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PART I - HABITAT
PART II - FISHERIES

BY

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NINETEEN EIGHTY NINE MARYLAND ANACOSTIA RIVER STUDY. PART I: HABITAT. MACROBENTHIC INVERTEBRATE COMMUNITIES AND WATER QUALITY ASSESSMENT

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ABSTRACT. PART I.

The Maryland tributaries of the Anacostia River have been the subject of increased interest by resource conservation groups and government agencies due to potential impact on the Potomac River and the Chesapeake Bay. From December 1988 to October 1989, twenty-six lotic sampling sites on these tributaries were intensively sampled for benthic macroinvertebrates, fecal coliform bacterial contamination, and water physical/chemical characteristics.

Water physical/chemical characteristics measured included temperature, total dissolved solids, dissolved oxygen, pH, turbidity, and total suspended solids.

Tributaries were found to have bacterial coliform contamination exceeding, at every sampling date, levels allowed for human consumption. In most instances levels exceeded those for primary contact water recreational activities.

Macroinvertebrate communities were sampled using the Surber method. Community analysis was based on a cumulative metric technique. These communities displayed considerable variability in abundance and diversity among all sites. However, there was remarkable consistency in these biological aspects within tributaries. The northernmost reaches of Northwest Branch, Paint Branch, and Indian Creek were found to be in the best condition based on the benthic macroinvertebrates and, in most cases, water physical/chemical characteristics. Sligo Creek, Beaverdam Creek, Brier Ditch, and Lower Beaverdam Creek are all in poor condition.

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INTRODUCTION

Recently, there has been substantial increase in worldwide public interest in natural resource conservation. This is due in part to the goal-oriented unification of ecologists from varied subdisciplines in calling attention to the rapid loss of biological diversity and the simultaneous local extinctions of floral and faunal components of our environment (Wilson 1988). Along with this has come an increased awareness of the importance of wetlands and waterways for the maintenance of aquatic as well as terrestrial biological communities.

The Anacostia River Watershed, a sub-watershed of the large Potomac River Basin, is made up of approximately 170 square miles and located in Maryland (Montgomery and Prince Georges Counties) and the District of Columbia. The condition of the Anacostia watershed affects that of the Potomac River below their confluence and consequently that of the Chesapeake Bay. Cummins (1989) notes the impressive ecological diversity of the Anacostia tributaries as including fast running piedmont streams, falls, slower coastal floodplain streams, wetlands, and areas subject to tidal effects. Much of the watershed, however, has become heavily degraded due to the effects of intense urbanization in the Washington metropolitan area. In general, visual evaluation of the watershed is much as either the public or professional field ecologists would expect: Those areas further north appear in better condition than those southern sites nearer the city. However, this is not always accurate as the bordering land of many smaller tributaries has been set aside as urban parks which appear healthy but still receive organic or inorganic toxins and erosional effects.

All living things tend to respond in their ecological distribution to variation in environmental conditions, and thus it is understandable why organisms may have restricted or non-continuous distributions in natural situations. It also follows that non-natural factors or perturbations will have an effect on distributions (Hilsenhoff 1977). Factors potentially affecting the distribution and abundance of aquatic organisms are organic or inorganic toxins (agricultural, industrial, or residential in origin), the levels of dissolved oxygen (as a result of eutrophication and/or temperature), solids (dissolved and suspended; from removal of riparian vegetation, lack of catchment areas, etc.), or substrate condition (homogeneity versus heterogeneity).

The purpose of this study is the ecological evaluation of 26 sampling sites located in the Maryland portion of the Anacostia watershed. These evaluations are based on diversity and abundance among benthic macroinvertebrate communities, water chemistry/quality, and bacterial contamination. We have attempted to correlate specific invertebrate community attributes with water chemistry conditions. From this data we present evaluations of site conditions and recommendations for restoration efforts.

Study Area

The twenty-six sampling sites (Fig. 1) are mostly identical to those evaluated on the basis of a previous pisciform survey (Cummins 1989). Prince Georges County contains 20 of the sites; six are in Montgomery County. The study area portion of the

Table 1. Anacostia River watershed. Maryland tributaries of the Anacostia River with numerical designations of the study sites evaluated.

I. Northeast Branch (NEB) - 1, 3, 4A, 4B, 5, 6B, 7, 8, 10, 12, 13, 14A, 14B

- A. NEB (lower) - 1, 3
- B. Brier Ditch (BD) - 4A
- C. Indian Creek (IC) - 5, 6A, 6B
- D. Beaverdam Creek (BDC) - 7
- E. Paint Branch (PB) - 8, 10, 12, 13, 14A, 14B
    1. Little Paint Branch (LPB) - 10, 12
    2. (Northwest section of PB above LPB) - 13, 14A, 14B

II. Northwest Branch (NWB) - 15/16, 17, 18, 19, 21, 22, 23, 24, 25, 26

- A. NWB (lower) - 15/16
- B. (NWB above Sligo Creek) - 17, 18, 19, 21, 22, 23
- C. Sligo Creek (SC) - 24, 25, 26

III. Lower Beaverdam Creek (LBC) - 27, 28

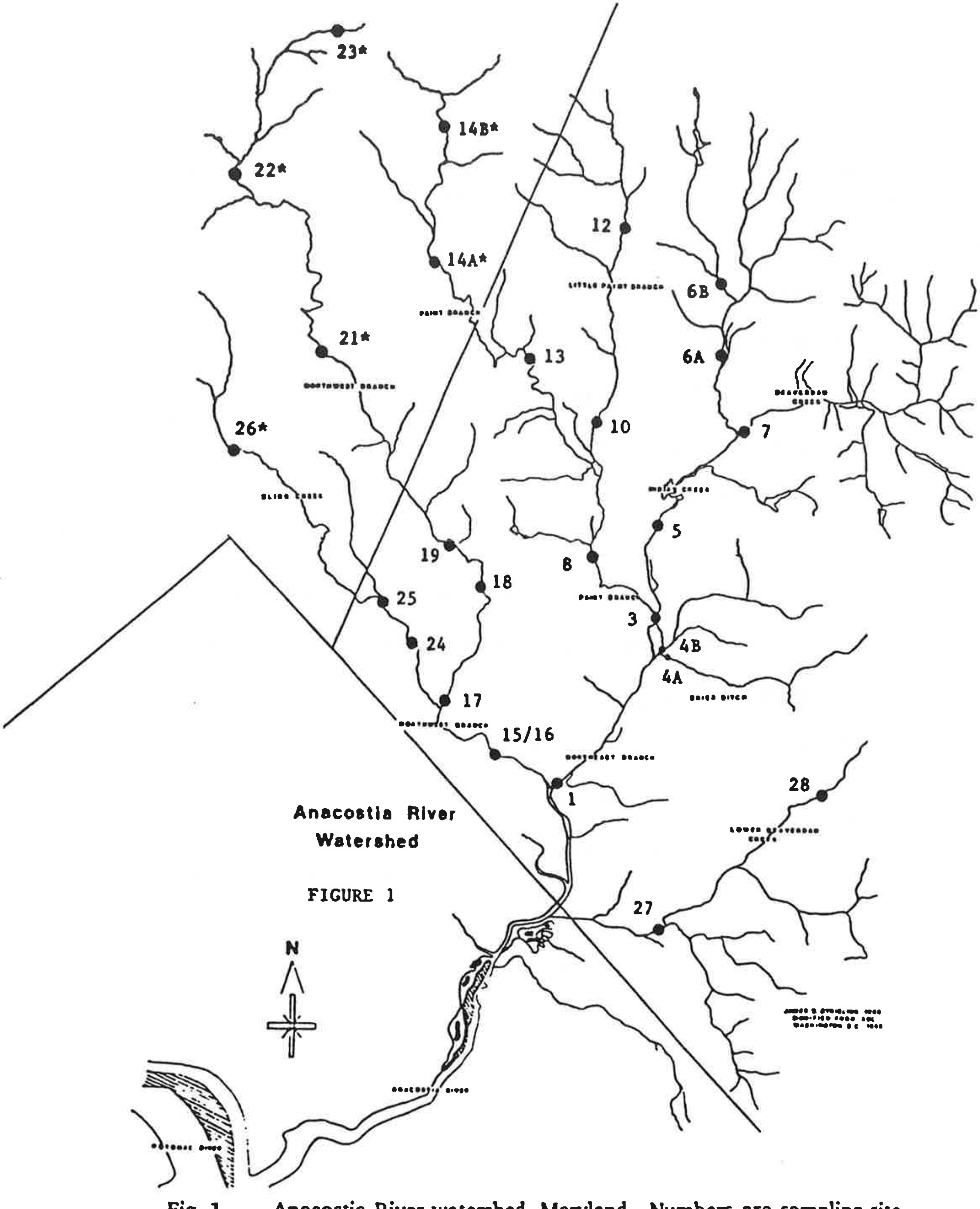

Fig. 1. Anacostia River watershed, Maryland. Numbers are sampling site designations. Those designations with asterisks indicate sites in Montgomery County; the remaining are in Prince Georges County.

watershed is broken down in outline form by the tributaries and sites they contain (Table 1). Differences in site designations between this study and that of Cummins (1989) are as follows:

A) not done 2, 9, 11, 20

B) new 6B, 14B

C) changes in numerical designation

This study	Cummins (1989)
6A (IC)	6
14A (PB)	14

Brief site descriptions are given by Cummins for all except the two new sites which will be described here. Site 6B is located on a headwater tributary to Indian Creek and at this point is approximately 4 meters wide. The stream emerges from a wooded area about 40 meters upstream from the sampling site where it flows over a mostly gravel and organic debris substrate usually covered by a fine silt, fifteen to twenty centimeters in depth; abundant emergent vegetation [e. g., cattails, burr-reed, sedges, rushes, water plantain] and sporadic filamentous algal growth; just below the site the stream is channelized with concrete sides and bottom. Site 14B is on Paint Branch about 70 meters south of Fairland Road in Montgomery County; the water is very fast flowing with a diverse substrate ranging from sand to pebbles to rocks 30-40 cm in diameter; emergent vegetation and algal growth are minimal; the west bank is becoming undercut, the east is flat and rock covered; the stream is approximately 3 to 4 meters wide at this point and varies in depth up to about 50 cm. Sebsequent site designation referrals are followed by the acronym of the tributary on which they are located. These acronyms are given in Table 1.

BENTHIC MACROINVERTEBRATES

The benthic macroinvertebrate fauna is a major contributor to the biomass and productivity of freshwater aquatic situations. These organisms represent an easily accessible and relatively easily identified component of benthic communities. In addition to their physical accessibility and taxonomic straightforwardness, they are also relatively stable in the benthos, being mechanically disturbed almost solely by large rainstorms and greatly increased flow rates. Invertebrate recolonization of lotic habitat following a severe storm event takes place fairly slowly, being governed by successional principles such as immediate dominance, predation, competition, reproductive potential, etc. (Fisher 1983). The intensity of disturbance also affects the pace of recolonization (Seigfried and Knight 1977, Collins et al. 1981). McElvray et al (1989) found statistically significant decreases in lotic macroinvertebrate abundance to be correlated with both higher than normal AND lower than normal rainfall. These are community responses to natural environmental variability in unimpacted sites. It is usually necessary for studies such as the one reported here to continue over a period of two or three years or more in order to ascertain the biological condition of an ecological situation in relation to abiotic factors. Extended studies are also necessary to separate natural seasonal variations from factors of unusual perturbance (Marchant 1988, Muhlenhardt-Siegel 1988, Hilsenhoff 1987). In spite of being without data on seasonal factors within this watershed, we feel that the data and analyses presented allow accurate evaluation of its varied ecological conditions.

METHODS

Sampling. Benthic sampling at each site is done by the Surber method using a surber sampler (Standard Methods 1985). At each sampling site two surber replicates are taken (a single surber replicate represents one square foot of benthos). Choice of exact placement of the sampler is based on the following factors:

> If the substrate is relatively homogenous, with substrate rocks, algal growth, depth, etc., relatively constant, placement of the surber is essentially in the center of the stream; with a heterogenous bottom, areas of potentially greater diversity, such as in a riffle zone with greater algal growth or detritus accumulation, are sampled.

Samples are picked in the field and preserved in 70% ethanol, returned to the lab, and identified with the most current literature available on each group (all aquatic insects, mostly to generic level: Merritt and Cummins 1984, Trichoptera: Wiggins 1977, Schefter and Wiggins 1986; Diptera: Johannsen 1933; Plecoptera: Stewart and Stark 1988; other invertebrates: Pennak 1978). After identification, individuals are sorted into life stages (larva, pupa, adult) and counted.

The identified voucher collection is housed in the Environmental Biology Laboratory at Georgetown University. More specific data on this collection may be obtained through the authors or the Interstate Commission on the Potomac River Basin.

Sites. Two of the 26 sites (1 [NEB] and 6A [IC]) could not be sampled for macroinvertebrates by the chosen method due to depth, complete absence of riffle areas, and low flow rates.

Analysis. The overall analytical technique is modelled after rapid bioassessment protocol II proposed by Plafkin et al. (1988) with variations. In that paper, a series of metrics are used, each of which reveals some aspect of a relationship among taxa and abundances thereof, which otherwise might remain hidden in unanalyzed data. For each metric used in this analysis, a numerical value is calculated according to the statistics or ratios required. In some cases, that numerical value is compared back to a reference for percentage similarity; in other cases, sites are ranked from best to worst with that reference site being at the "good" or unimpaired extreme. The rank list for each metric is divided into "poor", "fair", and "good" categories and those sites are scored according to the categorical placement of a site, e. g., a site falling into the "poor" range for a particular metric is scored 2 points, "fair", 4 points, and "good", 6 points. Sites with a metric point total of 10-18 are considered poor sites, 20-28 fair, and 30-36 good. These categories are placed in quotation marks because delineation is somewhat arbitrary. However, we feel that they indicate relative accuracy in the ranking of ecological situations.

The advantage of using multiple metrics is that inaccuracy or error in any single metric should not overly affect the total scoring or categorical placements. A total of six metrics have been selected for use in site analysis. They are as follows:

Metric 1. Taxonomic richness (family level).

Generally increases with improved water quality. Increases would also be detected with increase in habitat heterogeneity. Often highly variable; expected variability would decrease with similarity among the habitats samples. Ranking: Poor, 0-7 families; Fair, 8-13; Good, >13.

Metric 2. Taxonomic richness (generic level).

Similar to metric 1. Included to discriminate more diverse taxa from those less diverse; also adds weight to those sites supporting more diversity. Ranking: Poor, 0-9 genera; Fair, 10-18; Good, >18.

Metric 3. Community balance (EPTC).

Relative abundances of indicator groups (Plafkin et al. 1988) (Ephemeroptera, Plecoptera, Trichoptera, and Chironomidae) used as an indicator of habitat quality. Good biotic condition would generally be indicated in sites having balanced sample representation of these four major groups. Coefficients of variation (CV) are calculated on abundances (eight months totalled) of the four groups. Here, percent similarity to the reference site (Site 23, NWB) is the basis for ranking as follows: Poor, < 70%; Fair, 70% - 84.9%; Good, 85% - 100%.

Metric 4. Average generic diversity indices (GDI).

Similar to the Biotic Index (Hilsenhoff 1977, 1982, 1987, 1988). Index values (Appendix B) used in this study differ from the tolerance values of Hilsenhoff (references cited above) in being a measure of taxon ubiquity in the study area rather than sensitivity to organic pollution. If within-watershed distributions are affected by habitat degradation, increased variability would be detected. Index values (Appendix B) are calculated for each genus as the number of sites at which the taxon has been detected, divided by the total number of benthic sampling sites in the study (24). The index value is then used in calculation of the GDI as follows:

$$\text{GDI} = \frac{\text{Summation } (n)(a)}{N}$$

where n = number of individuals within a genus, a = index value of that genus, and N = total number of individuals within a sample. GDI's were calculated for each of the sampling dates (one per month for each site, 8 months). Average GDI's were calculated for each site and are the basis for ranking.

This metric has the disadvantage of occasionally ranking very poor sites among the best, occurring when 1-2 individuals of an otherwise rarely detected taxon are incidentally collected. Also, there is frequently no calculable index (nci) due to complete absence of specimens in a sample or collection of only Oligochaeta and/or larval Chironomidae (only those chironomids identifiable to genus are used in calculation of this index). These anomalies should be outweighed by the use of several metrics. Ranking: Poor, > 0.740; Fair, 0.650 - 0.739; Good, < 0.656.

Metric 5. EPT Index

Another measure of taxonomic richness. Used here as total number of genera within each of three relatively pollution-intolerant orders (Ephemeroptera, Plecoptera, and Trichoptera). This index intentionally disregards community contributions of watershed-rare taxa of other orders. Ranking: Poor, 0 - 3 genera; Fair, 4-9; Good, > 9.

Metric 6. Chironomidae dominance.

Biotic quality generally increases with decrease in chironomid dominance. Calculations are of percentage Chironomidae to total number of individuals in the sample. Ranking: Poor, 100%; Fair, 45.2% - 24%; Good, < 24%.

Table 2. Relative abundances of Ephemeroptera (E), Plecoptera (P), Trichoptera (T), and Chironomidae (C). Eight month totals and percentage of total number of these four taxa.

	E		P		T		C		
Site	no.	%	no.	%	no.	%	no.	%	CV
3	40	17.4	1	0.4	131	56.7	58	25.2	94.7
4A	10	10.6	0	0.0	5	5.3	79	84.0	158.4
4B	8	8.5	0	0.0	42	44.7	44	46.8	96.9
5	11	3.9	0	0.0	213	76.3	55	19.7	140.9
6B	23	11.9	30	15.6	76	39.6	63	32.8	53.2
7	0	0.0	0	0.0	31	55.3	25	44.6	116.8
8	26	21.1	0	0.0	73	59.3	24	19.5	99.2
10	2	2.9	0	0.0	24	35.8	41	61.2	115.9
12	51	24.8	1	0.5	113	54.9	41	19.9	89.9
13	24	9.2	6	2.3	184	70.8	46	17.7	124.6
14A	64	39.0	6	3.6	76	44.9	23	13.6	78.4
14B	209	54.7	19	4.9	134	35.1	20	5.2	97.3
15/16	2	3.1	0	0.0	0	0.0	62	96.9	191.8
17	13	13.0	0	0.0	14	14.0	73	73.0	130.5
18	32	12.7	0	0.0	185	73.4	35	13.9	131.5
19	15	22.7	0	0.0	32	48.5	19	28.8	79.9
21	42	17.4	3	1.2	122	50.4	75	30.9	83.4
22	17	14.7	4	3.4	43	37.1	52	44.8	76.9
23	141	52.2	13	4.8	79	29.3	37	13.7	83.1
24	46	33.8	0	0.0	4	2.9	86	63.2	118.9
25	10	28.6	0	0.0	2	5.7	23	65.7	119.3
26	32	10.5	0	0.0	170	55.6	104	33.9	99.4
27	2	2.2	0	0.0	1	1.1	87	96.7	191.2
28	0	0.0	0	0.0	0	0.0	95	100.0	199.6

Table 3. Relative abundance of Chironomidae. Eight month totals of Chironomidae and all other insects from surber sampling.

Abundance								
Site	Chir.	Other	Site	Chir.	Other	Site	Chir.	Other
3	58	180	12	41	173	21	75	164
4A	79	18	13	46	249	22	52	88
4B	44	53	14A	23	196	23	37	328
5	55	250	14B	20	466	24	86	71
6B	63	232	15/16	62	4	25	23	23
7	25	41	17	73	26	26	104	209
8	24	108	18	35	202	27	87	5
10	41	32	19	19	52	28	95	1

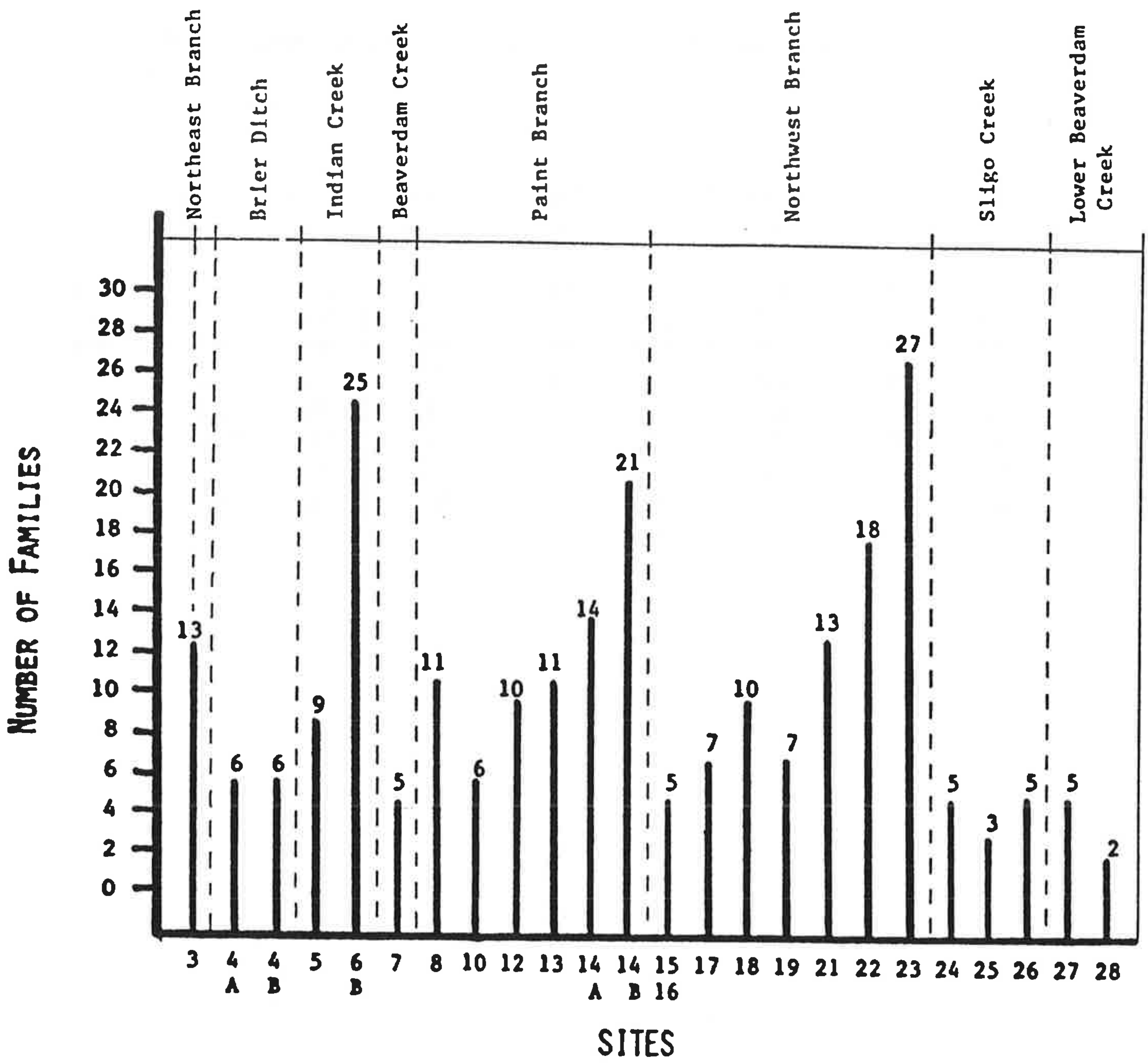

Fig. 2. Numbers of insect families detected through eight months of surber sampling at each site. Site numbers refer to those on Figure 1.

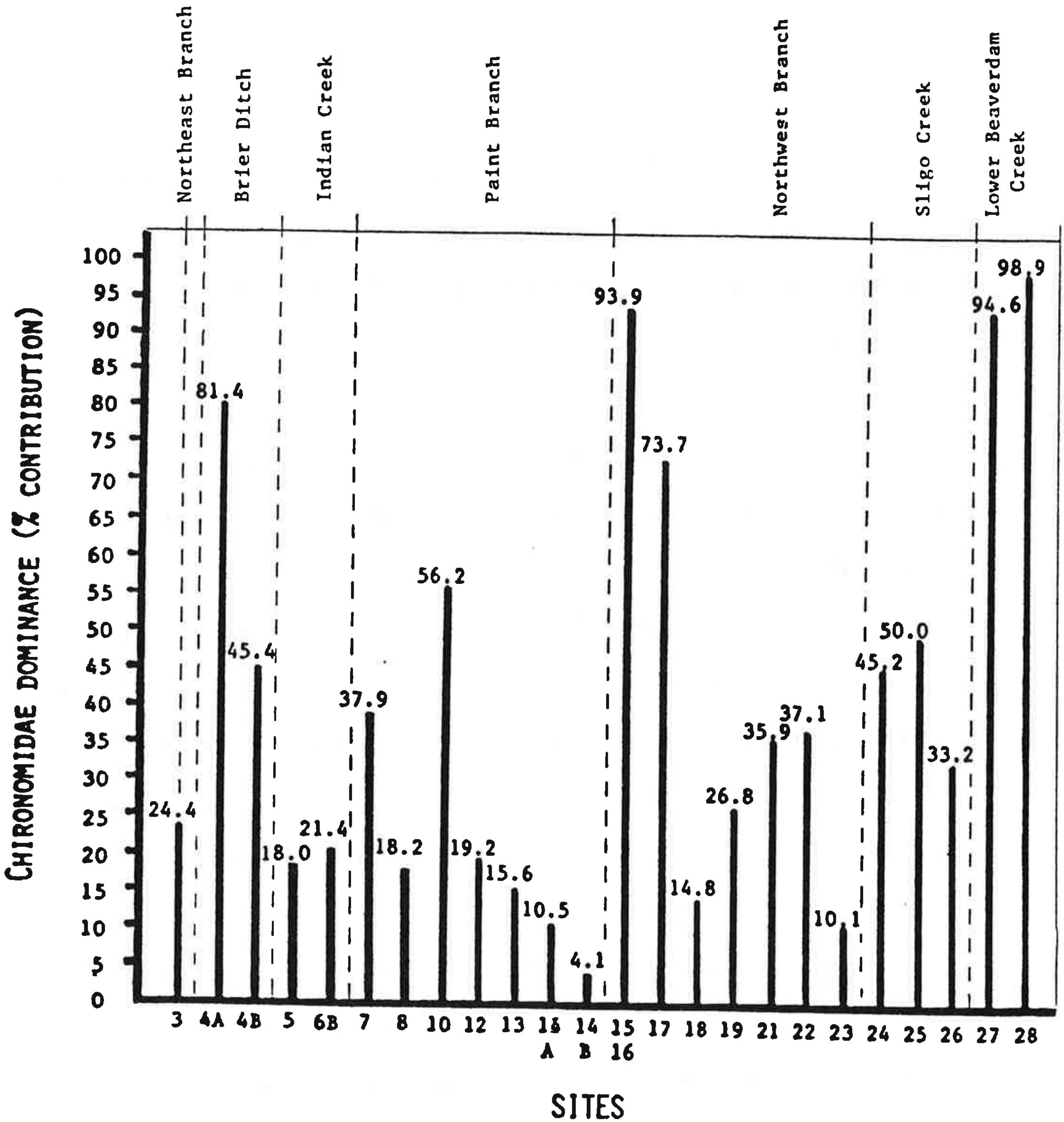

Fig. 3. Community dominance of Chironomidae. Vertical axis indicates percent of total insect individuals represented by the family Chironomidae. This includes individuals detected through eight months of surber sampling at each site. Site numbers refer to those on Figure 1.

RESULTS (TABLES 2-4)

Site distribution of macroinvertebrate taxa collected is summarized in Appendix A. Monthly invertebrate taxonomic lists with life stages and abundance levels are presented in Appendix C. These represent results from December 1988 and April - October 1989.

Metrics.

1. Taxonomic richness (family level) (Fig. 2, Table 4). Numbers of insect families range from the poorest condition, two at Site 28 (LBC), to the best, 27 at Site 23 (NWB).

2. Taxonomic richness (generic level) (Table 4). Generic representation of insects ranges from the poorest condition, one at site 28 (LBC), to the best, 39 at Site 23 (NWB). Between these first two metrics the ranking order is very similar.

3. Community balance (EPTC) (Table 4). Percent similarity to reference Site 23 (NWB) ranges from the most similar, Site 21 (NWB) (99.6% similarity) to the least similar, Site 28 (LBC) (41.6%).

4. Average generic diversity indices (GDI) (Table 4). Based only on genera of insects. Sites 15/16 (NWB), 27 (LBC), and 28 (LBC) are the three most severely impaired sites and their low average GDI's are considered to be an artifact of coincidental sampling. Due to this and the inconsistency of taxonomic occurrence at these sites, they are scored an overall 0 for this metric. Other than these sites, average GDI's range from the worst, Site 4A (BD) (0.817), to the best, Site 23 (NWB) (0.332).

5. EPT index. Total numbers of EPT genera range from the worst, 0 at Site 28 (LBC), to the best, 22 at Site 23 (NWB).

6. Chironomidae dominance (Fig. 3, Table 4). Percent Chironomidae individuals of total number of individuals of all taxa range from the worst, Site 28 (NWB) (98.9%) to the best, Site 14B (PB) (4.1%).

Sites.

Results are enumerated in Table 4 showing the metric values, point scores, and total score for each site.

Table 4. Sites with calculated metric values and assigned scores (in parentheses). Metrics used in this study are 1) taxonomic richness [family level], 2) taxonomic richness [generic level], 3) Community balance [EPTC], 4) Average generic diversity indices, 5) EPT index, 6) Chironomidae abundance. (nci = no calculable index).

Sites	Metrics 1	2	3	4	5	6	Total score
3	13(4)	18(4)	87.8(6)	0.745(2)	8(4)	24.4(4)	24
4A	6(2)	4(2)	52.5(2)	0.817(2)	2(2)	81.4(2)	12
4B	6(2)	6(2)	85.8(6)	0.773(2)	4(4)	45.4(2)	18
5	9(4)	9(2)	58.9(2)	0.717(4)	3(2)	18.0(6)	20
6B	25(6)	27(6)	64.0(2)	0.469(6)	13(6)	21.4(6)	32
7	5(2)	5(2)	71.1(4)	0.768(2)	2(2)	37.9(4)	16
8	11(4)	13(4)	83.8(4)	0.583(6)	7(4)	18.2(6)	28
10	6(2)	6(2)	71.7(4)	0.738(4)	3(2)	56.2(2)	16
12	10(4)	11(4)	92.4(6)	0.737(4)	6(4)	19.2(6)	28
13	11(4)	12(4)	66.7(2)	0.656(4)	6(4)	15.6(6)	24
14A	14(6)	18(4)	94.3(6)	0.569(6)	9(4)	10.5(6)	32
14B	21(6)	32(6)	85.4(6)	0.444(6)	20(6)	4.1(6)	36
15/16	5(2)	5(2)	43.3(2)	nci(0)	2(2)	93.9(2)	10
17	7(2)	8(2)	63.7(2)	0.672(4)	5(4)	73.7(2)	16
18	10(4)	11(4)	63.2(2)	0.777(2)	6(4)	14.8(6)	22
19	7(2)	5(2)	96.1(6)	0.779(2)	4(4)	26.8(4)	20
21	13(4)	17(4)	99.6(6)	0.682(4)	9(4)	35.9(4)	26
22	18(6)	22(6)	92.5(6)	0.524(6)	11(6)	37.1(4)	34
23	27(6)	39(6)	100(6)	0.332(6)	22(6)	10.1(6)	36
24	5(2)	6(2)	69.9(2)	0.679(4)	2(2)	45.2(4)	16
25	3(2)	4(2)	69.7(2)	0.721(4)	2(2)	50.0(2)	14
26	5(2)	6(2)	83.6(4)	0.778(2)	4(4)	33.2(4)	18
27	5(2)	6(2)	43.5(2)	nci(0)	2(2)	94.6(2)	10
28	2(2)	1(2)	41.6(2)	nci(0)	0(2)	98.9(2)	10

MICROBIOLOGY

Microbiological analyses of water samples from each of the 26 study sites were conducted according to the procedures outlined in Standard Methods (1985). Each site was sampled once a month and tested for total coliform most probable number (MPN) and fecal coliform MPN. Total coliform analysis consisted of two methods: Multiple - tube fermentation testing and membrane filtration (a direct count of individual bacteria per 100 ml. Fecal coliform MPN testing consisted of using Escherichia coli medium in a warm water bath for the selective identification of coliform bacteria from fecal sources.

RESULTS

Results are summarized in Tables 5-7 for seven months of sampling and testing (April through October).

DISCUSSION

Trends in the microbiological data indicate a significant increase in total fecal coliform numbers just after storm events. It is evident that within 2-4 days after a storm event these smaller tributaries tend to wash out the high levels of coliforms. Regardless of storm events, all sites tested well over the acceptable bacterial levels allowed for human consumption (approx. 1 bacterium per 100 ml water) on each sampling date. And, except for a few isolated sites, all showed coliform levels well above the limit (approx. 1000 bacteria per 1000 ml) set for water recreational activities on all sampling dates. Based on fecal coliform contamination, the water quality of all tributaries is below acceptable standards for primary contact recreation.

SITE #	APRIL* DAY**	APRIL* TOTAL COLIFORMS (MPN)	APRIL* TOTAL COLIFORMS*** # / 100mL (MF TEST)	APRIL* FECAL COLIFORMS (MPN)	MAY* DAY	MAY* TOTAL COLIFORMS (MPN)	MAY* TOTAL COLIFORMS # / 100mL (MF TEST)	MAY* FECAL COLIFORMS (MPN)	JUNE* DAY	JUNE* TOTAL COLIFORMS (MPN)	JUNE* TOTAL COLIFORMS # / 100mL (MF TEST)	JUNE* FECAL COLIFORMS (MPN)
1	(6)	24*	57	5	(23)	≥160	-2175	≥160	(21)	90	152	50
3	(15)	3	19	.7	(11)	14	18	3	(14)	3	12	.4
4 A	(15)	11	28	2.2	(11)	35	38	11	(14)	30	50	30
4 B	(15)	1.1	9	.4	(11)	8	12	3	(14)	6	24	.8
5	27	2.3	3	.4	(23)	≥160	-990	≥160	(14)	13	25	8
6 A	(15)	50	36	2.6	19	3	1	.4	(21)	50	78	17
6 B	(15)	8	34	.2	19	1.4	1	<.2	(21)	5	46	5
7	(15)	30	45	1.1	19	1.7	3	.4	(21)	50	86	50
8	27	.8	0	.4	(23)	≥160	-143	≥160	(21)	5	4	3
10	27	1.7	0	.2	(23)	≥160	-324	≥160	(14)	50	84	17
12	27	8	10	2.3	19	2.3	6	2.3	(21)	11	20	.4
13	27	.6	1	<.2	(23)	≥160	-720	≥160	27	26	30	.2
14 A	27	.8	0	.2	19	3	14	.4	27	3	14	.2
14 B	27	1.1	0	<.2	19	1.3	6	.4	27	3	15	.2
15-16	(6)	5	43	5	(23)	≥160	-2100	≥160	(14)	5	6	3
17	(6)	11	36	2.7	(11)	90	63	8	(21)	50	88	50
18	27	5	1	.2	(11)	90	23	.7	(14)	90	28	28
19	(6)	7	21	1.3	(11)	90	14	1.7	(14)	22	31	11
21	27	.4	3	.2	19	7	3	.2	27	7	27	2.3
22	27	1.7	1	<.2	19	.4	2	<.2	27	5	21	4
23	27	.8	3	<.2	19	8	0	.8	27	2.2	20	4
24	(6)	7	27	5	(11)	≥160	>400	≥160	(21)	≥160	204	≥160
25	(6)	7	7	1.3	(11)	8	22	1.4	(21)	≥160	182	90
26	27	1.3	3	<.2	19	2.2	1	.2	27	9	22	4
27	(15)	50	44	5	(23)	≥160	-1020	≥160	27	≥160	178	≥160
28	(15)	160	194	5	(23)	≥160	-278	≥160	27	≥160	272	≥160

* All numbers in thousands of individuals per 100mL
** Circled dates indicate significant rainfall within 24hrs before sampling
*** Represents direct colony counts via membrane filtration methods

TABLE 5. TOTAL AND FECAL COLIFORM COUNTS FROM 26 SITES ON TRIBUTARIES OF THE ANACOSTIA RIVER TAKEN DURING APRIL, MAY, AND JUNE 1989

SITE #	DAY**	JULY* TOTAL COLIFORMS (MPN)	TOTAL COLIFORMS*** # / 100mL (MF TEST)	FECAL COLIFORMS (MPN)	DAY	AUGUST* TOTAL COLIFORMS (MPN)	TOTAL COLIFORMS # / 100mL (MF TEST)	FECAL COLIFORMS (MPN)	DAY	SEPTEMBER* TOTAL COLIFORMS (MPN)	TOTAL COLIFORMS # / 100mL (MF TEST)	FECAL COLIFORMS (MPN)
1	11	50	19	13	(8)	160	142	160	30	11	16	1.1
3	28	1.7	2.5	.4	17	2.3	2.9	.4	30	2.2	7	.8
4 A	28	8	4.1	.6	17	17	2.4	.7	30	8	12	5
4 B	28	13	.7	.4	17	13	4	1.1	30	3	11	.8
5	28	2.3	.5	.8	17	11	3.7	1.7	30	3	7	.4
6 A	28	2.3	.2	.4	17	7	2.6	.2	30	6	19	1.3
6 B	28	5	2.1	0	17	.8	1.4	.2	30	.8	2	.2
7	28	22	1.6	17	17	5	1.5	.7	30	1.4	4	0
8	28	≥160	≥170	160	8	1.1	.9	.8	30	3	6	1.3
10	28	30	3	24	17	22	1.8	11	25	3	3	1.1
12	(21)	3	.7	1.7	28	30	20	30	25	30	12	11
13	(21)	8	8	8	28	1.7	3	.2	25	5	7	.7
14 A	11	2.3	.9	.2	28	1.3	4	.8	25	17	8	1.4
14 B	(21)	50	11	17	28	1.3	2	.4	25	8	9	.8
15-16	11	17	10	2.7	(8)	50	63	.7	25	8	7	2.3
17	11	90	63	50	(8)	160	158	90	25	8	18	2.3
18	11	30	36	8	(8)	3	13	.8	25	13	1	1.7
19	11	30	10	13	(8)	11	14	5	25	13	6	1.4
21	11	9	4	3	28	.8	3	.4	25	24	7	1.4
22	20	5	11	.8	28	3	1	.7	25	30	5	1.7
23	20	1.3	5	.4	28	1.3	8	.2	25	8	11	.2
24	11	7	3	.9	(8)	5	7	13	25	24	9	1.3
25	11	8	11	1.1	(8)	30	27	17	25	13	19	8
26	28	5	4	.4	28	9	15	5	25	13	5	.2
27	28	5	25	5	(8)	5	20	23	30	24	23	11
28	28	160	175	30	(8)	50	47	11	30	≥160	159	22

* All numbers in thousands of individuals per 100mL

** Circled dates indicate significant rainfall within 24hrs before sampling

*** Represents direct colony counts via membrane filtration methods

TABLE 6. TOTAL AND FECAL COLIFORM COUNTS FROM 26 SITES ON TRIBUTARIES OF THE ANACOSTIA RIVER TAKEN DURING JULY, AUGUST, AND SEPTEMBER 1989

SITE #	DAY**	OCTOBER * TOTAL COLIFORMS (MPN)	TOTAL COLIFORMS*** # / 100mL (MF TEST)	FECAL COLIFORMS (MPN)
1	(20)	280	20	70
3	(20)	220	80	220
4 A	(20)	170	80	30
4 B	(20)	900	90	80
5	(20)	170	80	21
6 A	(20)	170	140	11
6 B	(20)	300	60	30
7	(20)	110	50	50
8	28	17	20	17
10	28	3	2	.2
12	28	5	6	5
13	28	.8	1	0
14 A	28	1.1	1	.4
14 B	28	1.1	2	0
15-16	(20)	350	90	21
17	(20)	500	70	30
18	(20)	240	80	17
19	(20)	500	110	110
21	28	2.2	1	0
22	28	8	0	4
23	28	1.3	1	.4
24	(20)	1600	170	50
25	(20)	1600	220	20
26	28	1.1	2	0
27	(20)	900	120	110
28	(20)	900	230	4

* All numbers in thousands of individuals per 100mL
** Circled dates indicate significant rainfall within 24hrs. before sampling
*** Represents direct colony counts via membrane filtration methods

TABLE 7, TOTAL AND FECAL COLIFORM COUNTS FROM 26 SITES ON TRIBUTARIES OF THE ANACOSTIA RIVER TAKEN DURING OCTOBER 1989

WATER PHYSICAL / CHEMICAL PARAMETERS

All physical / chemical measurements are based upon Standard Methods (1985) and all calibrations and pretreatments made to standard operating procedures and manufacturer specifications. Results are presented in tables 8-13.

Stream pH was measured either in the field or in the lab on Hanna instruments microprocessing pH meter or a Fisher Accumet pH meter, respectively. The meters were calibrated daily, immediately before use. The calibration was checked regularly before pH measurement at each site.

Dissolved oxygen (DO) was evaluated with a Yellow Springs Instruments (YSI) model 58 DO meter. The DO probe membrane and potassium chloride solution were renewed weekly or immediately in the field upon signs of bubbles or wrinkles.

Dissolved solids were measured with a Myron Dissolved solids meter with an adjustable internal calibration. Beginning in June, total dissolved solids (TDS; mg/l) and conductivity (micro S/cm) measurements were taken from a Hach model 44600 conductivity/TDS meter. The meter was calibrated weekly with a sodium chloride solution.

Water temperature is based on the average temperature obtained from the thermistors in the DO, TDS, and pH meters and a mercury thermometer. Values were always within a few tenths of a degree of each other.

Air temperature was measured on site with a thermometer.

Total suspended solids (TSS) were measured from 250ml samples passed through Watman filter discs and weighed on a Sartorius analytical balance.

Turbidity, measured in nephelometric turbidity units (NTU), was evaluated in the lab using an HF scientific turbidimeter model DRT - 100. The turbidimeter was calibrated immediately before and during use after the initial warm-up period.

Biochemical Oxygen Demand (BOD) was determined on 300ml samples using a Yellow Springs Instruments 5720 BOD bottle probe and Hach nitrification inhibitor.

Ammonia concentration in stream waters was measured using a Solomat MPM 2000 mainframe and 2010 ion Modumeter in conjunction with an Orion ammonia gas sensing electrode.

INSTRUMENTS

<u>Field.</u>

pH < Hanna Instruments - H18424 microprocessor pH meter

DO < YSI model 58 Dissolved Oxygen meter, 5085 DO probe

Conductivity/TDS < Hach Co. model 44600 conductivity/TDS meter

Temperature < mercury thermometer, meter thermistors

<u>Laboratory.</u>

pH < Fisher scientific - Accumet pH meter model 815 MP

Turbidity < HF scientific turbidimeter model DRT - 100

Balance < Sartorius analytical balance

Oven < Precision scientific model 114 oven

DO < YSI model 58 DO meter, 5720 BOD bottle probe

Ion meter < Solomat MPM 2000 mainframe, 2010 ion modumeter

Incubator < Precision scientific model 805 incubator

WATER PHYSICAL / CHEMICAL ANALYSIS

RESULTS (TABLES 8-13)

The water physical chemical data were analyzed to determine those sites where the physical/chemical nature of the water may impair the growth of the benthic macroinvertebrate/fish populations. From strictly this standpoint sites were either categorized as good, fair, or poor. Later we will attempt to correlate these findings with the benthic macroinvertebrate communities.

Water temperature

Temperatures were in general within acceptable limits throughout the study area with the exception of a few sites in August. We noticed high temperatures, greater than 28 C, at sites 8 (PB), 13 (PB), 18 (NWB), and 24 (SC). High water temperature causes a stress on the aquatic biota through elevation of respiratory and metabolic rates. The oxygen-holding capacity of water is greatly reduced by high temperatures. Combinations of these factors usually lead to decreased biotic health which lowers or eliminates reproductivity capacity. High temperatures also increase growth of fecal coliforms and certain algae. Most importantly, spawning and egg development of most fishes, and growth of some, cease at these temperatures.

Total dissolved solids

Dissolved solids are generally not considered harmful to the aquatic communities examined even at the highest levels found during the study period (Water Quality Criteria 1968). However, if any of these dissolved substances are toxic, even very low concentrations may be detrimental (that is, substances such as pesticides and herbicides). We did not attempt to assay toxic substances. Sligo Creek and Lower Beaverdam Creek showed consistently high dissolved solids concentrations. Storm events lowered TDS at all sites. This may present the biota with an osmotic stress in addition to the other physical stresses encountered during these periods of greatly increased flow.

Dissolved oxygen

Water oxygen concentrations were found to be generally within the minimum limit (7 mg/l) for a diversified biota. However, a few sites showed consistently low oxygen levels (see Tables 8-13) which would compromise the diversity in the aquatic communities. Storm events eliminated low oxygen levels at all sites except Site 7 (BDC).

pH

Water pH is considered compatible with aquatic biota in the range of pH 6.0 - 9.0. Approaching these limits, however, creates a biotic stress. The study area was always well within the lower limit but approached and only barely exceeded the upper limits at several sites. Water pH in excess of 8.5 will be considered stressful to the aquatic community (Table 14).

Turbidity

Water turbidity measured in nephelometric turbidity units (NTU), is a critical water physical characteristic. Increased turbidity will greatly decrease algal growth, essential to herbivores, and is usually associated with high levels of sediment suspension. Organic acids will also increase water turbidity. Consistently high turbidities were recorded at several sites (Tables 8-13): Sites 6A (IC), 27 (LBC), and 28 (LBC) fall in this category. Sites 8 (LBC), 10 (LPB), 14A (PB), 14B (PB), 19 (NWB), 22 (NWB), 23 (NWB), 24 (SC), and 25 (SC) have the lowest turbidities. Storm events cause an intense pulse of high turbidity over the entire study area.

Total suspended solids

Suspended solids are closely correlated with water turbidity and adversely affect the aquatic biota through abrasion, light attenuation, and sedimentation. Storm events create a condition completely incompatible with aquatic biota. High levels of suspended materials move rapidly downstream during the event, abrading all exposed surfaces. As the flow rate decreases with the passing of the event, fouling sediment is deposited. Many sites carry high amounts of sediment under normal flow conditions (Tables 8-13). Faster flowing water is capable of carrying more sediment and should be considered when evaluating stream TSS.

Table 8. Anacostia River watershed. Physical / Chemical parameters. December 1988.

Site	Day	Temp. (C) Air	Water	DO ppm	DS ppm	pH
1	26	5.0	5.0	11.0	163	7.13
3	26	7.0	5.0	12.9	150	7.44
4A	26	8.0	5.0	10.7	155	7.22
4B	26	8.0	4.0	11.7	215	7.25
5	26	7.5	5.0	12.7	142	7.30
6A	28	5.0	5.5	9.5	156	7.20
6B	29	5.0	4.0	11.5	41	7.22
7	29	3.0	3.0	12.1	137	7.13
8	28	17.0	9.0	9.6	154	7.56
10	08	14.0	8.0	11.4	165	7.32
12	12	10.0	7.5	11.6	151	7.28
13	08	10.0	5.0	10.4	130	7.39
14A	29	15.5	2.0	12.2	88	7.47
14B	03	14.0	6.0	12.0	68	7.35
15/16	28	16.0	6.0	8.8	191	7.48
17	28	18.0	6.0	10.6	165	7.65
18	28	17.0	6.0	10.7	169	7.48
19	28	17.0	6.0	13.1	170	7.76
21	03	16.0	6.0	10.9	255	7.62
22	29	3.0	4.0	12.8	156	7.49
23	03	17.0	6.0	10.3	87	7.39
24	29	17.5	8.5	12.5	311	8.31
25	03	17.0	5.0	11.3	297	7.88
26	03	13.0	6.0	10.6	330	7.59
27	26	4.0	4.0	11.8	355	7.10
28	26	6.0	5.5	12.3	215	7.17

Table 9. Anacostia River watershed. Water physical / chemical parameters. April 1989.

Site	Day	Temp. (C) Air	Water	DS (ppm)	DO (% satn.) mg/l	pH
1	06	-	13	170	-	7.01
3	15	13	12	268	8.6 (78)	7.02
4A	15	13	12	349	7.6 (70)	6.99
4B	15	13	11	119	8.3 (74)	7.02
5	14	24	14	159	12.8 (121)	-
6A	15	13	11	228	18.0 (72)	7.02
6B	15	14	10	198	8.9 (79)	7.00
7	15	12	12	211	7.5 (69)	6.98
8	14	25	14	155	11.7 (117)	-
10	20	16	14	202	10.3 (99)	-
12	20	17	14	164	9.7 (94)	-
13	20	17	14	170	10.0 (96)	-
14A	01	-	09	110	-	6.97
14B	01	-	10	70	-	6.99
15/16	06	-	14	140	-	7.01
17	06	-	13	130	-	7.03
18	20	17	14	177	11.1 (107)	-
19	06	-	13	130	-	7.07
21	01	-	10	120	-	6.97
22	01	-	10	120	-	6.97
23	01	-	09	90	-	6.98
24	06	-	15	190	-	7.22
25	06	-	15	210	-	7.17
26	01	-	10	210	-	6.95
27	15	13	11	473	18.5 (77)	7.01
28	15	13	12	141	7.8 (73)	6.98

Table 10. Anacostia River watershed. Water physical / chemical parameters, June 1989. (Heading abbreviations: CND - conductivity, DO - dissolved oxygen, TDS - total dissolved solids).

Site	Day	Temp. (C) Air	Water	CND microS/cm	DO (% satn.) mg/l	pH	TDS mg/l
1	08	25	21.6	160.6	7.7 (88)	-	80.2
3	14	28	24.7	203.0	9.5 (115)	-	101.6
4A	14	29	22.9	185.0	6.9 (81)	-	92.5
4B	14	29	21.3	201.0	8.2 (92)	-	100.5
5	14	14	25.0	210.0	7.8 (90)	-	105.1
6A	15	26	23.4	162.9	3.9 (46)	-	81.5
6B	15	27	19.8	180.7	8.5 (94)	-	64.9
7	15	25	22.3	129.8	6.0 (70)	-	82.3
8	14	28	22.9	164.6	9.1 (106)	-	92.7
10	15	29	23.0	185.2	9.4 (110)	-	77.4
12	15	24	20.9	154.8	7.2 (81)	-	70.0
14A	20	25	19.4	159.1	8.2 (89)	7.52	79.5
14B	20	22	18.3	98.0	9.9 (105)	7.34	49.0
15/16	08	26	22.4	172.6	7.7 (89)	-	86.5
17	19	28	22.0	206.0	8.8 (102)	8.06	103.4
18	14	28	21.8	208.0	8.8 (102)	-	104.0
19	14	25	21.5	201.2	6.6 (75)	-	100.6
21	20	22	20.4	170.0	7.3 (81)	7.49	88.5
22	20	24	21.1	103.3	9.5 (105)	7.80	51.7
23	20	27	20.5	94.9	7.9 (87)	6.86	47.3
24	19	28	23.0	289.0	10.8 (126)	8.58	144.9
25	19	24	24.8	223.0	9.1 (102)	7.86	111.8
26	20	22	19.8	148.4	8.1 (89)	6.85	74.2
27	19	25	22.4	431.0	8.8 (102)	7.88	216.0
28	19	32	23.8	101.6	7.8 (88)	7.75	50.8

Table 11. Anacostia River watershed. Water physical / chemical parameters. August 1989. (Heading abbreviations: TDS - total dissolved solids; CND - conductivity; DO - dissolved oxygen; Turb. - turbidity, NTU - nephelometric turbidity units; Ammon. - Ammonia).

Site	Day	Temp. (C) Air	Water	TDS mg/l	CND microS/cm	DO (%satn.) mg/l	pH	Turb. NTU	Ammon. ppm
1	07	26	26.7	109.6	219.2	7.0 (85)	8.77	6.3	0.037
3	06	27	25.3	85.8	171.6	-	8.57	6.3	0.027
4A	06	26	25.4	152.7	305.4	6.4 (77)	7.24	6.6	0.138
4B	06	26	24.2	122.7	245.4	-	7.77	4.8	0.094
5	06	27	24.5	98.6	197.2	7.5 (90)	6.91	16.0	0.079
6A	06	27	25.4	82.6	165.2	4.0 (49)	6.66	9.2	0.507
6B	06	32	23.5	90.4	180.8	-	7.24	5.0	0.027
7	06	32	27.2	112.5	225.0	5.8 (72)	6.80	35.0	0.051
8	06	35	28.7	98.2	196.4	-	8.72	2.2	0.029
10	06	33	24.8	90.2	180.4	-	7.94	1.8	0.028
12	06	33	25.5	76.7	153.4	-	7.17	4.4	0.027
13	06	31	30.5	97.6	195.2	-	9.17	2.1	0.027
14A	09	20	17.2	74.9	149.7	9.8 (102)	7.42	1.3	-
14B	09	21	16.9	47.3	94.6	9.0 (90)	7.23	1.9	-
15/16	07	22	26.0	126.6	253.2	7.0 (85)	8.46	2.5	0.076
17	07	21	25.2	104.0	208.0	8.6 (104)	8.11	2.4	0.038
18	06	32	28.5	97.0	194.0	-	9.01	2.0	0.031
19	06	28	26.9	98.0	195.9	7.8 (98)	8.73	1.5	0.025
21	09	20	19.6	87.3	174.6	9.1 (99)	7.72	6.8	-
22	09	20	16.9	60.2	120.3	8.0 (83)	7.13	1.5	-
23	09	20	18.0	83.8	167.6	8.7 (91)	7.44	2.6	-
24	06	30	30.1	184.4	368.8	-	9.44	1.2	0.028
25	07	22	23.6	204.0	408.0	8.2 (96)	8.20	0.7	0.036
26	09	19	17.2	175.9	351.8	8.2 (85)	7.59	0.7	-
27	07	26	25.2	162.2	324.4	5.9 (72)	7.40	11.0	0.063
28	07	24	25.2	166.1	332.2	5.8 (70)	8.07	29.0	0.064

Table 12. Anacostia River watershed. Water physical / chemical parameters. September 1989. (Heading abbreviations: TDS - total dissolved solids; CND -conductivity; DO - dissolved oxygen; Turb. - turbidity; TSS - total suspended solids; BOD - biochemical oxygen demand).

Site	Day	Temp. (C) Air	Water	TDS mg/l	CND microS/cm	DO (%satn) mg/l	pH	Turb. NTU	TSS mg/l	BOD mg/l
1	28	15	14.4	102.0	204.0	8.7 (82)	7.46	18.0	12.0	3.52
3	15	24	23.8	114.0	227.0	9.8(114)	8.67	7.4	49.2	14.52
4A	15	25	22.7	96.2	192.3	5.4 (62)	7.15	65.0	55.2	8.04
4B	15	24	22.1	126.0	252.0	8.0 (90)	7.52	5.5	18.0	8.80
5	15	25	22.4	112.4	224.0	7.2(81)	7.39	18.0	24.8	7.52
6A	15	25	24.5	111.0	221.0	7.1 (83)	7.60	18.0	93.2	6.14
6B	30	19	16.0	89.8	179.6	9.5 (93)	7.75	4.8	5.2	2.19
7	30	17	15.8	90.7	182.5	8.5 (83)	7.41	10.0	7.6	7.08
8	30	20	17.9	98.8	197.5	10.3(105)	8.21	2.8	9.6	4.25
10	30	18	18.4	91.4	182.8	10.4(107)	8.07	4.1	34.4	8.45
12	30	19	16.6	79.9	159.8	10.0 (99)	7.71	9.9	31.6	5.52
13	30	17	14.5	86.7	173.3	9.9 (96)	8.20	1.2	8.4	6.36
14A	30	15	14.2	69.5	139.0	9.9 (93)	7.80	1.3	14.8	11.85
14B	30	16	14.3	49.6	99.3	8.9 (84)	7.85	1.4	10.4	12.93
15/16	28	20	16.9	111.0	222.0	8.6 (87)	7.46	19.0	12.8	9.08
17	28	20	14.7	84.8	169.6	8.4 (80)	7.52	20.0	10.8	3.72
18	30	18	16.7	93.9	187.7	10.4(109)	8.45	5.6	5.6	8.17
19	30	17	16.0	93.1	186.2	10.6(103)	8.81	4.9	6.0	6.36
21	30	15	16.9	86.8	173.5	10.6 (99)	8.03	8.5	20.8	9.75
22	30	17	14.7	85.7	171.3	10.0 (95)	7.75	3.1	8.0	8.31
23	30	17	14.3	61.0	121.9	10.0 (95)	7.75	1.7	24.0	9.18
24	28	21	17.5	168.0	336.0	8.0 (81)	8.88	1.9	21.2	4.12
25	28	20	15.3	177.0	353.0	9.9 (96)	8.20	3.9	5.2	0.80
26	30	15	15.3	162.0	324.0	9.1 (89)	7.72	10.5	76.2	7.52
27	28	14	13.3	200.1	400.1	8.7 (81)	7.46	405.0	24.0	3.83
28	28	15	14.7	87.1	174.2	8.5 (80)	7.46	85.0	40.0	5.78

Table 13. Anacostia River watershed. Water physical / chemical parameters. October 1989. (Heading abbreviations: TDS - total dissolved solids; CND - conductivity; DO - dissolved oxygen; Turb. - turbidity; TSS - total suspended solids.)

Site	Day	Temp. (C) Air	Temp. (C) Water	TDS mg/l	CND microS/cm	DO (%satn.) mg/l	pH	Turb. NTU	TSS mg/l
1	19	08	12.2	67.7	135.4	10.3 (90)	8.49	80	111.2
3	19	11	12.1	80.3	160.6	9.6 (84)	7.72	115	117.6
4A	19	10	12.1	45.6	91.2	10.5 (92)	7.80	95	148.0
4B	19	10	12.5	52.3	104.6	10.6 (94)	7.81	115	271.2
5	19	12	12.0	80.5	161.0	9.3 (82)	7.68	95	94.0
6A	19	12	11.9	74.6	149.2	9.6 (85)	7.77	119	120.8
6B	19	12	12.6	77.1	154.2	9.3 (83)	7.20	26	7.6
7	19	12	12.1	79.8	159.6	8.2 (73)	7.35	40	17.6
8	19	10	12.2	65.1	130.2	10.4 (92)	7.95	62	116.4
10	19	11	12.9	64.2	128.4	10.8 (94)	7.62	72	86.0
12	19	12	12.7	63.0	126.0	10.5 (93)	7.78	55	140.8
13	19	11	12.2	53.7	107.4	10.8 (94)	7.96	48	65.5
14A	17	20	18.2	83.7	167.4	8.8 (89)	7.95	21	18.0
14B	17	20	18.0	45.8	91.6	8.5 (86)	8.02	25	3.2
15/16	19	10	12.1	57.0	114.0	10.8 (94)	8.68	82	182.0
17	19	10	12.0	55.1	110.2	10.5 (91)	8.63	87	181.6
18	19	10	11.8	52.7	105.4	10.7 (93)	8.01	77	161.6
19	19	10	11.9	53.2	106.4	10.8 (95)	8.73	76	121.2
21	17	20	17.5	89.4	178.8	9.7 (97)	8.23	7	120.0
22	17	20	18.7	88.5	177.0	8.3 (85)	7.75	34	121.2
23	17	20	17.9	66.2	132.4	8.6 (86)	7.92	4	2.4
24	19	11	11.8	50.8	101.6	10.5 (90)	8.71	25	46.0
25	19	11	11.6	50.7	101.4	10.9 (94)	8.79	28	45.6
26	17	20	19.0	98.2	196.4	8.8 (91)	7.30	92	252.4
27	19	09	12.8	81.0	162.0	10.8 (98)	8.37	115	150.4
28	19	10	12.0	71.1	142.2	10.6 (92)	8.45	595	489.2

Table 14. Physical / chemical parameters (p/c) possibly stressful or threatening to the aquatic biota (stressful condition marked by X). (Heading abbreviations: DO - dissolved oxygen; Turb. - turbidity; TSS - total suspended solids.)

Site	Water Temp. (C)	DO (% satn) mg/l	pH	Turb. NTU	TSS mg/l	Ammonia	Overall p/c rating
1			x	x	x		poor
3			x	x	x		poor
4A		x		x	x	x	poor
4B					x		fair
5				x	x		fair
6A		x		x	x		poor
6B							good
7		x		x		x	poor
8	x		x				poor
10					x		fair
12					x		fair
13	x		x				poor
14A					x		fair
14B							good
15/16					x		fair
17							good
18	x		x				fair
19			x				fair
21					x		fair
22							good
23					x		fair
24	x		x		x		poor
25							good
26					x		fair
27		x		x	x		poor
28		x		x	x		poor

SITE BY SITE RESULTS (FIG. 4)

1 (NEB). No surber sampling. Fairly consistently showed high pH, turbidity, and TSS. P/c rating - poor.

3 (NEB). Surber samples revealed fairly low macroinvertebrate abundance levels and mediocre diversity. High pH, turbidity, and TSS. Rating: macrobenthos - fair, p/c - poor.

4A (BD). Low macrobenthic abundance and diversity; low DO, high turbidity, TSS, and ammonia. Rating: macrobenthos - poor, p/c - poor.

4B (BD). Low macrobenthic abundance and diversity; high turbidity and TSS. Rating: macrobenthos - poor, p/c - fair.

5 (IC). Macrobenthic invertebrates fairly diverse with occasional indications of high abundance; high turbidity and TSS. Rating: macrobenthos - fair, p/c - fair.

6A (IC). No surber sampling. Low DO, high turbidity and TSS. P/c rating - poor.

6B (IC). High diversity and abundance levels of macroinvertebrates. No p/c stresses detected. Rating: macrobenthos - good, p/c - good.

7 (BDC). Low macrobenthic abundance and diversity; low DO, high turbidity and very high ammonia levels. Rating: macrobenthos - poor, p/c - poor.

8 (PB). Fair macroinvertebrate diversity, low abundance; elevated water temperature and pH. Rating: macrobenthos - fair, p/c - poor.

10 (LPB). Low macroinvertebrate abundance and diversity; high TSS. Rating: macrobenthos - poor, p/c - poor.

12 (LPB). Macroinvertebrate abundance fair, diversity mediocre; high TSS. Rating: macrobenthos - fair, p/c - fair.

13 (PB). Fair diversity and low abundance of macroinvertebrates; high water temperatures and pH levels. Rating: macrobenthos - fair, p/c - poor.

14A (PB). Macrobenthic diversity fairly high, abundance levels low. High TSS. Rating: macrobenthos - good, p/c - fair.

14B (PB). Good macrobenthic diversity and high abundance levels. No p/c stresses detected. Rating: macrobenthos - good, p/c - good.

15/16 (NWB). Macroinvertebrates almost completely absent, low diversity and abundance. Condition of benthic communities may be result of low substrate heterogeneity and very little detrital accumulation. High TSS. Rating: macrobenthos - poor, p/c - fair.

17 (NWB). Low macrobenthic abundance and diversity. No p/c stresses detected. Rating: macrobenthos - poor, p/c - good.

18 (NWB). Abundance and diversity of macroinvertebrates fair. Occasional very high abundance levels of Trichoptera larvae. Water temperature and pH elevated. Rating: macrobenthos - fair, p/c - fair.

19 (NWB). Abundance and diversity of macroinvertebrates fair; elevated pH. Rating: macrobenthos - fair, p/c - fair.

21 (NWB). Fair diversity, low abundance of macroinvertebrates; high TSS. Rating: macrobenthos - fair, p/c - fair.

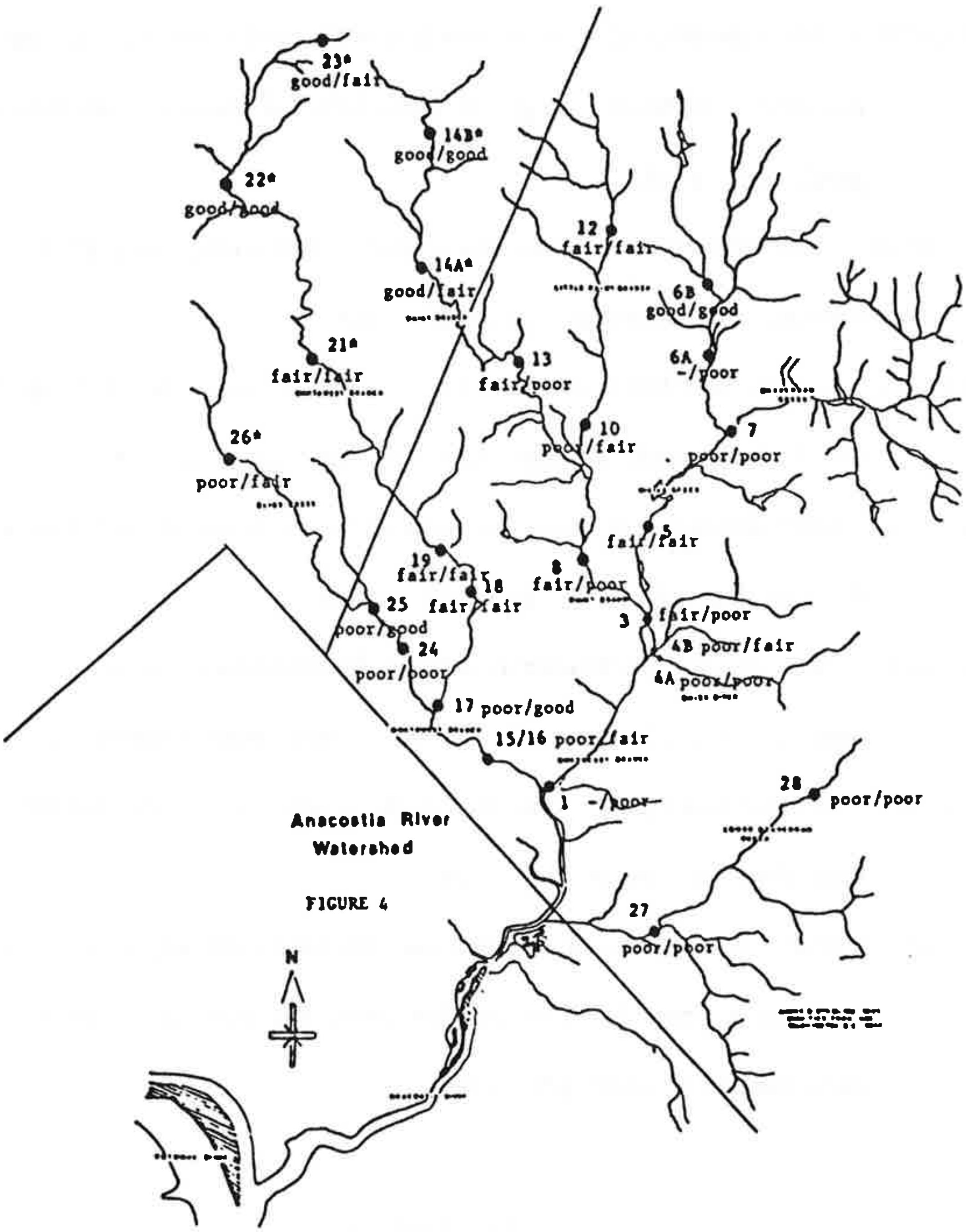

Fig. 4. Anacostia River watershed sampling sites. Condition ratings from macroinvertebrates (left) and water quality parameters (right).

22 (NWB). Macrobenthic abundance low but with good diversity and apparent community balance. No p/c stresses detected. Rating: macrobenthos - good, p/c - good.

23 (NWB). Macroinvertebrate abundance good and diversity, very good. High TSS. Rating: macrobenthos - good, p/c - fair.

24 (SC). Macroinvertebrate abundance and diversity poor. Water temperature, pH, and TSS elevated. Rating: macrobenthos - poor, p/c - poor.

25 (SC). Macroinvertebrate abundance and diversity poor. No p/c stresses detected. Rating: macrobenthos - poor, p/c - good.

26 (SC). Diversity and abundance of benthic invertebrates low with occasional large numbers of Trichoptera. High TSS. Rating: macrobenthos - poor, p/c - fair.

27 (LBC). Benthic biota poor. Low DO, high turbidity and TSS. Rating: macrobenthos - poor, p/c - poor.

28 (LBC). Macroinvertebrate abundance and diversity generally poor; occasional high levels of gastropods. Low DO, high turbidity and TSS. Rating: macrobenthos - poor, p/c - poor.

CONCLUSIONS

In general, the watershed as a whole is in a stressed condition as evidenced by relatively consistent fair/poor ratings in macrobenthic community composition, water chemistry/quality, and fecal coliform contamination. When attempting to evaluate ecological situations on the basis of biotic factors, especially when using numerical abundance figures, influential environmental conditions must be recognized. Seasonal climatic variability is highly correlated with invertebrate populations. For instance, indication of low numbers is potentially a result of two factors (in addition to the inherent problems of ecological sampling): A) populational circadian rhythmicity, or B) severe habitat disruption. In order to better understand which of these factors is influencing habitat evaluation longer term biomonitoring (2-3 years) would be a much superior approach. However, we feel that results presented in this document are relatively accurate. There is substantial positive correlation between the benthic macroinvertebrate analyses and the water physical / chemical analyses.

Improved stream quality will undoubtedly permit recolonization of streams by various submerged aquatic macrophytes. Sporadic appearance of several different submerged macrophytes has been noted at Sites 15/16 (NWB), 6A (IC), and 21 (NWB), some of the consistently poorer sites on the basis of the factors investigated in this study. Submerged vegetation is important as nursery for larval fishes and as substrate for many invertebrates.

RESTORATION RECOMMENDATIONS FOR IMPROVEMENT OF AQUATIC BIOTA AND WATER QUALITY

1. Reduction of water turbidity and suspended solids due to runoff. This may be achieved by creation of catchment marshes which will accept stream waters during

periods of high flow.

2. Reduction of water turbidity and suspended solids from point sources. Increased monitoring and enforcement of construction runoff and mining activities. Higher fines for violations.

3. Creation of catchment marshes in areas where urban and highway runoff is problematic. These marshes will effectively prevent excessive amounts of runoff water and pollutants from reaching the streams and create productive aquatic communities.

4. Reduction of thermal stress. Water temperatures may be improved by the planting of riparian vegetation to increase shade. Additionally, the practice of clear-cutting stream banks should be discontinued. These improvements will also reduce erosion.

5. Creation of a more heterogenous substratum would allow colonization of streams by more diverse faunal assemblages. For example, artificially placed snags (logs, large branches and rocks) would cause leaf litter and other detritus to accumulate, providing an organically rich detritus-based substrate (as opposed to the macrophyte substrate mentioned in the previous section). Natural snags and detritus are normal and desirable biproducts of riparian vegetation. Allowing streamside vegetation (grasses, shrubs, and trees) to remain and grow would: A) help prevent erosion, and B) provide input of leaf litter, snags, and twigs.

6. We feel that the most critical recommendations concern the creation of catchment marshes and the establishment of healthy growths of riparian vegetation.

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Appendix A. Site listings. Macroinvertebrates.

SITE	INSECT GENERA // OTHER INVERTEBRATE TAXA
3	Acricotopus, Allocapnia, Baetis, Berosus, Caenis, Cheumatopsyche, Conchapelopia, Guttipelopia, Hemerodromia, Hydropsyche, Isonychia, Labrundinia, Optioservus, Psephenus, Pseudocloeon, Simulium, Stenonema, Tanytarsus // Nematoda, Oligochaeta, Physa, Chironomidae
4A	Baetis, Hydropsyche, Psychoda, Simulium // Oligochaeta, Chironomidae
4B	Ameletus, Baetis, Calopteryx, Cheumatopsyche, Hydropsyche, Tipula // Physa, Oligochaeta, Hydracarina, Chironomidae
5	Baetis, Berosus, Calopteryx, Cheumatopsyche, Hemerodromia, Hydropsyche, Lutrochus, Simulium, Tipula // Nematoda, Oligochaeta, Physa, Hydracarina, Chironomidae
6B	Ablabesmyia, Acricotopus, Allocapnia, Ameletus, Amphinemura, Argia, Baetis, Calopteryx, Cernotina, Cheumatopsyche, Chimarra, Dicranota, Eurylophella, Hemerodromia, Hydropsyche, Lanthus, Leuctra, Neophylax, Nigronia, Optioservus, Serratella, Sialis, Simulium, Stenelmis, Stenonema, Taeniopteryx, Tipula // Physa, Oligochaeta, Astacidae, Gammaridae, Hydracarina, Chironomidae
7	Calopteryx, Cheumatopsyche, Hydropsyche, Nigronia, Tipula // Tricladida, Oligochaeta, Dina, Asellus, Gammaridae, Hydracarina, Chironomidae
8	Baetis, Berosus, Cheumatopsyche, Helichus, Hemerodromia, Hydropsyche, Isonychia, Nigronia, Paratrichocladius, Pseudocloeon, Serratella, Stenonema, Tipula // Oligochaeta, Physa, Gammaridae, Hydracarina, Chironomidae
10	Baetis, Cheumatopsyche, Hemerodromia, Hydropsyche, Paratrichocladius, Tipula // Oligochaeta, Hydracarina, Chironomidae
12	Antocha, Baetis, Cheumatopsyche, Cricotopus, Dubiraphia, Hemerodromia, Hydropsyche, Serratella, Stenonema, Taeniopteryx, Tipula // Oligochaeta, Hydracarina, Chironomidae
13	Antocha, Baetis, Cheumatopsyche, Clinocera, Hydropsyche, Isonychia, Nigronia, Optioservus, Oulimnius, Serratella, Taeniopteryx, Tipula // Oligochaeta, Physa, Hydracarina, Chironomidae

Appendix A (cont'd).

SITE	INSECT GENERA // OTHER INVERTEBRATE TAXA
14A	Acricotopus, Ameletus, Antocha, Baetis, Cheumatopsyche, Clinocera, Ephemerella, Hydropsyche, Isonychia, Nigronia, Ophiogomphus, Optioservus, Serratella, Simulium, Stenelmis, Stenonema, Taeniopteryx, Tipula // Oligochaeta, Hydracarina, Chironomidae
14B	Acricotopus, Ameletus, Amphinemura, Antocha, Baetis, Caenis, Calopteryx, Cheumatopsyche, Chimarra, Diploperla, Dolophilodes, Epeorus, Ephemerella, Eurylophella, Glossosoma, Hemerodromia, Hydropsyche, Isonychia, Neophylax, Nigronia, Optioservus, Paracricotopus, Promoresia, Psephenus, Pseudocloeon, Serratella, Simulium, Stenacron, Stenelmis, Stenonema, Taeniopteryx, Tipula // Nemertea, Oligochaeta, Hydracarina
15/16	Argia, Caenis, Guttipelopia, Hagenius, Heptagenia // Dina, Oligochaeta, Ferrissia, Physa, Gammaridae, Hydracarina, Chironomidae
17	Argia, Baetis, Caenis, Cheumatopsyche, Conchapelopia, Hydropsyche, Larsia, Stenonema // Oligochaeta, Physa, Hydracarina, Chironomidae
18	Argia, Ancyronyx, Ameletus, Baetis, Cheumatopsyche, Conchapelopia, Hemerodromia, Hydropsyche, Isonychia, Nigronia, Pseudosmittia, Stenonema // Oligochaeta, Helisoma, Hydracarina, Chironomidae
19	Antocha, Baetis, Cheumatopsyche, Cricotopus, Hydropsyche, Nigronia, Stenonema // Oligochaeta, Ferrissia, Physa, Asellus, Hydracarina, Chironomidae
21	Acricotopus, Ameletus, Antocha, Argia, Baetis, Cheumatopsyche, Hemerodromia, Hydropsyche, Isonychia, Neoephemera, Nigronia, Rheocricotopus, Stenacron, Stenelmis, Stenonema, Taeniopteryx, Tipula // Oligochaeta, Ferrissia, Physa, Pelecypoda, Astacidae, Asellus, Hydracarina, Chironomidae
22	Acricotopus, Ameletus, Amphinemura, Ancyronyx, Antocha, Baetis, Cheumatopsyche, Clinocera, Dolophilodes, Eurylophella, Helichus, Hydropsyche, Isonychia, Nigronia, Optioservus, Paraleptophlebia, Rheocricotpus, Simulium, Stenelmis, Stenonema, Taeniopteryx, Tipula // Nemertea, Oligochaeta, Asellus, Hydracarina, Chironomidae

Appendix A (cont'd).

SITE	INSECT GENERA // OTHER INVERTEBRATE TAXA
23	Agnetina, Allocapnia, Ameletus, Amphinemura, Antocha, Baetis, Caenis, Cheumatopsyche, Chimarra, Chrysops, Clinocera, Dolophilodes, Dubiraphia, Ephemerella, Ephemera, Eurylophella, Glossosoma, Gomphus, Gyrinus, Hagenius, Helichus, Hydropsyche, Isonychia, Neophylax, Nigronia, Optioservus, Ostrocerca, Oulimnius, Perlinella, Prosimulium, Protanypus, Psephenus, Pseudocloeon, Serratella, Simulium, Stenelmis, Stenonema, Suwallia, Taeniopteryx, Tipula // Tricladida, Oligochaeta, Physa, Chironomidae
24	Baetis, Clinocera, Conchapelopia, Hemerodromia, Hydropsyche, Tipula // Tricladida, Oligochaeta, Physa, Amphipoda, Asellus, Hydracarina, Chironomidae
25	Baetis, Guttipelopia, Hemerodromia, Isonychia // Nematoda, Oligochaeta, Ferrissia, Physa, Gyraulus, Gammaridae, Asellus, Hydracarina, Chironomidae
26	Ameletus, Baetis, Cheumatopsyche, Hydropsyche, Simulium, Tipula // Tricladida, Nematoda, Oligochaeta, Hirundinea, Pelecypoda, Ferrissia, Physa, Amphipoda, Asellus, Hydracarina, Chironomidae
27	Acricotopus, Baetis, Chimarra, Conchapelopia, Tipula // Oligochaeta, Chironomidae
28	Helochares // Oligochaeta, Physa, Gyraulus, Chironomidae

Appendix B. Insect Genera, Calculated Index Values, # of Sites at which Genus Occurred.

Genus	Index Value	# Sites Occurrence
Ablabesmyia	0.047	1
Acricotopus	0.292	7
Agnetina	0.047	1
Allocapnia	0.125	3
Ameletus	0.417	10
Amphinemura	0.167	4
Ancyronyx	0.083	2
Antocha	0.333	8
Argia	0.250	6
Baetis	0.875	21
Berosus	0.167	4
Caenis	0.208	5
Calopteryx	0.208	5
Cernotina	0.047	1
Cheumatopsyche	0.708	17
Chimarra	0.208	5
Chrysops	0.047	1
Clinocera	0.208	5
Conchapelopia	0.250	6
Cricotopus	0.083	2
Dicranota	0.047	1
Diploperla	0.047	1
Dolophilodes	0.125	3
Dubiraphia	0.083	2
Epeorus	0.047	1
Ephemera	0.047	1
Ephemerella	0.125	3
Eurylophella	0.208	5
Glossosoma	0.083	2
Gomphus	0.047	1
Guttipelopia	0.125	3
Gyrinus	0.047	1
Hagenius	0.083	2
Helichus	0.125	3
Helochares	0.047	1
Hemerodromia	0.500	12
Heptagenia	0.047	1
Hydropsyche	0.833	20
Isonychia	0.458	11

Appendix B (cont'd). Insect Genera, Calculated Index Values, # of Sites at which Genus Occurred.

Genus	Index Value	# Sites Occurrence
Labrundinia	0.083	2
Lanthus	0.047	1
Larsia	0.047	1
Leuctra	0.047	1
Lutrochus	0.047	1
Neoephemera	0.047	1
Neophylax	0.125	3
Nigronia	0.458	11
Ophiogomphus	0.047	1
Optioservus	0.292	7
Ostrocerca	0.047	1
Oulimnius	0.083	2
Paracricotopus	0.083	2
Paraleptophlebia	0.047	1
Paratricholcladius	0.083	2
Perlinella	0.047	1
Promoresia	0.047	1
Prosimulium	0.047	1
Protanypus	0.047	1
Psephenus	0.125	3
Pseudocloeon	0.167	4
Pseudosmittia	0.047	1
Psychoda	0.047	1
Rheocricotopus	0.083	2
Serratella	0.292	7
Sialis	0.047	1
Simulium	0.375	9
Stenacron	0.083	2
Stenelmis	0.292	7
Stenonema	0.500	12
Suwallia	0.047	1
Tanytarsus	0.047	1
Taeniopteryx	0.292	7
Tipula	0.750	18

Appendix C. Monthly invertebrate taxonomic lists. Sampling results from December 1988 and April - October 1989. Each surber replicate is kept separate, e. g., as follows: 3.1 designates replicate 1 at Site 3; 3.2, replicate 2 at Site 3. In the case of insects, life stages (larvae [nymphs/naiads], pupae, and adults) are segregated for enumeration but combined for a taxon total. In the calculation of metrics the replicate results are pooled for a site total. Broader taxonomic categories of those taxa listed may be found in Merritt and Cummins (1984) and Pennak (1978).

Benthic macroinvertebrates, 12/88

Stn.rep	Date	Taxon	L(N)	P	A	Total
1.1	12/26	---				0
1.2	12/26	---				0
*						
2.1	12/26	Oligochaeta				~5
2.1	12/26	Physa				5
2.1	12/26	Cheumatopsyche	1			1
2.1	12/26	Berosus	6			6
2.2	12/26	Hydropsyche morosa sp. group	1			1
*						
3.1	12/26	Cheumatopsyche	1			1
3.1	12/26	Hydropsyche	2			2
3.2	12/26	Oligochaeta				2
3.2	12/26	Isonychia	1			1
3.2	12/26	Allocapnia	1			1
3.2	12/26	Cheumatopsyche	5			5
3.2	12/26	Hydropsyche	6			6
*						
4A.1	12/26	Oligochaeta				~5
4A.1	12/26	Hydropsyche	1			1
4A.1	12/26	Tipula	1			1
4A.1	12/26	Chironomidae	1			1
4A.2	12/26	Oligochaeta				~2
4A.2	12/26	Hydropsyche	1			1
*						
4B.1	12/26	Oligochaeta				~2
4B.1	12/26	Physa				1
4B.1	12/26	Hydropsyche	11			11
4B.1	12/26	Cheumatopsyche	1			1
4B.1	12/26	Chironomidae	2			2
4B.2	12/26	Oligochaeta				~2
4B.2	12/26	Hydropsyche	2			2
*						
5.1	12/26	Nematoda				3
5.1	12/26	Physa				1
5.1	12/26	Hydropsyche	45			45
5.1	12/26	Cheumatopsyche	1			1
5.1	12/26	Berosus	1			1
5.1	12/26	Tipula	2			2
5.1	12/26	Chironomidae	5			5
5.2	12/26	Oligochaeta				~5
5.2	12/26	Hydropsyche	54			54
5.2	12/26	Cheumatopsyche	1			1
5.2	12/26	Berosus	10			10
5.2	12/26	Chironomidae	6			6
5.2	12/26	Tipula	4			4
*						
6B.1	12/30	Physa	1			1
6B.1	12/30	Taeniopteryx	1			1
6B.1	12/30	Stenonema	1			1
6B.1	12/30	Ephemeroptera (early instar)	1			1
6B.1	12/30	Nigronia	5			5
6B.1	12/30	Cheumatopsyche	3			3

December 1988, Benthic macroinvertebrates (cont'd)

Stn.rep	Date	Taxon	L(N)	P	A	Total
6B.1	12/30	Chimarra	2			2
6B.1	12/30	Chironomidae	1			1
6B.2	12/30	Physa	1			1
6B.2	12/30	Ephemeroptera (early instar)	1			1
6B.2	12/30	Taeniopteryx	4			4
6B.2	12/30	Allocapnia	1			1
6B.2	12/30	Nigronia	13			13
6B.2	12/30	Stenelmis			1	1
6B.2	12/30	Chimarra	11			11
6B.2	12/30	Hydropsyche	4			4
6B.2	12/30	Cheumatopsyche	8			8
6B.2	12/30	Tipula	1			1
6B.2	12/30	Chironomidae	18			18
*						
7.1	12/30	Chironomidae	2			2
7.2	12/30	Chironomidae	1			1
*						
8.1	12/28	Oligochaeta				2
8.1	12/28	Cheumatopsyche	6			6
8.1	12/28	Hydropsyche	3			3
8.1	12/28	Tipula	1			1
8.2	12/28	Oligochaeta	2			2
8.2	12/28	Stenonema	1			1
8.2	12/28	Isonychia	2			2
8.2	12/28	Berosus	1			1
8.2	12/28	Hydropsyche	38			38
8.2	12/28	Cheumatopsyche	9			9
8.2	12/28	Tipula	1			1
*						
10.1	12/08	Oligochaeta				~5
10.1	12/08	Hydropsyche	13			13
10.1	12/08	Cheumatopsyche	4			4
10.2	12/08	Oligochaeta				1
10.2	12/08	Hydropsyche	1			1
*						
11.1	12/08	Oligochaeta				~3
11.1	12/08	Hydracarina				1
11.1	12/08	Hydropsyche	114			114
11.1	12/08	Hydropsyche morosa sp. group	12			12
11.1	12/08	Cheumatopsyche	46			46
11.1	12/08	Chironomidae	1			1
11.1	12/08	Antocha	1			1
11.1	12/08	Tipula	1			1
11.2	12/08	Hydropsyche	4			4
11.2	12/08	Cheumatopsyche	2			2
*						
12.1	12/08	Oligochaeta				~1
12.1	12/08	Taeniopteryx	1			1
12.1	12/08	Hydropsyche	60			60
12.1	12/08	Hydropsyche morosa sp. group	1			1

December 1988, Benthic macroinvertebrates (cont'd)

Stn.rep	Date	Taxon	L(N)	P	A	Total
12.1	12/08	Cheumatopsyche	8			8
12.1	12/08	Antocha	1			1
12.1	12/08	Tipula	1			1
12.2	12/08	Cheumatopsyche	1			1
*						
13.1	12/08	Physa				1
13.1	12/08	Oligochaeta				~2
13.1	12/08	Taeniopteryx	1			1
13.1	12/08	Optioservus	1			1
13.1	12/08	Cheumatopsyche	28			28
13.1	12/08	Hydropsyche morosa sp. group	9			9
13.1	12/08	Hydropsychidae (early instars)	5			5
13.1	12/08	Antocha	1			1
13.1	12/08	Tipula	1			1
13.2	12/08	Isonychia	1			1
13.2	12/08	Taeniopteryx	5			5
13.2	12/08	Nigronia	1			1
13.2	12/08	Cheumatopsyche	32			32
13.2	12/08	Hydropsyche morosa sp. group	31			31
13.2	12/08	Hydropsyche	5			5
13.2	12/08	Antocha	1			1
*						
14A.1	12/30	Oligochaeta	2			2
14A.1	12/30	Taeniopteryx	1			1
14A.1	12/30	Cheumatopsyche	1			1
14A.1	12/30	Tipula	1			1
14A.2	12/08	Oligochaeta				2
14A.2	12/08	Taeniopteryx	5			5
14A.2	12/08	Nigronia	1			1
14A.2	12/30	Optioservus	20			20
14A.2	12/30	Stenelmis			1	1
14A.2	12/30	Hydropsyche	20			20
14A.2	12/30	Cheumatopsyche	10			10
14A.2	12/30	Hydropsyche morosa sp. group	4			4
14A.2	12/30	Antocha	1			1
*						
14B.1	12/03	Stenonema (Heptageniidae)	4			4
14B.1	12/03	Taeniopteryx	11			11
14B.1	12/03	Psephenus herricki (DeKay)			1	1
14B.1	12/03	Optioservus	6			6
14B.1	12/03	Cheumatopsyche	3			3
14B.1	12/03	Hydropsyche morosa sp. group	10			10
14B.1	12/03	Hydropsyche	3			3
14B.1	12/03	Tipula	1			1
14B.2	12/03	Taeniopteryx	4			4
14B.2	12/03	Optioservus			1	1
14B.2	12/03	Hydropsyche morosa sp. group	6			6

December 1988, Benthic macroinvertebrates (cont'd)

Stn.rep	Date	Taxon	L(N)	P	A	Total
14B.2	12/03	Hydropsyche	3			3
14B.2	12/03	Chironomidae	1			1
*						
15/16.1	12/28	Oligochaeta				~3
15/16.2	12/28	Oligochaeta				~5
*						
17.1	12/28	Hydropsyche	2			2
17.2	12/28	Nematoda				1
17.2	12/28	Physa				1
17.2	12/28	Oligochaeta				~3
17.2	12/28	Hydropsyche	6			6
17.2	12/28	Cheumatopsyche	1			1
17.2	12/28	Chironomidae	1			1
*						
18.1	12/28	---				0
18.2	12/28	Oligochaeta				1
*						
19.1	12/28	Ferrissia				1
19.1	12/28	Physa				1
19.1	12/28	Stenonema	1			1
19.2	12/28	Oligochaeta				1
19.2	12/28	Ferrissia				1
19.2	12/28	Hydropsyche	19			19
19.2	12/28	Antocha	1			1
*						
21.1	12/03	Taeniopteryx	3			3
21.1	12/03	Hydropsyche	9			9
21.2	12/03	Physa	3			3
21.2	12/03	Pelecypoda	3			3
21.2	12/03	Nigronia	1			1
*						
22.1	12/30	Cheumatopsyche	1			1
22.1	12/30	Tipula	2			2
22.1	12/30	Taeniopteryx	1			1
22.2	12/30	Oligochaeta	1			1
22.2	12/30	Taeniopteryx	1			1
22.2	12/30	Nigronia	1			1
22.2	12/30	Stenelmis	1			1
22.2	12/30	Elmidae (early instar larva)	1			1
22.2	12/30	Hydropsyche	26			26
22.2	12/30	Cheumatopsyche	2			2
22.2	12/30	Antocha	2			2
*						
23.1	12/03	Ameletus	1			1
23.1	12/03	Allocapnia	32		1	33
23.1	12/03	Taeniopteryx	5			5
23.1	12/03	Chimarra	2			2
23.1	12/03	Cheumatopsyche	2			2
23.1	12/03	Hydropsyche	2			2
23.1	12/03	Chironomidae	10	2		12
23.1	12/03	Tipula	1			1

December 1988, Benthic macroinvertebrates (cont'd)

Stn.rep	Date	Taxon	L(N)	P	A	Total
23.1	12/03	Prosimulium	4			4
23.1	12/03	Simulium	1			1
23.2	12/03	Oligochaeta				1
23.2	12/03	Allocapnia	20		2	22
23.2	12/03	Stenonema	1			1
23.2	12/03	Glossosoma		1		1
23.2	12/03	Chimarra	4			4
23.2	12/03	Hydropsyche	5			5
23.2	12/03	Taeniopteryx	2			2
23.2	12/03	Nigronia	1			1
23.2	12/03	Psephenus herricki (DeKay)	1			1
23.2	12/03	Stenelmis			1	1
23.2	12/03	Chironomidae	2			2
23.2	12/03	Tipula	1			1
*						
24.1	12/28	Hydropsyche	1			1
24.2	12/28	Tricladida				2
24.2	12/28	Oligochaeta				~2
24.2	12/28	Physa				1
24.2	12/28	Amphipoda				2
24.2	12/28	Chironomidae	1			1
*						
25.1	12/28	Nematoda				1
25.1	12/28	Oligochaeta				2
25.1	12/28	Chironomidae	1			1
25.2	12/28	---				0
*						
26	12/03	Nematoda				~14
26	12/03	Hirundinea				1
26	12/03	Physa				20
26	12/03	Ferrissia				1
26	12/03	Pelecypoda				1
26	12/03	Oligochaeta				~6
26	12/03	Amphipoda				1
26	12/03	Hydropsyche	147			147
26	12/03	Hydropsyche morosa sp. group	2			2
26	12/03	Chironomidae	35			35
26	12/03	Tipula	6			6
26	12/03	Simulium	1			1
*						
27.1	12/26	Oligochaeta				~5
27.2	12/26	Oligochaeta				~7
*						
28.1	12/26	Physa				2
28.1	12/26	Oligochaeta				~100
28.2	12/26	Oligochaeta				~10

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Stn.rep	Date	Taxon	L(N)	P	A	Total
3.1	04/15	Oligochaeta				2
3.1	04/15	Chironomidae		3	2	5
3.2	04/15	Hydropsyche	2			2
3.2	04/15	Chironomidae	3			3
*						
4A.1	04/15	---				0
4A.2	04/15	Chironomidae	2			2
*						
4B.1	04/15	Hydropsyche	8			8
4B.2	04/15	Tipula	2			2
4B.2	04/15	Chironomidae	3	1		4
*						
5.1	04/14	Hydropsyche	9			9
5.1	04/14	Chironomidae	2	1	1	4
5.2	04/14	Berosus	1			1
5.2	04/14	Hydropsyche	29			29
5.2	04/14	Chironomidae	1			1
5.2	04/14	Hydropsychidae, prob. Hydropsyche	1			1
5.2	04/14	Hydropsyche macleodi Flint	1			1
*						
6B.1	04/15	Nigronia	2			2
6B.1	04/15	Hydropsyche macleodi Flint	3			3
6B.1	04/15	Chironomidae	7	2		9
6B.1	04/15	Chimarra	1			1
6B.1	04/15	Hydracarina				1
6B.1	04/15	Serratella	1			1
6B.2	04/15	Chironomidae	3	1		4
6B.2	04/15	Baetis	3			3
6B.2	04/15	Cheumatopsyche	4			4
6B.2	04/15	Neophylax	2			2
6B.2	04/15	Hydropsyche	2			2
6B.2	04/15	Sialis	1			1
6B.2	04/15	Nigronia	1			1
6B.2	04/15	Chimarra	5			5
6B.2	04/15	Amphinemura	13			13
6B.2	04/15	Tipula	1			1
6B.2	04/15	Serratella	3			3
6B.2	04/15	Eurylophella	1			1
*						
7.1	04/15	Trichoptera (empty cases)				2
7.2	04/15	---				0
*						

April 1989, Benthic macroinvertebrates (cont'd)

Stn.rep	Date	Taxon	L(N)	P	A	Total
8.1	04/14	Chironomidae	1			1
8.2	04/14	Chironomidae	1	1		2
8.2	04/14	Hydracarina				1
*						
10.1	04/20	Oligochaeta				2
10.1	04/20	Chironomidae	6			6
10.1	04/20	Hydropsyche	1			1
10.1	04/20	Diptera	1			1
10.2	04/20	---				0
*						
12.1	04/20	Chironomidae	12	2		14
12.2	04/20	Chironomidae	6	1		7
12.2	04/20	Hydracarina				1
12.2	04/20	Serratella	1			1
*						
13.1	04/20	Chironomidae	9	1		10
13.1	04/20	Hydropsyche	2			2
13.1	04/20	Hydracarina				2
13.1	04/20	Hydropsyche cheilonis Ross	2			2
13.1	04/20	Clinocera	1			1
13.1	04/20	Stenelmis			1	1
13.1	04/20	Serratella	1			1
13.1	04/20	Cheumatopsyche	2			2
13.1	04/20	Nigronia	2			2
13.2	04/20	Antocha	2			2
13.2	04/20	Clinocera		2		2
13.2	04/20	Cheumatopsyche	7			7
13.2	04/20	Hydropsyche	4			4
13.2	04/20	Hydracarina				1
13.2	04/20	Hydropsyche cheilonis Ross	5			5
13.2	04/20	Chironomidae	18	5		23
13.2	04/20	Oligochaeta				1
*						
14A.1	04/01	Hydropsyche	1			1
14A.1	04/01	Chironomidae	2			2
14A.1	04/01	Clinocera	1			1
14A.2	04/01	Hydropsyche cheilonis Ross	3			3
14A.2	04/01	Hydropsyche	9			9
14A.2	04/01	Serratella	2			2
14A.2	04/01	Antocha		1		1
14A.2	04/01	Chironomidae	5			5
14A.2	04/01	Nigronia	1			1
14A.2	04/01	Clinocera	2			2
14A.2	04/01	Oligochaeta				2
14A.2	04/01	Cheumatopsyche	4			4

April 1989, Benthic macroinvertebrates (cont'd)

Stn.rep	Date	Taxon	L(N)	P	A	Total
*						
14B.1	04/01	Serratella	31			31
14B.1	04/01	Tipula	1			1
14B.1	04/01	Isonychia	2			2
14B.1	04/01	Amphinemura	1			1
14B.1	04/01	Diploperla	1			1
14B.1	04/01	Eurylophella	11			11
14B.1	04/01	Chironomidae	5			5
14B.1	04/01	Stenonema	3			3
14B.1	04/01	Hydropsyche vexa Ross (?)	1			1
14B.1	04/01	Hydropsyche sparna Ross	1			1
14B.2	04/01	Serratella	17			17
14B.2	04/01	Neophylax	3			3
14B.2	04/01	Isonychia	1			1
14B.2	04/01	Eurylophella	2			2
14B.2	04/01	Amphinemura	1			1
*						
15/16.1	04/06	Heptagenia	1			1
15/16.1	04/06	Oligochaeta				5
15/16.2	04/06	Chironomidae		1		1
*						
17.1	04/06	Oligochaeta				12
17.2	04/06	Oligochaeta				1
17.2	04/06	Chironomidae	10	1		11
*						
18.1	04/20	Helisoma anceps (Menke 1830)				2
18.1	04/20	Oligochaeta				~2
18.2	04/20	---				0
*						
19.1	04/06	Argia	1			1
19.1	04/06	Hydropsyche	6			6
19.1	04/06	Oligochaeta				1
19.2	04/06	Hydropsyche	1			1
19.2	04/06	Oligochaeta				1
19.2	04/06	Chironomidae	2			2
19.2	04/06	? egg ?				1
*						
21.1	04/01	Chironomidae	8	1		9
21.1	04/01	Cheumatopsyche	1			1
21.1	04/01	Hydropsyche	20			20
21.1	04/01	Helisoma anceps (Menke 1830)				1
21.1	04/01	Pelecypoda				4
21.2	04/01	Hydropsyche	2			2
21.2	04/01	Nigronia	1			1
21.2	04/01	Chironomidae	6			6
21.2	04/01	Argia	1			1
*						

April 1989, Benthic macroinvertebrates (cont'd)

Stn.rep	Date	Taxon	L(N)	P	A	Total
22.1	04/01	Chironomidae	3	4		7
22.1	04/01	Clinocera	1			1
22.1	04/01	Amphinemura	1			1
22.1	04/01	Eurylophella	2			2
22.2	04/01	Tipula	1			1
22.2	04/01	Isonychia	1			1
*						
23.1	04/01	Tipula	1			1
23.1	04/01	Neophylax				
23.1	04/01	Chimarra	2			2
23.1	04/01	Cheumatopsyche	1			1
23.1	04/01	Antocha	1			1
23.1	04/01	Simulium	1			1
23.1	04/01	Ostrocerca	1			1
23.1	04/01	Psephenus herricki (DeKay)	2			2
23.1	04/01	Amphinemura	1			1
23.1	04/01	Stenelmis	2			2
23.1	04/01	Eurylophella	1			1
23.1	04/01	Serratella	6			6
23.2	04/01	Oligochaeta				3
23.2	04/01	Serratella	15			15
23.2	04/01	Clinocera	1			1
23.2	04/01	Neophylax	5			5
23.2	04/01	Chironomidae	2			2
*						
24.1	04/06	Oligochaeta				~2
24.1	04/06	Clinocera	1			1
24.1	04/06	Chironomidae	5			5
24.2	04/06	Asellus				1
24.2	04/06	Chironomidae	2			2
*						
25.1	04/06	Chironomidae		1		1
25.1	04/06	Oligochaeta				~2
25.2	04/06	---				0
*						
26.1	04/01	Hydropsyche	2			2
26.1	04/01	Chironomidae	10	1		11
26.2	04/01	---				0
*						
27.1	04/15	Chironomidae	2			2
27.2	04/15	---				0

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Stn.rep	Date	Taxon	L(N)	P	A	Total
3.1	05/22	Oligochaeta				1
3.2	05/22	Oligochaeta				1
3.2	05/22	Trichoptera (empty pupal case)				1
*						
4A.1	05/22	Oligochaeta				~9
4A.1	05/22	Chironomidae	13			13
4A.2	05/22	Oligochaeta				10
4A.2	05/22	Chironomidae	6			6
*						
4B.1	05/22	Oligochaeta				2
4B.1	05/22	Hydropsyche	1			1
4B.1	05/22	Chironomidae	10			10
4B.2	05/22	Oligochaeta				2
4B.2	05/22	Chironomidae	6			6
*						
5.1	05/22	Oligochaeta				3
5.1	05/22	Hemerodromia	1	1		2
5.1	05/22	Tanypodinae	1			1
5.1	05/22	Chironomidae	2			2
5.2	05/22	Oligochaeta				6
5.2	05/22	Hydropsyche (plus 2 empty cases)	3	1		4
5.2	05/22	Berosus	1			1
5.2	05/22	Lutrochus	1			1
5.2	05/22	Tanypodinae	2	1		3
5.2	05/22	Chironomidae	5	2		7
*						
6B.1	05/24	Oligochaeta				1
6B.1	05/24	Eurylophella	1			1
6B.1	05/24	Hydropsyche macleodi Flint	1			1
6B.1	05/24	Elmidae (Ordobrevia?)	1			1
6B.1	05/24	Tanypodinae	1			1
6B.1	05/24	Chironomidae	1	1		2
6B.2	05/24	Oligochaeta				4
6B.2	05/24	Eurylophella	2			2
6B.2	05/24	Ameletus	1			1
6B.2	05/24	Chironomidae	1			1
6B.2	05/24	Tipula	1			1
6B.2	05/24	Empididae ?	1			1
6B.2	05/24	Dolichopodidae	1			1
*						
8.1	05/20	Helichus			1	1
8.1	05/20	Serratella	1			1
8.2	05/20	Oligochaeta				2
*						
10.1	05/24	---				0

May 1989, Benthic macroinvertebrates (cont'd)

Stn.rep	Date	Taxon	L(N)	P	A	Total
10.2	05/24	---				0
*						
12.1	05/24	Oligochaeta				2
12.2	05/24	---				0
*						
13.1	05/24	Oligochaeta				1
13.1	05/24	Eurylophella	1			1
13.1	05/24	Ephemeroptera (early instar)	1			1
13.2	05/24	---				1
*						
14A.1	05/25	Oligochaeta				1
14A.1	05/25	Ameletus	2			2
14A.1	05/25	Ephemerella	4			4
14A.1	05/25	Hydropsyche	1			1
14A.1	05/25	Hydropsyche macleodi Flint	1			1
14A.2	05/25	Stenonema	1			1
14A.2	05/25	Chironomidae	1			1
*						
14B.1	05/25	Amphinemura	1			1
14B.1	05/25	Ameletus	5			5
14B.1	05/25	Ephemerellidae (early instars)	9			9
14B.1	05/25	Glossosoma	2			2
14B.1	05/25	Stenelmis			1	1
14B.1	05/25	Heptageniidae (early instar)	1			1
14B.2	05/25	Oligochaeta				1
14B.2	05/25	Ephemerella	1			1
14B.2	05/25	Nigronia	1			1
*						
15/16.1	05/20	Oligochaeta				~15
15/16.2	05/20	Oligochaeta				~17
15/16.2	05/20	Chironomidae	1	1		2
*						
17.1	05/20	Oligochaeta				~1
17.1	05/20	Chironomidae	1	1		2
17.2	05/20	Oligochaeta				~3
17.2	05/20	Ameletus	1			1
17.2	05/20	Chironomidae	2			2
*						
18.1	05/20	---				0
18.2	05/20	---				0
*						
19.1	05/20	---				0
19.2	05/20	Oligochaeta				1
*						

May 1989, Benthic macroinvertebrates (cont'd)

Stn.rep	Date	Taxon	L(N)	P	A	Total
21.1	05/25	Oligochaeta				3
21.1	05/25	Ameletus	1			1
21.1	05/25	Stenacron	1			1
21.1	05/25	Nigronia	1			1
21.1	05/25	Stenelmis		1		1
21.1	05/25	Tanypodinae	1			1
21.1	05/25	Chironomidae	2	1		3
21.2	05/25	Oligochaeta				2
21.2	05/25	Astacidae				1
21.2	05/25	Asellus				1
21.2	05/25	Neoephemera	1			1
21.2	05/25	Tanypodinae	1			1
21.2	05/25	Chironomidae	3	4		7
*						
22.1	05/25	Oligochaeta				1
22.1	05/25	Chironomidae	3			3
22.2	05/25	Ameletus	1			1
22.2	05/25	Amphinemura	1			1
22.2	05/25	Hydropsyche	1			1
22.2	05/25	Stenelmis			1	1
22.2	05/25	Chironomidae	3			3
22.2	05/25	Muscoidea	1			1
*						
23.1	05/25	Oligochaeta				3
23.1	05/25	Ephemerella	12			12
23.1	05/25	Ephemera	1			1
23.1	05/25	Stenonema	1			1
23.1	05/25	Gomphus	1			1
23.1	05/25	Hydropsyche sparna Ross	1			1
23.1	05/25	Dolophiloides	3			3
23.1	05/25	Stenelmis			1	1
23.1	05/25	Tanypodinae		1		1
23.1	05/25	Chironomidae	4			4
23.1	05/25	Chrysops		1		1
23.2	05/25	Ephemerella	8			8
23.2	05/25	Stenonema	2			2
23.2	05/25	Stenelmis			1	1
23.2	05/25	Chironomidae	6			6
*						
24.1	05/20	Oligochaeta				~4
24.1	05/20	Chironomidae	4	4		8
24.2	05/20	Oligochaeta				1
24.2	05/20	Chironomidae	2			2
*						
25.1	05/20	Chironomidae		1		1
25.2	05/20	Oligochaeta				~1
*						
26.1	05/24	Oligochaeta				1

May 1989, Benthic macroinvertebrates (cont'd)

Stn.rep	Date	Taxon	L(N)	P	A	Total
26.1	05/24	Chironomidae	9			9
26.2	05/24	Oligochaeta				1
26.2	05/24	Chironomidae	3			3
26.2	05/24	Ameletus	1			1
*						
27.1	05/22	Oligochaeta				~3
27.1	05/22	Chironomidae	8			8
27.2	05/22	Oligochaeta				~4
27.2	05/22	Chironomidae	14			14
*						
28.1	05/22	Oligochaeta				~8
28.1	05/22	Chironomidae	14	5		19
28.2	05/22	Oligochaeta				9
28.2	05/22	Entomobryidae				1
28.2	05/22	Chironomidae	8	4	1	13

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Stn.rep	Date	Taxon	L(N)	P	A	Total
3.1	06/14	Optioservus			1	1
3.1	06/14	Hemerodromia	1			1
3.1	06/14	Chironomidae	6			6
3.2	06/14	Chironomidae	2			2
3.2	06/14	Simulium	1			1
*						
4A.1	06/14	Oligochaeta				~10
4A.1	06/14	Chironomidae	14			14
4A.2	06/14	Oligochaeta				~12
4A.2	06/14	Baetis	1			1
4A.2	06/14	Chironomidae	4			4
*						
4B.1	06/14	Oligochaeta				4
4B.1	06/14	Ameletus	1			1
4B.1	06/14	Chironomidae	7	2		9
4B.2	06/14	Oligochaeta				2
4B.2	06/14	Chironomidae	5			5
*						
5.1	06/14	Oligochaeta				2
5.1	06/14	Hydropsyche	3			3
5.1	06/14	Chironomidae	4			4
5.1	06/14	Simulium	1			1
5.2	06/14	Oligochaeta				5
5.2	06/14	Hydropsyche	1			1
5.2	06/14	Cheumatopsyche	3			3
5.2	06/14	Chironomidae	3			3
*						
6B.1	06/15	Baetis	1			1
6B.1	06/15	Ameletus	1			1
6B.1	06/15	Hydropsyche	1			1
6B.1	06/15	Cheumatopsyche	1			1
6B.1	06/15	Optioservus	1			1
6B.1	06/15	Chironomidae	2			2
6B.1	06/15	Tanypodinae	2			2
6B.2	06/15	Oligochaeta				~3
6B.2	06/15	Baetis	1			1
6B.2	06/15	Argia	1			1
6B.2	06/15	Lanthus	1			1
6B.2	06/15	Amphinemura	1			1
6B.2	06/15	Perlodidae	1			1
6B.2	06/15	Hydropsyche	5			5
6B.2	06/15	Cheumatopsyche	7			7
6B.2	06/15	Chimarra	2			2
6B.2	06/15	Simulium	6			6
6B.2	06/15	Dicranota	2			2
6B.2	06/15	Culicidoinae	2			2
6B.2	06/15	Chironomidae	6			6

June 1989, Benthic macroinvertebrates (cont'd)

Stn.rep	Date	Taxon	L(N)	A	P	Total
6B.2	06/15	Tanypodinae	3	1		4
*						
7.1	06/15	Oligochaeta				1
7.1	06/15	Hyalella azteca (Saussure)				1
7.1	06/15	Chrirnomidae	1			1
7.1	06/15	Tanypodinae	2			2
7.2	06/15	Hydropsyche	2			2
7.2	06/15	Chironomidae	2			2
7.2	06/15	Tanypodinae	1			1
*						
8.1	06/14	---				0
8.2	06/14	---				0
*						
10.1	06/15	Chironomidae	10			10
10.2	06/15	Chironomidae	1	1		2
*						
12.1	06/15	Baetis	5			5
12.1	06/15	Hydropsychidae (early instar)	1			1
12.1	06/15	Antocha	1			1
12.1	06/15	Simulium	1			1
12.1	06/15	Chironomidae	10			10
12.2	06/15	Hydropsyche	1			1
12.2	06/15	Tipula	1			1
12.2	06/15	Chironomidae	1			1
12.2	06/15	Tanypodinae	1			1
*						
13.1	06/15	Hydropsyche	1			1
13.1	06/15	Hydropsyche walkeri Betten & Mosely	1			1
13.1	06/15	Antocha	2			2
13.1	06/15	Chironomidae	3	1		4
13.1	06/15	Baetis	3			3
13.2	06/15	Chironomidae	2			2
*						
14A.1	06/20	Baetis	1			1
14A.1	06/20	Ameletus	2			2
14A.1	06/20	Hydropsyche	1			1
14A.1	06/20	Agasicles			1	1
14A.1	06/20	Stenelmis			1	1
14A.1	06/20	Chironomidae	5			5
14A.2	06/20	Hydropsyche	1			1
14A.2	06/20	Hydropsyche cheilonis Ross	1			1
*						
14B.1	06/20	Gyraulus				1
14B.1	06/20	Eurylophella	1			1

June 1989, Benthic macroinvertebrates (cont'd)

Stn.rep	Date	Taxon	L(N)	P	A	Total
14B.1	06/20	Stenelmis			2	2
14B.1	06/20	Antocha	1			1
14B.1	06/20	Chironomidae	2			2
14B.2	06/20	Oligochaeta				~4
14B.2	06/20	Baetis	1			1
14B.2	06/20	Stenonema	1			1
14B.2	06/20	Optioservus	1			1
14B.2	06/20	Chironomidae	2			2
*						
15/16.1	06/14	---				0
15/16.2	06/14	---				0
*						
17.1	06/19	Oligochaeta				2
17.1	06/19	Chironomidae	3	2		5
17.2	06/19	Chironomidae	12	2		14
*						
18.1	06/14	Ameletus	1			1
18.1	06/14	Hydropsyche	4			4
18.1	06/14	Chironomidae	4			4
18.2	06/14	Ameletus	2			2
18.2	06/14	Hydropsyche cheilonis Ross	1			1
18.2	06/14	Chironomidae	1			1
*						
19.1	06/14	Ferrissia				1
19.1	06/14	Hydropsyche vexa Ross		1		1
19.1	06/14	Hydropsyche (early instar)	1			1
19.1	06/14	Chironomidae	2			2
19.2	06/14	---				-
*						
21.1	06/20	Oligochaeta				1
21.1	06/20	Hydropsychidae (early instar)	1			1
21.1	06/20	Antocha	1			1
21.1	06/20	Chironomidae	15			15
21.2	06/20	Oligochaeta				~2
21.2	06/20	Ameletus	1			1
21.2	06/20	Cheumatopsyche	1			1
21.2	06/20	Chironomidae	9	3		12
*						
22.1	06/20	Optioservus	1			1
22.2	06/20	Oligochaeta				1
22.2	06/20	Stenelmis			1	1
22.2	06/20	Helichus			1	1
22.2	06/20	Chironomidae	5	2		7
22.2	06/20	Tanypodinae	1			1
*						

June 1989, Benthic macroinvertebrates (cont'd)

Stn.rep	Date	Taxon	L(N)	P	A	Total
23.1	06/23	Baetis	1			1
23.1	06/23	Suwallia	1			1
23.1	06/23	Agnetina	1			1
23.1	06/23	Stenelmis			1	1
23.1	06/23	Dubiraphia	5			5
23.1	06/23	Chironomidae	1			1
23.1	06/23	Tanypodinae	1			1
23.1	06/23	Tipula	1			1
23.2	06/23	Oligochaeta				~1
23.2	06/23	Ephemera	1			1
23.2	06/23	Hydropsyche	1			1
23.2	06/23	Chironomidae	3			3
*						
24.1	06/19	Oligochaeta				7
24.1	06/19	Chironomidae	8			8
24.2	06/19	Oligochaeta	1			1
24.2	06/19	Chironomidae	4	3		7
*						
25.1	06/19	Physa skinneri Taylor				1
25.1	06/19	Oligochaeta				3
25.1	06/19	Chironomidae	1			1
25.2	06/19	Oligochaeta				1
25.2	06/19	Chironomidae	1			1
*						
26.1	06/20	Oligochaeta				~3
26.1	06/20	Chironomidae	11			11
26.2	06/20	Oligochaeta				1
26.2	06/20	Chironomidae	6	2		8
26.2	06/20	Tanypodinae	2			2
*						
27.1	06/19	Oligochaeta				~6
27.1	06/19	Chironomidae	2			2
27.2	06/19	Oligochaeta				~3
27.2	06/19	Tipula	1			1
27.2	06/19	Hemerodromia	1			1
27.2	06/19	Chironomidae	1			1
*						
28.1	06/19	Physa skinneri Taylor				2
28.1	06/19	Gyraulus				1
28.1	06/19	Oligochaeta				~20
28.1	06/19	Chironomidae	5	1		6
28.2	06/19	Physa skinneri Taylor				9
28.2	06/19	Gyraulus				1
28.2	06/19	Oligochaeta				~15
28.2	06/19	Chironomidae	6			6
28.2	06/19	Tanypodinae	1			1
28.2	06/19	Aedes	1			1

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Stn.rep	Date	Taxon	L(N)	P	A	Total
1.1	07/14	Chironomidae	2			2
1.2	07/14	---				0
*						
3.1	07/22	Oligochaeta				1
3.1	07/22	Baetis	2			2
3.1	07/22	Hydropsyche	2			2
3.1	07/22	Tanypodinae	1			1
3.2	07/22	Oligochaeta				3
3.2	07/22	Baetis	8			8
3.2	07/22	Hydropsyche	2			2
*						
4A.1	07/22	Oligochaeta				~4
4A.1	07/22	Chironomidae	4			4
4A.2	07/22	Oligochaeta				~15
4A.2	07/22	Chironomidae	3	1		4
*						
4B.1	07/22	Oligochaeta				2
4B.1	07/22	Hydropsyche	3			3
4B.2	07/22	Oligochaeta				~3
4B.2	07/22	Hydropsyche	1			1
4B.2	07/22	Chironomidae	2			2
*						
5.1	07/22	Oligochaeta				1
5.1	07/22	Hydropsyche	6			6
5.2	07/22	Oligochaeta	4			4
5.2	07/22	Baetis	4			4
5.2	07/22	Hydropsyche	7			7
5.2	07/22	Chironomidae	8			8
*						
6B.1	07/22	Oligochaeta				~2
6B.1	07/22	Hydracarina				2
6B.1	07/22	Nigronia	2			2
6B.1	07/22	Hydropsyche	1			1
6B.1	07/22	Cheumatopsyche	1			1
6B.1	07/22	Chimarra	1			1
6B.1	07/22	Tanypodinae	2			2
6B.1	07/22	Chironomidae	2			2
6B.1	07/22	Acricotopus		1		1
6B.1	07/22	Tipula	1			1
6B.2	07/22	Oligochaeta				2
6B.2	07/22	Hydracarina				2
6B.2	07/22	Hydropsyche	2			2
*						
7.1	07/22	Oligochaeta				1
7.1	07/22	Dina				1
7.1	07/22	Asellus				3
7.1	07/22	Hydracarina				4

July 1989, Benthic macroinvertebrates (cont'd)

Stn.rep	Date	Taxon	L(N)	P	A	Total
7.1	07/22	Calopteryx	1			1
7.1	07/22	Nigronia	1			1
7.1	07/22	Hydropsyche	8			8
7.1	07/22	Cheumatopsyche	2			2
7.1	07/22	Tanypodinae	3			3
7.1	07/22	Chironomidae	3			3
7.2	07/22	Oligochaeta				1
7.2	07/22	Chironomidae	3			3
*						
8.1	07/18	Oligochaeta				~1
8.1	07/18	Chironomidae	1			1
8.1	07/18	Tanypodinae	1			1
8.2	07/18	Oligochaeta				2
8.2	07/18	Baetis	4			4
8.2	07/18	Nigronia	1			1
8.2	07/18	Hydropsyche	5			5
8.2	07/18	Chironomidae	4			4
8.2	07/18	Tanypodinae	3			3
8.2	07/18	Paracricotopus		1		1
8.2	07/18	Conchapelopia		1		1
*						
10.1	07/22	Baetis	1			1
10.1	07/22	Chironomidae	2			2
10.2	07/22	Hydracarina				1
10.2	07/22	Baetis	1			1
10.2	07/22	Chironomidae	1			1
*						
12.1	07/22	Hydracarina				2
12.1	07/22	Baetis	2			2
12.1	07/22	Hydropsyche	2			2
12.2	07/22	Hydracarina				1
12.2	07/22	Baetis	3			3
12.2	07/22	Hydropsyche	6			6
12.2	07/22	Dubiraphia prob. vittata (Melsheimer)			1	1
12.2	07/22	Chironomidae	1			1
*						
13.1	07/22	Oligochaeta				1
13.2	07/22	Hydracarina				1
*						
14A.1	07/19	Oligochaeta				1
14A.1	07/19	Baetis	22			22
14A.1	07/19	Hydropsyche	3			3
14A.1	07/19	Chironomidae	2			2
14A.2	07/19	Baetis	4			4
14A.2	07/19	Chironomidae	1			1
14A.2	07/19	Simulium	1			1
*						

July 1989, Benthic macroinvertebrates (cont'd)

Stn.rep	Date	Taxon	L(N)	P	A	Total
14B.1	07/19	Oligochaeta				1
14B.1	07/19	Baetis	5			5
14B.1	07/19	Stenonema	3			3
14B.1	07/19	Dolophilodes	4			4
14B.1	07/19	Hydropsyche walkeri Betten & Mosely	2			2
14B.1	07/19	Hydropsyche vexa Ross	1			1
14B.1	07/19	Hydropsyche	1			1
14B.1	07/19	Cheumatopsyche	1			1
14B.1	07/19	Nigronia	1			1
14B.1	07/19	Promoresia tardella (Fall)			2	2
14B.1	07/19	Stenelmis			1	1
14B.1	07/19	Simulium	10			10
14B.2	07/19	Baetis	7			7
14B.2	07/19	Caenis	2			2
14B.2	07/19	Stenonema	6			6
14B.2	07/19	Stenacron	1			1
14B.2	07/19	Dolophilodes	2			2
14B.2	07/19	Hydropsyche cheilonis Ross	1			1
14B.2	07/19	Hydropsyche	1			1
14B.2	07/19	Nigronia	3			3
14B.2	07/19	Chironomidae	2			2
14B.2	07/19	Simulium	1			1
*						
15/16.1	07/14	Ferrissia				2
15/16.1	07/14	Dina microstoma (Moore)				1
15/16.1	07/14	Hagenius brevistylus Selys	1			1
15/16.1	07/14	Chironomidae	29			29
15/16.2	07/14	Physa skinneri Taylor				1
15/16.2	07/14	Tanypodinae	2			2
15/16.2	07/14	Chironomidae	9	1		10
*						
17.1	07/18	Hydracarina				2
17.1	07/18	Baetis	1			1
17.1	07/18	Chironomidae	3			3
17.1	07/18	Conchapelopia		1		1
17.1	07/18	Larsia		1		1
17.2	07/18	Oligochaeta				2
17.2	07/18	Baetis	10			10
17.2	07/18	Stenonema	1			1
17.2	07/18	Chironomidae	9			9
*						
18.1	07/18	Baetis	8			8
18.1	07/18	Stenonema	1			1
18.1	07/18	Hydropsyche	20	1		21
18.1	07/18	Nigronia	1			1

July 1989, Benthic macroinvertebrates (cont'd)

Stn.rep	Date	Taxon	L(N)	P	A	Total
18.1	07/18	Hemerodromia		1		1
18.1	07/18	Chironomidae	12			12
18.1	07/18	Conchapelopia		1		1
18.2	07/18	Oligochaeta				~4
18.2	07/18	Baetis	1			1
18.2	07/18	Heptageniidae	1			1
18.2	07/18	Hydropsyche	11			11
18.2	07/18	Hemerodromia		1		1
18.2	07/18	Chironomidae	8			8
18.2	07/18	Tanypodinae	1			1
18.2	07/18	Conchapelopia		3		3
18.2	07/18	Pseudosmittia		1		1
*						
19.1	07/18	Asellus				3
19.1	07/18	Ferrissia				2
19.1	07/18	Physa skinneri Taylor				1
19.1	07/18	Baetis	3			3
19.1	07/18	Nigronia	2			2
19.1	07/18	Hydropsyche	1			1
19.1	07/18	Antocha	1			1
19.1	07/18	Chironomidae	7			7
19.2	07/18	Baetis	7			7
19.2	07/18	Stenonema	1			1
19.2	07/18	Hydropsyche	1			1
19.2	07/18	Cheumatopsyche	1			1
19.2	07/18	Chironomidae	4			4
*						
21.1	07/19	Hydracarina				1
21.1	07/19	Baetis	4			4
21.1	07/19	Stenonema	2			2
21.1	07/19	Nigronia	2			2
21.1	07/19	Hydropsyche	3			3
21.1	07/19	Chironomidae	2			2
21.1	07/19	Hemerodromia	1			1
21.2	07/19	Oligochaeta				1
21.2	07/19	Pelecypoda				2
21.2	07/19	Asellus				4
21.2	07/19	Hydracarina				1
21.2	07/19	Baetis	5			5
21.2	07/19	Stenonema	1			1
21.2	07/19	Hydropsyche	15			15
21.2	07/19	Chironomidae	5			5
21.2	07/19	Rheocricotopus		1		1
21.2	07/19	Acricotopus		1		1
*						
22.1	07/19	Oligochaeta				1
22.1	07/19	Asellus				1
22.1	07/19	Baetis	3			3

July 1989, Benthic macroinvertebrates (cont'd)

Stn.rep	Date	Taxon	L(N)	P	A	Total
22.1	07/19	Paraleptophlebia	1			1
22.1	07/19	Dolophilodes	1			1
22.1	07/19	Hydropsyche	1			1
22.1	07/19	Chironomidae	4			4
22.1	07/19	Tanypodinae	1			1
22.1	07/19	Rheocricotopus		1		1
22.1	07/19	Simulium	1			1
22.2	07/19	Oligochaeta				1
22.2	07/19	Nigronia	1			1
*						
23.1	07/19	Oligochaeta				~1
23.1	07/19	Isonychia	1			1
23.1	07/19	Baetis	1			1
23.1	07/19	Pseudocloeon	1			1
23.1	07/19	Chimarra	1			1
23.1	07/19	Cheumatopsyche	2			2
23.1	07/19	Hydropsyche	1			1
23.1	07/19	Stenelmis	1			1
23.1	07/19	Chrysops miti Osten-Sacken		1		1
23.1	07/19	Chironomidae	1			1
23.1	07/19	Simulium	5			5
23.2	07/19	Oligochaeta				~2
23.2	07/19	Baetis	1			1
23.2	07/19	Caenis	1			1
23.2	07/19	Stenonema	1			1
23.2	07/19	Agnetina	2			2
23.2	07/19	Psephenus herricki (DeKay)			2	2
23.2	07/19	Stenelmis			1	1
23.2	07/19	Tipula	1			1
*						
24.1	07/18	Oligochaeta				~6
24.1	07/18	Hemerodromia	3			3
24.1	07/18	Diptera		3		3
24.1	07/18	Chironomidae	13			13
24.2	07/18	Baetis	7			7
24.2	07/18	Hemerodromia	2	3		5
24.2	07/18	Chironomidae	10			10
*						
25.1	07/18	Ferrissia				1
25.1	07/18	Physa skinneri Taylor				1
25.1	07/18	Hydropsyche	2			2
25.1	07/18	Chironomidae	2			2
25.1	07/18	Tanypodinae	1			1
25.2	07/18	Gyraulus				1
25.2	07/18	Baetis	7			7
25.2	07/18	Chironomidae	3			3
25.2	07/18	Tanypodinae	2			2

July 1989, Benthic macroinvertebrates (cont'd)

Stn.rep	Date	Taxon	L(N)	P	A	Total
25.2	07/18	Guttipelopia		1		1
25.2	07/18	Chironomidae		1		1
*						
26.1	07/19	Oligochaeta				2
26.1	07/19	Physa skinneri Taylor				3
26.1	07/19	Ferrissia				1
26.1	07/19	Hydracarina				1
26.1	07/19	Entomobryinae				1
26.1	07/19	Baetis	3			3
26.1	07/19	Chironomidae	14			14
26.2	07/19	Oligochaeta				~5
26.2	07/19	Baetis	1			1
26.2	07/19	Chironomidae	4			4
26.2	07/19	Tanypodinae	1			1
*						
27.1	07/14	Tanypodinae	1			1
27.1	07/14	Chironomidae	17	2		19
27.2	07/14	Tanypodinae	1			1
27.2	07/14	Chironomidae	25	4		29
*						
28.1	07/14	Physa skinneri Taylor				17
28.1	07/14	Oligochaeta				~10
28.1	07/14	Chironomidae	18	1		19
28.2	07/14	Physa skinneri Taylor				2
28.2	07/14	Oligochaeta				~7
28.2	07/14	Chironomidae	10			10

Benthic macroinvertebrates, 8/89

Stn.rep	Date	Taxon	L(N)	P	A	Total
3.1	08/06	Baetis	1			1
3.1	08/06	Hydropsyche cheilonis Ross	1			1
3.1	08/06	Chironomidae	1	1		2
3.1	08/06	Tanypodinae	1			1
3.2	08/06	Oligochaeta				1
3.2	08/06	Chironomidae	8			8
*						
4A.1	08/06	Oligochaeta				8
4A.1	08/06	Baetis	5			5
4A.1	08/06	Chironomidae	4			4
4A.1	08/06	Tanypodinae	1			1
4A.2	08/06	Oligochaeta				3
4A.2	08/06	Chironomidae	4			4
*						
4B.1	08/06	Chironomidae	1			1
4B.2	08/06	Oligochaeta				1
4B.2	08/06	Baetis	2			2
4B.2	08/06	Hydropsyche	1			1
4B.2	08/06	Cheumatopsyche	1			1
4B.2	08/06	Chironomidae	2			2
4B.2	08/06	Tanypodinae	2			2
*						
5.1	08/06	Oligochaeta				1
5.1	08/06	Hydracarina				1
5.1	08/06	Chironomidae	1			1
5.1	08/06	Tanypodinae	2			2
5.2	08/06	Oligochaeta				1
5.2	08/06	Hydracarina				2
5.2	08/06	Chironomidae	3			3
5.2	08/06	Hemerodromia	1			1
*						
6B.1	08/06	Oligochaeta				~3
6B.1	08/06	Gammaridae				1
6B.1	08/06	Hydracarina				4
6B.1	08/06	Baetis	3			3
6B.1	08/06	Leuctra	5			5
6B.1	08/06	Nigronia	3			3
6B.2	08/06	Baetis	1			1
6B.2	08/06	Hydropsyche	1			1
6B.2	08/06	Cernotina	1			1
6B.2	08/06	Chironomidae	5			5
6B.2	08/06	Ablabesmyia		1		1
6B.2	08/06	Hemerodromia		1		1
*						
7.1	08/06	Oligochaeta				~2
7.1	08/06	Hydracarina				5
7.1	08/06	Hydropsyche	6			6

August 1989, Benthic macroinvertebrates (cont'd)

Stn.rep	Date	Taxon	L(N)	P	A	Total
7.2	08/06	Oligochaeta				-2
7.2	08/06	Asellus				1
7.2	08/06	Hydracarina				3
7.2	08/06	Nigronia	2			2
7.2	08/06	Hydropsyche	3			3
7.2	08/06	Chironomidae	3			3
7.2	08/06	Tanypodinae	2			2
*						
8.1	08/06	Baetis	1			1
8.1	08/06	Chironomidae	5			5
8.1	08/06	Paratrichocladius		1		1
8.2	08/06	Chironomidae	2			2
8.2	08/06	Hemerodromia	1	2		3
*						
10.1	08/06	Oligochaeta				1
10.1	08/06	Chironomidae	13	1		14
10.1	08/06	Hemerodromia	2	1		3
10.2	08/06	Hydracarina				1
10.2	08/06	Chironomidae	4	1		5
10.2	08/06	Paratrichocladius		1		1
*						
12.1	08/06	Baetis	19			19
12.1	08/06	Stenonema	1			1
12.1	08/06	Hydropsyche	11			11
12.1	08/06	Cheumatopsyche	1			1
12.1	08/06	Chironomidae	3			3
12.1	08/06	Cricotopus		1		1
12.2	08/06	Baetis	8			8
12.2	08/06	Hydropsyche	5			5
12.2	08/06	Chironomidae	3			3
12.2	08/06	Hemerodromia	1	1		2
*						
13.1	08/06	Baetis	1			1
13.1	08/06	Chironomidae	2			2
13.2	08/06	Baetis	2			2
13.2	08/06	Hydropsyche	2			2
13.2	08/06	Chironomidae	5			5
*						
14A.1	08/09	Hydracarina				1
14A.1	08/09	Baetis	6			6
14A.1	08/09	Heptageniidae	1			1
14A.1	08/09	Chironomidae	2			2
14A.1	08/09	Acricotopus		1		1
14A.2	08/09	Baetis	14			14
14A.2	08/09	Stenonema	2			2
14A.2	08/09	Hydropsyche cheilonis Ross	1			1
14A.2	08/09	Chironomidae	1			1

August 1989, Benthic macroinvertebrates (cont'd)

Stn.rep	Date	Taxon	L(N)	P	A	Total
14A.2	08/09	Antocha	2			2
*						
14B.1	08/09	Hydracarina				1
14B.1	08/09	Baetis	23		1	24
14B.1	08/09	Caenis	1			1
14B.1	08/09	Pseudocloeon	1			1
14B.1	08/09	Epeorus	2			2
14B.1	08/09	Stenonema	8			8
14B.1	08/09	Hydropsyche	10			10
14B.1	08/09	Hydropsyche cheilonis Ross	1			1
14B.1	08/09	Cheumatopsyche	4			4
14B.1	08/09	Dolophilodes	14			14
14B.1	08/09	Chimarra	2			2
14B.1	08/09	Nigronia	2			2
14B.1	08/09	Optioservus	1		16	17
14B.1	08/09	Chironomidae	4			4
14B.1	08/09	Acricotopus		1		1
14B.1	08/09	Simuliidae	10			10
14B.1	08/09	Hemerodromia		1		1
14B.2	08/09	Baetis	15			15
14B.2	08/09	Epeorus	1			1
14B.2	08/09	Stenonema	7			7
14B.2	08/09	Nigronia	1			1
14B.2	08/09	Optioservus			2	2
14B.2	08/09	Chimarra	1			1
14B.2	08/09	Dolophilodes	2			2
14B.2	08/09	Hydropsyche	6			6
14B.2	08/09	Chironomidae	3			3
14B.2	08/09	Simulium	2			2
*						
15/16.1	08/06	Oligochaeta				1
15/16.1	08/06	Pyrrhalta			2	2
15/16.1	08/06	Chironomidae	8			8
15/16.1	08/06	Guttipelopia		1		1
15/16.2	08/06	Oligochaeta				~3
15/16.2	08/06	Chironomidae	8			8
*						
17.1	08/06	Chironomidae	14			14
17.1	08/06	Tanypodinae				
17.2	08/06	Hydracarina				1
17.2	08/06	Chironomidae	5			5
17.2	08/06	Tanypodinae	2			2
*						
18.1	08/06	Baetis	6			6
18.1	08/06	Hydropsyche	3			3
18.1	08/06	Chironomidae	1			1

August 1989, Benthic macroinvertebrates (cont'd)

Stn.rep	Date	Taxon	L(N)	P	A	Total
18.2	08/06	Oligochaeta				1
18.2	08/06	Baetis	7			7
18.2	08/06	Isonychia	1			1
18.2	08/06	Hydropsyche	3			3
18.2	08/06	Hydropsyche cheilonis Ross	1			1
18.2	08/06	Chironomidae	3			3
18.2	08/06	Tanypodinae	1			1
18.2	08/06	Hemerodromia	1			1
*						
19.1	08/06	Baetis	1			1
19.1	08/06	Hydropsyche walkeri Betten & Mosely	1			1
19.2	08/06	Baetis	2			2
19.2	08/06	Chironomidae	3			3
19.2	08/06	Acricotopus	1			1
*						
21.1	08/09	Hydracarina				1
21.1	08/09	Baetis	8			8
21.1	08/09	Hydropsyche	1			1
21.1	08/09	Chironomidae	7			7
21.2	08/09	Pelecypoda				2
21.2	08/09	Ferrissia				1
21.2	08/09	Oligochaeta				1
21.2	08/09	Asellus				3
21.2	08/09	Baetis	6			6
21.2	08/09	Chironomidae	6			6
*						
22.1	08/09	Baetis	1			1
22.1	08/09	Chironomidae	11			11
22.1	08/09	Acricotopus		1		1
22.2	08/09	Tricladida				1
22.2	08/09	Asellus				1
22.2	08/09	Baetis	3			3
22.2	08/09	Stenonema	2			2
22.2	08/09	Ancyronyx variegata (Germar)			1	1
22.2	08/09	Chironomidae	11			11
22.2	08/09	Tanypodinae	2			2
*						
23.1	08/09	Oligochaeta				1
23.1	08/09	Baetis	1			1
23.1	08/09	Stenonema	2			2
23.1	08/09	Gyrinus	1			1
23.1	08/09	Helichus			1	1
23.1	08/09	Optioservus			1	1
23.1	08/09	Stenelmis			1	1
23.1	08/09	Chironomidae	2			2

August 1989, Benthic macroinvertebrates (cont'd)

Stn.rep	Date	Taxon	L(N)	P	A	Total
23.1	08/09	Simulium	1			1
23.2	08/09	Baetis	2			2
23.2	08/09	Stenonema	1			1
23.2	08/09	Hydropsyche	2			2
23.2	08/09	Chimarra	1			1
23.2	08/09	Stenelmis			1	1
23.2	08/09	Antocha		1		1
23.2	08/09	Tanypodinae	1			1
23.2	08/09	Simulium	2			2
*						
24.1	08/06	Baetis	6			6
24.1	08/06	Chironomidae	2			2
24.1	08/06	Labrundinia		1		1
24.2	08/06	Oligochaeta				2
24.2	08/06	Baetis	33			33
24.2	08/06	Chironomidae	9		1	10
24.2	08/06	Tanypodinae	4			4
24.2	08/06	Conchapelopia		1		1
24.2	08/06	Hemerodromia		3		3
*						
25.1	08/06	Hydracarina				1
25.1	08/06	Baetis	2			2
25.1	08/06	Chironomidae	1			1
25.1	08/06	Tanypodinae	2			2
25.2	08/06	Gammaridae				1
25.2	08/06	Asellus				1
25.2	08/06	Hydracarina				1
25.2	08/06	Baetis	1			1
25.2	08/06	Chironomidae	3			3
25.2	08/06	Tanypodinae	1			1
25.2	08/06	Guttipelopia		1		1
25.2	08/06	Hemerodromia	1			1
*						
26.1	08/06	Baetis	14			14
26.1	08/06	Tanypodinae	2			2
26.2	08/06	Baetis	6			6
26.2	08/06	Hydropsyche	1			1
26.2	08/06	Chironomidae	2			2
*						
27.1	08/06	Chironomidae	3			3
27.1	08/06	Tanypodinae	2			2
27.1	08/06	Acricotopus		1		1
27.2	08/06	Oligochaeta				1
27.2	08/06	Baetis	2			2
27.2	08/06	Chironomidae	1			1
27.2	08/06	Tanypodinae	2			2
27.2	08/06	Conchapelopia		1		1
*						

August 1989, Benthic macroinvertebrates (cont'd)

Stn.rep	Date	Taxon	L(N)	P	A	Total
28.1	08/06	Oligochaeta				2
28.1	08/06	Physa skinneri Taylor				2
28.1	08/06	Chironomidae	4			4
28.2	08/06	Oligochaeta				4
28.2	08/06	Helochares			1	1
28.2	08/06	Chironomidae	9			9
28.2	08/06	Tanypodinae	1			1

Benthic macroinvertebrates, 9/89

Stn.rep	Date	Taxon	L(N)	P	A	Total
3.1	09/15	Nematoda				3
3.1	09/15	Oligochaeta				4
3.1	09/15	Hydracarina				4
3.1	09/15	Stenonema	1			1
3.1	09/15	Baetis	17			17
3.1	09/15	Pseudocloeon	1			1
3.1	09/15	Caenis	3			3
3.1	09/15	Cheumatopsyche	12			12
3.1	09/15	Hydropsyche	78			78
3.1	09/15	Hydropsyche walkeri Betten & Mosely	10			10
3.1	09/15	Hydropsychidae		1		1
3.1	09/15	Berosus	1			1
3.1	09/15	Tanypodinae	4			4
3.1	09/15	Chironomidae	15			15
3.1	09/15	Tanytarsus		1		1
3.1	09/15	Acricotopus		1		1
3.1	09/15	Tipula	1			1
3.1	09/15	Hemerodromia		1		1
3.2	09/15	Oligochaeta				1
3.2	09/15	Hydracarina				10
3.2	09/15	Baetis	1			1
3.2	09/15	Caenis	5			5
3.2	09/15	Hydropsyche	5			5
3.2	09/15	Berosus	4			4
3.2	09/15	Psephenus herricki (DeKay)	1			1
3.2	09/15	Chironomidae	5			5
3.2	09/15	Guttipelopia		1		1
3.2	09/15	Labrundinia		1		1
3.2	09/15	Conchapelopia		1		1
3.2	09/15	Tanytarsus		1		1
*						
4A.1	09/15	Oligochaeta				12
4A.1	09/15	Hydropsyche	3			3
4A.1	09/15	Psychoda		1		1
4A.1	09/15	Tanypodinae	5			5
4A.1	09/15	Chironomidae	3			3
4A.2	09/15	Oligochaeta				7
4A.2	09/15	Baetis	4			4
4A.2	09/15	Tanypodinae	5			5
4A.2	09/15	Chironomidae	5			5
4A.2	09/15	Simulium	1			1
*						
4B.1	09/15	Hydracarina				5
4B.1	09/15	Baetis	5			5
4B.1	09/15	Hydropsyche	5			5
4B.1	09/15	Tanypodinae	1			1

September 1989, Benthic macroinvertebrates (cont'd)

Stn.rep	Date	Taxon	L(N)	P	A	Total
4B.2	09/15	Oligochaeta				2
4B.2	09/15	Hydracarina				1
4B.2	09/15	Calopteryx	1			1
4B.2	09/15	Hydropsyche	5			5
*						
5.1	09/15	Hydracarina				7
5.1	09/15	Baetis	4			4
5.1	09/15	Calopteryx	1			1
5.1	09/15	Hydropsyche	14			14
5.1	09/15	Chironomidae	4			4
5.1	09/15	Simulium	2			2
5.2	09/15	Hydracarina				1
5.2	09/15	Baetis	3			3
5.2	09/15	Hydropsyche	29			29
5.2	09/15	Chironomidae	1			1
5.2	09/15	Simulium	2			2
*						
6B.1	09/30	Astacidae				1
6B.1	09/30	Hydracarina				3
6B.1	09/30	Calopteryx	1			1
6B.1	09/30	Perlodidae	1			1
6B.1	09/30	Cheumatopsyche	1			1
6B.1	09/30	Chironomidae	2			2
6B.1	09/30	Tipula	1			1
6B.2	09/30	Hydracarina				6
6B.2	09/30	Calopteryx	1			1
6B.2	09/30	Tipula	1			1
*						
7.1	09/30	Hydropsyche	6			6
7.1	09/30	Chironomidae	1			1
7.2	09/30	Tricladida				1
7.2	09/30	Calopteryx	1			1
7.2	09/30	Hydropsyche	1			1
7.2	09/30	Tipula	3			3
*						
8.1	09/30	Physa skinneri Taylor				1
8.1	09/30	Oligochaeta				~2
8.1	09/30	Hydracarina				4
8.1	09/30	Baetis	9			9
8.1	09/30	Isonychia	6			6
8.1	09/30	Pseudocloeon	1			1
8.1	09/30	Hydropsyche	7			7
8.1	09/30	Hydropsyche walkeri Betten & Mosely	1			1
8.1	09/30	Cheumatopsyche	1			1
8.1	09/30	Chironomidae	1			1
8.2	09/30	Oligochaeta				2
8.2	09/30	Baetis	2			2

September 1989, Benthic macroinvertebrates (cont'd)

Stn.rep	Date	Taxon	L(N)	P	A	Total
8.2	09/30	Hydropsyche	1			1
8.2	09/30	Hydropsyche walkeri Betten & Mosely	1			1
8.2	09/30	Cheumatopsyche	1			1
8.2	09/30	Chironomidae	1			1
*						
10.1	09/30	Oligochaeta				~3
10.1	09/30	Hydracarina				2
10.1	09/30	Hydropsyche	1			1
10.2	09/30	Hydracarina				6
10.2	09/30	Hydropsyche	2			2
10.2	09/30	Berosus	1			1
10.2	09/30	Tipula	1			1
*						
12.1	09/30	Hydracarina				2
12.1	09/30	Baetis	2			2
12.1	09/30	Hydropsyche	2			2
12.2	09/30	Oligochaeta				2
12.2	09/30	Hydracarina				1
12.2	09/30	Baetis	9			9
12.2	09/30	Hydropsyche	2			2
12.2	09/30	Cheumatopsyche	1			1
12.2	09/30	Tipula	1			1
*						
13.1	09/30	Oligochaeta				1
13.1	09/30	Baetis	6			6
13.1	09/30	Isonychia	4			4
13.1	09/30	Hydropsyche	26			26
13.1	09/30	Cheumatopsyche	2			2
13.1	09/30	Chimarra	1			1
13.1	09/30	Optioservus	1			1
13.1	09/30	Tipula	2			2
13.2	09/30	Oligochaeta				~5
13.2	09/30	Baetis	1			1
13.2	09/30	Isonychia	2			2
13.2	09/30	Hydropsyche	18			18
13.2	09/30	Cheumatopsyche	2			2
13.2	09/30	Tipula	1			1
*						
14A.1	09/30	Hydracarina				1
14A.2	09/30	Oligochaeta				~2
14A.2	09/30	Hydracarina				5
14A.2	09/30	Stenonema	2			2
14A.2	09/30	Baetis	1			1
14A.2	09/30	Ophiogomphus	1			1
14A.2	09/30	Stenelmis			2	2
14A.2	09/30	Optioservus	6		1	7
14A.2	09/30	Cheumatopsyche	1			1

September 1989, Benthic macroinvertebrates (cont'd)

Stn.rep	Date	Taxon	L(N)	P	A	Total
14A.2	09/30	Hydropsyche	10			10
14A.2	09/30	Hydropsyche cheilonis Ross	2			2
14A.2	09/30	Chironomidae	3			3
*						
14B.1	09/30	Baetis	3			3
14B.1	09/30	Isonychia	2			2
14B.1	09/30	Stenonema	6			6
14B.1	09/30	Stenelmis	1		1	2
14B.1	09/30	Optioservus	3			3
14B.1	09/30	Elmidae	1			1
14B.1	09/30	Cheumatopsyche	4			4
14B.1	09/30	Hydropsyche	7			7
14B.1	09/30	Hydropsyche cheilonis Ross	3			3
14B.1	09/30	Chimarra	1			1
14B.1	09/30	Dolophilodes	7			7
14B.1	09/30	Paracricotopus		1		1
14B.1	09/30	Simulium	6			6
14B.2	09/30	Baetis	5			5
14B.2	09/30	Isonychia	4			4
14B.2	09/30	Stenonema	16			16
14B.2	09/30	Nigronia	1			1
14B.2	09/30	Stenelmis			1	1
14B.2	09/30	Optioservus	6			6
14B.2	09/30	Elmidae	1			1
14B.2	09/30	Cheumatopsyche	4			4
14B.2	09/30	Hydropsyche	4			4
14B.2	09/30	Hydropsyche cheilonis Ross	17			17
14B.2	09/30	Dolophilodes	1			1
*						
15/16.1	09/28	Oligochaeta				12
15/16.2	09/28	Oligochaeta				9
15/16.2	09/28	Hydracarina				2
15/16.2	09/28	Argia	1			1
15/16.2	09/28	Caenis	1			1
15/16.2	09/28	Chironomidae	1			1
*						
17.1	09/28	Argia	1			1
17.1	09/28	Hydropsyche	1			1
17.1	09/28	Chironomidae	1			1
17.2	09/28	Physa skinneri Taylor				1
17.2	09/28	Hydracarina				3
17.2	09/28	Caenis	1			1
17.2	09/28	Hydropsyche	1			1
17.2	09/28	Chironomidae	1			1
*						

September 1989, Benthic macroinvertebrates (cont'd)

Stn.rep	Date	Taxon	L(N)	P	A	Total
18.1	09/30	Hydracarina				1
18.1	09/30	Hydropsyche	6			6
18.2	09/30	Oligochaeta				4
18.2	09/30	Stenonema	3			3
18.2	09/30	Hydropsyche	73			73
*						
19.1	09/30	Ferrissia				2
19.1	09/30	Hydracarina				1
19.2	09/30	Hydracarina				2
*						
21.1	09/30	Ferrissia				1
21.1	09/30	Pelecypoda				1
21.1	09/30	Astacidae				1
21.1	09/30	Hydracarina				2
21.1	09/30	Baetis	1			1
21.1	09/30	Stenonema	1			1
21.1	09/30	Hydropsyche	2			2
21.1	09/30	Hydropsyche morosa sp. group	1			1
21.2	09/30	Pelecypoda				4
21.2	09/30	Ferrissia				1
21.2	09/30	Oligochaeta				3
21.2	09/30	Stenonema	4			4
21.2	09/30	Baetis	5			5
21.2	09/30	Isonychia	1			1
21.2	09/30	Hydropsyche	51			51
21.2	09/30	Hydropsyche cheilonis Ross	1			1
21.2	09/30	Nigronia	1			1
21.2	09/30	Chironomidae	5			5
21.2	09/30	Tipula	2			2
21.2	09/30	Antocha	1			1
*						
22.1	09/30	Hydracarina				1
22.1	09/30	Cheumatopsyche	2			2
22.1	09/30	Hydropsyche	1			1
22.1	09/30	Antocha	1			1
22.1	09/30	Tipula	1			1
22.2	09/30	Oligochaeta				1
22.2	09/30	Isonychia	1			1
22.2	09/30	Stenonema	1			1
22.2	09/30	Nigronia	1			1
22.2	09/30	Helichus			1	1
22.2	09/30	Cheumatopsyche	1			1
*						
23.1	09/30	Tricladida				1
23.1	09/30	Oligochaeta				~4
23.1	09/30	Stenonema	7			7

September 1989, Benthic macroinvertebrates (cont'd)

Stn.rep	Date	Taxon	L(N)	P	A	Total
23.1	09/30	Baetis	2			2
23.1	09/30	Isonychia	1			1
23.1	09/30	Perlinella	1			1
23.1	09/30	Cheumatopsyche	4			4
23.1	09/30	Chimarra	5			5
23.1	09/30	Stenelmis	1		4	5
23.1	09/30	Oulimnius latiusculus (LeConte)			1	1
23.1	09/30	Optioservus	1			1
23.1	09/30	Psephenus herricki (DeKay)	1			1
23.1	09/30	Chironomidae	1			1
23.1	09/30	Protanypus		1		1
23.1	09/30	Simulium	5			5
23.2	09/30	Physa skinneri Taylor				1
23.2	09/30	Stenonema	10			10
23.2	09/30	Isonychia	1			1
23.2	09/30	Hydropsyche	3			3
23.2	09/30	Cheumatopsyche	7			7
23.2	09/30	Chimarra	26			26
23.2	09/30	Dolophilodes	1			1
23.2	09/30	Glossosoma	1			1
23.2	09/30	Helichus			3	3
23.2	09/30	Optioservus	2		1	3
23.2	09/30	Stenelmis			2	2
23.2	09/30	Psephenus herricki (DeKay)	2			2
23.2	09/30	Chironomidae	1			1
*						
24.1	09/28	Tricladida				1
24.1	09/28	Hydracarina				2
24.1	09/28	Tipula	1			1
24.2	09/28	Oligochaeta				4
24.2	09/28	Hydracarina				7
24.2	09/28	Chironomidae	7			7
24.2	09/28	Tanypodinae	1			1
*						
25.1	09/28	---				0
25.2	09/28	Ferrissia				1
25.2	09/28	Hydracarina				3
*						
26.1	09/30	Physa skinneri Taylor				1
26.1	09/30	Oligochaeta				2
26.1	09/30	Baetis	1			1
26.1	09/30	Hydropsyche	6			6
26.2	09/30	Tricladida				1
26.2	09/30	Physa skinneri Taylor				3
26.2	09/30	Oligochaeta				3
26.2	09/30	Asellus				3

September 1989, Benthic macroinvertebrates (cont'd)

Stn.rep	Date	Taxon	L(N)	P	A	Total
26.2	09/30	Hydracarina				1
26.2	09/30	Baetis	6			6
26.2	09/30	Hydropsyche	12			12
*						
27.1	09/28	---				0
27.2	09/28	---				0
*						
28.1	09/28	Oligochaeta				~8
28.1	09/28	Sinella (Entomobryidae)				1
28.1	09/28	Chironomidae	6			6
28.2	09/28	Oligochaeta				1
28.2	09/28	Chironomidae	1			1

Benthic macroinvertebrates, 10/89

Stn.rep	Date	Taxon	L(N)	P	A	Total
3.1	10/25	Hydropsyche	3			3
3.2	10/25	---				0
*						
4A.1	10/25	Oligochaeta				1
4A.1	10/25	Chironomidae	1			1
4A.2	10/25	Oligochaeta				1
4A.2	10/25	Chironomidae	3			3
*						
4B.1	10/25	Hydropsyche	1			1
4B.2	10/25	Hydropsyche	2			2
*						
5.1	10/25	Hydropsyche	3			3
5.1	10/25	Berosus	1			1
5.2	10/25	Oligochaeta				2
5.2	10/25	Hydracarina				1
5.2	10/25	Hydropsyche	2			2
*						
6B.1	10/25	Hydracarina				1
6B.1	10/25	Heptageniidae	1			1
6B.1	10/25	Perlodidae	3			3
6B.1	10/25	Hydropsyche	1			1
6B.1	10/25	Chimarra	16			16
6B.1	10/25	Tipula	5			5
6B.1	10/25	Simulium	11			11
6B.2	10/25	Hydropsyche	4			4
6B.2	10/25	Cheumatopsyche	1			1
6B.2	10/25	Chimarra	2			2
6B.2	10/25	Tipula	3			3
*						
7.1	10/25	Oligochaeta				2
7.1	10/25	Hydropsyche	1			1
7.1	10/25	Chironomidae	1			1
7.1	10/25	Tipula	1			1
7.2	10/25	Tipula	1			1
*						
8.1	10/25	---				0
8.2	10/25	Oligochaeta				1
8.2	10/25	Gammaridae				1
*						
10.1	10/25	Oligochaeta				1
10.1	10/25	Hydracarina				2
10.2	10/25	Hydracarina				1
10.2	10/25	Hydropsyche	2			2
*						
12.1	10/25	Hydropsyche	6			6
12.1	10/25	Cheumatopsyche	1			1
12.2	10/25	Hydracarina				1
12.2	10/25	Hydropsyche	3			3

October 1989, Benthic macroinvertebrates (cont'd)

Stn.rep	Date	Taxon	L(N)	P	A	Total
12.2	10/25	Hydropsychidae	1			1
*						
13.1	10/25	Hydropsyche	4			4
13.1	10/25	Hydropsyche slossonae Banks	3			3
13.1	10/25	Oulimnius latiusculus (LeConte)			1	1
13.1	10/25	Tipula	2			2
13.2	10/25	Oligochaeta				2
13.2	10/25	Isonychia	1			1
13.2	10/25	Hydropsyche	11			11
13.2	10/25	Cheumatopsyche	1			1
*						
14A.1	10/23	Oligochaeta				5
14A.1	10/23	Hydracarina				1
14A.1	10/23	Baetis	1			1
14A.1	10/23	Hydropsyche cheilonis Ross	2			2
14A.1	10/23	Optioservus immunis (Fall)	3		1	4
14A.2	10/23	Oligochaeta				1
14A.2	10/23	Isonychia	1			1
*						
14B.1	10/17	Calopteryx	1			1
14B.1	10/17	Hydropsyche	2			2
14B.1	10/17	Cheumatopsyche	1			1
14B.2	10/17	Hydracarina				18
14B.2	10/17	Stenonema	2			2
14B.2	10/17	Hydropsyche	1			1
14B.2	10/17	Hydropsyche cheilonis Ross	3			3
14B.2	10/17	Nigronia	1			1
14B.2	10/17	Optioservus immunis (Fall)	1		1	2
*						
15/16.1	10/24	Physa skinneri Taylor				2
15/16.1	10/24	Oligochaeta				21
15/16.2	10/24	Gammaridae				1
*						
17.1	10/24	Hydropsyche	1			1
17.2	10/24	Hydracarina				1
17.2	10/24	Hydropsyche	3			3
*						
18.1	10/25	Ferrissia				1
18.1	10/25	Hydracarina				1
18.1	10/25	Argia	1			1
18.1	10/25	Hydropsyche	9			9
18.2	10/25	Baetis	1			1
18.2	10/25	Hydropsyche	53			53

October 1989, Benthic macroinvertebrates (cont'd)

Stn.rep	Date	Taxon	L(N)	P	A	Total
18.2	10/25	Ancyronyx variegata (Germar)	1			1
*						
19.1	10/25	---				0
19.2	10/25	---				0
*						
21.1	10/17	Pelecypoda				1
21.2	10/17	Hydropsyche	15			15
*						
22.1	10/23	Oligochaeta				1
22.1	10/23	Hydropsyche	1			1
22.2	10/23	Isonychia	1			1
22.2	10/23	Hydropsyche	4			4
22.2	10/23	Cheumatopsyche	2			2
*						
23.1	10/23	Oligochaeta				1
23.1	10/23	Cheumatopsyche	3			3
23.1	10/23	Optioservus immunis (Fall)	3			3
23.1	10/23	Stenelmis	1			1
23.1	10/23	Psephenus herricki (DeKay)	1			1
23.2	10/23	Tipula	1			1
23.2	10/23	Simulium	1			1
*						
24.1	10/24	Oligochaeta				3
24.1	10/24	Hydracarina				3
24.1	10/24	Hydropsyche	2			2
24.1	10/24	Chironomidae	2			2
24.1	10/24	Tipula	1			1
24.1	10/24	Hemerodromia	1			1
24.2	10/24	Hydracarina				4
24.2	10/24	Hydropsyche	1			1
24.2	10/24	Chironomidae	2			2
24.2	10/24	Tipula	1			1
*						
25.1	10/24	Hydracarina				2
25.2	10/24	---				0
*						
26.1	10/17	Chironomidae		1		1
26.2	10/17	Chironomidae	1			1
*						
27.1	10/24	Chimarra	1			1
27.2	10/24	Oligochaeta				2
*						
28.1	10/24	Oligochaeta				~10
28.2	10/24	Oligochaeta				~10

1989

MD Anacostia River Basin Study. PART II: Evaluation of Blockages to Migratory Fishes Estimates of Gamefish Distribution, Population, and Biomass

By

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Interstate Commission on the Potomac River Basin
Living Resources Section

Contract #F-65-89-008
Department of Natural Resources
State of Maryland
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I would like to extend my sincere appreciation to everyone who has contributed to this study. Special thanks goes to Mr. Mark S. Sommerfield for his invaluable participation in all aspects of field sampling, data entry, and report preparation. Also, I would like to thank Mr. Peter May for his assistance with field surveys, and Barbara Barritt and Patricia Rosenquist for your excellent word processing.

ABSTRACT

Fish surveys of Maryland portions of the Anacostia River were conducted during 1989 in order to measure the extent of migratory fish intrusions and to assess resident gamefish populations. Migratory fish runs of alewife herring (Alosa pseudoharengus), blueback herring (Alosa aestivalis), white perch (Morone americanus) and striped bass (Morone saxatilis) were monitored from March 10th to June 11th. Selected gamefish populations were estimated using three pass depletion models applied to information from backpack electrofishing captures taken at 19 stations between July and September.

The relative strengths of each migratory fish species spawning run was compared to the results of survey activities in 1988. The two primary blockages to migratory fishes were found to be the same for 1988 and 1989. There was no evidence that changes in flow altered the inability of any species to pass these barriers. As of this date, major portions of spawning habitat in the Anacostia River remain unavailable to migratory fishes due to fish blockages.

Brown trout (Salmo trutta), chain pickerel (Exos niger), largemouth bass (Micropterus salmoides), redbreast sunfish (Lepomis auritus), pumpkinseed sunfish (Lepomis gibbosus), bluegill sunfish (Lepomis macrochirus), green sunfish (Lepomis

cyanellus), brown bullhead catfish (*Ictalurus nebulosus*), and yellow bullhead catfish (*Ictalurus natalis*) were selected for population estimates. In most Anacostia tributaries the gamefish populations were found to be small, and the fishes themselves were small, rarely in the quality or preferred size ranges and never in memorable or trophy sizes. Of the species studied, largemouth bass, redbreast sunfish, bluegill sunfish, chain pickerel, and brown trout represent the best species to target for special management in the watershed. No smallmouth bass (*Micropterus dolomieui*) were captured and channel catfish (*Ictalurus punctatus*) represented an insignificant catch. Recommendations for fisheries restoration include providing for passage of migratory fish, stream habitat improvements and transport stocking.

INTRODUCTION

This document is meant to serve as a follow-up and companion document to the ICPRB report #89-2, entitled "1988 Survey and Inventory of the Fishes in the Anacostia River Basin, Maryland". The 1988 report provided information on fish community structure in relation to Anacostia tributaries and the effects of urbanization upon that structure. This document further refines this information to include more specific information on selected gamefish species, migratory fish blockages, and the recovery efforts which could enhance the survival of both of these categories of fishes. Before reading this document, it is advised that the reader be familiar with the 1988 report, as the information provided in that report serves as a base for this report.

The Anacostia River's regional reputation is that of a highly polluted resource. In many areas of the Anacostia basin this reputation is unfortunately deserving. On the other hand, the Anacostia River should also be recognized for its diverse aquatic habitats as well. Two of its streams, Paint Branch and Upper Beaverdam Creek, support unique assemblages of fishes which reflect good water quality and habitat. The Piedmont portions of Paint Branch have the well documented and publicized brown trout population (Galli, 1983, Gougeon 1985, ARC 1986, Washington Post, 1986). Upper Beaverdam Creek, a coastal floodplain stream, has a less well known but equally interesting fish community which includes chain pickerel and the American brook lamprey (Lampetra appendix) (Cummins, 1989).

If we were to view the tributaries of the Anacostia River as fingers on a hand, only a few of its fingers could be considered strong and in good shape. Sedimentation and contaminated urban runoff, long recognized as the Anacostia's major problems, continue to degrade aquatic habitat. Increased urbanization is still threatening the natural viability of its streams, although fish diversity has improved in the Anacostia River since 1948 and 1972. Allegorically, the Anacostia River is holding on with a weak but strengthening grip. This document is designed to provide direction for the restoration of the fisheries resources in the Anacostia River basin, Maryland.

MIGRATORY FISH BLOCKAGES

Materials and Methods

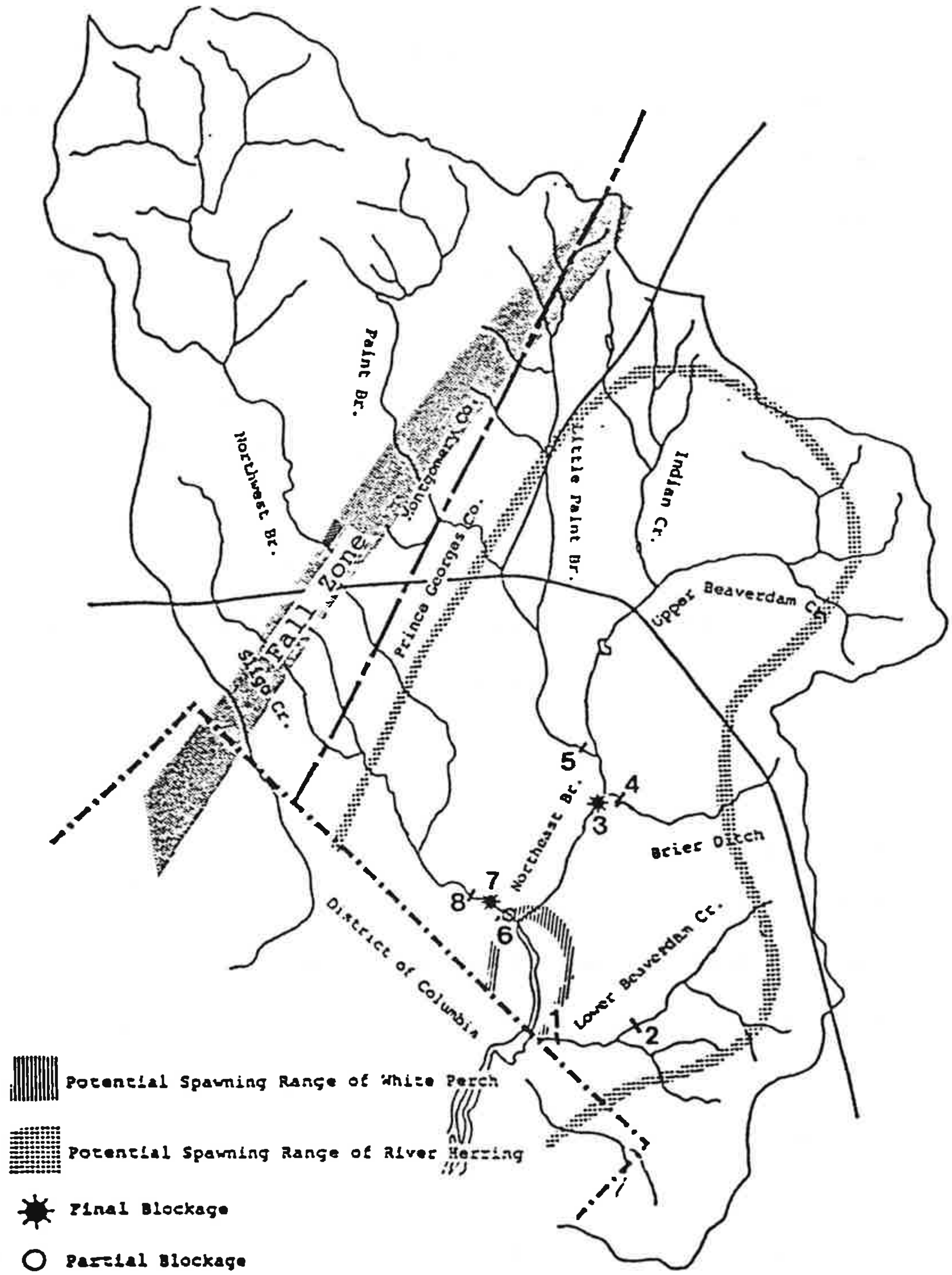
As in 1988, the major goals of the 1989 migratory fish survey were to determine the upstream limits to migration of the four anadromous species currently using the Anacostia watershed; the alewife herring, blueback herring, white perch and striped bass. Sampling methods and procedures replicated those used in 1988. The major objectives of each collecting trip were to determine the species presence, abundance and extent of upstream migrations which occurred on that particular day. Blockages were sampled twice weekly, stream conditions permitting, from March 10th to June 5th. Sampling consisted of electrofishing collections conducted immediately downstream of suspected blockages. On each sampling day the collections were initiated at the most downstream blockage of the tributaries. When migratory fish were captured sampling was then repeated at the next upstream blockage and the process continued until a blockage was reached at which no migratory fishes were captured.

Electrofishing collections were performed using a Smith-Root Model 15-A gas generator powered backpack electrofishing unit operating with direct current. One person operated the electrofisher while one other person netted stunned fish with a Smith-Root Model EDB-83-TD dip net with a 11" x 17" (27.9 cm. x 43.2 cm.) opening, 10" (25.4 cm.) bag, 0.25" (6.4 mm.) knotless mesh bag mounted on a six foot pole. Sampling areas at each blockage were intermittently shocked for a total duration of approximately six minutes. The output power was field adjusted to account for variation in stream conductivity.

Collected fish were counted, measured for length and weight, sexed by evidence of row or milt, notes were taken on their general condition, dorsal fins were clipped to identify that they had been captured, and then they were released. Attempts were made to capture all fish sighted during electrofishing.

When fish abundance was so high that capture of all individuals was not possible or desirable the fish were subsampled and records were kept on the estimated size of the school observed responding to electrofishing. Water temperature, clarity, general flow and weather conditions were recorded at each site visit. The blockages sampled were the same as in 1988 with the exclusion of the rock causeway located downstream from Riverdale Road on the Northeast Branch. This causeway was determined not to be a blockage in 1988 and was eliminated from the sampling effort. The blockages sampled are shown in Figure #1.

Figure 1. Map of Blockages to Migratory Fishes in the Anacostia Basin in Maryland with Potential Spawning Ranges.



1 Lower Beaverdam Creek at Kenilworth Avenue
2 Lower Beaverdam Creek near the Cheverly Metro Station
3 Northeast Branch at the MNCPPC Building
4 Brier Ditch at Kenilworth Avenue
5 Paint Branch at the weir near the confluence with Indian Creek
6 Northwest Branch at Route 1
7 Northwest Branch at 38th Street
8 Northwest Branch at the Pumping Station near 38th Street

Results of Migratory Fish Sampling

Results of this spring's sampling are found in Figures #2-#4. Also presented for comparison on each figure are the results of sampling over the same period in 1988. These figures reveal that there was a substantial increase in the strength of the migratory runs of alewives and white perch in 1989, as both of these species were captured in greater numbers while using the same sampling effort that was applied in 1988. The exact explanations for these increases are not apparent at this time.

As expected, alewife and blueback herring migrations were temporally separated, with the peak of the alewife run occurring in mid-April and the peak of the blueback herring run occurring in mid-May. Blueback herring (*Alosa pseudoharengus*) numbers were much lower than alewife numbers. Blueback herring represented the minor herring spawner during our two year period of sampling. No significant difference in the numbers of blueback herring was observed between 1988 and 1989. As evidenced by the lack of capture of any herring with a dorsal fin clip, no herring of either species were recaptured during our survey in 1989.

Figure #5 shows that the female alewives tended to be larger than the males. There were no distinct differences in the arrival time of the sexes of the migratory fishes. The sex

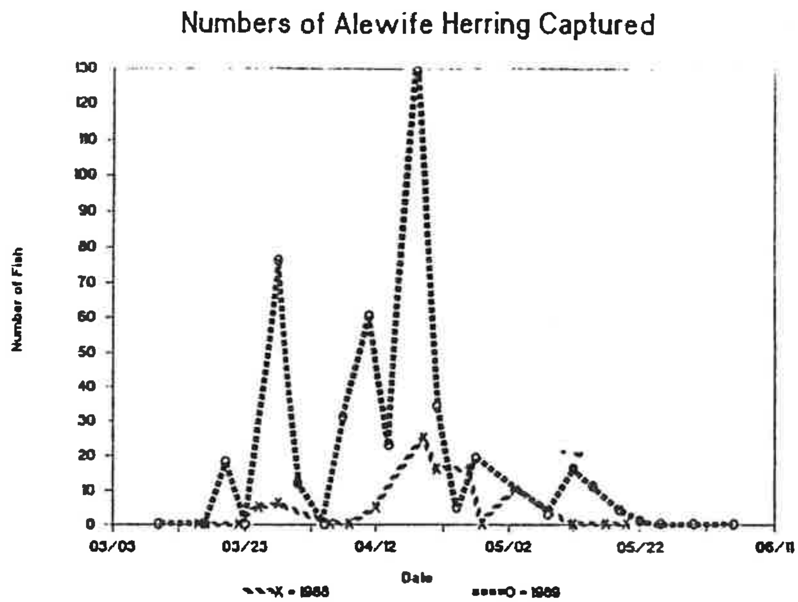


Figure 2

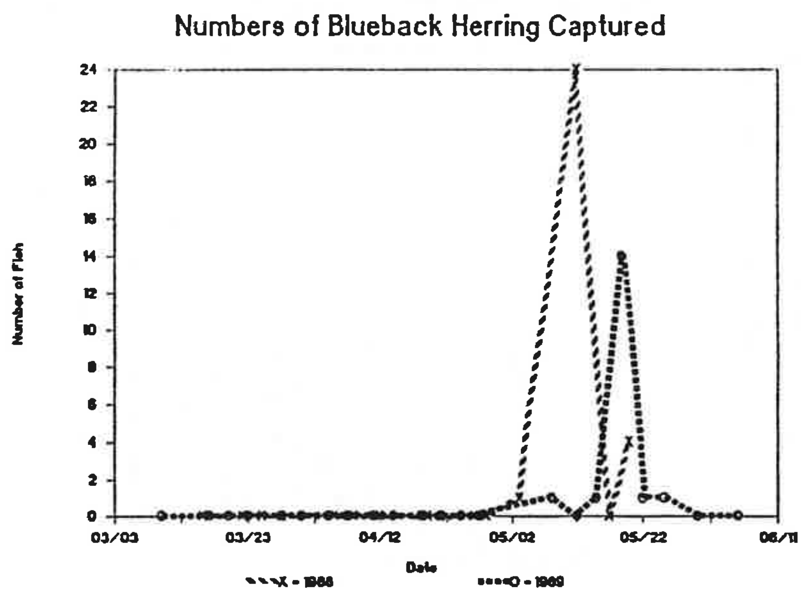


Figure 3

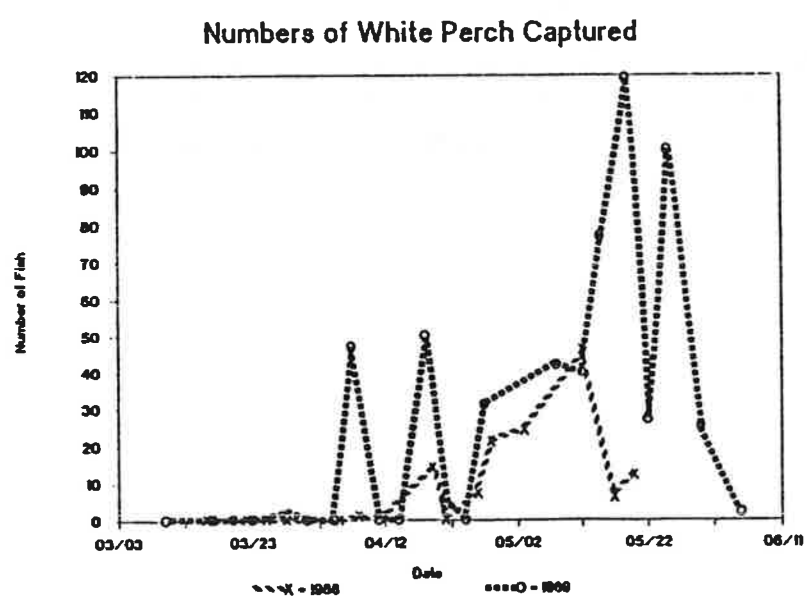
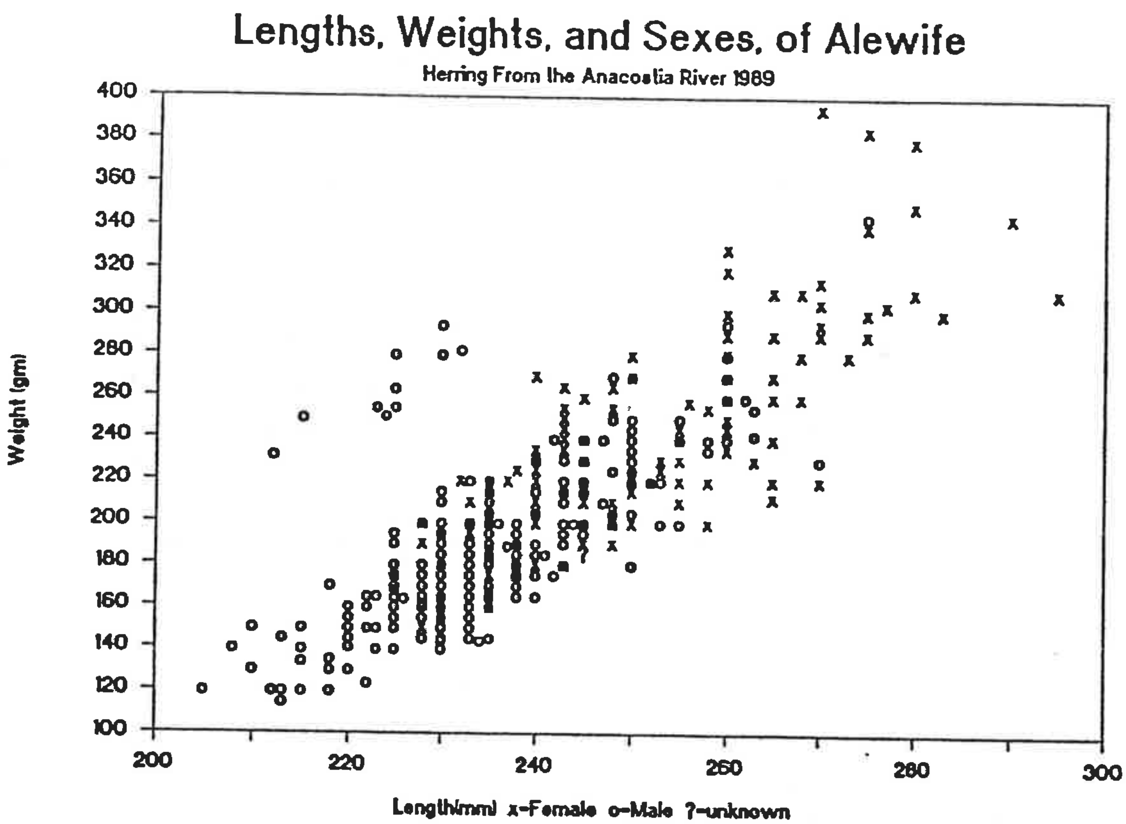


Figure 4

Figure 5



Lengths, Weights, and Sexes, of Alewife
Herring From the Anacostia River 1989
Weight (gm)
400
380
360
340
320
300
280
260
240
220
200
180
160
140
120
100
200
220
240
260
280
300
Length(mm) x-Female o-Male ?-unknown

ratios of alewife, blueback herring, and white perch are available in Table #1. Blueback herring and white perch males were more abundant than females during both 1988 and 1989. Alewife sex ratios were dominated by females in 1988 but males in 1989.

Peak discharges due to storm events occurred on March 24th and May 6th. The March 24th storm event resulted in a dramatic rise in water temperature (Figure #6). Following this storm event there was an increase in the strength of the alewife run, as evidenced by the increase in the number of alewives captured (see Figure #2). Alewife migrations were strongest when water temperatures rose from below 10 C to 15 C. The May 6th high flow also coincided with an increase in the numbers of herring captured. In this case it was blueback herring.

Although high flows appeared to initiate stronger migratory runs, high flows did not alter the migratory fishes inability to pass the two current final blockages to migration in the Anacostia basin, Maryland. In both 1988 and 1989, no migratory fish were captured upstream from the 38th Street weir on the Northwest Branch or upstream on the Northeast Branch from the weir near the Maryland National Capitol Parks and Planning Commission (M-NCPPC) offices.

Table 1

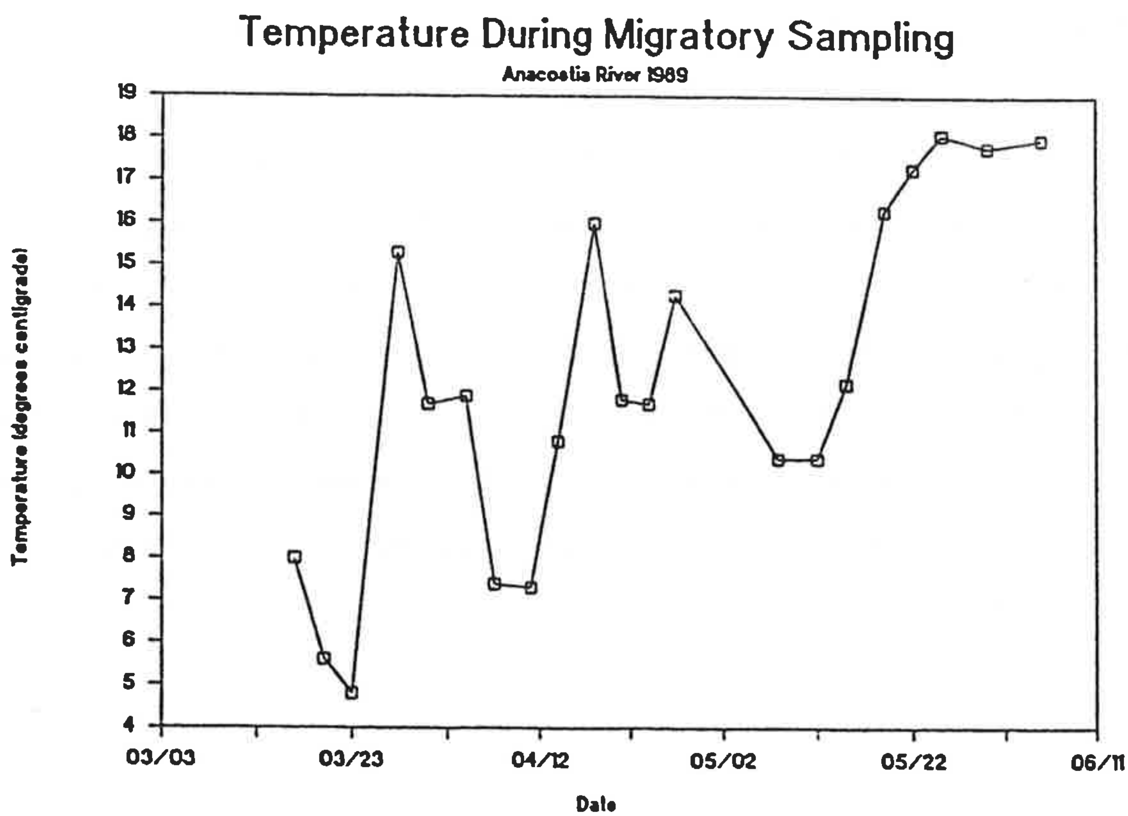
1989 Migratory Fish Sex Ratios

Sex	Alewife	Blueback	White Perch
Female	131 (35%)	5 (28%)	63 (21%)
Male	240 (65%)	13 (72%)	240 (79%)
Total	371	18	303

1988 Migratory Fish Sex Ratios

Sex	Alewife	Blueback	White Perch
Female	49 (61%)	10 (36%)	13 (11%)
Male	31 (39%)	18 (64%)	107 (89%)
Total	80	28	120

Figure 6



Eight striped bass (Morone saxatilis) were captured in 1989. None of the striped bass were mature. They ranged in size from 6.4" (163mm) to 9.4" (239mm). One yellow perch (Perca flavescens) (178 mm. x 70 g.) was captured in 1989. No yellow perch were captured in 1988.

Resident Gamefish Surveys

Materials and Methods

Resident gamefish sampling was conducted from July 17, 1989 through August 28, 1989. During this period, nineteen sites within the Anacostia Basin were surveyed for gamefish populations[1]. Descriptions of each sampling site are available in Appendix I. Sampling consisted of electrofishing for selected gamefish in pre-measured stream sections which we termed "transects". Sampling methods followed the protocol being developed by the University of Maryland's Appalachian Environmental Laboratory (AEL) in Frostburg, Maryland in order to help standardize coldwater stream fisheries sampling performed by Maryland's Department of Natural Resources.

Under the AEL approach, which is an adaptation of stream evaluations used by the U.S. Department of Agriculture, three electrofishing collections are conducted through each of three transect areas on any individual stream section, a total of nine collections at each site (Platts, Megahan, and Minshall, 1983).

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[1]The distribution and abundance of other fish species in the Maryland portions of the Anacostia River are available in the 1988 report.

Modifications of AEL's techniques were made to accommodate differences in the warmwater stream sampling environment encountered in most of the Anacostia's tributaries. Warmwater streams tend to be higher order streams than cold water streams (Kuehne 1962, Panitz 1964, Cummins 1977) and are usually larger, deeper, slower flowing, have greater species diversity and larger numbers of fish than coldwater streams (Hallam 1959, Sheldon 1960, Larimore 1961, Whiteside and McNatt 1972, Horwitz 1978). The basic difference in the two techniques was a reduction from the three transect approach used by AEL to a one or two transect approach in the Anacostia's warmwater surveys. This reduction was necessary because the increases in stream size (up to 26 meters in width at one site), species diversity and numbers of fish would have made three transect sampling impractical.

Sampling sites were selected on the basis of obtaining representative ranges of stream sizes along each tributary. At each site, sampling transects were selected in the field based upon the criteria that, in the view of the field researchers, they best represented the local stream conditions in that area. At the conclusion of sampling an electrofishing reconnaissance of adjacent stream sections was conducted to determine if the sampled transects were representative of the stream section. A reconnaissance survey verified the original transect selection when the types and numbers of collected fish in the adjacent stream sections did not dramatically differ from those collected in the transect areas.

Sampling was conducted by first setting a block seine of 1/4" mesh 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 electroshocking 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. Gamefish population estimates were based upon three pass depletion models (Zippin, 1956).

Results of Gamefish Surveys

In most of the Anacostia's tributaries the gamefish population levels were estimated to be low and the sizes of these fishes were found to be small (Table #2).

Maps showing population and biomass estimates for each gamefish species can be found in Appendix II. The most widespread and numerous gamefish species was the redbreast sunfish, being found at fourteen of the nineteen sampling sites (Figure #7).

Table 2

Estimates of Gamefish Population Density ($\hat{N}/h^1$)
and Size Distribution Estimates
1989 Resident Fish Sampling

Site	Species	# of Fish Collected	$\hat{N}/h^1$	Size[2] % ≥ Stock	% ≥ Quality	% ≥ Preferred
Wheaton Br. at Inwood Rd.						
Site A: No game fish collected.						
Sligo Cr. at the Golf Course						
Site B: No game fish collected.						
Sligo Cr. at Radio Dr.						
Site C:	Redbreast Sunfish	66	771	77%	0%	0%
Northwest Br. at Norwood Rd.						
Site D:	Redbreast Sunfish	7	293	14%	0%	0%
Northwest Br. at Randolph Rd.						
Site E:	Bluegill Sunfish	1	20	0%	0%	0%
	Redbreast Sunfish	2	40	50%	0%	0%
Northwest Br. at Riggs Rd.						
Site F:	Bluegill Sunfish	1	9	100%	0%	0%
	Redbreast Sunfish	97	1574	30%	6%	0%
Northwest Br. at Ager Rd.						
Site G:	Bluegill Sunfish	3	66	100%	0%	0%
	Redbreast Sunfish	61	1059	56%	0%	0%
	Largemouth Bass	1	17	0%	0%	0%
Paint Br. at Fairland Rd.						
Site H:	Brown Trout	1	11			
	Redbreast Sunfish	8	244	50%	12%	0%
Paint Br. at Powdermill Rd.						
Site I:	Bluegill Sunfish	2	15	50%	0%	0%
	Redbreast Sunfish	13	127	38%	0%	0%
Little Paint Br. at Cherry Hill Rd.						
Site J:	Yellow Bullhead Catfish	6	90	33%	17%	0%
	Bluegill Sunfish	1	13	0%	0%	0%
	Redbreast Sunfish	33	2008	45%	6%	0%
	Pumpkinseed Sunfish	1	13	100%	0%	0%
Paint Br. at Calvert Rd.						
Site K:	Yellow Bullhead Catfish	3	32	0%	0%	0%
	Redbreast Sunfish	39	436	41%	10%	0%
Indian Cr. above Quimby Rd.						
Site L:	Largemouth Bass	2	32	0%	0%	0%
Indian Cr. at Sunnyside Rd.						
Site M:	Chain Pickerel	7	127	71%	0%	0%
	Green Sunfish	6	94	67%	0%	0%
	Bluegill Sunfish	2	32	50%	0%	0%
	Redbreast Sunfish	17	263	29%	0%	0%
	Pumpkinseed Sunfish	18	325	11%	0%	0%

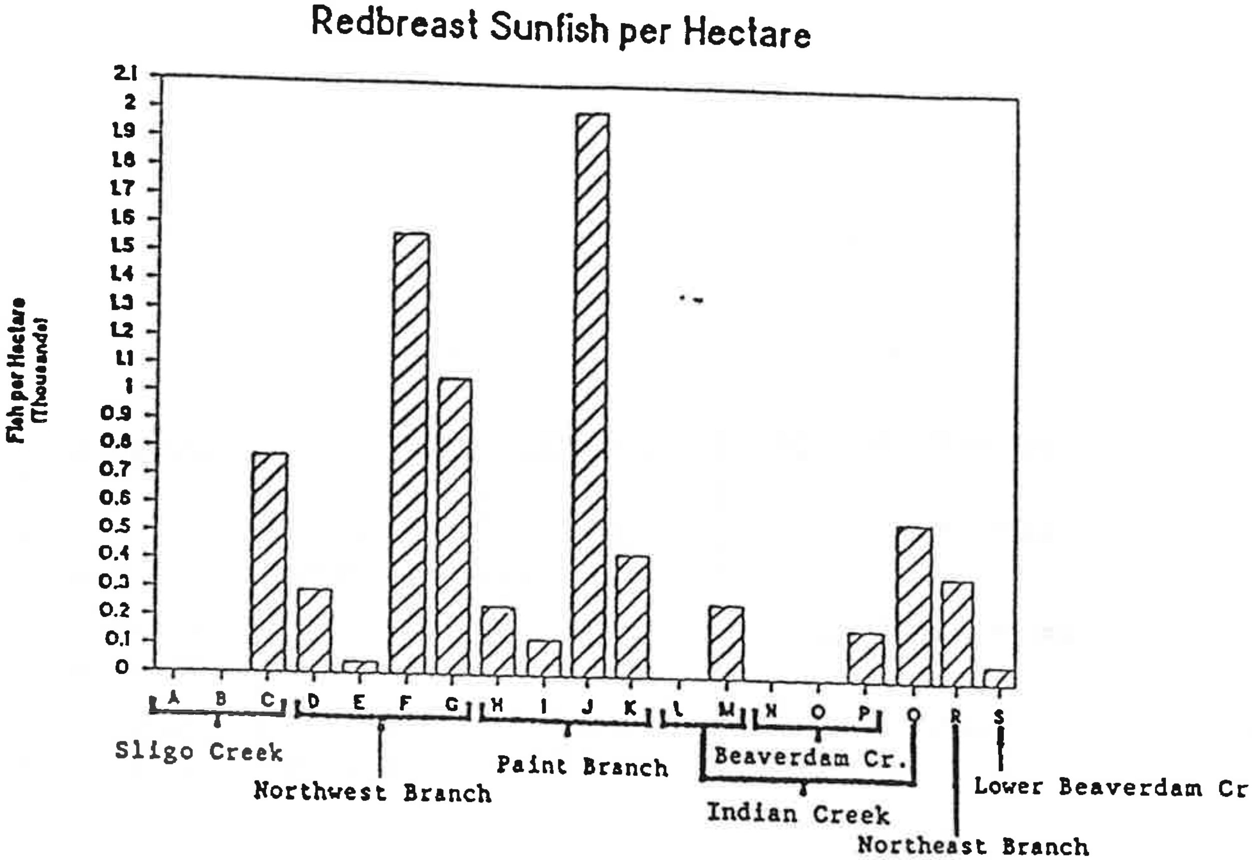
Estimates of Gamefish Population Density ($\hat{N}/h$[1])
and Size Distribution Estimates
1989 Resident Fish Sampling

Site	Species	# of Fish Collected	$\hat{N}/h$	Size % ≥ Stock	% ≥ Quality	% ≥ Preferred
Beaverdam Cr. at Powdermill Rd.						
Site N:	Chain Pickerel	1	69	0%	0%	0%
	Bluegill Sunfish	21	1559	19%	0%	0%
	Pumpkinseed Sunfish	2	151	100%	0%	0%
	Largemouth Bass	1	69	0%	0%	0%
Beaverdam Cr. at Beaverdam Rd.						
Site O:	Chain Pickerel	9	385	56%	0%	0%
	Bluegill Sunfish	9	406	100%	0%	0%
	Largemouth Bass	1	42	0%	0%	0%
Beaverdam Cr. at Edmonston Rd.						
Site P:	Chain Pickerel	7	370	29%	0%	0%
	Bluegill Sunfish	9	604	100%	67%	0%
	Redbreast Sunfish	7	181	43%	0%	0%
	Pumpkinseed Sunfish	3	78	66%	33%	0%
Indian at Calvert Rd.						
Site Q:	Yellow Bullhead Catfish	3	31	67%	33%	0%
	Green Sunfish	1	9	0%	0%	0%
	Bluegill Sunfish	1	9	0%	0%	0%
	Redbreast Sunfish	54	568	50%	4%	0%
	Pumpkinseed Sunfish	5	45	20%	0%	0%
Northeast Br. at Baltimore Blvd.						
Site R:	Yellow Bullhead Catfish	4	31	100%	25%	25%
	Brown Bullhead Catfish	3	23	100%	100%	0%
	Bluegill Sunfish	15	125	93%	20%	0%
	Redbreast Sunfish	47	373	77%	2%	0%
	Pumpkinseed Sunfish	24	197	88%	0%	0%
	Largemouth Bass	2	17	100%	50%	0%
	White Perch	2	17	100%	0%	0%
Lower Beaverdam Cr. at 61st St.						
Site S:	Yellow Bullhead	4	41	0%	0%	0%
	Brown Bullhead	2	16	100%	0%	0%
	Redbreast	7	63	71%	0%	0%

1. $\hat{N}/h$ is the estimate of the population size ($\hat{N}$) constructed using the Zippin method (Zippin, 1956) divided by the sampled surface area of the stream in hectares. See Appendix II for standard error and confidence intervals on population estimates.

2. The size groupings are taken from Gabelhouse (1984).

Figure 7



During our routine sampling, only one brown trout was captured. This individual was captured at site H, located on Paint Branch downstream from Fairland Road. However, during our verification survey of adjacent locations, we also captured several other brown trout. These fish tended to be small (between 16.5 cm. and 18.5 cm.) but were very active, healthy and had good coloration.

All gamefish captured had very poor representation in any length category above stock size. Table #3 provides an overview of size range categories.[3]

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[3]These size groupings are taken from Gabelhouse (1984).

Table 3

Gamefish Species	Stock	Quality	Preferred	
Sunfishes	3-6" 8-15cm.	6-8" 15-20cm.	8-10" 20-25cm.	
Largemouth Bass	8-12" 20-30cm.	12-15" 30-38cm.	15-20" 38-51cm.	
Bullheads	6-9" 15-23cm.	9-12" 23-30cm.	12-15" 30-38cm.	

"Stock" size fish are usually those which have reached maturity as well as those which are normally available to gear traditionally used by biologists to sample the species. Fish smaller than stock size have little or no recreational value (Gabelhouse, 1984). Stock size fish have some minimal recreational value. Anderson (1980) defined "quality" length as the size of fish most anglers are satisfied with catching.

Gabelhouse (1984) expanded upon Anderson's size categories and proposed that, while anglers may be satisfied to catch fish of quality length, most would prefer fish that were somewhat larger and he established the "preferred" length category. Gabelhouse further defined "memorable" as the size most anglers remember catching and "trophy" as the size of fish considered worthy of acknowledgment.

As can be seen from Table #2, quality size fish were extremely rare in our survey. Preferred size ranges did not exist except for one brown bullhead captured at Site R near the mouth of the Northeast Branch. A total of seven largemouth bass were captured during gamefish sampling, one of which was stock size and one of which was in the preferred size range.

Our migratory sampling also provided information of interest regarding resident gamefishes in the Anacostia. During migratory fish sampling we captured 32 largemouth bass in the plunge pool created by the Northeast Branch weir. These bass ranged in size from 1.54 pounds (295 g) to 2.49 pounds (1131 g) with an average size of 1.34 pounds (618 g). Twenty-five of these fish were quality size (> 15"). This plunge pool is one of the few pools on this stretch of the Northeast Branch. The size and abundance of largemouth basses in this pool are further evidences that such pools provide valuable deepwater habitat which is scarce in the channelized portions of the Anacostia basin.

Stream bottom imbeddedness is a measure of the degree to which larger particles (boulders, rubble, and gravel) are surrounded by fine sediment (Platts, Megahan, and Minshall, 1983). The average imbeddedness we encountered in the Anacostia tributaries was eighty-five percent, which is very high. Further evidence of a siltation problem was the predominance of fine sediment observed at the sites. Ten of the nineteen sites were classified as either dominated or partially dominated by fines in the bottom habitat type[4] (Table #4).

Table #4

Habitat Type	# of Sites
Grass + Boulders	1
Gravel + Roots	2
Boulders + Fines	1
Fines + Roots	1
Roots + Fines	5
Trees + Fines	2
Rubble + Fines	1
Roots + Trees	2
Trees + Roots	3

[4]These bottom habitat types are from Platts, Megahan, and Minshall, 1983

CONCLUSIONS

Most of the stream reaches surveyed are of sufficient size that they could normally support much larger and healthier fish populations. The stream conditions were often designated as poor, generally the apparent result of suburban runoff and subsequent erosion. Streams were generally categorized as too wide, too shallow, highly imbedded, and lacking pools of sufficient depth to provide refuge for gamefish from predators or from temperature extremes. This fisheries study and a related benthic macro-invertebrate survey (Stribling, et al, 1990) found that water quality in the Anacostia tributaries needs to be improved, especially in Indian Creek and Lower Beaverdam Creek. Our analysis of stream conditions and fisheries communities in the Anacostia Basin indicates a definite need to restore degraded stream habitat to increase gamefish size and numbers.

RECOMMENDATIONS

The Anacostia's streams require water quality improvements and stream habitat restorations before they will be able to support good gamefish populations. However, at this time a good initial goal and focus for a Fisheries Management Plan (FMP) in the Anacostia basin is to establish a "new angler" fishery, in essence to create "learn how to fish here" areas. Redbreast sunfish are generally abundant and are easy for beginning anglers to catch. Currently these fish are small but can be fun to catch. Due to their small size, catch-and-release fishing techniques could also be taught. Young people are obviously good candidates to use this type of fishery, but a "learn to fish" area can also be a great place for senior citizens and handicapped individuals. Obviously, better fishing opportunities should be available in the Anacostia basin. A logical and practical approach for improving the quality of the streams to produce better fishing is to coordinate stormwater management controls with stream restoration projects. The Washington Area Council of Government's (COG) inventories of Anacostia retrofit sites for Prince Georges and Montgomery Counties (Galli and Herson, 1989) provide lists of stormwater management projects which could be implemented within the basin to improve water quality. These documents also contain projects for stream restoration which were included as part of a cooperative effort between COG and the Interstate Commission on the Potomac River Basin. These stream restoration projects were included based upon information obtained from the 1988 and 1989 Anacostia fisheries surveys. Both documents serve as an excellent reference guide for selection of future restoration projects. The following recommendations reflect and expand upon those projects listed in the Anacostia retrofit inventories and seek to promote prime sites for concentrating our stream restoration efforts:

Sligo Creek:

Transplant stock native fishes into sections above Randolph Road. Macro-benthic invertebrate sampling (Stribling, et al, 1990) indicates that this section of Sligo Creek supports a reasonable food base for fish, and the near absence of fish in this section does not appear to be food limited. Initial fish transplants should be pollution tolerant native species including redbreast and bluegill sunfish, largemouth bass, golden shiner (Notemigonus chrysoleucas), common shiner (Notropis cornutus), satinfin shiner (Notropis analostanus), silverjaw minnow (Ericymba buccata) and the tesselated darter (Etheostoma olmstedi).

Sligo Creek has numerous blockages to migratory fishes (Cummins, 1989) and the removal of any individual blockage unfortunately does not produce a large net increase in stream miles for migratory spawners. Sligo Creek is also in close proximity to some of the Anacostia basin's highest human population densities and therefore suffers from many of the basin's worst pollution problems. Therefore, in these respects, Sligo Creek represents the greatest challenge to opening spawning habitat for migratory fishes in the Anacostia basin. However, Sligo Creek can serve as a measuring stick for our success in restoration.

The obstructions in Sligo Creek should be modified to permit passage of migratory fishes. Those modifications must include the concrete spillway downstream of Riggs Road, which has produced shallow stream channel conditions that interfere with migratory fish passage.

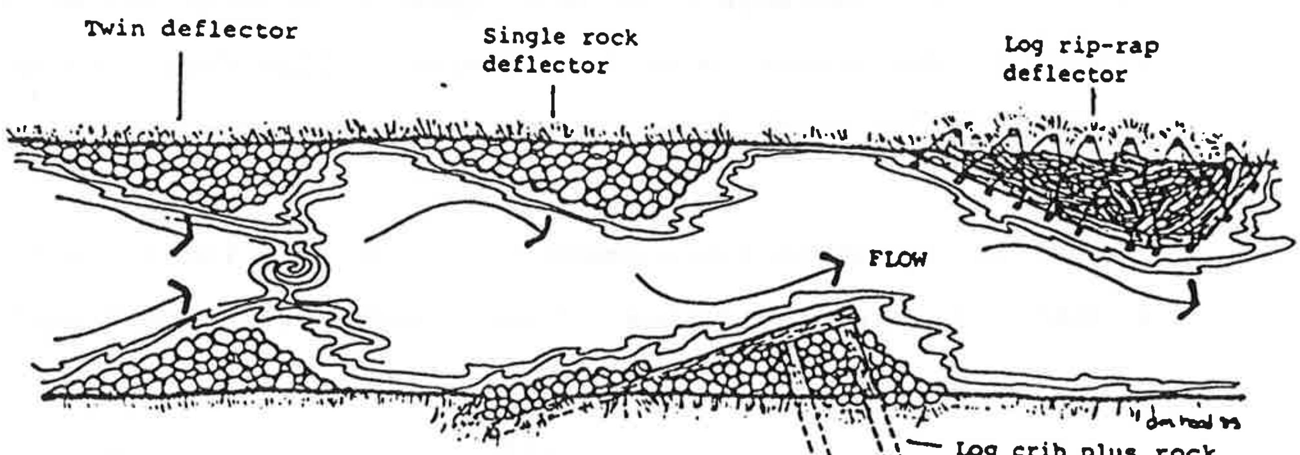
Northwest Branch

Improve instream habitat above Riggs Road by selectively placing large boulders in midchannel areas and using other types of flow deflectors to sequence riffles and pools at intervals approximately 5 to 7 times the width of the channel (Leopold et al. 1964). This will increase optimal habitat for resident fish. The deeper pools created may also prolong the residence time for stocked rainbow trout by providing cooler waters.

Habitat for large gamefish such as largemouth bass can also be improved by the installation of a series of wing deflectors (Figure #8) in the stream stretches below Riggs Road to the confluence with the Northeast Branch. The straight, channelized

Figure 8

Plan view of twin and single deflectors made of rock, log crib plus rock, and log rip-rap. In all cases the profile of the structure is kept low; an angle of less than 45 degrees is maintained. Sketch is not to scale.



Source: Ontario Ministry of Natural Resources.

areas along this stretch are conducive to the use of such structures as wing deflectors. Vegetative shading of the shoreline is recommended to help reduce water temperatures and to provide a more aesthetic environment. This area is also prime potential park land and would be an excellent area to provide access for both beginning and experienced anglers, understanding that these activities must be coordinated with the flood control criteria of the area.

Paint Branch:

One of the most important aspects of the Anacostia FMP is to continue to protect and enhance Paint Branch's Class III waters to ensure the survival of this unique and valuable brown trout population. These trout represent an important environmental barometer for measuring the success of our land management practices in an increasingly urbanized watershed and therefore their value extends beyond those of recreational fishing. The channelized portions running through the Beltsville Agricultural Research Center (BARC) below the Washington beltway require shading and instream restoration work.

Upper Paint Branch:

The channelized portions of Upper Paint Branch running through the Beltsville Agricultural Research Center (BARC), downstream of Sellman Road, also requires shading and instream restoration work. We recommend the use of vegetative shading and wetland filtering along the I-95 portion of this stream. Because of the coolwater character of this branch, the possibility of future transplanting of brown trout fingerlings from the Paint Branch brown trout stock to establish a population in Little Paint Branch should be considered. Paint Branch stock are recommended because the genetic base of these fish is likely to be well suited for Little Paint Branch as well.

Indian Creek:

Although one of the upper stretches of this stream has recently been found to be in good condition (Stribling, et al, 1990), the stream section between Route 1 and Powdermill Road is in extremely poor condition, principally due to the long expanse of concrete channel running through the city of Beltsville. This concrete section should at least be modified to provide shading and a channel deep enough (at least 6" deep) to permit fish migration through this area.

<u>Upper Beaverdam Creek:</u>

Protect and enhance the pickerel/brook lamprey community by conscientiously limiting disturbances along stream corridors. Upgrade animal wastewater handling and treatment at the BARC facilities.

<u>Northeast Branch</u>:

One of the best areas for stream restoration in the Anacostia basin is the entire stretch of the Northeast Branch from Calvert Road to the confluence with the Northwest Branch. As evidenced by the number and size of largemouth bass captured in the plunge pool at the Northeast Branch weir, this is an area that could provide good quality fishing for large gamefish. This is an ideal area to install a series of wing dams to create deeper pools, following the 5-7 rule described in the Northwest Branch section. Vegetative shading should also be provided along this section. Again, these lower sections are good areas to promote increased recreational use, provided that the safety concerns of these flood control areas are thoughtfully considered.

<u>Lower Beaverdam Creek</u>:

As evidenced by both fisheries and benthic macro-invertebrate surveys, this is the worst major tributary in the Anacostia basin in terms of degree of degradation. Improved stormwater management and enforcement is critical in this watershed, as is enforcement of illegal dumping, especially in the portions near Kenilworth Avenue.

Other Objectives:

In addition to the preceding list of individual stream restoration projects, there are several other areas that can be improved. First, it is imperative to improve the spawning success of migratory fishes by opening spawning habitat in the Anacostia basin. The ICPRB, in cooperation with local, state and federal agencies involved with migratory fish passage in the area, has established an "Anacostia Fish Passage Working Group" (AFPWG) to facilitate modifications of blockages to permit passage by migratory fishes. AFPWG will act as a subset of Maryland's Department of Natural Resources and the Chesapeake Bay Fish Passage Working Groups.

During our migratory sampling we often encountered anglers who were snagging for herring and we captured herring with brutal snag wounds. Snagging is currently illegal in Maryland and we recommend increased notification and enforcement of the snagging restrictions, especially in the Northeast Branch at the weir near the Maryland National Capital Park and Planning Commission offices. Considering the Bay-wide reductions in herring stocks, it may be reasonable to consider temporarily closing or reducing fishing effort for herring until these stocks have improved. Transporting gravid herring to sites upstream of current blockages is also recommended. This may help imprint the young with upstream natal waters, hopefully facilitating their return to these upstream reaches to spawn when the blockages are modified to permit passage.

An often overlooked concern is the reduction of thermal impacts received by the Anacostia's streams. Runoff from impervious surfaces such as rooftops, highways, and parking lots contribute thermal as well as toxic burdens to Anacostia's streams. Denuded streambanks cause solar overheating of the streams in the summer and loss of heat in the winter. Excessive or wildly fluctuating water temperatures will kill or reduce the vigor of many fishes. The answers to solving the thermal burden problem are complex, but a simple partial solution to the problem is vegetative shading, not just along stream corridors or stormwater management ponds, but also at areas with impervious surfaces such as parking lots.

In summation, although the Anacostia basin has water quality and stream habitat problems, once these problems are corrected the Anacostia can be managed to provide a close-to-home opportunity to learn how to fish for those people living in the surrounding urban and suburban neighborhoods. Learning how to fish may help give them an understanding and ethic about the outdoors, a concern for the environment, and the impetus to those who may currently ignore the problems of the Anacostia River to become responsible stewards of its waters. There is also the potential to establish some "experienced angler" areas with larger gamefish. As was noted in this report, the number and size of largemouth bass captured at the plunge pool created by the North East Branch sheet pile weir was encouraging. In the future, it is quite conceivable that, after we provide proper habitat, the thrill of capturing a 3-4 pound largemouth bass from the Anacostia River will be a reality.

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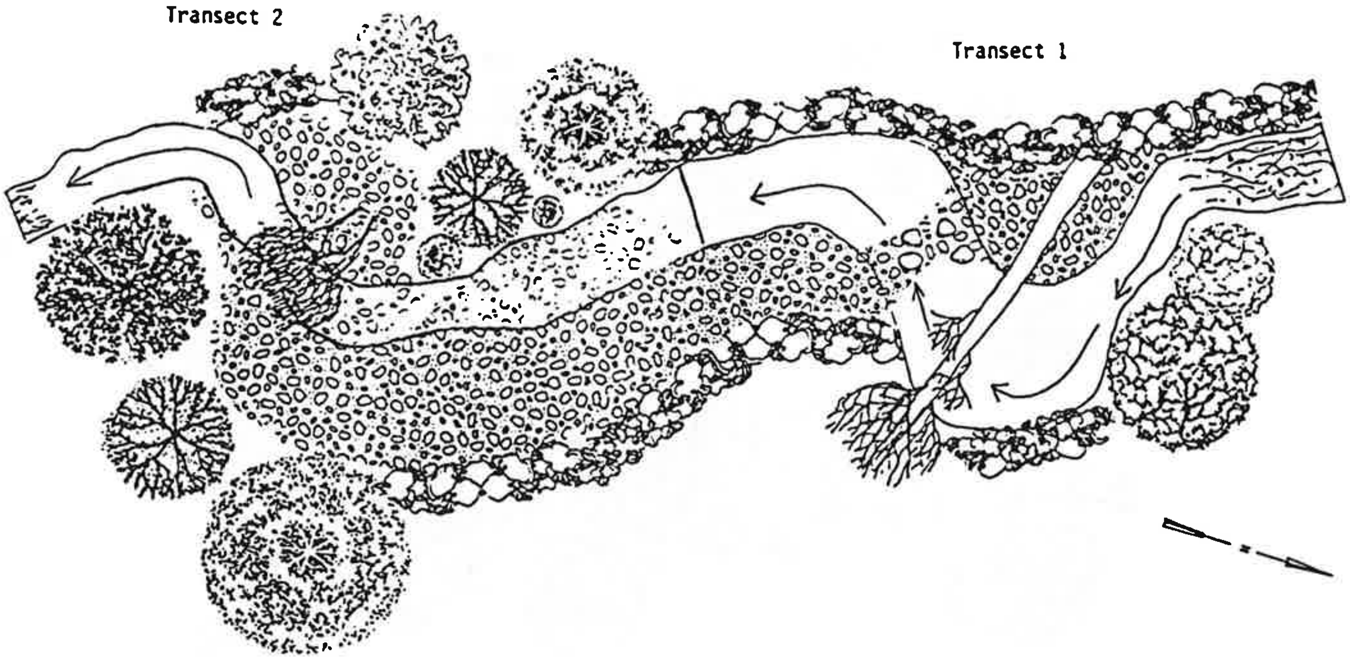
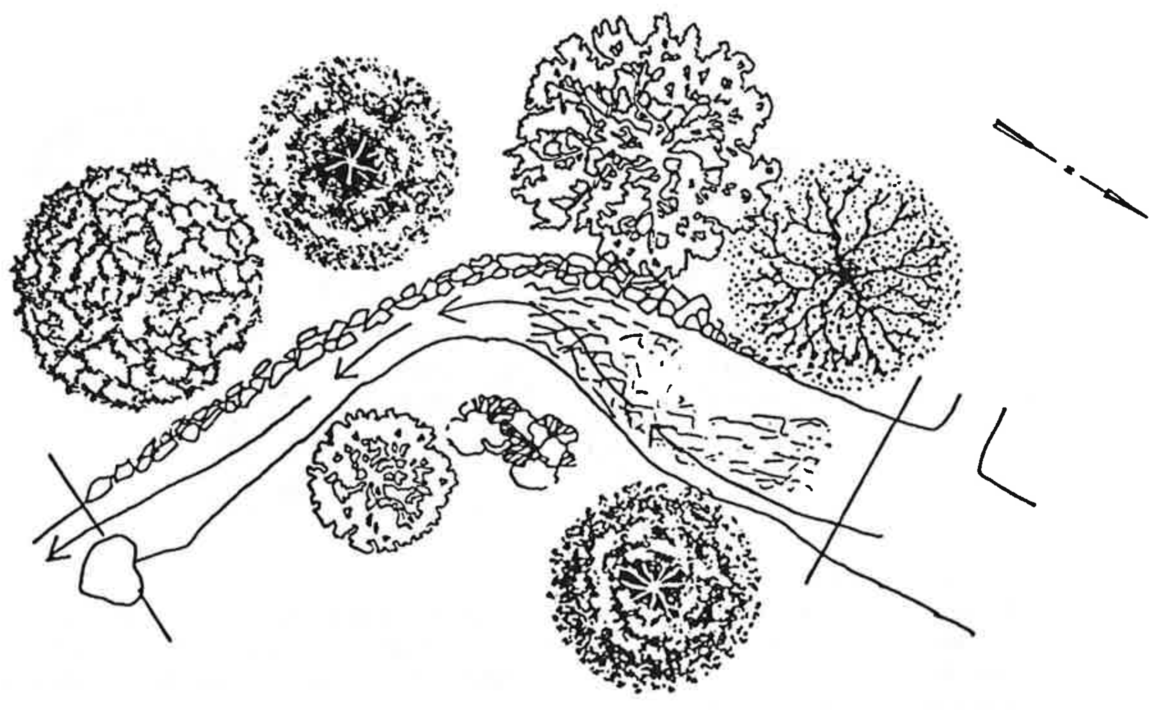
Appendix I: Site Descriptions and Diagrams

The following maps and accompanying site descriptions are intended to give the reader a general feel for the topography and appearance of our sample sites. They were drawn up from notes and rough sketches done in the field. Types and locations of trees and other vegetation are not depicted with extreme precision. They should not therefore be used as landmarks by persons attempting to locate these sites. Arrows shown in the streams indicate the thalweg. Additionally, an arrow indicating true north is included on each map. These are approximate also and should not be considered otherwise. A rough idea of the scale of these maps can be gained by looking at the length of the transects. The ends of each transect are indicated by solid lines crossing the stream. The straight line distance between these two points represents a length of approximately fifty meters.



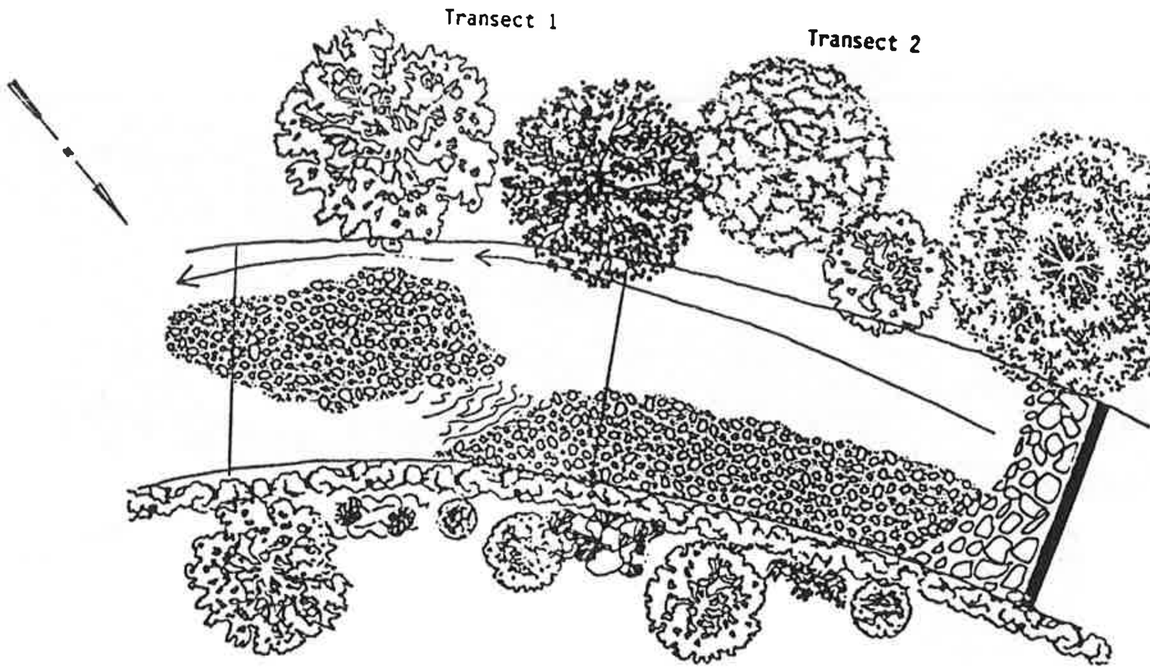
Site A: Wheaton Branch at Inwood Road

The upstream block of the first transect here was approximately 100 meters below the Inwood Rd. bridge. Woodman Rd. ran alongside the stream for a short distance at the upper end of the sampling area. The bed of the stream, much of which was exposed, is made up of gravel and cobbles for the most part. We estimated the bed to be over seventy-five percent embedded with sediment. The area is well forested with extensive undergrowth. The banks have many areas of exposed roots and there were a number of fallen trees in the stream. The stream had alternating riffles and pools. The riffle areas were very shallow but the pools were over a meter deep in places. The water seemed to be rather low when we were here. There was little distinct current in the pools. The width of the stream varied between two and a half and five and a half meters. The bankful width of the stream is about ten meters in most places.



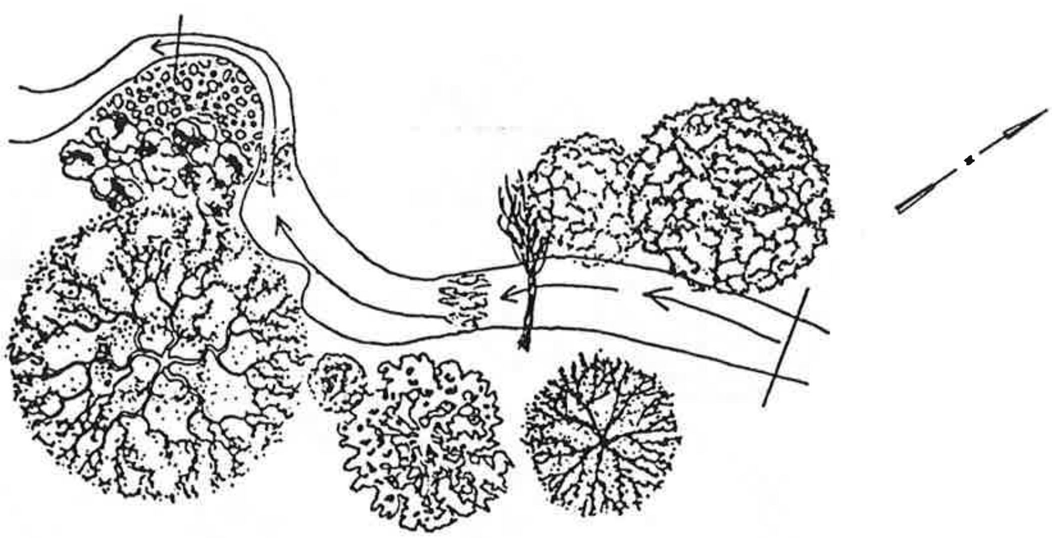
Site B: Sligo Creek at the Sligo Park Golf Course

At this location Sligo Creek runs alongside a soccer field and is approximately 75 meters to the west of Sligo Creek Parkway. There was a very large flat rock at the downstream end of the site. The banks are rip-rapped and the area has many large trees. The stream width was around five meters in most places with a couple places at the upstream end of the site being ten meters in width. The bankful width of the stream is about fifteen meters.



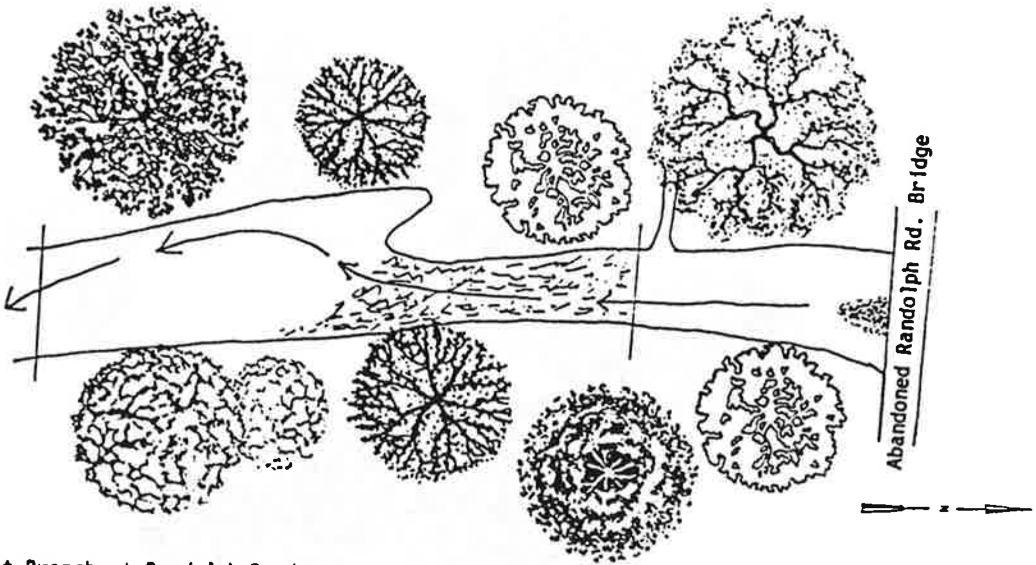
Site C: Sligo Creek at Radio Drive

This site is a short distance upstream from the confluence with Northwest Branch. The upstream boundary of the second transect was 20.5 meters downstream from a drop structure. The stream was separated from Radio Drive on the east bank by a part of Sligo Creek Park. This portion of the park was an open field about one hundred fifty meters across. The banks were very high and steep. The west bank was particularly high. The bed was sand and gravel and was very highly embedded with fines. The banks were made up of fines with exposed roots. There were trees growing on both banks. The bankful width was about thirty meters. The stream width in most places was between five and fifteen meters. The depth was less than a half a meter in most places.



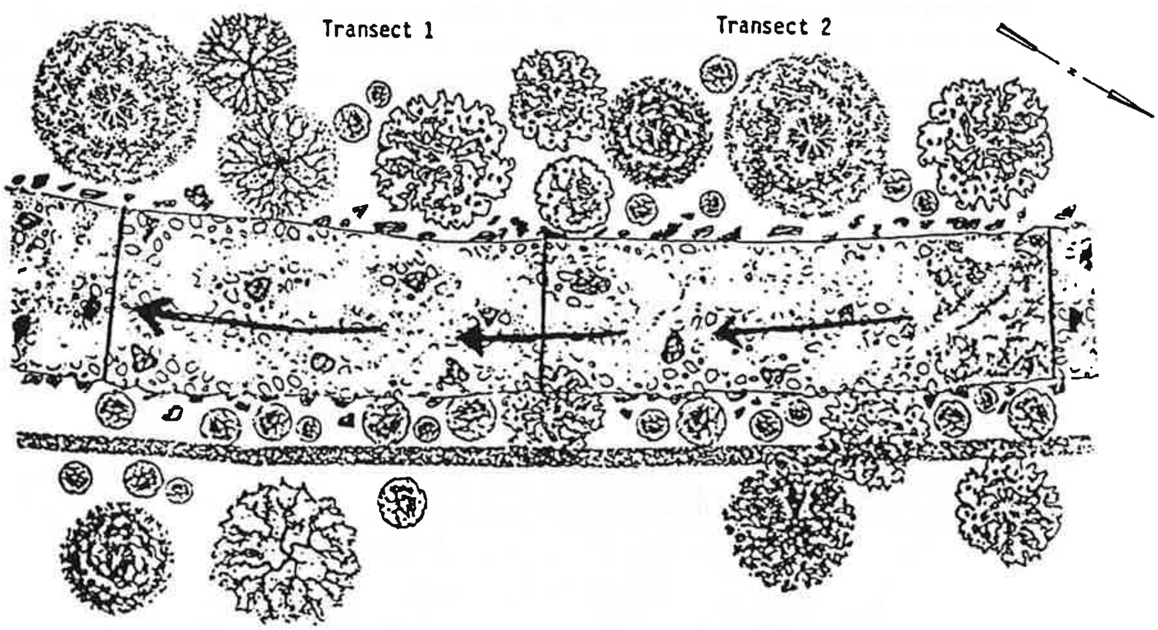
Site D: Northwest Branch above Norwood Road

Norwood Road was about one hundred meters downstream from the end of this transect. The banks are steep and about six feet in height in some places. There are trees on the banks except for a portion of the west bank at the downstream end of the transect. Here a lawn stretches down to the stream from the residence of a Mrs. Patton. In the pools, the bed is sandy. Gravel and cobbles cover the bottom in other areas. The degree of embeddedness is high. About thirty meters upstream from the lower end of the site there was a tree down across the stream. This resulted in a small drop. A small pool had formed below this drop. Downstream from this pool was a riffle followed by a larger pool at a bend in the channel. This pool had a very large sycamore root ball on its outside edge which was undercut. The depth in this pool reached about one and a half meters. In most other places the depth was less than a quarter meter. The bankful width varied from ten to twenty-three meters. The stream width was around four meters in most places but was up to eight meters at the large pool.



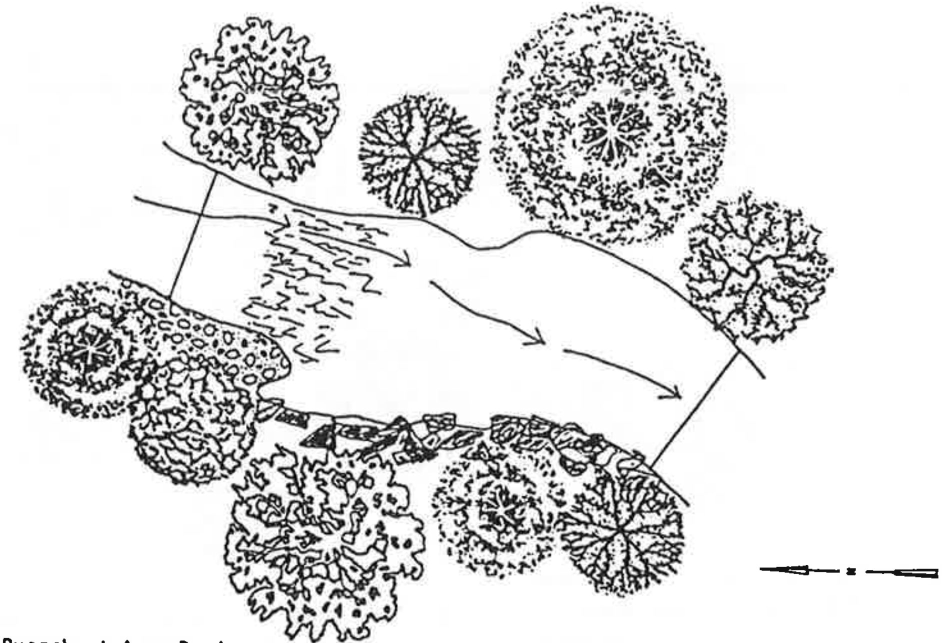
Site E: Northwest Branch at Randolph Road

The upper end of the transect was located thirty-one meters downstream from the abandoned Randolph Road bridge. The bed was predominantly fines and gravel. It was highly embedded. The banks were dominated by mature hardwood forest. The upstream half of the sample area was a riffle with a depth of about a quarter of a meter. The rest of the sample area was a pool, portions of which were over three quarters of a meter in depth. The bankful width was about fifteen meters. The stream width was around ten meters. Pool width was within ten percent of the average stream width. There was a moderate amount of instream structure providing cover for fish.



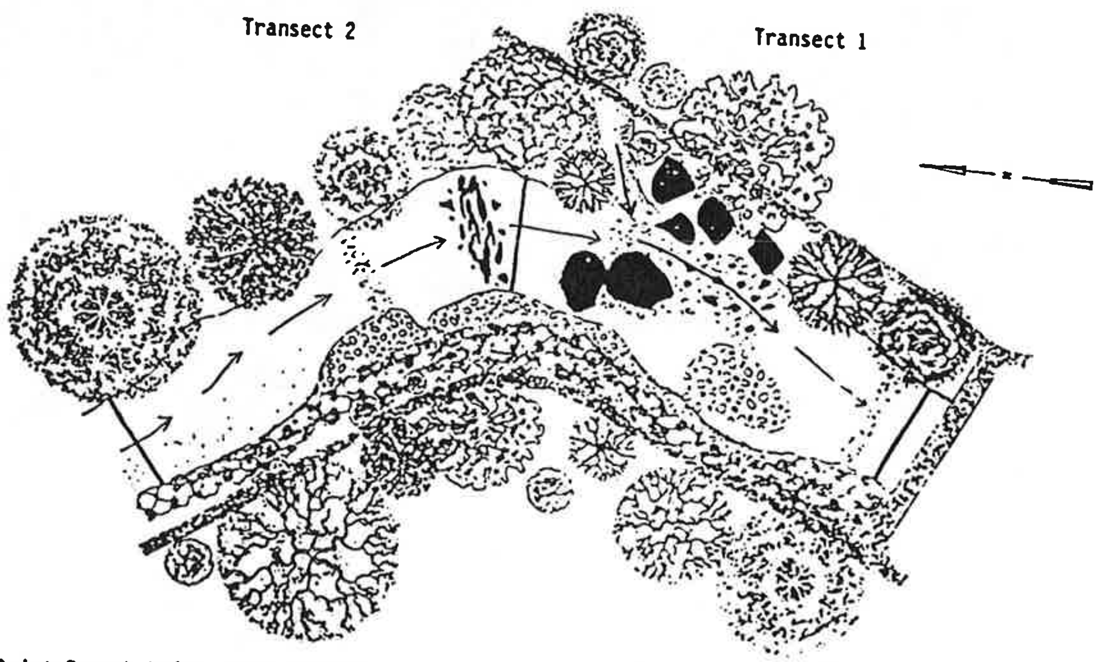
Site F: Northwest Branch at Riggs Road

This site began about one hundred meters downstream from New Hampshire Avenue but was accessed via the Adelphi Mill parking lot at Riggs Road. An asphalt bike path runs alongside the stream in this area. The stream itself is flowing through a deep and narrow valley with steep sides. The area has numerous trees of impressive size. The banks appear to have been rip-rapped and are straight and even. The width of the stream was in no place much greater or less than eleven meters. The bankful width was very even at around twenty meters. Despite the uniformity of their dimensions, enough vegetation has grown on the banks to give the area a very natural and undisturbed appearance. The bottom is very flat and regular. It is made up of sand, gravel and cobble with scattered boulders. The degree of embeddedness was very high. The depth of the stream was less than a half of a meter in most places. There was a moderate amount of algae growing in the stream on the day we were here.



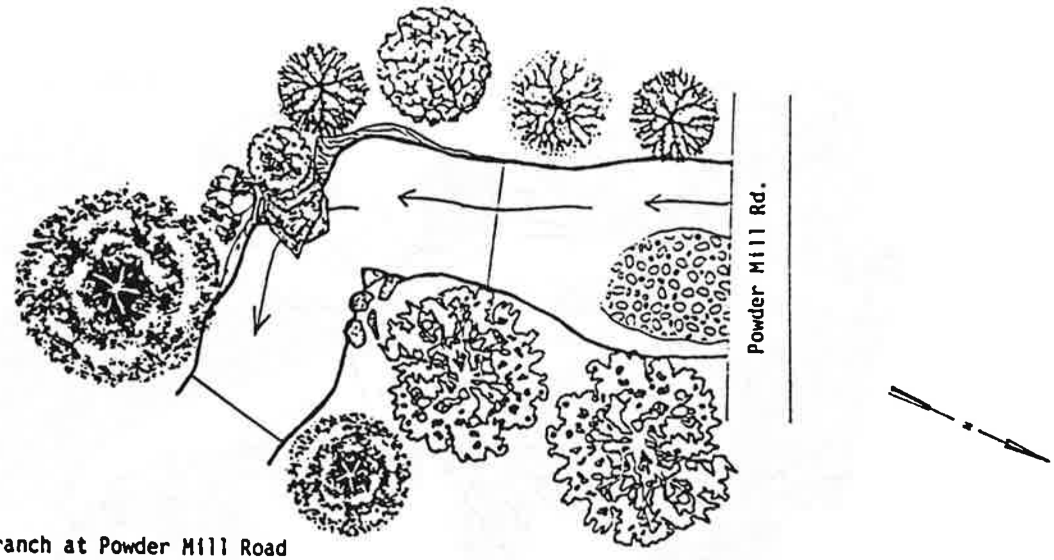
Site G: Northwest Branch at Ager Road

The upstream end of this site was one hundred fifty-five meters downstream from the Ager Road bridge. On the east bank was a garden store and nursery. Downstream from the nursery was an open grassy section of parkland. The confluence with Sligo Creek was a few hundred meters downstream. There are trees growing on the banks, which are fairly steep and about eight feet in height. The west bank was rip-rapped with many large boulders on the bank and submerged in the stream. The stream was as narrow as nine meters and as wide as twelve meters across. The bankful width varied from twenty to thirty meters. The bottom was composed of cobbles and gravel with large boulders in some areas. The bottom was highly embedded. The pool on the downstream end of the site was sandy on the east side. In the riffle upstream the depth was about a third of a meter. Midway downstream the depth was about a half a meter. The pool at the bottom of the site was measured at 1.15 meters in depth.



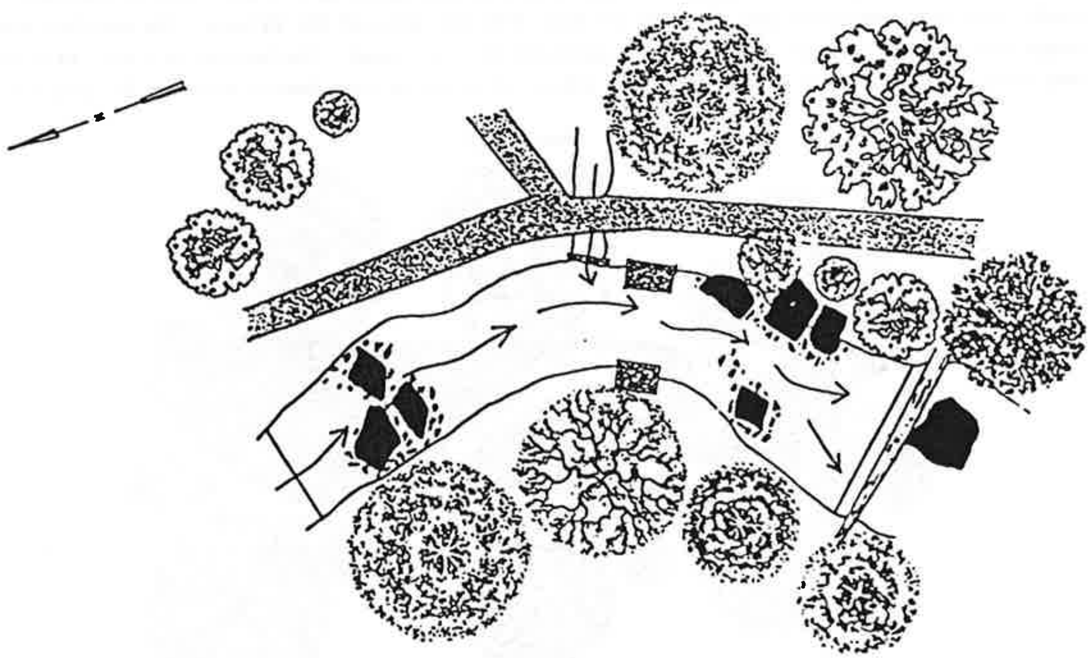
Site H: Paint Branch below Fairland Road

This site was located a short distance upstream of a footbridge over the branch. There was an asphalt path which ran along both sides of the stream here. The width of the stream varied from 4.5 meters to 11.9 meters. The bankful width was between eleven and eighteen meters. The area was well forested. The banks were steep and undercut in some places, especially underneath trees. The height of the banks was about six to eight feet. There were many very large boulders in this area. The bottom was of gravel and sand, and highly embedded. The depth of the stream was fairly even, being between a third and a half meter deep throughout most of the site. There was a deeper pool along the east bank at the upstream end of the sample area. The west bank in this area was sandy.

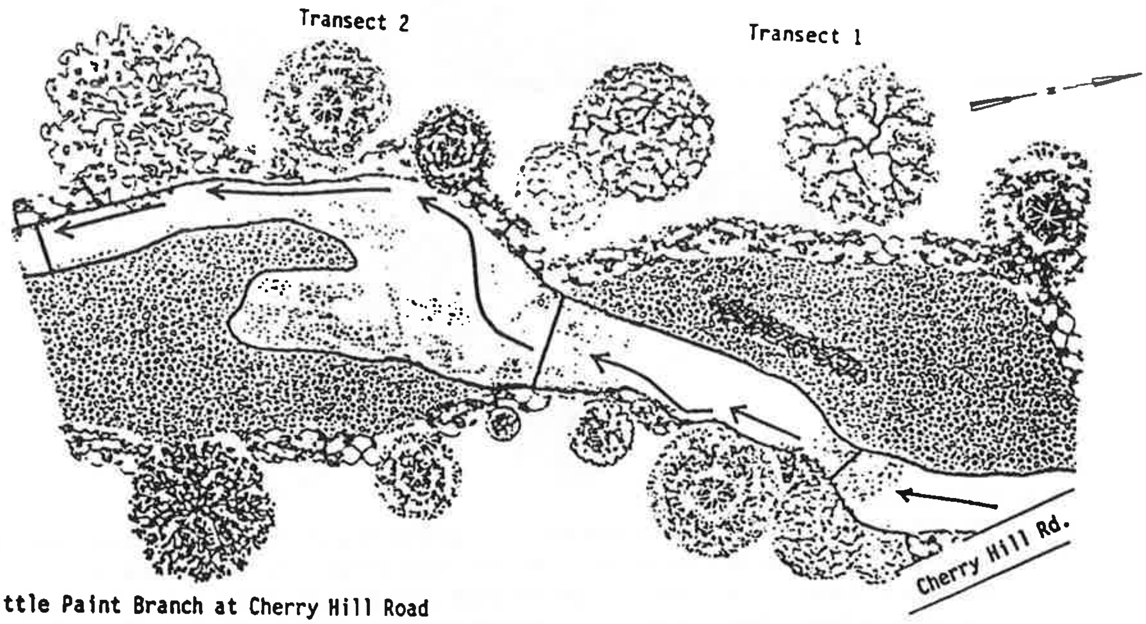


Site I: Paint Branch at Powder Mill Road

The two transects done at this site were of significantly different characters. The first transect began about one hundred meters below the Powder Mill Road bridge. The stream here is wider and slower than at the second transect upstream. The stream width here averaged twelve meters. It ranged between eight and seventeen meters. The bankful width averaged seventeen meters. It ranged from eleven to twenty meters. This transect was pool in character for its entire length. Midway along the transect the west bank is made up of an enormous rock exposure which is about twenty-five feet high and juts well out over the stream. The bed of the stream under this outcrop is also rock. Large portions of this rock project upward from the bottom here to within a short distance of the surface. The stream is over one and a half meters deep in this section. The stream is about a half meter in depth in most other portions of this transect. The bottom is mostly sand without much silt. The water cleared very quickly after being disturbed. The surrounding area had many small trees and shrubs. The stream is well shaded and was very clear on the day we sampled the site. There was alot of algae growing on the rocks.

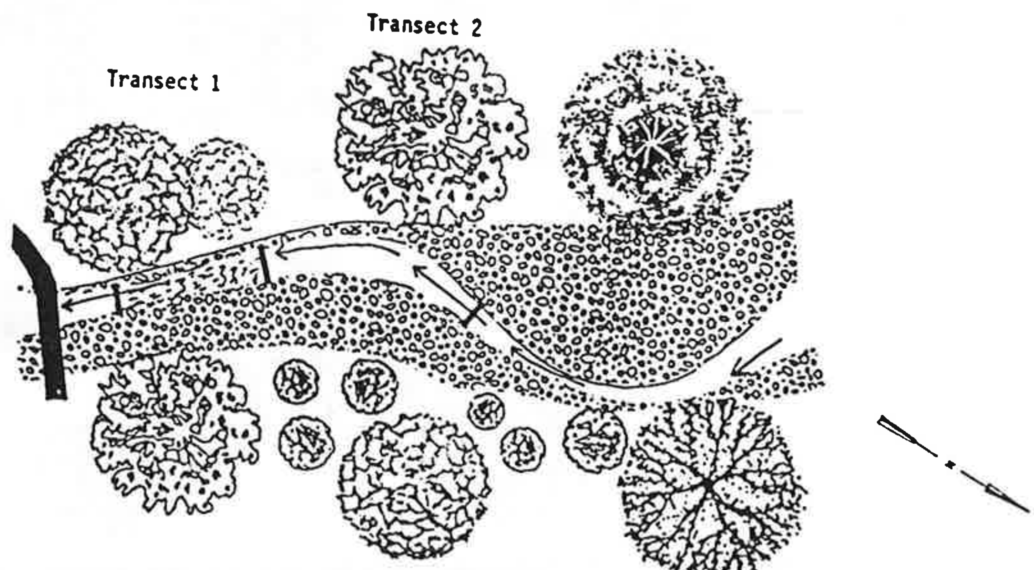


The second transect was located approximately two hundred meters upstream from Powder Mill Road near the Paint Branch Home. This area is notable for the great number of exceedingly large boulders in the streambed and the preponderence of large hardwoods growing in the area. This and the steep topography of this narrow valley gives the area the appearance of a remote mountain stream. The stream varied in width between four and twelve meters with an average width of nine meters. The bankful width was between fifteen and nineteen meters with an average of seventeen meters. The depth was in most places less than a half meter with a maximum measured depth of .70 meters at the upstream end of the site. The water was clear and flowing rapidly. The transect was made up entirely of riffles. The bottom was rocky with some sand. The area was highly embedded. On the day we sampled the rocks were covered with an extensive growth of a green filamentous algae. We found the footing to be very treacherous.



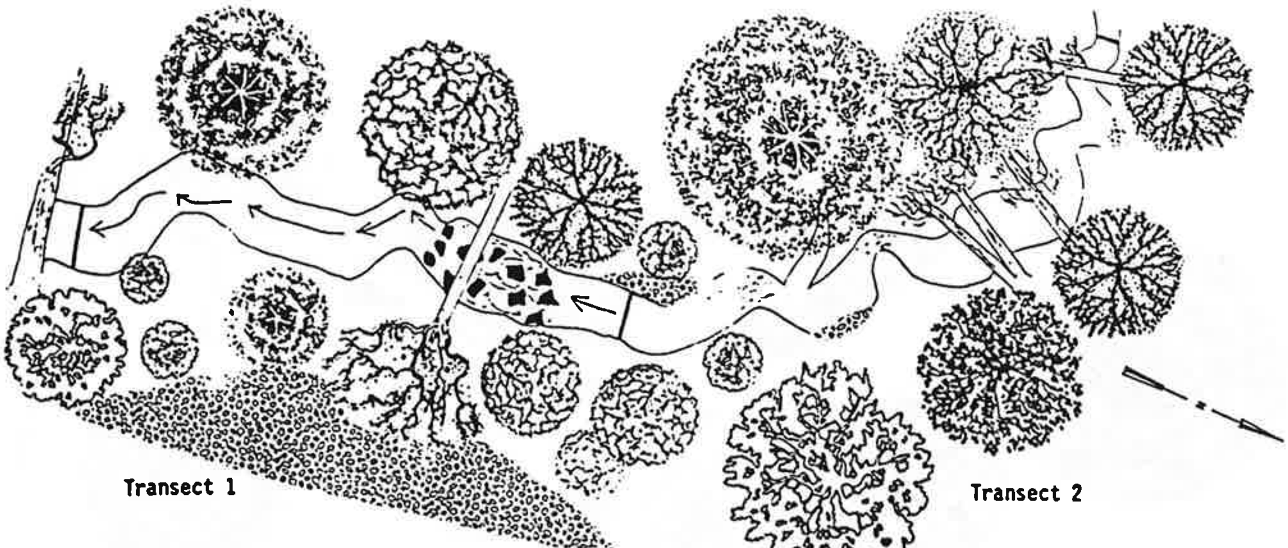
Site J: Little Paint Branch at Cherry Hill Road

The upstream boundary of this site was fifty-three meters downstream from the Cherry Hill Road bridge. The stream had an average width of six meters and ranged from two to eleven meters. The bankful width ranged from fifteen meters to thirty-seven meters with an average of twenty-two meters. The depth was less than a half a meter in most places. The second transect was deeper than the first since most of its length was comprised of a narrow channel about a half meter in depth with a very swift flow. There was a large and shallow pool of standing water at the upper end of the second transect. The first transect was almost all pool. The second transect was about half pool and half riffle. The first transect had a steep bank about six feet in height on the east and a gradual gravel bank on the west. The second transect had a steep bank of about the same height on the west and a gravel bank on the east. The gravel banks here were very wide and extended far back from the edge of the stream. The area has many small trees and shrubs, some of which overhang portions of the stream. The bottom is gravel with some rubble and sand. The degree of embeddedness was estimated to be between twenty-five and fifty percent.



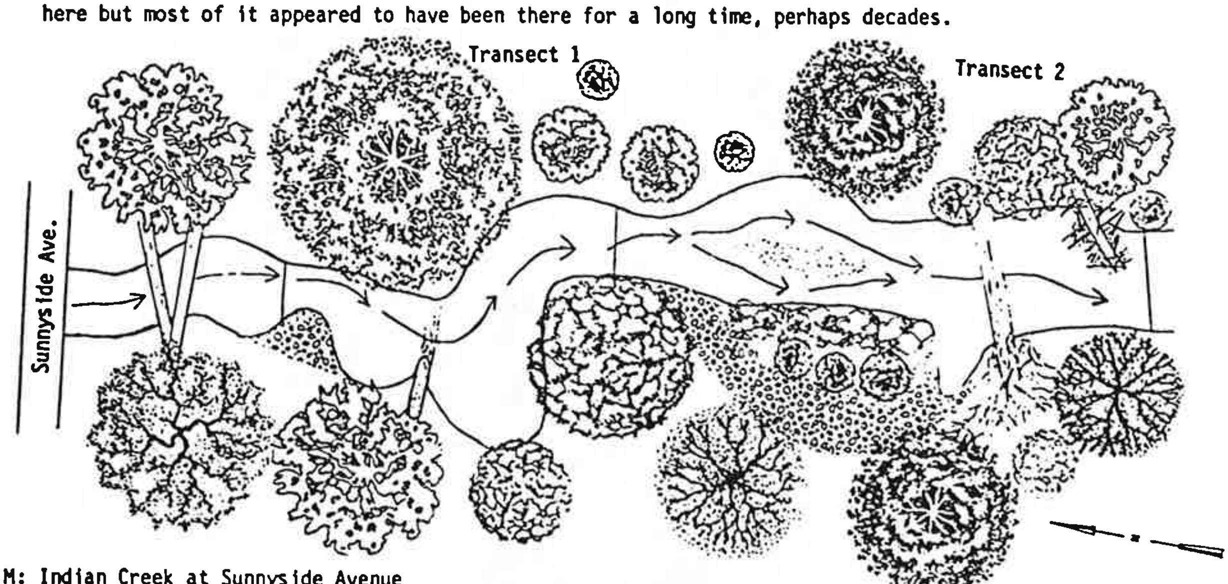
Site K: Paint Branch at Calvert Road

This site was a short distance upstream from the confluence with Indian Creek. There was a footbridge over the stream thirty-five meters below the end of the sample area. The first transect was almost entirely riffle. The second transect was almost all pool. There were extensive areas of exposed gravel here. The bed of the stream was composed of gravel and sand. The gravel was estimated to be seventy percent embedded. The banks were well forested. The average stream width was ten meters. The width was fairly even with a minimum of five meters and a maximum of thirteen meters. The average bankful width was thirty meters. The banks were narrowest at the downstream end of the sample area. At this point they were twenty-three meters apart. They were widest at the upstream end of the sample area where they were fourty-three meters apart. Throughout the first transect the depth of the stream was fairly even at around a quarter meter. In the second transect the depth approached a half meter on the outside of the bend.



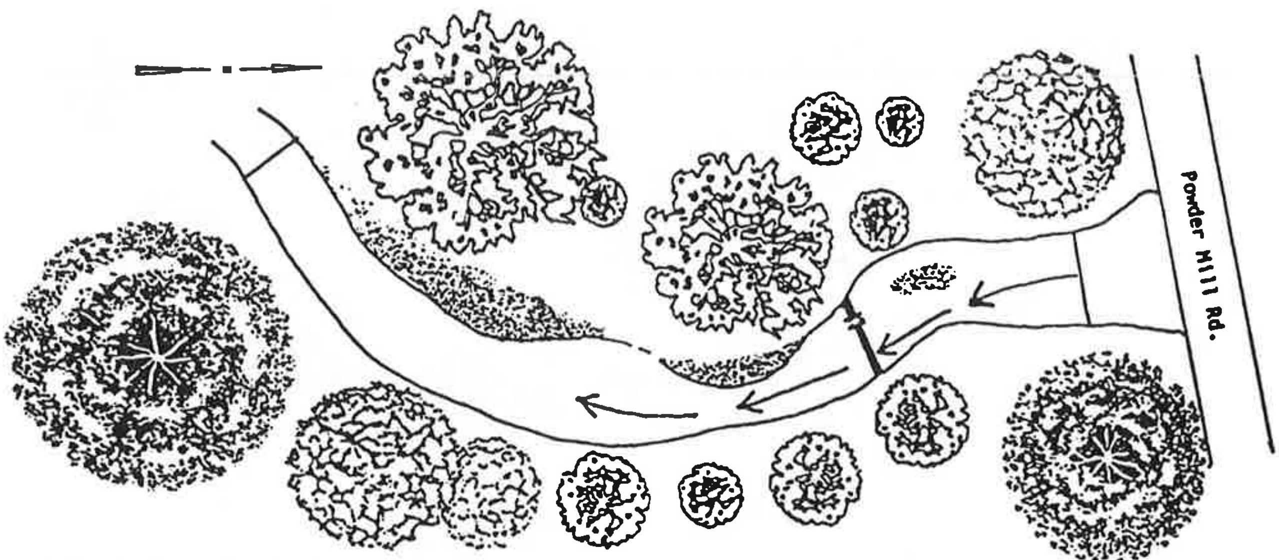
Site L: Indian Creek above Quimby Road

This site was accessed via the Christian Brothers property. We sampled the stream near an area which had previously been mined on a small scale for gravel. At this time the Christian Brothers no longer farm their property. Their old fields have been allowed to establish themselves as open meadows. Extensive forested areas adjacent to the stream remain relatively undisturbed. The rolling topography of this site and its unobstructed views of mature forest stretching out beyond abandoned farm fields make this spot one of striking beauty quite out of character with its urban location. The stream here is very small and follows a sinuous course. The streamside vegetation is dense and when added to the large number of trees down across the stream made sampling here rather difficult. The stream alternated frequently between riffles and pools. The bottom was of gravel and sand. The gravel was estimated to be more than fifty percent embedded in fine sediments. There were small gravel banks at points along the stream. In some areas the banks were steeply cut to heights of four or five feet. The stream was shallow, most places being less than a quarter meter in depth. Some areas approached a half meter in depth. The width of the stream averaged 2.4 meters. It was 3.5 meters at its widest point and one meter at its narrowest. The bankful width was fairly even at around five meters. There was a moderate amount of trash in the stream here but most of it appeared to have been there for a long time, perhaps decades.



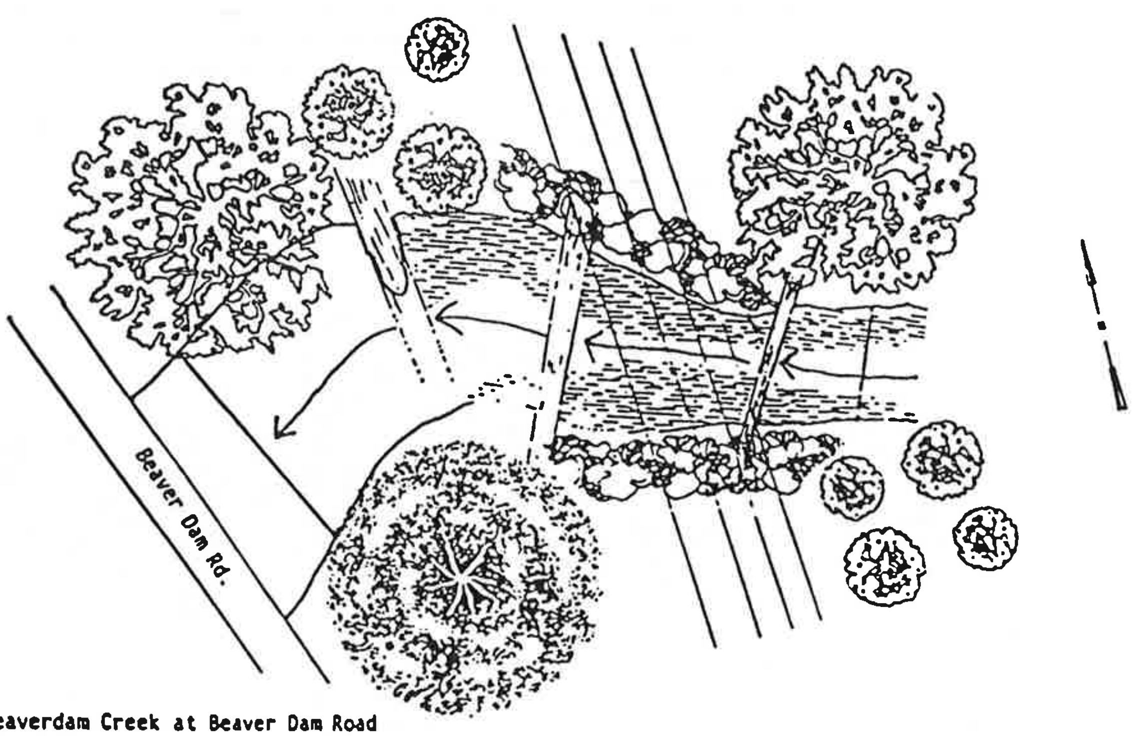
Site M: Indian Creek at Sunnyside Avenue

This site began fourty-one meters downstream from the Sunnyside Avenue bridge. There were many downed trees, logs and branches in the stream here. The area was swampy and densely forested with mature hardwoods. There was alot of garbage strewn about, primarily car tires. Apart from the garbage and faint traces of an abandoned road alongside the stream the area seemed relatively unimpacted. The flow seemed low to moderate and the banks were stable. In many areas roots were growing out from the banks in profusion. The water was darkly stained as is often the case in swampy areas. The visibility was about six inches. The bottom was of sand and gravel with large amounts of detritus present. The bottom was highly embedded. The area was almost exclusively made up of pool with only one small riffle. The stream width was six meters on average and ranged from 2.5 meters to 11.7 meters. The bankful width averaged ten meters and ranged from 7.2 meters to 15.3 meters. Depths were variable with a maximum of 1.3 meters. Most areas were shallower with the average depth being 0.3 meters.



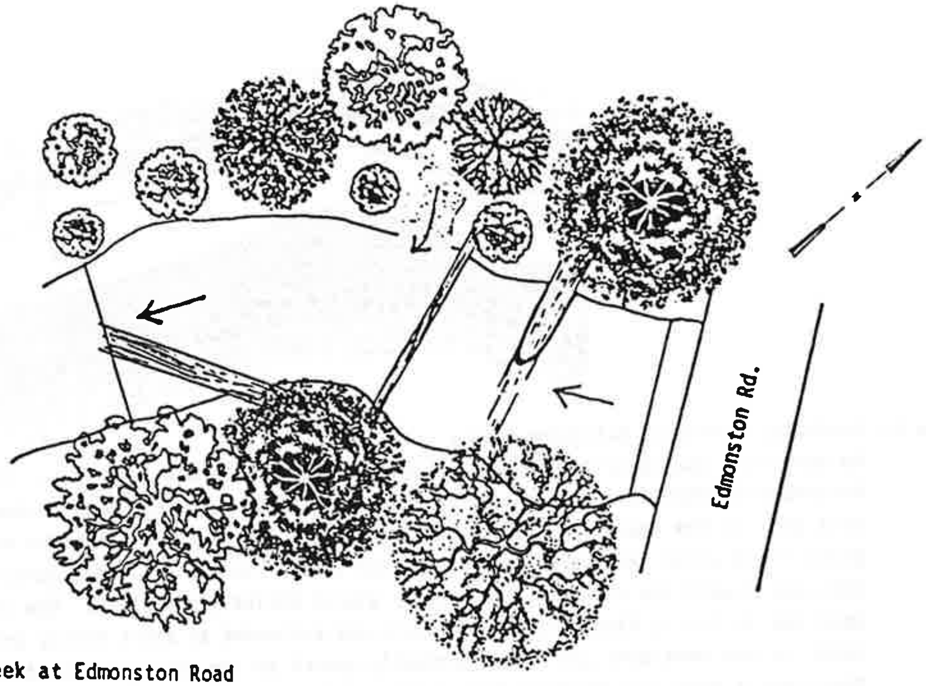
Site N: Beaverdam Creek at Powder Mill Road

The upstream boundary of this sample area was eleven meters downstream from the Powder Mill Road bridge. Immediately upstream from the bridge was Building 9200 of the Goddard Space Flight Center. The stream here was very shallow with a maximum depth of only twenty centimeters. The flow of the stream was slow. It appeared to be clogged with silt. The bottom was of sand and silt. The degree of embeddedness was close to one hundred percent. There was much algae in the stream and a moderate amount of garbage in the area including some construction debris. An exposed eight inch steel pipeline crossed the stream near the upper end of the transect. The banks of the stream were very steep and eroded. They were up to six feet in height. Some roots were growing out from the banks. The width of the stream was three meters on average. The maximum width was 4.4 meters. The minimum width was 1.4 meters. The bankful width was seven meters on average. The maximum was 7.9 meters. The minimum was 5.8 meters.



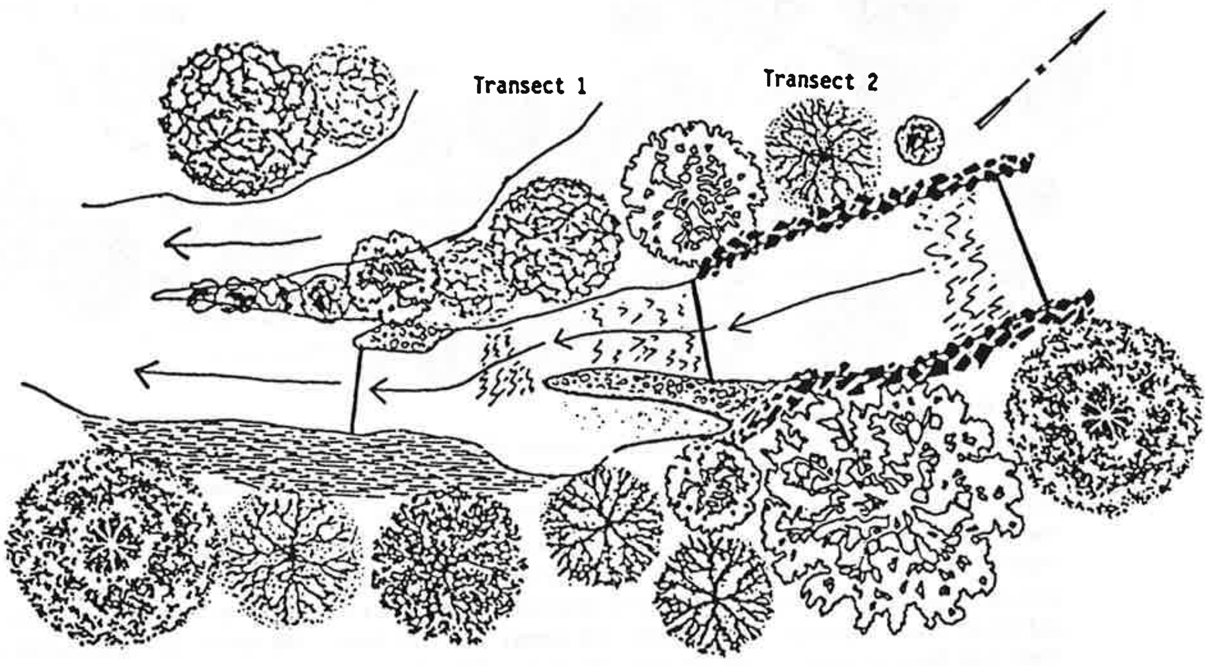
Site O: Beaverdam Creek at Beaver Dam Road

The downstream end of this site was five meters above the Beaverdam Road bridge. The stream was well shaded and the water was clear. The area was forested and slightly swampy. There was no garbage at the site. It appeared to be very pristine. A set of overhead powerlines crossed the stream at this point. There was an extensive amount of aquatic vegetation growing in the stream underneath this open area. Where these plants were growing as well as in other shallow areas the bottom was sandy. In deeper areas the bottom was detritus and sand. The average depth was 0.2 meters. Some areas were over a half meter in depth. There were quite a few downed trees in the stream. The stream was made up of pool throughout the length of the transect. The average width of the stream was 4.5 meters. The width ranged from 3.2 to 5.7 meters. The bankful width ranged from 5.8 to 11.8 meters. It averaged 7.4 meters.



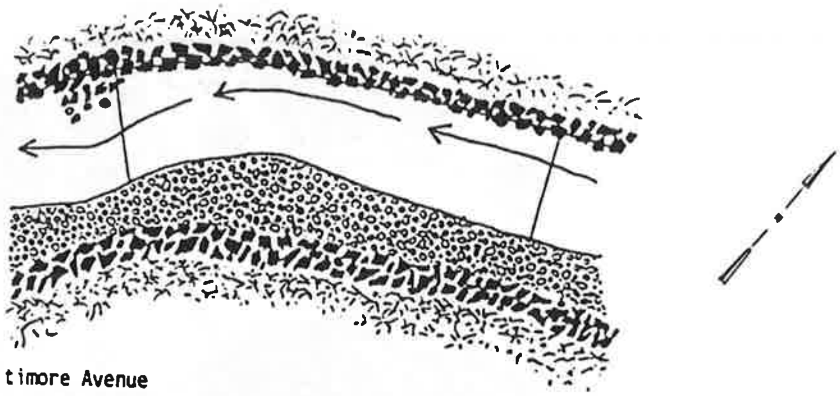
Site P: Beaverdam Creek at Edmonston Road

This area is very swampy and wet. The area is well vegetated with trees, vines and shrubs. There are many large trees down in the stream as well as numerous branches and logs. The water was darkly stained and easily clouded by movement. The bottom is composed of sand, silt and detritus. It is very sticky in some places. The entire transect was pool-like in character. The flow was slow and there was no distinct thalweg. The depth was fairly even at about half a meter. The maximum depth measured was 0.8 meters. The width of the stream averaged seven meters. It ranged from 6.6 to 8.2 meters. Due to the flat, swampy nature of the area, the bankful width was difficult to determine. We took it to be eight meters on average and ranging between 7.7 meters and 8.7 meters.



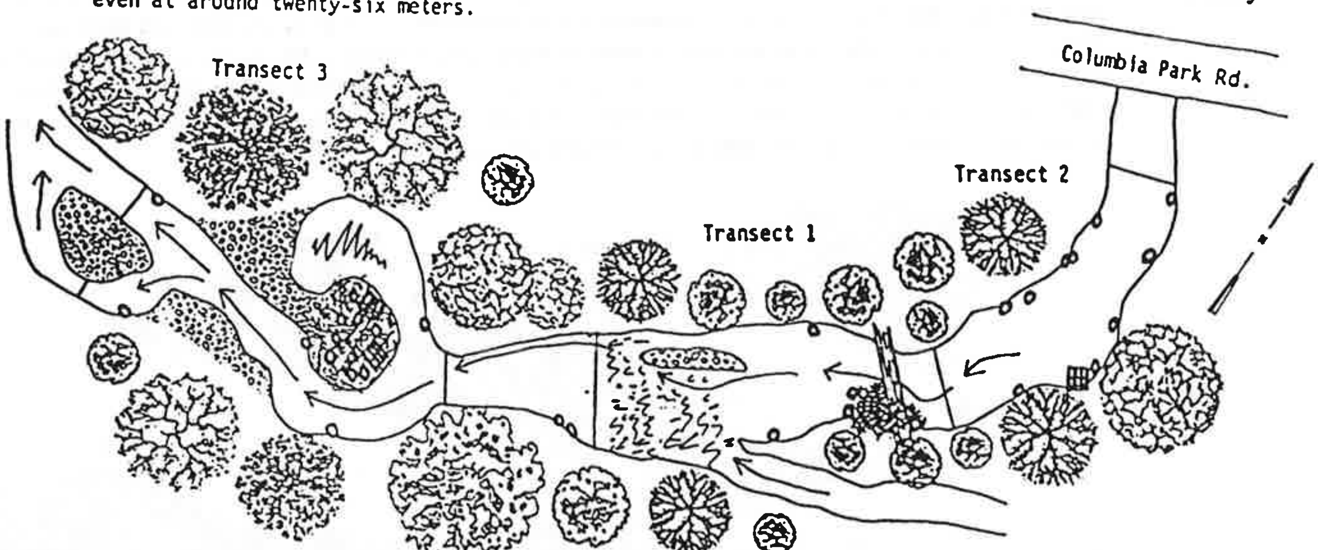
Site Q: Indian Creek at Calvert Road

The downstream end of this site was forty meters above the confluence with Paint Branch. The area was rip-rapped on both banks. The east bank was adjacent to a high ridge at the lower end of the site. The second transect had a notable abundance of rocks covering the banks which was not the case on the first transect. The area had many trees and was relatively free of underbrush. The bed was composed of rocks and gravel. Embeddedness was estimated at seventy-five percent. Upstream the bottom was very even. Depth was less than half a meter. The first transect had some spots over half a meter, especially in the pool on the east bank below the gravel bar, upstream from the grassy bank. The average stream width was ten meters. The banks were fairly straight and even, with the first transect being a little wider than the second. The bankful width was also fairly uniform with an average of seventeen meters.



Site R: Northeast Branch at Baltimore Avenue

We sampled a couple of hundred meters below the Baltimore Avenue bridge. The confluence with the Northwest Branch was a short distance downstream. This area has been channelized, rip-rapped and leveed as a part of the Anacostia Flood Control Project. The banks are straight and steep. There is a broad grass field which extends on the east to the levee. On the west some shrubs have been allowed to grow on the bank beyond the rip-rap. The area is almost entirely shadeless. The bed is made up of gravel and sand and is fairly flat. The embeddedness was estimated at about ninety percent. The depth was about a meter on the west bank and sloped gradually upward to the east. At the downstream end of the transect there was a deep spot upstream from a pile of large boulders. The depth here reached 1.6 meters. We sampled the site at low tide. The tide was rising when we measured the depth. The tidal amplitude at this site is about three feet. We considered the site to be all pool. The stream width here was very even at around twenty-six meters.

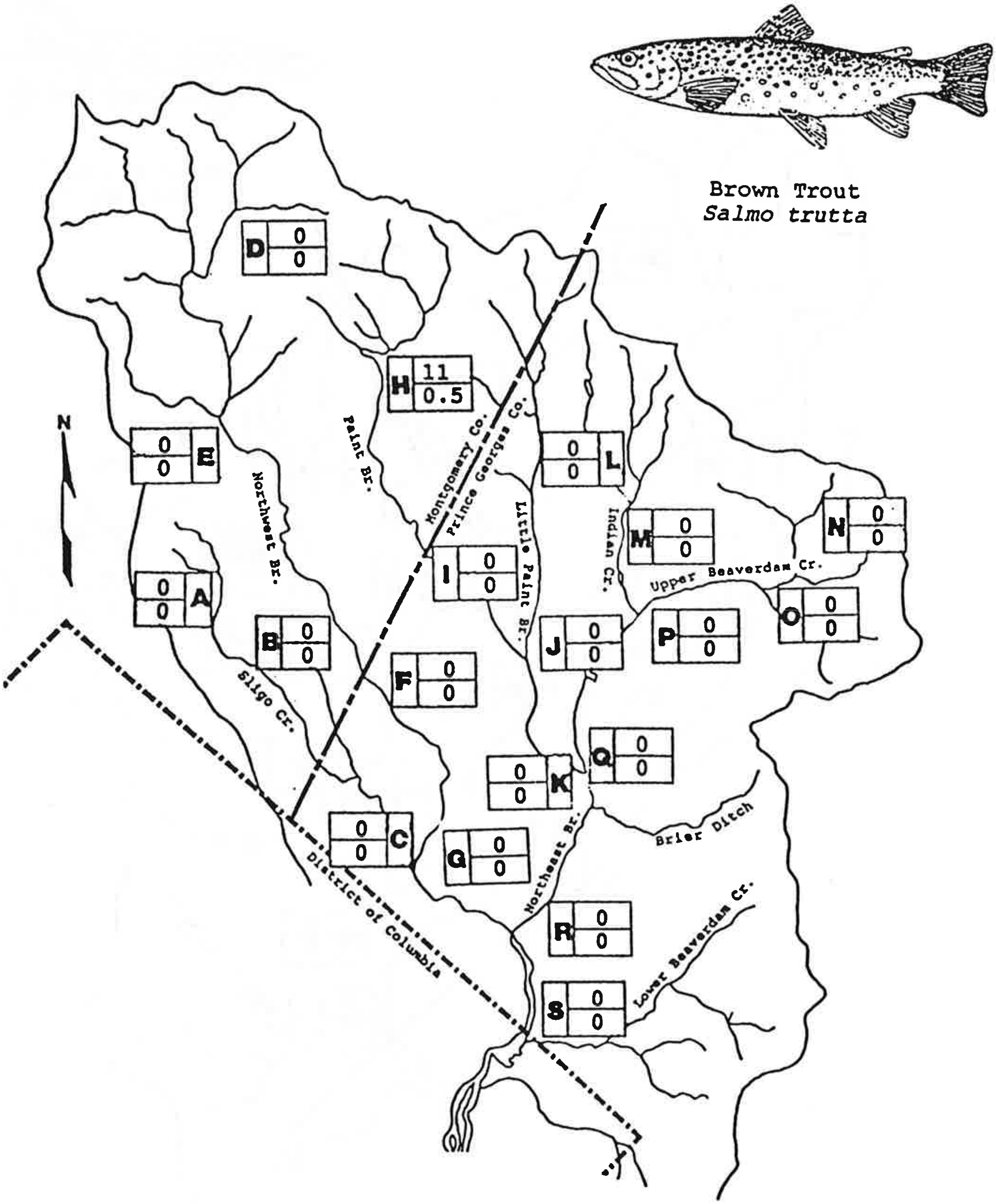


Site S: Lower Beaverdam Creek near 61st Street

This site was notable for the incredible volume of trash in the stream and on the banks. There were huge piles of wooden pallets, tires, and all sorts of other trash. The upstream boundary of the sample area was fifteen meters below the Columbia Park Road bridge. The third transect began fifteen meters below the end of the first transect. The bottom was of gravel, sand and silt. The gravel was highly embedded. There were gabions buried in the banks. They were only visible in a few places because they were covered with sediment and vegetation. The area adjacent to the banks had sandy soils supporting many red maples and other small saplings. The stream was almost all pool here. The water was very turbid even though there had been no rain in the previous few days. The stream was very shallow and had a flat bottom upstream. The depth in the first two transects was a quarter meter or less except for a deep spot below a downed tree at the top of the first transect. The depth there reached 1.2 meters. Further downstream, the third transect had some deeper areas and half way along reached 0.7 meters in depth. At either end it was much shallower with maximum depths of fifteen centimeters being recorded. The stream was especially deep around a six foot tall pile of trash and debris near the middle of the third transect. There was a large and deep pool of standing water near this pile of debris. The width of the stream varied a good deal. The first transect was widest with an average width of nine meters. The other two transects had average widths of six meters. The maximum width was twelve meters. The minimum was two meters. The bankful width was narrowest upstream with an average of eleven meters for the second transect. Downstream, the first transect had an average bankful width of seventeen meters. Further downstream, the third transect had an average bankful width of twenty-five meters.

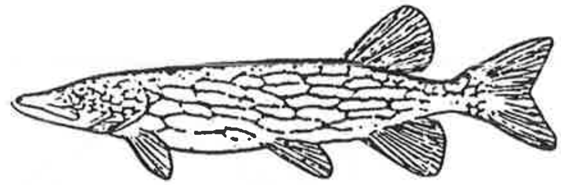
Appendix II

The following diagrams give our estimates of the number of gamefish per hectare at our sample sites. The number of fish was estimated using the Zippin (1956) method. This value was divided by the sampled surface area of the stream in hectares to obtain the estimate of the number of fish per hectare. Also shown are our estimates of fish biomass per hectare of stream surface area. These estimates were computed by multiplying the number of fish per hectare times the average weight of the fish at the site. Where multiple transects were done at a site the values were averaged.

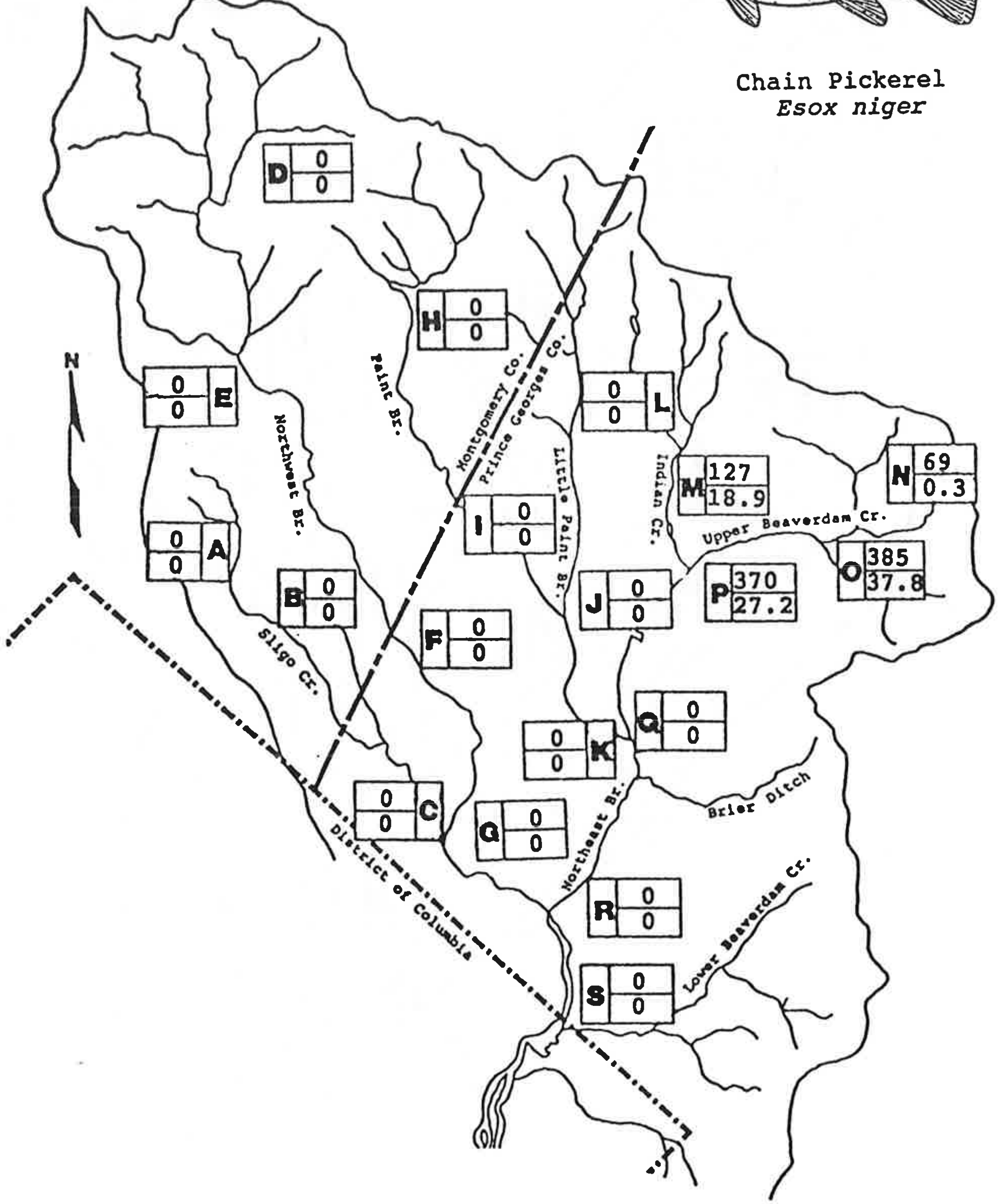


Estimates of Brown Trout per Hectare of Stream Surface Area
Anacostia Basin, Maryland 1989

Site ········· Number of fish per hectare
········· Kilograms of fish per hectare

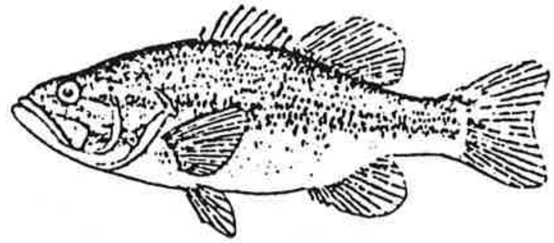


Chain Pickerel
Esox niger

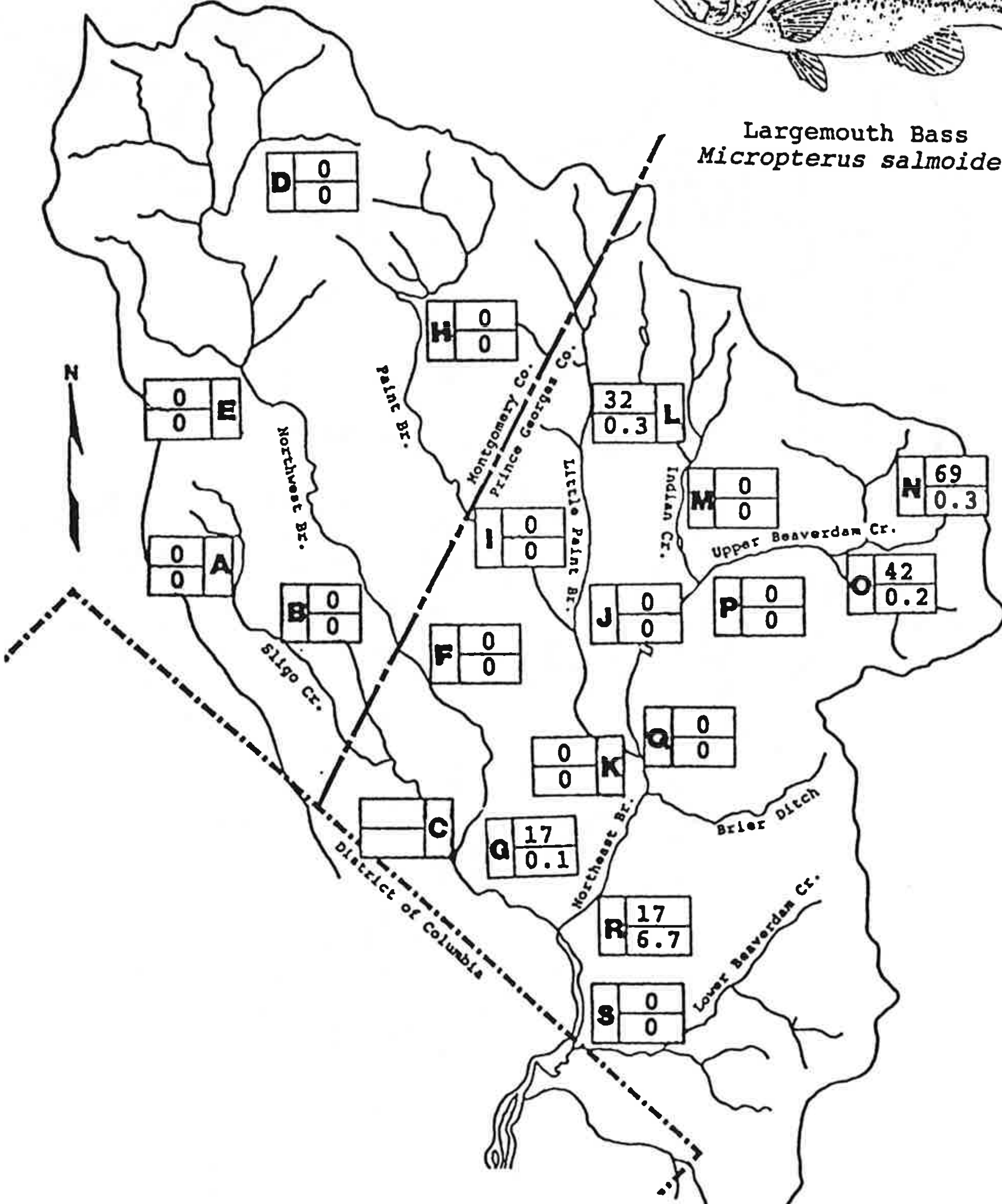


Estimates of Chain Pickerel per Hectare of Stream Surface Area
Anacostia Basin, Maryland 1989

Site ········· Number of fish per hectare
········· Kilograms of fish per hectare

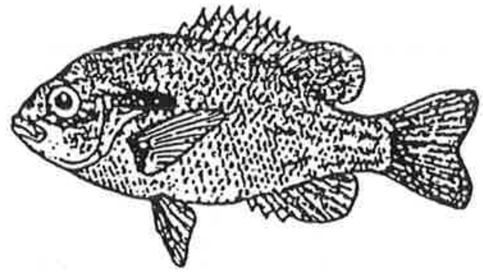


Largemouth Bass
Micropterus salmoides

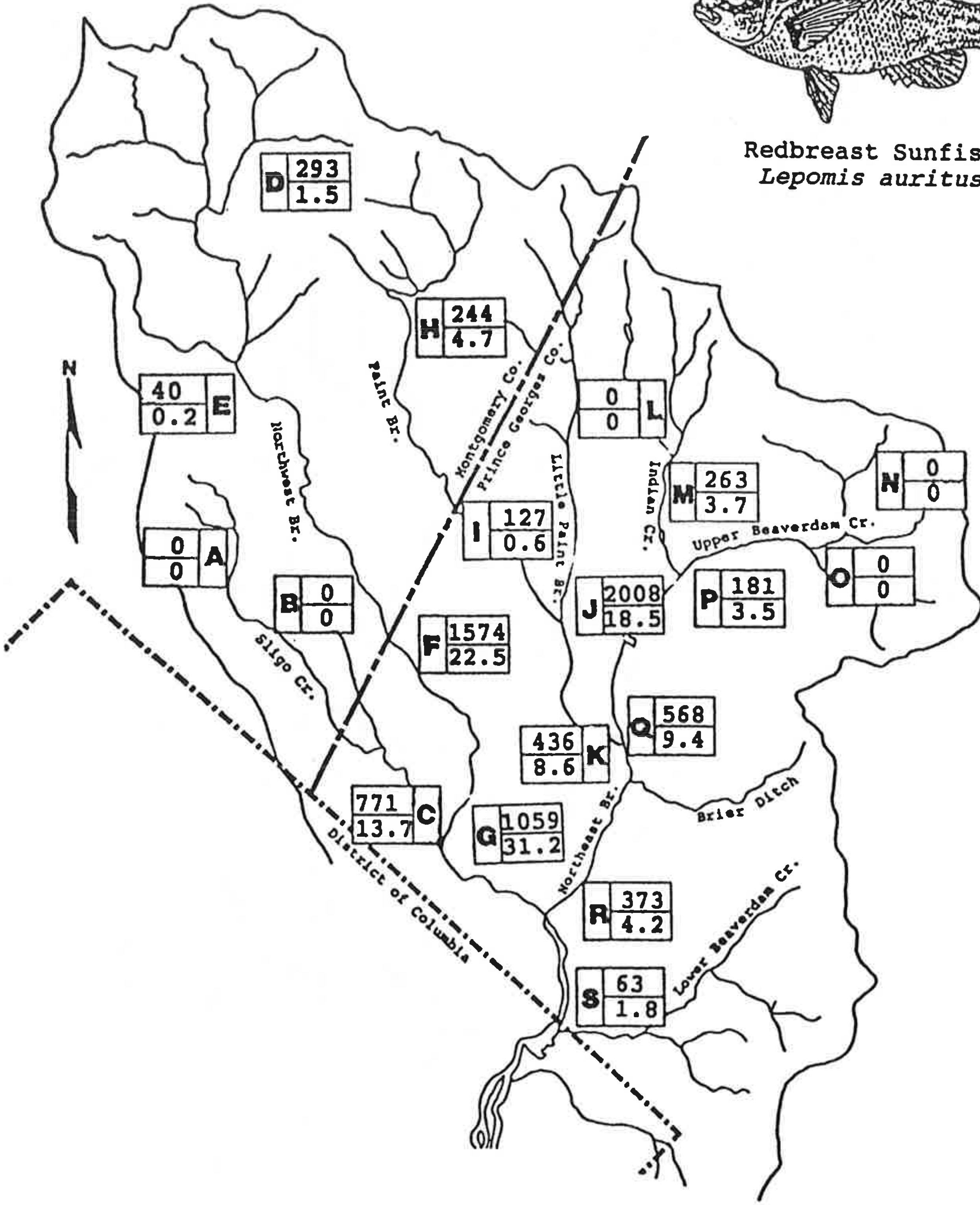


Estimates of Largemouth Bass per Hectare of Stream Surface Area
Anacostia Basin, Maryland 1989

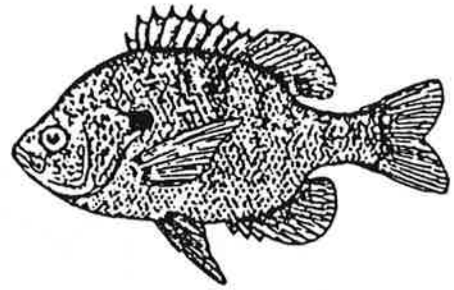
Site	Number of fish per hectare
	Kilograms of fish per hectare



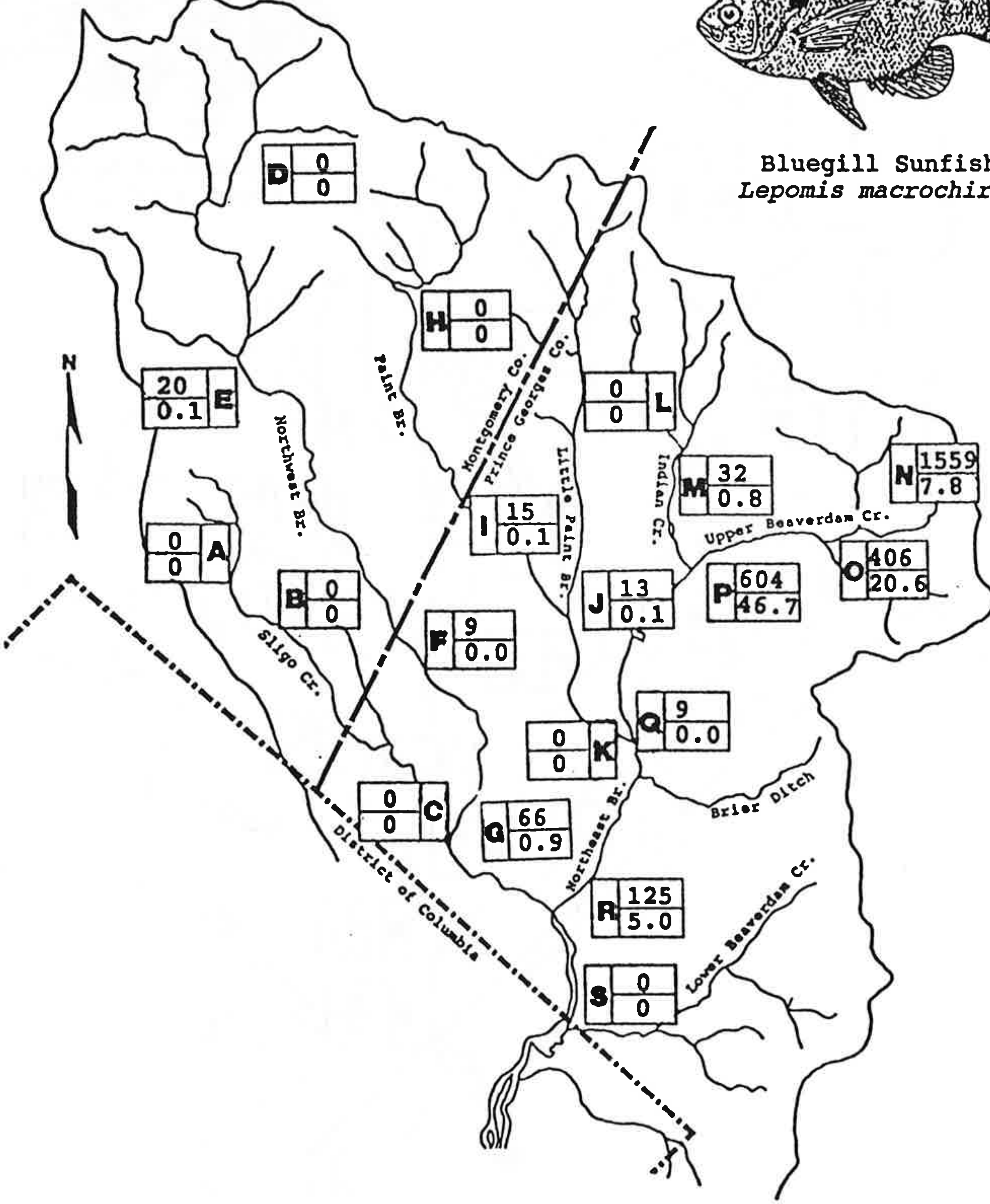
Redbreast Sunfish
Lepomis auritus



Estimates of Redbreast Sunfish per Hectare of Stream Surface Area
Anacostia Basin, Maryland 1989

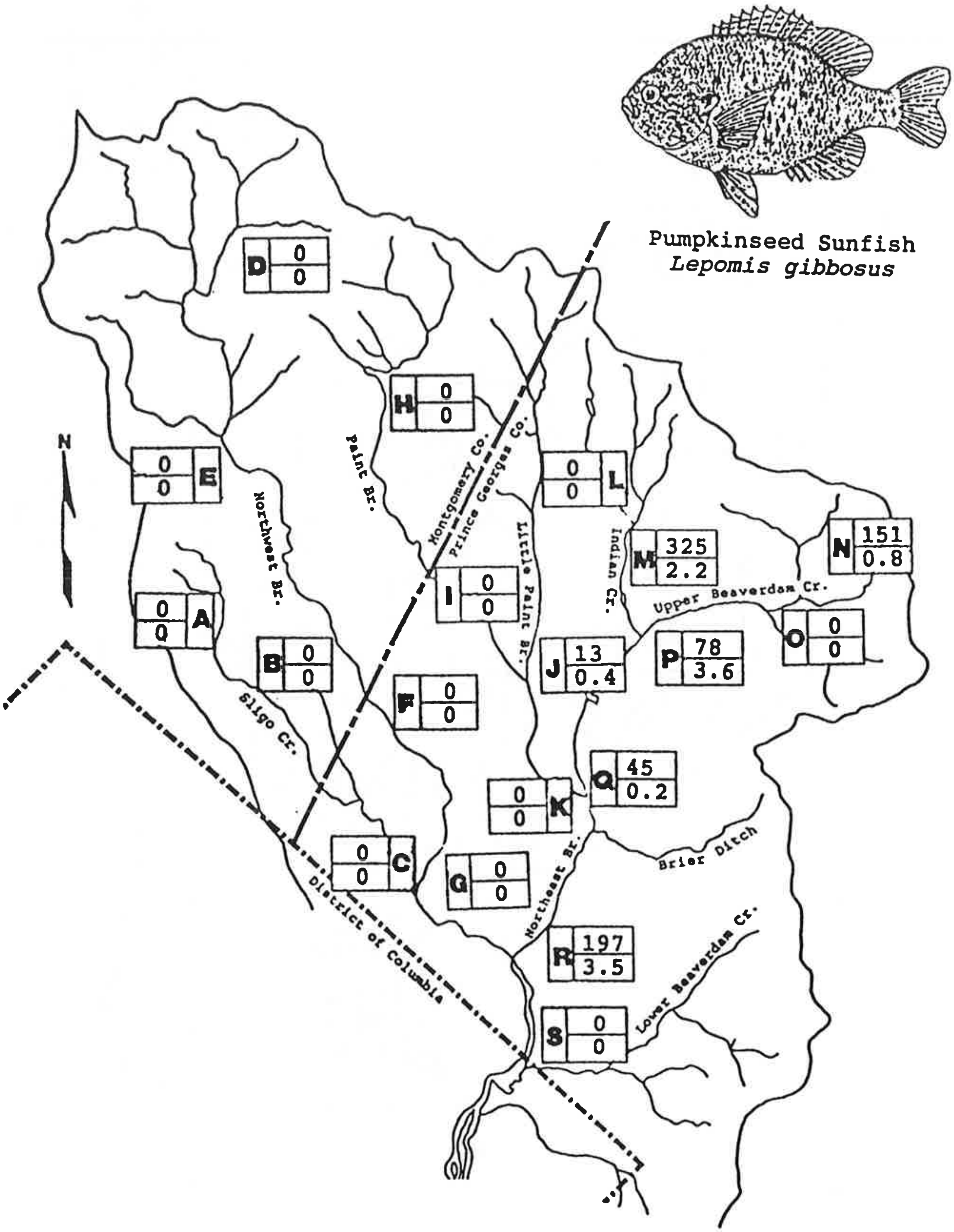


Bluegill Sunfish
Lepomis macrochirus



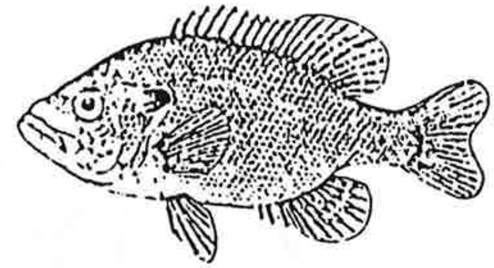
Estimates of Bluegill Sunfish per Hectare of Stream Surface Area
Anacostia Basin, Maryland 1989

Site .... Number of fish per hectare / Kilograms of fish per hectare

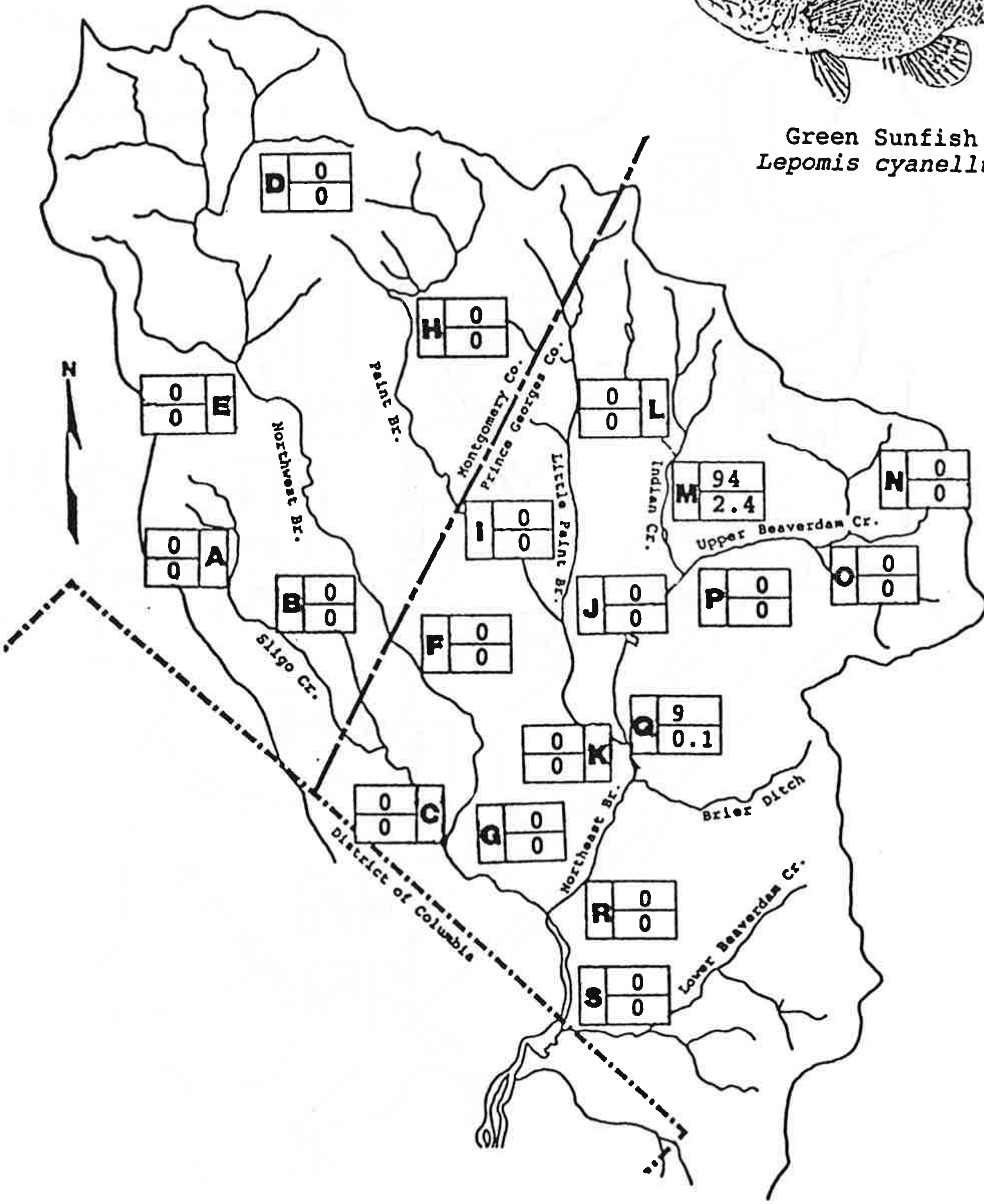


Estimates of Pumpkinseed Sunfish per Hectare of Stream Surface Area
Anacostia Basin, Maryland 1989

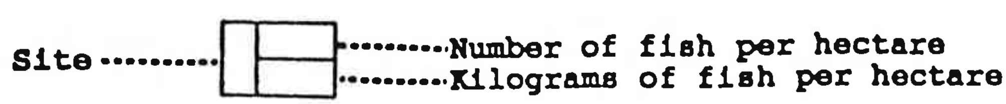
Site — Number of fish per hectare / Kilograms of fish per hectare

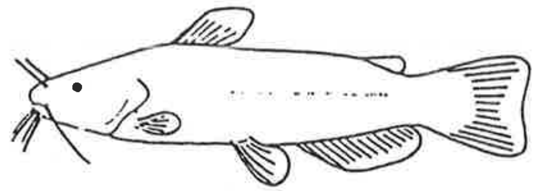


Green Sunfish
Lepomis cyanellus

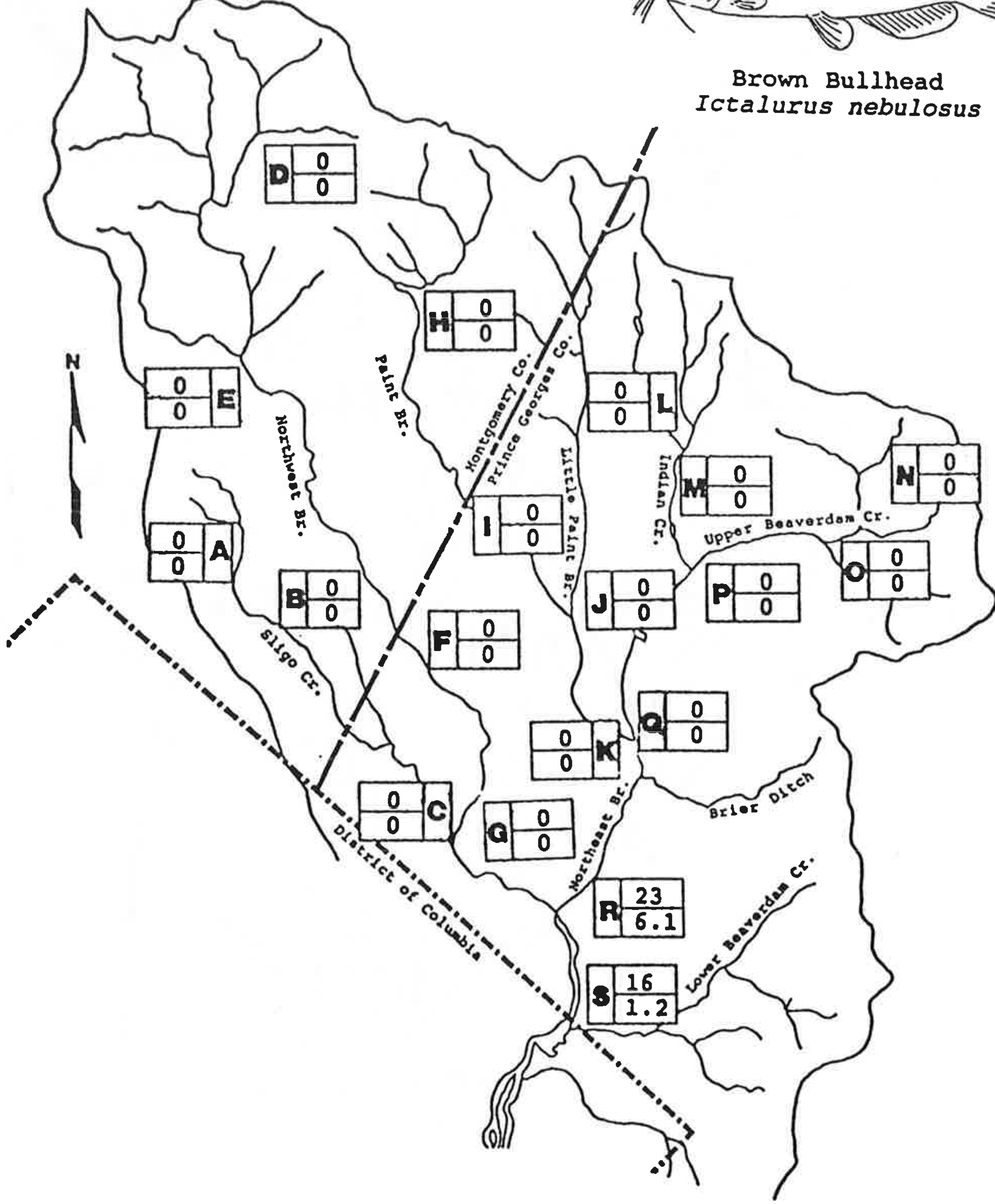


Estimates of Green Sunfish per Hectare of Stream Surface Area
Anacostia Basin, Maryland 1989



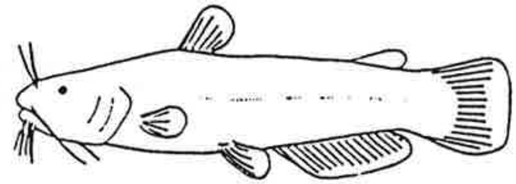


Brown Bullhead
Ictalurus nebulosus

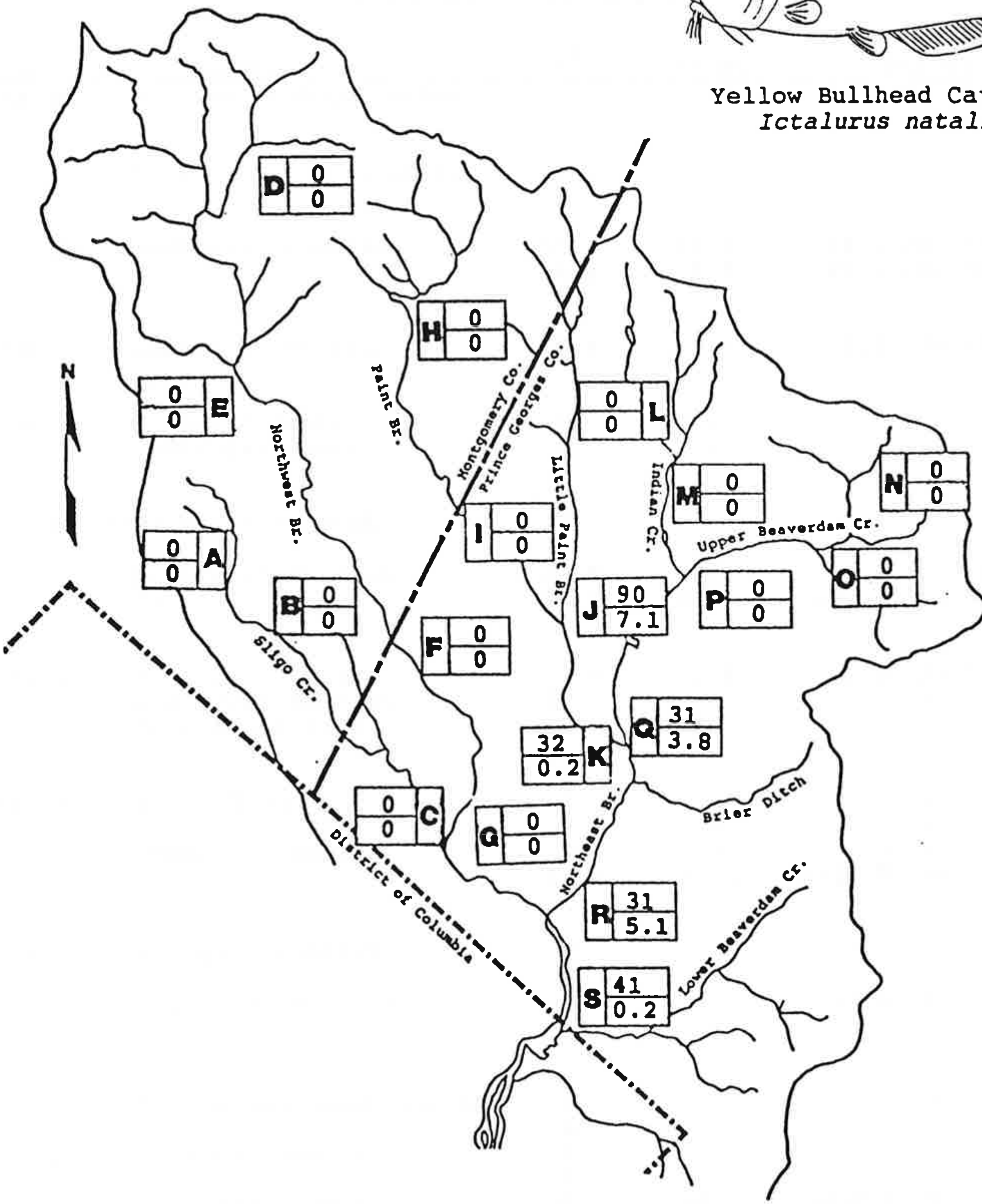


Estimates of Brown Bullhead per Hectare of Stream Surface Area
Anacostia Basin, Maryland 1989

Site ········ [legend box] ········ Number of fish per hectare
········ Kilograms of fish per hectare



Yellow Bullhead Catfish
Ictalurus natalis



Estimates of Yellow Bullhead Catfish per Hectare of Stream Surface Area
Anacostia Basin, Maryland 1989

Site .... [ ] .... Number of fish per hectare
.... Kilograms of fish per hectare