8	-	-
	Tubificida	Tubificidae	na	*7.5	-	*0.8	-	-	-	-	-	-
Arthropoda	Amphipoda	Crangonyctidae	*Crangonyx*	6.6	1	-	3.6	-	2.8	-	3.9	3.9
	(Scud)		*Stygobromus*	-	-	-	-	-	-	-	1	-

PHYLUM	ORDER	FAMILY	GENUS	2001 RA	2002 RA	2003 RA	2004 RA	2005 RA	2006 RA	2007 RA	2008 RA	2009 RA
			Synurella	-	-	-	2.4	-	-	-	-	-
		Hyallelidae	*Hyalella*	-	-	-	-	-	1.9	5.7	-	-
	Coleoptera	Dytiscidae	*na*	-	-	-	-	-	-	-	-	*1.9
	(Beetle)		*Neoporus*	-	1	-	6	1.1	10.2	0.9	-	-
		Elmidae	*Ancyronyx*	-	-	-	-	-	0.9	-	-	-
			Dubiraphia	-	3.8	-	-	-	2.8	-	-	-
	Decapoda	Cambaridae	na	-	-	-	-	-	*0.9	-	-	-
		(Crayfish)		-	-	-	-	-	-	-	-	-
		Palaemonidae	*Palaemonetes*	-	-	-	1.2	-	6.5	-	-	1
		(Shrimp)		-	-	-	-	-	-	-	-	-
	Diptera	Ceratopogonidae	na	-	-	*0.8	-	-	-	-	*33.3	-
	(True Fly)		*Bezzia*	-	-	-	-	-	0.9	-	-	-
		Chironomidae	*Ablabesmyia*	-	5.7	1.6	-	10.1	0.9	32.1	-	-
			Chironomini	-	-	-	-	*1.1	-	-	-	-
			Chironomus	-	-	-	2.4	-	-	-	-	-
			Corynoneura	-	-	-	-	-	-	-	2	-
			Dicrotendipes	-	-	-	-	-	-	-	-	5.8
			Larsia	-	5.7	-	-	-	-	-	-	-
			Limnophyes	0.9	-	-	-	-	-	-	-	2.9
			Micropsectra	-	-	-	-	13.5	0.9	-	-	-
			Microtendipes	-	1	-	-	-	-	-	-	-
			Natarsia	-	8.6	-	-	-	-	-	-	-
			Orthocladiinae	-	-	*1.6	-	*2.2	-	-	*2.9	-
			Orthocladius	-	-	7.4	4.8	-	8.3	1.9	-	4.9
			Parametriocnemus	-	-	-	-	-	4.6	-	-	1
			Paraphaenocladius	-	-	2.5	-	-	0.9	-	2	-
			Paratanytarsus	-	-	-	1.2	-	-	-	-	-
			Phaenopsectra	-	1	0.8	1.2	-	-	-	-	5.8
			Polypedilum	-	-	0.8	-	-	-	0.9	-	1
			Procladius	0.9	-	-	-	-	-	-	-	2.9
			Pseudosmittia	-	-	-	-	-	-	2.8	-	-
			Rheocricotopus	-	-	4.1	-	-	-	-	-	-
			Rheosmittia	-	1.9	-	-	7.9	-	-	-	-
			Rheotanytarsus	-	-	-	-	-	-	-	-	1.9
			Stempellinella	-	1	-	-	-	-	-	-	-
			Stenochironomus	-	1	-	-	-	-	-	-	-
			Tanypodinae	-	*12.4	*1.6	-	-	-	-	-	*22.3
			Tanytarsini	-	-	-	-	*1.1	*0.9	-	-	-
			Tanytarsus	-	4.8	13.9	-	10.1	-	3.8	-	6.8
			Thienemanniella	-	-	-	-	-	-	0.9	-	-
			Thienemannimyia Group	-	-	*4.9	*13.1	*11.2	-	*3.8	-	*5.8
			Tribelos	-	1	-	1.2	-	1.9	3.8	-	-
			Unniella	-	6.7	-	-	-	13.9	-	-	5.8
			Zalutschia	-	-	-	1.2	-	1.9	-	-	-
			Zavrelimyia	1.9	-	-	3.6	-	0.9	-	-	-
		Dolichopodidae	na	-	-	-	-	-	-	-	*1	-
		Empididae	*Hemerodromia*	-	-	-	-	1.1	-	-	-	-
		Ephydridae	na	-	-	-	-	-	-	-	*1	-
		Simuliidae	na	-	-	-	-	-	-	-	*1	-
			Cnephia	-	-	-	-	-	-	-	1	-
			Prosimulium	-	-	-	-	-	-	-	5.9	-
			Simulium	-	-	28.7	-	-	-	-	-	-
			Stegopterna	-	-	-	-	-	-	-	2	1.9
		Tipulidae	na	-	-	-	*1.2	-	*0.9	-	-	-
			Limonia	-	-	-	-	1.1	-	-	-	-
			Ormosia	-	-	-	-	-	-	-	1	-
	Ephemeroptera	Ephemerellidae	na	-	-	-	-	-	*0.9	-	-	*1
	(Mayfly)		*Eurylophella*	3.8	6.7	0.8	-	2.2	-	2.8	-	-
		Heptageniidae	*Stenacron*	-	-	-	-	-	-	-	-	1
			Stenonema	-	-	4.1	-	3.4	-	6.6	-	-
		Leptophlebiidae	na	-	*29.5	*13.1	-	-	*0.9	*0.9	-	*4.9
			Leptophlebia	47.2	-	1.6	38.1	-	22.2	-	-	-
	Hemiptera	Nepidae	na	-	-	-	-	-	-	*0.9	-	-
	(True Bug)	Notonectidae	*Notonecta*	-	-	-	-	-	0.9	-	-	-
	Isopoda	Asellidae	*Caecidotea*	8.5	-	4.9	4.8	28.1	1.9	7.5	31.4	2.9
	(Aquatic Sow Bug)		*Lirceus*	-	1	-	-	-	-	-	-	-
	Odonata	Aeshnidae	*Boyeria*		1	-	-	-	-	-	-	-
	(Dragonfly/Damselfly)		*Nasiaeschna*	-	-	-	1.2	-	-	-	-	-
		Corduliidae	*Somatochlora*	-	-	-	-	-	-	-	-	1
		Coenagrionidae	na	-	*1.9	-	-	-	-	-	-	-
		Gomphidae	*Gomphus*	-	-	-	-	-	-	1.9	-	-
		Libellulidae	na	-	-	-	-	-	-	-	*1	-
	Plecoptera	Taeniopterygidae	*Taeniopteryx*	-	-	-	4.8	-	-	-	-	6.8
	(Stonefly)											

PHYLUM	ORDER	FAMILY	GENUS	2001 RA	2002 RA	2003 RA	2004 RA	2005 RA	2006 RA	2007 RA	2008 RA	2009 RA
	Trichoptera	Hydropsychidae	*Cheumatopsyche*	-	-	0.8	-	-	-	-	-	-
	(Caddisfly)	Leptoceridae	*Oecetis*	-	1	-	-	-	-	-	-	-
			Triaenodes	-	1	-	-	-	4.6	1.9	-	-
		Limnephilidae	na	-	*1	-	-	-	*1.9	-	-	*1.9
			Ironoquia	-	-	2.5	-	-	-	-	-	1.9
			Limnephilus	-	-	-	1.2	-	-	-	-	-
			Platycentropus	-	-	-	-	-	-	0.9	-	-
			Pycnopsyche	5.7	-	1.6	2.4	-	-	0.9	-	1
		Phryganeidae	*Ptilstomis*	0.9	-	-	-	1.1	-	-	-	-
		Polycentropodidae	*Nyctiophylax*	-	-	-	-	-	0.9	-	-	-
			Polycentropus	-	1	-	-	-	0.9	-	-	-
Mollusca	Basommatophora	Physidae	*Physa*	-	-	-	-	-	0.9	-	-	-
	(Snail)	Planorbidae	*Menetus*	-	-	-	-	-	-	-	-	1
	Neotaenioglossa	Hydrobiidae	na	-	-	-	-	-	-	*6.6	-	-
	(Snail)			-	-	-	-	-	-	-	-	-
	Architaenioglossa	Viviparidae	*Campeloma*	-	-	-	-	-	-	7.5	-	1
	(Snail)			-	-	-	-	-	-	-	-	-
	Veneroida	Pisidiidae	na	-	-	-	-	-	*0.9	-	-	-
	(Bivalve)		*Musculium*	-	-	-	4.8	3.4	-	1.9	-	-
Platyhelminthes	Tricladida	Dugesiidae	*Cura*	-	-	0.8	-	-	-	-	-	-
	(Flatworm)			-	-	-	-	-	-	-	-	-

Green families are intolerant (family tolerance values from 0 to 3); blue are moderately tolerant (family tolerance values from 3.1 to 6.9); and red are tolerant (family tolerance values from 7 to 10).

* Taxa not identified to genus.

Unnamed Tributary to Skeleton Creek (UPCK-113-S)

Site UPCK-113-S is located on an unnamed tributary to Skeleton Creek in the Coastal Plain – eastern shore region of Maryland. It is in the Upper Choptank River watershed in Caroline County. This site was sampled in 1996 and 2000 to 2009. The site was not sampled in summer 2005. Its watershed is primarily forested (53%), with 45% agriculture, and 1% barren.

Skeleton Creek in the spring 2009.

Water Chemistry

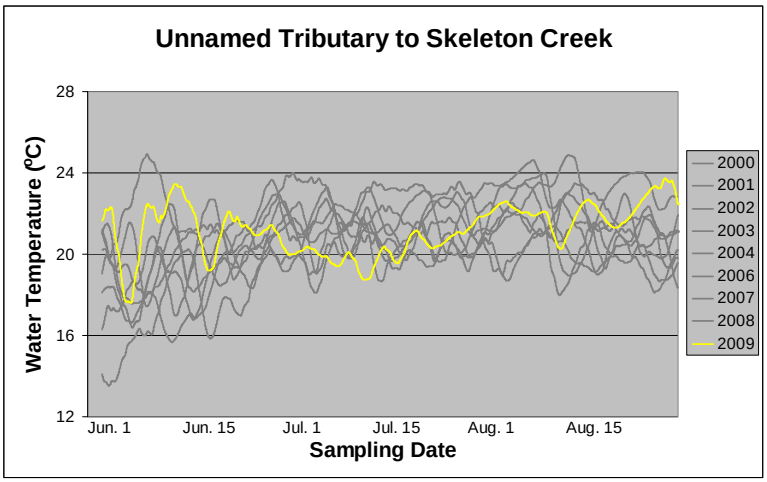
Summer water chemistry data collected at the unnamed tributary to Skeleton Creek (1996, 2000 through 2004, and 2006 through 2009).

Parameter	*1996*	*2000*	*2001*	*2002*	*2003*	*2004*	*2006*	*2007*	*2008*	*2009*
Field pH	6.8	5.7	6.8	6.9	6.6	6.8	6.2	7.1	6.3	6.5
Dissolved Oxygen (mg/L)	7.3	5.2	3.9	3.2	5.2	3.3	6.4	2.3	2.2	1.1
Conductivity (mS)	0.17	0.07	0.18	0.19	0.18	0.19	0.22	0.20	0.21	0.18
Turbidity (NTU)	Not measured	9.5	8.6	4.9	11.7	24.9	6.3	7.5	6.9	26.8

Physical Habitat

Physical habitat measurements collected at the unnamed tributary to Skeleton Creek (1996 and 2000 to 2004, 2006 to 2009). Scored parameters are on a 0 (worst) to 20 (best) scale.

Parameter	*1996*	*2000*	*2001*	*2002*	*2003*	*2004*	*2006*	*2007*	*2008*	*2009*
Instream habitat (0-20)	12	17	11	13	11	12	16	14	8	11
Epifaunal substrate (0-20)	10	17	9	13	11	11	11	10	10	13
Velocity/Depth Diversity (0-20)	4	14	10	8	13	10	10	7	7	8
Pool Quality (0-20)	8	14	12	12	14	13	14	12	12	13
Riffle Quality (0-20)	2	7	8	7	8	9	3	6	6	7
Shading (%)	80	96	97	96	95	95	98	85	95	85
Embeddedness (%)	85	40	40	15	50	65	40	30	70	45
Discharge (cfs)	0.13	1.00	0.04	0.02	0.04	0.04	0.06	0.00	0.03	0.05



The above graph displays the temperature logger data for the unnamed tributary to Skeleton Creek for 2000 to 2009. Maximum recorded temperatures occurred in June 2008. No data were available in 2005.

Biology

Fish

Cumulative list of fish species (with abundance) collected in the unnamed tributary to Skeleton Creek by sampling year.

Species	*1996*	*2000*	*2001*	*2002*	*2003*	*2004*	*2006*	*2007*	*2008*	*2009*
American eel	10	13	11	8	4	6	4	3	8	3
Bluegill	-	4	-	-	5	2	1	3	12	9
Brown bullhead	-	-	-	-	3	7	1	3	12	-
Creek chubsucker	2	-	1	2	-	9	2	9	4	4
Eastern mudminnow	51	25	30	55	95	53	35	26	33	17
Golden shiner	-	-	-	-	3	2	3	1	21	2
Green sunfish	-	-	-	-	-	-	-	3	-	6
Pirate perch	34	95	39	6	8	10	40	19	59	26
Pumpkinseed	5	-	-	-	1	3	7	16	35	9
Redfin pickerel	7	-	2	25	11	52	12	1	9	2

Green indicates intolerant fish; blue are moderately tolerant; and red are tolerant.

Crayfish

Cumulative list of crayfish species (with abundance or presence {P}/absence {A} data) collected in the unnamed tributary to Skeleton Creek by sampling year.

Species	*2006*	*2007*	*2008*	*2009*
(*Procambarus sp.*)	P	P	A	2

Mussels

Cumulative list of mussel species (with abundance or presence {P}/absence {A} data) collected in the unnamed tributary to Skeleton Creek by sampling year.

Species
None Observed

Herpetofauna

Cumulative list of herpetofauna species collected in or near the unnamed tributary to Skeleton Creek.

Order (Common)	*Species*
Anura (Frogs and Toads)	American bullfrog, Eastern American toad, Eastern spadefoot, Fowler's toad, Gray treefrog, New Jersey Chorus frog, Northern green frog, Northern spring peeper, Pickerel frog, Southern leopard frog
Squamata (Snakes)	Common five-lined skink, Eastern wormsnake, Northern black racer, Northern watersnake
Testudines (Turtles)	Eastern snapping turtle

Benthic Macroinvertebrates

Cumulative list of benthic macroinvertebrates collected in the unnamed tributary to Skeleton Creek by sampling year, RA = % Relative Abundance.

PHYLUM	*ORDER*	*FAMILY*	*GENUS*	*1996 RA*	*2000 RA*	*2001 RA*	*2002 RA*	*2003 RA*	*2004 RA*	*2005 RA*	*2006 RA*	*2007 RA*	*2008 RA*	*2009 RA*
Annelida	Haplotaxida	Enchytraeidae	na	-	-	-	-	*0.9	-	-	-	-	-	-
(Worm)	Lumbriculida	Lumbriculidae	na	*0.9	-	-	-	*3.7	-	*0.9	-	-	-	-
	Rhynchobdellida	Glossiphoniidae	na	-	-	-	-	-	-	-	-	-	-	*0.9
	Tubificida	Tubificidae	na	*0.9	*2.5	-	-	*3.7	-	*2.8	*3	-	-	-
Arthropoda	Amphipoda	na	na	-	-	-	-	-	-	*1.8	-	*1.9	-	-
	(Scud)	Crangonyctidae	na	-	-	-	-	-	-	-	*6.1	-	-	-
			Crangonyx	-	-	-	-	-	0.9	-	-	-	-	-
			Synurella	-	-	-	-	-	1.8	-	-	3.8	-	-
		Gammaridae	*Gammarus*	-	2.5	1.6	-	16.5	4.5	-	24.2	12.4	2.5	-
	Coleoptera	Dytiscidae	na	-	-	*0.8	-	-	-	-	-	-	-	-
	(Beetle)		*Neoporus*	-	-	-	0.8	3.7	-	-	7.1	6.7	3.4	0.9
		Elmidae	na	-	-	-	-	-	-	-	-	-	-	-
			Ancyronyx	-	-	-	-	-	-	-	-	1	-	-
			Dubiraphia	-	4.2	4.1	0.8	2.8	-	0.9	6.1	2.9	0.8	-
			Stenelmis	0.9	3.4	-	-	0.9	-	9.2	7.1	1	-	1.7
		Gyrinidae	*Dineutus*	-	-	-	-	-	-	-	1	-	-	-
		Hydrophilidae	*Tropisternus*	-	-	-	-	-	-	-	2	-	-	-

PHYLUM	ORDER	FAMILY	GENUS	1996 RA	2000 RA	2001 RA	2002 RA	2003 RA	2004 RA	2005 RA	2006 RA	2007 RA	2008 RA	2009 RA
		Ptilodactylidae	*Anchytarsus*	-	0.8	-	-	-	-	-	1	-	-	-
	Decapoda	Cambaridae	*Procambarus*	-	-	-	-	-	0.9	-	-	-	-	-
	(Crayfish)			-	-	-	-	-	-	-	-	-	-	-
	Diptera	Ceratopogonidae	na	-	-	-	-	-	-	*0.9	-	-	-	-
	(True Fly)		*Bezzia*	-	-	-	-	-	-	-	1	-	-	0.9
			Ceratopogon	-	-	-	-	-	-	-	-	2.9	-	-
			Probezzia	-	-	-	-	-	-	-	2	-	-	-
		Chironomidae	*Ablabesmyia*	-	-	-	-	-	-	1.8	-	-	-	0.9
			Chaetocladius	-	-	-	-	-	-	-	5.1	-	-	-
			Clinotanypus	0.9	-	-	-	-	-	-	-	-	-	-
			Conchapelopia	0.9	0.8	-	0.8	-	-	-	-	-	-	-
			Cricotopus	-	-	-	-	-	-	-	-	1	-	-
			Cryptochironomus	-	2.5	-	-	0.9	-	0.9	-	-	-	-
			Dicrotendipes	0.9	-	-	0.8	2.8	-	0.9	-	1.9	0.8	1.7
			Diplocladius	-	-	-	-	-	-	-	-	8.6	25.4	-
			Endochironomus	-	-	-	-	-	-	-	-	1	-	-
			Hydrobaenus	-	-	-	-	2.8	1.8	-	-	-	-	-
			Kiefferulus	-	-	-	-	-	-	-	-	-	-	0.9
			Labrundinia	-	-	-	-	-	-	0.9	-	-	-	-
			Microtendipes	0.9	0.8	-	-	2.8	-	-	1	1	0.8	0.9
			Natarsia	-	-	-	-	-	-	0.9	-	-	-	-
			Orthocladiinae	*27.2		*2.4	-	*1.8	-	-	-	-	-	-
			Orthocladius	0.9	-	-	6.6	1.8	5.4	0.9	-	-	-	2.6
			Paramerina	-	-	0.8	-	-	-	-	-	-	-	-
			Paraphaenocladius	-	-	-	-	-	-	-	-	-	-	2.6
			Parametriocnemus	-	-	-	-	0.9	-	-	3	-	-	-
			Paratendipes	-	-	-	0.8	-	-	-	-	-	-	1.7
			Phaenopsectra	-	-	-	-	0.9	-	-	-	-	-	-
			Polypedilum	0.9	-	-	-	-	0.9	3.7	1	2.9	-	-
			Rheocricotopus	17.3	14.3	50.8	37.2	2.8	4.5	47.7	-	10.5	-	28.4
			Stictochironomus	-	1.7	-	-	-	-	-	-	-	-	-
			Tanypodinae	-	-	*3.3	-	-	-	*0.9	-	-	-	-
			Thienemannimyia			-	-	-	-	-	-	-	-	-
			Thienemannimyia Group	-	-	*0.8	-	*1.8	*1.8	*0.9	*2	*7.6	-	*3.4
			Tribelos	-	0.8	-	-	3.7	-	0.9	-	1.9	-	1.7
			Zavrelimyia	1.8	-	0.8	-	4.6	-	0.9	1	-	-	-
		Simuliidae	na	-	*4.2	-	-	-	-	*0.9	-	*0.9	-	-
			Cnephia	-	-	0.8	-	-	1.8	-	-	-	-	-
			Prosimilium	21.8	9.2	5.7	19	7.3	57.7	3.7	-	-	31.4	7.8
			Simulium	-	19.3	0.8	-	-	-	1.8	-	-	-	-
			Stegopterna	14.5	16	4.9	14	2.8	0.9	1.8	-	1	22	37.9
		Tabanidae	*Tabanus*	-	-	-	-	-	-	-	1	-	-	-
		Tipulidae	*Hexatoma*	-	1.7	-	-	-	0.9	-	-	-	-	-
			Pseudolimnophila	-	-	-	-	-	0.9	-	-	-	0.8	-
	Ephemeroptera	Caenidae	*Caenis*	0.9	-	-	-	-	-	-	-	-	-	-
	(Mayfly)	Leptophlebiidae	na	*0.9	-	*1.6	-	*3.7	*0.9	-	-	*1	-	*0.9
			Leptophlebia	-	-	0.8	11.6	0.9	-	1.8	-	-	-	-
			Paraleptophlebia	-	-	1.6	-	-	-	-	-	-	-	-
	Hemiptera	Belostomatidae	*Belostoma*	-	-	-	0.8	-	-	-	-	1	-	-
	(True Bug)	Corixidae	na	-	-	*0.8	-	-	-	-	-	-	-	-
		Nepidae	*Ranatra*	-	-	-	-	-	0.9	-	-	-	-	-
	Isopoda	Asellidae	*Caecidotea*	-	-	4.1	4.1	16.5	5.4	2.8	13.1	14.3	1.7	1.7
	(Aquatic Sow Bug)													-
	Megaloptera	Corydalidae	*Chauliodes*	-	-	-	-	-	-	0.9	-	-	-	-
	(Dobsonfly/Fishfly)		*Nigronia*	-	-	0.8	-	-	-	-	1	-	-	-
	Odonata	Calopterygidae	*Calopteryx*	-	-	0.8	-	0.9	-	2.8	-	4.8	-	-
		Coenagrionidae	na	-	-	*0.8	-	-	-	-	-	*2.9	-	-
	Plecoptera	Capniidae	na	-	-	-	*0.8	-	*0.9	-	-	-	-	-
	(Stonefly)		*Allocapnia*	-	0.8	-	-	-	-	-	-	-	-	-
		Nemouridae	na	-	-	*1.6	-	-	*1.8	-	-	-	-	-
			Prostoia	5.5	5.9	-	-	-	-	-	-	-	-	0.9
	Trichoptera	Hydropsychidae	*Cheumatopsyche*	-	-	-	-	-	0.9	-	-	-	-	-
	(Caddisfly)	Limnephilidae	na	-	-	-	-	-	*0.9	-	-	*1	-	-
			Ironoquia	-	2.5	0.8	-	-	0.9	0.9	-	1.9	-	-
		Phryganeidae	*Ptilstomis*	-	-	-	-	0.9	-	-	-	-	-	-
		Psychomyiidae	*Lype*	-	-	1.6	-	-	1.8	-	-	-	-	-
		Uenoidae	*Neophylax*	-	-	-	-	-	-	0.9	-	-	-	-
Mollusca	Basommatophora	Physidae	*Physa*	-	-	1.6	-	-	-	-	1	-	-	-
	(Snail)	Planorbidae	*Menetus*	-	-	-	0.8	-	-	-	-	-	-	-
	Architaenioglossa	Bithyniidae	*Bithynia*	-	-	-	-	-	-	1.8	2	-	-	0.9
	(Snail)	Viviparidae	na	-	-	-	-	-	-	-	-	-	-	*0.9
			Campeloma	-	0.8	-	-	-	0.9	-	-	-	-	-
			Viviparus	0.9	-	-	-	-	-	-	-	-	-	-
	Neotaenioglossa	Hydrobiidae	na	-	*0.8	-	-	-	-	-	-	-	*0.8	-

PHYLUM	*ORDER*	*FAMILY*	*GENUS*	*1996 RA*	*2000 RA*	*2001 RA*	*2002 RA*	*2003 RA*	*2004 RA*	*2005 RA*	*2006 RA*	*2007 RA*	*2008 RA*	*2009 RA*
	Veneroida	Pisidiidae	na	-	-	-	-	*2.8	*0.9	*1.8	*4	-	*0.8	-
	(Bivalve)		*Musculium*	-	-	-	-	-	-	-	4	3.8	-	-
			Pisidium	0.9	3.4	-	0.8	-	-	-	-	-	-	-
			Sphaerium	-	-	3.3	-	-	-	-	-	-	8.5	-
Nematomorpha	Gordioidea	Gordiidae	na	-	*0.8	-	-	-	-	-	-	-	-	-
Platyhelminthes	Tricladida	na	na	-	-	-	-	*4.6	-	-	-	-	-	-
	(Flatworm)	Dugesiidae	*Cura*	-	-	0.8	-	-	-	-	-	-	-	-

Green families are intolerant (family tolerance values from 0 to 3); blue are moderately tolerant (family tolerance values from 3.1 to 6.9); and red are tolerant (family tolerance values from 7 to 10).

* Taxa not identified to genus.

Swan Creek (LOCR-102-S)

Site LOCR-102-S is located on Swan Creek in the Coastal Plain – eastern shore region of Maryland. It is in the Lower Chester River watershed in Kent County. This site was sampled in 1995 and 2000 to 2009. Its watershed is primarily forested (77%), with 16% agriculture, and 7% wetlands.


Swan Creek in spring 2009.

Water Chemistry

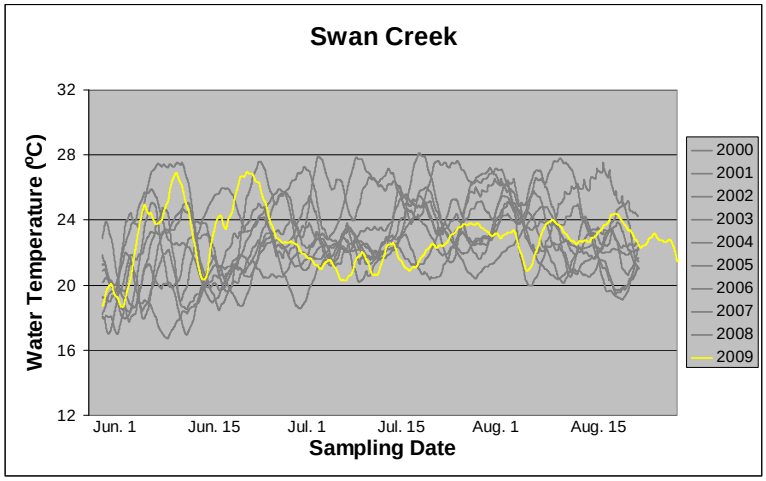
Summer water chemistry data collected at Swan Creek (1995 and 2000 to 2009)

Parameter	*1995*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
Field pH	6.3	7.0	6.7	4.7	5.9	6.0	5.9	6.1	6.0	6.2	6.2
Dissolved Oxygen (mg/L)	0.8	5	2.9	6.91	4.1	5.9	2.6	4.5	3	2.4	5.3
Conductivity (mS)	0.19	0.11	0.09	0.12	0.06	0.09	0.11	0.06	0.11	0.10	0.09
Turbidity (NTU)	Not measured	11.8	27.0	73.0	17.9	36.8	58.8	30.0	94.0	150.0	27.6

Physical Habitat

Physical habitat measurements collected at Swan Creek (1995 and 2000 to 2009). Scored parameters are on a 0 (worst) to 20 (best) scale.

Parameter	*1995*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
Instream habitat (0-20)	15	16	8	11	13	13	9	17	8	14	14
Epifaunal substrate (0-20)	5	17	8	11	14	11	9	16	8	13	15
Velocity/Depth Diversity (0-20)	3	8	4	5	12	9	4	10	2	3	6
Pool Quality (0-20)	14	11	7	5	13	12	8	10	7	8	9
Riffle Quality (0-20)	0	10	8	0	11	11	8	13	1	6	12
Shading (%)	80	40	20	65	65	40	45	40	80	70	60
Embeddedness (%)	100	30	99	100	30	100	100	30	95	100	100
Discharge (cfs)	0.00	0.29	0.05	0.00	0.22	0.21	0.02	0.02	0.00	0.02	0.33



The graph above displays the temperature logger data for Swan Creek for 2000 to 2009. Maximum recorded temperatures occurred during July 2004.

Biology

Fish

Cumulative list of fish species (with abundance) collected in Swan Creek by sampling year.

Species	*1995*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
American eel	1	9	6	10	4	6	11	12	4	4	-
Black crappie	34	-	-	-	-	1	-	6	-	-	-
Bluegill	7	27	-	-	-	9	2	2	17	1	6
Brown bullhead	119	-	22	8	2	26	12	7	-	8	1
Eastern mosquitofish	-	-	-	-	1	-	643	92	15	7	4
Eastern mudminnow	40	513	1603	515	1768	786	743	310	118	255	375
Golden shiner	97	86	97	42	2	39	57	26	34	28	20
Largemouth bass	19	-	-	-	-	-	-	-	-	-	1
Pumpkinseed	3	528	213	42	21	51	162	54	49	71	68
Redfin pickerel	4	-	2	-	7	4	-	5	6	12	4
Warmouth	-	16	4	1	-	1	5	4	1	-	1
Yellow bullhead	-	1	-	-	-	-	-	-	-	-	-
Yellow perch	-	-	-	-	-	1	-	-	-	-	-

Green indicates intolerant fish; blue are moderately tolerant; and red are tolerant.

Crayfish

Cumulative list of crayfish species (with abundance or presence {P}/absence {A} data) collected in Swan Creek by sampling year.

Species	*2006*	*2007*	*2008*	*2009*
Red swamp crawfish (*Procambarus clarkii*)	P	A	A	33
Devil crayfish (Cambarus diogenes)	A	A	P	P
(*Procambarus sp.*)	A	A	A	10

Mussels

Cumulative list of mussel species (with abundance or presence {P}/absence {A} data) collected in Swan Creek by sampling year.

Species
None Observed

Herpetofauna

Cumulative list of herpetofauna species collected in or near Swan Creek.

Order (Common)	*Species*
Anura (Frogs and Toads)	American bullfrog, Fowler's toad, Gray treefrog, Green tree frog, Northern cricket frog, Northern green frog, Pickerel frog, Southern leopard frog
Squamata (Snakes and Lizards)	Common five-lined skink, Eastern rat snake, Northern watersnake, Ringneck snake
Testudines (Turtles)	Eastern painted turtle, Eastern snapping turtle, Red bellied turtle

Benthic Macroinvertebrates

Cumulative list of benthic macroinvertebrates collected in the Swan Creek by sampling year,

RA = % Relative Abundance.

PHYLUM	*ORDER*	*FAMILY*	*GENUS*	*1995 RA*	*2000 RA*	*2001 RA*	*2002 RA*	*2003 RA*	*2004 RA*	*2005 RA*	*2006 RA*	*2007 RA*	*2008 RA*	*2009 RA*
Annelida	Haplotaxida	Enchytraeidae	na	-	-	*0.8	*1	-	-	-	-	-	-	-
(Worm)		Naididae	na	-	-	-	*2	*0.8	-	-	-	-	-	-
	Lumbriculida	Lumbriculidae	na	*1.0	*10.4	*5.9	*4	*1.6	-	-	-	*0.9	*1	-
	Arhynchobdellida	Erpobdellidae	na	-	-	-	-	-	-	-	*0.9	-	-	-
	Tubificida	Tubificidae	na	-	*5.7	*1.7	*4	*0.8	-	-	*1.7	-	-	*0.9
Arthropoda	Amphipoda	na	na	-	*1.9	-	-	-	-	-	-	-	-	-
	(Scud)	Crangonyctidae	na	-	-	-	-	-	-	-	-	*0.9	-	-
			Crangonyx	4.1	-	-	-	1.6	-	-	1.7	3.6	-	3.5
			Synurella	-	-	-	-	-	0.7	-	10.4	2.7	1	2.6
	Coleoptera	Dytiscidae	*Deronectes*	2	-	-	-	-	-	-	-	-	-	-
	(Beetle)		*Neoporus*	-	-	-	-	0.8	-	-	2.6	-	-	0.9
		Haliplidae	*Peltodytes*	-	-	-	3	-	-	-	-	-	1	0.9
		Scirtidae	na	*2.0	-	-	-	-	-	-	-	-	-	-
	Decapoda (Crayfish)	Cambaridae	na	-	-	-	-	-	-	-	-	-	*1	-

PHYLUM	ORDER	FAMILY	GENUS	1995 RA	2000 RA	2001 RA	2002 RA	2003 RA	2004 RA	2005 RA	2006 RA	2007 RA	2008 RA	2009 RA
	Diptera	na	na	-	-	-	-	*0.8	-	-	-	-	-	-
	(True Fly)	Ceratopogonidae	na	-	-	-	-	-	-	-	-	-	-	*0.9
			Bezzia	-	1.9	-	-	-	-	-	0.9	-	-	1.7
			Ceratopogon	1	-	-	-	-	-	-	-	-	-	-
			Mallochohelea	-	-	-	-	-	-	-	-	-	1	-
		Chironomidae	*Alotanypus*	-	-	-	1	-	-	-	-	-	-	-
			Chironomini	-	-	*0.8	-	-	-	-	-	-	-	*0.9
			Chironomus	1	-	-	1	-	-	-	-	-	-	-
			Clinotanypus	-	-	0.8	-	-	0.7	-	-	-	-	0.9
			Conchapelopia	9.2	3.8	-	10.1	-	0.7	-	-	1.8	-	-
			Cryptochironomus	-	-	-	-	-	-	-	-	1.8	-	0.9
			Dicrotendipes	8.2	-	0.8	9.1	3.2	0.7	0.9	0.9	-	-	2.6
			Diplocladius	-	0.9	-	2	-	-	1.8	-	18.9	2	-
			Endochironomus	-	3.8	0.8	-	-	0.7	-	-	0.9	-	-
			Glyptotendipes	2	-	-	-	-	0.7	-	-	-	-	-
			Hydrobaenus	6.1	-	-	-	-	-	-	-	-	-	2.6
			Kiefferulus	-	-	-	-	-	-	-	-	0.9	-	2.6
			Krenopelopia	-	0.9	-	-	-	-	-	-	-	-	-
			Labrundinia	-	-	-	-	-	-	-	0.9	-	-	-
			Limnophyes	-	0.9	-	-	-	-	-	-	-	-	-
			Mesosmittia	-	-	-	-	-	-	-	0.9	-	-	-
			Nanocladius	-	-	1.7	-	-	-	-	-	-	-	-
			Orthocladiinae	*11.2	*2.8	*11	-	*3.2	-	-	-	*0.9	*4.9	-
			Orthocladius	8.2	-	-	13.1	19.8	13.1	2.8	-	-	22.5	20
			Parachironomus	-	-	-	-	3.2	-	-	-	-	-	-
			Paramerina	-	-	-	-	-	-	-	-	-	-	0.9
			Parametriocnemus	-	0.9	0.8	4	-	1.5	-	-	-	-	4.3
			Paraphaenocladius	-	-	-	14.1	2.4	-	-	-	1.8	-	5.2
			Paratanytarsus	-	-	-	2	-	-	-	-	0.9	-	1.7
			Paratendipes	2	-	-	-	-	-	-	-	-	-	0.9
			Polypedilum	1	-	0.8	-	11.9	-	0.9	6.1	1.8	2	3.5
			Procladius	-	-	-	5.1	15.9	-	0.9	3.5	-	1	-
			Psilometriocnemus	-	-	-	-	-	-	-	-	-	-	-
			Rheocricotopus	-	1.9	1.7	-	1.6	-	-	-	-	-	-
			Tanypodinae	-	*0.9	*1.7	-	-	*1.5	*0.9	-	*0.9	-	-
			Tanypus	-	-	-	1	-	-	-	-	-	-	1.7
			Tanytarsini	-	-	-	-	*0.8	-	-	-	-	-	-
			Thienemannimyia Group	-	-	*5.1	-	-	*10.9	*0.9	-	*6.3	-	*5.2
			Tribelos	1	-	-	-	-	-	-	-	-	-	-
			Trissopelopia	-	-	-	-	1.6	-	-	-	-	-	-
			Zavrelimyia	-	-	-	-	-	-	-	-	-	-	0.9
		Simuliidae	na	-	-	-	-	*0.8	-	*1.8	*1.7	-	*5.9	-
			Cnephia	-	-	-	-	1.6	-	-	-	15.3	11.8	-
			Prosimulium	-	-	1.7	-	-	-	-	-	0.9	1	-
			Simulium	-	2.8	4.2	-	7.9	46.0	77.1	-	-	-	-
			Stegopterna	-	-	47.5	-	12.7	16.8	2.8	-	14.4	34.3	4.3
		Tabanidae	na	-	-	-	*1	-	-	-	-	*0.9	*1	-
			Chrysops	-	1.9	-	-	-	-	0.9	-	-	-	0.9
			Tabanus	1	-	-	-	-	-	-	-	-	-	-
		Tipulidae	na	-	-	-	-	*0.8	-	*0.9	*0.9	-	*1	-
			Hexatoma	-	-	0.8	-	-	-	-	-	-	-	-
			Ormosia	-	-	-	-	-	-	-	0.9	-	-	-
			Pedicia	-	-	-	1	-	-	-	-	-	-	-
			Pseudolimnophila	-	-	-	-	-	1.5	-	-	0.9	-	-
			Tipula	-	-	-	-	-	-	0.9	-	-	-	-
	Ephemeroptera	Caenidae	*Caenis*	-	-	-	1	-	-	2.8	-	-	-	-
	(Mayfly)			-	-	-	-	-	-	-	-	-	-	-
	Hemiptera (True Bug)	Corixidae	na	*1.0	-	-	-	-	-	-	-	-	-	*0.9
	Isopoda	Asellidae	*Caecidotea*	6.1	36.8	4.2	2	3.2	2.9	2.8	57.4	19.8	1	13
	(Aquatic Sow Bug)			-	-	-	-	-	-	-	-	-	-	-
	Lepidoptera (Moth)	Tortricidae	na	*3.1	-	-	-	-	-	-	-	-	-	-
	Megaloptera	Corydalidae	*Chauliodes*	-	-	-	-	-	-	-	0.9	-	-	-
	(Dobsonfly/Fishfly)			-	-	-	-	-	-	-	-	-	-	-
	Odonata	Calopterygidae	*Calopteryx*	-	-	-	-	-	-	-	-	0.9	-	-
	(Dragonfly/	Coenagrionidae	na	-	-	*0.8	-	-	-	-	-	-	-	-
	Damselfly)	Libellulidae	na	-	-	-	-	-	-	-	-	-	-	*1.7
	Plecoptera	Nemouridae	na	-	-	*1.7	-	*0.8	-	-	-	-	*5.9	*2.6
	(Stonefly)		*Ostrocerca*	-	-	-	-	0.8	-	-	-	-	-	-
			Prostoia	3.1	-	-	-	-	-	-	-	-	-	0.9
	Trichoptera	Hydropsychidae	*Cheumatopsyche*	-	-	-	-	-	0.7	-	-	-	-	-
	(Caddisfly)	Limnephilidae	na	-	-	-	*3	-	-	-	-	-	-	-
			Ironoquia	-	-	-	-	-	0.7	-	-	-	-	4.3
		Phryganeidae	*Ptilostomis*	-	-	-	-	-	-	-	-	-	-	1.7
Mollusca	Basommatophora	Lymnaeidae	*Pseudosuccinea*	1	-	-	-	-	-	-	-	-	-	-

PHYLUM	ORDER	FAMILY	GENUS	1995 RA	2000 RA	2001 RA	2002 RA	2003 RA	2004 RA	2005 RA	2006 RA	2007 RA	2008 RA	2009 RA
	(Snail)	Physidae	*Physa*	1	-	-	-	-	-	-	-	-	-	-
		Planorbidae	*Menetus*	4.1	-	0.8	3	-	-	-	-	-	-	2.6
	Veneroida	Pisidiidae	na	-	-	-	-	*0.8	-	-	-	-	-	-
	(Bivalve)		*Musculium*	-	-	-	12.1	-	-	0.9	7.8	1.8	1	0.9
			Pisidium	18.4	21.7	-	-	0.8	-	-	-	-	-	-
			Sphaerium	-	-	3.4	-	-	-	-	-	-	-	-

Green families are intolerant (family tolerance values from 0 to 3); blue are moderately tolerant (family tolerance values from 3.1 to 6.9); and red are tolerant (family tolerance values from 7 to 10).
* Taxa not identified to genus.

Appendix B
Sentinel Sites in the Coastal Plain – Western Shore Region

Hoghole Run (PTOB-002-S)
Mattawoman Creek (MATT-033-S)
Mill Run (Nanjemoy Creek, NANJ-331-S)
Unnamed Tributary to St. Clements Creek (STCL-051-S)
Swanson Creek (PAXL-294-S)
Unnamed Tributary to Zekiah Swamp Run (ZEKI-012-S)

Hoghole Run (PTOB-002-S)

Site PTOB-002-S is located on Hoghole Run in the Coastal Plain – western shore region of Maryland. It is in the Port Tobacco River watershed in Charles County. This site was sampled in 1995 and 2000 to 2009. Its watershed is primarily forested (70%), with 26% agriculture, 3% urban, and 1% barren.


Hoghole Run in spring 2009.

Water Chemistry

Summer water chemistry data collected at Hoghole Run (1995 and 2000 to 2009).

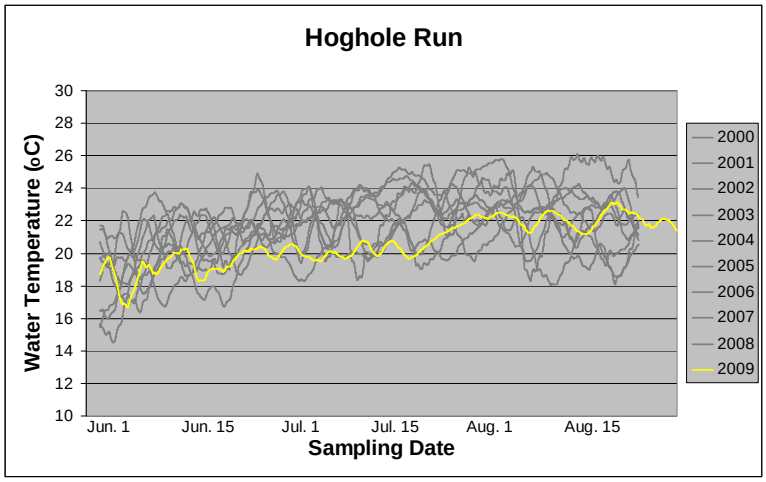
Parameter	*1995*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
Field pH	6.3	6.8	7.2	6.0	6.2	6.0	6.6	5.6	6.6	6.2	6.1
Dissolved Oxygen (mg/L)	7.4	5.7	7.7	1.2*	8.7	7.3	8.4	7.5	7.8	8.2	8.6
Conductivity (mS)	0.07	0.05	0.05	0.07	0.06	0.05	0.05	0.05	0.04	0.05	0.06
Turbidity (NTU)	Not measured	4.3	9.7	1.2	5.5	9.1	12.0	14.0	16.0	8.3	5.6

* Dissolved oxygen measured in a standing pool during extreme drought conditions.

Physical Habitat

Physical habitat measurements collected at Hoghole Run (1995 and 2000 to 2009). Scored parameters are on a 0 (worst) to 20 (best) scale.

Parameter	*1995*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
Instream habitat (0-20)	15	17	18	10	13	16	16	16	15	18	18
Epifaunal substrate (0-20)	16	15	18	9	17	15	14	14	16	16	16
Velocity/Depth Diversity (0-20)	16	14	14	2	12	13	14	13	14	15	13
Pool Quality (0-20)	15	16	15	9	14	14	15	14	14	16	14
Riffle Quality (0-20)	16	12	14	0	15	14	16	14	15	16	13
Shading (%)	75	80	90	96	93	85	90	90	96	75	85
Embeddedness (%)	15	40	15	21	35	40	60	45	40	25	20
Discharge (cfs)	1.41	0.38	0.36	0.00	3.89	0.28	1.18	0.91	0.69	2.70	2.41



The graph above displays the temperature logger data for Hoghole Run for 2000 to 2009. Maximum recorded temperatures occurred during the drought in August 2002.

Biology

Fish

Cumulative list of fish species (with abundance) collected in Hoghole Run by sampling year.

Species	*1995*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
American eel	61	2	4	-	2	-	-	1	1	1	2
Bluegill	13	2	-	-	-	-	1	-	-	-	-
Creek chub	31	71	60	121	1	78	56	18	34	7	6
Creek chubsucker	48	3	3	4	-	3	7	1	5	-	4
Eastern blacknose dace	31	58	101	13	17	175	89	32	67	53	72
Eastern mudminnow	69	61	11	142	54	260	63	122	113	28	40
Fallfish	8	7	3	3	-	-	1	2	-	1	-
Flier	1	-	-	-	-	-	-	-	-	-	-
Golden shiner	2	-	-	-	-	-	-	-	-	-	-
Largemouth Bass	-	-	-	-	-	-	-	-	-	2	-
Least brook lamprey	15	9	10	11	-	1	3	3	-	1	2
Pumpkinseed	2	-	-	2	-	-	-	-	-	-	-
Rosyside dace	74	82	210	92	-	39	85	36	110	33	22
Sea lamprey	-	-	-	-	-	-	-	-	1	-	-
Spottail shiner	2	-	-	-	-	-	-	-	-	-	-
Tadpole madtom	-	5	4	1	-	-	-	-	-	-	1
Tessellated darter	13	5	19	1	-	-	-	-	-	-	-
White sucker	13	27	17	7	-	-	-	-	-	-	-

Green indicates intolerant fish; blue are moderately tolerant; and red are tolerant.

Crayfish

Cumulative list of crayfish species (with abundance or presence {P}/absence {A} data) collected in the unnamed tributary to Hoghole Run by sampling year.

Species	*2006*	*2007*	*2008*	*2009*
Spinycheek crayfish (*Orconectes limosus*)	P	13	A	15
Common crayfish (*Cambarus bartonii bartonii*)	P	5	A	3

Mussels

Cumulative list of mussel species (with abundance or presence {P}/absence {A} data) collected in Hoghole Run by sampling year.

Species
None Observed

Herpetofauna

Cumulative list of herpetofauna species collected in or near Hoghole Run.

Order (Common)	*Species*
Anura (Frogs and Toads)	American bullfrog, Eastern American toad, Fowler's toad, Northern cricket frog, Northern green frog, Northern spring peeper, Pickerel frog, Wood frog
Caudata (Salamanders and Newts)	Northern dusky salamander, Northern two-lined salamander
Squamata (Snakes and Lizards)	Eastern wormsnake, Northern watersnake
Testudines (Turtles)	Eastern box turtle

Benthic Macroinvertebrates

Cumulative list of benthic macroinvertebrates collected in Hoghole Run by sampling year,

RA = % Relative Abundance.

PHYLUM	*ORDER*	*FAMILY*	*GENUS*	*1995 RA*	*2000 RA*	*2001 RA*	*2002 RA*	*2003 RA*	*2004 RA*	*2005 RA*	*2006 RA*	*2007 RA*	*2008 RA*	*2009 RA*
Annelida	Haplotaxida	Enchytraeidae	na	-	-	-	-	*0.9	-	-	-	-	-	-
(Worm)		Naididae	na	-	-	-	-	-	-	-	-	*1	*1.7	-
	Lumbriculida	Lumbriculidae	na	-	-	*0.9	-	*0.9	*0.8	-	*2.5	-	*1.7	*0.8
	Tubificida	Tubificidae	na	-	-	-	-	-	-	*1	-	-	-	-
			Spirosperma	-	-	-	-	-	-	-	0.8	-	-	-
Arthropoda	Amphipoda	Crangonyctidae	na	-	*6.1	-	-	-	-	-	-	*1.9	-	*0.8
	(Scud)		*Crangonyx*	-	-	-	-	-	-	-	-	-	-	0.8
			Synurella	-	-	-	-	-	1.7	-	1.7	5.8	3.4	10.5
	Coleoptera	Elmidae	*Ancyronyx*	-	-	-	-	-	-	2	-	-	-	-

PHYLUM	ORDER	FAMILY	GENUS	1995 RA	2000 RA	2001 RA	2002 RA	2003 RA	2004 RA	2005 RA	2006 RA	2007 RA	2008 RA	2009 RA
	(Beetle)		*Dubiraphia*	-	-	-	-	-	-	-	1.7	-	-	-
			Macronychus	-	-	-	-	-	-	-	-	-	0.9	-
			Optioservus	-	-	-	-	-	-	-	2.5	1	-	0.8
			Oulimnius	3.4	7.1	6.6	1.9	3.7	-	12.1	4.2	1.9	-	-
			Stenelmis	-	1	-	-	0.9	-	1	-	2.9	-	-
		Dryopidae	*Helichus*	-	-	-	-	-	-	-	-	-	-	2.4
		Psephenidae	*Psephenus*	-	-	1.9	0.9	-	-	-	-	1.9	0.9	-
	Collembola	na	na	-	-	-	-	*0.9	-	-	-	-	-	-
	(Springtail)			-	-	-	-	-	-	-	-	-	-	-
	Decapoda	Cambaridae	na	-	*1	-	-	-	-	-	-	-	-	-
	(Crayfish)			-	-	-	-	-	-	-	-	-	-	-
	Diptera	Ceratopogonidae	na	-	-	-	-	-	*0.8	-	-	-	-	-
	(True Fly)		*Bezzia*	-	-	-	-	0.9	-	-	-	-	1.7	-
			Ceratopogon	-	-	-	-	-	-	-	-	1	-	-
			Probezzia	-	-	-	-	0.9	-	-	0.8	-	-	0.8
		Chironomidae	*Ablabesmyia*	-	-	-	-	-	1.7	-	-	-	-	-
			Conchapelopia	-	-	-	1.9	-	-	-	-	-	-	-
			Corynoneura	2	1	-	-	-	-	-	-	-	-	-
			Cricotopus	2	4	-	-	-	-	-	-	-	-	-
			Cryptochironomus	8.1	-	-	-	-	-	-	-	-	-	-
			Diplocladius	-	-	-	-	-	-	-	-	-	1.7	0.8
			Eukiefferiella	0.7	3	0.9	-	1.8	-	1	7.5	1	2.6	0.8
			Heterotrissocladius	-	-	-	-	-	-	-	-	-	1.7	-
			Hydrobaenus	-	-	-	-	2.8	-	-	3.3	5.8	5.1	6.5
			Micropsectra	-	-	1.9	-	-	-	-	0.8	-	-	0.8
			Microtendipes	18.8	-	-	-	-	-	-	-	-	-	-
			Nanocladius	-	-	-	-	-	-	-	-	-	0.9	-
			Orthocladiinae	*6.7	*2	*1.9	*1.9	-	-	*3	*0.8	*1	-	*0.8
			Orthocladius	-	-	-	4.7	0.9	2.5	-	5	3.8	10.3	33.9
			Parakiefferiella	-	-	-	-	-	-	-	-	-	1.7	-
			Parametriocnemus	-	-	-	5.7	-	13.2	3	0.8	17.3	-	-
			Paraphaenocladius	-	-	-	-	-	-	-	-	-	-	1.6
			Paratanytarsus	2	-	-	-	-	-	-	-	-	-	-
			Polypedilum	-	-	-	-	-	2.5	-	-	7.7	-	-
			Rheocricoptous	-	-	0.9	-	-	8.3	1	-	1.9	-	-
			Rheosmittia	-	-	0.9	-	-	3.3	-	-	1	-	-
			Stempellinella	-	2	0.9	0.9	-	-	1	-	-	-	-
			Stenochironomus	-	-	-	-	0.9	-	-	-	-	-	-
			Stilocladius	-	-	-	-	-	-	-	-	-	-	0.8
			Sympotthastia	-	-	-	-	0.9	-	-	-	-	0.9	5.6
			Synorthocladius	-	-	-	-	-	-	-	-	-	0.9	-
			Tanytarsus	2	-	-	0.9	-	13.2	1	0.8	1	-	-
			Thienemannimyia	0.7	1	-	-	-	-	-	0.8	-	-	-
			Thienemannimyia Group	-	-	-	-	-	*11.6	*2	-	*2.9	*0.9	*0.8
			Tribelos	0.7	-	-	-	-	-	-	-	-	-	-
			Trissopelopia	-	-	-	-	-	1.7	-	-	-	-	-
			Tvetenia	-	-	-	0.9	-	-	-	-	1.9	-	-
		Empididae	*Chelifera*	-	-	-	-	-	-	-	-	1	-	-
			Clinocera	-	-	-	3.8	-	-	-	-	-	-	-
		Simuliidae	na	-	*2	-	-	-	-	-	*4.5	-	-	-
			Prosimulium	-	-	56.6	2.8	30.3	-		1.7	1	17.1	-
			Simulium	-	16.2	1.9	3.8	-	3.3	4	1.7	6.7	0.9	-
			Stegopterna	-	-	1.9	-	7.3	-	-	-	-	0.9	0.8
		Tabanidae	na	-	-	-	-	-	-	-	-	-	*0.9	-
			Chrysops	-	-	-	-	-	0.8	-	-	-	-	-
		Tipulidae	*Antocha*	3.4	-	-	0.9	-	-	1	-	-	-	-
			Dicranota	-	2	-	-	-	-	-	-	-	-	-
			Hexatoma	-	1	-	-	-	2.5	-	0.8	-	-	0.8
			Pseudolimnophila	-	-	-	-	0.9	-	-	-	1	-	-
			Tipula	-	1	-	-	0.9	-	-	-	-	1.7	-
	Ephemeroptera	Ameletidae	*Ameletus*	-	-	-	-	-	-	-	-	-	3.4	0.8
	(Mayfly)	Baetidae	*Acentrella*	-	12.1	-	-	-	-	-	-	-	-	-
			Acerpenna	38.3	1	2.8	22.6	-	-	21.2	2.5	-	-	-
			Centroptilum	-	-	-	-	-	-	-	-	1	-	-
		Ephemerellidae	*Ephemerella*	0.7	13.1	2.8	6.6	-	0.8	1	-	1.9	-	-
			Eurylophella	-	-	-	1.9	-	0.8	-	-	1.9	-	-
		Heptageniidae	*Maccaffertium*	-	-	-	-	-	-	-	-	-	-	0.8
			Stenonema	2.7	-	-	7.5	-	-	8.1	-	-	-	-
		Leptophlebiidae	na	-	-	-	*0.9	-	-	-	-	-	-	-
		Siphlonuridae	*Siphlonurus*	-	-	-	-	-	-	-	1.7	-	-	-
	Isopoda	Asellidae	*Caecidotea*	-	-	-	-	-	0.8	-	-	1.9	1.7	1.6

PHYLUM	ORDER	FAMILY	GENUS	1995 RA	2000 RA	2001 RA	2002 RA	2003 RA	2004 RA	2005 RA	2006 RA	2007 RA	2008 RA	2009 RA
	(Aquatic Sow Bug)			-	-	-	-	-	-	-	-	-	-	-
	Megaloptera	Corydalidae	*Nigronia*	-	-	-	-	-	-	2	-	1	-	0.8
	(Dobsonfly/Fishfly)			-	-	-	-	-	-	-	-	-	-	-
	Odonata	Aeshnidae	*Boyeria*	-	-	0.9	-	-	-	-	-	-	-	-
	(Dragonfly/	Gomphidae	na	-	-	-	*0.9	-	-	-	--	-	-	-
	Damselfly)			-	-	-	-	-	-	-	-	-	-	-
	Plecoptera	Capniidae	na	-	-	-	-	*0.9	-	-	-	-	*2.6	*2.4
	(Stonefly)		*Allocapnia*	0.7	-	-	-	5.5	-	-	-	-	-	-
		Chloroperlidae	na	-	*4	*1.9	*13.2	*0.9	*10.7	*2	*2.5	-	-	*0.8
			Haploperla	-	-	-	-	-	-	5.1	-	-	-	-
		Leuctridae	na	-	-	*0.9	-	*0.9	-	-	-	-	-	-
			Leuctra	0.7	9.1	-	0.9	-	9.9	4	-	1	3.4	-
		Nemouridae	na	-	-	*6.6	-	*5.5	-	-	-	-	*2.6	*4
			Amphinemura	-	6.1	4.7	3.8	4.6	-	12.1	35	14.4	17.1	7.3
			Ostrocerca	-	-	-	-	0.9	-	-	-	-	-	-
			Prostoia	2	-	-	4.7	14.7	-	-	5	-	3.4	4
		Perlidae	na	-	*1	-	-	-	-	-	-	-	-	-
			Eccoptura	0.7	-	-	-	-	5	-	-	-	-	-
		Perlodidae	na	-	-	*0.9	-	*1.8	-	-	*1.7	-	*0.9	*0.8
			Clioperla	-	-	-	0.9	0.9	-	-	-	-	3.4	-
			Isoperla	-	2	-	1.9	0.9	-	1	4.2	3.8	-	-
		Taeniopterygidae	*Oemopteryx*	-	-	-	0.9	-	-	-	-	-	-	-
			Strophopteryx	-	-	-	-	5.5	-	-	0.8	-	0.9	1.6
	Trichoptera	Hydropsychidae	*Cheumatopsyche*	1.3	-	-	-	-	-	3	-	-	-	-
	(Caddisfly)		*Hydropsyche*	0.7	-	0.9	-	-	-	2	-	-	-	-
		Lepidostomatidae	*Lepidostoma*	-	-	-	-	-	-	-	-	-	-	0.8
		Limnephilidae	na	-	-	-	-	-	-	*1	-	-	-	-
			Ironoquia	-	-	-	-	-	0.8	-	-	-	-	-
			Pyncopsyche	0.7	-	-	-	-	0.8	1	-	-	-	-
		Philopotamidae	*Wormaldia*	-	1	-	-	-	-	-	-	-	-	-
		Rhyacophilidae	*Rhyacophila*	-	-	-	-	0.9	-	-	0.8	-	-	-
		Uenoidae	*Neophylax*	1.3	-	-	0.9	-	1.7	2	3.3	-	2.6	2.4
Mollusca	Veneroida	Pisidiidae	na	-	-	-	-	-	-	-	-	*1	-	-
	(Bivalve)			-	-	-	-	-	-	-	-	-	-	-
Nematomorpha	Gordioidea	Gordiidae	na	-	-	-	*0.9	-	*0.8	-	-	-	-	-
	(Worm)			-	-	-	-	-	-	-	-	-	-	-
Nemertea	Hoplonemertea	Tetrastemmatidae	*Prostoma*	-	-	-	-	-	-	1	-	-	-	0.8
	(Worm)			-	-	-	-	-	-	-	-	-	-	-

Green families are intolerant (family tolerance values from 0 to 3); blue are moderately tolerant (family tolerance values from 3.1 to 6.9); and red are tolerant (family tolerance values from 7 to 10).

* Taxa not identified to genus.

Mattawoman Creek (MATT-033-S)

Site MATT-033-S is located on Mattawoman Creek in the Coastal Plain – western shore region of Maryland. It is in the Mattawoman Creek watershed in Charles County. This site was sampled in 1995 and 2000 to 2009. Its watershed is primarily forested (62%), with 18% agriculture, 18% urban, and 2% barren.


Mattawoman Creek in spring 2009.

Water Chemistry

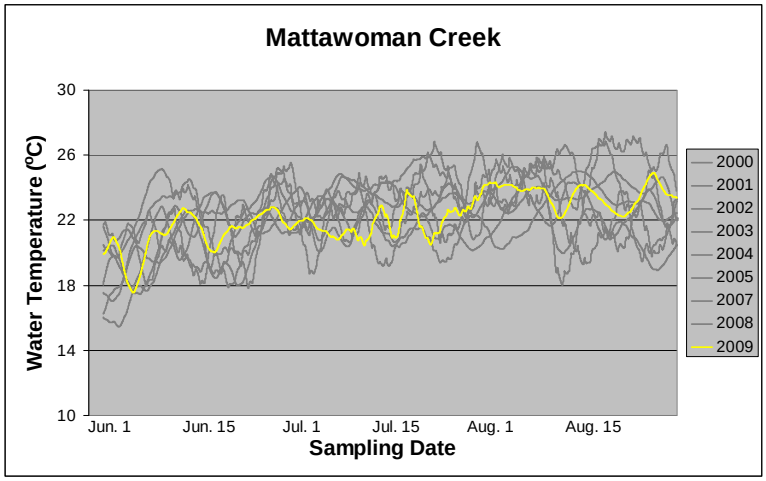
Summer water chemistry data collected at Mattawoman Creek (1995 and 2000 to 2009).

Parameter	*1995*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
Field pH	6.5	6.5	6.8	6.7	6.7	6.3	6.9	6.8	6.8	6.7	6.6
Dissolved Oxygen (mg/L)	7.1	8.6	0.9	2	6.7	7.4	0.9	3.8	3.7	5.9	5.9
Conductivity (mS)	0.11	0.08	0.14	0.18	0.11	0.12	0.14	0.13	0.14	0.11	0.14
Turbidity (NTU)	Not measured	5.6	8.4	15.0	10.3	8.5	8.1	9.3	4.0	8.1	4.6

Physical Habitat

Physical habitat measurements collected at Mattawoman Creek (1995 and 2000 to 2009). Scored parameters are on a 0 (worst) to 20 (best) scale.

Parameter	*1995*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
Instream habitat (0-20)	15	19	13	13	18	16	13	16	16	15	16
Epifaunal substrate (0-20)	14	18	3	11	17	16	6	13	14	13	14
Velocity/Depth Diversity (0-20)	17	17	8	6	15	15	10	10	10	13	11
Pool Quality (0-20)	15	12	14	12	19	16	16	17	17	18	14
Riffle Quality (0-20)	16	13	0	0	14	15	0	0	0	12	6
Shading (%)	80	85	90	91	90	85	90	85	88	80	80
Embeddedness (%)	40	35	40	35	5	15	30	40	40	35	15
Discharge (cfs)	8.28	5.51	0.00	0.00	18.89	9.19	0.00	0.00	0.00	3.27	0.47



The graph above displays the temperature logger data for Mattawoman Creek for 2000 to 2009. Maximum recorded temperatures occurred during the drought in August 2002. No data were available in 2006.

Biology

Fish

Cumulative list of fish species (with abundance) collected in Mattawoman Creek by year.

Species	*1995*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
Alewife	-	-	-	-	-	39	-	-	-	-	-
American eel	35	26	5	2	20	18	5	1	3	23	19
Black crappie	2	-	-	-	-	-	-	-	-	-	-
Bluegill	81	25	56	5	31	27	15	13	7	42	59
Bluespotted sunfish	-	8	8	-	-	10	3	1	-	1	1
Brown bullhead	6	18	3	2	13	36	12	1	5	5	-
Chain pickerel	8	3	7	4	6	6	3	-	4	4	4
Creek chub	-	1	-	-	-	-	-	-	-	-	-
Creek chubsucker	4	-	2	4	-	2	-	-	-	-	1
Eastern blacknose dace	3	-	-	-	-	-	-	-	-	-	-
Eastern mosquitofish	-	16	-	1	-	3	-	10	-	-	-
Eastern mudminnow	10	20	49	16	67	11	3	2	12	55	19
Eastern silvery minnow	2	-	-	-	-	-	-	-	-	-	-
Gizzard Shad	-	-	-	-	-	-	-	-	-	-	6
Green sunfish	-	1	-	-	2	1	-	-	-	5	9
Largemouth bass	-	-	9	-	51	-	-	-	-	2	2
Least brook lamprey	2	-	-	-	-	-	-	-	-	-	-
Longnose gar	-	-	-	-	1	-	-	-	-	-	-
Pirate perch	-	1	-	-	-	-	-	-	-	-	-
Pumpkinseed	16	443	49	8	41	58	17	18	3	21	5
Redbreast sunfish	1	-	-	-	-	-	-	-	-	-	-
Sea lamprey	2	5	5	-	-	2	7	-	-	-	-
Spottail shiner	252	2	-	3	84	54	-	-	-	-	-
Striped bass	-	-	-	-	-	1	-	-	-	-	-
Tadpole madtom	3	5	2	-	1	24	9	3	1	2	-
Tessellated darter	59	116	105	15	69	125	78	55	48	105	72
Warmouth	2	-	4	-	1	1	-	-	-	-	-
White catfish	-	-	-	-	4	-	-	-	-	1	7
White sucker	2	2	6	-	-	5	-	-	-	-	-
Yellow bullhead	-	1	1	-	1	3	-	-	3	1	2

Green indicates intolerant fish; blue are moderately tolerant; and red are tolerant.

Crayfish

Cumulative list of crayfish species (with abundance or presence {P}/absence {A} data) collected in the unnamed tributary to Mattawoman Creek by sampling year.

Species	*2006*	*2007*	*2008*	*2009*
Spinycheek crayfish (*Orconectes limosus*)	A	3	A	2
Red swamp crawfish (*Procambarus clarkii*)	A	6	A	2
Devil Crawfish (*Cambarus diogenes*)	A	A	A	P

Mussels

Cumulative list of mussel species (with abundance or presence {P}/absence {A} data) collected in the unnamed tributary to Mattawoman Creek by sampling year.

Species	*2007*	*2008*	*2009*
Eastern elliptio (*Elliptio complanata*)	P	P	P

Herpetofauna

Cumulative list of herpetofauna species collected in or near the Mattawoman Creek.

Order (Common)	*Species*
Anura (Frogs and Toads)	American bullfrog, Eastern American toad, Fowler's toad, Eastern cricket frog, Gray treefrog, Northern green frog, Northern spring peeper, Pickerel frog, Southern leopard frog, Upland chorus frog
Caudata (Salamanders and Newts)	Marbled salamander, Northern two-lined salamander
Squamata (Snakes and Lizards)	Common five-linked skink, Eastern garter snake, Eastern rat snake, Hog-nosed snake, Northern black racer
Testudines (Turtles)	Eastern box turtle, Eastern painted turtle, Eastern snapping turtle

Benthic Macroinvertebrates

Cumulative list of benthic macroinvertebrates collected in Mattawoman Creek by sampling year, RA = %Relative Abundance

PHYLUM	ORDER	FAMILY	GENUS	1995 RA	2000 RA	2001 RA	2002 RA	2003 RA	2004 RA	2005 RA	2006 RA	2007 RA	2008 RA	2009 RA
Annelida	Haplotaxida	Enchytraeidae	na	-	*0.9	-	*1.6	-	-	*0.9	-	-	-	-
(Worm)	Lumbriculida	Lumbriculidae	na	*0.8	*1.8	-	*7.8	*0.9	*1.6	-	-	*2.6	*12	*1
	Tubificida	Tubificidae	na	-	-	-	*3.1	-	-	*0.9	-	-	*0.9	-
			Spirosperma	-	-	-	7	-	-	-	-	-	-	1
Arthropoda	Amphipoda	Crangonyctidae	na	-	*4.4	-	-	-	-	-	-	-	-	-
	(Scud)		*Crangonyx*	0.8	-	-	-	-	-	-	-	-	0.9	-
	Coleoptera	Dryopidae	*Helichus*	-	-	0.8	-	-	-	-	-	-	-	-
	(Beetle)	Elmidae	*Optioservus*	-	-	0.8	-	-	-	-	-	-	-	-
			Oulimnius	-	-	-	-	-	-	-	0.9	-	-	-
			Stenelmis	-	1.8	10.1	2.3	9.7	7.8	46.2	20.9	28.9	-	5
		Hydrophilidae	*Sperchopsis*	0.8	-	-	-	-	-	-	-	-	-	-
	Collembola	Isotomidae	*Isotomurus*	-	-	-	0.8	-	-	-	-	-	-	-
	(Springtail)			-	-	-	-	-	-	-	-	-	-	-
	Decapoda	Cambaridae	*Orconectes*	-	-	-	-	-	-	-	-	0.9	-	-
	(Crayfish)			-	-	-	-	-	-	-	-	-	-	-
	Diptera	na	na	-	-	-	*3.1	-	-	-	-	-	-	-
	(True Fly)	Ceratopogonidae		-	-	-	-	-	-	-	-	-	-	-
			Probezzia	-	-	-	1.6	-	-	-	-	-	-	-
		Chironomidae	na	-	-	-	-	*1.8	-	-	-	-	-	-
			Ablabesmyia	-	-	-	-	-	-	-	0.9	-	-	-
			Brillia	-	-	2.5	-	-	-	-	-	-	-	-
			Chironomini	-	-	-	*0.8	-	-	-	-	-	-	-
			Conchapelopia	-	1.8	-	-	-	-	-	-	-	-	-
			Cricotopus	-	-	-	-	-	-	0.9	-	-	-	-
			Eukiefferiella	-	1.8	5	0.8	-	-	-	0.9	-	-	7
			Heterotrissocladius	-	-	-	1.6	-	-	-	-	-	-	-
			Hydrobaenus	-	-	-	21.1	-	-	-	7	-	8.3	13
			Labrundinia	-	-	-	-	-	-	-	-	0.9	-	-
			Nanocladius	-	-	-	-	-	0.8	-	-	0.9	-	-
			Natarsia	-	-	-	0.8	-	-	-	-	-	0.9	-
			Orthocladiinae	-	*0.9	*0.8	*1.6	*1.8	-	-	*0.9	-	*0.9	*6
			Orthocladius	0.8	-	-	10.9	-	-	-	1.7	2.6	1.9	8
			Parametriocnemus	0.8	-	-	0.8	-	0.8	-	-	-	-	-
			Paraphaenocladius	-	-	-	-	-	-	-	-	-	0.9	-
			Polypedilum	-	-	-	-	-	1.6	-	-	-	-	-
			Potthastia	-	-	0.8	-	-	-	-	0.9	-	-	-
			Rheosmittia	-	-	0.8	-	-	-	0.9	-	1.8	-	-
			Rheotanytarsus	-	-	-	-	-	-	-	-	-	0.9	1
			Stempellinella	-	-	-	-	-	-	0.9	1.7	1.8	-	1
			Stenochironomus	-	-	-	0.8	-	-	-	-	-	-	-
			Sympotthastia	-	-	-	-	-	-	-	-	-	0.9	-
			Tanypodinae	-	-	-	*0.8	-	-	-	-	-	-	*1
			Tanytarsini	-	-	-	*0.8	-	-	-	-	-	-	-
			Tanytarsus	-	0.9	-	-	-	-	1.9	0.9	3.5	-	-
			Thienemannimyia Group	-	-	-	-	-	-	*1.9	-	-	-	-
			Trissopelopia	-	-	-	-	-	-	0.9	-	-	-	-
			Tvetenia	-	-	1.7	-	-	-	-	2.6	-	11.1	2
			Zarvelimyia	-	-	-	-	-	-	0.9	-	-	-	-
		Empididae	*Clinocera*	-	-	-	0.8	-	-	-	0.9	-	-	-
			Hemerodromia	-	-	0.8	0.8	-	2.3	-	-	-	-	-
		Simuliidae	*Prosimulium*	81.2	-	31.9	4.7	63.7	-	-	11.3	-	4.6	-
			Simulium	-	10.5	-	-	0.9	22.5	1.9	-	-	-	-
			Stegopterna	-	-	-	-	-	-	-	-	-	0.9	-
		Tabanidae	*Chrysops*	-	-	-	1.6	-	-	-	-	-	-	-
		Tipulidae	na	-	-	-	-	-	-	-	-	-	*0.9	-
			Ormosia	-	-	-	1.6	0.9	-	-	-	-	-	1
			Tipula	-	-	0.8	-	-	-	-	-	-	0.9	-
	Ephemeroptera	Ameletidae	*Ameletus*	-	-	-	0.8	-	-	-	3.5	0.9	0.9	-
	(Mayfly)	Baetidae	na	-	-	*1.7	-	-	-	-	*0.9	-	-	*1
			Acentrella	-	36.8	-	-	-	6.2	-	-	-	-	-
			Acerpenna	-	-	-	-	-	1.6	3.8	-	2.6	-	-
			Centroptilum	-	-	-	-	-	-	-	-	0.9	-	-
		Caenidae	*Caenis*	-	-	-	-	-	-	-	0.9	-	-	-

PHYLUM	ORDER	FAMILY	GENUS	1995 RA	2000 RA	2001 RA	2002 RA	2003 RA	2004 RA	2005 RA	2006 RA	2007 RA	2008 RA	2009 RA
		Ephemerellidae	*Attenella*	-	14.9	-	-	-	-	-	-	-	-	-
			Ephemerella	-	0.9	-	-	-	-	-	-	0.9	-	-
			Eurylophella	-	-	-	0.8	-	-	-	1.7	4.4	-	3
			Timpanoga	-	-	-	-	-	12.4	-	-	-	-	-
		Heptageniidae	*Leucrocuta*	-	-	-	-	-	0.8	-	-	0.9	-	-
			Stenonema	-	-	-	-	-	0.8	6.6	-	1.8	-	-
		Leptophlebiidae	na	-	-	-	-	-	-	-	*1.7	-	-	-
		Siphlonuridae	*Siphlonurus*	-	-	-	-	-	-	2.8	1.7	-	7.4	11
	Isopoda	Asellidae	*Caecidotea*	-	8.8	-	1.6	1.8	1.6	-	-	-	-	-
	(Aquatic Sow Bug)			-	-	-	-	-	-	-	-	-	-	-
	Lepidoptera	Noctuidae	na	-	-	-	*0.8	-	-	-	-	-	-	-
	(Moth)			-	-	-	-	-	-	-	-	-	-	-
	Odonata	Aeshnidae	*Basiaeschna*	-	-	-	-	-	-	-	0.9	-	-	-
	(Dragonfly/	Calopterygidae	*Calopteryx*	-	-	-	-	-	-	-	-	0.9	-	-
	Damselfly)	Corduliidae	na	-	-	-	-	-	-	-	-	*0.9	-	-
			Somatochlora	-	-	-	-	-	-	0.9	-	-	-	-
	Plecoptera	Capniidae	na	-	-	-	-	*0.9	-	-	-	-	-	-
	(Stonefly)		*Allocapnia*	-	-	1.7	-	-	-	-	-	-	-	-
			Paracapnia	-	-	-	0.8	-	-	-	-	-	-	-
		Leuctridae	*Leuctra*	-	-	-	-	-	-	-	-	-	0.9	-
		Nemouridae	na	-	-	*1.7	-	-	-	-	-	-	-	-
			Amphinemura	-	7.9	0.8	-	-	-	-	0.9	1.8	4.6	1
			Prostoia	-	-	-	-	1.8	-	-	3.5	-	5.6	-
		Perlidae	na	-	-	-	*0.8	-	-	*0.9	*1.7	-	-	*1
			Perlesta	-	5.3	-	5.5	-	10.9	-	-	-	-	-
		Perlodidae	na	-	-	-	*3.1	*0.9	-	*3.8	-	-	-	-
			Clioperla	0.8	-	-	-	3.5	-	-	0.9	-	-	-
			Isoperla	-	0.9	1.7	1.6	3.5	10.9	8.5	24.3	38.6	15.7	8
		Taeniopterygidae	*Oemopteryx*	9.8	-	2.5	3.1	0.9	-	-	-	0.9	-	3
			Taeniopteryx	0.8	-	-	0.8	0.9	-	-	-	-	0.9	-
			Strophopteryx	-	-	7.6	-	5.3	-	-	4.3	-	14.8	7
	Trichoptera	Glossosomatidae	*Agapetus*	0.8	-	-	-	-	-	-	-	-	-	-
	(Caddisfly)	Hydropsychidae	*Cheumatopsyche*	-	-	17.6	-	-	11.6	11.3	-	-	-	-
			Hydropsyche	-	-	5.9	-	-	3.9	-	-	-	-	-
		Leptoceridae	*Triaenodes*	-	-	-	-	-	0.8	0.9	-	-	-	-
		Limnephilidae	na	*1.5	-	*0.8	-	*2.7	-	-	-	-	*0.9	-
			Ironoquia	-	-	-	0.8	-	-	0.9	-	-	-	13
		Philopotamidae	*Chimarra*	-	-	-	-	-	1.6	-	-	-	-	-
		Rhyacophilidae	*Rhyacophila*	1.5	-	-	-	-	-	-	0.9	0.9	-	-
		Uenoidae	*Neophylax*	-	-	0.8	-	-	-	0.9	-	-	-	1
Mollusca	Basommatophora	Physidae	*Physa*	-	-	-	-	-	-	-	-	-	0.9	3
	(Snail)	Planorbidae	*Menetus*	-	-	-	0.8	-	-	-	0.9	-	-	1
	Veneroida	Pisidiidae	*Sphaerium*	-	-	-	0.8	-	-	-	-	-	-	-
	(Bivalve)			-	-	-	-	-	-	-	-	-	-	-
Nemertea	Hoplonemertea	Tetrastemmatidae	*Prostoma*	-	-	-	0.8	-	-	-	-	-	-	-
	(Roundworm)			-	-	-	-	-	-	-	-	-	-	-

Green families are intolerant (family tolerance values from 0 to 3); blue are moderately tolerant (family tolerance values from 3.1 to 6.9); and red are tolerant (family tolerance values from 7 to 10).

* Taxa not identified to genus.

Mill Run (Nanjemoy Creek, NANJ-331-S)

Site NANJ-331-S is located on Mill Run in the Coastal Plain – western shore region of Maryland. It is in the Nanjemoy Creek watershed in Charles County. This site was sampled in 1995 and 2000 to 2009. Its watershed is primarily forested (75%), with 20% agriculture, 3% urban, and 1% barren.


Mill Run in spring 2008.

Water Chemistry

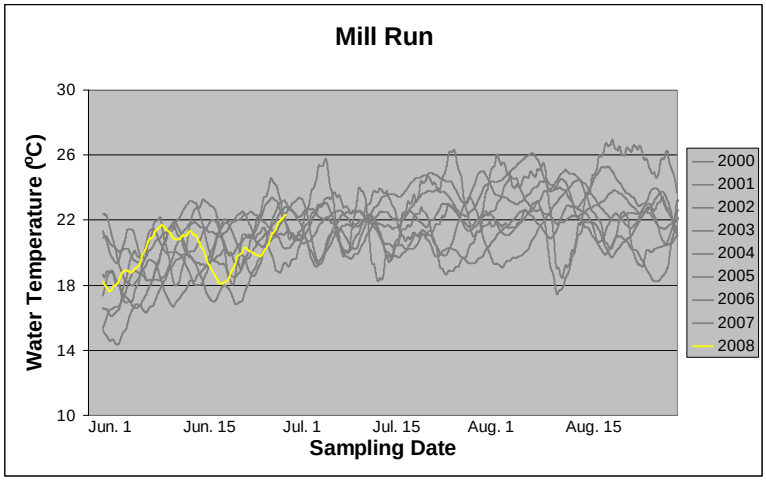
Summer water chemistry data collected at Mill Run (1995 and 2000 to 2009).

Parameter	*1995*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
Field pH	6.9	6.2	6.8	6.3	6.4	6.0	6.6	5.9	6.5	6.2	6.2
Dissolved Oxygen (mg/L)	6.4	7.2	7.2	0.3	8.6	7.7	4.2	8.8	7.2	6.1	5.7
Conductivity (mS)	0.06	0.05	0.06	0.14	0.07	0.07	0.08	0.06	0.06	0.07	0.06
Turbidity (NTU)	Not measured	7.2	8.1	159.0	4.8	8.8	10.6	11.0	11.0	5.4	8.6

Physical Habitat

Physical habitat measurements collected at Mill Run (1995 and 2000 to 2009). Scored parameters are on a 0 (worst) to 20 (best) scale.

Parameter	*1995*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
Instream habitat (0-20)	12	13	15	7	13	11	15	12	14	10	14
Epifaunal substrate (0-20)	5	11	10	7	14	13	10	9	8	7	9
Velocity/Depth Diversity (0-20)	14	15	13	2	14	12	7	11	11	11	12
Pool Quality (0-20)	13	16	15	6	15	16	16	11	14	12	14
Riffle Quality (0-20)	13	7	8	0	12	12	0	6	8	11	7
Shading (%)	90	94	95	95	92	85	93	90	95	85	85
Embeddedness (%)	80	80	40	100	40	30	40	80	60	40	45
Discharge (cfs)	8.84	1.32	0.74	0.00	12.07	1.40	0.00	3.10	1.34	1.75	1.06



The above graph displays the temperature logger data for Mill Run for 2000 to 2008. Due to programming error the 2008 logger only recorded data for 1 month. Maximum recorded temperatures occurred during the drought in August 2002. No data were available for 2009.

Biology

Fish

Cumulative list of fish species (with abundance) collected in Mill Run by sampling year.

Species	*1995*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
American eel	8	4	-	1	-	3	2	1	4	5	5
Bluegill	15	3	3	5	3	8	5	13	1	2	53
Bluespotted sunfish	-	-	-	3	-	-	-	1	-	-	-
Brown bullhead	-	2	2	72	3	4	2	-	1	-	-
Chain pickerel	-	1	1	-	1	-	-	-	-	-	-
Creek chub	35	3	4	23	-	-	5	4	-	2	2
Creek chubsucker	29	3	7	5	-	1	1	1	-	-	7
Eastern blacknose dace	14	-	4	-	-	31	-	-	2	-	23
Eastern mosquitofish	-	42	1	55	-	-	8	38	-	-	-
Eastern mudminnow	95	2	14	142	9	24	19	4	15	27	12
Eastern silvery minnow	-	-	-	-	-	-	-	-	1	-	-
Flier	-	-	-	-	-	-	-	-	-	1	4
Golden shiner	7	-	-	1	1	31	28	-	-	-	-
Largemouth bass	3	7	-	-	-	4	2	-	-	2	1
Least brook lamprey	31	-	-	3	-	1	1	2	-	-	1
Margined madtom	-	2	-	6	-	-	-	-	-	-	-
Pirate perch	-	-	-	1	-	-	-	-	-	-	-
Pumpkinseed	1	4	5	2	-	17	4	1	5	-	8
Redbreast sunfish	24	1	2	-	-	-	-	1	-	-	2
Rosyside dace	42	-	2	4	-	2	-	-	-	-	-
Satinfin shiner	-	-	-	-	1	-	-	-	-	-	-
Sea lamprey	5	-	-	-	-	3	36	7	11	3	-
Spottail shiner	-	-	-	-	5	3	23	-	-	-	-
Swallowtail shiner	-	-	-	-	-	1	-	-	-	-	-
Tessellated darter	7	24	13	1	-	38	12	9	5	21	16
White sucker	51	17	4	9	7	13	9	2	-	2	10
Yellow bullhead	-	1	-	3	2	4	2	9	-	1	7

Green indicates intolerant fish; blue are moderately tolerant; and red are tolerant.

Crayfish

Cumulative list of crayfish species (with abundance or presence {P}/absence {A} data) collected in the unnamed tributary to Mill Run by sampling year.

Species	*2006*	*2007*	*2008*	*2009*
Common Crayfish (*Cambarus bartonii bartonii*)	A	A	A	1
Devil crayfish (*Cambarus diogenes*)	A	A	P	A
Spinycheek crayfish (*Orconectes limosus*)	P	4	A	3
Red swamp crawfish (*Procambarus clarkii*)	P	2	A	5

Mussels

Cumulative list of mussel species (with abundance or presence {P}/absence {A} data) collected in Mill Run by sampling year.

Species
None Observed

Herpetofauna

Cumulative list of herpetofauna species collected in or near Mill Run.

Order (Common)	*Species*
Anura (Frogs and Toads)	American bullfrog, Eastern American toad, Eastern cricket frog, Fowler's toad, Northern green frog, Northern spring peeper, Pickerel frog, Southern leopard frog, Wood frog
Caudata (Salamanders and Newts)	Northern two-lined salamander
Squamata (Snakes and Lizards)	Common five-linked skink, Eastern rat snake, Northern ringneck snake
Testudines (Turtles)	Eastern snapping turtle

Benthic Macroinvertebrates

Cumulative list of benthic macroinvertebrates collected in Mill Run by sampling year, RA = %Relative Abundance.

PHYLUM	*ORDER*	*FAMILY*	*GENUS*	*1995 RA*	*2000 RA*	*2001 RA*	*2002 RA*	*2003 RA*	*2004 RA*	*2005 RA*	*2006 RA*	*2007 RA*	*2008 RA*	*2009 RA*
Annelida	Haplotaxida	Naididae	na	-	-	-	-	-	-	-	-	-	*1	
(Worm)	Lumbriculida	Lumbriculidae	na	-	-	-	-	-	*1.9	-	-	*1	*1	*0.8
	Tubificida	Tubificidae	na	-	-	-	-	*0.8	-	*1.9	-	-	*1	
			Limnodrilus	-	-	-	-	-	-	-	-	-	1	
Arthropoda	Amphipoda	Crangonyctidae	na	-	*1.9	-	-	-	-	-	-	-	-	
	(Scud)		*Crangonyx*	1	-	-		-	0.9	-		-	-	
			Synurella	-	-	-	0.9	0.8	0.9	-	0.9	1.9	1	1.6
	Coleoptera	Dytiscidae	*Neoporus*	-	-	-	-	-	-	0.9	-	-	1	
	(Beetle)	Elmidae	*Ancyronyx*	-	-	-	-	-	-	1.9	3.5	6.8	-	-
			Dubiraphia	-	-	-	-	-	-	-	0.9	1	-	-
			Macronychus	-	-	-	-	-	-	0.9	-	4.9	-	-
			Optioservus	9.4	-	4.2	8.8	0.8	-	-	0.9	-	-	-
			Oulimnius	1	2.8	16.7	9.6	5.5	-	-	-	-	-	-
			Stenelmis	-	-	1	-	-	-	0.9	-	1	-	-
		Gyrinidae	*Dineutus*	-	-	-	-	-	1.9	-	-	-	-	-
	Decapoda	Palaemonidae	*Palaemonetes*	-	-	-	-	-	-	-	0.9	-	-	-
	(Shrimp)			-	-	-	-	-	-	-	-	-	-	-
	Diptera	Ceratopogonidae	na	-	-	-	*0.9	-	*1.9	-	-	-	-	-
	(True fly)		*Bezzia*	-	-	-	-	-	-	-	-	-	1	-
			Probezzia	-	-	-	-	-	-	-	-	3.9	3.8	-
		Chironomidae	*Ablabesmyia*	1	-	-	-	-	2.8	0.9	1.7	1	1.9	0.8
			Chironomini	-	-	*1	-	-	-	-	-	-	-	-
			Chironomus	-	-	-	-	-	-	-	-	-	1	-
			Cladotanytarsus	-	0.9	-	-	-	-	-	-	-	-	-
			Conchapelopia	2.1	-	-	-	-	-	-	-	-	-	-
			Cricotopus	1	-	-	5..3	-	-	-	-	-	-	-
			Dicrotendipes	-	-	-	-	-	-	-	-	-	1	-
			Diplocladius	-	-	-	-	-	-	-	0.9	1	5.7	0.8
			Eukiefferiella	-	-	3.1	-	0.8	-	0.9	-	-	-	-
			Heterotrissocladius		-	-	-	-	-	0.9	-	1	-	-
			Hydrobaenus	-	-	-	0.9	-	0.9	0.9	22.6	6.8	26.7	0.8
			Micropsectra	-	-	-	3.5	-	-	0.9	-	-	-	0.8
			Microtendipes	-	-	-	0.9	-	-	-	-	-	-	-
			Nanocladius	-	-	-	1.8	-	-	-	1.7	-	-	-
			Orthocladiinae	-	-	*5.1	*2.6	*0.8	-	-	-	*1.9	-	*0.8
			Orthocladius	-	-	-	5.3	-	1.9	-	12.2	4.9	5.7	2.4
			Paracladopelma	-	-	-	-	-	0.9	-	-	-	-	0.8
			Parakiefferiella	-	-	-	-	-	-	-	0.9	-	-	-
			Paralauterborniella		-	-	-	-	-	0.9	-	-	-	-
			Paramerina	-	-	-	-	-	-	-	0.9	-	-	-
			Parametriocnemus	-	-	-	7	-	1.9	-	3.5	1.9	-	-
			Paraphaenocladius		-	-	-	-	0.9	-	1.7	1	-	-
			Paratanytarsus	-	-	-	0.9	-	-	-	-	1	1	0.8
			Phaenopsectra	-	-	-	-	-	-	-	-	1.9	1	-
			Polypedilum	1	-	1	-	-	0.9	-	-	1.9	-	-
			Potthastia	-	-	1	-	-	-	-	0.9	-	-	-
			Psectrocladius	6.3	-	-	-	-	-	-	-	-	-	-
			Pseudorthocladius	-	-	-	-	-	-	1.9	-	-	-	-
			Rheocricotopus	-	-	-	0.9	-	2.8	1.9	2.6	5.8	-	-
			Rheosmittia	-	-	8.3	-	-	1.9	7.5	-	-	-	-
			Rheotanytarsus	6.3	-	-	-	-	-	-	-	-	-	-
			Stempellinella	-	-	-	-	-	0.9	-	-	-	1.9	-
			Stenochironomus	-	-	-	-	-	0.9	-	-	-	-	-
			Symposiocladius	-	-	-	-	-	-	-	-	-	1	-
			Tanypodinae	-	-	-	-	-	-	*2.8	-	-	*1	-
			Tanytarsus	4.2	-	-	3.5	-	7.5	1.9	0.9	-	1.9	-
			Tanytarsini	-	-	-	-	-	-	-	-	-	*1	-
			Thienemannimyia Group	-	-	-	-	*0.8	*7.5	*1.9	*1.7	*1.9	*1	-
			Tribelos	-	-	1	0.9	-	0.9	-	-	-	-	-
			Trissopelopia	-	-	-	-	-	0.9	0.9	0.9	3.9	-	-
			Tvetenia	-	-	1	-	-	-	-	-	-	-	-
			Unniella	-	-	-	-	-	-	0.9	-	-	-	-
			Xylotopus	-	-	-	-	-	-	-	-	1	-	-
			Zavrelimyia	-	-	-	-	-	-	-	0.9	-	1.9	-
		Simuliidae	*Prosimulium*	-	-	5.2	-	9.4	-	-	-	1	-	-
			Simulium	-	12	-	-	-	-	0.9	-	-	-	-

PHYLUM	ORDER	FAMILY	GENUS	1995 RA	2000 RA	2001 RA	2002 RA	2003 RA	2004 RA	2005 RA	2006 RA	2007 RA	2008 RA	2009 RA
			Stegopterna	-	-	-	-	0.8	-	-	-	-	-	-
		Tabanidae	na	-	-	-	-	-	-	-	-	-	*1.9	-
			Chrysops	1	-	-	-	-	-	-	-	-	1.9	-
		Tipulidae	na	-	-	-	-	-	*0.9	-	-	-	-	-
			Hexatoma	-	-	2.1	0.9	-	-	-	-	-	1	-
			Ormosia	-	-	-	-	-	-	-	-	-	1	-
			Pilaria	-	-	-	-	-	-	-	-	-	1.9	-
			Pseudolimnophila	-	-	-	-	-	-	-	-	-	-	0.8
			Tipula	-	-	1	-	-	-	0.9	-	-	-	-
	Ephemeroptera	Ameletidae	*Ameletus*	-	-	-	-	0.8	-	-	-	1	1.9	0.8
	(Mayfly)	Baetidae	na	*1	-	-	-	-	-	-	*3.5	-	*1	-
			Acentrella	-	10.2	-	-	-	-	-	-	-	-	-
			Acerpenna	32.3	-	11.5	26.3	-	11.3	7.5	-	8.7	-	1.6
			Centroptilum	-	-	-	-	-	-	-	-	-	-	1.6
		Ephemerellidae	na	-	-	-	-	-	-	-	*0.9	-	-	-
			Ephemerella	7.3	66.7	13.5	0.9	-	6.6	5.7	-	2.9	3.8	-
			Eurylophella	13.5	1.9	-	0.9	-	4.7	7.5	0.9	11.7	1.9	12.2
		Heptageniidae	na	-	-	*2.1	-	-	-	*6.6	-	-	-	-
			Stenonema	-	0.9	-	5.3	-	8.5	7.5	-	1	-	-
		Leptophlebiidae	na	-	-	-	-	-	-	-	*7.8	-	*1.9	-
			Leptophlebia	1	-	-	-	-	0.9	-	-	-	-	8.1
			Paraleptophlebia	3.1	-	-	-	-	-	-	-	-	-	-
		Metretopodidae	*Siphloplecton*	-	-	-	-	-	-	-	-	1.9	-	-
		Siphlonuridae	*Siphlonurus*	-	-	-	-	-	-	-	7.8	-	7.6	52.8
	Hemiptera	Corixidae	na	-	-	-	-	-	-	-	-	-	*1	-
	(True bug)	Nepidae	*Ranatra*	-	0.9	-	-	-	-	-	-	-	-	-
	Isopoda	Asellidae	*Caecidotea*	-	-	1	-	0.8	-	2.8	-	1	-	3.3
	(Aquatic Sow Bug)			-	-	-	-	-	-	-	-	-	-	-
	Lepidoptera	na	na	-	-	-	-	-	-	-	-	*1	-	-
	(Moth)			-	-	-	-	-	-	-	-	-	-	-
	Megaloptera	Corydalidae	*Nigronia*	-	-	-	-	-	-	0.9	-	-	-	-
	(Dobsonfly/Fishfly)			-	-	-	-	-	-	-	-	-	-	-
	Odonata	Aeshnidae	*Boyeria*	-	-	-	-	-	-	-	-	-	-	0.8
	(Dragonfly/	Calopterygidae	*Calopteryx*	-	-	-	-	-	1.9	0.9	-	-	-	-
	Damselfly)	Gomphidae	na	-	-	-	*0.9	-	-	-	-	*1	-	-
			Dromogomphus	-	-	-	-	-	-	1.9	-	-	-	-
	Plecoptera	Capniidae	na	-	-	-	-	*2.3	-	-	-	-	-	-
	(Stonefly)		*Allocapnia*	-	-	-	-	-	-	-	-	-	-	0.8
		Chloroperlidae	na	-	-	*2.1	*2.6	-	*1.9	*0.9	-	-	-	-
		Leuctridae	*Leuctra*	-	-	1	-	-	-	-	0.9	1	-	-
		Nemouridae	na	*4.2	-	*4.2	-	*25.8	-	-	-	-	*1	-
			Amphinemura	1	1.9	-	1.8	0.8	1.9	3.8	3.5	-	-	-
			Ostrocerca	-	-	-	-	-	-	-	0.9	-	-	-
			Prostoia	-	-	-	1.8	39.1	-	-	3.5	1	-	-
		Perlidae	na	-	-	*1	-	-	*0.9	-	*0.9	-	-	-
			Eccoptura	-	-	2.1	-	-	10.4	-	-	-	-	-
		Perlodidae	na	-	-	*1	-	*4.7	*0.9	-	-	-	-	-
			Clioperla	-	-	-	-	-	-	-	-	1	-	-
			Isoperla	1	-	4.2	-	-	0.9	-	2.6	1	2.9	-
		Taeniopterygidae	*Oemopteryx*	-	-	-	-	0.8	-	-	-	-	-	-
			Strophopteryx	-	-	-	0.9	2.3	-	-	-	-	-	-
	Trichoptera	Hydropsychidae	na	-	-	-	-	-	-	*0.9	-	-	-	-
	(Caddisfly)		*Cheumatopsyche*	-	-	2.1	4.4	-	-	12.3	-	1.9	-	-
			Diplectrona	-	-	-	-	-	0.9	-	0.9	1	-	-
			Hydropsyche	-	-	-	-	-	-	0.9	-	-	-	-
		Leptoceridae	na	-	-	-	-	-	-	-	-	-	-	*5.7
			Triaenodes	-	-	-	-	-	-	1.9	0.9	1	-	-
		Limnephilidae	na	-	-	-	-	-	-	-	*0.9	-	*4.8	-
			Ironoquia	-	-	-	-	-	2.8	0.9	0.9	-	-	-
			Pycnopsyche	-	-	-	-	-	1.9	0.9	-	1.9	-	-
		Phryganeidae	*Ptilostomis*	-	-	-	-	-	-	0.9	0.9	-	-	-
		Psychomyiidae	*Lype*	-	-	-	-	-	0.9	0.9	-	-	-	-
		Uenoidae	*Neophylax*	1	-	2.1	-	1.6	-	-	-	1	-	-
Mollusca	Basommatophora	Physidae	*Physa*	-	-	-	-	-	-	-	-	-	1	0.8
	(Snail)			-	-	-	-	-	-	-	-	-	-	-
	Veneroida	Pisidiidae	*Musculium*	-	-	-	-	-	-	-	0.9	1	-	-
	(Bivalve)			-	-	-	-	-	-	-	-	-	-	-
Nematomorpha	Gordioidea	Gordiidae	na	-	-	-	-	*0.8	-	-	-	-	-	-
	(Worm)			-	-	-	-	-	-	-	-	-	-	-
Nemertea	Hoplonemertea	Tetrastemmatidae	*Prostoma*	-	-	-	-	-	-	0.9	0.9	-	-	-
	(Roundworm)			-	-	-	-	-	-	-	-	-	-	-

Green families are intolerant (family tolerance values from 0 to 3); blue are moderately tolerant (family tolerance values from 3.1 to 6.9); and red are tolerant (family tolerance values from 7 to 10).
* Taxa not identified to genus.

Unnamed Tributary to St. Clements Creek (STCL-051-S)

Site STCL-051-S is located on an unnamed tributary to St. Clements Creek in the Coastal Plain – western shore region of Maryland. It is in the St. Clements Bay watershed in St. Mary's County. This site was sampled in 1995 and 2000 to 2009. Its watershed is primarily forested (66%), with 32% agriculture and 2% urban.


Unnamed tributary to St. Clements Creek in spring 2009.

Water Chemistry

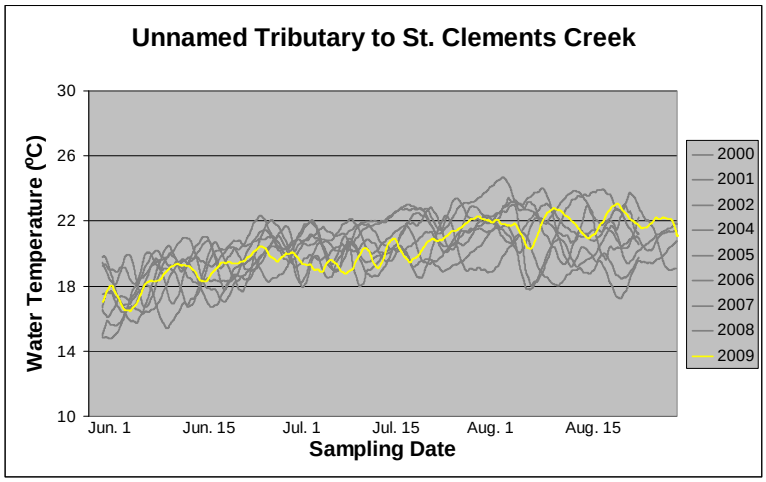
Summer water chemistry data collected at the unnamed tributary to St. Clements Creek (1995 and 2000 to 2009).

Parameter	*1995*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
Field pH	6.3	6.6	7.0	7.0	6.4	6.5	7.1	6.2	6.6	6.8	6.3
Dissolved Oxygen (mg/L)	7.5	5.7	7.6	4.8	8.6	7.1	8.1	8.3	7.6	10.1	6.8
Conductivity (mS)	0.09	0.08	0.07	0.09	0.06	0.07	0.07	0.08	0.08	0.08	0.08
Turbidity (NTU)	Not measured	5.0	4.1	4.3	2.7	8.8	4.5	8.0	4.4	5.9	5.4

Physical Habitat

Physical habitat measurements collected at the unnamed tributary to St. Clements Creek (1995 and 2000 to 2009). Scored parameters are on a 0 (worst) to 20 (best) scale.

Parameter	*1995*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
Instream habitat (0-20)	12	14	18	14	14	11	14	14	13	17	15
Epifaunal substrate (0-20)	11	13	16	15	14	13	14	15	16	14	9
Velocity/Depth Diversity (0-20)	12	5	13	8	12	11	8	6	4	7	6
Pool Quality (0-20)	11	10	15	7	15	12	10	10	10	10	10
Riffle Quality (0-20)	9	6	11	7	14	11	8	7	6	7	7
Shading (%)	90	95	95	95	95	92	91	92	95	75	80
Embeddedness (%)	5	40	25	30	40	20	30	40	15	40	45
Discharge (cfs)	0.06	0.11	0.16	0.01	0.40	0.12	0.17	0.09	0.02	0.10	0.02



The above graph displays the temperature logger data for the unnamed tributary to St. Clements Creek for 2000 to 2009. Maximum recorded temperatures occurred during August 2006.

Biology

Fish

Cumulative list of fish species (with abundance) collected in the unnamed tributary to St. Clements Creek by sampling year.

Species	*1995*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
American eel	1	1	-	-	-	-	-	-	-	-	-
Creek chubsucker	12	-	2	-	2	2	4	-	2	-	2
Eastern blacknose dace	97	26	95	34	13	179	143	59	118	41	82
Eastern mudminnow	162	51	80	54	42	73	59	42	37	12	11
Fallfish	16	2	8	-	-	-	-	-	2	-	-
Least brook lamprey	31	5	2	3	7	20	11	7	28	-	1
Pirate perch	9	-	-	-	-	-	-	-	-	-	-
Redbreast sunfish	2	-	-	-	-	-	-	-	-	-	-
Sea lamprey	1	-	-	-	-	-	-	-	-	-	-
Tessellated darter	9	-	3	-	-	1	2	-	2	4	-

Green indicates in tolerant fish; blue are moderately tolerant; and red are tolerant.

Crayfish

Cumulative list of crayfish species (with abundance or presence {P}/absence {A} data) collected in the unnamed tributary to St. Clements Creek by sampling year.

Species	*2006*	*2007*	*2008*	*2009*
Spinycheek crayfish (*Orconectes limosus*)	P	9	A	A
Devil crawfish (*Cambarus diogenes*)	A	1	A	1

Mussels

Cumulative list of mussel species (with abundance or presence {P}/absence {A} data) collected in the unnamed tributary to St. Clements Creek by sampling year.

Species
None Observed

Herpetofauna

Cumulative list of herpetofauna species collected in or near the unnamed tributary to St. Clements Creek.

Order (Common)	*Species*
Anura (Frogs and Toads)	American bullfrog, Eastern American toad, Fowler's toad, Northern green frog, Northern spring peeper, Pickerel frog, Southern leopard frog, Wood frog
Caudata (Salamanders and Newts)	Northern red salamander, Northern two-lined salamander, Spotted salamander
Squamata (Snakes and Lizards)	Northern black racer
Testudines (Turtles)	Eastern box turtle

Benthic Macroinvertebrates

Cumulative list of benthic macroinvertebrates collected in the unnamed tributary to St. Clements Creek by sampling year, RA = %Relative Abundance

PHYLUM	*ORDER*	*FAMILY*	*GENUS*	*1995 RA*	*2000 RA*	*2001 RA*	*2002 RA*	*2003 RA*	*2004 RA*	*2005 RA*	*2006 RA*	*2007 RA*	*2008 RA*	*2009 RA*
Annelida	Haplotaxida	Naididae	na	-	*6	-	-	-	-	-	-	-	*1.1	-
(Worm)	Lumbriculida	Lumbriculidae	na	-	*2.6	*0.9	-	-	*0.9	-	-	-	-	-
Arthropoda	Amphipoda	Crangonyctidae	na	-	*4.3	-	-	-	-	-	-	-	-	-
	(Scud)		*Synurella*	-	-	1.8	-	6	5.7	0.9	-	1.8	-	-
		Gammaridae	*Gammarus*	17.4	-	0.9	-	-	4.7	2.8	-	4.5	-	-
	Coleoptera	Dryopidae	*Helichus*	-	-	-	-	-	-	-	0.8	0.9	-	-
	(Beetle)	Dytiscidae	na	-	-	-	-	-	-	-	-	-	*1.1	-
		Elmidae	na	-	-	-	-	*0.9	-	-	*1.7	-	-	-
			Dubiraphia	-	-	-	-	-	-	-	-	0.9	-	-
			Microcylloepus	-	-	-	-	-	-	2.8	-	-	-	-
			Oulimnius	2.9	8.5	5.3	17.2	6.8	-	4.6	1.7	0.9	-	10.9
			Stenelmis	-	1.7	-	-	-	-	-	-	-	-	-
		Gerridae	*Trepobates*	1.4	-	-	-	-	-	-	-	-	-	-

PHYLUM	ORDER	FAMILY	GENUS	1995 RA	2000 RA	2001 RA	2002 RA	2003 RA	2004 RA	2005 RA	2006 RA	2007 RA	2008 RA	2009 RA
		Gyrinidae	*Dineutus*	-	-	-	-	-	0.9	-	-	-	-	-
		Hydrochidae	*Hydrochus*	-	-	-	-	-	-	0.9	-	-	-	-
		Hydrophilidae	*Helochares*	-	-	-	-	-	0.9	-	-	-	-	-
			Hydrobius	-	-	-	-	-	-	-	-	-	1.1	-
		Psephenidae	*Psephenus*	4.3	0.9	-	1.6	1.7	-	-	0.8	1.8	-	0.8
		Ptilodactylidae	*Anchytarsus*	-	1.7	1.8	8.2	-	1.9	7.4	5.9	3.6	4.2	4.2
	Diptera	Ceratopogonidae	na	-	-	-	-	*1.7	-	-	-	-	*2.1	-
	(True fly)		*Bezzia*	-	-	-	-	-	-	-	-	-	1.1	-
			Ceratopogon	-	-	-	-	-	0.9	-	-	-	-	0.8
			Culicoides	-	-	-	-	-	-	-	-	-	2.1	-
			Probezzia	-	0.9	-	-	-	-	-	0.8	-	-	-
		Chironomidae	*Ablabesmyia*	-	-	-	-	-	1.9	-	-	0.9	-	-
			Conchapelopia	-	4.3	-	-	-	-	-	-	-	-	-
			Corynoneura	-	-	1.8	-	-	-	-	-	1.8	5.3	-
			Eukiefferiella	-	0.9	2.7	-	1.7	-	-	-	-	1.1	-
			Heleniella	-	-	-	-	-	-	0.9	-	-	-	-
			Hydrobaenus	-	-	-	-	-	-	-	0.8	-	-	-
			Labrundinia	-	-	-	-	-	-	0.9	0.8	-	-	-
			Micropsectra	-	-	10.6	-	-	-	0.9	0.8	1.8	-	2.5
			Microtendipes	-	-	-	-	-	2.8	-	-	-	-	-
			Nanocladius	-	-	-	-	-	-	-	0.8	-	-	-
			Orthocladiinae	-	-	*1.8	-	*2.6	-	-	*0.8	*2.7	-	-
			Orthocladius	-	-	-	-	-	2.8	-	0.8	1.8	-	-
			Parametriocnemus	-	6.8	1.8	-	-	0.9	-	1.7	0.9	-	0.8
			Paraphaenocladius	-	-	-	-	-	-	-	-	-	3.2	-
			Polypedilum	-	0.9	0.9	-	-	2.8	-	-	-	-	-
			Potthastia	-	0.9	-	-	-	-	-	-	-	-	-
			Rheocricotopus	-	-	-	-	-	4.7	-	-	-	-	-
			Rheotanytarsus	-	-	-	-	-	-	-	-	-	-	1.7
			Stempellinella	-	-	-	-	-	-	-	1.7	-	-	0.8
			Symposiocladius	-	-	-	-	-	-	0.9	-	-	-	-
			Tanypodinae	-	*4.3	-	-	-	-	*0.9	*1.7	*1.8	*3.2	-
			Tanytarsini	-	-	-	*0.8	-	-	-	-	-	-	-
			Tanytarsus	-	-	-	-	-	6.6	-	-	0.9	-	-
			Thienemannimyia Group	-	-	-	-	*0.9	*7.5	*4.6	*0.8	*1.8	-	-
			Trissopelopia	-	-	-	0.8	-	9.4	1.9	0.8	0.9	-	-
			Tvetenia	1.4	-	-	-	-	-	-	0.8	-	-	-
			Zavrelimyia	-	5.1	-	-	-	-	-	0.8	0.9	9.5	-
		Dixidae	*Dixa*	-	-	-	0.8	-	-	-	-	-	-	-
			Dixella	-	-	-	-	-	-	-	-	0.9	-	-
		Simuliidae	*Prosimulium*	4.3	-	24.8	-	9.4	-	-	1.7	0.9	24.2	-
			Simulium	2.9	12.8	-	-	-	2.8	-	-	0.9	-	-
			Stegopterna	-	-	7.1	0.8	17.9	-	-	1.7	0.9	2.1	-
		Tabanidae	na	-	-	-	-	-	-	-	-	-	*2.1	-
		Tipulidae	na	-	-	-	-	-	*0.9	-	-	-	-	-
			Dicranota	-	-	-	2.5	-	-	-	-	-	1.1	-
			Hexatoma	-	-	-	0.8	-	0.9	-	0.8	2.7	-	-
			Pilaria	-	-	-	-	-	-	-	-	-	2.1	-
			Pseudolimnophila	-	0.9	-	-	-	0.9	2.8	-	-	-	1.7
			Tipula	1.4	1.7	0.9	-	7.7	0.9	0.9	0.8	-	-	-
	Ephemeroptera	Ameletidae	*Ameletus*	-	-	-	-	-	-	-	-	0.9	2.1	-
	(Mayfly)	Baetidae	na	-	*0.9	-	-	-	-	-	*2.5	-	-	-
			Acentrella	-	1.7	-	-	-	-	-	-	-	-	-
			Acerpenna	5.8	-	8	8.2	-	4.7	8.3	1.7	2.7	-	16.8
		Ephemerellidae	na	-	-	-	-	-	-	-	-	-	*1.1	-
			Ephemerella	21.7	4.3	8	32.8	6	3.8	13	29.4	4.5	1.1	27.7
			Eurylophella	1.4	0.9	-	1.6	-	0.9	0.9	2.5	-	-	-
		Heptageniidae	*Maccaffertium*	-	-	-	-	-	-	-	-	-	-	1.7
			Stenonema	-	-	0.9	1.6	-	1.9	5.6	0.8	0.9	-	-
		Leptophlebiidae	na	-	-	-	-	*0.9	*0.9	-	-	*1.8	-	-
			Habrophlebia	4.3	-	-	2.5	-	-	1.9	-	-	-	-
			Leptophlebia	-	-	0.9	-	0.9	0.9	-	0.8	-	5.3	-
			Paraleptophlebia	-	14.5	4.4	-	-	-	2.8	-	3.6	-	-
		Siphlonuridae	*Siphlonurus*	-	-	-	-	-	-	-	-	-	1.1	-
	Isopoda	Asellidae	*Caecidotea*	1.4	2.6	-	-	1.7	-	0.9	-	2.7	-	-
	(Aquatic Sow bug)			-	-	-	-	-	-	-	-	-	-	-
	Megaloptera	Corydalidae	*Nigronia*	-	-	-	-	-	1.9	-	0.8	0.9	-	0.8
	(Dobsonfly/Fishfly)			-	-	-	-	-	-	-	-	-	-	-
	Odonata	Aeshnidae	*Boyeria*	-	-	-	-	-	-	0.9	-	1.8	-	-
	(Dragonfly/	Calopterygidae	*Calopteryx*	-	-	-	-	-	1.9	0.9	-	-	-	-
	Damselfly)	Cordulegastridae	*Cordulegaster*	4.3	-	-	-	-	-	1.9	-	-	1.1	-

PHYLUM	ORDER	FAMILY	GENUS	1995 RA	2000 RA	2001 RA	2002 RA	2003 RA	2004 RA	2005 RA	2006 RA	2007 RA	2008 RA	2009 RA
		Gomphidae	na	-	*0.9	-	*2.5	-	-	-	-	-	-	*1.7
			Arigomphus	2.9	-	-	-	-	-	-	-	-	-	-
	Plecoptera	Capniidae	na	-	-	-	-	-	-	-	*0.8	-	*2.1	-
	(Stonefly)		*Paracapnia*	2.9	-	-	-	17.1	-	-	-	-	-	-
		Chloroperlidae	na	-	*0.9	*5.3	*6.6	*0.9	*1.9	-	-	-	-	-
			Haploperla	-	-	-	-	-	-	10.2	7.6	20.7	-	7.6
		Leuctridae	*Leuctra*	-	-	0.9	-	-	-	-	-	-	-	-
		Nemouridae	na	-	-	-	-	*4.3	-	-	*1.7	-	-	-
			Amphinemura	2.9	1.7	-	1.6	0.9	4.7	1.9	5.9	2.7	-	10.1
			Ostrocerca	-	-	-	-	4.3	-	-	-	-	-	-
			Prostoia	-	-	-	-	-	-	-	5	-	-	-
		Perlidae	na	-	-	-	*0.8	-	*0.9	-	-	*0.9	-	-
			Eccoptura	-	-	2.7	-	-	3.8	-	-	-	-	-
		Perlodidae	na	-	*5.1	-	-	*0.9	*0.9	-	-	-	*13.7	-
			Clioperla	-	-	-	-	0.9	-	-	-	-	-	-
			Isoperla	4.3	-	0.9	-	0.9	-	-	-	2.7	-	0.8
	Trichoptera	Brachycentridae	*Brachycentrus*	1.4	-	-	-	-	-	-	-	-	-	-
	(Caddisfly)	Calamoceratidae	*Anisocentropus*	-	-	-	-	-	-	-	0.8	-	-	-
		Hydropsychidae	na	-	-	-	-	-	-	*0.9	-	-	-	-
			Cheumatopsyche	-	-	-	6.6	-	-	1.9	-	0.9	-	1.7
			Diplectrona	1.4	-	2.7	0.8	-	1.9	1.9	-	-	-	5
		Lepidostomatidae	*Lepidostoma*	-	-	-	-	-	-	0.9	-	-	-	-
		Leptoceridae	na	-	-	-	-	-	-	-	*0.8	-	-	-
			Triaenodes	-	-	-	-	-	-	-	0.8	0.9	-	-
		Limnephilidae	na	-	-	*1.8	-	*1.7	-	-	-	*0.9	*1.1	-
			Ironoquia	-	-	-	-	-	2.8	2.8	-	1.8	-	-
			Pycnopsyche	-	-	-	-	-	1.9	2.8	-	5.4	-	0.8
		Philopotamidae	*Wormaldia*	-	-	-	-	-	-	-	0.8	-	-	-
		Phryganeidae	*Ptilostomis*	-	-	-	-	0.9	-	-	1.7	-	1.1	-
		Polycentropodidae	*Polycentropus*	-	-	-	-	-	0.9	0.9	-	-	-	-
		Psychomyiidae	*Lype*	1.4	-	-	0.8	-	-	0.9	-	0.9	-	-
		Odontoceridae	*Psilotreta*	-	-	-	-	-	0.9	-	-	3.6	-	-
		Rhyacophilidae	*Rhyacophila*	-	-	-	-	0.9	-	-	1.7	-	-	-
		Sericostomatidae	*Agarodes*	-	-	-	-	-	-	-	0.8	-	-	-
		Uenoidae	*Neophylax*	7.2	-	0.9	-	-	-	3.7	1.7	1.8	1.1	0.8
Mollusca	Veneroida	Pisidiidae	na	-	-	-	-	-	-	-	*0.8	-	-	-
	(Bivalve)		*Musculium*	-	-	-	-	-	-	-	-	-	3.2	-
Platyhelminthes	Tricladida	Planariidae	*Phagocata*	-	1.7	-	-	-	-	-	-	-	-	-
	(Flatworm)			-	-	-	-	-	-	-	-	-	-	-

Green families are intolerant (family tolerance values from 0 to 3); blue are moderately tolerant (family tolerance values from 3.1 to 6.9); and red are tolerant (family tolerance values from 7 to 10).
* Taxa not identified to genus.

Swanson Creek (PAXL-294-S)

Site PAXL-294-S is located on Swanson Creek in the Coastal Plain – western shore region of Maryland. It is in the Lower Patuxent River watershed in Charles County. This site was sampled in 1997 and 2000 to 2009. Its watershed is primarily forested (63%), with 31% agriculture, 4% urban, and 3% barren.


Swanson Creek in spring 2009.

Water Chemistry

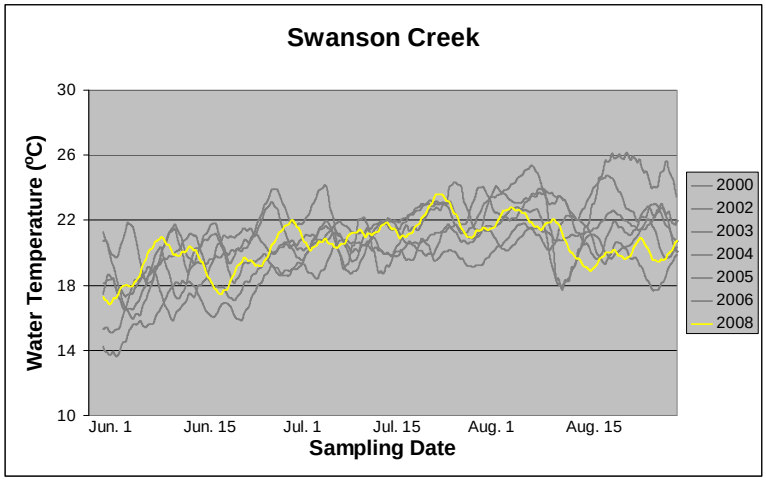
Summer water chemistry data collected at Swanson Creek (1997 and 2000 to 2009).

Parameter	1997	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Field pH	8.1	6.7	7.1	6.7	6.9	6.5	6.8	6.5	7.1	6.7	6.4
Dissolved Oxygen (mg/L)	9.8	7.4	8.2	2.1	8	8	7.1	7.6	7.9	9.7	8.9
Conductivity (mS)	.08	0.08	0.09	0.10	0.10	0.10	0.11	0.10	0.10	0.11	0.11
Turbidity (NTU)	Not measured	6.8	6.2	26.1	8.2	6.4	5.3	7.0	4.6	3.3	7.3

Physical Habitat

Physical habitat measurements collected at Swanson Creek (1997 and 2000 to 2009). Scored parameters are on a 0 (worst) to 20 (best) scale.

Parameter	*1997*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
Instream habitat (0-20)	14	18	15	6	14	12	16	16	16	17	17
Epifaunal substrate (0-20)	13	16	13	4	16	15	13	12	15	14	15
Velocity/Depth Diversity (0-20)	14	15	15	6	17	12	13	12	12	16	16
Pool Quality (0-20)	14	17	15	11	15	12	16	16	15	16	17
Riffle Quality (0-20)	16	14	15	0	16	15	13	16	16	17	17
Shading (%)	65	70	92	91	90	90	90	90	89	80	80
Embeddedness (%)	20	35	30	50	20	25	35	65	50	75	75
Discharge (cfs)	4.21	3.86	7.01	0.00	14.04	2.62	2.59	2.84	2.53	6.25	6.74



The above graph displays the temperature logger data for Swanson Creek for 2000 to 2009. Maximum recorded temperatures occurred during the drought in August, 2002. No data were available for 2007 and 2009.

Biology

Fish

Cumulative list of fish species (with abundance) collected in Swanson Creek by sampling year.

Species	*1997*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
American eel	7	5	-	-	1	3	6	11	9	14	7
Bluegill	-	1	-	-	-	1	-	-	-	-	-
Creek chubsucker	2	2	2	1	1	4	-	5	-	6	12
Eastern blacknose dace	103	16	97	62	-	93	26	34	28	34	56
Eastern mudminnow	10	21	15	3	2	29	10	8	3	6	4
Fallfish	34	3	2	4	-	1	-	1	7	23	41
Golden shiner	10	-	2	-	1	-	1	-	-	-	-
Largemouth bass	-	-	-	8	-	-	-	3	-	-	-
Least brook lamprey	21	-	2	7	-	6	9	2	-	-	2
Pumpkinseed	4	3	3	4	1	7	2	2	-	-	-
Redbreast sunfish	-	-	-	-	-	1	-	-	-	-	-
Redfin pickerel	-	-	1	-	-	-	2	1	-	-	-
Rosyside dace	76	40	25	26	17	1	1	5	-	4	26
Sea lamprey	4	-	-	26	-	-	-	22	27	5	9
Tadpole madtom	9	-	-	-	-	2	3	2	3	2	1
Tessellated darter	33	1	30	35	-	16	11	12	8	14	11
White sucker	3	1	-	33	-	-	-	1	-	-	-

Green indicates intolerant fish; blue are moderately tolerant; and red are tolerant.

Crayfish

Cumulative list of crayfish species (with abundance or presence {P}/absence {A} data) collected in the unnamed tributary to Swanson Creek by sampling year.

Species	*2006*	*2007*	*2008*	*2009*
Spinycheek crayfish (*Orconectes limosus*)	P	19	A	13

Mussels

Cumulative list of mussel species (with abundance or presence {P}/absence {A} data) collected in Swanson Creek by sampling year.

Species
None Observed

Herpetofauna

Cumulative list of herpetofauna species collected in or near Swanson Creek.

Order (Common)	*Species*
Anura (Frogs and Toads)	American bullfrog, Eastern cricket frog, Gray tree frog, Northern green frog, Northern spring peeper, Pickerel frog, Wood frog
Caudata (Salamanders and Newts)	Northern two-lined salamander
Squamata (Snakes and Lizards)	Eastern worm snake, Northern watersnake
Testudines (Turtles)	Eastern box turtle

Benthic Macroinvertebrates

Cumulative list of benthic macroinvertebrates collected in Swanson Creek by sampling year,

RA = %Relative Abundance.

PHYLUM	*ORDER*	*FAMILY*	*GENUS*	*1997 RA*	*2000 RA*	*2001 RA*	*2002 RA*	*2003 RA*	*2004 RA*	*2005 RA*	*2006 RA*	*2007 RA*	*2008 RA*	*2009 RA*
Annelida	Haplotaxida	Enchytraeidae	na	-	-	-	-	*1.8	-	-	-	-	-	-
(Worm)		Naididae	na	-	*0.7	-	-	-	-	-	-	-	-	*0.9
	Lumbriculida	Lumbriculidae	na	-	-	-	-	*2.7	-	*0.8	-	-	-	*1.8
Arthropoda	Amphipoda	Crangonyctidae	na	-	*3.4	-	-	-	-	-	-	-	-	-
	(Scud)	Gammaridae	*Gammarus*	-	-	-	-	0.9	1.9	4.1	0.9	1.7	-	-
	Coleoptera	Dryopidae	*Helichus*	-	0.7	-	-	-	-	-	-	-	-	-
	(Beetle)	Elmidae	*Ancyronyx*	-	-	-	-	-	-	-	-	1.7	-	-
			Dubiraphia	-	-	-	-	-	-	-	-	0.9	-	-
			Macronychus	-	-	-	-	-	-	-	-	0.9	-	-

PHYLUM	ORDER	FAMILY	GENUS	1997 RA	2000 RA	2001 RA	2002 RA	2003 RA	2004 RA	2005 RA	2006 RA	2007 RA	2008 RA	2009 RA
			Optioservus	-	0.7	0.7	-	-	-	-	3.5	-	-	-
			Oulimnius	2	-	9.7	3.2	-	-	16.5	17.5	6	0.9	3.5
			Stenelmis	-	-	-	-	-	-	0.8	0.9	1.7	-	-
		Ptilodactylidae	*Anchytarsus*	1	0.7	-	-	-	-	1.7	-	0.9	-	-
	Diptera	Ceratopogonidae	na	-	-	-	-	-	-	-	-	*1.7	-	*0.9
	(True Fly)		*Bezzia*	1	-	-	-	0.9	-	-	-	-	-	-
			Probezzia	-	-	-	-	0.9	-	-	-	0.9	1.9	-
		Chironomidae	*Ablabesmyia*	-	-	-	-	-	-	-	-	0.9	-	-
			Brillia	-	-	-	-	-	0.9	-	-	0.9	-	0.9
			Cricotopus	-	-	-	-	-	-	-	-	-	-	20.2
			Diamesa	-	-	-	-	-	2.8	-	-	-	-	-
			Eukiefferiella	1	-	-	-	-	-	-	-	0.9	0.9	-
			Heleniella	-	-	-	0.8	-	-	0.8	-	0.9	-	-
			Microtendipes	-	-	0.7	-	0.9	-	-	0.9	-	-	-
			Orthocladiinae	*1	-	-	-	-	-	*0.8	-	*0.9	-	-
			Orthocladius	1	-	-	1.6	-	16	-	-	0.9	2.8	8.8
			Parachaetocladius	-	-	-	-	1.8	-	-	-	-	-	-
			Parakiefferiella	-	-	-	-	-	-	-	-	0.9	-	-
			Parametriocnemus	1	1.4	1.5	-	1.8	3.8	-	-	0.9	2.8	2.6
			Paraphaenocladius	-	-	-	0.8	-	-	-	-	0.9	0.9	-
			Paratanytarsus	1	-	-	-	-	-	-	-	-	1.9	-
			Polypedilum	-	-	0.7	-	-	10.4	-	0.9	-	-	-
			Pseudorthocladius	-	-	-	-	-	-	0.8	-	-	-	-
			Rheocricotopus	1	-	-	-	-	-	-	1.8	2.6	-	-
			Rheosmittia	-	-	3	-	-	2.8	0.8	1.8	12	-	-
			Stempellinella	-	-	-	-	-	-	-	-	-	0.9	-
			Symposiocladius	-	-	-	-	-	-	-	-	-	-	0.9
			Tanypodinae	-	-	-	-	*0.9	-	-	-	*0.9	-	-
			Tanytarsini	-	-	-	-	-	-	-	-	-	-	*1.8
			Tanytarsus	-	-	0.7	5.6	-	-	-	0.9	-	0.9	-
			Thienemannimyia Group	-	-	-	-	*1.8	*4.7	*0.8	-	*1.7	*1.9	-
			Tribelos	-	-	-	-	-	-	-	-	-	3.7	-
			Trissopelopia	2	-	-	-	-	-	-	0.9	-	-	-
			Tvetenia	-	-	0.7	-	-	-	-	-	-	0.9	2.6
			Zavrelimyia	-	-	-	-	-	-	-	-	-	0.9	-
		Empididae	*Hemerodromia*	1	-	-	1.6	-	1.9	-	-	-	-	1.8
		Simuliidae	na	-	-	-	-	-	-	-	-	-	*0.9	-
			Prosimulium	9.2	-	1.5	-	1.8	0.9	-	6.1	-	9.3	-
			Simulium	9.2	3.4	-	-	0.9	0.9	-	0.9	-	-	-
			Stegopterna	-	-	0.7	-	0.9	-	-	-	-	-	-
		Tabanidae	*Chrysops*	-	-	-	0.8	0.9	-	-	-	-	-	-
		Tipulidae	*Antocha*	-	-	-	-	-	-	0.8	-	-	-	-
			Hexatoma	5.1	-	-	4	-	2.8	1.7	2.6	0.9	-	1.8
			Ormosia	-	-	-	-	-	-	-	-	-	0.9	-
			Pseudolimnophila	-	-	-	-	-	0.9	-	-	0.9	-	-
			Tipula	2	0.7	-	0.8	1.8	-	-	-	-	0.9	-
	Ephemeroptera	Baetidae	na	-	-	-	-	*0.9	-	-	-	-	-	*3.5
	(Mayfly)		*Acentrella*	-	42.1	-	-	-	-	-	-	-	-	-
			Acerpenna	18.4	9	6.7	12.1	3.6	0.9	33.9	6.1	6.8	-	14.9
		Ephemerellidae	na	-	-	-	-	-	-	-	-	-	-	*4.4
			Ephemerella	18.4	24.8	57.5	43.5	36.9	14.2	11.6	18.4	22.2	0.9	10.5
			Eurylophella	-	0.7	-	-	-	-	0.8	-	-	-	-
		Heptageniidae	na	-	-	-	-	-	*0.9	-	-	-	-	-
			Maccaffertium	-	-	-	-	-	-	-	-	-	-	0.9
			Stenonema	1	0.7	2.2	0.8	-	-	-	1.8	1.7	-	-
		Leptophlebiidae	na	-	-	-	-	-	-	*0.8	-	-	-	-
			Paraleptophlebia	-	-	0.7	-	-	-	-	-	-	-	-
	Isopoda	Asellidae	*Caecidotea*	-	2.8	0.7	-	-	-	-	-	-	-	-
	Lepidoptera	na	na	-	-	-	-	-	-	-	-	*0.9	-	-
	(Moth)			-	-	-	-	-	-	-	-	-	-	-
	Megaloptera	Corydalidae	*Nigronia*	-	-	-	-	0.9	-	-	0.9	1.7	0.9	-
				-	-	-	-	-	-	-	-	-	-	-
	(Dobsonfly/ Fishfly)			-	-	-	-	-	-	-	-	-	-	-
	Odonata	Aeshnidae	*Boyeria*	-	-	0.7	0.8	-	-	0.8	-	-	-	-
	(Dragonfly/	Calopterygidae	*Calopteryx*	-	-	-	-	-	0.9	-	-	-	-	-
	Damselfly)	Cordulegastridae	*Cordulegaster*	-	0.7	-	-	-	-	-	-	-	-	-
		Gomphidae	na	-	-	-	-	-	-	-	*0.9	-	-	-
	Plecoptera	Capniidae	na	-	-	-	-	-	-	-	-	-	*0.9	-
	(Stonefly)	Chloroperlidae	na	-	*2.8	*5.2	-	*1.8	*12.3	*9.1	-	*8.5	-	-
			Haploperla	15.3	-	-	12.9	-	-	4.1	11.4	-	-	11.4

PHYLUM	ORDER	FAMILY	GENUS	1997 RA	2000 RA	2001 RA	2002 RA	2003 RA	2004 RA	2005 RA	2006 RA	2007 RA	2008 RA	2009 RA
		Leuctridae	*Leuctra*	2	0.7	-	-	0.9	0.9	-	-	2.6	0.9	-
		Nemouridae	na	*1	-	-	-	-	-	-	-	-	*12.1	*0.9
			Amphinemura	3.1	0.7	-	-	0.9	2.8	2.5	3.5	6	-	1.8
			Ostrocerca	-	-	-	-	0.9	-	-	-	-	-	-
			Prostoia	-	-	0.7	-	4.5	-	-	4.4	-	13.1	-
		Perlidae	na	-	*1.4	*0.7	*0.8	*0.9	*3.8	*0.8	-	*0.9	-	-
			Eccoptura	1	-	-	-	-	2.8	-	-	-	-	-
			Perlesta	-	0.7	-	-	-	-	-	-	-	-	-
		Perlodidae	na	-	-	*0.7	*1.6	-	-	-	*2.6	-	-	-
			Cultus	1	-	-	-	-	-	-	-	-	-	-
			Isoperla	-	0.7	-	2.4	20.7	-	-	5.3	-	7.5	-
		Taeniopterygidae	*Strophopteryx*	-	-	-	-	0.9	-	-	-	-	27.1	-
	Trichoptera	Hydropsychidae	na	-	-	-	-	-	-	*0.8	-	-	-	*0.9
	(Caddisfly)		*Cheumatopsyche*	-	-	1.5	4.0	-	-	-	2.6	4.3	-	1.8
			Hydropsyche	-	-	1.5	-	-	-	0.8	-	1.7	-	0.9
		Limnephilidae	na	-	*0.7	-	-	-	*0.9	-	-	-	*1.9	-
			Limnephilus	-	-	-	-	-	-	0.8	-	-	-	-
			Pycnopsyche	-	-	-	0.8	0.9	-	-	-	-	-	-
		Phryganeidae	*Ptilostomis*	-	-	-	-	0.9	-	-	-	-	-	-
		Uenoidae	*Neophylax*	-	-	0.7	0.8	3.6	7.5	2.5	2.6	-	0.9	-
Nemertea	Hoplonemertea	Tetrastemmatidae	*Prostoma*	-	-	-	-	-	0.9	-	-	-	-	-
	(Worm)			-	-	-	-	-	-	-	-	-	-	-

Green families are intolerant (family tolerance values from 0 to 3); blue are moderately tolerant (family tolerance values from 3.1 to 6.9); and red are tolerant (family tolerance values from 7 to 10).

* Taxa not identified to genus.

Unnamed Tributary to Zekiah Swamp Run (ZEKI-012-S)

Site ZEKI-012-S is located on an unnamed tributary to Zekiah Swamp Run in the Coastal Plain – western shore region of Maryland. It is in the Zekiah Swamp watershed in Charles County. This site was sampled in 1995 and 2000 to 2008. Permission to sample in 2009 could not be obtained. Its watershed is primarily forested (80%), with 18% agriculture and 1% barren.


Unnamed tributary to Zekiah Swamp Run in spring 2008.

Water Chemistry

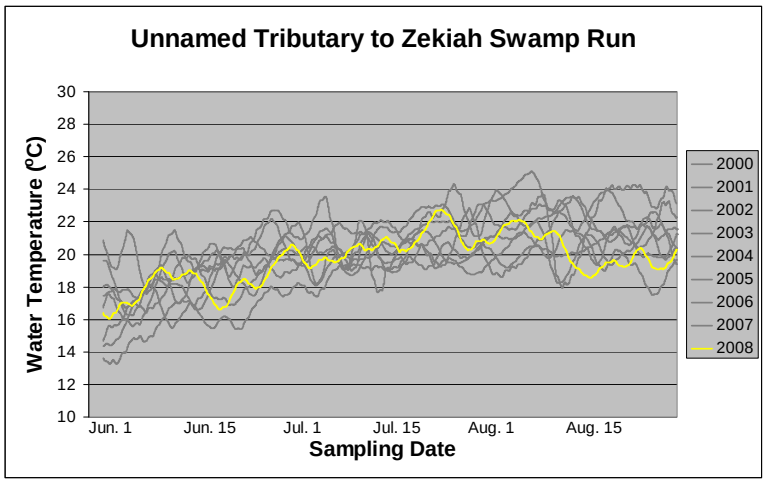
Summer water chemistry data collected at the unnamed tributary to Zekiah Swamp Run (1995 and 2000 to 2008).

Parameter	*1995*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
Field pH	6.6	8.1	6.9	6.4	6.2	6.4	6.9	5.9	6.8	6.5	
Dissolved Oxygen (mg/L)	8.4	5.2	8.2	2.9	8.1	8.3	9	7.8	7.9	9.7	
Conductivity (mS)	0.05	0.05	0.05	0.09	0.06	0.06	0.06	0.06	0.06	0.06	
Turbidity (NTU)	Not measured	3.0	3.6	26.1	2.7	4.4	3.1	7.8	2.0	2.1	

Physical Habitat

Physical habitat measurements collected at the unnamed tributary to Zekiah Swamp Run (1995 and 2000 to 2008). Scored parameters are on a 0 (worst) to 20 (best) scale.

Parameter	*1995*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
Instream habitat (0-20)	11	15	17	4	15	13	12	12	15	12	
Epifaunal substrate (0-20)	11	11	17	1	12	14	12	12	14	11	
Velocity/Depth Diversity (0-20)	7	10	10	2	8	11	9	6	9	7	
Pool Quality (0-20)	9	10	10	5	8	7	8	8	10	10	
Riffle Quality (0-20)	11	6	14	0	13	12	14	9	12	10	
Shading (%)	85	95	94	95	94	94	92	95	94	80	
Embeddedness (%)	15	45	16	100	40	15	40	45	40	40	
Discharge (cfs)	0.27	0.33	0.69	0.00	1.11	0.30	0.56	0.15	0.22	0.58	



The above graph displays the temperature logger data at the unnamed tributary to Zekiah Swamp Run for 2000 to 2008. Maximum recorded temperatures occurred during August 2006.

Biology

Fish

Cumulative list of fish species (with abundance) collected at the unnamed tributary to Zekiah Swamp Run by sampling year.

Species	*1995*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*
American eel	4	-	2	-	-	-	-	-	1	1
Eastern blacknose dace	-	23	21	-	11	20	31	12	34	12
Eastern mudminnow	99	15	49	57	9	234	29	15	5	1
Fallfish	-	-	-	2	-	-	-	-	-	-
Least brook lamprey	37	43	45	21	-	26	8	28	17	26
Pirate perch	8	-	7	5	-	5	-	-	-	-
Pumpkinseed	-	-	-	-	-	1	-	-	-	-
Redfin pickerel	-	10	-	2	-	7	10	4	15	1
Tessellated darter	-	-	-	2	-	-	1	2	-	-

Green indicates intolerant fish; blue are moderately tolerant; and red are tolerant.

Crayfish

Cumulative list of crayfish species (with abundance or presence {P}/absence {A} data) collected in the unnamed tributary to Zekiah Swamp Run by sampling year.

Species	*2006*	*2007*	*2008*
Devil crawfish (*Cambarus diogenes*)	A	P	P
Common crayfish (*Cambarus bartonii bartonii*)	P	2	A

Mussels

Cumulative list of mussel species (with abundance or presence {P}/absence {A} data) collected in the unnamed tributary to Zekiah Swamp Run by sampling year.

Species
None Observed

Herpetofauna

Cumulative list of herpetofauna species collected at or near the unnamed tributary to Zekiah Swamp Run.

Order (Common)	*Species*
Anura (Frogs and Toads)	Eastern American toad, Gray tree frog, Northern green frog, Pickerel frog, Wood frog
Caudata (Salamanders and Newts)	Northern dusky salamander, Northern red salamander, Northern two-lined salamander
Squamata (Snakes and Lizards)	Northern watersnake
Testudines (Turtles)	Spotted turtle

Benthic Macroinvertebrates

Cumulative list of benthic macroinvertebrates collected at the unnamed tributary to Zekiah Swamp Run by sampling year, RA = %Relative Abundance.

PHYLUM	*ORDER*	*FAMILY*	*GENUS*	*1995 RA*	*2000 RA*	*2001 RA*	*2002 RA*	*2003 RA*	*2004 RA*	*2005 RA*	*2006 RA*	*2007 RA*	*2008 RA*
Annelida	Haplotaxida	Naididae	na	-	*5.8	-	-	-	-	-	-	-	-
(Worm)	Lumbriculida	Lumbriculidae	na	-	-	-	*0.9	-	*0.8	*1	-	-	*1.8
	Tubificida	Tubificidae	na	-	-	-	-	-	-	-	-	-	*0.9
			Limnodrilus	-	-	-	-	-	-	-	0.9	-	0.9
Arthropoda	Amphipoda	Crangonyctidae	*Crangonyx*	-	-	-	-	-	-	-	-	0.9	-
	(Scud)			-	-	-	-	-	-	-	-	-	-
	Coleoptera	Dytiscidae	*Neoporus*	-	1.7	-	-	-	-	-	-	-	-
	(Beetle)	Elmidae	na	-	-	-	-	-	*0.8	-	-	-	*0.9
			Macronychus	-	-	-	-	-	-	-	-	3.5	-
			Optioservus	9.2	5.8	2.3	8.6	4.3	-	-	7.8	1.8	-
			Oulimnius	-	34.2	2.3	16.4	6.1	-	2.9	4.3	0.9	-
			Stenelmis	1.1	-	-	-	0.9	-	-	-	-	0.9
		Hydrophilidae	*Hydrobius*	-	0.8	-	-	-	-	-	-	-	-
			Tropisternus	-	-	-	-	-	-	-	-	0.9	-
		Ptilodactylidae	*Anchytarsus*	4.6	-	-	0.9	-	-	-	0.9	2.7	-

PHYLUM	ORDER	FAMILY	GENUS	1995 RA	2000 RA	2001 RA	2002 RA	2003 RA	2004 RA	2005 RA	2006 RA	2007 RA	2008 RA
	Collembola	na	na	-	*0.8	-	-	-	-	-	-	-	-
	(Springtail)			-	-	-	-	-	-	-	-	-	-
	Decapoda	Cambaridae	na	-	-	-	*0.9	-	-	-	-	-	-
	(Crayfish)			-	-	-	-	-	-	-	-	-	-
	Diptera	Ceratopogonidae	na	-	*0.8	-	-	-	-	-	-	*0.9	*1.8
	(True Fly)		*Bezzia*	-	-	-	-	-	-	-	-	4.4	0.9
			Ceratopogon	1.1	0.8	-	-	-	-	-	-	0.9	0.9
			Probezzia	1.1	-	0.8	5.2	-	-	-	-	-	-
		Chironomidae	na	-	-	-	-	-	-	*1	-	-	-
			Conchapelopia	-	0.8	-	0.9	-	-	-	-	-	-
			Corynoneura	-	1.7	-	-	-	-	1	-	0.9	2.6
			Cricotopus	-	-	-	-	0.9	-	-	-	-	-
			Cryptochironomus	-	-	-	-	-	0.8	-	-	-	-
			Eukiefferiella	1.1	1.7	-	-	0.9	-	1	0.9	12.4	0.9
			Heleniella	3.4	-	-	-	-	-	-	-	-	-
			Heterotrissocladius	-	-	-	-	-	-	1.9	-	-	0.9
			Micropsectra	3.4	-	0.8	0.9	-	-	1	-	-	-
			Nanocladius	-	-	0.8	-	-	-	-	-	-	-
			Orthocladiinae	*2.3	*4.2	*7.7	-	-	-	-	-	-	-
			Orthocladius	2.3	-	-	-	-	-	-	-	-	-
			Parachaetocladius	1.1	-	-	-	-	-	-	-	1.8	-
			Paralauterborniella	-	-	-	-	-	-	1	-	-	-
			Parametriocnemus	1.1	3.3	3.8	0.9	-	1.6	3.8	-	1.8	1.8
			Paraphaenocladius	-	-	-	-	-	-	-	-	-	1.8
			Paratanytarsus	-	-	0.8	-	-	-	-	-	-	-
			Polypedilum	-	2.5	-	-	-	0.8	-	-	-	-
			Potthastia	-	1.7	-	-	-	-	-	-	-	-
			Rheocricotopus	-	-	-	-	-	-	1	3.4	1.8	-
			Rheosmittia	-	-	-	-	-	1.6	-	-	-	-
			Stempellinella	-	-	-	-	-	-	-	-	0.9	1.8
			Symposiocladius	-	-	-	-	-	-	-	-	-	0.9
			Tanypodinae	-	-	-	-	-	-	-	-	*0.9	*0.9
			Tanytarsini	-	-	-	-	-	-	-	-	-	*0.9
			Tanytarsus	-	0.8	-	-	-	1.6	-	-	-	0.9
			Thienemanniella	-	0.8	-	-	-	-	-	-	-	0.9
			Thienemannimyia Group	-	-	-	-	-	-	-	-	-	*2.6
			Trissopelopia	1.1	-	-	0.9	-	0.8	-	-	-	2.6
			Zavrelimyia	-	-	-	-	-	0.8	-	-	-	-
		Dixidae	*Dixa*	2.3	-	0.8	-	-	-	-	-	-	-
		Empididae	*Chelifera*	-	-	-	-	-	0.8	-	-	-	-
			Hemerodromia	-	-	0.8	-	-	-	-	-	-	-
		Simuliidae	na	-	-	-	-	-	-	-	*2.6	-	-
			Prosimulium	1.1	-	42.7	3.4	67	-	-	21.6	1.8	22.8
			Simulium	-	2.5	-	0.9	-	0.8	1	-	1.8	-
			Stegopterna	6.9	0.8	5.3	0.9	9.6	-	-	3.4	-	1.8
		Tipulidae	na	*1.1	-	-	-	-	-	-	-	-	-
			Antocha	-	-	-	-	-	-	-	0.9	-	-
			Dicranota	-	0.8	-	-	-	-	-	-	-	-
			Hexatoma	-	0.8	-	-	-	-	-	0.9	-	-
			Tipula	3.4	0.8	-	-	-	0.8	-	-	-	-
	Ephemeroptera	Baetidae	na	-	-	-	-	-	-	-	*1.7	-	-
	(Mayfly)		*Acentrella*	-	0.8	-	-	-	-	-	-	-	-
			Acerpenna	9.2	-	6.9	14.7	-	1.6	22.9	-	8.8	9.6
		Ephemerellidae	na	-	-	-	-	-	-	-	-	-	*1.8
			Ephemerella	12.6	11.7	13.7	15.5	0.9	19.5	34.3	25	9.7	4.4
		Heptageniidae	na	-	*0.8	*0.8	-	-	-	-	*0.9	-	-
			Maccaffertium	-	-	-	-	-	-	-	-	-	0.9
			Stenonema	-	-	-	1.7	-	-	1	-	2.7	-
		Leptophlebiidae	na	-	*0.8	*0.8	-	-	-	-	-	-	-
	Hemiptera	Veliidae	*Microvelia*	-	-	-	-	-	-	-	-	1.8	-
	(True Bug)			-	-	-	-	-	-	-	-	-	-
	Isopoda	Asellidae	*Caecidotea*	-	-	-	-	-	0.8	-	-	-	-
	(Aquatic Sow Bug)			-	-	-	-	-		-	-	-	-
	Megaloptera	Corydalidae	*Nigronia*	-	-	-	-	-	0.8	-	-	-	0.9
	(Dobsonfly/Fishfly)			-	-	-	-	-	-	-	-	-	-
	Odonata	Aeshnidae	*Boyeria*	-	0.8	-	-	-	1.6	-	0.9	0.9	-
	(Dragonfly/	Calopterygidae	*Calopteryx*	-	-	-	-	-	1.6	-	-	-	0.9
	Damselfly)	Cordulegastridae	*Cordulegaster*	-	0.8	-	-	-	0.8	-	-	-	-
	Plecoptera	Capniidae	na	-	-	-	-	-	-	-	-	-	*0.9
	(Stonefly)	Chloroperlidae	na	*19.5	*5.8	*2.3	-	-	*3.3	*6.7	-	*2.7	*1.8
			Haploperla	-	-	-	19.8	-	-	3.8	0.9	3.5	-

PHYLUM	ORDER	FAMILY	GENUS	1995 RA	2000 RA	2001 RA	2002 RA	2003 RA	2004 RA	2005 RA	2006 RA	2007 RA	2008 RA
		Leuctridae	*Leuctra*	-	-	-	-	-	16.3	1.9	-	-	-
		Nemouridae	na	*1.1	-	-	-	*0.9	-	-	*3.4	-	*4.4
			Amphinemura	-	3.3	0.8	0.9	0.9	10.6	8.6	10.3	25.7	0.9
			Clioperla	1.1	-	-	-	-	-	-	-	-	-
			Prostoia	-	-	-	-	4.3	-	-	0.9	-	3.5
		Perlidae	na	-	-	-	-	-	*0.8	-	-	-	-
			Eccoptura	-	-	-	1.7	-	8.9	-	1.7	-	0.9
		Perlodidae	na	*1.1	*0.8	-	-	-	*0.8	-	*0.9	-	-
			Isoperla	-	-	-	-	-	-	1.9	1.7	-	0.9
	Trichoptera	Hydropsychidae	*Cheumatopsyche*	-	-	0.8	2.6	-	-	-	-	0.9	0.9
	(Caddisfly)		*Diplectrona*	3.4	-	1.5	-	0.9	5.7	-	1.7	0.9	0.9
			Hydropsyche	-	-	1.5	0.9	-	-	-	-	-	-
		Lepidostomatidae	*Lepidostoma*	-	-	-	-	-	8.1	1.9	0.9	-	-
		Leptoceridae	na	-	-	-	-	-	-	-	-	-	*0.9
		Limnephilidae	na	-	-	*0.8	-	*1.7	*0.8	-	-	*0.9	*6.1
			Ironoquia	-	-	-	-	-	-	-	0.9	-	-
			Pycnopsyche	1.1	-	-	-	-	-	1	-	-	-
		Odontoceridae	*Psilotreta*	1.1	-	-	-	-	-	-	0.9	-	-
		Philopotamidae	na	-	-	-	-	-	*1.6	-	-	-	*0.9
			Wormaldia	-	-	-	-	-	1.6	-	-	-	-
		Polycentropodidae	*Polycentropus*	-	-	-	-	-	-	-	-	-	1.8
		Psychomiidae	*Lype*	-	-	-	-	-	-	-	-	-	0.9
		Uenoidae	*Neophylax*	1.1	-	0.8	0.9	0.9	4.1	-	-	-	3.5
Mollusca	Veneroida	Pisidiidae	na	-	-	-	-	-	-	-	-	*0.9	-
	(Bivalve)		*Sphaerium*	-	-	0.8	-	-	-	-	-	*0.9	-

Green families are intolerant (family tolerance values from 0 to 3); blue are moderately tolerant (family tolerance values from 3.1 to 6.9); and red are tolerant (family tolerance values from 7 to 10).

* Taxa not identified to genus.

Appendix C
Sentinel Sites in the Eastern Piedmont Region

Baisman Run (LOCH-120-S)
Unnamed Tributary to Dipping Pond Run (JONE-109-S)
North Branch Jones Falls (JONE-315-S)
Unnamed Tributary to the Patuxent River (RKGR-119-S)
Unnamed Tributary to Principio Creek (FURN-101-S)
Timber Run (LIBE-102-S)

Baisman Run (LOCH-120-S)

Site LOCH-120-S is located on Baisman Run in the Eastern Piedmont region of Maryland. It is in the Loch Raven Reservoir watershed in Baltimore County. This site was sampled in 1996 and 2000 to 2009. Its watershed is primarily forested (56%), with 41% agriculture and 2% urban.


Baisman Run in spring 2009.

Water Chemistry

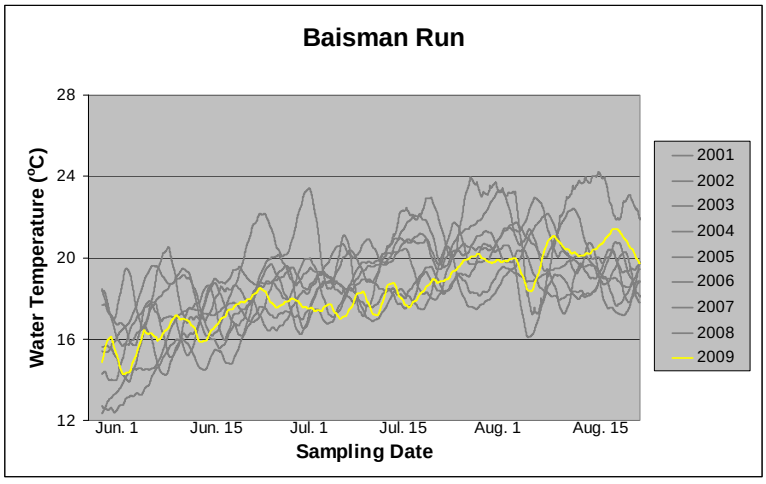
Summer water chemistry data collected at Baisman Run (1996 and 2000 to 2009).

Parameter	*1996*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
Field pH	7.1	7.2	6.7	7.3	7.2	6.9	6.7	7.2	7.5	7.1	7.0
Dissolved Oxygen (mg/L)	9.6	9.2	8.7	8.3	8.8	7.7	10.4	9.8	9.0	7.4	8.7
Conductivity (mS)	0.11	0.12	0.13	0.13	0.13	0.12	0.12	0.13	0.14	0.17	0.16
Turbidity (NTU)	Not measured	1.8	1.3	0.5	5.8	1.5	1.6	3.7	0.9	0.9	0.5

Physical Habitat

Physical habitat measurements collected at Baisman Run (1996 and 2000 to 2009). Scored parameters are on a 0 (worst) to 20 (best) scale.

Parameter	*1996*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
Instream habitat (0-20)	16	16	16	16	16	18	16	16	16	17	17
Epifaunal substrate (0-20)	12	16	17	17	17	18	15	17	18	16	18
Velocity/Depth Diversity (0-20)	10	8	10	9	10	10	13	10	11	9	12
Pool Quality (0-20)	10	9	10	9	10	10	13	10	11	10	14
Riffle Quality (0-20)	15	17	15	15	14	15	15	16	15	15	18
Shading (%)	95	95	95	98	95	95	94	90	90	90	90
Embeddedness (%)	40	20	20	35	35	25	35	40	25	40	40
Discharge (cfs)	0.83	1.29	0.80	0.37	5.91	1.15	2.16	0.86	0.96	0.75	1.49



The graph above displays the temperature logger data for Baisman Run for 2001 to 2009. Maximum recorded temperatures occurred during the drought in August 2002.

Biology

Fish

Cumulative list of fish species (with abundance) collected in Baisman Run by sampling year.

Species	*1996*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
Bluegill	-	-	-	-	-	-	-	-	-	1	-
Brook trout	31	19	31	17	2	5	4	33	11	10	10
Brown trout	-	1	-	-	1	1	-	2	-	-	-
Creek chub	9	41	80	95	13	34	41	50	22	94	87
Eastern blacknose dace	44	45	58	51	11	22	28	43	17	81	87
Longnose dace	-	20	20	20	1	3	5	5	3	9	4
Rosyside dace	-	8	14	25	10	5	6	21	-	58	42

Green indicates intolerant fish; blue are moderately tolerant; and red are tolerant.

Crayfish

Cumulative list of crayfish species (with abundance or presence {P}/absence {A} data) collected in the unnamed tributary to Baisman Run by sampling year.

Species	*2006*	*2007*	*2008*	*2009*
Virile crayfish (*Orconectes virilis*)	P	2	A	3
Common crayfish (*Cambarus bartonii bartonii*)	P	3	A	18

Mussels

Cumulative list of mussel species (with abundance or presence {P}/absence {A} data) collected in Baisman Run by sampling year.

Species
None Observed

Herpetofauna

Cumulative list of herpetofauna species collected in or near Baisman Run.

Order (Common)	*Species*
Anura (Frogs and Toads)	Eastern American toad, Northern green frog, Pickerel frog, Wood frog
Caudata (Salamanders and Newts)	Eastern red-backed salamander, Long-tailed salamander, Northern dusky salamander, Northern red salamander, Northern two-lined salamander, Spotted salamander
Squamata (Snakes and Lizards)	Eastern garter snake, Northern watersnake

Benthic Macroinvertebrates

Cumulative list of benthic macroinvertebrates collected in Baisman Run by sampling year,

RA = %Relative Abundance.

PHYLUM	*ORDER*	*FAMILY*	*GENUS*	*1996 RA*	*2000 RA*	*2001 RA*	*2002 RA*	*2003 RA*	*2004 RA*	*2005 RA*	*2006 RA*	*2007 RA*	*2008 RA*	*2009 RA*
Annelida	Haplotaxida	Enchytraeidae	na	-	-	-	-	*0.7	-	-	-	-	-	-
(Worm)		Naididae	na	-	*2.4	-	*1.8	-	-	-	-	-	*1	-
Arthropoda	Coleoptera	Dryopidae	*Helichus*	0.9	-	-	-	-	-	-	-	-	1	-
	(Beetle)	Elmidae	na	-	-	-	-	-	-	*1.6	-	*2	*1	*0.9
			Optioservus	2.8	3.2	3.2	3.6	-	-	4	-	-	1	0.9
			Oulimnius	0.9	0.8	-	4.5	-	-	5.6	-	1	-	0.9
			Promoresia	0.9	-	-	-	-	-	-	-	-	-	-
			Stenelmis	0.9	-	-	-	-	-	-	-	-	-	-
		Ptilodactylidae	*Anchytarsus*	-	-	-	-	-	-	-	-	-	-	6.4
	Diptera	Ceratopogonidae	*Bezzia*	-	-	-	-	-	-	-	-	-	1	-
	(True Fly)		*Ceratopogon*	-	-	0.8	-	-	-	0.8	-	1	-	-
			Probezzia	-	-	-	-	-	-	0.8	-	1	-	-
		Chironomidae	*Corynoneura*	0.9	0.8	0.8	-	1.4	0.8	-	-	2.9	-	1.8
			Diamesa	0.9	-	0.8	-	-	-	-	-	-	-	-
			Eukiefferiella	0.9	0.8	1.6	0.9	-	-	0.8	5.7	-	-	6.4
			Heterotrissocladius	-	-	0.8	-	-	-	-	-	-	-	-
			Micropsectra	-	-	-	0.9	-	-	-	-	5.9	-	0.9
			Orthocladiinae	*1.9	-	-	-	-	-	-	-	-	-	*0.9
			Orthocladius	-	-	-	-	0.7	-	-	-	1	-	-
			Parametriocnemus	-	-	-	1.8	0.7	1.6	2.4	0.8	2.9	2	0.9
			Paraphaenocladius	-	-	-	-	-	-	-	-	1	-	-
			Polypedilum	-	-	-	0.9	-	-	-	-	2	-	-
			Procladius	0.9	-	-	-	-	-	-	-	-	-	-

PHYLUM	ORDER	FAMILY	GENUS	1996 RA	2000 RA	2001 RA	2002 RA	2003 RA	2004 RA	2005 RA	2006 RA	2007 RA	2008 RA	2009 RA
			Rheosmittia	-	-	-	-	-	-	0.8	-	1	-	-
			Rheotanytarsus	1.9	-	-	-	-	-	-	-	-	-	-
			Stilocladius	-	-	-	-	-	-	-	-	-	-	0.9
			Symposiocladius	-	-	-	-	-	-	0.8	-	-	-	-
			Sympotthastia	-	-	3.2	-	1.4	-	0.8	-	-	-	0.9
			Tanypodinae	-	-	-	-	-	-	-	-	-	*1	-
			Tanytarsini	-	-	-	-	-	*0.8	-	-	-	-	-
			Tanytarsus	-	-	0.8	-	-	-	-	-	-	-	0.9
			Thienemanniella	-	-	-	-	-	-	-	-	-	-	0.9
			Tvetenia	-	-	0.8	0.9	5	-	0.8	0.8	2.9	2	-
		Dixidae	*Dixa*	-	-	-	-	-	-	-	0.8	-	-	-
		Empididae	na	-	-	-	-	-	-	*0.8	-	-	-	-
			Chelifera	-	-	0.8	-	-	-	-	-	-	-	0.9
			Clinocera	-	-	-	-	-	-	-	1.6	-	-	0.9
		Simuliidae	*Prosimulium*	12.3	18.5	13.6	6.3	62.4	40.5	5.6	34.1	37.3	43.1	32.7
			Simulium	-	-	-	1.8	-	0.8	-	-	-	-	-
			Stegopterna	-	-	0.8	-	2.1	-	-	-	-	1	-
		Tipulidae	*Antocha*	-	-	0.8	-	-	-	-	-	-	-	-
			Pseudolimnophila	-	-	-	-	-	-	0.8	-	-	-	-
			Tipula	0.9	0.8	1.6	-	0.7	0.8	-	-	4.9	1	2.7
	Ephemeroptera	Ameletidae	*Ameletus*	2.8	-	1.6	1.8	7.8	2.4	-	1.6	-	-	8.2
	(Mayfly)	Baetidae	*Acerpenna*	1.9	-	-	-	-	-	-	-	-	-	-
		Ephemerellidae	na	-	-	-	-	-	-	-	-	-	*11.8	*1.8
			Ephemerella	37.7	55.6	28	54.1	5	31.7	38.7	13.8	18.6	-	-
			Eurylophella	-	-	1.6	-	-	-	-	-	-	-	-
			Serratella	-	-	1.6	0.9	-	-	-	-	-	-	-
		Heptageniidae	na	-	-	-	*1.8	-	-	*1.6	*0.8	*1	*2	-
			Epeorus	-	8.1	13.6	0.9	-	-	4	17.9	1	8.8	4.5
			Maccaffertium	-	-	-	-	-	-	-	-	-	-	0.9
			Stenonema	0.9	0.8	1.6	-	-	1.6	-	-	2	-	-
		Leptophlebiidae	*Paraleptophlebia*	0.9	0.8	-	-	-	-	-	-	-	-	-
	Odonata	Aeshnidae	*Boyeria*	-	-	-	-	-	-	0.8	-	-	-	-
	(Dragonfly/	Cordulegastridae	*Cordulegaster*	-	-	-	-	-	-	-	-	-	1	-
	Damselfly)			-	-	-	-	-	-	-	-	-	-	-
	Plecoptera	na	na	-	-	-	*0.9	-	-	-	-	-	-	-
	(Stonefly)	Capniidae	na	-	-	*0.8	-	*5.7	-	-	*0.8	-	-	-
		Leuctridae	na	-	-	-	-	-	*1.6	*6.5	-	*1	*1	*0.9
		Nemouridae	na	-	-	*8	-	-	*3.2	-	*1.6	*1	-	-
			Amphinemura	14.2	-	-	1.8	-	0.8	3.2	-	-	-	-
			Prostoia	-	-	-	-	4.3	3.2	0.8	8.9	-	4.9	2.7
		Peltoperlidae	*Tallaperla*	1.9	0.8	-	-	-	-	-	-	-	-	-
		Perlidae	na	-	-	*5.6	-	-	-	-	*1.6	*1	*1	*0.9
			Acroneuria	1.9	0.8	1.6	0.9	-	-	0.8	2.4	1	3.9	2.7
		Perlodidae	na	-	*3.2	-	*1.8	-	*2.4	*1.6	-	-	-	*0.9
			Isoperla	3.8	-	-	3.6	-	-	0.8	-	-	-	-
		Pteronarcyidae	*Pteronarcys*	1.9	-	2.4	3.6	-	1.6	3.2	0.8	1	2	-
		Taeniopterygidae	*Oemopteryx*	-	-	0.8	-	-	-	-	0.8	-	-	-
			Strophopteryx	-	-	-	-	-	0.8	-	-	-	1	-
			Taeniopteryx	-	1.6	-	-	-	-	-	-	-	-	0.9
	Trichoptera	Glossosomatidae	na	-	-	-	*0.9	-	-	-	-	-	-	-
	(Caddisfly)		*Glossosoma*	-	-	-	0.9	-	-	0.8	-	-	-	0.9
		Hydropsychidae	*Cheumatopsyche*	-	-	-	1.8	-	-	0.8	0.8	1	2	3.6
			Diplectrona	0.9	-	-	-	-	-	4	1.6	2.9	1	4.5
			Hydropsyche	-	-	0.8	-	-	2.4	4	1.6	-	2	2.7
		Lepidostomatidae	*Lepidostoma*	-	-	-	-	0.7	3.2	-	-	-	-	-
		Limnephilidae	na	-	-	-	-	-	-	*0.8	-	-	-	-
			Pycnopsyche	-	-	1.6	-	-	-	-	-	-	-	-
		Philopotamidae	*Dolophilodes*	-	-	-	-	-	-	-	-	-	-	0.9
		Polycentropodidae	*Polycentropus*	-	-	-	-	0.7	-	-	-	-	-	-
		Rhyacophilidae	*Rhyacophila*	0.9	0.8	-	-	-	-	-	-	1	1	-
		Uenoidae	*Neophylax*	2.8	-	-	-	0.7	-	0.8	0.8	-	2	1.8
Platyhelminthes	Tricladida	Dugesiidae	*Cura*	-	-	-	0.9	-	-	-	-	-	-	-
	(Flatworm)			-	-	-	-	-	-	-	-	-	-	-

Green families are intolerant (family tolerance values from 0 to 3); blue are moderately tolerant (family tolerance values from 3.1 to 6.9); and red are tolerant (family tolerance values from 7 to 10).
* Taxa not identified to genus.

Unnamed Tributary to Dipping Pond Run (JONE-109-S)

Site JONE-109-S is located on an unnamed tributary to Dipping Pond Run in the Eastern Piedmont region of Maryland. It is in the Jones Falls watershed in Baltimore County. This site was sampled in 1995 and 2000 to 2009. Its watershed is primarily agricultural (58%), with 40% forest and 2% urban.


Unnamed tributary to Dipping Pond Run in spring 2009.

Water Chemistry

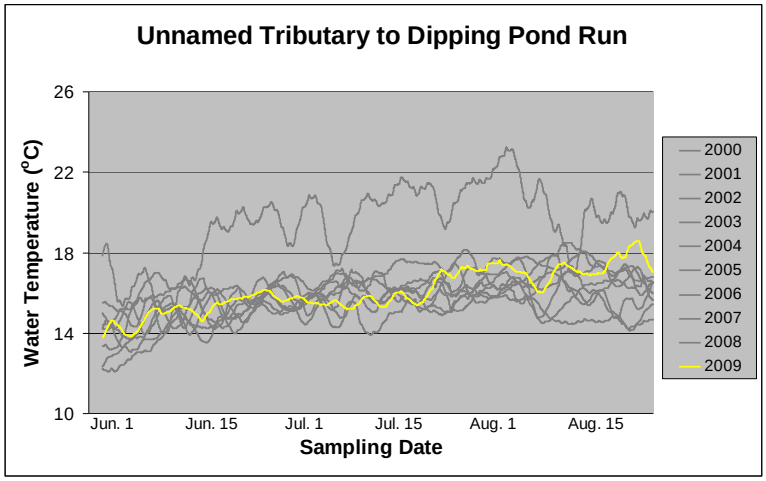
Summer water chemistry data collected at the unnamed tributary to Dipping Pond Run (1995 and 2000 to 2009).

Parameter	*1995*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
Field pH	7.5	6.2	6.9	7.8	6.5	6.2	6.33	6.83	6.33	6.31	6.04
Dissolved Oxygen (mg/L)	8.7	8.1	8.2	6.5	8.3	8.5	10.3	7.4	8.6	8	8.6
Conductivity (mS)	0.12	0.15	0.14	0.14	0.16	0.18	0.174	0.159	0.195	0.202	0.208
Turbidity (NTU)	Not measured	1.9	2	1.5	2.1	2.4	1.2	1.7	1.3	2.1	1.5

Physical Habitat

Physical habitat measurements collected at the unnamed tributary to Dipping Pond Run (1995 and 2000 to 2009). Scored parameters are on a 0 (worst) to 20 (best) scale.

Parameter	*1995*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
Instream habitat (0-20)	13	12	11	16	16	15	8	13	12	13	15
Epifaunal substrate (0-20)	13	11	13	16	18	17	9	13	12	12	15
Velocity/Depth Diversity (0-20)	7	8	7	11	11	9	7	7	9	7	8
Pool Quality (0-20)	8	6	7	11	11	8	6	6	8	6	10
Riffle Quality (0-20)	10	9	11	10	14	11	11	12	8	9	9
Shading (%)	95	90	95	95	97	95	90	95	90	95	85
Embeddedness (%)	25	25	40	35	15	23	40	40	30	40	50
Discharge (cfs)	0.07	0.12	0.08	0.06	0.26	0.10	0.16	0.13	0.04	0.08	0.10



The above graph displays the temperature logger data for the unnamed tributary to Dipping Pond Run for 2000 to 2009. Maximum recorded temperatures occurred during August 2001. No data were available for 2006.

Biology

Fish

Cumulative list of fish species (with abundance) collected in the unnamed tributary to Dipping Pond Run by sampling year.

Species	*1995*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
Brook trout	9	-	-	-	-	-	-	-	-	-	-
Brown trout	9	-	-	-	-	2	-	2	1	-	1
Eastern blacknose dace	53	41	93	49	28	52	64	42	60	59	78

Green indicates intolerant fish; blue are moderately tolerant; and red are tolerant.

Crayfish

Cumulative list of crayfish species (with abundance or presence {P}/absence {A} data) collected in the unnamed tributary to Dipping Pond Run by sampling year.

Species	*2006*	*2007*	*2008*	*2009*
Common crayfish (*Cambarus bartonii bartonii*)	P	P	A	A
Virile Crayfish (*Orconectes virilis*)	A	A	A	1

Mussels

Cumulative list of mussel species (with abundance or presence {P}/absence {A} data) collected in Dipping Pond Run by sampling year.

Species
None Observed

Herpetofauna

Cumulative list of herpetofauna species collected in or near the unnamed tributary to Dipping Pond Run.

Order (Common)	*Species*
Anura (Frogs and Toads)	American bullfrog, Eastern American toad, Gray tree frog, Northern green frog, Pickerel frog, Wood frog
Caudata (Salamanders and Newts)	Eastern red-backed salamander, Northern dusky salamander, Northern red salamander, Northern two-lined salamander
Squamata (Snakes and Lizards)	Northern watersnake
Testudines (Turtles)	Eastern box turtle

Benthic Macroinvertebrates

Cumulative list of benthic macroinvertebrates collected in the unnamed tributary to Dipping Pond Run by sampling year, RA = %Relative Abundance.

PHYLUM	*ORDER*	*FAMILY*	*GENUS*	*1995 RA*	*2000 RA*	*2001 RA*	*2002 RA*	*2003 RA*	*2004 RA*	*2005 RA*	*2006 RA*	*2007 RA*	*2008 RA*	*2009 RA*
Annelida	Haplotaxida	Enchytraeidae	na	-	-	-	-	*0.8	-	-	-	-	-	-
(Worm)		Naididae	na	-	*5.9	*5.5	*20.1	-	-	-	*5.3	*1.8	*1.7	*1.5
	Lumbriculida	Lumbriculidae	na	-	-	-	-	-	*1	-	-	-	-	-
Arthropoda	Coleoptera	Elmidae	na	-	-	*3.9	-	-	-	*1.7	*1.5	-	-	-
	(Beetle)		*Oulimnius*	5.5	1.7	2.4	-	-	-	2.6	7.5	0.9	-	-
		Hydrophilidae	*Tropisternus*	-	-	-	0.7	-	-	-	-	-	-	-
		Psephenidae	*Ectopria*	-	-	-	-	-	-	-	0.8	-	-	-
		Ptilodactylidae	*Anchytarsus*	-	-	-	0.7	-	-	-	-	-	1.7	-
	Collembola	na	na	-	*0.8	-	-	-	-	-	-	-	-	-
	(Springtail)	Isotomidae	*Isotomurus*	-	-	-	0.8	-	-	-	0.8	0.9	-	-
	Diptera	Ceratopogonidae	na	-	-	*1.6	-	-	-	-	-	-	-	-
	(True Fly)		*Ceratopogon*	-	-	-	-	4.1	-	0.9	1.5	-	-	0.7
		Chironomidae	*Brillia*	-	-	-	-	-	1	-	-	0.9	-	-
			Chaetocladius	-	-	-	-	-	-	-	0.8	-	-	2.2
			Corynoneura	-	-	-	1.5	0.8	1	-	-	3.5	1.7	7.4
			Diamesa	-	-	0.8	-	-	-	-	-	1.8	-	-
			Eukiefferiella	0.8	1.7	-	-	8.2	2	-	9.8	6.1	-	5.1
			Heleniella	-	-	-	-	2.5	-	-	-	-	-	-
			Micropsectra	-	-	3.1	-	-	2.9	0.9	-	-	-	-
			Orthocladiinae	-	*9.2	*1.6	-	-	-	-	-	-	*0.8	*0.7
			Orthocladius	-	-	-	-	-	-	-	-	0.9	0.8	2.2
			Paracladopelma	-	-	-	-	-	-	-	0.8	-	-	-
			Parametriocnemus	-	-	3.1	1.5	2.5	6.9	4.3	6.8	9.6	6.8	9.6

PHYLUM	ORDER	FAMILY	GENUS	1995 RA	2000 RA	2001 RA	2002 RA	2003 RA	2004 RA	2005 RA	2006 RA	2007 RA	2008 RA	2009 RA
			Paraphaenocladius	-	-	-	-	-	-	-	-	-	0.8	-
			Phaenopsectra	-	-	-	-	-	-	-	-	-	0.8	-
			Polypedilum	-	1.7	1.6	-	-	2	-	0.8	4.4	-	2.2
			Pseudorthocladius	-	-	-	-	-	-	-	1.5	-	-	-
			Stempellinella	-	-	-	-	-	-	-	-	2.6	-	0.7
			Sympotthastia	-	-	-	-	9.8	-	-	-	0.9	11	1.5
			Tanypodinae	-	-	-	-	-	*2	*0.9	-	-	*2.5	-
			Tanytarsini	-	-	-	-	-	-	-	-	-	*0.8	-
			Tanytarsus	-	-	-	-	-	-	-	-	1.8	-	
			Thienemanniella	-	-	-	-	-	1	-	0.8	-	-	0.7
			Thienemannimyia Group	-	-	-	-	-	*1	-	-	-	*0.8	*0.7
			Trissopelopia	-	-	1.6	0.7	-	5.9	-	1.5	-	-	-
			Tvetenia	-	-	2.4	-	0.8	5.9	-	-	0.9	1.7	2.2
			Zavrelimyia	-	-	-	-	-	-	-	0.8	-	-	-
		Dixidae	*Dixa*	-	-	-	-	-	-	-	-	-	-	2.2
		Empididae	na	-	-	-	-	-	-	-	-	-	*1.7	-
			Chelifera	3.1	-	0.8	0.7	-	1	-	-	-	-	-
			Clinocera	-	-	-	-	-	1	-	-	-	-	-
		Simuliidae	*Prosimulium*	-	-	-	-	3.3	2.9	-	8.3	0.9	1.7	0.7
			Simulium	-	-	-	-	-	1	-	-	0.9	-	2.9
			Stegopterna	1.6	-	-	-	0.8	-	-	-	0.9	1.7	-
		Tabanidae	*Chrysops*	-	-	-	-	0.8	-	-	-	-	-	0.7
		Tipulidae	na	-	-	-	-	-	-	-	*0.8	-	-	-
			Antocha	-	-	0.8	0.7	-	3.9	-	-	0.9	-	-
			Dicranota	-	-	-	-	0.8	1	-	-	-	-	-
			Hexatoma	-	-	-	-	1.6	-	1.7	-	-	-	-
			Pseudolimnophila	-	0.8	-	1.5	-	-	0.9	2.3	-	1.7	-
			Tipula	-	0.8	-	-	0.8	2.9	0.9	3.8	3.5	-	1.5
	Ephemeroptera (Mayfly)	Ameletidae	*Ameletus*	0.8	5	-	-	-	1	1.7	-	-	-	0.7
		Baetidae	na	-	*0.8	-	*1.5	*0.8	-	-	*0.8	-	-	*0.7
			Acerpenna	20.5	-	-	-	-	-	-	-	-	-	-
			Baetis	-	-	1.6	-	-	5.9	-	-	-	-	-
		Ephemerellidae	na	-	-	-	-	-	-	-	*2.3	-	-	-
			Ephemerella	36.2	23.5	27.6	18.7	16.4	-	11.1	1.5	4.4	17.8	0.7
			Eurylophella	-	0.8	-	-	0.8	-	-	-	-	2.5	0.7
		Heptageniidae	na	-	-	*0.8	-	-	-	-	-	*0.9	-	-
			Epeorus	0.8	-	-	-	-	-	-	-	-	-	-
			Maccaffertium	-	-	-	-	-	-	-	-	-	4.2	-
			Stenonema	-	0.8	2.4	0.7	6.6	2.9	8.5	9.8	0.9	-	-
		Leptophlebiidae	*Paraleptophlebia*	0.8	1.7	-	-	-	-	0.9	-	-	-	-
	Megaloptera (Dobsonfly/ Fishfly)	Corydalidae	*Nigronia*	0.8	0.8	0.8	-	0.8	-	-	1.5	2.6	-	-
		Sialidae	*Sialis*	-	-	-	-	0.8	-	0.9	-	-	-	-
				-	-	-	-	-	-	-	-	-	-	-
	Odonata (Dragonfly/Damselfly)	Cordulegastridae	*Cordulegaster*	-	-	-	0.7	0.8	-	-	-	1.8	-	-
				-	-	-	-	-	-	-	-	-	-	-
		Gomphidae	na	-	-	-	-	-	-	-	-	-	-	*0.7
	Plecoptera (Stonefly)	na	na	-	-	-	*0.7	-	-	-	-	-	-	-
		Chloroperlidae	na	-	-	-	-	-	*1	-	-	-	-	-
			Alloperla	-	-	-	0.7	-	-	-	-	-	-	-
		Leuctridae	na	-	*5	*3.1	*6.7	-	*2	*8.5	-	*1.8	*6.8	*16.2
			Leuctra	12.6	-	-	3	3.3	1	-	-	-	-	-
		Nemouridae	*Amphinemura*	7.1	22.7	17.3	11.9	1.6	5.9	17.9	8.3	15.8	12.7	27.9
			Prostoia	-	-	-	-	-	-	1.7	6.8	1.8	0.8	-
			Soyedina	-	-	-	-	-	-	-	0.8	-	-	-
		Peltoperlidae	*Peltoperla*	-	-	-	0.7	-	-	-	-	-	-	-
			Tallaperla	-	0.8	-	-	0.8	-	-	-	-	-	-
		Perlidae	na	-	-	-	-	*1.6	*2	-	-	-	-	-
			Eccoptura	0.8	-	-	-	1.6	1	0.9	-	0.9	0.8	-
		Perlodidae	na	-	*5.9	*3.1	*6	*2.5	*4.9	*3.4	-	-	-	-
			Diploperla	-	2.5	-	-	-	-	-	-	-	-	-
			Isoperla	3.9	-	-	-	-	2	-	-	0.9	-	-
	Trichoptera (Caddisfly)	Glossosomatidae	*Glossosoma*	-	-	-	0.7	-	1	-	-	-	-	-
		Hydropsychidae	*Cheumatopsyche*	-	-	-	-	0.8	1	5.1	0.8	2.6	0.8	0.7
			Diplectrona	0.8	5	9.4	7.5	16.4	14.7	23.9	12	21.9	12.7	5.1
			Hydropsyche	-	-	-	-	-	-	0.9	-	-	-	-
		Limnephilidae	*Pycnopsyche*	-	-	1.6	-	-	2.9	-	-	-	-	0.7
		Philopotamidae	na	-	-	*0.8	-	-	-	-	-	-	-	-
			Dolophiloides	-	0.8	-	-	-	-	-	-	-	-	-
			Wormaldia	-	-	-	6	-	-	-	-	-	-	-
		Rhyacophilidae	*Rhyacophila*	2.4	-	0.8	1.5	1.6	-	-	-	-	-	-
		Uenoidae	*Neophylax*	-	0.8	1.6	3.7	3.3	3.9	-	-	-	0.8	-
Mollusca	Veneroida (Bivalve)	Pisidiidae	*Pisidium*	0.8	-	-	-	-	-	-	-	-	-	-
				-	-	-	-	-	-	-	-	-	-	-

PHYLUM	*ORDER*	*FAMILY*	*GENUS*	*1995 RA*	*2000 RA*	*2001 RA*	*2002 RA*	*2003 RA*	*2004 RA*	*2005 RA*	*2006 RA*	*2007 RA*	*2008 RA*	*2009 RA*
Platyhelminthes	Tricladida	Dugesiidae	na	-	-	-	-	-	-	-	-	-	*0.8	-
	(Flatworm)	Planariidae	na	-	-	-	-	*1.6	*1	-	-	-	-	-

Green families are intolerant (family tolerance values from 0 to 3); blue are moderately tolerant (family tolerance values from 3.1 to 6.9); and red are tolerant (family tolerance values from 7 to 10).

* Taxa not identified to genus.

North Branch of Jones Falls (JONE-315-S)

Site JONE-315-S is located on the North Branch of Jones Falls in the Eastern Piedmont region of Maryland. It is in the Jones Falls watershed in Baltimore County. This site was sampled in 1996 and 2000 to 2009. Its watershed is primarily forested (54%), with 40% agriculture, 5% urban, and 1% barren.


North Branch of Jones Falls in spring 2009.

Water Chemistry

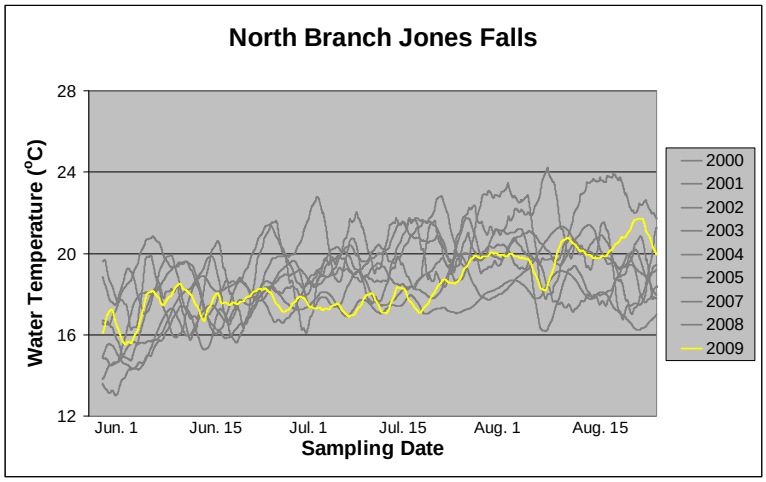
Summer water chemistry data collected at the North Branch of Jones Falls (1996 and 2000 to 2009).

Parameter	*1996*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
Field pH	7.4	7.6	7.4	7.8	7.5	7.7	7.6	7.6	7.7	7.6	7.7
Dissolved Oxygen (mg/L)	8.3	10.1	8.6	8.7	8.8	7.8	8.0	9.6	9.0	8.7	8.9
Conductivity (mS)	0.18	0.22	0.23	0.26	0.22	0.23	0.25	0.22	0.27	0.28	0.28
Turbidity (NTU)	Not measured	3.6	4.5	1.2	3.8	2.6	1.8	2.3	1.5	2.8	2.2

Physical Habitat

Physical habitat measurements collected at the North Branch of Jones Falls (1996 and 2000 to 2009). Scored parameters are on a 0 (worst) to 20 (best) scale.

Parameter	*1996*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
Instream habitat (0-20)	19	17	17	19	19	18	17	18	17	17	17
Epifaunal substrate (0-20)	18	17	18	19	18	16	17	17	16	14	17
Velocity/Depth Diversity (0-20)	18	15	15	15	17	16	15	16	14	13	13
Pool Quality (0-20)	17	16	16	19	17	17	17	17	16	17	15
Riffle Quality (0-20)	16	17	17	17	17	17	16	16	13	13	17
Shading (%)	87	95	83	96	98	80	90	90	85	80	80
Embeddedness (%)	20	15	20	16	20	15	30	35	20	25	20
Discharge (cfs)	6.85	2.77	3.05	0.59	8.44	4.73	1.25	2.62	0.99	2.59	3.06



The graph above displays the temperature logger data for the North Branch of Jones Falls for 2000 to 2009. Maximum recorded temperatures occurred during the drought in August 2007. No data were available for 2006.

Biology

Fish

Cumulative list of fish species (with abundance) collected in the North Branch of Jones Falls by sampling year.

Species	*1996*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
Bluegill	2	-	5	4	6	4	77	43	8	34	13
Brown trout	45	94	111	81	24	57	131	134	86	55	48
Creek chub	20	26	23	9	13	32	21	5	12	29	29
Cutlips minnow	8	13	7	6	11	27	18	7	10	1	27
Eastern blacknose dace	41	162	105	35	39	101	57	39	69	87	73
Green sunfish	3	16	9	2	8	108	162	63	58	26	6
Largemouth bass	-	-	7	4	-	1	4	-	3	2	6
Lepomis hybrid	-	-	-	-	-	-	-	4	-	-	-
Longnose dace	23	128	109	62	34	81	52	17	57	36	31
Pumpkinseed	-	-	-	-	-	-	-	4	5	-	-
Redbreast Sunfish	-	-	-	-	-	-	-	-	-	-	1
Rock bass	-	5	-	1	-	-	1	-	-	-	-
Rosyside dace	11	15	11	9	10	4	5	-	1	-	1
Smallmouth bass	1	-	-	-	-	-	-	-	-	-	-
Sunfish (unknown)	-	-	-	-	-	-	2	-	-	-	-
Tessellated darter	2	20	17	7	13	12	8	6	7	19	32
White sucker	30	49	29	33	23	39	30	37	50	14	46

Green indicates intolerant fish; blue are moderately tolerant; and red are tolerant.

Crayfish

Cumulative list of crayfish species (with abundance or presence {P}/absence {A} data) collected in the unnamed tributary to North Branch of Jones Falls by sampling year.

Species	*2006*	*2007*	*2008*	*2009*
Virile crayfish (*Orconectes virilis*)	P	61	A	74
Common crayfish (*Cambarus bartonii bartonii*)	P	5	A	4

Mussels

Cumulative list of mussel species (with abundance or presence {P}/absence {A} data) collected in the North Branch of Jones Falls by sampling year.

Species
None Observed

Herpetofauna

Cumulative list of herpetofauna species collected in or near the North Branch of Jones Falls.

Order (Common)	*Species*
Anura (Frogs and Toads)	American bullfrog, Eastern American toad, Northern green frog, Pickerel frog, Wood frog
Caudata (Salamanders and Newts)	Eastern red-backed salamander, Long-tailed salamander, Northern dusky salamander, Northern two-lined salamander,
Squamata (Snakes and Lizards)	Northern watersnake, Northern ring-necked snake
Testudines (Turtles)	Eastern box turtle

Benthic Macroinvertebrates

Cumulative list of benthic macroinvertebrates collected in the North Branch of Jones Falls by sampling year, RA = %Relative Abundance.

PHYLUM	*ORDER*	*FAMILY*	*GENUS*	*1996 RA*	*2000 RA*	*2001 RA*	*2002 RA*	*2003 RA*	*2004 RA*	*2005 RA*	*2006 RA*	*2007 RA*	*2008 RA*	*2009 RA*
Annelida	Haplotaxida	Naididae	na	-	-	-	-	*0.9	-	-	-	-	*0.9	-
(Worm)	Lumbriculida	Lumbriculidae	na	*1.1	-	-	-	-	*0.9	-	-	-	-	-
	Tubificida	Tubificidae	na	-	-	*1.8	-	-	-	-	-	-	-	-
			Limnodrilus	-	-	-	-	-	-	0.9	-	-	-	-
Arthropoda	Amphipoda	Crangonyctidae	na	-	-	-	-	-	-	-	-	-	-	*0.9
	(Scud)		*Crangonyx*	-	-	-	-	-	-	0.9	-	-	-	-
	Coleoptera	Elmidae	na	-	-	-	-	-	-	*0.9	-	-	-	-
	(Beetle)		*Dubiraphia*	-	-	-	-	-	-	-	-	-	-	0.9
			Optioservus	6.3	-	-	0.8	0.9	-	0.9	3.1	-	-	0.9

PHYLUM	ORDER	FAMILY	GENUS	1996 RA	2000 RA	2001 RA	2002 RA	2003 RA	2004 RA	2005 RA	2006 RA	2007 RA	2008 RA	2009 RA
			Oulimnius	-	-	0.9	0.8	-	-	5.5	3.9	2.9	0.9	-
			Promoresia	-	-	-	-	0.9	-	-	1.6	-	-	-
			Stenelmis	-	-	-	-	-	-	-	-	1	-	-
		Psephenidae	*Ectopria*	-	-	-	-	-	-	1.8	-	-	-	-
			Psephenus	-	-	-	0.8	-	-	-	0.8	1.9	-	-
	Diptera	Chironomidae	*Brillia*	-	-	-	-	-	-	-	-	1	-	-
	(True Fly)		*Conchapelopia*	1.1	0.8	-	-	-	-	-	-	-	-	-
			Corynoneura	-	-	-	-	1.7	-	-	-	-	0.9	-
			Diamesa	-	-	0.9	-	-	-	-	-	3.8	0.9	2.8
			Eukiefferiella	1.1	1.6	1.8	0.8	-	-	-	0.8	-	0.9	-
			Hydrobaenus	-	-	-	-	-	-	-	-	-	-	3.7
			Nanocladius	1.1	-	-	-	-	-	-	-	-	-	0.9
			Micropsectra	-	-	-	-	-	-	-	-	1	0.9	-
			Orthocladiinae	*2.1	*9.7	*9.8	-	-	-	*2.8	*0.8	-	*0.9	*5.6
			Orthocladius	1.1	-	-	-	9.5	1.8	1.8	14.1	16.3	6.2	38.9
			Parametriocnemus	2.1	1.6	1.8	0.8	-	2.6	2.8	1.6	6.7	6.2	4.6
			Phaenopsectra	-	-	-	-	-	-	-	-	-	0.9	-
			Polypedilum	-	-	-	-	-	-	1.8	-	1.9	1.8	0.9
			Pseudorthocladius	-	-	-	-	0.9	-	-	-	-	-	-
			Rheocricotopus	-	-	-	-	-	-	0.9	-	-	-	-
			Rheosmittia	-	-	-	-	-	1.8	-	-	-	-	-
			Rheotanytarsus	-	-	-	-	-	-	-	-	-	2.7	-
			Stempellinella	-	-	-	-	-	-	-	-	-	0.9	-
			Sympotthastia	-	1.6	-	-	5.2	-	-	0.8	1.9	2.7	-
			Thienemanniella	-	0.8	-	-	-	-	-	-	-	1.8	0.9
			Thienemannimyia Group	-	-	-	-	-	*1.8	-	-	*1	*0.9	-
			Tvetenia	-	-	-	-	-	4.4	-	1.6	1	0.9	0.9
			Zavrelimyia	1.1	-	-	-	-	-	-	-	-	-	-
		Empididae	na	-	-	-	-	-	-	-	-	-	*1.8	-
			Clinocera	-	1.6	-	-	-	-	3.7	1.6	5.8	-	8.3
			Hemerodromia	1.1	-	-	-	-	-	-	-	-	-	-
		Simuliidae	*Prosimulium*	24.2	12.2	33	26.3	61.2	10.5	3.7	29.7	8.7	3.5	0.9
			Simulium	-	0.8	-	0.8	-	-	-	-	-	-	0.9
			Stegopterna	-	-	-	-	-	1.8	-	-	1	-	-
		Tipulidae	*Antocha*	-	-	-	-	-	-	3.7	0.8	1	-	-
			Dicranota	-	-	-	-	-	2.6	-	0.8	1.9	2.7	-
			Pseudolimnophila	1.1	-	-	-	-	-	-	-	-	-	-
			Tipula	-	0.8	-	-	-	3.5	1.8	-	3.8	-	0.9
	Ephemeroptera	Ameletidae	*Ameletus*	-	3.3	-	-	-	-	-	-	-	-	-
	(Mayfly)	Baetidae	na	-	*0.8	*0.9	*0.8	-	-	*1.8	-	-	-	-
			Acentrella	-	-	-	-	-	-	0.9	-	-	-	-
			Baetis	5.3	-	-	-	-	21.9	5.5	-	-	-	-
		Ephemerellidae	*Drunella*	-	0.8	-	2.5	-	-	0.9	1.6	-	-	-
			Ephemerella	16.8	39	34.8	44.9	6.9	16.7	34.9	18.8	4.8	2.7	-
			Eurylophella	1.1	0.8	-	-	-	-	-	-	-	-	-
			Serratella	-	-	-	-	0.9	-	-	-	-	-	-
		Heptageniidae	na	-	-	-	-	*0.9	-	*0.9	-	-	*0.9	-
			Epeorus	4.2	-	-	0.8	-	-	-	-	-	-	-
			Leucrocuta	-	-	-	-	-	-	-	-	1	-	-
			Maccaffertium	-	-	-	-	-	-	-	-	-	-	3.7
			Stenonema	2.1	1.6	1.8	2.5	0.9	-	4.6	-	-	-	-
		Isonychiidae	*Isonychia*	5.3	0.8	-	-	0.9	-	0.9	-	-	-	-
	Megaloptera	Corydalidae	*Chauliodes*	-	-	-	-	-	-	-	0.8	-	-	-
	(Dobsonfly/Fishfly)		*Nigronia*	-	-	-	3.4	0.9	0.9	0.9	-	1	-	-
	Odonata	Aeshnidae	*Boyeria*	-	-	-	-	-	-	-	-	-	-	0.9
	(Dragonfly)	Gomphidae	*Lanthus*	-	-	-	-	0.9	-	-	-	-	-	-
	Plecoptera	Capniidae	*Allocapnia*	-	-	0.9	-	0.9	-	-	-	-	-	-
	(Stonefly)	Leuctridae	na	-	*1.6	*1.8	-	-	-	*0.9	-	-	-	-
		Nemouridae	na	-	-	-	-	-	-	-	*2.3	-	*0.9	-
			Amphinemura	-	2.4	-	-	-	-	4.6	-	1	-	-
			Prostoia	15.8	-	4.5	-	1.7	4.4	-	1.6	-	0.9	0.9
		Perlidae	na	*2.1	-	-	-	-	-	-	*0.8	*1	-	-
			Acroneuria	-	1.6	-	-	-	-	-	-	-	0.9	1.9
		Perlodidae	na	*1.1	*4.9	*1.8	*0.8	-	-	*0.9	-	-	-	-
		Taeniopterygidae	*Oemopteryx*	-	-	0.9	-	-	-	-	0.8	-	-	-
			Strophopteryx	-	-	2.7	-	0.9	5.3	-	-	-	-	-
	Trichoptera	Hydropsychidae	*Cheumatopsyche*	-	2.4	-	5.1	-	2.6	2.8	2.3	3.8	16.8	7.4
	(Caddisfly)		*Diplectrona*	-	6.5	-	1.7	1.7	1.8	0.9	0.8	-	1.8	2.8
			Hydropsyche	1.1	-	-	2.5	0.9	3.5	-	3.9	14.4	8	7.4
		Limnephilidae	*Pycnopsyche*	-	-	-	-	-	-	0.9	-	-	-	-
		Philopotamidae	na	-	*0.8	-	-	-	-	-	-	-	-	-
			Chimarra	-	-	-	-	-	3.5	0.9	3.9	8.7	25.7	1.9
			Dolophilodes	-	-	-	0.8	0.9	0.9	-	-	1	-	-

PHYLUM	*ORDER*	*FAMILY*	*GENUS*	*1996 RA*	*2000 RA*	*2001 RA*	*2002 RA*	*2003 RA*	*2004 RA*	*2005 RA*	*2006 RA*	*2007 RA*	*2008 RA*	*2009 RA*
		Psychomyiidae	*Lype*	-	-	-	-	-	-	-	-	1	-	-
			Psychomyia	-	-	-	0.8	-	-	-	-	-	-	-
		Rhyacophilidae	*Rhyacophila*	2.1	0.8	-	1.7	-	6.1	2.8	-	-	0.9	-
		Uenoidae	*Neophylax*	-	-	-	-	-	0.9	-	0.8	-	-	-
Platyhelminthes	Tricladida (Flatworm)	Dugesiidae	na	-	-	-	-	-	-	-	-	-	*1.8	-
				-	-	-	-	-	-	-	-	-	-	-

Green families are intolerant (family tolerance values from 0 to 3); blue are moderately tolerant (family tolerance values from 3.1 to 6.9); and red are tolerant (family tolerance values from 7 to 10).

* Taxa not identified to genus.

Unnamed Tributary to the Patuxent River (RKGR-119-S)

Site RKGR-119-S is located on an unnamed tributary to the Patuxent River in the Eastern Piedmont region of Maryland. It is in the Rocky Gorge Dam watershed in Howard County. This site was sampled in 1997 and 2000 to 2009. Its watershed is primarily agricultural (58%), with 35% forest, 5% urban, and 2% barren.


Unnamed tributary to the Patuxent River in spring 2009.

Water Chemistry

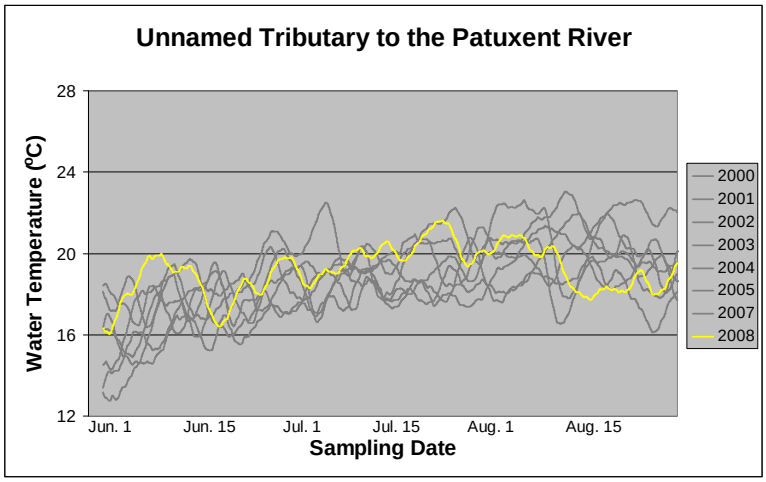
Summer water chemistry data collected at the unnamed tributary to the Patuxent River (1997 and 2000 to 2009).

Parameter	*1997*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
Field pH	7.6	7.6	7.2	7.3	7.3	8.3	7.3	7.6	7.6	7.5	7.6
Dissolved Oxygen (mg/L)	9.6	8.2	8.2	7	7.9	8	6.9	8.9	8.8	7.1	8.3
Conductivity (mS)	0.16	0.17	0.17	0.21	0.18	0.19	0.21	0.10	0.21	0.22	0.24
Turbidity (NTU)	Not measured	7.0	2.7	2.6	2.3	1.4	2.9	2.2	0.7	7.2	0.5

Physical Habitat

Physical habitat measurements collected at the unnamed tributary to the Patuxent River (1997 and 2000 to 2009). Scored parameters are on a 0 (worst) to 20 (best) scale.

Parameter	*1997*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
Instream habitat (0-20)	14	16	16	16	18	18	16	15	17	15	13
Epifaunal substrate (0-20)	16	17	17	16	18	19	13	16	17	16	15
Velocity/Depth Diversity (0-20)	14	14	14	13	14	14	14	12	14	11	13
Pool Quality (0-20)	12	12	11	13	14	14	15	14	13	13	13
Riffle Quality (0-20)	14	16	14	12	16	14	15	16	15	14	12
Shading (%)	90	90	95	95	93	95	96	95	95	90	90
Embeddedness (%)	30	35	25	18	10	15	35	35	35	20	20
Discharge (cfs)	0.62	1.35	0.97	0.17	1.58	0.85	0.54	0.62	0.23	0.43	0.65



The graph above displays the temperature logger data for the unnamed tributary to the Patuxent River for 2000 to 2009. Maximum recorded temperatures occurred during the drought in August 2007. No data were available in 2006 and 2009.

Biology

Fish

Cumulative list of fish species (with abundance) collected in the unnamed tributary to the Patuxent River by sampling year.

Species	*1997*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
Blue Ridge sculpin	25	111	283	233	87	121	192	154	67	92	140
Bluegill	1	9	10	-	5	-	1	2	-	2	4
Brown bullhead	-	-	1	-	-	-	-	-	-	-	-
Central stoneroller	-	-	-	-	-	1	-	-	-	-	-
Creek chub	1	16	5	56	9	-	18	-	-	9	7
Eastern blacknose dace	17	82	56	178	160	111	28	16	42	99	53
Fallfish	1	7	1	1	1	-	8	3	1	1	-
Green sunfish	-	-	-	-	2	-	-	-	-	2	8
Largemouth bass	-	1	-	-	1	-	2	-	-	17	5
Longnose dace	24	11	9	9	3	6	2	7	5	9	2
Rosyside dace	4	16	5	28	40	25	12	8	14	11	11
Tessellated darter	1	3	2	-	-	-	8	2	2	4	2
White sucker	2	2	2	1	2	-	1	1	-	3	-
Yellow bullhead	2	-	-	-	-	2	-	-	3	-	1

Green indicates intolerant fish; blue are moderately tolerant; and red are tolerant.

Crayfish

Cumulative list of crayfish species (with abundance or presence {P}/absence {A} data) collected in the unnamed tributary to the Patuxent River by sampling year

Species	*2006*	*2007*	*2008*	*2009*
Virile crayfish (*Orconectes virilis*)	P	3	A	11
Common crayfish (*Cambarus bartonii bartonii*)	P	4	A	6

Mussels

Cumulative list of mussel species (with abundance or presence {P}/absence {A} data) collected in the unnamed tributary to the Patuxent River by sampling year.

Species
None Observed

Herpetofauna

Cumulative list of herpetofauna collected in or near the unnamed tributary to the Patuxent River.

Order (Common)	*Species*
Anura (Frogs and Toads)	American bullfrog, Eastern American toad, Gray tree frog, Northern green frog, Pickerel frog, Southern leopard frog, Wood frog
Caudata (Salamanders and Newts)	Northern red salamander, Northern two-lined salamander, Spotted salamander
Testudines (Turtles)	Eastern box turtle

Benthic Macroinvertebrates

Cumulative list of benthic macroinvertebrates collected in the unnamed tributary to the Patuxent River by sampling year, RA = %Relative Abundance.

PHYLUM	*ORDER*	*FAMILY*	*GENUS*	*1997 RA*	*2000 RA*	*2001 RA*	*2002 RA*	*2003 RA*	*2004 RA*	*2005 RA*	*2006 RA*	*2007 RA*	*2008 RA*	*2009 RA*
Annelida (worm)	Haplotaxida	Naididae	na	-	-	-	*1	*2.4	-	-	-	-	-	*0.9
Arthropoda	Coleoptera	Dryopidae	*Helichus*	-	-	0.7	-	-	-	-	-	-	-	-
	(Beetle)	Elmidae	na	-	-	-	-	-	-	-	-	-	*1.6	-
			Ancyronyx	-	-	-	-	-	-	-	1.6	-	-	-
			Dubiraphia	1.1	-	-	-	-	-	-	-	-	-	-
			Oulimnius	-	-	-	-	-	-	1.9	2.4	1.8	1.6	-
			Stenelmis	-	-	-	-	0.8	-	-	-	-	-	-
		Ptilodactylidae	*Anchytarsus*	-	-	0.7	-	-	1.1	-	-	-	-	-
	Diptera	Ceratopogonidae	*Probezzia*	-	-	-	1	-	-	-	-	-	-	-
	(True Fly)	Chironomidae	*Brillia*	-	-	-	-	0.8	-	-	-	-	-	-
			Chaetocladius	-	-	-	1	-	-	-	-	-	-	-
			Conchapelopia	-	0.9	1.4	7.6	-	-	1	-	-	-	-
			Corynoneura	-	-	0.7	-	-	-	-	-	-	-	-
			Diamesa	-	-	-	1	0.8	1.1	1.9	0.8	0.9	-	-
			Dicrotendipes	-	-	-	-	-	-	-	-	-	-	0.9

PHYLUM	ORDER	FAMILY	GENUS	1997 RA	2000 RA	2001 RA	2002 RA	2003 RA	2004 RA	2005 RA	2006 RA	2007 RA	2008 RA	2009 RA
			Eukiefferiella	-	1.8	-	1	0.8	2.2	-	-	-	0.8	-
			Micropsectra	-	-	-	1	-	-	-	-	-	-	-
			Microtendipes	-	-	0.7	2.9	-	-	-	-	-	-	-
			Orthocladiinae	*5.7	-	*0.7	-	-	-	*1.9	-	*1.8	-	-
			Orthocladius	-	-	0.7	-	0.8	-	-	8.7	9.1	0.8	4.5
			Parametriocnemus	2.3	-	2.1	2.9	0.8	3.3	1	13.5	1.8	1.6	1.8
			Paraphaenocladius	-	-	-	-	-	1.1	-	-	4.5	0.8	-
			Polypedilum	-	-	-	1.9	-	-	-	6.3	-	-	-
			Potthastia	-	-	-	-	0.8	1.1	-	-	-	-	-
			Pseudorthocladius	-	-	-	-	-	-	1	-	-	-	-
			Rheocricotopus	-	-	-	1	-	-	-	-	-	-	-
			Rheosmittia	-	-	0.7	-	-	3.3	-	-	-	-	-
			Rheotanytarsus	-	-	-	-	-	-	-	-	-	0.8	-
			Symposiocladius	-	-	-	1	-	-	-	-	-	-	-
			Sympotthastia	-	-	-	-	-	-	-	-	0.9	-	-
			Tanypodinae	-	-	-	-	-	-	-	*0.8	-	-	-
			Tanytarsini	-	-	-	-	*0.8	-	*2.9	-	-	-	-
			Tanytarsus	1.1	-	-	-	-	-	-	-	1.8	-	-
			Thienemanniella	-	0.9	-	1	-	1.1	-	2.4	-	3.1	-
			Thienemannimyia	-	-	-	-	-	-	-	-	-	-	0.9
			Thienemannimyia Group	-	-	-	-	-	*1.1	*1	-	-	*1.6	-
			Trissopelopia	-	-	-	-	-	1.1	-	-	-	-	-
			Tvetenia	-	-	3.5	1	-	1.1	1	1.6	-	0.8	2.7
			Zavrelimyia	-	-	-	-	-	-	-	-	-	-	0.9
		Empididae	na	-	-	-	-	-	-	-	-	*0.9	-	*0.9
			Chelifera	2.3	-	-	-	0.8	1.1	1	0.8	-	-	-
			Clinocera	1.1	0.9	-	-	-	-	-	-	-	0.8	-
		Simuliidae	na	-	-	-	-	*1.6	-	-	-	*2.7	*0.8	-
			Prosimulium	2.3	7.3	34	21.9	41.7	27.5	1	4	1.8	10.9	31.3
			Simulium	2.3	3.6	-	-	0.8	-	2.9	2.4	1.8	1.6	-
			Stegopterna	-	-	-	-	-	-	-	-	-	-	1.8
		Tipulidae	*Antocha*	-	-	-	1	0.8	1.1	1	-	-	-	-
			Dicranota	-	-	-	-	-	-	-	1.6	-	-	-
			Hexatoma	-	-	-	-	-	1.1	1	3.2	-	1.6	-
			Pseudolimnophila	-	-	-	-	0.8	-	-	-	-	-	-
			Tipula	1.1	-	1.4	-	-	2.2	-	-	0.9	-	-
	Ephemeroptera	Ameletidae	*Ameletus*	3.4	2.7	0.7	-	-	-	-	-	-	1.6	-
	(Mayfly)	Baetidae	na	-	*1.8	*0.7	-	-	*2.2	-	-	-	-	-
			Acerpenna	2.3	-	-	-	-	-	-	-	-	-	-
			Baetis	-	-	-	-	-	-	-	0.8	-	-	-
		Ephemerellidae	na	-	-	-	-	-	-	-	-	-	-	*40.2
			Ephemerella	52.3	59.1	31.3	28.6	26	15.4	50.5	36.5	31.8	38.3	-
			Eurylophella	-	-	-	-	-	-	-	-	-	0.8	-
			Serratella	-	-	-	-	-	-	1	-	-	-	-
		Heptageniidae	na	-	*2.7	*3.5	-	-	-	-	*0.8	-	*0.8	*0.9
			Maccaffertium	-	-	-	-	-	-	-	-	-	0.8	-
			Stenonema	-	-	-	-	0.8	1.1	2.9	1.6	-	-	-
	Lepidoptera	na	na	-	-	-	-	-	-	*1	-	-	-	-
	Megaloptera (Dobsonfly/Fishfly)	Corydalidae	*Nigronia*	-	-	-	-	0.8	2.2	2.9	0.8	0.9	-	-
				-	-	-	-	-	-	-	-	-	-	-
	Odonata	Gomphidae	na	-	*0.9	*0.7	*1	-	-	*1.9	-	-	*0.8	-
	Plecoptera	Chloroperlidae	na	-	-	-	-	-	-	-	-	*0.9	-	-
	(Stonefly)	Leuctridae	na	-	-	-	-	-	*1.1	*1	-	-	*0.8	*0.9
			Leuctra	1.1	-	-	-	-	-	-	-	4.5	-	-
		Nemouridae	na	-	-	*1.4	-	-	-	-	-	-	-	-
			Amphinemura	6.8	12.7	3.5	11.4	4.7	2.2	7.8	1.6	20.9	14.1	1.8
			Ostrocerca	-	-	-	-	0.8	-	-	-	-	-	-
			Prostoia	2.3	-	-	-	-	-	-	-	-	0.8	-
		Perlidae	na	-	-	*1.4	-	-	-	-	-	-	*3.1	-
			Acroneuria	1.1	-	-	-	-	3.3	1	1.6	-	0.8	0.9
		Perlodidae	na	-	*1.8	-	*1	-	*3.3	*2.9	*0.8	*3.6	*6.3	-
			Isoperla	2.3	-	-	-	-	-	-	0.8	-	-	-
	Trichoptera	Glossosomatidae	na	-	-	-	-	-	-	-	*0.8	-	*0.8	-
	(Caddisfly)		*Agapetus*	2.3	-	-	-	-	-	-	-	-	-	-
			Glossosoma	-	-	-	-	-	-	-	-	-	-	0.9
		Hydropsychidae	*Cheumatopsyche*	2.3	0.9	4.2	1	1.6	3.3	1	0.8	-	-	1.8
			Diplectrona	1.1	0.9	0.7	-	0.8	2.2	-	0.8	0.9	-	0.9
			Hydropsyche	-	-	0.7	1	-	5.5	1	0.8	0.9	-	0.9
		Philopotamidae	na	-	-	-	-	-	-	-	-	*1.8	-	-
			Chimarra	2.3	-	-	-	-	2.2	-	-	-	0.8	-
			Dolophilodes	-	-	0.7	1.9	-	2.2	-	-	-	-	-
		Polycentropodidae	na	-	-	-	-	-	*1.1	-	-	-	-	-
			Polycentropus	-	-	-	-	-	-	2.9	-	-	-	-

PHYLUM	*ORDER*	*FAMILY*	*GENUS*	*1997 RA*	*2000 RA*	*2001 RA*	*2002 RA*	*2003 RA*	*2004 RA*	*2005 RA*	*2006 RA*	*2007 RA*	*2008 RA*	*2009 RA*
		Psychomyiidae	*Lype*	-	-	0.7	-	-	-	-	-	-	-	1.8
		Rhyacophilidae	*Rhyacophila*	-	-	0.7	3.8	0.8	-	1	0.8	1.8	-	-
		Uenoidae	*Neophylax*	1.1	0.9	2.1	1.9	7.1	2.2	1	0.8	-	0.8	2.7
Nematomorpha	Gordioidea (Worm)	Gordiidae	na	-	-	-	*1	*0.8	-	-	-	-	-	-
Platyhelminthes	Tricladida (Flatworm)	na	*Girardia*	-	-	-	-	0.8	-	-	-	0.9	-	-
				-	-	-	-	-	-	-	-	-	-	-

Green families are intolerant (family tolerance values from 0 to 3); blue are moderately tolerant (family tolerance values from 3.1 to 6.9); and red are tolerant (family tolerance values from 7 to 10).

* Taxa not identified to genus.

Unnamed Tributary to Principio Creek (FURN-101-S)

Site FURN-101-S is located on an unnamed tributary to Principio Creek in the Eastern Piedmont region of Maryland. It is in the Furnace Bay watershed in Cecil County. This site was sampled in 2000 to 2009. Its watershed is primarily forested (80%), with 17% agriculture, and 2% barren.


Unnamed tributary to Principio Creek in spring 2009.

Water Chemistry

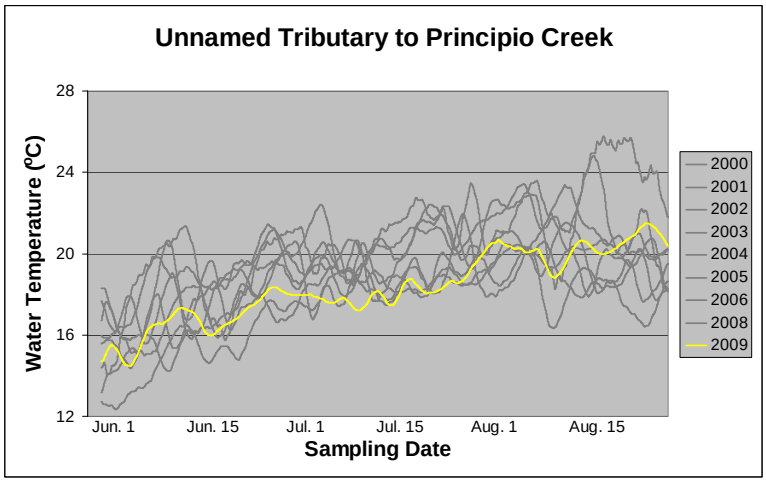
Summer water chemistry data collected at the unnamed tributary to Principio Creek (2000 to 2009).

Parameter	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
Field pH	6.7	6.6	6.8	5.7	7.7	6.7	6.2	7.1	6.5	6.6
Dissolved Oxygen (mg/L)	8.5	8.1	6.7	7.6	7.8	7.7	9.2	9	8.9	8.7
Conductivity (mS)	0.07	0.06	0.07	0.07	0.07	0.07	0.09	0.08	0.08	0.08
Turbidity (NTU)	1.3	0.9	1.6	0.4	1.6	0.5	1.3	1.6	0.1	0.9

Physical Habitat

Physical habitat measurements collected at the unnamed tributary to Principio Creek (2000 to 2009). Scored parameters are on a 0 (worst) to 20 (best) scale.

Parameter	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
Instream habitat (0-20)	16	16	16	15	16	14	16	16	16	16
Epifaunal substrate (0-20)	16	16	16	16	16	14	16	17	17	17
Velocity/Depth Diversity (0-20)	14	13	14	13	13	12	13	12	11	13
Pool Quality (0-20)	14	12	15	14	14	14	10	12	12	13
Riffle Quality (0-20)	15	14	14	15	15	11	15	13	12	13
Shading (%)	92	95	96	95	90	93	90	90	95	90
Embeddedness (%)	10	25	10	15	5	30	35	15	15	10
Discharge (cfs)	0.84	0.47	0.12	0.77	2.28	0.38	0.81	0.40	0.93	0.91



The graph above displays the temperature logger data for the unnamed tributary to Principio Creek for 2000 to 2009. Maximum recorded temperatures occurred during the drought in August 2002. No data were available in 2007.

Biology

Fish

Cumulative list of fish species (with abundance) collected in the unnamed tributary to Principio Creek by sampling year.

Species	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
American eel	22	25	26	16	33	13	18	21	13	9
Blue Ridge sculpin	40	73	49	2	3	16	32	34	20	14
Creek chub	49	60	56	29	58	-	56	32	29	15
Creek chubsucker	-	-	-	-	-	26	-	-	-	-
Cutlips minnow	3	-	-	4	7	9	5	2	3	1
Eastern blacknose dace	83	99	71	58	159	302	106	62	36	44
Margined madtom	4	1	3	1	-	2	2	2	-	1
Rosyside dace	107	125	168	80	199	125	239	95	56	62
Tessellated darter	-	1	4	-	3	6	6	2	2	-
White sucker	1	2	4	-	3	5	7	-	4	-

Green indicates intolerant fish; blue are moderately tolerant; and red are tolerant.

Crayfish

Cumulative list of crayfish species (with abundance or presence {P}/absence {A} data) collected in the unnamed tributary to Principio Creek by sampling year

Species	*2006*	*2007*	*2008*	*2009*
Common crayfish (*Cambarus bartonii bartonii*)	P	2	A	2

Mussels

Cumulative list of mussel species (with abundance or presence {P}/absence {A} data) collected in the unnamed tributary to Principio Creek by sampling year.

Species
None Observed

Herpetofauna

Cumulative list of herpetofauna species collected in or near the unnamed tributary to Principio Creek.

Order (Common)	*Species*
Anura (Frogs and Toads)	American bullfrog, Eastern American toad, Fowler's toad, Northern green frog, Pickerel frog
Caudata (Salamanders and Newts)	Eastern red-backed salamander, Northern dusky salamander, Northern red salamander, Northern two-lined salamander
Squamata (Snakes and Lizards)	Northern watersnake
Testudines (Turtles)	Common snapping turtle, Eastern box turtle

Benthic Macroinvertebrates

Cumulative list of benthic macroinvertebrates collected in the Unnamed Tributary to Principio Creek by sampling year, RA = %Relative Abundance.

PHYLUM	*ORDER*	*FAMILY*	*GENUS*	*2000 RA*	*2001 RA*	*2002 RA*	*2003 RA*	*2004 RA*	*2005 RA*	*2006 RA*	*2007 RA*	*2008 RA*	*2009 RA*
Annelida	Haplotaxida	Enchytraeidae	na	-	-	*0.7	-	-	-	-	-	-	-
(Worm)		Naididae	na	*4	-	-	-	-	-	-	*0.7	-	-
	Lumbriculida	Lumbriculidae	na	-	-	-	*2.3	*1.6	-	-	-	-	-
	Tubificida	Tubificidae	na	-	-	-	*0.8	-	-	-	-	-	-
Arthropoda	Coleoptera	Elmidae	na	-	-	-	-	-	*3	-	-	-	-
	(Beetle)		*Optioservus*	1.6	-	0.7	-	-	-	-	-	1.8	1.8
			Oulimnius	-	5.9	1.5	-	-	3	0.9	1.5	1.8	9.6
			Promoresia	-	0.8	-	0.8	-	-	-	-	-	-
			Stenelmis	-	-	-	-	-	-	-	-	-	0.9
		Psephenidae	*Psephenus*	3.2	-	-	-	-	-	-	0.7	-	-
	Diptera	Ceratopogonidae	*Bezzia*	-	-	-	0.8	-	-	-	-	-	-
	(True fly)		*Probezzia*	-	-	-	-	-	-	-	0.7	-	-
		Chironomidae	*Brillia*	-	-	0.7	-	-	-	-	-	-	-
			Conchapelopia	3.2	-	-	0.8	-	-	-	-	-	-
			Corynoneura	-	-	-	-	-	-	0.9	-	-	-
			Eukiefferiella	5.6	-	0.7	-	-	-	0.9	-	-	-
			Lopescladius	-	-	-	-	-	-	-	0.7	-	-
			Micropsectra	-	0.8	4.9	-	-	-	-	9.6	0.9	-

PHYLUM	ORDER	FAMILY	GENUS	2000 RA	2001 RA	2002 RA	2003 RA	2004 RA	2005 RA	2006 RA	2007 RA	2008 RA	2009 RA
			Microtendipes	-	-	-	-	-	-	-	14	-	-
			Nanocladius	0.8	-	-	-	-	-	-	-	-	-
			Natarsia	-	-	-	0.8	-	-	-	-	-	-
			Nilotanypus	-	-	-	-	-	-	-	0.7	-	-
			Orthocladiinae	-	-	-	-	-	*2	-	-	-	*0.9
			Orthocladius	-	-	0.7	3.9	-	-	0.9	0.7	-	-
			Parametriocnemus	-	-	0.7	0.8	2.4	1	-	0.7	-	-
			Paraphaenocladius	-	-	-	-	-	3	-	-	-	0.9
			Polypedilum	2.4	-	-	-	-	-	-	2.9	-	-
			Stempellinella	-	0.8	0.7	-	-	-	-	5.1	-	-
			Tanypodinae	*0.8	-	*1.5	*2.3	-	-	-	-	-	-
			Tanytarsini	*0.8	-	*1.5	*1.6	-	-	-	-	-	-
			Tanytarsus	-	-	-	-	-	-	-	-	-	0.9
			Thienemannimyia Group	-	-	-	-	*2.4	*1	-	*0.7	-	-
			Trissopelopia	-	0.8	-	-	-	-	-	0.7	-	-
			Tvetenia	-	0.8	-	-	-	-	-	-	-	-
			Zavrelimyia	3.2	1.7	-	-	-	-	-	-	-	-
		Empididae	*Clinocera*	-	-	-	-	-	1	-	-	-	-
		Simuliidae	na	-	-	-	*0.8	-	-	*0.9	-	-	-
			Prosimulium	4	31.1	18.4	25	25.6	9.9	70.2	8.8	73.5	9.6
			Simulium	5.6	-	0.7	3.1	-	1	-	1.5	-	-
			Stegopterna	-	-	-	-	-	1	0.9	-	-	0.9
		Tipulidae	*Antocha*	0.8	-	-	-	-	-	-	0.7	-	-
			Dicranota	0.8	0.8	0.7	2.3	1.6	1	-	-	0.9	0.9
			Erioptera	-	-	-	-	-	-	-	0.7	-	-
			Hexatoma	-	-	0.7	-	2.4	-	1.8	-	0.9	2.6
			Tipula	-	0.8	-	0.8	-	-	-	-	-	-
	Ephemeroptera	Ameletidae	*Ameletus*	-	-	-	7.8	0.8	-	-	-	-	-
	(Mayfly)	Baetidae	na	-	*0.8	-	-	-	-	-	-	-	-
			Acentrella	0.8	-	-	-	-	-	-	-	-	-
			Acerpenna	-	-	-	-	-	2	-	-	-	-
			Baetis	-	-	2.2	-	-	-	-	-	-	-
			Diphetor	-	-	-	-	-	-	-	0.7	-	-
		Ephemerellidae	na	-	-	-	-	-	-	-	-	*2.7	-
			Ephemerella	35.2	34.5	29.4	9.4	13.6	27.7	7	16.9	-	39.5
			Eurylophella	0.8	4.2	0.7	-	-	-	0.9	-	0.9	3.5
		Heptageniidae	na	-	*0.8	*0.7	-	-	-	-	-	-	*0.9
			Epeorus	0.8	1.7	5.1	0.8	9.6	7.9	5.3	1.5	3.5	12.3
			Stenonema	0.8	-	-	-	-	1	-	-	-	-
		Leptophlebiidae	na	-	*0.8	*4.4	*0.8	-	*2	-	-	-	-
			Paraleptophlebia	-	-	6.6	-	-	-	-	-	-	0.9
	Megaloptera	Corydalidae	*Nigronia*	-	-	-	-	-	3	-	-	-	-
	(Dobsonfly/Fishfly)			-	-	-	-	-	-	-	-	-	-
	Odonata	Gomphidae	na	*1.6	-	*2.2	-	-	-	-	*1.5	*0.9	*0.9
	(Dragonfly/Damselfly)			-	-	-	-	-	-	-	-	-	-
	Plecoptera	Chloroperlidae	na	-	-	-	-	*0.8	*1	-	*0.7	-	-
	(Stonefly)		*Sweltsa*	-	-	-	-	-	-	-	-	-	0.9
		Leuctridae	na	-	-	*0.7	*8.6	-	-	-	-	-	*0.9
			Leuctra	9.6	0.8	-	10.2	26.4	7.9	0.9	17.6	-	-
		Nemouridae	na	-	*2.5	*1.5	*2.3	-	-	-	-	-	*1.8
			Amphinemura	2.4	0.8	2.9	7	1.6	7.9	-	2.2	-	4.4
			Ostrocerca	-	-	-	0.8	-	-	-	-	-	-
			Prostoia	-	-	2.9	-	-	-	6.1	-	7.1	-
		Perlidae	na	-	*1.7	*0.7	-	-	-	-	-	*2.7	-
			Acroneuria	-	-	-	-	0.8	1	-	-	-	-
			Eccoptura	-	0.8	-	-	1.6	-	-	-	-	-
		Perlodidae	na	-	*4.2	*2.2	*1.6	*8	*5	*1.8	-	*0.9	*1.8
			Diploperla	0.8	-	-	-	-	-	-	-	-	-
			Isoperla	4	-	-	-	-	-	-	-	-	-
	Trichoptera	Brachycentridae	na	*0.8	-	-	-	-	-	-	-	-	-
	(Caddisfly)	Glossosomatidae	*Agapetus*	-	-	0.7	-	-	-	-	-	-	-
			Glossosoma	-	0.8	-	-	-	-	-	-	-	-
		Hydropsychidae	*Cheumatopsyche*	-	0.8	-	-	-	-	-	-	0.9	-
			Diplectrona	-	-	-	0.8	-	1	-	-	-	-
		Lepidostomatidae	*Lepidostoma*	0.8	-	-	-	-	2	-	1.5	-	-
		Limnephilidae	*Pycnopsyche*	-	-	-	-	-	-	-	0.7	-	-
		Odontoceridae	*Psilotreta*	0.8	-	-	-	-	-	-	-	-	-
		Philopotamidae	na	*2.4	-	-	-	*0.8	-	-	*1.5	-	-
			Wormaldia	-	-	-	0.8	-	-	-	-	-	-
		Polycentropodidae	na	-	-	-	-	-	*1	-	-	-	-
			Polycentropus	0.8	-	-	-	-	-	-	2.9	0.9	1.8
		Psychomyiidae	*Lype*	-	-	-	-	-	-	-	0.7	-	-
		Rhyacophilidae	*Rhyacophila*	-	-	0.7	-	-	-	0.9	-	-	-

PHYLUM	*ORDER*	*FAMILY*	*GENUS*	*2000 RA*	*2001 RA*	*2002 RA*	*2003 RA*	*2004 RA*	*2005 RA*	*2006 RA*	*2007 RA*	*2008 RA*	*2009 RA*
		Uenoidae	*Neophylax*	-	-	2.9	-	-	2	-	-	-	1.8
Mollusca	Basommatophora	Ancylidae	*Ferrissia*	-	-	-	0.8	-	-	-	-	-	-
	(Snail)			-	-	-	-	-	-	-	-	-	-
	Veneroida (Bivalve)	Pisidiidae	na	*0.8	-	-	*0.8	-	-	-	-	-	-
Platyhelminthes	Tricladida	na	*Girardia*	-	-	-	0.8	-	-	-	-	-	-
	(Flatworm)	Dugesiidae	*Cura*	-	-	-	-	-	1	-	-	-	-

Green families are intolerant (family tolerance values from 0 to 3); blue are moderately tolerant (family tolerance values from 3.1 to 6.9); and red are tolerant (family tolerance values from 7 to 10).

* Taxa not identified to genus.

Timber Run (LIBE-102-S)

Site LIBE-102-S is located on Timber Run in the Eastern Piedmont region of Maryland. It is in the Liberty Reservoir watershed in Baltimore County. This site was sampled in 2000 to 2009. Its watershed is primarily forested (70%), with 29% agriculture and 1% urban.


Timber Run in spring 2009.

Water Chemistry

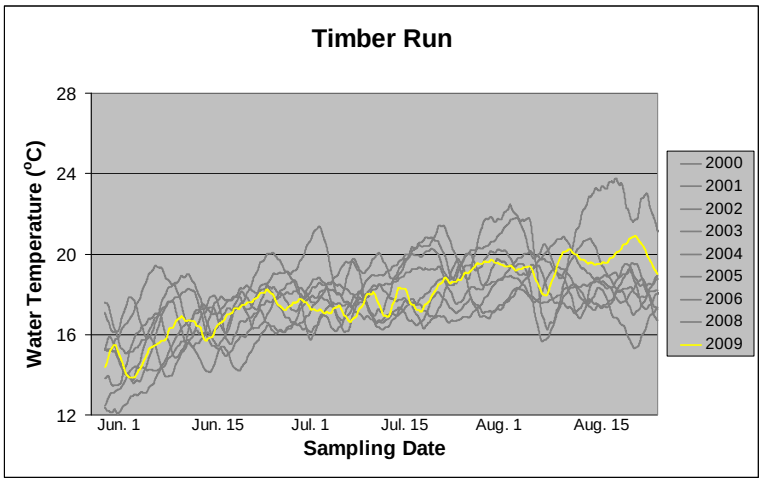
Summer water chemistry data collected at Timber Run (2000 to 2009).

Parameter	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
Field pH	9.3	8.4	7.5	9.4	8.0	6.6	7.0	7.1	6.8	6.8
Dissolved Oxygen (mg/L)	8.6	6.7	6.7	6.9	7.6	9.2	8.7	9.8	8.2	8.8
Conductivity (mS)	0.10	0.10	0.09	0.10	0.10	0.12	0.10	0.12	0.13	0.13
Turbidity (NTU)	1.3	2.2	1.6	3.4	2.0	1.1	2.3	0.5	0.8	1.2

Physical Habitat

Physical habitat measurements collected at Timber Run (2000 to 2009). Scored parameters are on a 0 (worst) to 20 (best) scale.

Parameter	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
Instream habitat (0-20)	18	17	16	17	16	16	16	14	17	16
Epifaunal substrate (0-20)	18	17	17	16	15	14	16	16	16	17
Velocity/Depth Diversity (0-20)	12	15	10	10	12	10	12	12	12	11
Pool Quality (0-20)	15	16	10	10	13	10	13	11	12	13
Riffle Quality (0-20)	15	13	14	15	14	15	14	12	16	14
Shading (%)	95	88	95	96	95	95	95	95	95	90
Embeddedness (%)	12	25	35	20	30	40	40	30	35	20
Discharge (cfs)	0.63	0.52	0.34	1.93	0.79	1.62	0.49	0.84	0.73	0.48



The graph above displays the temperature logger data for Timber Run for 2000 to 2009. Maximum recorded temperatures occurred during the drought in August 2002. No data were available in 2007.

Biology

Fish

Cumulative list of fish species (with abundance) collected in Timber Run by sampling year.

Species	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
Blue Ridge sculpin	180	250	162	51	157	147	168	113	116	128
Brook trout	18	2	17	3	-	-	1	-	-	-
Creek chub	53	52	29	16	61	39	25	18	21	30
Eastern blacknose dace	120	128	77	35	72	72	95	77	94	155
River chub	-	-	-	-	-	-	1	-	-	-
Rosyside dace	34	45	18	8	29	21	19	22	25	45

Green indicates intolerant fish; blue are moderately tolerant; and red are tolerant.

Crayfish

Cumulative list of crayfish species (with abundance or presence {P}/absence {A} data) collected in Timber Run by sampling year

Species	*2006*	*2007*	*2008*	*2009*
Virile crayfish (*Orconectes virilis*)	A	2	P	4
Common crayfish (*Cambarus bartonii bartonii*)	P	2	A	4

Mussels

Cumulative list of mussel species (with abundance or presence {P}/absence {A} data) collected in Timber Run by sampling year.

Species
None Observed

Herpetofauna

Cumulative list of herpetofauna species collected in or near Timber Run.

Order (Common)	*Species*
Anura (Frogs and Toads)	Eastern American toad, Fowler's toad, Northern green frog, Pickerel frog, Southern leopard frog, Wood frog
Caudata (Salamanders and Newts)	Eastern red-backed salamander, Northern dusky salamander, Northern red salamander, Northern two-lined salamander,
Squamata (Snakes and Lizards)	Eastern garter snake, Northern ringneck snake
Testudines (Turtles)	Eastern box turtle

Benthic Macroinvertebrates

Cumulative list of benthic macroinvertebrates collected in Timber Run by sampling year,

RA = %Relative Abundance.

PHYLUM	*ORDER*	*FAMILY*	*GENUS*	*2000 RA*	*2001 RA*	*2002 RA*	*2003 RA*	*2004 RA*	*2005 RA*	*2006 RA*	*2007 RA*	*2008 RA*	*2009 RA*
Annelida	Haplotaxida	Enchytraeidae	na	-	-	-	*0.8	-	-	-	-	-	-
(Worm)		Naididae	na	*0.8	-	*0.9	-	-	-	-	-	-	-
	Lumbriculida	Lumbriculidae	na	-	-	-	*0.8	-	-	-	-	-	-
Arthropoda	Coleoptera	Dryopidae	*Helichus*	0.8	-	-	-	-	-	-	1	-	-
	(Beetle)	Elmidae	na	-	*1.5	*4.3	-	-	-	-	-	-	-
			Ancyronyx	-	-	-	-	-	-	1.8	-	-	-
			Optioservus	0.8	1.5	0.9	0.8	-	-	7.1	2	6.8	2.3
			Oulimnius	1.6	-	3.4	-	-	3.6	2.7	-	0.8	0.8
		Psephenidae	*Ectopria*	-	0.8	-	-	-	-	-	-	-	-
		Ptilodactylidae	*Anchytarsus*	-	-	0.9	0.8	0.7	2.7	-	-	-	-
	Diptera	Ceratopogonidae	*Ceratopogon*	-	-	-	0.8	-	-	-	-	-	-
	(True Fly)		*Probezzia*	-	-	-	0.8	-	-	-	-	-	-
		Chironomidae	*Apsectrotanypus*	-	0.8	-	-	-	-	-	-	-	-
			Brillia	-	0.8	-	-	-	-	-	-	-	-
			Chaetocladius	0.8	-	-	-	-	-	-	-	-	-
			Chironominae	-	-	-	-	-	-	-	*1	-	-
			Conchapelopia	1.6	-	0.9	-	-	-	-	-	-	-
			Corynoneura	-	-	-	0.8	0.7	-	-	1	0.8	1.6
			Diamesa	-	2.3	-	2.5	-	-	-	-	-	-
			Eukiefferiella	-	-	-	1.7	-	-	5.4	2	2.5	3.1

PHYLUM	ORDER	FAMILY	GENUS	2000 RA	2001 RA	2002 RA	2003 RA	2004 RA	2005 RA	2006 RA	2007 RA	2008 RA	2009 RA
			Heleniella	-	-	-	0.8	-	-	0.9	3	0.8	0.8
			Micropsectra	-	1.5	18.8	-	-	2.7	0.9	1	-	-
			Microtendipes	-	0.8	-	-	-	-	-	-	-	-
			Nanocladius	-	-	0.9	0.8	-	-	-	-	0.8	-
			Orthocladiinae	*0.8	*2.3	*0.9	-	*0.7	-	*1.8	-	-	-
			Orthocladius	-	1.5	2.6	0.8	-	-	0.9	3	0.8	1.6
			Parametriocnemus	-	-	1.7	4.2	2.8	-	-	1	-	-
			Paraphaenocladius	-	-	-	0.8	-	0.9	-	-	-	2.3
			Platysmittia	-	-	1.7	-	-	-	-	-	-	-
			Polypedilum	-	-	1.7	-	-	-	-	-	-	0.8
			Pseudorthocladius	-	-	-	-	-	-	-	-	-	0.8
			Rheosmittia	-	-	-	-	2.8	3.6	-	1	-	-
			Stempellina	-	-	-	-	-	-	-	-	-	0.8
			Sympotthastia	-	0.8	-	10.9	-	-	-	1	2.5	-
			Tanypodinae	-	-	-	-	*1.4	-	-	-	-	*2.3
			Tanytarsini	-	-	*8.5	-	-	-	-	-	-	-
			Tanytarsus	-	-	2.6	0.8	-	-	2.7	-	-	1.6
			Thienemanniella	-	0.8	2.6	-	1.4	-	-	-	-	0.8
			Thienemannimyia Group	-	-	-	-	*0.7	*0.9	-	*1	*0.8	-
			Trissopelopia	-	0.8	-	-	2.1	-	0.9	-	-	-
			Tvetenia	-	-	-	-	-	-	-	-	-	0.8
			Zavrelimyia	0.8	-	-	-	-	-	-	-	0.8	-
		Dixidae	*Dixa*	-	1.5	0.9	-	-	-	-	-	-	-
		Empididae	*Chelifera*	-	-	-	-	0.7	-	-	-	-	-
			Hemerodromia	-	-	0.9	-	-	-	-	-	-	-
		Simuliidae	*Prosimulium*	3.2	48.9	1.7	23.5	35.7	13.4	24.1	41.6	11	10.9
			Simulium	14.3	-	1.7	-	-	-	-	1	0.8	-
		Tipulidae	*Antocha*	-	-	-	1.7	1.4	0.9	-	-	-	-
			Dicranota	-	2.3	1.7	0.8	1.4	3.6	0.9	3	4.2	3.9
			Hexatoma	-	-	-	-	-	-	1.8	-	0.8	0.8
			Limonia	-	-	-	0.8	-	-	-	-	-	-
			Tipula	0.8	-	-	2.5	1.4	-	0.9	2	0.8	0.8
	Ephemeroptera (Mayfly)	Baetidae	na	-	-	*1.7	-	-	-	-	*1	-	-
			Acentrella	2.4	-	-	-	-	-	-	-	-	-
			Baetis	-	-	-	-	7.7	-	-	-	-	-
		Ephemerellidae	na	-	-	-	-	-	-	-	*11.9	*11	*3.9
			Ephemerella	35.7	5.3	12.8	11.8	6.3	41.1	35.7	6.9	29.7	27.3
			Serratella	2.4	0.8	13.7	-	-	2.7	5.4	-	6.8	2.3
		Heptageniidae	na	*0.8	-	*0.9	-	-	*0.9	-	*2	-	*0.8
			Epeorus	0.8	1.5	-	-	-	-	1.8	2	2.5	1.6
			Maccaffertium	-	-	-	-	-	-	-	-	1.7	-
			Stenacron	-	-	-	1.7	-	-	-	-	-	-
			Stenonema	0.8	0.8	-	5	4.9	0.9	-	-	-	-
		Leptophlebiidae	na	-	-	-	*0.8	-	-	-	-	-	*0.8
			Leptophlebia	-	1.5	-	-	-	-	-	-	-	0.8
			Paraleptophlebia	-	0.8	-	-	-	-	-	-	-	-
	Megaloptera	Corydalidae	*Nigronia*	-	0.8	-	1.7	0.7	-	-	1	2.5	0.8
	Odonata	Aeshnidae	*Boyeria*	-	-	-	-	0.7	-	-	-	-	-
	(Dragonfly)	Gomphidae	na	-	-	-	*0.8	-	-	-	*1	-	-
	Plecoptera	Chloroperlidae	na	-	-	-	-	-	-	-	-	-	*0.8
	(Stonefly)		*Haploperla*	-	-	-	-	-	-	0.9	-	-	-
		Leuctridae	na	*4.8	-	*0.9	-	*2.8	*6.3	-	-	-	*2.3
		Nemouridae	na	-	-	-	*2.5	*2.8	-	-	-	-	-
			Amphinemura	13.5	-	1.7	-	2.8	7.1	-	-	1.7	10.9
			Prostoia	-	13.7	-	5	-	-	0.9	-	-	0.8
		Peltoperlidae	*Tallaperla*	-	-	-	-	0.7	-	-	-	-	-
		Perlidae	na	-	-	-	-	*0.7	-	-	-	-	-
			Acroneuria	-	-	-	-	0.7	-	-	-	0.8	-
			Eccoptura	-	-	-	-	0.7	-	-	-	0.8	-
		Perlodidae	na	*3.2	-	-	-	*2.8	*0.9	-	-	-	*0.8
			Diploperla	-	-	-	-	1.4	-	-	-	-	-
		Pteronarcyidae	*Pteronarcys*	-	-	0.9	-	-	-	-	-	-	-
	Trichoptera	na	na	-	-	*0.9	-	-	-	-	-	-	-
	(Caddisfly)	Glossosomatidae	*Glossosoma*	-	-	-	-	-	0.9	-	1	-	-
		Hydropsychidae	*Ceratopsyche*	-	-	-	-	-	-	-	-	-	0.8
			Cheumatopsyche	0.8	-	-	-	2.8	0.9	-	2	0.8	0.8
			Diplectrona	1.6	-	-	2.5	0.7	1.8	-	-	0.8	0.8
			Hydropsyche	-	-	-	-	2.8	2.7	-	2	-	-
		Lepidostomatidae	*Lepidostoma*	-	-	0.9	-	-	0.9	-	1	-	-
		Limnephilidae	*Hydatophylax*	-	0.8	-	-	-	-	-	-	-	-
			Pycnopsyche	-	0.8	-	-	2.1	-	-	-	-	0.8
		Philopotamidae	*Dolophilodes*	4	-	-	-	-	-	0.9	-	-	-
		Polycentropodidae	na	-	*0.8	-	-	-	-	-	-	-	-

PHYLUM	*ORDER*	*FAMILY*	*GENUS*	*2000 RA*	*2001 RA*	*2002 RA*	*2003 RA*	*2004 RA*	*2005 RA*	*2006 RA*	*2007 RA*	*2008 RA*	*2009 RA*
			Polycentropus	-	-	0.9	0.8	-	-	-	1	-	0.8
		Psychomyiidae	*Lype*	-	-	-	0.8	0.7	-	-	-	-	-
		Rhyacophilidae	*Rhyacophila*	0.8	-	0.9	1.7	-	-	0.9	-	0.8	0.8
		Uenoidae	*Neophylax*	2.4	3.8	3.4	4.2	1.4	0.9	0.9	2	4.2	4.7
Platyhelminthes	Tricladida	na	*Girardia*	-	-	0.9	-	-	-	-	-	-	-
	(Flatworm)	Planariidae	na	-	-	-	*1.7	-	-	-	-	-	-

Green families are intolerant (family tolerance values from 0 to 3); blue are moderately tolerant (family tolerance values from 3.1 to 6.9); and red are tolerant (family tolerance values from 7 to 10).

* Taxa not identified to genus.

Appendix D
Sentinel Sites in the Highlands Region

Bear Creek (YOUG-432-S)
Buzzard Branch (UMON-119-S)
Crabtree Creek (SAVA-204-S)
Double Lick Run (SAVA-276-S)
Fifteenmile Creek (FIMI-207-S)
High Run (UMON-288-S)
Mill Run (PRLN-626-S)
Savage River (SAVA-225-S)

Bear Creek (YOUG-432-S)

Site YOUG-432-S is located on Bear Creek in the Highlands region of Maryland. It is in the Youghiogheny River watershed in Garrett County. This site was sampled in 1995 and 2000 to 2009. Its watershed is primarily forested (67%), with 28% agriculture, 4% urban and 1% barren. Summer sampling was not performed in 2005 and 2006 due to contamination concerns at the Bear Creek Hatchery.


Bear Creek in spring 2009.

Water Chemistry

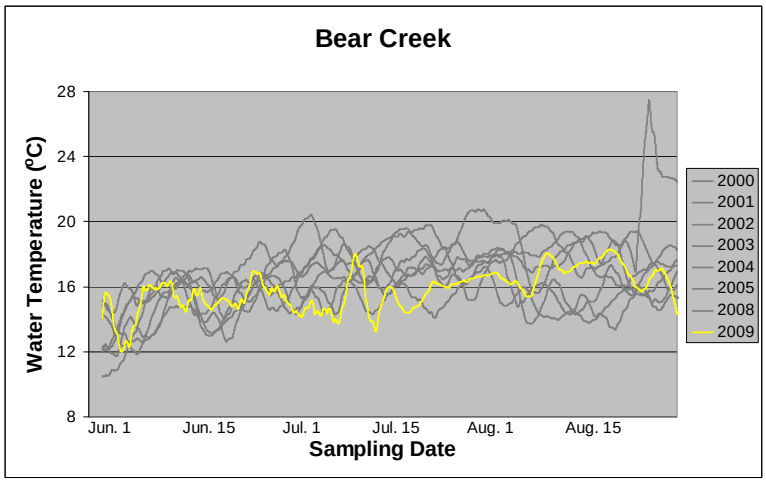
Summer water chemistry data collected at Bear Creek (1995, 2000 to 2004, and 2007 to 2009). The site was not sampled in the summer of 2005 or 2006.

Parameter	*1995*	*2000*	*2001*	*2002*	*2003*	*2004*	*2007*	*2008*	*2009*
Field pH	7.3	7.5	7.2	6.8	7.2	6.3	7.6	7.3	7.0
Dissolved Oxygen (mg/L)	7.4	8.5	8	10.7	7.9	8.9	9	6.6	9.6
Conductivity (mS)	0.07	0.05	0.07	0.08	0.07	0.07	0.06	0.06	0.06
Turbidity (NTU)	Not measured	8.0	3.4	6.4	5.8	5.8	1.8	4.3	2.5

Physical Habitat

Physical habitat measurements collected at Bear Creek (1995, 2000 to 2004, and 2007 to 2009). Scored parameters are on a 0 (worst) to 20 (best) scale. The site was not sampled in the summer of 2005 or 2006.

Parameter	*1995*	*2000*	*2001*	*2002*	*2003*	*2004*	*2007*	*2008*	*2009*
Instream habitat (0-20)	17	18	18	18	16	16	17	17	17
Epifaunal substrate (0-20)	19	18	17	15	14	14	17	19	19
Velocity/Depth Diversity (0-20)	14	12	17	10	9	15	10	14	16
Pool Quality (0-20)	16	13	16	17	9	14	10	12	14
Riffle Quality (0-20)	18	18	17	17	16	11	17	17	18
Shading (%)	80	85	85	92	93	88	97	85	85
Embeddedness (%)	25	10	20	35	35	35	35	20	35
Discharge (cfs)	4.04	2.55	2.86	1.33	1.16	2.00	1.19	5.84	2.22



The graph above displays the temperature logger data for Bear Creek for 2000 to 2005 and 2009. The temperature spike observed in August 2003 resulted from removing the temperature logger before the end of the month. No data were available in 2006 or 2007.

Biology

Fish

Cumulative list of fish species (with abundance) collected in Bear Creek by sampling year.

Species	*1995*	*2000*	*2001*	*2002*	*2003*	*2004*	*2007*	*2008*	*2009*
Brook trout	59	12	29	20	8	32	8	8	9
Brown Trout	-	-	-	-	-	-	-	1	5
Creek chub	-	-	-	-	10	8	-	-	-
Eastern blacknose dace	142	4	29	11	10	60	2	-	-
Longnose dace	4	-	-	-	-	-	1	-	-
Mottled sculpin	477	190	279	265	287	239	203	117	75
Rainbow trout	5	-	-	-	-	-	-	-	-
White sucker	11	1	-	1	24	28	1	2	3

Green indicates intolerant fish; blue are moderately tolerant; and red are tolerant. Site not sampled in summer 2006 and 2007.

Crayfish

Cumulative list of crayfish species (with abundance or presence {P}/absence {A} data) collected in Bear Creek by sampling year

Species	*2007*	*2008*	*2009*
Rock crayfish (Cambarus carinirostris)	32	P	23

Mussels

Cumulative list of mussel species (with abundance or presence {P}/absence {A} data) collected in Bear Creek by sampling year.

Species
None Observed

Herpetofauna

Cumulative list of herpetofauna species collected in or near Bear Creek.

Order (Common)	*Species*
Caudata (Salamanders and Newts)	Allegheny mountain dusky salamander, Northern dusky salamander, Northern spring salamander, Northern two-lined salamander, Seal salamander

Benthic Macroinvertebrates

Cumulative list of benthic macroinvertebrates collected in Bear Creek by sampling year, RA = %Relative Abundance.

PHYLUM	*ORDER*	*FAMILY*	*GENUS*	*1995 RA*	*2000 RA*	*2001 RA*	*2002 RA*	*2003 RA*	*2004 RA*	*2005 RA*	*2006 RA*	*2007 RA*	*2008 RA*	*2009 RA*
Annelida	Lumbriculida	Lumbriculidae	na	-	-	-	*1.7	-	-	-	-	*0.9	-	-
Arthropoda	Amphipoda (Scud)	Gammaridae	*Gammarus*	-	0.8	-	-	-	-	-	-	-	-	-
				-	-	-	-	-	-	-	-	-	-	-
	Coleoptera (Beetle)	Elmidae	na	-	-	0.9	-	-	-	-	-	-	-	-
			Promoresia	2.3	-	0.9	-	-	-	-	-	1.7	-	1
			Optioservus	-	-	-	2.5	-	2.8	10.3	3.1	11.2	7.9	1.9
			Oulimnius	4.6	2.4	3.4	9.2	10.8	-	8.4	2.3	8.6	15.9	2.9
		Psephenidae	*Ectopria*	-	0.8	-	-	-	-	-	-	0.9	-	-
	Collembola	Isotomidae	*Isotomurus*	-	-	-	-	-	-	-	-	-	-	1
	Decapoda (Crayfish)	Cambaridae	na	*0.8	-	-	-	-	-	-	-	-	-	*1
				-	-	-	-	-	-	-	-	-	-	-
	Diptera (True Fly)	Athericidae	*Atherix*	-	-	-	-	-	-	0.9	-	-	-	1
		Blephariceridae	*Blepharicera*	0.8	4	-	-	-	1.9	-	1.5	0.9	-	-
		Ceratopogonidae	*Bezzia*	-	-	-	-	-	-	-	1.5	-	-	-
			Probezzia	-	0.8	-	-	-	-	-	-	-	-	-
		Chironomidae	Chironominae	-	-	-	-	*0.8	-	-	-	-	-	-
			Diamesa	-	0.8	-	-	-	-	-	-	-	-	-
			Eukiefferiella	10.7	-	0.9	-	-	-	-	0.8	-	-	-
			Heleniella	-	-	-	-	-	-	-	-	0.9	-	-
			Micropsectra	1.5	-	0.9	3.3	-	-	-	-	-	-	-
			Microtendipes	-	-	-	-	-	-	-	0.8	-	-	-
			Nanocladius	0.8	-	-	-	-	-	-	-	-	-	-
			Orthocladiinae	-	-	*3.5	*1.7	*0.8	-	-	-	-	*0.8	-
			Orthocladius	0.8	-	-	-	-	-	-	0.8	-	2.4	1
			Parachaetocladius	-	-	-	-	-	-	-	-	-	0.8	-
			Parametriocnemus	9.2	3.2	2.6	-	3.1	-	4.7	0.8	-	2.4	-
			Paraphaenocladius	-	-	-	-	-	-	-	-	-	1.6	-
			Polypedilum	7.6	-	-	-	-	-	-	-	-	-	-
			Rheocricotopus	-	1.6	0.9	-	-	-	-	-	-	-	-
			Rheopelopia	1.5	-	-	-	-	-	-	-	-	-	-
			Stempellinella	1.5	5.6	-	-	-	-	-	-	-	-	-
			Sublettea	1.5	-	-	-	-	-	-	-	-	-	-
			Symposiocladius	0.8	-	-	-	-	-	-	-	-	-	-
			Tanypodinae	-	-	-	-	*0.8	-	-	-	-	-	-
			Tanytarsini	-	-	*1.7	10	-	-	-	-	-	-	-
			Tanytarsus	-	-	-	-	-	-	-	-	-	-	1.9
			Thienemanniella	2.3	-	-	-	-	-	-	-	-	-	-
			Thienemannimyia Group	-	-	-	-	-	-	-	-	-	*1.6	-
			Tvetenia	-	-	-	-	-	-	0.9	-	-	0.8	1
		Empididae	*Chelifera*	-	-	-	-	0.8	-	0.9	-	2.6	-	-
			Clinocera	1.5	-	-	-	-	-	-	-	-	-	-
			Hemerodromia	0.8	-	-	-	-	-	-	-	-	-	-
		Simuliidae	*Prosimulium*	3.8	3.2	21.4	5.8	20	0.9	9.3	30.8	8.6	-	1
		Tipulidae	*Antocha*	2.3	0.8	0.9	0.8	-	0.9	0.9	0.8	1.7	1.6	1
			Dicranota	0.8	-	0.9	-	1.5	-	-	-	0.9	3.2	-
			Hexatoma	-	1.6	-	0.8	0.8	0.9	1.9	-	-	0.8	1
	Ephemeroptera (Mayfly)	Baetidae	na	-	*0.8	*0.9	-	*1.5	-	-	-	-	-	-
			Acentrella	-	6.3	-	-	3.1	2.8	0.9	-	-	-	-
			Acerpenna	-	0.8	-	0.8	-	-	-	-	0.9	-	-
			Baetis	11.5	-	3.4	0.8	4.6	8.5	19.6	4.6	3.4	6.3	4.8
			Diphetor	-	-	-	-	-	-	-	-	-	2.4	-
		Ephemerellidae	na	-	-	-	-	-	-	-	*2.3	-	-	-
			Drunella	-	0.8	-	-	1.5	4.7	-	-	0.9	-	-
			Ephemerella	16	13.5	6	5	15.4	19.8	7.5	2.3	23.3	8.7	21.9
			Serratella	-	-	-	-	1.5	-	-	2.3	1.7	0.8	-
		Ephemeridae	*Ephemera*	-	-	-	-	-	-	-	-	-	0.8	-
		Heptageniidae	na	-	*2.4	*0.9	*1.7	*1.5	-	-	-	-	*2.4	-
			Cinygmula	-	1.6	2.6	1.7	-	5.7	-	0.8	-	3.2	1
			Epeorus	2.3	11.9	6	10.8	5.4	15.1	4.7	13.8	2.6	8.7	9.5
			Heptagenia	-	0.8	-	-	-	0.9	-	-	-	-	-
			Leucrocuta	-	-	-	-	-	0.9	-	-	-	0.8	-
			Rhithrogena	-	-	-	-	-	-	-	1.5	-	-	-
			Stenacron	-	-	0.9	-	0.8	-	-	-	0.9	-	2.9
			Maccaffertium	-	-	-	-	-	-	-	-	-	0.8	1

PHYLUM	ORDER	FAMILY	GENUS	1995 RA	2000 RA	2001 RA	2002 RA	2003 RA	2004 RA	2005 RA	2006 RA	2007 RA	2008 RA	2009 RA
			Stenonema	-	-	0.9	3.3	-	0.9	-	-	2.6	-	-
		Isonychiidae	*Isonychia*	-	0.8	-	-	-	-	-	-	-	-	-
		Leptophlebiidae	na	-	-	*1.7	*2.5	*9.2	-	*2.8	*7.7	*3.4	*8.7	-
			Paraleptophlebia	-	15.9	11.1	10.8	3.8	13.2	7.5	1.5	-	-	14.3
	Megaloptera	Corydalidae	*Nigronia*	0.8	-	-	-	-	-	-	-	-	-	-
	(Dobsonfly/Fishfly)			-	-	-	-	-	-	-	-	-	-	-
	Plecoptera	Chloroperlidae	na	-	*2.4	*2.6	*1.7	-	*3.8	*0.9	-	*4.3	*0.8	-
	(Stonefly)		*Haploperla*	-	-	-	-	-	-	-	1.5	-	-	-
			Sweltsa	-	-	-	0.8	-	-	1.9	-	-	-	1
		Leuctridae	na	-	-	*1.7	-	*2.3	-	*2.8	-	-	*4	*1
			Leuctra	1.5	2.4	0.9	5	0.8	-	-	2.3	-	-	-
		Nemouridae	*Amphinemura*	0.8	2.4	7.7	1.7	1.5	1.9	-	0.8	1.7	-	-
		Peltoperlidae	na	-	*0.8	-	-	-	*0.9	-	-	-	-	-
			Tallaperla	-	-	-	0.8	-	1.9	0.9	-	1.7	-	2.9
		Perlidae	na	-	-	-	-	-	*1.9	-	*0.8	*0.9	-	-
			Acroneuria	-	-	-	0.8	-	-	-	-	0.9	-	-
		Perlodidae	na	*0.8	-	*0.9	*0.8	*2.3	*1.9	*1.9	*2.3	*1.7	-	-
			Diploperla	0.8	-	-	-	-	-	-	-	-	-	-
			Isoperla	2.3	4	1.7	1.7	0.8	-	0.9	4.6	-	4	7.6
		Pteronarcyidae	*Pteronarcys*	1.5	-	-	-	-	-	-	0.8	-	-	-
		Taeniopterygidae	*Taenionema*	-	-	-	-	-	-	-	-	-	0.8	-
	Trichoptera	na	na	-	-	*0.9	-	-	-	-	-	-	-	-
	(Caddisfly)	Brachycentridae	*Micrasema*	-	-	-	-	-	-	-	-	-	0.8	-
		Hydropsychidae	na	-	-	-	-	*0.8	-	-	-	-	-	-
			Cheumatopsyche	-	-	-	0.8	-	1.9	-	0.8	0.9	2.4	1
			Diplectrona	0.8	2.4	3.4	8.3	1.5	3.8	6.5	3.8	4.3	0.8	5.7
			Hydropsyche	1.5	-	0.9	-	1.5	-	-	-	-	-	1
		Lepidostomatidae	*Lepidostoma*	1.5	3.2	-	0.8	-	-	-	-	0.9	0.8	-
		Limnephilidae	*Pycnopsyche*	-	-	0.9	-	-	-	-	-	-	-	-
		Philopotamidae	na	-	-	-	-	-	*0.9	-	-	-	-	-
			Dolophilodes	-	-	0.9	-	-	-	0.9	-	-	0.8	1.9
		Polycentropodidae	na	-	-	-	-	-	-	-	-	-	*0.8	-
			Nyctiophylax	-	-	-	-	-	-	-	-	-	-	1
			Polycentropus	-	-	-	0.8	-	-	-	0.8	-	-	-
		Psychomyiidae	*Lype*	-	-	-	-	-	-	-	-	-	-	1
			Psychomyia	-	-	-	-	-	-	-	-	2.6	-	-
		Rhyacophilidae	*Rhyacophila*	1.5	0.8	1.7	0.8	-	-	0.9	1.5	-	0.8	1.9
		Uenoidae	*Neophylax*	-	0.8	3.4	1.7	0.8	0.9	0.9	-	1.7	-	2.9
Mollusca	Veneroida	Pisidiidae	*Pisidium*	0.8	-	-	-	-	-	-	-	-	-	-
	(Bivalve)			-	-	-	-	-	-	-	-	-	-	-

Green families are intolerant (family tolerance values from 0 to 3); blue are moderately tolerant (family tolerance values from 3.1 to 6.9); and red are tolerant (family tolerance values from 7 to 10). * Taxa not identified to genus.

Buzzard Branch (UMON-119-S)

Site UMON-119-S is located on Buzzard Branch in the Highlands region of Maryland. It is in the Upper Monocacy River watershed in Frederick County. This site was sampled in 2000 and 2002 to 2009. Its watershed is primarily forested (97%), with 3% urban.

Buzzard Branch in the spring of 2009.

Water Chemistry

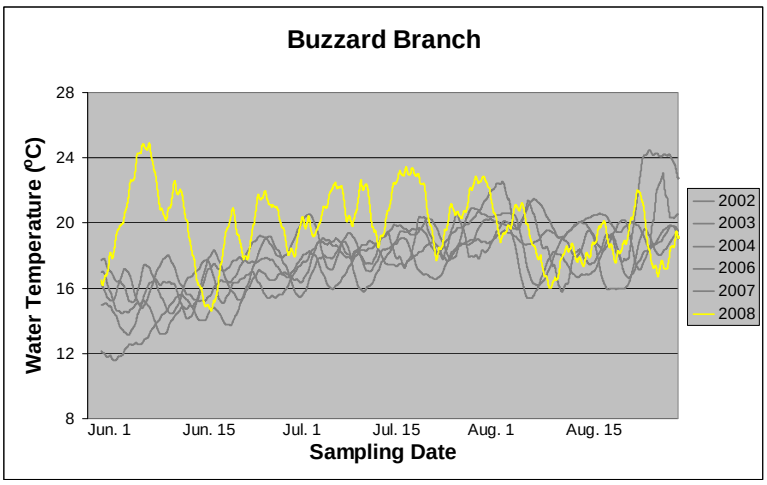
Summer water chemistry data collected at Buzzard Branch (2000 and 2002 to 2009).

Parameter	*2000*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
Field pH	6.9	7.2	7.2	6.2	7.0	6.8	8.2	7.4	6.8
Dissolved Oxygen (mg/L)	7.3	8.9	8.6	6.6	9.6	8.9	10.4	9.8	8.9
Conductivity (mS)	0.05	0.08	0.06	0.07	0.08	0.08	0.07	0.09	0.07
Turbidity (NTU)	3.1	2.8	2.9	3.8	3.0	4.3	2.2	3.4	3.6

Physical Habitat

Physical habitat measurements collected at Buzzard Branch (2000 and 2002 to 2009). Scored parameters are on a 0 (worst) to 20 (best) scale.

Parameter	*2000*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
Instream habitat (0-20)	17	17	16	16	17	18	18	17	17
Epifaunal substrate (0-20)	18	17	17	17	17	19	18	16	17
Velocity/Depth Diversity (0-20)	15	9	10	12	10	10	10	10	10
Pool Quality (0-20)	16	9	10	10	10	10	10	10	10
Riffle Quality (0-20)	15	14	15	16	16	19	17	13	14
Shading (%)	90	86	98	90	90	90	90	80	80
Embeddedness (%)	25	20	20	20	20	20	50	35	35
Discharge (cfs)	0.54	0.09	0.38	1.39	0.99	2.17	0.89	0.16	1.02



The graph above displays the temperature logger data for Buzzard Branch for 2002 to 2008. Maximum recorded temperatures occurred June 2008. No data were available in 2005 and 2009.

Biology

Fish

Cumulative list of fish species (with abundance) collected in Buzzard Branch by sampling year.

Species	*2000*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
Eastern blacknose dace	24	33	17	37	22	7	30	43	41
Brook trout	19	57	25	43	43	31	43	55	21
Brown trout	30	10	2	5	4	6	9	9	-
Largemouth Bass	-	-	-	-	-	-	-	1	-

Green indicates intolerant fish; blue are moderately tolerant; and red are tolerant.

Crayfish

Cumulative list of crayfish species (with abundance or presence {P}/absence {A} data) collected in Buzzard Branch by sampling year

Species	*2006*	*2007*	*2008*	*2009*
Common crayfish (*Cambarus bartonii bartonii)*	P	23	P	6

Mussels

Cumulative list of mussel species (with abundance or presence {P}/absence {A} data) collected in Buzzard Branch by sampling year.

Species
None Observed

Herpetofauna

Cumulative list of herpetofauna species collected in or near Buzzard Branch.

Order (Common)	*Species*
Anura (Frogs and Toads)	American bullfrog, Eastern American toad, Pickerel frog, Northern spring peeper
Caudata (Salamanders and Newts)	Eastern red-backed salamander, Northern dusky salamander, Northern slimy salamander, Northern two-lined salamander

Benthic Macroinvertebrates

Cumulative list of benthic macroinvertebrates collected in Buzzard Branch by sampling year, RA = %Relative Abundance.

PHYLUM	*ORDER*	*FAMILY*	*GENUS*	*2000 RA*	*2002 RA*	*2003 RA*	*2004 RA*	*2005 RA*	*2006 RA*	*2007 RA*	*2008 RA*	*2009 RA*
Annelida	Haplotaxida	Enchytraeidae	na	-	-	*1.6	-	-	-	-	-	-
(Worm)	Lumbriculida	Lumbriculidae	na	-	-	*0.8	-	-	-	-	-	-
Arthropoda	Coleoptera	Elmidae	na	-	-	-	-	-	*0.8	-	-	-
	(Beetle)		*Oulimnius*	6.6	27.2	0.8	2.2	8	12.7	0.9	2.8	8
		Psephenidae	*Psephenus*	-	1.6	0.8	-	1.8	0.8	-	0.9	-
			Ectopria	-	-	-	-	0.9	1.7	0.9	-	-
	Decapoda	Cambaridae	na	-	-	-	-	*0.9	*0.8	-	-	-
	(Crayfish)			-	-	-	-	-	-	-	-	-
	Diptera	Blephariceridae	*Blepharicera*	-	-	-	-	0.9	-	-	1.9	-
	(True Fly)	Ceratopogonidae	na	-	-	*0.8	-	-	-	-	-	-
			Bezzia	-	-	0.8	-	-	-	-	-	-
		Chironomidae	*Conchapelopia*	-	0.8	-	-	-	-	-	-	-
			Corynoneura	-	-	-	-	-	-	-	0.9	-
			Diamesa	-	-	1.6	-	-	4.2	-	-	0.9
			Diamesinae	*0.8	-	-	*2.2	-	*1.7	-	-	-
			Eukiefferiella	5	-	0.8	1.1	-	7.6	0.9	-	6.2
			Heleniella	-	-	-	-	-	-	-	0.9	-
			Parachaetocladius	-	0.8	-	-	-	-	-	-	-
			Parametriocnemus	0.8	0.8	0.8	2.2	-	0.8	7.5	2.8	-
			Paraphaenocladius	-	-	-	-	-	0.8	-	-	0.9
			Podonominae	-	-	-	-	-	-	-	*0.9	-
			Polypedilum	-	-	0.8	2.2	-	0.8	4.7	11.3	-
			Pseudorthocladius	-	-	-	1.1	-	-	-	-	-
			Micropsectra	-	10.4	3.9	-	-	2.5	0.9	-	-
			Microtendipes	-	-	2.4	-	-	-	-	-	0.9

PHYLUM	ORDER	FAMILY	GENUS	2000 RA	2002 RA	2003 RA	2004 RA	2005 RA	2006 RA	2007 RA	2008 RA	2009 RA
			Orthocladiinae	-	-	*3.1	-	*0.9	-	-	-	-
			Orthocladius	-	-	-	-	-	-	-	0.9	1.8
			Stempellina	-	0.8	-	-	-	-	-	-	-
			Stempellinella	-	-	3.9	1.1	-	-	-	0.9	3.5
			Sympotthastia	-	0.8	-	1.1	-	-	-	-	0.9
			Tanytarsini	-	-	*2.4	-	-	-	*0.9	-	-
			Tanytarsus	1.7	-	-	-	-	-	-	5.7	-
			Thienemannimyia Group	-	-	-	*1.1	-	-	-	*3.8	-
			Tvetenia	-	-	0.8	-	-	-	0.9	0.9	-
			Zavrelimyia	0.8	-	-	-	-	-	-	-	-
		Empididae	*Chelifera*	-	1.6	-	-	-	-	0.9	0.9	-
			Clinocera	-	-	-	-	-	-	-	0.9	-
		Simuliidae	*Prosimulium*	52.9	1.6	8.7	10	3.6	25.4	16.8	9.4	32.7
			Simulium	0.8	-	-	-	-	-	-	2.8	-
			Stegopterna	1.7	-	-	-	-	-	-	-	-
		Tipulidae	na	-	-	-	-	*0.9	-	-	*0.9	-
			Dicranota	-	1.6	-	1.1	-	1.7	-	0.9	-
			Hexatoma	-	1.6	6.3	7.8	1.8	-	4.7	0.9	0.9
			Tipula	-	-	0.8	-	-	-	2.8	0.9	-
	Ephemeroptera (Mayfly)	Baetidae	na	*2.5	*3.2	*0.8	-	*3.6	-	-	*0.9	*2.7
			Acentrella	0.8	-	-	-	-	-	-	-	-
			Baetis	-	-	-	27.8	6.3	2.5	-	0.9	-
			Diphetor	-	-	-	-	-	-	-	1.9	-
		Ephemerellidae	na	-	*5.6	-	-	*6.3	-	-	-	*3.5
			Drunella	-	-	-	-	1.8	-	-	-	-
			Ephemerella	7.4	3.2	8.7	6.7	5.4	6.8	1.9	2.8	-
			Eurylophella	-	-	-	-	-	-	-	0.9	-
			Serratella	-	-	-	-	0.9	-	-	-	-
		Heptageniidae	na	-	*2.4	-	-	*4.5	-	*0.9	*1.9	*1.8
			Cinygmula	-	-	-	-	-	-	-	-	3.5
			Epeorus	1.7	9.6	6.3	-	18.8	11.9	24.3	6.6	10.6
			Leucrocuta	-	0.8	-	-	-	-	-	0.9	-
			Stenacron	-	-	0.8	-	-	-	-	-	1.8
			Stenonema	-	0.8	-	-	-	-	-	-	-
		Isonychiidae	*Isonychia*	-	-	0.8	-	-	-	-	-	-
		Leptophlebiidae	na	-	-	*10.2	-	*1.8	*4.2	*5.6	*1.9	*0.9
			Paraleptophlebia	3.3	6.4	-	13.3	-	-	-	-	5.3
	Megaloptera (Dobsonfly/Fishfly)	Corydalidae	*Nigronia*	0.8	1.6	1.6	-	-	-	-	-	-
				-	-	-	-	-	-	-	-	-
	Odonata (Dragonfly/Damselfly)	Gomphidae	na	*0.8	-	-	-	-	-	-	-	-
			Lanthus	-	-	1.6	-	-	-	-	-	-
	Plecoptera (Stonefly)	na	na	-	-	*1.6	-	-	-	-	-	-
		Capniidae	*Paracapnia*	-	-	0.8	-	-	-	-	-	-
		Chloroperlidae	na	*0.8	-	*0.8	*2.2	*3.6	-	*6.5	*0.9	-
			Sweltsa	0.8	0.8	6.3	4.4	2.7	0.8	12.1	4.7	2.7
		Leuctridae	na	-	*1.6	-	-	-	-	-	*14.2	-
			Leuctra	1.7	-	1.6	3.3	6.3	0.8	-	-	-
		Nemouridae	na	*0.8	-	-	-	-	-	-	-	-
			Amphinemura	3.3	1.6	0.8	-	6.3	-	-	-	4.4
		Peltoperlidae	*Tallaperla*	-	-	1.6	-	-	-	-	-	-
		Perlidae	na	-	-	*0.8	-	*0.9	*0.8	-	*2.8	*1.8
			Acroneuria	-	-	3.1	1.1	-	0.8	0.9	1.9	-
		Perlodidae	na	-	*1.6	*0.8	-	*2.7	*0.8	-	*0.9	-
			Isoperla	1.7	0.8	-	3.3	-	0.8	2.8	-	0.9
		Pteronarcyidae	*Pteronarcys*	-	2.4	-	-	2.7	1.7	-	-	1.8
		Taeniopterygidae	*Oemopteryx*	-	-	0.8	1.1	-	0.8	-	-	-
			Taenionema	-	-	-	-	-	-	-	-	0.9
	Trichoptera (Caddisfly)	Hydropsychidae	*Cheumatopsyche*	-	-	-	-	0.9	-	-	-	-
			Diplectrona	0.8	4	3.1	1.1	3.6	3.4	0.9	1.9	-
			Hydropsyche	-	-	0.8	1.1	-	0.8	-	-	0.9
		Philopotamidae	*Dolophilodes*	0.8	1.6	0.8	-	-	-	0.9	-	-
		Rhyacophilidae	*Rhyacophila*	0.8	0.8	3.1	1.1	1.8	-	-	-	-
		Uenoidae	*Neophylax*	-	1.6	0.8	-	-	-	-	0.9	-

Green families are intolerant (family tolerance values from 0 to 3); blue are moderately tolerant (family tolerance values from 3.1 to 6.9); and red are tolerant (family tolerance values from 7 to 10).
* Taxa not identified to genus.

Crabtree Creek (SAVA-204-S)

Site SAVA-204-S is located on Crabtree Creek in the Highlands region of Maryland. It is in the Savage River watershed in Garrett County. This site was sampled in 2000 to 2009. Its watershed is primarily forested (84%), with 10% agriculture and 6% urban.

Crabtree Creek in spring 2009.

Water Chemistry

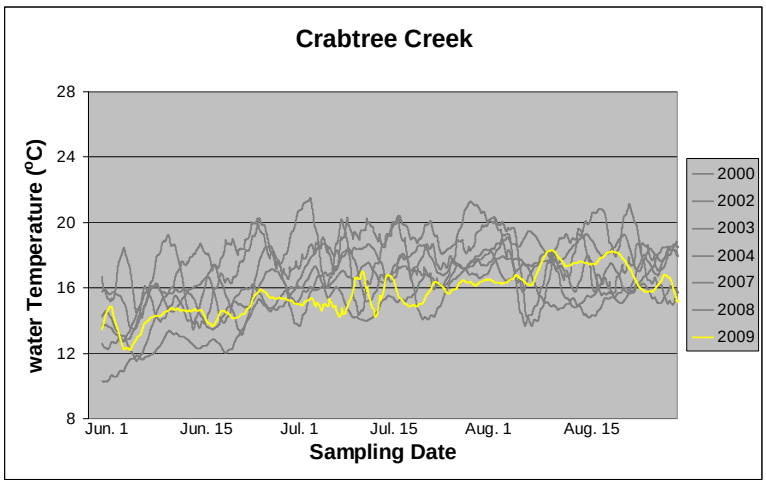
Summer water chemistry data collected at Crabtree Creek (2000 to 2009).

Parameter	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
Field pH	7.7	7.7	7.6	7.7	7.2	8.1	7.1	8.0	7.8	7.3
Dissolved Oxygen (mg/L)	9	8.2	9.3	8.6	8.1	7.4	9.4	8	8	9.9
Conductivity (mS)	0.14	0.16	0.17	0.13	0.19	0.19	0.18	0.17	0.17	0.14
Turbidity (NTU)	2.0	3.1	1.4	1.6	2.2	0.7	2.6	1.4	1.4	1.5

Physical Habitat

Physical habitat measurements collected at Crabtree Creek (2000 to 2009). Scored parameters are on a 0 (worst) to 20 (best) scale.

Parameter	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
Instream habitat (0-20)	20	19	19	20	18	17	18	19	18	18
Epifaunal substrate (0-20)	19	18	16	20	17	17	18	18	18	18
Velocity/Depth Diversity (0-20)	15	17	15	17	16	15	17	20	17	17
Pool Quality (0-20)	17	18	18	18	18	16	16	18	17	15
Riffle Quality (0-20)	17	18	18	19	18	16	19	20	19	19
Shading (%)	75	85	85	75	91	90	92	92	80	85
Embeddedness (%)	15	15	20	10	30	20	20	20	15	0
Discharge (cfs)	3.74	5.38	3.15	8.22	3.80	2.04	7.16	7.96	7.38	3.80



The above graph displays the temperature logger data for Crabtree Creek for 2000 to 2009. Maximum recorded temperatures occurred during the drought in July and August 2002. No data were available in 2001, 2005, and 2006.

Biology

Fish

Cumulative list of fish species (with abundance) collected in Crabtree Creek by sampling year.

Species	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
Blue Ridge sculpin	108	169	112	59	44	167	87	97	188	141
Bluntnose minnow	-	-	-	-	3	1	-	-	-	-
Brook trout	11	170	95	29	22	51	34	36	25	27
Brown trout	1	2	1	-	1	1	-	-	-	-
Central stoneroller	-	-	-	-	1	1	-	-	-	17
Common shiner	-	-	-	-	-	-	-	-	-	1
Creek chub	-	-	2	-	-	1	3	-	-	5
Cutlips minnow	-	-	-	-	-	-	1	-	-	-
Eastern blacknose dace	18	44	44	53	32	33	10	15	28	19
Fantail darter	37	31	13	51	14	24	16	44	57	24
Golden shiner	-	-	-	-	-	1	-	-	-	-
Longnose dace	41	18	30	43	48	58	25	48	72	51
Potomac sculpin	-	-	-	1	1	1	2	6	2	-
Pumpkinseed	-	-	-	-	-	-	-	-	3	-
Rainbow trout	-	-	-	-	1	-	-	-	-	-
Rock bass	-	-	-	37	36	55	27	26	21	4
White sucker	12	-	2	7	1	3	3	1	2	8
Yellow perch	-	-	-	-	-	-	1	-	-	-

Green indicates intolerant fish; blue are moderately tolerant; and red are tolerant.

Crayfish

Cumulative list of crayfish species (with abundance or presence {P}/absence {A} data) collected in Crabtree Creek by sampling year

Species	*2006*	*2007*	*2008*	*2009*
Common crayfish (*Cambarus bartonii bartonii*)	P	8	P	4

Mussels

Cumulative list of mussel species (with abundance or presence {P}/absence {A} data) collected in Crabtree Creek by sampling year.

Species
None Observed

Herpetofauna

Cumulative list of herpetofauna species collected in or near Crabtree Creek.

Order (Common)	*Species*
Caudata (Salamanders and Newts)	Allegheny mountain dusky salamander, Northern dusky salamander, Northern two-lined salamander, Long-tailed salamander, Seal salamander

Benthic Macroinvertebrates

Cumulative list of benthic macroinvertebrates collected in Crabtree Creek by sampling year, RA = %Relative Abundance.

PHYLUM	*ORDER*	*FAMILY*	*GENUS*	*2000 RA*	*2001 RA*	*2002 RA*	*2003 RA*	*2004 RA*	*2005 RA*	*2006 RA*	*2007 RA*	*2008 RA*	*2009 RA*
Annelida	Haplotaxida	Naididae	na	-	-	-	*0.8	-	-	-	-	-	-
(Worm)	Lumbriculida	Lumbriculidae	na	-	-	*1.8	-	-	-	*0.9	*0.9	-	*0.8
Arthropoda	Coleoptera	Elmidae	na	-	-	-	*0.8	-	-	-	-	-	-
	(Beetle)		*Oulimnius*	1.6	0.9	15.2	1.6	-	3.5	-	2.8	3.8	6.3
	Decapoda	Cambaridae	na	-	-	-	-	-	*0.9	-	-	-	*0.8
	(Crayfish)			-	-	-	-	-	-	-	-	-	-
	Diptera	Blephariceridae	*Blepharicera*	-	-	-	1.6	-	-	0.9	1.9	-	-
	(True Fly)	Ceratopogonidae	*Probezzia*	0.8	-	-	-	-	-	-	-	-	0.8
		Chironomidae	*Corynoneura*	-	-	-	-	-	-	-	-	-	0.8
			Cryptochironomus	-	0.9	-	-	-	-	-	-	-	-
			Diamesa	8.1	-	-	0.8	29.7	-	3.4	-	1.5	7.9
			Diamesinae	-	-	-	-	*3.4	-	-	-	*0.8	-

PHYLUM	ORDER	FAMILY	GENUS	2000 RA	2001 RA	2002 RA	2003 RA	2004 RA	2005 RA	2006 RA	2007 RA	2008 RA	2009 RA
			Eukiefferiella	-	1.8	-	2.4	2.5	-	-	-	2.3	1.3
			Heterotrissocladius	-	-	1.8	-	-	-	-	-	-	-
			Micropsectra	3.2	-	17.9	-	-	-	7.8	25.5	3.8	1.6
			Microtendipes	-	-	-	-	1.7	-	-	-	-	0.8
			Orthocladiinae	*1.6	-	-	*1.6	*0.8	-	*3.4	-	*1.5	-
			Orthocladius	1.6	-	-	-	-	-	0.9	0.9	1.5	3.2
			Parametriocnemus	4.8	0.9	2.7	-	2.5	1.7	4.3	-	0.8	3.2
			Paraphaenocladius	-	-	-	-	-	-	-	-	-	5.6
			Polypedilum	0.8	-	-	2.4	0.8	-	5.2	-	3.8	0.8
			Rheocricotopus	-	-	-	-	-	-	-	-	0.8	0.8
			Stempellinella	-	-	-	-	-	-	1.7	-	-	-
			Stilocladius	-	-	-	-	-	-	-	-	-	0.8
			Tanytarsini	*1.6	*4.5	-	-	-	-	-	-	*0.8	-
			Tanytarsus	-	-	-	-	-	-	0.9	-	-	0.8
			Thienemanniella	-	-	-	0.8	-	-	-	-	0.8	-
			Thienemannimyia Group	-	-	-	*2.4	-	-	*6	*0.9	*0.8	-
			Tvetenia	-	-	0.9	-	-	-	0.9	0.9	-	3.2
			Zavrelimyia	-	-	-	-	0.8	-	-	-	-	-
		Dixidae	*Dixa*	0.8	-	-	-	-	-	-	-	-	-
		Empididae	na	-	-	-	*0.8	-	-	-	-	-	-
			Chelifera	-	0.9	0.9	-	-	-	1.7	-	-	-
			Clinocera	-	0.9	-	-	-	-	0.9	-	1.5	-
		Simuliidae	na	-	-	-	*0.8	-	-	*0.9	-	-	-
			Prosimulium	1.6	0.9	-	-	-	0.9	0.9	1.9	1.5	0.8
			Simulium	-	-	-	-	-	-	0.9	-	-	-
		Tipulidae	*Antocha*	-	0.9	-	-	-	-	0.9	0.9	-	-
			Dicranota	0.8	-	-	0.8	-	-	1.7	-	-	-
			Hexatoma	0.8	-	-	-	-	1.7	-	-	-	-
			Ormosia	0.8	-	-	-	-	-	-	-	-	-
			Tipula	-	-	-	-	-	-	0.9	-	-	-
	Ephemeroptera (Mayfly)	Ameletidae	*Ameletus*	-	0.9	-	-	-	-	-	-	-	-
		Baetidae	na	*4	*0.9	*0.9	*15.1	-	-	-	*2.8	-	*1.6
			Acentrella	1.6	-	-	-	-	-	-	-	-	-
			Baetis	2.4	0.9	0.9	-	6.8	3.5	1.7	-	5.4	-
			Fallceon	-	-	0.9	-	-	-	-	-	-	-
		Ephemerellidae	na	-	*2.7	*1.8	20.6	-	-	*4.3	*0.9	*1.5	*4
			Drunella	-	-	-	-	-	-	-	1.9	-	-
			Ephemerella	21	7.1	9.8	7.1	8.5	13.9	-	4.7	10.8	3.2
		Heptageniidae	na	-	*9.8	*1.8	*2.4	-	-	-	-	-	-
			Cinygmula	5.6	-	-	-	-	6.1	-	-	3.1	2.4
			Epeorus	4.8	18.8	13.4	13.5	10.2	18.3	14.7	12.3	10.8	11.9
			Leucrocuta	-	-	-	-	-	-	-	0.9	2.3	-
			Maccaffertium	-	-	-	-	-	-	-	-	0.8	1.6
			Rhithrogena	-	-	-	-	-	0.9	-	-	-	-
			Stenonema	-	0.9	0.9	0.8	-	-	-	1.9	-	-
		Isonychiidae	*Isonychia*	0.8	-	-	0.8	-	0.9	0.9	-	-	-
		Leptophlebiidae	na	-	*2.7	*3.6	*2.4	*5.9	*9.6	*6	*9.4	*6.9	*4.8
			Paraleptophlebia	4	1.8	3.6	1.6	0.8	3.5	1.7	1.9	3.1	3.2
	Megaloptera (Dobsonfly/Fishfly)	Corydalidae	*Nigronia*	-	-	-	0.8	-	-	-	-	-	-
				-	-	-	-	-	-	-	-	-	-
	Odonata (Dragonfly/Damselfly)	Gomphidae	na	-	-	-	-	-	-	-	*0.9	-	-
				-	-	-	-	-	-	-	-	-	-
	Plecoptera (Stonefly)	Capniidae	*Paracapnia*	-	0.9	-	-	-	-	-	-	-	-
		Chloroperlidae	na	*4	*6.3	*0.9	*1.6	*10.2	*15.7	-	*0.9	*0.8	*0.8
			Alloperla	-	-	0.9	-	-	-	-	0.9	-	-
			Haploperla	-	-	-	-	-	-	3.4	-	2.3	-
			Sweltsa	-	-	-	0.8	-	0.9	0.9	-	-	1.6
		Leuctridae	na	-	*5.4	*4.5	*4	*5.9	-	-	*10.4	*13.1	*5.6
			Leuctra	1.6	-	1.8	-	-	-	0.9	-	0.8	-
		Nemouridae	*Amphinemura*	2.4	1.8	-	3.2	1.7	-	0.9	4.7	0.8	0.8
		Perlidae	na	-	-	-	-	-	-	*1.7	*0.9	-	*0.8
		Perlodidae	na	*3.2	*9.8	*0.9	*0.8	-	*0.9	-	-	*0.8	*0.8
			Isoperla	-	5.4	1.8	-	2.5	7	6	-	1.5	6.3
		Pteronarcyidae	*Pteronarcys*	2.4	1.8	-	0.8	-	-	0.9	-	-	0.8
		Taeniopterygidae	*Oemopteryx*	0.8	7.1	6.3	-	-	0.9	6.9	1.9	-	-
			Taenionema	-	-	-	-	-	-	-	-	0.8	2.4
			Taeniopteryx	-	-	-	-	0.8	-	-	-	-	-
	Trichoptera (Caddisfly)	Hydropsychidae	na	-	-	*0.9	-	-	0.9	-	-	-	-
			Ceratopsyche	-	-	-	-	-	-	-	-	-	3.2

PHYLUM	ORDER	FAMILY	GENUS	2000 RA	2001 RA	2002 RA	2003 RA	2004 RA	2005 RA	2006 RA	2007 RA	2008 RA	2009 RA
			Cheumatopsyche	2.4	-	-	-	-	-	-	0.9	2.3	2.4
			Diplectrona	-	-	-	-	0.8	-	-	-	-	-
			Hydropsyche	8.9	1.8	0.9	1.6	2.5	7.8	3.4	2.8	3.1	-
		Philopotamidae	*Dolophilodes*	-	-	1.8	-	-	-	-	-	-	-
			Wormaldia	0.8	-	-	-	-	-	-	-	-	-
		Polycentropodidae	na	-	-	-	-	-	-	-	*0.9	-	-
			Polycentropus								0.9	-	-
		Rhyacophilidae	*Rhyacophila*	-	0.9	0.9	4	0.8	0.9	-	-	-	-
		Uenoidae	*Neophylax*	-	-	-	-	-	-	0.9	-	0.8	1.6
Nemertea	Hoplonemertea (Worm)	Tetrastemmatidae	*Prostoma*	-	-	-	0.8	-	-	-	-	-	-
				-	-	-	-	-	-	-	-	-	-

Green families are intolerant (family tolerance values from 0 to 3); blue are moderately tolerant (family tolerance values from 3.1 to 6.9); and red are tolerant (family tolerance values from 7 to 10).

* Taxa not identified to genus.

Double Lick Run (SAVA-276-S)

Site SAVA-276-S is located on Double Lick Run in the Highlands region of Maryland. It is in the Savage River watershed in Garrett County. This site was sampled in 1996 and 2000 to 2009. Its watershed is primarily forested (80%), with 17% agriculture and 2% urban.


Double Lick Run in the spring 2009.

Water Chemistry

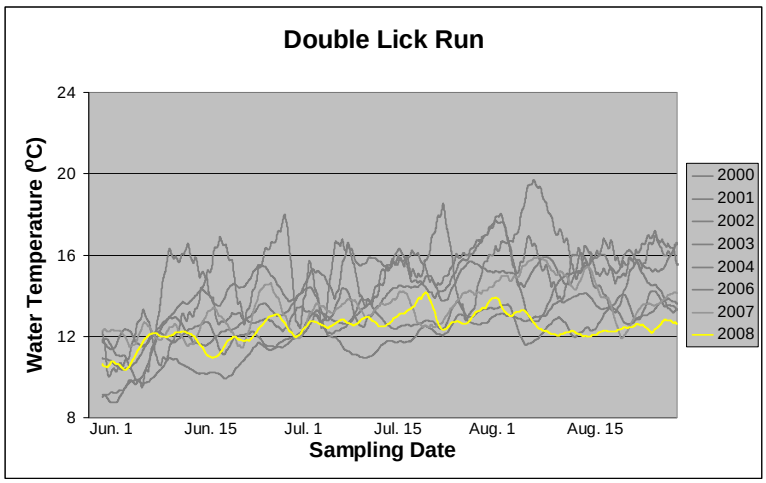
Summer water chemistry data collected at Double Lick Run (1996 and 2000 to 2009).

Parameter	*1996*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
Field pH	6.8	6.8	6.8	6.3	6.7	6.8	6.9	7.1	6.8	6.7	6.5
Dissolved Oxygen (mg/L)	9	8.3	10.1	11.8	10.0	8.1	9.5	10.2	8.8	10.7	9.3
Conductivity (mS)	0.06	0.05	0.05	0.05	0.05	0.05	0.05	0.04	0.04	0.05	0.04
Turbidity (NTU)	Not measured	2.6	0.7	1.5	1.1	2.6	1.8	6.9	1.2	2.1	2.9

Physical Habitat

Physical habitat measurements collected at Double Lick Run (1996 and 2000 to 2009). Scored parameters are on a 0 (worst) to 20 (best) scale.

Parameter	*1996*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
Instream habitat (0-20)	13	16	16	14	17	12	12	11	18	17	16
Epifaunal substrate (0-20)	12	18	19	18	19	15	15	16	17	18	18
Velocity/Depth Diversity (0-20)	9	10	13	10	15	10	7	8	10	10	10
Pool Quality (0-20)	7	10	15	10	16	10	9	7	10	10	10
Riffle Quality (0-20)	11	9	15	10	17	13	10	11	16	15	14
Shading (%)	90	98	93	95	98	96	95	95	95	90	85
Embeddedness (%)	40	10	15	20	15	30	25	20	40	25	15
Discharge (cfs)	0.33	0.36	0.20	0.07	0.64	1.12	0.16	0.10	0.15	0.36	0.20



The graph above displays the temperature logger data for Double Lick Run for 2000 to 2008. No data were available for 2005 and 2009.

Biology

Fish

Cumulative list of fish species (with abundance) collected in Double Lick Run by sampling year.

Species	*1996*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
Blue Ridge sculpin	39	16	19	16	19	19	9	18	13	20	17
Brook trout	4	32	59	44	67	152	53	7	19	9	11

Green indicates intolerant fish; blue are moderately tolerant; and red are tolerant.

Crayfish

Cumulative list of crayfish species (with abundance or presence {P}/absence {A} data) collected in Double Lick Run by sampling year

Species	*2006*	*2007*	*2008*	*2009*
Common crayfish (*Cambarus bartonii bartonii*)	P	2	P	7

Mussels

Cumulative list of mussel species (with abundance or presence {P}/absence {A} data) collected in Double Lick Run by sampling year.

Species
None Observed

Herpetofauna

Cumulative list of herpetofauna species collected in or near Double Lick Run.

Order (Common)	*Species*
Caudata (Salamanders and Newts)	Allegheny mountain dusky salamander, Northern dusky salamander, Northern slimy salamander, Northern spring salamander, Northern two-lined salamander, Eastern red-spotted newt, Seal salamander

Benthic Macroinvertebrates

Cumulative list of benthic macroinvertebrates collected in Double Lick Run by sampling year, RA = %Relative Abundance.

PHYLUM	*ORDER*	*FAMILY*	*GENUS*	*1996 RA*	*2000 RA*	*2001 RA*	*2002 RA*	*2003 RA*	*2004 RA*	*2005 RA*	*2006 RA*	*2007 RA*	*2008 RA*	*2009 RA*
Annelida	Lumbriculida	Lumbriculidae	na	-	-	*0.8	*0.9	*0.8	*1.7	-	-	-	*0.5	*0.7
(Worm)				-	-	-	-	-	-	-	-	-	-	-
Arthropoda	Amphipoda	na	na	-	-	-	-	-	-	-	-	-	*41.3	-
	(Scud)	Gammaridae	na	-	-	-	-	-	-	-	-	-	-	*1.5
			Gammarus	10	5.2	10.1	27.5	16.7	21.5	19.8	6.7	6.1	5.3	8.2
		Crangonyctidae	*Synurella*	-	-	-	-	-	-	1.7	-	-	-	-
	Coleoptera	Elmidae	na	-	*0.9	-	-	-	-	-	-	-	-	-
	(Beetle)		*Oulimnius*	1	-	-	-	-	0.8	-	0.8	-	-	-
	Collembola	Isotomidae	*Isotomurus*	-	-	-	-	-	-	0.9	-	-	-	-
	(Springtail)			-	-	-	-	-	-	-	-	-	-	-
	Decapoda	Cambaridae	na	-	-	-	-	-	-	-	-	*1	-	-
	(Crayfish)			-	-	-	-	-	-	-	-	-	-	-
	Diptera	Ceratopogonidae	*Bezzia*	-	-	-	-	-	-	-	-	-	0.5	-
	(True Fly)		*Probezzia*	-	-	0.8	-	-	-	-	-	1	-	-
		Chironomidae	*Cladotanytarsus*	-	-	-	0.9	-	-	-	-	-	0.5	-
			Diamesa	-	-	-	0.9	4	1.7	6	1.7	2	0.5	1.5
			Eukiefferiella	1	2.6	-	-	-	0.8	-	1.7	-	0.5	-
			Micropsectra	-	0.9	3.4	3.7	2.4	-	-	-	1	0.5	1.5
			Orthocladiinae	-	*1.7	-	-	-	-	-	-	-	-	-
			Orthocladius	-	-	-	-	-	-	-	0.8	-	-	-
			Parametriocnemus	-	0.9	1.7	0.9	-	0.8	-	-	1	0.5	1.5
			Paraphaenocladius	-	-	-	-	-	0.8	-	-	-	-	-
			Polypedilum	-	5.2	-	-	-	-	-	-	-	0.5	0.7
			Pseudorthocladius	-	-	0.8	-	-	-	-	-	-	-	-
			Rheocricotopus	-	-	-	-	-	-	-	0.8	-	-	0.7
			Stempellinella	-	0.9	-	-	-	-	-	-	-	-	-
			Symposiocladius	-	-	-	0.9	-	-	-	-	-	-	-
			Tanypodinae	-	-	-	-	-	-	-	*0.8	-	-	-

PHYLUM	ORDER	FAMILY	GENUS	1996 RA	2000 RA	2001 RA	2002 RA	2003 RA	2004 RA	2005 RA	2006 RA	2007 RA	2008 RA	2009 RA
			Tanytarsini	-	-	-	*1.8	-	*0.8	-	-	-	-	-
			Tanytarsus	1	-	-	-	-	-	-	-	-	-	-
			Thienemanniella	-	-	-	-	-	-	-	-	-	0.5	0.7
			Thienemannimyia Group	-	-	-	-	-	-	-	-	-	*0.5	-
			Tvetenia	-	-	-	-	1.6	-	-	-	-	-	-
		Empididae	*Chelifera*	-	0.9	-	-	-	-	0.9	-	1	-	-
		Simuliidae	*Prosimulium*	1	0.9	0.8	1.8	-	-	-	-	-	-	-
		Tipulidae	na	-	-	-	*0.9	-	-	-	-	-	-	-
			Dicranota	-	-	-	1.8	1.6	0.8	2.6	-	1	0.5	2.2
			Hexatoma	-	0.9	-	0.9	0.8	-	-	-	1	1.1	-
	Ephemeroptera	Ameletidae	*Ameletus*	-	-	2.5	1.8	0.8	-	-	0.8	1	0.5	-
	(Mayfly)	Baetidae	na	-	*0.9	-	-	-	-	-	-	-	-	*1.5
			Baetis	-	-	-	0.9	-	2.5	0.9	-	-	0.5	-
		Ephemerellidae	na	-	-	-	-	-	-	-	*13.3	*6.1	-	-
			Ephemerella	13	5.2	19.3	1.8	24.6	34.7	25.9	5.8	12.2	3.7	6.7
			Drunella	-	0.9	-	-	-	0.8	0.9	2.5	3.1	-	1.5
		Heptageniidae	na	*1	-	*8.4	*0.9	-	*0.8	-	*3.3	*1	-	-
			Cinygmula	8	13.9	-	6.4	-	-	5.2	19.2	2	1.6	2.2
			Epeorus	22	14.8	31.1	17.4	17.5	3.3	11.2	17.5	31.6	12.7	17.2
			Heptagenia	-	-	-	-	-	-	0.9	-	-	-	-
			Leucrocuta	-	2.6	-	-	-	-	-	-	-	1.1	-
			Stenonema	-	-	-	3.7	-	-	-	-	-	-	-
		Leptophlebiidae	na	-	-	-	*4.6	*0.8	-	*1.7	*3.3	-	*4.8	*6
			Paraleptophlebia	5	8.7	3.4	-	0.8	-	1.7	2.5	-	1.1	0.7
	Plecoptera	Chloroperlidae	na	*4	-	-	-	*2.4	*3.3	*2.6	-	*6.1	*1.1	-
	(Stonefly)		*Alloperla*	-	-	-	3.7	-	0.8	-	-	-	-	-
			Haploperla	-	-	-	-	-	-	-	0.8	-	-	-
			Sweltsa	-	2.6	-	1.8	-	-	-	-	-	-	-
		Leuctridae	na	-	-	*4.2	*0.9	-	-	-	-	-	*5.8	-
			Leuctra	6	14.8	-	1.8	9.5	9.9	4.3	10.8	6.1	7.4	26.1
			Paraleuctra	-	-	-	0.9	-	-	-	-	-	-	-
		Nemouridae	na	-	-	-	-	*0.8	-	-	-	-	-	-
			Amphinemura	9	7.8	6.7	0.9	4.8	1.7	1.7	0.8	5.1	1.1	6
			Ostrocerca	7	-	-	0.9	-	-	-	-	-	-	-
		Peltoperlidae	na	-	-	-	-	-	-	-	-	-	*0.5	*0.7
			Tallaperla	2	0.9	-	-	-	-	-	-	-	-	-
		Perlodidae	na	*2	*1.7	*1.7	*0.9	*3.2	*2.5	*6	*0.8	*1	-	*1.5
			Isoperla	-	-	-	-	-	-	-	-	1	-	-
			Malirekus	-	-	-	-	-	5	0.9	-	-	-	-
			Yugus	-	-	-	-	-	-	-	-	-	1.6	2.2
		Pteronarcyidae	*Pteronarcys*	2	1.7	1.7	0.9	-	0.8	0.9	2.5	5.1	-	3.7
	Trichoptera	Hydropsychidae	na	-	-	*0.8	-	-	-	-	-	-	-	-
	(Caddisfly)		*Cheumatopsyche*	-	-	-	-	-	-	-	-	-	-	-
			Diplectrona	2	0.9	-	0.9	1.6	-	-	-	-	1.1	0.7
			Hydropsyche	1	-	-	-	-	-	-	-	-	-	-
			Parapsyche	-	-	-	-	-	0.8	-	-	1	-	-
		Limnephilidae	*Pycnopsyche*	-	0.9	-	-	-	-	-	-	-	-	-
		Philopotamidae	na	-	-	-	-	*0.8	-	-	-	-	*0.5	-
			Dolophilodes	1	-	-	0.9	-	-	0.9	-	-	-	0.7
			Wormaldia	-	-	-	0.9	-	0.8	-	-	1	-	-
		Psychomyiidae	*Lype*	-	-	-	-	-	-	-	0.8	-	-	-
		Rhyacophilidae	*Rhyacophila*	-	0.9	0.8	0.9	2.4	2.5	2.6	0.8	1	1.6	2.2
		Uenoidae	*Neophylax*	1	-	0.8	1.8	2.4	-	-	0.8	-	-	0.7
Nematomorpha	Gordioidea	Gordiidae	na	-	-	-	*0.9	-	-	-	-	-	-	-
	(Worm)			-	-	-	-	-	-	-	-	-	-	-

Green families are intolerant (family tolerance values from 0 to 3); blue are moderately tolerant (family tolerance values from 3.1 to 6.9); and red are tolerant (family tolerance values from 7 to 10).
* Taxa not identified to genus.

Fifteenmile Creek (FIMI-207-S)

Site FIMI-207-S is located on Fifteenmile Creek in the Highlands region of Maryland. It is in the Fifteen Mile Creek watershed in Allegany County. This site was sampled in 1995 and 2000 to 2009. Its watershed is primarily forested (88%), with 7% agriculture and 5% urban.


Fifteenmile Creek in spring 2009.

Water Chemistry

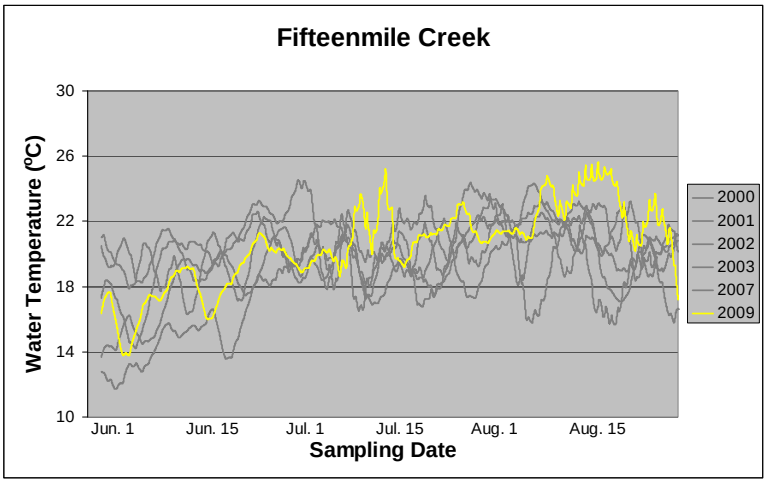
Summer water chemistry data collected at Fifteenmile Creek (1995 and 2000 to 2009).

Parameter	*1995*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
Field pH	7.3	7.6	7.2	7.3	7.3	6.2	7.1	6.6	7.2	7.0	6.9
Dissolved Oxygen (mg/L)	7.4	9	7.4	8.6	7.2	8.4	7.1	8.6	5.8	12	8.8
Conductivity (mS)	0.06	0.07	0.08	0.08	0.07	0.06	0.09	0.07	0.07	0.08	0.07
Turbidity (NTU)	Not measured	0.5	0.7	0.2	0.2	2.6	2.6	2.7	1.4	5.8	2.3

Physical Habitat

Physical habitat measurements collected at Fifteenmile Creek (1995 and 2000 to 2009). Scored parameters are on a 0 (worst) to 20 (best) scale.

Parameter	*1995*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
Instream habitat (0-20)	13	15	11	11	11	13	10	10	9	8	10
Epifaunal substrate (0-20)	8	10	11	11	10	16	10	13	8	9	11
Velocity/Depth Diversity (0-20)	8	9	5	5	8	10	8	11	9	9	10
Pool Quality (0-20)	18	8	6	10	9	10	7	11	9	8	8
Riffle Quality (0-20)	0	11	5	11	8	15	9	12	12	12	13
Shading (%)	30	50	50	65	60	60	76	65	60	65	70
Embeddedness (%)	0	5	10	15	20	20	30	30	0	0	0
Discharge (cfs)	2.23	0.55	0.10	0.09	0.22	3.05	0.42	1.60	2.47	5.06	2.09



The graph above displays the temperature logger data for Fifteenmile Creek for 2000 to 2009. Maximum recorded temperatures occurred during the drought in July and August 2002 and in August 2007. No data were available for 2004 through 2006 and 2008.

Biology

Fish

Cumulative list of fish species (with abundance) collected in Fifteenmile Creek by sampling year.

Species	*1995*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
Blue Ridge sculpin	-	-	-	1	-	-	-	31	1	-	1
Bluntnose minnow	9	23	5	28	26	43	85	63	40	19	29
Central stoneroller	-	208	125	30	79	182	111	33	75	19	40
Chain pickerel	19	-	2	-	-	-	2	-	-	-	-
Creek chub	-	28	85	43	5	24	82	5	21	21	34
Creek chubsucker	18	-	-	-	2	-	-	-	-	-	1
Eastern blacknose dace	-	215	211	83	34	17	50	29	67	91	75
Fallfish	1	-	-	-	3	-	1	-	-	-	-
Fantail darter	-	56	164	92	68	106	52	59	62	39	52
Green sunfish	11	1	-	-	3	-	1	-	1	-	-
Greenside darter	-	48	32	17	5	25	19	8	16	3	15
Largemouth bass	2	-	-	-	-	-	-	-	-	-	-
Longnose dace	-	29	35	1-	2	15	14	4	3	5	2
Northern hogsucker	-	-	4	-	-	2	-	-	-	-	1
Potomac sculpin	10	165	217	239	122	345	283	159	234	276	285
Rainbow darter	-	-	-	-	-	-	-	-	1-	17	46
Redbreast sunfish	-	-	-	-	1	-	-	-	-	-	-
Rock bass	16	-	3	6	-	7	6	1	-	-	-
Smallmouth bass	5	8	-	2	-	4	-	2	-	3	-
Tessellated darter	-	-	-	-	-	-	1	-	-	-	-
White sucker	3	9	22	10	3	5	9	-	7	10	7

Green indicates intolerant fish; blue are moderately tolerant; and red are tolerant.

Crayfish

Cumulative list of crayfish species (with abundance or presence {P}/absence {A} data) collected in Fifteenmile Creek by sampling year

Species	*2006*	*2007*	*2008*	*2009*
Common crayfish (*Cambarus bartonii bartonii*)	P	12	P	19
Allegheny crayfish (*Orconectes obscurus*)	A	65	A	92
(*Orconectes* sp.)	P	A	A	A

Mussels

Cumulative list of mussel species (with abundance or presence {P}/absence {A} data) collected in Fifteenmile Creek by sampling year.

Species
None Observed

Herpetofauna

Cumulative list of herpetofauna species collected in or near Fifteenmile Creek.

Order (Common)	*Species*
Anura (Frogs and Toads)	Eastern American toad, Northern green frog, Pickerel frog
Caudata (Salamanders and Newts)	Eastern red-spotted newt , Northern dusky salamander, Northern two-lined salamander
Squamata (Snakes and Lizards)	Northern watersnake

Benthic Macroinvertebrates

Cumulative list of benthic macroinvertebrates collected in Fifteenmile Creek by sampling year,

RA = %Relative Abundance.

PHYLUM	*ORDER*	*FAMILY*	*GENUS*	*1995 RA*	*2000 RA*	*2001 RA*	*2002 RA*	*2003 RA*	*2004 RA*	*2005 RA*	*2006 RA*	*2007 RA*	*2008 RA*	*2009 RA*
Annelida	Haplotaxida	Naididae	na	-	-	-	-	*0.8	-	-	-	-	-	-
(Worm)	Lumbriculida	Lumbriculidae	na	*4.4	-	-	-	-	-	-	-	-	-	-
Arthropoda	Coleoptera	Elmidae	*Optioservus*	-	-	-	1	-	-	-	-	-	-	-
	(Beetle)	Psephenidae	*Psephenus*	-	-	-	2.9	-	-	-	-	-	-	-
	Decapoda	Cambaridae	na	*1.1	-	-	-	-	-	-	-	-	-	-

PHYLUM	ORDER	FAMILY	GENUS	1995 RA	2000 RA	2001 RA	2002 RA	2003 RA	2004 RA	2005 RA	2006 RA	2007 RA	2008 RA	2009 RA
	(Crayfish)			-	-	-	-	-	-	-	-	-	-	-
	Diptera	Athericidae	*Atherix*	-	-	-	3.9	-	-	-	6	-	-	-
	(True Fly)	Chironomidae	*Conchapelopia*	14.3	0.8	-	-	-	-	-	-	-	-	-
			Corynoneura	1.1	-	-	-	-	-	-	-	-	-	-
			Diplocladius	-	-	-	2	-	-	-	-	-	-	-
			Eukiefferiella	-	-	-	-	0.8	-	-	-	-	1	-
			Micropsectra	3.3	3.4	3.6	-	11.2	3.4	-	0.9	7.1	2.9	0.9
			Microtendipes	2.2	-	0.9	2.9	-	-	-	-	-	1.9	-
			Parametriocnemus	-	-	2.7	3.9	0.8	0.8	2.7	2.6	-	-	-
			Paraphaenocladius	-	-	-	2	-	-	-	-	-	-	-
			Polypedilum	-	-	-	-	-	1.7	13..5	-	0.9	8.7	-
			Potthastia	-	-	1.8	-	-	-	-	-	-	-	-
			Orthocladiinae	-	-	-	-	*4	-	-	-	-	-	-
			Orthocladius	-	-	-	1	-	0.8	-	-	-	-	-
			Sympotthastia	1.1	-	-	-	-	-	-	-	-	-	-
			Tanytarsini	-	-	-	-	*0.8	-	-	-	-	-	-
			Tanytarsus	-	-	-	2	-	-	-	-	-	-	-
			Thienemannimyia Group	-	-	-	-	-	-	-	*0.9	*1.8	-	*0.9
		Empididae	*Clinocera*	-	-	-	-	-	-	-	-	0.9	1.9	-
		Simuliidae	na	-	-	-	-	*0.8	-	-	*0.9	-	-	-
			Prosimulium	-	13.6	20	7.8	8	-	11.7	25.6	9.8	16.5	21.3
			Simulium	-	9.3	-	-	-	-	-	-	0.9	-	-
			Stegopterna	1.1	-	-	-	-	-	-	-	-	-	-
		Tipulidae	*Antocha*	-	-	-	-	-	1.7	-	-	-	-	-
			Hexatoma	1.1	-	-	-	-	-	0.9	0.9	-	-	-
	Ephemeroptera	Ameletidae	*Ameletus*	1.1	-	-	-	1.6	-	-	-	-	-	0.9
	(Mayfly)	Baetidae	na	-	-	-	-	-	*0.8	*1.8	-	-	-	-
			Acentrella	-	2.5	-	-	-	-	2.7	1.7	-	-	-
			Heterocloeon	-	-	-	-	-	-	-	-	-	1	-
		Caenidae	*Caenis*	2.2	-	-	-	0.8	-	-	-	-	-	-
		Ephemerellidae	na	-	-	-	*1	-	-	*10.8	-	-	*8.7	*25.9
			Ephemerella	-	8.5	12.7	-	23.2	16.9	10.8	3.4	13.4	9.7	-
			Eurylophella	4.4	-	-	1	0.8	-	-	-	-	-	-
			Drunella	-	1.7	4.5	-	2.4	0.8	1.8	1.7	-	-	-
			Serratella	1.1	-	-	-	-	1.7	-	-	-	-	-
		Ephemeridae	*Ephemera*	2.2	-	-	-	-	-	-	-	-	-	-
		Heptageniidae	na	*1.1	-	*7.3	-	*5.6	-	-	*0.9	-	*9.7	*11.1
			Cinygmula	-	3.4	-	-	-	43.2	9	-	10.7	1	-
			Epeorus	1.1	0.8	3.6	-	1.6	7.6	6.3	4.3	3.6	5.8	8.3
			Leucrocuta	-	-	-	-	-	0.8	-	-	-	-	0.9
			Maccaffertium	-	-	-	-	-	-	-	-	-	1	0.9
			Stenacron	31.9	-	-	1	-	-	0.9	-	-	-	-
			Stenonema	9.9	-	-	9.8	0.8	-	-	0.9	1.8	-	-
		Isonychiidae	*Isonychia*	-	-	0.9	3.9	-	-	0.9	-	-	-	0.9
		Leptophlebiidae	na	-	*7.6	-	-	*1.6	-	*1.8	*0.9	*1.8	-	-
			Paraleptophlebia	-	-	-	-	1.6	-	-	-	-	-	-
	Isopoda	Asellidae	*Caecidotea*	1.1	-	0.9	-	-	1.7	-	-	-	-	-
	(Aquatic Sow Bug)			-	-	-	-	-	-	-	-	-	-	-
	Megaloptera	Corydalidae	*Nigronia*	-	-	-	1	-	-	-	-	-	-	-
	(Dobsonfly/Fishfly)			-	-	-	-	-	-	-	-	-	-	-
	Odonata	Gomphidae	na	-	-	-	*6.9	-	-	-	-	-	-	-
	(Dragonfly/Damselfly)		*Stylogomphus*	-	-	-	1	-	-	-	-	-	-	-
				-	-	-	-	-	-	-	-	-	-	-
	Plecoptera	Capniidae	na	-	-	-	*2	-	-	-	-	-	-	-
	(Stonefly)	Chloroperlidae	na	-	*5.9	*0.9	-	-	-	-	-	*8	*2.9	-
			Haploperla	-	-	-	-	-	-	13.5	-	-	-	0.9
			Sweltsa	7.7	-	-	-	-	5.9	1.8	0.9	0.9	1.9	0.9
		Leuctridae	na	-	-	*0.9	-	*0.8	*2.5	-	-	-	*1	-
		Nemouridae	na	-	-	-	*6.9	-	-	-	*2.6	-	-	*4.6
			Amphinemura	-	32.2	20.9	2.9	18.4	4.2	4.5	5.1	23.2	12.6	0.9
			Ostrocerca	3.3	-	-	-	3.2	-	-	0.9	-	-	-
			Prostoia	-	-	-	-	0.8	-	-	2.6	-	1	-
		Perlidae	na	-	-	-	*2	-	-	-	-	*0.9	-	-
			Acroneuria	-	-	0.9	-	-	-	-	0.9	-	-	0.9
		Perlodidae	na	*1.1	*1.7	*4.5	-	*3.2	-	-	-	*0.9	*1	*0.9
			Isoperla	-	0.8	-	-	1.6	4.2	1.8	20.5	11.6	6.8	10.2
		Taeniopterygidae	*Oemopteryx*	-	-	8.2	4.9	0.8	-	-	13.7	-	-	-
			Taenionema	-	-	-	-	-	-	-	-	-	1	4.6
	Trichoptera	Glossosomatidae	*Glossosoma*	-	-	-	-	-	-	0.9	-	-	-	-

PHYLUM	*ORDER*	*FAMILY*	*GENUS*	*1995 RA*	*2000 RA*	*2001 RA*	*2002 RA*	*2003 RA*	*2004 RA*	*2005 RA*	*2006 RA*	*2007 RA*	*2008 RA*	*2009 RA*
	(Caddisfly)	Hydropsychidae	*Cheumatopsyche*	1.1	0.8	2.7	20.6	-	-	0.9	-	-	-	-
		Lepidostomatidae	*Lepidostoma*	-	-	-	-	-	-	-	-	-	-	0.9
		Philopotamidae	na	-	*5.9	*1.8	-	*3.2	-	-	*0.9	*0.9	-	-
			Chimarra	-	-	-	1	-	-	-	-	-	-	-
		Polycentropodidae	na	-	-	-	-	-	-	*0.9	-	*0.9	-	-
			Polycentropus	1.1	-	-	-	-	-	-	0.9	*0.9	-	0.9
		Rhyacophilidae	*Rhyacophila*	-	-	-	-	-	-	-	-	-	1	-
		Uenoidae	*Neophylax*	-	-	-	3.9	0.8	0.8	-	-	-	1	1.9
Platyhelminthes	Tricladida	Dugesiidae	*Cura*	-	0.8	-	-	-	-	-		-	-	-
	(Flat Worm)	Planariidae	na	-	-	-	*1	-	-	-	-	-	-	-

Green families are intolerant (family tolerance values from 0 to 3); blue are moderately tolerant (family tolerance values from 3.1 to 6.9); and red are tolerant (family tolerance values from 7 to 10).
* Taxa not identified to genus.

High Run (UMON-288-S)

Site UMON-288-S is located on High Run in the Highlands region of Maryland. It is in the Upper Monocacy River watershed in Frederick County. This site was sampled from 2000 to 2009. Its watershed is 100% forested.


High Run in spring 2008.

Water Chemistry

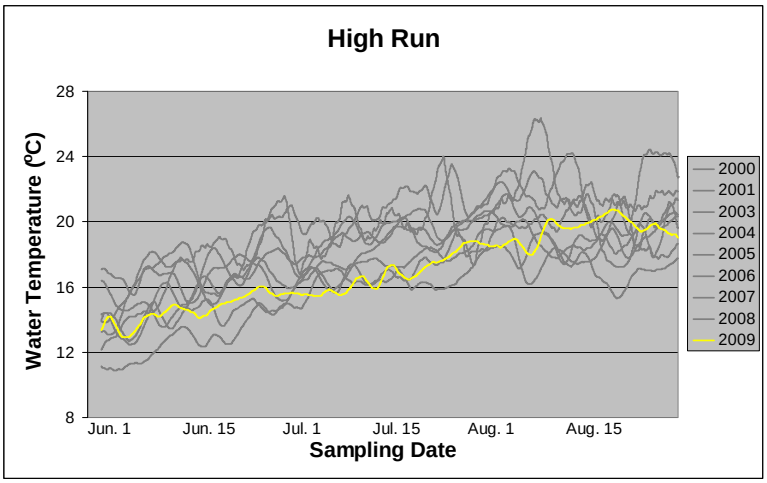
Summer water chemistry data collected at High Run (2000 to 2009)

Parameter	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
Field pH	7.1	6.7	6.1	6.5	6.6	6.5	5.8	6.4	6.4	6.0
Dissolved Oxygen (mg/L)	7.9	8.9	10.5	8.3	7.3	10.1	9.7	11.3	9.1	9.4
Conductivity (mS)	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Turbidity (NTU)	2.5	2.2	2.2	0.7	2.1	1.5	2.6	2.0	1.7	2.0

Physical Habitat

Physical habitat measurements collected at High Run (2000 to 2009). Scored parameters are on a 0 (worst) to 20 (best) scale.

Parameter	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
Instream habitat (0-20)	17	18	18	17	17	17	18	18	18	18
Epifaunal substrate (0-20)	18	16	18	16	19	18	18	18	18	18
Velocity/Depth Diversity (0-20)	14	10	10	11	16	15	15	10	10	10
Pool Quality (0-20)	17	15	13	14	16	16	18	10	10	10
Riffle Quality (0-20)	17	15	17	16	17	16	19	18	15	14
Shading (%)	95	85	92	95	95	98	95	90	85	85
Embeddedness (%)	20	20	20	35	20	25	35	25	25	25
Discharge (cfs)	1.11	0.28	0.46	0.84	1.48	1.03	1.44	0.58	0.39	1.60



The graph above displays the temperature logger data for High Run from 2000 to 2009. Maximum recorded temperatures occurred during August 2001. No data were available in 2002.

Biology

Fish

Cumulative list of fish species (with abundance) collected in High Run by sampling year.

Species	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
Brook trout	41	167	30	23	67	51	36	54	39	19

Green indicates intolerant fish; blue are moderately tolerant; and red are tolerant.

Crayfish

Cumulative list of crayfish species (with abundance or presence {P}/absence {A} data) collected in High Run by sampling year

Species	*2006*	*2007*	*2008*	*2009*
Common crayfish (*Cambarus bartonii bartonii*)	P	9	P	9

Mussels

Cumulative list of mussel species (with abundance or presence {P}/absence {A} data) collected in High Run by sampling year.

Species
None Observed

Herpetofauna

Cumulative list of herpetofauna species collected in or near High Run.

Order(Common)	*Species*
Anura (Frogs and Toads)	Eastern American toad, Gray tree frog, Northern green frog, Pickerel frog
Caudata (Salamanders and Newts)	Eastern red-backed salamander, Northern dusky salamander, Northern spring salamander, Northern two-lined salamander, Eastern red-spotted newt

Benthic Macroinvertebrates

Cumulative list of benthic macroinvertebrates collected in High Run by sampling year, RA = %Relative Abundance.

PHYLUM	*ORDER*	*FAMILY*	*GENUS*	*1996 RA*	*2000 RA*	*2001 RA*	*2002 RA*	*2003 RA*	*2004 RA*	*2005 RA*	*2006 RA*	*2007 RA*	*2008 RA*	*2009 RA*
Annelida	Branchiobdellida	na	na	-	*1.6	-	-	-	-	-	-	-	-	-
(Worm)	Haplotaxida	Naididae	na	*0.8	*0.8	-	-	-	-	-	-	-	-	-
Arthropoda	Coleoptera	Elmidae	*Oulimnius*	10.3	7.4	2.8	17.9	6.8	-	10.6	10.3	6	1.9	0.8
	(Beetle)		*Promoresia*	-	-	-	7.7	0.8	-	-	-	-	-	-
		Psephenidae	*Ectopria*	-	-	-	-	0.8	-	0.8	-	0.9	0.9	-
			Psephenus	-	-	-	-	-	-	-	0.9	-	-	-
	Decapoda	Cambaridae	na	-	-	-	-	-	-	-	-	-	-	*0.8
	(Crayfish)		*Cambarus*	-	0.8	-	-	-	-	-	1.7	-	-	-
	Diptera	Ceratopogonidae	*Bezzia*	-	-	-	-	-	-	-	-	-	0.9	-
	(True Fly)	Chironomidae	na	-	-	-	-	-	*0.8	-	-	-	-	-
			Brillia	-	-	-	-	-	-	-	-	-	0.9	-
			Cladotanytarsus	-	-	-	-	-	-	-	-	0.9	-	1.7
			Diamesa	-	-	-	-	1.7	-	0.8	2.6	2.6	-	0.8
			Eukiefferiella	1	0.8	-	2.6	1.7	2.4	-	0.9	3.4	-	2.5
			Micropsectra	-	0.8	6.5	4.3	4.2	4	16.3	-	0.9	-	-
			Microtendipes	-	-	-	-	-	-	-	-	-	1.9	-
			Orthocladiinae	-	-	-	-	*0.8	-	-	*0.9	-	*0.9	-
			Orthocladius	1	-	-	-	-	-	-	-	-	-	1.7
			Parametriocnemus	5.2	0.8	-	-	0.8	-	3.3	0.9	1.7	3.7	-
			Rheocricotopus	-	0.8	-	-	-	-	-	-	-	0.9	-
			Stempellinella	-	-	-	0.9	1.7	-	-	-	-	-	8.4
			Sympotthastia	13.4	-	-	-	-	-	-	0.9	-	-	-
			Tanypodinae	-	-	-	-	-	-	-	-	-	*0.9	-
			Tanytarsini	-	-	-	*0.9	*0.8	-	-	-	-	-	-
			Tvetenia	-	-	-	-	1.7	0.8	-	-	0.9	-	-
		Dixidae	*Dixa*	-	-	-	-	-	-	0.8	-	-	-	-
		Simuliidae	na	-	-	-	-	-	-	-	*0.9	*0.9	-	-
			Prosimulium	24.7	-	3.7	-	2.5	-	-	22.2	2.6	0.9	6.7

PHYLUM	ORDER	FAMILY	GENUS	1996 RA	2000 RA	2001 RA	2002 RA	2003 RA	2004 RA	2005 RA	2006 RA	2007 RA	2008 RA	2009 RA
			Stegopterna	1	0.8	-	-	-	-	-	-	-	-	-
		Tipulidae	*Antocha*	1	-	-	0.9		-	1.6	-	-	-	0.8
			Dicranota	-	-	-	0.9	0.8	2.4	0.8	-	-	2.8	-
			Hexatoma	-	-	-	1.7	0.8	2.4	-	0.9	3.4	-	-
			Tipula	1	-	-	-	-	-	-	-	-	-	-
	Ephemeroptera	Ameletidae	*Ameletus*	-	-	-	-	-	-	-	-	-	-	4.2
	(Mayfly)	Baetidae	na	-	-	*4.6	*1.7	-	-	-	-	-	-	*0.8
			Acentrella	-	0.8	-	-	-	-	-	-	-	-	-
			Baetis	-	6.6	-	-	-	13.5	7.3	-	1.7	-	1.7
			Diphetor	-	-	-	-	-	-	-	-	-	0.9	-
		Ephemerellidae	na	-	-	-	-	-	-	-	-	*19.8	-	*16.8
			Ephemerella	-	36.9	41.7	22.2	20.3	17.5	23.6	24.8	12.1	18.5	-
			Eurylophella	1	-	-	-	-	-	-	-	-	-	0.8
		Heptageniidae	na	-	-	*13	*8.5	*9.3	-	-	-	*4.3	-	*11.8
			Cinygmula	-	4.1	-	-	-	-	4.9	6	3.4	5.6	2.5
			Epeorus	1	3.3	7.4	5.1	2.5	15.1	1.6	6	5.2	5.6	14.3
			Leucrocuta	-	2.5	-	-	-	-	-	-	-	2.8	-
			Maccaffertium	-	-	-	-	-	-	-	-	-	0.9	-
			Stenacron	4.1	-	-	-	-	-	-	-	-	-	-
			Stenonema	11.3	-	-	-	-	0.8	-	-	0.9	-	-
		Isonychiidae	*Isonychia*	2.1	-	-	-	-	-	-	-	-	-	-
		Leptophlebiidae	na	-	-	*4.6	-	*5.9	*6.3	-	*6	*6	*2.8	*2.5
			Paraleptophlebia	-	11.5	-	9.4	5.1	0.8	1.6	-	-	0.9	4.2
	Megaloptera	Corydalidae	*Nigronia*	-	-	-	-	-	-	-	-	0.9	-	-
	(Dobsonfly/ Fishfly)			-	-	-	-	-	-	-	-	-	-	-
	Plecoptera	Capniidae	na	*1	-	-	-	-	-	-	-	-	-	-
	(Stonefly)	Chloroperlidae	na	-	*0.8	-	-	-	*1.6	*2.4	*1.7	-	*0.9	*0.8
			Sweltsa	-	0.8	-	-	0.8	2.4	1.6	0.9	0.9	-	3.4
		Leuctridae	na	-	-	-	-	-	-	-	-	-	*6.5	*0.8
			Leuctra	-	2.5	3.7	1.7	2.5	4.8	6.5	-	1.7	7.4	-
		Nemouridae	*Amphinemura*	-	2.5	-	-	-	-	-	0.9	3.4	4.6	0.8
			Prostoia	4.1	-	-	-	-	-	-	-	-	-	-
		Peltoperlidae	*Tallaperla*	-	-	-	-	2.5	-	-	-	2.6	-	-
		Perlidae	na	-	-	-	-	*0.8	*0.8	*0.8	*0.9	*0.9	-	-
			Acroneuria	-	-	0.9	-	-	-	-	0.9	-	-	0.8
		Perlodidae	na	*4.1	*4.1	*1.9	*4.3	*4.2	*2.4	*4.1	*1.7	*2.6	*2.8	*3.4
		Pteronarcyidae	*Pteronarcys*	-	-	-	0.9	-	-	2.4	-	-	-	-
	Trichoptera	Hydropsychidae	na	-	-	*2.8	-	-	-	-	-	-	-	-
	(Caddisfly)		*Cheumatopsyche*	2.1	-	0.9	-	-	-	-	-	-	-	-
			Diplectrona	7.2	6.6	1.9	5.1	13.6	11.1	5.7	4.3	7.8	16.7	2.5
			Hydropsyche	1	-	-	-	-	7.1	0.8	-	-	-	-
		Lepidostomatidae	*Lepidostoma*	-	2.5	0.9	3.4	0.8	-	0.8	0.9	-	3.7	0.8
		Philopotamidae	*Chimarra*	1	-	-	-	-	-	-	-	-	-	-
			Dolophilodes	-	-	-	-	0.8	-	-	-	-	1.9	-
		Polycentropodidae	*Polycentropus*	-	-	-	-	0.8	-	0.8	-	-	-	-
		Rhyacophilidae	*Rhyacophila*	1	-	0.9	-	0.8	3.2	-	0.9	0.9	0.9	-
		Uenoidae	*Neophylax*	4.1	-	0.9	-	0.8	-	-	1.7	0.9	-	2.5
Nematomorpha	Gordioidea	Gordiidae	na	-	-	*0.9	-	*1.7	-	-	-	-	-	-
	(Worm)			-	-	-	-	-	-	-	-	-	-	-

Green families are intolerant (family tolerance values from 0 to 3); blue are moderately tolerant (family tolerance values from 3.1 to 6.9); and red are tolerant (family tolerance values from 7 to 10).

* Taxa not identified to genus.

Mill Run (PRLN-626-S)

Site PRLN-626-S is located on Mill Run in the Highlands region of Maryland. It is in the Lower North Branch Potomac River watershed in Allegany County. This site was sampled in 1996 and 2000 to 2009. Its watershed is 98% forested and 2% agriculture.


Mill Run in spring 2008.

Water Chemistry

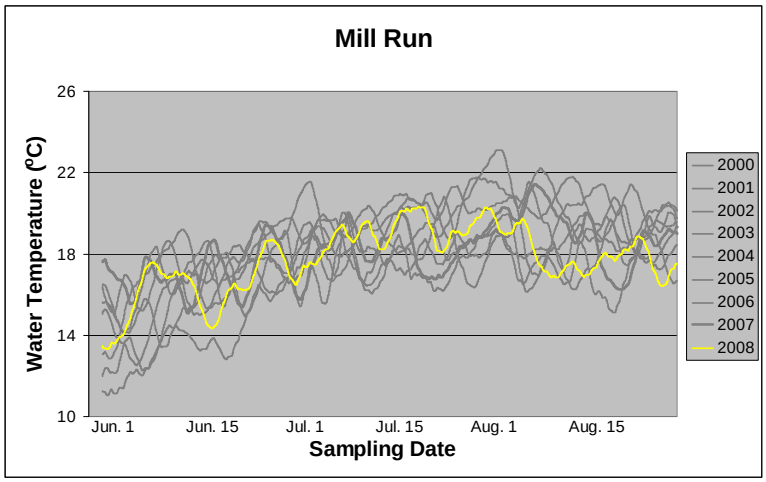
Summer water chemistry data collected at Mill Run (1996 and 2000 to 2009).

Parameter	1996	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Field pH	7.7	7.4	7.7	7.9	7.5	7.7	7.8	7.6	8.0	7.7	7.5
Dissolved Oxygen (mg/L)	8.5	6.8	8.9	8.8	8.4	8.3	9.4	8.1	7.6	7.4	9.7
Conductivity (mS)	0.14	0.11	0.16	0.19	0.12	0.16	0.21	0.19	0.17	0.16	0.12
Turbidity (NTU)	Not measured	6.2	4.3	13.2	7.6	4.3	4.4	6.5	3.2	12.3	7.6

Physical Habitat

Physical habitat measurements collected at Mill Run (1996 and 2000 to 2009). Scored parameters are on a 0 (worst) to 20 (best) scale.

Parameter	*1996*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
Instream habitat (0-20)	15	17	18	16	18	16	16	15	18	18	18
Epifaunal substrate (0-20)	10	17	18	16	14	16	16	12	18	19	19
Velocity/Depth Diversity (0-20)	14	16	10	10	10	10	10	10	10	10	11
Pool Quality (0-20)	15	16	15	10	12	14	10	10	11	10	13
Riffle Quality (0-20)	12	17	16	14	16	15	15	15	17	13	15
Shading (%)	95	90	85	94	95	90	95	98	95	90	90
Embeddedness (%)	0	0	15	20	35	35	35	30	20	0	0
Discharge (cfs)	0.51	1.47	0.29	0.26	0.73	0.50	0.21	0.23	0.24	0.47	0.89



The above graph displays the temperature logger data for Mill Run for 2000 to 2008. No data were available in 2009.

Biology

Fish

Cumulative list of fish species (with abundance) collected in Mill Run by sampling year.

Species	*1996*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
Blue Ridge sculpin	-	54	137	120	40	40	24	23	28	20	16
Brook trout	5	28	36	16	61	96	52	30	13	47	22
Eastern blacknose dace	-	100	124	134	108	79	53	51	90	68	42

Green indicates intolerant fish; blue are moderately tolerant; and red are tolerant.

Crayfish

Cumulative list of crayfish species (with abundance or presence {P}/absence {A} data) collected in Mill Run by sampling year

Species	*2006*	*2007*	*2008*	*2009*
Common crayfish (*Cambarus bartonii bartonii*)	P	9	P	2

Mussels

Cumulative list of mussel species (with abundance or presence {P}/absence {A} data) collected in Mill Run by sampling year.

Species
None Observed

Herpetofauna

Cumulative list of herpetofauna species collected in or near Mill Run.

Order (Common)	*Species*
Anura (Frogs and Toads)	Eastern American toad, Northern green frog , Northern spring peeper
Squamata (Snakes and Lizards)	Northern fence lizard
Caudata (Salamanders and Newts)	Eastern red-spotted newt, Northern dusky salamander, Northern slimy salamander, Northern two-lined salamander, Seal salamander

Benthic Macroinvertebrates

Cumulative list of benthic macroinvertebrates collected in Mill Run by sampling year, RA = %Relative Abundance.

PHYLUM	*ORDER*	*FAMILY*	*GENUS*	*1996 RA*	*2000 RA*	*2001 RA*	*2002 RA*	*2003 RA*	*2004 RA*	*2005 RA*	*2006 RA*	*2007 RA*	*2008 RA*	*2009 RA*
Annelida	Haplotaxida	Enchytraeidae	na	-	-	-	-	*0.8	-	-	-	-	-	-
(Worm)	Lumbriculida	Lumbriculidae	na	-	-	-	-	*0.8	-	*0.8	-	-	-	-
Arthropoda	Amphipoda	Gammaridae	*Gammarus*	-	-	-	-	-	-	0.8	-	-	-	-
	(Scud)			-	-	-	-	-	-	-	-	-	-	-
	Coleoptera	Elmidae	*Optioservus*	-	-	-	-	-	-	-	-	-	-	0.8
	(Beetle)		*Oulimnius*	-	0.8	-	1.9	0.8	-	0.8	-	1.9	-	-
			Promoresia	-	0.8	-	-	-	-	-	-	-	-	-
		Psephenidae	*Ectopria*	-	0.8	-	-	-	-	-	1.1	1.9	0.9	-
			Psephenus	-	-	-	-	-	-	-	-	-	-	0.8
	Decapoda	Cambaridae	*Cambarus*	-	-	-	-	0.8	-	-	-	-	-	-
	(Crayfish)			-	-	-	-	-	-	-	-	-	-	-
	Diptera	Ceratopogonidae	na	-	-	-	-	*0.8	-	-	-	-	-	-
	(True Fly)		*Bezzia*	-	-	-	-	-	-	-	-	-	-	0.8
			Ceratopogon	-	-	-	-	-	0.8	-	-	-	-	-
			Probezzia	-	-	-	-	-	-	-	-	0.9	-	-
		Chironomidae	Chironominae	-	-	-	-	*0.8	-	-	-	-	-	-
			Corynoneura	-	-	-	1	0.8	-	-	-	-	-	-
			Diamesa	3.3	2.5	0.8	-	-	-	-	4.4	-	-	-
			Eukiefferiella	5.8	-	-	1	0.8	-	2.4	-	-	2.6	0.8
			Heleniella	-	-	-	-	-	-	-	2.2	0.9	-	-
			Micropsectra	-	8.5	6.8	21	0.8	2.5	9.6	22.2	-	-	1.6
			Microtendipes	-	-	-	-	-	0.8	-	-	-	-	-
			Orthocladiinae	*1.7	-	-	*1.9	*0.8	-	*2.4	*1.1	-	-	-
			Parametriocnemus	-	-	-	1	-	1.7	3.2	4.4	-	6.1	0.8
			Paraphaenocladius	-	-	-	-	-	-	-	-	-	-	2.5

PHYLUM	ORDER	FAMILY	GENUS	1996 RA	2000 RA	2001 RA	2002 RA	2003 RA	2004 RA	2005 RA	2006 RA	2007 RA	2008 RA	2009 RA
			Platysmittia	-	-	-	1	-	-	-	-	-	-	-
			Polypedilum	-	-	-	-	-	-	0.8	-	-	0.9	-
			Stempellina	-	-	-	-	-	-	-	-	-	-	2.5
			Stempellinella	-	-	-	2.9	-	-	-	-	-	5.3	-
			Tanytarsini	-	-	-	-	*3.4	-	-	*3.3	-	-	*1.6
			Tanytarsus	-	-	-	-	-	-	-	-	-	1.8	2.5
			Thienemannimyia Group	-	-	*0.8	-	-	-	-	-	-	-	-
			Trissopelopia	-	0.8	-	-	-	-	-	-	-	-	-
			Tvetenia	-	-	2.5	1	0.8	-	-	-	-	1.8	0.8
		Empididae	*Chelifera*	-	-	3.4	-	-	-	-	-	-	-	-
			Clinocera	-	-	-	-	-	-	-	4.4	-	-	-
		Simuliidae	*Prosimulium*	1.7	3.4	31.4	3.8	13.4	11.9	0.8	3.3	23.6	7.9	0.8
			Simulium	0.8	0.8	-	-	-	-	-	1.1	-	-	0.8
		Tipulidae	*Dicranota*	-	0.8	-	-	-	-	-	-	0.9	0.9	0.8
			Hexatoma	0.8	-	-	1	-	-	0.8	1.1	4.7	-	-
			Pseudolimnophila	-	0.8	-	-	-	-	-	-	0.9	-	-
	Ephemeroptera	Ameletidae	*Ameletus*	-	-	-	-	0.8	-	-	-	0.9	0.9	1.6
	(Mayfly)	Baetidae	na	-	*13.6	*5.9	-	*3.4	-	*0.8	*1.1	*4.7	-	*2.5
			Acentrella	-	-	-	-	0.8	-	-	-	-	-	-
			Baetis	5	1.7	-	-	1.7	12.7	18.4	4.4	-	-	4.1
			Diphetor	-	-	-	11.4	-	-	-	-	-	9.6	1.6
		Ephemerellidae	na	-	-	-	-	-	-	*1.6	-	-	-	-
			Drunella	-	-	-	-	0.8	-	-	-	-	0.9	3.3
			Ephemerella	4.2	2.5	4.2	2.9	5	1.7	1.6	3.3	4.7	3.5	4.9
			Eurylophella	-	-	-	-	-	-	-	-	-	0.9	-
			Serratella	-	-	-	-	-	-	0.8	-	-	-	-
		Heptageniidae	na	-	-	*1.7	-	*4.2	-	*5.6	*1.1	*4.7	-	*0.8
			Cinygmula	-	11	-	2.9	5	-	-	11.1	-	2.6	4.1
			Epeorus	16.7	5.9	9.3	3.8	7.6	32.2	2.4	4.4	8.5	2.6	6.6
			Leucrocuta	-	0.8	-	-	-	-	-	-	-	-	-
			Stenacron	-	-	-	-	2.5	-	-	-	-	-	0.8
			Stenonema	5	-	-	-	-	-	-	-	-	-	-
		Isonychiidae	*Isonychia*	-	-	-	1	-	-	-	-	-	-	-
		Leptophlebiidae	na	-	-	-	*10.5	*6.7	-	*12.8	*3.3	*6.6	*6.1	*1.6
			Habrophlebia	-	-	-	-	-	-	-	-	-	0.9	-
			Paraleptophlebia	5	13.6	8.5	9.5	3.4	6.8	0.8	-	-	8.8	3.3
	Megaloptera	Sialidae	*Sialis*	-	-	-	1	-	-	-	-	-	-	-
	(Dobsonfly/Fishfly)			-	-	-	-	-	-	-	-	-	-	-
	Odonata	Gomphidae	na	-	-	-	-	-	-	-	-	-	*0.9	*0.8
	(Dragonfly/Damselfly)		*Stylogomphus*	-		-	1	-	-	-	-	-	-	-
	Plecoptera	na	na	-	-	-	-	*0.8	-	-	-	-	-	-
	(Stonefly)	Capniidae	*Allocapnia*	0.8	-	-	1	-	-	-	-	-	-	-
		Chloroperlidae	na	-	*0.8	*0.8	-	-	*1.7	*0.8	*1.1	*0.9	*1.8	*2.5
			Alloperla	-	-	-	-	-	-	-	2.2	-	-	-
			Haploperla	-	-	-	-	-	-	4.8	1.1	-	-	-
		Leuctridae	na	-	*1.7	-	-	-	-	*11.2	-	-	*6.1	*4.9
			Leuctra	2.5	-	3.4	-	1.7	3.4	3.2	1.1	-	-	0.8
		Nemouridae	na	*1.7	-	-	-	-	-	-	-	-	-	-
			Amphinemura	27.5	11	5.9	6.7	11.8	-	1.6	4.4	16	14	18
		Peltoperlidae	na	-	-	-	-	-	-	*0.8	-	-	-	-
			Peltoperla	1.7	-	-	-	-	-	-	-	-	-	-
			Tallaperla	-	-	0.8	-	-	-	-	-	-	-	-
		Perlidae	na	-	*0.8	-	*1.9	*0.8	*1.7	*0.8	*1.1	*4.7	*1.8	*2.5
			Acroneuria	-	-	2.5	-	-	-	-	-	0.9	-	-
		Perlodidae	na	-	-	*1.7	-	-	-	-	-	-	*0.9	-
			Isoperla	6.7	5.1	1.7	1.9	1.7	5.9	0.8	4.4	0.9	1.8	-
		Pteronarcyidae	*Pteronarcys*	2.5	4.2	0.8	1	2.5	1.7	1.6	-	3.8	2.6	1.6
	Trichoptera	Glossosomatidae	*Agapetus*	-	-	-	-	-	-	-	-	-	-	1.6
	(Caddisfly)	Hydropsychidae	*Cheumatopsyche*	-	-	-	1	-	-	-	-	-	-	-
			Diplectrona	6.7	5.9	3.4	1.9	8.4	6.8	4.8	5.6	2.8	3.5	9.8
			Hydropsyche	-	-	-	1	1.7	2.5	-	1.1	-	-	-
		Lepidostomatidae	*Lepidostoma*	-	-	-	-	-	-	-	-	0.9	-	-
		Limnephilidae	na	-	-	-	-	-	-	-	-	-	*0.9	-
			Pycnopsyche	-	-	-	-	0.8	-	-	-	-	-	-
		Philopotamidae	na	-	-	-	-	-	-	*0.8	-	-	-	-
			Dolophilodes	-	0.8	-	-	-	-	-	-	-	-	-
		Polycentropodidae	na	-	-	-	-	-	-	-	-	-	*0.9	-
			Polycentropus	-	-	-	1	-	-	-	-	-	-	0.8
		Rhyacophilidae	*Rhyacophila*	-	-	1.7	-	-	1.7	-	-	0.9	-	-

PHYLUM	ORDER	FAMILY	GENUS	1996 RA	2000 RA	2001 RA	2002 RA	2003 RA	2004 RA	2005 RA	2006 RA	2007 RA	2008 RA	2009 RA
		Uenoidae	*Neophylax*	-	-	1.7	1.9	1.7	3.4	1.6	-	1.9	-	3.3

Green families are intolerant (family tolerance values from 0 to 3); blue are moderately tolerant (family tolerance values from 3.1 to 6.9); and red are tolerant (family tolerance values from 7 to 10).

* Taxa not identified to genus.

Savage River (SAVA-225-S)

Site SAVA-225-S is located on the Savage River in the Highlands region of Maryland. It is in the Savage River watershed in Garrett County. This site was sampled in 1996 and 2000 to 2009. Its watershed is primarily forested (77%), with 17% agriculture and 5 % urban.


Savage River in spring 2009.

Water Chemistry

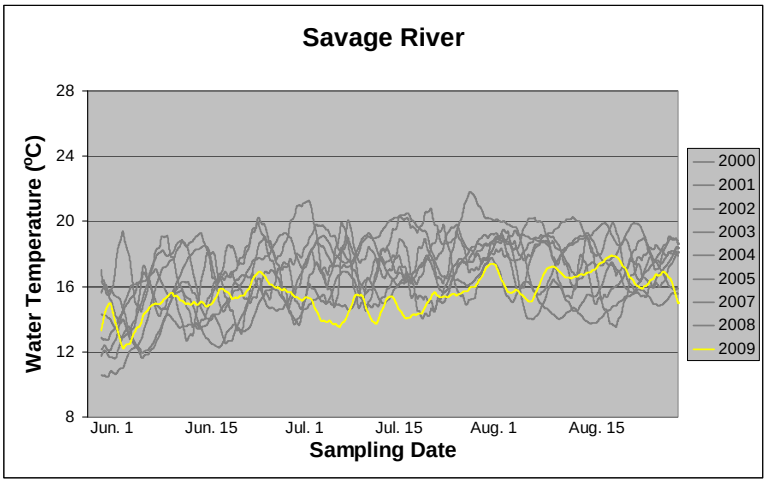
Summer water chemistry data collected at the Savage River (1996 and 2000 to 2009).

Parameter	*1996*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
Field pH	6.8	7.6	7.5	7.0	7.1	6.7	7.6	7.2	7.5	7.4	6.9
Dissolved Oxygen (mg/L)	7.8	8.9	7.9	10.6	8.9	8.3	7.9	8.5	8.6	6.9	10.2
Conductivity (mS)	0.09	0.14	0.21	0.18	0.17	0.22	0.21	0.19	0.19	0.16	0.16
Turbidity (NTU)	Not measured	0.9	2.2	2.6	2.8	2.0	1.0	2.5	1.3	3.5	1.2

Physical Habitat

Physical habitat measurements collected at the Savage River (1996 and 2000 to 2009). Scored parameters are on a 0 (worst) to 20 (best) scale.

Parameter	*1996*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
Instream habitat (0-20)	16	19	18	19	19	17	17	19	18	17	17
Epifaunal substrate (0-20)	16	18	16	17	19	17	17	19	18	18	18
Velocity/Depth Diversity (0-20)	13	18	16	16	17	15	15	17	16	18	16
Pool Quality (0-20)	15	19	17	17	18	18	17	18	17	16	15
Riffle Quality (0-20)	16	18	18	20	18	17	18	18	18	17	16
Shading (%)	40	75	75	65	90	85	85	80	91	75	70
Embeddedness (%)	25	15	10	20	25	30	25	25	15	15	15
Discharge (cfs)	6.81	4.91	4.84	3.45	4.60	4.95	1.87	7.17	0.18	11.48	3.05



The graph above displays the temperature logger data for the Savage River for 2000 to 2009. Maximum recorded temperatures occurred during the drought in July and August 2002. No data were available in 2006.

Biology

Fish

Cumulative list of fish species (with abundance) collected in the Savage River by sampling year.

Species	*1996*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
Blue Ridge sculpin	140	161	213	225	213	127	331	195	235	225	115
Brook trout	1	10	30	42	24	33	41	26	28	19	15
Brown trout	-	3	-	-	1	1	-	-	1	1	-
Central stoneroller	51	-	-	-	-	-	-	-	2	-	4
Common shiner	4	-	1	-	-	1	4	5	11	-	-
Creek chub	1	2	4	11	3	1	-	2	-	1	3
Cutlip minnow	28	24	33	58	61	55	46	24	36	24	14
Eastern blacknose dace	165	89	88	134	99	130	160	71	163	165	74
Fantail darter	62	34	56	27	41	24	54	32	68	45	14
Longnose dace	209	107	82	90	142	128	347	157	190	141	94
Margined madtom	9	-	-	-	-	-	-	-	-	-	-
Northern hogsucker	1	-	-	-	-	-	-	-	-	1	-
Potomac sculpin	10	23	30	23	28	24	25	8	14	15	8
Rainbow trout	1	-	-	1	1	-	-	2	2	1	-
River chub	25	-	-	-	-	-	-	-	1	-	-
Rock bass	15	-	-	-	-	-	-	-	-	-	-
Rosyside dace	1	3	12	18	3	6	6	2	19	14	4
Smallmouth bass	1	-	-	-	-	-	-	-	-	-	-
White sucker	34	7	18	11	19	1-	1-	12	15	10	11
Yellow perch	-	-	2	-	-	-	-	-	-	-	-

Green indicates intolerant fish; blue are moderately tolerant; and red are tolerant.

Crayfish

Cumulative list of crayfish species (with abundance or presence {P}/absence {A} data) collected in the Savage River by sampling year

Species	*2006*	*2007*	*2008*	*2009*
Common crayfish (*Cambarus bartonii bartonii*)	P	3	A	9
Allegheny crayfish (*Orconectes obscurus*)	A	4	A	A

Mussels

Cumulative list of mussel species (with abundance or presence {P}/absence {A} data) collected in Savage River by sampling year.

Species
None Observed

Herpetofauna

Cumulative list of herpetofauna species collected in or near the Savage River.

Order (Common)	*Species*
Caudata (Salamanders and Newts)	Allegheny mountain dusky salamander, Eastern red-backed salamander, Long-tailed salamander, Northern dusky salamander, Northern spring salamander, Northern two-lined salamander,
Squamata (Snakes and Lizards)	Eastern rat snake, Northern watersnake

Benthic Macroinvertebrates

Cumulative list of benthic macroinvertebrates collected in the Savage River by sampling year, RA = %Relative Abundance.

PHYLUM	*ORDER*	*FAMILY*	*GENUS*	*1996 RA*	*2000 RA*	*2001 RA*	*2002 RA*	*2003 RA*	*2004 RA*	*2005 RA*	*2006 RA*	*2007 RA*	*2008 RA*	*2009 RA*
Annelida	Haplotaxida	Enchytraeidae	na	-	-	-	-	*0.8	-	-	-	*1	-	-
(Worm)	Lumbriculida	Lumbriculidae	na	-	*1	*0.8	-	-	-	-	-	*1	-	-
Arthropoda	Coleoptera	Elmidae	*Oulimnius*	-	1	-	1	-	-	-	-	-	1.8	-
	(Beetle)		*Promoresia*	-	-	-	-	-	-	-	-	-	-	1
		Psephenidae	*Psephenus*	-	-	-	-	-	1	-	-	-	-	1
	Diptera	Athericidae	*Atherix*	-	-	-	-	-	-	-	0.8	-	-	-
	(True Fly)	Blephariceridae	*Blepharicera*	-	-	-	-	-	1	-	-	-	-	-

PHYLUM	ORDER	FAMILY	GENUS	1996 RA	2000 RA	2001 RA	2002 RA	2003 RA	2004 RA	2005 RA	2006 RA	2007 RA	2008 RA	2009 RA
		Ceratopogonidae	na	-	-	-	-	*0.8	-	-	-	-	-	-
			Bezzia	-	-	-	-	-	-	-	-	-	-	1
		Chironomidae	*Brillia*	-	-	-	-	0.8	-	-	-	-	-	1
			Conchapelopia	-	1	-	-	0.8	-	-	-	-	-	-
			Corynoneura	-	-	0.8	-	0.8	-	-	-	-	-	-
			Cricotopus	-	-	-	-	-	-	-	-	-	0.9	-
			Diamesa	-	-	-	-	0.8	4	0.8	-	1	-	-
			Eukiefferiella	5.2	-	-	-	-	-	-	-	1	-	-
			Heleniella	-	-	-	-	-	-	-	-	1	-	-
			Nanocladius	-	-	1.7	-	1.7	-	-	-	-	-	-
			Micropsectra	2.1	2	-	10.7	0.8	2	1.7	-	1	1.8	-
			Microtendipes	-	2.9	-	-	-	-	1.7	-	1	-	-
			Orthocladiinae	*1	*1	*1.7	-	*1.7	-	-	-	*1	-	-
			Orthocladius	-	-	-	-	-	1	-	0.8	1	2.7	3
			Parametriocnemus	3.1	3.9	1.7	-	3.4	2	-	-	1	1.8	2
			Paraphaenocladius	-	-	-	-	3.4	-	-	-	-	-	-
			Polypedilum	-	2	5.8	1	3.4	5	3.3	0.8	-	7.3	2
			Rheocricotopus	-	-	0.8	-	1.7	-	-	-	-	-	1
			Rheosmittia	-	-	-	-	-	-	-	0.8	-	-	-
			Rheotanytarsus	-	-	-	-	-	-	-	-	-	0.9	-
			Stempellinella	-	1	-	-	-	-	-	-	1	2.7	-
			Stilocladius	-	-	-	-	-	-	-	-	-	0.9	2
			Tanypodinae	-	-	-	-	-	-	-	-	*1	*0.9	*2
			Tanytarsini	-	-	*6.6	-	-	-	-	-	-	*1.8	-
			Tanytarsus	1	1	-	-	-	-	-	-	-	0.9	-
			Thienemanniella	-	-	-	-	-	-	-	0.8	-	0.9	-
			Thienemannimyia Group	-	-	-	-	-	-	*0.8	*0.8	-	*0.9	-
			Trissopelopia	-	-	-	-	-	1	-	-	-	-	-
			Tvetenia	-	-	4.1	2.9	-	-	0.8	-	1.9	3.6	1
		Empididae	*Clinocera*	-	-	-	-	-	-	0.8	0.8	1	0.9	-
		Simuliidae	*Prosimulium*	1	1	23.1	-	3.4	4	-	15.3	1	-	-
		Tipulidae	*Antocha*	1	-	-	-	-	-	0.8	-	-	0.9	2
			Dicranota	-	1	-	-	0.8	-	-	-	-	-	-
			Hexatoma	-	1	-	-	-	-	-	-	-	0.9	-
			Tipula	-	-	-	-	0.8	-	-	-	-	-	-
	Ephemeroptera	Ameletidae	*Ameletus*	-	-	-	-	0.8	-	-	0.8	-	-	-
	(Mayfly)	Baetidae	na	-	-	-	*5.8	*1.7	-	*1.7	-	-	-	-
			Acentrella	-	-	-	-	1.7	-	-	-	-	-	-
			Acerpenna	-	2	-	-	-	-	-	-	1	7.3	1
			Baetis	1	2	4.1	-	-	6	5.8	4.2	1	1.8	-
			Diphetor	-	-	-	-	-	-	-	-	-	0.9	-
			Fallceon	-	-	-	-	0.8	-	-	-	-	-	-
		Ephemerellidae	na	-	-	-	-	*1.7	-	-	-	-	-	*4
			Drunella	-	1	-	1.9	2.5	1	5.8	5.1	7.6	-	-
			Ephemerella	27.8	33.3	31.4	28.2	19.3	23	24.2	39	21.9	8.2	30.7
			Eurylophella	-	-	-	1	-	-	-	-	-	-	-
			Serratella	-	1	-	-	7.6	-	2.5	3.4	2.9	0.9	3
		Ephemeridae	*Ephemera*	1	-	-	1	-	-	-	-	-	-	-
		Heptageniidae	na	-	-	-	*1	-	-	-	*5.1	-	-	*1
			Cinygmula	-	7.8	-	-	-	1	9.2	-	5.7	8.2	4
			Epeorus	11.3	2.9	7.4	1.9	3.4	8	4.2	3.4	-	2.7	3
			Heptagenia	4.1	-	-	-	-	-	-	-	-	-	-
			Leucrocuta	-	-	-	-	-	-	0.8	-	-	0.9	-
			Stenonema	-	1	-	-	-	-	-	-	-	-	-
		Isonychiidae	*Isonychia*	6.2	3.9	-	3.9	0.8	2	3.3	-	1.9	1.8	-
		Leptophlebiidae	na	-	-	-	-	*7.6	-	*0.8	*3.4	*8.6	*10.9	*4
			Paraleptophlebia	12.4	9.8	3.3	18.4	11.8	10	10	1.7	-	7.3	5.9
	Megaloptera	Corydalidae	*Nigronia*	-	-	-	-	-	1	-	-	-	0.9	-
	(Dobsonfly/Fishfly)			-	-	-	-	-	-	-	-	-	-	-
	Odonata	Aeshnidae	*Boyeria*	-	-	-	1	-	-	-	-	-	-	-
	(Dragonfly/Damselfly)			-	-	-	-	-	-	-	-	-	-	-
	Plecoptera	Capniidae	*Paracapnia*	1	-	-	-	-	-	-	-	-	-	-
	(Stonefly)	Chloroperlidae	na	-	*1	-	-	-	*1	*0.8	-	*5.7	-	-
			Haploperla	-	-	-	-	-	-	-	0.8	-	0.9	-
			Sweltsa	-	1	-	-	0.8	-	-	-	1.9	-	2
		Leuctridae	na	-	-	-	-	*0.8	-	*2.5	-	*12.4	*1.8	-
			Leuctra	-	-	1.7	1	-	8	-	-	-	0.9	-
		Nemouridae	na	*1	-	-	-	-	-	-	-	-	-	-
			Amphinemura	-	2.9	-	-	1.7	1	1.7	0.8	4.8	-	-

PHYLUM	ORDER	FAMILY	GENUS	1996 RA	2000 RA	2001 RA	2002 RA	2003 RA	2004 RA	2005 RA	2006 RA	2007 RA	2008 RA	2009 RA
		Perlidae	na	-	*1	-	-	-	-	-	-	-	*0.9	*1
			Acroneuria	5.2	2	-	-	-	4	-	3.4	-	0.9	-
		Perlodidae	na	-	-	-	*2.9	*3.4	-	-	*0.8	*1	-	-
			Isoperla	5.2	3.9	1.7	-	0.8	6	7.5	0.8	1.9	3.6	5.9
		Pteronarcyidae	*Pteronarcys*	-	-	-	-	-	-	0.8	-	-	-	-
	Trichoptera	Brachycentridae	*Brachycentrus*	1	-	-	-	-	-	-	-	-	-	-
	(Caddisfly)	Hydropsychidae	*Ceratopsyche*	-	-	-	-	-	-	-	-	-	-	3
			Cheumatopsyche	6.2	-	-	1.9	-	4	0.8	0.8	2.9	3.6	1
			Diplectrona	-	-	0.8	-	0.8	2	-	-	-	-	1
			Hydropsyche	-	2	0.8	2.9	-	1	4.2	1.7	-	0.9	1
		Lepidostomatidae	*Lepidostoma*	2.1	-	1.7	11.7	2.5	-	-	0.8	1	0.9	1
		Limnephilidae	*Pycnopsyche*	-	-	-	-	0.8	-	-	-	-	-	-
		Odontoceridae	*Psilotreta*	-	-	-	-	-	-	-	-	1	-	-
		Philopotamidae	*Dolophilodes*	-	-	-	-	-	-	-	0.8	1	-	-
		Polycentropodidae	na	-	-	-	-	-	-	*0.8	-	-	-	-
			Polycentropus	-	-	-	-	-	-	-	-	-	0.9	-
		Rhyacophilidae	*Rhyacophila*	-	1	-	-	1.7	-	0.8	0.8	1	-	-
		Uenoidae	*Neophylax*	-	1	-	-	-	-	0.8	-	-	-	-
Mollusca	Gastropoda	na	na	-	-	-	-	*0.8	-	-	-	-	-	-
	(Snail)			-	-	-	-	-	-	-	-	-	-	-

Green families are intolerant (family tolerance values from 0 to 3); blue are moderately tolerant (family tolerance values from 3.1 to 6.9); and red are tolerant (family tolerance values from 7 to 10).
* Taxa not identified to genus.

APPENDIX E

Distribution and Life History Characteristic of 16 Coldwater-Preference Benthic Macroinvertebrate Genera

compiled by
Patrick H. Graves
Maryland Department of Natural Resources

Order Diptera

Bittacomorpha (Ptychopteridae)

Distribution and Conservation Status of *Bittacomorpha*

Two species of *Bittacomorpha* occur in the United States and Canada. A global conservation status ranking for this genus has not been designated.

Distribution of *Bittacomorpha* Species in Maryland

Bittacomorpha has a limited and scattered distribution in Maryland. This genus has been found from Garrett County to Worcester County (MBSS, unpublished data). The majority of *Bittacomorpha* records are from streams in the eastern portion of the western shore of Maryland. *B. clavipes* has been reported from the Delaware River basin (Bilger et al. 2004) and likely occurs in Maryland.

Life History and Ecology

In general, larvae of *Bittacomorpha* are associated with depositional areas of streams and vascular hydrophytes in the emergent zone of lakes. In lakes and ponds, they occur in rich detritral areas of swamp and pond margins (Wirth and Stone 1956) at depths of 2-3cm (McCafferty 1981). The larvae are atmospheric air-breathing organisms utilizing caudal retractile respiratory siphons to reach the water surface from the shallow waters they inhabit. Adults are lazy fliers, have alternating white and black bands on their legs, and are given the name "phantom" because of the difficulty to see the adult in flight. The first tarsomere of each adult leg (black in color) is dilated and filled with air, allowing adults to drift with the wind.

Bowles (1998) documented the life history of *B. clavipes* in an Ozark spring. The author determined this species has 4 instars and an asynchronous, non-seasonal, multivoltine life history with three cohorts. Bowles (1998) suggested that growth and reproduction are not seasonally dependent for the population of this species.

Voltinism

Multivoltine: Ozark stream (Bowles 1998)

Emergence Pattern

Emergence information for *Bittacomorpha* was not found.

Tolerance Values

Maryland 4, Pennsylvania 8

Dixa (Dixidae)

Distribution and Conservation Status of *Dixa*

Twenty-three species of *Dixa* occur in North America. Species records of *Dixa* reported from Maryland were not found. A global conservation status ranking for this genus has not been designated.

Distribution of *Dixa* Species in Maryland

Dixa has a scattered and limited distribution throughout the western shore of the Coastal Plain, eastern Piedmont, and Highlands. No records of *Dixa* from the Eastern Shore were found. According to unpublished MBSS data, 40.5% of the sites at which *Dixa* was collected occur in the eastern Piedmont, while 31% and 28.6% occur in the Highlands and Coastal Plain, respectively.

Life History and Ecology

In general, *Dixa* larvae inhabit protected areas of erosional streams and detritus in depositional streams. They are primarily swimmers but have the ability to climb over damp surfaces. *Dixa* larvae are considered collectors-filterers and facultative collectors-gatherers.

Dixa life cycle includes four instars and a pupal stage (Wagner et al. 2008). The larvae prefer stream banks where they lie on the water surface and bow their body in an inverted U position with their head and posterior end in the water (Wirth and Stone 1956, McCafferty 1981). The pupae are less active than the larvae and prefer drier habitat. The short-lived adults do not feed and are typically found resting in vegetation and on rocks near streams and ponds.

In a Kentucky stream, Minshall (1968) reports *Dixa* prob *modesta* as restricted to his upper two study sites. These sites were characterized by cool water, high elevation and gradient, a dense canopy, and little temperature fluctuation (~10-14^{o}C) throughout the year. The furthest upstream site was a spring source and the substrate was composed of limestone slab with little loose substrate. The site below the spring source was a cascade area on a 45^{o} slope with unstable boulder and cobble substrate.

Dixa individuals in drift have been reported in a number of publications. *Dixa sp.* and two simuliid species dominated dipteran drift in a 4th-order spring-fed stream in the Piedmont of South Carolina (Stoneburner and Smock 1979). There was a summer peak and winter peak in *Dixa sp.* drift density. In studying *Dixa sp.* drift in England and the French Pyreenees, Elliott and Tullett (1977) found that fourth and final instars dominated *Dixa* drift; the seasonal peaks occurred when adults and pupae were present and when the larvae were searching for prepupation sites. Waters (1962) suggests *Dixa* larvae are highly susceptible to drift due to their association with the water's edge and surface film. The author also observed increased drift at night.

Dixa is considered a significant indicator taxon of good to excellent ecological integrity in the Northwestern Great Plains Perennial Spring Ecosystem (Stagliano et al. 2006). The authors assigned a tolerance value of 2 to *Dixa* in the Custer National Forest Ashland ranger District in Montana.

Voltinism

Voltinism information was not found.

Emergence Pattern
Emergence information was not found.

Tolerance Values
Maryland 5.8, Pennsylvania 1, Southeast 2.8, Northwest 1, Custer National Forest Ashland Ranger District in Montana 2

Heleniella (Chironomidae: Orthocladiinae)

Distribution and Conservation Status of *Heleniella*

Three species of *Heleniella* occur in North America. These species are *H. curtistila*, *H. hirta*, and *H. parva*. Species records of *Heleniella* reported from Maryland were not found. A global conservation status ranking for this genus has not been designated.

Distribution of *Heleniella* Species in Maryland

With the exception of one Eastern Shore record, *Heleniella* is distributed from the Coastal Plain of the Western Shore north to the eastern Piedmont and west to the mountains of Allegany and Garrett counties. According to unpublished MBSS data, 57.7% of the sites at which *Heleniella* was collected occur in the Highlands, while 21.8% and 20.5% occur in the eastern Piedmont and Coastal Plain, respectively.

Life History and Ecology

Little information exists on the life history and ecology of *Heleniella*. Information found in an extensive literature review is presented here. In general, *Heleniella* is found in erosional lotic systems where they are considered sprawlers. In the southeast US, Hudson et al. (1990) identified the habitat of *H. hirta* and *H. parva*. The larvae of both species typically occur in low-order streams in winter and early spring. *H. hirta* are found in mountain streams and *H. parva* are found in seeps/springs and streams in the mountains and Piedmont.

Heleniella individuals are generally considered collectors-gatherers. In cold desert springs in eastern Washington, Gaines et al. (1989) studied the trophic relations of benthic insects, including *Heleniella sp.* The authors examined the gut contents of *Heleniella sp.* and found detritus and algae. They considered their trophic level as detritivore and their functional feeding group as collectors-gatherers.

In another study, Tixier et al. (2009) mimicked the influence global warming could have on chironomid larvae. The authors manipulated the thermal regime of a shallow groundwater ecosystem in southern Ontario to study the response of chironomids to the manipulation. *Heleniella sp.* were among the coldstenothermal taxa that remained unaffected throughout the manipulation.

The Idaho Department of Environmental Quality and the Ohio EPA consider *Heleniella* a cool water taxon (Grafe et al. 2002, OHEPA 2009, Stagliano et al. 2007). Stagliano et al. (2007) determined the temperature preference of *Heleniella* to be 8.13^{o}C and consider it to be a "stenothermal: cold" genus. *Heleniella* is also considered a significant indicator taxon of good to excellent ecological integrity in the Northwestern Great Plains Perennial Spring Ecosystem (Stagliano et al. 2006). The authors also determined a tolerance value of 4 for *Heleniella* in the Ashland Ranger District of the Custer National Forest in Montana.

Voltinism
Multivoltine (2-3/year) for *Heleniella sp.* in Coweeta, North Carolina (Huryn 1990)

Emergence Pattern
Emergence information was not found.

Tolerance Values
Maryland 0.9, Southeast 0, Northwest 6.5, Custer National Forest Ashland Ranger District in Montana 4

Prodiamesa (Chironomidae: Prodiamesinae)

Distribution and Conservation Status of *Prodiamesa*

Two species of *Prodiamesa*, *P. cubita* and *P. olivacea*, occur in the United States and Canada. A global conservation status ranking for this genus has not been designated.

Distribution of *Prodiamesa* Species in Maryland

In Maryland, *Prodiamesa* has been collected throughout the State (MBSS, unpublished data). *P. olivacea* has been reported from the Delaware River basin (Bilger et al. 2004).

Life History and Ecology

In general, *Prodiamesa* inhabits detritus in fast- and slow-moving streams. They are considered burrowers/sprawlers and collectors-gatherers (Merritt and Cummins 2007). *Prodiamesa sp.* and Prodiamesinae are considered "eurythermal: cool" by the Idaho Department of Environmental Quality (Grafe et al. 2002).

Voltinism
Voltinism information for this genus was not found.

Emergence Pattern
Emergence information for *Prodiamesa* was not found.

Tolerance Values
Maryland 6.6, Pennsylvania 3, Southeast 7.9, Upper Midwest 3, Northwest 3

Order Ephemeroptera

Cinygmula (Heptageniidae)

Distribution and Conservation Status of *Cinygmula*

Ten species of *Cinygmula* occur in the United States and Canada. *Cinygmula* is predominantly a Western U.S. genus with only one species, *C. subaequalis*, occurring in the Eastern U.S. *C. subaequalis* occurs in Maryland and states surrounding it. The global conservation status rank for this species is G5-globally secure (InfoNatura 2007).

Distribution of *Cinygmula* Species in Maryland

An extensive review of the literature did not reveal a published record of *C. subaequalis* in Maryland but since this is the only *Cinygmula* species in eastern North America, all *Cinygmula* records in Maryland must be *C. subaequalis*.

Life History and Ecology

C. subaequalis is restricted to cool fast-flowing streams of the Appalachian mountains and foot hills in eastern North America (Burian and Bednarik 1994, Chandler et al. 2006). The nymphs cling to rocks and primarily feed by scraping diatoms off the substrate. They are also facultative collectors-gatherers.

Studies have documented certain aspects of the life history of *C. subaequalis*. Dobrin and Giberson (2003) studied this species in a cold springbrook (mean water temperatures of 10.2^{o} and 9.9^{o}C during the two year study) on Prince Edward Island. *C. subaequalis* was the second most productive mayfly species in the cold springbrook with total production (P) of 0.9 $g \cdot m^{-2} \cdot year^{-1}$ and an annual P/B of 5.9. The nymphs displayed slow growth through the winter, then rapidly grew in the spring prior to emergence in June and July. New recruits were first seen in late August. Chandler et al. (2006) reported that nymphs were present from April-June in northern New Hampshire rivers, with blackwings (mature, final instar nymphs) present in May and June. Penrose et al. (1982) found that *C. subaequalis* nymphs were most abundant in March and April in the three major areas (streams, upper river-montane, upper river-lowland) of the French Broad River and tributaries in North Carolina. Delucchi and Peckarsky (1989) studied *C. subaequalis* nymphal growth and development in intermittent and permanent streams in New York. They found that nymphs at the dry/intermittent sites were more mature in spring than those at the permanent streams, supporting their hypothesis that populations of the same species develop earlier in intermittent streams than permanent streams. Wipfli et al. (1998) studied insect and biofilm densities in Alaskan streams treated with salmon carcasses. In the treated streams, both stream biofilm Ash-Free Dry Mass and *Cinygmula sp.* densities were higher than in the untreated stream.

Voltinism

Univoltine:

- NY: in permanent and intermittent streams in Tompkins County (Delucchi and Peckarsky 1989)
- NH: univoltine spring, spring/early summer cycle - small larvae or larvae appear shortly after the initiation of sampling in mid-spring, with maturation of these larvae during the spring or by early summer (Chandler et al. 2006)

Prince Edward Island: univoltine with synchronous development (Dobrin and Giberson 2003)

Emergence Pattern
C. subaequalis: NY: early June (Delucchi and Peckarsky 1989); ME: June (Burian and Gibbs 1991); Prince Edward Island: June and July with peak emergence in early July (Dobrin and Giberson 2003)

Tolerance Values
Maryland 1.6, Pennsylvania 1, Southeast 0, Northwest 4

Diphetor hageni (Baetidae)

Distribution and Conservation Status of *D. hageni*

Diphetor hageni is the only species in this genus. The global conservation status rank for this species is G5-globally secure (InfoNatura 2007). *D. hageni* is a transcontinental species.

Distribution of *D. hageni* in Maryland

In Maryland, its range extends from the northeastern corner of the State south to Anne Arundel County and west to Garrett County. 75% of the sites where it has been collected are in the Highlands, 23.1% are in the Eastern Piedmont, and 1.9% are in the Coastal Plain (MBSS, unpublished data)

Life History and Ecology

D. hageni is found in both erosional and depositional lotic systems and is considered a swimmer and clinger (Waltz and Burian 2008). The diet of *D. hageni* has not been reported.

In Tompkins County, NY, nymphs were collected in both permanent and intermittent streams (Delucchi and Peckarsky 1989). In an Oregon stream, the majority of *D. hageni* (reported as *Baetis parvus*) were found in riffle habitat in May and October and backwater areas in December and February with the highest numbers collected from October to early December (Lehmkuhl and Anderson 1972). Drifting by the nymphs was greatest in May and June.

Bergman and Hilsenhoff (1978) collected three mature female nymphs from a Wisconsin stream, reared them to imagoes in the lab, and then reared the eggs of the imagoes. The eggs of two of the females (1796 eggs) were incubated at 19-23^{o}C and the mean incubation period was 8.5 days with 97% of the eggs hatching. The 872 eggs of the third female hatched out (97% hatch success) after 19 days of incubation at 13-15^{o}C.

In Kentucky, Minshall (1968) collected *D. hageni* (reported as *Baetis herodes*) from every sampling site along the course of Morgan's Creek: from a cool-water spring source near the headwaters to a stretch with substrate composed of sand, silt, and clay mixed with plant debris near its confluence with the Ohio River. The highest numbers of *D. hageni* were collected from an undisturbed site with cobbles and pebbles intermixed with gravel and coarse sand and a dense canopy, and also at another site with loose flat cobble- and boulder-rubble overlying a stable base of coarse sand, gravel, and pebbles and a canopy beginning to open. Both of these sites had the coolest water temperatures and exhibited little variation in temperature throughout

the year. Nymphs were found throughout the year. Minshall considers *D. hageni* to be an opportunist as its nymphs were most abundant during different seasons in the study's two years.

Sexually reproducing individuals and parthenogenetic populations of *D, hageni* have been found (Bergman and Hilsenhoff 1978, McCafferty and Morihara 1979, Grant et al. 1997). Bergman and Hilsenhoff (1978) refer to *D. hageni* displaying thelytokous (females produced from unfertilized eggs) and obligatory parthenogenesis. They report southern populations are sexually reproducing while northern ones are parthenogenetic.

Voltinism

Bivoltine: NY (Delucchi and Peckarsky 1989); WI (Bergman and Hilsenhoff 1978)
Multivoltine: southern Ontario: 3-4 generations/year (Harper and Harper 1984)

Emergence Pattern

D. hageni has a relatively long emergence period throughout its range.
KY: mid-April to November (Minshall 1968)
PA: early May to mid-September (longest emergence period for any of the mayflies collected from Erie County streams during this study) (Grant et al. 1997)
NY: June to August (Delucchi and Peckarsky 1989)
OR: April to October (Lehmkuhl and Anderson 1972)
NH: mid-May (McCafferty et al. 2004)

Tolerance Values

Maryland 2.3, Pennsylvania 6, Northwest 5, Midwest 2.3

Epeorus (Heptageniidae)

Distribution and Conservation Status of *Epeorus*

Eighteen species of *Epeorus* occur in the United States and Canada. Nine of these species occur in the northeast and southeast United States. To date, only one published record of an *Epeorus* species in Maryland, *E. pleuralis*, was found. Five species have been reported from States surrounding Maryland [Natureserve Global conservation status ranks for these species are provided by InfoNatura (2007)]:

Maryland: *E. pleuralis*-G4
Surrounding States: *E. vitreus*-G5 (VA, PA, DE), *E. fragilis* (PA). *E. punctatus*-G2G3 (WV), *E. dispar*-G5 (VA, WV)

The Global conservation status ranks of species in *Epeorus* are as follows: 6 G5, 3 G4, 3 G3G4, 2 G2G3, 1 G1G2Q, 2 G1Q, 1 G1

Distribution of *Epeorus* Species in Maryland

McCafferty (2009) report the first State record of *E. pleuralis*, collected from a tributary in the northeast cove of Loch Raven Reservoir on 9 May 1970. Unpublished data from Maryland's Core/Trend Monitoring Program included the collection of *Epeorus fragilis* from the Upper Potomac River, Allegany County, in 1994. It is likely that more species of *Epeorus* exist in Maryland, due to the fact that 3,914 individuals were collected by MBSS from sites in

Maryland (unpublished MBSS data). Future literature searches and identification of *Epeorus* individuals to species-level will likely turn up new records of *Epeorus* sp(p). in Maryland

With the exception of one record from Wicomico County, the majority of sites from which *Epeorus* were collected are in the northern half of Maryland in the eastern Piedmont and Highlands. According to unpublished MBSS data, 70.2% of these sites are in the Highlands, 29.3% are in the eastern Piedmont, and 0.4% are in the Coastal Plain.

Life History and Ecology

In general, *Epeorus* are found in lotic-erosional areas where they cling to rocks and other substrate. They are considered scrapers and facultative collector-gatherers.

From reviewing the literature it appears that *Epeorus* species can be found in a number of sites along the course of a stream or river but are in greatest numbers, and typically dominate the mayfly fauna, in cool, fast-flowing headwater sites (Minshall 1968, Penrose et al. 1982). Minshall (1967) reports that *E. pleuralis*, one of the two most widespread *Epeorus* species in eastern North America, is restricted to cool mountain streams and springs in the southern part of its range.

The life history of *E. pleuralis* has been well documented by Minshall (1964, 1967, 1968). Minshall studied the species in a small, spring-fed, stony stream in Kentucky. Female *E. pleuralis* had a three day preoviposition period (including time as a subimago) from March-May (Minshall 1964). Females oviposited in fast-flowing areas of streams by dipping their ovipositor in the stream several times, washing their eggs off into the stream. Females oviposited between 2000-6000 eggs (Minshall 1964) with 4260 eggs/female being the average (Minshall 1967).

The eggs of *E. pleuralis* hatched after a seven month incubation period in the field at 11-14^{o}C (Minshall 1964). Hatching began in late September through May with peak recruitment in January and February. Small nymphs (0.5mm) were almost always found on the undersides of small stones (10x15cm). Nymphal growth continued through the winter. Nymphs were taken in samples from December through July with a peak in March/April and a rapid decline in early June after most had emerged. Nymphs attained the greatest mean length in February or March. Mature *E. pleuralis* nymph length ranged from 5-13mm and the average mature male and female was 7.8mm and 9.7mm, respectively (Minshall 1967). Mature nymphs were found on the undersides of larger rocks than smaller nymphs. Nymphs were herbivorous and their diet consisted primarily of allochthonous leaf litter with some diatoms. Nymphs emerged underwater. In a lab, the subimago stage lasted 2-2.5 days and only 36% of the subimagoes shed their skin and became a reproductive adult (Minshall 1967). The mean length of male and female adults emerging during peak emergence was smaller than those emerging earlier in the season.

Minshall (1964, 1967, 1968) collected the majority of *E. pleuralis* in a high elevation and high gradient cascade near the source of a spring. The species was restricted to sites with dense canopy and cool water, fast-flowing riffle and cascade habitats with substrate composed of loose, flat and smooth rubble and boulders. Dissolved oxygen was near saturation and temperatures were cool and constant year-round.

Two studies reported production estimates for *E. fragilis* and *E. pleuralis*. In a cold spring brook (mean water temperatures of 10.2^{o}C and 9.9^{o}C for the two years) on Prince Edward Island, Dobrin and Giberson (2003) calculated total production (P) of *E. fragilis* as 0.028 $g \cdot m^{-2} \cdot year^{-1}$ and an annual Production/Biomass (P/B) of 7.8. (P) for *E. pleuralis* was 0.3 $g \cdot m^{-2} \cdot year^{-1}$

and P/B was 6.9. Huryn and Wallace (1987) estimated the cohort production interval (CPI) of *E.pleuralis* in 1st- and 2nd-order Coweeta, North Carolina streams to be around 240 days.

Chandler et al. (2006) reported on their observation of two species of *Epeorus* in New Hampshire. The authors suggested that *E. pleuralis* and *E. vitreus* have extended univoltine patterns in areas of New Hampshire where mature larvae were taken for extended periods of time: April-September for *E. pleuralis* and May-early August for *E. vitreus*.

Both the Ohio EPA and Idaho Department of Environmental Quality (ID DEQ) consider *Epeorus* a cool water taxon (Grafe et al. 2002, OHEPA 2009, Stagliano et al. 2007). The ID DEQ considers four *Epeorus* species (*E. albertae*, *E. deceptivus*, *E. grandis*, *E. longimanus*) "eurythermal: cool summer" taxa. Temperature preferences were determined for *E. deceptivus* (9.9°C) and *E. grandis* (9.95°C).

Voltinism

Univoltine:

E. fragilis: Erie County, PA (Grant et al. 1997); NH (Chandler et al. 2006)

E. pleuralis: Erie County, PA (Grant et al. 1997); KY (Minshall 1967, 1968); Coweeta, NC (Huryn and Wallace 1987); NH (Chandler et al. 2006)

E. vitreus: NH (Chandler et al. 2006)

Emergence Pattern

The emergence period for each *Epeorus* species is presented separately below.

E. fragilis: VA: mid-May (Webb and McCafferty 2006); PA: early June (Webb and McCafferty 2006), mid-May to early June in Erie County, PA (Grant et al. 1997); ME: late June to late September (Burian et al. 2008), July (Burian and Gibbs 1991); VT: late July (Webb and McCafferty 2006); Prince Edward Island, Canada: late July-early August(Dobrin and Giberson 2003)

E. pleuralis: VA: late April-early May (Webb and McCafferty 2006); PA: April-June-mostly in April (Webb and McCafferty 2006), late April-late May with peak emergence in mid-May in Erie County, PA (Grant et al. 1997); KY: mid-February to July with peak in late April to early May (Minshall 1967, 1968); NY: late April (Webb and McCafferty 2006); CT: mid-April to early May (Webb and McCafferty 2006); ME late April-late June (Burian et al. 2008); Prince Edward Island, Canada: late June (Dobrin and Giberson 2003)

E. vitreus: PA: mid-May to late May (Webb and McCafferty 2006); VA: mid-May to late July (Webb and McCafferty 2006); NC: late May-late July (Webb and McCafferty 2006); CT: early June-early July (Webb and McCafferty 2006); MN: late May (Webb and McCafferty 2006); NH: mid-June in NH (Webb and McCafferty 2006); NY: mid-June to mid-July (Webb and McCafferty 2006); VT: early June (Webb and McCafferty 2006); MA: mid-May to early July (Webb and McCafferty 2006); TN: mid-May (Webb and McCafferty 2006); ME: June-August (Burian and Gibbs 1991)

E. punctatus: WV: mid-September (Webb and McCafferty 2006)

Tolerance Values

Maryland 1.7, Pennsylvania 0, Southeast 1.3, Upper Midwest 0, Northwest 1,5

Ephemera (Ephemeridae)

Distribution and Conservation Status of *Ephemera*

Six species of *Ephemera* occur in the United States and Canada. One of these species, *E. compar*, is presumed to be extinct. Four *Ephemera* species occur in the northeast and southeast United States. Three species have been reported from Maryland and one species has been reported from States surrounding Maryland [Natureserve Global conservation status ranks for these species are provided by InfoNatura (2007)]:

Maryland: *E. guttulata*-G5, *E. simulans*-G5, *E. varia*-G5

Surrounding States: *E. blanda*-G5 (VA, WV)

The Global conservation status ranks of species in *Ephemera* are as follows: 4 G5, 1 G4, 1 G2, 1 GX

Distribution of *Ephemera* Species in Maryland

Ephemera was reported from western and northern Maryland in the eastern Piedmont and Highlands. According to unpublished MBSS data, 77.6% of the sites at which *Ephemera* were collected occurred in the Highlands and 22.4% occurred in the eastern Piedmont. The following is distribution information on *Ephemera* species reported from Maryland, including their North American range. This information comes from unpublished data of Maryland's Core/Trend Monitoring Program (C/T), the Mid-Atlantic Highlands Assessment (MAHA), or the Mid-Atlantic Integrated Assessment (MAIS).

- *E. guttulata*: MD-Potomac River Lower North Branch watershed (C/T), Savage River watershed (MAHA); NA-Ozarks of AR south to AL and north through the Appalachians of KY, VA, WV, MD (McCafferty 1994) and PA (McCafferty 2009)
- *E. simulans*: MD- Sideling Hill Creek watershed (MAIS); NA-widespread throughout NA and Canada (McCafferty 1994)
- *E. varia*: MD-Antietam Creek watershed and Potomac River Lower North Branch (MAHS); NA-MN in the west, south to AL and GA, and north to MN and ME (McCafferty 1994)

Life History and Ecology

Ephemera are burrowing mayflies that burrow in sand, gravel, and silt substrates in quieter areas of small creeks, rivers, and lakes. *E. guttulata* and *E. blanda* are lotic taxa and are restricted to smaller swifter streams (McCafferty 1975). Kennedy (1926) collected *E. guttulata* from coarse sand and muck substrate in a basin below waterfalls in a small shaded mountain stream in Tennessee. According to McCafferty (1975), southeastern records of *E. varia* are from high mountainous areas. The *Ephemera sp*. reported in Woodall and Wallace (1972) in Coweeta, NC, were only collected in a watershed with a warmer and more turbid stream with little deciduous leaf input.

Ephemera nymphs are considered collector-gatherers, predators (engulfers), and filterers and can swim by undulating their body. Nymphs also undulate their gills in a metachronal rhythm, creating a flow through their burrows which brings in food particles that are filtered and consumed. Coffman et al. (1971) report that, in a Pennsylvania stream, *E. varia* is herbivorous and *E. simulans* is largely carnivorous based on the highest percentage of its diet being animal matter. Conversely, Shapas and Hilsenhoff (1976) found that the diet of *E. simulans* collected from gravel riffles in northern Wisconsin was 96% detritus and 4% diatoms.

The results of studies on *E. simulans* and *E. varia* provide useful life history information. Eriksen (1964) provided *E. simulans* with different substrates in the lab; its rate of oxygen consumption was highest on the least preferred substrate and lowest on the most preferred. In an oligotrophic lake in southwestern Michigan, Leonard (1947) studied the occurrence of *E. simulans* in the stomachs of trout. Leonard reported that *E. simulans* nymphs likely burrowed too far down into the substrate for trout to find them. Nymphs were only eaten by rainbow trout during emergence periods. On days of *E. simulans* emergence, trout stomachs averaged 507 nymphs/stomach and 106 subimagoes/stomach while an average rate of 3 *E. simulans*/stomach were taken on non-emergence days. Chandler et al. (2006) studied *E. varia* in New Hampshire streams and reported the appearance of the smallest larvae in August and September and the taking of blackwings (nymphs in or near their final instar) in July. The authors consider *E. varia* an Appalachian/Northeast Boreal species that inhabits cold streams.

Voltinism

Semivoltine life cycle (2-year) is typical of *Ephemera*.
Published reports of 2-year semivoltine life cycles among *Ephemera* species include:
E. simulans: Dauphin Lake, Manitoba: 2-year semivoltine (Heise et al. 1987)
E. varia: NH: 2-year semivoltine cycle (Chandler et al. 2006)

Emergence Pattern

In general, *Ephemera* emergence occurs from May-August and rarely as late as October. The emergence period for each *Ephemera* species will be presented separately below.
E. blanda: KY: early May (McCafferty 1994)
E. guttulata: KY: early June early (McCafferty 1975); SC: early June (McCafferty 1975); GA: late May (McCafferty 1975)
E. simulans: VA: early July (McCafferty 1994); KY: early June (McCafferty 1975); SC: late April (McCafferty 1975); MI: synchronous emergence in late May (Leonard 1947); MO: late May (McCafferty 1994); OK: mid-June (McCafferty 1994); IN: late June (McCafferty 1994); MN: late June (McCafferty 1994)
E. varia: ME: June-August (Burian and Gibbs 1991)

Tolerance Values

Maryland 3, Pennsylvania 2, Southeast 1.1, Upper Midwest 1, Midwest 3.1, Northwest 4

Habrophlebia vibrans (Leptophlebiidae)

Distribution and Conservation Status of *H. vibrans*

Habrophlebia vibrans is the only species in this genus. *H. vibrans* is an eastern US species found from Florida north through the Atlantic States to Ontario. The global conservation status rank for this species is G5-globally secure (InfoNatura 2007).

Distribution of *H. vibrans* in Maryland

To my knowledge, there is no published report of *H. vibrans* occurring in Maryland. According to unpublished MBSS data, *H. vibrans* has a scattered and limited distribution

throughout Maryland with 46.2% of the sites where *H. vibrans* was collected occurring in the Coastal Plain, 30.8% in the eastern Piedmont, and 23.1% in the Highlands.

Life History and Ecology

In general, *H. vibrans* is found in both erosional and depositional lotic systems inhabiting a variety substrates. Peters (1979) reported that the species occurs from mountain streams in Eastern Canada to lowland streams of northern Florida. In a 2nd-order southern Quebec stream, Lauzon and Harper (1986) collected nymphs in areas of gravel that suggest the nymphs prefer larger particles and limited amounts of FPOM. Edmunds et al. (1976) reported that *H. vibrans* nymphs inhabit the edges of small streams among vegetation or leaf debris where silt has accumulated. Little to no published information is available on the diet and habit of this species.

The life history and production of *H. vibrans* in a 2nd-order southern Quebec stream was reported in Lauzon and Harper (1986). The nymphal life was approximately 23 months. Eggs collected from ovipositing females at the stream were incubated in a lab where they synchronously hatched in three weeks (mid-July). The hatchlings measured 0.46 mm. After one and a half months the mean nymph size was 1.65mm. Growth stopped when water temperatures decreased to 9-15°C and did not continue until the water temperature reached 12-17°C (mid-May). After a year (mid-July), the nymphs measured 2.1mm and by the end of their second summer had reached 3mm. Nymphs reached their final instar length of 5mm in the weeks before their synchronous June emergences. Final instar densities were 648/m^2, drastically down from the 27,500 nymphs/m^2 during their first summer and the 4000-9500/m^2 after the next 18 months. Adult *H. vibrans* females oviposited a mean of 239 eggs and the oviposition was concentrated in a 4m stretch of stream. A mean of 851 females/m^2 (maximum of 6867females/m^2) were collected from oviposition trays floating on the stream surface. Annual production of *H. vibrans* was 710-829 mg/m^2, P/B was 2.5-3.2, and 75% of production was due to the 2nd-year cohort and half was accumulated in the last 2 months of the nymphal life. Lauzon and Harper (1986) also observed the drift behavior of *H. vibrans*, finding that 87% of drift occurred in spring. Small nymphs drifted during August of their first year, larger nymphs drifted spring runoff, and mature nymphs drifted during emergence.

A few other publications reported *H. vibrans* life history and ecology data. Chandler et al. (2006) observed blackwing (near or in final instar) nymphs from June to July in New Hampshire. In a North Carolina stream, Huryn and Wallace (1987) observed early instar nymphs in March and suggested that *H. vibrans* eggs undergo a 7-8 month diapause. They also found that nymphs reached their final instar in February following a growth period during late fall and early winter. Giberson and Mackay (1991) and Rowe et al. (1988) studied *H. vibrans* in low pH streams. The former collected *H. vibrans* from acid streams with a pH range of 4.8-6.8 in southern Ontario. Rowe et al. (1988) found that *H. vibrans* eggs took twice as long as to develop at pH 5 than at pH 6.5.

Voltinism

Studies have found semivoltinism in *H. vibrans*. Lauzon and Harper (1986) consider semivoltinism rare for a small insect and very rare for a leptophlebiid.

Semivoltine: NC: 16 month life cycle (Huryn and Wallace 1987); Quebec (Lauzon and Harper 1986); Ontario (Giberson and Mackay 1991)

Univoltine: NH (Chandler et al. 2006)

Emergence Pattern
ME: June-July
NC: mid-June through mid-July (Huryn and Wallace 1987)
SC: no month(s) given, 13-17 week emergence with peak during weeks 1-3 (Carlson 1973)
Southern Quebec: June; synchronous emergence; 3-7 week emergence period with peak between 3rd-8th day; mean emergence period was 31 days; mean annual emergence density was 875 adults/m^2; mean Male:Female was 1.46 (Lauzon and Harper 1986)

Tolerance Values
Maryland 1.7, Pennsylvania 4

Paraleptophlebia (Leptophlebiidae)

Distribution and Conservation Status of *Paraleptophlebia*

Thirty-nine species of *Paraleptophlebia* occur in the United States and Canada. The range of this genus is widespread throughout both countries. Fourteen species occur in the northeast and/or southeast United States. One species was recorded in Maryland and eight species were reported from States surrounding Maryland [Natureserve Global conservation status ranks for these species are provided by InfoNatura (2007)]:

Maryland: *P. assimilis*-G4
Surrounding States: *P. adoptiva*-G5 (PA, VA, WV), *P. debilis*-G5 (PA,VA, WV), *P. guttata*-G5 (VA, WV), *P. jeanae*-G3G4 (VA), *P. moerens*-G4 (PA, VA), *P. mollis*-G5 (PA, VA, WV), *P. ontario*-G4 (VA, WV), *P. praepedita* (WV), *P. strigula*-G4 (PA), *P. volitans*-G5 (VA, WV)

The Global conservation status ranks of species in *Paraleptophlebia* are as follows: 7 G5, 8 G4, 4 G3G4, 1 G2G4, 1 G2G3 , 1 G2, 3 G1G3, 7 G1G2, 1 G1, 1 G2Q, 1 GHQ, 4 GH

Distribution of *Paraleptophlebia* Species in Maryland

In Maryland, *Paraleptophlebia* is distributed throughout the State, with the highest concentrations in the northern part of the State west of the Fall Line, especially in western Maryland. According to unpublished MBSS data, 64.5% of the sites in which *Paraleptophlebia* was collected occurred in the Highlands, 26.6% occurred in the eastern Piedmont, and 8.9% were in the Coastal Plain.

An extensive literature review revealed only one published record of *Paraleptophlebia* in Maryland. Randolph and McCafferty (1996) first described the nymphal stage of *P. assimilis* from nymphs collected from a tributary to the northeast corner of Loch Raven Reservoir in Baltimore County.

Distribution of non-Maryland *Paraleptophlebia* Species in Surrounding States

In northwestern Pennsylvania, Grant et al. (1997) examined the emergence of mayflies from two 1st-order streams in Erie County over a period of three years. The shortest emerging period observed was 15 days by *P. debilis*, a late summer to fall emerging species. *P. moerens* was the most abundant species emerging from the two streams. Over the three years, the emergence period of *P. moerens* was mid-May to mid-September in 1980, late May to mid-

September in 1989, and early April to early August in 1990. In 1990, higher-than-usual mid-March through early April temperatures led to the early April emergence. Cooler temperatures halted the emergence for nearly a month until optimal emerging temperatures returned. This early emergence led to *P. moerens* completing emergence a month sooner than normal. A similar emergence pattern was observed for *P. strigula*.

Life History and Ecology

In general, *Paraleptophlebia* nymphs are typically found in sediments and detritus in erosional areas of streams and rivers. The nymphs of this genus are characterized as swimmers, clingers, and sprawlers. Nymphs swim by undulating their body. They are primarily considered collectors-gatherers, feeding on coarse detritus and diatoms but can also be facultative shredders-detritivores.

Edmunds et al. (1976) provides detailed generic *Paraleptophlebia* life history information. Nymphs are most commonly found in shallow, fast-flowing small- to moderate-sized streams but can also inhabit rivers. *Paraleptophlebia* nymphs inhabit a number of habitats in streams: coarse gravel, leaf debris in slow to moderately swift water, riffles, woody debris, moss and other vegetation, and crevices on the underside of rocks in rapids. In larger streams and rivers, they are found on rootwads near banks or associated with undercut banks. Day (1963) describes the preferred *Paraleptophlebia* habitat as deposits of decaying leaves, bark, and wood in slow-moving shoal water 0.25-12 inches deep. The nymphal and subimaginal period is shorter in populations in the South (Edmunds et al. 1976). As nymphs mature, they migrate from faster-flowing waters of the riffles to slower moving parts of the stream. In the adult stage, the female oviposits immediately after mating.

A number of studies have reported *Paraleptophlebia* life history characteristics. Minshall (1968) observed *P. moerens* in a Kentucky stream. The highest percentage of nymphs occurred in open canopy stream segments and the greatest abundance was found in a slow, silt-covered pool. The life cycle of *P. moerens* in this stream was considered fast seasonal in which the hatching period is short and growth is rapid. Giberson and Mackay (1991) studied four species of *Paraleptophlebia* in southern Ontario acid streams. These species were found in the following pH ranges: *P. adoptiva* 5.7-6.8, *P. debilis* 5-6.8, *P. mollis* 7.2-7.8, and *P. moerens* 4.7-6.4. In acidic streams, *P. adoptiva* exhibited a univoltine winter cycle in which nymphs grow fast in the fall, stop growth during winter, resume rapid growth in the spring prior to emergence, and reproduce during the following summer. Univoltine winter cycles were also observed for *P. mollis* and *P. moerens*. *P. moerens* egg development took four months, suggesting a summer diapause. Rowe et al. (1988) studied egg development of *Paraleptophlebia sp.* in a lab and found that eggs took up to twice as long to develop at pH 5 than pH 6.5.

Voltinism

Univoltine:

P. moerens: KY: fast seasonal (Minshall 1968)

P. adoptiva: NH: winter cycle in southern rivers and summer cycle in northern rivers (Chandler et al. 2006); southern Ontario: winter cycle (Giberson and Mackay 1991)

P. debilis: NH: summer cycle (Chandler et al. 2006); southern Ontario: summer cycle (Giberson and Mackay 1991)

P. guttata: NH: winter-summer cycle (Chandler et al. 2006)

P. mollis: NH: winter cycle (Chandler et al. 2006); southern Ontario: winter cycle

(Giberson and Mackay 1991)
P. moerens: southern Ontario: winter cycle (Giberson and Mackay 1991)
Semivoltine:
P. adoptiva: Ontario (Giberson and Mackay 1991)
P. debilis: Ontario (Giberson and Mackay 1991)
P. gregalis: OR (Lehmkuhl and Anderson 1971)
P. moerens: Ontario (Giberson and Mackay 1991)
P. mollis: Ontario (Giberson and Mackay 1991)
P. temporalis: OR (Lehmkuhl and Anderson 1971)
P. volitans: SC (Smock 1988)
Bivoltine:
P. guttata: NH: winter-summer cycle (Chandler et al. 2006)

Emergence Pattern

In general, *Paraleptophlebia* emergence may be year-round in the South, while it is restricted to summer months in the North (Edmunds et al. 1976). The emergence periods for each *Paraleptophlebia* species are presented separately below.

P. adoptiva: ME: April-early June (Burian and Gibbs 1991); southern Ontario: May (Giberson and Mackay 1991)

P. assimilis: MD: April from Loch Raven Reservoir tributary (Randolph and McCafferty 1996); late May to early June in Fishing Creek, Frederick County (Turcsanyi unpublished data); NC: April-August (Huryn and Wallace 1987)

P. debilis: PA: late summer-fall (Grant et al. 1997); ME: July-October (Burian and Gibbs 1991); southern Ontario: August (Giberson and Mackay 1991, Dobrin and Giberson 2003)

P. guttata: ME: June-August (Burian and Gibbs 1991); NC: restricted to late June (Huryn and Wallace 1987)

P. moerens: PA: April-September (Grant et al. 1997); KY: May-September (Minshall 1968); southern Ontario: May (Giberson and Mackay 1991), after spring thaw April to mid-June (Coleman and Hynes 1970)

P. mollis: MD: late May from Fifteen Mile Creek, Allegany County (Turcsanyi unpublished data); ME: July-August (Burian and Gibbs 1991); southern Ontario: mid-to-late May (Giberson and Mackay 1991)

P. ontario: MD: late May to early June from Fifteen Mile Creek, Allegany County (Turcsanyi unpublished data)

P. strigula: PA: June-August in 1989 and April-July in 1990 (Grant et al. 1997)

Tolerance Values
Maryland 2, Pennsylvania 1, Mid-Atlantic 1, Southeast 1.2, Upper Midwest 1, Midwest 2.8, Northwest 1-4

Order Plecoptera

Alloperla (Chloroperlidae)

Distribution and Conservation Status of *Alloperla*

Thirty-five species of *Alloperla* occur in the United States and Canada. Twenty-six of these occur in eastern North America (Willett and Stark 2009). Six species have been reported from Maryland and eight species have been reported from States surrounding Maryland [Natureserve Global conservation status ranks for these species are provided by InfoNatura (2007)]:

Maryland: *A. aracoma*-G3, *A. atlantica*-G5, *A. biserrata*-G3, *A. chloris*-G5, *A. imbecilla*-G4, *A. usa*-G5

Surrounding States: *A. banksi*-G4 (VA), *A. concolor*-G5 (PA), *A. idei*-G3 (VA), *A. nanina*-G4 (VA), *A. neglecta*-G3 (VA), *A. petasata*-G4 (PA, VA, WV), *A. stipitata*-G2G3 (VA only), *A. vostoki*-G3 (PA)

The Global conservation status ranks of species in *Alloperla* are as follows: 10 G5, 8 G4, 8 G3, 2 G2G3, 4 G2, 1 G1G2, 1 G1, 1 GXQ

Distribution of *Alloperla* Species in Maryland

The following is distributional information for *Alloperla* species reported from Maryland and includes their North American range. The Maryland and North American data were reported by Grubbs (1997) and Surdick (2004), respectively, unless otherwise noted. Grubbs (1997) expects *A. banksi*, *A. caudata*, *A. concolor*, *A. idei*, and *A. nanina* to occur in Maryland. However, *A. caudata* appears restricted to Illinois, the Ozarks, the Lower Tennessee River in Alabama, and Mississippi (Earle 2009). It appears more likely that a similar species, *A. petasata*, could occur in Maryland.

- *A. aracoma*: MD: location not reported; NA: Allegheny Plateau and Ridge and Valley of PA, MD, and WV
- *A. atlantica*: MD: Baltimore County and Fishing Creek and Little Hunting Creek in Frederick County, likely limited to Blue Ridge and eastern Piedmont; NA: MN eastward and AL and GA northward
- *A. biserrata*: MD: streams and springs in Green Ridge State Forest in Allegany County; NA: Allegheny Mountains and Ridge and Valley of MD, WV, and VA in upper reaches of the Potomac, North Fork of the Shenandoah, James, and New-Kanawha River drainages
- *A. chloris*: MD: streams in Savage River State Forest (Garrett County) and Green Ridge State Forest (Allegany County); NA: GA and TN north to OH and Nova Scotia
- *A. imbecilla*: MD: location not reported; NA: Ohio River drainage from IN to NY, including New-Kanawha River in Allegheny Plateau of WV, plus immediately adjacent Great Lakes drainage and Ridge and Valley province of northern VA
- *A. usa*: MD: Little Laurel Run in Garrett County (Nelson et al. 2002); NA: GA and AL north to OH and PA

The majority of sites (74.1%) at which MBSS collected *Alloperla* are in the Highlands, followed by 14.8% in the eastern Piedmont and 11.1% in the Coastal Plain (unpublished MBSS data).

Distribution of non-Maryland *Alloperla* Species in Surrounding States

Of the eight *Alloperla* species reported from States surrounding Maryland, five are expected to occur in Maryland (Grubbs 1997). Based on distribution records, it is also possible that *A. neglecta* and *A. petasata* occur in Maryland. It is unlikely that either *A. vostocki* or *A. stipitata* occur in Maryland. *A. vostocki* appears to be a northern species and *A. stipitata* has only been collected from the James River drainage and South Fork of the Shenandoah River drainage of the Blue Ridge. The following North American distribution information for these species is reported in Surdick (2004):

A. banksi: NA: VA through Great Lakes-St. Lawrence River drainage to ME and Nova Scotia
A. concolor: WV to Ontario and Newfoundland
A. idei: AL and GA north to Ontario and Maine
A. nanina: Upper Tennessee River drainage of the southern Blue Ridge and areas adjacent to southwestern VA
A. petasata: GA and TN north to Ontario and Newfoundland

Life History and Ecology

According to Stewart and Stark (2002), little to no published information on *Alloperla* nymphal biology exists, primarily because this genus has previously been a "catch-all" taxon. The little general information available is given here. Larger and more mature chloroperlid nymphs are usually found among rocks and debris in riffle areas as well as clumps of submerged moss in clean springs, streams, and creeks (Surdick 2004). The younger instars of some chloroperlid species inhabit the hyporheic zone and are seldom collected. They generally are not found in fast rocky bottom mountain streams (Hitchcock 1968). Some species of *Alloperla* are associated with slower areas of streams, springs, and lowlands. Adults are typically green or yellow.

Voltinism

Information on *Alloperla* voltinism was not found.

Emergence Pattern

The general emergence data were taken from Surdick (2004) and the State emergence data were taken from Baumann and Kondratieff (2009) unless otherwise noted.

A. aracoma: early June to mid-July; WV: early May
A. atlantica: late April to mid-July; AL: late April-late May; GA: mid-July; NC: late May; TN: late April
A. banksi: early May to mid-August
A. biserrata: May through June; VA: early June; PA: mid-May (Earle 2004)
A. caudata: late April to mid-July
A. chloris: late May-late August; WV: late June; NY: mid-to-late June; KY: late May
A. concolor: late May-early August
A. idei: late May to mid-August; NY: late June; ME: late June; New Brunswick: mid-June; AL: mid-April; PA: late June (Earle 2009)
A. imbecilla: early May-early July; VA: mid-May
A. nanina: late April-early June; NC: late May to mid-June

A. neglecta: late April-early July; TN: mid-Mat to early June
A. petasata: mid-May to mid-August; VA: late May; WV: late May; PA: late May; NC: mid-May; KY: late May-early June; TN: mid-June; NH: late May; OH: late May-June; ME: June-early July; NY: late June; Nova Scotia: June; New Brunswick: June
A. stipitata: mid-May to mid-June
A. usa: early May-late July; MD: mid-June (Nelson et al. 2002); PA: mid-June; WV: mid-to-late May; VA: mid-May to late July; OH: early June; NC: mid-May to mid-July; SC: May; TN: early May; GA: mid-May; AL: mid-May
A. vostocki: mid-June to mid-August; PA: early June; NY: late June-late July; Nova Scotia: mid-August

Tolerance Values
Maryland 1.6, Pennsylvania 0. Southeast 1.4, Northwest 1

Leuctra (Leuctridae)

Distribution and Conservation Status of *Leuctra*

Twenty-six species of *Leuctra* occur in the United States and Canada. *Leuctra* is predominantly an eastern North American genus as only one species occurs west of the Mississippi River. Ten species have been reported from Maryland and six additional species have been reported from States surrounding Maryland [Natureserve Global conservation status ranks for these species are provided by InfoNatura (2007)]:

Maryland: *L. alexanderi*-G4, *L. carolinensis*-G4, *L. duplicata*-G5, *L. ferruginea*-G5, *L. grandis*-G4, *L. rickeri*-G4 *L. sibleyi*-G5, *L. tenella*-G5, *L. tenuis*-G5, *L. variabilis*-G4

Surrounding States: *L. biloba*-G5 (VA) , *L. maria*-G4 (PA, WV), *L. mitchellensis*-G3 (VA), *L. monticola*-G1Q (VA), *L. triloba*-G5 (VA, WV), *L. truncata*-G4 (PA, VA, WV)

The Global conservation status ranks of species in *Leuctra* are as follows: 7 G5, 7 G4, 1 G3G4Q, 3 G3, 3 G2, 3 G1Q, 2 GHQ

Distribution of *Leuctra* Species in Maryland

With the exception of the eastern shore, records of *Leuctra* are scattered throughout the State with the highest concentration in the Highlands of western Maryland. 67.5% of the sites where *Leuctra* was collected from are in the Highlands while 19.4% are in the Coastal Plain and 13% are in the eastern Piedmont (MBSS, unpublished data). There are only two records of *Leuctra* from the eastern shore of Maryland (MBSS, unpublished data).

The following is distribution information of *Leuctra* species reported from Maryland, including their North American range. These data were reported by Grubbs (1997) unless otherwise noted. Grubbs (1997) believes that *L. maria*, *L. triloba*, and *L. truncata* occur in Maryland, even though they have not been reported.

L. alexanderi: MD: abundant in small spring-fed streams throughout Allegany and Garrett counties; NA: central and southern Appalachians
L. carolinensis: MD: Big Hunting Creek (Duffield and Nelson 1990), small spring-fed

streams in Appalachian Plateau of Garrett County and Blue Ridge of Frederick county (Grubbs 2003); NA: central and southern Appalachians

- *L. duplicata*: MD: Big Hunting Creek (Duffield and Nelson 1990) and in small spring-fed streams in Garrett, Potomac, and Savage River State Forests in Garrett county and Green Ridge State Forest and Warrior Mountain Wildlife Management Area in Allegany County; NA: Appalachian species from Virginia to Maritime Provinces of Canada
- *L. ferruginea*: MD: collected in large numbers from spring-fed streams in Garrett County and sporadically in Allegany, Frederick, and Washington counties, collected from Big Hunting Creek (Duffield and Nelson 1990), collected from the watersheds of the Savage River, Wills Creek, Deep Creek Lake, and both the Upper and Lower North Branch of the Potomac River watersheds by the Maryland Core/Trend Monitoring Program; NA: throughout North America
- *L. grandis*: MD: spring-fed streams in Savage River State Forest and a few spring-fed streams in Frederick and Washington counties; NA: Appalachian species
- *L. rickeri*: MD: Deep Run and a spring-fed stream into Fifteen Mile Creek in Allegany County; NA: Mississippi north to Illinois and east to Maryland
- *L. sibleyi*: MD: common in small spring-fed streams in Savage River State Forest and Green Ridge State Forest in Garrett and Allegany county, respectively, and from a few sites in Frederick and Washington counties, collected from Big Hunting Creek (Duffield and Nelson 1990); NA: throughout eastern North America
- *L. tenella*: MD: spring-fed streams in Garrett county and one site each in Frederick and Washington counties; NA: distributed over northern tier of eastern North America
- *L. tenuis*: MD: variety of streams and small rivers in Allegany, Frederick, Garrett, and Washington counties, Big Hunting Creek (Duffield and Nelson 1990), collected from the watersheds of Prettyboy Reservoir, Savage River, Youghiogheny River, and Deep Creek Lake by the Maryland Core/Trend Monitoring Program; NA: throughout eastern North America
- *L. variabilis*: MD: small amount of small spring-fed streams in Savage River State Forest and Garrett State Forest, collected from bogs in Charles and Prince George's counties (Nelson et al. 2002); NA: Appalachian species

Life History and Ecology

In general, *Leuctra* species inhabit erosional and depositional lotic systems. They are considered shredders-detritivores and facultative collectors-gatherers.

A handful of studies reported life history information on species of *Leuctra*. Nelson et al. (2002) collected adult *L. variabilis* from bogs in Charles and Prince George's counties in Maryland. They report a close association between *L. variabilis* and the purple pitcher plant, *Sarracenia purpurea*, and found 40 *L. variabilis* adults trapped in 19 individuals of *S. purpurea*. *L. tenuis* is called a common large river species. It was found in open gravel habitats associated with FPOM in Ozark foothills stream (Ernst and Stewart 1986). Minshall (1968) reports that *L. sibleyi* was most abundant in spring and exhibited a slow seasonal cycle (long hatching period with slow continuous growth over long period of time) in a Kentucky stream.

Two studies on aquatic insect drift in South Carolina Piedmont streams reported information on the drift of *Leuctra* spp. Stoneburner and Smock (1979) found that *Leuctra* spp.

were among the dominant drifting stonefly taxa in a 4th-order spring-fed stream in the South Carolina Piedmont. Drift density peaks occurred during May, July, and November. The period of maximum density (89 individuals/100m^2) occurred in November. In northwestern South Carolina, Reissen and Prins (1972) found *Leuctra* drifting peaks in March, May, and September. The September drift was associated with emergence.

The life history of *L. ferruginea* was studied in Canada and North Carolina. Harper (1973, 1990) found this species inhabiting permanent streams with a width of 0.4-1.2m wide and an annual temperature regime of 0-4^{o}C minimum to 12-23^{o}C maximum in Ontario. Stewart and Stark (2002) believe this is generally true of *L. ferruginea* in eastern North America. In a cold spring brook (mean water temperature of 10.2 C and 9.9 C in the two years studied) on Prince Edward Island, Dobrin and Giberson (2003) report that the two cohorts present on most sampling dates indicate a semivoltine 2-year life cycle for *L. ferruginea*. The total production (P) and Production/Biomass (P/B) for this species was 0.052 g·m^{-2}·year^{-1} and 3.4, respectively. *L. ferruginea* also exhibited an asynchronous life cycle in the spring brook. In Coweeta, North Carolina 1st- and 2nd-order streams, Huryn and Wallace (1987) reported the presence of two synchronized cohorts indicating a semivoltine life cycle for a *Leuctra* species assumed to be *L. ferruginea*. The cohort production interval (CPI) for this species was given a conservative estimate of 540 days.

The Ohio EPA considers *Leuctra sp.* to be a cool water taxon (OHEPA 2009).

Voltinism

Stewart and Stark (1998) suggested that *Leuctra* species are semivoltine in smaller streams, but tend to be univoltine in larger, warmer streams.

Semivoltine:

L. ferruginea: NC: from 1st- and 2nd-order streams in Coweeta (Huryn and Wallace 1987); Prince Edward Island, Canada: from a cold springbrook (Dobrin and Giberson 2003)

Univoltine:

L. duplicata: Quebec: univoltine, fast life cycle in a small intermittent stream (Harper 1990)

L. tenuis: southern Ontario (Harper 1973); OK: univoltine, fast life cycle in Ozark foothills stream (Stewart 1986), fast, seasonal life cycle in the Oklahoma Ozarks (Ernst and Stewart 1985); in or near Canada (general) univoltine, slow (Harper 1973, Krueger and Cook 1981)

Emergence Pattern

The emergence pattern for each *Leuctra* species is presented separately below.

L. biloba: NC: peak emergence April-May (Huryn and Wallace 1987)

L. carolinensis: MD: late spring (Grubbs 2003); early June, 1 adult collected from Big Hunting Creek (Duffield and Nelson 1990)

L. duplicata: Quebec: late May to mid-June, small intermittent stream (Harper 1990)

L. ferruginea: MD: mid-April to mid-December, extended and non-synchronous emergence from Big Hunting Creek (Duffield and Nelson 1990); NC: peak emergence April-May (Huryn and Wallace 1987); Prince Edward Island: June through November, asynchronous (Dobrin and Giberson 2003); New Brunswick: late August (Giberson and Garnett 1996)

L. sibleyi: MD: May-July, 46 adults collected from Big Hunting Creek (Duffield and Nelson 1990); KY: mid-April to mid-May (Minshall 1968); PA: May peak emergence in Sixmile Creek (Mastellar 1983)

L. tenuis: MD: mid-July to mid-November, 550 adults collected from Big Hunting Creek (Duffield and Nelson 1990); PA: July peak emergence, most abundant stonefly in Sixmile Creek (Mastellar 1983); southern Ontario: early July to late August (Harper 1973)

L. triloba: NC: peak emergence April-May (Huryn and Wallace 1987)

L. variabilis: MD: late fall (Grubbs 2003); mid-November from a Charles County bog and early December from a Prince Georges County bog (Nelson 2002)

Tolerance Values

Maryland 0.4, Pennsylvania 0, Mid-Atlantic 0, Southeast 0.7

Sweltsa (Chloroperlidae)

Distribution and Conservation Status of *Sweltsa*

Thirty-two species of *Sweltsa* occur in the United States and Canada. Twenty-three species are exclusively western (west of the Mississippi River) and nine are exclusively eastern. Four species have been reported from Maryland and five species have been reported from States surrounding Maryland [Natureserve Global conservation status ranks for these species are provided by InfoNatura (2007)]:

Maryland: *S. lateralis*-G5, *S. onkos*-G5, *S. palearata*-G2G3, *S. pocahontas*-G2

Surrounding States: *S. holstonensis*-G1 (VA), *S. mediana*-G5 (VA), *S. naica*-G5 (PA, VA, WV), *S. urticae*-G4 (VA), *S. voshelli*-G3 (VA)

The Global conservation status ranks of species in *Swelsta* are as follows: 12 G5, 5 G4, 7 G3, 1 G2G3, 4 G2, 1 G1G2, 2 G1.

Distribution of *Sweltsa* Species in Maryland

In Maryland, *Sweltsa* has a scattered distribution in the Western Shore of the Coastal Plain and Piedmont with two areas of concentration: one in the Upper Monocacy watershed around Catoctin and the other in the Licking Creek watershed. The largest concentration of sites at which *Sweltsa* was collected is in Allegany and Garrett counties, in the Highlands province. 85.6% of the sites at which *Sweltsa* was collected are in the Highlands, 9.6% are in the Eastern Piedmont, and 4.8% are in the Coastal Plain (MBSS, unpublished data). There is one record of *Sweltsa* from the Eastern Shore where it was collected from Marshyhope Creek.

The following is distribution information on *Sweltsa* species reported from Maryland (MD), including their North American (NA) range. The MD distribution information comes from Grubbs (1997) and the NA information from Surdick (2004), unless otherwise noted.

S. lateralis: MD- streams and springs in Garrett County; NA- distributed throughout Appalachian mountains from GA and TN north to Quebec and New Brunswick

S. onkos: MD- streams of varying sizes in Garrett, Allegany, and Washington counties, and Big Hunting Creek in Frederick County (Duffield and Nelson 1990); NA- throughout NE US from southern VA north to Ontario and Newfoundland

S. pocahontas: MD- a rare Appalachian species collected from small springs in the

Savage river drainage; NA- Ridge and Valley and Allegheny Plateau of WV and MD in upper drainage areas of the Greenbrier, Elk, and Little Kanawha Rivers and the North Branch of the Potomac River

S. palearata: MD- a spring feeding Fifteen Mile Creek in Green Ridge State Forest, Allegany County; NA- Ridge and Valley Province of MD, WV, and northern VA in drainage areas of the upper Potomac River and the North and South Forks of the Shenandoah River

Distribution of non-Maryland *Sweltsa* Species in Surrounding States

Of the five *Sweltsa* species that were reported from States surrounding Maryland, only one species, *S. naica*, is believed to occur in Maryland (Grubbs 1997). The reported range of *S. naica* is West Virginia and Virginia north to Labrador and Newfoundland. In Virginia, the other species (*S. holstonensis*, *S. mediana*, *S. urticae*, and *S. voshelli*) are primarily found in the southern Appalachians and unlikely to occur in Maryland.

Life History and Ecology

Sweltsa individuals are typically found in cool fast-flowing temporary streams of mountainous areas (Stewart and Stark 2008, Surdick 2004). They are predators (engulfers) whose main prey items are chironomids and simuliids. At times, they are facultative collectors-gatherers.

The nymphs of chloroperlids are typically found among gravel and debris in riffle areas. According to Surdick (2004), the young instars of some chloroperlid species are found in surface gravel or in gravel substrate deep below the surface in the hyporheic zone, while the older instars are found in riffles among rocks, debris, gravel, and submerged moss. In a southern Ontario stream, Mackay (1969) found *S. onkos* to be common in detritus, gravel, stones, leaves but not sand.

Various aspects of the life history and ecology of four *Sweltsa* species have been reported. In a cold spring brook (mean water temperature of 10.2^{o}C in 1997 and 9.9^{o}C in 1998) on Prince Edward Island, total production (P) of *S. naica* was 0.015 g $\cdot$ m^{-2} $\cdot$ year^{-1} and annual Production/Biomass (P/B) was 3.7 (Dobrin and Giberson 2003). The authors reported the presence of two cohorts in samples which suggests a semivoltine 2-year cycle for *S. naica*.

Harper (1973) collected *S. onkos* from a southern Ontario stream and, in a lab, reared eggs and nymphs hatching from these eggs. The eggs developed slowly and took 113-173 days to hatch. The nymphs had a slow but continuous growth through the first winter, but they developed quickly during the second summer. The final instar of these nymphs was present in February and March.

Cushman et al. (1977) studied *S. mediana* in an Appalachian Highland 1st-order stream in Tennessee. The authors suggested that the eggs of *S. mediana* undergo a seven month diapause due to early instar nymphs not appearing until December. Two cohorts were found in December through May suggesting a semivoltine 2-year cycle. The maximum monthly density of *S. mediana* nymphs in July was 83+/-21 individuals/m^2. Biomass was reported as 61 mg/m^2 in April.

S. lateralis early instar nymphs were observed in August and September, and the two cohorts grew slowly throughout the year in 1st- and 2nd- order streams in Coweeta, North Carolina (Huryn and Wallace 1987). The presence of two cohorts suggests a semivoltine 2-year synchronous cycle for *S. lateralis*. The cohort production interval (CPI) for *S. lateralis* was 630

days. (CPI refers to the interval in days from peak occurrence of the smallest size larval class until the onset of emergence)

The Ohio EPA and Idaho Department of Environmental Quality (ID DEQ) consider *Sweltsa* a cool water taxon (OHEPA 2009, Grafe et al. 2002, Stagliano et al. 2007). The ID DEQ determined the temperature preference of the genus to be 11.45^{o}C (Grafe et al. 2002).

Voltinism

Semivoltine life cycle (2 years) is typical of *Sweltsa*.
Published reports of 2-year semivoltine life cycles among *Sweltsa* species:
S. onkos: southern Ontario (Harper 1973, Mackay 1969)
S. mediana: TN: Appalachian Highland 1st-order stream (Cushman et al. 1977)
S. lateralis: NC: 1st- and 2nd-order streams in Coweeta (Huryn and Wallace 1987)
S. naica: Prince Edward Island: from a cold springbrook (Dobrin and Giberson 2003)

Emergence Pattern

The emergence periods for each *Sweltsa* species are presented separately below and are from Surdick (2004) unless otherwise noted.
S. holstonensis: mid-May
S. lateralis: NC: late April to late July; synchronous emergences in April-July in Coweeta (Huryn and Wallace 1987)
S. mediana: TN: late April to early July; April-May in Appalachian Highland 1st-order stream (Cushman et al. 1977)
S. naica: New Brunswick, Canada: mid-May to late July; June-July (Giberson and Garnett 1996)
S. onkos: southern Ontario and Quebec, Canada: early April to early August; short, synchronous emergence in May (Harper 1973, Harper et al. 1991)
S. palearata: late May to late June
S. pocahontas: mid May to mid June
S. voshelli: late April to mid-June

Tolerance Values

Maryland 1.9, Pennsylvania 0, Southeast 0, Northwest 1

Tallaperla (Peltoperlidae)

Distribution and Conservation Status of *Tallaperla*

Seven species of *Tallaperla* occur in the United States and Canada. *Tallaperla* is an eastern North American species and is not found west of the Mississippi River. All seven species in this genus occur in the southeast and/or northeast United States. One species has been reported from Maryland and three have been reported from States surrounding Maryland [Natureserve Global conservation status ranks for these species are provided by InfoNatura (2007)]:

Maryland: *T. maria*-G5

Surrounding States: *T. anna*-G4 (VA), *T. cornelia*-G4 (VA), *T. lobata*-G2 (VA)

The Global conservation status ranks of species in *Tallaperla* are as follows: 1 G5, 2 G4,

2 G3, 1 G2, 1 G1G2.

Distribution of *Tallaperla* Species in Maryland

Tallaperla occurs in the eastern Piedmont and Highlands in northern Maryland. According to unpublished MBSS data, 74.4% of the sites at which *Tallaperla* have been collected occur in the Highlands and 25.6% occur in the eastern Piedmont. In eastern Maryland, the majority of *Tallaperla* records are from Harford County and Cecil County. The majority of western Maryland *Tallaperla* records are from Garrett County.

Life History and Ecology

Tallaperla nymphs are associated with leaf litter typically in riffle areas of erosional and depositional lotic systems. They are shedders-detritivores that primarily feed on leaf litter. The nymphs of *T. anna*, *T. cornelia*, and *T. lobata* are poorly known. As a defense mechanism, *Tallaperla* adults are reported to auto-hemorrhage.

The life history and ecology of *T. maria* is well documented. Elwood and Cushman (1975) studied *T. maria* in a Tennessee stream. The eggs of these *T. maria* underwent a 7-8 month diapause. The nymphs were found in riffles among leaf packs and detritus. Detritus and diatoms were the primary contents found in the guts of the nymphs. Peak drift density primarily involved the younger cohort and occurred in March. In an Appalachian mountain spring population, Grubbs and Cummins (1996) found 1st-year cohorts in mid-November. Their growth was slow during fall and winter, and greatest growth occurred during spring and summer. In forested headwater streams in West Virginia, Yokum et al. (1995) reported an 18 month nymph period with 14 instars and a 6 month egg diapause *T. maria* were restricted to sites with a baseflow alkalinity of >2mg L^{-1} $CaCO_3$ and were the dominant peltoperlid only at sites with an alkalinity of >15mg L^{-1}. Production of these nymphs (271 $mg \cdot m^{-2} \cdot y^{-1}$) was highest in the portion of the watershed underlain by limestone.

The majority of *T. maria* literature comes from studies in Coweeta, North Carolina. Wallace et al. (1970) found that nymphs skeletonized leaves by feeding on the cuticle and mesophyll but not the vascular system of the leaves. This feeding increased the leaching of tannic acids from the leaves. The authors studied the feeding preferences of *T. maria* nymphs and found they preferred elm, sourwood, alder, and dogwood leaves, while they least preferred rhododendron, white pine, white oak, and chestnut oak. Woodall and Wallace (1972) found that peaks in *T. maria* abundance were positively correlated with peaks in hardwood leaf detritus. In studying the drift behavior of *T. maria*, O'Hop and Wallace (1983) reported that early instar nymphs are the dispersive stages of this species, based on a correlation between benthic density and number of early instar nymphs in drift samples was found. The authors also observed the nymphs drifting at night significantly more than during the day, and the larger nymphs drifting more at night than during the day.

Voltinism

Semivoltine:

T. maria: PA (Grubbs and Cummins 1996); WV (Yokum et al. 1995); NC (O'Hop and Wallace 1983, O'Hop et al. 1984, Huryn and Wallace 1987); TN (Elwood and Cushman 1975); Quebec (Harper et al. 1991)

Emergence Pattern

T. cornelia: VA: mid May (Stark and Armitage 2000); NC: mid-May to mid-June (Stark and Armitage 2000)

T. maria: MD: mid-May to early July, 60 adults captured from Big Hunting Creek- reported as *T. elisa* (Duffield and Nelson 1990); WV: May-July (Yokum et al. 1995); NC: May (O'Hop et al. 1984)

Tolerance Values

Maryland 1.5, Pennsylvania 0, Southeast 1.4

Order Trichoptera

Diplectrona (Hydropsychidae)

Distribution and Conservation Status of *Diplectrona*

Five species of *Diplectrona* occur in the United States and Canada. Two of these species, *D. metaqui* and *D. modesta*, occur in the northeastern United States. One species occurs in Maryland and one species has been reported from States surrounding Maryland [Natureserve Global conservation status ranks for these species are provided by InfoNatura (2007)]:

Maryland: *D. modesta*-G5

Surrounding States: *D. metaqui*-G4G5 (PA, VA)

The Global conservation status ranks of species in *Diplectrona* are as follows: 1 G5, 1 G4G5, 1 G1G2, 2 G1

Distribution of *Diplectrona* Species in Maryland

D. modesta was reported throughout Maryland by unpublished data collected by the Maryland Core/Trend Program, the Multiple and Single Habitat Assessment, the National Water Quality Assessment Program, the Mid-Atlantic Integrated Assessment, and the Mid-Atlantic Highlands Assessment. According to unpublished MBSS data, of the sites at which *D. modesta* was collected, 44.5% occurred in the Highlands, 36.2% in the eastern Piedmont, and 19.3% in the Coastal Plain.

Life History and Ecology

In general, *D. modesta* larvae inhabit headwater streams. They are net-spinning caddisflies that construct a fixed retreat. The larvae are collectors-filterers that feed on the coarse particles, especially detritus, which collect on their net. Late instar larvae consume mostly vascular plant and detritus fragments and fine particulate detritus in early instars (Malas and Wallace 1977).

The larval habitat of *D. modesta* was reported in a number of publications. Ross (1944) considers spring-fed streams to be their primary habitat. Wiggins (1977) reported that larvae of *Diplectrona* primarily inhabit rapid portions of small, cool streams. Along the course of a Kentucky stream, *D. modesta* was most abundant at an undisturbed site with dense canopy and with riffle habitat composed of a thin layer of cobbles and pebbles intermixed with gravel and coarse sand (Minshall 1968). Minshall collected larvae from every site along the course of the stream, except for a site at which pool habitat was dominant and from the furthest downstream

floodplain site where silt/sand/clay substrate was dominant. In Quebec, Mackay (1968) found *D. modesta* in leaf packs and in moss on submerged rocks. Malas and Wallace (1977) primarily found *D. modesta* on the undersides of rocks in intermediate velocities (20-60 cm/s) in North Carolina. Imhof and Harrison (1981) reported that *D. modesta* larvae survived dessication for at least a month in a small intermittent headwater stream in Ontario. In a lab, they found the larvae's mean survivorship was 50% after 30 days without water. The larvae were allowed to construct nets in gravel and stones before the water was taken away. Larvae that constructed their nets deep in the substrate were the ones that survived.

D. modesta construct nets on the underside of rocks. In general, the larger the larva get, the larger the mesh of the net becomes and the larger the volume of water that is filtered (Malas and Wallace 1977, Georgian and Wallace 1981). Table 1 is adapted from Georgian and Wallace (1981) and shows this relationship. *D. modesta* was found to construct nets on the top of rocks in moss when rock type does not allow them to construct their nets on the underside of rocks (Malas and Wallace 1977). Malas and Wallace (1977) also reported current velocities in which *D. modesta* constructed their nets ranging from ~5cm/s to ~70cm/s, with the majority occurring from 20-60cm/s.

Table 1. Relationship between *D. modesta* size, net mesh opening, and volume of water filtered.

Instar	Mean mesh opening (μm)	Volume filtered (1 d^{-1})
I	42.66	2.124
II	58.31	7.432
III	88.62	28.575
IV	152.8	138.479
V	191.51	571.74

A number of studies reported the feeding habits and production of *D. modesta*. In Coweeta, North Carolina streams, Ross and Wallace (1983) examined the annual production and production attributable to food types of *D. modesta* at sites with varying physical conditions. Table 2 shows the physical characteristics and annual and mean production parameters at two sites in which *D. modesta* was studied. The averages of the foregut contents of *D. modesta* among these sites were 73.6% fine detritus, 15.9% animal material, 8.45% vascular plant detritus, 0.44% filamentous algae, and 1.6% diatoms.

Table 2. *D. modesta* annual and mean production parameters from two sites in North Carolina and the physical characteristics of each site.

Physical characteristics						
	Gradient	Mean daily discharge	Median phi	Annual mean temperature		
Station C	11.6%	93 l s^{-1}	-6.9	9.8°C		
Station D	3.5%	179 l s^{-1}	-6.6	10.2°C		
Annual production parameters						
	Annual Production mg AFDM ($m^{-2}yr^{-1}$)	Fine detritus	Animal matter	Vascular plant detritus	Filamentous algae	Diatoms

Station C	244	45.2%	46.7%	6.9%	0.7%	0.5%
Station D	212	26.7%	69.9%	0.9%	0.2%	2.3%
Mean production parameters						
	No. m-2	Mean biomass	Annual Production mg AFDM ($m^{-2}yr^{-1}$)	Annual P/B		
Station C	225.6	46	244	5.3		
Station D	129.2	43	212	4.9		

Cushman et al. (1977) and Benke and Wallace (1980) also reported *D. modesta* production from Appalachian streams. In a Tennessee stream, annual production rates of *D. modesta* were estimated at 585.7 $mg \cdot m^{-2} \cdot yr^{-1}$ (Cushman et al. 1977). In the Tallulah River on the border of Georgia and North Carolina, Benke and Wallace (1980) report *D. modesta* annual production as 53 $mg \cdot m^{-2} \cdot yr^{-1}$. Approximately 59.9% of this is attributed to animal material, followed by vascular plant detritus (17.1%), fine detritus (16.6%), filamentous algae (2.4%), and diatoms (4%). They also found that foregut contents of *D. modesta* instars II-V were composed of 38.5% vascular plant detritus, 37.3% fine detritus, 19.3% animal material, 3% diatoms, and 1.8% filamentous algae.

The Ohio EPA considers *Diplectrona* a cool water taxon (OHEPA 2009). The Idaho Department of Environmental Quality considers *Diplectrona* a "eurythermal: cool" taxon (Grafe et al. 2002).

Voltinism

Univoltine:

D. modesta: KY: slow seasonal, long hatching period, slow growth over long period of time (Minshall 1968); NC (Ross and Wallace 1983, Benke and Wallace 1980); GA (Benke and Wallace 1980); TN (Cushman et al. 1977); Quebec: eggs hatch in late summer and autumn, larvae overwinter and mature in early summer (Mackay 1968)

Emergence Pattern

Ross (1944) reports *D. modesta* emerges as early as April in southern States and as late as July in northern States.

D. modesta: KY: May to mid-July (Minshall 1968); IL: May-June (Ross 1944)

Tolerance Values

Maryland 2.7, Pennsylvania 0, Southeast 2.2, Northwest 0

Wormaldia (Philopotamidae)

Distribution and Conservation Status of *Wormaldia*

Nineteen species of *Wormaldia* occur in the United States and Canada. Five species occur in northeastern US. An extensive literature review did not reveal any records of

Wormaldia in Maryland other than unpublished MBSS data in which aquatic insect larvae are not identified to species. Based on distribution records, it is likely both *W. moesta* and *W. shawnee* occur in Maryland. Three *Wormaldia* species have been reported from States surrounding Maryland [Natureserve Global conservation status ranks for these species are provided by InfoNatura (2007)]:

Surrounding States: *W. moesta*-G5 (VA, WV, PA, DE), *W. shawnee*-G4G5 (VA, WV, PA, DE), *W. thyria*-G3 (VA)

The Global conservation status ranks of species in *Wormaldia* are as follows: 3 G5, 1 G4G5, 1 G4, 1 G3, 4 G2G3, 1 G2, 3 G1G3, 2 G1G2, 3 G1.

Distribution of *Wormaldia* in Maryland

Wormaldia has a scattered distribution in Maryland with the area of highest concentration in western MD from Licking Creek west into Garrett County (MBSS, unpublished data). 74% of the sites at which *Wormaldia* was collected by the MBSS occurred in the Highlands while 17.8% were in the Coastal Plain and 7.8% in the eastern Piedmont.

Life History and Ecology

In general, *Wormaldia* are found in lotic-erosional systems where they build sac-like silk nets on the underside of rocks. Ross (1956) suggestsed that philopotamids, like *Wormaldia*, are a cool-water adapted group. Representatives of *Wormaldia* are obligate collectors-gatherers and consume particles captured in their nets. The nets of *Wormaldia* are composed of several layers of variable rectangular mesh that when fitted together make a meshed sieve (Wallace and Malas 1976). The nets collapse as "amorphous silt-covered masses" when removed from the water (Wiggins 1977).

Wiggins et al. (2001) collected adult *W. shawnee* in mid-June near a limestone sink in Tennessee that contained varying levels of water throughout the year. They believe the larvae occur in shallow springs feeding the sink or in the seeps and drainages flowing into the seep. This habitat is consistent with the small springs and clear swift temporary streams Ross (1944) reported for *W. shawnee*.

Two studies reported life history information on *W. moesta*. Singh et al. (1984) studied *W. moesta* in a headwater wooded stream in southern Ontario. The larvae preferred bare stones as did the pupae, which tended to aggregate on these stones. The larval diet primarily consisted of detritus but changed to diatoms when detritus was low. The authors suggested that *W. moesta* is univoltine in this stream and believe that water temperature is an important factor regulating growth and voltinism of this species.

Ross and Wallace (1983) collected *W. moesta* from a high-gradient mountain stream in North Carolina. The species was only collected from the headwater site during this study. This site had a 24% gradient, mean daily discharge = 1 Ls^{-1}, median phi = $-3.9\Phi^2$, and a 9.5°C annual mean temperature. Annual production was 67 AFDM $m^{-2}yr^{-1}$ and the production attributable to each food type is as follows: 96.3% fine detritus, 2.9% diatoms, 0.7% animal material, and 0.1% vascular plant detritus. The mean production parameters reported by Ross and Wallace (1983) are as follows: mean number m^{-2} = 40.2 m^{-2}; mean biomass = 5mg AFDM m^{-2}; Annual P/mean B = 13.4.

The Ohio EPA considers *Wormaldia sp.* a cool water taxon (OHEPA 2009). The Idaho Department of Environmental Quality considers *Wormaldia* a "eurythermal: cool summer" taxon (Grafe et al. 2002).

Voltinism
W. moesta:
Bivoltine: NC (Huryn and Wallace 1988)
Univoltine: AR (Bowles and Allen 1992); southern Ontario (Singh et al. 1984)

Emergence Pattern
W. shawnee: TN: mid-June (Wiggins et al. 2001)

Tolerance Values
Maryland 1.8, Pennsylvania 0, Southeast 0.4, Northwest 3

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