REPORT

Survey of the Shale and Cobble Zone Macroinvertebrate Community
1995

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Executive Summary

1. During the summers of 1994 and 1995, the Vermont Department of Environmental Conservation (VTDEC) conducted quantitative benthic surveys at nine cobble and shale littoral sites in Northern Lake Champlain. Depth at all sites ranged from two to four meters. Sites spanned a range of trophic level as measured by water column phosphorus concentration. The primary objective of the survey was to document macroinvertebrate community structural and functional characteristics prior to zebra mussel colonization. Seven sites were sampled in both 1994 and 1995. Results from the 1995 survey are reported here, with some comparisons to the 1994 data.

2. Samples were collected using SCUBA-assisted areal sampling methods. From five to eight replicate .25 m2 quadrats were randomly sampled at each site. Replication was designed to attain a precision level for density estimates of 20% percent standard error of the mean. Samples were preserved in alcohol and separated from the substrate in the laboratory. All organisms in the sample were counted and identified to the lowest practicable taxonomic level, usually genus or species.

3. The mean density of organisms ranged from 326 to 3703 per square meter. Changes in density at sites between years ranged from -39 percent to +39 percent. Density changes of this magnitude are with the range of expected natural variability. Total taxa richness ranged from 41 to 66 taxa. Mean taxa richness was highest at the mesotrophic sites (total P 16-20 ppb), ranging from 34 to 39 taxa. At sites of higher and lower trophic level, mean taxa richness ranged from 25 to 33 taxa. Changes in taxa richness between years ranged from -28 percent to +6 percent.

4. Snails were a major component of the biologic community at all sites, ranging up to 77 percent of the total density. The most common snail was the exotic species *Bithnyia tentaculata*. Other cosmopolitan and sometimes numerous taxa were the mussels and fingernail clams, amphipods, beetles, chironomidae and caddisflies. Some biometrics, such as taxa richness, the modified Hilsenhoff BioIndex, and the number of sensitive species present appeared to be good discriminators of trophic level. Zebra mussels were collected at one site in 1995 at vey low densities. It is anticipated that all sites will be colonized by zebra mussels at some point in the future.

5. Functional composition at all sites was dominated by scrapers, primarily snails. Deposit feeders such as amphipods, midges and beetles were also an important functional component at many of the sites.

6. This shale/cobble macroinvertebrate survey has established two years of good pre-zebra mussel baseline data spanning the trophic ranges found within the northern part of Lake Champlain. The second year of data has allowed the temporal variability (between years at constant calendar period) of these communities to be assessed. Future monitoring and data analysis should be conducted to help further define the boundaries of natural temporal variability, determine what species are at risk, and describe changes to the habitat and biological integrity of the macroinvertebrate communities resulting from colonization of these areas by the zebra mussel.

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Introduction:

Recently (July 1993), zebra mussels (*Dreissena polymorpha*) were discovered in Lake Champlain. Zebra mussels grow in dense colonies on lake and river bottoms, and can clog public and industrial water intake pipes, foul boat hulls and engines, cover beaches, and disrupt aquatic ecosystems. This study addresses the recommendations of the Vermont Zebra Mussel Study Committee (Vermont Agency of Natural Resources, 1994) to the Vermont General Assembly that:

"The Vermont Department of Environmental Conservation Biomonitoring and Aquatic Studies Unit should initiate a survey of the shale and cobble littoral zone at selected sites in Lake Champlain during the summer of 1994 to assess the potential ecological consequences of zebra mussels on the lake bottom macroinvertebrate community."

Effects that zebra mussels will have on the benthic fauna in Lake Champlain are not clear. Initial sampling conducted by the Vermont DEC in 1993 and 1994 indicates that the shale/cobble littoral zones of Lake Champlain, which are prime zebra-mussel habitat, are inhabited by the most diverse bottom-dwelling biological communities in the Lake. Heavy infestation of these areas by zebra mussels could drastically alter the species composition and diversity of these communities, resulting in as yet unknown ecological consequences. It is important to document the native species composition and diversity that presently exist in these areas in order to understand how zebra mussel colonization will alter the structure and function of these shale/cobble bottom macroinvertebrate communities and the higher food chain fish species that may depend on them.

In August of 1994, the Vermont Department of Environmental Conservation, in cooperation with the Lake Champlain Basin Program, initiated a monitoring program that would look at these shale/cobble communities and would track changes to those communities resulting from zebra mussel colonization. This report summarizes the results of monitoring activities conducted by the Vermont Department of Environmental Conservation for the Lake Champlain Basin Program during the summer of 1995, with comparisons to 1994 data. 1994 sampling results have been previously reported in VTDEC (VTDEC,1995).

Project Description:

Presently, two years of comprehensive data on the benthic fauna of the shale/cobble littoral areas has been established. The two years of baseline data established on these communities of Lake Champlain will help document alterations resulting from the encroachment of zebra mussels onto these habitats. The goals of this monitoring program are to: **1) establish baseline benthic macroinvertebrate monitoring data in selected shale/cobble littoral habitats of Lake Champlain, and 2) monitor the changes that occur to the structure and function of that community, including colonization by zebra mussels, as the zebra mussel invasion of Lake Champlain progresses.**

Objectives:

1) Document the existing benthic macroinvertebrate composition, and the progressive colonization by adult zebra mussels, of shale/cobble littoral zones at selected sites representing different trophic zones in Lake Champlain. Achieve a sampling precision, as measured by the percent standard error of the mean total density and mean taxa richness estimates, of 20 and 10 percent or less respectively. The establishment of these baseline parameters of macroinvertebrate community structure and function, prior to zebra mussel colonization, will allow a better understanding of the ecological consequences of zebra mussel colonization within the different trophic zones of Lake Champlain.

2) Document selected water quality parameters that are pertinent to zebra mussel requirements at all sites.

Study Design:

A primary objective of this study is to document, prior to the arrival of zebra mussels at the sampling sites (hopefully a period of three or more years), baseline measurements of community structure and function. Community measurements (biometrics) include density, taxa richness, EPT and ECT richness, Bio Index, and percent community composition by taxa and by functional feeding groups. These baseline data will be used to measure the natural spatial and temporal (between years for the sampling index period) variation within sampling sites. The data will also be used to measure the differences in community structure and function across different trophic zones within the similar habitat type shale/cobble littoral zone. These data can then be used to help evaluate any biological changes occurring over time within different trophic zones of the lake as zebra mussels progressively colonize the lake. This project defines biologically significant change as a change of 50 percent or greater in total density and 30 percent of more in mean taxa richness. With the attainment of sampling QA objectives, changes at these levels can be described statistically as significant.

Sample Site Selection :

Sampling sites were selected to represent typical shale/cobble zone habitat and areas within each lake water quality trophic segment as defined by Total Phosphorus (TP) concentrations from Lake Champlain Lay Monitoring data (**Table 1**). Substrate characterization was determined by habitat evaluation and trophic representation was determined using existing Lake Champlain monitoring information. Nine sites were sampled in the northern portion of Lake Champlain, within each of the four identified trophic zones (**Figure 1**). All sites were dominated by shale/cobble substrates and located at depths between 2.0 and 4.0 meters, based on the lake level at Burlington Harbor.

Table 1: Locations and Total Phosphorus Concentration Ranges of Shale/Cobble Zone Macroinvertebrate Sites Sampled in August 1994 and 1995 in Northern Lake Champlain. (*sampled only in 1994, **sampled only in 1995)

SITE NAME	ID	Total-P ug/l P	Latitude	Longitude	Site ID #
Province Pt., Vt	PP	31-40	45 00 45	73 11 35	LC0930000002
Savage Point, Vt	SP	21-30	44 50 11	73 17 29	LC0960000001
Knight Point, Vt	KP	21-30	44 46 06	73 17 51	LC0860000002
Isle La Motte, Vt	ILM	16-20	44 54 20	73 20 38	LC0550000003
North Hero, Vt	NHS	16-20	44 51 04	73 16 03	LC0870000002
Ladd Point, Vt	LP	16-20	44 46 09	73 17 02	LC0850000003
****Cumberland Head, NY**	CH	16-20	44 41 35	73 23 37	LC0460000003
***Whites Beach, Vt**	WB	11-15	44 37 15	73 19 50	LC0400000001
Allen Point, Vt	AP	11-15	44 35 43	73 18 17	LC0710000009

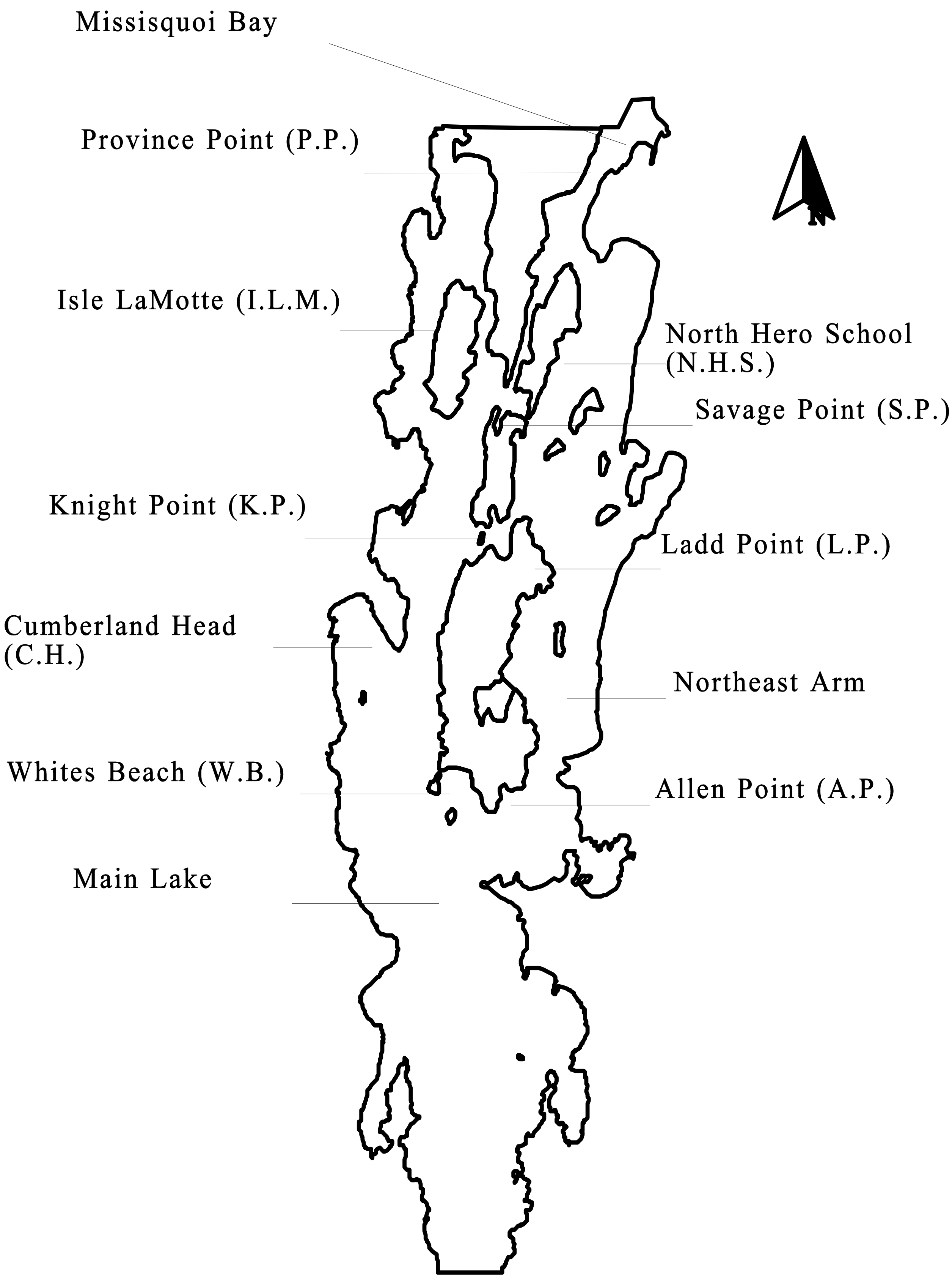

Figure 1. Map of Northern Lake Champlain showing locations of Shale/cobble macroinvertebrate sampling sites.

Sampling and Analysis Procedures:

Quantitative sampling of the benthic macroinvertebrate community was conducted at the nine sites between August 1 and 9 of 1994 and 1995, by use of SCUBA areal sampling methods. Five replicate one-quarter square meter samples were taken at all sites except for Allen Point and Province Point in 1995, where six and eight replicates respectively were taken. Results from the 1994 survey indicated that greater replication was needed at Allen Point and Providence Point in order to attain QA objectives.

All substrate within the one-quarter square meter quadrate was removed and placed into a large 500 micron mesh bag. The bag was then sealed and brought to the surface (boat/shore) for further processing. Each sample was then washed through a U.S. Standard No. 30 sieve (600um openings). The retained sediment, debris, and organisms were then placed into labeled jars and preserved with 75 percent ETOH.

Macroinvertebrate samples were processed at the Vermont DEC R.A.LaRosa Environmental Laboratory. Processing procedures followed Vermont DEC methods 4.6.1-.4 (Vermont DEC Field Methods Manual 1989). Samples were thoroughly rinsed with tap water through a U.S. Standard No. 30 sieve. The entire sample was then placed onto a large (12 x 18 inch) gridded shallow white tray. The material was covered with enough water to spread it evenly over the entire bottom of the tray. Using a 1.25X illuminated magnifier, all animals were systematically removed from the tray, and placed in divided petri dishes with 75 percent ETOH. The animals were then sorted to major groups using a dissecting microscope and placed in labeled tightly capped bottles with 75 percent ETOH.

Macroinvertebrate identifications were made to the lowest possible taxonomic level, usually genus and species for most groups, with the exception of some minor taxa and the Oligocheata.

The **density** of macroinvertebrate animals at a site is reported as the number per square meter as determined by taking the average number of organisms per replicate and multiplying this mean number per replicate by four. The **percent composition of a taxon** was calculated by dividing the mean density of a taxon by the mean density of all animals at a site.

Taxa richness is the number of distinct taxa found at a site. It is a simple measure of the macroinvertebrate community diversity. We have reported both the **mean taxa richness** (average number of taxa per replicate) and the **total taxa richness** (total number of taxa) found at a site.

The **EPT index** measures the mean number of distinct taxa per replicate within the orders *Ephemeroptera*, *Plecoptera*, and *Trichoptera* present at a site. The value summarizes taxa richness within the insect orders that are generally considered to be the most pollution sensitive. With the exception of one species at one site, the order *Plecoptera* is not represented in this survey. The *Coleoptera* were present at all sites and were represented by moderately sensitive species. Therefore, the **ECT index** was determined for each site as a possible substitute index for the EPT index. We also reported the total number of species from the Order *Trichoptera* at each site. The *Trichoptera* were represented by the most number of species within the sensitive taxa indices mentioned above, and seemed to differentiate between sites of differing trophic state.

The **Hilsenhoff biotic index (BI)** (Hilsenhoff 1987) is a measure of a community's tolerance toward "organic enrichment." It was developed by Hilsenhoff in 1977, and improved in his 1987 publication, to be applied in lotic studies of macroinvertebrate community impact assessments due to organic stream pollution. We have applied it here, with specific modifications made by Vermont DEC for the aquatic macroinvertebrate (including non Arthropod) fauna of Vermont, to see if it would distinguish lentic communities from areas of differing "Trophic State" in Lake Champlain. The BI is an integrating index which utilizes information concerning both the relative abundance and organic pollution tolerance of individual taxa to give an overall community level rating of the community's tolerance to enrichment. The Bio Index "1987" ranges from 0 to 10 with 0 being the least tolerant (oligotrophic) and 10 most tolerant (eutrophic) community type.

The **percent composition of the functional feeding groups** was determined for each site by replicate and reported as the mean for each site. The functional groups assigned to a taxon are as determined by Merritt and Cummins 1984 and as assigned by the Vermont DEC for non-insect taxa.

Water quality samples were collected at each site at the time of macroinvertebrate sample collection. The parameters measured (**Table 2**) are pertinent to zebra mussel requirements and include: **total alkalinity, calcium, pH, specific conductance, and temperature**. The samples were collected following Vermont DEC Field Methods Manual 1989 Section 2.2.1 (See **Table 2**).

Quality assurance/quality control:

Quality control procedures for chemical parameters followed the Quality Assurance Plan (section 11.0, Vermont DEC,1992). Biological samples were replicated in the field from all sites to determine within-site sampling variability (see section on Results and Discussion). All biological samples were checked for picking completeness by a second aquatic biologist. Taxonomic identifications were repeated by a second biologist on 5 percent of all samples. Retraining was employed where discrepancies occurred on some difficult taxa. Voucher specimens from Crustacea and Mollusca were verified by an outside expert, Dr.Douglas Smith, Zoology Dept, University of Massachussetts, Amhearst, MA. Voucher specimens from Gastropoda were verified by Eileen H. Jokinen, Institute of Water Resources, University of Connecticut at Storrs,CT.

Table 2: Summary of Chemical Water Quality Analytical Methods.

Parameter	Samples/site	Matrix	Reference	Unit Report
Dissolved Oxygen	1	water	3.1[2]	mg/l
Alkalinity	1	water	2320B[1]	mg/l
Calcium	1	water	7140[1]	mg/l
pH	1	water	1.5.2,4[2]	Std.unit
Specific Conductance	1	water	1.6.2[2]	µmho/cm
Temperature	1	water	1.1[2]	C°

1 = ASTM 1992; 2 = VTDEC 1989

Results and Discussion:

The macroinvertebrate community biometrics for nine shale/cobble sites sampled in 1994 and 1995 are presented in **Table 3**. The percent standard error of the mean (%SEM) for density and mean taxa richness, as measures of within-site variance, are also presented in **Table 3**. The within-site variance in density met the targeted 20 %SEM at all sites in 1995, so that future changes in density at a site of greater then 50 percent should be detectable using the same level of sampling effort. The within-site variance in mean taxa richness also met the targeted 10 %SEM at all sites except Savage Point in 1995. At most sites, the variance in mean richness was at or below 6 %SEM, therefore the targeted 30 percent change in mean richness within a site should be detectable at most sites with a similar level of effort employed in 1995. The Mann-Whitney U nonparametric statistic was used to verify all biologically significant within-site differences in the biometric values, taxa densities, and functional group compositions between the two years sampled. The temporal differences in the biometrics that were determined to be statistically significant at $p<.05$ or greater are noted in **Table 3** with an asterisk.

The mean density of macroinvertebrates in 1995 ranged from a low of $326/m^2$ at the highly eutrophic Province Point site, to a high of $3703/m^2$ at the mesotrophic North Hero site. At sites with two years data, the temporal change in density from 1994 to 1995 ranged from -39 percent at Knight Point to +39 percent at the Isle LaMotte site. The change in density at these two sites was statistically significant at $p<.05$. However, the change in density at these and all the other sites was within the anticipated natural variability of macroinvertebrate populations (±50%).

The increase in macroinvertebrate community density at the Isle LaMotte site was primarily due to a 178 percent increase in the dominant **Gastropoda** and to a lesser extent a 700 percent increase in the less dominant **Amphipoda** at the site from 1994 to 1995. Within the **Gastropoda**, the only species to increase in density was the exotic *Bithnyia tentaculata* (+569%, $p<.008$). Several native species of **Gastropoda** actually decreased in overall density; these include *Amnicola limosa* (- 59%), and *Stagnicola catascopium* (-88% $p<.008$) .

The 39 percent decrease in macroinvertebrate community density at Knight Point was due to the combined decrease in most taxa from the **Trichoptera, Gastropoda, Bivalvia, Oligocheata,** and **Hirudinea**. A few taxa within these orders declined significantly. The **Trichoptera** species *Agraylea sp,* and *Nectopsyche sp* decreased in density by 85 percent and 67 percent respectively ($p<.008$). The **Gastropoda** species *Helisoma sp,* and *Gyraulus deflectus* decreased by 90 percent, and 91 percent respectively ($p<.008$). The **Bivalvia** taxa *Pisidium spp* decreased by 78 percent ($p<.008$). Because most of the other taxa within these dominant orders all decreased between 30 and 40 percent, the community percent composition at Knight Point remained relatively unchanged at the order level. The order **Amphipoda** was the only exception to the general decrease in density; the **Amphipoda** increased in density by 100 percent ($p<.008$) and as a result increased in community composition from 5 percent to 18 percent at Knight Point.

The total taxa richness of a site for the eight sites sampled in 1995 ranged from 41 taxa at the eutrophic Knight Point site to 66 taxa at the mesotrophic Ladd Point site. The mean richness ranged from a low of 25 taxa at the highly eutrophic Province Point site to 39 taxa at both the Isle LaMotte and Ladd Point sites, both categorized as mesotrophic sites. Consistent with the 1994 results, the mesotrophic sites with total phosphorous (TP) in the range of 16 to 20 ug/l had the higher mean richness values, with means from 34 to 39 taxa. All other sites with higher or lower phosphorus levels had mean richness values from 25 to 33 taxa. Changes in species richness between 1994 and 1995 at sites with two years data ranged from -28 percent at Province Point, to +6percent at Allen Point. None of the changes are considered to be biologically significant, nor were they found to be statistically significant.

The EPT index values were lowest at the more eutrophic sites with Province Point recording the lowest EPT index at 2.8 taxa. The highest number of EPT taxa recorded was from the mesotrophic North Hero site at 12 taxa. The ECT index ranged from a high of 17 taxa, also at the North Hero site, to a low of 4.8 taxa at Savage Point. The ECT index also identified the more eutrophic sites as being poor in sensitive taxa. The ratio of EPT/Richness values ranged from 0.30 to 0.11, with the two most eutrophic sites of Savage Point and Province Point having the lowest proportion of sensitive EPT taxa compared to the other sites. The number of Trichoptera taxa ranged from a low of 5 at the eutrophic Savage Point site to a high of 17 at the mesotrophic North Hero site. In general, the number of Trichoptera taxa also identified the two most eutrophic sites as being poor in taxa richness when compared to the other sites.

The Biotic Index ranged from 5.0 at the mesotrophic Cumberland Head site to 7.40 at the mesotrophic Ladd Point site. The Biotic index in its present form did a good job in 1995 of ranking the sites in their a priori order of trophic state based on phosphorus concentrations, with the exception of the mesotrophic Ladd Point site, which it placed in with sites considered to be eutrophic. In 1994, the Ladd Point site Bio Index value was 6.21, significantly ($p<.008$) lower then the 7.40 reported in 1995. Two species appear to be responsible for the significant change in the Bio Index value at Ladd Point. The Trichoptera *Neophylax sp* (with a Bio Index of 3) significantly decreased in density by 92 percent, causing it to decrease in percent composition by 10 percent in the community. The Gastropod *Stagnicola catascopium* (Bio Index of 6), significantly increased in density, making it a dominant taxon within the community at 11 percent.

The Bio Index value also changed significantly ($p<.008$) at the Allen Point, Isle LaMotte, and Savage Point sites. Allen Point increased by 1.25 units, primarily due to the combined decrease in density of several Coleoptera and Diptera species with relatively low Bio Index values (<6) and as a result a lowering of their community percent compositions, and a sharp increase in several Gastropod species with relatively high (>6) Bio Index values, and a resulting increase in their community compositions. Significant ($p<0.008$) decreases in density of the Coleoptera *Stenelmis sp* (-71%), and *Psephenus herricki* (-98%); and the Diptera *Pseudochironomous sp* (-74%) were recorded. Significant ($p<0.008$) increases in density of the Gastropod *Bithynia tentaculata* (+3,466%), *Stagnicola catascopium* (+916%), and *Gyraulus deflectus* (new species at site),were documented.

The Isle LaMotte site increased significantly ($p<0.008$) in Bio Index value by 1.43, the greatest change in any site. The primary taxa shifts at this site were similar to those at Allen Point. The relatively low Bio Index Coleoptera *Stenelmis sp* decreased in density by 37 percent. The relatively high Bio Index value Gastropod species *Bithnyia tentaculata* increased significantly ($p<0.008$) by 569 percent, and the Amphipod *Gammarus fasciatus* significantly increased ($p<0.008$) by 700 percent from 1994 to 1995.

The Savage Point site decreased significantly ($p<0.008$) in Bio Index value by 0.97. The change is primarily due to a significant ($p<0.008$) increase of 470 percent in the relatively low Bio Index Amphipoda *Gammarus fasciatus*, and decrease of 78 percent in the relatively higher Bio Index Isopoda *Asellus racovitzai.* The Province point site also decreased significantly ($p<0.008$) in BioIndex value by 0.54. This small change however is not considered to be biologically significant.

Table 3: The macroinvertebrate community biometrics for nine shale/cobble zone sites sampled in Northern Lake Champlain in 1994 and 1995. Data represent mean values from five 1/4m^2 replicates (%SEM values for density metric and m-richness metric in parenthesis).An ***** indicates the 1995 metric value was significantly different then that determined in 1994 using the non-parametric Mann-Whitney U statistic ($p<0.05$).

Site	Date	Density m2 (%SEM)	Total Richness	Mean Richness (%SEM)	EPT Index	ECT-Index	EPT/ Richnes s	Biotic Index	Trichop Taxa
Whites Beach	8/94	2995 (30)	63	34.0 (10)	7.2	9.2	.21	6.20	13
Allen Point	8/94	822 (18)	54	29.2 (9)	8.8	12.2	.30	**5.39**	13
Allen Point	8/95	1060 (8)	60	30.9 (2)	7.0	11.0	.22	**6.64***	10
Isle LaMotte	8/94	**1982 (8)**	63	41.2 (6)	11.2	16	.27	**5.53**	15
Isle LaMotte	8/95	**2768* (3)**	64	39.8 (3)	7.4	12.4	.18	**6.96***	13
North Hero	8/94	4307 (21)	75	49 (4)	13.6	17.4	.28	5.70	17
North Hero	8/95	3703 (11)	60	38 (4)	12	17	.30	6.43	17
Ladd Point	8/94	3204 (6)	75	48 (1)	8.2	11.0	.17	**6.21**	14
Ladd Point	8/95	2849 (14)	66	39.6 (6)	6.8	10.8	.17	**7.40***	10
Knight Point	8/94	**3786 (12)**	53	36.6 (6)	5.8	8.4	.16	6.87	9
Knight Point	8/95	**2300* (12)**	41	28.6 (6)	4.6	7.6	.157	7.09	8
Savage Point	8/94	1721 (6)	62	32.2 (6)	3.2	3.6	.10	**7.62**	6.
Savage Point	8/95	1974 (7)	56	33.2 (11)	3.8	4.8	.11	**6.65***	5
Province Point	8/94	1538 (19)	59	35.0 (9)	2.8	4.4	.08	**7.36**	5
Province Point	8/95	1291 (6)	53	25 (4)	2.8	5.8	.13	**6.82***	6
Cumber-land Head	8/95	3068 (10)	50	34.0 (4)	10.6	14.6	.27	5.0	12

The Percent Composition of the major macroinvertebrates groups is presented in **Table 4**. A complete list of the benthic macroinvertebrates identified and the percent composition of each taxon making up more than 1 percent of the community abundance from the eight shale/cobble sites is provided in **Appendix A. Appendix B** lists the raw count data by site and replicate.

A total of 161 taxa of benthic macroinvertebrates were identified, including 11 Hirudinea, 21 Gastropoda, 18 Bivalvia, 8 Crustacea, 7 Ephemeroptera, 28 Trichoptera, 31 Diptera and 11 Coleoptera.

Gastropoda (snails) continued to be a major component of the community in the 1995 survey, accounting for more than 55 percent of the community composition at five of the eight sites, with values ranging from 16.4 percent at Savage Point to 77 percent at Ladd Point. The most abundant and widespread species included the exotic Gastropod, *Bithynia tentaculata,* occuring at all but one site and comprising up to 52 percent of the community at the Ladd Point site. The Gastropod, *Amnicola limosa*, occurred at all sites and comprised up to 24 percent of the community at the Province Point site. These two species are very similar in their niche requirements in terms of habitat and feeding. Data from the 1994 survey suggest that at sites where the exotic *B. tentaculata* is very abundant (>60%), *A. limosa* populations are depressed at less than 2 percent, suggesting some direct competition between the two species. Harman and Forney, 1970, presented data that suggests *B. tentaculata* has become the dominant Gastropod in Lake Oneida, N.Y., at the demise and even localized extirpation of Planorbidae from 1917 to 1967.

At Isle LaMotte and Allen Point, the percent composition of the Gastropoda increased dramatically in 1995 due to the significant ($p<0.008$) increase in *B. tentaculata*. At the Isle LaMotte site, two native gastropods decreased in density from 1994 to 1995; *A. limosa* decreased by 59 percent, and *Stagnicola catascopium* decreased significantly ($p<0.008$) by 88 percent. At the Allen point site, many of the native gastropods increased in density along with *B. tentaculata*. These included *A. limosa* (+56%), *Physa heterostropha* (+63%) and, *S. catascopium* (+916 %, $p<0.008$).

The **Bivalvia** (mussels and clams) were represented at all sites and ranged from 4.4 percent at Ladd Point to 17 percent at Savage Point. The abundance of the Bivalves *Elliptio complanata* and *Lampsilis radiata* continues to be among the highest reported from northeastern lakes (Downing and Downing, 1991). The Bivalvia decreased in abundance noticeably at Knight Point (-68%), and increased in abundance at N.Hero School (+65%). Two taxa decreased significantly at Knight Point, *Elliptio complanata* (-40%,p<.01), and *Pisidium casertanum* (-78%,p<.008). Two taxa, *E. complanata,* and *Sphaerium corneum* (+224%,p<.008), increased in density at the N.Hero School site.

The **Amphipoda** (scuds) were present at all sites and ranged from 0.3 percent at the North Hero site to 49 percent of the community composition at the Savage Point site. Between 1994 and 1995, Amphipoda increased significantly ($p<.008$) at one site, Savage Point, with *Gammarus sp* increasing in density by 470 percent, going from 10 percent of the species composition in 1994 to nearly 50 percent in 1995.

The **Isopoda** (sowbugs) were only present at the Savage Point site and comprised 11 percent of the community in 1995. This represents a 78 percent decrease ($p<.008$) in *Asellus racovitzai* from 1994, when it comprised 60 percent of the community at Savage Point, to 1995.

Coleoptera (beetles) were present at all sites and comprised from 0.04 percent at Savage Point to 14 percent of the community at Isle LaMotte. Significant decreases in the Coleoptera community composition were seen at two sites, Allen Point and Isle LaMotte. At Allen Point, three taxa decreased in density; *Dubiraphia vittata* (-50%), *Stenelmis spp* (*quadrimaculata,* and *crenata*) decreased by 71 percent ($p< .008$), and *Psephenus herricki* (-98%,p<.008). At Isle LaMotte, *Stenelmis spp* decreased by 57 percent ($p<.008$).

The percent composition of **Diptera** (flies) was relatively low (<5%) at all sites except Cumberland Head, where they represented 57 percent of the community. Two taxa in the family **Chironomidae**, *Microtendipes sp* and *Pseudochironomus sp,* comprised 51 percent of the community at this site. The Allen Point site was the only area that showed a major shift in community composition of Diptera from 32 to 5 percent composition from 1994 to 1995; the taxa *Microtendipes sp*, and *Pseudochironomous sp* decreased in density by 98 percent (p<.008) by 74 percent (p<.008) respectively.

The **Ephemeroptera** (mayflies) were found at seven of the eight sites surveyed in 1994 and 1995. They were not represented at the eutrophic Savage Point site either year. They were never very abundant and accounted for only 0.1 percent at several sites to 3 percent of the community at the Allen Point site.

The **Trichoptera** were present at all sites and comprised from 4 percent at Province Point to 22.7 percent of the community composition at North Hero School. Shifts in Trichoptera community composition from 1994 to 1995 were seen at three sites. At the North Hero and Savage Point sites the Trichoptera increased in density, and at the Ladd Point site a decrease in density was seen. At the North Hero School site, *Helicopsyche borealis* increased by 366 percent (p<.008), *Neophylax sp* increased by 288 percent (p<.008) and *Lepidostoma sp* appeared at the site at 3 percent, accounting for the increase in community composition by the Trichoptera at the site. At Savage Point the taxa *Polycentropus sp* increased by 127 percent, and *Agraylea sp* appeared at 3 percent of the community in 1995. The taxa *Neophylax sp* decreased in density by 92 percent (p<.008), accounting for the decrease in Trichoptera composition at the Ladd Point site.

Oligochaeta (worms) were present at all sites, the percent composition ranging from 0.4 percent at Cumberland Head to 4.9 percent of the community at Knight Point. The **Hirudinea** (leaches) were present at all sites, their percent composition ranged from 0.24 percent at Savage Point to 2.3 percent at Knight Point. Other orders that were present at many of the sites in small numbers were the **Odonata** (dragonflies), **Lepidoptera** (moths), **Megaloptera** (alderflies), **Turbellaria** (flatworms), and **Decapoda** (crayfish). **Plecoptera** (stoneflies) and **Neuroptera** (spongilla flies) were identified at only one site each.

Table 4: The percent composition of the major macroinvertebrate groups from nine shale/cobble sites sampled in Northern Lake Champlain in 1994 and 1995. An asterisk indicates that significant changes in density occurred to some taxa within the major group at a site.

Site	Date	Coleop-tera	Diptera	Epheme r-optera	Trich-optera	Oligo-chaeta	Hirud-nea	Amph-ipoda	Iso-poda	Bival-via	Gastro-poda
Whites Beach	8/94	5.0	2.0	1.0	1.0	2.0	1.0	1.0	0	3.0	85.0
Allen Point	8/94	**16.0***	**33.0***	3.0	13.0	2.0	1.0	10.0	0	5.0	**15.0***
Allen Point	8/95	**3.8***	**5.0***	3.1	11.2	3.9	1.3	7.4	0	5.4	**55.8***
Isle LaMotte	8/94	**32.0***	1.0	1.0	14.0	6.0	3.0	1.0	0	12.0	**31.0***
Isle LaMotte	8/95	**14.5***	0.4	0.1	8.0	3.5	0.3	4.9	0	5.6	**62.2***
North Hero	8/94	4.0	2.0	1.0	**7.0***	4.0	1.0	1.0	0	**5.0***	73.0
North Hero	8/95	2.3	0.3	0.2	**22.7***	1.7	1.0	0.3	0	**9.7***	60.0
Ladd Point	8/94	1.0	6.0	1.0	**14.0***	2.0	1.0	3.0	0	6.0	65.0
Ladd Point	8/95	1.2	0.6	0.1	**7.0***	1.7	1.2	5.9	0	4.4	77.0
Knight Point	8/94	1.0	1.0	1.0	6.0	7.0	4.0	6.0	1.0	**14.0***	61.0
Knight Point	8/95	2.5	0.1	0.1	4.8	4.9	2.3	18.5	0	**7.4***	58.6
Savage Point	8/94	1.0	7.0	0	3.0	2.0	1.0	**10.0***	**60.0***	4.0	12.0
Savage Point	8/95	0.04	4.4	0	7.9	2.4	0.24	**49.6***	**11.5***	4.5	17..5
Province Point	8/94	1.0	6.0	1.0	**1.0***	2.0	1.0	12.0	0	17.0	52.0
Province Point	8/95	0.6	1.0	0.1	**3.9***	2.2	0.76	32.7	0	13.5	42.0
Cumber-land Head	8/95	6.2	57.9	0	10.1	0.4	0.55	0.92	0	4.6	16.4

Genus-level functional feeding group designations for most of the macroinvertebrates encountered were found in Merritt and Cummins, 1984. **Table 5** presents the percent composition of the macroinvertebrate functional feeding groups from the nine sites surveyed.

Scrapers (non-filamentous algae and bacterial biofilm grazers) accounted for more than 40 percent of the community at six of the eight sites. The percent scrapers ranged from a low of 17 percent at Savage Point to a high of 78 percent at the Isle LaMotte site. The Gastropods accounted for the largest percent of scrapers at all of the sites; however the Trichoptera, and Coleoptera also contributed to the scraper percent composition at several sites, most notably Isle LaMotte.

Collector gatherers (deposit feeders) were generally the next most dominant in percent composition, ranging from 11 percent at the North Hero site to 67 and 68 percent at Savage Point and Cumberland Head respectively. Amphipods and Isopods were responsible for the high composition of collector gatherers at Savage Point and Province Point. The Chironomidae *Pseudochironomous sp*. and *Microtendipes sp.* contributed 55 percent of the collector gatherers present at the Cumberland Head site..

The percent composition of collector filterers (suspension feeders) was fairly evenly distributed at all sites, ranging in percent composition from 4.0 to 14 percent at all sites. Province Point had the highest composition at 14 percent. The Bivalvia was the leading contributor to this functional group.

The Shredder functional feeding group accounted for only 1 to 3 percent of the community. Shredders were represented by species from the Trichoptera, Chironomidae, and Coleoptera.

Predators accounted for 1 to 7 percent of the community. Taxa in this functional feeding group were represented by numerous groups, including the Chironomidae, Megaloptera, Coleoptera and Hirudinea.

Significant biological changes to the functional composition of the macroinvertebrate community occurred between 1994 to 1995 at three of the sites. At Allen Point the collector gather composition decreased by 31 percent ($p<.004$), and the scraper composition increased by 30 percent ($p<.004$). This appears to be due to the increase in the Gatsropoda and decreases in the Chironomidae and Coleoptera as mentioned above. The only other site with an apparent major shift in its functional composition was Province Point, where the collector gatherer group increased by 18 percent ($p<.002$), and the scraper group decreased by about 10 percent ($p<.03$).

Table 5 : The percent composition of macroinvertebrate functional feeding groups from nine shale/cobble sites sampled in Northern Lake Champlain in 1994 and 1995. An asterisk indicates that a significant biological shift occurred between the two years in that functional group at the site.

Sites	Date	Collector Gatherer	Collector Filterer	Predator	Shredder	Scraper
Whites Beach	8/94	6	4	1	1	89
Allen Point	8/94	**50***	6	5	1	**35***
Allen Point	8/95	**19***	6	2	2	**65***
Isle LaMotte	8/94	14	11	1	2	69
Isle LaMotte	8/95	14	6	<0.5	1	78
North Hero	8/94	8	5	4	1	80
North Hero	8/95	11	10	2	4	72
Ladd Point	8/94	10	7	3	3	76
Ladd Point	8/95	12	4	1	4	67
Knight Point	8/94	17	14	1	3	64
Knight Point	8/95	34	8	1	2	56
Savage Point	8/94	77	4	5	1	9
Savage Point	8/95	67	5	7	3	17
Province Point	8/94	**22***	19	5	3	**50***
Province Point	8/95	**40***	14	2	2	**40***
Cumberland Head	8/95	68	5	2	3	21

Table 6 presents the habitat characteristics of the shale/cobble sites. All sites were sampled at a depth of between 2.5 and 3.0 meters. The lake level at Burlington Harbor was 94.96 feet at the time of sampling . Cobble, shale, and gravel comprised at least 70 percent of the bottom substrate at all sites sampled. The percent composition of boulder ranged from 5 to 15 percent, and sand comprised 5 to 25 percent of the bottom substrate.

Macrophytes observed at the sites covered from 5 to 80 percent of the bottom. *Myriophyllum sp* (Watermilfoil) was responsible for the high macrophyte composition at the Savage Point site. The most common macrophyte encountered was *Vallesneria sp* (Wild Celery), followed by *Heteranthera sp* (Waterstar Grass), *Najas flexilis* (Bushy Pondweed), *Myriophyllum sp* (Watermilfoil) and *Elodea sp* (Waterweed).

Periphyton observations shown in **Table 8** indicate that a diatom community was present at all sites except Province Point and Savage Point. At the Savage Point site, a thick covering of blue-green algae covered 90 percent of the substrate. Filamentous algae covered 5 to 10 percent of the substrate at five of the sites.

Table 6: Habitat characterization from eight shale/cobble sites in Northern Lake Champlain

% Substrate Composition	Cumber-land Head	Allen Point	Isle LaMotte	North Hero	Ladd Point	Knight Point	Savage Point	Province Point
Bedrock	-	5	-	-	-	-	-	-
Boulder	-	15	-	-	5	5	-	10
Cobble	50	65	60	75*	40	45	50	50
Gravel	25	5	25	25	30	25	30	35
Sand	25	15	15	5	25	25	20	5
Silt	-	-	-	+	+	+	+	+
%Periphyton								
Filamentous	-	5	5	-	5	-	-	-
Blue Green	-	5	5	-	10	10	90	90
Diatom	+	+	+	+	+	+	-	-
Tight Green	25	-	-	-	-	-	-	-
% Macrophyte	15	35	30	15	20	35	10	20
Depth (m)	3.0	2.0	2.5	2.5	2.5	2.0	3.0	2.0

The water quality conditions appear to be suitable for the growth of zebra mussels in most areas of Lake Champlain. Zebra mussels can survive and reproduce within a pH range of 7.4 to 9.4, and Calcium concentrations of at least 12 mg/l (Vermont ANR 1994). The Calcium concentrations in Lake Champlain range from 12 to 27 mg/l (Neil Kamman memo 1993). The water chemistry results from the 8 shale/cobble sites from this study are presented in **Table 7**. Calcium levels ranged from 13.5 mg/l (Allen Point) to 17.4 mg/l at the Cumberland Head site. According to O'Neill, (1996), calcium levels between 9 - 20mg/l will provide a low zebra mussel colonization potential. The pH, also within zebra mussel requirements, ranging from 7.68 at the Isle La Motte site to 8.75 at Savage Point. The alkalinity ranged from 36 to 49 mg/l and the conductance from 122 to 165 umho/cm.

Table 7: Summary of chemical water quality results

Sites	Cumber-land Head	Allen Point	Isle LaMotte	North Hero	Ladd Point	Knight Point	Savage Point	Province Point
pH (STD.un)	7.87	8.02	7.68	7.95	8.72	8.45	8.75	7.88
Alkalinity mg/l	49	37	46	45	46	49	49	36
Conductance umho/cm	165	165	165	155	151	151	160	122
Calcium mg/l	17.4	13.5	17	16.2	16.5	17.0	16.2	12.4
Temperature C⁰	24.5	24	24	24.5	25	24	24.5	24.5

Conclusions and Recommendations:

The shale/cobble macroinvertebrate survey has established two years of good pre-zebra mussel baseline data spanning the trophic ranges found within the northern part of Lake Champlain. The second year of data has allowed the temporal variability (between years at constant calendar period) of these communities to be assessed. Future monitoring and data analysis should be conducted to help further define the boundaries of natural temporal variability, determine what species are at risk, and describe changes to the habitat and biological integrity of the macroinvertebrate communities resulting from colonization of these areas by the zebra mussel.

The sampling effort put forth in this study can provide data with the ability to measure appropriate degrees of change in terms of community abundance and taxa richness at most sites. With the exception of the Savage Point site (10.6 percent SEM for taxa richness), all sites were within the targeted ranges of 20 percent SEM for density and 10 percent SEM for taxa richness. The data from several sites (**Table 3**) was very precise with very low percent SEM's for both density and richness. Maintaining the level of replication currently employed and assuming variability will remain within the observed ranges, it will be possible to measure 50 percent density or 30 percent richness changes at these sites.

As noted at several of the sites, although the overall community biometrics of density and richness didn't change, the Bio Index changed significantly due to shifts in the community composition caused by significant changes in the density of individual taxa. Some of this alteration in community composition is due to the exotic Gastropod *Bithnyia tentaculata* increasing in abundance at several of the sites. Other significant species density changes may be due in part to insect species hatches, or more or less favorable conditions related to habitat condition at a site for a specific species between the two years.

Overall, the monitoring of these sites has established a solid baseline of data for shale/cobble zone macroinvertebrate communities in Northern Lake Champlain. Future monitoring of these sites should yield valuable information on the status of these communities over time as the lake ecosystem changes.

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Appendix A: Listing Percent Composition of all Benthic Macroinvertebrates from Shale/Cobble sites Sampled in August 1995. (K.Pt.= Knight Point, A.P.= Allen Point, I.L.= Isle LaMotte N.H.= North hero School, L.Pt.= Ladd Point, C.H.= Cumberland Head, S.Pt.= Savage Point, P.Pt.= Province Point

	K.Pt.	A.Pt.	I.L.	N.H.	L.Pt.	C.H.	S.Pt.	P.Pt.	
Annelida									
Polychaeta									
Sabellidae									
Manayunkia speciosa		*<1*						*<1*	
Oligochaeta									
Enchytraeidae UID	*<1*								
Lumbricidae UID	*1.1*	*<1*		*<1*	*2.3*		*<1*	*<1*	
Lumbriculidae UID	*<1*	*<1*	*2.1*	*<1*	*<1*		*<1*	*1.4*	
Naididae UID		*<1*		*<1*					
Tubificidae UID	*2.0*	*1.1*	*2.8*	*<1*	*<1*	*<1*	*<1*	*<1*	
Hirudinea									
Erpobellidae UID		*<1*	*<1*	*<1*	*<1*		*<1*		
Mooreobdella microstoma								*<1*	
Glossiphonidae UID								*<1*	
Albogiossiphonia heteroclita	*<1*			*<1*			*<1*	*<1*	
Batracobdella phalera								*<1*	
B. sp						*<1*			
Glossiphonia complanata	*<1*		*1.7*	*<1*	*<1*	*<1*	*<1*	*<1*	
Helobdella elongata		*<1*							
H. fusca			*<1*	*<1*	*<1*		*<1*	*<1*	
H. triseralis	*<1*		*<1*	*<1*	*<1*		*<1*		
Placobdella montifera		*<1*							
Platyhelminthes									
Turbellaria									
Tricladida									
Planariidae									
Cura sp.						*<1*			
Dugesia sp.		*<1*	*<1*	*<1*	*<1*	*<1*	*<1*	*1.2*	*1.2*
Rhabdocoela UID	*<1*	*<1*	*<1*	*<1*	*<1*		*<1*	*<1*	
Gastropoda									
Amnicola limosa		*1.9*	*5.7*	*6.3*	*6.1*	*8.8*	*<1*	*2.3*	*24.2*
Bithynia tentaculata	*52.4*	*<1*	*36.2*	*40.6*	*30.2*	*2.5*	*45.2*		
Ferrissia californica		*<1*						*<1*	
Fossaria obrussa					*<1*				
Gillia altilis					*<1*		*<1*	*<1*	
Goniobasis livescens			*<1*	*<1*	*<1*				
Gyraulus deflectus		*2.8*		*<1*	*1.0*	*3.5*		*<1*	
G. parous	*<1*	*<1*	*1.7*	*1.4*	*<1*		*<1*	*<1*	
Helisoma anceps			*<1*		*<1*				*<1*

	K.Pt.	A.P.	I.M.	N.H.	L.P.	C.H.	S.P.	P.P
Helisoma campanulata	<1	<1			<1			
H. trivolvis	<1		<1	1.0			<1	7.9
Lyogyrus pupoidea	<1	<1		<1				
Promenetus exacuous	<1		1.9	<1	<1			<1
Physa heterostropha	1.9	<1	1.6	3.9	5.8	5.5	3.0	
P. sp.								3.5
Pyrgulopsis lustrica						<1		
Stagnicola catascopium	<1		8.0	11.1	5.7	7.2	7.7	
Valvata tricarinata	<1	9.3	1.1	10.0	<1	<1	1.2	3.5
V. sincera				<1		<1		
Viviparus georgianus		<1		<1				<1
Gastropoda UID		<1		<1		<1	<1	
Pelecypoda								
Bivalvia								
Unionidae UID<1	<1							
Pyganodon cataracta	<1				<1			
Elliptio complanata	<1	<1	1.1	<1	<1	<1	<1	2.1
Lampsilis radiata	<1	<1	<1	<1	<1	<1	<1	<1
Dreissena polymorpha						<1		
Pisidium adamsi	<1	<1	<1	<1	<1	<1	<1	<1
P. anicum	<1			<1			<1	
P. dubium								<1
P. casertanum1.5	1.2	2.5	1.7	3.0	1.6	1.8	2.8	
P. fallax				<1				
P. henslowanum	1.0		<1		<1		<1	<1
P. sp.	<1	1.9	<1	<1			<1	3.8
P. sp a	<1		<1					
P. sp b	<1							
P. walkeri		<1		<1	<1	<1	<1	<1
Sphaerium simule	<1			<1	<1	<1	<1	
S. corneum	1.4		2.0	1.2	<1	1.3	5.6	
S. striatum								<1
S. sp.						<1		3.3
Crustacea								
Amphipoda								
Gammarus fasciatus	5.0	4.3	18	5	7			33
Gammarus sp.		6	1.0	<1				
Pontoporeia affinis	<1							
Hyallela azteca		<1		<1	<1	<1		<1
Isopoda								
Asellus racovitzai								11.5
Decapoda								
Oronectes limosus			<1					
O. obscurus								<1
O. sp.			<1			<1		

	K.Pt.	A.P.	I.M.	N.H.	L.P.	C.H.	S.P.	P.P
Ephemeroptera								
Baetidae								
Psudocloeon sp.								
Ephemerellidae			<1					
Eurylophella sp.							<1	
Heptageniidae								
Stenacron interpunctatum				<1	<1			<1
Stenonema femoratum	<1			<1	<1	1.0	<1	
Leptophlebiidae unid			<1					
Siphlonuridae unid					<1			
Tricorythidae								
Tricorythodes sp.	<1							
Plecoptera								
Perlidae								
Acroneuria evoluta						<1		
Trichoptera								
Trichoptera UID			<1					
Brachycentridae								
B. micrasema rusticum						<1	<1	
B. micrasema sp.			<1	<1	<1			
Helicopsychidae								
Helicopsyche borealis	1.5		<1		<1	<1	10.9	
Hydropsychidae								
Cheumatopsyche sp.							<1	
Symphitopsyche morosa						<1		
Hydroptilidae								
Agraylea sp		2.4	<1	1.5			<1	1.6
Hydroptila sp.			<1	<1				<1
Ochrotrichia sp.		<1						
Oxyethira sp.		<1						
Lepidostomatidae								
Lepidostoma sp.				2.9		2.1		
Leptoceridae								
Ceraclea sp.					<1	<1	<1	
Mystacides sp.		<1			1.8			
Nectopsyche albida	<1		1.1	2.1	<1		<1	<1
N. sp.		<1						
Oecetis sp.	<1			<1		<1	<1	
Setodes sp.	<1				<1	<1	<1	
Triaenodes injusta					<1		<1	
T. sp.	<1							
T. tarda				<1			<1	<1
Limnephilidae								
Apatania sp.	<1				<1	<1	<1	
Psychoglypha sp.			<1	<1				
Pycnopsyche sp.	<1							
Hydatophylax sp.	<1					<1	<1	
Odontoceridae								
Psilotreta sp.	<1		<1			4.3	<1	<1
Polycentropodidae								
Nyctiophylax sp.							<1	

	K.Pt.	A.P.	I.M.	N.H.	L.P.	C.H.	S.P.	P.P.
Polycentropus sp.	<1	4.7		<1	<1	<1	<1	<1
Philopotomiidae								
Dolophilodes sp.					<1			
Uenoidae								
Neophylax sp.	3.6		2.9	<1	7.9	<1	6.1	
Diptera								
Ceratopogonidae								
Bezzia sp.		<1						<1
Chironomidae								
Ablabesmyia sp.		<1	1.0		<1	<1	<1	
Chironomus sp.			1.4					
Cladotanytarsus sp.								<1
Cladopelma sp.		<1		<1				
Cricotopus sp.	<1	<1		<1	<1	<1	<1	<1
Cryptochironomus sp.						<1		
Dicrotendipes neomodestus	<1			<1				<1
Dicrotendipes sp			<1				<1	<1
Endochironomus sp.		<1						<1
Glyptotendipes sp.						<1		<1
Labrudinia sp.								<1
Micropsectra sp.		<1			<1	<1	9.0	<1
Nanocladius sp.		<1						
Orthocladiinae UID								
Parachironomus sp.		<1		<1	<1		<1	
Paratanytarsus sp.	<1	<1		<1				<1
Pseudochironomus sp.	<1				3.6	46.1		
Procladium sp.	<1	<1		<1				
Psectrocladius sp.		<1	<1					
Polypedilum fallax						<1		
P. nubeculosum			<1					
Sphaeromias sp.								
Stictochironomous sp.					<1			
Thienemanniella sp.	<1					<1	<1	
Thienemannemyia sp.						<1		
Tanytarsus sp.								
Tribelos sp.				<1	<1	<1		
Xenochironomus sp.		<1	<1	<1				
Culicidae								
Culicoides sp								<1
Odonata								
Epicordulia princeps								<1
Neurocordulia sp		<1						
Argia sp.							<1	
Enallagma sp.		<1						
Lepidoptera								
Pyralidae UID								<1
Petrophila sp.				<1	2.3	1.8		
Acentria sp.		<1						
Eoparargyractis sp.	<1							
Neuroptera								
Neuroptera UID	<1							

	K.Pt.	A.P.	I.M.	N.H.	L.P.	C.H.	S.P.	P.P.
Megaloptera								
Nigronia sp.					<1		<1	
Sialis sp.		<1		<1	<1		<1	
Coleoptera								
Elmidae								
Dubiraphia sp.	4.7			<1	1.5	1.2	<1	<1
D. vittata	<1				<1	<1	<1	
Macronychus glabratus							<1	
Stenelmis bicarinata	<1					<1		<1
S. crenata								
S. quadrimaculata	<1		<1		<1		<1	
Stenelmis sp.	7.9	<1	2.0	<1	1.1	3.6	1.1	<1
Haliplidae								
Haliplus sp.				<1	<1			<1
Berosus sp.			<1					
Psephenidae								
Ectopria nervosa	<1			<1			<1	
Psephenus herricki	<1		<1		<1	<1	<1	
Ouliminius latisculus						<1		

Appendix B: Raw count data (# per 1/4 square meter) of Macroinvertebrate Taxa from the eight Shale/Cobble Littoral Zone sites sampled from Lake Champlain in 1995.

Allen Point site 1995

Order	Genera	Species	Count 1	Count 2	Count 3	Count 4	Count 5	Count 6
COLEOPTERA	DUBIRAPHIA	sp	4	8	5	0	5	3
	DUBIRAPHIA	vittata	0	0	1	0	1	0
	STENELMIS	sp	6	5	1	1	1	4
	STENELMIS	quadrimaculata	1	0	0	0	1	0
	PSEPHENUS	herricki	1	0	0	0	0	0
	HALIPLUS	sp	0	4	3	0	4	1
DIPTERA	SPHAEROMIAS	sp	0	0	1	0	0	0
	ABLABESMYIA	sp	1	1	0	2	2	0
	CRICOTOPUS	sp	0	0	0	0	0	1
	MICROTENDIPES	sp	0	1	1	1	0	0
	PARACHIRONOMUS	sp	1	0	0	0	1	1
	PSEUDOCHIRONOMUS	sp	5	5	25	7	1	15
	TRIBELOS	sp	0	0	2	1	0	4
	XENOCHIRONOMUS	sp	0	1	0	0	0	0
EPHEMEROPTERA	STENACRON	interpunctatum	0	0	0	2	0	2
	STENONEMA	femoratum	4	10	0	16	5	10
	SIPHLONURIDAE	unid	0	0	0	0	0	1
TRICHOPTERA	MICRASEMA	sp	1	0	0	0	0	0
	HELICOPSYCHE	borealis	2	2	0	1	2	1
	CERACLEA	sp	0	0	1	0	0	2
	NECTOPSYCHE	albida	0	2	2	2	2	2
	SETODES	sp	1	0	1	0	1	0
	TRIAENODES	injusta	0	1	0	2	0	0
	APATANIA	sp	0	4	1	0	4	0
	DOLOPHILODES	sp	0	0	1	0	0	0
	POLYCENTROPUS	sp	3	1	6	1	2	1
	NEOPHYLAX	sp	23	23	23	17	17	23
MEGALOPTERA	NIGRONIA	sp	0	0	0	0	1	0
	SIALIS	sp	0	1	0	0	0	0
LEPIDOPTERA	PETROPHILA	sp	8	6	4	8	1	10
AMPHIPODA	GAMMARUS	fasciatus	15	24	11	27	20	20
	HYALLELA	azteca	0	2	0	0	0	0
DECAPODA	ORONECTES	sp	0	0	0	1	0	1
GASTROPODA	AMNICOLA	limosa	19	16	5	14	53	34

Order	Genera	Species	Count 1	Count 2	Count 3	Count 4	Count 5	Count 6
	GILLIA	altilis	0	0	0	0	1	0
	BITHYNIA	tentaculata	85	88	103	50	102	54
GASTROPODA	GONIOBASIS	livescens	0	0	0	1	0	0
	VALVATA	tricarinata	7	0	3	1	3	0
	STAGNICOLA	catascopium	16	18	29	2	22	4
	PHYSA	heterostropha	9	22	11	8	26	17
	GYRAULUS	parvus	0	0	0	0	1	0
	GYRAULUS	deflectus	8	21	10	7	11	0
	HELISOMA	campanulata	0	0	4	0	3	0
	PROMENETUS	exacuous	0	0	0	0	1	0
BIVALVIA	PISIDIUM	casertanum	4	5	15	3	17	5
	PISIDIUM	henslowanum	0	0	0	0	1	0
	PISIDIUM	walkeri	0	2	0	0	0	0
	PISIDIUM	amnicum	0	2	0	0	0	1
	SPHAERIUM	corneum	2	5	1	0	5	0
	SPHAERIUM	simule	1	0	0	0	0	0
	PYGANODON	cataracta	1	0	0	0	0	0
	ELLIPTIO	complanata	1	7	2	0	0	2
	LAMPSILIS	radiata	1	0	2	1	0	1
TRICLADIDA	DUGESIA	sp	0	0	1	0	0	1
RHABDOCOELA	UID		0	0	1	0	0	0
OLIGOCHAETA	TUBIFICIDAE	unid	5	2	6	0	0	0
	LUMBRICULIDAE	unid	3	3	2	3	0	1
	LUMBRICIDAE	UID	10	10	5	3	5	4
HIRUDINEA	GLOSSIPHONIA	complanata	8	2	0	1	0	1
	HELOBDELLA	fusca	0	0	1	1	0	0
	HELOBDELLA	triseralis	0	0	0	0	4	1
	ERPOBDELLIDAE	unid	0	1	0	1	0	1

Cumberland Head site 1995

Order	Genera	Species	Count 1	Count 2	Count 3	Count 4	Count 5
COLEOPTERA	DUBIRAPHIA	sp	24	7	13	2	3
	DUBIRAPHIA	vittata	2	1	18	9	0
	OULIMNIUS	latiusculus	0	0	1	0	0
	STENELMIS	sp	63	17	28	12	20
	STENELMIS	bicarinata	4	3	4	3	1
	PSEPHENUS	herricki	0	0	1	0	0
DIPTERA	ABLABESMYIA	sp	0	0	3	3	1
	CRICOTOPUS	sp	1	0	0	0	0
	CRYPTOCHIRONOMUS	sp	1	0	0	0	0
	DICROTENDIPES	sp	2	2	0	0	0
	GLYPTOTENDIPES	sp	0	1	1	1	0
	MICROTENDIPES	sp	111	64	55	90	29
	POLYPEDILUM	fallax	1	0	0	1	1
	PSEUDOCHIRONOMUS	sp	472	412	304	311	273
	STICTOCHIRONOMUS	sp	8	6	6	3	2
	THIENEMANNIELLA	sp	1	0	0	0	0
	THIENEMANNEMYIA	sp	1	0	2	0	0
	TRIBELOS	sp	18	6	5	1	0
EPHEMEROPTERA	STENONEMA	femoratum	13	2	10	14	0
TRICHOPTERA	MICRASEMA	rusticum	2	2	6	4	6
	HELICOPSYCHE	borealis	2	3	3	7	5
	SYMPHITOPSYCHE	morosa	0	0	0	0	1
	LEPIDOSTOMA	sp	20	2	12	23	26
	CERACLEA	sp	1	4	2	0	1
	OECETIS	sp	1	0	1	0	0
	SETODES	sp	1	2	2	1	4
	APATANIA	sp	3	4	2	3	8
	HYDATOPHYLAX	sp	0	0	0	3	0
	PSILOTRETA	sp	34	27	36	44	26
	POLYCENTROPUS	sp	1	2	8	10	8
	NEOPHYLAX	sp	2	1	3	0	15
PLECOPTERA	ACRONEURIA	evoluta	0	0	0	0	1
LEPIDOPTERA	PETROPHILA	sp	2	8	21	10	31
AMPHIPODA	GAMMARUS	fasciatus	2	0	4	0	0
	HYALLELA	azteca	2	0	1	23	3
GASTROPODA	UNID		0	1	0	0	2
	AMNICOLA	limosa	2	23	5	0	3

Order	Genera	Species	Count 1	Count 2	Count 3	Count 4	Count 5
	PYRGULOPSIS	lustrica	0	1	0	0	0
GASTROPODA	BITHYNIA	tentaculata	12	50	9	20	5
	VALVATA	tricarinata	0	0	0	1	0
	VALVATA	sincera	0	1	0	0	0
	STAGNICOLA	catascopium	28	144	61	14	30
	PHYSA	heterostropha	37	51	51	35	37
BIVALVIA	PISIDIUM	casertanum	11	21	22	5	4
	SPHAERIUM	sp	4	4	2	0	0
	SPHAERIUM	corneum	22	5	11	9	4
	SPHAERIUM	simule	3	11	3	3	3
	ELLIPTIO	complanata	2	1	2	1	0
	LAMPSILIS	radiata	4	8	3	4	3
	DREISSENA	polymorpha	0	1	1	0	0
TRICLADIDA	DUGESIA	sp	10	9	7	1	2
	CURA	sp	2	1	0	0	0
OLIGOCHAETA	TUBIFICIDAE	unid	4	7	5	1	0
HIRUDINEA	BATRACOBDELLA	sp	0	1	0	0	1
	GLOSSIPHONIA	complanata	1	5	8	4	1

Isle LaMotte site 1995

Order	Genera	Species	Count 1	Count 2	Count 3	Count 4	Count 5
COLEOPTERA	DUBIRAPHIA	sp	40	24	25	26	49
	DUBIRAPHIA	vittata	8	0	9	1	2
	STENELMIS	sp	33	61	62	56	62
	STENELMIS	bicarinata	0	1	1	0	1
	STENELMIS	quadrimaculata	1	4	2	7	7
	ECTOPRIA	nervosa	2	2	1	3	3
	PSEPHENUS	herricki	2	1	0	3	3
DIPTERA	ABLABESMYIA	sp	1	0	0	0	0
	CRICOTOPUS	sp	0	0	0	1	0
	DICROTENDIPES	neomodestus	0	0	0	1	0
	MICROTENDIPES	sp	0	0	1	0	1
	NANOCLADIUS	sp	2	0	0	0	0
	PARATANYTARSUS	sp	1	0	1	0	0
	PROCLADIUS	sp	0	0	0	2	0
	PSEUDOCHIRONOMUS	sp	0	0	1	0	0
	TANYTARSUS	sp	0	0	1	1	0
	THIENEMANNIELLA	sp	0	0	0	1	0
EPHEMEROPTERA	STENONEMA	femoratum	2	0	0	0	0
	TRICORYTHODES	sp	1	0	0	0	1
TRICHOPTERA	HELICOPSYCHE	borealis	21	5	8	8	12
	LEPIDOSTOMA	sp	0	0	0	3	0
	MYSTACIDES	sp	1	0	0	0	0
	NECTOPSYCHE	albida	4	4	7	0	3
	OECETIS	sp	1	0	0	0	0
	SETODES	sp	3	0	0	0	0
	TRIAENODES	sp	1	0	0	0	1
	APATANIA	sp	17	3	3	4	3
	HYDATOPHYLAX	sp	0	1	1	0	0
	PYCNOPSYCHE	sp	1	0	0	0	0
	PSILOTRETA	sp	18	4	2	8	2
	POLYCENTROPUS	sp	0	3	0	0	0
	NEOPHYLAX	sp	13	36	28	27	24
LEPIDOPTERA	EOPARARGYRACTIS	sp	0	0	1	0	0
AMPHIPODA	GAMMARUS	fasciatus	58	18	46	24	22
	PONTOPOREIA	affinis	0	0	1	1	0
GASTROPODA	AMNICOLA	limosa	6	9	11	12	29
	LYOGYRUS	pupoidea	0	0	0	1	0

Order	Genera	Species	Count 1	Count 2	Count 3	Count 4	Count 5
	BITHYNIA	tentaculata	383	241	444	419	328
GASTROPODA	VALVATA	tricarinata	1	0	0	1	0
	STAGNICOLA	catascopium	4	3	10	8	4
	PHYSA	heterostropha	13	14	10	19	10
	GYRAULUS	parvus	0	1	1	1	1
	GYRAULUS	deflectus	6	17	32	19	23
	HELISOMA	campanulata	2	1	5	18	1
	HELISOMA	trivolvis	2	1	5	18	1
	PROMENETUS	exacuous	1	3	4	7	3
BIVALVIA	PISIDIUM	sp	8	1	0	0	5
	PISIDIUM	casertanum	15	5	11	17	7
	PISIDIUM	henslowanum	13	3	9	4	6
	PISIDIUM	amnicum	3	1	1	1	2
	PISIDIUM	sp a	1	0	0	0	1
	PISIDIUM	sp b	0	0	1	0	0
	SPHAERIUM	corneum	15	13	7	10	5
	SPHAERIUM	simule	0	0	0	0	1
	UNIONIDAE	unid	1	0	0	0	0
	PYGANODON	cataracta	0	0	0	1	0
	ELLIPTIO	complanata	6	3	3	6	3
	LAMPSILIS	radiata	1	1	3	1	2
TRICLADIDA	DUGESIA	sp	1	1	0	1	0
OLIGOCHAETA	TUBIFICIDAE	unid	33	4	10	19	6
	LUMBRICULIDAE	unid	1	2	2	2	1
	ENCHYTRAEIDAE	unid	0	1	0	1	0
	LUMBRICIDAE	UID	5	7	12	7	9
HIRUDINEA	ALBOGLOSSIPHONIA	heteroclita	0	1	1	0	1
	GLOSSIPHONIA	complanata	1	1	2	1	3
	HELOBDELLA	triseralis	0	1	0	0	0
NEUROPTERA	UID		0	0	1	0	0

Knight Point site 1995

Order	Genera	Species	Count 1	Count 2	Count 3	Count 4	Count 5
COLEOPTERA	STENELMIS	sp	5	15	13	13	12
	STENELMIS	quadrimaculata	1	1	1	2	2
	PSEPHENUS	herricki	1	0	0	0	0
	BEROSUS	sp	0	2	2	1	2
DIPTERA	XENOCHIRONOMUS	sp	0	3	0	1	1
EPHEMEROPTERA	PSEUDOCLOEON	sp	0	0	1	0	0
	LEPTOPHLEBIIDAE	unid	0	0	1	0	0
TRICHOPTERA	MICRASEMA	sp	0	0	0	0	1
	HELICOPSYCHE	borealis	0	0	0	3	1
	AGRAYLEA	sp	0	1	5	2	1
	HYDROPTILA	sp	1	0	0	0	1
	NECTOPSYCHE	albida	0	3	10	10	9
	PSYCHOGLYPHA	sp	0	0	2	0	0
	PSILOTRETA	sp	0	0	0	1	1
	NEOPHYLAX	sp	23	20	25	4	14
AMPHIPODA	GAMMARUS	sp	9	5	4	11	0
	GAMMARUS	fasciatus	76	130	80	109	109
DECAPODA	ORONECTES	limosus	0	0	0	0	1
GASTROPODA	AMNICOLA	limosa	25	10	55	58	35
	BITHYNIA	tentaculata	191	145	274	271	161
	GONIOBASIS	livescens	0	1	1	0	0
	VALVATA	tricarinata	4	5	3	10	10
	STAGNICOLA	catascopium	32	5	85	75	34
	PHYSA	heterostropha	5	7	21	8	5
	GYRAULUS	parvus	5	5	10	20	10
	GYRAULUS	deflectus	7	12	5	2	2
	HELISOMA	trivolvis	2	4	7	0	1
	PROMENETUS	exacuous	9	2	7	22	17
BIVALVIA	PISIDIUM	sp	0	0	5	7	8
	PISIDIUM	casertanum	5	5	18	18	26
	PISIDIUM	henslowanum	0	2	4	4	6
	PISIDIUM	sp a	0	0	2	1	0
	SPHAERIUM	corneum	6	10	15	16	13
	ELLIPTIO	complanata	6	8	6	10	4
	LAMPSILIS	radiata	3	2	2	2	1
TRICLADIDA	DUGESIA	sp	0	0	6	0	6
RHABDOCOELA	UID		0	0	0	1	0

Order	Genera	Species	Count 1	Count 2	Count 3	Count 4	Count 5
OLIGOCHAETA	TUBIFICIDAE	unid	7	13	23	15	23
OLIGOCHAETA	LUMBRICULIDAE	unid	10	6	16	16	13
HIRUDINEA	GLOSSIPHONIA	complanata	12	9	12	12	6
	HELOBDELLA	fusca	0	0	0	1	3
	HELOBDELLA	triseralis	0	2	4	3	3
	ERPOBDELLIDAE	unid	0	0	0	1	0

Ladd Point site 1995

Order	Genera	Species	Count 1	Count 2	Count 3	Count 4	Count 5
COLEOPTERA	DUBIRAPHIA	sp	7	1	2	1	10
	STENELMIS	sp	8	2	0	0	3
	ECTOPRIA	nervosa	0	0	1	0	0
	HALIPLUS	sp	0	2	2	1	1
DIPTERA	ABLABESMYIA	sp	1	0	0	0	1
	CLADOPELMA	sp	0	0	0	0	1
	CRICOTOPUS	sp	0	1	1	0	0
	DICROTENDIPES	neomodestus	2	0	0	0	0
	MICROTENDIPES	sp	0	0	0	0	1
	PARACHIRONOMUS	sp	1	2	0	1	1
	PARATANYTARSUS	sp	1	0	0	0	0
	PROCLADIUS	sp	0	0	1	0	3
	PSECTROCLADIUS	sp	0	1	0	1	0
	TANYTARSUS	sp	0	0	1	0	0
	TRIBELOS	sp	0	0	0	0	1
EPHEMEROPTERA	STENACRON	interpunctatum	0	0	0	0	1
	STENONEMA	femoratum	0	1	0	1	2
TRICHOPTERA	MICRASEMA	sp	3	0	4	4	0
	AGRAYLEA	sp	16	9	24	3	3
	HYDROPTILA	sp	0	0	1	0	0
	MYSTACIDES	sp	23	15	20	9	0
	NECTOPSYCHE	albida	29	25	12	10	1
	OECETIS	sp	0	1	1	0	0
	TRIAENODES	tarda	2	0	0	0	0
	PSYCHOGLYPHA	sp	0	0	1	0	0
	POLYCENTROPUS	sp	1	1	2	1	0
	NEOPHYLAX	sp	4	2	10	0	14
MEGALOPTERA	SIALIS	sp	2	3	0	3	1
LEPIDOPTERA	PETROPHILA	sp	0	0	0	1	0
AMPHIPODA	GAMMARUS	sp	20	0	0	0	0
	GAMMARUS	fasciatus	110	32	26	4	10
	HYALLELA	azteca	7	0	2	1	1
GASTROPODA	UNID		1	3	0	3	0
	AMNICOLA	limosa	37	67	48	21	45
	LYOGYRUS	pupoidea	0	0	1	0	0
	BITHYNIA	tentaculata	243	218	551	274	162
	GONIOBASIS	livescens	0	0	0	1	1

Order	Genera	Species	Count 1	Count 2	Count 3	Count 4	Count 5
	VALVATA	tricarinata	79	77	155	34	12
GASTROPODA	VALVATA	sincera	1	0	0	0	0
	VIVIPARUS	georgianus	1	0	0	0	0
	FOSSARIA	obrussa grp	4	0	3	0	0
	STAGNICOLA	catascopium	10	48	55	129	156
	PHYSA	heterostropha	26	50	20	24	22
	GYRAULUS	parvus	8	12	15	8	7
	GYRAULUS	deflectus	12	15	10	0	0
	HELISOMA	anceps	6	11	4	0	0
	HELISOMA	trivolvis	3	6	13	9	6
	PROMENETUS	exacuous	4	5	6	2	0
BIVALVIA	PISIDIUM	sp	12	5	2	0	0
	PISIDIUM	casertanum	13	19	14	8	10
	PISIDIUM	walkeri	0	0	1	1	0
	PISIDIUM	fallax	0	0	1	0	0
	PISIDIUM	amnicum	0	0	0	1	0
	SPHAERIUM	corneum	11	11	7	6	8
	SPHAERIUM	simule	1	2	0	2	1
	ELLIPTIO	complanata	3	2	3	3	1
	LAMPSILIS	radiata	3	2	2	2	1
TRICLADIDA	DUGESIA	sp	7	2	2	1	0
RHABDOCOELA	UID		2	1	0	1	0
OLIGOCHAETA	NAIDIDAE	unid	6	0	6	0	0
	TUBIFICIDAE	unid	0	1	0	0	3
	LUMBRICULIDAE	unid	5	7	8	1	3
	LUMBRICIDAE	UID	4	6	2	3	4
HIRUDINEA	GLOSSIPHONIIDAE	unid	9	3	4	0	0
	ALBOGLOSSIPHONIA	heteroclita	1	0	0	0	0
	GLOSSIPHONIA	complanata	1	3	3	0	3
	HELOBDELLA	fusca	4	0	2	0	0
	HELOBDELLA	triseralis	1	3	1	1	1
	ERPOBDELLIDAE	unid	1	1	1	0	0

North Hero School site 1995

Order	Genera	Species	Count 1	Count 2	Count 3	Count 4	Count 5
COLEOPTERA	DUBIRAPHIA	sp	2	2	0	0	0
	DUBIRAPHIA	vittata	1	5	0	2	2
	MACRONYCHUS	glabratus	1	0	0	0	0
	STENELMIS	sp	9	16	3	5	19
	STENELMIS	quadrimaculata	0	3	0	0	1
	ECTOPRIA	nervosa	7	8	3	3	7
	PSEPHENUS	herricki	0	1	2	1	4
DIPTERA	CRICOTOPUS	sp	1	1	2	0	5
	DICROTENDIPES	sp	0	1	0	0	0
	MICROTENDIPES	sp	0	0	1	0	0
	PARACHIRONOMUS	sp	0	0	1	0	0
	THIENEMANNIELLA	sp	0	0	0	1	0
EPHEMEROPTERA	EURYLOPHELLA	sp	1	0	0	0	0
	STENONEMA	femoratum	0	0	0	2	6
TRICHOPTERA	MICRASEMA	rusticum	3	1	1	0	3
	AGAPETUS	sp	1	1	0	1	0
	HELICOPSYCHE	borealis	79	81	105	81	162
	CHEUMATOPSYCHE	sp	3	1	1	3	10
	AGRAYLEA	sp	1	1	0	1	0
	LEPIDOSTOMA	sp	12	22	17	24	62
	CERACLEA	sp	0	0	0	0	2
	NECTOPSYCHE	albida	5	1	1	0	0
	OECETIS	sp	0	0	1	1	2
	SETODES	sp	2	0	3	0	2
	TRIAENODES	injusta	2	0	0	0	0
	TRIAENODES	tarda	1	0	0	0	1
	APATANIA	sp	2	0	9	0	4
	HYDATOPHYLAX	sp	0	0	0	0	1
	PSILOTRETA	sp	5	6	2	4	7
	NYCTIOPHYLAX	sp	1	1	0	1	0
	POLYCENTROPUS	sp	4	2	5	2	11
	NEOPHYLAX	sp	66	62	79	32	48
ODONATA	ARGIA	sp	2	2	1	1	1
MEGALOPTERA	NIGRONIA	sp	1	0	1	0	1
	SIALIS	sp	3	0	0	1	0
AMPHIPODA	GAMMARUS	fasciatus	5	4	0	4	1
GASTROPODA	UNID		0	0	0	1	0

Order	Genera	Species	Count 1	Count 2	Count 3	Count 4	Count 5
	AMNICOLA	limosa	40	22	15	20	13
GASTROPODA	GILLIA	altilis	0	0	1	0	0
	BITHYNIA	tentaculata	673	396	319	280	432
	VALVATA	tricarinata	15	12	3	17	13
	STAGNICOLA	catascopium	122	61	50	68	58
	PHYSA	heterostropha	51	37	23	15	15
	GYRAULUS	parvus	5	1	0	0	2
	GYRAULUS	deflectus	0	0	4	0	2
	HELISOMA	trivolvis	0	2	0	0	0
BIVALVIA	PISIDIUM	sp	2	7	5	11	5
	PISIDIUM	casertanum	18	35	11	12	8
	PISIDIUM	henslowanum	0	3	0	0	0
	PISIDIUM	walkeri	0	3	0	0	0
	PISIDIUM	amnicum	0	1	0	0	0
	SPHAERIUM	corneum	57	33	42	82	46
	SPHAERIUM	simule	15	4	3	6	13
	ELLIPTIO	complanata	2	1	2	1	0
	LAMPSILIS	radiata	4	8	3	4	3
TRICLADIDA	DUGESIA	sp	18	12	3	14	12
RHABDOCOELA	UID		0	0	0	4	0
OLIGOCHAETA	TUBIFICIDAE	unid	6	4	3	4	2
	LUMBRICULIDAE	unid	10	13	6	12	4
	LUMBRICIDAE	UID	6	2	2	6	1
HIRUDINEA	ALBOGLOSSIPHONIA	heteroclita	1	0	0	0	0
	GLOSSIPHONIA	complanata	7	5	7	7	7
	HELOBDELLA	fusca	2	0	1	0	0
	HELOBDELLA	triseralis	3	1	1	0	1
	ERPOBDELLIDAE	unid	1	0	0	0	0

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Order	Genera	Species	Count 1	Count 2	Count 3	Count 4	Count 5	Count 6	Count 7	Count 8
COLEOPTERA	DUBIRAPHIA	sp	1	1	0	0	0	0	1	0
	STENELMIS	sp	3	1	1	0	0	1	1	0
	STENELMIS	bicarinata	0	2	1	0	0	1	1	0
	HALIPLUS	sp	1	0	0	0	0	0	0	0
DIPTERA	BEZZIA	sp	2	0	0	1	1	0	0	0
	CULICOIDES	sp	0	0	1	0	0	0	0	0
	CLADOTANYTARSUS	sp	0	0	1	0	0	0	0	0
	CRICOTOPUS	sp	0	0	0	0	0	0	1	0
	DICROTENDIPES	neomodestus	0	1	0	0	0	0	0	0
	ENDOCHIRONOMUS	sp	1	2	0	0	0	1	2	0
	GLYPTOTENDIPES	sp	0	0	0	0	0	1	1	2
	LABRUNDINIA	sp	0	0	1	0	0	0	0	0
	PARACHIRONOMUS	sp	1	3	0	0	1	0	0	0
	PARATANYTARSUS	sp	0	1	0	0	0	1	1	0
EPHEMEROPTERA	STENACRON	interpunctatu m	0	0	0	0	0	2	0	0
TRICHOPTERA	AGRAYLEA	sp	13	8	2	4	4	3	8	0
	HYDROPTILA	sp	0	0	0	0	0	0	2	0
	NECTOPSYCHE	albida	1	2	1	2	1	1	2	1
	TRIAENODES	tarda	0	0	0	0	1	0	0	0
	PSILOTRETA	sp	0	0	1	0	0	0	0	0
	POLYCENTROPUS	sp	0	0	1	0	1	1	1	0
ODONATA	EPICORDULIA	princeps	0	0	0	0	1	0	0	0
LEPIDOPTERA	PYRALIDAE	unid	0	1	0	0	0	0	0	0
AMPHIPODA	GAMMARUS	fasciatus	122	121	75	141	83	148	103	62
	HYALLELA	azteca	1	1	0	0	0	0	1	0
DECAPODA	ORONECTES	obscurus	0	0	0	1	0	0	0	0
GASTROPODA	AMNICOLA	limosa	119	113	53	32	57	44	98	121
	GILLIA	altilis	1	0	1	0	0	0	2	2
	VALVATA	tricarinata	18	22	16	0	6	2	9	21
	VIVIPARUS	georgianus	0	0	0	1	0	0	1	0
	FERRISSIA	californica	1	0	0	0	0	3	7	3
	PHYSA	sp	4	18	6	7	7	19	10	23
	GYRAULUS	parvus	3	4	1	0	1	0	2	0
	HELISOMA	anceps	5	2	4	0	2	0	5	5
	HELISOMA	trivolvis	18	19	13	31	37	21	35	34
	PROMENETUS	exacuous	1	3	2	1	0	0	4	3

Order	Genera	Species	Count 1	Count 2	Count 3	Count 4	Count 5	Count 6	Count 7	Count 8
BIVALVIA	PISIDIUM	sp	6	18	42	3	2	2	10	19
	PISIDIUM	casertanum	6	11	18	4	6	4	8	19
BIVALVIA	PISIDIUM	henslowanum	0	0	2	0	0	0	0	0
	PISIDIUM	walkeri	1	0	0	1	0	0	0	1
	PISIDIUM	dubium	0	0	0	1	1	0	0	1
	SPHAERIUM	sp	4	18	30	13	3	3	13	4
	SPHAERIUM	simule	0	0	0	0	0	1	0	0
	SPHAERIUM	striatum	0	0	0	0	0	1	0	0
	ELLIPTIO	complanata	10	7	3	4	10	8	7	8
	LAMPSILIS	radiata	2	4	1	2	2	5	3	3
TRICLADIDA	DUGESIA	sp	10	9	10	1	0	0	0	3
RHABDOCOELA	UID		0	6	8	2	2	6	0	2
POLYCHEATA	MANAYUNKIA	speciosa	1	2	16	0	0	0	0	0
OLIGOCHAETA	TUBIFICIDAE	unid	1	2	2	0	0	0	0	0
	LUMBRICULIDAE	unid	3	3	5	7	6	4	6	5
	LUMBRICIDAE	UID	0	0	0	4	2	6	1	0
HIRUDINEA	ALBOGLOSSIPHONIA	heteroclita	0	0	0	0	1	1	0	0
	BATRACOBDELLA	phalera	0	0	0	0	0	2	1	1
	GLOSSIPHONIA	complanata	1	0	0	1	0	0	0	0
	HELOBDELLA	fusca	2	0	1	0	0	0	0	0
	MOOREOBDELLA	microstoma	3	1	0	1	1	2	1	0
HYDRACHNIDIA	UID		0	0	0	0	0	0	1	1

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Order	Genera	Species	Count 1	Count 2	Count 3	Count 4	Count 5
COLEOPTERA	STENELMIS	sp	0	0	0	1	0
DIPTERA	BEZZIA	sp	0	0	0	0	1
	ABLABESMYIA	sp	8	1	8	4	4
	CHIRONOMUS	sp	3	0	8	7	18
	CLADOPELMA	sp	0	0	1	0	0
	CRICOTOPUS	sp	1	0	0	0	3
	DICROTENDIPES	sp	1	1	1	2	6
	ENDOCHIRONOMUS	sp	1	0	0	0	0
	KRENOPELOPIA	sp	1	0	0	0	0
	PARACHIRONOMUS	sp	1	0	0	0	0
	PARATANYTARSUS	sp	1	0	4	2	2
	POLYPEDILUM	nubeculosum	0	0	0	0	2
	PROCLADIUS	sp	4	0	0	1	1
	PSECTROCLADIUS	sp	1	0	0	0	0
	TANYTARSUS	sp	1	0	5	3	0
	XENOCHIRONOMUS	sp	0	0	0	0	1
TRICHOPTERA	UNID		0	1	0	0	0
	AGRAYLEA	sp	13	4	6	31	7
	OCHROTRICHIA	sp	3	0	1	0	0
	OXYETHIRA	sp	1	0	5	3	0
	NECTOPSYCHE	sp	3	0	1	1	0
	POLYCENTROPUS	sp	30	23	21	23	19
ODONATA	ENALLAGMA	sp	1	0	0	0	0
	NEUROCORDULIA	sp	0	0	2	0	0
MEGALOPTERA	SIALIS	sp	3	2	1	2	2
LEPIDOPTERA	ACENTRIA	sp	0	0	2	2	0
AMPHIPODA	GAMMARUS	sp	34	16	32	43	23
	GAMMARUS	fasciatus	211	127	228	268	230
	HYALLELA	azteca	1	4	2	0	7
ISOPODA	ASELLUS	racovitzai	60	14	85	69	56
DECAPODA	ORONECTES	sp	0	0	1	0	0
GASTROPODA	UNID		0	1	1	1	1
	AMNICOLA	limosa	32	12	28	44	27
	LYOGYRUS	pupoidea	0	0	1	0	0
	BITHYNIA	tentaculata	1	2	2	0	1
	VALVATA	tricarinata	102	23	44	36	25
	VIVIPARUS	georgianus	3	3	2	1	1

Order	Genera	Species	Count 1	Count 2	Count 3	Count 4	Count 5
	FERRISSIA	californica	0	4	0	0	0
GASTROPODA	PHYSA	heterostropha	5	1	4	5	1
	GYRAULUS	parvus	2	2	1	1	4
	HELISOMA	anceps	2	0	0	2	1
	HELISOMA	campanulata	2	0	0	2	0
BIVALVIA	PISIDIUM	sp	4	3	13	20	8
	PISIDIUM	casertanum	3	10	2	14	2
	PISIDIUM	walkeri	1	2	0	1	0
	UNIONIDAE	unid	0	0	0	0	1
	ELLIPTIO	complanata	6	3	2	3	5
	LAMPSILIS	radiata	2	2	1	3	2
TRICLADIDA	DUGESIA	sp	1	2	3	4	0
RHABDOCOELA	UID		0	2	2	2	1
POLYCHEATA	MANAYUNKIA	speciosa	1	0	2	0	0
OLIGOCHAETA	NAIDIDAE	unid	3	0	4	0	0
	TUBIFICIDAE	unid	7	6	13	1	2
	LUMBRICULIDAE	unid	5	4	4	3	0
	LUMBRICIDAE	UID	4	3	0	2	0
HIRUDINEA	HELOBDELLA	elongata	2	2	0	0	0
	PLACOBDELLA	montifera	0	0	1	0	0
	ERPOBDELLIDAE	unid	0	1	0	0	0
HYDRACHNIDIA	UID		1	0	0	0	0