

Biological Assessment of the Rocky Gorge, Hammond Branch, and Dorsey Run Watersheds, Howard County, Maryland

Spring 2003 Index Period



Tiber Branch



UT to Patapsco River



UT to Dorsey Run

January 2004

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Prepared for:

Howard County, Maryland
Department of Public Works
Stormwater Management Division
6751 Columbia Gateway Dr., Ste. 514
Columbia, MD 21046-3143

Prepared by:

Tetra Tech, Inc.
10045 Red Run Blvd., Ste. 110
Owings Mills, MD 21117-6102

Acknowledgement

The principal authors of this report are Kristen L. Pavlik and James B. Stribling, both of Tetra Tech. They were also assisted by Erik W. Leppo. This document reports results from three of the six subwatersheds sampled during the Spring Index Period of the third year of biomonitoring by the Howard County Stormwater Management Division.

Fieldwork was conducted by Tetra Tech staff including Kristen Pavlik, Colin Hill, David Bressler, and Jennifer Pitt. All laboratory sample processing was conducted by Carolina Gallardo, Shabaan Fundi, Curt Kleinsorg, Chad Bogues, Joey Rizzo, Elizabeth Yarborough, Jessica Garrish, Chris Hines, and Sara Waddell. Taxonomic identification was completed by Dr. R. Deedee Kathman and Todd Askegaard; Aquatic Resources Center (ARC). Hunt Loftin, Linda Shook, and Brenda Decker (Tetra Tech) assisted with budget tracking and clerical support.

This work was completed under the Howard County Purchase Order L 5305 to Tetra Tech, Inc. The enthusiasm and interest of the staff in the Stormwater Management Division, including Howard Saltzman and Angela Morales is acknowledged and appreciated. Their dedication to a complete characterization of the condition of County streams ensures the continuation and success of the Howard County Stream Biomonitoring Program.

The appropriate citation for this report is:

Pavlik, K.L., and James B. Stribling. 2004. *Biological Assessment of the Rocky Gorge, Dorsey Run, and Hammond Branch Watersheds, Howard County, Maryland*. Prepared by Tetra Tech, Inc., Owings Mills, MD for Howard County, Department of Public Works. Stormwater Management Division. Columbia, MD. January 2004.

For more information, please contact:

Howard Saltzman
Angela Morales
Stormwater Management Division
Howard County Department of Public Works
6751 Columbia Gateway Dr., Suite 514
Columbia, Maryland 21046
410-313-6444

Abstract

Stream biota rely on the quality of physical habitat, hydrology, and water chemistry for their survival and reproduction. Human activities, such as land cover alteration, can affect abiotic stream conditions, which, in turn, can influence biotic communities. Thus, many biological monitoring and assessment programs, including Howard County, use composite biological indicators both as a measure of stream ecological response to land cover conversions, and as an overall portrayal of water resource integrity.

Several indicators (benthic macroinvertebrates, physical habitat quality, sediment particle size distribution, and channel size/shape) were sampled or measured at 30 stream sites in the Rocky Gorge, Dorsey Run, and Hammond Branch subwatersheds (10 sites in each) in Howard County, Maryland during March 2003. Sampling site locations were selected at random and were pre-stratified by subwatershed and stream order. Benthic macroinvertebrates were collected using Maryland Biological Stream Survey (MBSS) methods (multihabitat, 20 ft²).

This document reports the sampling and assessment results for all three subwatersheds, as well as composite assessments for watershed-scale biological and habitat assessments from the previous two years of sampling (2001, 2002). Individual site assessments from the Rocky Gorge, Dorsey Run, and Hammond Branch stream sites are also included. Watershed comparisons were made between the 12 (of 15) total subwatersheds sampled to date.

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Acronyms

ARC	Aquatic Resources Center
B-IBI	Benthic Index of Biotic Integrity
BMP	Best Management Practice
BRF	Biological Research Facility
DQO	Data Quality Objectives
DNR	Department of Natural Resources
DPW	Department of Public Works
DPZ	Department of Planning and Zoning
DRP	Department of Recreation and Parks
DS	Downstream
EDAS	Ecological Data Application System
EPT	Ephemeroptera, Plecoptera, Trichoptera
FLD	Field
MBSS	Maryland Biological Stream Survey
QA/QC	Quality Assurance/Quality Control
QAPP	Quality Assurance Project Plan
RBP	Rapid Biological Protocols
RPD	Relative Percent Difference
SD	Standard Deviation
SOP	Standard Operating Procedure
SWMD	Stormwater Management Division
TAC	Technical Advisory Committee
TCR	Taxonomic Certainty Rating
Tt	Tetra Tech
TV	Tolerance Value
USEPA	United State Environmental Protection Agency
US	Upstream
UT	Unnamed Tributary
WRD	Watershed Restoration Division

Executive Summary

In 2001, the Howard County Department of Public Works (DPW) Stormwater Management Division (SWMD) initiated biological monitoring for County streams and wadeable rivers on an annual, rotating basin cycle. The primary goal of this program is to assess the current status of the County's streams and watersheds and to establish a baseline for comparing future assessments. The program is designed to provide assessments at three geographic scales: stream-specific; watershed wide; and after the three-year sampling rotation is complete, county-wide. The Howard County Biomonitoring Program was designed to be comparable with the statewide Maryland Biological Stream Survey (MBSS). Comparability allows a greater density of sampling locations with consistent interpretation. Watersheds sampled during the first two years of the program include: Little Patuxent River (2001), Cattail Creek (2001), Brighton Dam (2001), and Middle Patuxent River (2002). This report presents results of 2003 sampling in the Rocky Gorge, Dorsey Run, and Hammond Branch subwatersheds. Sampling occurred during the Spring Index Period and methods were identical to those used by the MBSS: benthic macroinvertebrates sampled using a D-frame net (595 μm mesh) in multiple habitats (20 ft^2), visual-based assessment of physical habitat quality, and selected field chemistry measurements. In addition to MBSS protocols, substrate particle size distribution and stream channel cross sectional area were also evaluated. Biological condition scores were derived using MBSS's Benthic Index of Biotic Integrity (B-IBI). The B-IBI was used to rate the biological condition of each site as good, fair, poor, or very poor. Assessment of physical habitat quality combined MBSS methods and USEPA's Rapid Bioassessment Protocols (RBPs). A rating scale based on the latter was assigned to each site, and used categories of: comparable, supporting, partially supporting, or non-supporting. MBSS measures were taken for additional qualitative information. Results of this study will be used for developing protection/restoration priorities across the County. The public will be able to access the yearly report via the County website, as well as through brochures highlighting specific watersheds.

All three subwatersheds received "non-supporting" physical habitat ratings. Two of the three subwatersheds, Dorsey Run and Hammond Branch, received "poor" biological ratings, while Rocky Gorge received a "fair" rating. Land use percentages in these subwatersheds follow similar patterns of disturbance, both impaired subwatersheds Dorsey Run and Hammond branch have over 40% commercial and pasture land respectively. The relatively undisturbed Rocky Gorge on the other hand, maintains just over 45% forest cover.

I. PROGRAM OVERVIEW

Introduction

Background

The mission of the Howard County Stormwater Management Division (SWMD) is to improve the quality of life of the citizens of Howard County through managing the quality and quantity of County waters (Howard 2003). Three years ago, the SWMD initiated a multi-year, rotating basin biomonitoring effort to assess the ecological condition of streams and watersheds throughout the County. This report includes results from three watersheds sampled during the Spring Index Period of 2003 (Rocky Gorge, Dorsey Run, and Hammond Branch), as well as comparisons of past sampling efforts (2001 & 2002).

Howard County is surrounded by the Patuxent River to the south and west, and the Patapsco River to the north and east (Figure 1). Many of the sites sampled for this report empty directly into the Patuxent River. The County wishes to gather data about the physical and biological condition of these streams, and be able to educate the public on the health of the waters in their community. To this end, data collected is analyzed, and this report synthesizes the results.

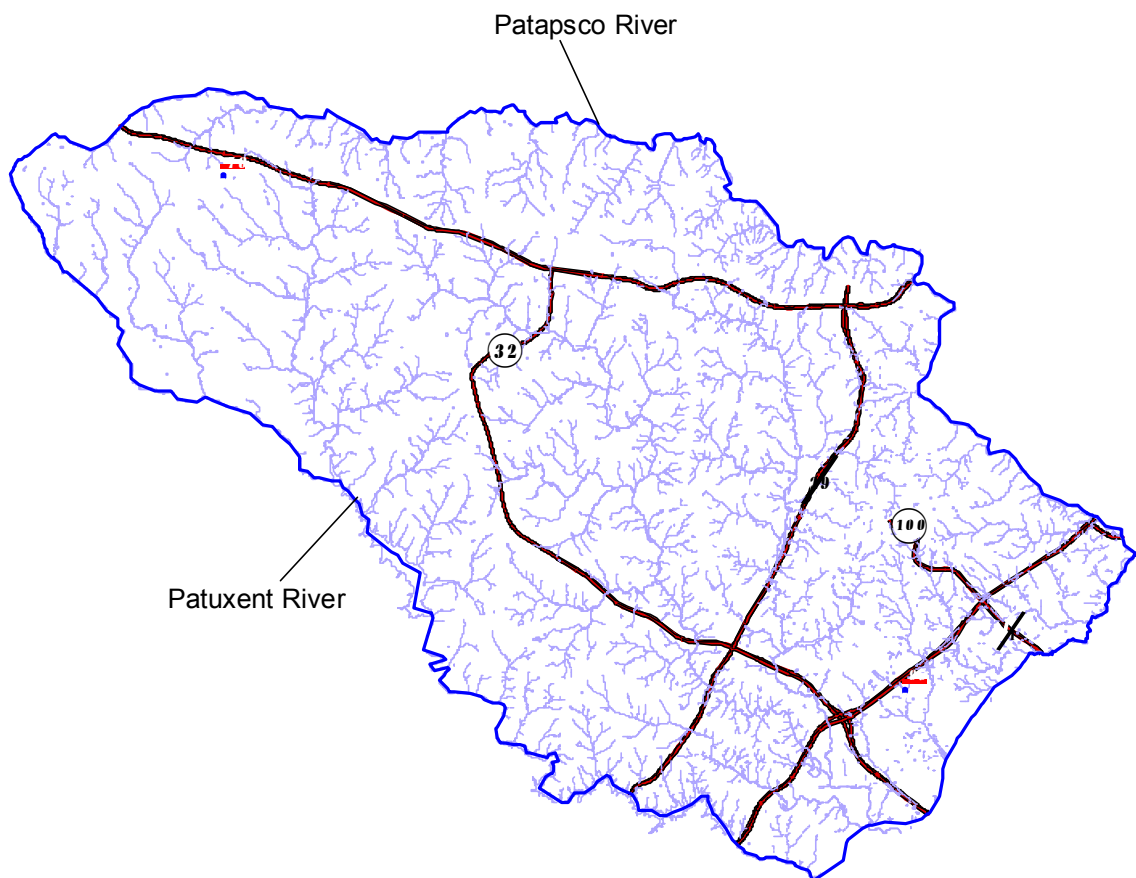


Figure 1. The Patapsco and Patuxent Rivers form the boundaries of Howard County.

The County bases its biological findings by sampling benthic macroinvertebrates. Benthic macroinvertebrates are the preferred organism to sample due to their large numbers; ability to assimilate the effects of physical habitat alterations, point source pollution, non-point source contaminants, periodic contaminant spills, and cumulative pollutants; and relative inability to quickly move away from such affected areas. Each organism has a particular sensitivity to pollution. The resident biota of a stream responds to prolonged periods of disturbance with a high number of pollution-tolerant organisms while a relatively stress-free system will support more pollution sensitive organisms.

The County has already completed one state-funded Watershed Restoration Action Strategy (WRAS) in the Little Patuxent River watershed. Results from the Rocky Gorge, Dorsey Run, and Hammond Branch watersheds will be used to supplement the original document. The biomonitoring program allows the County to collaborate with the state and other counties in order to characterize and restore degraded habitats or protect high quality streams on a watershed-wide basis.

Purpose of Biological and Physical Habitat Assessment

Physical habitat quality is visually assessed at each site (Barbour 1999). Cross-sectional measurements and pebble counts are also completed to gain a better understanding of the composition of the stream bed and to characterize the channel shape. A full physical assessment reflects the potential of a stream to support a dynamic biological community and to maintain normal hydrogeomorphic function.

Howard County is currently undergoing major changes in its land use patterns. Hundreds of years of farming activity is quickly being replaced by suburban sprawl along the Baltimore-Washington DC corridor. This drastic change in land use/land cover creates changes in stream and watershed hydrology that cause acceleration of stream channel erosion. Encroachment on physical habitat through higher housing density, new roads and schools, and other urban-suburban developments cause increased runoff, sedimentation, destruction of riparian vegetation, and bank instability, leading to reduced overall habitat quality (Richards et al. 1996).

While habitat alteration may lessen the ability of a stream to support a healthy biota, many other factors also affect the biological quality of any stream or watershed (Figure 2). Degraded habitat quality, interruption of natural hydrologic regimes, alterations in food/energy sources and water quality, and unnatural biologic interactions cause the biological condition of a stream to worsen (Karr et al. 1986). Potential stressors that cause this type of degradation include but are not limited to nutrient enrichment, toxic spills, flood control engineering, temperature extremes due to depletion of riparian zones or effluent discharge, elevated levels of suspended sediment due to animal access, clearing of riparian areas, and construction runoff. Sources of these stressors exist throughout Howard County and the state. Headwaters of many streams are located outside of the County, but they eventually flow into County watersheds and bring many pollutants in with them. Although biological monitoring is a critical tool for detecting impairment, it alone cannot identify specific causal relationships between stressors and stressor sources (Cormeir et al. 2000). More specific chemical analysis is necessary to pinpoint the origin of stressors. This report examines the current biological and physical interactions that dictate the condition of the

Rocky Gorge, Dorsey Run, and Hammond Branch watersheds, and provides possible explanations for those conditions.

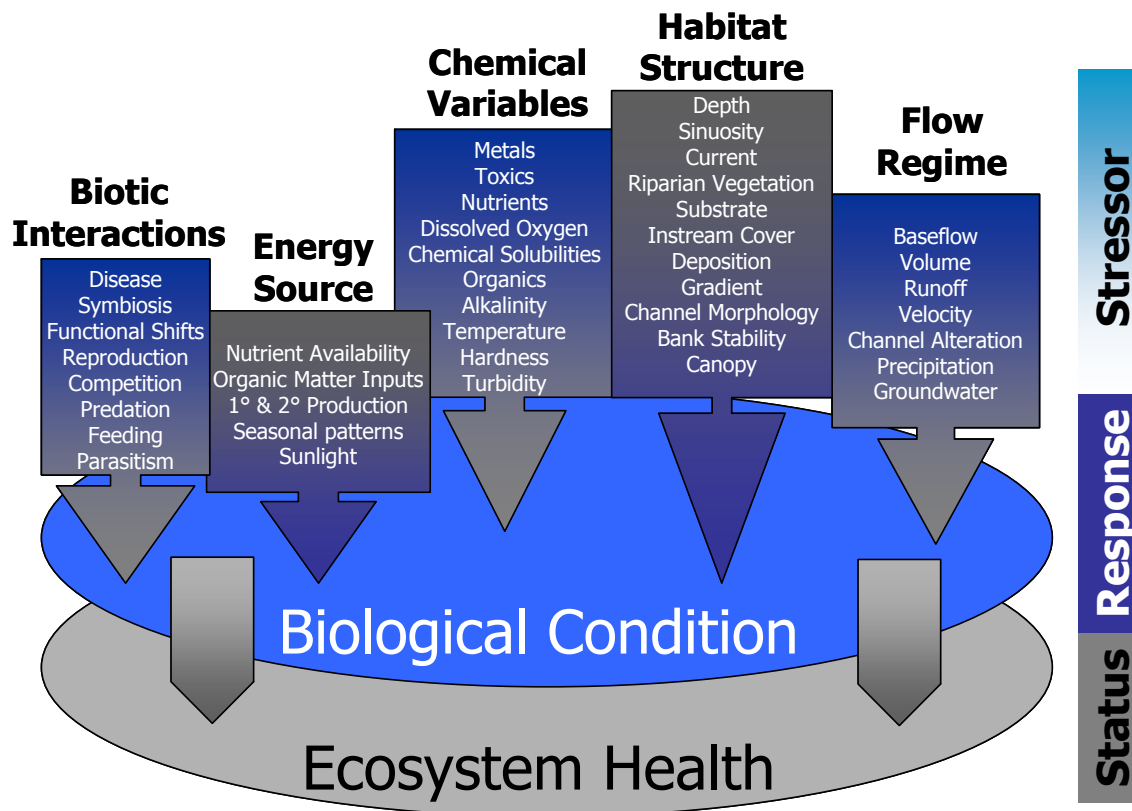


Figure 2. Five classes of environmental variables that affect water resource integrity and overall biological condition (modified from Karr et al. 1999).

Participating Agencies

Various County, State, and Regional personnel were and continue to be involved in the development of the County’s ongoing biomonitoring program. Membership on the County’s Technical Advisory Committee (TAC) includes Howard County Government (Stormwater Management Division (SWMD), the Department of Recreation and Parks (DRP), and the Department of Planning and Zoning (DPZ)), the State of Maryland Department of Natural Resources (DNR) Maryland Biological Stream Survey (MBSS), Montgomery County Department of Environmental Protection, and the Region 3 United States Environmental Protection Agency. Selected TAC members (Howard County SWMD, DRP, DPZ; MBSS) reviewed the first draft of this report, and provided comments that were integrated into the final report.

Methods

Network Design

Summary of Sampling Design

The measurement and data quality objectives (MQOs and DQOs) on which the Howard County biomonitoring program is based can be found in the *Quality Assurance Project Plan (QAPP)* for

Howard County Biological Monitoring and Assessment Program (DPW 2001). The overall sampling design was developed to be directly comparable to the MBSS, and allow the eventual sharing of data assessment among agencies. The program is designed so that in any given year, 10 sites per subwatershed are sampled. A total of 15 subwatersheds will be sampled during a span of three years. Specific details of the sampling design can be found in *Design of the Biological Monitoring and Assessment Program for Howard County Maryland* (Pavlik et al. 2000). Spatial allocation of the sampling segments was based on random selection within Strahler (1957) stream orders. The number of sampling segments within each of the first through fourth order channel distances (m) was proportional to total stream length. Thus, final selection and placement of sampling segments was random, and stratified by subwatershed and stream order.

To reduce issues of measurement error (= systematic error), duplicate (repeated) biological samples are taken at 10% of the overall number of sites. Since there are 10 sites in any given subwatershed, one additional quality control (QC) sample (biology, chemistry, and RBP habitat) is taken in each subwatershed. Duplicate sites are randomly chosen before the sampling event takes place.

Site Selection

In 2003, the remaining six subwatersheds not yet sampled in the County were completed. The full sampling schedule (2001-2003) is detailed in Table 1. During Year 1, the Little Patuxent watershed was sampled by MDNR's Watershed Restoration Division (WRD), as part of the statewide Watershed Restoration Action Strategy (WRAS) cooperative. The sites were randomly chosen by the County, therefore they are comparable with the remaining County samples. Figure 3 displays the watersheds and site locations sampled in 2003 that are covered in this report.

Table 1. Howard County sampling schedule by watershed. WRD indicates field sampling and laboratory processing of benthic samples performed by DNRs Watershed Restoration Division.

Year	Watershed Name or Surrogate	Subwatershed #	Primary Sampling Unit (PSU)
1 (2001)	Little Patuxent River	11	Upper Little Patuxent (10 sites, WRD)
		12	Mid Little Patuxent (10 sites, WRD)
		13	Lower Little Patuxent (10 sites, WRD)
	Brighton Dam	2	Upper Brighton Dam (10 sites)
		5	Lower Brighton Dam (10 sites)
		3	Cattail Creek (10 sites)
2 (2001)	Middle Patuxent River	6	Upper Middle Patuxent (10 sites)
		7	Mid Middle Patuxent (10 sites)
		8	Lower Middle Patuxent (10 sites)
3 (2003)	Little Patuxent River	14	Hammond Branch (10 sites)
		15	Dorsey Run (10 sites)
		9	Rocky Gorge (10 sites)
	Boundary Tributaries	10	S Branch Patapsco R Tribs (10 sites)
		1	Patapsco River L Branch A (10 sites)
		4	Patapsco River L Branch B (10 sites)

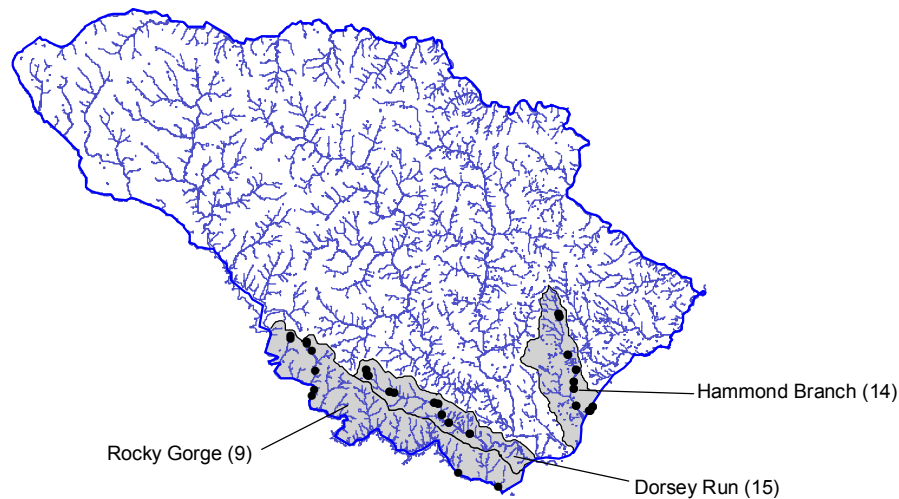


Figure 3. Location of sites sampled in the Rocky Gorge, Dorsey Run, and Hammond Branch subwatersheds in 2003.

Field Sampling and Laboratory Processing

Two two-person field teams completed sampling during the Spring 2003 Index Period. Benthic macroinvertebrates and physical habitat assessments are conducted in accordance with the Standard Operating Procedures (SOP FLD003/09.07.00; FLD005/02.27.01) contained within the Howard County QAPP (DPW 2001), as well as methods explained in the MBSS Sampling manual (Kazyak 2000). *In-situ* water chemistry sampling, modified Wolman pebble count, and channel cross sectional measurements are conducted according to SOPs BRF050/07.07.97, FLD032/01.25.99, and FLD043/07.19.99, respectively. Laboratory sorting and subsampling are completed in accordance with SOP BRF004/02.23.01.

Benthic Sampling and Processing

At each site, benthic macroinvertebrates are collected from a 75m reach by sampling approximately 20ft² of surface area with a D-frame net (595 μ m mesh), in proportion to the frequency of high quality habitat types (riffle/cobble; gravel, broken peat, clay; snags; undercut bank; SAV; and detrital/sandy bottom areas) found within the reach. All sampled material is then composited into a 595 μ m sieve bucket, placed in one or more one liter sample containers and preserved in a solution of 70-80% ethanol. Internal and external labels are completed for each container. Samples are tracked on chain-of-custody forms for each subwatershed. In the Tetra Tech Biological Research Facility (BRF), the composited samples are randomly subsampled to 100 organisms (\pm 10%) (DPW 2001, Boward and Friedman 2000). In accordance with MBSS methods, samples containing <60 organisms are not given index scores and therefore are not included in overall watershed assessments (Boward personal communication 2001).

Benthic Taxonomy

Benthic macroinvertebrates are usually identified to the genus level. Early instars or individuals that have damaged or missing diagnostic morphological features are identified at a higher taxonomic level, such as family. All identifications are performed by Aquatic Resources Center (ARC), College Grove, Tennessee (R.D. Kathman, principal). Taxonomic data are loaded into the Ecological Data Application System, Version 3.0 (EDAS; Tetra Tech 1999). Functional feeding group, habitat, and tolerance value designations are assigned to each taxon according to Barbour et al. (1999), Meritt and Cummins (1996), and USEPA (1990). Tolerance of a taxon is based on its ability to survive short and long term exposure to physicochemical stressors that result from chemical pollution, hydrologic alteration, or habitat degradation (Stribling et al. 1998). Following Hilsenhoff's basic framework (1982), tolerance values are assigned to individual taxa on a scale of 0-10, with zero identifying taxa that are the most sensitive (least tolerant) to stressors, and 10, the least sensitive (tolerant) to stressors.

Physical Habitat Rating (Methods for Calculation and Scoring)

Howard County uses the non-Coastal plain categories found in the Rapid Bioassessment Protocols (RBPs; Barbour et al. 1999) for measuring physical habitat characteristics at each site (DPW 2001). Ten parameters describing physical habitat quality and stability are visually assessed at each site. These parameters are ranked as optimal, suboptimal, marginal, or poor based on a 20-point scale, with 20 being the best possible (optimal) conditions, and zero representing the worst (poor) conditions. MBSS has not developed a degraded/non-degraded threshold for direct comparison to physical habitat characteristics. Furthermore, MBSS records qualitative physical habitat measurements during the Summer Index Period, while sampling fish. Currently, Howard County does not support summer fish sampling, therefore physical habitat characteristics are measured during the Spring Index Period. However, since the RBPs were not used to rate reference sites in Maryland or Howard County, the values are summed and compared to the maximum possible score (200) for overall percent comparability for each site. The following 10 parameters are evaluated:

1. *Epifaunal substrate/available cover*. Includes the relative quantity and variety of natural structures in the stream, such as cobble (riffles), large rocks, fallen trees, logs and branches, and undercut banks, available as refuge, feeding, or sites for spawning and nursery functions of aquatic macrofauna.
2. *Embeddedness*. Refers to the extent to which rocks (gravel, cobble, and boulders) and snags are covered or sunken into the silt, or mud of the stream bottom.
3. *Velocity/depth regime*. The occurrence of flow patterns relates to the stream's ability to provide and maintain a stable aquatic environment.
4. *Sediment deposition*. Measures the amount of sediment that has accumulated in pools and the changes that have occurred to the stream bottom as a result of deposition.
5. *Channel flow status*. The degree to which a stream is filled with water.
6. *Channel alteration*. Measures large-scale (usually anthropogenic) changes in the shape of the stream channel.
7. *Frequency of riffles/bends*. Measures the heterogeneity occurring in a stream. Riffles are a source of high-quality habitat and diverse fauna. Therefore, increased frequency of occurrence greatly enhances the diversity of the stream community.

8. *Bank stability.* Measures whether the stream banks are eroded (or have potential for erosion).
9. *Vegetative protection.* Measures the amount of vegetative protection afforded to the stream bank and the near-stream portion of the riparian zone.
10. *Riparian vegetative zone width.* Measures the width of natural vegetation from the edge of the stream bank out through the riparian zone.

Parameters 8-10 evaluate each bank separately. The range of scores for each bank is 0 (poor) to 10 (optimal). Left and right banks are determined looking downstream. Example habitat forms can be found in the QAPP (SOP FLD005/02.27.01). Table 2 provides narrative ratings that correspond to physical habitat quality scores. These scores express the potential of a stream or watershed to support a healthy biological community. Percentages and their narrative ratings were adapted from Plafkin et al. (1989).

Table 2. Total habitat scores as a percentage of maximum possible and corresponding ratings.

% of Maximum	Narrative Habitat Rating	Definition
>90.0	Comparable	Capable of maintaining biological conditions similar to reference streams
75.1-89.9	Supporting	Habitat of somewhat reduced condition, but often can support reference quality biology
60.1-75.0	Partially Supporting	Capable of supporting biological conditions of lower quality than reference conditions
<60.0	Non-Supporting	Not able to maintain healthy biological conditions

Habitat forms developed by MBSS are also completed at each site. These sheets evaluate land use/land cover designations, occurrence/severity of refuse, buffer breaks (storm drains, roads, pastures, etc.), and channelization. Information from these forms is described in the narrative watershed and site-by-site assessment sections of this report.

Water Quality

Conductivity, dissolved oxygen, pH, and temperature are measured at each site using a YSI 600 QS Multi-Parameter Water Quality Monitor. This instrument is calibrated for each parameter at the start of each sampling day, and the readings are recorded in the calibration log book.

Modified Wolman Pebble Count

In addition to the qualitative habitat assessment, this physical habitat feature is measured for all stream sites. While not a part of the MBSS protocols, the County performs pebble counts to obtain more specific data on stream substrates. Ten transects are evenly distributed (approximately every 7.5m) through the site. Ten particles are selected starting at one bank at approximate bankfull level and spanning the width of the active channel. Each particle is defined as a size of geologic substrate material within various classes: silt/clay, sand, gravel, cobble, boulder, and bedrock. Each particle is chosen, measured, and recorded at evenly spaced intervals across the channel. To reduce sampler bias, each particle is chosen without the sampler looking in the stream at what is being collected (DPW 2001, SOP FLD032/01.25.99; Harrelson et al. 1994). Calipers and a sand card are used for particle measurement.

Channel Cross-Section

Although not measured by MBSS, the County includes this characterization to provide a coarse characterization of channel cross-sectional area, shape, and changes to channel volume over time. After a thorough visual assessment of the site characteristics, a representative section is selected for the cross-section transect. A tape measure is drawn between pins that are set on each bank. The pins keep the tape taut during measurement, ensuring accurate width values. Height measurements are taken using a laser-level and top-setting survey rod (DPW 2001, SOP FLD043/07.19.99). The measurements are taken across the entire width of the channel, at transitional areas along the bank and streambed (e.g., bankfull, thalweg, edge of water, etc.).

Inability to Sample Stream Sites

In the event that access to a stream is denied by a landowner, or prohibited by any other means (fenced, inside small culvert, dammed, etc.), 10 alternate sampling sites are randomly chosen in each watershed. Only one alternate was used for the Rocky Gorge, Dorsey Run, and Hammond Branch watersheds during the 2003 Spring Index Period. The original site was located in the Hammond Branch watershed and was directly downstream of I-95, near route 216. There is no safe parking area in that vicinity, therefore the first alternate of the same stream order was sampled in place of the primary site.

Data Analysis

Data Structure

Benthic macroinvertebrate, physical habitat, and water quality data are entered into EDAS Version 3.0 (Tetra Tech, 1999). This relational database allows for the management of location and other metadata, taxonomic and count data, raw physical habitat scores, the calculation of metric values, physical habitat, and B-IBI values. All three years of sampling data and results are stored in EDAS.

Biological Index Rating (Methods for Calculation and Scoring)

The biological indicator used in this project is based on the Index of Biological Integrity (IBI; Karr et al. 1986) and uses characteristics of the benthic macroinvertebrate assemblage structure and function to assess the overall water resource condition. A benthic IBI was developed by the MBSS and calibrated for different geographic regions (Coastal Plain, Non-Coastal Plain) in Maryland (Stribling et al. 1998). The majority of Howard County lies in the non-Coastal plain, however, 10 sites (two in Rocky Gorge and eight in Dorsey Run) lie in the fall-zone between strictly Coastal plain and non-Coastal plain areas.

Watershed Assessments

In this report, a narrative explanation of the biological condition and physical habitat quality scores are given for each site. Important features recorded during sampling or found during subsampling are used to further illustrate potential reasons for site rating. Tolerance values (t.v.) are used in the site descriptions to add information about the organisms collected, and how their tolerance to pollution affects the overall metric score. The mean and standard deviation for benthic macroinvertebrate metrics and physical habitat scores are calculated in MS Excel for each watershed. The “percent of maximum” habitat values presented in the appendix are calculated by dividing the total habitat score by the total possible score represented on the habitat data sheets (method maximum), rather than a mean of field measurements or median from a set of reference sites. RBP habitat data sheets have a total possible score of 200.

Quality Assurance/Quality Control

Quality Assurance/Quality Control (QA/QC) activities are designed to ensure data quality and to document data characteristics. To this end, Howard County has:

- documented standard operating procedures (SOPs) for field sampling, laboratory processing, and completing chain-of-custody forms

The SOPs and procedures for these QC activities are documented in the Howard County Biological Monitoring and Assessment Program plan (DPW 2001). All SOPs are cited in the methods section of this report. Chain-of-custody and sample log sheets are maintained to track the inventory and processing status of all samples. Sample documentation forms are kept in three-ring binders in Tetra Tech’s Biological Research Facility (BRF).

- held annual orientation sessions for field sampling

The County field orientation is held as a “refresher” for experienced samplers and as an introduction for new samplers. All two-person field teams are divided into Team Leader and Crew Member. Team Leaders are required to have completed at least one field season as a Crew Member. Crew Members have completed either the introductory or “refresher” field orientation. The orientation for this index period was held on February 25 and 28, 2003. This orientation covered field note requirements and procedural guidelines. The Team Leader from each field crew also attended the MBSS training session conducted by DNR staff, which was held on March 3, 2003, at Morgan Run Natural Environmental Area (Carroll County). The MBSS training session included both general direction and hands-on field training.

- conducted field audits

Each County field crew is visited on-site by an experienced field ecologist who is not involved in the fieldwork for the project. MBSS staff also conducts independent audits of the Howard County field teams. Field team procedures are observed for adherence to SOPs and consistency in completion of all data collection requirements including, field data sheets, sample preservation, and photo documentation. Results of field audits can be found in Appendix D.

- repeated continual training and QC checks for sample sorting and subsampling

All sorting and subsampling of samples is performed by a single individual in the Tetra Tech BRF. Early sorting is checked by the biological QC officer to ensure that there are no missed specimens in removed grid debris. Once a 90% sorting efficiency is attained, random checks are performed on approximately one out of 10 samples.

- made consistent use of up-to-date technical taxonomic literature

The target level of taxonomic identification for benthic macroinvertebrates for this project is genus. State-of-the-science technical literature is used throughout and includes the references listed in Table 3.

Table 3. Taxonomic references used for organism identification.

Burch, J. B. 1989. <i>North American Freshwater Snails</i> . Malacological Publ., Hamburg, Michigan. 365p.
Burch, J. B. 1982. <i>Freshwater Snails (Mollusca: Gastropoda) of North America</i> . EPA-600/3-82-026, USEPA, Cincinnati, Ohio. 294 p.
Edmunds, G. F., Jr., Jensen, S. K. and Berner, L. 1976. <i>The Mayflies of North and Central America</i> . Univ. Minn. Press, Minneapolis. 330 p.
Epler, J. H. 1995. <i>Identification Manual for the Larval Chironomidae (Diptera) of Florida</i> . rev. ed. Dept. Environ. Prot., Tallahassee, FL. 9 sections.
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- verified taxonomy for questionable invertebrate specimens by senior taxonomists or independent specialists

There are two principal sources of error that can cause uncertainty in some taxonomic identifications. One is that the specimens in question are of very early instars (juvenile) and lack morphological structures necessary for positive identification. Another is that any specimen can

have damaged or missing morphological features (gills, antennae, legs, caudal filaments) rendering final, positive identification problematic. In addition, for midges or worms, inadequate mounting medium can make genus level identification nearly impossible. Depending on the condition of an organism, the taxonomist will either request a second opinion from an expert in that particular field (e.g., worms, midges, beetles, etc.) or will identify it to the next highest positive classification (i.e., family instead of genus).

- created, maintained, and used reference collection and voucher samples

During the first sampling year, Howard County created a taxonomic reference collection for benthic macroinvertebrates collected in the county. One or more specimens removed from samples are kept as representative of the taxonomist's concept of that taxon. Organisms of reference quality collected during the spring 2002 and 2003 index periods are added to the reference collection. As sampling continues, the reference collection will be updated with any new example specimens. Specimens in the reference collection were identified by Aquatic Resources Center (ARC), College Grove, TN (R. Deedee Kathman, Ph.D.). Voucher samples (stored in ~ 75% ethanol) are kept from all sampling in Howard County for at least three years in the Tetra Tech BRF.

- standardized data entry and management system

All biological, physical habitat, chemical, and ancillary data are entered directly from field data sheets or Excel spreadsheets into EDAS. The data and analytical results from future index periods will be managed in this system.

- conducted independent QC checks of all data entry

One hundred percent of the data set, once entered, is checked by hand against the original, hand-written field sheets. If discrepancies are encountered, they are corrected in EDAS.

- collected duplicate samples for estimating precision using Relative Percent Difference (RPD)

Duplicate biological and physical habitat samples are taken at three sites (10% of the total sampled), one per subwatershed. Comparisons of the differences between the results from these sites provide estimates of the precision of the biological assessments and the consistency of sampling activity. Relative percent difference (RPD) provides an estimate of the difference between sample pairs. Table 4 illustrates RPD for biological metrics and Table 5 presents RPD for physical habitat scores.

Table 4. Relative Percent Difference (RPD) calculations of biological scores for sites in the Rocky Gorge, Dorsey Run, and Hammond Branch watersheds.

Station #	186	186QC	274	274QC	285	285QC
Stream Name	UT to Patuxent	UT to Patuxent	Dorsey Run	Dorsey Run	Hammond Branch	Hammond Branch
Location	13942 Rt. 108	13942 Rt. 108	Maple Park	Maple Park	approx. 100 m behind house on Hammond Dr.	approx. 100 m behind house on Hammond Dr.
Metric Score	4.11	3.89	1.44	2.11	2.56	3.22
Narrative Rating	Good	Fair	Very Poor	Poor	Poor	Fair
Total Organisms	97	114	106	116	104	119
RPD	5.56		37.50		23.08	

The measurement performance criteria outlined in the QAPP (DPW 2001) calls for RPD agreement of the overall bioassessment scores to be $\leq 5\%$. Since the metric scores are based on a 1, 3, 5 scale, and not a continuous scale (e.g., 0-100), a change in only one metric category (i.e., one “point”) is enough to alter the overall score above the acceptable limit. Site 186 had one different metric score than its QC site (% Ephemeroptera). Site 274 had three metrics that were different from its QC site (Total Taxa, Ephemeroptera Taxa, and % Ephemeroptera). Site 285 had four metrics that were different from its QC site (Total Taxa, EPT Taxa, Ephemeroptera Taxa, and % Collector). However, none of the metrics changed more than one level (i.e., from a score of 1 to 5). The most likely reason that the QC sites score slightly different than the probability sites is that the QC sites are assigned to the probability sites before they are visited. Therefore, the QC site might not be a good representation of the probability site; tributaries could be entering the stream, bridges or roads could be built across the stream, drains could be entering the stream that would have different effects on the biota at the QC site that the probability site may not have to deal with. There is also natural variability in the habitats available for sampling, and the biological composition of those habitats. For example, cobble made up 85% of the sampling effort at site 285 and its QC site. However, the probability site only needed four grids of the Caton tray to be sorted until 100 organisms were found; while the QC site needed 11 grids sorted to reach the 100 organism target. This occurrence, while unusual, is not cause to completely discount the data. The data from these site pairs are examined more closely to understand reasons for the difference. Results such as these will be considered during the planning stage of Round 2 of the County Biomonitoring Program, and possibly new criteria will be set that more accurately characterize the natural variability of the biological composition of Howard County streams.

Table 5. Relative Percent Difference (RPD) calculations of physical habitat scores for sites in the Rocky Gorge, Dorsey Run, and Hammond Branch watersheds.

Station #	186	186QC	274	274QC	285	285QC
Stream Name	UT to Patuxent	UT to Patuxent	Dorsey Run	Dorsey Run	Hammond Branch	Hammond Branch
Location	13942 Rt. 108	13942 Rt. 108	Maple Park	Maple Park	approx. 100 m behind house on Hammond Dr.	approx. 100 m behind house on Hammond Dr.
Total Score	145	146	99	95	118	109
% Compared to Maximum	72.5	73	49.5	47.5	59	54.5
Narrative Rating	Partially Supporting	Partially Supporting	Non Supporting	Non Supporting	Non Supporting	Non Supporting
RPD (%)	0.69		4.12		7.93	

The measurement performance criteria outlined in the QAPP (DPW 2001) calls for RPD agreement of the overall physical habitat scores to the $\leq 20\%$. The QC sites in each subwatershed meet this criterion.

- Compared sample variation with design assumptions

The standard deviations from the Rocky Gorge, Dorsey Run, and Hammond Branch subwatersheds were compared to the standard deviations associated with MBSS samples (reference and test) collected in general non-Coastal plain proximity and in Howard County. In the program sampling design (Pavlik et al. 2001), the MBSS values were used to assign a target number (number of sites to sample) per subwatershed to meet specified data quality objectives (DQOs).

- ◆ Reference = 0.69
- ◆ MBSS Test = 0.83
- ◆ Rocky Gorge, Dorsey Run, Hammond Branch = 0.81

Since the SD from this dataset is 0.81, below the MBSS threshold for probability sites, the County's DQO is met.

II. SUBWATERSHED SITE ASSESSMENTS

Metric Selection

Ten of the 20 probability sites sampled in Rocky Gorge and Dorsey Run are located in the transitional zone between Non-Coastal Plain (NCP) and Coastal Plain (CP) ecoregions (all of Hammond Branch is located in the Non-Coastal Plain). A correlation analysis was performed on the final biological index scores of the 10 transitional zone sites. A comparison of the final index scores revealed that there was not a significant difference in rating, $r = 0.84$. Figure 4 graphically shows the relationship. Since no significant difference was found, all of the sites from Rocky Gorge, Dorsey Run, and Hammond Branch were scored using the NCP metrics. These will be able to be compared to past and future assessments across the County.

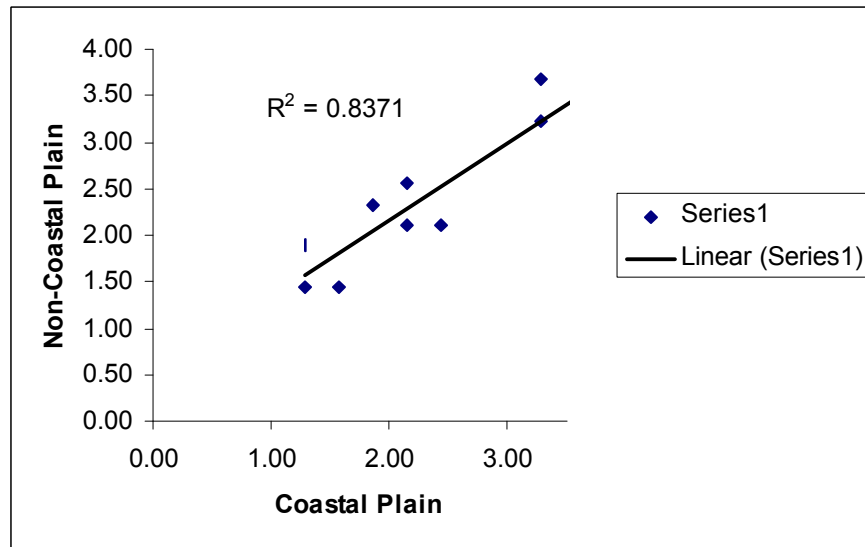


Figure 4. Correlation of NCP and CP final index scores for 10 sites in the transitional zone of Howard County.

Subwatershed Results

General Overview

Each of these subwatersheds drain into the Patuxent River. Dorsey Run and Hammond Branch first drain into the Little Patuxent, which meets the Patuxent just south in Prince George’s County. Table 6 provides an overview of mean scores and narrative characterization for each subwatershed.

Table 6. Means of the biological and physical habitat scores for each subwatershed, with their corresponding narrative ratings. Confidence limits are represented by a single standard deviation.

	Narrative Rating	Index Mean Score
Rocky Gorge		
Physical Habitat Quality	“Non-Supporting”	$\bar{x} = 114.3 \pm 19.35$ (n = 10)
Biological Condition (B-IBI)	“Fair”	$\bar{x} = 3.29 \pm 0.80$ (n = 10)
Dorsey Run		
Physical Habitat Quality	“Non-Supporting”	$\bar{x} = 100.3 \pm 24.9$ (n = 10)
Biological Condition (B-IBI)	“Poor”	$\bar{x} = 2.51 \pm 0.74$ (n = 10)
Hammond Branch		
Physical Habitat Quality	“Non-Supporting”	$\bar{x} = 115.10 \pm 16.20$ (n = 10)
Biological Condition (B-IBI)	“Poor”	$\bar{x} = 2.84 \pm 0.69$ (n = 10)

Land use percentages were calculated for each subwatershed sampled this year (Figure 5). Rocky Gorge and Hammond Branch, both in the southwestern part of the County, are dominated by pasture and deciduous forest. Dorsey Run (in the southeastern section of the County) however, has more commercial land use. This could be due to I-95 and it’s various interchanges running through that section of the County.

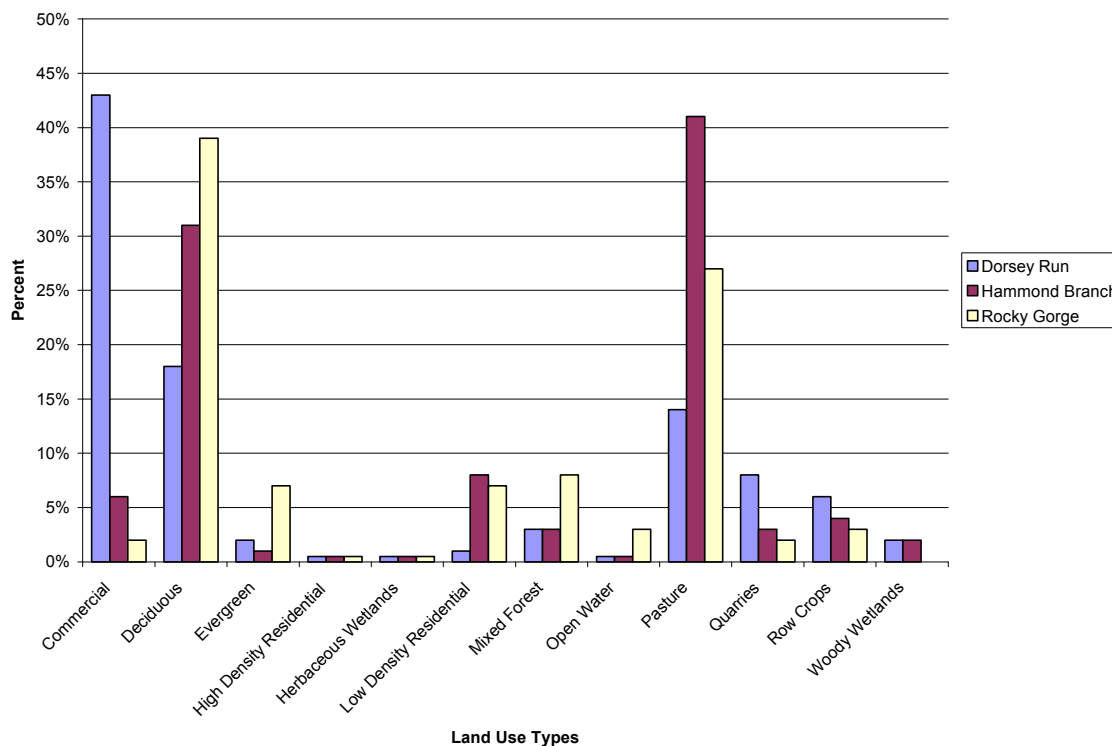


Figure 5. Percent land use type in the Dorsey Run, Hammond Branch, and Rocky Gorge subwatersheds.

Biological integrity was compared to physical habitat condition for the subwatersheds sampled in the 2003 sampling period (Figure 6). The lack of positive correlation between biology and habitat could be attributed to effects of excess nutrients (Rocky Gorge) or chemical runoff (Dorsey Run and Hammond Branch) that were not measured in this study. Figure 7 shows overall biological condition for the Dorsey Run, Hammond Branch, and Rocky Gorge subwatersheds.

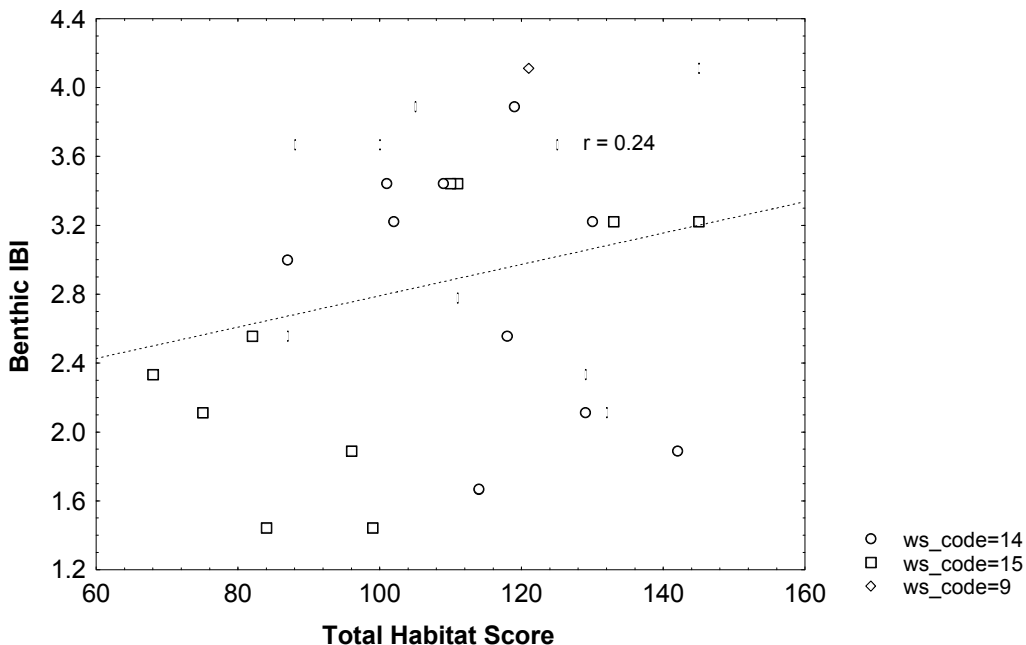


Figure 6. Scatterplot of the biological and physical habitat scores among the Dorsey Run, Hammond Branch, and Rocky Gorge subwatersheds.

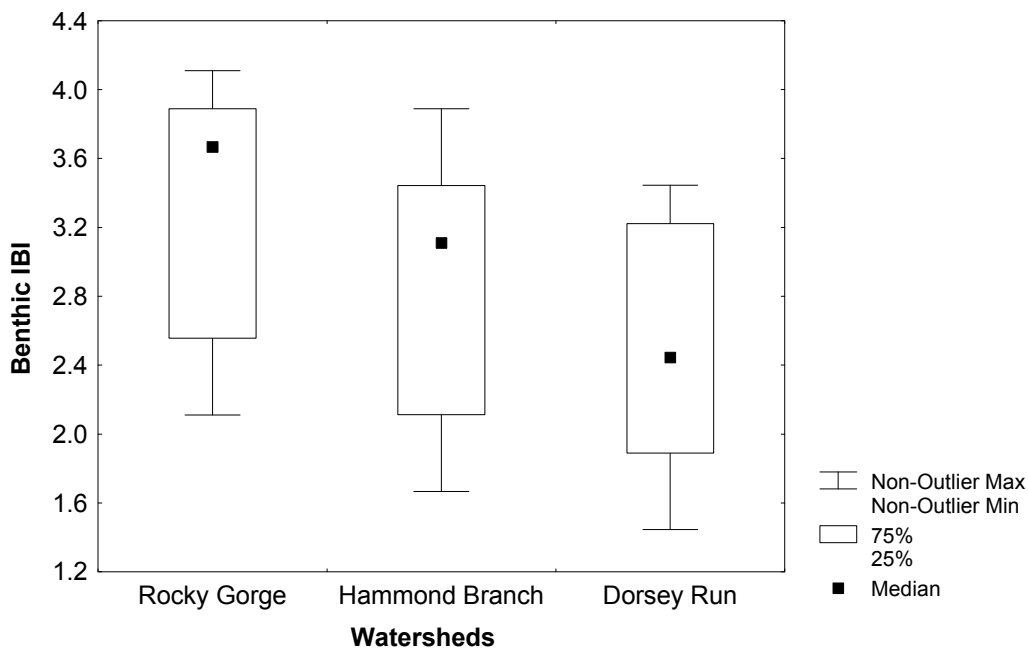


Figure 7. Biological scores in the Rocky Gorge, Hammond Branch, and Dorsey Run subwatersheds.

Rocky Gorge

Data Overview

This subwatershed is along the southwestern border of Howard County. The Rocky Gorge Reservoir is in the subwatershed, formed on the mainstem Patuxent River. Major thoroughfares that run across the Rocky Gorge subwatershed include I-95, US 1, US 29, MD 216, and MD108. Sharing a border with Montgomery County, this is one of the more populated subwatersheds sampled.

The mean biological condition for this subwatershed is “fair” ($\bar{x} = 3.29 \pm 0.80$, $n = 10$). Two sites rated “good”, four sites rated “fair”, and four sites rated in “poor” biological condition (Table 7, Figure 8). The mean physical habitat rating for this subwatershed is “non-supporting” (57% of maximum; Table 7). Of the ten sites sampled, 50% were “partially supporting” and the other 50% were rated as “non-supporting”. Correlation between physical habitat quality and biological condition had a very low r -value ($r = 0.12$; Pearson product moment), suggesting that stressors other than habitat are having a substantial effect on overall biological condition in this subwatershed.

Table 7. Summary of biological and habitat scores for each sampled site in the Rocky Gorge subwatershed.

Site	Benthic IBI Score	Biological Rating	Habitat Score	Habitat Rating	Stream Order
181	2.33	Poor	129	Partially Supporting	1
182	3.67	Fair	125	Partially Supporting	1
183	2.56	Poor	87	Non Supporting	1
184	2.78	Poor	111	Non Supporting	1
185	4.11	Good	121	Partially Supporting	1
186	4.11	Good	145	Partially Supporting	1
187	3.89	Fair	105	Non Supporting	4
188	2.11	Poor	132	Partially Supporting	4
189	3.67	Fair	88	Non Supporting	4
190	3.67	Fair	100	Non Supporting	4

Site Specific Results

Site 181 – This site is on an Unnamed Tributary (UT) to the Patuxent River. It is upstream (US) of 13491 Villadest Drive. It received a “poor” biological condition rating (B-IBI = 2.33). Only four pollution sensitive EPT (Ephemeroptera, Plecoptera, Trichoptera) taxa were sampled. Tanytarsini, a relatively pollution sensitive midge-fly, was also not found in the sample. However, the most common taxa was a pollution sensitive midge, *Sympotthastia* (Diptera: Chironomidae, $tv = 2$). Physical habitat condition rated “partially supporting” (65% of maximum). The lowest scores were for bank stability and vegetative protection. The Sediment Deposition category received a sub-optimal rating, which was confirmed by pebble count data that revealed 61% of the bottom substrate was composed of silt/clay and sand-sized particles.

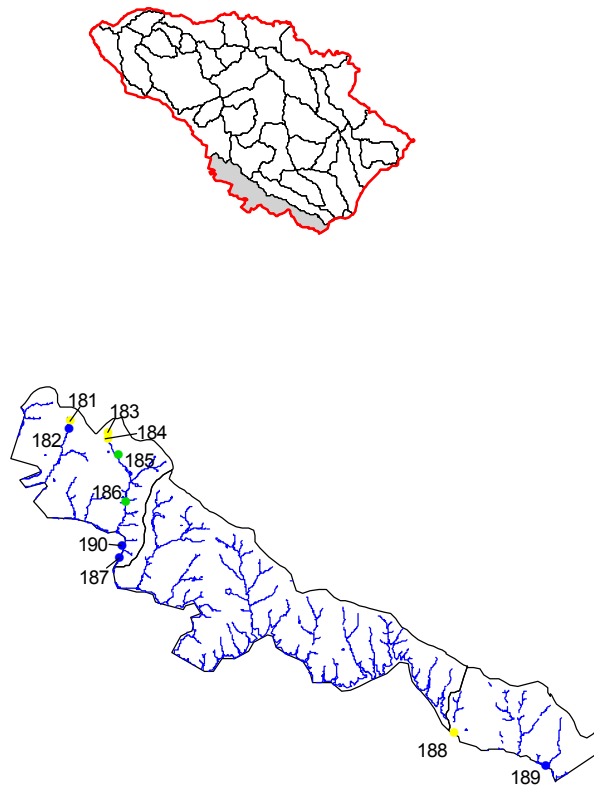


Figure 8. Color-coded biological ratings for the Rocky Gorge subwatershed. Green = good, blue = fair, yellow = poor, red = very poor. 181-190 indicate site numbers.

Site 182 – This site is on a first order UT to the Patuxent River. Located directly behind 13491 Villadest Drive, it received a “fair” biological condition rating (B-IBI = 3.67). Thirty-eight total taxa were subsampled, 24 of which were dipterans. Over 50% of the sample was comprised of Collector taxa, which is typically a sign of low habitat disturbance levels. The most common taxa was *Symptothastia* (tv = 2). Physical habitat condition rated “partially supporting” (63% of maximum). Again, the major problems at the site were bank stability and vegetative protection. The streambed consisted of close to half sand, half gravel-sized particles.

Site 183 – Located behind 6685 Mink Hollow Road, this first order UT to the Patuxent was rated in “poor” biological condition (B-IBI = 2.56). Only 19 total taxa were found, and 20% of them were pollution-tolerant taxa. Only one EPT taxa was found, *Limnephilus* (Trichoptera: Limnephilidae; tv = 2). The most common taxa was *Rheocricotopus* (Diptera: Chironomidae; tv = 6), which made up 65% of the sample. A very narrow riparian zone led to this site receiving a “non-supporting” (44% of maximum – the lowest score in this subwatershed) physical habitat rating. The stream flows in between fenced cow pastures. However, the cows have access to the water. In addition, both the Embeddedness and Epifaunal Substrate/Available Cover parameters were scored in the Poor category. Silt/clay covered 87% of the streambed. Accumulation of fine sediments make it difficult for organisms to find good places for cover, or to feed, due to the sediment filling up spaces in between gravel and cobble (sizes generally found in riffles), or completely covering riffle habitat altogether.

Site 184 – This first order UT to the Patuxent is located behind the 6606 block of Mink Hollow Drive. It received a “poor” biological condition rating (B-IBI = 2.78). Although 33 taxa were sampled, over 50% of them were pollution-tolerant organisms. There were no Ephemeroptera found in the sample. The most common organism was *Stegopterna* (Diptera: Simuliidae, tv = 7). Physical habitat condition rated “non-supporting” (56% of maximum). The majority of the parameters were scored in the low to mid Suboptimal category. It was also noted that the riparian zone was narrow, with horse pastures, maintained lawns, and fences on either side of the stream.

Site 185 – Behind 7005 Deer Valley Road, this first order UT to the Patuxent received a “good” biological condition rating (B-IBI = 4.11). The highest number of taxa in the subwatershed, 40, were found in this sample. There were also 5 Ephemeroptera (mayfly) taxa, and 13% of the sample were Tanytarsini, a relatively pollution-sensitive midge fly. *Stegopterna* was the most common organism in the sample. Poor vegetative protection and bank stability lead to this site receiving only a “partially supporting” (61% of maximum) physical habitat rating. Pebble count data show that 63% of the stream bed was composed of silt/clay and sand-sized particles, which was reflected in a Marginal score for the Embeddedness parameter.

Site 186 – Located off of the 13000 block of MD Rte. 108, this UT to the Patuxent was rated in “good” biological condition (B-IBI = 4.11). It had 31 total taxa, 39% of which were Collectors. It also had the highest percentage of Ephemeroptera (mayfly) taxa (32%) of any site in this subwatershed. *Ephemerella* (Ephemeroptera: Ephemerellidae, tv = 2), and *Prosimulium* (Diptera: Simuliidae, tv = 7) were the most common taxa. Physical habitat rated as “partially supporting” (73% of maximum) at this site. This habitat score was also the highest in this subwatershed, just 2% below the cut-off for a “supporting” rating. A wide riparian zone; stable, well vegetated banks; little channel alteration; and good flow levels all exist at this site, and were responsible in part for its relatively high physical habitat rank.

Site 187 – This site on the mainstem Patuxent River off of Tucker Lane received a “fair” biological condition rating (B-IBI = 3.89). Thirty-five taxa were found, including 20 dipterans. A high diversity of Diptera generally suggests good water quality. Collectors were in 58% of the sample. Although this site had a fairly high biological rating, its physical habitat received a “non-supporting” rating (53% of maximum). Marginal vegetative bank protection and a low occurrence of riffles in the stream segment are the most likely causes for the degraded habitat rating.

Site 188 – Another site on the mainstem Patuxent, this site is behind River Hill Drive. Biological condition rated as “poor” (B-IBI = 2.11). Only 16 total taxa were found, the lowest total in this subwatershed. No Ephemeroptera were found, and the only two EPT taxa found were *Hydropsyche* (tv = 6) and *Cheumatopsyche* (tv = 5), both relatively tolerant Trichoptera (caddisflies). This site did have the lowest occurrence of pollution tolerant taxa, however, that could be a product of having very few taxa overall. Only 6% of the sample were collectors, also the lowest percentage in this subwatershed. Physical habitat rated “partially supporting” (66% of maximum). In this case, the physical habitat is reflective of the current biological condition (poor). Marginal bank stability, vegetative protection, and a relatively narrow riparian zone along the right bank were the greatest problems at this site.

Site 189 – This mainstem Patuxent site is at the end of B Street and received a “fair” (B-IBI = 3.67) biological condition rating. Eleven Ephemeroptera taxa were found, and 54% of the sample contained collectors. The most abundant organism was *Crangonyx* (Amphipoda: Crangonyctidae, tv = 4), a scud. Poor bank stability and vegetative protection again led to a physical habitat rating of “non-supporting” (44% of maximum). This site also had a narrow riparian zone and Marginal sediment deposition scores, supported by the pebble count data that show the streambed is composed of 69% sand-sized particles.

Site 190 – Also on the mainstem Patuxent behind Tucker Lane, this site received a “fair” biological condition rating (B-IBI = 3.67). Thirty-two total taxa were found, 17 of which were dipterans. Also, 71% of this sample contained taxa that feed by passive collection of detritus. The most common organism was *Orthocladius* (Diptera: Chironomidae, tv = 6). Physical habitat rated “non-supporting” (50% of maximum). The location of this site, low in the watershed and on the mainstem of the Patuxent, allowed sampling to occur only along the banks. In many cases, 4th order streams are able to be sampled just as 1st-3rd order streams. However, the unusually wet fall and winter led to deeper waters than expected. Therefore some habitat features (i.e., frequency of riffles, velocity/depth regime) were difficult to score, because there was too much water in the channel to see clearly.

Dorsey Run

Data Overview

This subwatershed is located in the southeastern portion of Howard County. Major highways crossing this area include: I-95, US Rte. 1, and MD 175 (see Figure 1). The Dorsey Run subwatershed is south of the quickly growing and heavily populated Little Patuxent watershed, which includes Columbia and Ellicott City. Its position between two major metropolitan areas (Baltimore, MD and Washington, DC), plus easy access to I-95, create potential development issues in this subwatershed.

The mean biological condition in this subwatershed is “poor” ($\bar{x} = 2.51 \pm 0.74$, $n = 10$). Four sites were rated as “fair,” three as “poor,” and the last three as “very poor” (Table 8, Figure 9). Mean physical habitat is “non-supporting” ($\bar{x} = 110.3 \pm 24.90$, $n = 10$) of a healthy biological community. Only two sites were rated as “partially supporting,” while the remaining eight sites were “non-supporting” (Table 8). Pearson product-moment showed that biological condition is somewhat correlated with physical habitat condition ($r = 0.63$).

Table 8. Summary of biological and habitat scores for each sampled site in the Dorsey Run subwatershed.

Site	Benthic IBI Score	Biological Rating	Habitat Score	Habitat Rating	Stream Order
261	2.56	Poor	82	Non Supporting	1
262	2.11	Poor	75	Non Supporting	1
263	3.44	Fair	111	Non Supporting	1
264	3.44	Fair	110	Non Supporting	1
265	3.22	Fair	133	Partially Supporting	2
266	3.22	Fair	145	Partially Supporting	1
267	1.44	Very Poor	84	Non Supporting	2
269	1.89	Very Poor	96	Non Supporting	2
271	2.33	Poor	68	Non Supporting	1
274	1.44	Very Poor	99	Non Supporting	1

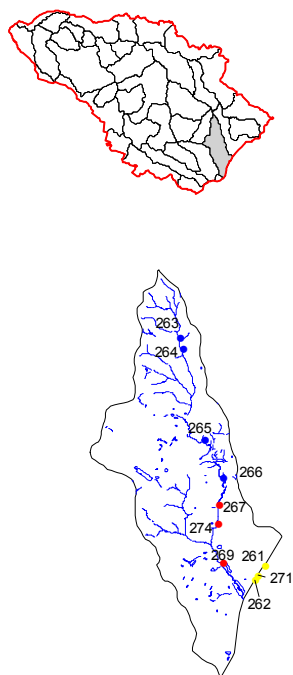


Figure 9. Color-coded biological condition ratings for the Dorsey Run subwatershed. Green = good, blue = fair, yellow = poor, red = very poor. 261 –274 indicate site numbers.

Site Specific Results

Site 261 – This first order UT to Dorsey Run is off Old Jessup Road. Biological condition rated as “poor” (B-IBI = 2.56). Only two EPT taxa were found, both Plecoptera (stoneflies). Pollution-tolerant taxa made up 81% of the sample. The most common organism was *Hydrobaenus* (Diptera: Chironomidae, tv = 8), a tolerant midge-fly. Physical habitat condition rated as “non-supporting” (41% of maximum). This section of stream runs between a parking lot and railroad. The riparian zone is extremely narrow, and the banks have very little vegetation. At least half of the stream is shored with concrete, and runs through a culvert under a bridge (US) and under Rte. 175 (DS).

Site 262 – This UT to the Patapsco river is a first order stream located 0.3 miles DS of Old Jessup Road. Biological condition rated “poor” (B-IBI = 2.11). Only 22 total taxa were found, none of which were EPT. However, 77% of the sample were tolerant taxa, and only 25% of the sample were collectors. The most common organism was the pollution-tolerant *Hydrobaenus*. In addition to a narrow riparian zone, poor bank stability and vegetative protection, the channel was altered with the insertion of a concrete culvert at the midpoint of the reach creating a substantially straighter than natural stream. These factors led to a “non-supporting” (38% of maximum) physical habitat rating.

Site 263 – This site on a first order section of Dorsey run received a “fair” (B-IBI = 3.44) biological condition rating. The sample was taken just north of the intersection of Tamar Drive and Old Montgomery Road. A subwatershed high 48 total taxa were found, 27 of them were Diptera. Collectors were found in 51% of the sample. However, the most common organism was *Parametrioctenus* (Diptera: Chironomidae, tv = 5). Physical habitat received a “non-supporting” rating (56% of maximum). A narrow riparian zone on the left bank, and substantial channel alteration were factors resulting in low scores for those two parameters.

Site 264 – This first order section of Dorsey Run is located behind 8113 Sea Light Lane. Biological condition rated as “fair” (B-IBI = 3.44). Thirty-four total taxa were found, 17 dipterans. This sample had the lowest percentage of pollution-tolerant individuals (13%) in this subwatershed. Collectors comprised 34% of the sample. The most abundant organism was *Orthocladus* (tv = 6). An open field on the right bank lowered the riparian zone score. Marginal scores for embeddedness and sediment deposition led to this site’s “non-supporting” (55% of maximum) physical habitat rating. Pebble count data confirmed that the stream bed was 62% silt/clay and sand-sized particles. This has an adverse effect on the biota by taking up interstitial space that could be used for feeding and/or hiding from predators.

Site 265 – This site is located on one of the second order sections of Dorsey Run running under the ramp connecting MD-175 to I-95. It received a “fair” (B-IBI = 3.22) biological condition rating. Thirty-five total taxa were found, 18 dipterans. A subwatershed high (9%) of the sample were Tanytarsini, a relatively sensitive midge-fly. Collectors were in 40% of the sample. The most common organism was *Chimarra* (Trichoptera: Philopotamidae, tv = 4). Physical habitat was “partially supporting” (67% of maximum) of a healthy biological community. The lowest scores were in the bank vegetation and stability parameters. According to pebble counts, only 30% of the channel were fines (silt/clay and sand-sized particles).

Site 266 – This site is on Dorsey Run as it runs behind the Fairfield Inn near MD Route 1. Forty taxa were found, 17 dipterans. Half of the sample were collectors. The most common organisms were *Cheumatopsyche* (Trichoptera: Hydropsychidae, tv = 7) and *Pseudorthocladius* (Diptera: Chironomidae, tv = 10). This site was rated in “fair” biological condition (B-IBI = 3.22). Although this site had a narrow riparian zone along the left bank, physical habitat was rated as “partially supporting” (73% of maximum), the highest percentage in this subwatershed. High scores were received in the channel alteration and flow parameters. The stream also had a high frequency of riffles. Pebble count data showed that 70% of the channel was made of gravel and cobble-sized rocks.

Site 267 – This second order section of Dorsey Run is behind Freemont Auto Parts off MD Route 1. Biological condition was rated as “very poor” (B-IBI = 1.44). Only 15 different taxa were found in the sample. A beaver dam was immediately US of the sampling site. Pollution-tolerant taxa made up 97% of the sample, the highest percentage in this subwatershed. *Limnodrilus* (Tubificida: Tubificidae, tv = 10), a pollution tolerant worm, made up 72% of the sample. Physical habitat condition rated “non-supporting” (42% of maximum). The riparian zone was narrow, and bank vegetative protection received a low Marginal score. The channel was also relatively straight (channel alteration) with few riffles (frequency of riffles parameter). The channel consisted of 44% sand-sized particles.

Site 269 – This site on Dorsey Run is US of the stream-crossing at Dorsey Run Road. There is a sewer-line clearing, commercial buildings, and a construction site along the right bank. Biological condition could be negatively influenced through excess runoff from these areas. In fact, the site received a “very poor” (B-IBI = 1.89) biological condition rating. No Ephemeroptera were found, 81% of the sample contained pollution tolerant taxa. The most common organism was *Limnodrilus* (62% of sample). Physical condition rated “non-supporting” (48% of maximum). The bank stability, vegetative protection, embeddedness, and frequency of riffles parameters all were scored in the low Marginal category. Sand and hard-pan clay made up 77% of the channel. Exposed hard-pan clay indicates that water rushes through this channel and often clears out sand, gravel, and cobble-sized particles. This makes it difficult for a quality biological community to colonize and remain in this section of Dorsey Run.

Site 271 – This site on a UT to Dorsey Run is 0.2 miles DS of Old Jessup Road. Habitat assessment noted that there were not many quality riffles to sample in this stream. Absence of good habitat resulted in, biological condition receiving a “poor” rating (B-IBI = 2.33). Only one EPT taxa was found, 75% of the sample were pollution tolerant taxa. The most common organism was *Hydrobaenus* (tv = 8). The stream runs parallel to railroad tracks that are less than six meters from the right bank. Physical habitat condition rated “non-supporting” (34% of maximum), with this site receiving the lowest total habitat score (68) in the Dorsey Run subwatershed. The channel was straightened along the railroad, which lowered the channel alteration and frequency of riffles/bends parameter scores. Loose rocks were between the railroad tracks and the stream bank, lowering the stability of the right bank. Fines (silt/clay and sand-sized particles) made up 79% of the channel.

Site 274 – The last site in this subwatershed is on a first order section of Dorsey Run, flowing through Maple Park (trailer park), off of MD Route 1. The site is directly behind a commercial

lot. Biological condition rated “very poor” (1.44). Only 13 total taxa were found, the lowest total in this subwatershed. No EPT taxa were sampled, only five Diptera taxa were found. On the other hand, 95% of the sample contained pollution tolerant organisms. The most common was *Limnodrilus* (tv = 10, 82% of sample). A narrow riparian zone along the right bank, and Marginal scores for embeddedness, epifaunal substrate/available cover, and sediment deposition led to this site’s “non-supporting” (50%) physical habitat rating. Pebble count data showed 68% of the channel was comprised of silt/clay and sand-sized particles.

Hammond Branch

Data Overview

Hammond Branch is located in the southwestern part of the County, in between the Little Patuxent and Rocky Gorge drainages (Figure 10). Highways I-95, MD-29 and MD 216 run through this subwatershed. Easy access to these major traffic corridors are encouraging more people to move into this area, and more subdivisions, schools, and shopping areas are being built to support the influx of people.

The mean biological condition of this subwatershed is “poor” ($\bar{x} = 2.84 \pm 0.69$, $n = 10$). Although “fair” assessments were given to six of the ten sites, the four “poor” (2) and “very poor” (2) sites had scores low enough to pull down the overall average (Figure 10, Table 9). Mean physical habitat was rated “non-supporting” ($\bar{x} = 115.1 \pm 16.2$, $n = 10$) of a healthy biological community. Three sites were rated “partially supporting” while the rest received “non-supporting” ratings (Table 9).

Table 9. Summary of biological and habitat scores for each sampled site in the Hammond Branch subwatershed.

Site	Benthic IBI Score	Biological Rating	Habitat Score	Habitat Rating	Stream Order
281	1.67	Very Poor	114	Non Supporting	1
282	1.89	Very Poor	142	Partially Supporting	1
283	3.44	Fair	109	Non Supporting	1
284	3.22	Fair	102	Non Supporting	1
285	2.56	Poor	118	Non Supporting	1
286	3.22	Fair	130	Partially Supporting	1
287	3.44	Fair	101	Non Supporting	1
289	3.00	Fair	87	Non Supporting	1
291	2.11	Poor	129	Partially Supporting	1
292	3.89	Fair	119	Non Supporting	1

Site Specific Results

Site 281 – Located behind 7104 Crabbury Court, biological condition was rated as “very poor” (B-IBI = 1.67). This is the lowest score of the subwatershed. This site is located at the headwaters of Hammond Branch; the area immediately US of the site turned into many braided channels, the shape of which were also affected by recent snow-melt. Only nine total taxa were found, the lowest total of the subwatershed. None of them were EPT, 94% of the organisms were pollution tolerant. The most common organism was *Diplocladius* (Diptera: Chironomidae, tv = 7). Physical habitat condition rated as “non-supporting” (57% of maximum). Marginal scores were given in the bank stability, vegetative protection, and embeddedness parameters.

Pebble count data showed that 72% of the channel was composed of fines (silt/clay and sand-sized particles), confirming the visual embeddedness and sediment deposition scores.

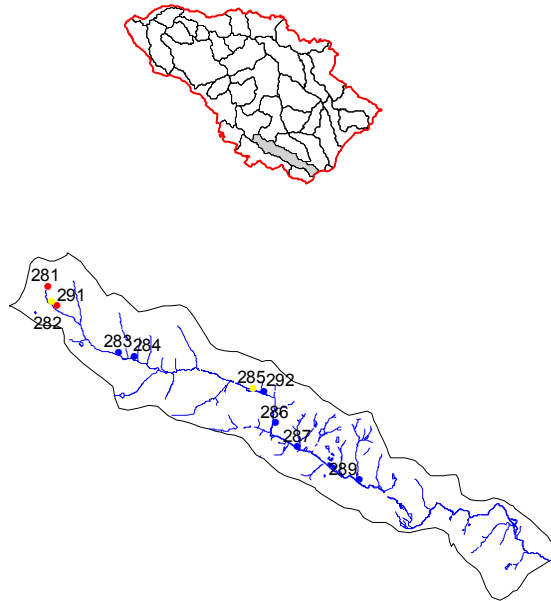


Figure 10. Color-coded biological condition ratings for the Hammond Branch subwatershed. Green = good, blue = fair, yellow = poor, red = very poor.

Site 282 – This site is also behind Crabbury Court, but farther DS on Hammond Branch behind the cul-de-sac. Biological condition was also rated as “very poor” (B-IBI = 1.89). Fifteen total taxa were found, however, none of them were Ephemeroptera. Pollution-tolerant organisms were in 75% of the sample. The most common organism was *Prosimulium* (Diptera: Simuliidae, tv = 7). A wide riparian zone, stable banks with relatively good vegetation were some of the factors that helped this site receive the highest physical habitat rating of the subwatershed, “partially supporting” (71% of maximum). The channel was composed primarily of gravel and cobble-sized rocks (68%), which should provide shelter for benthos. One possible explanation for the physical habitat receiving a higher rating than the biological community displays is that chemicals could potentially be leaching from the sediment. Farmland upstream and around this site could be influencing the current biological community. A stressor identification should be performed at this site to target the source of possible contaminants.

Site 283 – This site on Hammond Branch is south of Wayneridge Street. It received a “fair” (B-IBI = 3.44) biological condition rating. Thirty-eight total taxa were found, 11 were EPT. There were also 14 different Diptera taxa, a good indicator of stream health through biological

diversity. Ten intolerant taxa were found, the highest in this subwatershed. The most common organism was *Prosimulium*. Physical habitat was rated as “non-supporting” (55% of maximum). A relatively narrow riparian zone and Marginal bank stability and vegetation were the main sources of degradation at the site. Pebble count data showed that 53% of the channel was made of silt/clay and sand.

Site 284 – This site is 260 m through the woods behind the cul-de-sac at the end of Wayneridge Road. At this point, Hammond Branch runs through a cow pasture. Thirty-seven total taxa were sampled, 15 were dipterans. Overall biological condition rated “fair” (B-IBI = 3.22).

Prosimulium was the most common organism. The location of this site within a pasture led to a “non-supporting” physical habitat rating (51% of maximum). Animals had free access to the stream; a wooden plank was even propped along one bank most likely to assist the animals in and out of the stream. The result was unstable banks with poor vegetative protection. Exposed silt/clay and sand are easily eroded from the banks into the stream channel.

Site 285 – Here, Hammond Branch runs north of Hammond Drive, south of the MD-29 bridge crossing. Biological condition was rated as “poor” (B-IBI = 2.56). Twenty-two total taxa were found, only one Ephemeroptera taxa (*Ephemerellidae*, tv = 2). However, the lowest percentage of pollution tolerant organisms (7%) occurred at this site. The most common organisms were *Chimarra* and *Cheumatopsyche* (22 and 24 individuals, respectively). Physical habitat condition rated as “non-supporting” (59% of maximum). Several parameters received Poor or Marginal scores, including bank stability and vegetation, riparian zone width, and epifaunal substrate/available cover. The left bank had an especially narrow riparian zone, with mowed lawns less than six meters from the stream bank. Pebble count data showed that fines (silt/clay, sand-sized particles) composed 42% of the channel.

Site 286 – This site is about 200 m behind the Glen Hannah townhomes. Thirty-five total taxa were found, 13 of which were Diptera. There were also 10 pollution intolerant taxa. The most common taxa was *Cheumatopsyche*, tv = 5. These factors led to a “fair” biological condition rating (B-IBI = 3.22). This was one of the three “partially supporting” (65% of maximum) sites in this subwatershed. Bank stability and vegetative protection received the lowest scores, both in the Marginal category. Pebble count data showed that over half (56%) of the channel was composed of silt/clay and sand-sized particles.

Site 287 – This site on Hammond Branch runs alongside the new construction of the extension for Route 216. Biological condition rated as “fair” (B-IBI = 3.44). The highest total taxa count in this subwatershed was at this site (39). There were also 16 Diptera taxa, and nine intolerant taxa. The most common organism was *Cheumatopsyche*, tv = 5. The current road construction near the stream lowered the physical habitat to the “non-supporting” (51% of maximum) level. Marginal embeddedness and sediment deposition ratings were given in response to the large amounts of loose sediment unearthed by the construction. Sediment fences were present, but failing (i.e., overflowing or knocked over) in many areas. The construction is confined to the right bank, where the riparian zone score was in the poor category.

Site 289 – This site on Hammond Branch is along the gravel access road in between power lines and I-95 off ramps near Rte. 216. It received a “fair” (B-IBI = 3.00) biological condition rating.

This site also had 39 total taxa in the subsample, 16 of which were dipterans. Tanytarsini, a relatively sensitive midge fly, made up 8% of the sample. The most common organism was *Cheumatopsyche*, tv = 5. Physical habitat condition rated “non-supporting,” receiving the lowest visual assessment score in this subwatershed (44% of maximum). Due to the location near a power line clearing, the riparian zone width was rated in the Poor category. Also, the lack of trees led to unstable, banks with little or no vegetation. Epifaunal substrate/available cover, sediment deposition, and embeddedness all received Marginal ratings.

Site 291 – This site behind the cul-de-sac at the end of Crabbury Court was rated “poor” (B-IBI = 2.11) for biological condition. No Ephemeroptera or Tanytarsini were found. *Prosimulium* (tv = 7) was the most common organism. Pollution-tolerant taxa were found in 67% of the sample. Marginal and Sub-Optimal visual habitat assessments led to this site’s “partially supporting” physical habitat rating. The lowest scores were in the bank vegetation and stability parameters. Pebble count data showed that 46% of the channel was composed of sand-sized particles.

Site 292 – This site received the highest biological condition score in this subwatershed (B-IBI = 3.89) and was rated “fair”. Thirty-six total taxa were found, 11 EPT, five of which were Ephemeroptera. Fifteen dipteran taxa were also found; 33% of the sample were pollution-sensitive collectors. Physical habitat was rated at the top of the “non-supporting” category (60% of maximum). The left bank of the stream was lawns of houses on Graylock Drive, placing the riparian zone width in the Poor category. Bank vegetative protection was Marginal.

Watershed Comparisons

The Howard County Biomonitoring Program has sampled 12 of the 15 total subwatersheds in the County. Of the 12 analyzed watersheds, average biological rating scores range from 1.5 (“very poor,” Lower and Middle Little Patuxent - 2001) to 4.5 (“good,” Cattail Creek - 2001). Figure 11 displays a comparison of the subwatersheds. There is a range of land cover types across the County, from rural agriculture uses in the western portion, to quickly growing suburban/commercial uses in the east. The data support generally higher quality habitat in the western part of the County, and more degraded habitat in the eastern portion of the County.

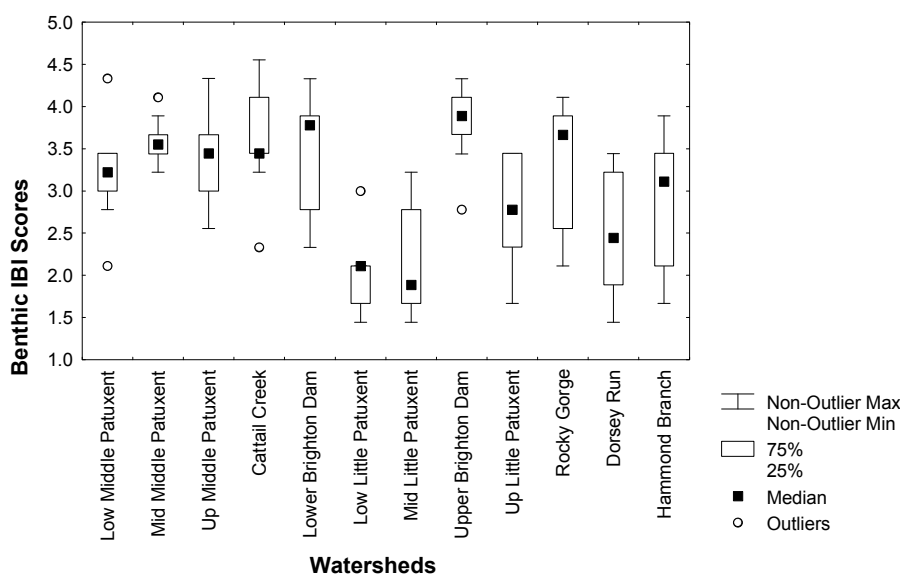


Figure 11. Benthic IBI scores for each of 12 sampled subwatersheds in Howard County.

III. CONCLUSIONS AND RECOMMENDATIONS

The results of these biological assessments lead to the following general recommendations:

- Continue watershed-based sampling design to complete the County rotation (currently 12 of 15 total subwatersheds have been sampled)

Although the last three subwatersheds (tributaries of the Patapsco River) were sampled during the Spring 2003 Index Period, the results will be reported in a separate document, which will also summarize the condition of all County watersheds. It is recommended that the County continue its biomonitoring program, either under the original 5-year rotating basin plan, or some other annual combination that meets County watershed prioritization needs.

- Prioritize watersheds for protection and restoration activities

The County, along with the Center for Watershed Protection (CWP), concentrated on 10 small watersheds (Centennial Lake, Wilde Lake, Lower Rocky Gorge Reservoir, North Laurel, Little Patuxent below Lake Elkhorn, Deep Run Tributaries, Elkridge, Rockburn Branch, Plumtree Branch, and Font Hill tributaries) to prioritize those that were most in need of protection or restoration. The prioritization is based on land use/land cover designations. The County should utilize the biomonitoring results as a companion to the current watershed prioritizations. Biological monitoring results could be used as a way to gauge restoration progress, or as an indicator of successful restoration.

- Implement public outreach strategies

The final watershed reports are currently available through the County website. More reader-friendly brochures can be created for each subwatershed sampled, or one for the entire County that details the condition of streams and watersheds in a short summary that would be easier for the public to understand. Brochures are just one way of developing community interest in County programs. The County currently sponsors many volunteer activities, such as tree plantings and park/stream clean-ups. Connecting the idea of stream health to these types of activities could potentially lead to a volunteer stream monitoring program that could engender more public interest in the County biomonitoring program.

- Maintain comparability with State methods

All field team leaders attend the yearly state-sponsored training. The training serves both as a refresher of the state methods, as well as a way to keep informed of any updates the state might implement to their sampling protocols.

- Maintain and enhance quality assurance/quality control program (QA/QC), including documentation and reporting of performance characteristics

Measurement quality objectives (MQOs) should be established for each step of field-based assessments. While the current County QA/QC program includes field audits, sorting efficiency, checks of data entry and metric calculation, and relative percent difference (RPD) between QC sites, the program does not currently document each step. Developing a more rigorous QA/QC

program will improve the County's ability to compare its biomonitoring program with the MBSS as well as other County programs.

- Initiate routine for assessing taxonomic precision and comparability with MBSS database

Generally, taxonomic precision is calculated using 10% of any sample set for re-identification by a second, independent taxonomic laboratory. This will provide the County with documentation of the precision of its dataset and reference collection of benthic macroinvertebrates. It will also establish a level of agreement between County and State taxonomists.

- Develop research studies that can be enhanced by the addition of biological data

Howard County is unique in many ways. It is located in the Non-Coastal Plain physiographic region and has a history of agricultural land use that is quickly developing between the Baltimore, Washington D.C. metro corridor. Biological data can be used in comparisons of taxa richness in developed vs. rural land, or Non-Coastal Plain developed areas vs. Coastal Plain developed areas. Other potential studies include the importance of a wide riparian zone to overall stream health, and when a loss of a specific amount of riparian coverage due to increased impervious surface, crop, or pasture land has a negative affect on biology.

- Quantify the effects of nutrients on stream biological condition

Crop and pasture land use make up 30-50% of the land use designation for the Rocky Gorge, Dorsey Run, and Hammond Branch watersheds alone. Nutrient input originating on farmland and flowing into streams occasionally has a positive short-term effect on local biology. However, extended periods of nutrient input can lead to over-enrichment and eutrophication. Protecting streams from this end is a priority. Studies that include nutrient concentrations and loading (especially nitrogen and phosphorus) could enhance the understanding of stream biological condition.

- Determine the critical point at which impervious surface lead to impairment a stream or watershed beyond reference conditions

The County population is growing at an rapid rate. Along with population growth, increases in roadways, parking lots, houses, driveways, schools, and shopping centers are increasing the amount of impervious surface within the County. If the point at which impervious surfaces begin to have a negative effect on stream biology is known, steps can be taken (i.e., BMP installation or LID) to protect stream resources before they are damaged.

- Target individual streams or subwatersheds for diagnostic stressor identification

Using biological condition as an indicator, specific streams or watersheds can be chosen for more intensive study to determine the potential cause for degradation (stressor). Knowledge of specific stressors will allow the County to better plan and implement restoration activities that will target and correct the main problem in a stream.

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V. APPENDICES