BIOLOGICAL RESPONSES TO STREAM HABITAT REHABILITATION IN THE SLIGO CREEK WATERSHED, MONTGOMERY COUNTY, MARYLAND

December, 1998

Chemical, Physical, and Biological Monitoring Results from 1 Year Pre-Restoration to 2 Years Post-Restoration

BY

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List of Figures

List of Tables

Appendices

Table of Contents

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ABSTRACT

Figure 1. Wheaton Branch, a tributary of the Anacostia's Sligo Creek, before (left, 1989) and after (right, 1993) restoration. Photographs by John Galli, Metropolitan Washington Council of Governments.

The restoration of degraded urban streams to near pre-development conditions is both a formidable and expensive challenge. Upper Sligo Creek is a typical degraded 3rd order Piedmont stream which flows though an older suburban area located in Montgomery County, Maryland. Since 1989 an interagency effort, as part of a larger Anacostia River restoration initiative, has been underway to restore 7.5 km of the stream and its environs. The restoration strategy has consisted of the comprehensive employment of stormwater retrofits, structural stream habitat creation and rehabilitation, riparian reforestation, wetland construction and native fish and amphibian re-introduction. A wide variety of fish habitat enhancement structures, such as rootwads, stone wing deflectors, log drop structures, boulder placement, brush bundles, etc. were employed. The project was performed in three phases. Biomonitoring of fish and macroinvertebrates was conducted before, during and after each construction phase of the project. In addition, physical habitat, hydrological and chemical conditions were monitored in the last phase. The number of fish species living in the system has risen from a low of three in 1988 to 27 in 1995. Monitoring results were used to adjust fish stocking strategies, document recruitment success, and to help critique the overall success of the restoration effort.

1.0 Introduction

1.1 Project Background

An interjurisdictional agreement to commit resources to restoration of the Anacostia River Watershed was signed in 1987 and was closely followed by implementation of the Anacostia Watershed Restoration Committee (AWRC). In 1991, the AWRC adopted a six-point action plan that included: 1) reduction of pollutant loads to the tidal estuary, 2) restoration and protection of the ecological integrity of the watershed, 3) restoration of anadromous fish spawning ranges, 4) increase (restore and create) the acreage of wetlands within the basin, 5) expand forest cover throughout the watershed, especially near stream and river channels, and 6) increase the public's awareness of cleanup and restoration activities. Since that time, over a dozen major restoration projects have begun in Northeast Branch, Northwest Branch, Paint Branch, and Sligo Creek primarily related to the restoration of ecological integrity (goal no. 2) (ICPRB 1994).

This project is part of a comprehensive multi-agency effort to restore the Anacostia River basin. Participating agencies include the Montgomery County Department of Environmental Protection (DEP), Maryland Department of the Environment (MDE), the Maryland National Capital Park and Planning Commission (M-NCPPC), the Metropolitan Washington Council of Governments (COG), and the Interstate Commission on Potomac River Basin (ICPRB).

The long-term objectives of the overall project are to 1) replace, through restoration, the dynamic stability of the physical habitat and flow regime to one of the Anacostia's most urban streams, 2) to restore the upper Sligo Creek fishes and aquatic community structure, and 3) to measure and gauge how well the restoration effort is progressing by evaluating how well the fish and aquatic community are doing. The purpose of this paper is to present the results of biological, chemical and habitat monitoring of upper Sligo Creek and its tributaries which, over a period of four years, have undergone various stages of physical habitat and hydrological rehabilitation and have had water quality controls implemented. We also assessed the effectiveness of reintroducing native fish species in Wheaton Branch. Further, we evaluate the appropriateness of the methods used, discuss potential further restoration activities that might be needed, and provide recommendations for the long-term detection of changes in biological condition.

1.2 The Sligo Creek Watershed

The Sligo Creek watershed is located primarily in Montgomery County, Maryland, and drains part of the Piedmont region of the Anacostia River watershed (Figure 2). Having experienced severe development pressure, it is one of the most heavily urbanized of the Anacostia sub-basins (ICPRB 1994). This report concentrates on the upper portions of Sligo Creek, a complex of small streams that encompasses approximately 1,215 hectares (4.7 square miles). Earlier biological monitoring efforts in the upper mainstem of Sligo Creek found it to have generally poor to fair biological conditions based on biological community structure and function, specifically, benthic macroinvertebrates and fish (Cummins 1989, Stribling et al. 1989, Cummins 1990, Stribling and Thaler 1990, Cummins and Stribling 1992). The primary reason for impaired biota was stormwater input and debris of human origin causing poor water quality (toxics, nutrients, and solid waste) and degradation of instream physical habitat quality.

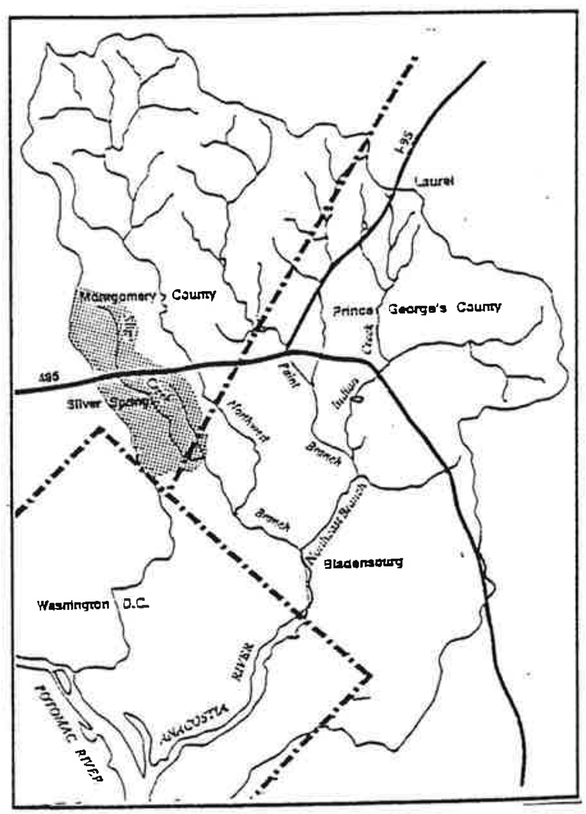

Figure 2. The Anacostia Basin with the Sligo Creek subwatershed (shaded).

Much of the stormwater and trash enters the upper Sligo Creek mainstem through small streams such as Wheaton Branch and the Flora Lane and Woodside Park tributaries which were part of this project.

1.3 General Effects of Urbanization on Streams

Individual freshwater streams are dynamic ecological systems in themselves; however, they also function ecologically as hierarchical components of larger systems, i. e., watersheds (Vannote et al. 1980, Frissell et al. 1986, Pringle et al. 1988, Power et al. 1988, Gregory et al. 1991). Human-induced alteration in the chemical, physical, or biological condition of a stream can affect the function of that stream in its relation to the remainder of the watershed. There are many different kinds of stressors that cause changes in a stream with accumulation of stressors causing both large- and small-scale degradation (Burns 1991, Cocklin et al. 1992). Karr et al. (1986) describe five classes of environmental variables: food or energy source, water quality, habitat structure, flow regime, and biotic interactions (Figure 3) on which human actions place pressure that causes ecological changes. Various stressors in urban streams, such as heavy metals, organic pollutants, fecal coliform bacteria and pathogens, sediment, and thermal loading are attributed to urban stormwater discharges (Gilbert 1989, Field and Pitt 1990). This holds true for both large and small waterbodies; exactly how the stressors and responses are described and evaluated depends on the geographic scale of concern.

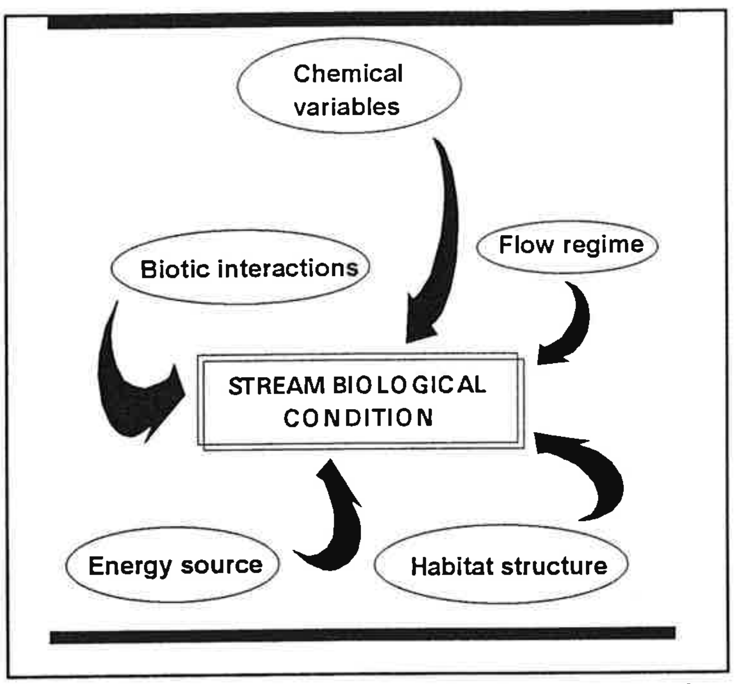

Figure 3. Five classes of environmental variables affecting the quality of stream biological condition (Karr et al. 1986).

Hydrophysical characteristics

Erosion in stream channels is a phenomenon that results from the interaction of water and soil and occurs at natural rates. In dynamically-stable streams there is a geomorphic structure that serves to maintain natural rates of erosion through the dissipation of flow energy. Changes in that structure cause alteration of the flow pattern, and consequently a reduction in the capacity of the stream channel to dissipate energy (Leopold et al. 1964, Rosgen 1994). When this happens, accelerated rates of erosion occur and the stream is no longer dynamically-stable.

The physical characteristics of a stream channel that provide for appropriate distribution of flow energy are channel width, channel depth, roughness of channel materials, sediment load, sediment size distribution, and channel slope. These, in addition to flow velocity and discharge, affect the stability of the stream channel. In broader terms, the features of the stream geomorphic system that are related to its stability are;

- sinuosity
- roughness of bed and bank materials (includes diversity of substrate particle sizes, woody debris [snags], overhanging vegetation, exposed roots, and undercut banks)
- presence and placement of point bars (point bar slope is an important characteristic)
- vegetative conditions of the stream banks and the riparian zone
- condition of the floodplain (accessibility from stream channel overflows and size are important characteristics)

Anthropogenic alteration of channel morphology or flow causes increases in erosion and sediment load, destabilization of the stream system, and the stream to hydrologically "seek" a new equilibrium state (Simon and Hupp 1987, Simon 1989, Hupp and Simon 1991, Hupp 1992). This is usually by erosion and deposition of soil and other materials to form a stream with a different flow pattern, sediment load, and geomorphological characteristics. Because these are so closely interrelated, these three stressors are described together.

Relationship to habitat quality and biological condition

In dynamically stable streams, the natural roughness and other characteristics that mediate flow energy also provide the complexity of a habitat that is able to support a "healthy" biota. Such features have been shown to directly affect the ability of biota to withstand or recover from relatively harsh disturbance events (Pearsons et al. 1992). Aquatic invertebrate taxa are dependent on the hydrologic and hydraulic characteristics of stream and river systems (Newbury 1984, Statzner and Higler 1986). In general, habitat degradation can be thought of as any activity of human origin that directly or indirectly alters or reduces the complexity of habitat (although this may not be true in low gradient coastal-type streams with sandy bottoms).

Construction of impervious surfaces in a watershed, such as rooftops, roads, and parking lots of urban and suburban areas, changes the hydrology of a stream. Coupled with the removal of riparian and upland vegetation, rainwater percolation into soils and the evapo-transpiration component of the hydrologic cycle are impeded. Riparian vegetation also provides for soil stability, "cool-down" of runoff, and the filtering of eroded sediments and chemical contaminants. Lacking percolation and evapo-transpiration, rainfall from even small storm events is instantly converted into runoff and produces flashy stream flows of high velocity and erosive force; in partially impervious watersheds these flows are usually of rapid onset and cessation. In an undisturbed watershed, groundwater acts as a reservoir, providing baseflow during times of reduced rain frequency, and absorbing rainfall during storms. Once rains end there is often little flow remaining for flashy streams since the baseflow has been limited due to imperviousness. The stream channel erodes more rapidly during the flash floods, downcutting into its bed and banks (Yorke and Herb 1978). As downcutting progresses, a stream loses its "access" to the floodplain, becoming more entrenched. The hydrological function of a floodplain to aid in dissipating the erosive flow energy by spreading it shallowly over the broader area becomes lost. Thus, increased downcutting and the resultant building of levees and channelization in an attempt to control flooding eliminate additional hydrophysical features that help maintain natural erosion rates. Channelization is the most severe and includes removal of most instream habitat structure (and thus complexity) for benthic macroinvertebrates and fish. It alters flow patterns by greatly increasing the gradient of a channel, removing any meander pattern, and constructing linear banks (Gordon et al. 1992). The historical purpose of channelization is to increase the efficiency with which a drainage system removes stormwaters thus reducing flood magnitudes and frequencies (Simon and Hupp 1987, Simon 1989). However, it is recognized that it causes direct loss of habitat, accelerated rates of bed and bank erosion upstream of channelized areas, and increases in sedimentation and flow pattern variability downstream (Hupp 1992). The geomorphic recovery process for disturbed stream channels described by Hupp and Simon will occur only if the sources of disturbance are removed or corrected (Simon 1989).

1.4 The Restoration Process in Sligo Creek

In June of 1990, a stormwater management pond retrofit was completed for Wheaton Branch, a major tributary of the Sligo Creek sub-watershed. This pond was designed to help provide control of Wheaton Branch's stormwater quantity and quality, thereby reducing the effects of urbanization on Sligo Creek. In addition, major physical habitat restoration was completed for Wheaton Branch in April 1991. Habitat complexity for fish and benthic macroinvertebrates was enhanced via streambank stabilization and revegetation and the creation of instream structures to enhance riffle and pool habitat and to control scour and erosion of the streambed. These activities concluded Phase I restoration.

In addition, prior to Phase 2, the University Boulevard stormwater management wet pond retrofit was brought on-line. This facility provides water quality and quantity control for a 162 hectare (400 acre) drainage area.

The restoration activities that occurred during Phase 2 involved creation of a 0.1 hectare (0.25 acre) buttonbush marsh, reforestation of 2.0 hectares of riparian zones, and selective re-creation of fish habitat along approximately 7.0 kilometers of the Sligo Creek mainstem and construction of a 300 meter long parallel pipe system along the Flora Lane tributary.

Phase 2 Sligo Creek stream habitat enhancement featured the installation of a wide variety of structural measures designed to both increase the number and improve the quality of pool and riffle habitat and bank stability. A total of 19 sub-project sites were enhanced. Restoration measures included the following:

- employment of four double and six single wing stone deflectors;
- installation of one log drop structure to create deep pool habitat;
- 11 boulder placement areas to improve structural habitat;
- four rootwads to provide stream bank protection and pool habitat with overhead cover;
- the repair of one 6.3 meter (20 linear feet) eroding stream bank area via the bioengineering technique of coconut 'fiber rolls', in conjunction with native shrub plantings; and
- stabilization of approximately 37 meters (120 linear feet) of stream via placed rip-rap.

The restoration of aquatic habitat conditions in the Flora Lane tributary was accomplished through the construction of a parallel pipe stormflow diversion system. The flow-splitting system was designed to divert stormflow generated from up to 90 percent of all one-hour storm events (peak one-hour discharge is approximately 1.6 m^3/s or 55 cfs). In order to accomplish this objective, two proportioning weirs were employed. One weir diverted both the small baseflow and stormflows from a 54 inch storm drain system. The second weir, which featured a port, permitted only the cleaner baseflow from the 48 inch Columbia Boulevard storm drain system to flow through. In addition, native tree and shrub plantings were incorporated in the project to enhance wildlife habitat opportunities in this stream valley area.

2.0 Study Design/Methods

2.1 Biological Sampling Locations

Fish and benthic macroinvertebrate sampling at a total of ten sites were conducted periodically between 1990 and 1995 for the purpose of monitoring restoration effects upon Sligo Creek's aquatic communities (see Appendix I for a list of sampling dates). Of the ten sites, four were established in the Sligo Creek mainstem, two were located in a feeder tributary which flows next to Flora Lane south of Interstate 495, and two sites were within the existing restoration area of Wheaton Branch. For Phase 3, all of these sites were sampled in addition to one site on the Woodside Park tributary (also upper Sligo Creek) and Crabb's Branch (part of the Rock Creek watershed). The sampling sites in Sligo Creek are mapped on Figure 4, illustrated in Appendix II, and described on the following pages.

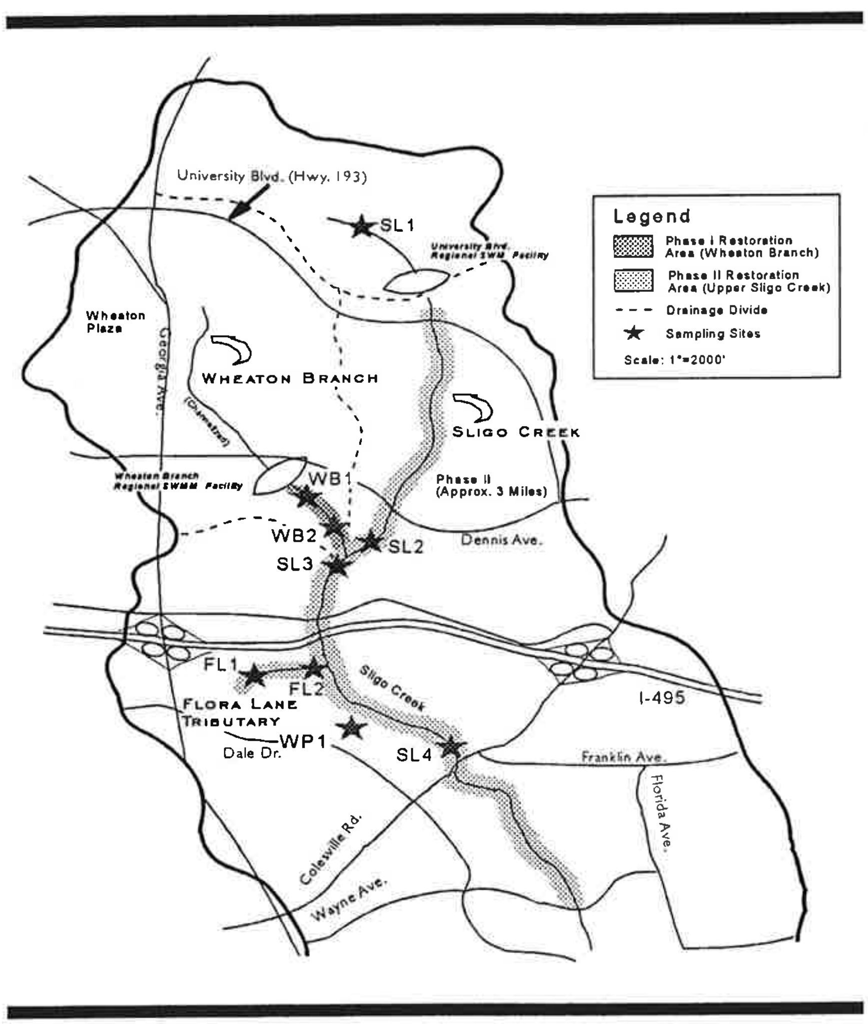

Figure 4. Sligo Creek watershed, Montgomery County, Maryland. Area map of biological sampling locations.

Sligo Creek Mainstem

SL1 *Above University Ave. (Rte. 193)* - Located near the headwaters of Sligo Creek, the downstream boundary of this site is approximately 14 meters upstream from a hiker/biker bridge at the Kemp Mill Shopping Center. This site is in a park surrounded by a heavily urbanized area and, likely, with a higher percentage of impervious surface and less control over stormwater discharges than most of the downstream sites.[1] Due to an apparently high frequency of scouring stormflows, habitat is less than optimal with an unstable bottom (sand and gravel) and moderate bank erosion. The stream averages about one meter in width. Riffles are relatively infrequent in the sampling area.

SL2 *Upstream of confluence with Wheaton Branch (= WB3 of Cummins and Stribling [1992])* - This site is located on Sligo Creek approximately 90 meters upstream from its confluence with Wheaton Branch. The site is approximately one mile downstream from SL1, but now the stream averages about 2 meters in width with fairly frequent riffles, pools and glides. The substrate particle size within riffles ranged from sand to gravel and medium cobble and is not heavily embedded. The right bank is reinforced with rip-rap of placed boulders; the left is a sand and gravel point bar on the inside bend. There is adequate shading even though mowing of the park grass occurred close to the eastern edge of the stream until 1992. Since that time a no-mow area has been maintained in t his location and new riparian vegetation has been established.

SL3 *Downstream of confluence with Wheaton Branch (= WB4 of Cummins and Stribling [1992])* - This site is very similar in habitat to that of SL2, although the additional flow from Wheaton Branch has caused it to be wider than upstream (SL2). The site is located about 30 meters downstream of the confluence. The range of substrate particle size in the riffle is similar to that of SL2, with very little embeddedness and adequate shading. Both banks are stable; some undercutting is occurring on the right bank, adding habitat dimension not found at SL2.

SL4 *At Colesville Road (Rte. 29)* - The downstream boundary of this site is about 50 meters upstream from Colesville Road and is close to Sligo Creek Parkway and the hiker/biker trail. The site contains large sections of riffle habitat with low embeddedness and good bottom substrate. The stream is now about 3 meters wide.

Wheaton Branch

The two Wheaton Branch sites are downstream from a large stormwater management pond which was retrofitted in 1990. The section of Wheaton Branch being studied also underwent extensive bank stabilization (imbricated rip-rap, placed rip-rap, root wads) and instream habitat restoration (boulder placement, log drop structures, wing deflectors) following the Phase I study. At both sampling sites the stream is fairly narrow (approximately 2 meters), but there are small pools, riffles and glides. Both sites underwent extensive habitat restorations between Phases 1 and 2.

WB1 *Downstream from Woodman Avenue* - This site is approximately 130 meters downstream from the Inwood Avenue bridge, immediately downstream of a small feeder stream and the beginning of park property next to Woodman Avenue.

WB2 *Above Sligo Creek confluence* - The downstream edge of the sampling areas is approximately 25 meters upstream of the Sligo Creek Park's hiker/biker bridge (approximately 130 meters upstream from the Wheaton/Sligo confluence). The lower third of this site has a relatively deep pool (approximately 1.5 meters or 5 feet) near a large boulder (this boulder can be seen in the figure accompanying the Recommendation Section of this report). This site was previously designated as Wheaton Branch #3 (WB3) in the Phase I study, which focused on Wheaton Branch, but its number was changed to reflect the broader focus of Phases 2 and 3.

1 The upstream drainage area of this site is 30% impervious with no stormwater management controls.

Flora Lane Tributary

A second order tributary of Sligo Creek, this channel is south of, and runs parallel to, the beltway (Interstate 495).

FL1 *Upstream end of tributary* - The downstream edge of this station is an old concrete weir (purpose of weir is unknown). The upstream boundary is approximately 15 meters downstream from a recently (1994) constructed weir (weir no. 2) and flow splitter (part of a new parallel pipe system designed to help reduce stream channel erosion). The straight nature of the main stream channel and its rather uniform 2 meter stream banks are probably due to channelization during development of the adjacent 50 year old residential neighborhood. However, the baseflow of this tributary meanders considerably as a result of over 40 years of natural channel adjustment, as well as woody debris deposited in the stream (some of which appears to be from local dumping).

FL2 *Downstream end of tributary* - The site's downstream boundary was just upstream from the confluence with Sligo Creek and the upstream boundary was 21 meters downstream from the Sligo Creek Parkway footbridge. The 21 meter unmonitored section consisted of a large plunge-pool area resulting from a hiker/biker bridge culvert. It was felt this section of the stream was atypical and therefore it was excluded from the sampled area. The southern edge of this site had several areas with steep and eroded banks. Most of the fish were captured in a pool near the middle of the sample area.

Woodside Park Tributary

WP1 This site is located in a small, wooded, first order tributary of Sligo Creek. It is on the west side of Sligo Creek, near Dallas Avenue. The downstream end of the transect was 13 meters upstream from the bridge on the Sligo Creek hiker/biker pathway. The stream is shallow, the deepest pool being only 0.45 meters. The base flow, while small, is fairly strong and consistent considering the small drainage area of the branch (approximately 81 hectares or 200 acres). The substrate is principally sand and gravel.

Crabb's Branch

CB1 This is the only site that is not on a tributary of Sligo Creek, it is located on a tributary of the Rock Creek watershed. The site is located on Crabb's Branch approximately 300 meters downstream from Redland Road, Montgomery County (for a map to this location, please see Crabbs Branch under Appendix II). The site has no large trees nearby, with much evidence of recent beaver activity. The lower third of the transect was approximately 50 meters northeast of apartment buildings on Indian Hills Terrace. This site was chosen to serve as a comparison stream site to the Wheaton Branch and Sligo Creek #1 sites due to similarities in watershed areas, land uses, imperviousness, and the configuration of the stormwater management facilities immediately upstream of Redland Road.

2.2 Chemical Water Quality

2.2.1 *Sampling Locations*

Stream water quality grab sampling was performed between May, 1994 and July, 1995 at the following sites: Wheaton Branch - WB1; Sligo Creek - SL2, SL3 and SL4; Flora Lane tributary - FL1 and FL2; and Crabbs Branch - CB1. Note, paired baseflow and stormflow water samples for full Washington Suburban Sanitary Commission (WSSC) laboratory analysis were collected at WB1 and FL1 between June, 1994 and July, 1995.

Monthly pond water column sampling was performed at Wheaton Branch stormwater management pond no. 3 between May and November, 1994. The actual monitoring site was located approximately four meters from the invert of the reverse sloping outlet pipe in 1.45 meters of water. The Crabbs Branch stormwater management pond water column site was located approximately two meters from riser/outlet structure in 2.59 meters of water.

2.2.2 *Water Chemistry Sampling*

Stream Sampling

Spot baseflow and stormflow water quality readings (Appendix III) for the following parameters were taken in the field using a Horiba U-10, multi-probe water quality meter: water temperature, pH, conductivity, dissolved oxygen (DO), turbidity and salinity. Total dissolved solids (TSS) concentrations were measured with a Hach TDS meter. Both meters were calibrated prior to actual use. Wheaton Branch and Flora Lane tributary stormflow samples were collected via the use of a modified suspended sediment sampler featuring a vertical 3/8 inch diameter steel pipe intake; which was connected to a 20 liter, rectangular polyethylene, Naglene carboy. The sampler, which operates on a siphoning principle, was housed within a large steel ammo box, secured within the stream, and set so as to begin collecting runoff associated with a three to five inch rise in stream water surface elevation (i.e., first flush). Baseflow water chemistry samples were collected via completely immersing a 20 liter polyethylene carboy in an undisturbed pool area. Both baseflow and stormflow water chemistry samples were iced and delivered (within 24 hours) to WSSC's Patuxent Water Quality Laboratory located in Laurel, Maryland. Chemical analysis was performed using the most current EPA standard methods. Baseflow sampling was generally performed between 1400 and 1700 hours. Stormflow sampling times varied.

Pond Water Column Sampling

Both Wheaton Branch and Crabbs Branch stormwater management pond water samples were collected, at established representative surface, mid-level and bottom depths, using a 2.0 liter Van Dorn water sampler. Water temperature, pH, conductivity, DO, turbidity, TDS and salinity levels were measured in the field with the Horiba U-10 and Hach meters. Water transparency was determined using a 20 centimeter diameter Secchi disk. Total alkalinity was measured in the field using a Hach water quality analysis kit (Model No. AL-36 DT). At the Wheaton Branch pond, one four liter water sample was collected from each of the following depths: 0.5, 2.0 and 4.0 feet. These samples were placed on ice and delivered (within 24 hours) to the WSSC Patuxent laboratory for total phosphorous, total suspended solids and chlorophyll a analysis. Pond sampling was performed between 0930 and 1600 hours.

2.2.3 *Sediment Chemistry*

Sediment grab samples were collected from representative locations within the Sligo Creek study area, so as to provide insight into both the type and concentrations of possible toxicants present. Six locations were selected for taking grab samples for sediment chemistry (Table 1). All samples were taken from either the stormwater detention pond itself (sediment sample No. 5) or from pool areas in the streams. To have enough material to perform priority pollutant analysis, a total of eight liters (=approx. two gallons) of fine sediment were taken from each location using a coring device. Samples from 3-5 locations *within each site* were taken and composited to make up the eight liters and to ensure greater representativeness of the site. The composite was homogenized in a porcelain mixing basin, random subsamples taken, and each transferred to sample containers. Each subsample container was appropriately labeled and placed in an ice cooler. The cooled sample containers were delivered to Gascoyne Laboratories, Inc. (2101 Van Deman Street, Baltimore, Maryland 21224) which performed priority pollutant analysis.

Table 1. Locations in study area from which grab samples were taken for sediment chemistry analysis (in relastive downstream order).

Sediment Sample No.	Sample Location
5	Wheaton Branch stormwater management pond #3
1	in Wheaton Branch
2	in Sligo Creek mainstem above Wheaton Branch confluence
3	in Sligo Creek mainstem between Interstate 495 and (upstream of) Flora Lane tributary confluence
4	in Sligo Creek mainstem downstream of Flora Lane tributary confluence
6	in Flora Lane tributary downstream of structure

2.3 Physical/Hydrological Conditions

2.3.1 *1994 Stream Thermal Regime Characterization*

Characterization of late spring through early fall thermal regimes within key representative portions of the Sligo Creek and Crabbs Branch study areas was accomplished via the systematic employment of Ryan Temp Mentor recording thermograph thermometers. A five station network, which corresponded to water quality grab sampling and macroinvertebrate and fish monitoring sites, was employed. The five temperature monitoring stations were: 1.) SL2 - Sligo Creek approximately 10 meters upstream of the Wheaton Branch confluence; 2.) WB1 - Wheaton Branch approximately 100 meters below Woodman Avenue; 3.) FL2 - Flora Lane tributary approximately 15 meters below parallel pipe system weir no. 2; 4.) SL4 - Sligo Creek approximately 150 meters upstream of Colesville Road (MD Rte 29); and 5.) Crabbs Branch approximately 300 meters downstream of Redland Road.

At each station, the thermograph thermometer was placed into a waterproof Ryan Temp Mentor plastic case, then wrapped in plastic sheeting. The units were carefully buried, six to eight inches below ground level, in an overbank area so as to reduce the risk of damage or loss from flooding and/or vandalism. Actual stream water temperature readings were made via an associated 15-foot long sensor cable that extended from the buried unit into the stream. The buried sensor cables were attached to steel rebars driven into the stream bottom. All cables were located in well-shaded undercut bank areas of the stream where depth of flow was sufficient to keep the sensor tip completely submerged at all times. Temp Mentors were deployed from May 16, 1994 to November 3, 1994 and programmed to continuously record water temperature every 20 minutes. Data was downloaded into a PC and statistically analyzed using Quattro Pro version 5.0. Climatological information used during the study period was obtained from NOAA (1994) for Washington National Airport.

2.3.2 *Physical Habitat Assessment*

Evaluations of the quality of the stream's physical habitat were performed as part of Phase I and II of this project. Prior to, during, and following restoration of hydrophysical characteristics the stream habitat of the eight sites studied during those two phases were assessed using an approach based on visual observation (Barbour and Stribling 1991), a modification of that in Plafkin et al. (1989). In addition, the Rapid Stream Assessment Technique (Galli, 1996) was used to provide additional physical and riparian habitat data.

2.4 Biological Conditions

For this project the major indicators of stream health and the recovery process were the condition of the benthic macroinvertebrate assemblage and the ability of the stream to sustain reproducing populations of re-introduced native fish species.

2.4.1 *Benthic Macroinvertebrates*

Sampling. Both riffle and pool habitat were sampled in each of the three phases. Riffles were sampled using a square foot Surber sampler with U.S. Standard No. 30 mesh net (595 micron openings). The one square foot frame is placed in the upstream area of the riffle, substrate within the square foot is disturbed by hand or garden trowel to a depth of approximately 5 cm. Larger embedded substrate particles, such as cobble or small boulders, are washed/scrubbed by hand to remove attached organisms. The entire sample is washed into a white porcelain sorting tray and picked in the field. Specimens are handled with fine forceps and placed into 4-6 dram, pre-labelled glass vials containing approximately 70% ethanol.

The long-handled D-frame net (595 micron mesh openings) is used more as a qualitative method to provide information on species composition not likely to be evident with Surber sampling alone. Its primary use is for sampling pools. In this habitat, the bottom substrate is disturbed by foot and the net is swept through the resulting cloudy water. The D-frame is also used for sampling rootwads and root mats hanging into the water by raking through them. Following this, the sample is field processed as described for the Surber samples.

With a single exception[2] three Surber samples (riffle) and a single D-frame (pool/root wad) sample were taken. All samples were placed in separate containers; taxonomy was performed on each individually.

Taxonomy. Taxonomic identification for Phase I and 2 samples were performed by Tetra Tech (Stribling). Those for Phase 3 were by Mr. Dave Penrose. Using dissecting, and where necessary, compound microscopes, specimens were identified to the lowest practical taxonomic level using primarily Merritt and Cummins (1984), supplemented with Burch (1982), Edmunds et al. (1972), Johannsen (1934-35), and Wiggins (1977).

For several groups of organisms, more detailed taxonomy was performed for Phase 3, than in either of Phases I and 2. Those groups included the (aquatic earthworms, leeches [Hirudinea], Oligochaeta, midges [Chironomidae], and certain of the net-spinning caddisflies [Hydropsychidae: *Symphitopsyche*]). Although presented in Appendix VII, these finer level identifications were not used in calculation of several metrics so that comparability with Phase I and 2 results could be maintained.

Metrics. For this phase of the project, there has been calculation of additional metrics beyond those presented for Phases I and 2 (Cummins and Stribling 1990, 1993). Five metrics are used in our site/sample comparisons that are known to change in certain directions in the presence of stressors (Table 2).

Calculated metric values for the invertebrates were compared with scoring criteria developed by Stribling and Thaler (1990) for the piedmont streams of the Anacostia River basin (Table 3). They used the same sampling methods as in this project. A possible limitation in use of those scoring criteria is that they represent a composite of data spanning several seasonal sampling events, whereas in this study, assessments and data are kept separate by sampling season.

Table 2. Benthic macroinvertebrate metrics calculated for this study. They are scored using the Anacostia piedmont criteria developed by Stribling and Thaler (1990).

Metric	Definition	Direction of change in presence of stressors
Taxa Richness	The total number of taxonomic categories represented in a sample	decrease
Hilsenhoff Biotic Index	Documents the relative abundance of pollution tolerant and pollution sensitive taxa in a sample	increase
EPT	The total number of distinct taxonomic categories of the relatively pollution-sensitive insects mayflies (Ephemeroptera), stoneflies (Plecoptera), and caddisflies (Trichoptera) in a sample.	decrease
% contribution of dominant taxon	Percentage of individuals in a sample of the most dominant taxon	increase
Shredders/Total	Percentage of individuals in a sample that are of the "shredder" functional feeding group	decrease

2 The set of samples taken on 3/26/90 comprised two Surbers and two D-frame samples; thereafter, the level of effort was three and one, respectively.

Table 3. Scoring criteria for benthic macroinvertebrate metrics using a composite of Surber samples from 1st - 3rd order streams, Anacostia River basin, Piedmont (Stribling and Thaler 1990).

	Scoring Criteria		
Metric	**2**	**4**	**6**
1. Taxa Richness	0 - 5	6 - 14	15 - 23
2. HBI	7.1 - 4.8	4 - 8	2.3 - 0
3. EPT Index	0 - 4	4 - 8	9 - 13
4. % Contribution of Dominant Taxon	53 - 36	35 - 18	17 - 0
5. Shredders/Total	0 - 1.8	1.9 - 4.0	4.1 - 6.2

[1] It should be noted that regional, physiographic scoring criteria for benthic invertebrate metrics are currently being developed by the Maryland Biological Stream Survey, Department of Natural Resources.

Calculated metric values are normalized to bioassessment scores by comparison to scoring criteria, which allows them to be summed, or aggregated, for an overall biological index score. The relationship of these index scores to each other at individual sites over time, or at separate sites simultaneously, provides the basis for interpreting biological responses.

2.4.2 *Fishes*

Sampling. The primary fish sampling technique followed the procedures discussed by Plafkin et al. (1989) and as described and modified by Cummins (1989 and 1991, respectively). Sampling was conducted at each site by first setting a block seine (1/4" mesh x 4' deep) across the downstream boundary of the sampling site, then fifty meters directly upstream a second block seine was set across the upstream boundary, thus impounding the fish in that section of the stream during sampling. Three backpack electrofishing passes were then made in the sampling area moving in an upstream direction. The duration of electrofishing time on an individual pass was approximately ten minutes. Stunned fish collected from each proceeding pass were individually identified, counted, measured, kept separated from the other collections and then released at the end of sampling. Fish population estimates were based upon three pass depletion models (Zippin, 1956).

In addition to the sampling performed at each site, additional electrofishing "sweep samples" were performed to help determine any effects that took place outside of the site locations. Sweep sampling, a term used for this project, was a one-pass technique employed as this project progressed to screen long stretches of Sligo Creek for areas of potential establishment of re-introduced fish species outside of the fixed sampling sites . The sweep sampling technique was an upstream electrofishing of a long stream stretch (from 100 to 500 meters) with a focused collection effort aimed at capturing only specific target species, in this case all fishes except blacknose dace, northern creek chubs, and goldfish (the only surviving species found in the study area prior to restoration and re-introductions). Since this technique was used to help see how well the re-introduced fishes were doing in areas of the stream outside of the collecting sites, collection of the pre-restoration species was generally avoided unless there was a question as to species identity. Similar to the technique employed at the blocked-netted fixed sites, a Smith-Root backpack shocker was used with two people netting. Target fishes were collected, identified, counted, observed for general condition, and released back into the stream. Concentrations or "hotspot" locations, where large numbers of a specific species or rare species were collected, were identified and the location noted.

Habitat assessments were performed as part of Phase 1 and Phase 2 and they followed the approach developed by Plafkin et al. (1989) and modified (Barbour and Stribling 1991) to include new parameters described below. The condition of each site under study was rated as a function of its capacity to support a healthy biological community. Appendix IV contains the twelve habitat parameters used for the

Phase 2 part of the study. These twelve parameters include three new ones added by EPA protocols after the Phase I study. The new parameters were: canopy cover (#4), lower bank channel capacity (#8), and riparian vegetation zone width (#12).

Data Analysis:

Biological data analysis for fishes incorporated the Index of Biological Integrity (IBI) developed for fresh water fishes by Montgomery County (Van Ness et al., 1996). As this IBI was only recently developed by Montgomery County, IBI scores for Phase I and Phase 2 samples were recalculated as well. IBI scoring for all sites and all phases were based upon the criteria for silt loam region, first and second order streams (Appendix V).

Sweep sampling information was used to identify areas that were utilized by the more pollution tolerant fish species and as evidence of young of the year fishes using in the stream outside of the fixed sampling sites.

3.0 Results

3.1 Water Quality

Results from the Phase 3 water quality grab sampling portion of the study are summarized in Figures 5 to 8, Tables 4 and 5 and Appendix III. As previously indicated, due to budgetary constraints, WSSC laboratory water chemistry analysis of baseflow and stormflow grab samples was only performed for Wheaton Branch, the Flora Lane tributary and Wheaton Branch stormwater management pond No. 3.

3.1.1 *Stream Chemistry*

DO

As seen in Figure 5, of the three major tributaries surveyed, Wheaton Branch exhibited the lowest baseflow dissolved oxygen (DO) levels. Violations of Maryland Department of the Environment's (MDE) 5.0 mg/L DO criteria were recorded at Wheaton Branch on four out of the 30 sampling dates (5/23/94, 6/18/94, 6/22/94 and 6/9/95). The lowest stream DO concentration observed during the study, 2.87 mg/L, was recorded on 6/18/94 approximately 250 meters downstream of the Wheaton Branch stormwater management facility (SWM). While some aquatic insects can tolerate low dissolved oxygen levels (or even anaerobic conditions) for short periods, concentrations of 6.0 mg/L or higher are often required for long-term survival (Lyttle, 1956; Nebeker, 1972; Gaufin and Nebeker, 1973). Stormflow DO levels were all above 5.0 mg/L.

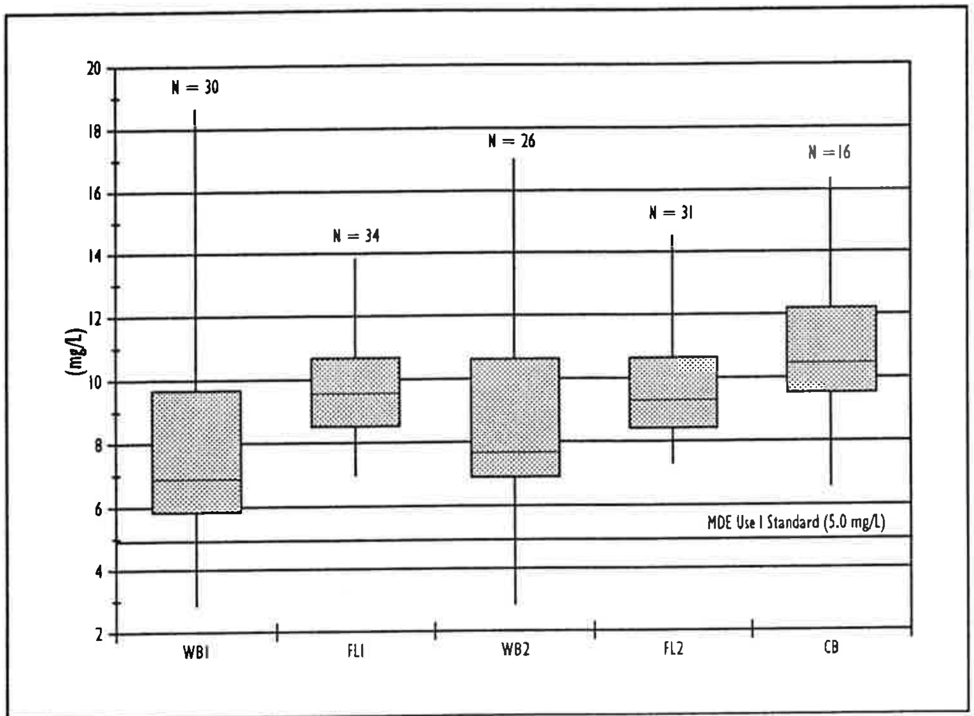

Figure 5. Wheaton Branch (WB), Flora Lane (FL) and Crabbs Branch (CB) - Baseflow DO (5/16/94 to 7/24/95). Source: MWCOG, 1997.

Conductivity

Conductivity, which provides an indirect measure of dissolved anions and cations present in water (e.g., carbonates, chlorides, sulfates, nitrates, sodium, potassium, calcium and magnesium), was lower in Wheaton Branch than in either Flora Lane or Crabbs Branch. Median baseflow conductivity for the three streams ranged from 230 to 350 umhos/cm (Figure 6). By comparison, the median conductivity level observed during the same period in the Good Hope tributary of Paint Branch (a nearby reference, Montgomery County, MD trout stream) was 160 umhos/cm.[3] Not surprisingly, conductivity often increases in response to a variety of pollutants such as sewage from sanitary sewer line/septic field leakage, road salts, fertilizers, etc. The high Crabbs Branch reading of 1340 umhos/cm, which was recorded on 3/17/95, is believed to be the result of an episodic release of road salt from county salt storage domars located off of Crabbs Branch Way.

Baseflow TSS, TOC, BOD, NO_3, TP and CU

Baseflow water chemistry analysis results indicate that: 1.) total suspended solids (TSS), total organic carbon (TOC) and biochemical oxygen demand (BOD) levels in both Wheaton Branch and the Flora Lane tributary are within normal ranges for Piedmont streams (Thomas, 1966; MCDEP, 1981; MWCOG, 1991) and 2.) concentrations for each of the preceding parameters were generally higher in Wheaton Branch. These higher observed levels are, in all likelihood, associated with the release of organic material from the 2.4 hectare Wheaton Branch SWM pond.

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[3] Monitoring performed by COG staff in vicinity of Hobbs Drive.

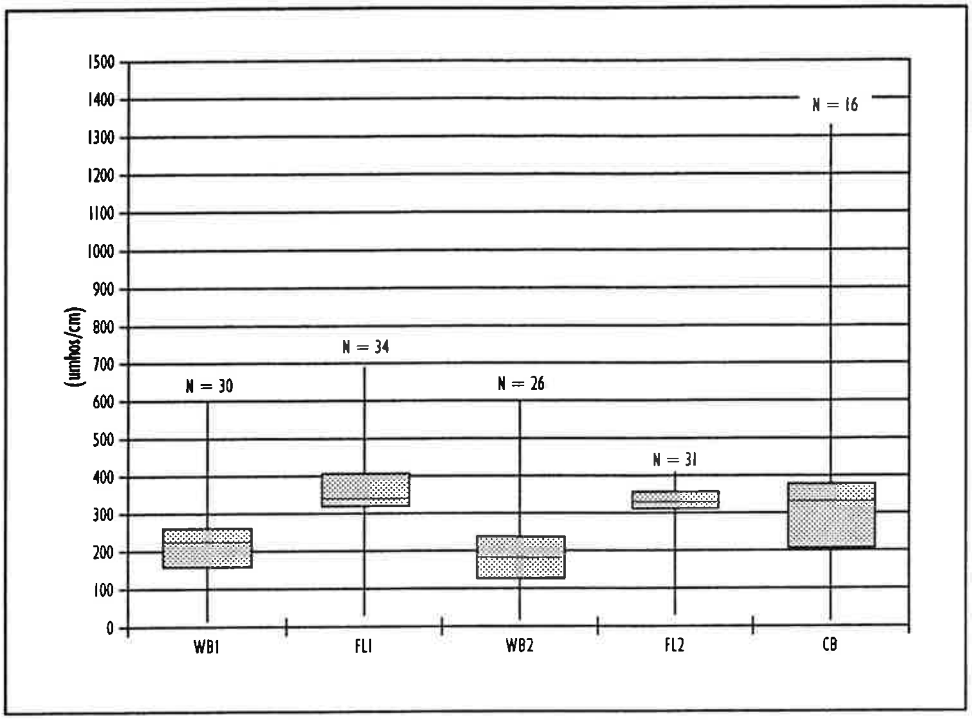

Figure 6. Wheaton Branch (WB), Flora Lane (FL) and Crabbs Branch (CB) - Baseflow Conductivity (5/16/94 to 7/24/95). Source: MWCOG, 1997.

For reporting purposes, nitrate (NO_3) concentrations were arbitrarily grouped, per USGS, 1993, into three concentration classes: 1.) low, less than 1.0 mg/L; 2.) moderate, 1.0 to 3.0 mg/L; and 3.) high, over 3.0 mg/L. As seen in Figure 8, Wheaton Branch nitrate levels were in the low range; whereas, Flora Lane's were in the low to moderate range. It should be noted that a value of 0.5 mg/L is sometimes used as a threshold separating natural background levels from surface waters affected by human activities (Ferari and Ator, 1995).

Baseflow total phosphorus (TP) concentrations in Wheaton Branch and Flora Lane were also low (i.e., $\leq$ 0.17 mg/L). From the data, it is apparent that both streams do occasionally exceed the 0.10 mg/L TP concentration threshold level recommended by EPA (1976) for the reduction and/or prevention of nuisance plant growths in streams.

Results (Figure 7) indicate that baseflow copper (CU) concentrations in Wheaton Branch and Flora Lane ranged from 0.0 to 50.0 ug/L and 0.0 to 20.0 ug/L, respectively. Both streams had, at 10 ug/L, identical median copper concentrations. Total hardness for the two streams was in the 63 to 162 mg/L $CaCO_3$ range. According to EPA (1986), in order to protect most aquatic organisms, hourly copper concentrations should not (at a hardness level of 100 mg/L $CaCO_3$) exceed 18 ug/L. Similarly, an 18 ug/L level is used by the State of Maryland for its acute freshwater copper toxicity concentration criterion (MDE, 1995).

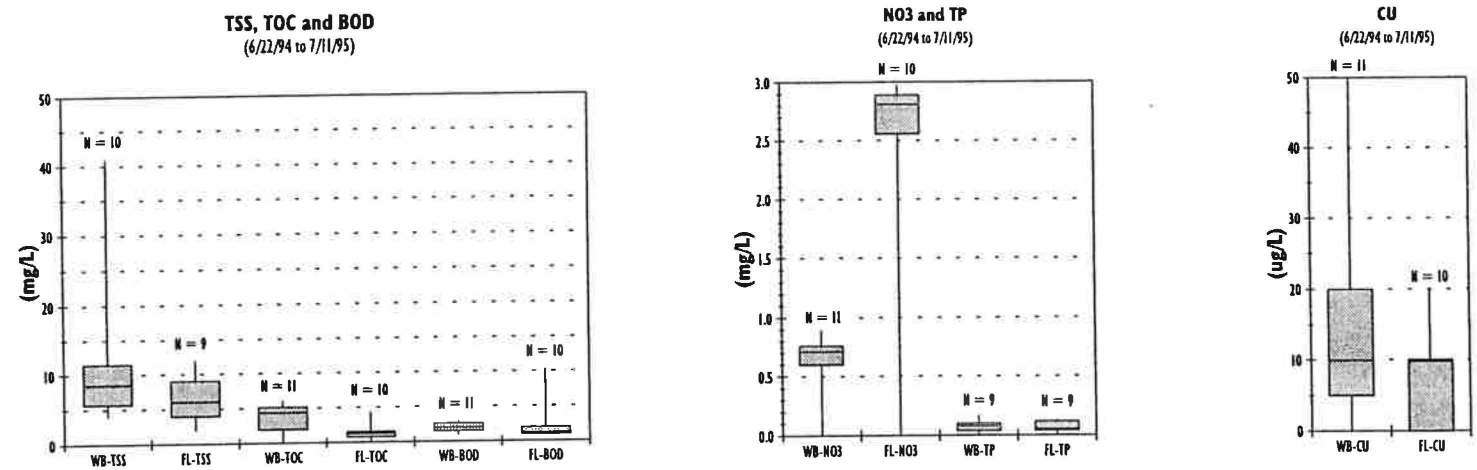

Figure 7. **Wheaton Branch (WB) and Flora Lane (FL) - Baseflow TSS, TOC, BOD, NO3, TP and CU**

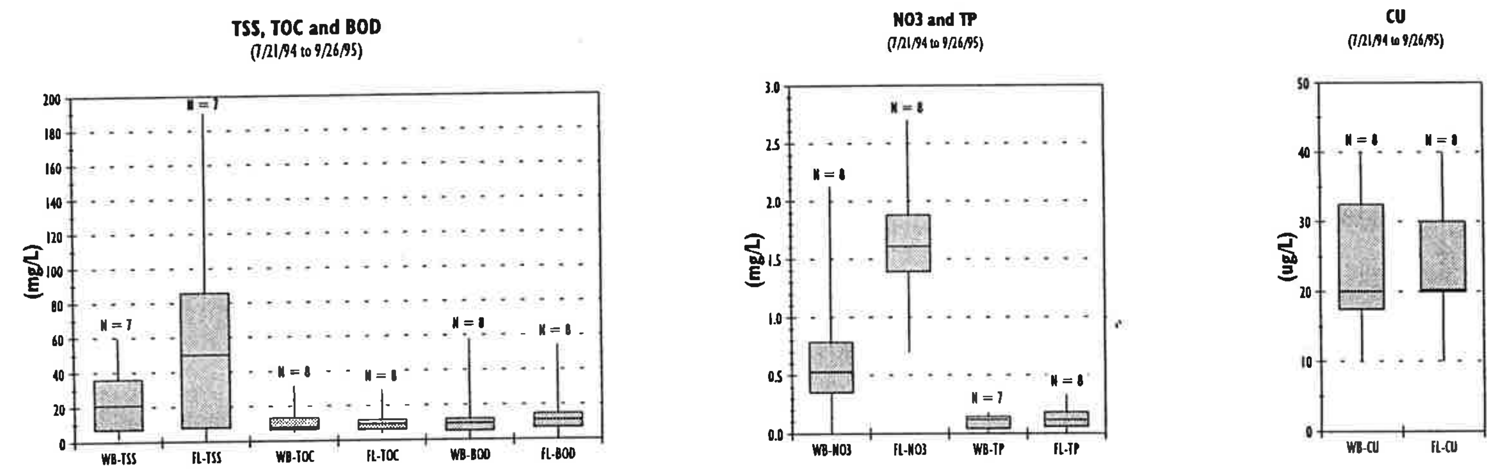

Figure 8. **Wheaton Branch (WB) and Flora Lane (FL) - Stormflow TSS, TOC, BOD, NO3, TP and CU**

Source: MWCOG, 1997

Stormflow TSS, TOC, BOD, NO_3, TP and CU

Compared to Wheaton Branch, stormflow TSS, TOC and BOD levels were generally slightly higher in Flora Lane (Figure 8).[4] Interestingly, the mean TSS concentration for Flora Lane, 61.3 mg/L, was less than half the nation-wide highway runoff average concentration of 143.0 mg/L (Streker et. al., 1987). Given the high traffic volumes associated with this subwatershed's two principal highways, it would appear that the parallel pipe stormflow diversion system is diverting a substantial portion of the pollutant loads away from the Flora Lane stream restoration site.[5] Also, unlike Wheaton Branch, Crabbs Branch and the Sligo Creek mainstem which run off-color for one to two days following a significant storm event, the Flora Lane tributary typically clears within a span of three to four hours.

Not surprisingly, the median NO_3 concentration was three times higher in the uncontrolled Flora Lane tributary (1.6 mg/L) than in Wheaton Branch (0.5 mg/L). Stormflow NO_3 concentrations for both streams were in the low to moderate range.

As seen in Figure 8, stormflow copper concentration ranges were nearly identical for both streams. The median stormflow concentration for both Wheaton Branch and Flora Lane was 20.0 ug/L. This median level was double that recorded under baseflow conditions. Also, the mean stormflow total hardness concentrations for Wheaton Branch (80.3 mg/L $CaCO_3$) and Flora Lane (105.2 mg/L $CaCO_3$) were considerably lower than under baseflow conditions. Although copper is readily adsorbed by suspended matter, the preceding findings are of concern and strongly suggest that copper concentrations could be limiting to the biological communities in both streams.

3.1.2 *Wheaton Branch and Crabbs Branch Stormwater Management Pond Chemistry*

Without question, both the Wheaton Branch and Crabbs Branch stormwater management facilities significantly affected downstream hydrology, water chemistry, temperature, substrate particle size and stability and stream bioenergetics.[6] As part of the overall study, an effort was made to characterize general water column chemistry in the vicinity of each pond's outlet/control structure so as to provide additional insight into release depth as a contributing factor in downstream water quality.

As expected, water quality in both Wheaton Branch pond No. 3 and the Crabbs Branch SWM pond was typically highest at the surface and gradually declined with increasing depth (Tables 4 and 5). It is important to note that the Wheaton Branch SWM pond discharges water from approximately 0.30 meters (1.0 foot) above the pond bottom. Unfortunately, the pond's release depth of approximately 1.1 meters draws and discharges poorly oxygenated water high in organic materials and fine inorganic sediments to downstream areas. During stormflow conditions, this release feature is thought to function as a siphon; thereby reducing the pond's overall pollutant removal efficiency (Environmental Dynametrics, Inc., 1993). By comparison, Crabbs Branch's surface release design results in the discharge of warmer yet clearer and more highly oxygenated water. Also, the larger permanent pool surface area and volume and presence of extensive stands of hydrilla verticillata (which cover approximately 75 percent of the pond bottom) contributed to Crabbs Branch's better performance.

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[4] For all intents and purposes, stormwater management controls in the 96 ha. Flora Lane tributary subwatershed are non-existent.

[5] According to the Maryland Department of Transportation State Highway Administration, annual average daily traffic volumes for I-495 at Georgia Avenue (MD Rte 97) and MD Rte 97 at I-495 are 281,275 and 76,300, respectively.

[6] Pond characteristics -- Wheaton Branch: D.A. = 326 ha.; permanent pool surface area = 2.4 ha.; bottom release design; maximum depth 1.75 m.; constructed 1990; SAV absent; 24-36 hr. extended detention control. Crabbs Branch: D.A. = 238 ha.; permanent pool surface area = 3.1 ha.; surface release design; maximum depth 2.60 m.; constructed 1983; SAV (hydrilla) covers approx. 75% of pond bottom; no formal extended detention.

Table 4. Summary: 1994 Wheaton Branch Stormwater Management Pond No. 3 Water Quality[1]

Date	Depth (m/ft)	Temp. (°C)		DO (mg/L)	Field pH	Cond. (umhos/cm)	Turb. (NTU)	TSS (mg/L)	TP (mg/L)	Chl 'a' (ug/L)	Secchi Depth (m)
		Air	Water								
6/22/94	0.15/0.5	32.0	28.5	12.13	7.30	146	16	19	0.12	4.41	0.50
	0.30/1.0		28.6	12.46	7.21	146	14	---	---	---	
	0.61/2.0		28.2	11.79	7.12	146	18	20	0.13	93.45	
	0.91/3.0		27.5	5.93	6.72	147	17	---	---	---	
	1.22/4.0		26.5	1.20	6.53	210	34	31	0.56	28.99	
	1.45/4.5		26.0	0.23	6.21	227	34	---	---	---	
7/13/94	0.15/0.5	38.0	29.4	17.40	8.33	226	20	4	0.06	9.42	0.55
	0.30/1.0		28.9	15.66	8.41	225	17	---	---	---	
	0.61/2.0		28.4	19.99	8.51	220	21	12	0.09	45.82	
	0.91/3.0		27.9	11.47	7.48	227	27	---	---	---	
	1.22/4.0		27.5	3.50	6.80	224	13	17	0.08	19.51	
	1.45/4.5		27.3	1.78	6.54	224	34	---	---	---	
8/25/94	0.15/0.5	24.0	22.6	6.18	6.83	104	27	9	0.10	19.53	0.48
	0.30/1.0		22.8	5.88	6.81	104	24	---	---	---	
	0.61/2.0		22.6	5.33	6.82	107	25	13	0.11	13.92	
	0.91/3.0		22.6	5.30	6.71	105	28	---	---	---	
	1.22/4.0		22.5	5.41	6.66	101	26	16	0.11	15.49	
	1.45/4.5		22.3	4.82	6.45	102	35	---	---	---	
9/21/94	0.15/0.5	28.0	23.6	15.29	8.94	277	13	16	---	5.90	0.60
	0.30/1.0		23.4	16.55	8.99	277	17	---	---	---	
	0.61/2.0		22.2	15.75	8.86	278	19	27	---	37.25	
	0.91/3.0		22.2	14.23	8.76	280	23	---	---	---	
	1.22/4.0		21.9	11.67	8.55	282	25	30	---	150.01	
	1.45/4.5		21.6	9.34	8.32	284	25	---	---	---	
10/19/94	0.15/0.5	23.0	15.4	5.20	7.23	231	3	5	ND	4.36	1.35
	0.30/1.0		15.1	3.90	7.12	230	3	---	---	---	
	0.61/2.0		14.8	3.64	7.06	229	3	8	ND	4.06	
	0.91/3.0		14.4	3.56	7.01	227	7	---	---	---	
	1.22/4.0		14.2	3.44	6.98	223	11	10	ND	2.64	
	1.45/4.5		14.1	3.35	6.97	223	14	---	---	---	
11/30/94	0.15/0.5	13.0	7.1	4.49	6.31	92	10	6	0.07	2.35	0.45
	0.30/1.0		7.1	4.55	6.35	92	10	---	---	---	
	0.61/2.0		7.1	4.52	6.40	92	10	7	0.06	3.30	
	0.91/3.0		7.1	4.58	6.45	92	10	---	---	---	
	1.22/4.0		7.1	4.54	6.54	92	10	9	0.06	0.72	
	1.45/4.5		7.1	5.18	6.73	91	10	---	---	---	

[1] Water column readings taken approximately 4 meters from base of riser's 18-inch reverse sloping pipe. Note: invert of reverse sloping pipe located approximately 0.30 meters (1.0 foot) above pond bottom.
ND = not detected.

Source: MWCOG, 1997

Table 5. Summary: 1994 Crabbs Branch Stormwater Management Pond Water Quality[1]

Date	Depth (m/ft)	Temp. (°C)		DO (mg/L)	Field pH	Cond. (umhos/cm)	Turb. (NTU)	Secchi Depth (m)
		Air	Water					
6/23/94	0.15/0.5	32.0	28.4	12.73	8.77	300	11	0.72
	0.30/1.0		28.3	12.12	8.71	299	14	
	0.91/3.0		27.8	10.44	8.51	294	13	
	1.22/4.0		27.0	3.75	7.26	298	14	
	1.83/6.0		23.0	0.22	6.60	423	139	
	2.59/8.5		25.2	0.11	6.57	595	87	
9/20/94	0.15/0.5	24.0	22.3	7.17	8.44	391	2	2.0
	0.30/1.0		22.4	6.99	7.29	387	2	
	0.91/3.0		22.1	5.80	8.13	385	2	
	1.22/4.0		21.8	6.31	8.42	383	2	
	1.83/6.0		21.7	5.87	8.47	401	5	
	2.59/8.5		21.2	1.40	8.29	441	14	
11/25/94	0.15/0.5	9.0	7.4	8.07	7.26	309	5	2.0
	0.30/1.0		7.0	8.50	7.15	311	3	
	0.91/3.0		6.8	8.18	7.05	313	2	
	1.22/4.0		6.4	7.57	6.73	317	2	
	1.83/6.0		6.4	6.91	6.69	317	2	
	2.59/8.5		6.4	0.25	6.97	317	7	

[1] Water column readings taken approximately 2 meters from base of riser. Note: riser has surface release design.

Source: MWCOG, 1997

3.1.3 *Sediment Chemistry*

Analytical results from the sediment grab samples which revealed no unusual or high concentrations of detected components, are presented below in Table 6. Many of the compounds that were detected are those that commonly originate with roadway runoff (Pitt and Amy, 1973).

Table 6. Positive results from laboratory analysis of sediment chemistry

Method No.	Analyte (mg/kg)	Sample Locations* (arranged in relative downstream order)					
		5	1	2	3	4	6
	HYDROCARBONS						
3, 5	Phenanthrene	1.4	---	---	0.58	---	1.9[5]
3	Di-n-butyl phthalate	1.7	1.1	0.8	0.94	0.66	3.4[3]
3, 5	Fluoranthene	3.3	---	---	0.66	0.61	2.5[5]
3, 5	Pyrene	2.5	---	---	0.64	0.52	2.9[5]
3, 5	Benzo(a)anthracene	1.1	---	---	---	---	1.1[5]
3, 5	bis(2-Ethylhexyl) phthalate	10	---	---	---	---	0.8[4,5]
3, 5	Chrysene	2.1	---	---	---	---	1.4[5]
3,5	Benzofluoranthenes[2]	3.3	---	---	0.43	0.48	2.1[5]
3, 5	Benzo(a) pyrene	1.2	---	---	---	---	1.0[5]
3, 5	Indeno(1,2,3-cd) pyrene	1.2	---	---	---	---	0.57[2]
3, 5	Benzo(g,h,i) perylene	1.5	---	---	---	---	0.60[5]
	METALS						
1	Arsenic	2.4	0.52	0.66	0.68	0.8	---
6	Beryllium	---	---	---	---	---	0.4
2, 6	Chromium	48	3.3	23	13	30	37
2, 6	Copper	55	23	7.4	6.0	15	26
2, 6	Lead	75	9.7	9.8	8.9	23	50
2, 6	Nickel	53	23	19	12	31	63
8	Phenol (4AAP)	---	---	---	---	---	0.2
2, 6	Zinc	280	47	35	35	44	110
	OTHER						
7	Sulfide	110	---	110	---	---	2
4	TOC	27,000	---	---	---	---	---

* Sampling Site Locations: 1-in Wheaton Branch (WB); 2-in Sligo Creek (SC) mainstem above WB confluence; 3-in SC mainstem bet. I-495 and Flora Lane trib. (FL) confluence; 4-in SC mainstem downstream of FL confluence; 5-in detention pond #3; 6-in FL downstream of structure

1 All EPA Methods unless otherwise stated: 1-7060; 2-6010; 3-355/8270A; 4- (non-EPA) Walkley-Blank procedure; 5-3550/8270B; 6-6010A; 7-9030A; 8-420.2

2 Detected and reported as the sum of Benzo(b)fluoranthene and Benzo(k)fluoranthene

3 Detected 2.2 mg/kg (ppm) of this analyte in the calculated soil laboratory reagent blank

4 Detectged 0.82 mg/kg (ppm) of this analyte in the calculated soil laboratory reagent blank

5 All analytes using Method No. 5, detection limit of 0.45

6 "---" indicates non-detects.

Unfortunately, interpretation of the sediment chemical results is difficult at this time because: 1) the U. S. EPA has not developed sediment quality criteria (SQC) for most of the compounds analyzed in this study, and 2) the actual bioavailability of bulk sediment compounds (particularly metals and polar organics) is extremely complex and poorly understood. Also, recent work by EPA and others suggests that interstitial or pore water concentrations of pollutants is a much better indicator of bioavailable pollutant concentration than bulk or whole sediment concentrations (as was done in this study). Sediment pore water concentrations can be compared with EPA water quality criteria, if available, as a satisfactory risk benchmark. Interstitial water, however, is likely to be a useful indicator of pollutant bioavailability in fine sediments from depositional areas (pools and lentic areas). In this study, only the sample from Wheaton Branch pond #3 (sample location 5) qualifies as a potential pore water pollutant sink. Indeed, the highest concentrations of pollutants recorded in this study occurred at this site (Table 5). Of the compounds observed in measurable quantities in this study (as listed in Table 5), only phenanthrene has a published EPA SQC, which is greater than two orders of magnitude higher than the highest concentration recorded (its SQC is approximately 100mg/kg of organic carbon). Given this finding, it does not appear that other pollutants measured pose serious environmental toxic risks.

However, it cannot be ignored that many of the contaminants found in the sediments originated with roadway runoff and, if found in high concentrations, or working synergistically with other toxicants could cause mortality of benthic macroinvertebrates and fish. It is quite possible that additional, controlled sampling and analysis of sediment in other parts of the Sligo Creek watershed could reveal concentrations of at least the metals that could be toxic to benthic invertebrates. In addition, it is interesting to note that for all metals detected, higher concentrations occurred in the Sligo Creek mainstem below the Flora Lane tributary confluence than above. In all likelihood, this enrichment is associated with large volumes of highway runoff from Interstate 495 and Georgia Avenue (MD Rte 97), which are conveyed via the Flora Lane tributary to Sligo Creek.

3.2 Physical/Hydrological

3.2.1 *1994 Stream Temperature Monitoring*

Results from the 5/17/94 to 11/2/94 continuous stream temperature monitoring portion of the study are presented in Figures 9, 10 and 11. As seen in Figure 9 (Panel A), Sligo Creek (SL2) temperatures upstream of Wheaton Branch are well below the MDE Use I maximum temperature standard of 32.2°C (90°F) for the stream. In fact, during the monitoring period, the MDE Use IV temperature criteria of 23.9°C (75°F) was only exceeded under stormflow conditions. Results (Figure 9, Panel B), also show that mainstem stream temperatures along the 1.8 kilometers (1.1 miles) reach between stations SL2 and SL4 remain relatively constant. Instantaneous water temperature readings made during the study revealed that the Flora Lane tributary had a slight cooling influence on Sligo Creek. This effect becomes more pronounced during hot, summer low flow periods.

Of all the stream areas monitored during the study, the Flora Lane tributary was by far the coldest (Figure 9, Panel C). It is important to note that groundwater from the Washington Metropolitan Transit Authority's (WMATA) red line metro train tunnel (located approximately 61 meters, or 200 feet, below ground level) is pumped to a surface pipe storm drainage system which discharges to the stream. Consequently, the Flora Lane tributary had both a disproportionately higher and colder baseflow than did other streams in the study area. As seen in Figure 9 (Panel C), were it not for the short duration stormflow temperature spikes, the Flora Lane tributary would probably meet the MDE Use III (natural trout waters) 20°C temperature criterion.

As expected, Crabbs Branch had the warmest stream temperatures (Figure 9, Panel D). This was not surprising given its location downstream of a large stormwater managment wet pond. During the monitoring period, Crabbs Branch routinely violated its MDE Use IV stream temperature standard of 23.9°C (75°F). From mid-June through mid-August maximum daily stream temperatures frequently approached the MDE Use I temperature criterion. Compared to Wheaton Branch (Figures 10 and 11), Crabbs Branch was typically 3 to 4°C warmer. This condition remained operative throughout the temperature monitoring period. Last, it should be noted that based on long-term averages reported for Washington National Airport (NOAA, 1994), the May to July portion of the monitoring survey was warmer and drier than normal; whereas, the August to October portion was slightly cooler and drier.

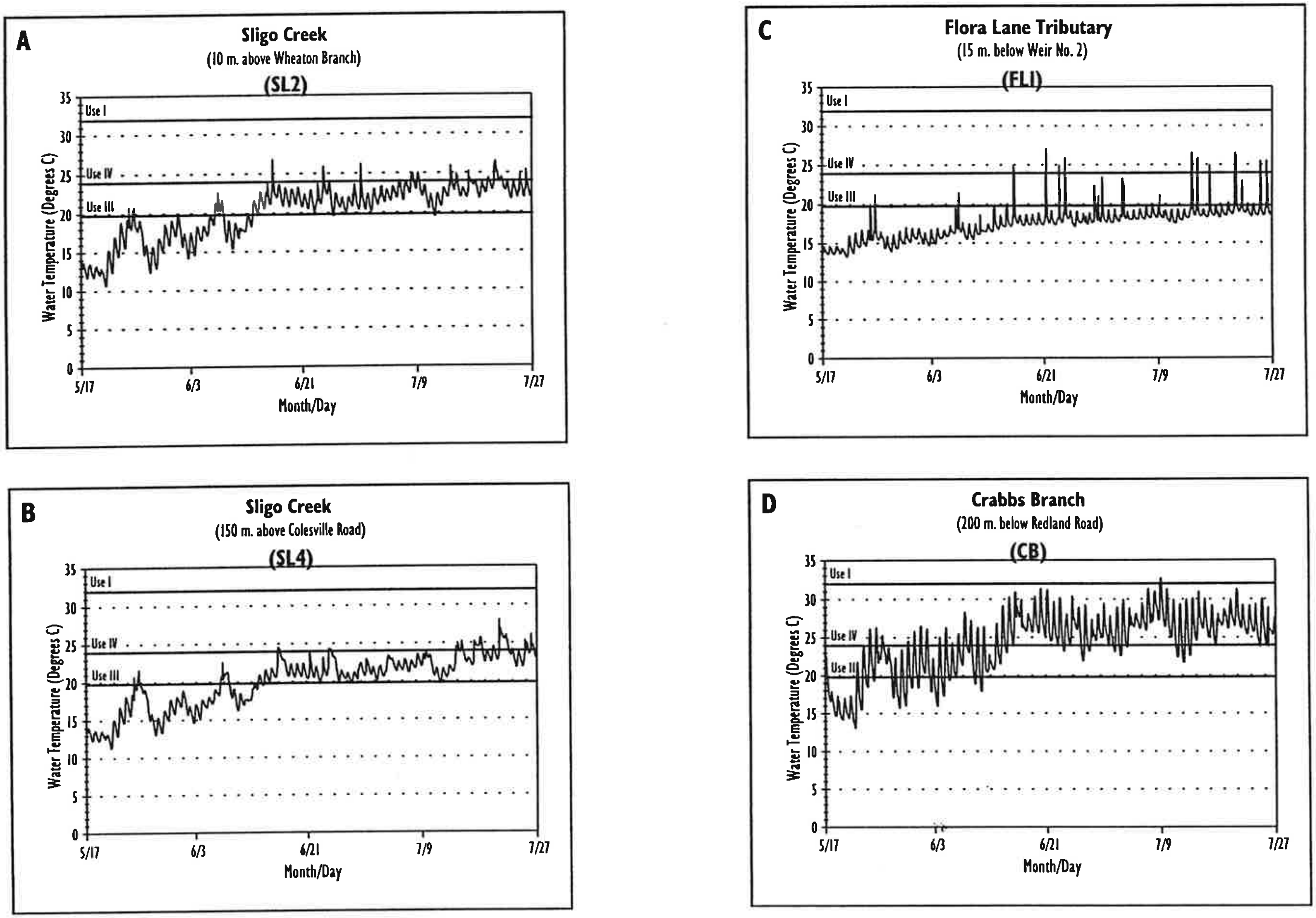

Figure 9. Summary: Sligo Creek, Flora Lane Tributary and Crabbs Branch Twenty-Minute Temperature Readings (5/17/94 to 7/27/94)[1]

[1] MDE Maximum Water Temperature Standards: Use I (water contact recreation, aquatic life and water supply) = 32°C; Use III (natural trout waters) = 20°C; Use IV (recreational trout waters) = 24°C.

Source: MWCOG, 1997

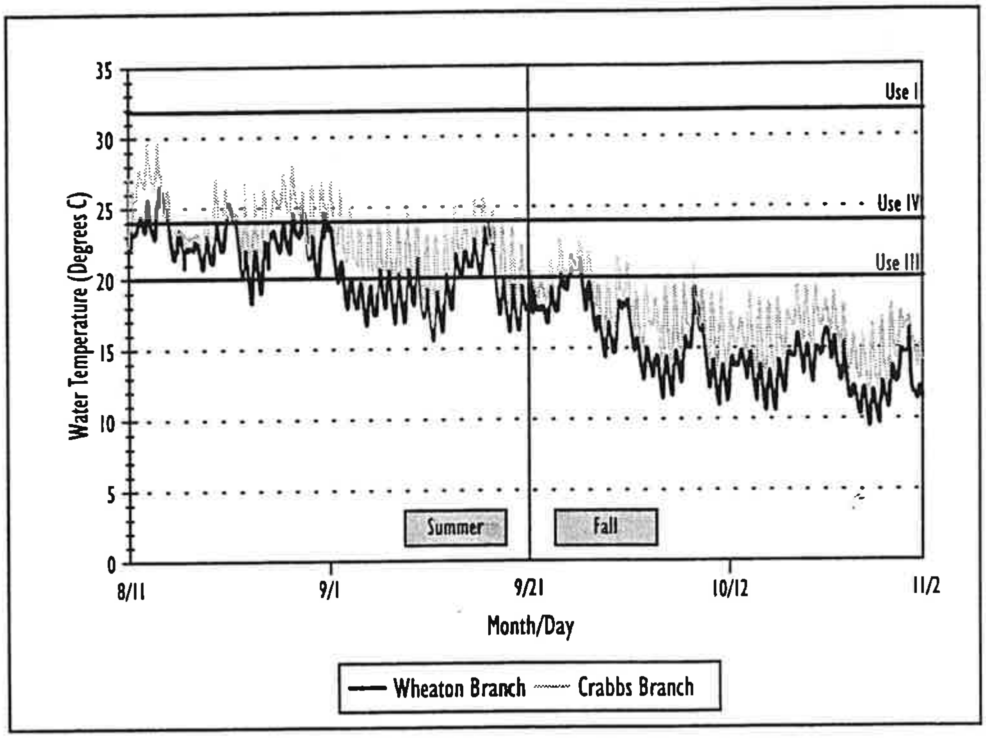

Figure 10. Wheaton Branch (WBI) Versus Crabbs Branch (CB) Twenty-Minute Water Temperature Readings (8/11/94 to 11/2/94)

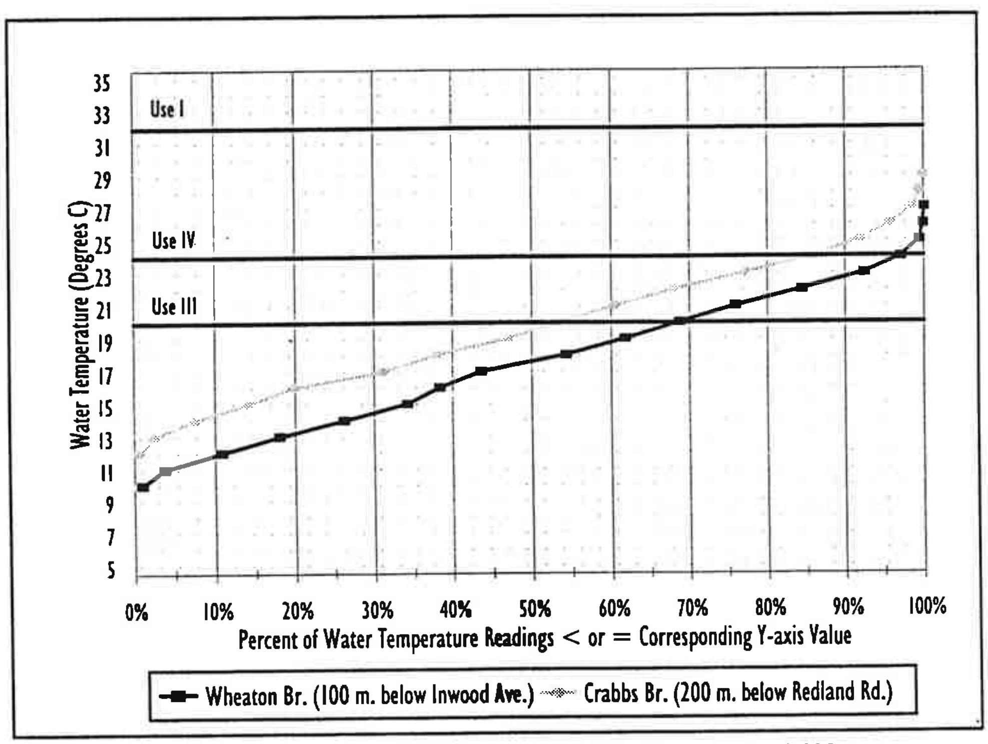

Figure 11. Wheaton Branch (WBI) Versus Crabbs Branch (CB) Water Temperature Distribution (8/11/94 to 11/2/94)

Source: MWCOG, 1997

Based on the preceding water temperature monitoring results, the temperature regimes of these streams can be generally categorized, per Galli (1990), as follows: 1.) Sligo Creek mainstem - coolwater; 2.) Crabbs Branch - coolwater bordering on warm; and 3.) Flora Lane tributary - coolwater bordering on cold. Summer temperatures in all but the Flora Lane tributary regularly exceeded temperature levels considered optimal (i.e., less than 17 to 20 °C) for many stonefly, mayfly and caddisfly species (Gaufin and Nebeker, 1973; Ward and Stanford, 1979; Fraley, 1979). In addition, it should be noted that: 1.) temperatures exceeding 21 °C have been shown to severely stress most coldwater organisms and 2.) as a group, stoneflies (Plecoptera) are the least temperature tolerant and are restricted to cold to cool flowing waters.

3.2.2 *Habitat Conditions*

Habitat conditions from Phase 1 to Phase 2. Habitat improvements occurred in the study area between Phase 1 and Phase 2, with extensive work done in Wheaton Branch. Habitat assessments were conducted at eight study sites during these two Phases of the project. The results of these assessments, with comparisons to a reference site value, are shown below in Table 7. Wheaton Branch showed dramatic improvements in habitat quality, primarily in reduced embeddedness (fine sediment surrounding gravel, which was reduced by about 25%) and greater bank stability (from poor to sub-optimal) with less channel alterations (from poor to optimal). Good habitat was found at the Sligo Creek mainstem sites (SL2 & SL3) near the confluence with Wheaton Branch as well as the most downstream site (SL4). Poor to fair habitat was found at the Flora Lane tributary sites and the most upstream mainstem site (SL1). It was visually determined that Flora Lane stream bank erosion and embeddedness levels were diminished and trash reduced.

Table 7. Phase 1 and 2 Habitat Assessment Scores

SITE	Pre-Restoration habitat assessment	% of reference	Post-Restoration habitat assessment	% of reference
REF	88	100	120	100
SL2	93	106	117	98
SL3	97	110	116	97
WB1	43	49	125	104
WB2	49	56	129	108
FL1	100	83		
FL2	67	56		
SL1	87	73	not applicable	
SL4	126	105	no change	

Please note that the increase in the habitat score for the habitat reference site (Layhill Park, Northwest Branch, Anacostia River) is due to the addition of three habitat parameters in the updated and therefore different habitat assessment methodology used between Phases I and II of the study (Cummins and Stribling 1995). The Phase 2 "twelve parameter" habitat assessment more accurately characterized stream habitat conditions than its "nine parameter" predecessor. The twelve parameter assessments also has a greater potential total score than the nine parameter assessment (180 vs 135, respectively) and will tend to increase the total score of any site previously evaluated with the older nine parameter assessment method[7]. Therefore, direct numeric comparisons between habitat scores of Phase I and Phase 2 were not made. However, because sites are evaluated by their percent similarities to reference site conditions, comparisons were made by using the differences between the "percent of reference site" scores.

[7] The updated scores for the Reference Site in the Phase 2 study for these new parameters were 17, 7, and 8, respectively. For additional information on embeddedness and physical habitat see Appendix VI.

For example, refer to the habitat scores of site WB1 as seen in Table 7. In the Phase I study (9 parameter habitat assessment) this site attained a habitat score of 43, which was 49% of the original reference site score of 88. After restoration (12 parameter habitat assessment) this site scored 125 habitat points, 104% of the same reference site's new score of 120 (the three new parameters added 32 points to the old score of 88). WB2's relative habitat scores also improved, from 56% of reference conditions to 108% of reference. WB1 and WB2 habitat scores for embeddedness and channel alteration also improved considerably. Many other habitat parameters at these two stations also showed increased scores, indicating improved ability to support aquatic communities. Restoration activities such as stormwater pond construction, streambank stabilization, revegetation, and instream structures reduced stream scouring and erosion, and therefore most likely improved the aquatic communities there. In contrast, the unrestored site, Upper Sligo Creek above University Boulevard (SL1), did not compare favorably with reference site habitat conditions. Small decreases at some sites are not likely attributable to any significant changes in habitat, but are more likely due to the subjective nature and variance inherent in successive habitat scoring.

3.3 Biological

3.3.1 *Benthic Macroinvertebrates*

Sampling and taxonomic results are presented in Appendix VII. Calculated metric results (Table 8, p 26) are organized by sampling period, of which there were twelve. Over the 6-year duration of this project, the two locations on Wheaton Branch (WB1 and WB2), and the two sites on the Sligo Creek mainstem just up- and downstream of the Wheaton Branch confluence (SL2 and SL3), each had a total of 10 sampling events. Consequently, they have the longest record of conditions in this study (Table 7), with sampling and index results comparable in spring 1990, 1991, 1993, and 1995 (Figure 12). The fall sampling events at these same locations are comparable during three separate years: 1990, 1992, and 1994 (Figure 13). At the sampling location in Wheaton Branch downstream of the actual instream restoration work(WB2), there was no change in the biological index score.

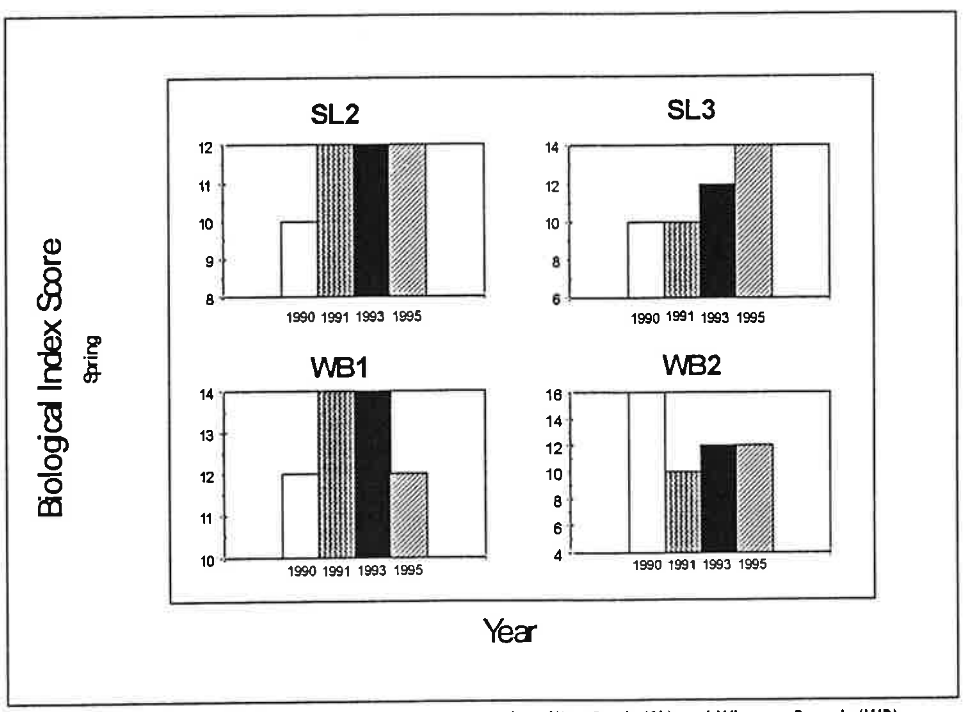

Figure 12. Spring biological index scores over a six year period on Sligo Creek (SL) and Wheaton Branch (WB).

The scoring criteria used (Table 3, p 11) would have allowed a maximum biological condition score of 30 (five metrics, each with a possible score of 6). Using results presented in Tables 8 and 9, calculations of mean scores by sampling period (11.7 [Winter, n = 14, sd = 1.89], 12.2 [Spring, n = 26, sd = 2.14], 12.0 [Summer, n = 12, sd = 1.48], and 12.9 [Fall, n = 22, sd = 2.2]) shows that biological condition in none of the seasons reach even 50% of the Piedmont reference condition of the Anacostia River Basin.[8]

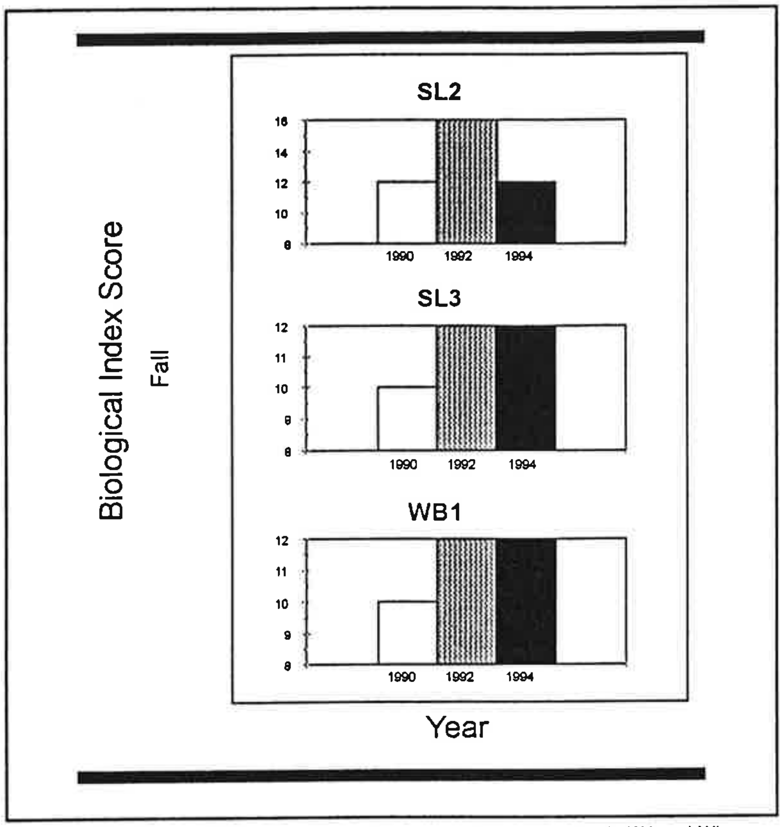

Figure 13. Fall biological index scores over a five-year period on Sligo Creek (SL) and Wheaton Branch (WB).

[8] This project used the site-specific reference condition based on data from Northwest Branch at Layhill Park, which had a total bioassessment score of 38 (Stribling and Thaler, 1991).

Table 8. Calculated metric values (benthic macroinvertebrates) for twelve sampling periods, 1990-95. Metrics: 1 - Taxa Richness, 2 - Hilsenhoff Biotic Index, 3 - EPT, 4 - Percent Dominant Taxon, 5 - Shredders / Total Sample.

Sampling Period: Winter 1990

Sites	Metrics 1	2	3	4	5
SL1					
SL2	4	6.3	1	55.6	0
SL3	3	8.6	0	50	0
SL4					
WB1	2	7.9	0	70.5	0
WB2	5	7.5	1	33.3	0
FL1					
FL2					
WP1					
CB1					

Sampling Period: Spring 1990

Sites	Metrics 1	2	3	4	5
SL1					
SL2	5	4.9	1	43.2	0
SL3	5	7.2	1	41	0
SL4					
WB1	5	6.1	0	53.7	0.02
WB2	7	7.7	0	46.1	0.06
FL1					
FL2					
WP1					
CB1					

Sampling Period: Summer 1990

Sites	Metrics 1	2	3	4	5
SL1					
SL2	6	5.9	2	63	0
SL3	8	7.1	2	42.2	0
SL4					
WB1	9	6.7	3	25.6	0.008
WB2	9	5.9	3	57.7	0
FL1					
FL2					
WP1					
CB1					

Sampling Period: Fall 1990

Sites	Metrics 1	2	3	4	5
SL1					
SL2	6	5.2	2	91.7	0
SL3	5	5.4	2	80.6	0
SL4					
WB1	5	5.8	1	67.3	0.009
WB2	7	5.2	1	93.9	0.01
FL1					
FL2					
WP1					
CB1					

Sampling Period: Spring 1991

Sites	Metrics 1	2	3	4	5
SL1					
SL2	4	5.4	1	73.5	0.03
SL3	3	7.6	1	38.9	0
SL4					
WB1	6	7.4	1	30.3	0
WB2	5	8.5	2	62.2	0
FL1					
FL2					
WP1					
CB1					

Sampling Period: Summer 1992

Sites	Metrics 1	2	3	4	5
SL1	6	6.9	0	31.2	0
SL2					
SL3					
SL4	7	5.7	2	56.8	0
WB1					
WB2					
FL1	5	7.6	0	57.1	0
FL2	6	7.3	0	71.9	0.02
WP1					
CB1					

Table 8 (cont'd). Calculated metric values (benthic macroinvertebrates) for 12 sampling periods, 1990-95. Metrics: 1 - Taxa Richness, 2 - Hilsenhoff Biotic Index, 3 - EPT, 4 - Percent Dominant Taxon, 5 - Shredders / Total.

Sampling Period: Fall 1992

Sites	Metrics 1	2	3	4	5
SL1	10	7.9	0	43.8	0.01
SL2	15	7.7	2	40	0.03
SL3	13	6.3	2	55.3	0.004
SL4	8	7.7	2	51.9	0.02
WB1	12	8.2	2	64	0.0003
WB2	12	6.5	2	38.4	0.003
FL1	5	7.8	0	27.5	0.07
FL2	7	6.8	0	27	0.2
WP1					
CB1					

Sampling Period: Spring 1993

Sites	Metrics 1	2	3	4	5
SL1	10	7.3	2	72.5	0.004
SL2	7	7.2	2	38	0.01
SL3	9	8.0	3	45.6	0.01
SL4	9	8.4	2	50.9	0.025
WB1	12	6.4	2	35	0
WB2	13	6.6	2	39.1	0.004
FL1	4	8.7	0	56.2	0
FL2	2	7.4	0	93	0
WP1					
CB1					

Sampling Period: Summer 1993

Sites	Metrics 1	2	3	4	5
SL1	6	6.6	3	40	0.1
SL2					
SL3					
SL4	11	6.2	2	62.9	0.03
WB1					
WB2					
FL1	5	8.2	0	47.6	0
FL2	3	8.3	0	40	0
WP1					
CB1					

Sampling Period: Fall 1994

Sites	Metrics 1	2	3	4	5
SL1					
SL2	7	6.2	3	57	0
SL3	10	6.0	3	46	0
SL4	10	6.6	3	43	0.018
WB1	8	6.0	3	43	0
WB2	10	7.0	3	36	0.005
FL1	8	8.6	2	62	0.09
FL2	7	7.2	2	65	0.31
WP1	4	7.3	1	75	0.1
CB1	8	6.2	3	40	0.006

Sampling Period: Winter 1994

Sites	Metrics 1	2	3	4	5
SL1	4	6.4	2	54	0.06
SL2	5	6.9	3	58	0.006
SL3	7	7.1	2	46	0.005
SL4	8	7.2	2	32	0.005
WB1	5	7.0	2	38	0
WB2	7	6.4	2	65	0
FL1	6	7.1	2	40	0.1
FL2	7	7.1	2	54	0.2
WP1	6	6.1	1	30	0.25
CB1	6	6.1	3	51	0

Sampling Period: Spring 1995

Sites	Metrics 1	2	3	4	5
SL1	7	7.8	2	63	0
SL2	10	6.5	3	47	0.01
SL3	9	7.0	3	26	0
SL4	10	6.9	3	30	0.12
WB1	11	6.8	3	46	0.006
WB2	7	6.3	3	78	0
FL1	2	8.0	0	67	0
FL2	6	7.3	2	48	0.05
WP1	3	8.1	0	61	0
CB1	10	7.0	3	43	0.007

Table 9. Total Biological Index Scores, Sligo Creek Phases 1, 2, and 3. Bioassessment scores aggregated across five metrics.

	1	1	1	1	1	2	2	2	2	3	3	3
	Wi90	Sp90	Su90	Fa90	Sp91	Su92	Fa92	Sp93	Su93	Fa94	Wi94	Sp95
SL1						14	12	12	12	10	10	12
SL2	10	10	12	12	12		16	12		12	10	12
SL3	10	10	12	10	10		12	12		12	12	14
SL4						12	14	14	12	12	14	18
WB1	10	12	14	10	14		12	14		12	10	12
WB2	12	16	12	12	10		12	12		12	12	12
FL1						10	16	10	10	16	12	10
FL2						14	18	10	10	16	14	16
WP1										14	16	10
CB1										12	12	12

SL Sligo Creek mainstem, WB Wheaton Branch mainstem, FL Flora Lane Tributary mainstem, WP Woodside Park Tributary, CB Crabb's Branch

Individual metric values fluctuated widely among the stations and the seasons, but some reasonable changes, that is, changing in the direction expected with improving conditions, were apparent in values from single locations over time. For example, the metric "Taxa Richness" (Spring) at the Wheaton Branch sites (WB1 and WB2), changed from 5 and 7 taxa in 1990 to 6 and 5 in 1991, 12 and 13 in 1993, to 11 and 7 in 1995 (Figure 14, top panel). Other metrics, like "Percent Dominant Taxon" did not show any discernible changes (Figure 14, bottom panel). As noted in an earlier report, the metric "EPT index" is currently not very useful for distinguishing among these sites (Cummins and Stribling 1995), having very low values at all locations, ranging from 0-3, and never scoring more than 2 bioassessment points. However, this does not mean that with additional time for further improvements in habitat and flow conditions, that the metric would not become useful. If, in maintaining a similar level of taxonomic analysis, new taxa of mayflies and caddisflies began being detected, along with stoneflies, this metric could begin distinguishing among sites.

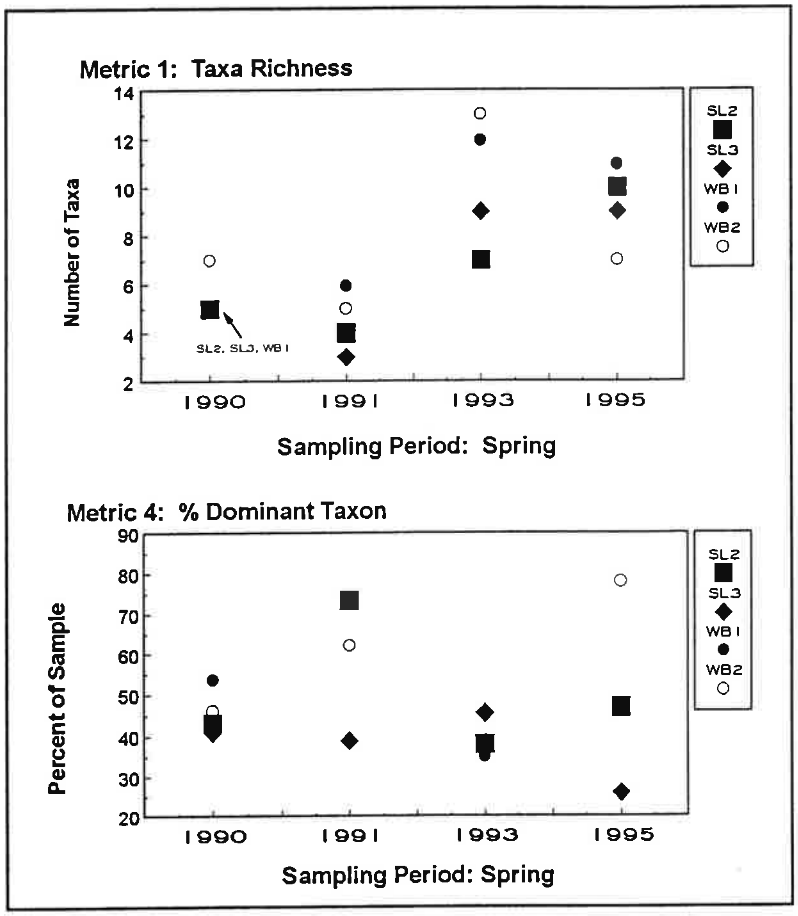

Figure 14. Differences over time in calculated Spring values of "Metric 1: Taxa Richness" and "Metric 4: Percent Dominant Taxon" at sites on Wheaton Branch (WB) and Sligo Creek (SL).

For all samples and all sites, the metric "HBI" ranged from 4.9 to 8.7. No single site nor single season had a tendency of showing either consistently high values (pollution or stressor tolerant organisms) or low values (pollution or stressor sensitive organisms). The metric "shredders/total" ranged from 0, when no shredder organisms were in a sample, to 0.31; however, the large majority of values were lower than 0.1.

3.3.2 *Fish*

Phase I fisheries surveys found, similar to earlier studies (Cummins 1989, 1990), that the upper Sligo Creek sites had only three species of fish; blacknose dace, northern creek chub, and goldfish. These species are all highly pollution tolerant (Plafkin et. al. 1989). The blacknose dace accounted for 77% of all individuals captured. An indication of environmental stress was that 11% (20 of 182) of the northern creek chubs collected had either fin erosions, skin lesions, external fungal infections or combinations of these external symptoms. These symptoms are associated with environmental degradations such as chronic, sublethal exposure to contaminants, low dissolved oxygen, or high levels of suspended solids (Wedemeyer et al. 1990).

Stormwater management upgrades and improvements in the habitat complexity of upper Sligo Creek were completed in 1993. Based on the Phase I findings, these streams should support a greater diversity of fish species. Unfortunately, downstream blockages to fish migration prevented the natural re-establishment of a more diverse fish community in Wheaton Branch. Therefore, as per Phase I recommendations, experimental transplant stockings of selected native fish species were done into the upper Sligo Creek mainstem, Wheaton Branch and Flora Lane (See Appendix VIII for records of transplant stockings). Periodic monitoring of the nine selected sites in upper Sligo Creek were then conducted to help determine which species were surviving and how these species were dispersing into the mainstem of upper Sligo Creek. Only select fish species which are indigenous to small streams and native to the area were stocked, following the recommendations of the Phase I and 2 study reports (Cummins et al. 1992, Cummins et al. 1995). These fishes were collected from the Northwest Branch (another sub-watershed of the Anacostia River immediately to the east of the Sligo Creek sub-watershed) and then re-introduced into the Sligo Creek study area. As in the past, the re-stocking was done with the help of local citizen volunteers. The following ten species were selected as primary target introductions;

Swallowtail Shiner (Notropis procne)
Satinfin Shiner (Notropis analostanus)
White Sucker (Catostomus commersoni)
Bluntnose Minnow (Pimephales notatus)
Common Shiner (Notropis cornutus)
Cutlips Minnow (Exoglossum maxillinqua)
Longnose Dace (Rhinichthys cataractae)
Tessellated Darter (Etheostoma olmstedi)
Silverjaw Minnow (Ericymba buccata)
Rosyside Dace (Clinostomus funduloides)

Except for a single but large stocking event that occurred in the upper Sligo Creek watershed prior (1990) to the start of this project, stocking was phased in order to permit less prolific species to establish themselves prior to the introduction of more prolific species, thereby reducing inter-species competition pressures. Stocking occurred at two principal seasons; 1) in early spring, to take advantage of a time when most species are in preparation for spawning, and 2) fall, as an alternate strategy which would permit species to find and occupy suitable niches prior to the following spring spawning season. Both had the underlying philosophy that the fish would subsequently spawn in the study area and further increase the chances of establishing viable fish populations. Monitoring of each phase of stocking occurred prior to any subsequent stocking.

As the project progressed, three additional fish species were added to the introduction list; Northern Hog Suckers (Hypentelium nigricans), Fantail Darter (Etheostoma flabellare), and the Mottled Sculpin (Cottus bairdi). No sunfish species were stocked into the study area because of expected problems with possible sunfish predation on the establishing minnow populations and, from researcher experience, sunfish tend to be introduced rapidly by local anglers.

One site outside of the Sligo Creek watershed, Crabb's Branch (part of the Rock Creek watershed), was also monitored as a comparison of the effectiveness of different types of stormwater management wet pond designs (i.e., Crabbs Branch - large surface area and volume with surface release versus Wheaton Branch - slightly smaller surface area and smaller volume with both bottom release and 24 to 36 hour extended detention control).

The results of the Phase 3 fish study for each site are presented along with the site maps in Appendix II. The IBI average score for each site studied in Phase 3, along with re-calculated IBI scores from the previous two phases, are presented below in Figure 15. The general trend for these sites is an improvement from very poor scores (10 is the lowest score possible under the Montgomery County IBI index, the initial score of 7 of the 9 Sligo Creek sites) to near or at the poor/fair category (Fair begins at a score of 22). Crabbs Branch, which was used as a comparison site, consistently scored in the fair/good range (Good begins at 34).

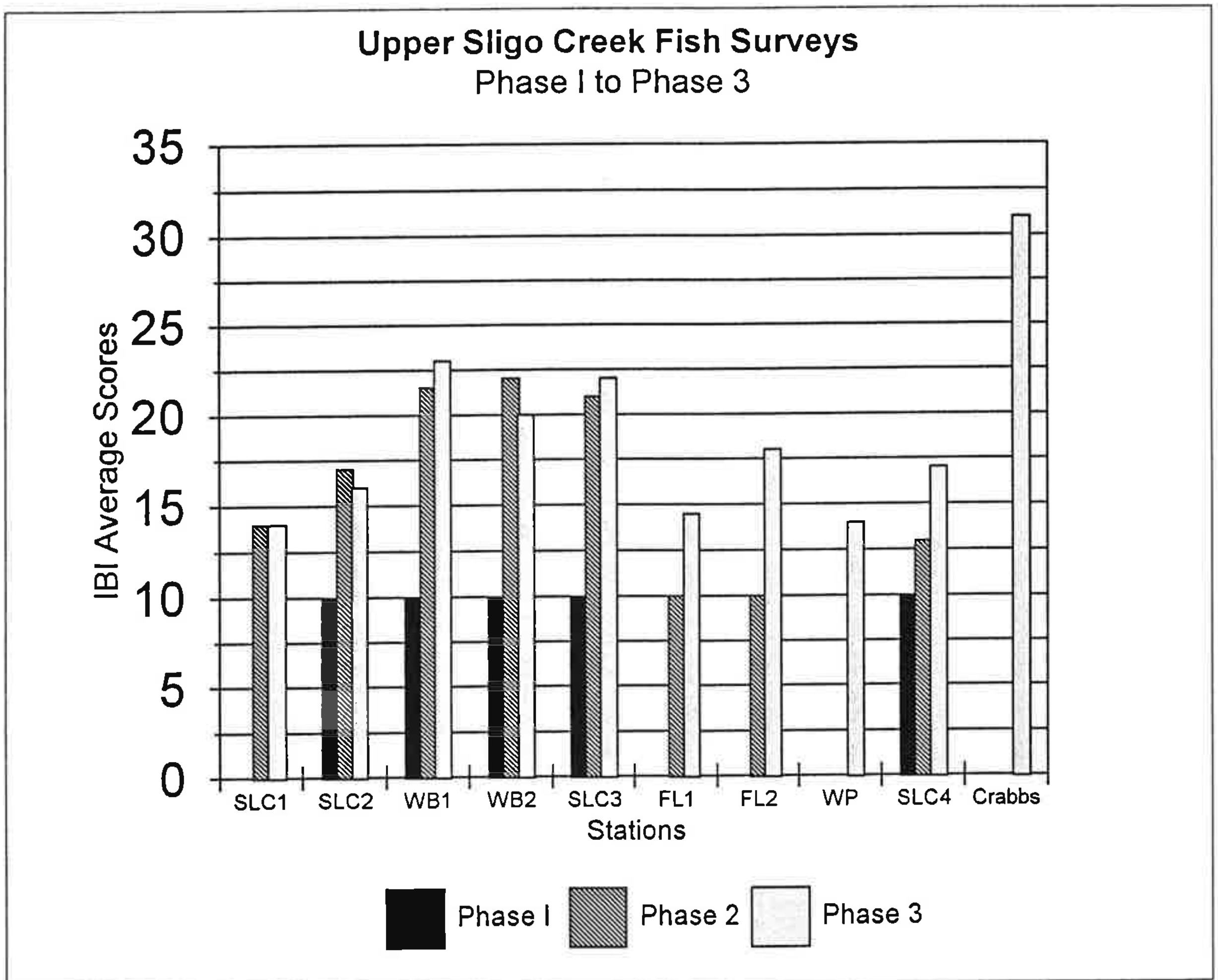

Figure 15. The IBI average score for each site studied in Phase 3, along with re-calculated IBI scores from Phases 1 & 2.

At the conclusion of the study, Wheaton Branch (WB1 & WB2) had gone from three to six fish species. Three of these species were there at the beginning of the study and are highly pollution tolerant; goldfish, blacknose dace and northern creek chubs. The other three; golden shiners, white suckers and green sunfish, are also pollution tolerant fishes. Sligo Creek immediately downstream from Wheaton (SLC3) made the greatest improvement in fish diversity (from 3 to 9 species), including two fairly pollution intolerant species; rosyside dace and the mottled sculpin, although this improvement is not well reflected in the IBI scores. The Woodside Park tributary site was only sampled during Phase 3, had no restoration, and consistently had very low species diversity (1-2 species). Throughout the study area the incidences of fish deformities, skin erosions, lesions and tumors (DELTS) were found to be insignificant (less than 3%) by the end of the study, as compared to the high incidences (11%) at the beginning of the project.

The sweep sampling data (Table 10, below) revealed additional encouraging information. Sixteen species were recaptured in these sampled areas between 1994 and 1996. Several of the studied stream reaches were found to hold pollution intolerant species. In sweep area #4, which is in the vicinity of Dallas Avenue, longnose dace were found at each sampling event in the stream section which has a fairly steep gradient with large substrate (cobbles, bedrock and boulders). The stream reach just downstream from Sligo Creek's confluence with Flora

Table 10: Results of Sweep Sampling for Selected Fishes in Upper Sligo Creek

COMMON NAME	SCIENTIFIC NAME	1994						1995				1996		
	STREAM SECTION ID's	1	2	3	4	5	6	2	4	LFL	UFL	2 - 6	7	Total
1. American Eel	Anquilla rostrata												3	3
2. Central Stoneroller	Campostoma anomalum				1	4			1					6
3. Silverjaw Minnow	Ericymba buccata			1		1								2
4. Swallowtail Shiner	Notropis procne			3										3
5. Golden Shiner	Notropis crysoleucas		4			3						1		8
6. Bluntnose Minnow	Pimephales notatus					1								1
7. Rosyside Dace	Clinostomus funduloides									2		1		3
8. Longnose Dace	Rhinichythys cataractae				4			7	1	1		26	2	41
9. White Sucker	Catostomus commersoni	13	22	2		15	5		6	3	7	39	16	128
10. Northern Hog Sucker	Hypentelium nigricans		p	2		2								5
11. Mummichog Killifish	Fundulus heteroclitus		1											1
12. Bluegill Sunfish	Lepomis macrochirus											3	1	4
13. Green Sunfish	Lepomis cyanellus											2	2	4
14. Fantail Darter	Etheostoma flabellare		1				1		2		1			4
15. Tessellated Darter	Etheostoma olmstedi		4	2	4	5	2	1	4			1	5	28
16. Mottled Sculpin	Cottus bairdi					1	1		6		1	1		10
Number of Introduced Species Collected		1	6	5	3	8	4	2	6	3	3	8	5	252

Sweep Area 1 = Colesville Road to a sewerline cap approximately 100 meters downstream from Brunette Avenue.
Sweep Area 2 = Sewerline cap as above to the "Izaak Walton Drop Structure" at Brunette Avenue.
Sweep Area 3 = Rootwads at Restoration Worksite #15 to Checkdam 25 meters downstream from Woodside Park
Sweep Area 4 = Dallas Avenue to Restoration Worksite #13.
Sweep Area 5 = Worksite #13 to Bahai Monument at Soccerfields downstream from Washington Beltway.
Sweep Area 6 = Bahai Monument to Log Check Dam just upstream from confluence with Flora Lane tributary
Sweep Area UFL = "Upper" Flora Lane, from park boundary at Crosby Road upstream to flow splitter.
Sweep Area LFL = "Lower" Flora Lane, from Hiker/Biker path downstream to confluence with Sligo Creek.
Sweep Area 2-6 = Long sweep through areas 2,3,4,5 and 6.
Sweep Area 7 = Approximately 100 meters from Forest Glen Hiker/Biker spur trail.
p = sighted but not captured

Lane tributary (in sweep area #6) had tesselated darters, mottled sculpins and longnose dace at each sampling event (several of these were young-of-the-year fish, indicating successful reproduction). Sweep area #7, which is located upstream from the other sweep sampling areas and between fixed sites SLC3 and the Sligo Creek confluence with the Flora Lane tributary, was sampled only in 1996 and that area contained longnose dace and tesselated darters amongst the six introduced species, an additional indication that these fish are dispersing and establishing themselves in certain areas of the system. A total of twenty seven fish species were collected in upper Sligo Creek after restoration, nine of these are considered re-established with thirteen uncertain, as compared to three that were found prior (Table 11).

Table II: List of Fishes Found Before and After Restoration in Upper Sligo Creek

COMMON NAME	SCIENTIFIC NAME	1988	1995
1. American Eel	Anguilla rostrata		E
2. Goldfish	Carassius auratus	*	E
3. Central Stoneroller	Campostoma anomalum		U
4. Silverjaw Minnow	Ericymba buccata		U
5. Cutlips Minnow	Exoglossum maxillingua		U
6. Golden Shiner	Notemigonus crysoleucas		E
7. Swallowtail Shiner	Notropis procne		U
8. Satinfin Shiner	Notropis spilopterus		U
9. Common Shiner	Notropis cornutus		U
10. Spottailed Shiner	Notropis hudsonius		U
11. Bluntnose Minnow	Pimephales notatus		U
12. Rosyside Dace	Clinostomus funduloides		U
13. Longnose Dace	Rhinichythys cataractae		E
14. Blacknose Dace	Rhinichythys atratulus	*	*
15. Northern Creek Chub	Semotilus corporalis	*	*
16. White Sucker	Catostomus commersoni		E
17. Northern Hog Sucker	Hypentelium nigricans		E
18. Brown Bullhead	Ictalurus nebulosus		U
19. Mosquitofish	Gambusia affinis		U^1
20. Mummichog	Fundulus heteroclitus		U^2
21. Green Sunfish	Lepomis cyanellus		E
22. Bluegill Sunfish	Lepomis macrochirus		U
23. Redbreast Sunfish	Lepomis auritus		U
24. Pumpkinseed Sunfish	Lepomis gibbosus		U
25. Largemouth Bass	Micropterus salmoides		U
26. Tessellated Darter	Etheostoma olmstedi		E
27. Fantail Darter	Etheostoma flabellare		E

E = Species believed to be established (i.e., reproducing population) by evidence of young fish and/or general abundance.
U = Collected but uncertain about establishement.
U^1 = Collected, but probalby not established, part of Maryland's mosquito control program, seldom overwinters in peidmont streams.
U^2 = Collected, probalby an anomolie of the 1990 stocking event.

4.0 Discussion

The results of this study indicate there are some general improvements in biological and habitat conditions which are attributable to the upper Sligo Creek restoration effort. Also, in the six years of monitoring on Wheaton Branch downstream of the stormwater management facility (3-celled, 2.4 hectare surface area, bottom-release wet pond), the amount of trash in the stream was dramatically reduced, there is much less stream bank erosion (A graphic example can be seen in Figure 1 before and after photos of Wheaton Branch) . Much of the riparian area has been revegetated and stabilized with instream physical habitat and flow enhancement features (see Table 12, below). Also, at the end of Phase 3 all instream habitat enhancement structures were still in place and in working order.

Table 12 . Sampling locations in the Sligo Creek watershed and the rehabilitation/retrofit features affecting instream and riparian conditions.

Sampling Reach Location	Rehabilitation/Retrofit Features Affecting
Wheaton Branch upstream (WB1)	3-celled extended detention wet pond
Wheaton Branch downstream (WB2)	3-celled extended detention wet pond, riparian revegetation, bank stabilization, instream physical habitat/flow enhancement features
Flora Lane Tributary upstream (FL1)	parallel pipe flow splitter
Flora Lane Tributary downstream (FL2)	parallel pipe flow splitter
Sligo Creek upstream of WB confluence (SL2)	University Blvd. stormwater management extended detention wet pond
Sligo Creek downstream of WB confluence (SL3)	"improved" flows on mainstem and from WB; created wetland
Sligo Creek downstream of FL confluence (SL4)	"improved" flows from mainstem, WB, and Sligo Golf Course wet pond; additional riparian revegetation; created artificial wetlands

A site for which representative changes between the three phases can be examined is on the Sligo Creek mainstem just downstream of its confluence with Wheaton Branch. For macroinvertebrate collections in both spring (1990, 1993) and fall (1990, 1992), changes in numbers of individuals were generally much greater than 50 percent from Phase 1 to Phase 2, as were numbers of taxa. For the latter, the spring samples changed from number of taxa ranging from 4-7 (1990) to 7-13 (1993); similarly, fall samples ranged from 5-7 taxa in 1990 to 12-15 in 1992.

Although, in themselves, high numbers of species or other taxa should not be the ultimate indicator of improving ecological conditions, these changes do signal a general improvement in habitat conditions in Wheaton Branch, the Flora Lane tributary and Sligo Creek since completion of construction. Often, improving conditions are reflected in benthic macroinvertebrate assemblages by one or a few taxa not being overly dominant (Cummins and Stribling, 1992). This characteristic is in part described by the metric "percent contribution of dominant taxon." Thus, when conditions improve, there are typically lower values for this metric. In the spring samples, there was a change from 50-80 percent dominance (1990) to approximately 37-45 percent (1995). Percent dominance changed from a range of approximately 67-93 percent in 1990 to 39-63 percent in 1992. Similarly to the change in numbers of taxa, substantial changes are seen from Phase 1 to Phase 2, with less change evident after Phase 2. While the total number of invertebrate taxa still remains relatively low compared to unimpaired streams, these changes signal improving conditions in both Wheaton Branch and Sligo Creek.

Crabbs Branch, which was used as a comparison site, consistently scored in the fair/good range in terms of fish community structure(Good begins at 34), an indication that the stormwater management measures for that tributary are more effective.

In additon, little is known regarding the re-introduction of fishes into restored urban streams. Understanding of the fishes subsequent dispersions and survival successes in the system may not have been adequately addressed by the fixed site studies.

Conclusions

Upper Sligo Creek's stream habitat and its macroinvertebrate, fish and amphibian communities recovered considerably from Phase I to Phase 3. The general increase in the number of macroinvertebrate individuals together with the decrease in the dominance of the most common taxon signal both an increasingly healthy stream and improved food base for fish. The fish assemblage, particularly that of Wheaton Branch, appears far healthier. For example, the percentage of fishes with external anomalies such as tumors or infections decreased to negligible levels. Overall, fish community structure showed their greatest gain in the Sligo Creek mainstem. The number of fish species residing in the Upper Sligo Creek mainstem has increased from three in 1988 to twenty-seven in 1995. The system presently features a wide diversity of native non-game and gamefish species and supports relatively pollution intolerant species, such as the rosyside dace (Clinostomus funduloides), northern hogsucker (Hypentelium nigricans) and the mottled sculpin (Cottus bairdi). With regard to the amphibian assemblage, vernal pool and wetland creation areas now provide habitat for both native resident and reintroduced species. Natural colonization and successful reproduction by five of these species has been documented. In addition, all of the in-stream habitat enhancement structures remain in good condition and functioning as designed.

However, there remains room for improvement, particularly in the area related to water quality and the control of stormwater runoff volumes in both the Wheaton Branch and Flora Lane tributaries. At the end of Phase 3, even the best of the sites studied remained well below the reference site conditions. With the exceptions of a few short selected reaches, the uppermost Sligo Creek mainstem fish communities have not recovered.

There are several aspects of this project that should also be noted relative to its overall design, data analysis, and interpretation of the results. Because urbanization and stormwater impacts have such significant ecological effects on streams, biological communities are often completely eliminated or reduced to extremely small numbers. Nearly 45 percent of the benthic samples used for analysis in this study (3 surbers combined) had less than 100 organisms; 30 percent had less than 50. Such small numbers, though they might be representative, may give a false indication of conditions when compared to those with higher numbers. For example, Flora Lane tributary (FL2) had the highest bioassessment score of all sites in the fall 1992 sample period (18), but had only 39 organisms. It received a higher score primarily because of the metric "shredders/total". That score of "18" should not be viewed as an improvement, but rather as an artifact of obtaining such a small number of organisms in the sample. Two factors can address this methodological problem: establish a lower limit on the number of organisms on which metrics can be calculated; or use a sampling method that ensures a larger number of organisms.

Although the complete duration of this project was six years (1990 - 1995), there were several events during that period which may have retarded additional biological recovery. Most aspects of the Wheaton Branch retrofit and rehabilitation were completed in 1991. Following that, the stream at various times received input from a ruptured sewer line, dewatering due to valve malfunction (from the detention pond), and a drought in the summer of 1993. These events likely contribute to the variability seen in the overall biotic index scores. Another factor affecting the variability is the somewhat sporadic nature of sample timing. Only four locations had samples taken in four separate years for a single season (SL2, SL3, WB1, and WB2), providing assessments of changes over time. Greater adherence to sampling schedules and more complete sampling at all locations would help reduce variability in interpretation of results. More distinct changes in the biology may become apparent as more time elapses, that is, the duration of this project may not have been sufficient to see distinct changes. Our ability to detect those changes is affected by the sampling methods and the interpretive framework used.

5.0 Recommendations

It is very difficult and expensive to restore highly degraded urban streams to levels that support diverse biological communities. The findings of this study that, despite the best efforts of many people and significant monetary investments, the gains in aquatic ecological health were generally limited to a shift from a very poor stream to a fair category add emphasis to this. However, other benefits of the project; cleaner water, a healthier and more pleasing environment, the parklike nature of what was once an eyesore that many people avoided, the improved property values of adjacent homes and businesses, and other human factors must also be part of the picture. These factors, while not measured by this study, were evident. Also, while the gains to the aquatic community may seem meager to some, it is not well understood what level of effort is required to shift from one threshold to another, and whether that shift is linear. There is a great deal of satisfaction in knowing that a dozen fish species or more now exist in a system that ten years ago could support only three. Therefore, we recommend continued efforts to reduce and/or contain excessive stormwater runoff and to improve water quality in Sligo Creek and the Anacostia watershed.

Specific to upper Sligo Creek, we strongly recommend evaluating a change in the design of the outflow pipe of the third and final pond at the retrofitted Wheaton Branch Stormwater management facility to stop discharging water from near the bottom of the pond. The current design at the pond was done to both reduce trash clogging problems and thermal inputs to the stream. That was a good faith effort based on the assumption that the groundwater present together with the bottom release design would help ensure the discharge of cooler waters. There are some limited thermal benefits in this design. However, the design also appears at times to be discharging poorly oxygenated water with a high colloidal urban residue that may be limiting biological activity in Wheaton Branch. In addition, while it is recognized that the presence of sanitary sewer lines may increase construction costs, serious consideration should be given to expanding the permanent pool area associated with pond no. 3. Based on available plans, it appears that approximately 0.33 hectares (0.9 acres) could be added.

While the Flora Lane parallel pipe system has resulted in positive changes in the Flora Lane tributary, it is undersized. Therefore, it is strongly recommended that the County and MSHA seriously explore the possibility of constructing a stormwater management facility along the north side of the I-495/Georgia Avenue ramp. At a minimum, the on-going stream channel erosion problems present there need to be corrected as soon as possible. This would reduce both the amount of downstream bedload movement and the need for annual sediment removal within the weir no. 2 micropool (which, unfortunately, is not being done on a regular basis).

Figure 16. Two friends fishing in Wheaton Branch after restoration (1994).

Another concern is that the biological measurements of this study were performed over a relatively short time frame (two to three years) in terms of recovery. It is recommended that additional comprehensive chemical, physical and biological monitoring be performed in another three to four years, using biological sampling methods recently developed by Montgomery County's Department of Environmental Protection (DEP) (VanNess et al. 1997) or the Maryland Department of Natural Resources Biological Stream Survey (MBSS). Also, the scoring criteria appropriate for this stream system will have been developed by the MBSS and should be used for future evaluations of the biological condition of streams in the Sligo Creek watershed.

Finally, summer stream temperatures in Crabbs Branch could be reduced through riparian reforestation. Because of the active beaver population present, the use of wire mesh tree guards or equivalent should be considered.

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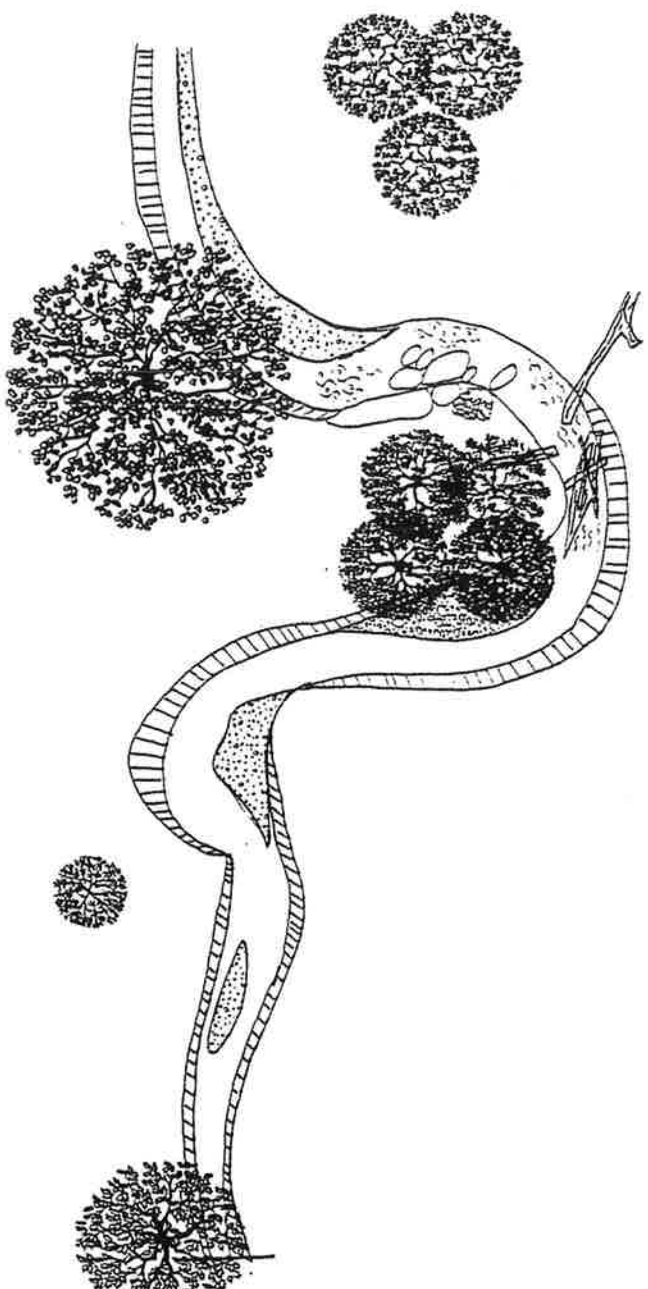
Appendix I. Benthic macroinvertebrate site labels, locations, and dates sampled.

Site Labels*					Sampling Dates		
Phase I 1990-91	Phase II 1992-93	Phase III 1994-95	Stream	General Location	Phase I 1990-91	Phase II 1992-93	Phase III 1994-95
WB1	WB1	WB1	Wheaton Branch	below Woodman Ave.	3/26, 5/14, 7/28, 11/03, 4/06	12/15, 6/7	9/15, 12/2, 5/31
WB2	WB2	WB2	Wheaton Branch	approx. 100 m downstream of WB1	3/26, 5/14, 7/28, 11/03, 4/06	12/15, 6/7	9/16. 12/2, 5/31
WB3	SL2	SL2	Sligo Creek	upstream of WB confluence	3/26, 5/14, 7/28, 11/03, 4/06	12/15, 5/28	9/15, 12/7, 5/31
WB4	SL3	SL3	Sligo Creek	downstream of WB confluence	3/26, 5/14, 7/28, 11/03, 4/06	12/15, 5/28	9/15, 12/7, 5/30
	SL1	SL1	Sligo Creek	above University Ave.		8/21, 12/15, 6/7, 10/5	9/16, 12/2, 5/31
	SL4	SL4	Sligo Creek	just upstream of Colesville Rd.		8/25, 12/14, 5/28, 7/29	9/15, 12/2, 5/30
	FL1	FL1	Flora Lane Tributary	upstream site		8/25, 12/14, 5/13, 10/5	9/16, 12/7, 5/31
	FL2	FL2	Flora Lane Tributary	downstream site		8/25, 12/14, 5/13, 10/5	9/16, 12/7, 5/31
		WP1	Woodside Park Trib.	a small tributary of Sligo Creek near Dallas Avenue.			9/15, 12/2, 5/30
		CB1	Crabbs Branch	a Rock Creek tributary downstream from Redmond Road.			9/19, 12/7, 6/5

* Note that two of the duplicated sites changed identifying labels from Phase I sampling to Phase II sampling; WB3 changed to SL2, and WB4 changed to SL3

APPENDIX II

Appendix II. The following pages (43-71) are site maps, habitat assessments, and fish sampling results from Sligo Creek Phase 3.



Site SLC1: Sligo Creek x University Blvd.

Habitat Assessment

Habitat Parameter	Rank	Score	Description
Bottom Substrate	Marginal	7	10-30% Mix of Rubble, Gravel, or other stable habitat.
Embedded-ness	Poor	5	Gravel, cobble and boulder particles are over 75% surrounded by fine sediment
Velocity/ Depth	Marginal	7	Only 2 of the 4 habitat types present (missing riffles/runs get lower score)
Canopy Cover	Optimal	16	Some areas of water surface fully exposed to sunlight, and other receiving various degrees of filtered light.
Channel Alteration	Marginal	4	Moderate deposition of new gravel, coarse sand on old and new bars; and/or embankments on both banks.
Scouring/ Deposition	Sub-Optimal	8	5-30% affected. Scour at constrictions and where grades steepen. Some deposition in pools.
Pool/Riffle Ratio	Sub-Optimal	8	7-15. Infrequent repeat pattern. Variety of microhabitats less than optimal.
Lower Bank Stability	Sub-Optimal	8	Overbank (lower) flows occasional. W/D ration 8-15.
Upper Bank	Marginal	4	Moderately unstable. Moderate frequency and size of erosional areas. Side slopes up to 60% on some banks. High erosion potential during extreme high flow.
Bank Vegetative Protection	Poor	2	Less than 50% of the streambank surfaces covered by protection vegetation.
Streamside Cover	Sub-Optimal	8	Dominant vegetation is of tree form.
Riparian Vegetative Zone	Optimal	10	>18 meters.
TOTAL		87	

Sligo Creek Phase III Fisheries Survey

Site SLC1: Sligo Creek above University Blvd.

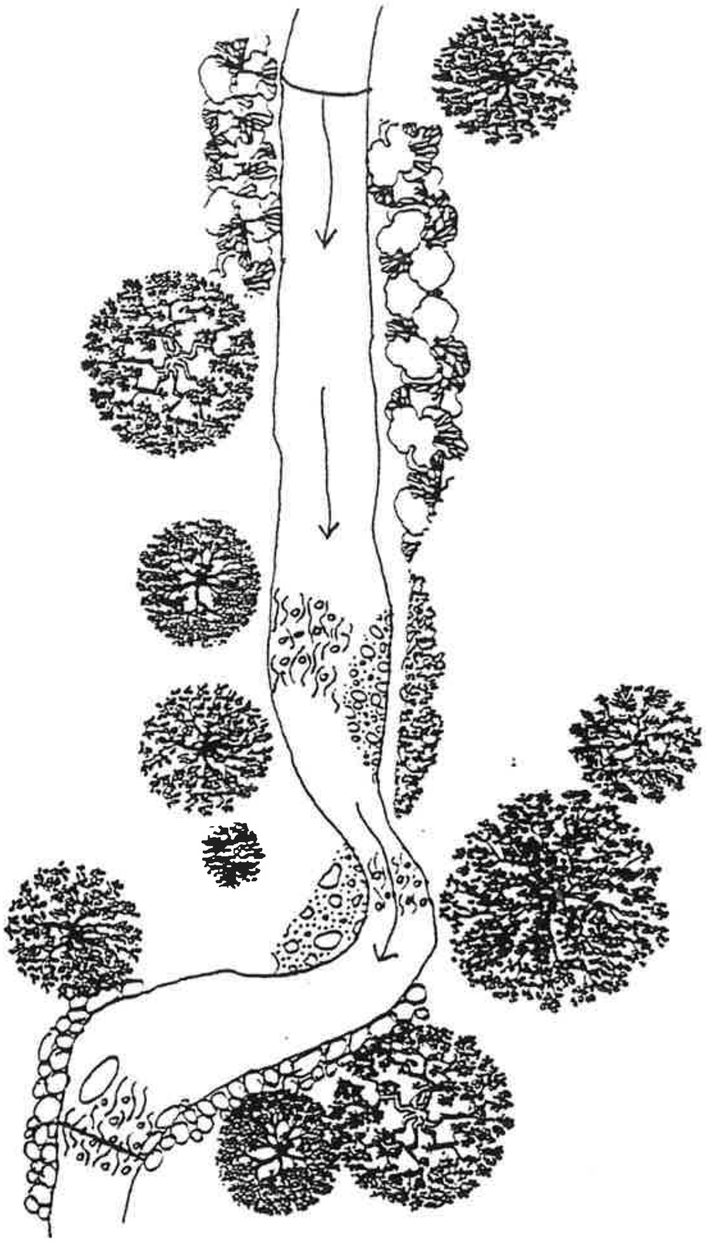
Species Captured	Trophic	Tolerance	08/10/94	10/31/94	06/05/95
1. Black Nose Dace	GE	TOLER	4	12	18
# of Species			1	1	1
# of Individuals			4	12	18
Estimate of total population			4		
± 2 SE			2.87		

Water Quality Conditions:

08/10/94	Temp: 19.0	Turbidity: 1.8 NTU			
	Air Temp: 70's	Wind: None	Cloud Cover: Hazy		
10/31/94	Temp: 15.0	pH: 7.2	Cond. .188	Turbidity: 1.0 NTU	
	Air Temp: 60's	Wind: light	Cloud Cover: overcast		
06/05/95	Temp: 19.39	pH: 6.82	Conductivity: .194		DO: 4.16 (45%)
	Air Temp: 80's	Wind: none	Cloud Cover: hazy		

IBI SCORES:		14		14		14
	8/10/94		10/31/94		6/5/95	
	#	SCORES	#	SCORES	#	SCORES
1	1	1	1	1	1	1
2	0	1	0	1	0	1
3	1	1	1	1	1	1
4	0	1	0	1	0	1
5	100	1	100	1	100	1
6	100	1	100	1	100	1
7	0	1	0	1	0	1
8	100	1	100	1	100	1
9	0	1	0	1	0	1
10	0	5	0	5	0	5

Site SLC2: Sligo Creek x Wheaton Branch (upstream)



Habitat Assessment

Habitat Parameter	Rank	Score	Description
Bottom Substrate	Marginal	10	10-30% Mix of Rubble, Gravel, or other stable habitat.
Embedded-ness	Marginal	8	Gravel, cobble and boulder particles between 50-75% surrounded by fine sediment
Velocity/ Depth	Marginal	8	Only 2 of the 4 habitat types present (missing riffles/runs get lower score)
Canopy Cover	Optimal	16	Some areas of water surface fully exposed to sunlight, and other receiving various degrees of filtered light.
Channel Alteration	Sub-Optimal	8	Some new increase in bar formation, mostly from coarse gravel; and/or some channelization present
Scouring/ Deposition	Sub-Optimal	9	5-30% affected. Scour at constrictions and where grades steepen. Some deposition in pools.
Pool/Riffle Ratio	Sub-Optimal	9	7-15. Infrequent repeat pattern. Variety of microhabitats less than optimal.
Lower Bank Stability	Sub-Optimal	11	Overbank (lower) flows occasional. W/D ration 8-15.
Upper Bank	Sub-Optimal	8	Moderately stable. Infrequent, small areas of erosion mostly healed over. Side slopes up to 40% on one bank. Slight potential in extreme floods.
Bank Vegetative Protection	Sub-Optimal	8	70-89% of the streambank surfaces covered by protection vegetation.
Streamside Cover	Sub-Optimal	8	Dominant vegetation is of tree form.
Riparian Vegetative Zone	Marginal	5	Between 6-12 meters.
TOTAL		108	

Sligo Creek Phase III Fisheries Survey

Site SLC2: Sligo Creek x Wheaton Branch, Upstream

Species Captured	Trophic	Tolerance	08/03/94	11/01/94	06/02/95
1. Swallowtail Shiner	OM	TOLER		1	
2. Black Nose Dace	GE	TOLER	43	59	72
3. Northern Creek Chub	GE	TOLER	41	32	26
4. Green Sunfish	INV	TOLER	5	3	
5. Tesselated Darter	IN	TOLER			
6. Rosyside Dace	IN	INTER			2
7. White Sucker	OM	TOLER		2	
# of Species			3	5	3
# of Individuals			89	97	100
Estimate of total population			148		
± 2 SE			33.9		

Length of Fish in millimeters: Sligo Creek x Wheaton Branch, Upstream. (08/03/94)

Northern Creek Chub: 107,90,70,70,120,141,140,129,140,90,104,100,90,32,35,35,160,144,100,85,95,131,114,116, 108,93,99,88,72,96,80,75,100,125,83,90,100,75,80,30,84. (one severely eroded tail)

Green Sunfish: 70,62,85,88,65.

Water Quality Conditions:

08/03/94	Temp: 20.0	Turb: 4.5 NTU	
	Air Temp. 80's	Wind: None	Cloud Cover: Hazy

Length of Fish in millimeters: Sligo Creek x Wheaton Branch, Upstream. (11/01/94)

Northern Creek Chub: 105,155,114,82,75,60,52,45,195,135,80,130,130,110,78,55,125,35,110,80,55,55,100,120,95, 145,120,60,65,48,120,80.

Green Sunfish: 96,76,66.

White Sucker 175,160.

Water Quality Conditions:

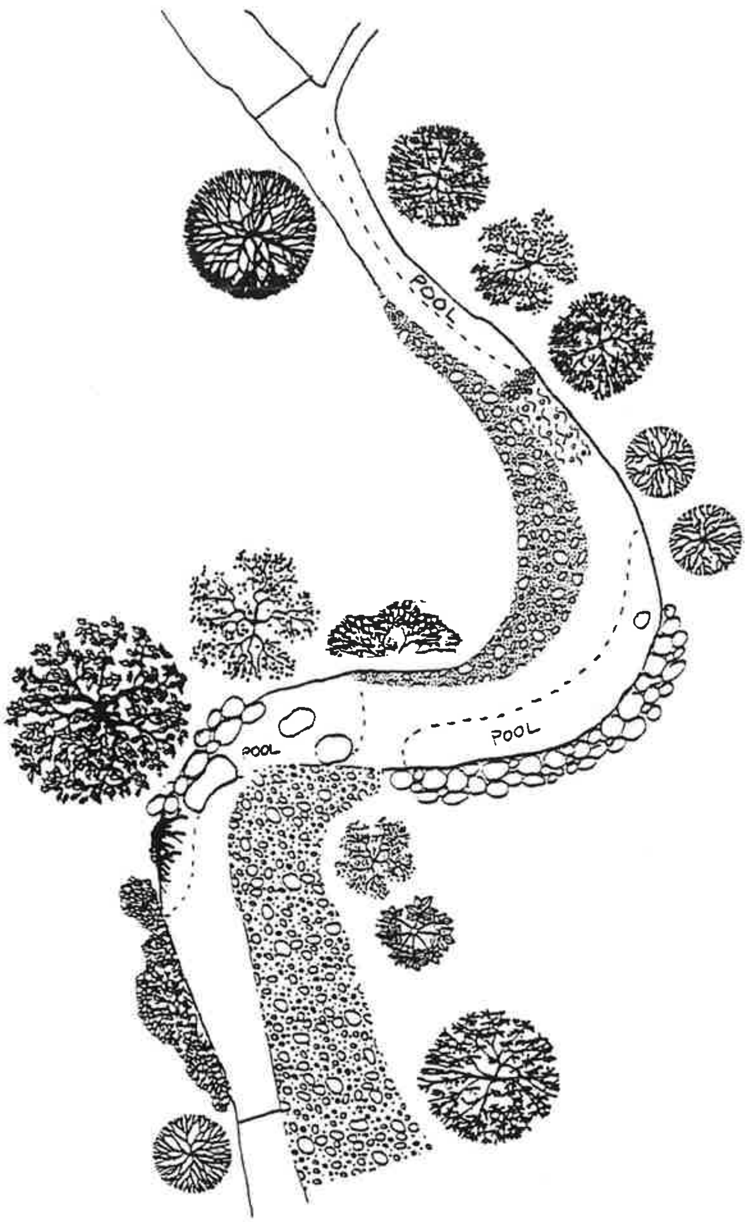
11/01/94	Temp: 14.96	pH: 7.04	Cond: .208	Turb: 0.65 NTU

Water Quality Conditions:

06/02/95	Temp: 19.40	pH: 7.10	Cond: .211	DO: 5.7 (61%)	Turb: 2.15 NTU

IBI SCORES:		14		18		16
	8/3/94		11/1/94		6/2/95	
	#	SCORES	#	SCORES	#	SCORES
1	3	1	5	3	3	1
2	0	1	0	1	2	1
3	2	1	3	3	3	3
4	0	1	0	1	0	1
5	100	1	100	1	98	1
6	94	1	99	1	98	1
7	0	1	0	1	2	1
8	100	1	99	1	98	1
9	0	1	0	1	2	1
10	1	5	0	5	0	5

Site WB1: Upper Wheaton Branch.



Habitat Assessment

Habitat Parameter	Rank	Score	Description
Bottom Substrate	Sub-Optimal	12	30-50% Mix of rubble, gravel, or other stable habitat.
Embedded-ness	Sub-Optimal	11	Gravel, cobble and boulder particles between 25-50% surrounded by fine sediment
Velocity/ Depth	Sub-Optimal	14	Only 3 of the 4 habitat types present (missing riffles/runs get lower score)
Canopy Cover	Optimal	17	Some areas of water surface fully exposed to sunlight, and other receiving various degrees of filtered light.
Channel Alteration	Optimal	13	Little or no enlargement of islands or point bars, and/or no channelization
Scouring/ Deposition	Sub-Optimal	10	5-30% affected. Scour at constrictions and where grades steepen. Some deposition in pools.
Pool/Riffle Ratio	Sub-Optimal	11	7-15. Infrequent repeat pattern. Variety of microhabitats less than optimal.
Lower Bank Stability	Sub-Optimal	8	Overbank (lower) flows occasional. W/D ration 8-15.
Upper Bank	Sub-Optimal	7	Moderately stable. Infrequent, small areas of erosion mostly healed over. Side slopes up to 40% on one bank. Slight potential in extreme floods.
Bank Vegetative Protection	Marginal	5	50-79% of the streambank surfaces covered by protection vegetation.
Streamside Cover	Sub-Optimal	8	Dominant vegetation is of tree form.
Riparian Vegetative Zone	Optimal	9	>18 meters.
TOTAL		125	

TABLE 5: Sligo Creek Phase III Fisheries Survey

Site WB1: Upper Wheaton Branch

Species Captured	Trophic	Tolerance	08/03/94	10/27/94	06/01/95
1. Goldfish	OM	TOLER	24	20	10
2. Stoneroller	HE	INTER	1		
3. Blacknose Dace	GE	TOLER	7	12	12
4. Northern Creek Chub	GE	TOLER	9	11	14
5. White Sucker	OM	TOLER	11	25	7
6. Brown Bullhead	IN	TOLER	1	1	
7. Green Sunfish	INV	TOLER	18	27	19
8. Golden Shiner	OM	TOLER		8	9
9. Gambusia	IN	INTER		6	
# of species			7	8	6
# of individuals			71	110	71
Estimate of total population			104		
± 2 SE			66.25		

Length of fish in millimeters. **Wheaton Branch Upstream** (08/03/94)

White Sucker	145,155,124,131,145,152,134,160,200,156,130.
Green Sunfish	90,68,75,85,94,89,82,90,65,65,64,63,80,75,85,75,60,54. (two with bulging eyes)
Brown Bullhead	75.

Water Quality Conditions:
08/03/94 Temp: 21 Turb: 3.4 NTU
Air temp: 80's Wind: None Cloud Cover: Hazy

Length of fish in millimeters. **Wheaton Branch Upstream** (10/27/94)

White Sucker	230,155,195,175,173,165,170,135,165,160,160,160,170,175,140,150,150,155,158,170,150, 168,170,143.
Green Sunfish	90,75,65,65,60,75,90,75,72,65,65,60,105,95,95,60,45,85,80,100,70,95,75,78,88,72,33.
Northern Creek Chub	140,135,105,135,140,110,145,125,60,105,115.
Brown Bullhead	88.

Water Quality Conditions:
10/27/94 Temp: 7.5
Air temp: 60's Wind: light Cloud Cover: Overcast

Length of fish in millimeters. **Wheaton Branch Upstream** (06/01/95)

White Sucker	166,175,140,142,152,188,158.
Green Sunfish	100,118,68,98,114,98,94,103,80,78,113,92,70,109,102,77,85,93,93. (1 w/ tail cut in half)

note: 1 goldfish w/ head tumor, 1 goldfish w/ numerous bites in caudal fin, one blacknose dace with tumor

Water Quality Conditions:
06/01/95 Temp: 21.09 pH: 6.97 DO: 4.16 Cond: .214 Turb: 1.95 NTU
Air temp: low 80's Wind: None Cloud Cover: Hazy

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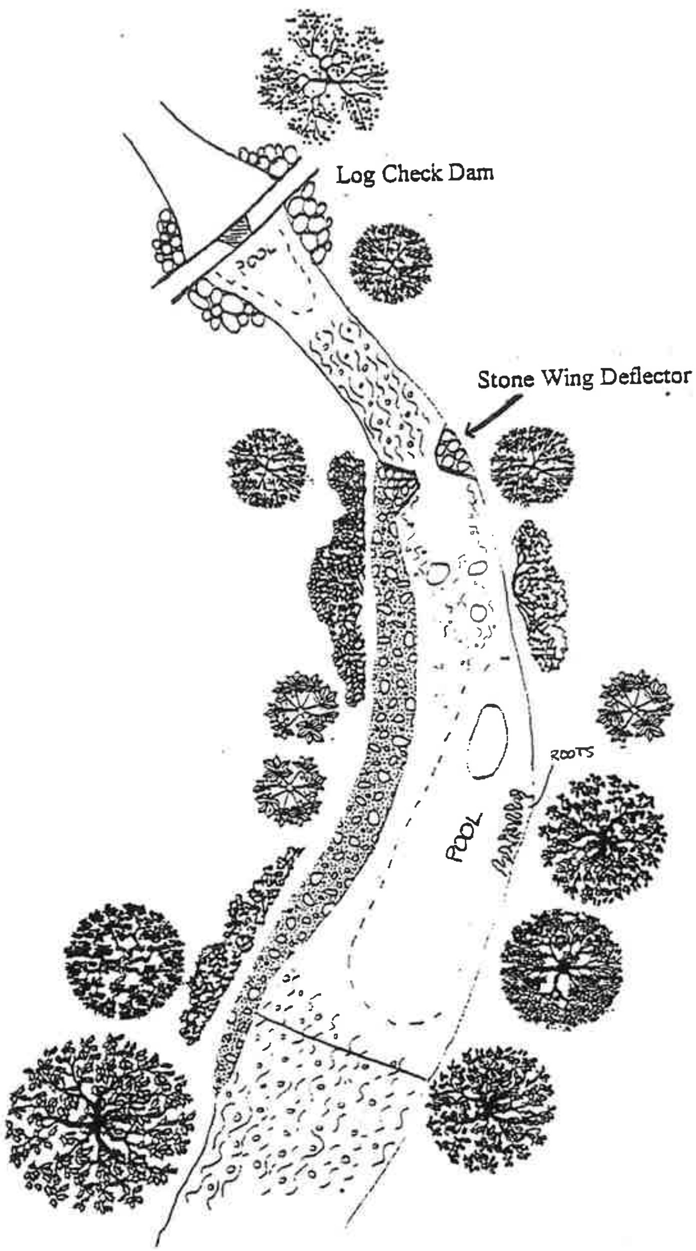
SITE WB1: UPPER WHEATON BRANCH

IBI SCORES:		22		28		18
	8/3/94		10/27/94		6/1/95	
	#	SCORES	#	SCORES	#	SCORES
1	7	3	8	5	6	3
2	0	1	0	1	0	1
3	4	3	6	5	4	3
4	0	1	0	1	0	1
5	100	1	95	1	100	1
6	72	3	69	3	73	3
7	1	1	6	1	0	1
8	48	5	45	5	63	3
9	15	1	6	1	0	1
10	2.8	3	0	5	5.6	1



Site WB2: Lower Wheaton Branch.

Habitat Assessment

Habitat Parameter	Rank	Score	Description
Bottom Substrate	Sub-Optimal	11	30-50% Mix of rubble, gravel, or other stable habitat.
Embedded-ness	Sub-Optimal	12	Gravel, cobble and boulder particles between 25-50% surrounded by fine sediment
Velocity/ Depth	Sub-Optimal	14	Only 3 of the 4 habitat types present (missing riffles/runs get lower score)
Canopy Cover	Optimal	18	Some areas of water surface fully exposed to sunlight, and other receiving various degrees of filtered light.
Channel Alteration	Sub-Optimal	10	Some new increase in bar formation mostly from coarse gravel; and/or some channelization present.
Scouring/ Deposition	Sub-Optimal	10	5-30% affected. Scour at constrictions and where grades steepen. Some deposition in pools.
Pool/Riffle Ratio	Optimal	13	Ratio 5-7. Variety of habitats. Repeat pattern of sequence relatively frequently.
Lower Bank Stability	Sub-Optimal	9	Overbank (lower) flows occasional. W/D ration 8-15.
Upper Bank	Sub-Optimal	8	Moderately stable. Infrequent, small areas of erosion mostly healed over. Side slopes up to 40% on one bank. Slight potential in extreme floods.
Bank Vegetative Protection	Marginal	7	50-79% of the streambank surfaces covered by protection vegetation.
Streamside Cover	Sub-Optimal	8	Dominant vegetation is of tree form.
Riparian Vegetative Zone	Optimal	9	>18 meters.
TOTAL		129	

Sligo Creek Phase III Fisheries Survey

Site WB2: Lower Wheaton Branch

Species Captured	Trophic	Tolerance	08/03/94	10/27/94	06/01/95
1. Goldfish	OM	TOLER	29	11	12
2. Golden Shiner	OM	TOLER	9	23	11
3. Common Shiner	IN	INTER	1		
4. Spottailed Shiner	IN	INTER		1	
5. Blacknose Dace	GE	TOLER	26	96	67
6. Northern Creek Chub	GE	TOLER	8	10	16
7. White Sucker	OM	TOLER	9	18	14
8. Green Sunfish	INV	TOLER	49	14	15
9. Gambusia	IN	INTER	1		
10. Tesselated Darter	IN	TOLER	1		
# of species			9	7	6
# of individuals			133	173	135
Estimate of total population			177		
± 2 SE			*		

* Standard error too large

Length of fish in millimeters. **Wheaton Branch Downstream** (08/03/94)

Northern Creek Chub	78,72,147,116,75,99,38,66.
White Sucker	195,235,90,240,257,240,138,145,130.
Green Sunfish	80,55,53,43,58,63,63,50,60,68,88,100,60,58,70,70,73,70,63,68,60,90,60,65,93,80,60,63,85, 90,56,52,55,91,82,50,66,70,58,50,53,70,80,58,59,51,56,51,58. (six with bulging eyes)

Water Quality Conditions:
08/03/94 Temp: 21 Turb: 3.4 NTU
08/03/94 Air temp: 80's Wind: None Cloud Cover: Hazy

Length of fish in millimeters. **Wheaton Branch Downstream** (10/27/94)

Northern Creek Chub	80,110,80,115,63,58,55,104,88,148.
White Sucker	240,185,145,130,140,153,120,155,112,120,133,125,195,155,140,148,100,128. (1 eroded fin)
Green Sunfish	95,88,58,75,80,50,68,55,55,62,75,55,68,45.

Water Quality Conditions:
10/27/94 Temp: 7.5
Air temp: 60's Wind: light Cloud Cover: Overcast

Length of fish in millimeters. **Wheaton Branch Downstream** (06/01/95)

White Sucker	240,158,150,133,175,138 (caudal pedunch erosion), 125,140,170 (right fin clip, caudal tail cut) 165,163,131,162,128.
Green Sunfish	103,91,68,92,68,63,68,92,80,60,122 (hooking injury - jaw), 71,85,68,91,71,69,72,73.

Water Quality Conditions:
08/03/94 Temp: 18.3 pH: 7.14 DO: 6.27 Cond: .223 Turb: 2.55 NTU
Air temp: 70's Wind: None Cloud Cover: partly cloudy

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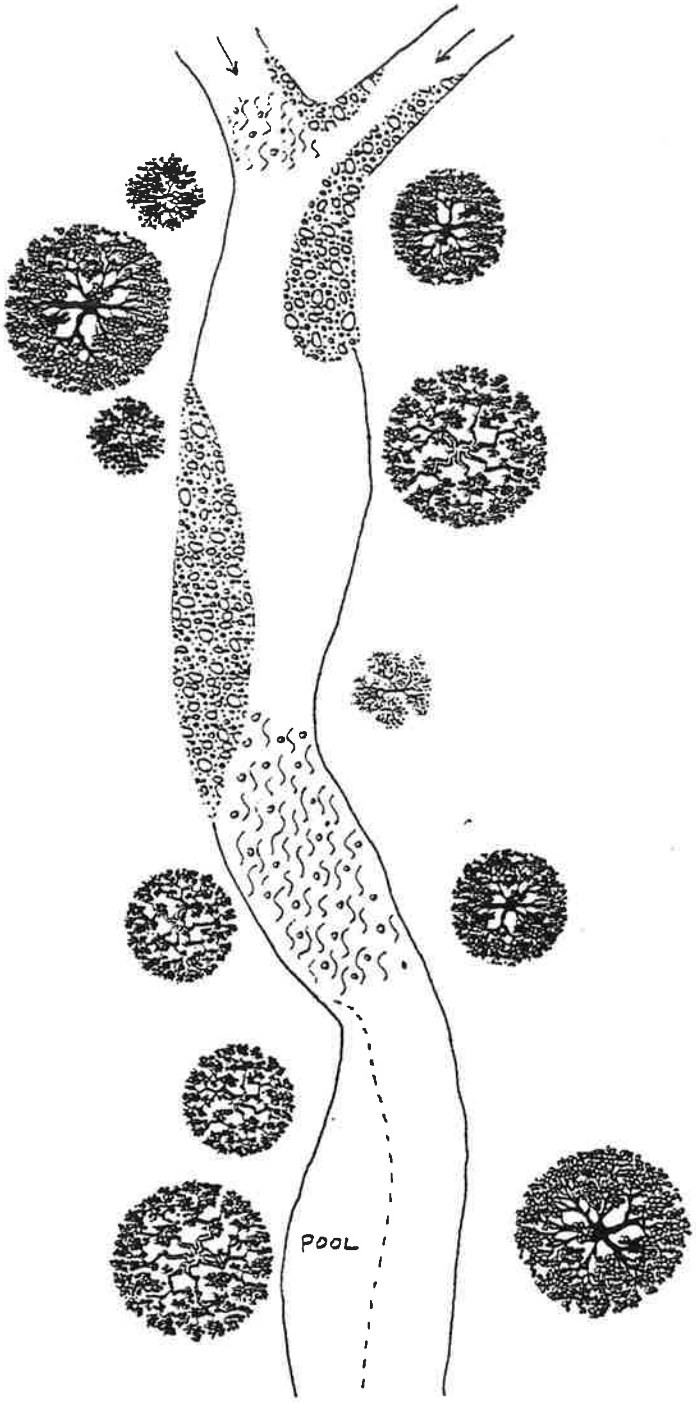
SITE WB2: LOWER WHEATON BRANCH

	8/3/94		10/27/94		6/1/95	
	#	SCORES	#	SCORES	#	SCORES
1	9	5	7	3	6	3
2	1	1	0	1	0	1
3	6	5	5	5	4	3
4	0	1	0	1	0	1
5	100	1	100	1	100	1
6	61	3	91	1	89	1
7	2.3	1	0	1	0	1
8	63	3	69	3	73	3
9	2	1	1	1	0	1
10	4.5	1	0	5	2.9	3
IBI SCORES:		22		22		18



Site SLC3: Sligo Creek x Wheaton Branch (downstream)

Habitat Assessment

Habitat Parameter	Rank	Score	Description
Bottom Substrate	Sub-Optimal	11	30-50% Mix of rubble, gravel, or other stable habitat.
Embedded-ness	Sub-Optimal	13	Gravel, cobble and boulder particles between 25-50% surrounded by fine sediment
Velocity/ Depth	Sub-Optimal	9	Only 3 of the 4 habitat types present (missing riffles/runs get lower score)
Canopy Cover	Optimal	16	Some areas of water surface fully exposed to sunlight, and other receiving various degrees of filtered light.
Channel Alteration	Sub-Optimal	11	Some new increase in bar formation mostly from coarse gravel; and/or some channelization present.
Scouring/ Deposition	Sub-Optimal	11	5-30% affected. Scour at constrictions and where grades steepen. Some deposition in pools.
Pool/Riffle Ratio	Marginal	6	Ratio 15-25. Occasional riffle or bend. Bottom contours provide some habitat.
Lower Bank Stability	Sub-Optimal	11	Overbank (lower) flows occasional. W/D ration 8-15.
Upper Bank	Sub-Optimal	8	Moderately stable. Infrequent, small areas of erosion mostly healed over. Side slopes up to 40% on one bank. Slight potential in extreme floods.
Bank Vegetative Protection	Sub-Optimal	8	70-89% of the streambank surfaces covered by protection vegetation.
Streamside Cover	Sub-Optimal	8	Dominant vegetation is of tree form.
Riparian Vegetative Zone	Marginal	4	Between 6 and 12 meters.
TOTAL		116	

Sligo Creek Phase III Fisheries Survey

Site SLC3: Sligo Creek below Wheaton Branch

Species Captured	Trophic	Tolerance	08/03/94	10/27/94	06/01/95
1. American Eel	PS	INTER	4		2
2. Goldfish	OM	TOLER	3	1	3
3. Swallowtail Shiner	OM	TOLER	3		
4. Goldden Shiner	OM	TOLER	8		
5. Spottailed Shiner	IN	INTER			
6. Black Nose Dace	GE	TOLER	24	65	62
7. Longnose Dace	IN	INTOL			
8. Northern Creek Chub	GE	TOLER	15	12	10
9. White Sucker	OM	TOLER	39	3	11
10. Spotfin Shiner	IN	INTER			
11. Brown Bullhead	IN	TOLER			
12. Green Sunfish	INV	TOLER	6	1	4
13. Tesselated Darter	IN	TOLER			5
14. Rosyside Dace	IN	INTER			5
15. Mottled Sculpin	IN/PS	INTOL			1
# of Species			8	5	9
# of Individuals			102	82	103
Total population estimate			136		
± 2 SE			24.4		

* Standard error too large

Length of fish in millimeters. Sligo creek at Wheaton Branch, Downstream (08/03/94)

White Sucker	258,155,248,225,185,177,233,158,140,190,165,138,163,145,150,160,150,130,142,160,148,135, 140,148,160,160,148,165,153,153,145,160,146,155,140,150,143,120,135.
Green Sunfish	72,68,88,70,82,67.
Northern Creek Chub	125,90,140,145,78,127,105,98,68,65,73,73,80,95,80. (one deformed head)
American Eel	495,395,440,540.

Water Quality Conditions:

08/03/94	Temp: 19.0	Turb: 4.7 NTU	
	Air Temp: 80's	Wind: None	Cloud Cover: Hazy

Length of fish in millimeters. Sligo creek at Wheaton Branch, Downstream (10/27/94)

White Sucker	195,180,125.
Green Sunfish	106.
Northern Creek Chub	58,90,90,60,55,140,105,98,110,115,110,92.

Water Quality Conditions:

10/27/94	Temp: 8.5	Turb: 4.7 NTU
	Wind: light	Cloud Cover: Overcast

Length of fish in millimeters. Sligo creek at Wheaton Branch, Downstream (06/01/95)

White Sucker	163,195,183,183,178,170,240,168,188,160,195 (left fin clip).
Green Sunfish	90,82,89,80.
Mottled Sculpin	81.

Water Quality Conditions:

08/03/94	Temp: 17.7	pH: 7.1	Cond: .214	DO: 5.48	Turb: 1.55 NTU

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SLC3: SLIGO CREEK BELOW WHEATON BRANCH

IBI SCORES:	26		18		22	
	8/3/94		10/27/94		6/1/95	
	#	SCORES	#	SCORES	#	SCORES
1	8	5	5	3	9	5
2	0	1	0	1	6	1
3	5	5	3	3	4	3
4	0	1	0	1	1	3
5	96	1	100	1	92	1
6	90	1	100	1	83	1
7	0	1	0	1	11	1
8	44	5	95	1	79	1
9	4	1	0	1	8	1
10	1	5	0	5	1	5

Site FL1: Upper Flora Lane.

Habitat Assessment

Habitat Parameter	Rank	Score	Description
Bottom Substrate	Sub-Optimal	14	30-50% mix of rubble, gravel, or other stable habitat. Adequate habitat.
Embedded-ness	Marginal	6	Gravel, cobble and boulder particles between 50-75% surrounded by fine sediment
Velocity/ Depth	Sub-Optimal	15	Only 3 of the 4 habitat types present (missing riffles/runs get lower score)
Canopy Cover	Marginal	10	Completely covered by dense canopy; water surface completely shaded OR nearly full sunlight reaching water surface. Shading limited to <3 hours per day.
Channel Alteration	Marginal	7	Moderate deposition of new gravel, coarse sand on old and new bars; and/or embankments on both banks.
Scouring/ Deposition	Marginal	7	30-50% affected. Deposits and/or scour at obstructions, constrictions, and bends. Filling in pools prevalent.
Pool/Riffle Ratio	Marginal	7	15-25. Occasional riffle or bend. Bottom contours provide some habitat.
Lower Bank Stability	Optimal	12	Overbank flows rare. W/D ratio <7.
Upper Bank	Sub-Optimal	8	Moderately stable. Infrequent, small areas of erosion mostly healed over. Side slopes up to 40% on one bank. Slight potential in extreme floods.
Bank Vegetative Protection	Marginal	5	50-79% of the streambank surfaces covered by protection vegetation.
Streamside Cover	Sub-Optimal	7	Dominant vegetation is of tree form.
Riparian Vegetative Zone	Poor	2	<6 meters.
TOTAL		100	

Sligo Creek Phase III Fisheries Survey

Site FL1: Upper Flora Lane

Species Captured	Trophic	Tolerance	08/10/94	10/31/94	06/01/95
1. Black Nose Dace	GE	TOLER	17	46	66
2. Green Sunfish	INV	TOLER	1	6	6
3. Northern Creek Chub	GE	TOLER	2	13	5
4. Fantail Darter	IN	INTER		1	
# of Species			3	4	3
# of Individuals			20	66	77
Total population estimate			24		
± 2 SE			9.1		

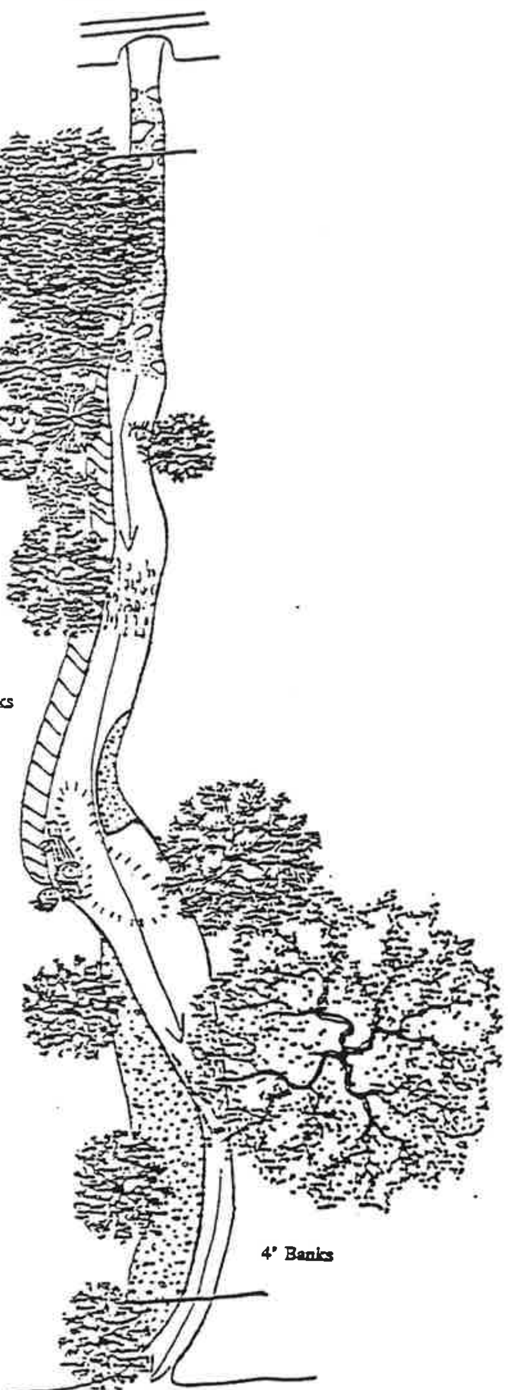
Water Quality Conditions:
08/10/94 : Temp: 18.0 pH: 7.39 DO: 7.05 Cond: Turb: 10 NTU
Air Temp: 70's Wind: None Cloud Cover: Hazy

Water Quality Conditions: Above Weir:
10/31/94 Temp: 17.30 pH: 8.03 DO: 6.83 (70%) Cond: .428 Turb: 1.2 NTU

Water Quality Conditions: Below Weir:
10/31/94 Temp: 17.08 pH: 8.08 DO: 8.89 (92%) Cond: .430 Turb: 0.6 NTU
Air Temp: 60's Wind: Light Cloud Cover: Overcast

Water Quality Conditions:
06/01/95 : Turb: 1.65 NTU
Air Temp: 80's Wind: None Cloud Cover: Hazy

IBI SCORES:		14		16		14
	8/10/94		10/31/94		6/1/95	
	#	SCORES	#	SCORES	#	SCORES
1	3	1	4	3	3	1
2	0	1	1	1	0	1
3	2	1	2	1	2	1
4	0	1	0	1	0	1
5	100	1	100	1	100	1
6	95	1	89	1	92	1
7	0	1	0	1	0	1
8	100	1	100	1	100	1
9	0	1	1	1	0	1
10	0	5	0	5	0	5



Site FL2: Lower Flora Lane.

Habitat Assessment

Habitat Parameter	Rank	Score	Description
Bottom Substrate	Marginal	6	10-30% mix of rubble, gravel, or other stable habitat. Habitat availability less than desirable.
Embedded-ness	Poor	4	Gravel, cobble and boulder particles over 75% surrounded by fine sediment
Velocity/ Depth	Marginal	6	Only 2 of the 4 habitat types present (missing riffles/runs get lower score)
Canopy Cover	Optimal	16	A mixture of conditions where some areas of water surface fully exposed to sunlight and other areas receiving various degrees of filtered light.
Channel Alteration	Marginal	4	Moderate deposition of new gravel, coarse sand on old and new bars; and/or embankments on both banks.
Scouring/ Deposition	Marginal	4	30-50% affected. Deposits and/or scour at obstructions, constrictions, and bends. Filling in pools prevalent.
Pool/Riffle Ratio	Poor	3	>25. Essentially a straight stream. Generally all flat water or shallow riffle. Poor habitat.
Lower Bank Stability	Sub-Optimal	8	Overbank flows occasional. W/D ratio 8-15.
Upper Bank	Poor	2	Unstable. Many eroded areas. "Raw" areas frequent. Side slopes > 60% common.
Bank Vegetative Protection	Poor	2	Less than 50 of the streambank surfaces covered by protection vegetation.
Streamside Cover	Sub-Optimal	8	Dominant vegetation is of tree form.
Riparian Vegetative Zone	Marginal	4	Between 6 - 12 meters.
TOTAL		67	

Sligo Creek Phase III Fisheries Survey

Site FL2: Lower Flora Lane

Species Captured	Trophic	Tolerance	08/10/94	10/31/94	06/01/95
1. Black Nose Dace	GE	TOLER	109	114	78
2. Northern Creek Chub	GE	TOLER	10	32	6
3. Green Sunfish	INV	TOLER	6	5	
4. Stoneroller	HE	INTER	1		
5. White Sucker	OM	TOLER	1	1	
6. Fantail Darter	IN	INTER	1		
7. Rosy Sided Dace	IN	INTER		1	1
8. Goldfish	OM	TOLER			1
# of Species			6	5	4
# of Individuals			128	153	86
Total population estimate			132		
±2 SE			18.98		

* Standard error too large

Length of Fish in Millimeters. **Flora Lane Downstream** (08/10/94)

Northern Creek Chub 103,85,172,127,142,132,120,73,160,129.
Green Sunfish 95,95,59,49,65,81.
White Sucker 143.

Water Quality Conditions:
08/10/94: Temp: 18 Turb: 10 NTU
Air Temp: 70's Wind: none Cloud Cover: Overcast

Length of Fish in Millimeters. **Flora Lane Downstream** (10/31/94)

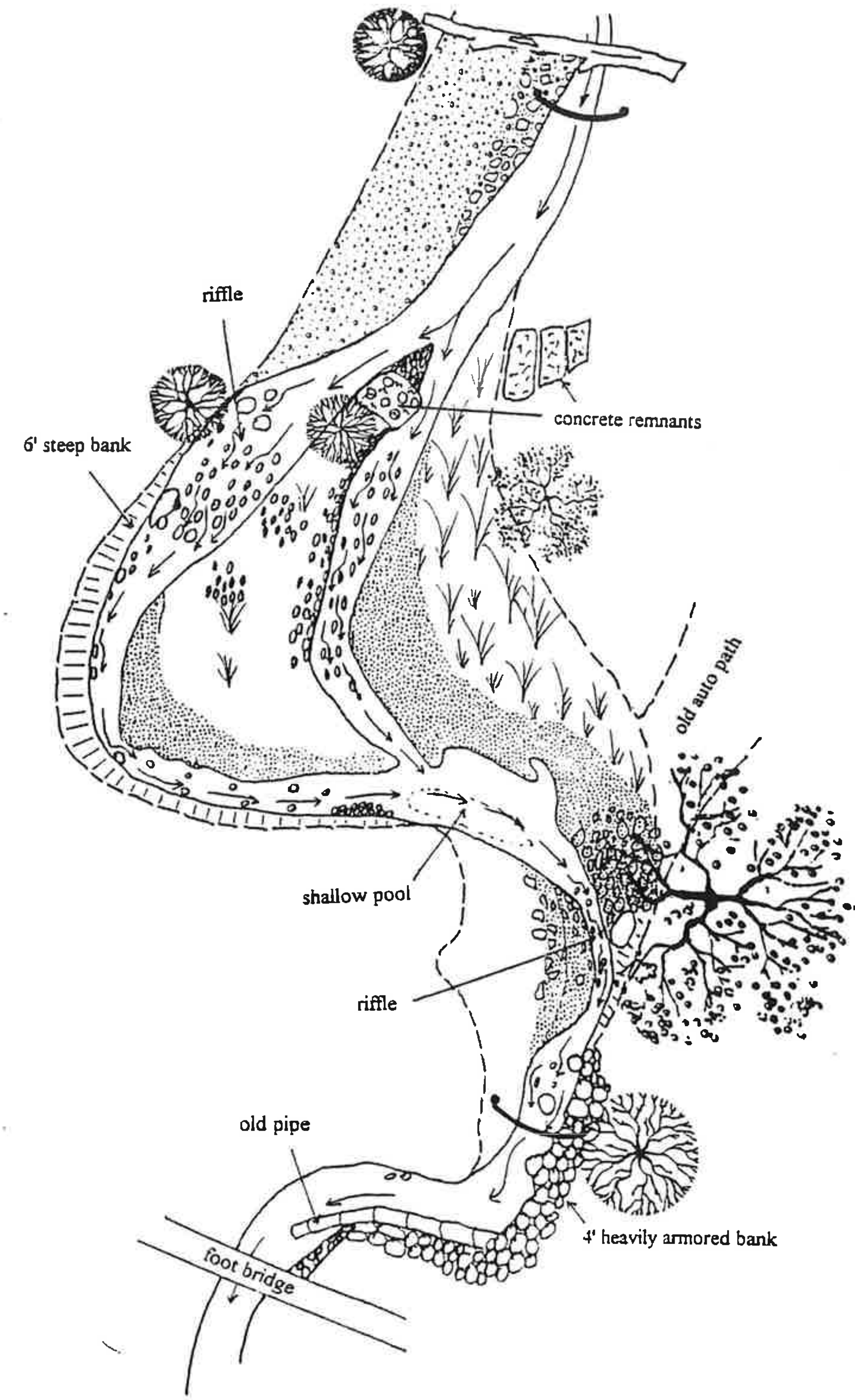
Northern Creek Chub 55,75,68,115,135,55,150,118,110,115,105,150,122,100,145,108,180,136,128,125,115,95,97,57,110,100,113,146,150,180,110,118.
Green Sunfish 92,75,70,68,80. (one with caudal fin eroded)
White Sucker 165.

Water Quality Conditions: @ site
10/31/94 Temp: 16.64 pH: 7.77 DO: 5.5 (57%) Cond: .420 Turb: 0.70
Air temp: 60's Wind: light Cloud Cover: overcast

Water Quality Conditions: Upstream of confluence w/ Sligo Creek
10/31/94 Temp: 14.0 pH: 7.34 Cond: .247 Turb: 0.80
Air temp: 60's Wind: light Cloud Cover: overcast

Water Quality Conditions:
06/01/95 Temp: 18.80 pH: 7.90 DO: 7.2 Cond: .404 Turb: 0.90
Air temp: 80's Wind: light Cloud Cover: partly cloudy

IBI SCORES:	18		18		18	
	8/10/94		10/31/94		6/1/95	
	#	SCORES	#	SCORES	#	SCORES
1	6	3	5	3	4	3
2	1	1	0	1	0	1
3	3	3	3	3	4	3
4	0	1	0	1	0	1
5	99	1	100	1	100	1
6	94	1	96	1	100	1
7	0	1	0	1	0	1
8	99	1	100	1	100	1
9	2	1	1	1	1	1
10	0	5	0	5	0	5


riffle
6' steep bank
concrete remnants
old auto path
shallow pool
riffle
old pipe
4' heavily armored bank
foot bridge

Sligo Creek Phase III Fisheries Survey

Site WP1: Woodside Park above confluence with Sligo Creek

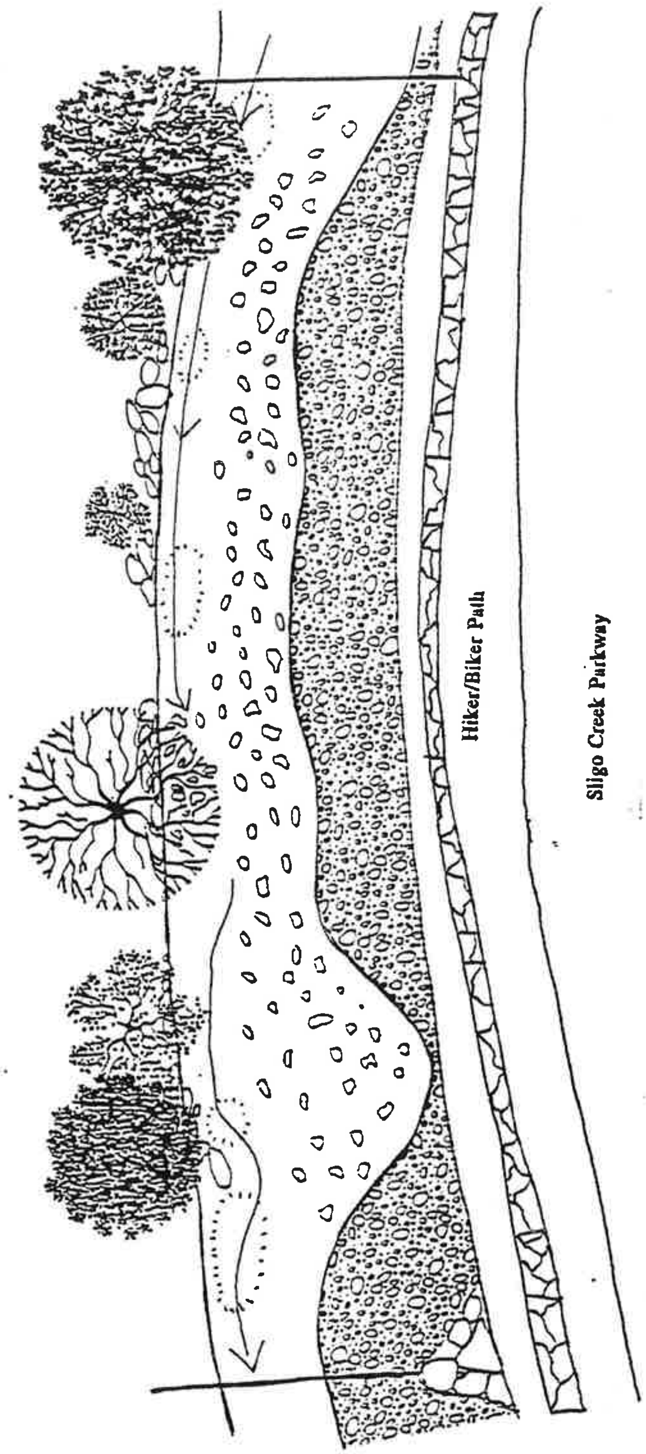
Species Captured	Trophic	Tolerance	08/24/94	10/28/94	06/02/95
1. Blacknose Dace	GE	TOLER	72	20	35
2. Green Sunfish	INV	TOLER		1	
# of species			1	21	1
# of individuals			72	2	35
Estimate of total population			95		
± 2 SE			31.7		

* Standard error too large

Water Quality Conditions:

08/24/94	Temp: 18.0	pH: 7.44	DO: 5.8 (62%)	Cond: .438	Turb: 0.9 ntu
	Air temp: 70's	Wind: none	Cloud Cover: clear		
10/28/94	Temp: 14.7	pH: 7.66	DO: 7.66 (62%)	Cond: .425	TDS: 190 ntu
	Air temp: 70's	Wind: none	Cloud Cover: clear		
06/02/95	Temp: 17.5	pH: 7.19	DO: 5.21 (54%)	Cond: .398	Turb: 0.7 ntu
	Air temp: 70's	Wind: none	Cloud Cover: hazy		

IBI SCORES:	14			14			14		
	8/24/94			10/28/94			6/2/95		
	#	SCORES		#	SCORES		#	SCORES	
1	1	1		2	1		1	1	
2	0	1		0	1		0	1	
3	1	1		1	1		1	1	
4	0	1		0	1		0	1	
5	100	1		100	1		100	1	
6	100	1		100	1		100	1	7
0	1		0	1		0	1		
8	100	1		100	1		100	1	
9	0	1		0	1		0	1	
10	0	5		0	5		0	5	



Site SLC4: Sligo Creek above Colesville Road

Habitat Assessment

Habitat Parameter	Rank	Score	Description
Bottom Substrate	Sub-Optimal	15	30-50% Mix of rubble, gravel, or other stable habitat.
Embedded-ness	Sub-Optimal	13	Gravel, cobble and boulder particles between 25-50% surrounded by fine sediment
Velocity/ Depth	Sub-Optimal	14	Only 3 of the 4 habitat types present (missing riffles/runs get lower score)
Canopy Cover	Optimal	16	Some areas of water surface fully exposed to sunlight, and other receiving various degrees of filtered light.
Channel Alteration	Sub-Optimal	11	Some new increase in bar formation mostly from coarse gravel; and/or some channelization present.
Scouring/ Deposition	Sub-Optimal	11	5-30% affected. Scour at constrictions and where grades steepen. Some deposition in pools.
Pool/Riffle Ratio	Sub-Optimal	11	Ratio 7-15. Infrequent repeat pattern. Variety of macrohabitat less than optimal.
Lower Bank Stability	Sub-Optimal	11	Overbank (lower) flows occasional. W/D ration 8-15.
Upper Bank	Sub-Optimal	8	Moderately stable. Infrequent, small areas of erosion mostly healed over. Side slopes up to 40% on one bank. Slight potential in extreme floods.
Bank Vegetative Protection	Sub-Optimal	6	70-89% of the streambank surfaces covered by protection vegetation.
Streamside Cover	Sub-Optimal	8	Dominant vegetation is of tree form.
Riparian Vegetative Zone	Poor	2	<6 meters.
TOTAL		126	

Sligo Creek Phase III Fisheries Survey

Site WP1: Woodside Park above confluence with Sligo Creek

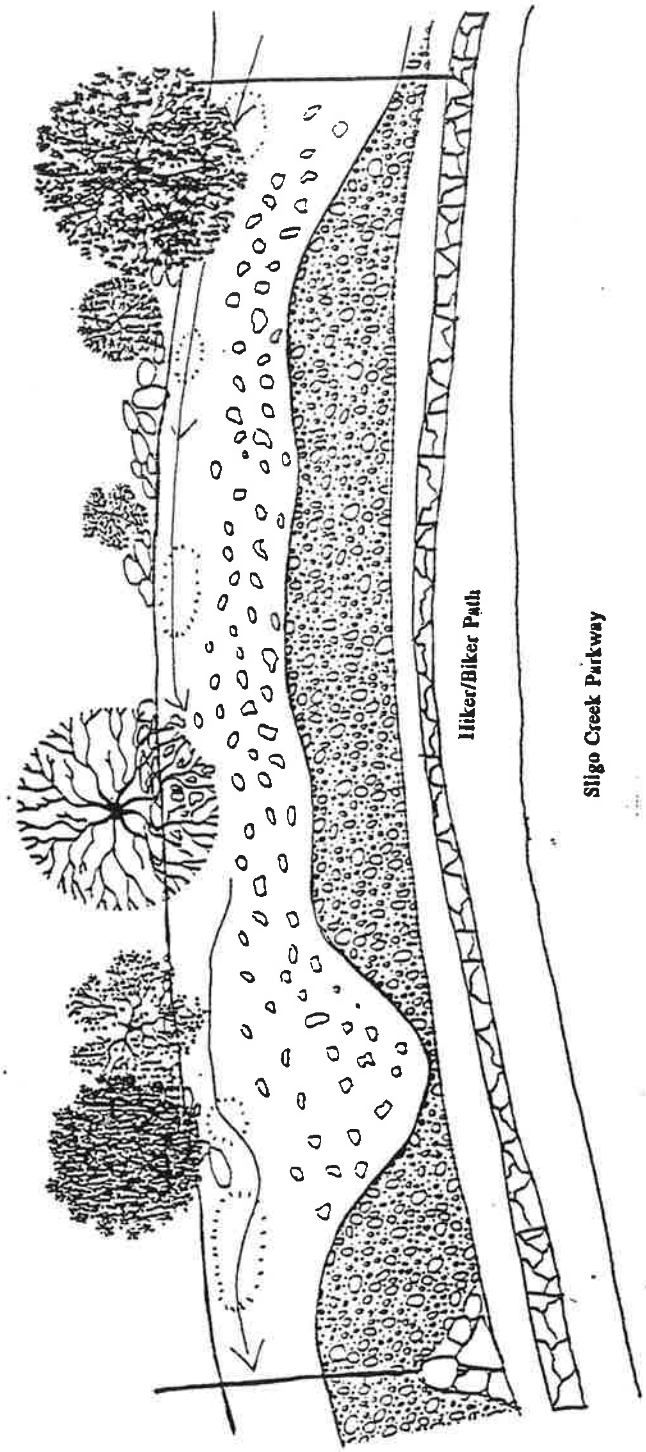
Species Captured	Trophic	Tolerance	08/24/94	10/28/94	06/02/95
1. Blacknose Dace	GE	TOLER	72	20	35
2. Green Sunfish	INV	TOLER		1	
# of species			1	21	1
# of individuals			72	2	35
Estimate of total population			95		
± 2 SE			31.7		

* Standard error too large

Water Quality Conditions:

08/24/94	Temp: 18.0	pH: 7.44	DO: 5.8 (62%)	Cond: .438	Turb: 0.9 ntu
	Air temp: 70's	Wind: none	Cloud Cover: clear		
10/28/94	Temp: 14.7	pH: 7.66	DO: 7.66 (62%)	Cond: .425	TDS: 190 ntu
	Air temp: 70's	Wind: none	Cloud Cover: clear		
06/02/95	Temp: 17.5	pH: 7.19	DO: 5.21 (54%)	Cond: .398	Turb: 0.7 ntu
	Air temp: 70's	Wind: none	Cloud Cover: hazy		

IBI SCORES:		14			14			14	
	8/24/94			10/28/94			6/2/95		
	#	SCORES		#	SCORES		#	SCORES	
1	1	1		2	1		1	1	
2	0	1		0	1		0	1	
3	1	1		1	1		1	1	
4	0	1		0	1		0	1	
5	100	1		100	1		100	1	
6	100	1		100	1		100	1	7
0	1		0	1		0	1		
8	100	1		100	1		100	1	
9	0	1		0	1		0	1	
10	0	5		0	5		0	5	



Site SLC4: Sligo Creek above Colesville Road

Habitat Assessment

Habitat Parameter	Rank	Score	Description
Bottom Substrate	Sub-Optimal	15	30-50% Mix of rubble, gravel, or other stable habitat.
Embedded-ness	Sub-Optimal	13	Gravel, cobble and boulder particles between 25-50% surrounded by fine sediment
Velocity/ Depth	Sub-Optimal	14	Only 3 of the 4 habitat types present (missing riffles/runs get lower score)
Canopy Cover	Optimal	16	Some areas of water surface fully exposed to sunlight, and other receiving various degrees of filtered light.
Channel Alteration	Sub-Optimal	11	Some new increase in bar formation mostly from coarse gravel; and/or some channelization present.
Scouring/ Deposition	Sub-Optimal	11	5-30% affected. Scour at constrictions and where grades steepen. Some deposition in pools.
Pool/Riffle Ratio	Sub-Optimal	11	Ratio 7-15. Infrequent repeat pattern. Variety of macrohabitat less than optimal.
Lower Bank Stability	Sub-Optimal	11	Overbank (lower) flows occasional. W/D ration 8-15.
Upper Bank	Sub-Optimal	8	Moderately stable. Infrequent, small areas of erosion mostly healed over. Side slopes up to 40% on one bank. Slight potential in extreme floods.
Bank Vegetative Protection	Sub-Optimal	6	70-89% of the streambank surfaces covered by protection vegetation.
Streamside Cover	Sub-Optimal	8	Dominant vegetation is of tree form.
Riparian Vegetative Zone	Poor	2	<6 meters.
TOTAL		126	

Sligo Creek Phase III Fisheries Survey

Site SLC4: Sligo Creek above Colesville Road

Species Captured	Trophic	Tolerance	08/10/94	10/28/94	06/02/95
1. Black Nose Dace	GE	TOLER	136	81	124
2. Northern Creek Chub	GE	TOLER	3		
3. Green Sunfish	INV	TOLER	20	5	11
4. Tesselated Darter	IN	TOLER			
5. Longnose Dace	IN	INTOL			1
6. Mottled Sculpin	IN/PS	INTOL			3
# of Species			3	2	4
# of Individuals			159	86	138
Estimate of total population			190		
± 2 SE			70.7		

Length of fish in millimeters. Sligo Creek above Colesville Road (08/10/94)

Green Sunfish 85,100,90,78,65,75,68,75,68,80,60,68,75,62,62,92,91,74,65,78. (one with eroded caudal fin)
Northern Creek Chub 85,68,35.

Water Quality Conditions:
08/10/94 Temp: 19.0 Turb: 2.3 NTU
Air Temp: High 70's Wind: None Cloud Cover: Overcast

Length of fish in millimeters. Sligo Creek above Colesville Road (10/28/94)

Green Sunfish 88,103,65,70,88. (one with ulcer on side)

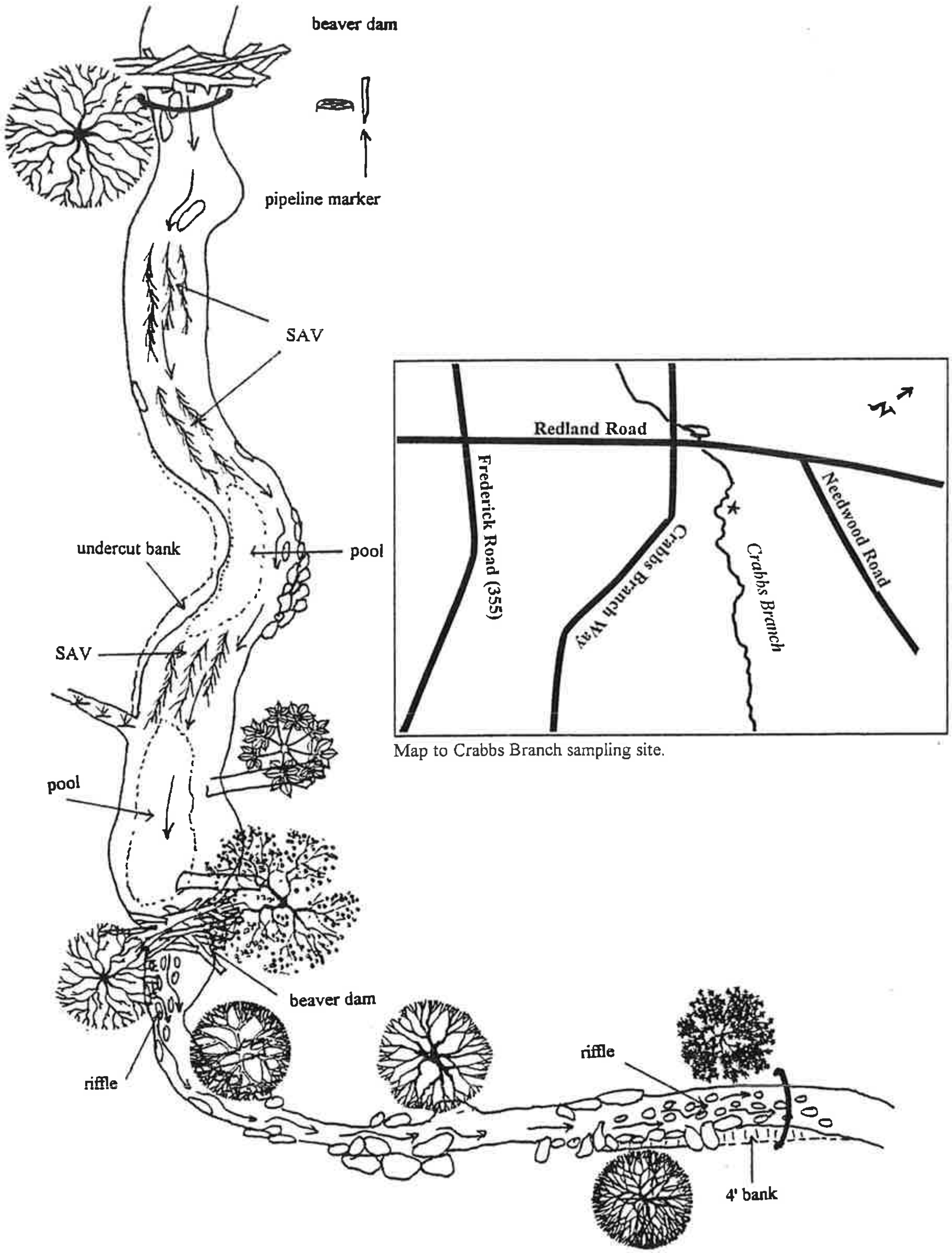
Water Quality Conditions:
10/28/94 Temp: 14.2 pH: 7.82 DO: 9.67 Cond: .360 TDS: 130
Air Temp: 70's Wind: Light Cloud Cover: Clear

Length of fish in millimeters. Sligo Creek above Colesville Road (06/02/95)

Green Sunfish 80,75,120,115,95,80,93,85,90,114 (one w/ eroded fin).
Mottled Sculpin 83,70,70.

Water Quality Conditions:
06/02/95 Temp: 18.7 pH: 7.46 DO: 7.67 (82.4%) Cond: .331 Turb: 1.78 NTU
Air Temp: 80's Wind: none Cloud Cover: hazy

IBI SCORES:	14		14		20	
	8/10/94		10/28/94		6/2/95	
	#	SCORES	#	SCORES	#	SCORES
1	3	1	2	1	4	3
2	0	1	0	1	3	1
3	2	1	1	1	2	1
4	0	1	0	1	2	5
5	100	1	94	1	97	1
6	87	1	94	1	90	1
7	0	1	0	1	3	1
8	100	1	100	1	98	1
9	0	1	0	1	4	1
10	0	5	1.2	5	0	5



Map to Crabbs Branch sampling site.

Sligo Creek Phase III Fisheries Survey

Site CB1: Crabbs Branch Upstream

Species Captured	Trophic	Tolerance	08/24/94	10/28/94	06/05/95
1. Golden Shiner	OM	TOLER	2		
2. Satinfin Shiner	IN	TOLER	1	1	
3. Common Shiner	IN	INTER	1		
4. Blacknose Dace	GE	TOLER	26	43	10
5. Longnose Dace	IN	INTOL	30	2	8
6. Northern Creek Chub	GE	TOLER	18	10	2
7. White Sucker	OM	TOLER	57	29	6
8. Yellow Bullhead	IN	TOLER	2		
9. Brown Bullhead	IN	TOLER	3		3
10. Green Sunfish	INV	TOLER	17	65	25
11. Bluegill Sunfish	IN	TOLER	93	45	43
12. Redbreast Sunfish	INV	TOLER	26	4	3
13. Pumpkinseed	INV	TOLER	1	1	9
14. Bluegill/Pumpkinseed Hybrid	INV	TOLER	1		
15. Green/Pumpkinseed Hybrid	INV	TOLER			2
15. American Eel	PS	INTER	6	1	2
16. Cutlips Minnow	OM	INTER		1	
17. Central Stoneroller	HE	INTER		2	
18. Fallfish	GE	INTER			1
# of species			15	12	12
# of individuals			227	204	114
Estimate of total population			241		
± 2 SE			32.7		

Length of fish in millimeters, Crabbs Branch, Upstream (08/24/94)

Brown Bullhead	115,152.
Yellow Bullhead	80,155.
White Sucker	120,145,160,120,118,138,140,135,132,113,110,153,135,122,235,110,148,145,160,130,120, 128,165,123,178,133,133,160,170,115,130,145,125,155,150,128,110,105,125,135,165,140, 130,140,170,110,125.
Green Sunfish	105,95,35,40,90,78,53,35,108,96,40,85,70,53,72,108,90.
Bluegill	90,88,80,83,68,90,73,60,90,82,65,70,35,125,85,110,58,70,80,60,60,78,88,65,60,65,33,78, 60,115,70,35,30,80,80,30.
Pumkinseed	58.
Redbreast	75,88,50,90,63,43,70,38,42,56,46,48,43,38,48,53,60,53,50,48,35,48,78,76,45,48.

Water Quality Conditions:

08/24/94	Temp: 24.5	pH: 7.37	DO: 7.8 (94%)	Cond: 206	Turb: 6.0
	Air temp: 24.5	Wind: light/none	Cloud Cover: clear		

Length of fish in millimeters, Crabbs Branch, Upstream (10/28/94)

White Sucker	153,130,108,128,170,155,135,140,135,118,108,112,148,120,115,132,88,110,135,130,135,170, 115,135,123,130,115,152,120. (one w/ eroded fins)
Green Sunfish	58,58,53,50,60,48,50,42,52,48,50,52,52,59,45,58,53,75,62,52,35,58,48,35,58,122,75,85,52, 52,40,38,50,45,55,45,60,40,83,73,55,105,90,50,42,48,38,115,92,85,65,68,58,55,72,45,105, 60,58,53,52,90,104,55,75.
Bluegill	83,110,40,85,42,52,88,58,45,53,43,38,90,80,75,35,72,43,75,75,72,75,38,35,40,33,88,38,38, 48,38,73. (one w/ no tail, one w/ tail erosion)
Pumkinseed	88.
Redbreast	80,58,73,38.

Water Quality Conditions:

08/24/94	Temp: 11.7	pH: 7.99	DO: 9.86	Cond: .390	TDS: 190
	Air temp: 60's	Wind: light/none	Cloud Cover: clear		

Length of fish in millimeters. **Crabbs Branch, Upstream** (05/05/95)

Brown Bullhead	148,164,160.
White Sucker	143,171,168,168,160,150.
Green Sunfish	63,69,115,78,52,74,88,68,72,51,61,105,71,83,69,72,93,115,60,92,80,60,88,88,64.
Bluegill	95,83,56,68,48,115,128,95,62,40,52,68,57,50,130,118,138,112,60,56,70,123,55, 60,55,58,60,128,110,75,68,48,51,67,100,58,55,45,120,52,75,45,115,105,93,90,65, 90,62,48,55,60,80,55,60,48,114,75,65,58,53,68,60,58,48,62,55,42,60,60,55,53. Note: 5 with fin erosion, 1 with no tail, 1 with large ulcerous tumor
Pumkinseed	115,132,160,50,112,45,110,90,74 (2 with fin erosion).
Redbreast	95,55,78.
Green/Pumpkin Hybrid	75,130.
American Eel	345,515.

Water Quality Conditions:

05/05/95	Temp: 25.78	pH: 7.44	DO: 5.99 (74.7%)	Cond: 0.357
	Air temp: 80's	Wind: light/none	Cloud Cover: partly cloudy	

IBI SCORES:	8/24/94	34	10/28/94	28	6/5/95	30
	#	SCORE	#	SCORE	#	SCORE
1	15	5	12	5	12	5
2	0	1	0	1	0	1
3	6	1	6	1	4	3
4	1	3	1	3	1	3
5	84	1	97	1	90	1
6	45	5	41	5	16	5
7	57	5	24	3	47	5
8	27	5	58	3	32	5
9	37	3	6	1	9	1
10	0	5	1.5	5	8	1

APPENDIX III

Appendix III. Phase 3 Sligo Creek and Crabbs Branch Water Quality Grab Sampling; Tables 1-6.

APPENDIX III (cont.)

Table I. Wheaton Branch (WBI) BASEFLOW Water Quality Grab Sampling Results(I) (6/22/94 to 7/II/95)

Parameter	06/22/94	07/13/94	08/03/94	08/25/94	09/13/94	09/21/94	10/04/94	10/19/94	11/30/94	04/05/95	07/11/95
Alkalinity (mg CaCO3/L)	105	75	55	54	80	85	75	77	56	93	NR
Hardness (Total) (mg/L as CaCO3)	155	135	63	73	110	127	85	105	100	153	NR
pH (units)	8.1	7.5	7.2	7.7	8.0	7.4	7.2	7	6.9	7.5	NR
Specific Conductance (mohm/cm)	392	284	155	170	286	306	241	261	175	735	230
Total Dissolved Solids (mg/L)	NR	200	108	120	192	220	160	140	130	432	NR
Total Suspended Solids (mg/L)	12	8	4	9	4	22	8	10	5	41	NR
Turbidity (NTU)	2	0.97	3	3	2.4	4	1.22	1	3	3	7.3
Nitrate Nitrogen (mg/L as N)	0.72	0.71	0.79	0.63	0.81	0.49	0.73	ND	0.57	0.9	0.64
Ortho Phosphate (mg/L as P)	NA	NA	0.021	ND	NR	NR	ND	ND	ND	0.012	0.050
Total Phosphate (mg/L as P)	0.17	0.08	0.11	0.10	NR	NR	ND	ND	0.06	0.04	0.09
Total Organic Carbon (mg/L)	4.45	5.11	1.18	ND	4.17	6.11	2.76	ND	5.19	4.36	5.45
Biochemical Oxygen Demand (mg/L)	2.7	2.5	1	3	1	2	1.8	1.3	2	3	2.0
Cadmium (ug/L)	0	0	0	0	0	0	0	0	0	1	0
Copper (ug/L)	0	10	0	10	20	20	20	10	0	50	10
Zinc (ug/L)	13	4	15	54	12	27	11	4	21	47	17
Fats, Oils and Grease (mg/L)	NA	<0.1	0.75	5.7	ND	ND	ND	0.7	1.11	4.2	4.6
Methylene Blue Active Sub. (mg/L)	NR	NR	NR	NR	NR	NR	ND	ND	ND	NR	NR
Fecal Coliform (MPN) (MPN/100 mL)	NS	700	300	800	300	500	170	130	50	23	1300
Total Coliform (MPN) (MPN/100 mL)	NS	3000	2800	3000	7000	11000	1300	2200	1300	500	7000

(I) Chemical analysis performed by WSSC Patuxent Laboratory.

Source: MWCOG, 1997

APPENDIX III (cont.)

Table 2. Flora Lane (FLI) BASEFLOW Water Quality Grab Sampling Results(1) (6/22/94 to 7/11/95)

Parameters	06/22/94	07/13/94	08/03/94	08/25/94	09/13/94	10/04/94	10/19/94	11/30/94	04/05/95	07/11/95
Alkalinity (mg CaCO3/L)	100	100	100	95	90	95	97	100	90	NR
Hardness (Total) (mg/L as CaCO3)	160	150	150	162	150	141	153	140	150	NR
pH (units)	8.3	7.7	7.8	7.6	7.4	8	7.7	7.8	7.8	8
Specific Conductance (mohm/cm)	439	413	428	431	430	427	423	420	434	409
Total Dissolved Solids (mg/L)	NR	270	300	310	295	278	240	306	271	NR
Total Suspended Solids (mg/L)	9	4	6	8	3	2	12	6	9	NR
Turbidity (NTU)	0.34	0.58	0.80	0.3	0.48	0.57	0.49	0.38	1	NR
Nitrate Nitrogen (mg/L as N)	2.84	2.84	2.96	2.975	2.91	2.78	ND	2.64	2.53	2.53
Ortho Phosphate (mg/L as P)	NA	NA	0.103	ND	NR	ND	ND	ND	0.029	0.030
Total Phosphate (mg/L as P)	0.13	0.07	0.12	0.13	NR	ND	ND	0.04	0.04	0.04
Total Organic Carbon (mg/L)	1.35	1.62	4.38	ND	1.56	0.7	ND	1.43	1.18	1.21
Biochemical Oxygen Demand (mg/L)	1.1	1.8	10.3	1	1	1.1	<1.0	<1.0	4	2
Cadmium (ug/L)	0	0	0	1	1	2	0	0	0	0
Copper (ug/L)	0	10	0	0	10	10	10	0	10	20
Zinc (ug/L)	17	6	6	14	16	12	13	11	24	13
Fats, Oils and Grease (mg/L)	NA	1.71	27.1	0.1	ND	0.2	ND	0.38	1.3	4.1
Methylene Blue Active Sub. (mg/L)	NR	NR	NR	NR	NR	ND	ND	ND	NR	NR
Fecal Coliform (MPN) (MPN/100 mL)	NS	500	2300	3000	30	300	300	30	300	230
Total Coliform (MPN) (MPN/100 mL)	NS	5000	17000	50000	1700	3000	5000	800	300	500

(1) Chemical analysis performed by WSSC Patuxent Laboratory.

Source: MWCOG, 1997

APPENDIX III. (cont.)

Table 3. Wheaton Branch (WBI) STORMFLOW Water Quality Grab Sampling Results(I) (7/21/94 to 9/26/95)

Parameters	07/21/94	07/27/94	11/01/94	02/15/95	03/21/95	05/10/95	07/06/95	09/26/95
Alkalinity (mg CaCO3/L)	27	31	84	77	83	56	27	47
Hardness (Total) (mg/L as CaCO3)	43	62	120	127	118	77	37	58
pH (units)	6.7	7.4	7	7.4	7.4	6.9	7	7.2
Specific Conductance (mohm/cm)	124	141	321	2520	802	232	114	190
Total Dissolved Solids (mg/L)	94	100	280	1310	484	1442	NR	90
Total Suspended Solids (mg/L)	60	12	24	48	2	21	NR	2
Turbidity (NTU)	10	14.5	3	51	9	9	8	10
Nitrate Nitrogen (mg/L as N)	0.95	0.73	0	2.13	0.61	0.29	0.38	0.45
Ortho Phosphate (mg/L as P)	NA	0.023	ND	ND	0.03	0.034	0.084	0.041
Total Phosphate (mg/L as P)	0.15	0.12	ND	ND	NS	0.14	0.18	0.09
Total Organic Carbon (mg/L)	6.09	8.06	33.24	5.03	9.22	26.09	7.8	6.98
Biochemical Oxygen Demand (mg/L)	8.9	10.0	58	<1	11	15.2	6	3
Cadmium (ug/L)	0	0	0	0	0	0	0	4
Copper (ug/L)	30	40	20	20	10	40	20	10.0
Zinc (ug/L)	162	76	68	51	44	36	44	25
Fats, Oils and Grease (mg/L)	6.09	30.2	2.6	18.9	2.2	2.5	2.5	3.29
Methylene Blue Active Sub. (mg/L)	NR	NR	ND	ND	NR	NR	NR	NR
Fecal Coliform (MPN) (MPN/100 mL)	5000	1300	30000	80	170	3000	8000	220000
Total Coliform (MPN) (MPN/100 mL)	23000	5000	170000	1700	3500	80000	50000	500000

(I) Chemical analysis performed by WSSC Patuxent Laboratory. Source: MWCOG, 1997

APPENDIX III. (cont.)

Table 4. Flora Lane (FLI) STORMFLOW Water Quality Grab Sampling Results(l) (7/21/94 to 9/26/95)

Parameters	07/21/94	07/27/94	11/01/94	02/15/95	03/21/95	05/10/95	07/06/95	09/26/95
Alkalinity	83	33	80	89	80	47	33	85
Hardness (Total)	143	52	128	141	133	62	46	136
pH	7.2	7.8	7.5	7.7	7.6	6.8	7.5	7.8
Specific Conductance	343	111	398	2180	824	199	151	314
Total Dissolved Solids	267	84	241	1260	495	129	NR	214
Total Suspended Solids	190	50	50	122	8	8	NR	1
Turbidity	12	23	0.66	89	20	7	12	11
Nitrate Nitrogen	1.46	0.70	1.67	2.7	2.04	1.55	1.2	1.83
Ortho Phosphate	NA	NA	ND	ND	0.13	0.082	0.118	0.055
Total Phosphate	0.10	0.13	ND	ND	0.34	0.19	0.18	0.08
Total Organic Carbon	5.63	6.53	30.97	9.62	16.25	9.37	10.4	4.05
Biochemical Oxygen Demand (mg/L)	8.8	12	56	<1	19	<1	10	13.4
Cadmium	0	0	0	1	0	0	0	4
Copper	20	20	40	20	30	20	30	10
Zinc	51	44	144	93	118	44	52	21
Fats, Oils and Grease	4.8	23.1	4.3	11.3	8.8	3.1	5.1	2.70
Methylene Blue Active Sub.	NR	NR	ND	ND	NR	NR	NR	NR
Fecal Coliform (MPN)	30000	50000	50000	11000	8000	5000	130000	50000
Total Coliform (MPN)	230000	500000	300000	17000	24000	80000	300000	70000

(l) Chemical analysis performed by WSSC Patuxent Laboratory.

Source: MWCOG, 1997

Appendix III, Table 5. Summary: Sligo Creek and Crabbs Branch Baseflow Water Quality Grab Sampling Results (5/16/94 to 7/24/95)

Station No. and Location	Field pH	DO (mg/L)	Turb. (NTU)	TDS[1] (mg/L)	Cond. (umhos/cm)	Substrate Fouling[2] (%)
1. SL-2: Sligo Cr. 33 m. above Wheaton Br.						
• Maximum Value	8.0	17.0	24.0	130.0	230	NS
• Minimum Value	5.8	4.2	0.0	70.0	132	
• Mean Value	7.4	10.4	3.4	95.7	185	
• Median Value	7.5	8.9	2.0	100.0	185	
• N	23	23	23	22	23	
2. WB-1: 100 m. below Woodman Ave.						
• Maximum Value	8.2	18.7	64.0	340.0	594	95.0
• Minimum Value	5.5	2.9	0.0	50.0	103	42.0
• Mean Value	7.3	8.2	8.3	117.2	235	72.0
• Median Value	7.4	6.9	3.0	110.0	228	75.0
• N	30	30	30	29	30	55
3. WB-2: Wheaton Br. 50 m. above Sligo Cr.						
• Maximum Value	8.3	17.0	33.0	370.0	597	same as WB-1
• Minimum Value	6.6	2.9	0.0	50.0	102	
• Mean Value	7.6	9.1	5.2	118.8	226	
• Median Value	7.7	7.7	2.5	110.0	212	
• N	26	26	26	25	26	
4. SL-3: Sligo Cr. 33 m. below Wheaton Br.						
• Maximum Value	7.9	17.2	17.0	200.0	425	NS
• Minimum Value	6.7	6.7	0.0	60.0	124	
• Mean Value	7.3	10.1	3.2	106.4	204	
• Median Value	7.4	8.7	2.0	100.0	192	
• N	23	23	23	22	23	
5. FL-1: 15 m. below weir No. 2						
• Maximum Value	8.1	13.8	229.0	380.0	688	86.0
• Minimum Value	5.1	7.0	0.0	130.0	314	18.0
• Mean Value	7.3	9.9	15.9	190.6	373	47.6
• Median Value	7.6	9.6	1.0	180.0	343	45.0
• N	34	34	34	33	34	39
6. FL-2: Flora La. Trib. 15 m. above Sligo Cr.						
• Maximum Value	8.2	14.7	45.0	240.0	450	same as FL-1
• Minimum Value	6.7	7.3	0.0	130.0	254	
• Mean Value	7.6	10.0	2.5	174.5	348	
• Median Value	7.7	9.3	1.0	180.0	335	
• N	31	31	31	29	31	
7. SL-4: Sligo Cr. 150 m. above Colesville Rd.						
• Maximum Value	7.9	10.2	185.0	190.0	391	NS
• Minimum Value	7.1	7.3	1.0	80.0	243	
• Mean Value	7.6	8.8	28.7	130.0	270	
• Median Value	7.8	8.6	2.0	120.0	253	
• N	7	7	7	7	7	

Table 5 (cont'd.). Summary: Sligo Creek and Crabbs Branch Baseflow Water Quality Grab Sampling Results (5/16/94 to 7/24/95)

Station No. and Location	Field pH	DO (mg/L)	Turb. (NTU)	TDS[1] (mg/L)	Cond. (umhos/cm)	Substrate Fouling[2] (%)
8. CB-I: Crabbs Br. 300 m. below Redland Rd.						
• Maximum Value	8.6	16.3	11.0	750.0	1340	97.0
• Minimum Value	6.4	6.6	1.0	100.0	162	19.0
• Mean Value	7.6	11.0	3.6	229.3	416	59.3
• Median Value	7.5	10.5	3.0	180.0	332	59.0
• N	16	16	16	15	16	32
Total N	190	190	190	188	190	126

[1] RSAT TDS rating scale: <50 mg/L = Excellent, 50-100 mg/L = Good, 101-150 mg/L = Fair, >150 mg/L = Poor.
[2] RSAT Substrate fouling rating scale: 0-10% = Excellent, 11-20% = Good, 21-50% = Fair, >50% = Poor. Sligo Creek mainstem not surveyed (NS).
Note, MDE standards for pH: 6.5-8.5; DO: ≥ 5 mg/L; Turbidity < 150 NTU (max.).

Source: MWCOG, 1997

Appendix III, Table 6. Summary: Sligo Creek and Crabbs Branch Stormflow Water Quality Grab Sampling Results (7/21/94 to 7/10/95)

Station No. and Location	Field pH	DO (mg/L)	Turb. (NTU)	TDS[1] (mg/L)	Cond. (umhos/cm)	Substrate Fouling[2] (%)
1. SC-2: Sligo Cr. 33 m. above Wheaton Br.						
• Maximum Value	8.0	19.7	352.0	2000.0	4310	NS
• Minimum Value	6.9	7.8	0.0	40.0	68	
• Mean Value	7.5	12.6	50.0	299.3	589	
• Median Value	7.5	11.4	15.0	90.0	161	
• N	15	15	15	15	15	
2. WB-1: 100 m. below Woodman Ave.						
• Maximum Value	7.7	17.9	190.0	1330.0	2340	95.0
• Minimum Value	7.2	6.2	5.0	50.0	81	42.0
• Mean Value	7.5	11.0	41.1	357.5	677	72.0
• Median Value	7.5	9.3	25.5	100.0	183	75.0
• N	16	16	16	16	16	55
3. WB-2: Wheaton Br. 50 m. above Sligo Cr.						
• Maximum Value	8.0	19.3	124.0	1280.0	2280	same as WB-1
• Minimum Value	7.2	7.7	2.0	50.0	82	
• Mean Value	7.5	12.0	27.8	372.7	698	
• Median Value	7.6	10.4	23.0	90.0	159	
• N	15	15	15	15	15	
4. SC-3: Sligo Cr. 33 m. below Wheaton Br.						
• Maximum Value	7.7	19.5	196.0	1510.0	3080	NS
• Minimum Value	6.9	7.3	0.0	40.0	76	
• Mean Value	7.3	12.3	29.4	347.3	621	
• Median Value	7.3	11.0	13.0	90.0	158	
• N	15	15	15	15	15	
5. FL-1: 15 m. below weir No. 2						
• Maximum Value	7.9	14.4	192.0	1110.0	1960	86.0
• Minimum Value	5.9	6.3	0.0	40.0	122	18.0
• Mean Value	7.3	10.6	40.8	275.6	464	47.6
• Median Value	7.5	10.8	27.5	175.0	307	45.0
• N	16	16	16	16	16	39
6. FL-2: Flora La. Trib. 15 m. above Sligo Cr.						
• Maximum Value	7.9	16.3	324.0	2000.0	4940	same as FL-1
• Minimum Value	7.1	7.5	0.0	40.0	90	
• Mean Value	7.5	11.8	68.9	387.1	786	
• Median Value	7.5	11.3	19.5	175.0	297	
• N	14	14	14	14	14	
7. SL-4: Sligo Cr. 150 m. above Colesvile Rd. (only one sample taken)	7.8	7.9	9.0	110.0	192	NS
8. CB-1: Crabbs Br. 300 m. below Redland Rd.						
• Maximum Value	8.4	16.7	27.0	1050.0	1930	97.0
• Minimum Value	7.0	7.8	2.0	80.0	134	19.0
• Mean Value	7.7	12.0	13.4	393.8	695	59.3
• Median Value	7.7	11.5	15.5	245.0	417	59.0
• N	8	8	8	8	8	32
Total N	100					126

[1] RSAT TDS rating scale: <50 mg/L = Excellent, 50-100 mg/L = Good, 101-150 mg/L = Fair, >150 mg/L = Poor.
[2] RSAT Substrate fouling rating scale: 0-10% = Excellent, 11-20% = Good, 21-50% = Fair, >50% = Poor. Sligo Creek mainstem not surveyed (NS).
Note, MDE standards for pH: 6.5-8.5; DO: $\geq$ 5 mg/L.; Turbidity < 150 NTU (max.).

Source: MWCOG, 1997

APPENDIX IV

Twelve parameter habitat fieldsheet

REVISED 25 SEPTEMBER 1990
HABITAT ASSESSMENT FIELD DATA SHEET
RIFFLE/RUN PREVALENCE

Habitat Parameter	Category: Optimal	Sub-Optimal	Marginal	Poor
1. Bottom substrate/ instream cover (a)	Greater than 50% mix of rubble, gravel, submerged logs, undercut banks, or other stable habitat. 16-20	30-50% mix of rubble, gravel, or other stable habitat. Adequate habitat. 11-15	10-30% mix of rubble, gravel, or other stable habitat. Habitat availability less than desirable. 6-10	Less than 10% rubble, gravel, or other stable habitat. Lack of habitat is obvious. 0-5
2. Embeddedness (b)	Gravel, cobble, and boulder particles are between 0-25% surrounded by fine sediment. 16-20	Gravel, cobble, and boulder particles are between 25-50% surrounded by fine sediment. 11-15	Gravel, cobble, and boulder particles are between 50-75% surrounded by fine sediment. 6-10	Gravel, cobble, and boulder particles are over 75% surrounded by fine sediment. 0-5
3. ≤0.15 cms (5 cfs)→ Flow at rep. low	Cold >0.05 cms (2 cfs) Warm >0.15 cms (5 cfs) 16-20	0.03-0.05 cms (1-2 cfs) 0.05-0.15 cms (2-5 cfs) 11-15	0.01-0.03 cms (.5-1 cfs) 0.03-0.05 cms (1-cfs) 6-10	<0.01 cms (.5 cfs) <0.03 cms (1 cfs) 0-5
OR >0.15 cms (5 cfs)→ velocity/depth	Slow (<0.3 m/s), deep (>0.5 m): slow, shallow (<0.5 m); fast (>0.3 m/s), deep; fast, shallow habitats all present. 16-20	Only 3 of the 4 habitat categories present (missing riffles or runs receive lower score than missing pools). 11-15	Only 2 of the 4 habitat categories present (missing riffles or runs receive lower score). 6-10	Dominated by 1 velocity/ depth category (usually pools). 0-5
4. Canopy cover (shading) (c)(d)(g)	A mixture of conditions where some areas of water surface fully exposed to sunlight, and other receiving various degrees of filtered light. 16-20	Covered by sparse canopy; entire water surface receiving filtered light. 11-15	Completely covered by dense canopy; water surface completely shaded OR nearly full sunlight reaching water surface. Shading limited to <3 hours per day. 6-10	Lack of canopy, full sunlight reaching water surface. 0-5
5. Channel alteration (a)	Little or no enlargement of islands or point bars, and/or no channelization. 12-15	Some new increase in bar formation, mostly from coarse gravel; and/or some channelization present. 8-11	Moderate deposition of new gravel, coarse sand on old and new bars; and/or embankments on both banks. 4-7	Heavy deposits of fine material, increased bar development; and/or extensive channelization. 0-3

Appendix IV. Twelve parameter habitat fieldsheet (cont.)

RIFFLE/RUN PREVALENCE

Habitat Parameter	Category: Optimal	Sub-Optimal	Marginal	Poor
6. Bottom scouring and deposition (a)	Less than 5% of the bottom affected by scouring and/or deposition. 12-15	5-30% affected. Scour at constrictions and where grades steepen. Some deposition in pools. 8-11	30-50% affected. Deposits and/or scour at obstructions, constrictions, and bends. Filling of pools prevalent. 4-7	More than 50% of the bottom changing frequently. Pools almost absent due to deposition. Only large rocks in riffle exposed. 0-3
7. Pool/riffle, run/bend ratio (a) (distance between riffles divided by stream width)	Ratio: 5-7. Variety of habitat. Repeat pattern of sequence relatively frequent. 12-15	7-15. Infrequent repeat pattern. Variety of macrohabitat less than optimal. 8-11	15-25. Occasional riffle or bend. Bottom contours provide some habitat. 4-7	>25. Essentially a straight stream. Generally all flat water or shallow riffle. Poor habitat. 0-3
8. Lower bank channel capacity (b)	Overbank (lower) flows rare. Lower bank W/D ratio <7. (Channel width divided by depth or height of lower bank.) 12-15	Overbank (lower) flows occasional. W/D ratio 8-15. 8-11	Overbank (lower) flows common. W/D ratio 15-25. 4-7	Peak flows not contained or contained through channelization. W/D ratio >25. 0-3
9. Upper bank stability (a)	Upper bank stable. No evidence of erosion or bank failure. Side slopes generally <30%. Little potential for future problems. 9-10	Moderately stable. Infrequent, small areas of erosion mostly healed over. Side slopes up to 40% on one bank. Slight potential in extreme floods. 6-8	Moderately unstable. Moderate frequency and size of erosional areas. Side slopes up to 60% on some banks. High erosion potential during extreme high flow. 3-5	Unstable. Many eroded areas. "Raw" areas frequent along straight sections and bends. Side slopes >60% common. 0-2
10. Bank vegetative protection (d)	Over 90% of the streambank surfaces covered by vegetation. 9-10	70-89% of the streambank surfaces covered by vegetation. 6-8	50-79% of the streambank surfaces covered by vegetation. 3-5	Less than 50% of the streambank surfaces covered by vegetation. 0-2
OR Grazing or other disruptive pressure (b)	Vegetative disruption minimal or not evident. Almost all potential plant biomass at present stage of development remains. 9-10	Disruption evident but not affecting community vigor. Vegetative use is moderate, and at least one-half of the potential plant biomass remains. 6-8	Disruption obvious; some patches of bare soil or closely cropped vegetation present. Less than one-half of the potential plant biomass remains. 3-5	Disruption of streambank vegetation is very high. Vegetation has been removed to 2 inches or less in average stubble height. 0-2

3107505;17;p

Appendix IV. Twelve parameter habitat fieldsheet (cont.)

RIFFLE/RUN PREVALENCE

Habitat Parameter	Category			
	Optimal	Sub-Optimal	Marginal	Poor
11. Streamside cover (b)	Dominant vegetation is shrub. 9-10	Dominant vegetation is of tree form. 6-8	Dominant vegetation is grass or forbes. 3-5	Over 50% of the streambank has no vegetation and dominant material is soil, rock, bridge materials, culverts, or mine tailings. 0-2
12. Riparian vegetative zone width (least buffered side) (e)(f)(g)	>18 meters. 9-10	Between 12 and 18 meters. 6-8	Between 6 and 12 meters. 3-5	<6 meters. 0-2
Column Totals	____	____	____	____

Score ____

(a) From Ball 1982.
(b) From Platts et al. 1983.
(c) From EPA 1983.
(d) From Hamilton and Bergersen 1984.
(e) From Lafferty 1987.
(f) From Schueler 1987.
(g) From Bartholow 1989.

APPENDIX V

Appendix V. Scoring Criteria for fish Index ofBiological Integrity metrics calculated for Silt Loam Regions, 1st and 2nd Order streams in Montgomery County, Maryland.

Scoring Criteria for Fish IBI Metrics

METRIC[b]	SCORING CRITERIA[a]		
	5	3	1
1. Total number of fish species	>7	4-7	<4
2. Number of riffle benthic insectivorous individuals	>13	7-13	<7
3. Number of minnow species (Cyprinidae)	>4	3-4	<3
4. Number of intolerant species	>1	1	0
5. Proportion of tolerant individuals	<60%	60-81%	>81%
6. Proportion of individuals as omnivores/generalists	<55%	55-77%	>77%
7. Proportion of individuals as insectivores	>39%	20-39%	<20%
8. Proportion of individuals as pioneering species	<53%	53-76%	>76%
9. Total number of individuals (excluding tolerant sp.)	>50	26-50	<26
10. Proportion with disease/anomalies	<2.2%	2.2-4.1%	>4.1%

(a) Scoring criteria are based on the **1995** and **1996** reference streams.

(b) Metrics are based on Karr et al. (1986) original scoring criteria, and modifications from Plafkin et al. (1989) and Hall et al. (1993).

From Montgomery County Water Quality Monitoring Program Stream Monitoring Protocols.

Appendix VI. Summary: Wheaton Branch, Flora Lane and Crabbs Branch - General Physical Aquatic Habitat Conditions[1] (1/7/93 to 7/24/95)

				Riffle Characteristics:				Pool Characteristics:				
Stream	N	Survey Length (m)	Mean Baseflow (L/s)[2]	No. of Riffles*	Mean Riffle Depth (cm/in)	Mean Riffle Substrate Quality[3] (pts)	Mean Riffle Embeddedness[4] (%)	No. of Pools*	Mean Max. Depth (m/in)	Mean Pool Quality (pts)	Riffle/ Pool Ratio[5]	Observed No. of Fish Barriers
Wheaton Branch	11	335	27.98	12	7.11/2.8	2.71	67.7	15	0.86/33.8	4.5	0.8:1	0
Flora Lane	10	411	20.91	14	7.62/3.0	2.44	73.2	12	0.66/25.9	3.5	1.2:1	1
Crabbs Branch	8	427	24.71	21	7.11/2.8	2.94	67.1	29	0.59/23.3	3.1	0.7:1	1

[1] Based on Rapid Stream Assessment Technique (RSAT) surveys (Galli, 1996).
[2] Baseflow was estimated using the Embody Float Method (Embody, 1929); 1 cfs = 28.317 L/s.
[3] Riffle substrate quality rating scale: 3.25-4.00 = Excellent, 2.50-3.24 = Good, 1.75-2.49 = Fair, 1.00-1.74 = Poor.
[4] Riffle embeddedness rating scale: <25% = Excellent, 25-50% = Good, 50-75% = Fair, >75% = Poor.
[5] Riffle/pool ratio rating scale: 0.9-1.1:1 = Excellent; 0.70-0.89:1 or 1.11-1.3:1 = Good; 0.5-0.69 or 1.31-1.5:1 = Fair; 0.49:1≤ or ≥1.51:1 = Poor.
* Number observed during most recent survey is given.

Source: MWCOG, 1997

APPENDIX VII

Appendix VII. Benthic Macroinvertebrate Sampling and Taxonomic Results from 12 Sampling Periods in the Sligo Creek Watershed, Maryland (1990-1995). (*Electronic and hardcopy versions of this appendix (pgs 86-96) are available from the senior author on request*).

Fall 1990																					
Sampling Stations	WB1				WB2				WB3 (=SL2)				WB4 (=SL3)					WB1	WB2	WB3 (=SL2)	WB4 (=SL3)
Date	Nov 3				Nov 3				Nov 3				Nov 3					Nov 3	Nov 3	Nov 3	Nov 3
Taxon	S1	S2	S3	N	S1	S2	S3	N	S1	S2	S3	N	S1	S2	S3	N		Composite Surber			
Simulium																					
Muscidae (Lispe?)																					
Chironomidae (larvae)	9	15		13	1	1		6		2				2	1	2		24	2	2	3
Tanypodinae (larvae)																					
Chironomidae (pupae)																					
Diamesa																					
Guttipelopia																					
Conchapelopia																					
Cricotopus																					
Acricotopus																					
Theinemanniella																					
Zavrelia																					
Chironominae (pupae)																					
Culicidae																					
Culex																					
Tipulidae																					
Tipula		1		1		1	1											1	2		
Antocha																					
Dicranota																					
Empididae																					
Hemerodromia																					
Dolichopodidae																					
Allognosta																					
Sciomyzidae																					
Lepidoptera																					
Nepticulidae																					
Nepticula																					
Braconidae																					
Total No. Organisms	51	42	11	25	51	318	106	12	86	19	3	3	3	6	23	5		104	475	108	32
Composite Totals (3 surbers)		104				475				108				32							
*WB4N collected one Lampyridae																					
	[shaded] not counted as separate taxon, count of individuals not included in total																Total # of Individu	104	475	108	31
	[boxed] not counted as separate taxon, count of individuals included in total																Total # of Taxa	5	7	6	5
	[dotted] count of individuals not included in total																# of EPT Taxa	1	1	2	2
																	% Contribution of	67.3	93.9	91.7	80.6

Fall 1990																					
Sampling Stations	WB1				WB2				WB3 (=SL2)				WB4 (=SL3)					WB1	WB2	WB3 (=SL2)	WB4 (=SL3)
Date	Nov 3				Nov 3				Nov 3				Nov 3					Nov 3	Nov 3	Nov 3	Nov 3
Taxon	S1	S2	S3	N	S1	S2	S3	N	S1	S2	S3	N	S1	S2	S3	N		Composite Surber			
Fall 1990																					
Sampling Stations	WB1				WB2				WB3 (=SL2)				WB4 (=SL3)					WB1	WB2	WB3 (=SL2)	WB4 (=SL3)
Date	Nov 3				Nov 3				Nov 3				Nov 3					Nov 3	Nov 3	Nov 3	Nov 3
Taxon	S1	S2	S3	N	S1	S2	S3	N	S1	S2	S3	N	S1	S2	S3	N		Composite Surber			
Nematoda																					
Nemertea																					
Prostoma graecense																					
Tricladida																					
Oligochaeta	1	6	1	1	12		3	6		2		3			1	1		8	15	2	1
Hirudinea																					
Pelecypoda																					
Pisiidae																					
Pisidium																					
Gastropoda						1													1		
Physidae																					
Physella																					
Physella heterostropha									3											3	
Ancylidae																					
Ferrissia																					
Planorbidae																					
Gyraulus																					
Menetus dilatatus																					
Planorbella																					
Lymnaeidae																					
Pseudosuccinea columella																					
Stagnicola																					
Asellidae																					
Lirceus																					
Caecidotea																					
Asellus							3												3		
Gammaridae																					
Gammarus																					
Crangonyctidae																					
Crangonyx											1				1	1				1	1
Cambaridae																					
Procambarus																					
Hydracarina																					
Entomobryidae																					
Sminthuridae																					

Fall 1990																					
Sampling Stations	WB1				WB2				WB3 (=SL2)				WB4 (=SL3)					WB1	WB2	WB3 (=SL2)	WB4 (=SL3)
Date	Nov 3				Nov 3				Nov 3				Nov 3					Nov 3	Nov 3	Nov 3	Nov 3
Taxon	S1	S2	S3	N	S1	S2	S3	N	S1	S2	S3	N	S1	S2	S3	N		Composite Surber			
Dicyrtoma																					
Baetidae																					
Baetis																					
Zygoptera																					
Coenagrionidae																					
Argia																					
Enallagma																					
Ischnura				4																	
Calopterygidae																					
Calopteryx																1					
Aeshnidae																					
Aeshna																					
Gomphidae																					
Corixidae																					
Palmacorixa																					
Notonectidae																					
Notonecta																					
Saldidae																					
Gerridae																					
Trepobates																					
Gerris													1								1
Veliidae																					
Microvelia																					
Corydalidae																					
Nigronia serricornis																					
Hydroptilidae																					
Hydroptila																					
Hydropsychidae (larvae)																					
Hydropsyche	40	20	10	6	36	312	98		82	15	2		2	3	20			70	446	99	25
Cheumatopsyche									1					1						1	1
Hydropsyche morosa sp. grp.						2													2		
Hydropsychidae (pupae)																					
Dryopidae (adults)																					
Helichus																					
Hydrophilidae																					
Berosus																					
Dytiscidae																					
Matus																					
Simuliidae	1				2	1	1											1	4		

SLIGO1.WB2

Fall 1992																															
Sampling Stations	SL1				SL2				SL3				SL4				WB1				WB2				FL1				FL2		
Date	Dec 15				Dec 15				Dec 15				Dec 14				Dec 15				Dec 15				Dec 14				Dec 14		
Taxon	S1	S2	S3	N	S1	S2	S3	N	S1	S2	S3	N	S1	S2	S3	N	S1	S2	S3	N	S1	S2	S3	N	S1	S2	S3	N	S1	S2	S3
Fall 1992																															
Sampling Stations	SL1				SL2				SL3				SL4				WB1				WB2				FL1				FL2		
Date	Dec 15				Dec 15				Dec 15				Dec 14				Dec 15				Dec 15				Dec 14				Dec 14		
Taxon	S1	S2	S3	N	S1	S2	S3	N	S1	S2	S3	N	S1	S2	S3	N	S1	S2	S3	N	S1	S2	S3	N	S1	S2	S3	N	S1	S2	S3
Nematoda																															
Nemertea																															
Prostoma graecense					1																										
Oligochaeta	17	2	8		49	4	58		48	3	34	4		13	10	4	5	10	29	4	7	7	62	3	10	18	10	1	1	3	1
Hirudinea				1							3						48	29	27		9	3	46	2							
Pelecypoda																															
Pisiidae																															
Pisidium											1						22	2		3			6								
Gastropoda																															
Physidae																															
Physella																	2			1	3										
Physella heterostropha	5	2	4	1	2																		4	3	4	6	1			4	
Ancylidae																															
Ferrissia	2		3				2			1	14			1						1				2							
Planorbidae																															
Gyraulus							1													1											
Menetus dilatatus			1																											1	
Planorbella																															
Lymnaeidae																															
Pseudosuccinea columella																	1			2											
Stagnicola																															
Asellidae																															
Lirceus					2									1	1																
Caecidotea																															
Gammaridae																															
Gammarus					5					1	1																				
Cambaridae															1															1	
Procambarus																															
Hydracarina																															
Entomobryidae																															
Sminthuridae																															
Dicyrtoma																									1						
Baetidae																															
Baetis																															
Zygoptera																															
Coenagrionidae																															
Enallagma			1																			1									
Calopterygidae																															
Calopteryx	1																														
Aeshnidae																															
Aeshna																															
Gomphidae																															

* Shaded cells indicate those taxa NOT included in taxa counts and/or totals of individuals

Fall 1992																															
Sampling Stations	SL1				SL2				SL3				SL4				WB1				WB2				FL1				FL2		
Date	Dec 15				Dec 15				Dec 15				Dec 14				Dec 15				Dec 15				Dec 14				Dec 14		
Taxon	S1	S2	S3	N	S1	S2	S3	N	S1	S2	S3	N	S1	S2	S3	N	S1	S2	S3	N	S1	S2	S3	N	S1	S2	S3	N	S1	S2	S3
Notonectidae																															
Notonecta																															
Veliidae																															
Microvelia																															
Corydalidae																															
Nigronia serricornis																		1													
Hydropsychidae (larvae)							3		6		9							6	2				7								
Hydropsyche					42	3	53		109	16	404			5	4		393	471	421		2	1	273								
Cheumatopsyche					18		13		168	10	263				9		122	135	206		13	2	267								
Hydropsychidae (pupae)																															
Dryopidae (adults)																															
Helichus																															
Hydrophilidae																															
Berosus																				1											
Simuliidae																															
Simulium											1																				
Muscidae (Lispe?)																				1											
Chironomidae (larvae)	14	4	23	1	5				5		1		1	3			46	1	4	2	2	2			6	7	21	1	6	3	
Tanypodinae (larvae)	2	4	1		8		1		11		10							8	7	1	5		4		19	7	10		1	6	2
Chironomidae (pupae)																															
Conchapelopia																															
Cricotopus																									1		1		1	1	
Theinemanniella																															
Zavrelia																															
Chironominae (pupae)																															
Culicidae																															
Culex																															
Tipulidae																															
Tipula	1				4	1			2		1						1						2		3	6				7	1
Antocha					1				5		7			1	2								3								
Dicranota																															
Empididae																															
Hemerodromia		1			1				1		2						5	2	2		1	1	1								
Dolichopodidae					1																										
Sciomyzidae																				1											
Lepidoptera																															
Braconidae																															
Total No. Organisms	42	13	41	3	138	8	131	0	355	31	751	4	1	24	27	4	645	665	698	18	42	17	675	10	44	44	43	2	9	26	4
Surber Total (3)		96				277				1137				52				2008				734				131				39	
Total Number of Individuals	42																														
Total Number of Taxa	8																														
Number of EPT Taxa																															

Fall 1992																															
Sampling Stations	SL1				SL2				SL3				SL4				WB1				WB2				FL1				FL2		
Date	Dec 15				Dec 15				Dec 15				Dec 14				Dec 15				Dec 15				Dec 14				Dec 14		
Taxon	S1	S2	S3	N	S1	S2	S3	N	S1	S2	S3	N	S1	S2	S3	N	S1	S2	S3	N	S1	S2	S3	N	S1	S2	S3	N	S1	S2	S3
Percent Contribution of Dominar	40																														

* Shaded cells indicate those taxa NOT included in taxa counts and/or totals of individuals

SLIGO3.WB2

Spring 1995

Sampling Stations			SL1		SL2		SL3		SL4		WB1		WB2		FL1		FL2		WP1		CB1	
Sample Date			May 31		June 2		May 30		May 30		May 31		May 31		May 31		May 31		May 30		June 5	
Sample Type	TV	FFG	Rf	Pl	Rf	Pl	Rf	Pl	Rf	Pl	Rf	Pl	Rf	Pl*	Rf	Pl	Rf	Pl	Rf	Pl	Rf	Pl

Sligo Creek Phase 3 Benthic macroinvertebrates *taxonomy performed by Mr. Dave Penrose, Raleigh, North Carolina*

Spring 1995

Sampling Stations			SL1		SL2		SL3		SL4		WB1		WB2		FL1		FL2		WP1		CB1	
Sample Date			May 31		June 2		May 30		May 30		May 31		May 31		May 31		May 31		May 30		June 5	
Sample Type	TV	FFG	Rf	Pl	Rf	Pl	Rf	Pl	Rf	Pl	Rf	Pl	Rf	Pl*	Rf	Pl	Rf	Pl	Rf	Pl	Rf	Pl
TAXON																						
Nematoda																						
Gordiidae																						
Gordius																						
Nemertea		PC																				
Prostoma graecense																						
Tricladida																						
Dugesia tigrina		CG																			6	6
Oligochaeta	10	CG																				
Lumbriculidae	8	CG			1	1	7		18	1	16				4		7		13	1		
Enchytraeidae	10	CG		1																		
Tubificidae	10	CG																				
Aulodrilus	8	CG																			6	
Limnodrilus hoffmeisteri	10	CG																	2			
Spirosperma sp	10	CG																				
immature Tubificidae	10	CG			1		4				2	1	8						18		8	6
Naididae	9	CG																				
Nais sp	8	CG	60	1	1	1	13	1	1		1	14							1		12	14
Amphichaeta sp	6	CG																				
Slavina	6	CG										1										
Opistosystidae		CG																				
Opisthophora (correct fam?)									2										5			
Hirudinea	7;6	P																				
Erpobdella/Mooreobdella	8	P									2	1					2					1
Helobdella sp (fusca?)	6	P																				
Pelecypoda																						
Pisiidae	8	FC																				
Pisidium	5;8	FC										1										
Sphaeriidae	8	FC																				
Sphaerium	5;8	FC									2										9	1
Gastropoda		SR																				
Physidae		SR																				
Physella	8	CG			1		11	1	2	4	15	5	4	5					2		1	1
Physella heterostropha	8	CG																				
Ancylidae	7	SC																				

Rf - riffle samples, Surber; Pl - pool samples, D-frame; TV - Tolerance Value; FFG - Functional Feeding Group

1 of 5

Spring 1995

Sampling Stations			SL1		SL2		SL3		SL4		WB1		WB2		FL1		FL2		WP1		CB1	
Sample Date			May 31		June 2		May 30		May 30		May 31		May 31		May 31		May 31		May 30		June 5	
Sample Type	TV	FFG	Rf	Pl	Rf	Pl	Rf	Pl	Rf	Pl	Rf	Pl	Rf	Pl*	Rf	Pl	Rf	Pl	Rf	Pl	Rf	Pl
Ferrissia	7	SC	2																			
Planorbidae	6	SC																				
Gyraulus	6	SC																				
Helisoma anceps	6	SC										2										1
Menetus dilatatus	6	SC																				
Planorbella											1											
Lymnaeidae		SC																				
Pseudosuccinea columella	6	CG																				1
Stagnicola	7	SC																				
Asellidae	6;8																					
Lirceus	4;8	CG																				
Caecidotea	6	CG																				
Asellus	8	SH;CG							19	1												
Gammaridae	4	SH																				
Gammarus	3;6	SH;CG																				
Crangonyx	4	CG	1				1		1	1												
Cambaridae		SH						1		2	1										1	
Procambarus	6	SH																				
Hydracarina																						
Entomobryidae																						
Sminthuridae																						
Dicyrtoma																						
Caenidae																						
Caenis	7	CG																				1
Baetidae		CG																				
Baetis	6	CG																				
Baetis flavistriga	4	CG	1		2		1		1		4		6								1	
Cloeon	3;4	CG																				
Zygoptera		PC																				
Coenagrionidae	9	P																				
Argia	6	P																				
Enallagma	8	P																				4
Ischnura	9	P										1										
Calopterygidae	5	P																				
Calopteryx	6	P						1														
Aeshnidae		PC																				
Aeshna	5	P																				
Libellulidae	9	P																				
Pachydiplax longipennis	8	P																				
Corixidae		Pl;P																				
Sigara	5	Pl																				

Rf - riffle samples, Surber; Pl - pool samples, D-frame; TV - Tolerance Value; FFG - Functional Feeding Group

SLIGO3.WB2

Spring 1995

Sampling Stations			SL1		SL2		SL3		SL4		WB1		WB2		FL1		FL2		WP1		CB1	
Sample Date			May 31		June 2		May 30		May 30		May 31		May 31		May 31		May 31		May 30		June 5	
Sample Type	TV	FFG	Rf	Pl	Rf	Pl	Rf	Pl	Rf	Pl	Rf	Pl	Rf	Pl*	Rf	Pl	Rf	Pl	Rf	Pl	Rf	Pl
Notonectidae																						
Notonecta	5	P																				
Veliidae		P																				
Microvella	5	P																				
Corydalidae																						
Nigronia serricornis	2	P																				
Hydropsychidae (larvae)	5	FC																				
Hydropsyche betteni	6	FC			24		35		44		3		3				1				15	3
Hydropsyche	5	FC																				
Cheumatopsyche	6	FC	4		34		29		17		97	1	152				10				73	1
Symphitopsyche bronta	6	FC					1															
Symphitopsyche morosa	6	FC																				
Hydropsychidae (pupae)																						
Haliplidae																						
Peltodytes	5	SH																				1
Dryopidae (adults)		CG																				
Helichus	5	SC																				
Hydrophilidae		P																				
Berosus	5	CG;P																				
Enochrus	5	CG																				
Helophorus	5	SH			1																	
Simuliidae	6	FC																				
Simulium	6	FC	9		7		7		7		24		2								21	1
Muscidae (Lispe?)																						
Chironomidae (larvae)																						
Tanypodinae (larvae)																						
Chironomidae (pupae)																						
Conchapelopia																						
Zavrelia																						
Cricotopus																						
Chironominae (pupae)																						
Ceratopogonidae	6	P																				
Palpomyia (group)	6	P																				1
Culicidae	8	FC																				
Culex	8	FC										4										
Aedes	8	FC																				
Tipulidae	4	SH																				
Tipula	4	SH			1																	1
Antocha	5	CG			10		5		11	1												
Dicranota	4	P																				
Limonia	6	SH															1					

Rf - riffle samples, Surber; Pl - pool samples, D-frame; TV - Tolerance Value; FFG - Functional Feeding Group

SLIGO3.WB2

Spring 1995

Sampling Stations			SL1		SL2		SL3		SL4		WB1		WB2		FL1		FL2		WP1		CB1	
Sample Date			May 31		June 2		May 30		May 30		May 31		May 31		May 31		May 31		May 30		June 5	
Sample Type	TV	FFG	Rf	Pl	Rf	Pl	Rf	Pl	Rf	Pl	Rf	Pl	Rf	Pl*	Rf	Pl	Rf	Pl	Rf	Pl	Rf	Pl
Empididae		CG																				
Hemerodromia	6	P																				
Dolichopodidae	5	P																				
Ephydridae	8	CG																				
Ephydra	8	CG																				
Sciomyzidae	10	P																				
Lepidoptera	5	SH																				
Braconidae																						
Total No. Organisms (w/o Chiron.)			77	2	83	2	114	4	123	10	168	31	175	0	4	0	21	0	41	1	153	44
Total including Chironomidae			209	6	158	3	155	6	149	13	213	48	196	5	12	2	40	3	104	5	169	65

Chironomidae, Sligo Phase 3, Fall 1994

Ablabesmyia peleensis	6	P																				
Ablabesmyia mallochi	8	P																				
Brillia spp.	5	SH	1		1			1			2											
Cardiocladius	6	P							1													
Chironomus spp.	10	SH;CG															1	1	1	1	2	6
Conchapelopia group	6	P	27	1	18		20	1	7	1	22	5	14						14	2		1
Cricotopus bicinctus	10	CG			1		8		8	1	6		1		4	2	5	2				
Cricotopus infuscatus gr.	7	SH	6	3											4		7		43			
Cricotopus nr intersectus	7	SH																				
Cricotopus nr sylvestrus	7	SH	6								4									1	4	6
Cricotopus varipes gr.	8	CG;SH																				7
Orthocladius (C/O sp3)	6	CG															3					
Orthocladius obumbratus (C/O sp10)	6	CG																				
Eukiefferiella sp.	8	CG																				
Eukiefferiella bavarica group	8	CG			27		2															
Eukiefferiella claripennis group	8	CGCG	90		22		5		9		3		1				1		4			
Glyptotendipes	10	FC										1										
Limnophyes	8	CG																				
Nanocladius	3	CG										1										
Natarsia	8	P									1											
Parametriocnemus lundbecki	5	CG	1		1																4	
Phaenopsectra flavipes	7	SC	1																			
Phaenopsectra	7	SC																				
Polypedilum aviceps	6	SH																				
Polypedilum convictum	6	SH					1															
Polypedilum fallax	6	SH											2									
Polypedilum halterale	6	SH			2								1									
Polypedilum illinoense	6	SH			3	1	3				7	1					2				2	1

Rf - riffle samples, Surber; Pl - pool samples, D-frame; TV - Tolerance Value; FFG - Functional Feeding Group

SLIGO3.WB2
Spring 1995

Sampling Stations			SL1		SL2		SL3		SL4		WB1		WB2		FL1		FL2		WP1		CB1	
Sample Date			May 31		June 2		May 30		May 30		May 31		May 31		May 31		May 31		May 30		June 5	
Sample Type	TV	FFG	Rf	Pl	Rf	Pl	Rf	Pl	Rf	Pl	Rf	Pl	Rf	Pl*	Rf	Pl	Rf	Pl	Rf	Pl	Rf	Pl
Polypedilum scalaenum	6	SH											2									
Psectrotanypus	10	P										9										
Rheocricotopus sp.	6	CG																				
Rheotanytarsus sp.	6	FC																				
Tanytarsus sp	7	FC					1			1											4	
Thienemanniella	6	CG					1															
Zavrelmyia sp	8	P							1										1			
Total No. Chironomidae			132	4	75	1	41	2	26	3	45	17	21	0	8	2	19	3	63	4	16	21

*sample WB-2 dipnet was broken in transit

Total Number of Individuals	209
Total Number of Taxa	13
Number of EPT Taxa	
Percent Contribution of Dominant Taxon	43.1

Rf - riffle samples, Surber; Pl - pool samples, D-frame; TV - Tolerance Value; FFG - Functional Feeding Group

Appendix VIII: Transfer Stockings of Fishes into Upper Sligo Creek

COMMON NAME	SCIENTIFIC NAME	1990[1]	1992[2]	1993[2]	1994[3]	TOTAL
1. Silverjaw Minnow	Ericymba buccata	123			91	214
2. Cutlips Minnow	Exoglossum maxillingua	9		5	1	15
3. Swallowtail Shiner	Notropis procne	2071		36	16	2123
4. Satinfin Shiner	Notropis spilopterus	1064			2	1066
5. Common Shiner	Notropis cornutus	65		11	29	105
6. Golden Shiner	Notropis crysoleucas				1	1
7. Spottailed Shiner	Notropis hudsonius	82			10	92
9. Bluntnose Minnow	Pimephales notatus	40	171	46	24	281
10. Rosyside Dace	Clinostomus funduloides	10		45	95	150
11. Longnose Dace	Rhinichythys cataractae	9	14	10	44	77
12. White Sucker	Catostomus commersoni	11	97		32	140
13. Northern Hog Sucker	Hypentelium nigricans	13		6	29	48
14. Margined Madtom	Noturus insignis				1	1
15. Bluegill Sunfish	Lepomis macrochirus	2				2
16. Redbreast Sunfish	Lepomis auritus	2				2
17. Pumpkinseed Sunfish	Lepomis gibbosus	2				2
18. Largemouth Bass	Micropterus salmoides	(yoy) 3				3
19. Fantail Darter	Etheostoma flabellare				109	109
20. Tessellated Darter	Etheostoma olmstedi	57	133	30	38	258
21. Mottled Sculpin	Cottus bairdi				98	98
22. Banded Killifish	Fundulus diaphanus	39				39
	GRAND TOTALS	3602	415	189	668	4826

[1]Introduced into Sligo Creek mainstem near SL-4, prior to existing project; [2]Introduced into Wheaton Branch, tributary of Sligo Creek
[3]Introduced into Flora Lane Tributary and Sligo Creek Mainstem