Wood-Pawcatuck Watershed Association
2002 Aquatic Benthic Macroinvertebrate Sampling Project

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Background: Wood-Pawcatuck Watershed Association (WPWA) has been involved with volunteer water quality monitoring since its inception in the mid 1980's. Most of the monitoring sites have been on ponds, lakes, and impounded areas of rivers. In 1998, WPWA collaborated with Elizabeth Heron at the University of Rhode Island Cooperative Extension Watershed Watch to begin water quality monitoring of low order streams in the Pawcatuck Watershed using volunteers. In 1999 WPWA received a grant from the Partners for Resource Protection to expand the Stream Monitoring program, which continues today. The parameters measured for water quality indications are dissolved oxygen, temperature, pH, nutrients, bacteria, and flow volume, all of which are abiotic indicators. It is commonly held that comprehensive measurements of stream quality should also include biotic components of the habitat.

Introduction: The highest concentration and greatest diversity of macroinvertebrates live in riffle areas of streams and rivers. Some macroinvertebrate orders and families live two years or longer. Each family has a different tolerance level to pollution and low aerobic conditions. An indication of water quality can be made by looking at the make up of the stream community, particularly the presence or absence of low tolerance families and orders.

This past summer WPWA launched a pilot program using volunteers to do macroinvertebrate sampling on selected streams in the Pawcatuck Watershed. The goal of the project was to collect information about the types of macroinvertebrate communities in the streams and to see how this information could be used to evaluate the water quality of that stream. A secondary goal was to evaluate the efficacy of volunteers in this type of biosurvey.

Sara da Silva, a graduate student at the University of Rhode Island in Natural Resources Science, helped design the program and develop the protocols for the volunteers. Da Silva was employed this past summer by the US Environmental Protection Agency to do macroinvertebrate sampling. She also did similar sampling for the State of Rhode Island during the three previous summers. The volunteers were three teachers from the WPWA membership; Roberta Engle, Dan Potts, and Susan Cerrulo. WPWA interns, Melanie Cheeseman and Katherine Fisher also participated in the sampling and later identification of the macroinvertebrates.

Method: Three volunteers were recruited from current WPWA Water Quality Monitors. It was decided to keep the number of volunteers small so that each would get the maximum amount experience sampling and identifying organisms and keep consistency within sampling methods. Training was conducted at the WPWA headquarters by da Silva in June 2002. Streams sites selected were already being monitored by WPWA for other projects. Procedures were based on

methods described in the EPA Volunteer Water Quality Monitoring. Forms used to record data included "Streamside Biosurvey: Macroinvertebrates" from EPA Volunteer Water Quality Monitoring. All organisms collected in the field were brought back to the WPWA office for verification and further identification down to family. The following procedures were used for collection:

Steps:

1) Select site characteristic of the stream which includes riffles.
2) Record site information and habitat characteristics. Draw a site sketch.
3) Choose 1 to 3 collection spots evenly spaced over the riffle area.
4) Approach the site from downstream and place the net on the bottom, facing upstream. Use a collection net that is a rectangle 18" x 8" with a 0.59 mm mesh. The collection area of the stream bed is a rectangle as wide as the net and 1 foot back from the opening.
5) Collect a sample with one person holding the net and another person standing in front of the net, facing downstream:
    -Time the collection for 3 minutes.
    -Pick up and rub large cobbles and small boulders from the river bottom in front of the net then place them in the 5 gallon bucket for further inspection.
    -Shuffle and kick up the substrate in front of the net for the remainder of the time.
    -When collection is complete scoop the net upstream a few times to wash through any residue.
6) Wash the contents of the net into a sieve bucket using squirt bottles. Take sieve bucket, rocks in 5 gallon bucket, and net back to the bank for inspection.
7) Have 2-3 people examine all materials for organisms. Remove each organism found and sort according to order into jars containing 70% isopropyl alcohol. Continue to accumulate until 100 organisms have been collected.
8) If there are not enough organisms in the first sampling to add up to 100, repeat steps 4 through 7 until 100 organisms have been collected.
9) Obtain dissolved oxygen, temperature, and flow volume.
10) Take the sample back to the WPWA headquarters, preserved in alcohol, to be analyzed.
11) Using simple key guide from River Watch Network "Living Waters" verify order of organisms and, where able, identify down to family.
12) Preserve, label and retain at least one organism from each order and family identified.

Streams were scored according to EPA Water Quality Rating Index. Originally, a random sampling method was to be used to select the 100 organisms. All organisms from the sample were to be placed on a tray marked with squares and numbered. Numbered cards would be drawn randomly and the organisms on the corresponding square would become part of the final sample set. Cards would be drawn until 100 organisms had been obtained. In practice, this proved to be very time consuming. Often far more than 100 organisms were obtained during the first sampling, requiring great effort just to retrieve all of them out from the collection net and rocks. In effect, volunteers would be doing twice the work. It was decided that instead, just the first 100 organisms found would be used. This may introduce some bias into the sample sets. However, Burgess and da Silva felt that the volunteers were doing an adequate job of finding a

wide variety of organisms, including ones as small as 1-2 mm in length. Also, to reduce individual bias, 3 or 4 people would examine all the sampled materials.

The EPA Index for Water Quality groups macroinvertebrates according to their tolerance level. They are also assigned a number code based on their abundance. For the purpose of the WPWA study, R(rare) =1-3 organisms; C(common) = 4-33; and D(dominant) = 34-100. To calculate the index value, order abundance was multiplied by a weighting factor for each tolerance level, and then added to receive a final numerical score. Scores were assigned a rating based on the following ranges:

Good	*> 40*
Fair	*20-40*
Poor	*<20*

Results: Six sites were sampled and evaluated for water quality: Meadow Brook #2, above Pine Hill Road, Richmond; Meadow Brook #3, above Meadowbrook Pond, Richmond; Locke Brook at Mail Road, Exeter; Queen River at Mail Road, Exeter; Falls River above Austin Farm Road, Exeter; and Breakheart Brook, near Frosty Hollow Road, Exeter. Although more sites were planned, scheduling conflicts made it difficult to do more than the six. It was felt that a minimum of three people were required to adequately complete the tasks in a reasonable amount of time. WPWA staff did the final identification of organisms, using dissecting scopes on loan from Chariho Middle School. Da Silva checked on final identifications of two of the sample sites.

Based on the EPA Index for Water Quality Rating, the following results were obtained:

Site	**EPA Rating**	**Numerical Score**
Meadow Brook #2	*Fair*	*34.3*
Meadow Brook #3	*Good*	*49.7*
Locke Brook	*Fair*	*36.5*
Queen River	*Fair*	*33.5*
Falls River	*Good*	*41.9*
Breakheart Brook	*Good*	*50.5*

Comparisons were also made with the River Watch Network Benthic Macroinvertebrate Streamside Survey Field Sheet. That form rates streams as either "seriously impaired" or "not impaired or slightly impaired." Essentially this is a "yes or no" rating system. Some of those results did not correspond well with the EPA readings on a given site. The difference in results may be because the River Watch Network rating system does not use a weighted metric for pollution tolerance among orders. Instead, it focuses on EPT richness (Ephemeroptera, Plecotoptera, and Trichoptera). Also, the River Watch Network rating system does not have a corresponding rating for "fair", and so is not as sensitive to slight differences between streams. The results for both ratings methods are:

Site	***EPA Rating***	***River Watch Network Rating***
Meadow Brook #2	*Fair*	*Impaired*
Meadow Brook #3	*Good*	*Impaired*

Locke Brook	*Fair*	*Not impaired*
Queen River	*Fair*	*Impaired*
Falls River	*Good*	*Not impaired*
Breakheart Brook	*Good*	*Impaired*

Further comparisons with the State of RI Reference Stream methodology will be done when these metrics become available.

Conclusions: The findings based on the EPA Index for Water Quality were consistent with land use practices near the stream sites. Locke Brook and the Queen River are both just off of Mail Road, in slightly impacted areas. Falls River and Breakheart Brook are in the Arcadia Management Area, in relatively pristine areas. The most surprising finding was the water quality rating difference between the two sites on the Meadow Brook. Site #2 is in the Carolina Management Area, a heavily wooded, protected area. Site #3 is at the end of long agricultural fields. However, it has a better rating than the first site. This may be due to low flow conditions of the first site. It may also show that the agricultural management practices near the second site are doing a good job of protecting the water quality. Chemical analysis alone of the sites would not have stimulated these suppositions.

The pilot project worked very well in terms of using volunteers to obtain data, and in the information obtained. The volunteers in this pilot project had been involved in other monitoring projects for WPWA. One in particular was already adept at identifying macroinvertebrates. However, the other volunteers also became proficient at identifying to at least order in the field. Their initial lack of experience was not seen as problem because final identification would be made using a dissecting scope. WPWA staff also became adept at identification with the scope, although more practice would be helpful. However, the Simple Key Guide from the River Watch Network "Living Waters" did not provide enough information for clear identification for all family levels. Da Silva provided her own reference manual "Peckarsky et al. 1990". Freshwater Macroinvertebrates of Northeastern North America."

For WPWA purposes, the index that was the easiest to use and gave the most useful information was the EPA Index for Water Quality. Because this index also generates a numerical value, statistical changes in values from future years will more easily be assessed. The River Watch Network rating was difficult for volunteers to use. It's rating was not very useful for streams in this watershed, where most of them are not highly impacted. The results were often incompatible with the EPA Index for Water Quality.

Recommendations:

1. Continue program in 2003 using the same methodology and, if possible, same volunteers.
2. Continue to use EPA Index for Water Quality as a rating guide.
3. Expand program to include all stream sites currently monitored by WPWA up to 20 sites.
4. Obtain reference guide books for macroinvertebrate identification as recommended by Sara da Silva.
5. Do a 3 hour refresher course with da Silva for macroinvertebrate identification prior to the first sampling.
6. Conduct a field test to determine the amount of bias introduced by current methods.

7. Explore other types of water quality indices that could be used with current sampling methods.

References:

Dates, G. and J. Byrnd, Living Waters, River Watch Network, Montpelier, VT, 1997.

Mitchell, M. and W. Stapp, Field Manual for Water Quality Monitoring, Thomas-Shore, Dexter, Michigan, 1995.

U. S. Environmental Protection Agency, Office of Water, Volunteer Stream Monitoring, A Methods Manual, EPA 841-B-97-003, 1997. website *www.epa.gov/owow/monitoring/volunteer/stream*.

Appendix I

Lists of Aquatic Benthic Macroinvertebrate by Common Name, Orders, Families (where available) tolerance level, and number of organisms found at each site. Tolerance levels are based on a value range of 0 to 10, with 0 the most sensitive or intolerant to pollution and 10 being the most tolerant, according to EPA standards.

Meadow Brook #2 (Carolina Management Area, north of Pine Hill Road) 7/30/02

Common Name	***Order***	***Family***	***Tolerance Level (0-10)***	***Number of Organisms***
Caddisflies	Trichoptera	Hydropsychidae	4	12
		Limnephilidae	4	19
		Polycentropodidae	6	15
Mayflies	Ephemeroptera	Heptageniidae	4	3
		Baetidae	4	2
Stoneflies	Plecoptera	Perlidae	1	6
		Capniidae	1	1
Riffle Beetles	Coleoptera	Elmidae	4	34
Dragonflies	Odonata	Gomphidae	1	1
Scuds	Amphipoda	Gammaridae	4	3
Worms	Godiida	Gordiidae	8	3
Leeches	Rhynchobdellida	Glossiphoniidae	8	1

(Field Note: Very low water level, no measurable flow.)

Meadow Brook #3 (Carolina Management Area, north of Meadowbrook Pond) 7/3/02

Common Name	***Order***	***Family***	***Tolerance Level (0-10)***	***Number of Organisms***
Caddisflies	Trichoptera	Hydropsychidae	4	12
		Limnephilidae	4	9
		Phryganeidae	4	1
Mayflies	Ephemeroptera	Heptageniidae	4	5

		Ephemerelidae	1	3
Stoneflies	Plecoptera	Perlidae	1	5
		Chloroperlidae	1	13
Black Flies	Diptera	Simuliidae	6	2
Fishflies	Megaloptera	Corydalidae	0	2
Riffle Beetles	Coleoptera	Elmidae	4	9
Dragonflies	Odonata	Gomphidae	1	5
Scuds	Amphipoda	Gammaridae	4	12
Worms	Godiida	Gordiidae	8	17
Snail	(class) Gastropoda		7	1
Clams	(class) Pelecypoda		8	4

(Field Note: Very low flow. Two brown trout swam past study area looking for deeper water, the tops of their bodies above the surface of the stream. Three osprey were heard overhead.)

Queen River (south of Mail Road, near USGS gauging station) **8/1/02**

Common Name	***Order***	***Family***	***Tolerance Level (0-10)***	***Number of Organisms***
Caddisflies	Trichoptera	Hydropsychidae	4	13
		Limnephilidae	4	3
		Polycentropodidae	6	2
Mayflies	Ephemeroptera	Heptageniidae	4	3
Stoneflies	Plecoptera	Perlidae	1	24
		Capniidae	1	6
Midges	Diptera	Chironomidae	6	3
Aquatic Dance Flies		Empididae	6	1
Riffle Beetles	Coleoptera	Elmidae	4	36
Whirligig Beetles		Gyrinidae	6	5
Dragonflies	Odonata	Gomphidae	1	2
Worms	Godiida	Gordiidae	8	2

Locke Brook (south of Mail Road) **8/1/02**

Common Name	***Order***	***Family***	***Tolerance Level (0-10)***	***Number of Organisms***
Caddisflies	Trichoptera	Hydropsychidae	4	27
		Limnephilidae	4	5
		Polycentropodidae	6	21
Mayflies	Ephemeroptera	Ephemerelidae	1	10
		Baetidae	4	8
Stoneflies	Plecoptera	Perlidae	1	5
		Peltoperlidae	0	2
		Capniidae	1	3
Midges	Diptera	Chironomidae	6	1
Black flies		Simulidae	6	7
Fishflies	Megaloptera	Corydalidae	0	3

Riffle Beetles	Coleoptera	Elmidae	4	3
Dragonflies	Odonata	Gomphidae	1	4
Leeches	Rhynchobdellida	Glossiphoniidae	8	1

Falls River (north of Austin Farm Road, Arcadia Management Area) 8/16/02

Common Name	***Order***	***Family***	***Tolerance Level (0-10)***	***Number of Organisms***
Caddisflies	Trichoptera	Hydropsychidae	4	2
		Philopotamidae	3	1
		Glossosomatidae	0	9
		Limnephilidae	4	12
		Lepidostomatidae	1	28
Mayflies	Ephemeroptera	Heptageniidae	4	13
		Baetidae	4	15
Stoneflies	Plecoptera	Capniidae	1	7
Midges	Diptera	Chironomidae	6	2
Fishflies	Megaloptera	Corydalidae	0	5
Riffle Beetles	Coleoptera	Elmidae	4	2
Water Penny		Psephenidae	4	1
Dragonflies	Odonata	Gomphidae	1	1
		Aeshnidae	3	2

Breakheart Brook (west of Frosty Hollow Road, Arcadia Management Area) 8/27/02

Common Name	***Order***	***Family***	***Tolerance Level (0-10)***	***Number of Organisms***
Caddisflies	Trichoptera	Hydropsychidae	4	17
		Brachycentridae	1	1
		Philopotameidae	3	1
		Limnephilidae	4	1
Mayflies	Ephemeroptera	Heptageniidae	4	16
		Baetidae	4	3
Stoneflies	Plecoptera	Perlidae	1	14
		Chloroperlidae	1	9
Midges	Diptera	Chironomidae	6	6
Aquatic Dance Flies		Empididae	6	1
Fishflies	Megaloptera	Corydalidae	0	5
Riffle Beetles	Coleoptera	Elmidae	4	14
Water Penny		Psephenidae	4	6
Dragonflies	Odonata	Gomphidae	1	2
Scuds	Amphipoda	Gammaridae	4	1
Clams	(class) Pelecypoda		8	3