AQUATIC MACROINVERTEBRATE MONITORING AT THE VERMONT MONITORING COOPERATIVE SITE UNDERHILL, VERMONT

by the

Vermont Department of Environmental Conservation

SUMMARY

Aquatic macroinvertebrates were sampled at two sites in the upper Brown's River drainage basin using standardized sampling methods. The macroinvertebrate communities were dominated by mayflies, stoneflies, and caddisflies and were fairly typical of high-quality, high-elevation, high-gradient streams in the Green Mountains. Slight differences in community structure suggest potential differences in watershed character. 1993 is the third year of DEC sampling at these sites. Comparison of data between years shows considerable annual variation within certain structural components of the macroinvertebrate community. Overall biological integrity at both sites is excellent.

INTRODUCTION

The Vermont Department of Environmental Conservation (DEC) maintains a Statewide monitoring program, the Ambient Biomonitoring Network (ABN), which samples aquatic biological communities in rivers and streams at 50-70 sites annually. There is a core of 30-40 sites that are sampled every year during the late summer/fall period for the purpose of evaluating temporal variability and tracking long-term trends in biological integrity at those sites. Other sites are sampled on a one time basis for the purpose of making site-specific water quality/habitat evaluations related to some specific watershed disturbance. In 1991, DEC added two sites, located in the vicinity of the Vermont Monitoring Cooperative (VMC) research area on the west slope of Mount Mansfield, to the core sites sampled as part of the ABN. These sites have been integrated into the Statewide long-term biological monitoring program and were sampled in October of 1991 and 1992, and September of 1993. The results of the 1991 and 1992 sampling were reported last year. This report will present and discuss the 1993 sampling results and observations on results from the sampling to date.

LOCATION

The two sampling sites are located in the upper reaches of the Brown's River watershed - one on Stevensville Brook and one on the Brown's River upstream of its confluence with Stevensville Brook. Both sampling sites are located at an elevation of 1400 feet. The Stevensville Brook site is located about 50m above the bridge at the parking lot for the Nebraska Notch trail (lat 44 30 21:long 72 50 45) and drains approximately 5.2 km^2 of forested watershed. The Brown's River site is located about 100m above the last bridge before the State Park gate (lat 44 51 09:long 72 31 28) and drains approximately 6.1 km^2 of forested watershed. Physical characteristics at the two sampling sites are very similar: substrate composition is similar with 35% boulder, 30% cobble, 20% course gravel, 10% gravel, and 5% sand at both sites; canopy cover (shading) is approximately 80% at both sites; sampling depth averages 0.2 m at both sites. Both sites were sampled on September 24, 1993.

METHODS

Duplicate samples of aquatic macroinvertebrates were collected from riffle areas using a standardized "kick-net" procedure used by DEC at all ABN sites. The use of standardized sampling methods results in an equal sampling effort applied to all sites sampled, providing a quantitative basis for making comparisons between sites. The sampler holds a 500u mesh D-frame net in the stream and vigorously disturbs the substrate immediately above the net, dislodging macroinvertebrates associated with the substrate and allowing them to be carried into the net by the current. A sample consists of all the organisms and detritus that are dislodged from the substrate during two minutes (as timed by a stopwatch) of active substrate disturbance. During the two minute active sampling period, the sampler moves the net to a minimum of four locations, representing an equal number of high and low water velocity habitats. The sample is removed from the net, placed in labeled jars, and preserved in alcohol. A habitat evaluation of the sample site is conducted at the time of sampling. Temperature, pH, alkalinity, and specific conductance of the water column are measured at the time the sample is collected. Samples are returned to the DEC laboratory in Waterbury where organisms are separated from the detritus, sorted into taxonomic groups, and identified to the lowest possible taxonomic levels, usually genus/species, using appropriate identification keys. Data are tabulated and entered into a computer data management system using Paradox software and IBM-compatible DOS-PC systems. Data can be outloaded in a variety of formats, including ASCII, dBase, and Lotus.

The data are analyzed by calculating various community structural and functional attributes that are indicative of overall biological integrity at the sampling site. Calculated attributes can be affected by habitat and water quality, riparian characteristics in the watershed, as well as the hydro-geo-physical nature of the watershed. Appendix 1 summarizes the potential information obtained from the evaluation of some of the major community attributes which DEC regularly calculates.

RESULTS

In 1993, 41 and 44 taxa of aquatic invertebrates were identified from Browns River and Stevensville Brook respectively. In general, the composition of the invertebrate communities was typical of high elevation oligotrophic streams draining steep forested watersheds, dominated by species of mayflies, stoneflies, and caddisflies. There were some differences between the two streams.

There were six and seven taxa that made up 4% or more of the community composition at Stevensville Brook and Brown's River respectively, indicating good evenness of taxa distribution within the community. In Stevensville Brook, three stonefly families (Peltoperlidae, Chloroperlidae, and Leuctridae) were the dominant taxa, making up sixty-two percent (62%) of the overall community. In the Brown's River, two stonefly families (Chloroperlidae and Leuctridae) and one Caddisfly genus (Lepidostoma) were the dominant taxa, making up fifty-five percent (55%) of the overall community. Taxa richness and diversity indices indicate excellent diversity at both sites.

DISCUSSION

The three years of data collected to date show considerable variability between years among certain community attributes describing structure and function of the macroinvertebrate community. The relative abundance of stoneflies was greatly reduced at both sites in 1992, due primarily to reduced numbers of the Leuctridae Family of stoneflies and increased abundance of mayflies and Chironomid dipterans. 1993 saw the return of

stonefly dominance in both streams, with the caddisfly Lepidostoma sp. emerging as a co-dominant taxon in the Brown's River. The following Table describes the major community structure and function differences observed among the three years of sampling at the two sites by comparing the observed ranges in the relative abundance (per-cent composition) of the important taxonomic and functional groups. The attributes showing the greatest year-to-year variability are highlighted.

Taxonomic Order	% Comp Stevensville Range 91-93	% Comp Brown's Range 91-93
Diptera	8.5 - 19	**16 - 47**
Ephemeroptera	**2.0 - 40**	11 - 29
Plecoptera	**28 - 76**	**13 - 43**
Trichoptera	12 - 22	10 - 31
Functional Group		
Collector/Gatherer	**5.3 - 54**	**15 - 74**
Collector/Filterer	5.4 - 10.4	6.3 - 8.0
Predator	10 - 29	12 - 30
Detrital Shredder	**28 - 67**	**6.8 - 40**

The community attributes found at these two sites can be compared with a Statewide data-base for 23 stream sites with similar watershed characteristics, including watershed area and elevation. The following table compares Statewide ranges of community attributes with those found at these sites.

Attribute[1]	Statewide Range	Stevensville 1991 - 1993	Brown's 1991 - 1993
Mean Richness	25.5 - 51	27.5 - 37.5	29 - 32
EPT Richness	13 - 29.5	18 - 21	17 - 20
Biotic Index	.52 - 2.03	**.52** - .96	.71 - 1.27
% Mayflies	2 - 47	**2** - 40	11 - 29
% Stoneflies	6 - 76	28 - **76**	13 - 43
% Diptera	9 - 53	**9** - 19	14 - 47
% Collector/Gatherer	5.3 - 74	**5.3** - 54	15 - **74**
% Detrital Shredder	3 - 67	28 - **67**	6.8 - 40

1 - see Table 1 for description of attributes
bold - extreme of Statewide range for similar stream types

Several of the attributes for the 1991 Stevensville Brook sample represent extremes of the Statewide distribution for streams of similar size and elevation. Overall biological integrity at both sites, as determined from community attribute evaluation, is excellent.

While the total number of taxa, the total number of EPT taxa, and the overall percent composition of the EPT taxa have remained relatively consistent between streams and years, structural and functional composition at the species level shows considerable variability between years.

	Total Taxa Richness	Total EPT Taxa Richness	EPT Taxa as Percent Total Taxa Richness
Stevensville Brook	37 - 44	22 - 24	55 - 66
Brown's River	37 - 41	21 - 24	59 - 68

Figures 1-3 show differences between streams across years in three attributes: relative abundance; percent composition of stoneflies, a structural attribute; and percent composition of detrital shredders, a functional atrribute. The most interesting observation to be made here is that although there are differences between streams and years, both streams appear to respond in the same manner to whatever factors, be they physical or biological, are responsible for the annual variability in macroinvertebrate community attributes. It is probable that annual variations in stream biota in undisturbed watersheds occur primarily due to meteorological and hydrological differences between years, as well as the timing of the sampling event relative to seasonal events such as leaf fall and emergence/diapause.

Figure 1: Relative Abundance of Macroinvertebrates
Stevensville Brook and Browm's River

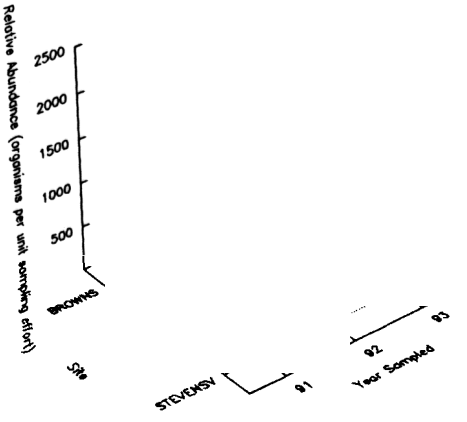
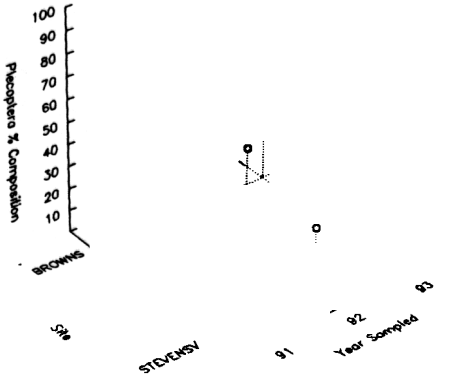
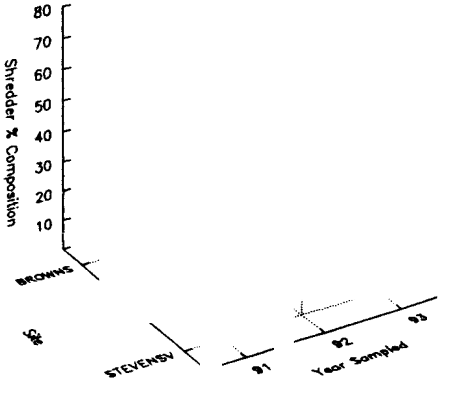


Figure 2: Plecoptera % Composition
Stevensville Brook and Brown's River



igure 3: Percent Composition of Shredder Functional Group
Aquatic Macroinvertebrate Commmunity
Stevensville Brook and Brown's River



One of the primary goals of Statewide biological monitoring programs is to determine biological conditions that fall outside the range of natural variability and thus represent an abnormal condition that may be related to antropogenic stressors. The most efficient indicators for determining "abnormal" conditions would be those that show the greatest amount of independence from measurements which show a great deal of natural variability. Data from these two sites provide some insights into the appropriate choice of macroinvertebrate community metrics for general use as water quality indicators that behave independently of annual variability, and thus are most likely to be of use when evaluating biological conditions.

It is clear from these data, and from other data collected Statewide, that the measurement of "relative abundance" of organisms exhibits considerable variability from year to year. These data also suggest, based in part on covariance seen in Figures 1-3, that metrics based on "percent composition" or ratios show a large degree of dependence on relative abundance estimates and thus show similar variability behaviour. Metrics based on "species richness" appear to be less dependent on relative abundance variability and thus would be more useful for determining biological conditions that are abnorrmal or outside the range of natural variability. Complex metrics such as "diversity" and "biotic index" show intermediate dependence on relative abundance variability. Data from these sites will be combined with a Statewide data base to make more comprehensive evaluations of these variability factors.

DEC will continue monitoring these sites on an annual basis. Continued monitoring will permit future evaluation of annual variability observed during the first three years of sampling. Other research occurring in the watersheds, including hydrology, stream chemistry, tree phenology, and adult insect sampling will provide important information relative to evaluating the causes of annual variation in stream biological communities. More intensive sampling could perhaps lead to some clearer definition of the observed differences in community structure between the two watersheds and provide some information relative to the factors causing these differences.

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Water Quality Division - Vt. Dept. of Environmental Conservation
Biomonitoring and Aquatic Studies Unit

4/04/94

Browns River 20.8
Site Id: 461100000208

Ambient Biomonitoring Summary Report

Town: Underhill
Waterbody Id: VT07-11

Description: Located above last bridge before State Park gate about 100m.

	10/30/91	10/19/92	9/24/93							
MACROINVERTEBRATES: Id#	91.086	92.097	93.092							
Sampling Method	KN	KN	KN							
Density/Unit	1068	2262	495							
Species Richness	29.5	29.0	32.0							
EPT Richness	19.5	17.0	20.0							
EPT/Richness	.66	.59	.64							
Bio Index	.71	1.27	.83							
Diversity	3.89	3.12	3.79							
# E/P/T Taxa	5/8/9	5/9/11	8/7/9							
EPT/EPTChiro										
Hydro/Total										
Dominant Taxa %	23	38	20							
Coleoptera %	.8	.8	3.7							
Diptera %	15.5	47.0	13.7							
Ephemeroptera %	26.2	29.0	10.7							
Trichoptera %	14.5	10.3	31.3							
Plecoptera %	42.9	12.8	39.9							
Oligochaeta %	0.0	0.0	.2							
Other %	0.0	.1	.5							
Collector Gatherer %	39.0	74.1	15.2							
Collector Filterer %	8.0	6.3	8.1							
Predator %	15.4	11.5	30.3							
Shredder - Detritus %	36.5	6.8	39.7							
Shredder - Herbivore %	0.0	.1	.5							
Scraper	.8	.9	4.5							
Comm. Assessment	good	exc	exc							

Dominant Taxa	10/30/91	10/19/92	9/24/93							
Oulimnius	.8	.6	3.7							
Parametriocnemus	.7	.4	4.5							
Polypedilum	3.9	4.7	.2							
Micropsectra	6.7	38.0	.2							
Hexatoma	.2	.1	3.0							
Baetidae	6.7									
Baetis	7.0	14.7	6.1							
Epeorus	10.5	13.5	2.3							
Lepidostoma	1.3	1.7	20.1							
Dolophilodes	7.3	5.0	5.6							
Rhyacophila	4.5	2.2	2.3							
Chloroperlidae	7.1	7.7	18.9							
Leuctridae	22.6	1.0	16.1							
Taenionema	6.1	1.7								

Brown's River 9/24/93

Lab Id: 93.092 Composites/Rep: 1 Area: m2

Order	Genera	species	Count 1	Count 2	Count 3	Count 4	Count 5	Count 6	Count 7	Count 8	Count 9	Count 10
COLEOPTERA	OULIMNIUS	latiusculus	15	8								
DIPTERA	CERATOPOGON	sp	1	0								
DIPTERA	CORYNONEURA	sp	0	1								
DIPTERA	DICRANOTA	sp	3	13								
DIPTERA	EMPIDIDAE	unid	0	4								
DIPTERA	HEXATOMA	sp	4	14								
DIPTERA	MICROPSECTRA	sp	0	1								
DIPTERA	MOLOPHILUS	sp	1	0								
DIPTERA	ORTHOCLADIUS	sp	1	0								
DIPTERA	PARACHAETOCLADIUS	sp	0	3								
DIPTERA	PARAMETRIOCNEMUS	sp	9	18								
DIPTERA	POLYPEDILUM	aviceps	0	1								
DIPTERA	SIMULIUM	tubersom	0	1								
DIPTERA	PSEUDOLIMNOPHILA	sp	0	1								
DIPTERA	THIENEMANNEMYIA	sp	0	1								
DIPTERA	TVETENIA	bavarica	3	2								
EPHEMEROPTERA	BAETIS	flavistriga	2	0								
EPHEMEROPTERA	BAETIS	sp	7	3								
EPHEMEROPTERA	BAETIS	tricaudatus	12	14								
EPHEMEROPTERA	EPEORUS	sp	8	6								
EPHEMEROPTERA	EURYLOPHELLA	funeralis	3	0								
EPHEMEROPTERA	HEPTAGENIIDAE	unid	4	1								
EPHEMEROPTERA	LEPTOPHLEBIIDAE	unid	4	2								
EPHEMEROPTERA	PSEUDOCLOEON	sp	1	0								
ODONATA	GOMPHIDAE	imm	1	2								
OLIGOCHAETA	ENCHYTRAEIDAE	unid	0	1								
PLECOPTERA	CAPNIIDAE	imm	1	1								
PLECOPTERA	CHLOROPERLIDAE	imm	57	59								
PLECOPTERA	LEUCTRIDAE	imm	41	57								
PLECOPTERA	MALIREKUS	hastatus	5	4								
PLECOPTERA	PELTOPERLA	sp	8	3								
PLECOPTERA	PTERONARCYS	proteus	2	6								
PLECOPTERA	TAENIOPTERYGIDAE	imm		0								
TRICHOPTERA	DOLOPHILODES	sp	19	16								
TRICHOPTERA	GLOSSOSOMA	sp	0	2								
TRICHOPTERA	LEPIDOSTOMA	sp	56	67								
TRICHOPTERA	NEOPHYLAX	sp	2	0								
TRICHOPTERA	PARAPSYCHE	apicalis	1	3								
TRICHOPTERA	POLYCENTROPUS	sp	1	1								
TRICHOPTERA	RHYACOPHILA	carolina spa	2	2								
TRICHOPTERA	RHYACOPHILA	carolina spb	4	6								
TRICHOPTERA	SYMPHITOPSYCHE	slossonae	5	5								

Water Quality Division - Vt. Dept. of Environmental Conservation
Biomonitoring and Aquatic Studies Unit

4/04/94

Stevensville Brook 2.1
Site Id: 461143000021

Ambient Biomonitoring Summary Report

Town: Underhill
Waterbody Id: VT07-10

Description: Located above bridge at parking area for Nebraska Notch trail,about 50m.

	10/30/91	10/19/92	9/24/93							
MACROINVERTEBRATES: Id#	91.087	92.098	93.094							
Sampling Method	KN	KN	KN							
Density/Unit	269	945	376							
Species Richness	27.5	37.5	35.5							
EPT Richness	18.0	20.5	21.0							
EPT/Richness	.65	.55	.59							
Bio Index	.52	.96	.64							
Diversity	3.32	3.87	3.65							
# E/P/T Taxa	3/7/11	3/8/11	4/9/11							
EPT/EPTChiro										
Hydro/Total										
Dominant Taxa %	38	29	22							
Coleoptera %	.4	.1	.5							
Diptera %	9.5	18.7	8.5							
Ephemeroptera %	2.0	40.1	2.8							
Trichoptera %	11.9	12.5	21.8							
Plecoptera %	76.2	28.3	66.0							
Oligochaeta %	0.0	.1	0.0							
Other %	0.0	.1	.4							
Collector Gatherer %	7.8	54.0	5.3							
Collector Filterer %	5.4	5.4	10.4							
Predator %	18.2	9.8	28.6							
Shredder - Detritus %	67.5	28.4	53.5							
Shredder - Herbivore %	0.0	2.0	.4							
Scraper	1.1	.4	.9							
Comm. Assessment	good	exc	exc							

Stevensville Brook 2.1 DOMINANT MACROINVERTEBRATE TAXA COMPOSITION (%) 4/04/94

Dominant Taxa	10/30/91	10/19/92	9/24/93							
Micropsectra	3.2	9.7	.7							
Baetis	.4	28.7	.8							
Epeorus	1.1	10.6	.5							
Parapsyche	1.7	1.3	3.6							
Lepidostoma	1.1	3.6	4.4							
Dolophilodes	1.5	2.4	3.5							
Rhyacophila	4.1	3.5	6.4							
Capniidae	6.3	2.7	1.7							
Chloroperlidae	11.9	4.6	17.8							
Leuctridae	38.5	7.3	21.9							
Peltoperlidae			22.5							
Peltoperla	9.7	4.5								
Taenionema	7.1	5.5								

Stevensville Brook 9/24/93

Lab Id: 93.094 Composites/Rep: 1 Area: m2

Order	Genera	species	Count 1	Count 2	Count 3	Count 4	Count 5	Count 6	Count 7	Count 8	Count 9	Count 10
COLEOPTERA	OULIMNIUS	latiusculus	2	1								
COLEOPTERA	PROMORESIA	tardella	0	1								
DECAPODA	CAMBARUS	bartoni	1	0								
DIPTERA	BRILLIA	sp	3	0								
DIPTERA	CRICOTOPUS	sp	0	1								
DIPTERA	DICRANOTA	sp	5	10								
DIPTERA	EMPIDIDAE	unid		0								
DIPTERA	EUKIEFFERIELLA	brevicalar	5	2								
DIPTERA	HEXATOMA	sp	5	1								
DIPTERA	MICROPSECTRA	sp	3	2								
DIPTERA	PARACHAETOCLADIUS	sp	4	2								
DIPTERA	PARAMETRIOCNEMUS	sp	2	1								
DIPTERA	RHEOCRICOTOPUS	sp	2	0								
DIPTERA	SIMULIUM	tubersom	3	3								
DIPTERA	THIENEMANNEMYIA	sp	0	2								
DIPTERA	TIPULA	sp	0	2								
DIPTERA	TVETENIA	bavarica	2	2								
DIPTERA	UNID			0								
EPHEMEROPTERA	BAETIS	sp		2								
EPHEMEROPTERA	BAETIS	tricaudatus	1	2								
EPHEMEROPTERA	EPEORUS	sp	4	0								
EPHEMEROPTERA	EURYLOPHELLA	funeralis	1	0								
EPHEMEROPTERA	EURYLOPHELLA	sp	0	2								
EPHEMEROPTERA	HEPTAGENIIDAE	imm	4	1								
EPHEMEROPTERA	STENONEMA	sp	3	0								
LEPIDOPTERA	PYRALIDAE	unid	1	0								
LEPIDOPTERA	TORTRICIDAE	unid		0								
PLECOPTERA	ACRONEURIA	carolinesis	0									
PLECOPTERA	ACRONEURIA	sp	0	1								
PLECOPTERA	CAPNIIDAE	imm	5	8								
PLECOPTERA	CHLOROPERLIDAE	imm	70	64								
PLECOPTERA	ISOPERLA	sp	2	2								
PLECOPTERA	LEUCTRIDAE	imm	71	94								
PLECOPTERA	MALIREKUS	hastatus	1	0								
PLECOPTERA	PELTOPERLIDAE	unid	82	87								
PLECOPTERA	SOYEDINA	sp	1	0								
PLECOPTERA	TAENIOPTERYGIDAE	imm	0	7								
TRICHOPTERA	DOLOPHILODES	sp	12	14								
TRICHOPTERA	LEPIDOSTOMA	sp	15	18								
TRICHOPTERA	PALAEGAPETUS	sp	7	2								
TRICHOPTERA	PARAPSYCHE	apicalis	15	12								
TRICHOPTERA	POLYCENTROPUS	sp	1	1								
TRICHOPTERA	RHYACOPHILA	carolina spa	4	3								
TRICHOPTERA	RHYACOPHILA	carolina spb	3	2								
TRICHOPTERA	RHYACOPHILA	fuscula	17	10								
TRICHOPTERA	RHYACOPHILA	minora	5	4								
TRICHOPTERA	SYMPHITOPSYCHE	macleodi	5	3								
TRICHOPTERA	SYMPHITOPSYCHE	slossonae	5	6								