Bioassessment of Prince William County Watersheds

Final Report

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Introduction and Literature Review

The management of nonpoint source pollution (NPS) in urban and suburban watersheds is becoming an increasing focus of strategies designed to improve water quality in receiving waters such as streams, rivers, lakes, and estuaries. While substantial progress has been made in formulating strategies to manage NPS pollution, questions still exist regarding the trade-offs between preserving stream reaches and wetlands in urban areas versus concentrating on practices like regional ponds which may be better at trapping some pollutants, but sacrifice upstream watershed areas. Designing an appropriate mix of on-site and regional facilities requires substantial knowledge of impacts on stream biotic communities at both the level of individual facilities and the whole watershed.

Ideally, NPS effects should be controlled on-site by eliminating sources and/or trapping pollutants before they leave the site. On-site controls minimize the portion of downstream watercourses impacted by NPS pollution. However, substantial obstacles exist to total reliance on on-site treatment of NPS pollution. Among these are poor performance and maintenance problems of on-site methods (Galli 1992) as well as the high cost of retrofitting these facilities in built-up areas. Thus, some have called for regional facilities which are located some distance downstream and handle NPS pollution from larger areas. While these facilities, mostly regional ponds, may provide economies-of-scale in construction, in maintenance, and in the potential for good pollutant removal, upstream lotic habitats go unprotected and large areas of valuable wetland may be inundated by the impoundments. Furthermore, regional facilties are large enough to have their own impacts on downstream habitats such as increased temperature and altered trophic webs.

Numerous constituents of urban NPS may have deleterious or undesirable impacts on freshwater communities. Suspended sediment levels are markedly enhanced in urban and suburban streams. Suspended sediments may interfere with respiration and feeding of stream invertebrates (Lemly 1982) and fish (Gardner 1981). Deposited fine sediments may provide a poor substrate for many invertebrates and eliminate fish nesting areas. The increased levels of toxic contaminants such as heavy metals, petroleum hydrocarbons, and pesticides found in urban NPS pollution contribute to its deleterious effect. Road de-icing salts can have a major negative impact on stream invertebrates (Crowther and Hynes 1977). Although less important in flowing waters than in lakes and ponds, nitrogen and phosphorus can stimulate the growth of nuisance algae which can alter stream food webs. Temperature is a critical factor controlling the life cycles of many aquatic organisms (Vannote and Sweeney 1980). Urbanization alters the temperature regime of streams by decreasing riparian vegetation and base flow (Galli and Dubose 1990). This results in the elimination of cold-water animals such as stonefly nymphs and trout.

Knowing the potential for urban NPS constituents to impact freshwater organisms, it should not be surprising to find that most watershed studies to date indicate substantial degradation of the fauna of urban streams. Jones and Clark (1987) found that watershed urbanization had a major impact on benthic insect communities even in the absence of point source discharges. Watershed development had little impact on total insect numbers, but shifted the taxonomic composition markedly. Chironomids increased while mayflies, stoneflies, beetles, and dobsonflies decreased. Other studies report similar results (Benke et al. 1981, Pitt and Bozeman 1982, Duda et al. 1982, DiGiano et al. 1975).

Little data exist which allow evaluation of the impacts of specific BMP's on stream communities. Galli (1988) examined the response of downstream communities to discharge from a small wet pond BMP. The benthic invertebrate community was substantially degraded downstream due to adverse water quality impacts and changes in organic matter supply. Impoundments generally harbor substantial quantities of plankton which can alter downstream food webs. Trophic structure downstream of impoundments often shifts to filter-feeding invertebrates which utilize the plankton being flushed from the impoundment (Herlong and Mallin 1985, Mackay and Waters 1986, Robinson and Minshall 1990). Robinson and Minshall concluded that impoundments also interfere with colonization of downstream reaches by drift and that reestablishment of the native stream community may not occur for some distance downstream. Deeper impoundments also stratify thermally which may dramatically alter temperature regimes and chemical concentrations in downstream reaches. Marcus (1980) found that periphyton increased downstream of a hypolimnetic impoundment discharge due to enhanced ammonia levels.

Methods for determining impacts on stream communities range rather widely depending upon the study objectives and availability of funding. In-depth studies of population dynamics or production of individual species are usually conducted by researchers focusing on basic ecological problems at a few sites. Larger scale watershed level studies must rely on more rapid assessment using qualitative or semiquantitative methods. In conjunction with the states, EPA has developed several rapid bioassessment protocols utilizing fish and macroinvertebrate communities (Plafkin et al. 1989). Samples from these communities allow the calculation of certain community indices (metrics) which are related to the relative health or impairment of ecosystem function. Selected water quality analyses, physical characterization and habitat assessment are conducted concurrently. Reference sites are sampled to determine regional species pools and habitat potential. These factors are then integrated into an overall assessment of ecological condition.

In this study rapid bioassessment of fish and macroinvertebrate communities was used to determine impacts of nonpoint pollution on stream ecosystems in Prince William

County in northern Virginia. The first objective was to examine the effects of nonpoint pollution at the landscape level on watersheds draining 10 km^2 or more. The second objective was to evaluate the effectiveness of individual Best Management Practices (BMP's) in mitigating nonpoint pollution impacts on stream communities.

Study Sites

Sites were selected to accomplish these two objectives. To accomplish the first objective sites were established on watersheds draining 10 km^2 or more. These sites were located as far downstream as possible without encountering interference from point source inputs or major hydrologic factors like large lakes. The presence of a point source discharge on Neabsco Creek at Minnieville Road dictated the location of the Neabsco integrator site at Delaney Rd., just upstream. Likewise, the presence of Lake Montclair on Powells Creek just downstream from Spriggs Road made that the farthest downstream integrator site. In the Quantico Creek watershed a greater length of stream was available, and the entire South Fork could be used for integrator sampling. An additional reference site was located on the North Fork of Quantico Creek. Sites were spaced down the watershed to encompass a range of watershed areas in the Quantico basin. In each basin one integrator site was sampled at two stations; other integrator sites were sampled at only one station each.

The second objective was to quantify the impacts of individual Best Management Practices (BMP's) on stream communities. This was accomplished by locating individual BMP sites and attempting to sample at one station above and two stations below each BMP. In a number of cases it was impossible to sample above the BMP since runoff entered through small, normally dry channels or directly from storm drains. The BMP types studied included wet ponds, dry ponds, and riparian park land. In addition, sampling was conducted above and below an unprotected storm sewer. Site locations are described in Table 1. Location of sites mapped on Figure 1.

Six additional stations were added for macroinvertebrate sampling. These were located in the Occoquan watershed and are shown in Figure 2.

Methods

A modification of EPA Rapid Bioassessment Protocol (RBP) II was used as the basic tool for macroinvertebrate bioassessment (Plafkin et al. 1989). RBP II utilizes semiquantitative field collections in riffle/run habitats to determine the values of eight metrics (Table 2) which characterize the status of the benthic macroinvertebrate community. The protocol allows for the modification of metrics and the use of alternative metrics depending on regional conditions. Based on previous work in these watersheds (Jones and Kelso 1994), we deleted the scrapers/filter collectors metric. We used Sorensen's index (SI) for community similarity. The ratio shredders/total number could not be used as CPOM was not available at many sites. Biological scoring criteria for the remaining five metrics (taxa richness, family biotic index, EPT/chironomids, % dominant family, and EPT index) were as described in Plafkin et al. (1989). The criteria for SI as follows: SI>0.5=6,0.5>SI>0.3=3, SI<0.3=0 . Macroinvertebrates were sampled at each station once in June of 1996 (except for six new Occoquan stations sampled in late July-early August).

Macroinvertebrate communities were sampled at each site using a 44 cm x 22 cm kick net. The 0.5 mm mesh net was held to the bottom facing upstream and the substrate was disturbed for 1 m directly upstream from the net for one minute. Larger stones were also wiped clean manually when deemed necessary. Contents of the net were placed in a shallow pan. The net was inspected to remove adhering animals. Large stones and leaves were rinsed and discarded. Obvious animals were picked directly into the sample jar. The remaining sample was collected by pouring the contents of the pan through a 0.5 mm sieve. This material was also transferred to the sample jar. The sample was preserved with formalin. Samples were collected from two locations at each station, a rapidly flowing riffle and a less rapid run, and composited into a single jar.

In the lab samples were rinsed with tap water through a 500 um sieve to remove formalin and placed into a 35 cm x 40 cm pan marked with 5 cm x 5 cm squares. The pan was then shaken to distribute the sample evenly over the entire surface of the pan. Using a random number table, squares were selected for organism removal until a target number of organisms was achieved. The target number was 200. The remaining sample was returned to the sample jar and represerved with alcohol/glycerine. In some cases, the entire sample contained less than 100 animals. The selected organisms were sorted into ethanol-glycerine, identified to family and enumerated. Taxonomic references included Merritt and Cummins (1978), Pennak (1978), and Clifford (1991).

Fish bioassessments were conducted using RBP V (Plafkin et al. 1989). At each site a 200 m reach containing riffles, runs, and pools was measured from a reference point such as a bridge crossing or other easily distinguishable landmark to serve as the sample area. In some cases, where the entire stream reach of interest was less than 200 m, the entire reach was sampled.

Sampling was accomplished using backpack-mounted, battery-powered electroshocking gear. Boundary nets were set at either end of the stream reach when the reach boundaries coincided with deep pools or a wide channel. Once collected, the fish were measured to the nearest cm (standard length) and identified to species. The incidence of hybrids and diseased or anomalous individuals was also noted. Individuals which could not be accurately identified in the field were preserved for later analysis.

Index of Biotic Integrity was calculated using the procedure outlined in Plafkin et al. (1989). The twelve metrics employed are listed in Table 2. The only modification was substitution of %Generalists for %Omnivores and %Specialists for %Insectivores.

Habitat assessment was conducted using the methods outlined in the EPA bioassessment document (Plafkin et al. 1989). At each site the Physical Characterization/Water Quality and Habitat Assessment field data sheets were filled out during the fish sampling. This information was used to construct a rating based on the criteria in the habitat assessment portion of the document.

Watershed landuse was calculated using ARCVIEW 2 and GIS files obtained from Prince William County. Data in the County's GIS files was checked and augments using a global positioning system (Trimble Pathfinder). Watershed boundaries were first mapped using the topographic layer. Then the plat and road layers were used to identify land uses. In some cases this information was not sufficient and site visits were necessary to much of the Neabsco watershed to obtain further information.

Results

Land Use

Table 3 contains the results of the land use analysis. The Neabsco sites represent both residential and commercial development. The Prince William Parkway Pond watershed is a rapidly developing commercial area, home to the Potomac Mills shopping center. Above the pond development is relatively light at this point with only 10-12% commercial land use while below the pond commercial development intensifies. The PPD1 sites reach 37% commercial. Below this point the major tributaries are large storm sewers draining Potomac Mills. Since the drainage has been altered it is not clear what the contributing acreage is, but a 44 inch pipe enters between PPD1 and PPD2 and an 84 inch pipe enters between PPD2 and PPD3. Commercial land uses are dominant in the GE and GW watersheds. GE is the most developed with 50-65% commercial land use. GW has 26-30% commercial development, but another 50-60% has been cleared for commercial development.

Residential land uses dominate in the other Neabsco watersheds. Single family detached housing with lots less than 1 acre dominates at the Daleview Manor sites covering 45-65% of the land. At the DM site townhouse development is also important with about 15% coverage. The Minnieville Elementary sites also show over 50% single family detached housing on small lots. The Dale Boulevard Culvert site is slated to be small lot detached residential, but at this time only about 13-14% of the land has been developed although clearing has begun for more development. The non-structural BMP sites actually differ substantially in land use, although not in the manner initially anticipated. The N@P site has rather low intensity of development at this point, but like the Dale Boulevard site is undergoing clearing. The N@L site has a much higher proportion of already constructed housing as does N@D, the integrator site. Wexford-Highbridge show a mix of several land use types.

Land use in the Powells Creek basin ranges from very low intensity to tract developments with 1-5 acre lots. In Quantico Creek land use is assumed to be 100% open space, although there are a few small enclaves along the margins of the watershed.

Macroinvertebrates

Numbers of individuals of each macroinvertebrate family found in each sample are contained in Appendix A. These data were used to calculate the individual metrics and the composite RBP index. Metric values are shown in Appendix A for each site. QA@7 was selected as the reference site for this dataset. It had the highest taxa richness and EPT index and the lowest FBI value of the three sites with taxa richness above 20. Table 4 shows the composite 6-metric index score and the corresponding condition rating (*=severely impaired, **=moderately impaired, ***=non-impaired).

With regards to overall watershed impacts, it is clear that the Neabsco sites have a biological community reflecting substantially impaired conditions relative to the reference Quantico sites. Using a 6 metric index, values of 9 or less indicate severe impairment, while those of 27 or less indicate moderate impairment. Box plots pooling all sites in each watershed (Figure 3) showed that Neabsco sites tended to be less than 10, while Powells sites were generally in the low 20's and Quantico sites in the upper 20's. A strong positive relationship was found between the percentage of low intensity land use and the 6-metric RBP composite index (Figure 4). All of the individual metrics were significantly correlated with percentage of low intensity land use with highest correlation being for EPT index and taxa richness and lowest correlation with EPT/chironomid abundance (Table 5). Interestingly, the composite index correlated better with low intensity land use than did any of the individual metrics. Only one metric (EPT/chironomid abundance) correlated significantly with watershed area.

The integrator sites exhibited a similar pattern. The integrator site on Neabsco (N@D) had an RBP index of 3, while those in Quantico (Q@M, Q@S, and NF@B) averaged 23. The Powells integrator (P@S, P@M) averaged 23. Smaller watershed sites followed a similar or even more pronounced trend with the other twenty-six Neabsco sites averaging 7.2, while the twelve smaller Quantico sites averaged 28.5. The other Powells sites averaged 18.8.

Overall, the sites below BMP's were highly degraded relative to small watershed reference sites (Figure 5). Wet ponds sites generally performed marginally better than the dry pond site. The effect of individual BMP's was mixed. At the Prince William Parkway Pond site, one of the upstream sites showed only moderate impairment, while the other upstream site exhibited severe impairment. Below the pond the community did not improve, but continued to exhibit severe impairment. Further degradation occurred at PPD3 and PPD 4 with scores dropping to minimal levels. This corresponds with the additional nonpoint pollution load and associated habitat damage resulting from flows from the 84 inch storm sewer draining the Potomac Mills area.

Severe impairment was also observed at GE despite the presence of a wet pond upstream. GW showed a mixed response with one site demonstrating only moderate impairment. The differing response of GE and GW may be due to the higher intensity of existing commercial development in the GE watershed. This result is similar to observations in other years.

The dry ponds in Daleview Manor do not appear to be providing substantial protection to the stream macroinvertebrate community from nonpoint pollution from the mix of single family residences and townhouses. Conditions were characterized as severely impaired at all three stations. The dual wet ponds at Wexford-Highbridge do appear to be supporting a moderately healthy macroinvertebrate assemblage downstream showing only moderate impairment. The Dale Boulvard Culvert site did not demonstrate a clear pattern. While impairment seemed less severe than at some other sites, the land use in the watershed is also less intense at the current time. The Minnieville Elementary site was intended to examine the impact of an uncontrolled storm sewer. Little difference was observed between sites upstream and downstream of the sewer with all four being severely impaired. This was probably due to the relatively small area drained by the sewer relative to the whole watershed area as well as the moderate impairment already found upstream.

The six sites in the Occoquan watershed exhibited varying degrees of moderate impairment.

Fish

The number of fish collected at each site by species is shown in Appendix B as are plots of watershed area vs. 6 metrics used to generate IBI scores. The IBI values for each collection at each site and the quality category that each falls within are shown in Table 6 and summarized by watershed in Figure 6. The integrator site IBI values are somewhat similar for all three watersheds, ranging from 34 to 47. The mean of all integrator site collections for Neabsco Creek (N@D and N@D2) is 34. The mean of all integrator sites in Powells Creek (P@M, P@S, and P@S2) is 38. The mean of all integrator sites in Quantico Creek (Q@M, Q@S, Q@C, Q@C2, and NF@B) is 41. This pattern among the watersheds is similar to that obtained for the benthic macroinvertebrates and relates roughly to the percentage of open land in the three watersheds above the integrator sites: 46% in Neabsco, 74-77% in Powells, and 100% in Quantico. However, it should be noted that the differences observed in fish IBI among watersheds were much less distinct than those found for macroinvertebrates.

Fish communities were examined in relation to several BMP's (Table 6). IBI values above the Prince William Parkway Pond were 26 and 34. Immediately below the pond the mean value rose slightly to 36, then fell to 20 below the first storm sewer, and 24 at both sites below the larger storm sewer. Except for the site immediately below the pond, all downstream sites were classified as "very poor", whereas the upstream sites were considered "poor". The site immediately below the pond rated "fair-poor". IBI values from sites below other wet ponds in Neabsco were consistently "poor". Fish communities were also considered "poor" at the single dry pond site. Fish IBI did increase slightly when comparing a site above a county park (N@P) with one below the park (N@L). The mean values for the sites above and below an uncontrolled stormwater discharge (MEU and MED) located were also "poor".Site N@J was classified "poor-very poor" and appears to be only an intermittently flowing stream.

While the IBI values for BMP sites indicated only "fair" to "poor" biotic integrity, these values were not that different from the small watershed reference sites in the Quantico Creek basin (Figure 7). In fact there was considerable overlap between the two sets of sites. This suggests that low values observed in the vicinity of the BMP sites are at least partly explained by the small size of streams on which this sites are located. The IBI methodology recognizes this dependency on stream size and attempts to remove it by making several of the metrics dependent on drainage area (see Appendix A). However, this was not entirely successful in the current data set as shown in Figure 8, which illustrates that the IBI scores continue to show a significant correlation to area, in this case log of area. This correlation is roughly equal to that between fish IBI and % low density land use (Figure 9). The correlation between log area and % low density land use was not significant and a multiple regression using both factors to predict fish IBI explained 34% of the variance in IBI as compared to each individual factor's ability to explain only 21%.

Physical Characteristics/Water Quality/Habitat

Results of these analyses are shown in Appendix C and can be divided into four components: riparian zone/instream features, substrate, water quality, and habitat. Some riparian zone factors were clearly related to watershed development. In the Neabsco basin, commercial and industrial land uses were most dominant, while in Powells (forest and field) and Quantico (forest) less intensive land uses predominated. Local erosion was often heavy and local nonpoint sources were obvious in Neabsco, while in Powells and Quantico these were less common. Dams and channelization were common in Neabsco and absent (except for a beaver pond) in Powells and Neabsco. Quantico sites had a high degree of canopy cover, while Neabsco sites were more open.

Substrate characteristics also demonstrated clear trends among the watersheds. Sediment odors and oils were common in Neabsco, but absent in Quantico. Black stones indicative of sediment anoxia were found at some sites in Neabsco, but none in Quantico. Particle size of bottom sediments did not show obvious variation between watersheds and sand was the principal deposit forming particle in all basins. Base flow water quality did not exhibit obvious differences between watersheds. However, water odors, surface oils, and turbidity were clearly more common in Neabsco than in Quantico.

A formal rating process for habitat analysis generated a composite rating (Habitat Score) based on eight habitat criteria (Table 7). The theoretical range of this rating was 0 to 115. Quantico and Powells exhibited consistently high scores, generally in the range of 70 to 90 (Figure 10). While some of the Neabsco sites reached 85, the majority of Neabsco values were 40 to 70. Some Neabsco scores were as low as 22. Habitat scores were significantly correlated with both watershed area and % low density land use. Examination of the subscores (Figure 11) showed that Neabsco scored consistently lower than Quantico on channel alteration, scour and deposition, pool/riffle structure, and bank stability. There was substantial overlap in substrate and cover, embededness, bank vegetation, and stream cover. Low levels of scour and deposition and band stability were most positively correlated with % low density land use, while substrate and cover and embeddedness showed little relationship. Substrate and cover and embeddedness received highest ratings at sites draining larger watershed areas.

Habitat below BMP's showed substantial degradation relative to reference streams of the same size in the Quantico watershed. Channel alteration, scour and deposition, bank stability, bank vegetation, and stream cover were most consistently different.

Relationships between Macroinvertebrates, Fish, and Habitat

Both macroinvertebrate index and fish IBI were significantly positively related to habitat index which explained about 30% of the variation in each biological index. The correlation between the fish and macroinvertebrates was also significant, but less strongly so explaining only 16% of the variation in each.

Discussion

Macroinvertebrate communities demonstrated a clear difference between the suburbanized Neabsco Creek watershed and the reference Quantico Creek sites. These differences were highly correlated to the intensity of land use as illustrated by correlations with percent low intensity development in each catchment. Differences in fish communities between these two basins were apparent, but less marked. Macroinvertebrate communities in the intermediately developed Powells Creek watershed were of intermediate quality, but tended to be more similar to Quantico. Powells Creek fish communities demonstrated IBI values that were equivalent to those of Quantico Creek. Thus, in general, stream community integrity was negatively correlated with the intensity of suburban development.

Best Management Practices appeared to mitigate impacts of nonpoint pollution at some sites, but this effect was less marked in 1996 data than in previous years. Immediately below the Prince William Parkway Pond fish communities recovered slightly, but invertebrates were severely impaired. Further downstream, unmitigated storm sewer discharges resulted in the fish community being degraded to "very poor". Some other wet pond sites, notably Wexford-Highbridge, biotic integrity appeared to benefit somewhat from the presence of the BMP. Other BMP's showed little ability to mitigate nonpoint effects on the stream community. At no BMP site did the macroinvertebrate community approach the biotic integrity of the reference sites in Quantico Creek.

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Table 1
Prince William Watersheds Study
Site Descriptions

Site	Drainage Area (km^2)	Stream Order*	Watershed
Structural BMP Sites			
Prince William Parkway Pond			Neabsco
PPUL	0.53	1	
PPUR	0.40	1	
PPD1	1.30	2	
PPD2	1.47	2	
PPD3	1.64	2	
PPD4	1.82	2	
Dale Boulevard Culvert	2.01	2	Neabsco
DBU			
DBD			
Wexford-Highbridge Ponds (WH)	0.34	1	Neabsco
Galinsky Blvd West Pond (GW)	0.21	1	Neabsco
Galinsky Blvd East Pond (GE)	0.23	1	Neabsco
Minnieville Elementary	4.84	3	Neabsco
MEU			
MED			
Daleview Manor Dry Ponds	1.00	1	Neabsco
DM			
DM2			
Pond 4	6.18	2	Powells
P4U			
P4D			
NonStructural BMP Sites			
Neabsco Cr. @ Princedale Rd. (N@P)	3.06	2	Neabsco
Neabsco Cr. @ Lindendale Rd. (N@L)	8.65	3	Neabsco
Integrator Site			
Neabsco Cr. @ Delaney Rd. (N@D)	15.71	3	Neabsco
Reference Sites			
Powells Cr. @ Minnieville Rd. (P@M)	14.75	3	Powells
Powells Cr. @ Spriggs Rd. (P@S)	20.96	3	Powells
S.Fork Quantico Cr. @ Mawavi Fire Rd. (Q@M)	23.45	3	Quantico
S.Fork Quantico Cr. @ Scenic Dr. (Q@S)	33.80	3	Quantico
S.Fork Quantico Cr. just above confl. (Q@C)	43.56	3	Quantico
Mary Bird Branch @ Park Loop Rd. (MB@S)	1.71	2	Quantico
Mary Bird Branch @ T-11 fire road (MB@11)	0.94		Quantico
Mary Bird Branch @ T-7 fire road (MB@7)	0.23		Quantico
S. Fork Trib A @ old blacktop fire road (QA@O)	0.39		Quantico
S. Fork Trib A @ T-7 fire road (QA@7)	0.70		Quantico
S. Fork Trib A @ Scenic Drive (QA@S)	1.25		Quantico
S. Fork Trib B @ Scenic Drive (QB@S)	3.47		Quantico
North Fork @ Burma Fire Road (NF@B)	12.19		Quantico

*Stream order calculation uses smallest (intermittent usually) streams shown on 7.5" USGS Topo Map as first order.

Table 2
Metrics for Rapid Bioassessment Protocols

Macroinvertebrates (EPA RBP II)

Taxa Richness (total number of families)
Family Biotic Index
Ratio of Scrapers to Filter Collectors
Ratio of EPT to Chironomid Abundance
Percent Contribution of Dominant Family
EPT Index (number of EPT families)
Community Similarity Index
Ratio of Shredders to Total Abundance (CPOM sample)

Fish (EPA RBP V)

Number of Native Fish Species
Number of Darter or Benthic Species
Number of Sunfish or Pool Species
Number of Sucker or Long-lived Species
Number of Intolerant Species
Proportion of Green Sunfish or Tolerant Individuals
Proportion of Omnivorous Individuals
Proportion Insectivores
Proportion Top Carnivores
Total Number of Individuals
Proportion Hybrids or Exotics
Proportion with Disease/Anomalies

Table 3
Land Use in Prince William Watersheds - 1995

	SingFamRes (<1 ac lot)	Townhouse /Apt	* SingFamRes (>1 ac lot)	* Misc. (>1 ac lot)	Commercial	* Open Space	Highways (>=4 ln)	Total
GE 50mDS	0.0	0.0	0.0	0.0	62.6	35.2	2.2	100.0
GE 200mDS	0.0	0.0	0.0	0.0	51.4	45.5	3.1	100.0
GW 50mDS	0.0	0.0	0.0	0.0	30.1	63.8	6.1	100.0
GW 200mDS	0.0	0.0	0.0	0.0	26.8	66.1	7.0	100.0
PPUR 150mUS	0.0	0.0	0.0	49.9	10.1	31.0	9.0	100.0
PPUL 100mUS	0.0	0.0	0.0	11.7	11.5	67.5	9.3	100.0
PPD1 50mDS	0.0	0.0	0.0	17.6	27.3	43.7	11.4	100.0
PPD1 200mDS	0.0	0.0	0.0	15.3	36.8	38.0	9.9	100.0
DM2 50mDS	45.5	0.0	0.0	0.0	0.0	54.5	0.0	100.0
DM2 200mDS	57.4	0.3	0.0	0.0	0.0	42.3	0.0	100.0
DM 17mDS	65.0	14.5	0.0	0.0	0.0	13.1	7.4	100.0
DB 100mUS	13.5	4.7	0.0	0.0	0.0	81.8	0.0	100.0
DB 5mDS	13.9	4.0	0.0	0.0	5.1	77.1	0.0	100.0
DB 100mDS	13.7	3.9	0.0	0.0	5.0	77.4	0.0	100.0
DB 150mDS	13.7	3.9	0.0	0.0	5.0	77.4	0.0	100.0
MEU 100mUS	53.4	1.8	0.0	0.0	2.4	41.1	1.3	100.0
MEU 100mDS	53.3	1.8	0.0	0.0	2.3	41.3	1.3	100.0
N@P	13.1	1.1	7.5	0.0	0.0	73.1	5.1	100.0
N@L	42.3	0.9	3.1	0.0	0.8	50.9	1.9	100.0
N@D 200mUS	41.7	1.6	3.3	0.0	0.7	51.0	1.6	100.0
N@D 50mUS	42.2	1.5	3.0	0.0	0.8	50.7	1.7	100.0
N@D 200mDS	41.9	1.8	3.0	0.0	0.8	50.8	1.7	100.0
WH 150mDS	33.2	10.8	19.3	0.0	0.0	31.3	5.4	100.0
P4U	0.4	0.0	3.1	0.0	0.0	96.5	0.0	100.0
P@M	0.2	0.0	26.3	0.0	0.0	73.6	0.0	100.0
P@S	0.1	0.0	22.4	0.0	0.0	77.4	0.0	100.0

*Low Density Land Uses

Table 4
Macroinvertebrate Bioassessment Scores by Station

Station	Location	Date	Analyst	6-metric Index	%REF	Condition Category
PPUL	100mUS	06/18/96	AVN	18	50.0	**
PPUR	100mUS	06/18/96	AVN	6	16.7	*
PPUR	50mUS	06/18/96	AVN	6	16.7	*
PPD1	50mDS	06/17/96	AVN	6	16.7	*
PPD1	200mDS	06/17/96	AVN	6	16.7	*
PPD2		06/17/96	AVN	9	25.0	*
PPD3		06/17/96	AVN	3	8.3	*
PPD4		06/17/96	AVN	3	8.3	*
DBD	5mDS	06/27/96	AVN	9	25.0	*
DBD	200mDS	06/27/96	AVN	12	33.3	**
WH	50mDS	06/13/96	AVN	15	41.7	**
GW	50mDS	06/13/96	AVN	12	33.3	**
GW	150mDS	06/13/96	AVN	9	25.0	*
GE	50mDS	06/13/96	AVN	6	16.7	*
GE	200mDS	06/13/96	AVN	3	8.3	*
MEU	200mUS	06/10/95	AVN	3	8.3	*
MEU	50mUS	06/10/95	AVN	3	8.3	*
MED	50mDS	06/10/95	AVN	3	8.3	*
MED	200mDS	06/10/95	AVN	3	8.3	*
DM	17mDS	06/10/96	AVN	6	16.7	*
DM2	50mDS	06/24/96	AVN	3	8.3	*
DM2	200mDS	06/24/96	AVN	6	16.7	*
P4U	200mUS	06/25/96	AVN	21	58.3	**
P4U	50mUS	06/25/96	AVN	18	50.0	**
P4D	50mDS	06/25/96	AVN	18	50.0	**
P4D	200mDS	06/25/96	AVN	18	50.0	**
N@P	200mUS	06/11/96	AVN	15	41.7	**
N@P	50mUS	06/11/96	AVN	6	16.7	*
N@L	50mUS	06/24/96	AVN	3	8.3	*
N@L	150mUS	06/24/96	AVN	12	33.3	**
N@D	200mUS	06/17/96	AVN	3	8.3	*
N@D	50mUS	06/17/96	AVN	3	8.3	*
P@M	100mUS	06/11/96	AVN	21	58.3	**
P@M	100mDS	06/11/96	AVN	24	66.7	**
P@S	50mDS	06/30/96	AVN	24	66.7	**
P@S	200mDS	06/30/96	AVN	24	66.7	**
Q@M	50mDS	06/25/96	AVN	18	50.0	**
Q@S	50mUS	06/14/96	AVN	30	83.3	***
MB@S	50mUS	06/12/96	AVN	27	75.0	**
MB@11	5mUS	06/27/96	AVN	24	66.7	**
MB@7	50mDS	06/21/96	AVN	30	83.3	***
MB@7	200mDS	06/21/96	AVN	27	75.0	**
QA@O	50mDS	06/21/96	AVN	30	83.3	***
QA@O	200mDS	06/21/96	AVN	30	83.3	***
QA@7	5mDS	06/27/96	AVN REF	33	91.7	***
QA@S	5mDS	06/12/96	AVN	33	91.7	***
QA@S	200mUS	06/12/96	AVN	27	75.0	**
QB@S	210mUS	06/14/96	AVN	27	75.0	**
QB@S	5mDS	06/14/96	AVN	21	58.3	**
NF@B	11mDS	06/27/96	AVN	21	58.3	**
QB@S	50mUS	06/14/96	AVN	33	91.7	***
NF@mine	200mUS	06/26/96	AVN	15	41.7	**
NF@mine	50mUS	06/26/96	AVN	6	16.7	*
NF@mine	50mDS	06/26/96	AVN	30	83.3	***
NF@mine	200mDS	06/26/96	AVN	18	50.0	**
C@RH	Pond	08/06/96	AVN	18	50.0	**
C@RH	US left	08/06/96	AVN	24	66.7	**
LH@DD		07/24/96	AVN	21	58.3	**
LH@W		07/29/96	AVN	15	41.7	**
LH@G		07/29/96	AVN	18	50.0	**
B@28		07/26/96	AVN	21	58.3	**

Table 5

Correlation Coefficients between Macroinvertebrate Metrics and Watershed Parameters

	Area	% Low Density Land Use
Taxa richness	-0.007	0.755**
Family Biotic Index	0.035	-0.664**
EPT/Chironomid Abundance	0.487**	0.380**
% Dominant Taxon	-0.202	-0.723**
EPT Index	0.208	0.768**
Sorensen's Index	0.050	0.682**
Composite Index (6-metric)	0.168	0.843**

*: significant at the 0.05 level (n=45)
**: significant at the 0.01 level (n=45)

Table 6
Fish Bioassessment Scores by Station

Site	Site Code	IBI Score	Rating
Neabsco Creek Prince William Co. Parkway Wet Pond (upstream) Left	PPUL	26	Poor
Neabsco Creek Prince William Co. Parkway Wet Pond (upstream) Right	PPUR	34	Poor
Neabsco Creek Prince William Co. Parkway Wet Pond (downstream)	PPD1	36	Fair
Neabsco Creek Prince William Co. Parkway Wet Pond (downstream) Riparian Veg. area	PPD2	20	Very Poor
Neabsco Creek Prince William Co. Parkway Wet Pond (100 m downstream of sewer outfall)	PPD3	24	Very Poor
Neabsco Creek Prince William Co. Parkway Wet Pond (100 m upstream of sewer outfall)	PPU4	24	Very Poor
Neabsco Creek PrinceWilliam Commons @ Golansky Blvd. (Pond 2)	GW	32	Poor
Neabsco Creek PrinceWilliam Commons @ Golansky Blvd. (Pond 1)	GE	32	Poor
Neabsco Creek Daleview Mannor	DM	32	Poor
Neabsco Creek Wexford Highbridge	WH	34	Poor
Neabsco Creek @ Dale Blvd. (downstream)	DBD	30	Poor
Neabsco Creek Unprotected Storm Sewer near Minnieville Elementary School (upstream)	MEU	30	Poor
Neabsco Creek Unprotected Storm Sewer near Minnieville Elementary School (downstream)	MED	34	Poor
Neabsco Creek Mainsteam @ Princedale Rd.	N@P	38	Fair
Neabsco Creek Mainsteam @ Lindondale Rd.	N@L	32	Poor
Neabsco Creek @ Minnieville Rd. (delany US)	N@D	34	Poor
Neabsco Creek @ Minnieville Rd. #2 (delany DS)	N@D2	34	Poor
Neabsco Creek @ Jenkins Park	N@J	26	Poor
Powells Creek Pond 4 (upstream 200m)	P4U	46	Good
Powells Creek Pond 4 (downstream 200m)	P4D	40	Fair
Powells Creek @ Minnieville Rd.	P@M	36	Fair
Powells Creek @ Spriggs Rd. (downstream)	P@S	38	Fair
Powells Creek @ Spriggs Rd. #2 (upstream)	P@S2	40	Fair
Quantico Creek South Branch @ Mawavi Fire Rd.	Q@M	42	Fair
Quantico Creek South Branch @ Scenic Drive	Q@S	46	Good
Quantico Creek Above Confluence with Northfork	Q@C	36	Fair
Quantico Creek Above Confluence with Northfork 2	Q@C2	38	Fair
Quantico Creek Mary Bird Branch @ Park Loop Rd.	MB@S	40	Fair
Quantico Creek @ T11	MB@11	24	Poor
Quantico Creek Mary Bird Branch @ Right off OBT.	MB@7	26	Poor
Quantico Creek @ Old Blacktop Fire Rd.	QA@O	36	Fair
Quantico Creek T7 @ Left off OBT	QA@7	30	Poor
Quantico Creek @ Scenic Drive Trib. A	QA@S	46	Good
Quantico Creek South Fork @ Trib. B	QB@S	50	Good
Quantico Creek @ Burma Fire Rd.	NF@B	44	Fair

Table 7
Habitat Assessment Scores by Station

STATION	Date	Substrate & Cover	Embeddedness	Flow	Channel alteration	Scour & Deposition	Pool/riffle	Bank Stability	Bank Vegetation	Stream Cover	Overall Score
PPUL	24-Oct-96	6	7		3	7	9	4	4	4	44
PPUR	31-Oct-96	6	8		5	10	9.5	5	4	7	54.5
PPD1	21-Nov-96	10	2		2	4	8	0	2	3	31
PPD2	21-Nov-96	10	5		6	6	9	5	6	5	52
PPD3	21-Nov-96	1	2		0	1	15	0	1	2	22
	21-Nov-96	4	2		3	4	15	3	4	6	41
	21-Nov-96	2	6		1	1	15	3	1	2	31
	21-Nov-96	4	11		4	5	15	3	1	6	49
PPD4	21-Nov-96	3	6		3	3	15	3	2	5	40
GW	24-Oct-96	6	9		8	4	14	0	2	6	49
GE	04-Oct-96	12	11		8	9	11	5	8	8	72
DM	27-Jun-94	10	8		5	3	9	0	1	1	37
WH	18-Dec-96	7	13		11	9	11	4	6	6	67
DBU											
DBD	28-Dec-96	5	6		6	7	13	5	7	5	54
MEU	16-Dec-96	16	13		8	9	9	4	8	7	74
MED	17-Dec-96	14	14		9	9	10	7	7	7	77
N@P	16-Oct-96	4	3		4	6	10	5	6	4	42
N@L	11-Nov-96	6	7		5	1	13	3	4	4	43
N@J	25-Jul-96	13	18		5.5	6	5.5	1	1	7	57
N@D	15-Oct-96	19	13		12	8	10	7	8	8	85
N@D2	15-Oct-96	19	16		10	7	12	7	8	7	86
P4U											
P4D											
P@M	16-Dec-96	13	12		9	9	11	8	8	8	78
P@S	17-Jul-96	18	18		9	10	9	8	7	7	86
P@S2	22-Jul-96	18	18		9.5	13.5	8	7	7	5	86
Q@M	05-Nov-96	17	15		15	13	9	8	9	9	95
Q@S	07-Nov-96	14	12		9	11	13	5	6	8	78
Q@C	04-Nov-96	17	19		9	12	13	6	5	7	88
Q@C2	04-Nov-96	14	13		15	9	14	6	6	6	83
MB@S	15-Nov-96	10	14		8	9	13	5	8	6	73
MB@11	19-Nov-96	8	6		12	9	14	8	8	5	70
MB@7	23-Nov-96	10	8		14	12	13	9	10	9	85
QA@O	23-Nov-96	7	10		12	8	12	9	10	8	76
QA@7	20-Nov-96	6	7		5	9	14	7	9	9	66
QA@S	14-Nov-96	15	12		9	8	14	5	7	8	78
QB@S	15-Nov-96	16	15		12	12	13	7	8	8	91
NF@B	26-Jul-94	19	17		11	11	14	7	6	5	90

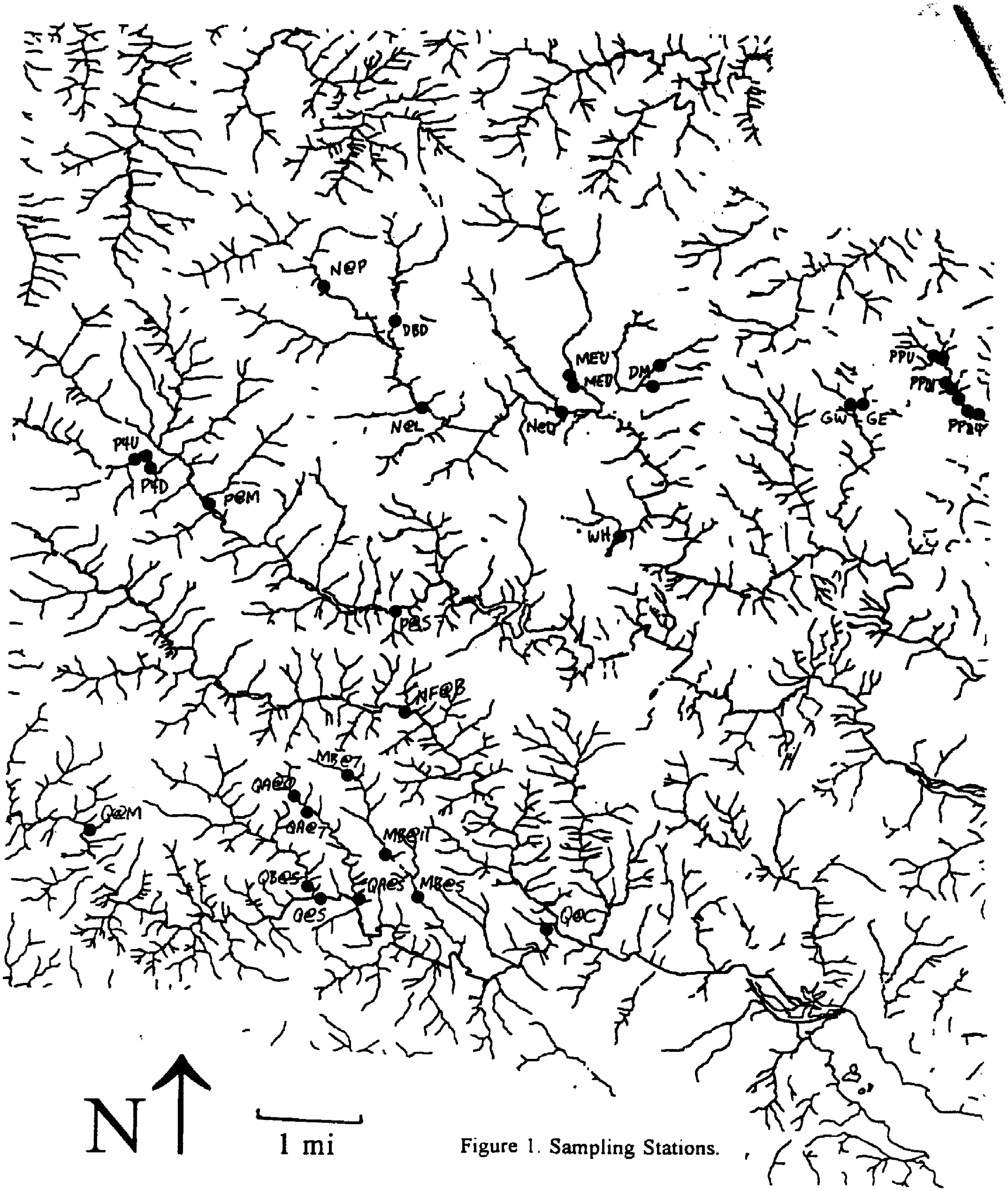
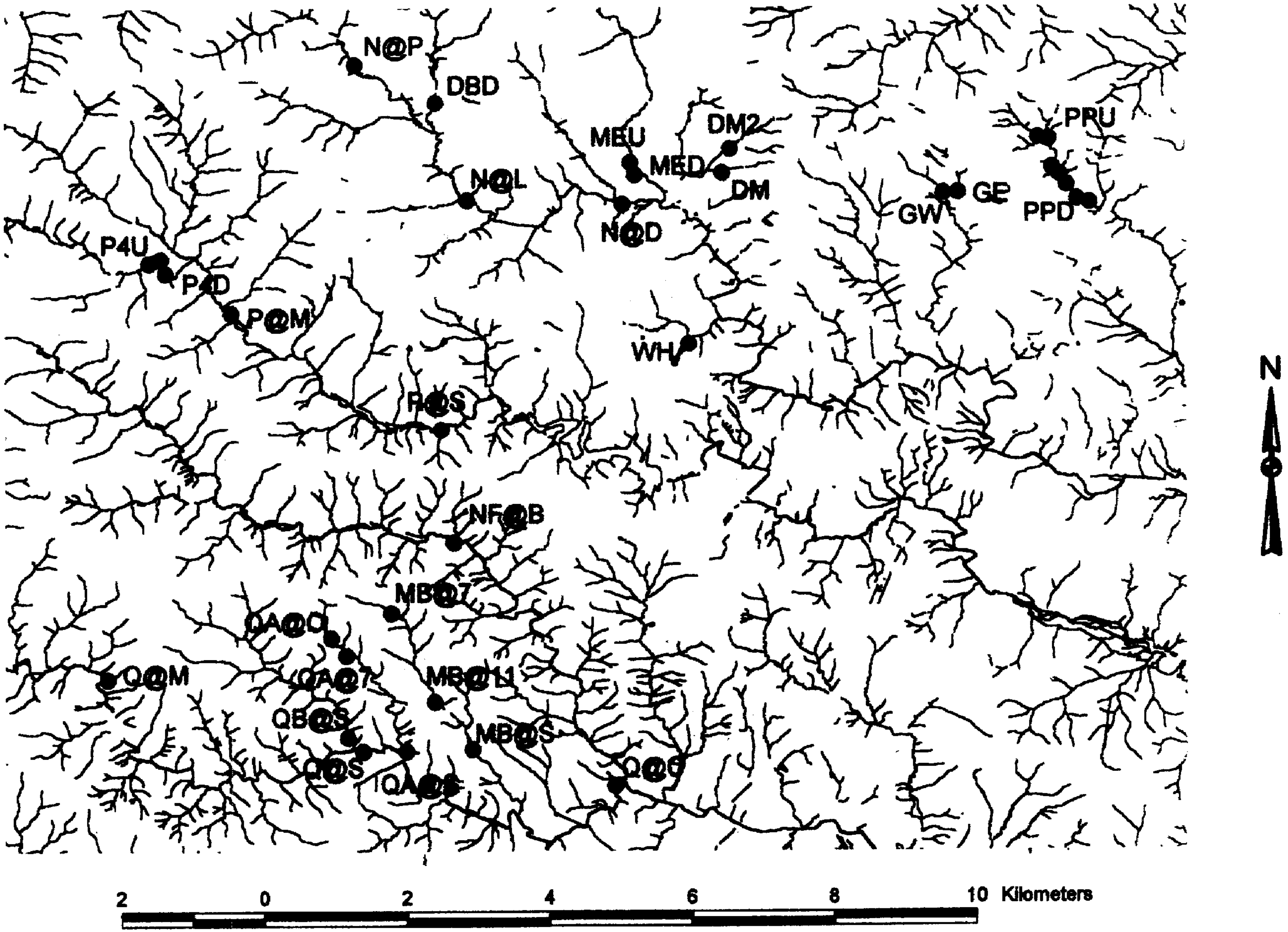


Figure 1. Sampling Stations.

Prince William Watersheds
Bioassessment Sampling



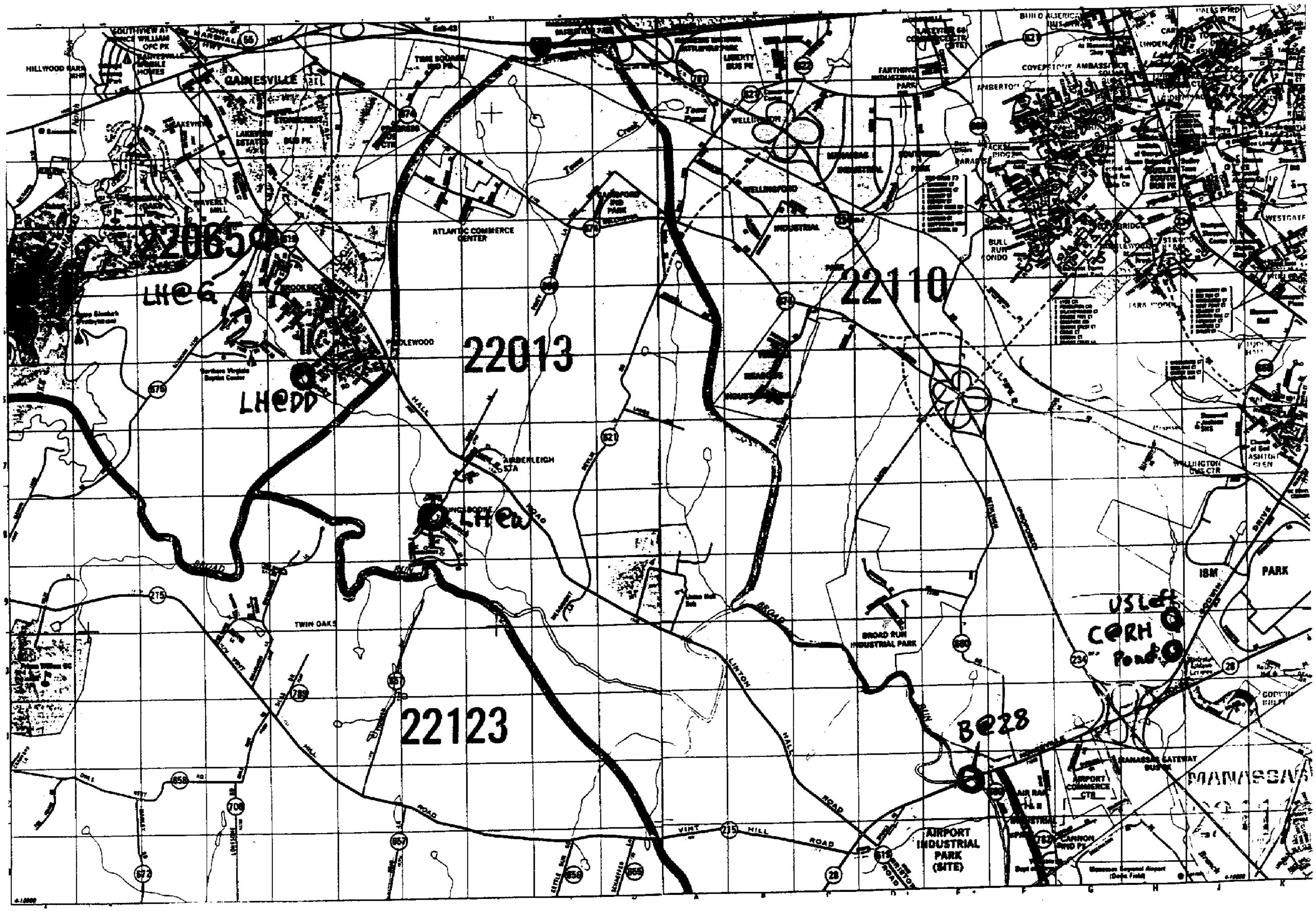
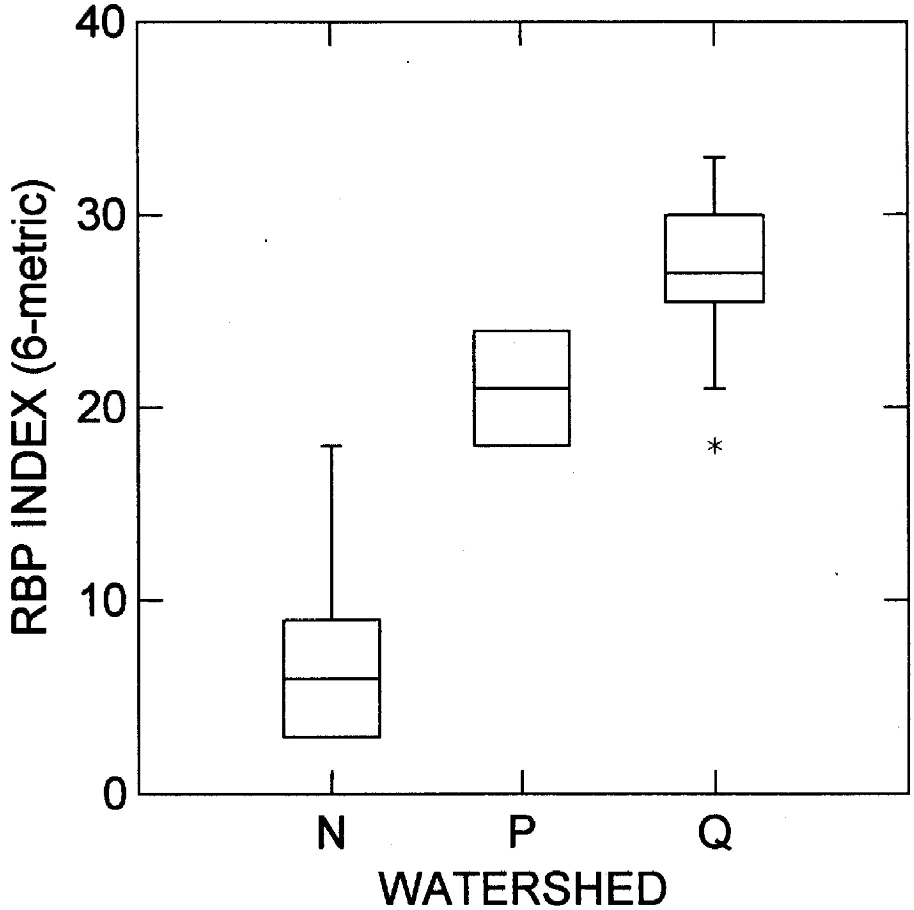


Figure 2. Occoquan Watershed Stations



Watershed Codes: N=Neabsco, P=Powells, Q=Quantico

Figure 3

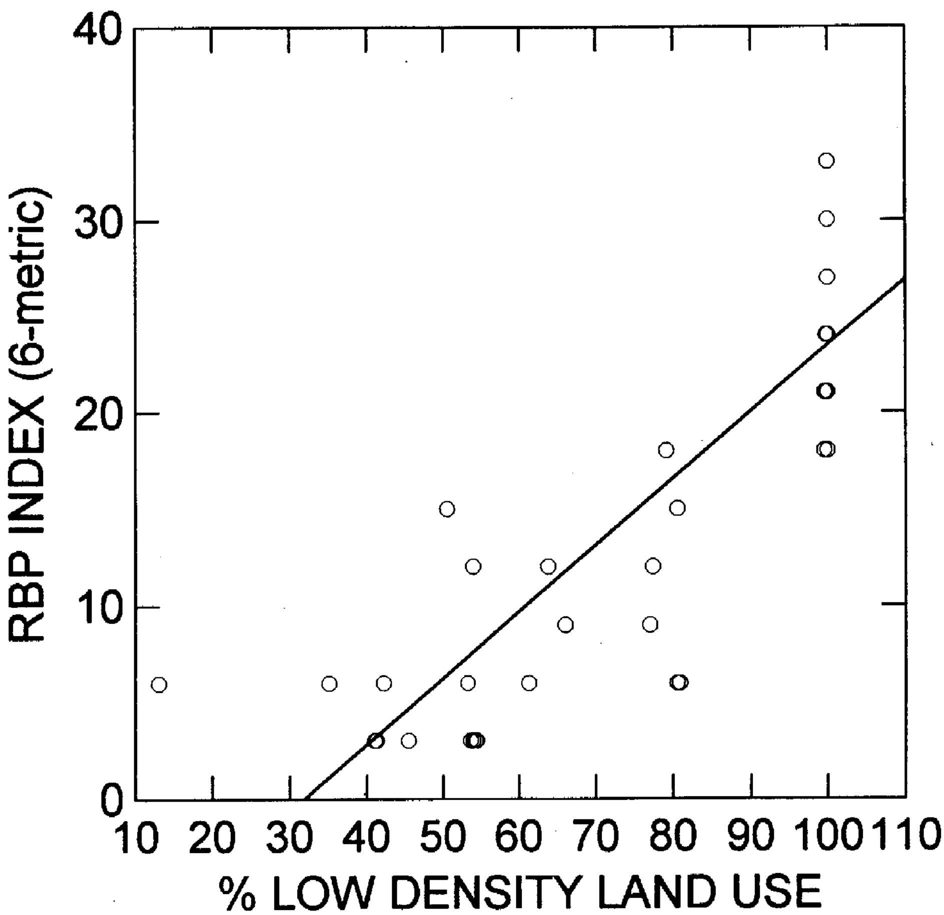
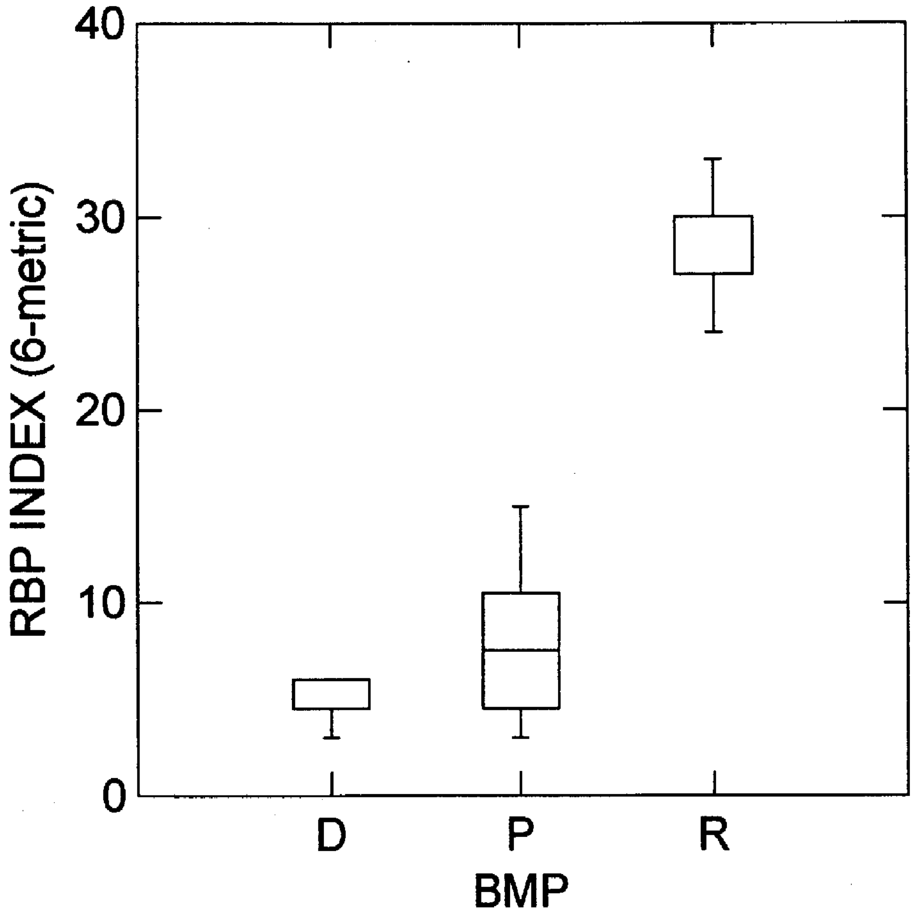
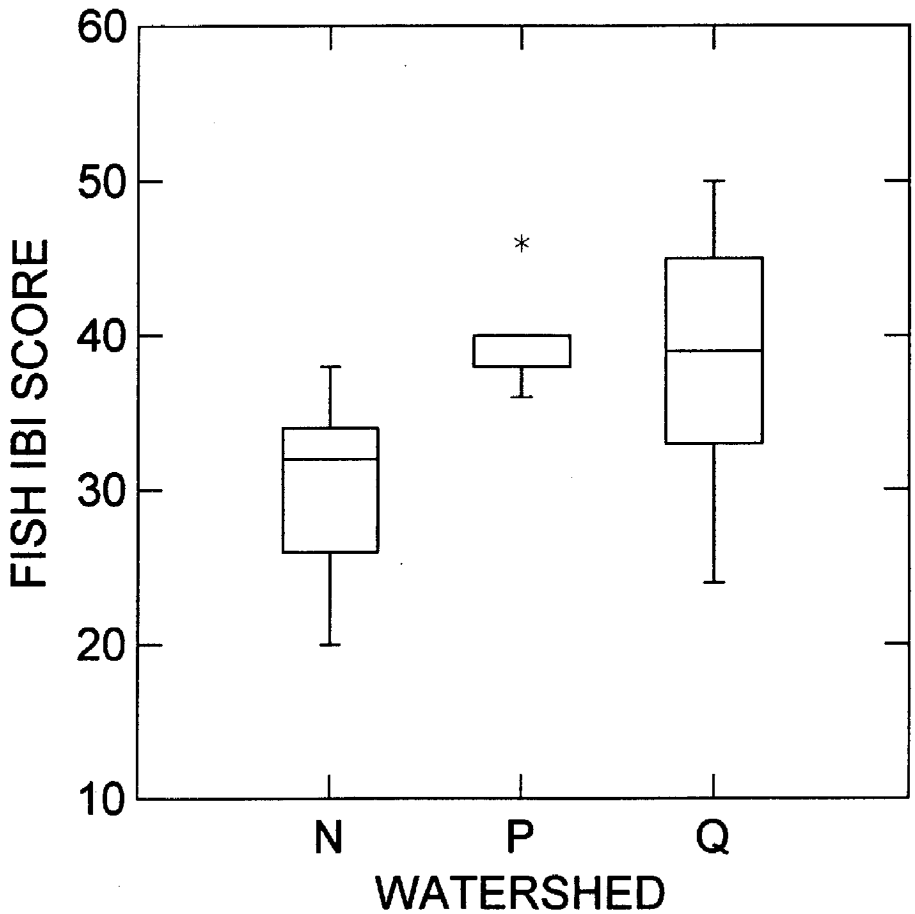

40
30
20
10
0
RBP INDEX (6-metric)
10 20 30 40 50 60 70 80 90 100 110
% LOW DENSITY LAND USE

Figure 4



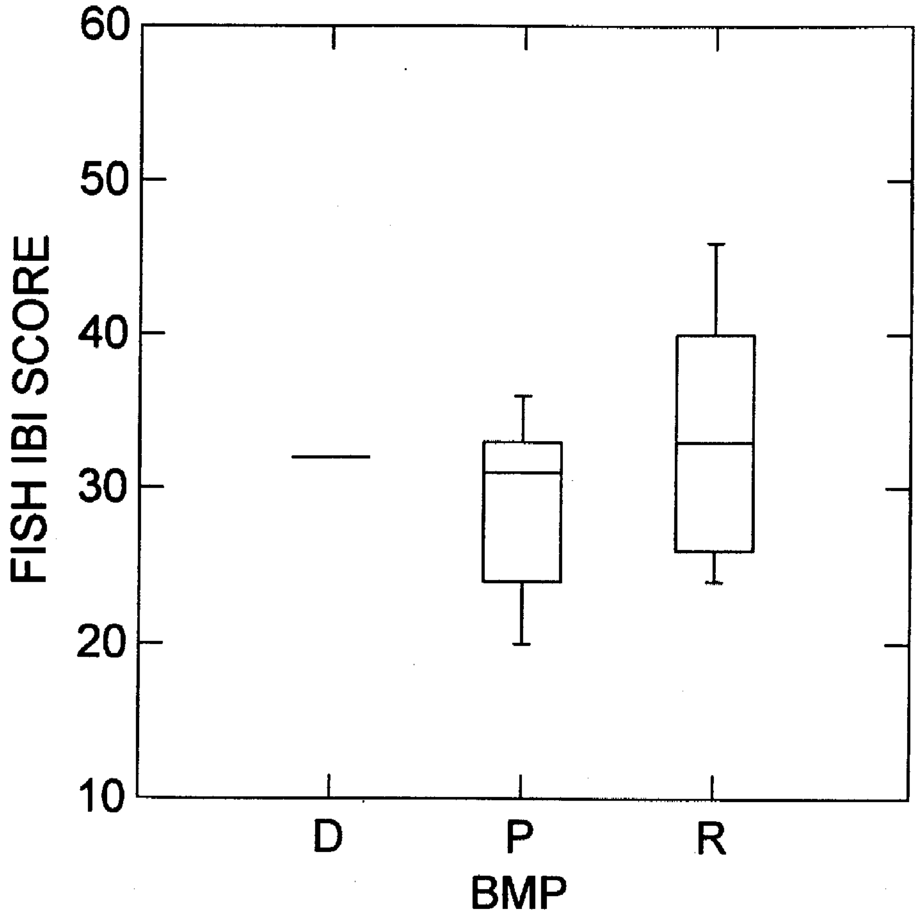
BMP Codes: D=dry pond, P=wet pond, R=reference

Figure 5



Watershed Codes: N=Neabsco, P=Powells, Q=Quantico

Figure 6



BMP Codes: D=dry pond, P=wet pond, R=reference

Figure 7

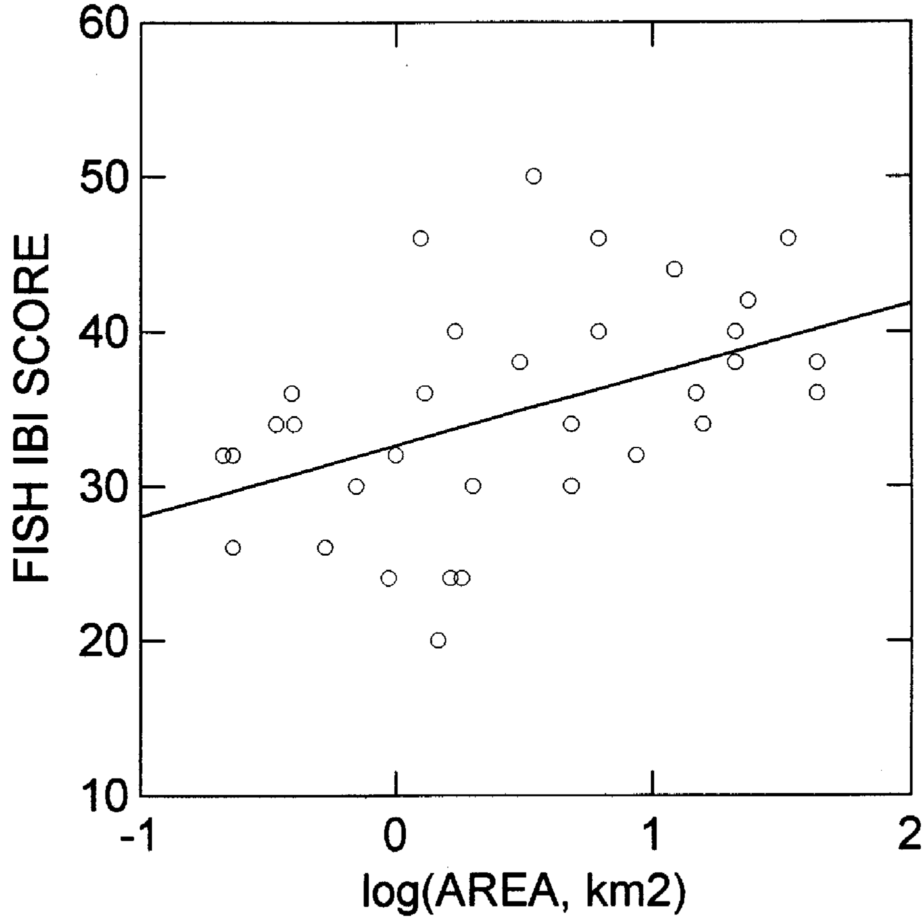
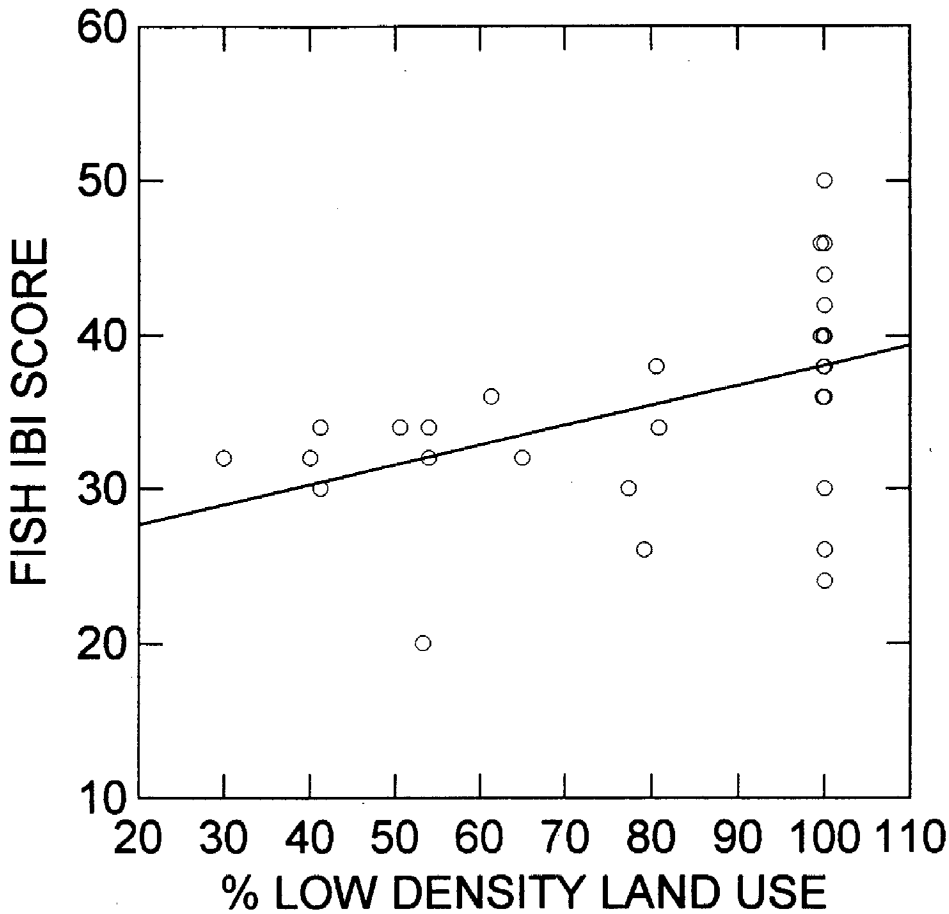
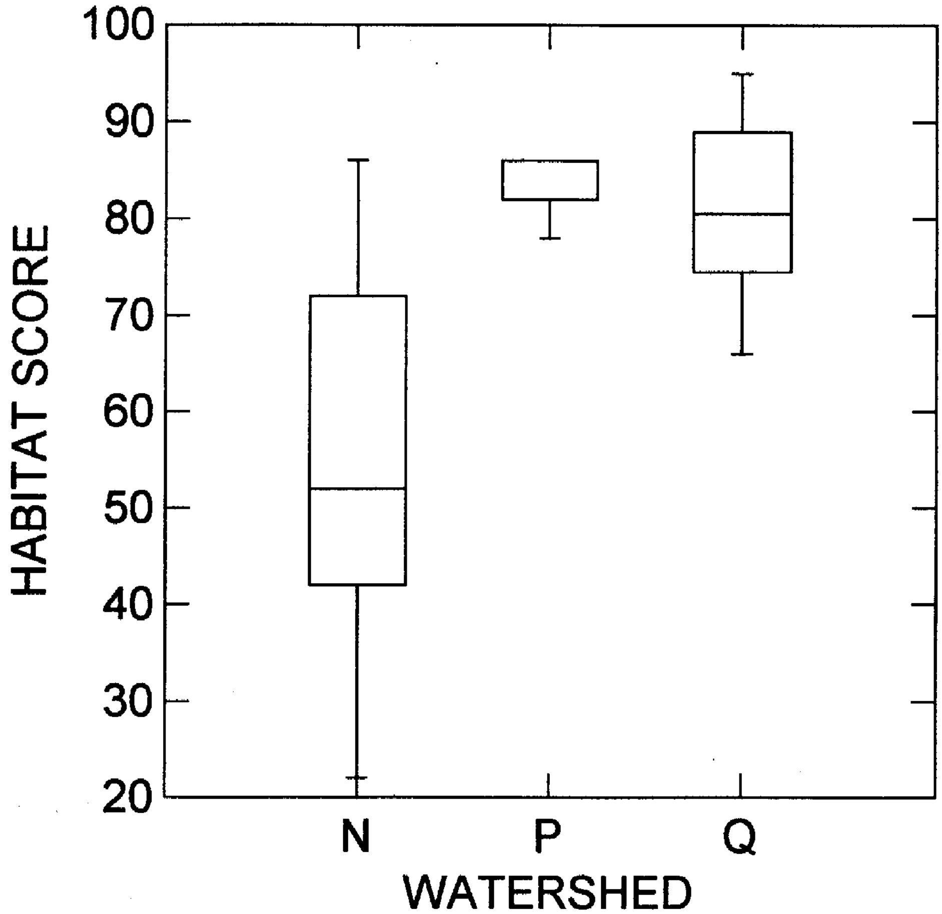


Figure 8



60
50
40
30
20
10
20 30 40 50 60 70 80 90 100 110
FISH IBI SCORE
% LOW DENSITY LAND USE

Figure 9



Watershed Codes: N=Neabsco, P=Powells, Q=Quantico

Figure 10

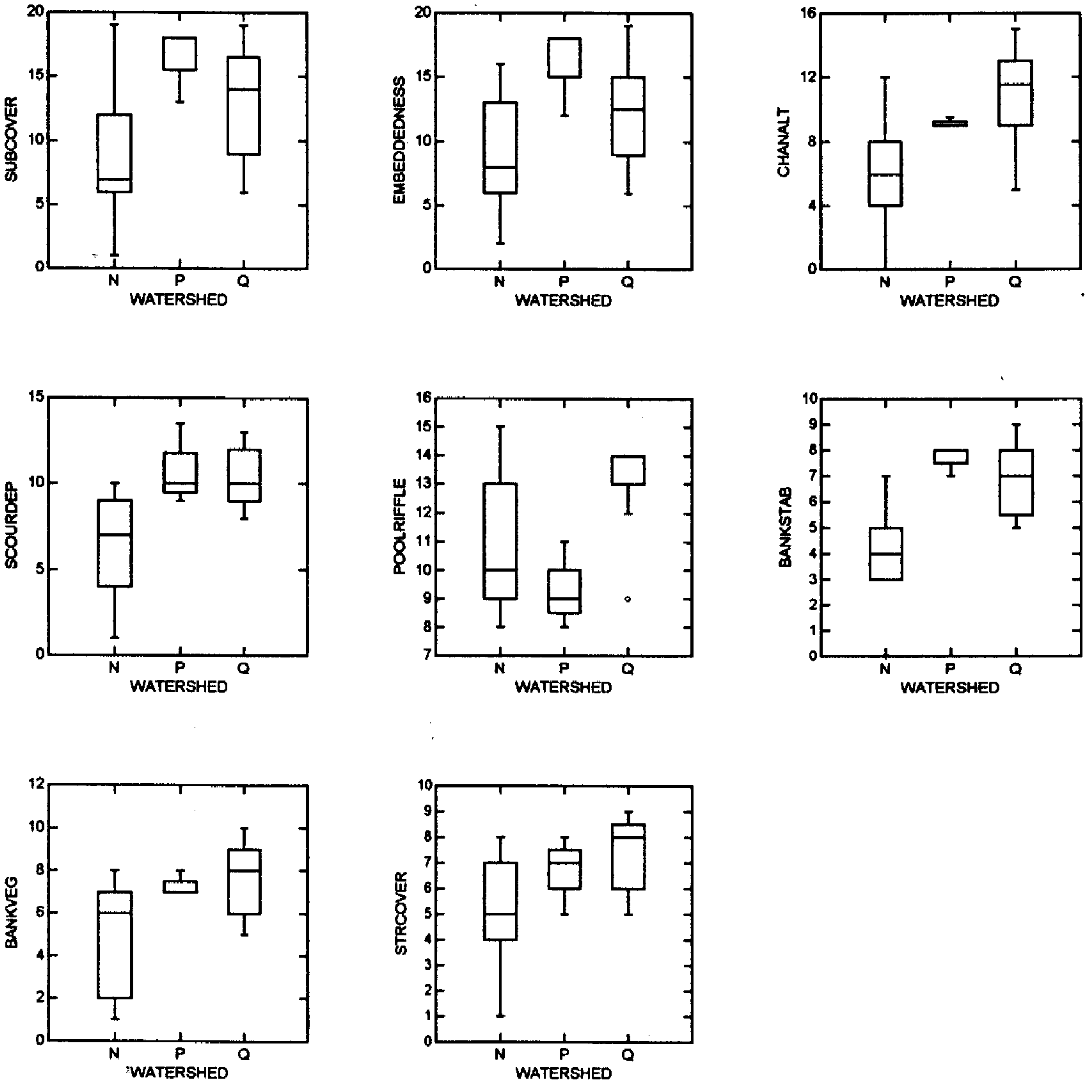

SUBCOVER
EMBEDDEDNESS
CHANALT
SCOURDEP
POOLRIFFLE
BANKSTAB
BANKVEG
STRCOVER
N P Q
WATERSHED

Figure 11

Appendices

A. Macroinvertebrate Data

Table 1. Raw Metric Scores
Table 2. Metric Scores Standardized to Reference
Table 3. Numerical Rating for Each Metric and Multimetric Index Calculation
Table 4. Abundance of Each Family for Each Sample (Raw Data)

B. Fish Data

Table 1. Raw Metric Scores and IBI Calculation
Table 2. Abundance of Each Species for Each Sample (Raw Data)
Figure 1. Graphs for Area Correction of Metric Scores

C. Physical Characterization/Water Quality Data

Table 1. Water Quality Data
Table 2. Sediment Data
Table 3. Stream Channel/Riparian Data

A. Macroinvertebrate Data

Table 1. Raw Metric Scores

Station	Location	Date	Analyst	TaxRich	FBI	ept/chr	%dom	EPT Index	Soren
PPUL	100mUS	06/18/96	AVN	12	4.16	2.87	60.1	2	0.444
PPUR	100mUS	06/18/96	AVN	8	5.64	0.09	69.7	1	0.375
PPUR	50mUS	06/18/96	AVN	9	5.53	0.16	76.6	1	0.485
PPD1	50mDS	06/17/96	AVN	9	5.94	0.16	72.1	1	0.364
PPD1	200mDS	06/17/96	AVN	11	5.96	0.04	57.6	1	0.286
PPD2		06/17/96	AVN	6	5.91	0.31	80.0	1	0.400
PPD3		06/17/96	AVN	6	5.94	0.03	82.2	1	0.333
PPD4		06/17/96	AVN	6	6.06	0.00	84.6	0	0.200
DBD	5mDS	06/27/96	AVN	7	5.51	0.30	60.6	1	0.387
DBD	200mDS	06/27/96	AVN	7	4.29	7.50	63.8	1	0.323
WH	50mDS	06/13/96	AVN	13	4.86	3.00	44.4	2	0.270
GW	50mDS	06/13/96	AVN	7	4.95	1.04	34.4	1	0.323
GW	150mDS	06/13/96	AVN	7	5.13	0.71	60.0	1	0.387
GE	50mDS	06/13/96	AVN	5	5.25	0.38	91.0	1	0.345
GE	200mDS	06/13/96	AVN	4	5.80	0.00	89.6	1	0.286
MEU	200mUS	06/10/95	AVN	3	6.05	0.00	69.6	0	0.148
MEU	50mUS	06/10/95	AVN	5	5.89	0.00	86.3	0	0.345
MED	50mDS	06/10/95	AVN	4	5.97	0.02	77.5	1	0.286
MED	200mDS	06/10/95	AVN	6	5.97	0.03	51.9	2	0.333
DM	17mDS	06/10/96	AVN	9	5.85	0.00	88.2	0	0.364
DM2	50mDS	06/24/96	AVN	8	5.97	0.00	88.5	0	0.250
DM2	200mDS	06/24/96	AVN	9	5.92	0.02	91.6	1	0.424
P4U	200mUS	06/25/96	AVN	12	5.17	1.21	25.5	1	0.389
P4U	50mUS	06/25/96	AVN	12	4.20	13.18	64.2	4	0.444
P4D	50mDS	06/25/96	AVN	15	4.73	3.47	38.3	4	0.410
P4D	200mDS	06/25/96	AVN	10	4.07	ERR	63.0	3	0.353
N@P	200mUS	06/11/96	AVN	14	5.78	0.03	46.9	1	0.632
N@P	50mUS	06/11/96	AVN	5	5.93	0.06	47.2	1	0.276
N@L	50mUS	06/24/96	AVN	3	5.00	0.00	85.7	0	0.148
N@L	150mUS	06/24/96	AVN	8	4.54	0.00	36.0	0	0.375
N@D	200mUS	06/17/96	AVN	7	5.92	0.02	90.4	1	0.323
N@D	50mUS	06/17/96	AVN	3	5.83	0.15	54.2	1	0.222
P@M	100mUS	06/11/96	AVN	17	4.53	4.03	43.1	5	0.439
P@M	100mDS	06/11/96	AVN	12	4.58	4.33	48.4	6	0.500
P@S	50mDS	06/30/96	AVN	14	4.85	1.84	26.7	4	0.579
P@S	200mDS	06/30/96	AVN	14	4.94	25.50	29.6	5	0.526
Q@M	50mDS	06/25/96	AVN	13	5.77	9.09	53.2	7	0.541
Q@S	50mUS	06/14/96	AVN	14	4.58	7.63	25.8	8	0.526
MB@S	50mUS	06/12/96	AVN	18	3.97	1.31	29.7	8	0.571
MB@11	5mUS	06/27/96	AVN	15	3.58	1.26	33.3	6	0.615
MB@7	50mDS	06/21/96	AVN	20	4.00	1.08	26.9	7	0.682
MB@7	200mDS	06/21/96	AVN	20	4.39	0.51	31.8	6	0.682
QA@O	50mDS	06/21/96	AVN	20	4.62	0.69	27.1	7	0.545
QA@O	200mDS	06/21/96	AVN	19	3.63	1.24	26.9	6	0.558
QA@7	5mDS	06/27/96	AVN REF	24	3.96	1.01	36.6	11	1.000
QA@S	5mDS	06/12/96	AVN	22	4.57	0.97	34.6	10	0.652
QA@S	200mUS	06/12/96	AVN	22	4.90	1.47	29.9	9	0.565
QB@S	210mUS	06/14/96	AVN	19	3.34	1.98	27.1	7	0.419
QB@S	5mDS	06/14/96	AVN	16	4.07	1.81	60.6	6	0.600
NF@B	11mDS	06/27/96	AVN	13	5.82	25.43	63.6	8	0.595
QB@S	50mUS	06/14/96	AVN	20	3.43	2.97	25.4	8	0.500
NF@mine	200mUS	06/26/96	AVN	11	5.40	0.42	54.7	4	0.629
NF@mine	50mUS	06/26/96	AVN	9	5.64	0.17	73.5	3	0.485
NF@mine	50mDS	06/26/96	AVN	14	4.66	3.75	21.4	6	0.579
NF@mine	200mDS	06/26/96	AVN	13	4.94	0.71	53.7	7	0.595
C@RH	Pond	08/06/96	AVN	10	5.22	0.88	42.1	3	0.412
C@RH	US left	08/06/96	AVN	15	4.41	3.83	29.0	2	0.359
LH@DD		07/24/96	AVN	11	4.73	3.11	44.2	4	0.514
LH@W		07/29/96	AVN	17	5.33	0.47	57.0	4	0.585
LH@G		07/29/96	AVN	11	5.25	0.76	33.8	4	0.343
B@28		07/26/96	AVN	17	3.92	5.08	39.8	6	0.439

Table 2. Metric Scores Standardized to Reference

Station	Location.	Date	Analyst	TaxRich	FBI	ept/chr	%dom	EPT Inde	Soren
PPUL	100mUS	06/18/96	AVN	50.0	95.1	284.1	60	18.2	0.444
PPUR	100mUS	06/18/96	AVN	33.3	70.2	8.6	70	9.1	0.375
PPUR	50mUS	06/18/96	AVN	37.5	71.7	15.7	77	9.1	0.485
PPD1	50mDS	06/17/96	AVN	37.5	66.7	15.8	72	9.1	0.364
PPD1	200mDS	06/17/96	AVN	45.8	66.4	3.5	58	9.1	0.286
PPD2		06/17/96	AVN	25.0	67.0	30.7	80	9.1	0.400
PPD3		06/17/96	AVN	25.0	66.7	3.3	82	9.1	0.333
PPD4		06/17/96	AVN	25.0	65.4	0.0	85	0.0	0.200
DBD	5mDS	06/27/96	AVN	29.2	71.8	29.9	61	9.1	0.387
DBD	200mDS	06/27/96	AVN	29.2	92.4	742.6	64	9.1	0.323
WH	50mDS	06/13/96	AVN	54.2	81.6	297.0	44	18.2	0.270
GW	50mDS	06/13/96	AVN	29.2	80.0	103.3	34	9.1	0.323
GW	150mDS	06/13/96	AVN	29.2	77.2	70.7	60	9.1	0.387
GE	50mDS	06/13/96	AVN	20.8	75.4	38.1	91	9.1	0.345
GE	200mDS	06/13/96	AVN	16.7	68.3	0.0	90	9.1	0.286
MEU	200mUS	06/10/95	AVN	12.5	65.5	0.0	70	0.0	0.148
MEU	50mUS	06/10/95	AVN	20.8	67.2	0.0	86	0.0	0.345
MED	50mDS	06/10/95	AVN	16.7	66.4	2.1	77	9.1	0.286
MED	200mDS	06/10/95	AVN	25.0	66.4	2.8	52	18.2	0.333
DM	17mDS	06/10/96	AVN	37.5	67.7	0.0	88	0.0	0.364
DM2	50mDS	06/24/96	AVN	33.3	66.3	0.0	88	0.0	0.250
DM2	200mDS	06/24/96	AVN	37.5	66.9	1.7	92	9.1	0.424
P4U	200mUS	06/25/96	AVN	50.0	76.5	120.2	25	9.1	0.389
P4U	50mUS	06/25/96	AVN	50.0	94.4	1305.1	64	36.4	0.444
P4D	50mDS	06/25/96	AVN	62.5	83.7	343.9	38	36.4	0.410
P4D	200mDS	06/25/96	AVN	41.7	97.3	ERR	63	27.3	0.353
N@P	200mUS	06/11/96	AVN	58.3	68.6	2.8	47	9.1	0.632
N@P	50mUS	06/11/96	AVN	20.8	66.8	5.8	47	9.1	0.276
N@L	50mUS	06/24/96	AVN	12.5	79.2	0.0	86	0.0	0.148
N@L	150mUS	06/24/96	AVN	33.3	87.2	0.0	36	0.0	0.375
N@D	200mUS	06/17/96	AVN	29.2	66.9	1.5	90	9.1	0.323
N@D	50mUS	06/17/96	AVN	12.5	67.9	15.2	54	9.1	0.222
P@M	100mUS	06/11/96	AVN	70.8	87.4	399.2	43	45.5	0.439
P@M	100mDS	06/11/96	AVN	50.0	86.5	428.2	48	54.5	0.500
P@S	50mDS	06/30/96	AVN	58.3	81.6	181.9	27	36.4	0.579
P@S	200mDS	06/30/96	AVN	58.3	80.1	2524.8	30	45.5	0.526
Q@M	50mDS	06/25/96	AVN	54.2	68.6	899.7	53	63.6	0.541
Q@S	50mUS	06/14/96	AVN	58.3	86.4	755.4	26	72.7	0.526
MB@S	50mUS	06/12/96	AVN	75.0	99.8	130.0	30	72.7	0.571
MB@11	5mUS	06/27/96	AVN	62.5	110.6	125.2	33	54.5	0.615
MB@7	50mDS	06/21/96	AVN	83.3	99.0	106.9	27	63.6	0.682
MB@7	200mDS	06/21/96	AVN	83.3	90.1	50.3	32	54.5	0.682
QA@O	50mDS	06/21/96	AVN	83.3	85.7	68.5	27	63.6	0.545
QA@O	200mDS	06/21/96	AVN	79.2	109.1	122.3	27	54.5	0.558
QA@7	5mDS	06/27/96	AVN REF	100.0	99.9	100.4	37	100.0	1.000
QA@S	5mDS	06/12/96	AVN	91.7	86.7	96.3	35	90.9	0.652
QA@S	200mUS	06/12/96	AVN	91.7	80.7	146.0	30	81.8	0.565
QB@S	210mUS	06/14/96	AVN	79.2	118.4	196.2	27	63.6	0.419
QB@S	5mDS	06/14/96	AVN	66.7	97.4	179.5	61	54.5	0.600
NF@B	11mDS	06/27/96	AVN	54.2	68.0	2517.7	64	72.7	0.595
QB@S	50mUS	06/14/96	AVN	83.3	115.6	294.4	25	72.7	0.500
NF@mine	200mUS	06/26/96	AVN	45.8	73.3	41.4	55	36.4	0.629
NF@mine	50mUS	06/26/96	AVN	37.5	70.2	17.3	74	27.3	0.485
NF@mine	50mDS	06/26/96	AVN	58.3	85.0	371.3	21	54.5	0.579
NF@mine	200mDS	06/26/96	AVN	54.2	80.2	69.9	54	63.6	0.595
C@RH	Pond	08/06/96	AVN	41.7	75.9	86.6	42	27.3	0.412
C@RH	US left	08/06/96	AVN	62.5	89.8	379.0	29	18.2	0.359
LH@DD		07/24/96	AVN	45.8	83.8	307.7	44	36.4	0.514
LH@W		07/29/96	AVN	70.8	74.2	47.0	57	36.4	0.585
LH@G		07/29/96	AVN	45.8	75.5	75.4	34	36.4	0.343
B@28		07/26/96	AVN	70.8	101.0	503.3	40	54.5	0.439

Table 3. Numerical Rating for Each Metric and Multimetric Index Calculation

Station	Location	Date	Analyst	TaxRich	FBI	ept/chr	%dom	EPT Index	Soren	6-metric Index	%REF	Condition Category
PPUL	100mUS	06/18/96	AVN	3	6	6	0	0	3	18	50.0	**
PPUR	100mUS	06/18/96	AVN	0	3	0	0	0	3	6	16.7	*
PPUR	50mUS	06/18/96	AVN	0	3	0	0	0	3	6	16.7	*
PPD1	50mDS	06/17/96	AVN	0	3	0	0	0	3	6	16.7	*
PPD1	200mDS	06/17/96	AVN	3	3	0	0	0	0	6	16.7	*
PPD2		06/17/96	AVN	0	3	3	0	0	3	9	25.0	*
PPD3		06/17/96	AVN	0	3	0	0	0	0	3	8.3	*
PPD4		06/17/96	AVN	0	3	0	0	0	0	3	8.3	*
DBD	5mDS	06/27/96	AVN	0	3	3	0	0	3	9	25.0	*
DBD	200mDS	06/27/96	AVN	0	6	6	0	0	0	12	33.3	**
WH	50mDS	06/13/96	AVN	3	3	6	3	0	0	15	41.7	**
GW	50mDS	06/13/96	AVN	0	3	6	3	0	0	12	33.3	**
GW	150mDS	06/13/96	AVN	0	3	3	0	0	3	9	25.0	*
GE	50mDS	06/13/96	AVN	0	3	3	0	0	0	6	16.7	*
GE	200mDS	06/13/96	AVN	0	3	0	0	0	0	3	8.3	*
MEU	200mUS	06/10/95	AVN	0	3	0	0	0	0	3	8.3	*
MEU	50mUS	06/10/95	AVN	0	3	0	0	0	0	3	8.3	*
MED	50mDS	06/10/95	AVN	0	3	0	0	0	0	3	8.3	*
MED	200mDS	06/10/95	AVN	0	3	0	0	0	0	3	8.3	*
DM	17mDS	06/10/96	AVN	0	3	0	0	0	3	6	16.7	*
DM2	50mDS	06/24/96	AVN	0	3	0	0	0	0	3	8.3	*
DM2	200mDS	06/24/96	AVN	0	3	0	0	0	3	6	16.7	*
P4U	200mUS	06/25/96	AVN	3	3	6	6	0	3	21	58.3	**
P4U	50mUS	06/25/96	AVN	3	6	6	0	0	3	18	50.0	**
P4D	50mDS	06/25/96	AVN	3	3	6	3	0	3	18	50.0	**
P4D	200mDS	06/25/96	AVN	3	6	6	0	0	3	18	50.0	**
N@P	200mUS	06/11/96	AVN	3	3	0	3	0	6	15	41.7	**
N@P	50mUS	06/11/96	AVN	0	3	0	3	0	0	6	16.7	*
N@L	50mUS	06/24/96	AVN	0	3	0	0	0	0	3	8.3	*
N@L	150mUS	06/24/96	AVN	0	6	0	3	0	3	12	33.3	**
N@D	200mUS	06/17/96	AVN	0	3	0	0	0	0	3	8.3	*
N@D	50mUS	06/17/96	AVN	0	3	0	0	0	0	3	8.3	*
P@M	100mUS	06/11/96	AVN	3	6	6	3	0	3	21	58.3	**
P@M	100mDS	06/11/96	AVN	3	6	6	3	0	6	24	66.7	**
P@S	50mDS	06/30/96	AVN	3	3	6	6	0	6	24	66.7	**
P@S	200mDS	06/30/96	AVN	3	3	6	6	0	6	24	66.7	**
Q@M	50mDS	06/25/96	AVN	3	3	6	0	0	6	18	50.0	**
Q@S	50mUS	06/14/96	AVN	3	6	6	6	3	6	30	83.3	***
MB@S	50mUS	06/12/96	AVN	3	6	6	3	3	6	27	75.0	**
MB@11	5mUS	06/27/96	AVN	3	6	6	3	0	6	24	66.7	**
MB@7	50mDS	06/21/96	AVN	6	6	6	6	0	6	30	83.3	***
MB@7	200mDS	06/21/96	AVN	6	6	6	3	0	6	27	75.0	**
QA@O	50mDS	06/21/96	AVN	6	6	6	6	0	6	30	83.3	***
QA@O	200mDS	06/21/96	AVN	6	6	6	6	0	6	30	83.3	***
QA@7	5mDS	06/27/96	AVN REF	6	6	6	3	6	6	33	91.7	***
QA@S	5mDS	06/12/96	AVN	6	6	6	3	6	6	33	91.7	***
QA@S	200mUS	06/12/96	AVN	6	3	6	3	3	6	27	75.0	**
QB@S	210mUS	06/14/96	AVN	6	6	6	6	0	3	27	75.0	**
QB@S	5mDS	06/14/96	AVN	3	6	6	0	0	6	21	58.3	**
NF@B	11mDS	06/27/96	AVN	3	3	6	0	3	6	21	58.3	**
QB@S	50mUS	06/14/96	AVN	6	6	6	6	3	6	33	91.7	***
NF@mine	200mUS	06/26/96	AVN	3	3	3	0	0	6	15	41.7	**
NF@mine	50mUS	06/26/96	AVN	0	3	0	0	0	3	6	16.7	*
NF@mine	50mDS	06/26/96	AVN	3	6	6	6	3	6	30	83.3	***
NF@mine	200mDS	06/26/96	AVN	3	3	3	0	3	6	18	50.0	**
C@RH	Pond	08/06/96	AVN	3	3	6	3	0	3	18	50.0	**
C@RH	US left	08/06/96	AVN	3	6	6	6	0	3	24	66.7	**
LH@DD		07/24/96	AVN	3	3	6	3	0	6	21	58.3	**
LH@W		07/29/96	AVN	3	3	3	0	0	6	15	41.7	**
LH@G		07/29/96	AVN	3	3	6	3	0	3	18	50.0	**
B@28		07/26/96	AVN	3	6	6	3	0	3	21	58.3	**

Sor>0.5-->6 %Ref<=25--->*
0.5>Sor>0.3-->3 25<%Ref<=75--->**
Sor<0.3-->0 %Ref>75--->***

Table 4. Abundance of Each Family for Each Sample (Raw Data)

Station	Location	Date	Hydr	Psychom	Odontoce	Glossoso	Philopota	Limnephilid	Rhyacop	Helicopsy	Hydroptili	Lepidosto
PPUL	100mUS	06/18/96	119									
PPUR	100mUS	06/18/96	2									
PPUR	50mUS	06/18/96	27									
PPD1	50mDS	06/17/96	7									
PPD1	200mDS	06/17/96	2									
PPD2		06/17/96	9									
PPD3		06/17/96	5									
PPD4		06/17/96										
DBU	5mUS	06/27/96										
DBD	5mDS	06/27/96	32									
DBD	50mDS	not done										
DBD	200mDS	06/27/96	30									
WH	50mDS	06/13/96	40									
GW	50mDS	06/13/96	73									
GW	150mDS	06/13/96	35									
GE	50mDS	06/13/96	5									
GE	200mDS	06/13/96	2									
MEU	200mUS	06/10/95										
MEU	50mUS	06/10/95										
MED	50mDS	06/10/95										
MED	200mDS	06/10/95										
DM	17mDS	06/10/96										
DM2	50mDS	06/24/96										
DM2	200mDS	06/24/96	3									
P4U	200mUS	06/25/96	17									
P4U	50mUS	06/25/96	136									
P4D	50mDS	06/25/96	46								1	
P4D	200mDS	06/25/96	34									
N@P	200mUS	06/11/96										
N@P	50mUS	06/11/96										
N@L	50mUS	06/24/96										
N@L	150mUS	06/24/96										
N@D	200mUS	06/17/96	3									
N@D	50mUS	06/17/96	2									
N@D	50mDS	not done										
N@D	200mDS	not done										
P@M	100mUS	06/11/96	84									
P@M	100mDS	06/11/96	119									
P@S	50mDS	06/30/96	20									
P@S	200mDS	06/30/96	60									
Q@M	50mDS	06/25/96	15				5					
Q@C	200mUS											
Q@C	50mUS											
Q@S	50mUS	06/14/96	62				8					
MB@S	50mUS	06/12/96	8									
MB@11	5mUS	06/27/96	22				1					
MB@7	50mDS	06/21/96	8				2					
MB@7	200mDS	06/21/96	9				7					
QA@O	50mDS	06/21/96	1									
QA@O	200mDS	06/21/96	4									
QA@7	5mDS	06/27/96	31			2	2				1	
QA@S	5mDS	06/12/96	1									
QA@S	200mUS	06/12/96	9				1					
QB@S	210mUS	06/14/96	4				7					
QB@S	5mDS	06/14/96	7				1					
NF@B	11mDS	06/27/96	23				1					
QB@S	50mUS	06/14/96	13				6					
NF@mi	200mUS	06/26/96	39								1	
NF@mi	50mUS	06/26/96	12				2					
NF@mi	50mDS	06/26/96	44				26					
NF@mi	200mDS	06/26/96	40				14				1	
C@RH	Pond	08/06/96	78									
C@RH	US left	08/06/96	75									
LH@DD		07/24/96	103				1					
LH@W		07/29/96	59									
LH@G		07/29/96	4									
B@28		07/26/96	45									

Station	Location	Date	Calamoce	Brachycen	Perlidae	Perlodida	Leuctri	Taeniop	Nemour	Capniidae	Ceratopo	Simulidae
PPUL	100mUS	06/18/96			13							
PPUR	100mUS	06/18/96										
PPUR	50mUS	06/18/96										4
PPD1	50mDS	06/17/96										168
PPD1	200mDS	06/17/96										121
PPD2		06/17/96										196
PPD3		06/17/96										22
PPD4		06/17/96										1
DBU	5mUS	06/27/96										
DBD	5mDS	06/27/96										1
DBD	50mDS	not done										
DBD	200mDS	06/27/96										3
WH	50mDS	06/13/96										13
GW	50mDS	06/13/96										1
GW	150mDS	06/13/96										
GE	50mDS	06/13/96										
GE	200mDS	06/13/96										2
MEU	200mUS	06/10/95										
MEU	50mUS	06/10/95										5
MED	50mDS	06/10/95										10
MED	200mDS	06/10/95				1					1	15
DM	17mDS	06/10/96									1	
DM2	50mDS	06/24/96										10
DM2	200mDS	06/24/96										1
P4U	200mUS	06/25/96										27
P4U	50mUS	06/25/96										36
P4D	50mDS	06/25/96										9
P4D	200mDS	06/25/96										
N@P	200mUS	06/11/96									1	82
N@P	50mUS	06/11/96									2	7
N@L	50mUS	06/24/96										
N@L	150mUS	06/24/96										18
N@D	200mUS	06/17/96										12
N@D	50mUS	06/17/96										9
N@D	50mDS	not done										
N@D	200mDS	not done										
P@M	100mUS	06/11/96			9							1
P@M	100mDS	06/11/96			12		1					7
P@S	50mDS	06/30/96									1	
P@S	200mDS	06/30/96			1							28
Q@M	50mDS	06/25/96			1							2
Q@C	200mUS											
Q@C	50mUS											
Q@S	50mUS	06/14/96			21		3					
MB@S	50mUS	06/12/96			33	1			1	6		2
MB@11	5mUS	06/27/96			49		7					1
MB@7	50mDS	06/21/96			5		1		5		1	3
MB@7	200mDS	06/21/96			6		6				1	
QA@O	50mDS	06/21/96	1		2		3					
QA@O	200mDS	06/21/96			6		3		1			
QA@7	5mDS	06/27/96			13	1				11	6	1
QA@S	5mDS	06/12/96			15	15			2	2	1	9
QA@S	200mUS	06/12/96			16	3	4		4			17
QB@S	210mUS	06/14/96			25		42					1
QB@S	5mDS	06/14/96			14	1					1	8
NF@B	11mDS	06/27/96			7							3
QB@S	50mUS	06/14/96			14		47				1	2
NF@mi	200mUS	06/26/96			4						2	1
NF@mi	50mUS	06/26/96								1		1
NF@mi	50mDS	06/26/96			3							1
NF@mi	200mDS	06/26/96			4							4
C@RH	Pond	08/06/96										37
C@RH	US left	08/06/96									1	1
LH@DD		07/24/96										44
LH@W		07/29/96									1	1
LH@G		07/29/96										
B@28		07/26/96		3								

Station	Location	Date	Chironom	Tipulidae	Culicidae	Dixidae	Ptychopte	Psychodi	Empidida	Isonychiid	Baetidae	Ephemer
PPUL	100mUS	06/18/96	46	10								
PPUR	100mUS	06/18/96	23	2					1			
PPUR	50mUS	06/18/96	170	2					8			
PPD1	50mDS	06/17/96	44						2			
PPD1	200mDS	06/17/96	57	1					5			
PPD2		06/17/96	29	1					7			
PPD3		06/17/96	152					1	4			
PPD4		06/17/96	33						1			
DBU	5mUS	06/27/96										
DBD	5mDS	06/27/96	106						26			
DBD	50mDS	not done										
DBD	200mDS	06/27/96	4						3			
WH	50mDS	06/13/96	14						4		2	
GW	50mDS	06/13/96	70									
GW	150mDS	06/13/96	49									
GE	50mDS	06/13/96	13	1								
GE	200mDS	06/13/96	16									
MEU	200mUS	06/10/95	82					1				
MEU	50mUS	06/10/95	21	1								
MED	50mDS	06/10/95	48								1	
MED	200mDS	06/10/95	72							1		
DM	17mDS	06/10/96	82	3								
DM2	50mDS	06/24/96	138						2			
DM2	200mDS	06/24/96	174	3					3			
P4U	200mUS	06/25/96	14	2								
P4U	50mUS	06/25/96	11							1	4	
P4D	50mDS	06/25/96	19						2	9		
P4D	200mDS	06/25/96		1					1	1		
N@P	200mUS	06/11/96	71	4					2			2
N@P	50mUS	06/11/96	17								1	
N@L	50mUS	06/24/96	2	1								
N@L	150mUS	06/24/96	4	2					3			
N@D	200mUS	06/17/96	198	2								
N@D	50mUS	06/17/96	13									
N@D	50mDS	not done										
N@D	200mDS	not done										
P@M	100mUS	06/11/96	31	6						20	6	
P@M	100mDS	06/11/96	40	8					1	31	4	
P@S	50mDS	06/30/96	43	4					10	21	3	
P@S	200mDS	06/30/96	6	1					1	53	4	
Q@M	50mDS	06/25/96	23							142	12	1
Q@C	200mUS											
Q@C	50mUS											
Q@S	50mUS	06/14/96	27	2						62	30	
MB@S	50mUS	06/12/96	48	2		2					1	
MB@11	5mUS	06/27/96	68	23				1				
MB@7	50mDS	06/21/96	25	3							1	
MB@7	200mDS	06/21/96	63	2					1			
QA@O	50mDS	06/21/96	39	1							18	
QA@O	200mDS	06/21/96	17	10							5	
QA@7	5mDS	06/27/96	70	7					5		4	1
QA@S	5mDS	06/12/96	73	4						10	22	2
QA@S	200mUS	06/12/96	59	7					1	34	13	
QB@S	210mUS	06/14/96	54	4						10	6	
QB@S	5mDS	06/14/96	16	3							5	
NF@B	11mDS	06/27/96	7	3						124	6	1
QB@S	50mUS	06/14/96	37	6					2	17	4	
NF@mi	200mUS	06/26/96	110						38		2	
NF@mi	50mUS	06/26/96	86						12			
NF@mi	50mDS	06/26/96	40	1					2	32	40	
NF@mi	200mDS	06/26/96	102						3	3	6	
C@RH	Pond	08/06/96	96						1		5	
C@RH	US left	08/06/96	29	5							36	
LH@DD		07/24/96	37						1			
LH@W		07/29/96	139	4					4		1	
LH@G		07/29/96	67								7	
B@28		07/26/96	12	1							1	1

Station	Location	Date	Heptagen	Batiscida	Siphloneu	Leptophle	Tricorythi	Caenidae	Gomphid	Coenagri	Calipteryg	Cordulag
PPUL	100mUS	06/18/96							2			1
PPUR	100mUS	06/18/96										
PPUR	50mUS	06/18/96										
PPD1	50mDS	06/17/96										
PPD1	200mDS	06/17/96										
PPD2		06/17/96										
PPD3		06/17/96										
PPD4		06/17/96										
DBU	5mUS	06/27/96										
DBD	5mDS	06/27/96										
DBD	50mDS	not done										
DBD	200mDS	06/27/96										
WH	50mDS	06/13/96										
GW	50mDS	06/13/96							1		1	
GW	150mDS	06/13/96										1
GE	50mDS	06/13/96										
GE	200mDS	06/13/96										
MEU	200mUS	06/10/95										
MEU	50mUS	06/10/95										
MED	50mDS	06/10/95										
MED	200mDS	06/10/95										
DM	17mDS	06/10/96										
DM2	50mDS	06/24/96										
DM2	200mDS	06/24/96										
P4U	200mUS	06/25/96										
P4U	50mUS	06/25/96	4									
P4D	50mDS	06/25/96	10									
P4D	200mDS	06/25/96	5									
N@P	200mUS	06/11/96										
N@P	50mUS	06/11/96										
N@L	50mUS	06/24/96										
N@L	150mUS	06/24/96										
N@D	200mUS	06/17/96										
N@D	50mUS	06/17/96										
N@D	50mDS	not done										
N@D	200mDS	not done										
P@M	100mUS	06/11/96	6									
P@M	100mDS	06/11/96	6									
P@S	50mDS	06/30/96	35									
P@S	200mDS	06/30/96	35									1
Q@M	50mDS	06/25/96	33						1			
Q@C	200mUS											
Q@C	50mUS											
Q@S	50mUS	06/14/96	14			6						
MB@S	50mUS	06/12/96	5		8				1			
MB@11	5mUS	06/27/96	2			5						3
MB@7	50mDS	06/21/96				5						1
MB@7	200mDS	06/21/96	1			3						1
QA@O	50mDS	06/21/96	1			1			2			1
QA@O	200mDS	06/21/96				2			2			2
QA@7	5mDS	06/27/96	3			2						1
QA@S	5mDS	06/12/96	1					1				
QA@S	200mUS	06/12/96	3									1
QB@S	210mUS	06/14/96	13						4			
QB@S	5mDS	06/14/96	1						1			
NF@B	11mDS	06/27/96	15		1							
QB@S	50mUS	06/14/96	7		2				1			
NF@mi	200mUS	06/26/96										
NF@mi	50mUS	06/26/96										
NF@mi	50mDS	06/26/96	5									
NF@mi	200mDS	06/26/96	4									
C@RH	Pond	08/06/96	1						1	1		
C@RH	US left	08/06/96										
LH@DD		07/24/96	6					5				
LH@W		07/29/96	3					3				
LH@G		07/29/96	8					32				
B@28		07/26/96	10				1		1			

Station	Location	Date	Petalurida	Corduliida	Aeshnida	Libellulida	Lestidae	Macromii	Elmidae	Dryopidae	Hydrophili	Psepheni
PPUL	100mUS	06/18/96							2			
PPUR	100mUS	06/18/96									1	
PPUR	50mUS	06/18/96							1		2	
PPD1	50mDS	06/17/96									2	
PPD1	200mDS	06/17/96										
PPD2		06/17/96										
PPD3		06/17/96										
PPD4		06/17/96										
DBU	5mUS	06/27/96										
DBD	5mDS	06/27/96										
DBD	50mDS	not done										
DBD	200mDS	06/27/96										
WH	50mDS	06/13/96		1						2		
GW	50mDS	06/13/96										
GW	150mDS	06/13/96										
GE	50mDS	06/13/96							1			
GE	200mDS	06/13/96										
MEU	200mUS	06/10/95										
MEU	50mUS	06/10/95										
MED	50mDS	06/10/95										
MED	200mDS	06/10/95										
DM	17mDS	06/10/96										
DM2	50mDS	06/24/96										
DM2	200mDS	06/24/96									1	
P4U	200mUS	06/25/96								1	1	
P4U	50mUS	06/25/96										
P4D	50mDS	06/25/96								1		
P4D	200mDS	06/25/96			1							
N@P	200mUS	06/11/96							1		1	
N@P	50mUS	06/11/96										
N@L	50mUS	06/24/96										
N@L	150mUS	06/24/96							3			
N@D	200mUS	06/17/96										
N@D	50mUS	06/17/96										
N@D	50mDS	not done										
N@D	200mDS	not done										
P@M	100mUS	06/11/96							10	1		
P@M	100mDS	06/11/96							14			
P@S	50mDS	06/30/96							1			
P@S	200mDS	06/30/96										
Q@M	50mDS	06/25/96										
Q@C	200mUS											
Q@C	50mUS											
Q@S	50mUS	06/14/96							2			1
MB@S	50mUS	06/12/96							54	4		
MB@11	5mUS	06/27/96							14			1
MB@7	50mDS	06/21/96			1				36			
MB@7	200mDS	06/21/96			1				20			
QA@O	50mDS	06/21/96				4	4		31	3		
QA@O	200mDS	06/21/96							50	8		
QA@7	5mDS	06/27/96							3		2	
QA@S	5mDS	06/12/96							9	2		1
QA@S	200mUS	06/12/96			1				12	2		1
QB@S	210mUS	06/14/96			1				17	1		3
QB@S	5mDS	06/14/96							1	1		
NF@B	11mDS	06/27/96							1			
QB@S	50mUS	06/14/96			1				10	1		10
NF@mi	200mUS	06/26/96							1			
NF@mi	50mUS	06/26/96										
NF@mi	50mDS	06/26/96							6			
NF@mi	200mDS	06/26/96							2			
C@RH	Pond	08/06/96							6			
C@RH	US left	08/06/96									11	
LH@DD		07/24/96							28			
LH@W		07/29/96							11			
LH@G		07/29/96							59			2
B@28		07/26/96							59			4

Station	Location	Date	Dytiscida	Carabida	Ptiliidae	Gyrinidae	Haliplidae	Curculioni	Scirtidae	Heterocer	Chrysom	Corydalid
PPUL	100mUS	06/18/96	1	1								1
PPUR	100mUS	06/18/96										
PPUR	50mUS	06/18/96										7
PPD1	50mDS	06/17/96				1	6					
PPD1	200mDS	06/17/96				2		1				
PPD2		06/17/96										
PPD3		06/17/96										1
PPD4		06/17/96										
DBU	5mUS	06/27/96										
DBD	5mDS	06/27/96										1
DBD	50mDS	not done										
DBD	200mDS	06/27/96						1				2
WH	50mDS	06/13/96	3									
GW	50mDS	06/13/96										
GW	150mDS	06/13/96										
GE	50mDS	06/13/96										
GE	200mDS	06/13/96										
MEU	200mUS	06/10/95										
MEU	50mUS	06/10/95										
MED	50mDS	06/10/95										
MED	200mDS	06/10/95										
DM	17mDS	06/10/96	1									
DM2	50mDS	06/24/96	1		1							
DM2	200mDS	06/24/96						1				
P4U	200mUS	06/25/96				1						1
P4U	50mUS	06/25/96										14
P4D	50mDS	06/25/96										3
P4D	200mDS	06/25/96										
N@P	200mUS	06/11/96										2
N@P	50mUS	06/11/96										
N@L	50mUS	06/24/96										
N@L	150mUS	06/24/96										7
N@D	200mUS	06/17/96										1
N@D	50mUS	06/17/96										
N@D	50mDS	not done										
N@D	200mDS	not done										
P@M	100mUS	06/11/96				2	1					
P@M	100mDS	06/11/96										
P@S	50mDS	06/30/96				6						10
P@S	200mDS	06/30/96				1						9
Q@M	50mDS	06/25/96										8
Q@C	200mUS											
Q@C	50mUS											
Q@S	50mUS	06/14/96										1
MB@S	50mUS	06/12/96	1									2
MB@11	5mUS	06/27/96										4
MB@7	50mDS	06/21/96						1				3
MB@7	200mDS	06/21/96										3
QA@O	50mDS	06/21/96	1									2
QA@O	200mDS	06/21/96										14
QA@7	5mDS	06/27/96										18
QA@S	5mDS	06/12/96										2
QA@S	200mUS	06/12/96										
QB@S	210mUS	06/14/96	1									
QB@S	5mDS	06/14/96										
NF@B	11mDS	06/27/96										3
QB@S	50mUS	06/14/96										
NF@mi	200mUS	06/26/96										2
NF@mi	50mUS	06/26/96				1						1
NF@mi	50mDS	06/26/96				1						3
NF@mi	200mDS	06/26/96				1						6
C@RH	Pond	08/06/96										
C@RH	US left	08/06/96	6			1	1					
LH@DD		07/24/96										3
LH@W		07/29/96					1					1
LH@G		07/29/96					6					
B@28		07/26/96										7

Station	Location	Date	Sialidae	Veliidae	Gerridae	Notonecti	Corixidae	Belastom	Entomobr	Noctuidae	Pyralidae	Cosmopt
PPUL	100mUS	06/18/96	1									
PPUR	100mUS	06/18/96		1								
PPUR	50mUS	06/18/96							1			
PPD1	50mDS	06/17/96										
PPD1	200mDS	06/17/96										
PPD2		06/17/96										
PPD3		06/17/96										
PPD4		06/17/96										
DBU	5mUS	06/27/96										
DBD	5mDS	06/27/96	7									
DBD	50mDS	not done										
DBD	200mDS	06/27/96										
WH	50mDS	06/13/96										
GW	50mDS	06/13/96	1									
GW	150mDS	06/13/96	1	1								
GE	50mDS	06/13/96										
GE	200mDS	06/13/96										
MEU	200mUS	06/10/95										
MEU	50mUS	06/10/95										
MED	50mDS	06/10/95										
MED	200mDS	06/10/95										
DM	17mDS	06/10/96	1						1			
DM2	50mDS	06/24/96										
DM2	200mDS	06/24/96										
P4U	200mUS	06/25/96	6									
P4U	50mUS	06/25/96	2									
P4D	50mDS	06/25/96	4									
P4D	200mDS	06/25/96	1									
N@P	200mUS	06/11/96	1									
N@P	50mUS	06/11/96										
N@L	50mUS	06/24/96										
N@L	150mUS	06/24/96										
N@D	200mUS	06/17/96										
N@D	50mUS	06/17/96										
N@D	50mDS	not done										
N@D	200mDS	not done										
P@M	100mUS	06/11/96							1			
P@M	100mDS	06/11/96										
P@S	50mDS	06/30/96	1									
P@S	200mDS	06/30/96										
Q@M	50mDS	06/25/96										
Q@C	200mUS											
Q@C	50mUS											
Q@S	50mUS	06/14/96							1			
MB@S	50mUS	06/12/96										
MB@11	5mUS	06/27/96										
MB@7	50mDS	06/21/96		2								
MB@7	200mDS	06/21/96										
QA@O	50mDS	06/21/96	8									
QA@O	200mDS	06/21/96	2									
QA@7	5mDS	06/27/96	2									
QA@S	5mDS	06/12/96										
QA@S	200mUS	06/12/96										
QB@S	210mUS	06/14/96			2							
QB@S	5mDS	06/14/96		2								
NF@B	11mDS	06/27/96										
QB@S	50mUS	06/14/96		2								
NF@mi	200mUS	06/26/96	1									
NF@mi	50mUS	06/26/96										
NF@mi	50mDS	06/26/96										
NF@mi	200mDS	06/26/96										
C@RH	Pond	08/06/96										
C@RH	US left	08/06/96			1		12					
LH@DD		07/24/96										
LH@W		07/29/96										
LH@G		07/29/96										
B@28		07/26/96										

Station	Location	Date	Isotomida	Gammari	Asellidae	Sphaero	Cambarid	Harpactic	Cladocer	Hydracari	Sperchon	Libertiida
PPUL	100mUS	06/18/96										
PPUR	100mUS	06/18/96					1					
PPUR	50mUS	06/18/96										
PPD1	50mDS	06/17/96					1					
PPD1	200mDS	06/17/96										
PPD2		06/17/96					3					
PPD3		06/17/96										
PPD4		06/17/96			1							
DBU	5mUS	06/27/96										
DBD	5mDS	06/27/96										
DBD	50mDS	not done										
DBD	200mDS	06/27/96										
WH	50mDS	06/13/96										
GW	50mDS	06/13/96										
GW	150mDS	06/13/96					5					
GE	50mDS	06/13/96										
GE	200mDS	06/13/96										
MEU	200mUS	06/10/95										
MEU	50mUS	06/10/95					2					
MED	50mDS	06/10/95										
MED	200mDS	06/10/95										
DM	17mDS	06/10/96		1			1					
DM2	50mDS	06/24/96		2								
DM2	200mDS	06/24/96										
P4U	200mUS	06/25/96			1							
P4U	50mUS	06/25/96					1			1		
P4D	50mDS	06/25/96								2		
P4D	200mDS	06/25/96					2					
N@P	200mUS	06/11/96		2	2		1					
N@P	50mUS	06/11/96										
N@L	50mUS	06/24/96										
N@L	150mUS	06/24/96										
N@D	200mUS	06/17/96										
N@D	50mUS	06/17/96										
N@D	50mDS	not done										
N@D	200mDS	not done										
P@M	100mUS	06/11/96										
P@M	100mDS	06/11/96										
P@S	50mDS	06/30/96					2					
P@S	200mDS	06/30/96										
Q@M	50mDS	06/25/96					8					
Q@C	200mUS											
Q@C	50mUS											
Q@S	50mUS	06/14/96										
MB@S	50mUS	06/12/96		3								
MB@11	5mUS	06/27/96					3					
MB@7	50mDS	06/21/96		17			5					
MB@7	200mDS	06/21/96		26			5			1		
QA@O	50mDS	06/21/96		16								
QA@O	200mDS	06/21/96		46	1		3					
QA@7	5mDS	06/27/96		1			3					
QA@S	5mDS	06/12/96					1					
QA@S	200mUS	06/12/96					2			2		
QB@S	210mUS	06/14/96										
QB@S	5mDS	06/14/96			1							
NF@B	11mDS	06/27/96										
QB@S	50mUS	06/14/96										
NF@mi	200mUS	06/26/96										
NF@mi	50mUS	06/26/96					1					
NF@mi	50mDS	06/26/96										
NF@mi	200mDS	06/26/96										
C@RH	Pond	08/06/96			2							
C@RH	US left	08/06/96			1							
LH@DD		07/24/96					3					
LH@W		07/29/96		1	5		2					
LH@G		07/29/96		10	2					1		
B@28		07/26/96		113								

Station	Location	Date	Physidae	Lymnaeid	Planorbid	Ancylidae	Viviparida	Corbiculid	Sphaeriid	Pelecypo	Oligochae	Lumbricul
PPUL	100mUS	06/18/96									1	
PPUR	100mUS	06/18/96									2	
PPUR	50mUS	06/18/96										
PPD1	50mDS	06/17/96									2	
PPD1	200mDS	06/17/96	17	1	1						2	
PPD2		06/17/96										
PPD3		06/17/96										
PPD4		06/17/96			2						1	
DBU	5mUS	06/27/96										
DBD	5mDS	06/27/96									2	
DBD	50mDS	not done										
DBD	200mDS	06/27/96									4	
WH	50mDS	06/13/96	79	11						6	2	
GW	50mDS	06/13/96										
GW	150mDS	06/13/96										
GE	50mDS	06/13/96										
GE	200mDS	06/13/96										
MEU	200mUS	06/10/95										
MEU	50mUS	06/10/95										
MED	50mDS	06/10/95										
MED	200mDS	06/10/95										
DM	17mDS	06/10/96									2	
DM2	50mDS	06/24/96	1								1	
DM2	200mDS	06/24/96										
P4U	200mUS	06/25/96					19				16	
P4U	50mUS	06/25/96	1				1					
P4D	50mDS	06/25/96					3			6	3	
P4D	200mDS	06/25/96					1			7		
N@P	200mUS	06/11/96									3	
N@P	50mUS	06/11/96									9	
N@L	50mUS	06/24/96									18	
N@L	150mUS	06/24/96									12	
N@D	200mUS	06/17/96									2	
N@D	50mUS	06/17/96										
N@D	50mDS	not done										
N@D	200mDS	not done										
P@M	100mUS	06/11/96								4	9	
P@M	100mDS	06/11/96									3	
P@S	50mDS	06/30/96								4		
P@S	200mDS	06/30/96								1	2	
Q@M	50mDS	06/25/96								16		
Q@C	200mUS											
Q@C	50mUS											
Q@S	50mUS	06/14/96										
MB@S	50mUS	06/12/96										
MB@11	5mUS	06/27/96										
MB@7	50mDS	06/21/96										
MB@7	200mDS	06/21/96							1		2	
QA@O	50mDS	06/21/96									5	
QA@O	200mDS	06/21/96									8	
QA@7	5mDS	06/27/96										
QA@S	5mDS	06/12/96							4		3	
QA@S	200mUS	06/12/96									4	
QB@S	210mUS	06/14/96									3	
QB@S	5mDS	06/14/96										
NF@B	11mDS	06/27/96										
QB@S	50mUS	06/14/96									2	
NF@mi	200mUS	06/26/96										
NF@mi	50mUS	06/26/96										
NF@mi	50mDS	06/26/96									2	
NF@mi	200mDS	06/26/96										
C@RH	Pond	08/06/96										
C@RH	US left	08/06/96	72	7								
LH@DD		07/24/96			2							
LH@W		07/29/96	7								1	
LH@G		07/29/96										
B@28		07/26/96		9		11				3		

Station	Location	Date	Brachiob	Naididae	Haplotaxi	Hirundine	Planariida	Nematom	Nematoda
PPUL	100mUS	06/18/96							
PPUR	100mUS	06/18/96							
PPUR	50mUS	06/18/96							
PPD1	50mDS	06/17/96							
PPD1	200mDS	06/17/96							
PPD2		06/17/96							
PPD3		06/17/96							
PPD4		06/17/96							
DBU	5mUS	06/27/96							
DBD	5mDS	06/27/96							
DBD	50mDS	not done							
DBD	200mDS	06/27/96							
WH	50mDS	06/13/96							1
GW	50mDS	06/13/96		77					
GW	150mDS	06/13/96		138					
GE	50mDS	06/13/96		201					
GE	200mDS	06/13/96		173					
MEU	200mUS	06/10/95		190					
MEU	50mUS	06/10/95		183					
MED	50mDS	06/10/95		203					
MED	200mDS	06/10/95		97					
DM	17mDS	06/10/96							
DM2	50mDS	06/24/96							
DM2	200mDS	06/24/96		3					1
P4U	200mUS	06/25/96							
P4U	50mUS	06/25/96							
P4D	50mDS	06/25/96							2
P4D	200mDS	06/25/96							
N@P	200mUS	06/11/96							
N@P	50mUS	06/11/96							
N@L	50mUS	06/24/96							
N@L	150mUS	06/24/96							1
N@D	200mUS	06/17/96							1
N@D	50mUS	06/17/96							
N@D	50mDS	not done							
N@D	200mDS	not done							
P@M	100mUS	06/11/96		3					1
P@M	100mDS	06/11/96							
P@S	50mDS	06/30/96							
P@S	200mDS	06/30/96							
Q@M	50mDS	06/25/96							
Q@C	200mUS								
Q@C	50mUS								
Q@S	50mUS	06/14/96							
MB@S	50mUS	06/12/96							
MB@11	5mUS	06/27/96							
MB@7	50mDS	06/21/96		46					
MB@7	200mDS	06/21/96		39					
QA@O	50mDS	06/21/96							
QA@O	200mDS	06/21/96							2
QA@7	5mDS	06/27/96		1					
QA@S	5mDS	06/12/96		31					
QA@S	200mUS	06/12/96							1
QB@S	210mUS	06/14/96							1
QB@S	5mDS	06/14/96		97					
NF@B	11mDS	06/27/96							
QB@S	50mUS	06/14/96							
NF@mi	200mUS	06/26/96							
NF@mi	50mUS	06/26/96							
NF@mi	50mDS	06/26/96							
NF@mi	200mDS	06/26/96							
C@RH	Pond	08/06/96							
C@RH	US left	08/06/96							
LH@DD		07/24/96							
LH@W		07/29/96							
LH@G		07/29/96							
B@28		07/26/96					3		

B. Fish Data

Table 1. Raw Metric Scores and IBI Calculation

Site Code	Total # of Species	# Native Sp.	#exotic sp.	Metric value ibi	# Darter Sp.	ibi	# Sunfish Sp.	ibi	# Sucker Sp.	ibi	# Intolerant Sp.	ibi	#green SF	% Green Sunfish	IBI Score
PPUL	3	1	2	1	0	1	2	5	0	1	0	1	12	2.86	5
PPUR	4	3	1	5	0	1	2	5	0	1	0	1	0	0.00	5
PPD1	7	4	3	3	0	1	3	5	0	1	0	1	2	1.31	5
PPD2	2	1	1	1	0	1	1	1	0	1	0	1	0	0.00	5
PPD3	1	1	0	1	0	1	0	1	0	1	0	1	0	0.00	5
PPU4	4	2	2	1	0	1	2	3	0	1	0	1	0	0.00	5
GW	5	4	1	5	0	1	2	5	0	1	0	1	0	0.00	5
GE	4	3	1	5	0	1	2	5	0	1	0	1	0	0.00	5
DM	3	3	0	3	0	1	0	1	1	5	0	1	0	0.00	5
WH	4	4	0	5	0	1	0	1	1	5	0	1	0	ERR	5
DBD	8	6	2	3	0	1	3	5	0	1	2	5	7	ERR	3
MEU	10	9	1	5	1	5	1	1	1	3	2	3	4	1.98	5
MED	8	7	1	3	1	5	1	1	1	3	2	3	1	3.23	5
N@P	7	6	1	3	1	5	2	3	0	1	1	3	0	0.00	5
N@L	11	9	2	3	1	5	2	3	0	1	2	3	1	0.33	5
N@D	12	11	1	5	1	3	2	1	0	1	4	5	1	0.30	5
N@D2	11	10	1	3	1	3	2	1	1	3	3	5	2	0.82	5
N@J	1	1	0	3	0	1	0	1	0	1	0	1	0	0.00	5
P4U	10	9	1	5	1	5	3	3	1	3	3	5	0	0.00	5
P4D	12	11	1	5	1	5	3	3	1	3	2	3	0	0.00	5
P@M	11	9	2	3	1	3	2	1	1	3	2	3	0	0.00	5
P@S	13	11	2	3	1	3	3	3	1	3	3	5	0	0.00	5
P@S2	13	11	2	3	1	3	2	1	1	3	3	5	0	0.00	5
Q@M	18	15	3	5	1	3	4	3	1	3	4	5	3	0.85	5
Q@S	19	17	2	5	2	5	3	3	1	3	5	5	0	0.00	5
Q@C	18	15	3	5	1	3	4	3	1	3	4	5	3	2.68	5
Q@C2	19	16	3	5	2	5	4	3	1	3	5	5	1	50.00	5
MB@S	6	6	0	5	1	5	0	1	0	1	2	5	0	0.00	5
MB@11	2	2	0	1	0	1	0	1	0	1	0	1	0	0.00	5
MB@7	1	1	0	3	0	1	0	1	0	1	0	1	0	0.00	5
QA@O	4	4	0	5	0	1	0	1	0	1	1	5	0	0.00	5
QA@7	4	4	0	3	0	1	0	1	0	1	1	3	0	0.00	5
QA@S	11	11	0	5	1	5	0	1	1	5	2	5	0	0.00	5
QB@S	18	16	2	5	1	5	3	5	1	5	4	5	1	0.13	5
NF@B	13	12	1	5	1	3	2	3	2	5	4	5	0	0.00	5

Site Code	% Generalists	IBI Score	% Specialists	IBI Score	#top	% Top Carnivores	IBI Score	% Hybrids or Exotics	IBI Score	% with Disease or Anomalies	IBI Score	Total # Individuals	IBI Score	TOTALS IBI SCOR
PPUL	96.19	1	3.81	1	0	0.00	1	6.67	1	0.00	5	420	3	26
PPUR	-88.89	3	188.89	5	0	0.00	1	188.89	1	0.00	5	18	1	34
PPD1	-132.68	5	232.68	5	1	0.65	1	232.03	1	1.31	3	153	5	36
PPD2	96.77	1	3.23	1	0	0.00	1	3.23	1	0.00	5	31	1	20
PPD3	100.00	1	0.00	1	0	0.00	1	0.00	5	0.00	5	302	1	24
PPU4	99.85	1	0.15	1	1	0.15	3	0.45	1	0.00	5	670	1	24
GW	81.40	1	18.60	1	0	0.00	1	13.95	1	0.00	5	43	5	32
GE	95.79	1	4.21	1	0	0.00	1	2.68	1	0.00	5	261	5	32
DM	100.00	1	0.00	1	0	0.00	1	0.00	5	0.00	5	343	3	32
WH	100.00	1	0.00	1	0	ERR	1	0.00	5	0.00	5	0	3	34
DBD	ERR	1	ERR	3	0	ERR	1	ERR	1	0.00	5	0	1	30
MEU	84.16	1	15.84	1	0	0.00	1	1.98	1	3.47	1	202	3	30
MED	-29.03	1	129.03	1	0	0.00	1	3.23	3	0.00	5	31	3	34
N@P	-63.28	3	163.28	5	0	0.00	1	9.38	1	0.00	5	128	3	38
N@L	86.42	1	13.58	3	0	0.00	1	0.99	1	0.00	5	302	1	32
N@D	73.05	1	26.95	3	0	0.00	1	0.30	3	0.00	5	334	1	34
N@D2	70.37	1	29.63	3	0	0.00	1	0.82	3	0.00	5	243	1	34
N@J	100.00	1	0.00	1	0	0.00	1	0.00	5	0.00	5	108	1	26
P4U	8.51	5	91.49	5	1	2.13	3	6.38	1	0.00	5	47	1	46
P4D	20.69	3	79.31	5	3	5.17	5	17.24	1	1.72	1	58	1	40
P@M	34.18	3	65.82	5	3	3.80	3	12.66	1	0.00	5	79	1	36
P@S	45.95	1	54.05	5	1	1.35	3	13.51	1	0.00	5	74	1	38
P@S2	31.82	3	68.18	5	3	6.82	5	29.55	1	0.00	5	44	1	40
Q@M	19.49	5	80.51	5	3	0.85	1	1.98	1	0.00	5	354	1	42
Q@S	-79.56	5	179.56	5	4	1.46	1	2.19	1	0.00	5	274	3	46
Q@C	-75.00	3	175.00	5	3	2.68	1	15.18	1	3.57	1	112	1	36
Q@C2	-8400.00	3	8500.00	5	1	50.00	1	300.00	1	150.00	1	2	1	38
MB@S	78.28	1	21.72	3	0	0.00	1	0.00	5	0.00	5	580	3	40
MB@11	100.00	1	0.00	1	0	0.00	1	0.00	5	0.00	5	384	1	24
MB@7	100.00	1	0.00	1	0	0.00	1	0.00	5	0.00	5	337	1	26
QA@O	91.30	1	8.70	1	0	0.00	1	0.00	5	0.00	5	253	5	36
QA@7	98.38	1	1.62	1	0	0.00	1	0.00	5	0.00	5	431	3	30
QA@S	54.86	1	45.14	3	0	0.00	1	0.00	5	0.00	5	319	5	46
QB@S	69.20	3	30.80	5	2	0.26	1	0.39	3	0.00	5	776	3	50
NF@B	20.04	3	79.96	5	0	0.00	1	0.55	3	0.55	3	549	3	44

Table 2. Abundance of Each Species for Each Sample (Raw Data)

Site Code	*Lam aep*	*Lam app*	*Ang ros*	*Exo max*	*Not cry*	*Cli fun*	*Pim pro*	*Rhi atr*	*Sem atr*	*Sem cor*	*Lux cor*	*Cyp spi*	*Not pro*	*Not hud*	*Not bif*	*Eri obl*	*Hyp nig*
PPUL	0	0	0	0	0	0	0	233	0	0	0	0	0	0	0	0	0
PPUR	1	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0
PPD1	0	0	4	0	4	0	0	57	0	0	0	0	0	0	0	0	0
PPD2	0	0	0	0	0	0	0	17	0	0	0	0	0	0	0	0	0
PPD3	0	0	0	0	0	0	0	153	0	0	0	0	0	0	0	0	0
PPU4	0	0	0	0	0	0	0	28	0	0	0	0	0	0	0	0	0
GW	0	0	0	0	0	0	0	289	0	0	0	0	0	0	0	0	0
GE	0	0	2	0	0	0	0	657	0	0	0	0	0	0	0	0	0
DM	0	0	0	0	0	0	0	140	36	0	0	0	0	0	0	0	0
WH	0	0	0	0	0	0	0	27	73	0	0	0	0	0	0	0	0
DBD	0	0	3	0	0	2	0	2	7	0	0	0	0	0	0	6	0
MEU	0	0	2	1	0	3	0	182	125	0	0	0	21	0	0	1	0
MED	0	0	0	0	0	9	0	200	90	0	3	0	21	0	0	0	0
N@P	0	0	2	0	0	0	0	6	85	0	0	0	0	0	0	59	0
N@L	0	0	1	6	2	0	0	16	69	0	2	0	24	0	0	0	0
N@D	0	0	14	15	0	5	0	182	47	0	2	16	17	0	0	0	0
N@D2	0	0	8	20	0	0	0	153	6	0	0	0	1	2	0	0	0
N@J	0	0	0	0	0	0	0	108	0	0	0	0	0	0	0	0	0
P4U	0	0	0	0	5	7	0	0	1	0	0	0	0	0	0	9	0
P4D	0	0	0	0	4	0	0	1	3	0	0	0	8	0	0	9	0
P@M	17	0	0	0	0	0	0	2	2	0	0	0	8	0	0	1	0
P@S	12	0	0	2	0	0	0	1	0	7	0	0	1	0	0	5	0
P@S2	1	0	1	2	1	0	0	0	1	4	0	0	0	0	0	0	0
Q@M	0	0	6	28	0	57	0	7	2	35	0	0	35	0	0	10	0
Q@S	0	2	15	21	0	15	0	22	2	35	48	0	2	284	0	16	0
Q@C	0	1	5	21	0	34	0	40	24	36	40	0	34	0	0	7	0
Q@C2	0	2	13	36	0	17	0	25	10	18	13	0	38	0	0	6	0
MB@S	0	0	1	0	0	123	0	107	85	0	0	0	0	0	0	2	0
MB@11	0	0	0	0	0	0	0	93	19	0	0	0	0	0	0	0	0
MB@7	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0
QA@O	0	0	0	0	0	18	0	278	249	0	0	0	0	0	0	4	0
QA@7	0	0	0	1	0	6	0	86	160	0	0	0	0	0	0	0	0
QA@S	0	0	3	5	0	78	0	173	78	29	31	0	1	0	0	4	0
QB@S	0	1	6	10	0	57	0	48	31	51	71	0	42	0	0	20	0
NF@B	0	0	0	95	0	104	0	152	2	131	159	0	0	7	0	0	19

Site Code	*Cat com*	*Fun dia*	*Not ins*	*Ame nat*	*Ame neb*	*Eso nig*	*Mic sal*	*Pom nig*	*Lep gul*	*Lep cya*	*Lep meg*	*Lep aur*	*Lep mac*	*Lep gib*	*Per pel*	*Eth olm*
PPUL	0	0	0	0	0	0	0	0	0	12	0	0	16	0	0	0
PPUR	0	0	0	0	0	0	0	0	3	0	0	0	31	0	0	0
PPD1	0	0	0	0	0	0	1	0	2	2	0	0	350	0	0	0
PPD2	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
PPD3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PPU4	0	0	0	0	0	0	1	0	1	0	0	0	1	0	0	0
GW	0	0	0	1	4	0	0	0	0	0	0	0	6	2	0	0
GE	0	0	0	0	0	0	0	0	0	0	0	0	7	4	0	0
DM	26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WH	1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
DBD	0	0	0	0	0	0	0	0	0	7	0	1	3	0	0	0
MEU	39	0	0	0	0	0	0	0	0	4	0	0	0	0	0	6
MED	12	0	0	0	0	0	0	0	0	1	0	0	0	0	0	7
N@P	0	0	0	0	0	0	0	0	0	0	0	0	12	9	0	129
N@L	0	0	1	0	0	0	0	0	0	1	0	0	2	0	0	4
N@D	0	0	6	0	0	0	0	0	0	1	0	20	0	0	0	9
N@D2	2	0	17	0	0	0	0	0	0	2	0	8	0	0	0	24
N@J	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P4U	2	0	0	0	0	1	0	0	0	0	0	5	3	2	0	12
P4D	3	0	0	2	0	3	0	0	1	0	0	4	9	0	0	11
P@M	3	0	0	0	0	1	2	0	0	0	0	12	8	0	0	23
P@S	13	0	2	0	0	0	1	0	0	0	0	5	9	2	0	14
P@S2	4	0	1	0	0	1	2	0	0	0	0	6	11	0	0	9
Q@M	12	0	34	1	0	1	2	0	0	3	0	19	2	8	0	92
Q@S	8	0	21	0	0	0	4	0	0	0	0	26	2	13	6	38
Q@C	29	0	15	0	0	0	3	0	0	3	0	8	5	13	0	19
Q@C2	34	0	13	0	0	0	1	0	0	1	0	12	3	13	2	17
MB@S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
MB@11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MB@7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
QA@O	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
QA@7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
QA@S	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	25
QB@S	4	0	2	0	1	0	2	0	0	1	0	7	0	9	0	21
NF@B	34	0	9	0	0	0	0	0	0	0	0	23	3	0	0	38

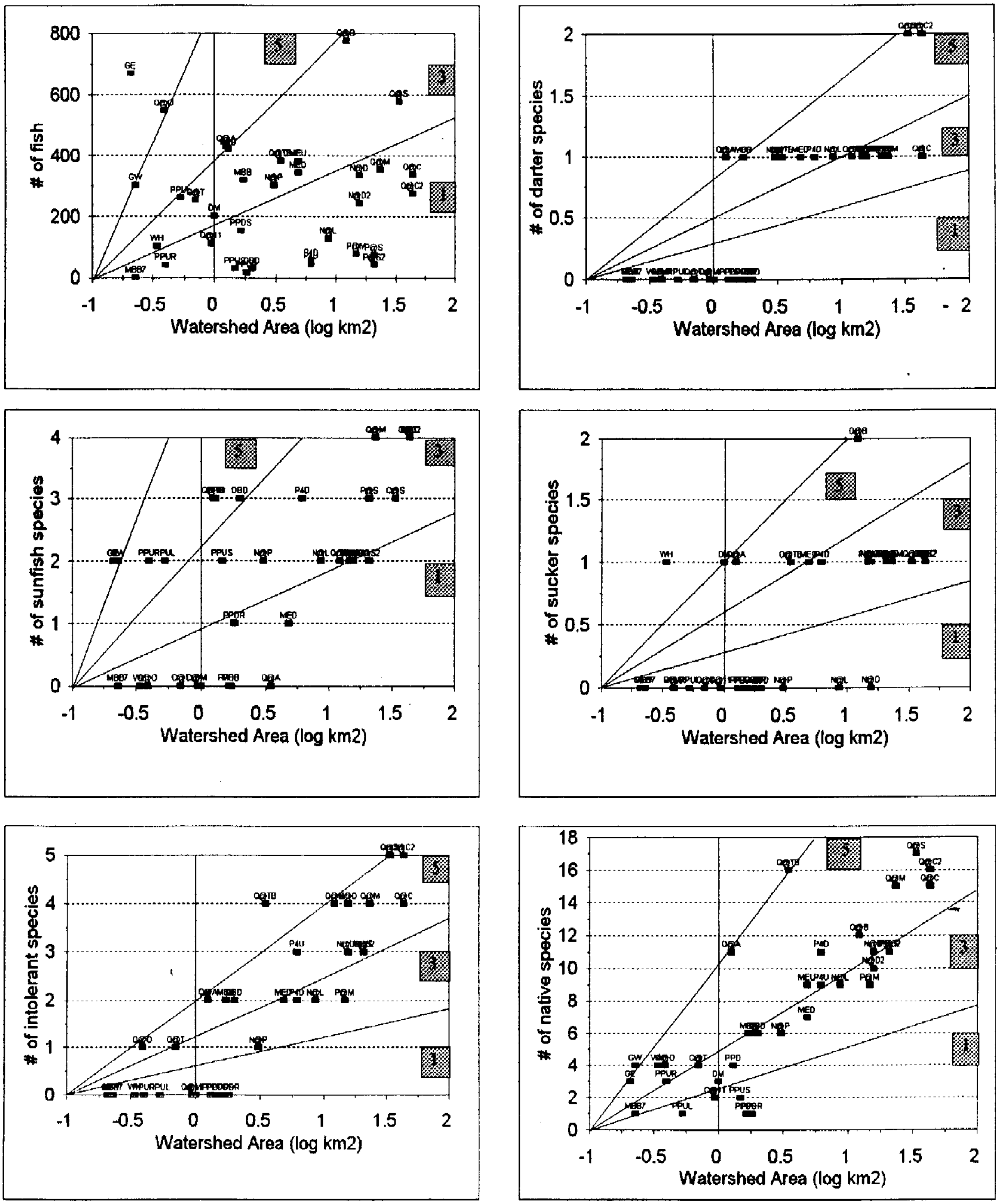


Figure 1. Graphs for Area Correction of Metric Scores

C. Physical Characterization/Water Quality Data

Table 1. Water Quality Data

STATION	Date	Temp (oC)	DO (mg/L)	DO (%sat)	pH	Cond (umho)	Water Odors	Surface Oils	Turbidity	Color
PPUL	24-Oct-96	13.6	9.90	96	7.00	126	None	None	Clear	LtBr
PPUR	31-Oct-96	17.5	8.13	85	6.50	88	Normal	None	Clear	LtBr
PPD1	21-Nov-96	6.8	13.35	109	6.75	155	Normal	Globs	Slight	
PPD2	21-Nov-96	6.1	6.90	56	6.75	91	None	None	Turbid	LtBr
PPD3	21-Nov-96	6.9	6.80	56	6.20	115	Sewage	Sheen/Glob	Turbid	Or/Br
	21-Nov-96	6.6	10.55	86	6.75	100	Petroleu	Globs	Turbid	LtBr
	21-Nov-96	6.4	11.70	95	6.50	88	Petroleu	None	Turbid	LtBr
	21-Nov-96	6.3	11.72	95	6.75	84	Petroleu	None	Turbid	LtBr
PPD4	21-Nov-96	6.4	11.32	92	6.67	91	Petroleu	Globs	Turbid	LtBr
GW	24-Oct-96	13.2	8.27	79	6.00	62	Petroleu	None	Clear	Or/Br
GE	04-Oct-96	14.2	7.27	71	6.25	85	Normal	None	Slight	
DM	16-Oct-96	14.6	9.74	96	6.75	111	Normal	None	Clear	
WH	18-Dec-96	8.4	12.58	108	6.75	143	None	None	Turbid	
DBU										
DBD	28-Dec-96	6.5	10.26	83	7.00	145	None	None	Opaque	
MEU	16-Dec-96	7.8	11.26	95	7.00	75	None	None	Slight	
MED	17-Dec-96	7.8	12.18	103	7.00	80	Sewage	Slick	Slight	
N@P	16-Oct-96	12.6	9.17	87	6.50	81	None	Flecks	Slight	LtBr
N@L	11-Nov-96	6.5	11.58	94	6.50	58	Normal	None	Turbid	LtBr
N@J	25-Jul-96	20.9	7.34	82	06/03	112	Normal	Globs	Clear	
N@D	15-Oct-96	12.9	10.41	99	7.50	100	Normal	None	Slight	LtBr
N@D2	15-Oct-96	12.0	10.13	94	7.25	96	Normal	None	Slight	DkBr
P4U										
P4D										
P@M	16-Dec-96	6.4	12.66	103	6.50	54	Normal	None	Slight	
P@S	17-Jul-96	23.5	7.72	91	6.70	125	Normal	None	Turbid	Br
P@S2	22-Jul-96	22.2	7.89	91	6.72	149	Normal	None	Turbid	Br
Q@M	05-Nov-96	7.0	11.90	98	6.50	32	None	None	Clear	DkBr
Q@S	07-Nov-96	11.2	10.60	97	7.00	34	None	None	Clear	DkBr
Q@C	04-Nov-96	5.8	12.14	97	7.00	35	None		Clear	
Q@C2	04-Nov-96	5.8	11.91	95	7.00	35	None	None	Clear	
MB@S	15-Nov-96	5.9	11.66	93	6.50	121	None	None	Clear	LtBr
MB@11	19-Nov-96	10.1	10.05	90	6.00	58	None	None	Clear	LtBr
MB@7	23-Nov-96	6.8	11.67	96	6.00	75	None	None	Clear	DkBr
QA@O	23-Nov-96	6.4	10.46	85	6.00	82	None	None	Clear	
QA@7	20-Nov-96	8.9	12.43	108	6.00	65	None	None	Clear	
QA@S	14-Nov-96	5.0	12.11	95	6.50	45	None	None	Clear	
QB@S	15-Nov-96	5.0	12.40	97	6.75	142	None	None	Clear	DkBr
NF@B	19-Nov-96	7.1	11.70	97	6.75	30	None	None	Clear	LtBr

Table 2. Sediment Data

STATION	Date	Odor	Sediment Oils	Deposits	Black Stones	Bedrock	Boulder	Cobble	Gravel	Sand	Silt	Clay
PPUL	24-Oct-96	Normal	Absent	Sand	No	0	0	25	25	30	20	0
PPUR	31-Oct-96	Anaerobic	Slight	Sand	No	0	0	20	30	40	10	0
PPD1	21-Nov-96	None	Absent	Sand	No	0	0	30	30	40	0	0
PPD2	21-Nov-96	None	Absent	Sand	No	0	5	25	30	30	5	5
PPD3	21-Nov-96	Sewage	Slight	Sand	No	0	40	20	20	20	0	0
	21-Nov-96	None	Absent	Sand	No	5	0	40	40	15	0	0
	21-Nov-96	None	Absent	Sand	No	0	0	40	40	20	0	0
	21-Nov-96	None	Absent	Sand	No	0	0	65	10	25	0	0
PPD4	21-Nov-96	None	Absent	Sand	No	2	0	48	30	20	0	0
GW	24-Oct-96	Petroleum	Absent	Sand	No	0	0	20	10	65	5	0
GE	04-Oct-96	Petroleum	Slight	Sand	Yes	0	0	60	20	15	5	0
DM	16-Oct-96	Sewage	Slight	Sand		40	5	30	10	15	0	0
WH	18-Dec-96	None	Absent	Sand	Yes	35	35	10	10	10	0	0
DBU												
DBD	28-Dec-96	None	Absent	Sand	No	0	0	5	20	40	25	10
MEU	16-Dec-96	None	Absent	Sand	No	5	0	15	20	60	0	0
MED	17-Dec-96	None	Absent	Sand	No	5	5	15	30	45	0	0
N@P	16-Oct-96	None	Slight	Sand	No	0	0	0	20	65	15	0
N@L	11-Nov-96	None	Absent	Sand	No	0	0	30	10	60	0	0
N@J	25-Jul-96	Normal	Absent	Sand	No	20	0	0	30	45	0	5
N@D	15-Oct-96	Sewage	Absent	Sand	No	0	30	35	10	25	0	0
N@D2	15-Oct-96	None	Absent	Sand	Yes	0	30	30	15	25	0	0
P4U												
P4D												
P@M	16-Dec-96	None	Absent	Sand	No	0	0	0	10	90	0	0
P@S	17-Jul-96	Normal	Absent	Clay/silt	No	0	0	30	25	25	20	0
P@S2	22-Jul-96	Normal	Absent	Sand	No	0	5	5	60	30	0	0
Q@M	05-Nov-96	None	Absent	Sand	No	0	20	40	20	15	5	0
Q@S	07-Nov-96	None	Absent	Sand	No	0	5	30	25	40	0	0
Q@C	04-Nov-96	None	Absent	Sand	No	0	10	40	15	25	10	0
Q@C2	04-Nov-96	None	Absent	Sand	No	0	15	35	25	20	5	0
MB@S	15-Nov-96	None	Absent	Sand	No	5	0	25	40	30	0	0
MB@11	19-Nov-96	None	Absent	Sand	No	10	0	10	60	20	0	0
MB@7	23-Nov-96	None	Absent	Sand	No	0	0	5	40	50	5	0
QA@O	23-Nov-96	None	Absent	Sand	No	0	5	10	20	60	0	5
QA@7	20-Nov-96	None	Absent	Sand	No	5	0	20	20	40	10	5
QA@S	14-Nov-96	None	Absent	Sand	No	10	0	30	35	25	0	0
QB@S	15-Nov-96	None	Absent	Sand	No	5	10	30	40	15	0	0
NF@B	19-Nov-96	None	Absent	Sand	No	10	25	35	15	15	0	0

Table 3. Stream Channel/Riparian Data

STATION	Date	Land Use	Local Erosion	Local NPS	Stream Width (m)	Stream Depth (cm) Riffle	Run	Pool	High Water Mark (cm)	Velocity (m/sec)	Dam	Channelized	Canopy Cover
PPUL	24-Oct-96	Com/Ind	Moderate	Potential	1.29	4.6	17.0		38	0.37	No	No	MostOp
PPUR	31-Oct-96	Commercial	Moderate	Potential	1.17	3.2	22.5	38.4	17	0.34	No	No	MostSh
PPD1	21-Nov-96	Commercial	Heavy	Obvious	0.97	11.1	15.0	32.0	53	0.54	Yes	Yes	MostOp
PPD2	21-Nov-96	Commercial	Heavy	Obvious	1.78	13.1	17.3	63.2	37	1.04	Yes	No	MostOp
PPD3	21-Nov-96	Commercial	Heavy	Obvious	2.50	10.0	12.0	1.5	78	0.25	No	Yes	Open
		Commercial	Heavy	Obvious	2.98	8.0	21.5	46.0	42.5	0.49	No	Yes	MostOp
		Commercial	Heavy	Obvious	2.18	6.0	13.5	24.5	36	0.65	No	Yes	Open
		Commercial	Heavy	Obvious	2.20	7.0	14.3	19.5	56	0.74	No	No	MostSh
PPD4	21-Nov-96	Commercial	Heavy	Obvious	2.45	7.0	16.4	30.0	45	0.63	No	Yes	MostOp
GW	24-Oct-96	Commercial	Heavy	Potential	1.25	4.5	10.9	28.3	89	0.22	No	No	MostSh
GE	04-Oct-96	Commercial	Heavy	Obvious	1.24	3.2	7.5	21.0	35	0.28	No	No	MostSh
DM	16-Oct-96	Residential	Heavy	Obvious	1.60	7.2	15.3	38.0	151	0.37	No	Yes	MostOp
WH	18-Dec-96	Residential	Heavy	Obvious	1.03	7.0	16.0	21.0	33	0.33	Yes	Yes	MostOp
DBU													
DBD	28-Dec-96	Residential		Obvious	0.98	3.5	14.0	24.0	19	0.54	Yes	Yes	MostSh
MEU	16-Dec-96	Residential	Heavy	Obvious	3.98	9.0	37.0	64.0	34	0.87	No	No	MostOp
MED	17-Dec-96	Residential	Heavy	Obvious	3.00	8.4	20.0	49.5	62.5	0.66	No	No	MostOp
N@P	16-Oct-96	Residential	Moderate	Potential	2.26	15.5	32.0	54.0	21	0.64	No	No	MostOp
N@L	11-Nov-96	Residential	Heavy	Potential		18.2	48.5	83.0	37	0.65		No	MostOp
N@J	25-Jul-96	Residential	Heavy	Obvious	2.26	3.0	28.0	52.0	72.5		No	No	Shade
N@D	15-Oct-96	Residential	Moderate	Obvious	4.98	19.2	29.0		28	0.62		No	MostSh
N@D2	15-Oct-96	Comm/Ind	Moderate	Potential	7.95	20.0	33.0	78.0	48	0.83	No	No	MostOp
P4U													
P4D													
P@M	16-Dec-96	Forest/Res	Moderate	Potential	3.80	25.0	36.0	63.0	52	1.02	No	No	MostOp
P@S	22-Jul-96	Forest/Field	Moderate	Potential	3.85	12.0	25.8	81.0	44	0.58	No	No	MostSh
P@S2	22-Jul-96	Forest/Field	Moderate	Potential	5.00	10.0	74.0	0.0	60		No		MostSh
Q@M	05-Nov-96	Forest	Moderate	No	6.70	16.3	40.7	130.0	23.5	0.83	No	No	MostSh
Q@S	07-Nov-96	Forest	Heavy	No	7.20	18.3	58.2	114.0	51.2	0.88	No	No	MostSh
Q@C	04-Nov-96	Forest		No	5.50	27.0	51.0	86.0	35.5	0.77	No	No	MostSh
Q@C2	04-Nov-96	Forest		No	10.50	12.5	58.2	1.6	34	0.94	No	No	MostSh
MB@S	15-Nov-96	Forest	Moderate	No	2.05	5.0	13.8	21.2	51.3	0.66	No	No	MostSh
MB@11	19-Nov-96	Forest	Moderate	No	1.65	7.6	13.0	29.8	37	0.54	No	No	MostOp
MB@7	23-Nov-96	Forest	None	No	0.73	2.5	19.2	24.2	14.5	0.3	No	No	Shaded
QA@O	23-Nov-96	Forest	Moderate	No	0.79	8.3	15.2		22.5	0.43	No	No	Shaded
QA@7	20-Nov-96	Forest	None	No	1.03	6.5	28.0	35.5	30	0.67	Beav	No	MostSh
QA@S	14-Nov-96	Forest	Moderate	No		4.5	14.0	66.0	62	0.68	No	No	Shaded
QB@S	15-Nov-96	Forest	Moderate	No	3.35	6.0	14.5	52.4	37	0.88	No	No	Shaded
NF@B	19-Nov-96	Forest	Moderate	No	6.34	4.5	34.0	60.5	51	1.1	No	No	MostOp

PPD4 habitat was assessed in three distinct stretches and then averaged.