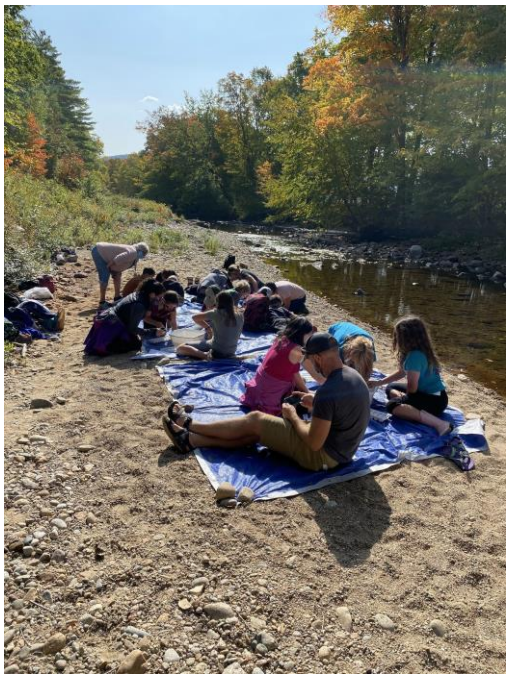
Volunteer Biological Assessment Program
Stream Data Collection Report for the Saco Watershed
2020



Green Mountain Conservation Group
P.O Box 95
236 Huntress Bridge Rd.
Effingham, NH 03882
(603) 539-1859
www.gmcg.org

Prepared by:

Emma Brandt, GMCG Education and Outreach Assistant, Americorps Member
Tara Schroeder, GMCG Education Coordinator

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ACKNOWLEDGEMENTS

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Volunteers & Staff

Emma Brandt, GMCG Education and Outreach Assistant, Americorps Member
Tara Schroeder, GMCG Education Coordinator
Moselle Spiller, GMCG Outreach Coordinator
Ben Nugent, New Hampshire Fish & Game Department
Blair Folts
Rich Fahy

Participating School Groups:

Ossipee Central School
Interlakes Elementary School
Sandwich Central School

Businesses:

Mad Cow Screen Print

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Introduction

Since 1997, the New Hampshire Department of Environmental Services (DES) has conducted stream surveys to determine the health of aquatic ecosystems. As part of these efforts, DES developed a preliminary screening protocol for 1st through 4th order streams that is appropriate for volunteers to evaluate the biological condition of aquatic macroinvertebrate communities. The goals of the protocol are as follows:

- To educate the public about water quality issues as interpreted through biological assessments;
- To build a constituency of individuals who will practice sound water quality management at the local level; and
- To build public support for water quality protection.

Since 2006, Green Mountain Conservation Group (GMCG) has collaborated with DES, NH Fish & Game Department and local volunteers and schools for the Volunteer Biological Assessment Program (VBAP). While NH DES no longer oversees the program "due to lack of staff support" according to David Neils, Chief Aquatic Pollution Biologist, GMCG continues to offer the VBAP program to schools in the Ossipee Watershed for educational purposes following the recommendation of NH DES and NH Fish & Game Department. In 2018 and 2019, the program expanded to additional schools and sites outside of the Ossipee Watershed, including parts of the Saco River Watershed in Conway, NH and Porter, ME. Due to Covid-19, many of the school groups that traditionally participate were unable to participate this year. Of the six sites sampled in 2020, one site was sampled in-person with student volunteers, three sites were sampled with virtual involvement from school groups, and two sites were sampled by GMCG staff for New Hampshire Fish & Game whose Covid-19 policies did not allow for volunteer or school group participation.

GMCG worked with students and teachers from three local schools across the Ossipee Watershed in New Hampshire to sample the six sites, collecting, sorting and analyzing macroinvertebrates either in person or virtually with GMCG staff onsite. This report contains the results of that sampling with additional data analysis to compare sites across the watershed and over time since some of these sites are year-round sampling sites for GMCG's RIVERS program (Regional Interstate Volunteers for the Ecosystems and Rivers of Saco). As monitoring continues, data will continue to be evaluated and analyzed for any trends or water quality issues.

Methods

A training session was held in person or virtually for students during a scheduled classroom period and consisted of the following components: macroinvertebrate identification skills; biomonitoring and macroinvertebrate tolerance levels; macroinvertebrate sampling protocols; and an introduction to watersheds; riparian ecosystems; and aquatic food chains. Additionally, student volunteers were trained to collect and record supplementary data for physical and chemical parameters of the rivers/streams, including: habitat assessments; stream measurements; pH; conductivity; temperature; dissolved oxygen and turbidity.

Sampling Sites

All six sampling sites were accessible, wadeable, approximately 200 feet in length, 1st through 4th order streams and contained appropriate sampling habitat (at least one riffle, one pool, and one run with mixed cobble substrate). Four of the sites were chosen in collaboration with New Hampshire Fish & Game due to their locations upstream of the Beech River dam. Two sites were located on the Dan Hole River, two on the Beech River, and all of these sites were in the town of Ossipee.The Beech River dam is under review to determine the impact of potential removal. In a draft review of the macroinvertebrate and fish survey assessments from this fall, New Hampshire Fish & Game states that removal of the dam would allow for fish and aquatic life passage, opening up about 25 miles of rivers and streams in the Beech River and Dan Hole River watershed (Nugent, 2020). Currently, water temperatures in mainstream sections of the Beech River and Dan Hole River exceed tolerable levels for wild brook trout. It is therefore important to allow access to colder tributaries and sections with groundwater contribution (Nugent, 2020). Understanding the macroinvertebrate communities upstream of the dam is important for determining the success of wild brook trout and other species of conservation concern in that area.

The Cold Brook site in Freedom was chosen for sampling due to a heating oil spill that occurred in downtown Freedom in late September. Due to this spill, there were concerns about the health of the river which raised the site's priority to be sampled in 2020.

Additional sites are sampled from spring through fall for RIVERS, and have been sampled by school groups in the past for VBAP periodically. While some schools sample their adopted VBAP site annually, some are on an every-other-year schedule due to combined classes. Sampling was scheduled throughout September and October and required three to four hours per site.

Data Collection

The data collection at each site and along the stream followed the same protocol. The protocol was as follows:

- A 500-micron mesh kicknet was placed perpendicular to stream flow and held firmly against the streambed with the opening of the net facing upstream to promote macro invertebrate collection.
- A collector would disturb the sample area (1/5 m^2) upstream of the net for a total of 60 seconds (30 second hand-scrub followed by a 30 second kick).
- The kicknet was carefully lifted out of the water and the contents of the net were emptied into a shallow container with a small amount of water. All organisms remaining on the net were carefully removed and added to the sample.
- The same process was repeated four additional times with each sample collected further upstream (spanning 200 feet). Collectively, active sampling time approximated five minutes within one square meter area at each sampling station.

Macroinvertebrate Sorting and Identification

For approximately 60 minutes, student volunteers, teachers and/or staff removed macroinvertebrates from the selected portion of the sample with spoons or pipettes and placed them into separate containers according to common attributes. After sorting, specimens were

identified to various coarse taxonomic groups. The number of macroinvertebrates within each taxonomic group was identified, calculated, and recorded, see Table 1. Students were assisted by GMCG staff and/or trained volunteers with the process of identifying the macroinvertebrates in the sample. When students were not present due to Covid-19, sorting was completed by GMCG staff then methods and findings were conveyed to students participating virtually.

Table 1. Total Macroinvertebrates Found Across the Watershed in 2020. For individual site macroinvertebrate counts see Appendix A.

Order	Common Name	Number of Macroinvertebrates Collected
Ephemerotera	Mayfly nymph	259
Plecoptera	Stonefly nymph	71
Trichoptera	Caddisfly larvae	145
Odonata	Dragonfly larvae	36
	Damselfly nymph	2
Diptera	Black fly larvae	10
	Midge larvae	2
	True flies	17
Megaloptera	Alderfly	0
	Hellgrammite	20
Coleoptera	Riffle Beetle	17
	Water Penny	30
	Beetle/Beetle like	5
Other	Crayfish	0
	Snails	0
	Aquatic Worms	53
	Scuds	0
	Sowbug	0
	Leech	0
	Water Mites	2

Biotic Index Computation

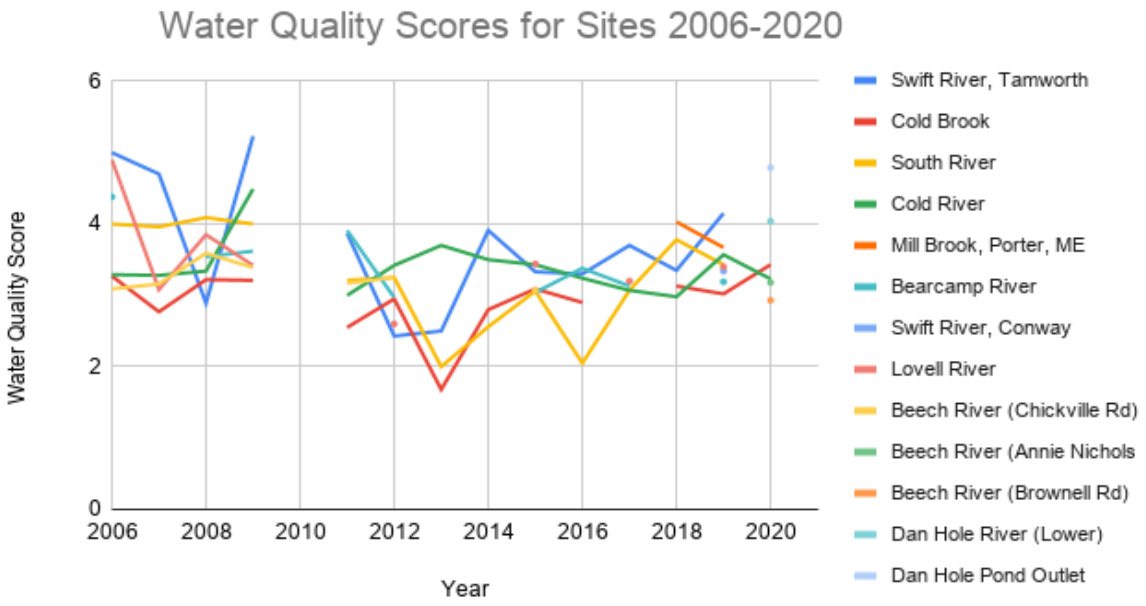
Biotic scores are based on pollution tolerance values ranging from 0 to 9 and are assigned to individual taxonomic groups. More tolerant groups have higher tolerance values and less tolerant groups have lower values. A standardized computational worksheet was used to compute the biotic scores for each sample site (stream/river). Taxonomic-specific biotic scores for individual samples were computed by multiplying the number of individual organisms by their respective tolerance value; summing the taxonomic-specific biotic scores; and then dividing the sum by the total number of individuals identified in the respective sample. Final biotic scores correspond to three interim narrative categories:

- Excellent (0 to 3.5)
- Good (3.5 to 4.8)
- Fairly Poor (greater than 4.8).

Table 2. Biotic Scores of Sampling Sites. Table 2 highlights the biotic score and the narrative category for each sampling site tested in the Ossipee Watershed. Four of the six scores fell in the "Excellent" category while two fell in the "Good" category.

School	Date	Location	Total Macros	Biotic Score	Water Quality Score
GMCG Staff	9/9/20	Dan Hole Pond Outlet	82	4.79	Good
GMCG Staff	9/9/20	Dan Hole Lower	69	4.04	Good
Sandwich Central School (SCS)	9/23/20	Cold River	185	3.227	Excellent
Ossipee Central School	10/6/20	Beech River-Annie Nichols Road	55	3.18	Excellent
Ossipee Central School	10/9/20	Beech River-Brownell Road	98	2.93	Excellent
SCS and Interlakes Elementary School	10/19/20	Cold Brook	183	3.43	Excellent

Figure 1. Water Quality Scores. Figure 1. shows changes in water quality scores over time at the sites sampled in 2020 and in years past. Scores appear to be variable over time, with some years of more pollution tolerant macroinvertebrates such as black fly larvae affecting the biotic score at sites such as Swift River and Cold River (2006, 2009). Overall, it appears that water quality scores are variable year-to-year.



Supplementary Data

The water chemistry and physical parameters of the stream were recorded. Physical parameters recorded included width/depth of the stream, canopy cover, observations of nearby erosion or human influence, turbidity, pH, conductivity and temperature. A multi-parameter submersible Hach water quality probe was used to collect pH, dissolved oxygen, conductivity and temperature data (see Table 3). Turbidity samples and pH samples were also taken at each site with Hach meters and pH was measured using equipment at the GMCG lab.

Water Quality Results

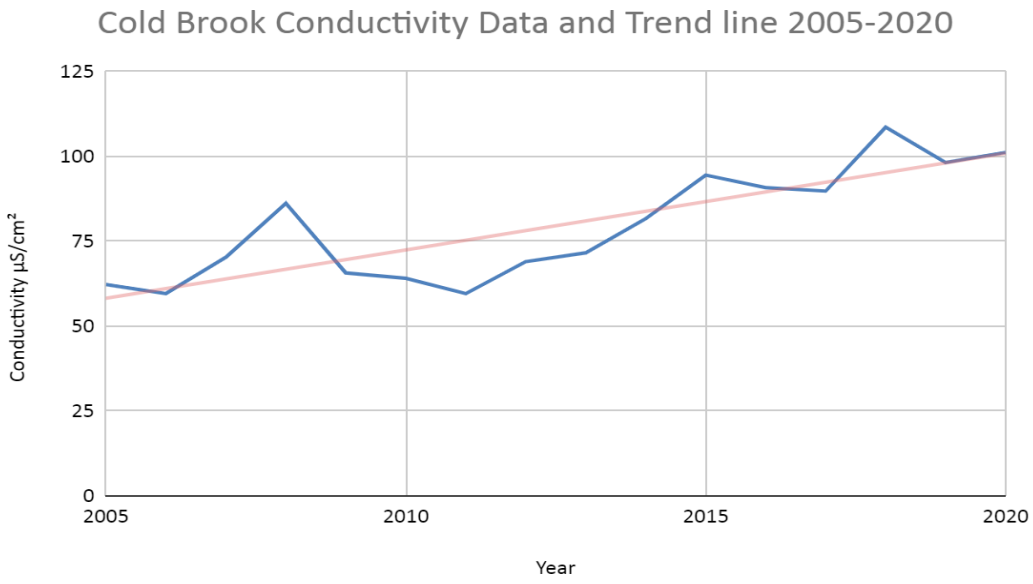
Basic water quality data were collected at each of the sampling locations. The data included chemical parameters, physical parameters, and calculating a biotic score for each of the sampling sites. Macroinvertebrate samples from each site were evaluated using the VBAP biotic score index utilizing taxa-specific tolerance values. A cumulative biotic score for all sites and individual site-specific biotic scores were computed. The average biotic score for all sites was 3.60 and corresponds to the "Good" narrative category. See Table 2 for biotic scores for the individual streams. Overall, mayfly nymphs were the most dominant taxon 259 (39%), followed by stonefly nymphs 145 (22%) and caddisfly larvae 71 (11%). Together, these three taxa comprised nearly 72% of all individuals and are some of the least tolerant taxonomic groups. In completing the sampling effort, volunteers collected and staff identified 669 macroinvertebrates (See Figure 1).

Table 3. Physical & Chemical Parameters of Sampling Sites

Physical & Chemical Parameters	Normal Range/ Optimal Value	Dan Hole River Outlet	Dan Hole River Lower	Cold River	Beech River - Annie Nichols Rd	Beech River - Brownell Rd	Cold Brook
pH	6.5-8.0	N/A	N/A	6.43	6.56	6.82	6.69
Dissolved Oxygen	5 mg/L and above	N/A	N/A	10.11 mg/L	9.54 mg/L	10.87 mg/L	11.64 mg/L
Conductivity	Below 100µS/cm²	N/A	N/A	33.27 µS/cm²	30.1µS/cm²	68.5µS/cm²	82.7µS/cm²
Turbidity	Under 10NTUs	N/A	N/A	N/A	0.71 NTUs	0.61 NTUs	0.98 NTUs
Temperature	21ºC below for trout/mayfly nymphs	N/A	N/A	12˚C	15.4˚C	8.3˚C	7.5˚C

pH, dissolved oxygen, and turbidity levels as well as temperature were all conducive to supporting aquatic life at all sites. Variability in temperature and oxygen levels may be attributed to when sampling was conducted as some sites were sampled earlier in the fall than others, and air and water temperatures had begun to drop significantly for sites sampled later in the fall. While conductivity levels across all sites remain low, conductivity levels at Cold Brook in Freedom continue to be slightly elevated. Simple trend line analysis of historical data taken through GMCG's RIVERS program (Regional Interstate Volunteers for the Ecosystems and Rivers of Saco) demonstrates that conductivity levels at this site are slightly increasing over time, likely due to road salting activities (see Figure 2).

Figure 2. Cold Brook Conductivity and Trend line analysis from 2005-2020. The analysis shows a steady increase in salt levels in the Cold Brook over the past fifteen years.



Conductivity is a measure of the concentration of dissolved salts in water. For reference, seawater has a Specific Conductance of 55,000 µS. Conductivity levels are not a concern to the EPA (Environmental Protection Agency) unless they rise above 500 µS/cm² for rural areas or 1500 µS/cm² for urban areas, according to Jill Emerson, GMCG's Water Quality Coordinator. NH DES states that conductivity levels in freshwater bodies across the state are rising, in general, mostly due to road salting, faulty septic systems and urban/agricultural runoff (NHDES, 2004).

In the past, to bring this issue of slowly rising conductivity levels to the attention of Ossipee Watershed towns, GMCG has co-hosted workshops such as Green SnowPro with UNH T2 Center, NH DES and NH DOT to help train area road agents and plow drivers on efficient use/spreading of salt to help educate those on the front lines about the importance of not over-salting our freshwater ecosystems. GMCG's staff once again collaborated in 2020 for the Green SnowPro training and provided 200+ private contractors, road agents and municipal officials from across the state with important findings about salt from the Ossipee Watershed's surface and groundwater studies.

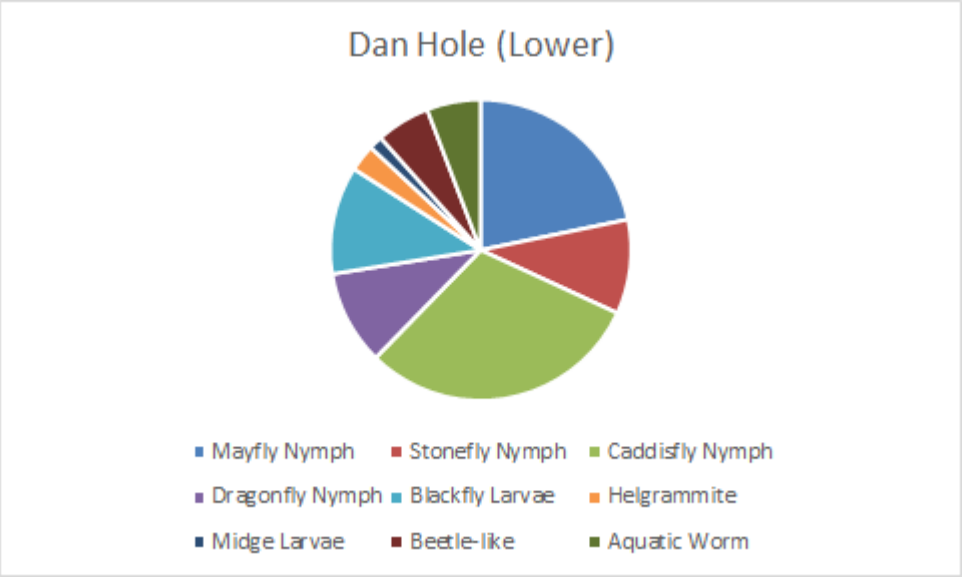
For more detailed water quality analyses on the water bodies in the Ossipee Watershed, please see the 10 Year Water Quality Report (GMCG, 2015) or town reports as recent as 2019: http://www.gmcg.org/research/water-quality-program-data/.

Future Recommendations

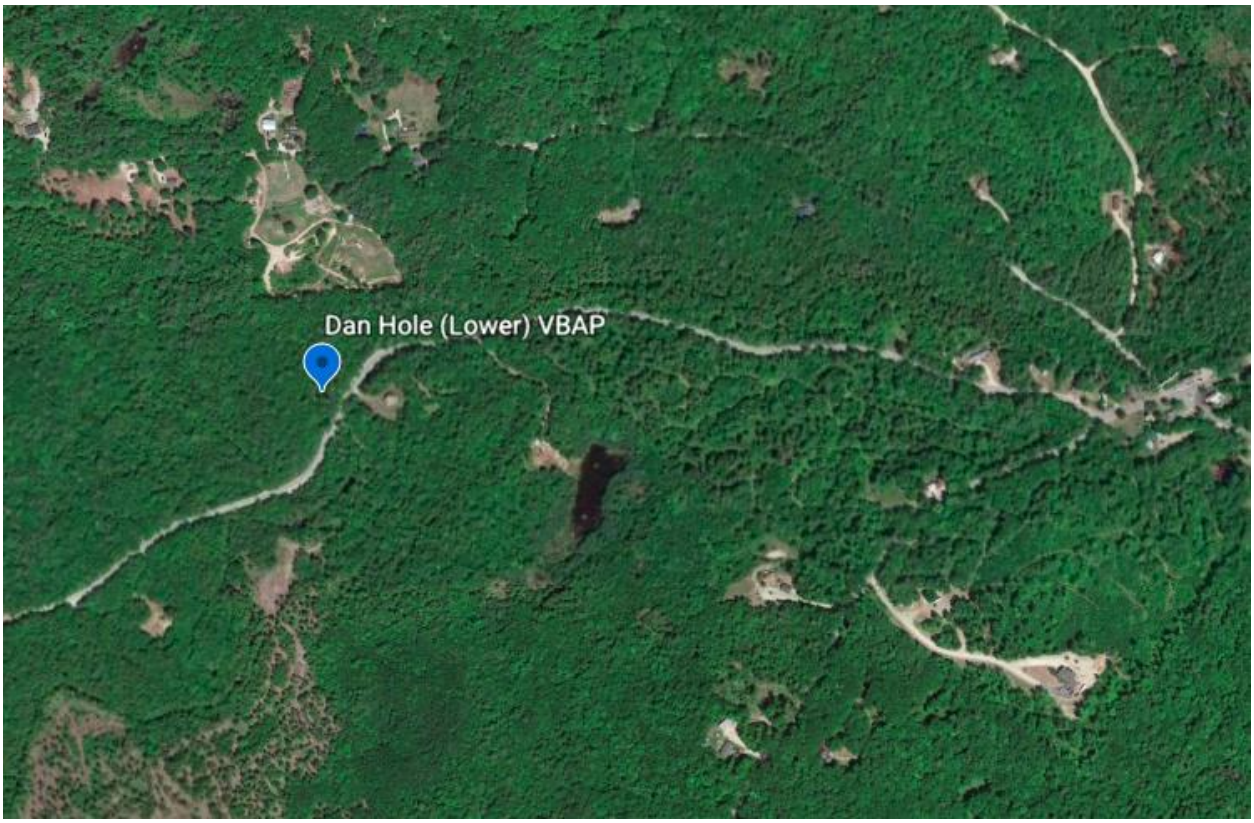
The documentation by volunteers of the invertebrate communities using the VBAP protocol during fall 2020 in the Ossipee Watershed marked the fifteenth year of 'screening' efforts to evaluate the status of aquatic communities. Sampling efforts included six sites in the Ossipee Watershed. Macroinvertebrates are widely used as indicators of water quality that can show the effects of multiple pollutants over time. It is important to recognize that the results obtained from the VBAP protocol are not intended to represent formal water quality assessments, but rather, a basic indicator of aquatic community condition. Ultimately, the results from the Volunteer Biological Assessment Program for 2020 build upon the efforts conducted by GMCG, NH DES and NH Fish & Game to establish reference sites in the state, compare sites across the state, and provide watershed education to youth. The results of the program serve as a basis for further monitoring and management practices to be put into use throughout the watershed.

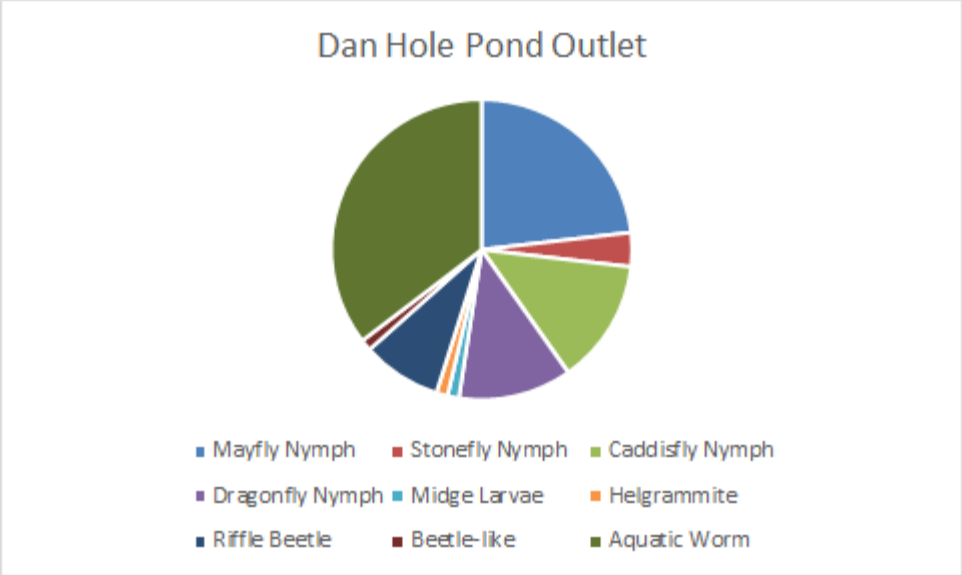
The Ossipee Watershed has a reputation for having great water quality overall and the VBAP results validate this statement. It is recommended that Green Mountain Conservation Group continue to work with schools in the Ossipee Watershed and continue to monitor the water quality of the local streams and rivers. Biotic scores from the Beech River and Dan Hole suggest removal of the Beech River dam would allow aquatic life access to "Excellent" and "Good" habitat upstream. Biotic scores for sites sampled in 2020 ranged from good to excellent, and continued monitoring will be essential to track any water quality changes over time. The long-term health of surface waters will depend on preventing potential sources of contamination from entering water bodies and using best management practices that reduce or prevent adverse impacts from human activities, such as road salting. Sites where human activities appear to be impacting water quality should be monitored closely for potential sources of contamination, and road salting alternatives should be sought.

Appendix A: Site Maps and Pie Charts of Macros

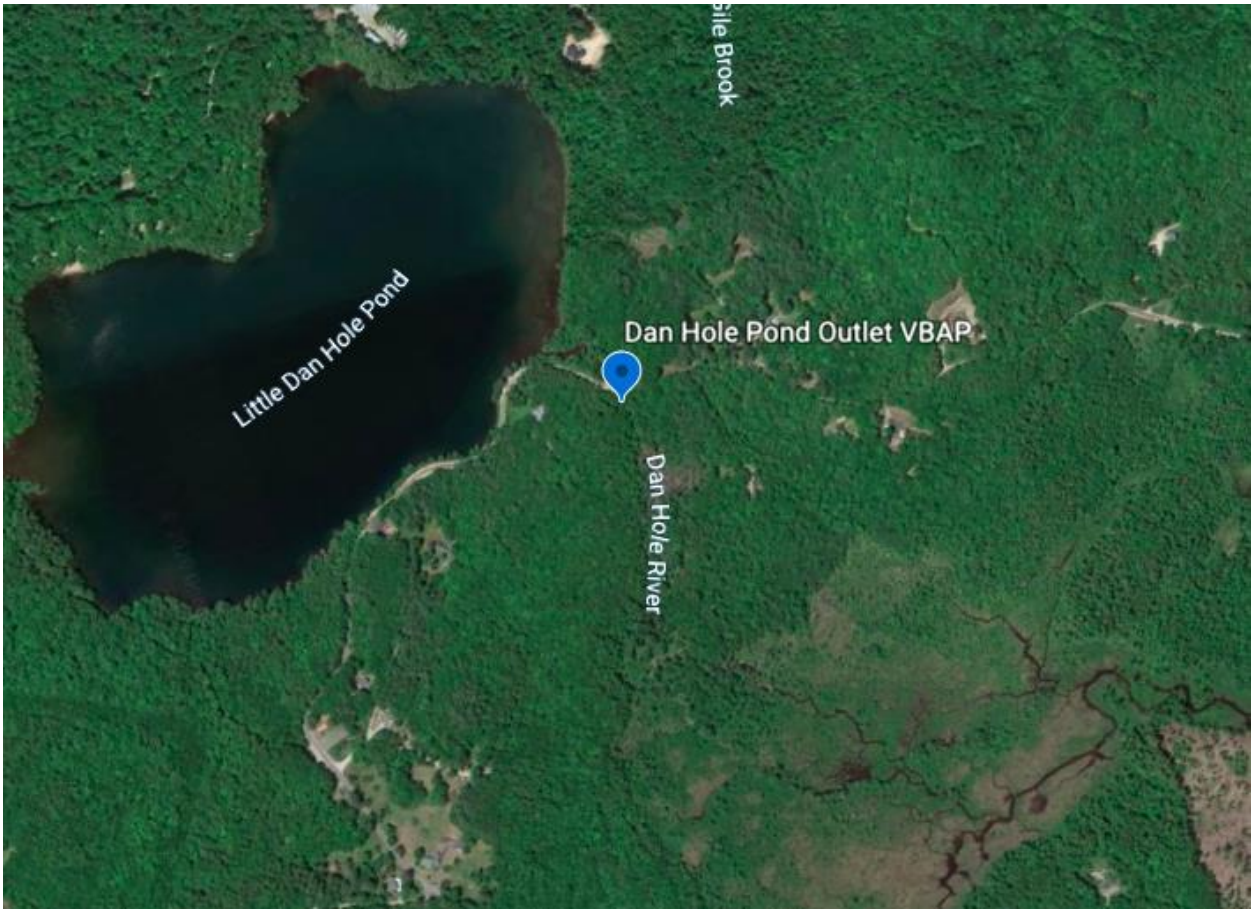


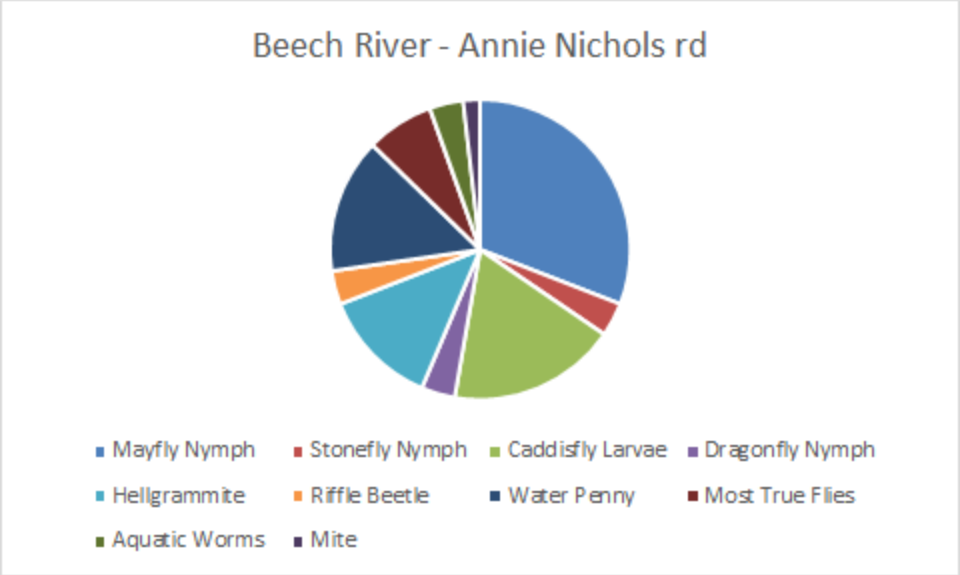
(Above) Total macroinvertebrates found at Dan Hole (Lower) in Ossipee, NH (Below)



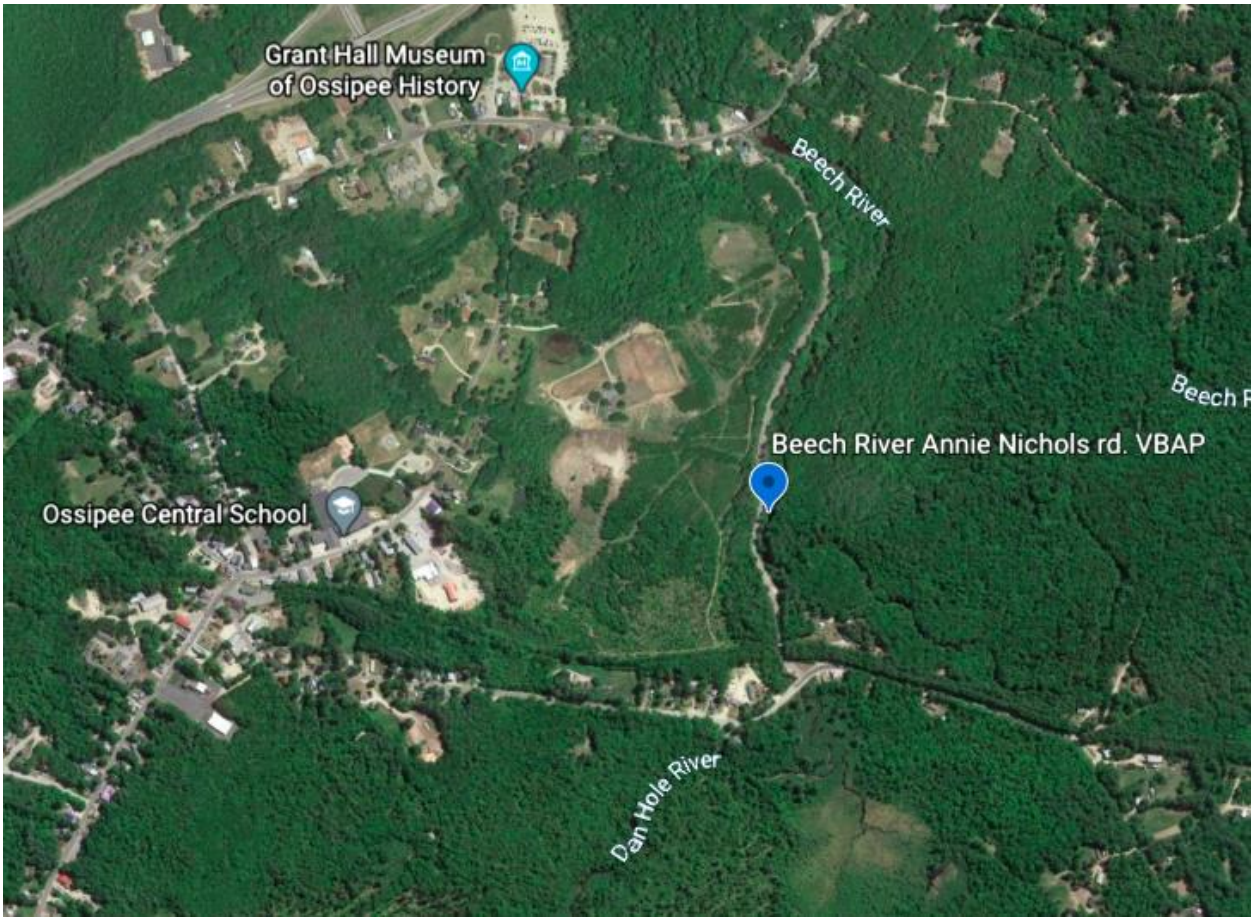


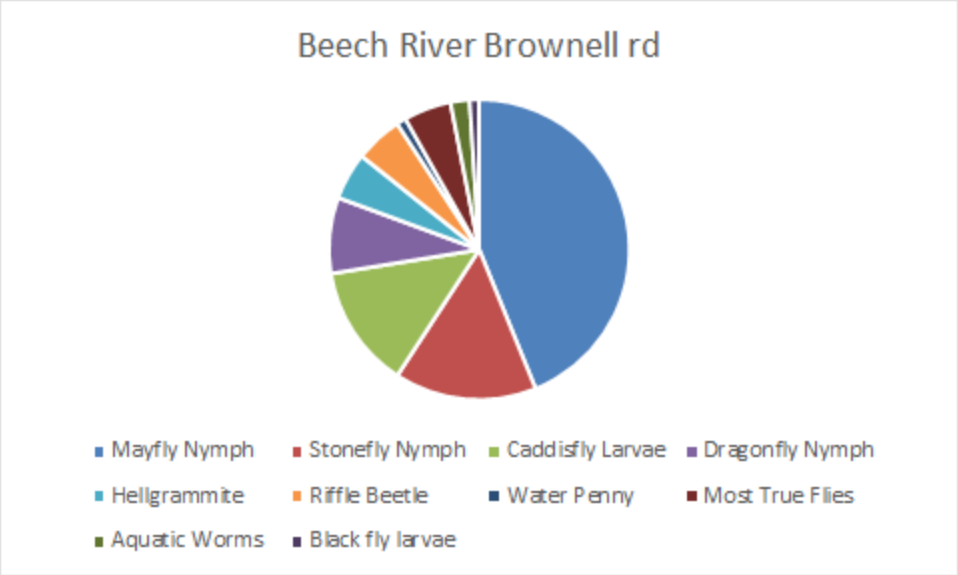
(Above) Total macroinvertebrates found at Dan Hole Pond Outlet in Ossipee, NH (Below)



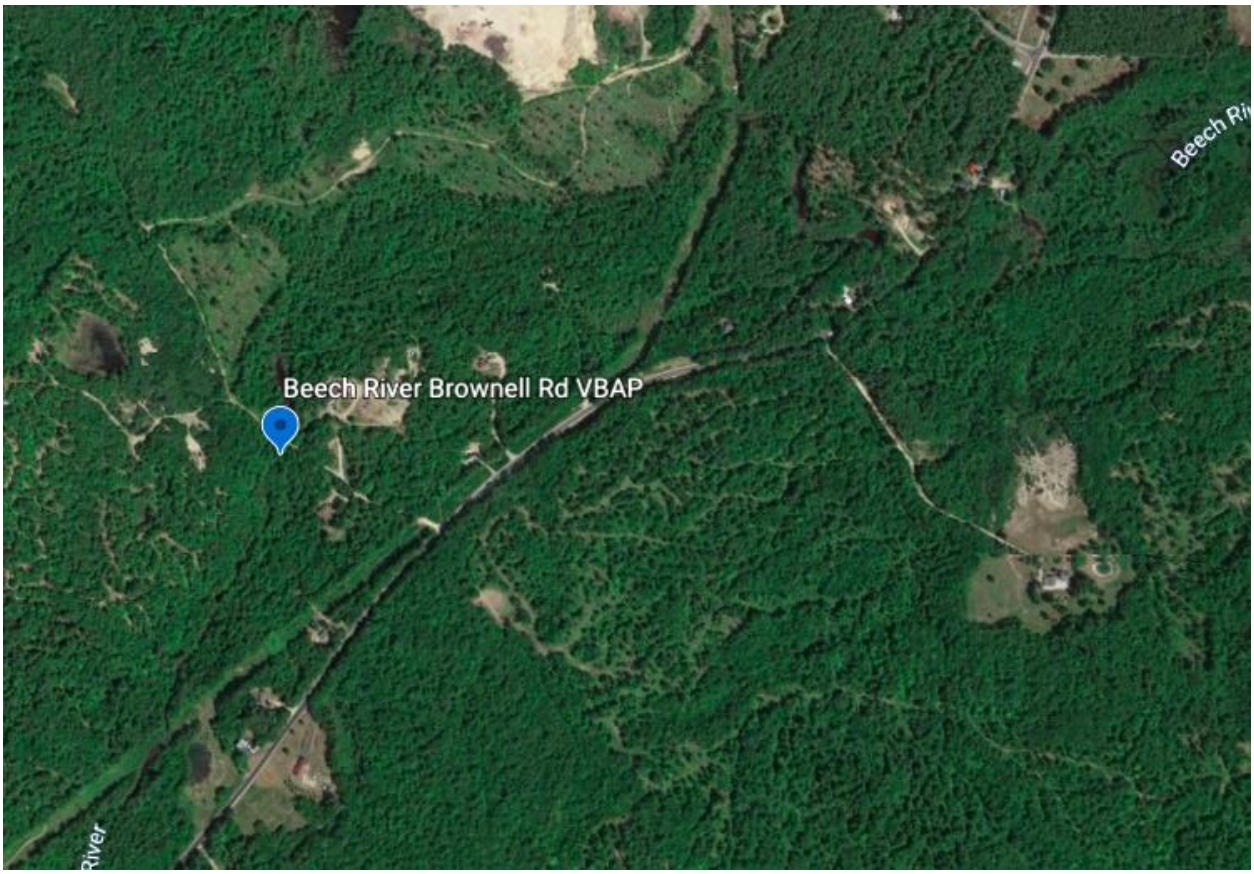


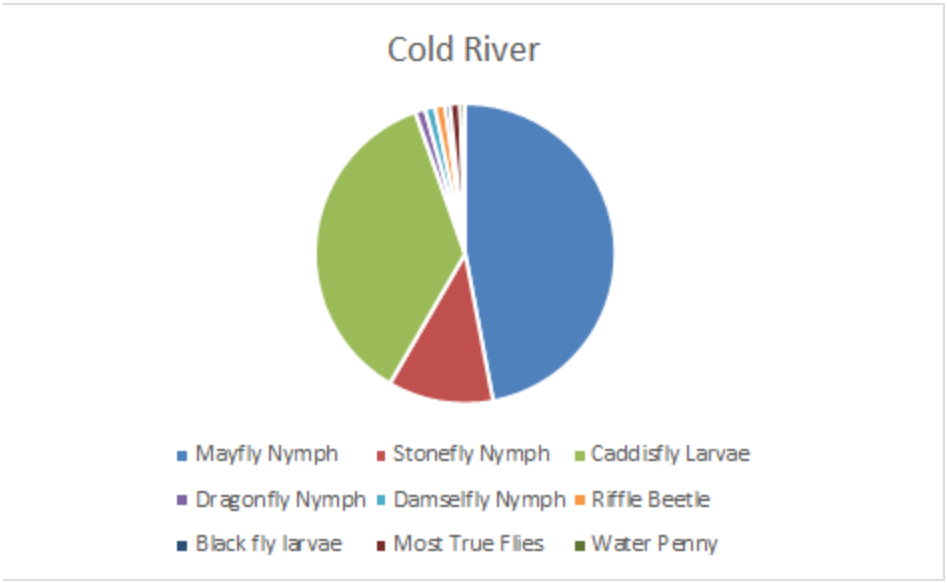
(Above) Total macroinvertebrates found at Beech River Annie Nichols rd in Ossipee, NH (Below)



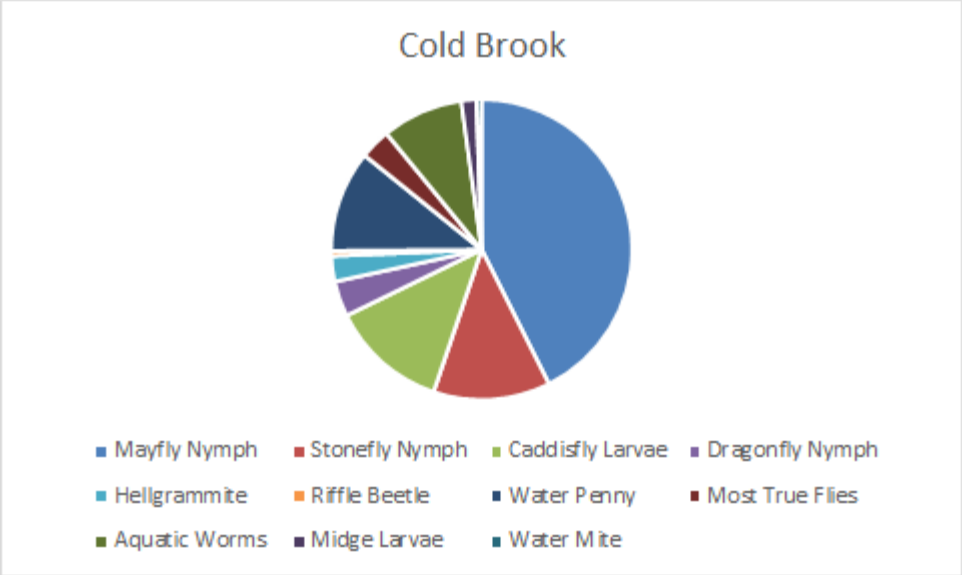


(Above) Total macroinvertebrates found at Beech River Brownell rd in Ossipee, NH (Below)





(Above) Total Macroinvertebrates found at Cold River in Sandwich, NH (Below)



(Above) Total macroinvertebrates found at Cold Brook in Freedom, NH (Below)

Appendix B: Site Data Sheets

Dan Hole (Lower)

Order	Common Name	Value	*	Found	=	Score	Score	Category
Ephemeroptera	Mayfly Nymph	3	*	15	=	45		
Plecoptera	Stonefly Nymph	1	*	7	=	7		
Trichoptera	Caddisfly Larvae	4	*	21	=	84		
Odonata	Dragonfly Nymph	3	*	7	=	21		
	Damselfly Nymph	7	*	0	=	0		
Diptera	Black fly larvae	7	*	8	=	56		
	Midge larvae	6	*	1	=	6		
	Most True flies	4	*	0	=	0		
Megaloptera	Alderfly	4	*	0	=	0		
	Hellgrammite	0	*	2	=	0		
Coleoptera	Riffle beetle	4	*	0	=	12		
	Water Penny	4	*	0	=	24		
	Beetle & Beetle-like	7	*	4	=	28		
Others	Crayfish	6	*	0 0	=	0		
	Snails	7	*	0	=	0		
	Aquatic Worms	8	*	4	=	32		
	Scuds	8	*	0	=	0		
	Sowbugs	7	*	0	=	0		
	Clams and Mussels Water Mites	4	*	1	=	4		
Totals				**69**		**279**	**4.04**	**Good**

Dan Hole Pond Outlet

Order	Common Name	Value	*	Found	=	Score	Score	Category
Ephemeroptera	Mayfly Nymph	3	*	19	=	57		
Plecoptera	Stonefly Nymph	1	*	3	=	3		
Trichoptera	Caddisfly Larvae	4	*	11	=	44		
Odonata	Dragonfly Nymph	3	*	10	=	30		
	Damselfly Nymph	7	*	0	=	0		
Diptera	Black fly larvae	7	*	0	=	0		
	Midge larvae	6	*	1	=	6		
	Most True flies	4	*	0	=	0		
Megaloptera	Alderfly	4	*	0	=	0		
	Hellgrammite	0	*	1	=	0		
Coleoptera	Riffle beetle	4	*	7	=	28		
	Water Penny	4	*	0	=	0		
	Beetle & Beetle-like	7	*	1	=	7		
Others	Crayfish	6	*	0 0	=	0		
	Snails	7	*	0	=	0		
	Aquatic Worms	8	*	29	=	232		
	Scuds	8	*	0	=	0		
	Sowbugs	7	*	0	=	0		
	Clams and Mussels Water Mites	4	*	0	=	0		
Totals				**82**		**407**	**4.79**	**Good**

Beech River Annie Nichols Road

Order	Common Name	Value	*	Found	=	Score	Score	Category
Ephemeroptera	Mayfly Nymph	3	*	17	=	51		
Plecoptera	Stonefly Nymph	1	*	2	=	2		
Trichoptera	Caddisfly Larvae	4	*	10	=	40		
Odonata	Dragonfly Nymph	3	*	2	=	6		
	Damselfly Nymph	7	*	0	=	0		
Diptera	Black fly larvae	7	*	0	=	0		
	Midge larvae	6	*	0	=	0		
	Most True flies	4	*	4	=	16		
Megaloptera	Alderfly	4	*	0	=	0		
	Hellgrammite	0	*	7	=	0		
Coleoptera	Riffle beetle	4	*	2	=	8		
	Water Penny	4	*	8	=	32		
	Beetle & Beetle-like	7	*	0	=	0		
Others	Crayfish	6	*	0	=	0		
	Snails	7	*	0	=	0		
	Aquatic Worms	8	*	2	=	32		
	Scuds	8	*	0	=	0		
	Sowbugs	7	*	0	=	0		
	Clams and Mussels Water Mites	4	*	1	=	4		
Totals				**55**		**175**	**3.18**	**Excellent**

Beech River Brownell Road

Order	Common Name	Value	*	Found	=	Score	Score	Category
Ephemeroptera	Mayfly Nymph	3	*	43	=	129		
Plecoptera	Stonefly Nymph	1	*	15	=	15		
Trichoptera	Caddisfly Larvae	4	*	13	=	52		
Odonata	Dragonfly Nymph	3	*	8	=	24		
	Damselfly Nymph	7	*	0	=	0		
Diptera	Black fly larvae	7	*	1	=	7		
	Midge larvae	6	*	0	=	0		
	Most True flies	4	*	5	=	20		
Megaloptera	Alderfly	4	*	0	=	0		
	Hellgrammite	0	*	5	=	0		
Coleoptera	Riffle beetle	4	*	5	=	20		
	Water Penny	4	*	1	=	4		
	Beetle & Beetle-like	7	*	0	=	0		
Others	Crayfish	6	*	0	=	0		
	Snails	7	*	0	=	0		
	Aquatic Worms	8	*	2	=	16		
	Scuds	8	*	0	=	0		
	Sowbugs	7	*	0	=	0		
	Clams and Mussels Water Mites	4	*	0	=	0		
Totals				**98**		**287**	**2.93**	**Excellent**

Cold River

Order	Common Name	Value	*	Found	=	Score	Score	Category
Ephemeroptera	Mayfly Nymph	3	*	87	=	261		
Plecoptera	Stonefly Nymph	1	*	21	=	21		
Trichoptera	Caddisfly Larvae	4	*	67	=	268		
Odonata	Dragonfly Nymph	3	*	2	=	6		
	Damselfly Nymph	7	*	2	=	14		
Diptera	Black fly larvae	7	*	1	=	7		
	Midge larvae	6	*	0	=	0		
	Most True flies	4	*	2	=	8		
Megaloptera	Alderfly	4	*	0	=	0		
	Hellgrammite	0	*	0	=	0		
Coleoptera	Riffle beetle	4	*	2	=	8		
	Water Penny	4	*	1	=	4		
	Beetle & Beetle-like	7	*	0	=	0		
Others	Crayfish	6	*	0	=	0		
	Snails	7	*	0	=	0		
	Aquatic Worms	8	*	0	=	0		
	Scuds	8	*	0	=	0		
	Sowbugs	7	*	0	=	0		
	Clams and Mussels Water Mites	4	*	0	=	0		
Totals				**185**		**597**	**3.23**	**Excellent**

Cold Brook

Order	Common Name	Value	*	Found	=	Score	Score	Category
Ephemeroptera	Mayfly Nymph	3	*	78	=	234		
Plecoptera	Stonefly Nymph	1	*	23	=	23		
Trichoptera	Caddisfly Larvae	4	*	23	=	92		
Odonata	Dragonfly Nymph	3	*	7	=	21		
	Damselfly Nymph	7	*	0	=	0		
Diptera	Black fly larvae	7	*	0	=	0		
	Midge larvae	6	*	3	=	18		
	Most True flies	4	*	6	=	24		
Megaloptera	Alderfly	4	*	0	=	0		
	Hellgrammite	0	*	5	=	0		
Coleoptera	Riffle beetle	4	*	1	=	4		
	Water Penny	4	*	20	=	80		
	Beetle & Beetle-like	7	*	0	=	0		
Others	Crayfish	6	*	0	=	0		
	Snails	7	*	0	=	0		
	Aquatic Worms	8	*	16	=	128		
	Scuds	8	*	0	=	0		
	Sowbugs	7	*	0	=	0		
	Clams and Mussels Water Mites	4	*	1	=	4		
Totals				**183**		**628**	**3.43**	**Excellent**

Works Cited

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