

STATE OF THE UPPER MERRIMACK 1995-1997

a river quality report



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Upper Merrimack Monitoring Program
a citizen watershed monitoring program



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ACKNOWLEDGEMENTS

The work of the Upper Merrimack Monitoring Program would not be possible without its volunteers and partners (all individuals and organizations listed in appendices).

We would like to acknowledge the following people with our deepest gratitude,

- ✂ Tom Bugely for tireless assistance in coordinating sample collection and delivery in addition to monitoring two of his own sites, and his tireless faith in and promotion of the UMMP;
- ✂ Geoff Dates for his invaluable scientific guidance, substantive assistance, insight, and for making it all interesting and fun with great patience and tireless good humor;
- ✂ Franklin Waste Water Treatment Facility staff for analyzing at no charge all of the UMMP's bacteria samples and monitoring two sites;
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- ✂ The many volunteers who have given their time unselfishly and enthusiastically to make the Upper Merrimack Monitoring Program interesting, fun, and a success.



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UPPER MERRIMACK MONITORING PROGRAM

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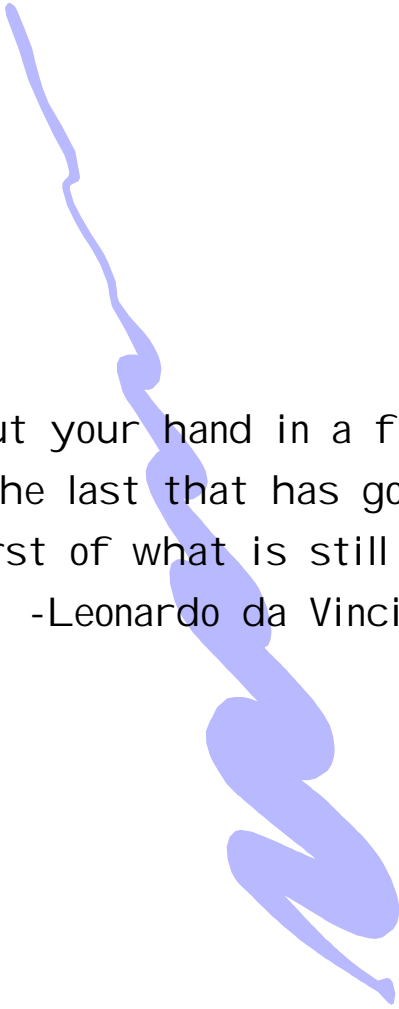
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Designed by Michele L. Tremblay

Unless otherwise noted, all quotations from The River, by Henry David Thoreau



When you put your hand in a flowing stream,
you touch the last that has gone before and
the first of what is still to come.

-Leonardo da Vinci



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INTRODUCTION

The Upper Merrimack Monitoring Program (UMMP) monitors river quality from the Upper Merrimack (Franklin to Bow), Pemigewasset, Winnepesaukee, and Contoocook Rivers through *E. coli* bacteria, field chemistry, and benthic macroinvertebrates analysis. The volunteer-staffed program began in 1995, when a cooperative agreement was signed by the Upper Merrimack River Local Advisory Committee (known locally by its acronym, UMRAC), Merrimack River Watershed Council, and the NH Department of Environmental Services. At that time, the UMMP sampled seven sites. In 1996, the program was expanded to include a total of eleven sites. Many partnerships, including Franklin Waste Water Treatment Facility, Franklin High School, River Watch Network, and Saint Paul's School (see appendix for full list), have contributed to the success of the UMMP. The UMMP has also hosted guests including Governor Jeanne Shaheen, who donned waders on Earth Day and learned about biomonitoring with her daughter, Molly.

In 1996, the UMMP received the first of two grants from the New England Interstate Water Pollution Control Commission. These grants allowed UMMP sustainability and independence by funding the purchase of equipment and support materials. The second grant provided support to expand the UMMP's strong educational component. In addition to grants, support has been provided by municipalities and through innovative programs such as "Adopt-a-River Site." This program works with corporations and groups who support the program by sponsoring a monitoring site. Sponsors provide financial support as well as volunteer time and receive free training in a number of river monitoring techniques.

The UMMP generated the data in this report by adhering to its US Environmental Protection Agency-approved Quality Assurance/Quality Control Plan. Although one of the goals of the UMMP to generate credible water quality data, a significant component of its work has focuses on watershed education efforts. This document is intended not only to present data and the validity of volunteer work, but also as an educational tool. The Upper Merrimack Monitoring Program volunteers have presented at conferences and other events throughout the northeast and at national conferences, conducted workshops, and provided assistance to other watershed groups.

Hundreds of volunteers (see appendix for full list) from all over the region have spent countless hours participating in the UMMP. River conservationists, municipal officials, anglers, teachers, students, and many others have assisted the UMMP by collecting water samples and benthic macroinvertebrate specimens, analyzing macroinvertebrates, and performing other field tasks. Their willingness to learn about watershed science and spend their free time is at the core of the UMMP's success—making it one of the most ambitious volunteer water quality monitoring programs in the country. The Upper Merrimack Monitoring Program has been featured numerous times in the press and is proud of the accomplishments of this completely volunteer-staffed and managed monitoring program.

EXECUTIVE SUMMARY

When asked at a recent conference to summarize the state of the Upper Merrimack River watershed in the form of a newspaper headline, the Upper Merrimack Monitoring Program responded, "When it rains, it's poor!" Three years of *E. coli* sampling on the Upper Merrimack River by UMMP volunteers has been plotted against flow data to illustrate the impacts of nonpoint source pollution (or polluted runoff) on river quality during high flow events in the Upper Merrimack River watershed. Elevated concentrations of *E. coli* bacteria associated with rain events and/or high flow events were recorded during each of the three study years. During one high flow event in 1995, *E. coli* concentration at six out of seven sites monitored exceeded the Class B Surface Water Quality Standard for New Hampshire. This demonstrates that the Upper Merrimack River is constantly at risk from the threat of nonpoint source pollutants such as fertilizers and poorly-maintained septic systems.

Contrary to the *E. coli* monitoring data that provides the UMMP with an immediate or "snapshot" assessment of river quality when comparing to state surface water quality standards, the collection and analyses of benthic macroinvertebrate community data provides a long term diagnosis of river health. Although three years of biological community data are too sparse for discerning long-term river quality trends, the data collected since 1995 provides enough information to allow for biological community assessments at each site from which river quality can be inferred. One distinctive trend or transition in community composition is evident when bio-

logical data from 1995 to 1997 is analyzed from site to site from confluence to Garvins Falls in Bow at the terminus of the Upper Merrimack. There are parallel declines in the number of sensitive macroinvertebrate species (EPT Richness) and habitat assessment scores that mirror the flow of the river from Franklin down to Bow. A corresponding decline in overall river assessment scores results from this gradual decline in biological community health and diminished habitat. It is important to note however, that seven out of the ten sites that had biological community assessments performed, contained high percentages (at least > 50%) of EPT taxa within the macroinvertebrate community. This indicates that river quality at these sites is considered to be “non-impaired” or “excellent” which directly corresponds with the overall river quality ratings (assigned by the UMMP) that ranged from “good” to “excellent.” Sites 9, 10, and 11 failed to produce a macroinvertebrate population that had a significant percentage of EPT organisms and subsequently received the lowest range of overall river assessment ratings from “poor” to “fair.”

Although there is a definite decline in community diversity and taxa richness associated with the UMMP sites located in the lower reaches of the Upper Merrimack River, it is important to note that EPT taxa have been collected at all eleven sites since 1995. This indicates that although the habitat may not be ideal and that certain field chemistry parameters may be somewhat limiting, representatives from sensitive taxa are present and indicate the absence of concentrated sources of pollution. Field chemistry parameters collected over the three-year period support this statement and reflect results that fall well within the acceptable ranges established for New Hampshire surface waters.

The UMMP will continue to collect *E. coli*, field chemistry, and macroinvertebrate samples to establish a baseline biological “standard” for the Upper Merrimack as well as for the purpose of distinguishing long-term river quality trends. In summary, water quality in the Upper Merrimack is generally good—but a significant threat exists from nonpoint source pollution. It is imperative that Best Management Practices be implemented for commercial and industrial properties, municipal storm water, agricultural operations, and residential areas. The Upper Merrimack is the primary artery that courses through the hearts of our communities. We all have the responsibility to keep it clean and healthy for this and future generations.

SAMPLE PARAMETERS AND METHODOLOGY

The following sample parameters have been employed by the Upper Merrimack Monitoring Program:

- ✧ *E. coli*
- ✧ Field chemistry
- ✧ Benthic macroinvertebrates
- ✧ Habitat assessment

E. coli samples were collected using Whirlpaks™ and were processed by the Franklin Waste Water Treatment Facility, an UMMP partner. A small number of random samples were processed by the NH Department of Environmental Services (DES) Laboratory Services Unit.

E. coli bacteria is found in the intestinal tracts of all warm-blooded animals (including humans). While it is not necessarily harmful, it is used as a relatively inexpensive indicator organism which can point to other pathogens, such as viruses, that might be present in the water). The NH Class B water Quality Standard for *E. coli* is 406 colony counts per 100ml. All *E. coli* samples from surface waters with this designation should not exceed this standard. Although sample dates were scheduled at the beginning of each season, many coincided with major rain events, illustrating the effects of nonpoint source pollution through significant spikes in *E. coli*.

Field chemistry samples were collected and analyzed using a Hydrolab™ borrowed from the DES. Because this unit was not available to the UMMP during 1995, no ambient data is recorded for that year. Field chemistry data collection is coordinated with the deployment and retrieval of rock baskets. Field chemistry parameters can compliment and add valuable insight to the interpretation of results produced from macroinvertebrate surveys. **Temperature** within the aquatic habitat dictates the abundance and diversity of species found in a particular river reach. Drastic changes in temperature that do not correspond with seasonal fluctuations can have detrimental effects on aquatic life. Maintaining suitable **dissolved oxygen** (DO) levels is crucial to the survival of many aquatic species. Low levels of DO can stress aquatic organisms and interfere with growth and reproduction, very low levels can result in fish kills. The DO criteria for Class B waters in New Hampshire is a minimum value of no less than 5.0 mg/L (unless naturally occurring). The measurement of **pH** is essential to determine living conditions within an aquatic community. The pH of natu-

ral waters ranges from less than 3.0 to greater than 12.0. As pH values decrease, the environment becomes more acidic and stresses the aquatic community. Acid waters are generally characterized by low species diversity and low productivity. Aquatic organisms each have an optimal pH range for functioning and extreme pH conditions can be toxic to them. **Alkalinity or Acid Neutralizing Capacity (ANC)** is a measure of the river's ability to neutralize acid inputs from rain, snow, or discharges. Rivers with low alkalinity are subject to great fluctuations in pH that disrupt aquatic life. **Conductivity** measures the various natural and human-introduced materials that have the ability to pass an electric current. As an indicator of the presence of chlorides, nitrates, sulfates, and phosphate anions (ions that carry a negative charge) and sodium, magnesium, calcium, iron, and aluminum cations (ions that carry a positive charge); high conductivity levels may indicate a problem from these materials.

The Upper Merrimack Monitoring Program focuses much of its effort on biomonitoring. As illustrated by the *E. coli* data, degradation of water quality—and in many cases violation of the Class B Standards—occurs primarily during and just after storm events. Most of the time, bacteria testing indicates good water quality. Unfortunately, these water samples only provide a “snapshot” of water quality, i.e., what happened during that moment in the site sampled.

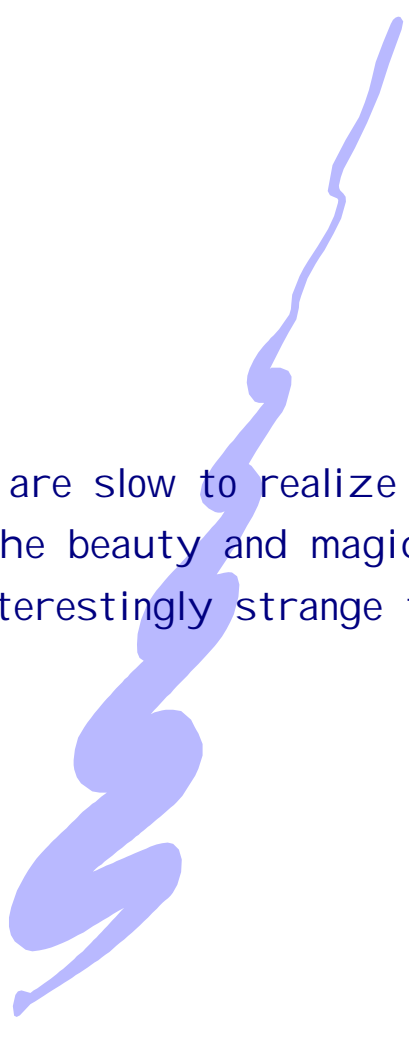
With guidance and counsel from Geoff Dates, Science Coordinator, River Watch Network (now River Network), UMMP determined that collection and analysis of **Benthic Macroinvertebrates** would be a better measure of long-term water quality. Benthic macroinvertebrates, or nymph stage insects, and other aquatic animals spend a significant portion of their life in the river. Their survival challenge is that they are not very mobile—when a pollution source is pronounced or prolonged, they cannot move very fast or very far. As a result, their diversity and health paint a much more accurate picture of the long-term health of a river system. Additional benefits to biomonitoring include ease and cost-effectiveness of sample collection and analysis. Habitat assessments are conducted at each site to record conditions such as flow, river-bottom composition, and other natural features such as tree canopy. Volunteers are trained in the collection and preservation of specimens as well as identification of the organisms to the family level. Random Quality Assurance/Quality Control samples are processed by EcoAnalysts in Idaho.

Each number or *metric* in this report analyzes a different aspect of biomonitoring. **Organism Density** is an estimate of the total number of individuals in a sample. **EPT Richness** indicates the number of Mayfly (Ephemeroptera), Stonefly (Plecoptera), and Caddisfly (Trichoptera) found in the sample. These are generally the major families found in a sample and often the most sensitive to pollution. Although higher sample density is considered an indicator of better water quality, the diversity of the sample is important, especially the composition of sensitive organisms. **Total Taxa Richness** is an actual count of all of families identified in the sample. The **Biotic Index** summarizes the various pollution tolerances of the families that comprise the aquatic insect community. Each family has a pollution tolerance level rated from 0-10 with 0 being intolerant and 10 being the most tolerant. **Percent Contribution of Dominant Family** indicates how large a part of the sample is made up of the most abundant family. This indicates organism and habitat diversity. The Pinkham and Pearson **Community Similarity Index** shows the degree of similarity between a reference site and another site in the study. Site 1 was chosen for its diverse, yet average conditions compared to other sites.

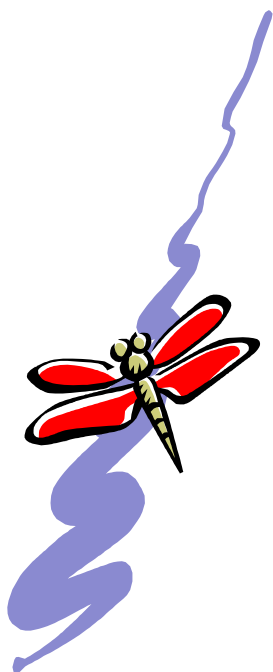
Habitat Assessments are also conducted at each site to inventory conditions such as flow, tree cover or canopy, river-bottom type, and vegetation. This information combined with other parameters help form a complete analysis of each site's conditions and the effects on water quality.

Finally, all sites are scored by evaluating all of the metrics explained above. A non-impaired site is anything greater than 79% compared to the reference site, moderate impairment ranges 29 to 72%. Anything less than 21% is severely impaired. Sampling results are evaluated with habitat assessments and other information such as flow history. The result is reported at the end of each site narrative with a “Dragonfly” rating system with five Dragonflies indicating the best river conditions and zero Dragonflies indicating the worst. Dragonfly ratings are graphically presented with a picture of each site and a topographic map illustrating the monitoring location.

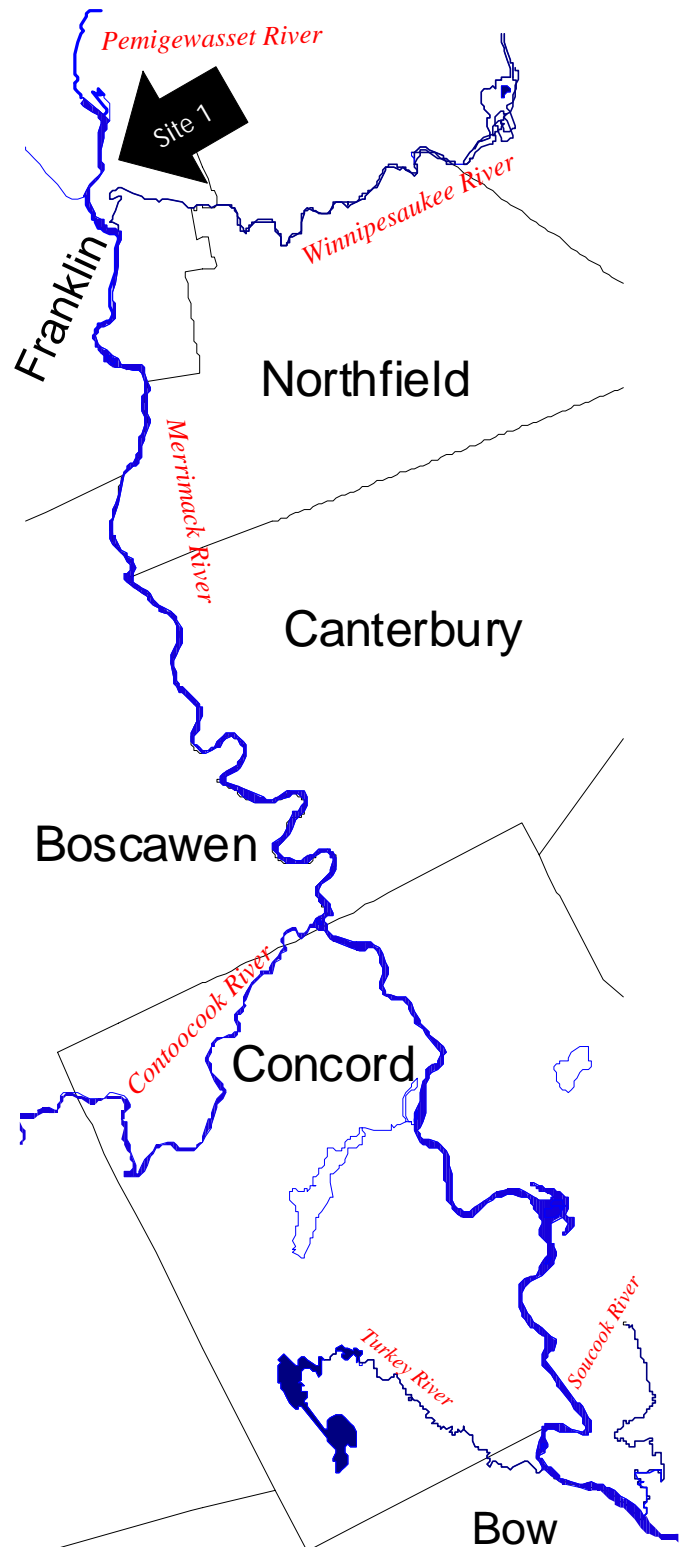
*Denoted by a * in each of the site report pages, there are some sampling events for which data is not available. Although great care has been taken to coordinate the UMMP and its volunteers, some sites were not sampled during each scheduled event.*



We are slow to realize water, -
the beauty and magic of it.
It is interestingly strange to us forever.

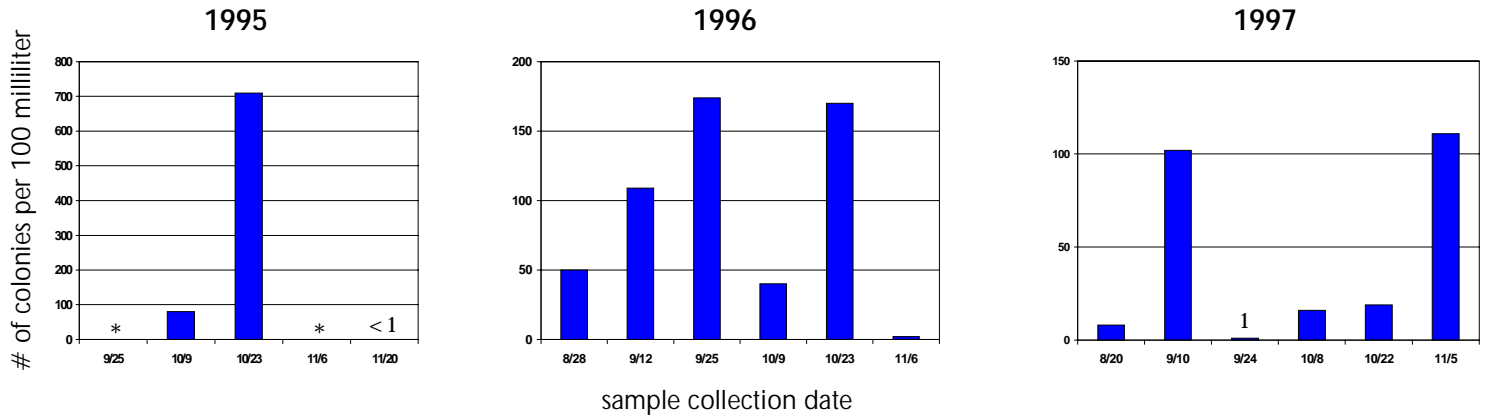


Site 1

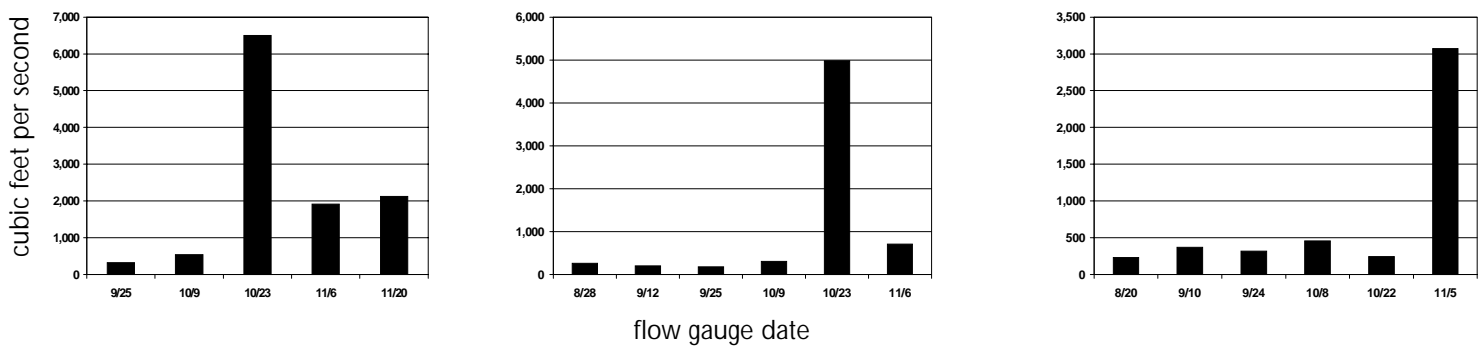


A tender place in Nature,
an exposed vein...

E. coli



Flow



Benthic Macroinvertebrates

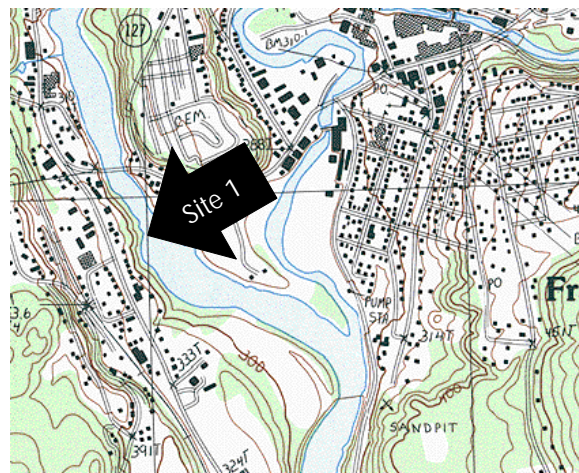
	1995	1996	1997
Organism Density	392	3769	865
EPT Richness	9	9	16
Total Taxa Richness	18	14	25
Biotic Index	6.30	4.13	5
Percent Contribution of Dominant Family	26	66	38
Community Similarity Index (1)	100%	100%	100%
Total Score (possible 42)	42	31	39

* indicates sample not taken for this date

The Pemigewasset River

Site description

Located on the Pemigewasset River, Site 1 is situated two miles downstream of the Franklin Falls Dam, and just below the Routes 3 and 11 bridge. There, the Pemigewasset River is 150' to 200' wide with 61% open tree canopy. The fast-moving water, large boulders and cobble, well developed riffles, and numerous pools provide excellent habitat for invertebrates and fish, making this a popular flyfishing destination. There is very little sediment at this site and many bedrock exposures on the stream bottom. Approximately 70 to 90% of the streambanks are covered by vegetation with no evidence of erosion or bank failure. Some channel alteration from bridge abutments does exist 500' upstream, but no other disruptions are evident.



Field chemistry and *E. coli*

Field chemistry data collected at Site 1 from 1996 and 1997 indicate very stable conditions for pH, adequate acid neutralizing capacity, fairly low conductivity, and abundant dissolved oxygen. ***E. coli*** bacteria and corresponding flow data collected at this site from 1995 through 1997 indicate that significant rain events trigger bacterial contamination of this river reach. Although significant spikes in *E. coli* were documented during each of the annual sampling periods, only the rain event on 10/23/95 generated *E. coli* concentrations high enough to exceed the Class B Water Quality Standard for New Hampshire.

Benthic macroinvertebrates

Benthic macroinvertebrate data from this site have been collected and analyzed for three years. Rock baskets are set in a riffle environment in three feet of water with an average velocity of three feet per second. **Organism Density** fluctuates dramatically from 1995 through 1997. These shifts in population correlate to the flow data and directly relate to the operations at the Franklin Falls Dam which governs the nature and volume of organic material delivered to the river and its macroinvertebrate community at this site.

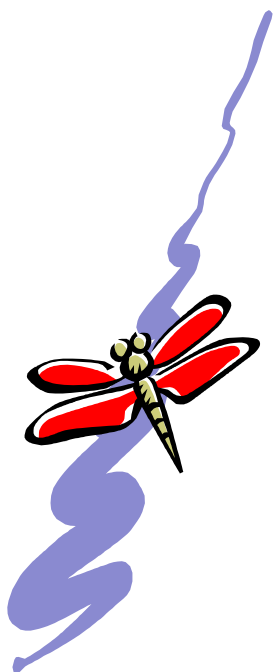
Although the density of the community shifted during the three-year period, the community composition remained relatively stable with **EPT Richness** contributions averaging 59% from 1995 to 1997. River quality is considered to be “non-impaired” or “excellent” when EPT families comprise at least 50% of the sample. The three-year **Biotic Index** averaged 5.14 or “fair.” The Biotic Index will increase as organic pollution is introduced into the river and its tributaries. However, the conditions at this site may be reflecting nutrient loading from the “lake effect” caused by the impoundment of river water upstream of the Franklin Falls Dam. In 1995, 1996, and 1997; the **Percent Contribution of Dominant Family** shifted from Oligochaeta, Hydropsychidae to Chironomidae respectively. These shifts mirror the changes in organism density and food composition. Percent contribution of the Oligochaeta and Chironomidae remained below 50% which indicates non-impaired river quality. The **Community Similarity Index** has been set at 100% and will serve as the reference site for the other ten sites in the Upper Merrimack Monitoring Program.

This section of the Pemigewasset River scored 83% on its habitat assessment and had a total average score from 1995 to 1997 of 37 out of a possible 42. Site 1 receives a 4.5 Dragonfly Rating for this sample period out of a possible six which indicates “good” to “very good” river quality.

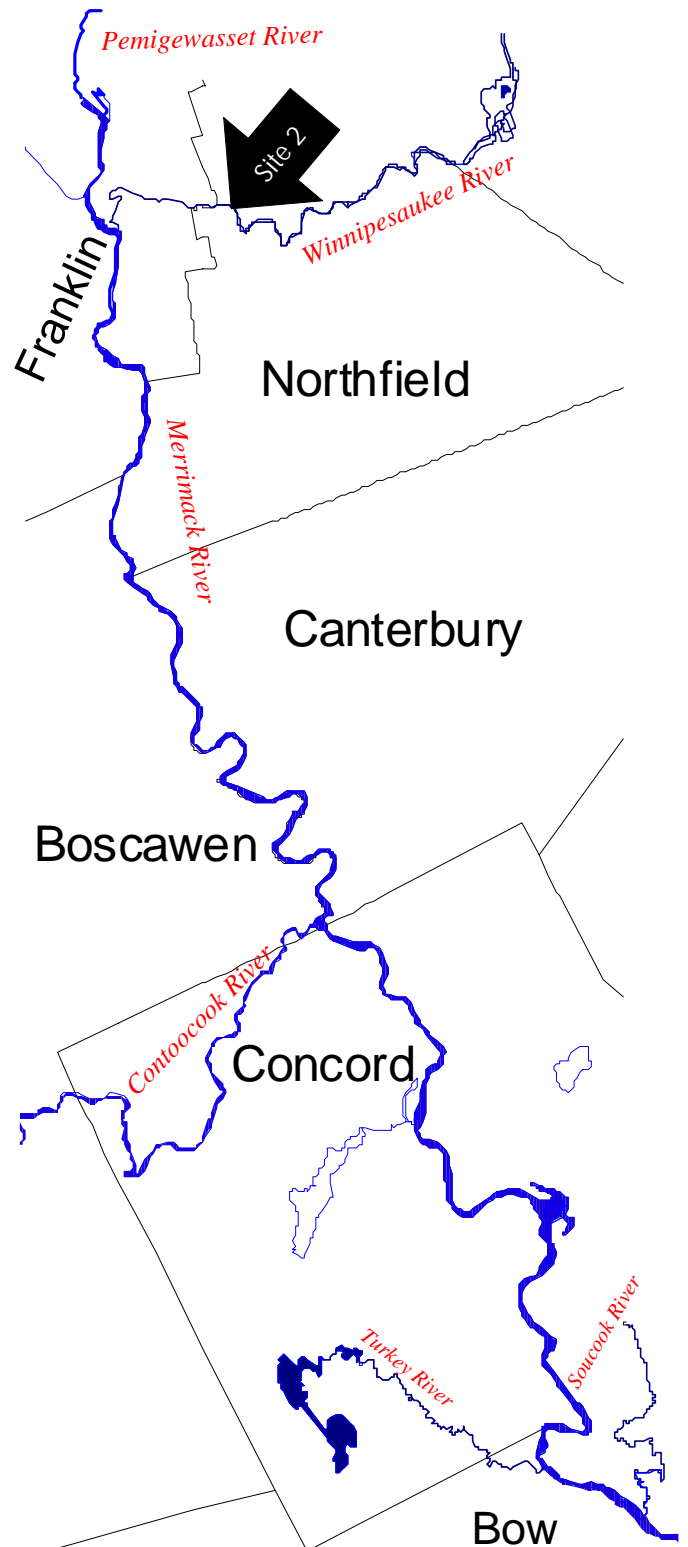


Adopt-a-River Site Sponsor:

Webster Valve, Inc, Watts Regulator Co.
Franklin, NH

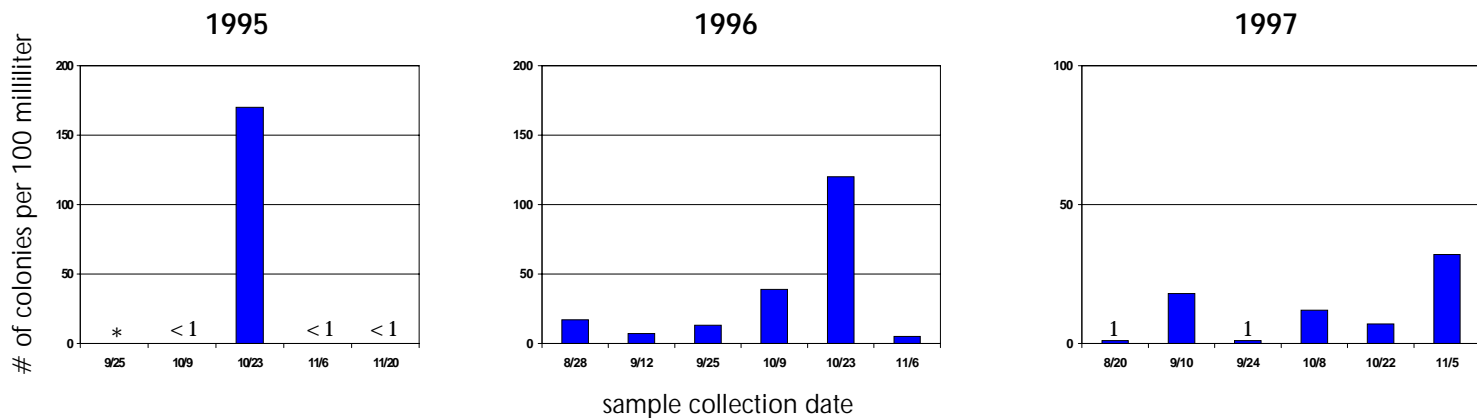


Site 2

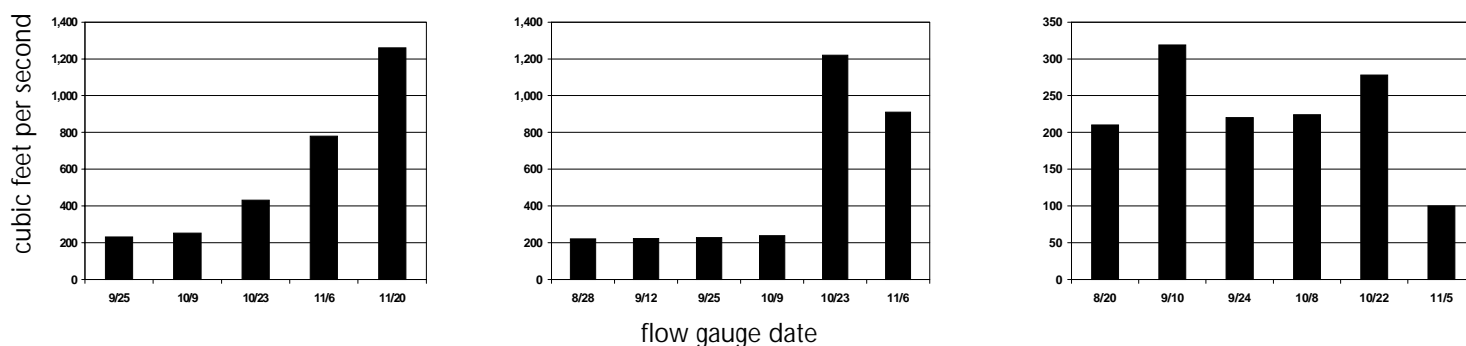


The sudden apparition of this dark-blue water on the surface of the earth is exciting. I must now walk where I can see the water... this is the blood of the earth, and we see its blue arteries pulsing with new life...

E. coli



Flow



Benthic Macroinvertebrates

	1995	1996	1997
Organism Density	1616	473	1591
EPT Richness	14	9	16
Total Taxa Richness	24	14	23
Biotic Index	3.84	4.09	3.45
Percent Contribution of Dominant Family	57	25	56
Community Similarity Index (1)	95%	95%	.95%
Total Score (possible 42)	29	36	24

* indicates sample not taken for this date

The Winnepesaukee River

Site description

The corridor of the Winnepesaukee River surrounding Site 2 is situated on a beautiful three-mile stretch of heavily wooded, undisturbed shoreline with abundant whitewater and excellent aquatic habitat. Its steep grade and good distribution of boulders and large cobble invite whitewater paddlers to challenge Class II and III rapids during high water. The river bottom or substrate provides a wide variety of flow and habitat for both fish and macroinvertebrates. Volunteers visiting the site often report on the abundance of wildlife there including herons, ospreys, and many tracks along the banks from nocturnal visitors. The site is characterized by steep, well vegetated banks and 80% tree canopy cover. The Winnepesaukee River is heavily influenced by many impoundments in the watershed regulating water levels at Silver Lake, Paugus and Opechee Bays, and Lake Winnepesaukee.



Field chemistry and *E. coli*

Field chemistry data collected at Site 2 from 1996 and 1997 indicate very stable conditions for pH, adequate acid neutralizing capacity, moderate conductivity, and abundant dissolved oxygen. *E. coli* bacteria and corresponding flow data at this site from 1995 through 1997 indicate that significant rain events trigger isolated rises of bacterial contamination. However, *E. coli* concentrations over the three-year sample period never exceeded the Class B Water Quality Standard and only two sample events exceeded the Standard for designated swim beaches in New Hampshire.

Benthic macroinvertebrates

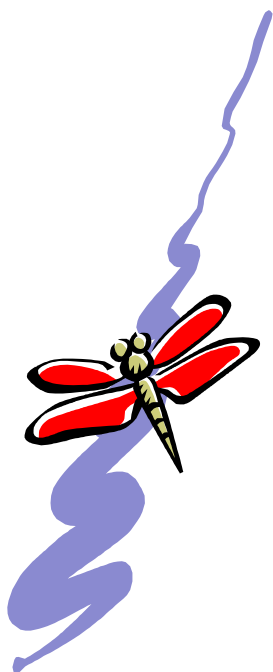
Benthic macroinvertebrate data from this site have been collected and analyzed for three years. Rock baskets are set in three feet of riffle water with an average velocity of 4.5 feet per second. **Organism Density** dropped significantly in 1996 and reflects a change in conditions influenced by the relocation of the baskets. Baskets were deployed in a shallow, fast moving, riffle habitat in 1995 and 1997. In 1996, the baskets were placed behind a large boulder which deflected a significant amount of flow. Many of the predators were not present in the macroinvertebrate community collected in 1996 and as a result, both **Organism Density** and **Total Taxa Richness** were reduced.



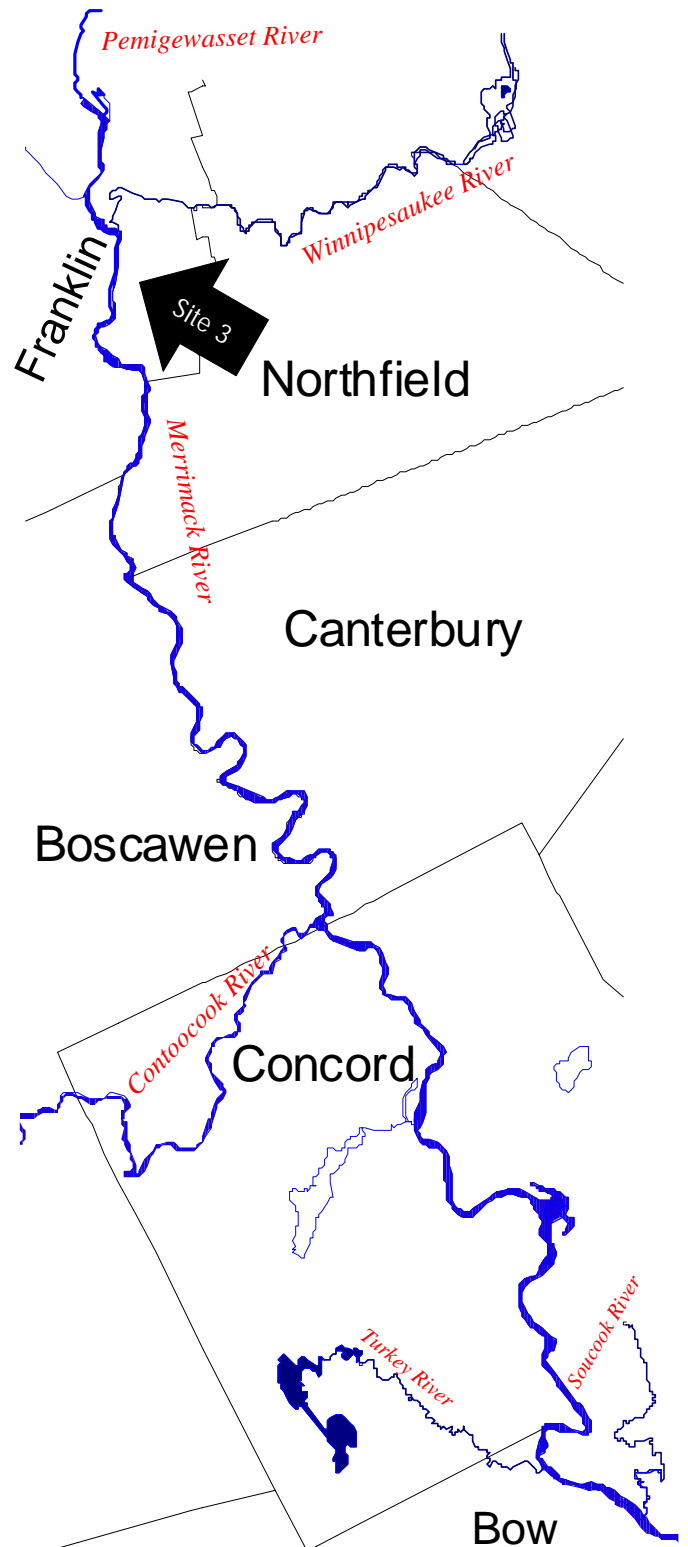
Adopt-a-River Site Sponsor:
Franklin Savings Bank
Franklin, NH

Although the density of the community shifted in 1996, the community composition remained relatively stable with **EPT Richness** averaging 64% from 1995 to 1997. River quality is considered to be “non-impaired” or “excellent” when EPT families comprise at least 50% of the sample. The three-year **Biotic Index** averaged 3.79 or “very good” which indicates very little organic pollution entering this portion of the Winnepesaukee River. The **Percent Contribution of Dominant Family** over the three-year period remained stable with Philopotamidae (Caddisfly larvae) dominating. Although the placement of the baskets was shifted to a lower velocity environment in 1996, the invertebrate community dominance did not shift, indicating a uniform and well-distributed food supply in the stream habitat.

The three-year average total score based upon benthic macroinvertebrate metrics was 29, the **Community Similarity Index** ranked 95% with this section of the Winnepesaukee River scoring 93% for habitat assessment. Site 2 receives a 5.5 Dragonfly Rating from 1995 to 1997 and indicates “very good” to “excellent” river quality.

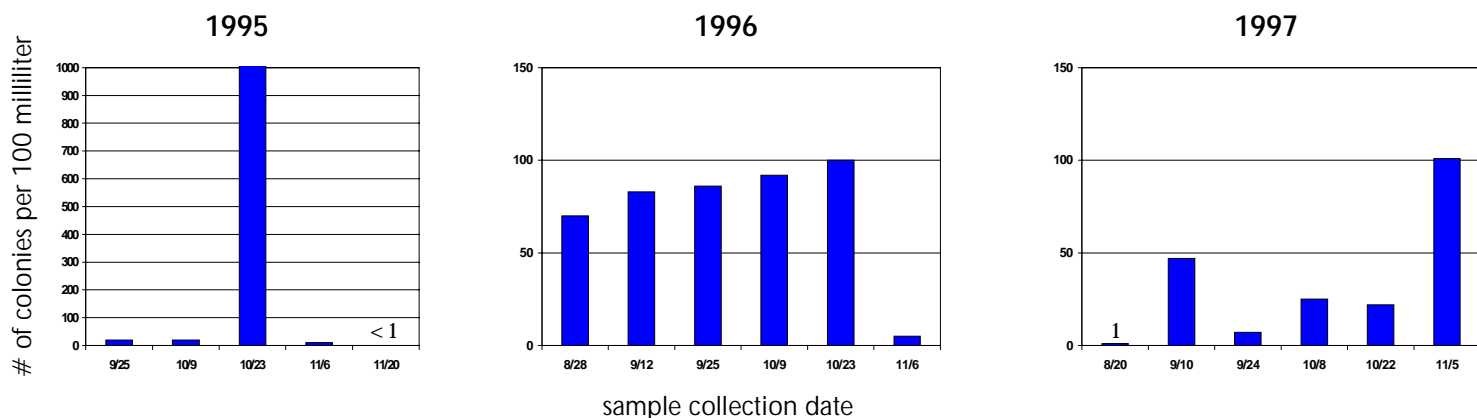


Site 3

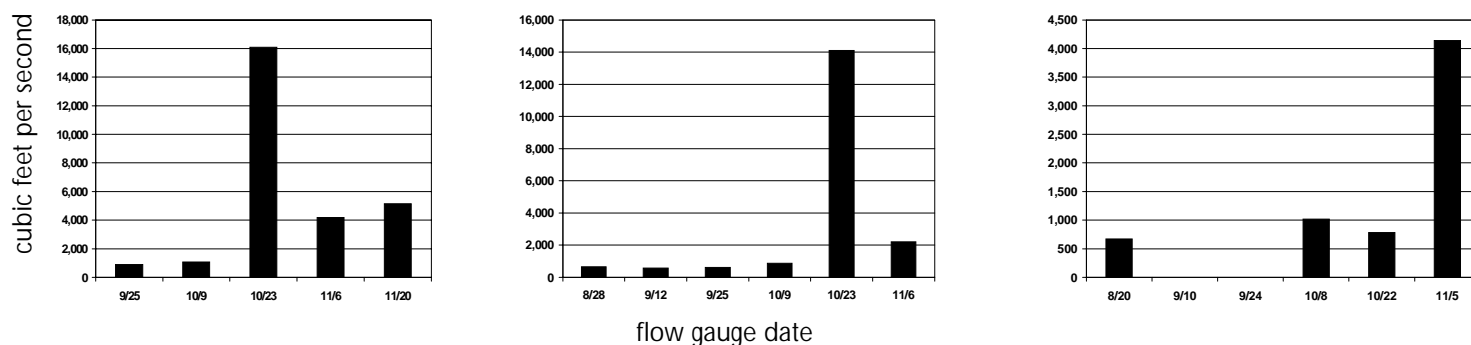


The river is my own highway, the only wild and unfenced part of the world hereabouts.

E. coli



Flow



Benthic Macroinvertebrates

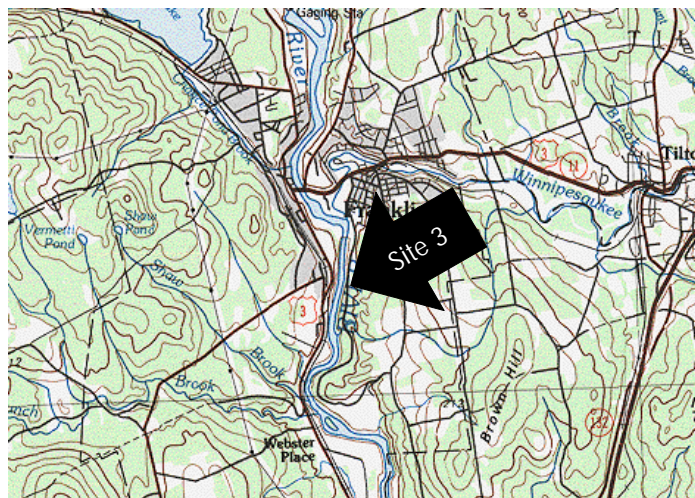
	1995	1996	1997
Organism Density	1853	1512	1905
EPT Richness	13	12	14
Total Taxa Richness	19	19	21
Biotic Index	3.94	4.30	3.97
Percent Model Affinity**	33	35	26
Community Similarity Index (1)	87%	87%	87%
Total Score (possible 42)	29	31	25

* indicates sample not taken for this date

The Merrimack River

Site description

The confluence of the Pemigewasset and Winnepesaukee Rivers forms the Merrimack River. One half-mile downstream of this confluence, Site 3 is located in a deep riffle habitat. Large boulders are strewn across the width of the river and the entire corridor is characterized by overhanging plants, submerged logs, and undercut banks. In addition to the large number of boulders dominating the aquatic habitat, cobble and gravel comprise the river bottom or substrate. The tree canopy is only 34% with much of the river exposed to sunlight. As a result, 20% of the submerged substrate is covered with periphyton (algae on rocks). Both banks along this corridor are steep and heavily wooded with no evidence of erosion.

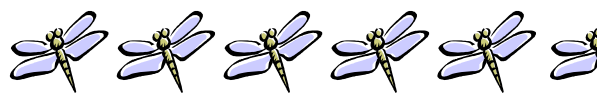


Field chemistry and *E. coli*

Field chemistry data collected at Site 3 from 1996 and 1997 indicate very stable conditions for pH, adequate acid neutralizing capacity, moderate conductivity, and abundant dissolved oxygen. *E. coli* bacteria and corresponding flow data compiled for this site from 1995 through 1997 indicate that a significant rain event just before the October 23, 1995 sampling day produced a significant spike in bacterial contamination. However, *E. coli* concentrations observed in 1996 during a similar level of flow on the same day in October produced insignificant concentrations of *E. coli* bacteria. Except for the one isolated event in 1995, every sample collected from this site has been well below the Class B Water Quality Standard for surface waters in New Hampshire.

Benthic macroinvertebrates

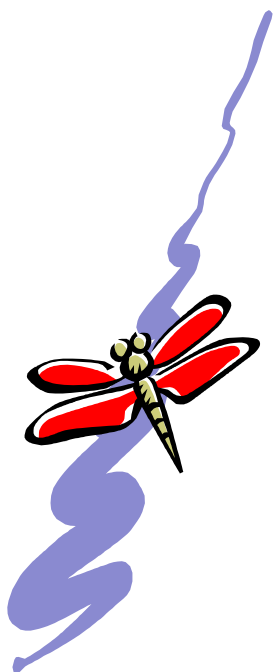
Benthic macroinvertebrate data from this site have been collected and analyzed for three years. Rock baskets are set in a riffle environment in three feet of water with an average velocity of 2.6 feet per second. Organism density remained very stable over the three-year sample period and correlates with the consistent basket placement each year. The community composition remained extremely stable over the three-year period with **EPT Richness** averaging 66% from 1995 to 1997. River quality is considered to be “non-impaired” or “excellent” when EPT families



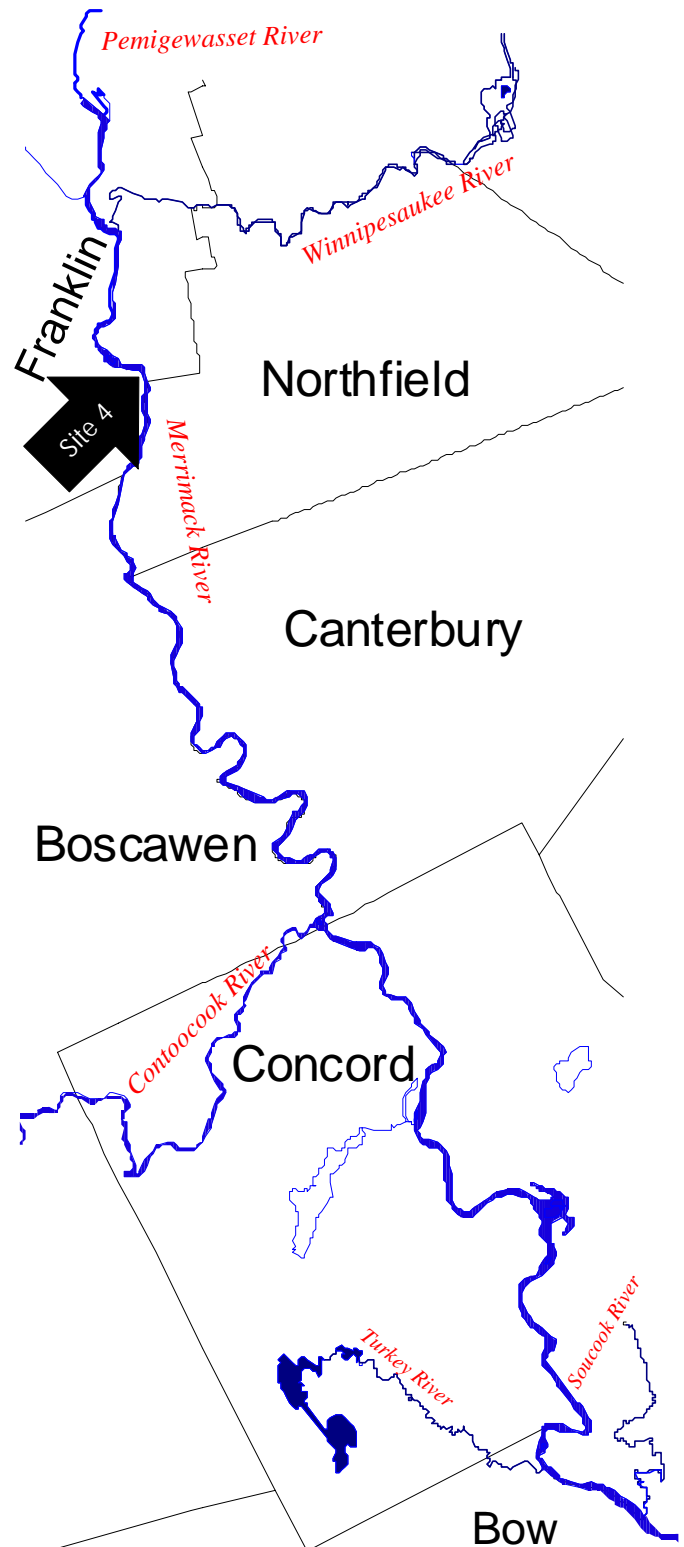
Adopt-a-River Site Sponsor:
Franklin Waste Water Treatment Facility
Franklin, NH

comprise at least 50% of the sample. The three-year **Biotic Index** averaged 4.07 or “very good” which indicates very little organic pollution entering this portion of the Merrimack River. The **Percent Contribution of Dominant Family** over the three-year period remained stable with Hydropsychidae remaining dominant. The Hydropsychidae are “filtering collectors.” Their dominance in the samples indicates that the food supply reaching this site is comprised of very fine particles. Given the location of Site 3, this most probably indicates that coarse materials have been broken down in both the Pemigewasset and Winnepesaukee Rivers and the “fines” drift downstream past this site and support a community dominated by filtering collectors.

The three-year average total score based upon benthic macroinvertebrate metrics was 28, the **Community Similarity Index** ranked 87% and this section of the Merrimack River scored 89% for habitat assessment. Site 3 receives a 5.5 Dragonfly Rating from 1995 to 1997 and indicates “very good” to “excellent” river quality.

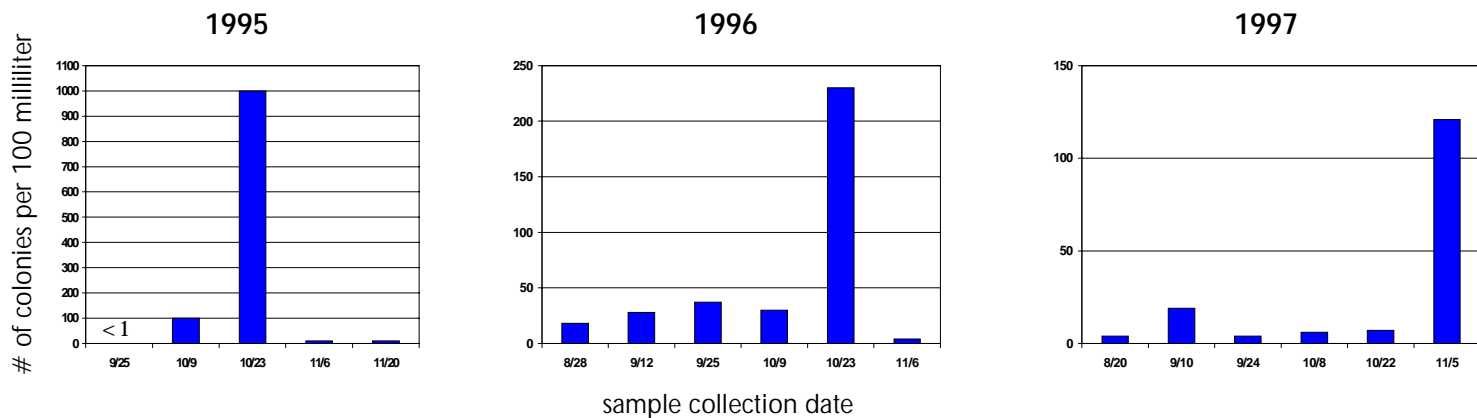


Site 4

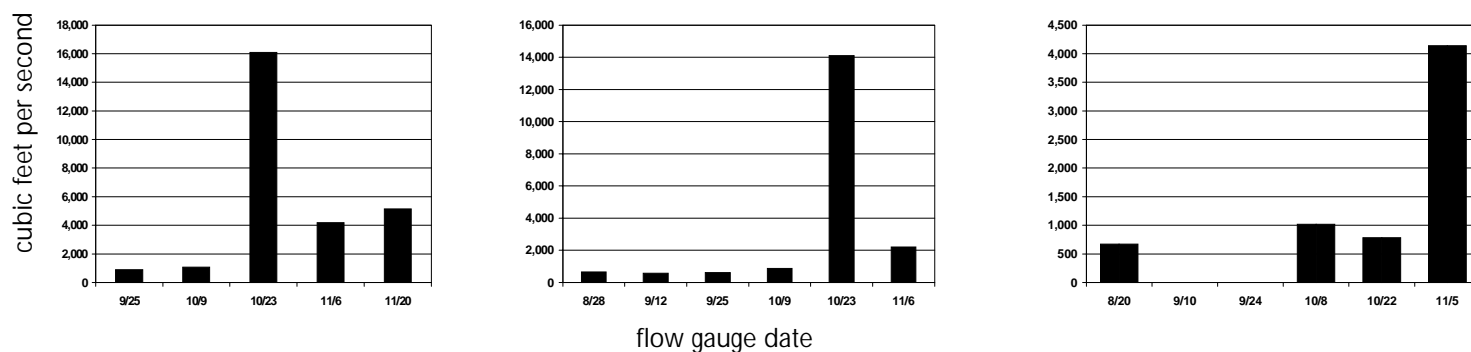


I notice first to my surprise, that the river was all alive with leaping fish, their heads seen continually darted above the water... it was a great flight of ephemerae.

E. coli



Flow



Benthic Macroinvertebrates

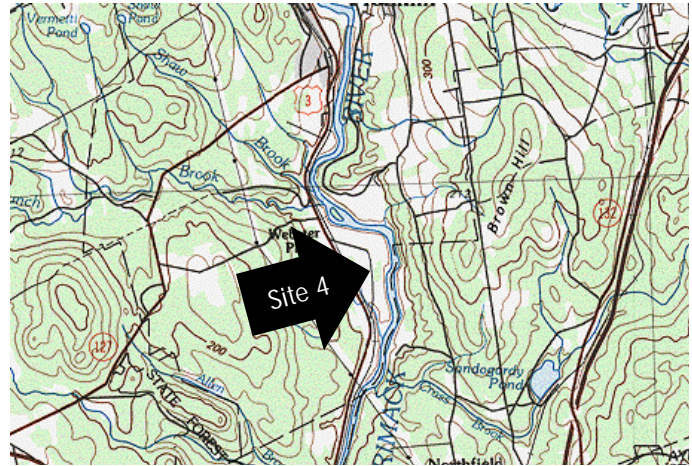
	1995	1996	1997
Organism Density	527	2001	1153
EPT Richness	12	13	12
Total Taxa Richness	24	22	21
Biotic Index	4.52	4.87	3.90
Percent Contribution of Dominant Family	28	33	48
Community Similarity Index (1)	89%	89%	89%
Total Score (possible 42)	36	33	27

* indicates sample not taken for this date

The Merrimack River

Site description

Site 4 is located on the Merrimack River approximately .8 miles downstream of the Franklin Wastewater Treatment Facility. This site was chosen for its location in the river where complete mixing of treatment plant effluent has occurred. Site 4 is characterized by a smooth, unbroken glide or “run” with no riffle habitat due to the extremely low gradient. The river there is between 100 and 115' wide with well-vegetated banks that provide 60% tree canopy cover. Substrate at this site is extremely uniform with gravel and small cobble comprising 90% of the riverbed material. Land-use along this corridor is primarily agricultural with much of the cropland planted with corn.



Field chemistry and *E. coli*

Field chemistry data collected at Site 4 from 1996 and 1997 indicate very stable conditions for pH, acid neutralizing capacity, and conductivity. The dissolved oxygen is slightly reduced along this stretch of the Merrimack and reflects the change in gradient and lack of natural aeration provided by the riffles encountered at previous sites. *E. coli* bacteria and corresponding flow data compiled for this site from 1995 through 1997 indicate that significant rain events produced spikes in bacterial contamination. In 1995, a substantial rain event in October triggered a spike in *E. coli* bacteria that exceeded the Class B Water Quality Standard. Similar events with corresponding elevations in *E. coli* concentrations were recorded in 1996 and 1997. The annual spikes in *E. coli* at this site merit further investigation into nonpoint sources of pollution (runoff) along the corridor.

Benthic macroinvertebrates

Benthic macroinvertebrate data from this site have been collected and analyzed for three years. Rock baskets are set in a glide or “run” environment in two to three feet of water with an average velocity of 2.3 feet per second.

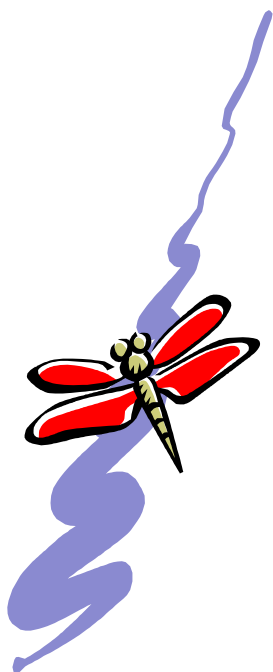
Organism Density increased dramatically from 1995 to 1996, due to approximately one-third of the basket area being above the water line in 1995 during low flow conditions. The community composition remained relatively stable over the three-year period with **EPT Richness** contributions averaging 55% from 1995 to 1997. River quality is



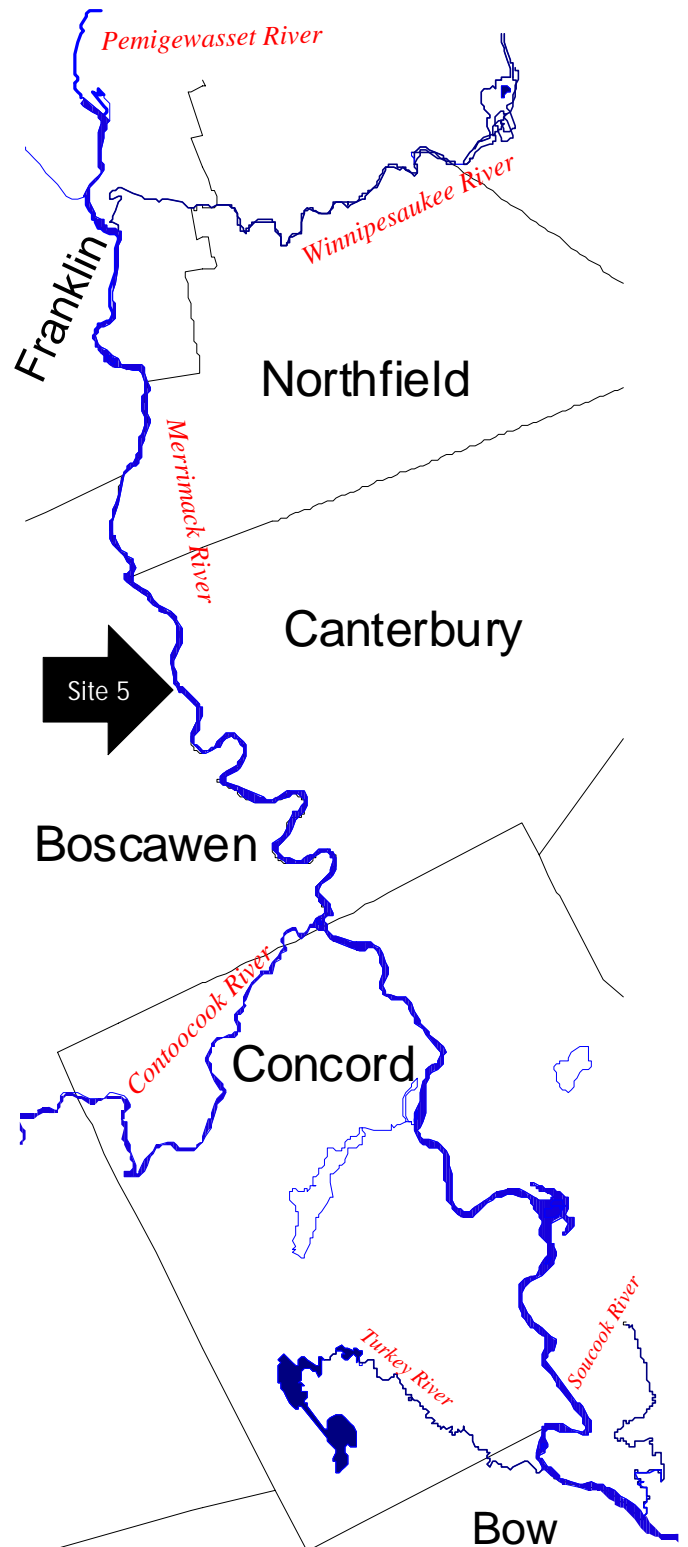
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Franklin Waste Water Treatment Facility
Franklin, NH

considered to be “non-impaired” or “excellent” when EPT families comprise at least 50% of the sample. The three-year **Biotic Index** averaged 4.43 or “good” which indicates an intermittent supply of organic pollution (such as bacteria and fertilizers) to this portion of the Merrimack River. The **Percent Contribution of Dominant Family** over the three-year period fluctuated with Hydropsychidae dominance in 1995 and 1997 and Chironomidae in 1996. Although the Chironomidae comprised 33% of the community in 1996, it does not indicate stream degradation. A river is considered to be severely degraded when the Chironomidae or Oligochaeta represent more than 50% of the invertebrate community.

The three-year average total score based upon benthic macroinvertebrate metrics was 32, the **Community Similarity Index** ranked 89%. This section of the Merrimack River scored 72% for habitat assessment. Site 4 receives a 4.5 “Dragonfly rating” from 1995 to 1997 and indicates “good” to “very good” river quality.

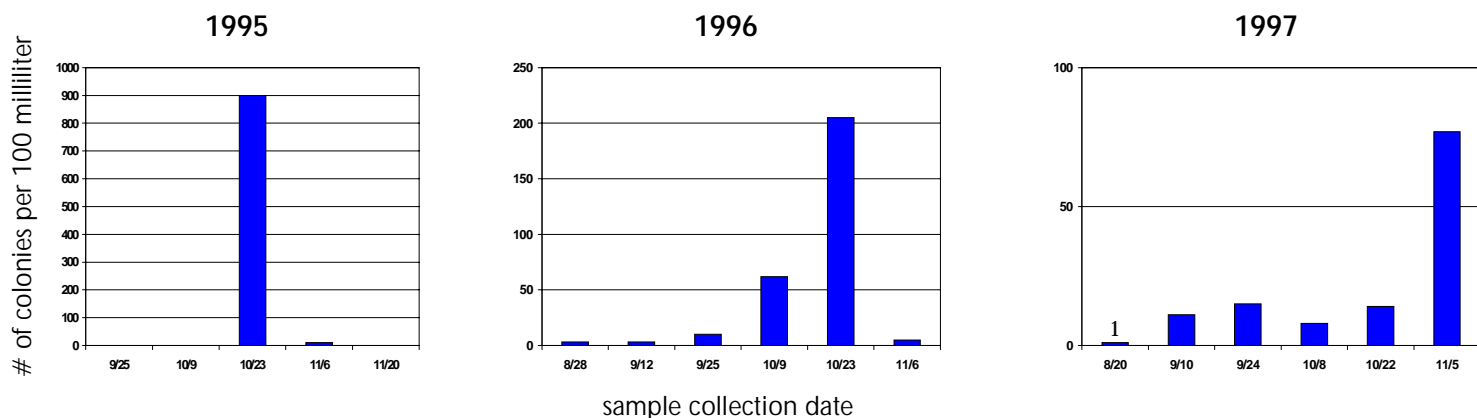


Site 5

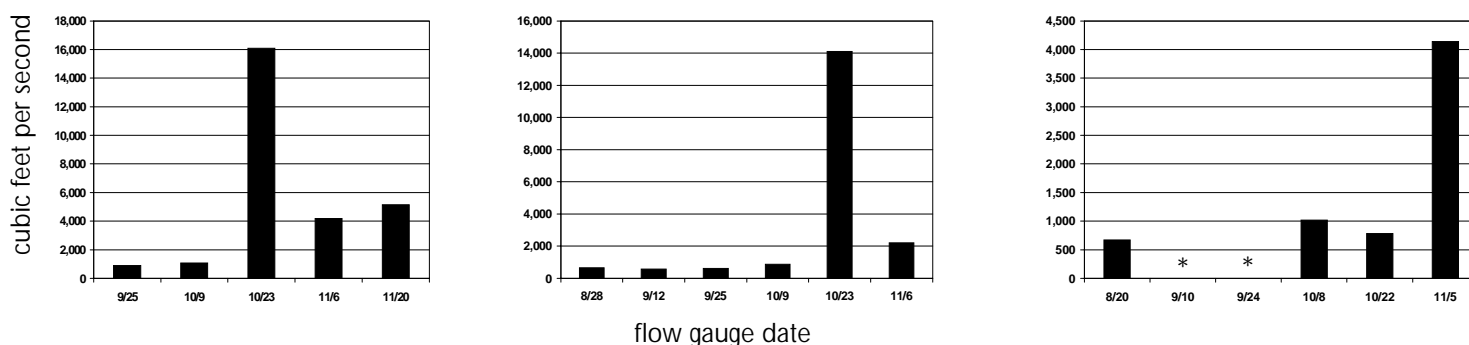


There is nothing to be seen but the smooth black mirror of the water... the river is here for half a mile completely shut in by the forest.

E. coli



Flow



Benthic Macroinvertebrates

	1995	1996	1997
Organism Density	3343	1436	746
EPT Richness	16	12	11
Total Taxa Richness	24	24	20
Biotic Index	3.99	4.27	4.47
Percent Contribution of Dominant Family	68	58	40
Community Similarity Index (1)	75%	75%	75%
Total Score (possible 42)	29	28	33

* indicates sample not taken for this date

The Merrimack River

Site description

The Merrimack River at Site 5 forms the boundary between the towns of Boscaawen and Canterbury where the river is very flat with a continuous, smooth glide. The bottom consists of uniform substrate composed primarily of gravel with some cobble. Emergent and submergent vegetation is common at this site with 61% open tree canopy allowing for ample sunlight with periphyton covering 30% of the river-bottom. Both banks are well-vegetated and exhibit bedrock exposures on either side of the river. Land-use along the corridor is primarily forested (Merrimack River State Forest in Boscaawen) and agricultural (sod farm in Canterbury).



Field chemistry and *E. coli*

Field chemistry data from Site 5 from 1996 and 1997 indicate very stable conditions for pH, acid neutralizing capacity, and dissolved oxygen. Conductivity values at this site do not indicate any sources of nonpoint source pollution immediately upstream. *E. coli* bacteria concentrations were all well below the Class B Water Quality Standard of 406 counts per 100ml except for the collection conducted on October 23, 1995. This sampling event corresponded with the highest flow event of the 3-year period. Upstream investigations may determine sources of polluted runoff including bacterial contamination.

Benthic macroinvertebrates

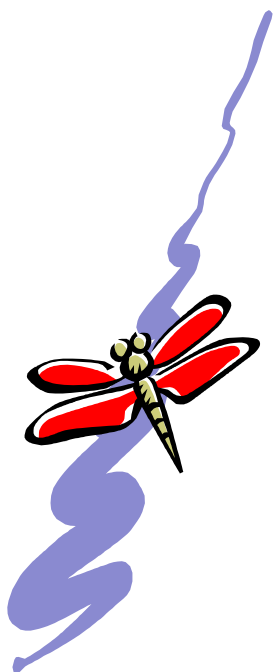
Benthic macroinvertebrate data from this site have been collected and analyzed for three years. Rock baskets were set in a “glide” (gentle downward grade) environment in two to three feet of water with an average velocity of 1.8 feet per second. Organism density decreased steadily from 1995 to 1997. This may be due to a change in habitat. In a dynamic river such as the Merrimack, bottom depth and composition can change rapidly. In this case, aquatic plant areas grew in size, covering the basket area. This resulted in their being hidden from many of the insects who colonized baskets in previous years. Although the organism density dropped from 3,343 to 746, **Total Taxa Richness** remained basically unchanged. This is important to note because although the density dropped over the three-year study period, virtually no representative organisms were lost, which indicates a stable trend in river quality. The **EPT Richness** contributions to the macroinvertebrate community averaged 57% from 1995 to 1997. River quality is considered to be “non-impaired” or “excellent” when EPT families comprise at least 50% of the sample. The three-year **Biotic Index** averaged 4.24 or “very good” which indicates that although organism density declined, organisms comprising that community are mostly intolerant to pollution. The **Percent Contribution of Dominant Family** over

the three-year period fluctuated with Hydropsychidae dominance in 1995 and 1996 and Gammaridae in 1997. The shift in dominance to Gammaridae is due to a change to coarse organic matter and a population dominated by gathering collectors. This usually indicates decomposed sewage, animal manure, or other organic material deposited on the bottom. Without additional *E. coli* sampling to support this theory, it is highly likely that the shift in dominant family can be attributed to the high degree of river bottom covered with silt (embeddeness) observed during the 1997 basket retrieval and the abundant plants surrounding the baskets forming a coarse, unprocessed food supply.

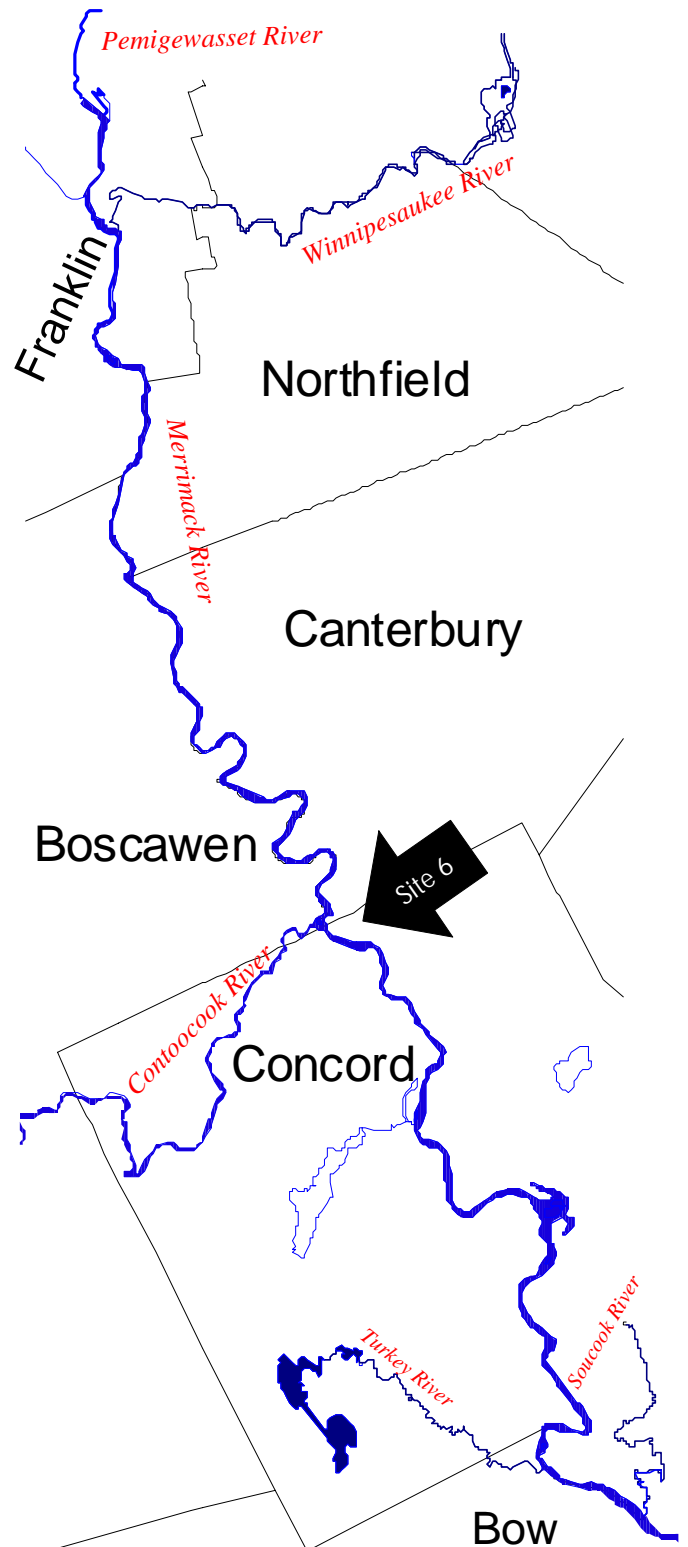
The three-year average total score based upon benthic macroinvertebrate metrics was 30, the **Community Similarity Index** ranked 75%. This section of the Merrimack River scored 65% for habitat assessment. Site 5 receives a 5.0 Dragonfly Rating from 1995 to 1997 and indicates “very good” river quality.



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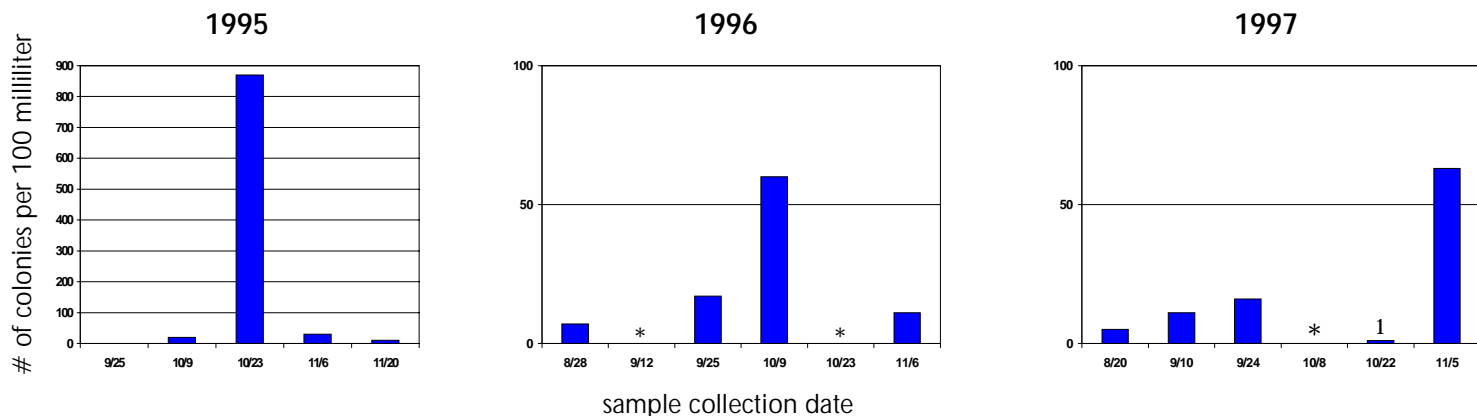


Site 6

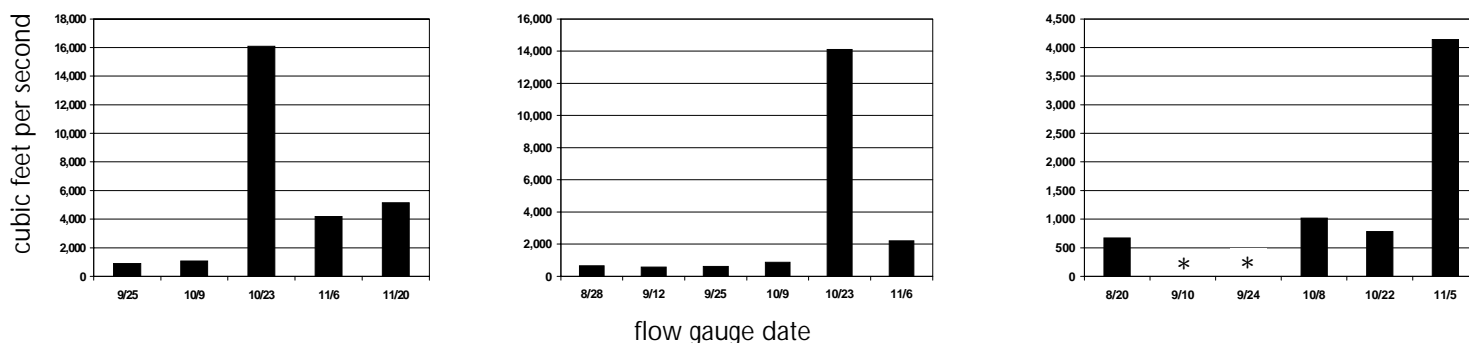


The inhabitants of the river are peculiarly wide awake this warm day - fishes, frogs, and toads, from time to time - and quite often I hear a tremendous rush of a pickerel after his prey.

E. coli



Flow



Benthic Macroinvertebrates

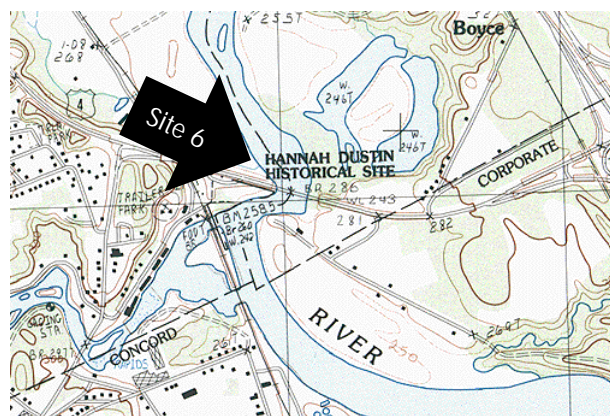
	1995	1996	1997
Organism Density	2172	*	816
EPT Richness	11	*	12
Total Taxa Richness	17	*	15
Biotic Index	4.32	*	4.59
Percent Contribution of Dominant Family	68	*	55
Community Similarity Index (1)	79%	*	79%
Total Score (possible 42)	29	*	31

* indicates sample not taken for this date

The Merrimack River

Site description

Located on the upstream side of the Route 4 bypass bridge on the Merrimack River, Site 6 is downstream of extensive agricultural operations and the Riverlands Conservation Area, a popular swimming location. This site is characterized by deep, slow moving water with abundant sedimentation, deposition, and shifting sand bars. The river bottom is composed primarily of coarse and fine grained sand with some gravel along point bars. The river is 150' to 200' wide at this site with 30% tree canopy cover and many large meanders with steep banks along the main channels or thalwegs. The banks are fairly well-vegetated but erosion and undercutting is evident in this dynamic area. The riparian corridor is narrow in sections where agricultural activities are well-established.



Field chemistry and *E. coli*

Field chemistry data was collected at Site 6 in 1996 and reflects conditions consistent with a slow moving, deep river channel for pH, acid neutralizing capacity, and dissolved oxygen. Conductivity at this site was relatively low and does not indicate any sources of nonpoint source pollution immediately upstream. *E. coli* bacteria at this site were all well below the Class B Water Quality Standard of 406 counts per 100ml except for the sample collected on October 23, 1995, which corresponded with the highest flow event of the three-year period. Upstream investigations may reveal causes of nonpoint source pollution (runoff) including bacterial contamination.

Benthic macroinvertebrates

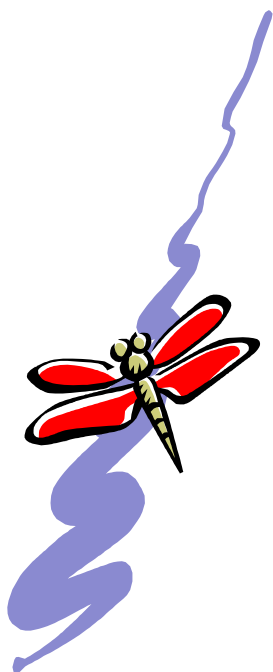
Benthic macroinvertebrate data from this site has been collected and analyzed for two years. Rock baskets were set in a shallow glide environment in two to three feet of water in 1995 and 1996. Unfortunately, the baskets were vandalized in 1996 and no data is available for that year. In 1997, the location was shifted to deeper water to discourage disturbance. Both sites have an average velocity of 2.2 feet per second. Although **Organism Density** decreased significantly from 1995 to 1997, **Total Taxa Richness** only decreased by two. The dramatic drop in density from 2,172 to 816 is attributable to the change in habitat resulting from basket relocation but the stability in **Total Taxa Richness** reflects good river quality at this site. In support of this trend, the **EPT Richness** contributions to the macroinvertebrate community averaged 75% for the two-year period. River quality is considered to be “non-



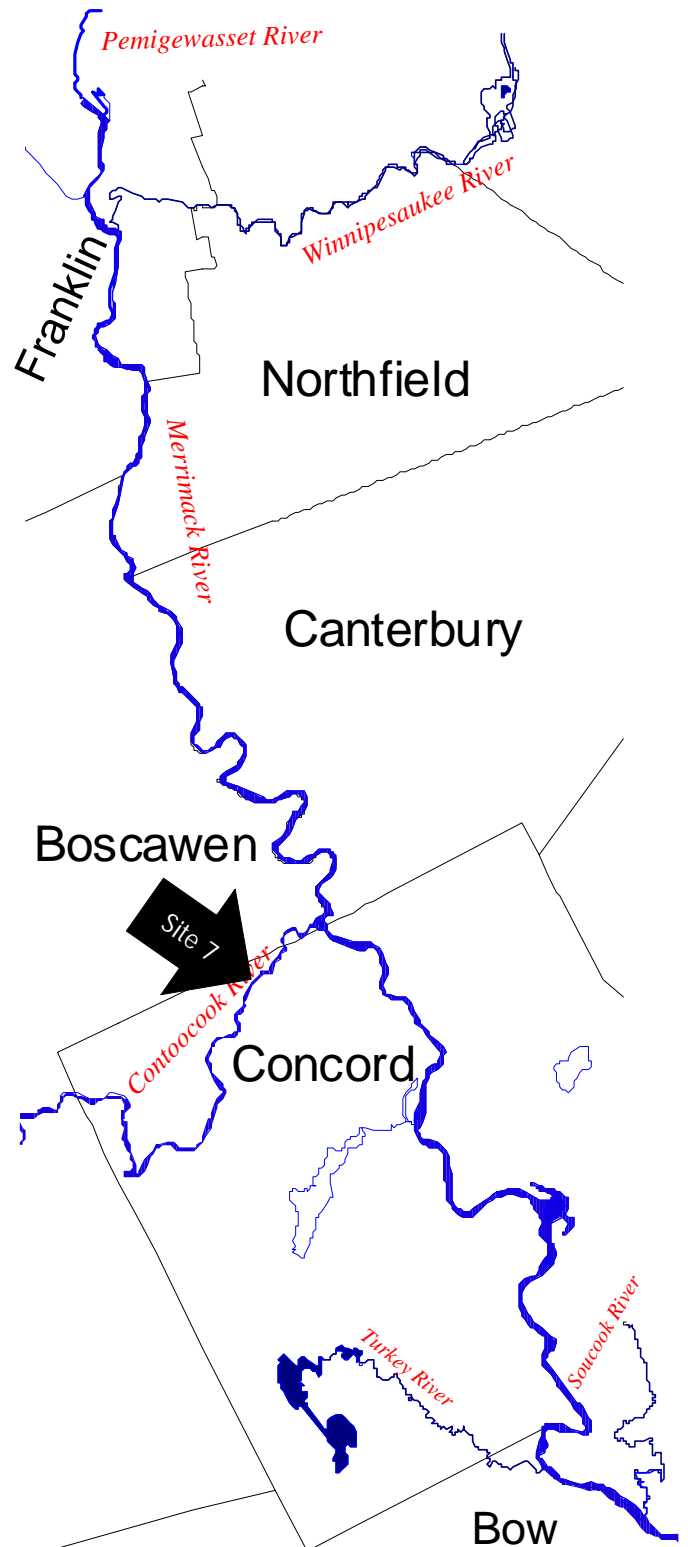
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impaired” or “excellent” when EPT families comprise at least 50% of the sample and the abundance of Mayfly taxa at this site account for the high EPT percentage. The two-year **Biotic Index** averaged 4.45 or “good” which indicates that although organism density showed a decline, the organisms comprising that community are mostly intolerant to pollution. The **Percent Contribution of Dominant Family** over the two-year period averaged 60.5% with Hydropsychidae representing the dominant family in the community. The abundance of well-processed organic matter such as fallen leaves and other vegetation at this site are ideal for filtering collectors such as Hydropsychidae.

The two-year average total score based upon benthic macroinvertebrate metrics was 30, the **Community Similarity Index** ranked 79%. This section of the Merrimack River scored 38% for habitat assessment. Site 6 receives a 4.0 Dragonfly Rating from 1995 to 1997 and indicates “good” river quality.

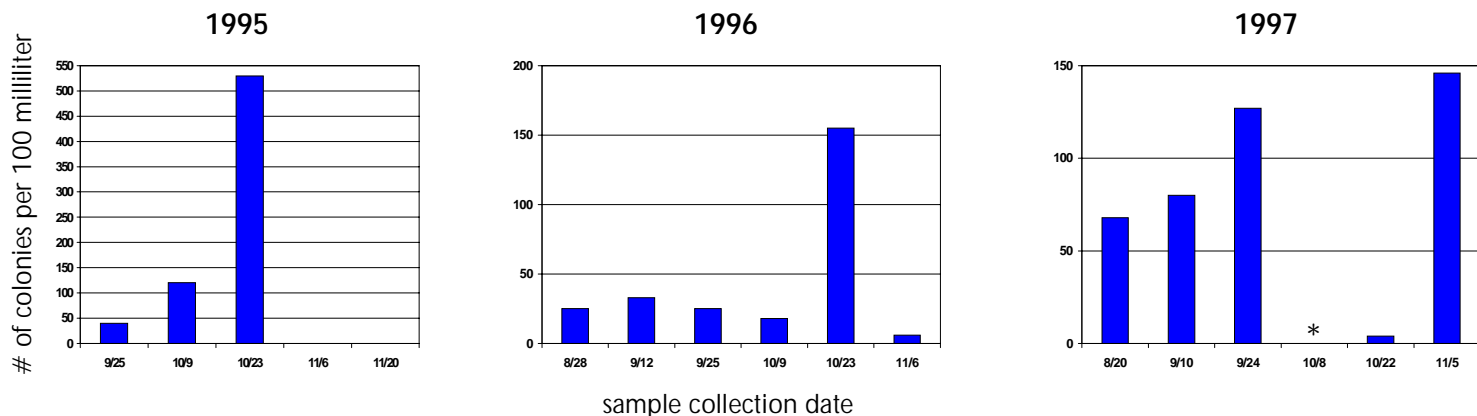


Site 7

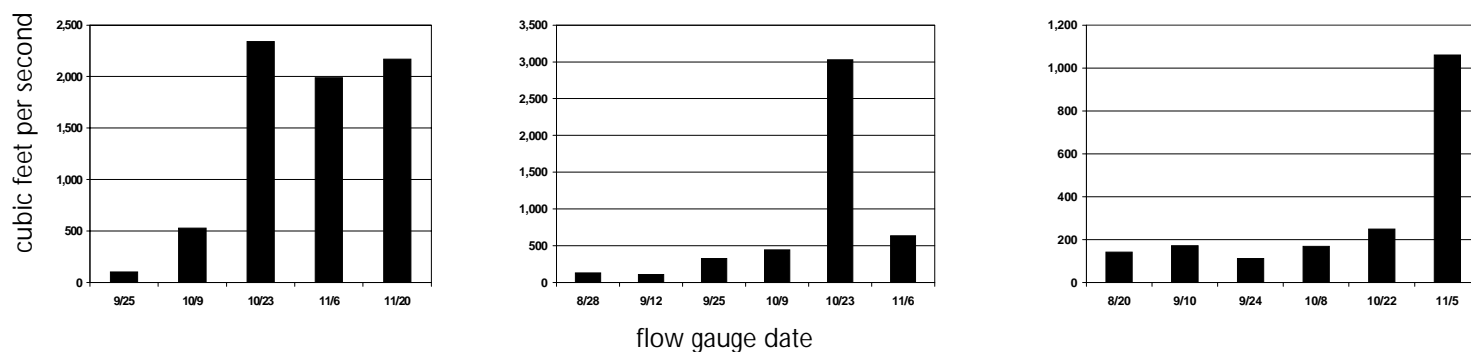


The river is so low now that you can see its bottom, shined on by the sun...

E. coli



Flow



Benthic Macroinvertebrates

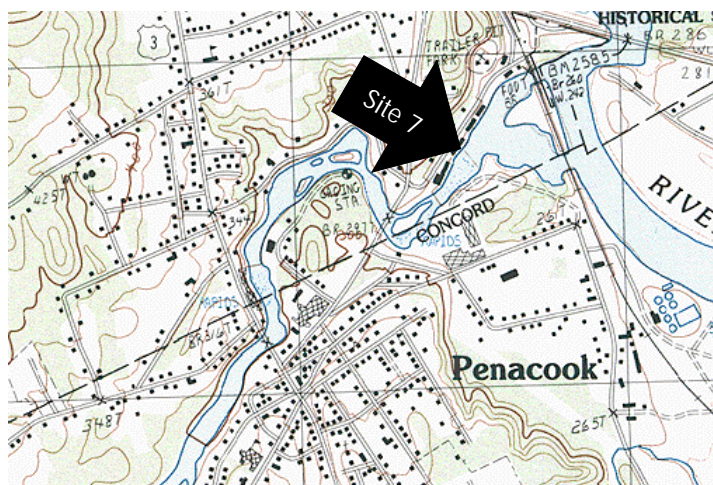
	1995	1996	1997
Organism Density	1256	1020	1795
EPT Richness	11	6	15
Total Taxa Richness	17	12	20
Biotic Index	4.12	3.86	3.77
Percent Contribution of Dominant Family	54	64	65
Community Similarity Index (1)	65%	65%	65%
Total Score (possible 42)	29	28	20

* indicates sample not taken for this date

The Contoocook River

Site description

Located on the Contoocook River in Boscawen just upstream of the confluence with the Merrimack River, Site 7 is adjacent to the old Stratton Flour Mill complex and Rivco Industries. Fluctuations in flow can be quite dramatic at this site with a hydroelectric dam situated approximately 1000' upstream. Historical channelization (deep water gouges) has occurred at this site from long concrete footings that support the abandoned tannery/flour mill complex. The riffle habitat at this site, however, is very well-developed and offers a wide variety of flow, substrate, and tree canopy cover for both fish and macroinvertebrates. Substrate is comprised of large cobble, gravel, and boulders with a few permanently exposed. The river averages 100' in width at this location with 66% open tree canopy and 60% algal cover on the river bottom.



Field chemistry and *E. coli*

Field chemistry data have been recorded at this site in 1996 and 1997. Conditions are consistent with a fast moving, shallow river for pH, acid neutralizing capacity, and dissolved oxygen. Conductivity data at this site were somewhat elevated and indicate a high incidence of sediment and other solids suspended in the water—not unusual given the turbulent nature of this stretch. ***E. coli*** bacteria concentrations at this site were all well below the Class B Water Quality Standard of 406 counts per 100ml except for the sample collected on October 23, 1995 which corresponded with the second highest flow of the 3-year period. The correlating spikes in *E. coli* bacteria with increased flows reflect many sources of polluted runoff from a large and diverse watershed.

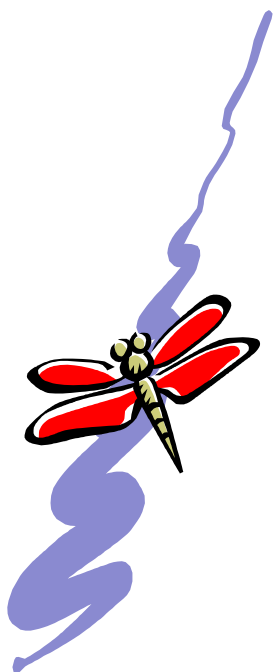
Benthic macroinvertebrates

Benthic macroinvertebrate data from this site have been collected and analyzed for three years. Rock baskets were set in a shallow, swift moving riffle habitat in one to two feet of water with an average velocity 5.11' per second. **Organism Density** measured during the three years at this site remained very stable and reflects consistent deployment of baskets at the same location within the riffle. The three-year **EPT Richness** contribution to overall taxa at this site averaged 63% which indicates a healthy community dominated by intolerant or sensitive organisms. River quality is considered “non-impaired” or “excellent” when EPT families comprise at least 50% of the community. The three-year **Biotic Index** averaged 3.92 or “very good” which indicates that the majority of organisms present at this site are sensitive or intolerant to pollution. The **Percent Contribution of Dominant Family** averaged 61.0% with Hydropsychidae larvae representing the dominant family in the community. The abundance of well-processed organic matter such as decayed fallen leaves and plants at this site make it ideal for filtering collectors such as Hydropsychidae. The average total score based upon benthic macroinvertebrate metrics was 26, with the **Community Similarity Index** ranking 65%, indicating minimal impairment.

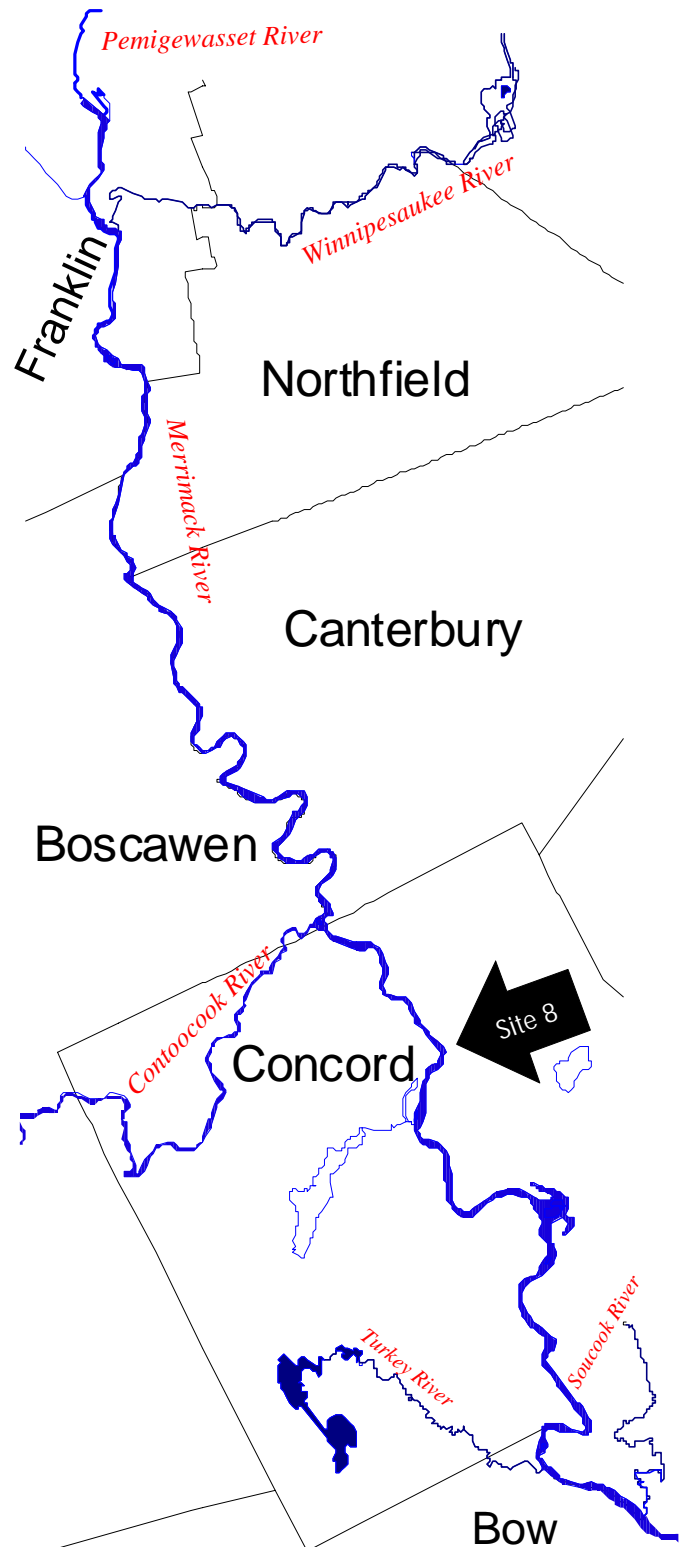


Available for adoption.

This section of the Contoocook River scored 78% for habitat assessment and received a 4.5 Dragonfly Rating from 1995 to 1997 indicating “good to very good” river quality.

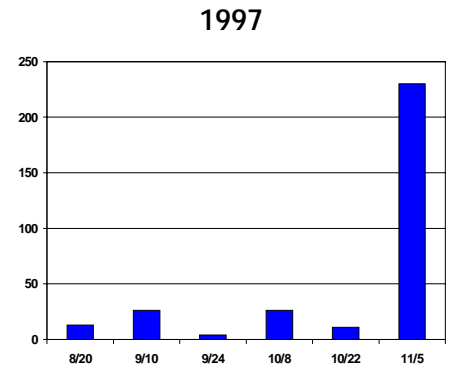
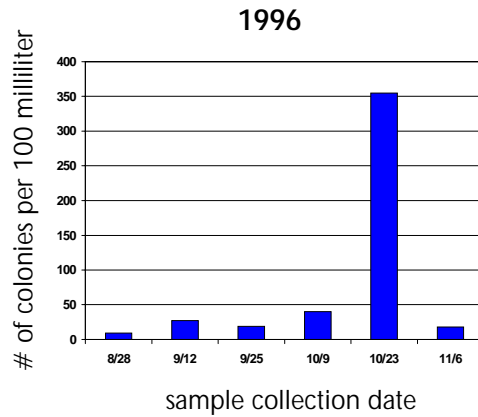


Site 8

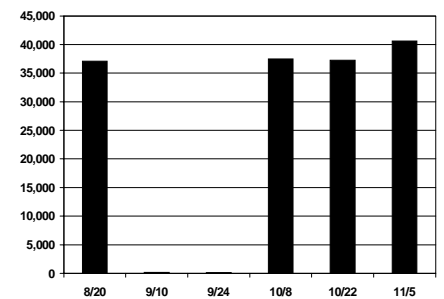
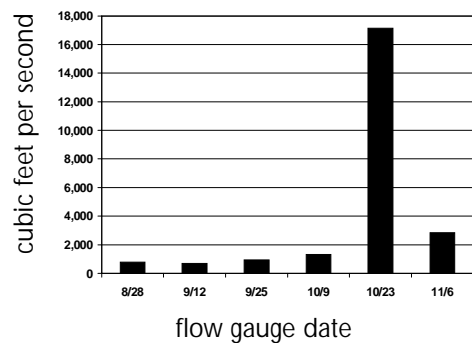


How many memorable localities in a river walk! Here is the warm wood-side; next the good fishing bay; and next, where the old settler was drowned when crossing on the ice a hundred years ago. It is all storied.

E. coli



Flow



Benthic Macroinvertebrates

	1995	1996	1997
Organism Density	*	*	*
EPT Richness	*	*	*
Total Taxa Richness	*	*	*
Biotic Index	*	*	*
Percent Contribution of Dominant Family	*	*	*
Community Similarity Index (1)	*	*	*
Total Score (possible 42)	*	*	*

* indicates sample not taken for this date

The Merrimack River

Site description

The main channel of the Merrimack River just below Sewalls Falls is non-wadable and somewhat treacherous during high flows. Site 8 is situated in an accessible portion of the river where conditions are deeper and more slow-moving with abundant ledge and sand deposition. At this point, the Merrimack River is between 180' and 200' across with large boulders and cobble dominating the river bottom. There are several slower pools and backwater areas along this stretch where large deposits of sand have accumulated, giving rise to abundant stands of aquatic plants. Both banks are well-vegetated with little evidence of erosion. The 58% open tree canopy allows ample sunlight penetration of the water at this site. Ten percent of the submerged cobble and gravel are covered by stream channel alterations upstream of this site including the Merrimack River Dam and Bypass Facility, and Sewalls Falls Dam and bypass facility.



Field chemistry and *E. coli*

Field chemistry data were collected at Site 8 in 1996 and 1997. Conditions at the site are consistent with a fast-moving, river habitat for pH, acid neutralizing capacity, and dissolved oxygen. Conductivity values at this site were somewhat lower than expected in a river of this size. This is probably due to its stable banks with minimal erosion. *E. coli* bacteria samples were collected in 1996 and 1997 with concentrations at the site well below the Class B Water Quality Standard of 406 colonies per 100ml. Although some significant flow events were recorded in 1997, there was only one corresponding spike in *E. coli* bacteria on the November 5th sample date which was well below the Class B Standard. Although dilution of contaminants at this site is extremely high, a consistent source of *E. coli* bacteria would have produced a discernible spike during times of high flow.

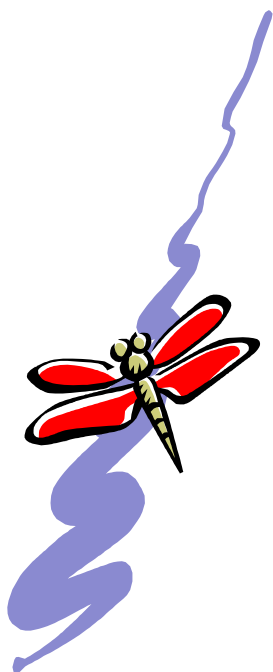
Due to lack of macroinvertebrate data, no Dragonfly Rating is available for this site.



*Adopt-a-River Site Sponsor:
Aries Engineering, Inc.
Concord, NH*

Benthic macroinvertebrates

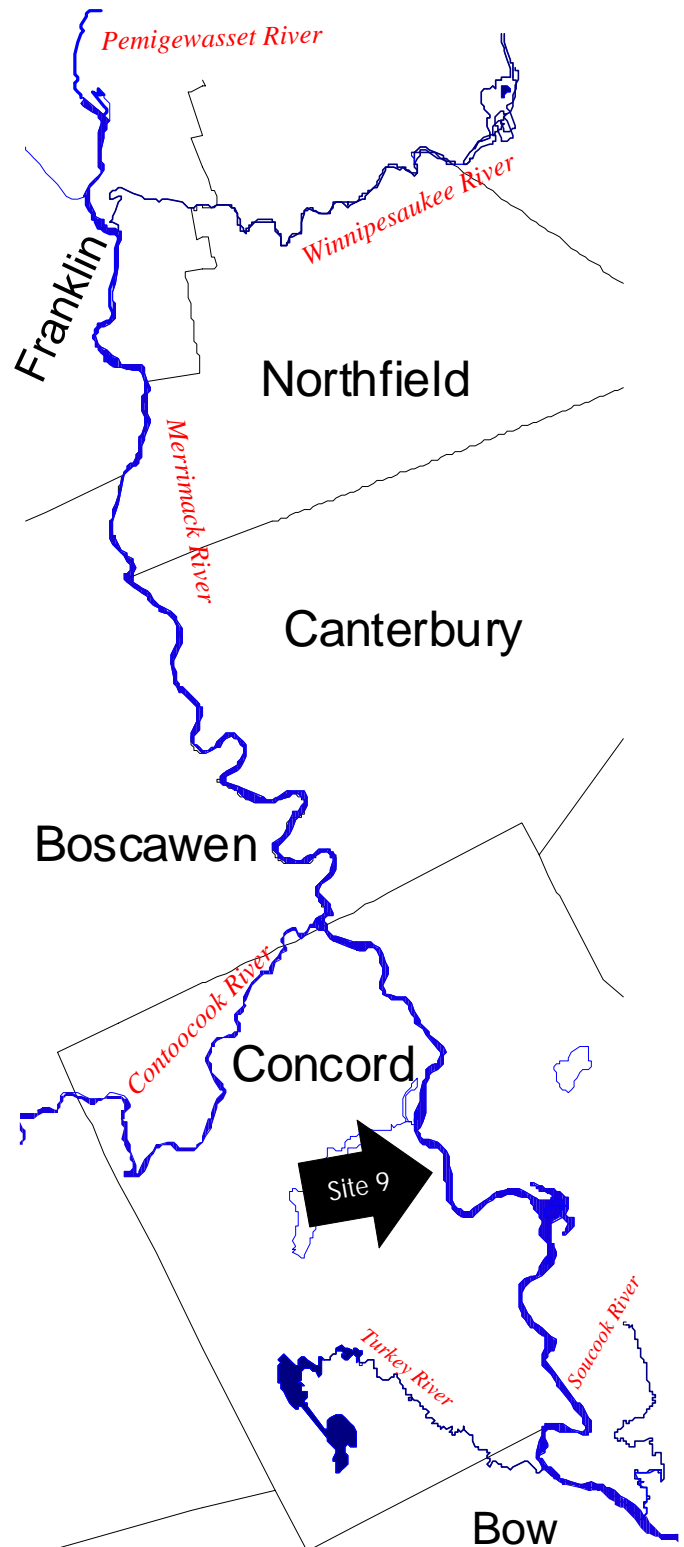
Artificial substrate or rock baskets were placed at Site 8 in 1996 and 1997. Unfortunately, the baskets set in 1996 were vandalized and never found. In 1997, the baskets were completely buried in sediment during high flow. Rock baskets will be relocated in 1998 and subsequent sampling years with deployment planned for upstream of the Sewalls Falls Road Bridge. The habitat assessment completed for this site scored 88 out of a possible 240 points (36%), which reflects numerous instream alterations, lack of instream fish habitat, and high degree of embeddedness of gravel and cobble by sediment on the river bottom. A cursory examination of the macroinvertebrate habitat at this site revealed a large number of Odonata, Ephemeroptera, Plecoptera, Trichoptera, and Megaloptera with several Chironomidae cases present on substrate. The Upper Merrimack Monitoring Program looks forward to collecting biological community data from this site in the future.



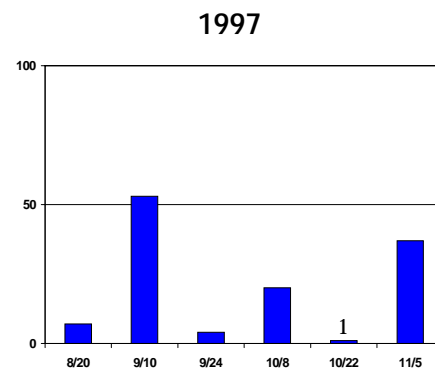
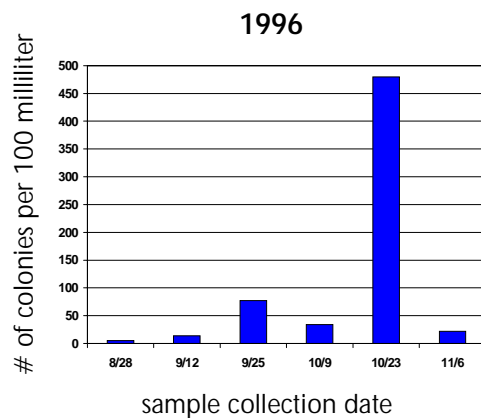
Site 9



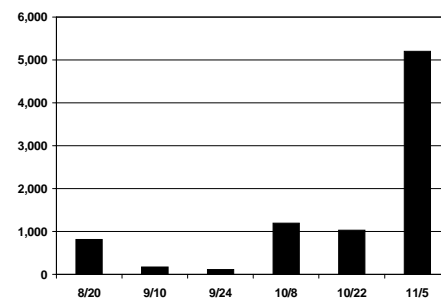
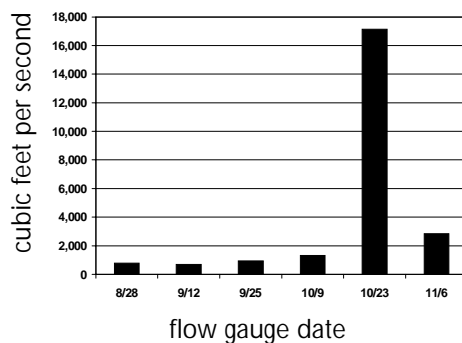
What an entertainment this river affords! It is subject to so great overflows owing to its broad intervals, that a day's rain produces a new landscape. It is an advantage which all towns do not possess.



E. coli



Flow



Benthic Macroinvertebrates

	1995	1996	1997
Organism Density	*	*	247
EPT Richness	*	*	7
Total Taxa Richness	*	*	15
Biotic Index	*	*	5.49
Percent Contribution of Dominant Family	*	*	42
Community Similarity Index (1)	*	*	58
Total Score (possible 42)	*	*	18

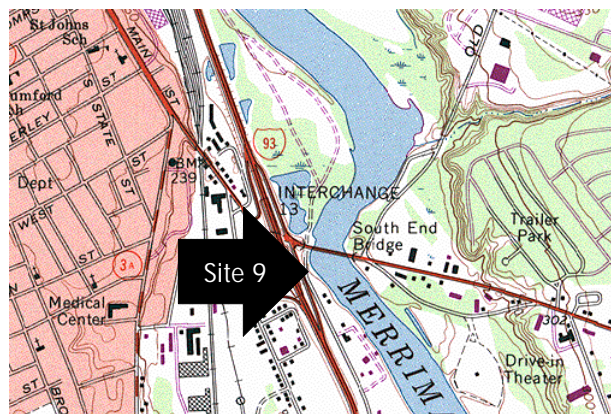
* indicates sample not taken for this date

The Merrimack River

Site description

Downtown Concord is the backdrop for Site 9 which lies downstream of the Manchester Street Bridge. As the river meanders through the capital city, the water is slow-moving and confined to a deep channel with steep banks. The river-bottom at this site is composed primarily of sand and silt with an isolated shoal in the middle of the channel. Both banks are fairly well-vegetated with some undercut and eroded areas. Channel width at this site measures 200' with tree canopy cover limited to 36%. Upstream land-use includes agriculture, commercial properties, and the downtown Concord business district which generates significant

amounts of stormwater runoff. Substantial upstream alterations and bank disturbance occurred from 1996 through 1997 during the demolition of the old Manchester Street bridge and the simultaneous construction of a new bridge. Bank disturbance, erosion, and subsequent turbidity and sedimentation in the river occurred during construction, particularly during rain events.



Field chemistry and *E. coli*

Field chemistry data collected at Site 9 from 1996 and 1997 indicate very stable conditions for pH, adequate acid neutralizing capacity, and abundant dissolved oxygen. The conductivity values recorded at this site escalated from 63.2 $\mu\text{mhos/cm}$ in 1996 to 101.3 $\mu\text{mhos/cm}$ in 1997, which reflects the increase in turbidity and sedimentation from the upstream construction activities. *E. coli* bacteria and corresponding flow data compiled for this site from 1996 and 1997 indicate that the significant rain event recorded on October 23, 1996 resulted in a violation of the Class B Water Quality Standard designated at this site. A substantial portion of the watershed upstream of this site is impervious (pavement, building roofs, etc.). The October rain event generated significant amounts of runoff from urban areas which reach the river with little or no opportunity for absorption or filtration through vegetation. Many other nonpoint source pollutants commonly associated with *E. coli* bacteria elevations probably entered the river during the same rain event.

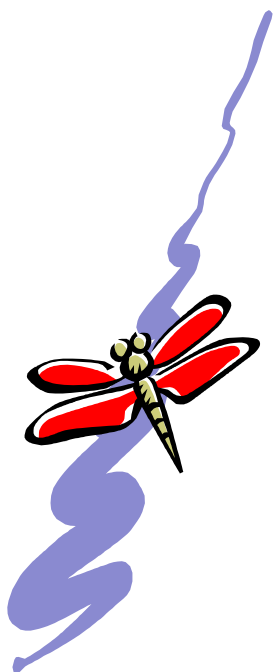
Benthic macroinvertebrates

Benthic macroinvertebrates were collected using rock baskets that were set in a slow moving, glide habitat with a depth of two feet and a velocity of 1.8 feet per second. **Organism Density** at the site was very low which corresponds with its low **Taxa Richness** of fifteen. River quality is considered to be “non-impaired” or “excellent” when EPT families comprise at least 50% of the sample. At this site, **EPT Richness** only represented 46% of the community which is considered “good.” The **Biotic Index** measured 5.49 or “fair” and indicates that excessive nutrients are entering the river and shifting the macroinvertebrate community. Gastropods (snails) were the dominant family in 1997 comprising 42% of the invertebrates. This site is characterized by slow moving water, abundant sunlight, weed beds, and 75% periphyton cover (algae) on the river-bottom. Gastropods tend to favor nutrient rich environments where they scrape algae or periphyton off substrate for food.

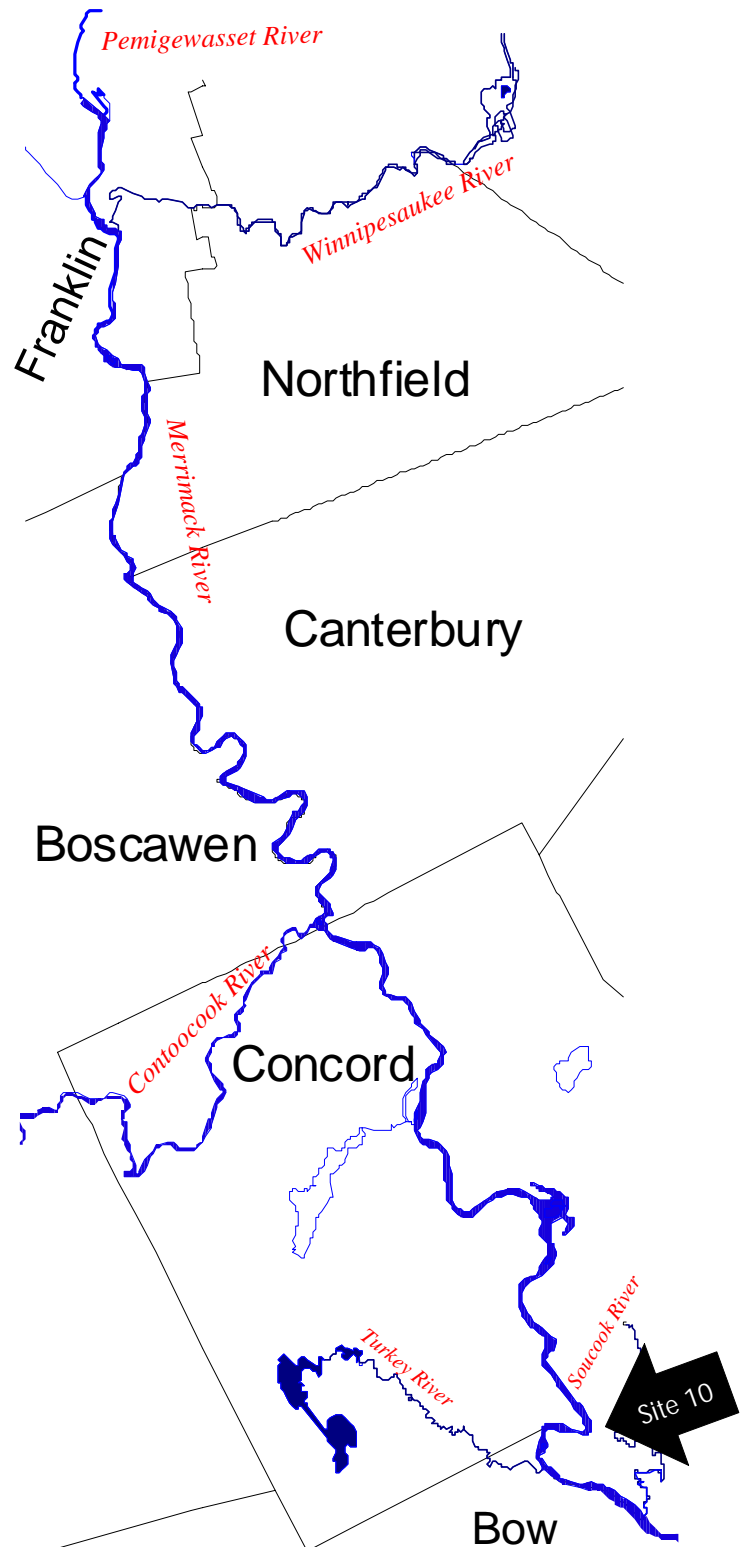
The total score for Site 9, based upon benthic macroinvertebrate metrics was 18, the **Community Similarity Index** ranked 58% and scored 58% for habitat assessment. Site 9 receives a 2.5 Dragonfly Rating for 1997 and indicates “poor” to “fair” river quality.



Available for adoption

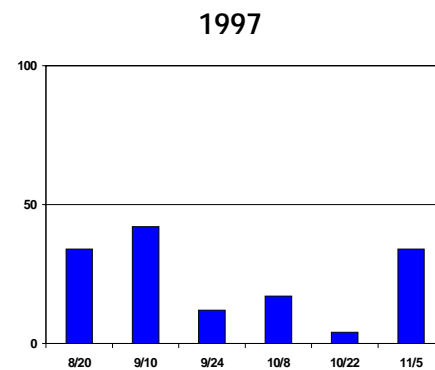
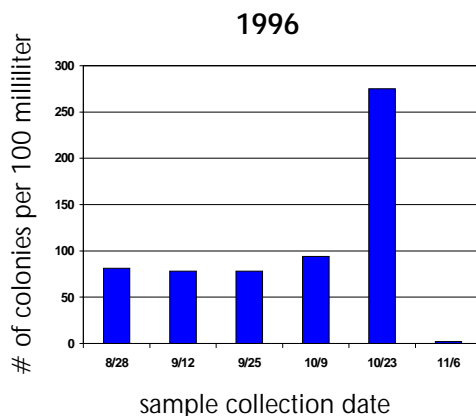


Site 10

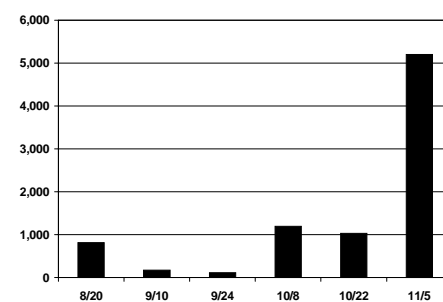
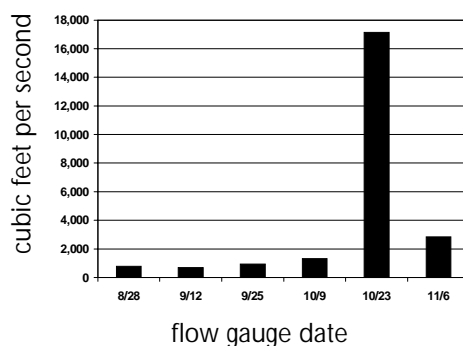


When I examine a flat sandy shore on which the ripples now break, I find the tracks of many little animals that have lately passed along close to the water's edge.

E. coli



Flow



Benthic Macroinvertebrates

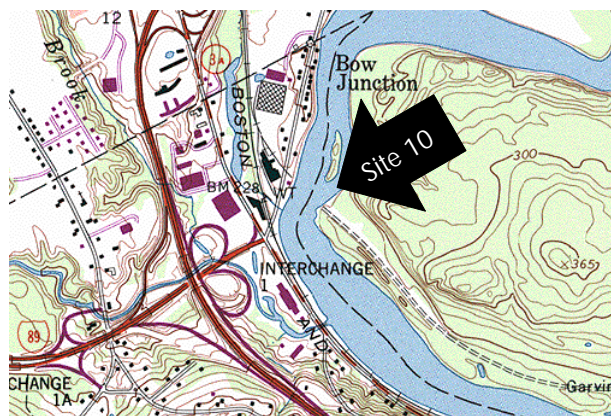
	1995	1996	1997
Organism Density	*	824	428
EPT Richness	*	10	8
Total Taxa Richness	*	20	18
Biotic Index	*	5.15	5.51
Percent Contribution of Dominant Family	*	21	33
Community Similarity Index (1)	*	50	50
Total Score (possible 42)	*	36	24

* indicates sample not taken for this date

The Merrimack River

Site description

Situated on the east bank of the Merrimack River, adjacent to Bow Junction, Site 10 is approximately .8 miles downstream of the Concord Wastewater Treatment Facility. While the western corridor along this stretch of the Merrimack is dominated by a commercial zone and Interstates 93 and 89, the eastern corridor is primarily wooded with some agricultural fields upstream. A small island constricts flow along the eastern bank near a large outcropping of ledge in a shallow, swift-moving section of river. The site has a mixture of ledge, boulders, and large cobble with many snags and submerged logs, providing abundant cover for fish. The width of the Merrimack River at this point is 250-300' with well-vegetated banks and 45% open canopy. Abundant sunlight encourages growth of a diverse community of algae, sponges, and submerged and emergent plants.



Field chemistry and *E. coli*

Field chemistry data collected at Site 10 from 1996 and 1997 indicate very stable conditions for pH, adequate acid neutralizing capacity, and abundant dissolved oxygen. The conductivity values are consistent with a high volume, slow moving river. *E. coli* bacteria and corresponding flow data compiled for this site from 1996 and 1997 indicate that the significant flow event recorded on October 23, 1996, triggered an elevation in bacteria. However, *E. coli* concentrations during this event were well below the Class B Water Quality Standard which indicates that the Merrimack River probably met its designation at that time.

Benthic macroinvertebrates

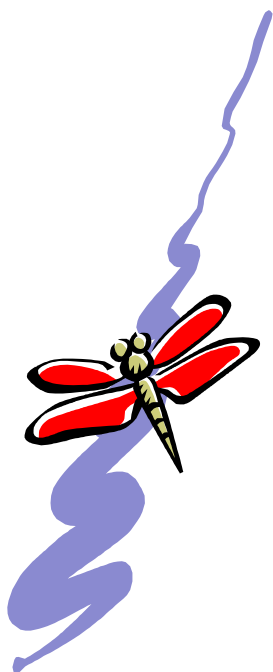
Benthic macroinvertebrate data for 1996 and 1997 have been collected and analyzed for Site 10. Rock baskets were set in a swift-moving, deep riffle habitat with a depth of 2 feet and a velocity of 1.2 feet per second. **Organism Density** dropped by 400 from 1996 to 1997 with a corresponding loss of **Taxa Richness** and **EPT Richness**. Changing the location of the rock baskets in 1997 most likely resulted in this shift in community structure. In 1996, EPT organisms represented 50% of the community while only 44% of the macroinvertebrate community was comprised of EPT organisms in 1997. Although river quality is considered to be "impaired" when EPT organisms account for less than 50% of the community, the low representation in 1997 is more due to its habitat characteristics than river quality. The **Biotic Index** measured 5.33 or "fair" and indicates that abundant nutrients are entering the system and shifting the community accordingly. In 1996, the macroinvertebrate community at this site was dominated by Gammaridae (scuds) which are gathering collectors. This indicates that coarse organic debris collects on the bottom. Favoring a community dominated by gathering collectors, changing the rock basket location to a swift, riffle habitat in 1997 resulted in a community dominated by "filtering collectors," indicating that the supply of nutrients is well-decomposed and in fine particles.



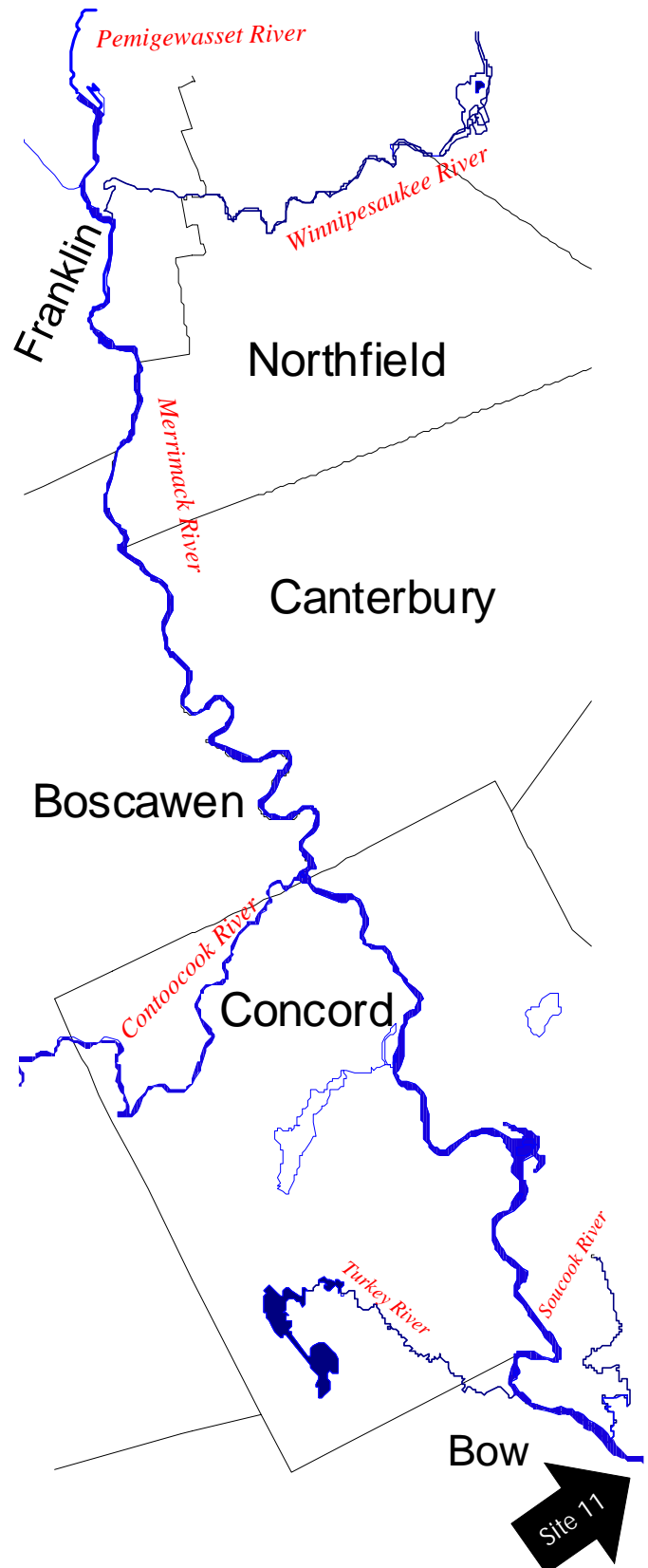
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Public Service of NH, Corporate Office
Manchester, NH

This section of the Merrimack River scored 64% for habitat assessment while the two-year average total score for Site 10, based upon benthic macroinvertebrate metrics was 30. The **Community Similarity Index** ranked 50%, indicating substantial impairment.

Site 10 receives a 3.0 Dragonfly Rating for the three-year period, indicating "fair" river quality.

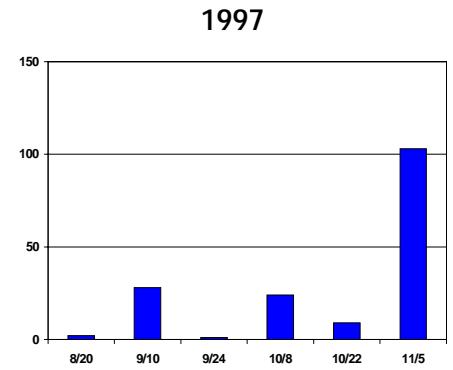
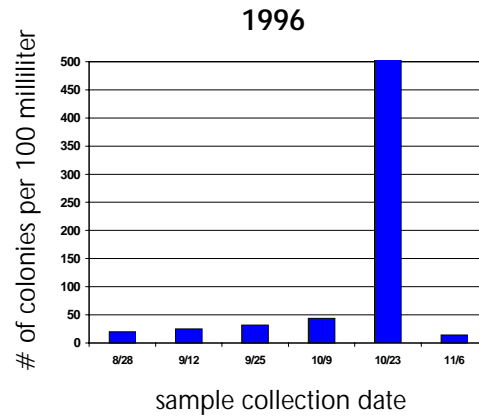


Site 11

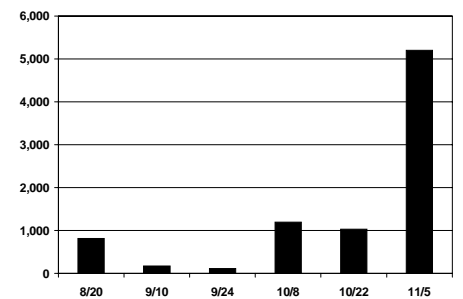
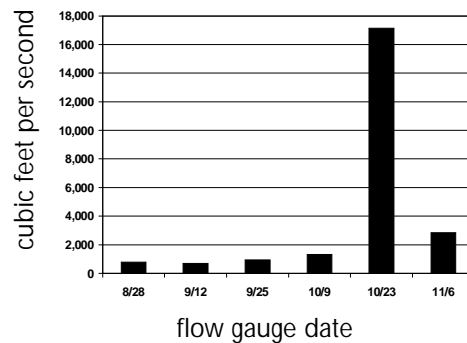


Cultivated field and wood and pasture and house are brought into ever new and unexpected positions and relations to the water. There is just stream enough for a flow of thought.

E. coli



Flow



Benthic Macroinvertebrates

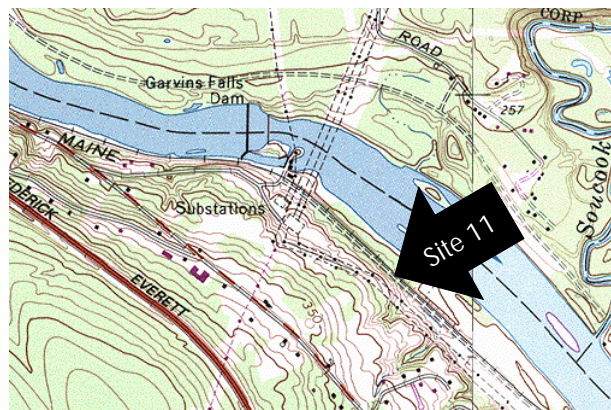
	1995	1996	1997
Organism Density	*	*	583
EPT Richness	*	*	7
Total Taxa Richness	*	*	16
Biotic Index	*	*	4.55
Percent Contribution of Dominant Family	*	*	53
Community Similarity Index (1)	*	*	48
Total Score (possible 42)	*	*	28

* indicates sample not taken for this date

The Merrimack River

Site description

Situated on the Merrimack River in Bow, Site 11 is one half-mile downstream of the Garvin Falls Hydroelectric Dam. The river is wide, slow-moving, and characterized by a deep channel with coarse and fine sands. The Garvin Falls Dam spans the 250' width of the river channel. Both river banks are well-vegetated and relatively undisturbed. A canoe portage access area is located along the west bank just downstream of the dam. An active railroad bed runs parallel to the river along the west bank. Isolated boulders in the channel and dense stands of pickerel weed along the banks provide habitat and cover for fish. The 30% tree canopy cover allows abundant sunlight penetration through the river, resulting in warm water temperatures, and algal growth covering a high percentage of rocks and woody debris.



Chemistry and *E. coli*

Field chemistry data collected at Site 11 from 1996 and 1997 indicate very stable conditions for pH, conductivity, and adequate acid neutralizing capacity. The dissolved oxygen measured 7.89 mg/L which is the lowest value among UMMP sites. A dissolved oxygen deficit is created by the impoundment of the Merrimack River at the Garvin Falls Dam. However, aquatic organisms will not become stressed until the dissolved oxygen drops below 5.0 mg/L. *E. coli* bacteria and corresponding flow data compiled for this site from 1996 and 1997 indicate that the significant flow event recorded on October 23, 1996 triggered an elevation in bacterial loading. Although the *E. coli* concentrations on that date exceeded the Class B Water Quality Standard, this appears to have been an isolated event as all other sample events were below the Class B Standard of 406 *E. coli* counts/100ml.

Benthic macroinvertebrates

Benthic macroinvertebrate data for 1997 have been collected and analyzed for Site 11. Rock baskets were set in a slow-moving, deep habitat with a depth of four feet and a velocity of 1.4' per second. **Organism Density** was very similar to that found at Site 10. This condition reflects the lack of "choice" habitat for macroinvertebrate colonization. **EPT Richness** only comprised 44% of the community which normally indicates minimal impact when there is optimal habitat availability. Although river quality is considered to be "impaired" when EPT organisms account for less than 50% of the community, the low percentage in 1997 is due more to habitat than water quality. Similarly, the **Per-**

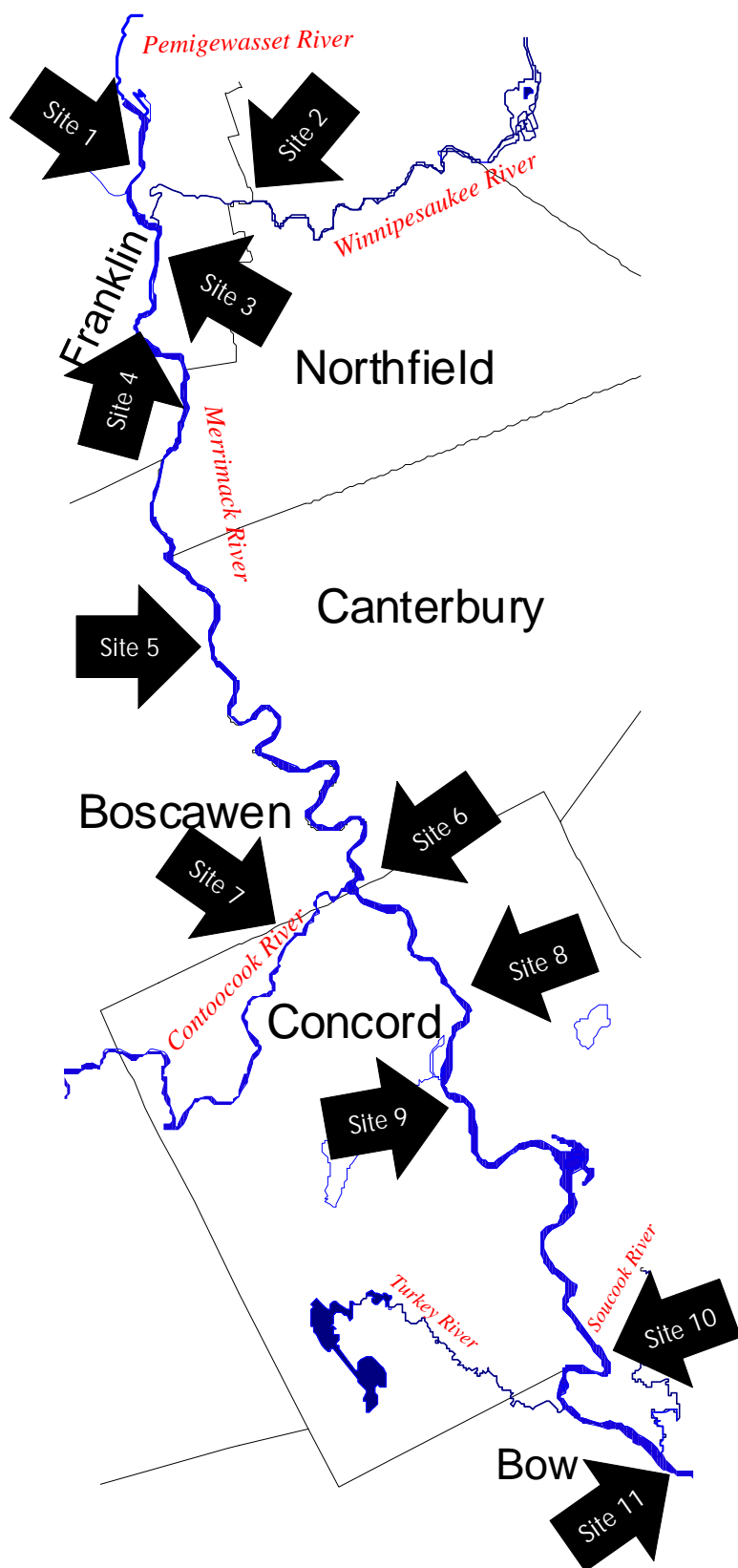


Adopt-a-River Site Sponsor:
Public Service of NH, Merrimack Station
Bow, NH

cent Contribution of Dominant Family reveals that Lep-toceridae make up 53% of the community at this site. Generally, a sample dominated (greater than 50%) by one family indicates an environmental impact. However, given the substantial width of the river at this point and the location just below Garvin Falls Dam, the community structure is most likely dictated by the habitat as well as the upstream impoundment or "lake effect" caused by the dam. The **Biotic Index** measured 5.33 or "fair" and indicates a lack of suitable habitat and a nutrient rich environment. Moving the rock baskets upstream will be investigated in following years. The bypass area contains riffles, which should provide a better representation of macroinvertebrates than the slow-moving water site used from 1995-1997.

This section of the Merrimack River scored 72% for habitat assessment while the total score based upon benthic macroinvertebrate metrics was 28. The **Community Similarity Index** ranked 48%, indicating substantial impairment. Site 10 receives a 3.0 Dragonfly Rating for the three year period, indicating "fair" river quality.

UPPER MERRIMACK MONITORING PROGRAM SITE MAP AND MONITORING LOCATIONS



Site 1

Pemigewasset River, Franklin

Site 2

Winnepesaukee River, Franklin

Site 3

Above Franklin Wastewater Treatment Facility, Franklin

Site 4

Below Franklin Wastewater Treatment Facility, Franklin

Site 5

Merrimack River State Forest, Boscawen and Canterbury

Site 6

Below Riverlands, Boscawen and Canterbury

Site 7

Contoocook River, Boscawen and Penacook

Site 8

Sewall's Falls, Concord

Site 9

Manchester Street Bridge, Concord

Site 10

Above Garvins Falls Dam, Bow

Site 11


Below Garvins Falls Dam, Bow

UPPER MERRIMACK MONITORING PROGRAM PARTNERS

Concerned citizens from NH, VT, MA, and ME
Franklin High School, students and faculty
Franklin Wastewater Treatment Facility
Manchester Fly Fishing Club
Merrimack River Watershed Council
NH Department of Environmental Services
Notre Dame College, students and faculty
River Watch Network
Rundlett Junior High School
St. Paul's School, students and faculty
Trout Unlimited, Basil W. Woods Chapter
Upper Merrimack River Local Advisory Committee
Volunteer Environmental Monitoring Network
The Conservation Commissions of the Towns of Boscaawen, Bow, Canterbury, and Northfield
and the Cities of Concord and Franklin

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Lesley Blecharczyk
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Michele L. Tremblay

Canterbury

Vacant

Franklin

Marilee A. Horn
Richard LaFlamme

Bow

Gary Lynn
Susan Paschell

Concord

Edwin Robinson
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Northfield

Richard Bellerose

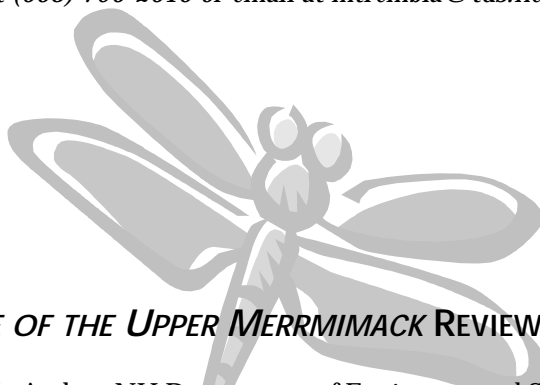
ADOPT-A-RIVER SITE SPONSORS

Adopt-a-River Site Sponsors have demonstrated river stewardship by their commitment to preserving and protecting the upper Merrimack and its watershed. Sponsors provide annual financial assistance and volunteer effort to the Upper Merrimack Monitoring Program.

The UMMP recognizes the following organizations:

Aries Engineering, Inc., Concord, NH
Franklin Waste Water Treatment Facility, Franklin, NH
Franklin Savings Bank, Franklin, NH
Public Service of NH, Corporate Offices, Manchester, NH
Public Service of NH, Merrimack Station, Bow, NH
Webster Valve, Inc., Watts Regulator, Co., Franklin, NH

*Would you or your organization like to become a friend of the upper Merrimack?
For further information on the Adopt-a-River Site Program, please contact Michele L. Tremblay
at (603) 796-2615 or email at mtrembla@tds.net*



STATE OF THE UPPER MERRIMACK REVIEW TEAM

Angela Archer, NH Department of Environmental Services
Susan Paschell, UMLAC
Keith Robinson, United States Geological Survey
Stephanie Vaine, Central NH Regional Planning Commission

The Upper Merrimack Monitoring Program extends its gratitude to the members of the Team who painstakingly reviewed this report and made it better with their input and perspectives.

***E. coli* Data Summary**

(Colonies per 100 milliliters)

	9/25/95	10/9/95	10/23/95	11/6/95	11/20/95
Site 1	*	80	710	70	<1
Site 2	*	<1	170	<1	<1
Site 3	20	20	1150	10	<1
Site 4	<1	100	1000	10	10
Site 5	<1	*	900	10	*
Site 6	<1	20	870	30	10
Site 7	40	120	530	<1	<1

	8/28/96	9/12/96	9/25/96	10/9/96	10/23/96	11/6/96
Site 1	50	109	174	40	170	2
Site 2	17	7	13	39	120	5
Site 3	70	83	86	92	100	5
Site 4	18	28	37	30	230	4
Site 5	3	3	10	62	205	5
Site 6	7	*	17	6	*	11
Site 7	25	33	25	18	155	6
Site 8	9	27	19	40	355	18
Site 9	5	14	77	34	480	22
Site 10	81	78	78	94	275	2
Site 11	20	25	32	44	525	14

	8/20/97	9/10/97	9/24/97	10/8/97	10/22/97	11/5/97
Site 1	8	102	1	16	19	111
Site 2	1	18	1	12	7	32
Site 3	1	47	7	25	22	101
Site 4	4	19	4	6	7	121
Site 5	1	11	15	8	14	77
Site 6	5	11	16	*	1	63
Site 7	68	80	127	*	4	146
Site 8	13	26	4	26	11	230
Site 9	7	53	4	20	1	37
Site 10	34	42	12	17	4	34
Site 11	2	28	1	24	9	103

Flow Data Summary

(Cubic feet per second)

	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11
9/25/95	321	232	883	883	883	883	101	*	*	*	*
10/9/95	542	253	1,070	1,070	1,070	1,070	529	*	*	*	*
10/23/95	6,500	431	16,100	16,100	16,100	16,100	2,340	*	*	*	*
11/6/95	1,910	779	4,190	4,190	4,190	4,190	1,990	*	*	*	*
11/20/95	2,120	1,260	5,150	5,150	5,150	5,150	2,170	*	*	*	*

	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11
8/28/96	262	221	652	652	652	652	132	784	784	784	784
9/12/96	204	222	576	576	576	576	108	684	684	684	684
9/25/96	181	228	614	614	614	614	327	941	941	941	941
10/9/96	303	238	879	879	879	879	445	1,324	1,324	1,324	1,324
10/23/96	4,980	1,220	14,100	14,100	14,100	14,100	3,030	17,130	17,130	17,130	17,130
11/6/96	705	910	2,210	2,210	2,210	2,210	634	2,844	2,844	2,844	2,844

	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11
8/20/97	231	210	670	670	670	670	142	812	812	812	812
9/10/97	371	319	*	*	*	*	171	171	171	171	171
9/24/97	317	220	*	*	*	*	111	111	111	111	111
10/8/97	455	224	1,020	1,020	1,020	1,020	169	1,189	1,189	1,189	1,189
10/22/97	244	278	780	780	780	780	249	1,029	1,029	1,029	1,029
11/5/97	3,070	100	4,140	4,140	4,140	4,140	1,060	5,200	5,200	5,200	5,200

Field Chemistry Data Summary

	Parameter	pH (units)			ANC (mg/L)			Conductivity (µmhos/cm)			Dissolved Oxygen (mg/L)		
		1996	1997	1998	1996	1997	1998	1996	1997	1998	1997	1998	1997
Site 1		6.38	6.32	6.71	4.6	5.2	6.4	42.3	51.6	59.1	9.06		
Site 2		6.78	6.62	6.81	7.5	6.4	7.4	75.6	71.1	70.2	9.12		
Site 3		6.66	6.45	6.89	7.4	7.3	7.3	71.1	69.1	70.4	9.35		
Site 4		6.57	6.55	6.52	6.1	8.1	7.2	55.6	62.6	64.7	8.74		
Site 5		6.58	6.72	6.78	6.6	8.7	7.5	59.4	64.2	67.5	9.17		
Site 6		6.51	6.53	n/a	6.6	7.5	n/a	59.5	66.1	n/a	8.94		
Site 7		6.48	6.88	6.95	7.2	12.3	9.6	65.9	91.9	83.0	9.22		
Site 8		6.50	6.57	6.56	6.8	8.5	8.0	60.3	69.3	84.3	8.98		
Site 9		6.47	6.37	6.70	6.4	8.4	7.4	63.2	101.3	74.5	8.36		
Site 10		6.45	6.51	6.70	6.9	12.1	8.0	65.4	83.2	76.3	8.26		
Site 11		6.48	6.27	6.51	7.2	9.9	8.4	67.1	74.2	78.1	7.89		

Macroinvertebrate Data Summary

1995

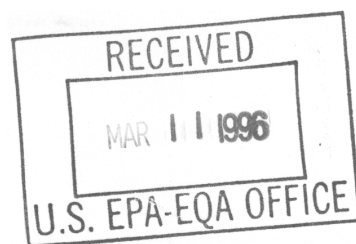
	Sites										
Metric	1	2	3	4	5	6	7	8	9	10	11
Organism Density	392	1616	1853	527	3343	2172	1256	*	*	*	*
EPT Richness	9	14	13	12	16	11	11	*	*	*	*
Total Taxa Richness	18	24	19	24	24	17	17	*	*	*	*
Biotic Index	6.30	3.84	3.94	4.52	3.99	4.32	4.12	*	*	*	*
% Contribution of Dominant Family	26%	57%	64%	28%	68%	68%	54%	*	*	*	*
Community Similarity Index (1)	1	0.95	0.87	0.89	0.75	0.79	65%	*	*	*	*

1996

	Sites										
Metric	1	2	3	4	5	6	7	8	9	10	11
Organism Density	3769	473	1512	2001	1436	0	1020	0	0	824	0
EPT Richness	9	9	12	13	12	0	6	0	0	10	0
Total Taxa Richness	14	14	19	22	24	0	12	0	0	20	0
Biotic Index	4.13	4.09	4.30	4.87	4.27	*	3.86	*	*	5.15	*
% Contribution of Dominant Family	66%	25%	60%	33%	58%	*	64%	*	*	21%	*
Community Similarity Index (1)	1	0.95	0.87	0.89	0.75	*	65%	*	*	0.5	*

1997

	Sites										
Metric	1	2	3	4	5	6	7	8	9	10	11
Organism Density	865	1591	1905	1153	746	816	1795	*	247	428	583
EPT Richness	15	16	14	12	11	12	15	*	7	8	7
Total Taxa Richness	25	23	21	21	20	15	20	*	15	18	16
Biotic Index	5.00	3.45	3.97	3.90	4.47	4.59	3.77	*	5.49	5.51	4.55
% Contribution of Dominant Family	38%	56%	76%	48%	40%	55%	65%	*	42%	33%	53%
Community Similarity Index (1)	1	0.95	0.87	0.89	0.75	0.79	65%	*	0.58	0.5	0.48



UPPER MERRIMACK MONITORING PROJECT

a citizen volunteer water quality monitoring program

prepared by
UPPER MERRIMACK RIVER LOCAL ADVISORY COMMITTEE

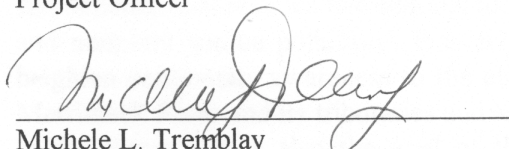
Stephen C. Landry
UMRLAC Water Quality Project Director

Michele L. Tremblay
Chairperson, UMRLAC

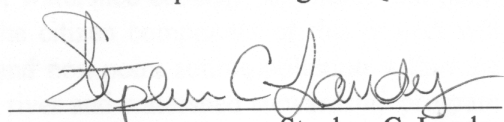
Funded by
Merrimack River Initiative
New England Interstate Water Pollution Control Commission

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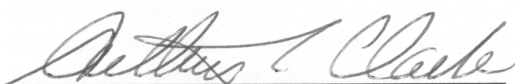
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RESOURCES AND REFERENCES

- Dates, Geoff.** 1995. Benthic Macroinvertebrate Monitoring Manual. River Watch Network. Montpelier, Vermont
- Landry, Stephen C. and Tremblay, Michele L.** 1999. Macroinvertebrates of the Upper Merrimack, an annotated picture key. Upper Merrimack Monitoring Program
- McCafferty, Patrick W.** 1981. Aquatic Entomology The Fishermen's and Ecologists' Illustrated Guide to Insects and Their Relatives. Jones and Bartlett Publishers. Boston and London
- Merritt, RW and Cummins, KW.** 1996. An Introduction to the Aquatic Insects of North America, Third Edition. Kendall/Hunt Publishing Company
- Pecarsky, Barbara L., Fraissinet, Pierre R., Penton, Marjory A., and Conklin, Jr., Don J.** 1990. Freshwater Macroinvertebrates of Northeastern North America. Comstock Publishing Associations, A division of Cornell University Press. Ithaca and London
- Stewart, Kenneth W., and Stark, Bill P.** 1988. Nymphs of North American Stonefly Genera (Plecoptera). University of North Texas Press. Denton, TX
- Wiggins, Glenn B.** 1996. Larvae of the North American Caddisfly Genera (Trichoptera), Second Edition. University of Toronto Press
- United States Geological Survey** in cooperation with the US Department of the Interior and States of New Hampshire and Vermont. 1995, 1996, and 1997. Water Resources Data New Hampshire and Vermont
- Macroinvertebrate data processed with customized data processing templates created by River Watch Network, Montpelier, Vermont
- E. coli* samples processed by Franklin Waste Water Treatment Facility, Franklin, New Hampshire
- Random Quality Control/ Quality Assurance *E. coli* samples processed by the NH Department of Environmental Services, Concord, New Hampshire
- Quality Control/ Quality Assurance macroinvertebrate samples processed by EcoAnalysts, Moscow, Idaho
- Topographic maps produced using TOPO! Software, Wildflower Productions, San Francisco, California
- All photographs from Stephen C. Landry, Boscawen, NH except for the photograph on page 6 by James M. MacCartney, Boscawen, NH

