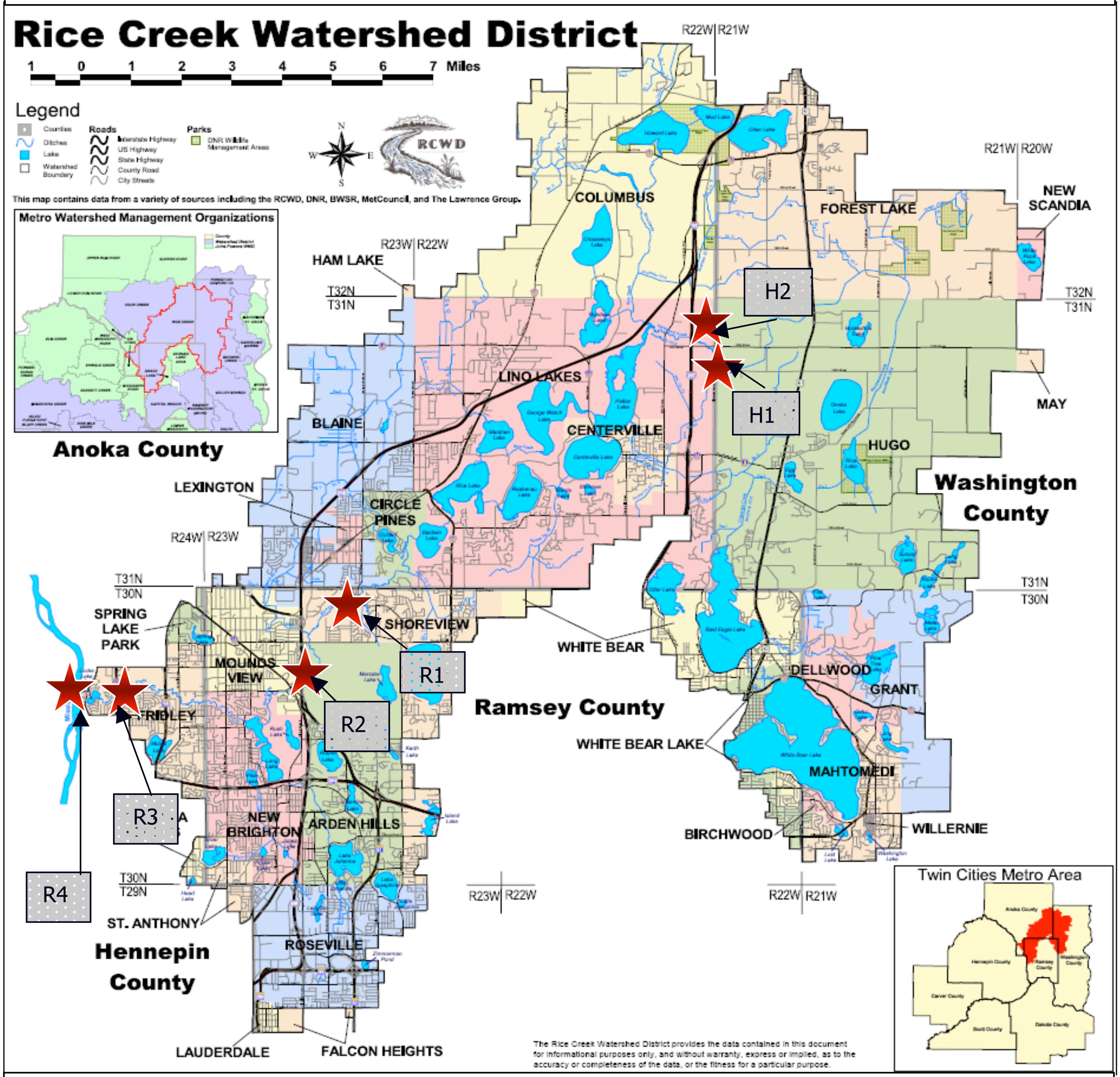
2007 Rice Creek Watershed District
Stream Health Evaluation Program Sampling Sites



MAP KEY:
H1: Hardwood Creek Site (above)
H2: Hardwood Creek Site (below)
R1: Rice Creek Site (above)
R2: Rice Creek Site (below)
R3: Locke Lake (above)
R4: Locke Lake (below)

APPENDIX B:
2006 RCWD SHEP DATA WORKSHEETS

Attached are sample data worksheets used by Rice Creek Watershed District SHEP volunteers in the 2006 / 2007 SHEP season. These data worksheets include the following:

1. Habitat Assessment Field Data Sheets (5 pages)
2. Biological Survey Lab Data Sheet (1 page)
3. Macroinvertebrate Identification Lab Data Sheet (5 pages)

Habitat Assessment Field Data Sheet

Volunteer Stream Monitoring Partnership

SITE (include county)	SITE NUMBER	
INVESTIGATOR	DATE	TIME
LOCAL COORDINATOR / ORGANIZATION	GPS ☐ YES ☐ NO	GPS COORDINATES

WEATHER

In past 24 hours:

- ☐ Storm (heavy rain)
- ☐ Rain (steady)
- ☐ Showers (intermittent)
- ☐ Overcast
- ☐ Clear/Sunny

Now:

- ☐ Storm (heavy rain)
- ☐ Rain (steady)
- ☐ Showers (intermittent)
- ☐ Overcast
- ☐ Clear/Sunny

TEMPERATURE READINGS (Take in the shade)

Water temperature: ____________

Air temperature: ____________

WATER APPEARANCE (check one)

- ☐ Clear
- ☐ Green
- ☐ Brown
- ☐ Blue-green
- ☐ Yellow
- ☐ Milky

WATER ODOR (check one)

- ☐ None
- ☐ Musty
- ☐ Septic
- ☐ Fishy
- ☐ Rotten eggs

LOCAL LAND USE

Land use in the local watershed within approx.1/4 mile of the site. Check all that apply. Circle the dominant feature.

- ☐ Residential
- ☐ Commercial
- ☐ Agricultural
- ☐ Natural/Preserve
- ☐ Lawns
- ☐ Wooded
- ☐ Crop land
- ☐ Grazing land
- ☐ Feed lot
- ☐ Paved roads or bridges
- ☐ Unpaved roads
- ☐ Construction
- ☐ Recreational use
- ☐ Industry
- ☐ Land fill
- ☐ Waste treatment plant
- ☐ Evidence of past alteration

TYPE OF SAMPLING (check one)

☐ ROCKY BOTTOM

☐ MUDDY BOTTOM

Record the number of jabs taken in each habitat type:

Vegetated bank margins ____________

Snags and logs ____________

Aquatic vegetation beds ____________

Silt/sand/gravel substrate ____________

STREAM WIDTH

3 Measurements (in feet)

1 ____________

2 ____________

3 ____________

Average Stream Width: ____________

STREAM DEPTH

Minimum of 10 measurements (in feet)

Measure the depth across the stream, from right bank to left bank in one-foot intervals for a minimum of 10 measurements.

1 ________	2 ________	3 ________	4 ________
5 ________	6 ________	7 ________	8 ________
9 ________	10 ________	11 ________	12 ________
13 ________	14 ________	15 ________	16 ________
17 ________	18 ________	19 ________	20 ________
21 ________	22 ________	23 ________	24 ________
25 ________	26 ________	27 ________	28 ________
29 ________	30 ________	31 ________	32 ________
33 ________	34 ________	35 ________	36 ________
37 ________	38 ________	39 ________	40 ________

NOTE: Conduct all habitat assessments IN THE FIELD. Complete all data sheets before leaving the site.

Habitat Assessment Field Data Sheet

SKETCH OF SITE

On your sketch, note features that affect stream habitat, such as: riffles, runs, pools, ditches, wetlands, dams, riprap, outfalls, tributaries, landscape features, vegetation, and roads. Include all pipes draining directly into the stream and indicate direction of flow.

Were photos taken?

FIELD NOTES

Include notable observations such as any major landscape changes (including construction projects, bridge projects, etc.) upstream or adjacent to your site.

Habitat Assessment Field Data Sheet

Rocky Bottom Sampling

Volunteer Stream Monitoring Partnership

SITE (include county)	DATE

HABITAT PARAMETER	Optimal	Suboptimal	Marginal	Poor
1 ATTACHMENT SITES FOR MACRO-INVERTEBRATES	Well-developed riffle and run; riffle is as wide as stream and length extends 2 times the width of the stream; cobble predominate; boulders and gravel common.	Riffle is as wide as stream but length is less than 2 times width; cobble less abundant; boulders and gravel common.	Run maybe be lacking; riffle not as wide as stream and its length is less than 2 times the stream width; gravel or large boulders and bedrock prevalent; some cobble present.	Riffle or run virtually nonexistent; large boulders and bedrock prevalent; cobble lacking.
Score	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2 EMBEDDEDNESS	Fine sediment surrounds and fills in 0-25% of the living spaces around and in between the gravel, cobble, and boulders.	Fine sediment surrounds and fills in 25-50% of the living spaces around and in between the gravel, cobble, and boulders.	Fine sediment surrounds and fills in 50-70% of the living spaces around and in between the gravel, cobble, and boulders.	Fine sediment surrounds and fills in more than 75% of the living spaces around and in between the gravel, cobble, and boulders.
Score	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3 SHELTER FOR FISH	Snags and submerged logs, undercut banks, cobble and large rocks or other stable habitat are found in over 50% of the site.	Snags and submerged logs, undercut banks, cobble and large rocks or other stable habitat are found in over 30-50% of the site.	Snags and submerged logs, undercut banks, cobble and large rocks or other stable habitat are found in over 10-30% of the site.	Snags and submerged logs, undercut banks, cobble and large rocks or other stable habitat are found in less than 10% of the site.
Score	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
4 CHANNEL ALTERATION	Stream straightening, dredging, artificial embankments, dams or bridge abutments absent or minimal; stream with meandering pattern.	Some stream straightening, dredging, artificial embankments or dams present, usually in areas of bridge abutments; no evidence of recent channel alteration activity.	Artificial embankments present to some extent on both banks; and 40-80% of stream site straightened, dredged, or otherwise altered.	Banks shored with gabion or cement; over 80% of the stream site straightened and disrupted.
Score	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
5 SEDIMENT DEPOSITION	Little or no enlargement of islands or point bars and less than 5% of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from coarse gravel; 5-30% of the bottom affected, slight deposition in pools.	Moderate deposition of new gravel, coarse sand on old and new bars; 30-50% of the bottom affected; sediment deposits at stream obstructions and bends; moderate deposition in pools.	Heavy deposits of fine material, increased bar development; more than 50% of the bottom affected; pools almost absent due to substantial sediment deposition.
Score	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

NOTE: Conduct all habitat assessments IN THE FIELD. Complete all data sheets before leaving the site.
For complete directions and definitions, refer to the EPA, *Volunteer Stream Monitoring: A Methods Manual,* Section 4.3

Habitat Assessment Field Data Sheet

Rocky Bottom Sampling

HABITAT PARAMETER	CATEGORY Optimal	Suboptimal	Marginal	Poor
6 STREAM VELOCITY AND DEPTH COMBINATION	Slow (<1 ft/s)/deep (>1.5 ft); slow/shallow; fast/shallow; fast/deep; combinations all present.	3 of the 4 velocity/depth combinations are present; fast current areas generally dominate.	Only 2 of the 4 velocity/depth combinations present. Score lower if fast current areas missing.	Dominated by 1 velocity/depth category (usually slow/shallow areas)
Score	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7 CHANNEL FLOW STATUS	Water reaches base of both lower banks and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; <25% of channel substrate is exposed.	Water fills 25-75% of the available channel and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
Score	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
8 BANK VEGETATIVE PROTECTION (score each bank) Note: Determine left or right side by facing downstream)	More than 90% of the streambank surfaces covered by natural vegetation, including trees, shrubs, or other plants; vegetative disruption, through grazing or mowing, minimal or not evident; almost all plants allowed to grow naturally.	75-90% of the streambank surfaces covered by natural vegetation; some vegetative disruption evident; more than one-half of the potential plant stubble height remaining.	50-75% of the streambank surfaces covered by vegetation; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 2 inches or less in average stubble height.
Score (LB)	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
Score (RB)	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
9 CONDITION OF BANKS (score each bank) Note: Determine left or right side by facing downstream)	Banks stable; no evidence of erosion or bank failure; little potential for future problems.	Moderately stable; infrequent, small areas of erosion mostly healed over.	Moderately unstable; up to 60% of banks in site have areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; “raw” areas frequent along straight sections and bends; obvious bank collapse or failure; 60-100% of bank has erosional scars.
Score (LB)	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
Score (RB)	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
10 RIPARIAN VEGETATIVE ZONE WIDTH (Score each bank riparian zone)	Width of riparian zone >50 feet; no evidence of human activities (i.e. parking lots, road beds, clear-outs, mowed areas, or crops) within the riparian zone.	Width of riparian zone 35-50 feet.	Width of riparian zone 20-35 feet	Width of riparian zone <20 feet.
Score (LB)	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
Score (RB)	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

TOTAL SCORE

VSMP 2002 adapted from EPA, Volunteer Stream Monitoring: A Methods Manual

Habitat Assessment Field Data Sheet

Muddy Bottom Sampling

Volunteer Stream Monitoring Partnership

SITE (include county)	DATE

HABITAT PARAMETER	CATEGORY Optimal	Suboptimal	Marginal	Poor
1 SHELTER FOR FISH AND MACRO-INVERTEBRATES	Snags, submerged logs, undercut banks, rubble or other stable habitat found over 50% of the site; logs/snags are old fall.	Snags, submerged logs, undercut banks, rubble or other stable habitat found over 30-50 % of the site; some old fall, but preponderance of new fall.	Snags, submerged logs, undercut banks, rubble or other stable habitat found over 10-30 % of the site; appears unstable; some new fall.	Snags, submerged logs, undercut banks, rubble or other stable habitat found less than 10% of the site; appears unstable; no old or new fall.
Score	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2 POOL SUBSTRATE CHARACTERIZATION	Pools have mixture of substrate materials, with gravel and firm sand prevalent; root mats and submerged vegetation common.	Pools have mixture of soft sand, mud, or clay substrate; mud may be dominant; some root mats and submerged vegetation present.	Pools have all mud or clay or sand substrate; little or no root mat; no submerged vegetation.	Pools have hard-pan clay or bedrock substrate; no root mat or vegetation.
Score	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3 POOL VARIABILITY	Even mix of large-shallow, large-deep, small-shallow, small-deep pools.	Majority of pools large-deep; very few shallow.	Shallow pools much more prevalent than deep pools.	Majority of pools small-shallow or pools absent.
Score	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
4 CHANNEL ALTERATION	Stream straightening, dredging, artificial embankments, dams or bridge abutments absent or minimal; stream with meandering pattern.	Some stream straightening, dredging, artificial embankments or dams present, usually in areas of bridge abutments; no evidence of recent channel alteration activity.	Artificial embankments present to some extent on both banks; and 40-80% of stream site straightened, dredged, or otherwise altered.	Banks shored with gabion or cement; over 80% of the stream site straightened and disrupted.
Score	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
5 SEDIMENT DEPOSITION	Less than 20% of stream bottom affected by extensive sediment deposition; minor accumulation of fine and coarse material at snags and submerged vegetation; little or no enlargement of islands or point bars.	20-50% of stream bottom affected by extensive sediment deposition; moderate accumulation; substantial sediment movement only during major storm event; increase in bar formation.	50-80% of stream bottom affected by extensive sediment deposition; pools shallow, heavily silted; embankments may be present on both banks; frequent and substantial sediment movement during storm events.	Greater than 80% of stream bottom affected by extensive sediment deposition; heavy deposits; mud, silt, and/or sand in braided or non-braided channels; pools almost absent due to deposition.
Score	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

NOTE: Conduct all habitat assessments IN THE FIELD. Complete all data sheets before leaving the site.
For complete directions and definitions, refer to the EPA, *Volunteer Stream Monitoring: A Methods Manual,* Section 4.3

Habitat Assessment Field Data Sheet

Muddy Bottom Sampling

HABITAT PARAMETER	CATEGORY Optimal	Suboptimal	Marginal	Poor
6 CHANNEL SINUOSITY	The bends in the stream would increase the stream length 3 to 4 times longer than if it was in a straight line.	The bends in the stream would increase the stream length 2 to 3 times longer than if it was in a straight line.	The bends in the stream would increase the stream length 1 to 2 times longer than if it was in a straight line.	Channel straight; waterway has been channelized.
Score	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7 CHANNEL FLOW STATUS	Water reaches base of both lower banks and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; <25% of channel substrate is exposed.	Water fills 25-75% of the available channel and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
Score	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
8 BANK VEGETATIVE PROTECTION (score each bank) Note: Determine left or right side by facing downstream)	More than 90% of the streambank surfaces covered by natural vegetation, including trees, shrubs, or other plants; vegetative disruption, through grazing or mowing, minimal or not evident;almost all plants allowed to grow naturally.	75-90% of the streambank surfaces covered by natural vegetation, but one class of plant is not well represented; some vegetative disruption evident; more than one-half of the potential plant stubble height remaining.	50-75% of the streambank surfaces covered by vegetation; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 2 inches or less in average stubble height.
Score (LB)	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
Score (RB)	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
8 CONDITION OF BANKS (score each bank) Note: Determine left or right side by facing downstream)	Banks stable; no evidence of erosion or bank failure; little potential for future problems.	Moderately stable; infrequent, small areas of erosion mostly healed over.	Moderately unstable; up to 60% of banks in site have areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; “raw” areas frequent along straight sections and bends; obvious bank collapse or failure; 60-100% of bank has erosional scars.
Score (LB)	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
Score (RB)	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
10 RIPARIAN VEGETATIVE ZONE WIDTH (Score each bank riparian zone)	Width of riparian zone >50 feet; no evidence of human activities (i.e. parking lots, road beds, clear-outs, mowed areas, or crops) within the riparian zone.	Width of riparian zone 35-50 feet.	Width of riparian zone 20-35 feet	Width of riparian zone <20 feet.
Score (LB)	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
Score (RB)	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

TOTAL SCORE

VSMP 2002 adapted from EPA, Volunteer Stream Monitoring: A Methods Manual

Biological Survey Lab Data Sheet

Volunteer Stream
Monitoring Partnership

SITE (include county)	SITE NUMBER

INVESTIGATOR	DATE	TIME

LOCAL COORDINATOR / ORGANIZATION	GPS	GPS COORDINATES
	☐ YES ☐ NO	

PROTOCOL USED:

☐ Multi-Habitat (Dip net) ☐ Riffles (Net) ☐ Artificial Multi-Plate Sampler

Subsampling Procedure

Randomly sample a square making sure ALL organisms have been picked from that square before you move to the next. Mark the estimated total number of individual organisms taken from each square. DO NOT STOP UNTIL YOU HAVE AT LEAST 100 INDIVIDUALS.

1	4	7	10
2	5	8	11
3	6	9	12

A. Total number of organisms picked: _______________

B. Number of squares selected: ____________________

C. Average organisms per square: __________________ (# of organisms / # of squares)

D. Estimated organisms in tray (C x 12): _____________ (organisms / tray)

Macroinvertebrate Identification

Volunteer Stream Monitoring Partnership

SITE (include county)	SITE NUMBER	
INVESTIGATOR	**DATE**	**TIME**
LOCAL COORDINATOR / ORGANIZATION	**GPS** ☐ YES ☐ NO	**GPS COORDINATES**

Order Ephemeroptera (Mayflies)		
Family	Tolerance Value	Total
Baetidae	4	
Baetiscidae	3	
Caenidae	7	
Ephemerellidae	1	
Ephemeridae	4	
Heptageniidae	4	
Isonychiidae	2	
Leptohyphidae (Tricorythidae)	4	
Leptophlebiidae	2	
Metretopodidae	2	
Oligoneuriidae	2	
Polymitarcyidae	2	
Potamanthidae	4	
Siphlonuridae	7	
Tricorythidae	4	
Unidentified		
Unidentified		
Unidentified		

Order Megaloptera (Fishflies, Dobsonflies, Alderflies)		
Family	Tolerance Value	Total
Corydalidae	0	
Sialidae	4	
Unidentified		
Unidentified		
Unidentified		

Macroinvertebrate Identification

Order Odonata (Dragonflies, Damselflies)		
Family	Tolerance Value	Total
Aeshnidae	3	
Calopterygidae	5	
Coenagrionidae	9	
Cordulergastridae	3	
Corduliidae	5	
Gomphidae	1	
Lestidae	9	
Libellulidae	9	
Macromiidae	3	
Unidentified		

Order Plecoptera (Stoneflies)		
Family	Tolerance Value	Total
Capniidae	1	
Chloroperlidae	1	
Leutridae	0	
Nemouridae	2	
Perlidae	1	
Perlodidae	2	
Pteronarcidae	0	
Taeniopterygidae	2	
Unidentified		

Order Coleoptera (Water Beetles)		
Family	Tolerance Value	Total
Dryopidae	5	
Dytiscidae	5	
Elmidae (adults and larvae)	4	
Gyrinidae	4	
Haliplidae	7	
Hydrophilidae	5	
Psephenidae	4	
Scirtidae	7	
Unidentified		
Unidentified		

Macroinvertebrate Identification

Order Hemiptera		
Family	Tolerance Value	Total
Belostomatidae	10	
Corixidae	9	
Gelastocoridae	**	
Gerridae	**	
Hebridae	**	
Hydrometridae	**	
Mesoveliidae	**	
Naucoridae	5	
Notonectidae	**	
Pleidae	**	
Saldidae	**	
Veliidae	6	
Unidentified		

Order Trichoptera (Caddisflies)		
Family	Tolerance Value	Total
Brachycentridae	1	
Glossosomatidae	0	
Helicopsychidae	3	
Hydropsychidae	4	
Hydroptilidae	4	
Lepidosomatidae	1	
Leptoceridae	4	
Limnephilidae	4	
Molannidae	6	
Odontoceridae	0	
Philopotamidae	3	
Phryganeidae	4	
Polycentropodidae	6	
Psychomyiidae	2	
Rhyacophilidae	0	
Sericostomatidae	3	
Uenoidae	3	
Unidentified		

** Tolerance values have not been determined. These should NOT be included in calculations and do not count toward the 100 count needed for a usable sample.

Order Diptera (Midges, Gnats, Mosquitoes, and Flies)		
Family	Tolerance Value	Total
Athericidae	2	
Blephariceridae	0	
Ceratopogonidae	6	
Chaoboridae	8	
Chironomidae (Red)	8	
Chironomidae (Other)	6	
Culicidae	8	
Dixidae	1	
Dolichopodidae	4	
Empididae	6	
Ephydridae	6	
Muscidae	6	
Psychodidae	10	
Ptychopteridae	8	
Sciomyzidae	6	
Simuliidae	6	
Stratiomyidae	8	
Syrphidae	10	
Tabanidae	6	
Tipulidae	3	
Unidentified		
Unidentified		

Order Lepidoptera (Aquatic Moths)		
Family	Tolerance Value	Total
Pyralidae	5	
Unidentified		
Unidentified		

Order Amphipoda (Scuds)		
Family	Tolerance Value	Total
Gammaridae	4	
Hyaliellidae	8	
Unidentified		

Macroinvertebrate Identification

Order Isopoda (Aquatic Sowbugs)		
Family	Tolerance Value	Total
Asellidae	8	
Unidentified		
Unidentified		
Other		
Family	Tolerance Value	Total
Decapoda - Cambaridae (Crayfish)	6	
Class Oligochaeta (Aquatic Worms)	8	
Class Hirundinea (Leeches)	10	
Class Gastropoda (Snails)	7	
Class Pelecypoda (Clams)	7	
Family Hydracarina		
Class Arachnida		
Phylum Nematoda		
Unidentified		
Unidentified		
Unidentified		
Unidentified		
Unidentified		
Unidentified		

TOTAL	

APPENDIX C:

AN ANALYSIS OF THE STREAM HEALTH EVALUATION PROGRAM'S FIRST SEASON:

SUCCESSES AND RECOMMENDATIONS

Final Report

May 2007

Julia Frost Nerbonne
Eleonore Wesserle

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A Collaborative Effort
The Stream Health Evaluation Program partners (Minnesota Pollution Control Agency, Friends of the Mississippi River, Minnesota Waters, Rice Creek Watershed District, Anoka Conservation District, University of Minnesota, City of Lino Lakes, Anoka Parks, Volunteer Stream Monitoring Partnership), the Higher Education Consortium for Urban Affairs, and Friends of the Mississippi River

For more information contact the Friends of the Mississippi River, 360 North Robert Street, Saint Paul, Minnesota, 55101, (651) 222-2193, www.fmr.org.

Executive Summary

Population growth and land development in peri-urban areas can strongly affect water quality. Construction of impervious surfaces concomitant with development increases storm water runoff to nearby bodies of water. Recent population growth trends in the seven-county metropolitan area of Minneapolis/St. Paul indicate the fastest population growth and resulting development is largely in the Rice Creek Watershed District (RCWD). The RCWD holds numerous lakes, chains of lakes, rivers, and streams across three counties and twenty-seven cities. This concern over local water resources has increased in the face of current and future development.

In response to this concern, the Friends of the Mississippi River (FMR) in partnership with the RCWD, the Anoka Conservation District, a number of local cities, Minnesota Waters and the Minnesota Pollution Control Agency (MPCA), began a pilot project in 2006 to monitor water quality in Rice Creek Watershed using adult volunteers. The project, called Stream Health Evaluation Program (SHEP) used 28 adult volunteers organized in three teams to monitor a total of six sites in the fall of 2006, two sites each at Hardwood Creek, Rice Creek, and the inlet of Locke Lake. Locations were chosen to study the effects of recent restorations on these streams, with one site being upstream of the restoration site and ones below the restoration site at each location.

The SHEP monitoring protocol was adapted from similar methods used by the Volunteer Stream Monitoring Partnership and the MPCA. The protocol was divided into two sections: a physical habitat assessment and a biological assessment of aquatic macroinvertebrates. Volunteers participated in 1.5 days of training, covering the in-stream physical assessment and macroinvertebrate collection methods, and laboratory macroinvertebrate identification procedure. Each volunteer group collected data at one site and cross-checked a separate site. After macroinvertebrate collection was completed, volunteers spent one day in the lab identifying samples. The samples were later cross-checked by professionals.

SHEP held three main goals for the first year of the program: accurate and useful data collection, cultivation of a volunteer base to perpetuate the program in the future, and motivating citizen engagement in the quality of the water in the area. SHEP organizers partnered with the Higher Education Consortium for Urban Affairs (HECUA) Environmental Sustainability program to evaluate SHEP's first year in relation to these goals.

Guided by Dr. Julia Frost Nerbonne and Robby Schreiber, one graduate student and thirteen undergraduate students in the HECUA Environmental Sustainability program completed an evaluation of SHEP's first season. The class split into three groups to evaluate each of SHEP's goals: the *technical group* researched the efficacy of the data that SHEP groups collected, the *volunteer group* evaluated the experience of the SHEP volunteers to better understand volunteer interests and motivations, and the *broader context group* studied the value of the SHEP program as it relates to public policy.

Methods

The technical evaluation assessed both the accuracy and utility of data collected by SHEP volunteers. Was the data collected in 2006 able to help SHEP meet the goals of accurate and useful data? This group performed a literature review of both professional and volunteer macroinvertebrate monitoring techniques and examined three case studies of successful macroinvertebrate monitoring programs in California, Michigan, and Washington State. Semi-structured in person, phone, and email interviews of seven Twin Cities water resources professionals were conducted. Interviews were transcribed and coded for emerging themes. Students observed four of the six in-stream monitoring days, examining volunteer field monitoring for replicability and accuracy.

The volunteer evaluation assessed what motivated SHEP volunteers to participate in the program, what might motivate them to continue, and examined the program for successes and potential areas of improvement. This group conducted a mail survey sent to all 28 volunteers who participated in the SHEP program. The survey consisted of 17 multi-part questions, both scaled and open-ended. Questions focused on the broad categories of motivation and program success/improvement. All 28 surveys were returned.

To understand the context of survey results, semi-structured phone and in-person interviews were conducted of three volunteer group leaders and seven volunteers. Interviews were recorded, transcribed and coded for emerging themes.

The broader context evaluation focused on how the SHEP program could influence public policy in a way that contributes to an overall increase in the quality of watershed stewardship. This group conducted a focus group of the volunteer group leaders, interviewed eight decision-makers related to the RCWD, and reviewed the decision-making structures that existed within the local area.

Findings

Technical Efficacy

From literature and case study review, macroinvertebrate monitoring programs across the country commonly include three components: macroinvertebrate assessment, habitat assessment (including substrate classification, describing surrounding vegetation, and taking a picture or drawing the site), and water chemistry testing (including temperature, pH, turbidity, conductivity, and nutrient tests.) The case studies were shown to be successful in providing baseline stream quality data, as well as identifying potential restoration sites, mapping floodplains, and tracking the effects of development.

Observations of SHEP's in-stream monitoring protocol showed consistent and confident macroinvertebrate collection methods. During collection, volunteers paid close attention to detail, randomness, and replicability, a great success and positive indicator for the SHEP protocol. However, methodological consistency of the physical habitat assessment varied widely from group to group. While some volunteers were more systematic and technical, others demonstrated broader estimation and guesswork, indicating that this portion of the monitoring would benefit from greater focus.

The accuracy of the macroinvertebrate identification by the volunteers was extremely high: quality control by professionals showed greater than 95% of 1,477 samples were correctly identified to family by the volunteers. This is a remarkable accuracy rate for a pilot program and a great success.

The Family Biotic Index (FBI) for each site is summarized in the Table 1:

	Above Restoration	*Below Restoration*
Rice Creek	8.8	8.3
Locke Lake	5.0	5.3
Hardwood Creek	7.6	5.1

Table 1*: FBIs for each location above and below restoration sites.*

As illustrated, Rice Creek and Locke Lake show little difference this season, while Hardwood Creek demonstrates some positive change. Water resources professionals indicated that differences between above and below restoration sites may take several seasons to demonstrate change in the biotic community, and it is likely that SHEP methods will track those changes.

Interviews with water resource professionals indicated that we can expect SHEP to provide baseline data on stream quality. Whether the program will be able to expand from this data use remains to be seen. Water resource professionals expressed that the higher the accuracy, replicability, and variety of the data, the more useful, and likely to be used, it will be. As stated, the accuracy of the macroinvertebrate identification was extremely high. Water resource professionals expressed some doubt over the replicability of the habitat assessment, echoed by the volunteers themselves in interviews and the survey, and observed by the technical evaluation group. The professionals also commented that adding water chemistry information to a more standardized habitat assessment would make the macroinvertebrate data more robust, echoed by comments from decision-makers in the broader context interviews. A greater variety of analysis methods allows for a more specific explanation of biotic index results, as well as providing opportunities for more immediate data.

The Volunteer Experience

From the survey, the volunteer group found the following demographic results: 11 of the SHEP volunteers live in the RCWD, while 16 live in other areas of the metro; and 9 of the volunteers are retirees while 16 are not. In a scaled, multi-part question on volunteer motivation, the most popular motivation for volunteers to participate in SHEP was educational (26/28), followed closely by a desire to help protect water quality (25/28), building naturalist skills (23/28), getting outdoors (23/28), and having fun (22/28). 14/27 volunteers chose educational experience as the most important reason for getting involved in SHEP, 9/27 chose collecting data, and 4/27 chose fighting pollution.

In interviews and open-ended survey comments, volunteers expressed comfort with the macroinvertebrate collection training, but felt they could use more training on habitat assessment and macroinvertebrate identification. Group leaders also felt that they could benefit from a separate training.

Volunteers expressed confidence in the in-stream macroinvertebrate collection, but would like to see the habitat assessment more systematized. Interestingly, volunteers also expressed uncertainty on their identification process, though the quality control proved their skills to be more than adequate.

In interviews and open-ended survey comments, volunteers made several comments on the organization of the program. Two people dropped out of the program due to scheduling conflicts, and nine other volunteers mentioned they would like to see the groups matched by schedule. The volunteers also suggested improving the organization of equipment, as well as double-checking to ensure that all private landowners receive prior notice of monitoring on their property. Group leaders mentioned a desire for more organization around their roles, as well.

28/28 volunteers expressed that they enjoyed their SHEP experience. The majority of volunteers agreed that they had fun, learned a lot of interesting information, and met new people whose company they enjoyed. The majority of volunteers would like to participate in SHEP next year, a great success for the program. The main reason cited for this enthusiasm was fun, stemming from the educational and social opportunity the program presented.

The majority of volunteers also reported that their SHEP experience made them more aware of and engaged in local watershed politics, that they would be more likely to participate in those politics, and that they would be willing to help present their data to local decision-makers. Interviews and open-ended answers indicated an overwhelming amount of enthusiasm and support for SHEP from the volunteers, with a broad interest in learning about ways they could support and present SHEP in watershed decision-making.

Utility of SHEP Data in the Broader Public Policy Arena

The broader context group found that decision-makers were most influenced by watershed data when data demonstrates impacts on health, recreation, valued wildlife, or finances. Hard, visual evidence such as changes in water clarity and visible pollution are also seriously considered. Decision-makers also consider citizen concern about water quality. This concern tends to be two-fold in relation to development: during construction, soil displacement, compaction and erosion can affect water clarity, impacting wildlife and recreational enjoyment; after development is completed, new impervious surfaces increase storm water runoff, disrupting stream flow and adding contaminants from roads and stressed sewer drainage. Though decision-makers value both data and citizen concern, they expressed that an engaged, educated citizenry has a much greater influence than data alone, and that they believed a program such as SHEP would produce such a group of educated citizen advocates.

Recommendations

From these findings, we identified several areas of potential growth for SHEP, as well as several areas of success.

First, we recommend **increasing targeted portions of the training**. From both volunteer and technical results, deeper understanding and stricter methodology on the physical habitat assessment would be useful for all volunteers, giving better data for professionals and decision-makers. Though volunteers were outstanding at macroinvertebrate collection, their survey and interview responses showed that they were less confident about collecting quality physical habitat data. In addition, adding an optional identification training would allow those less confident to feel more comfortable in this area, giving volunteers a better experience. Finally, providing an extra training specifically for group leaders would give those leaders more confidence and information to enforce the scientific method and answer questions when needed.

Second, we recommend an **expansion of the monitoring focus** to include simple water quality and physical habitat parameters that would keep volunteers active year round and give the SHEP program data that can be more immediately related to the expansion of development in the watershed. Both the technical and broader context results support broadening SHEP protocols to include the collection of more data that can be used to assess the immediate impact of development on in-stream water quality and public health. Volunteer leaders also expressed an interest in expanding monitoring activities so that they can keep their group active throughout the year. Adding a component to the SHEP program that is simple, inexpensive, and enhances the immediacy of the biotic data would be valuable across all areas of interest. For example, turbidity tubes are an inexpensive and simple way to measure water clarity, and taking a photo of the physical habitat in addition to the assessment ensures more consistent results.

Finally, we recommend **greater communication and organization between all audiences**: SHEP organizers, volunteers, water resources professionals, decision-makers, and the broader community. Greater communication and organization can avoid equipment confusion, landowner conflicts, and scheduling difficulties. Greater communication between SHEP organizers, water resource professionals, and local decision-makers can help SHEP choose whether and how to grow their data collection. Finally, facilitating communication between SHEP volunteers and the broader community can keep the enthusiastic momentum of the program going strong even outside of the field season, and can harness the deeper feelings of engagement that volunteers feel because of SHEP.

Overall, we feel that this first year of SHEP was a great success. We find the outstanding macroinvertebrate identification accuracy to be a reflection of the commitment and interest of the 28 volunteers participating. The enormous volunteer enthusiasm and support this program fostered is outstanding. Volunteers made it very clear that they had lots of fun and a very enjoyable experience, and indicated a strong desire for future participation. Not only did this program provide baseline data on streams, but it also developed a great group of volunteers, who came back with a deeper appreciation for the watershed and a willingness to let others know about it.

This first year is a valuable and fortuitous foundation on which SHEP can build an even better season than the first. Something great happened, and it can also be used to effect change in and engage the broader community.

Final Report

Introduction

Stream monitoring plays an important role in tracking changes and trends in water quality over time. Information gathered in stream monitoring can be used to implement restoration programs, prevent pollution and assess the execution of in stream programs.

Using volunteers to do stream monitoring has many benefits, one of the foremost being the wide availability of volunteers compared to specialists. Because volunteer programs can provide training to their volunteers, it is possible to find a large number of volunteers and monitor a large number of water bodies. This leads to a considerable amount of collected data. Other benefits of volunteer monitoring include increased awareness of water quality problems in citizens, increased citizen involvement in watershed health and increased availability of data to governments.

Population growth and land development in peri-urban areas can strongly affect water quality. According to the Metropolitan Council, recent population growth trends in the seven-county metropolitan area of Minneapolis/St. Paul indicate the fastest population growth and resulting development is largely in the Rice Creek Watershed District (RCWD). The RCWD holds numerous lakes, chains of lakes, rivers, and streams across three counties and twenty-seven cities. This concern over local water resources has increased in the face of current and future development. Construction of impervious surfaces concomitant with development increases storm water runoff to nearby bodies of water, but water bodies in the area need to be monitored in order to properly assess impact.

To respond to this need, the Friends of the Mississippi River (FMR) in partnership with the RCWD, the Anoka Conservation District, a number of local cities, Minnesota Waters and the Minnesota Pollution Control Agency (MPCA), began a pilot project in 2006 to monitor water quality in Rice Creek Watershed using adult volunteers. The project, called Stream Health Evaluation Program (SHEP) used 28 adult volunteers organized in three teams to monitor a total of six sites in the fall of 2006, two sites each at Hardwood Creek, Rice Creek, and the inlet of Locke Lake. Locations were chosen to study the effects of recent restorations on these streams, with one site being upstream of the restoration site and ones below the restoration site at each location.

The SHEP monitoring protocol was adapted from similar methods used by the Volunteer Stream Monitoring Partnership and the MPCA. The protocol was divided into two sections: a physical habitat assessment and a biological assessment of aquatic macroinvertebrates. The habitat assessment consists of volunteers recording habitat data including vegetation cover, plant life, bank erosion and stream depth.

Volunteers participated in 1.5 days of training, covering the in-stream physical assessment and macroinvertebrate collection methods, and laboratory macroinvertebrate identification procedure. Each volunteer group collected data at one site and cross-checked a separate site. After macroinvertebrate collection was completed, volunteers spent one day in the lab identifying samples. The samples were later cross-checked by professionals.

SHEP held three main goals for the first year of the program: accurate and useful data collection, cultivation of a volunteer base to perpetuate the program in the future, and motivating citizen engagement in the quality of the water in the area. SHEP organizers partnered with the Higher Education Consortium for Urban Affairs (HECUA) Environmental Sustainability program to evaluate SHEP's first year in relation to these goals.

Guided by Dr. Julia Frost Nerbonne and Robby Schreiber, one graduate student and thirteen undergraduate students in the HECUA Environmental Sustainability program completed an evaluation of SHEP's first season. The class split into three groups to evaluate each of SHEP's goals: the *technical group* researched the efficacy of the data that SHEP groups collected, the *volunteer group* evaluated the experience of the SHEP volunteers to better understand volunteer interests and motivations, and the *broader context group* studied the value of the SHEP program as it relates to public policy.

Understanding the Volunteer Experience

Methods

In this section of the project we were interested in understanding what motivated SHEP volunteers to participate in the program, what might motivate them to continue, and what they thought were both the successes and failures of the current program. To do this we administered a pre-program, we conducted semi-structured interviews with select volunteers and group leaders, and we conducted a mail survey of all the volunteers after the closing of the first season of monitoring.

On the 26th of August, 2006, we administered an open ended survey (the pre-survey)during the orientation session. The pre-survey consisted of eight open-ended questions designed to assess their experience prior to the monitoring that asked volunteers to explain who they were, how they had heard of SHEP, and what they hoped to gain from the experience.. Twenty-five of the original 30 volunteers filled out pre-surveys.

In November, 2006 we conducted a mail survey of the 28 volunteers after they completed their monitoring experience. The survey consisted of 17 questions: 9 fully or partially open-ended, 3 multi-part questions using a 0-4 Likert scale, 3 yes/no questions, and one multiple choice and one ranking question. (See Appendix A for the full survey instrument.) Questions focused on the broad categories of motivation and program success/improvement. $2 bills were enclosed with the surveys as incentive. All 28 surveys were returned.

To understand the deeper context of survey results, semi-structured phone and in-person interviews were conducted, consisting of eleven open-ended questions with prepared probes. One leader from each volunteer group, three volunteers from group 1, and 2 volunteers each from groups 2 and 3 were interviewed. Interviews were recorded, transcribed and coded for emerging themes.

Volunteer Results

<u>Demographics and Background</u>

Eleven of 27 volunteers live in the Rice Creek Watershed, whereas 16 of 27 of volunteers came from other watersheds in the metropolitan area. Nine of 27 volunteers are retired while eighteen are not retired. Only nine out of the twenty-eight volunteers had participated in citizen stream monitoring before. These demographics illustrate that the majority of volunteers have not necessarily joined SHEP because of a compelling local issue.

Pre-survey results showed that volunteers found out about SHEP in a variety of ways (see Figure 1).

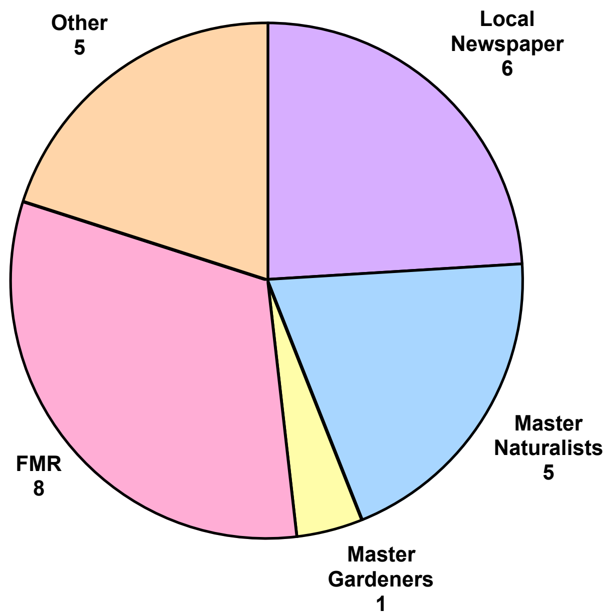

Figure 1. *Chart of how respondents found out about SHEP.*

Motivation

In a scaled, multi-part question on volunteer motivation, respondents rated their reason for participating in SHEP based on a Likert scale from 0 (not true) to 4 (very true.) Figure 2 reflects the number of volunteers that selected a 3 for true or 4 for very true in response to each statement. The most popular motivation for volunteers to participate in SHEP was educational (26/28), followed closely by a desire to help protect water quality (25/28). Building naturalist skills, getting outdoors, having fun, and building political skills followed, while meeting people and fighting development lagged behind other reasons.

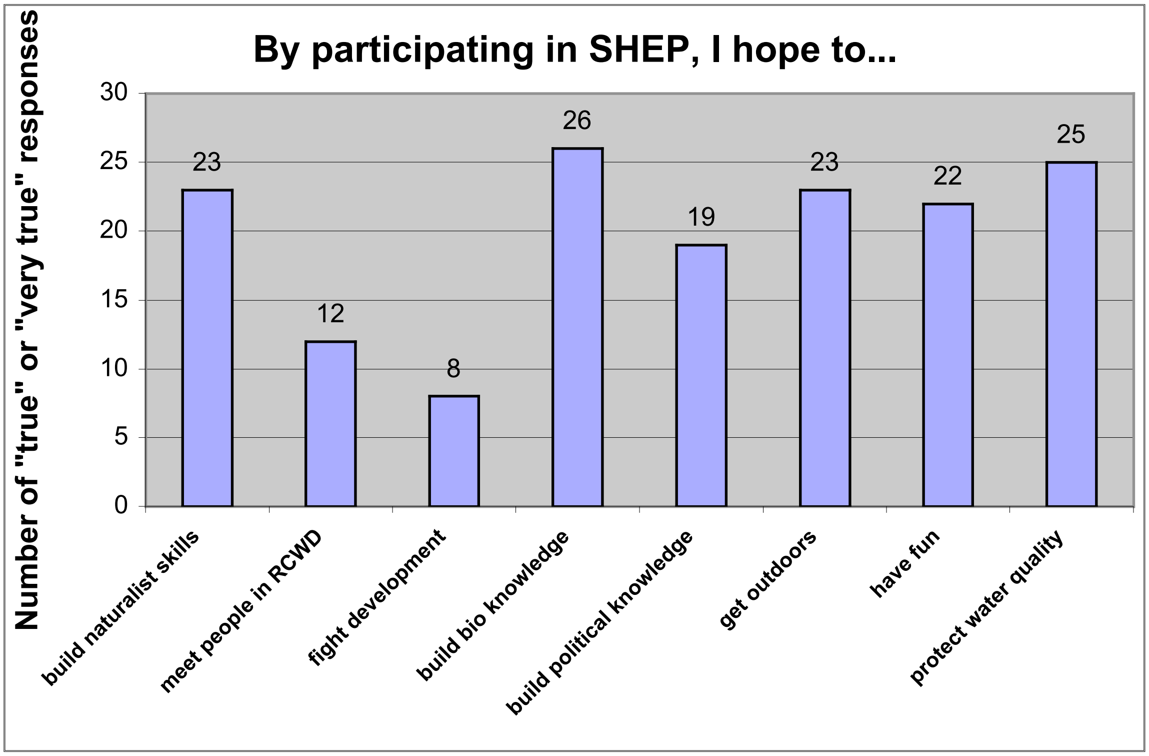

Figure 2. *Number of "true" or "very true" responses to supplied reasons for SHEP participation.*

In response to a follow-up multiple choice question on motivation, volunteers were asked to choose one predominant reason they participated in SHEP. They were asked to choose from the following options:

1. SHEP provides an educational experience and improves awareness of local water quality issues
2. SHEP provides data that can be used by state and local government for reporting the state of the waters
3. SHEP gives us the ability to identify problems in our watershed which we can use to fight pollution.

The majority of volunteers chose education and raising awareness as their primary reason for their involvement in SHEP (see Figure 3).

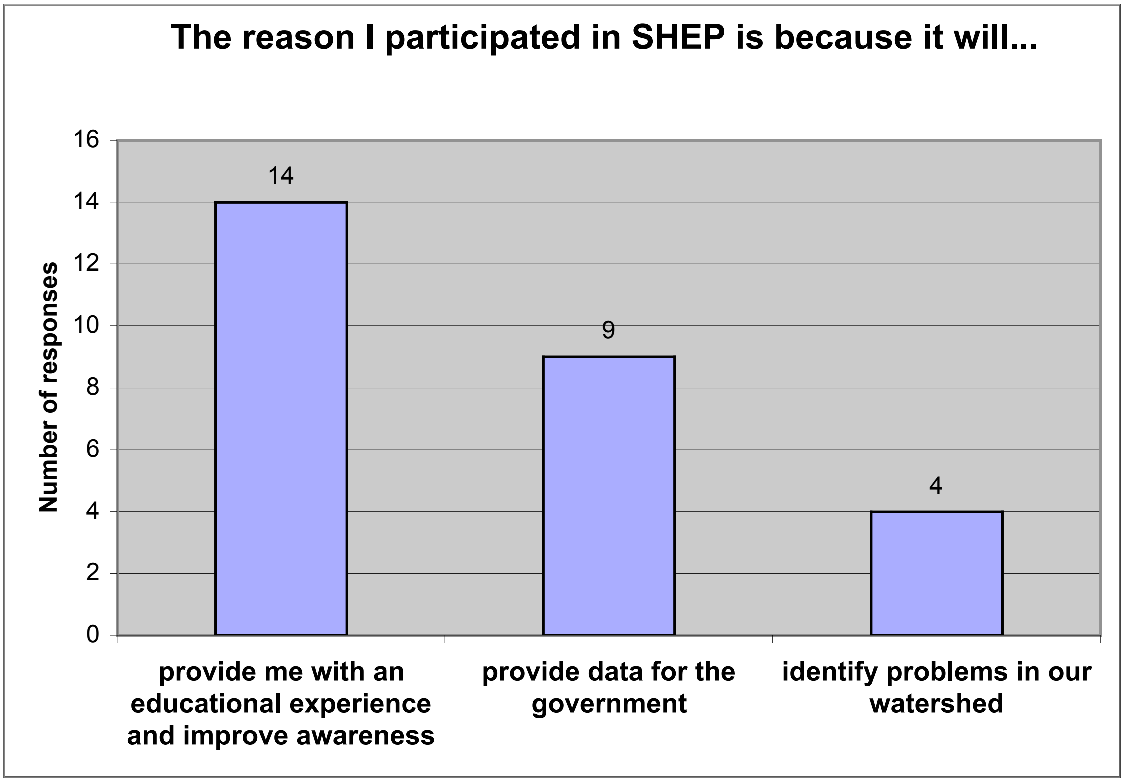

Figure 3. *Volunteers' responses on the reason for their SHEP involvement.*

Training

Figures 4, 5 and 6 illustrate responses to three parts of question twelve on the volunteer survey.

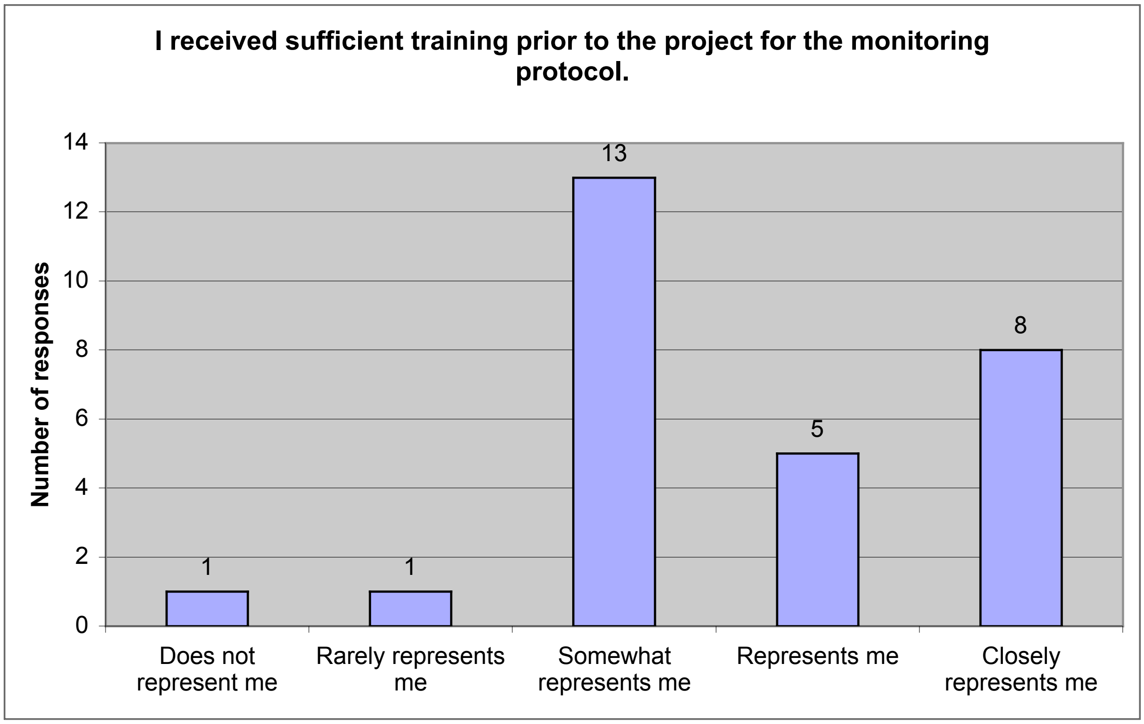

Figure 4. *Volunteers' Likert scale responses to whether volunteers received sufficient training.*

As can be seen from the survey (figure 4) as well as from responses in interviews and the open-ended survey, volunteers demonstrated mixed feelings on whether they received sufficient training prior to the project for the monitoring protocol.

Based on comments made in interviews and open-ended survey questions, the volunteers who felt less prepared felt more time could have been spent in training. Quotes included:

> *"More time for the first day of training-we did not get to make it to each station."*

> *"If we could have spent maybe just another hour during the training on the field portion, I think that would have been very helpful."*

> *"Well, we went through the training session, but of course, we've got thirty people and you're not all going to have a chance to use the net and do everything and then you get one exposure, and then you forget, even if you're looking at the instructions."*

> *"When we did the first evening of the training, the time we spent out in the stream going through what the sampling involved, I do not think that was enough. I think they should look at changing how much time is spent in the field during training."*

> *"More training on the paperwork. Stream flow, stream velocity. I know we were rushed for time with MPCA people, but the paperwork part was rushed and it seems like it wasn't important. I think for complete results and an accurate report, it was important."*

> *"Improve the field training segment by spending more time discussing methods. Go over the field sheets and protocols more carefully."*

As demonstrated in these and other quotes, many of the volunteer concerns around training focused on the physical habitat description in the field, specifically the organization and methodology of that portion of the protocol. Seven volunteers mentioned this in their survey comments, even though the survey did not solicit comments about specific portions of the protocols. Comments demonstrated that volunteers were concerned about sufficient training because they hoped to produce quality data that would be useful, illustrating that they are holding themselves and SHEP organizers to high standards of accuracy and replicability.

Volunteers also provided insight into the macroinvertebrate identification training:

> *" For training in identification, I think it might be nice to step the students through actual identification of particular creatures. For example, have everyone do a scud and step through all identification steps in the identification manual. Do the most common macroinvertebrates that we might encounter. The diagram for the aquatic moth did not show the leg like hooks very well. It had to be pointed out by an expert what those were."*

> *"I would add a lab section on processing the sample that was collected in the field, rather than just identifying samples of organisms without the processing of a sample."*

These comments again demonstrate volunteer concerns about thoroughness and methodology, however they appeared to have a higher level of confidence in identification training than in-stream training.

Volunteers demonstrate less ambivalence about the amount of support they received from SHEP staff. (Figure 5) Over half of the respondents answered that this statement "closely represents me" or "represents me," while twelve of the twenty-seven volunteers answered either somewhat, rarely or does not represent me.

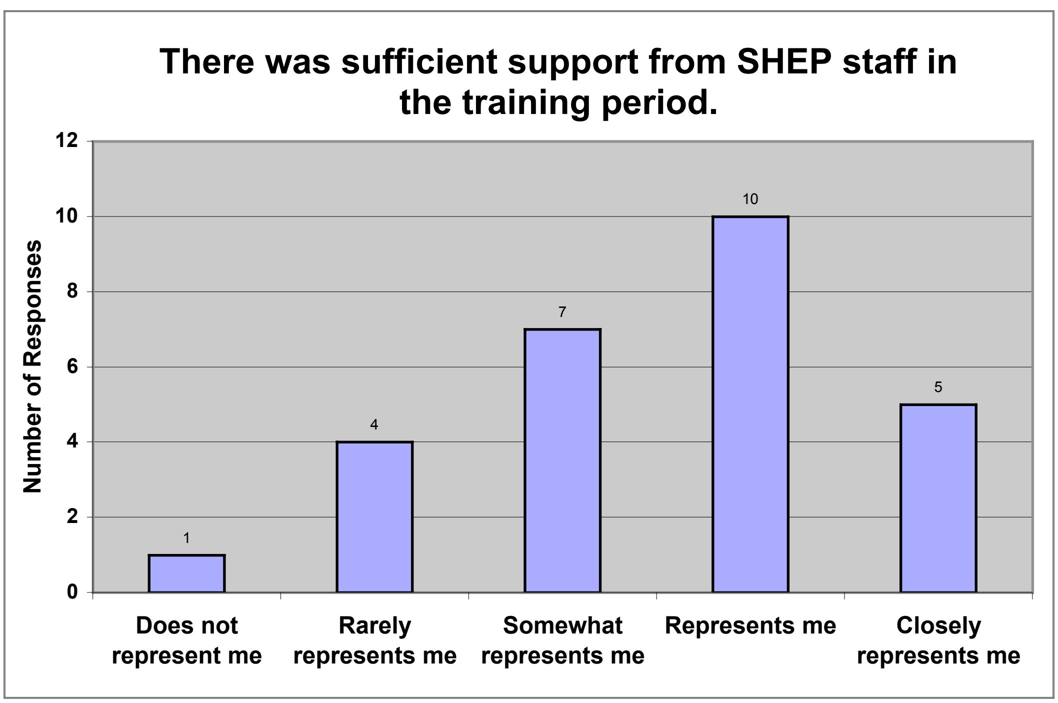

Figure 5. *Volunteers' Likert scale responses to the supplied statement.*

The mode in these responses has shifted from “somewhat represents me” to “represents me;” in addition, fifteen respondents are in the two most positive categories, as opposed to thirteen for the previous question. This indicates that while some volunteers would have liked more training, they did feel supported in the amount of training they received.

Interestingly, volunteer group leader responses to the above questions illustrated the lowest levels of confidence, a theme that was echoed in their interviews:

> *“I think there was a challenge being a group leader. The expectations about what the group leader would be were not clear. I don’t think we felt prepared enough.”*

> *“It would have helped if the group leaders had met with FMR before we started. The team leaders need to meet at the beginning of the project, before we start, for better direction.”*

> *“From the start, get the leaders together.”*

Other volunteers also had input on the group leaders training, again demonstrating volunteer concern for data quality:

> *“I would train the group leaders more in depth. Ours didn't quite get the ‘scientific method’ idea about how important it was to do the samples methodologically so every one was doing the same thing & it could be replicated. This was a little frustrating to me because if things aren't done right, our time and work wouldn't be valid.”*

However, another shift towards more confidence is illustrated by volunteer responses to the statement: “During the project, I felt knowledgeable about performing the monitoring protocols.” (Figure 6)

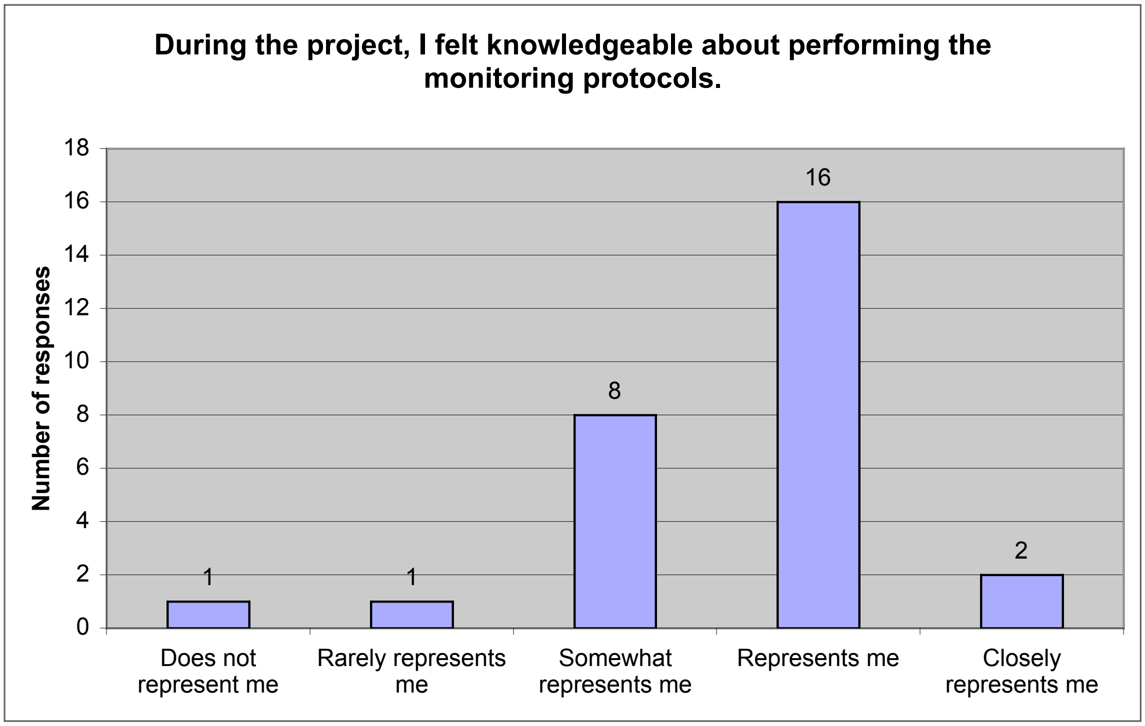

Figure 6. *Volunteers' Likert scale responses whether they felt knowledgeable about performing monitoring tasks.*

Despite ambivalence demonstrated in the responses to previous questions, the majority of volunteers did feel knowledgeable about performing monitoring tasks. Several comments also supported positive volunteers responses to the current training model:

> *"With limited time and resources, it is always tough, and overall, the training job got done fairly well."*

> *"The training was sufficient but not too long."*

However, leaders again supplied some of the lowest agreement with this statement.

In-stream Experience

From responses in the survey to the statement "There was sufficient time in each stream to thoroughly complete the monitoring," (Figure 7) most volunteers felt they had an acceptable amount of in-stream time.

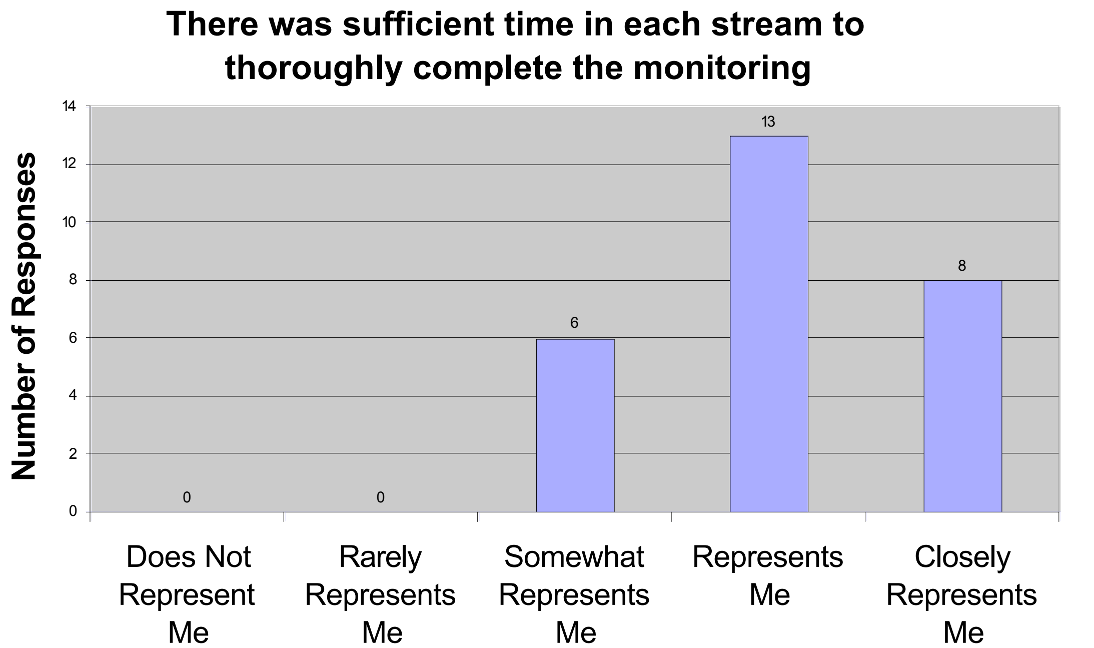

Figure 7. *Volunteers' Likert scale responses to whether there was sufficient in stream time to complete monitoring.*

From the survey responses to the statement "There was sufficient support from SHEP staff while completing the actual in-stream monitoring," the majority of volunteers felt supported in the actual collection process.

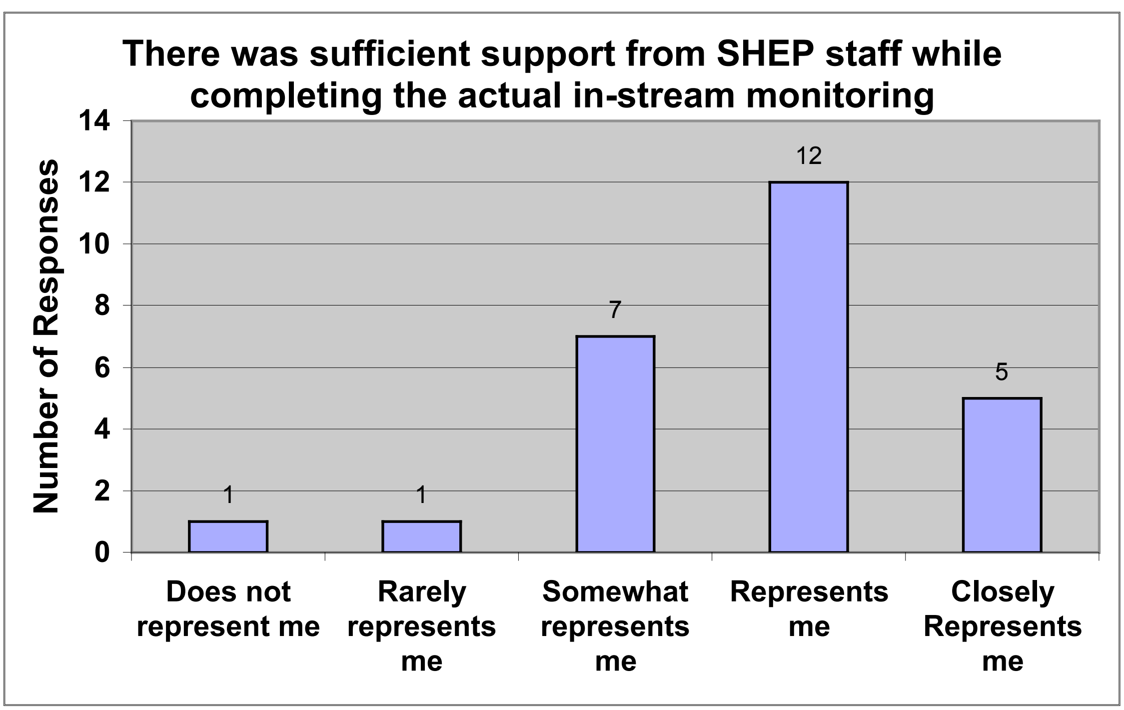

Figure 8. *Volunteers' Likert scale responses to whether there was sufficient support from SHEP staff during the actual monitoring.*

A few survey comments on open-ended questions did indicate a desire for more time and in-stream support. This sentiment was reiterated in a number of interviews. Quite a few respondents mentioned that they would like more time and more support in the field collection process, especially with regards to physical habitat characterization.
It is evident that some volunteers, including the leaders, felt that this part of the field protocol could benefit from a more systematic, methodological process, with increased time and more support.

Identification Process
Interestingly, volunteers also expressed uncertainty about the identification process, though the quality control proved their skills to be more than adequate (Volunteers successfully identified >95% of the 1,477 organisms sorted from their samples). In an open-ended response section on the survey, 7 survey respondents recommended improvements to the identification portion of the training and/or protocol:

> *"Better support while identifying organisms."*
>
> *"Provide resource or identification book rather than having [volunteers] print out. (encourage people to do stuff on their own)"*
>
> *"Add more reference books for identification. Allow (2) sessions for final identification."*

Volunteers expressed that they would like more professional support for the identification protocol and more reference books. A few volunteers suggested making reference books or online identification sites available before the identification, which would allow volunteers to have the opportunity to familiarize themselves with identification even before the training. Volunteers also expressed a desire for more time during the identification process, perhaps even making it possible to attend two sessions for the final identification.

Organization
In interviews and open-ended survey comments, volunteers reflected on the organization of the program. The four organization topics mentioned were: group scheduling and organization, equipment organization, communication with landowners, and group leader organization.

Two people dropped out of the program due to scheduling conflicts, and nine other volunteers mentioned they would like to see the groups matched by schedule.

The volunteers also suggested improving the organization of equipment, since during the monitoring season one group experienced a conflict where necessary equipment was locked in the garage of a different group's member

One group had an interesting encounter with a local landowner who was not aware that a group of ten people would be traversing his property twice to sample a stream flowing through his land. While he ended up allowing the monitoring to take place, it was clear that he was not informed and was worried about liability issues.

Group leaders mentioned a desire for more organization around their roles, as well. After short period of time, and even more so after the equipment confusion, leaders fell into communication with each other on their own. They did mention that it would have been easier on them and their groups had they met together previous to the monitoring process.

SHEP Succeeds with Volunteer Satisfaction

Though the above paragraphs may seem littered with gloomy reactions and calls for improvement, it must be kept in mind that a) one open-ended survey question was specifically asking for potential changes in the program and b) this is the first year of SHEP, so bumps in the road are expected. When asking the volunteers specifically about their level of satisfaction, it is abundantly clear that SHEP was an outstanding program for achieving its goals of cultivation of a volunteer base to perpetuate the program in the future, and motivating citizen engagement in the quality of the water in the area. SHEP created a great amount of volunteer enthusiasm and education.

Above all, this was a great program for the volunteers. People really enjoyed themselves. In fact, all 28 of the survey respondents chose “represents me” or “closely represents me” to the survey statement, “Overall, I enjoyed my experience as a SHEP volunteer.” This is a tremendous success.

The majority of volunteers had a lot of fun (Figure 9), and the majority of volunteers met people whose company they enjoyed (Figure 10). Finally, a majority of the volunteers want to participate again next year (Figure 11).

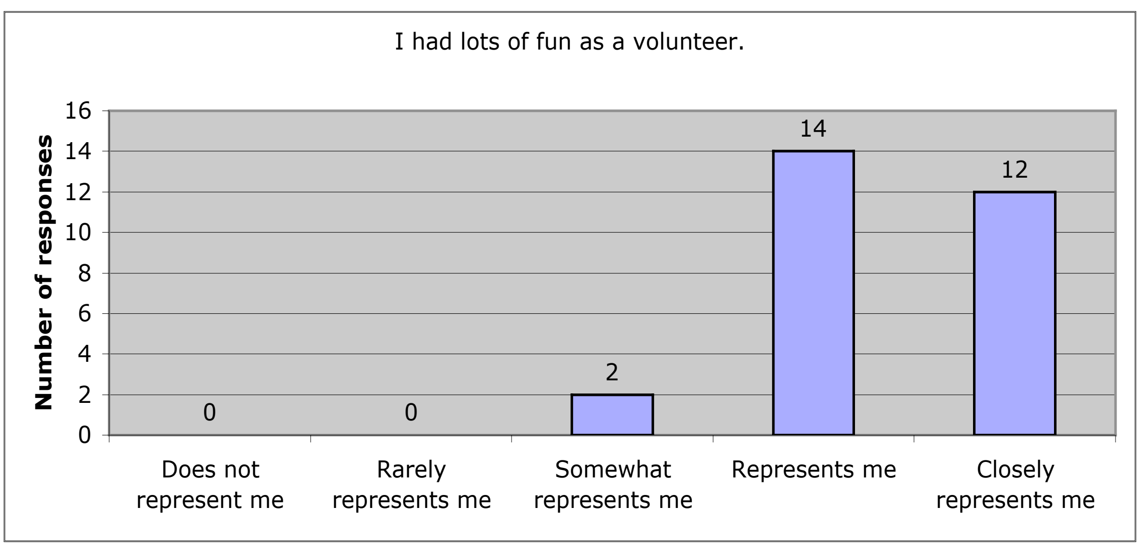

Figure 9. *Volunteers’ Likert scale responses to whether they had fun as a volunteer.*

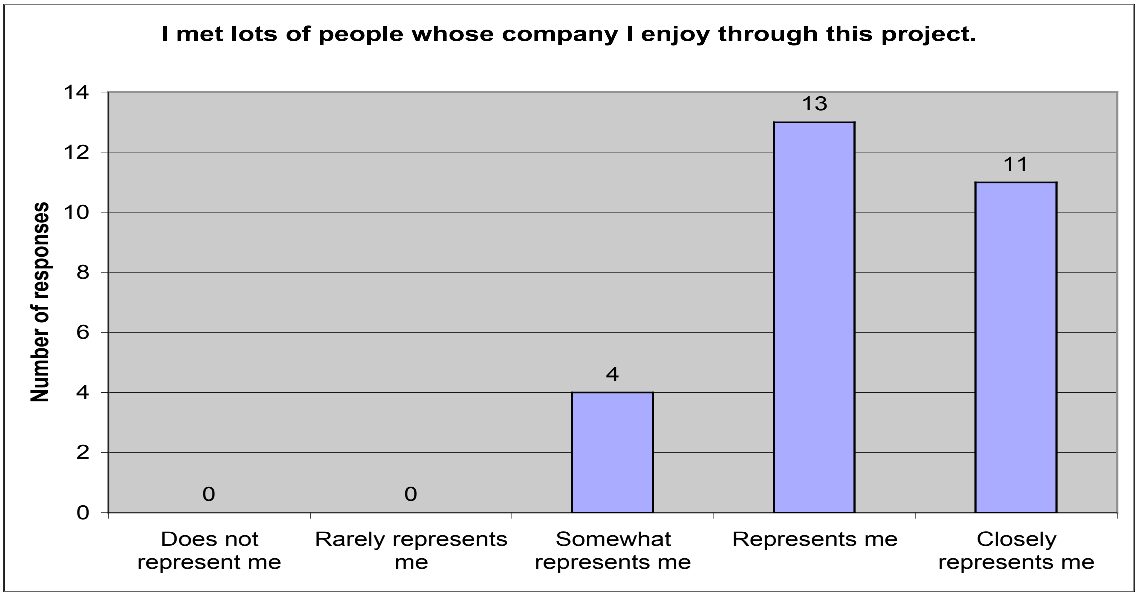

Figure 10. *Volunteers' Likert scale responses to whether they met people whose company they enjoyed.*

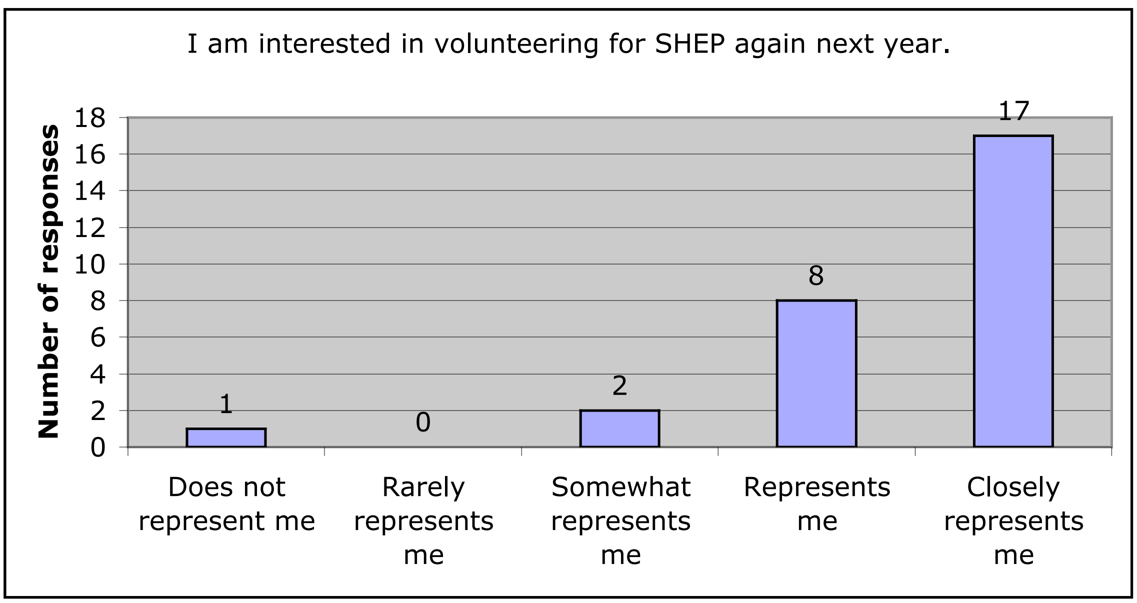

Figure 11. *Volunteers' Likert scale responses to whether they would be interested in volunteering for SHEP next year.*

A few wonderful quotes about the program from the survey and interviews:

> *"I enjoyed the learning experience this project brought me as well as the chance to meet other members of our community."*

> *"I was able to walk into areas I did not even know existed until I was part of this program. A very rewarding experience!"*

"The program was run exceedingly well. Best run program I have been involved in."

"I was very happy with the mix of our team and the way the program ran."

"Grateful for opportunity to discover more of biology of streams, lakes, and rivers, and how creatures living there are indicators of water quality."

"Hopefully it is just the beginning of great happenings!"

"I would say that I have enjoyed all aspects of the project so far….Thank you very much for what has been done!!!!"

Both in the survey responses and the interviews, the main reasons cited for this enthusiasm was fun, stemming from the educational and social opportunity the program presented. Volunteers had fun learning about the "critters" and "creepy-crawlies" of the streams, and enjoyed getting to know one another as well.

Future Involvement and Volunteer Engagement in Broader Context Issues

From both the survey and interview responses, it is clear that the great enthusiasm volunteers have for their SHEP experience did translate into eagerness to continue and expand their involvement, another great success for the SHEP program.

Volunteer support for further involvement in SHEP is evidenced by response to the survey question, "If a SHEP representative asked you to assist them in presenting the findings from this project at a city council or environmental meeting, would you be willing to assist them?" Twenty out of 27 volunteers said they would be willing to assist.

Reasons were mainly grouped into three categories, including that SHEP is such a great program that it needs to be shared:

"I've learned a lot and if my presence helps others understand the value of SHEP, I'd be happy to be there."

"To encourage others to be a part of the project."

"I would be willing to talk about what we as volunteers did."

"I think having volunteers do important work is a great idea. Promoting it is a good idea too."

To increase public and decision maker awareness:

"We have to protect our water. We have to be informed others about findings. Our water is our lifeblood. We cannot afford to mess it up."

"Education is a high priority for me- both to learn and to pass on knowledge to others."

"I think people in local government appreciated the views and efforts of a common citizen. All too often they hear the views of experts who represent a special interest."

"To assist Trevor and Dawn to make public officials aware of SHEP findings on stream health."

To ensure that their work is used and taken seriously:

> *"If I can assist in supporting "citizen science" as a resource to local government staff and decision-makers I am glad to help."*
>
> *"It's important to me that the data gets used. If this data can affect water policy for the better, then I would be willing to help get that done."*
>
> *"Real change and protection will only occur if the proper authorities like city council's watershed district boards and other decision makers get the information and that they listen to and understand the information."*

Volunteers are invested in the program and the time they spent on it, and are interested in applying their time and results to the real world.

We asked the volunteers if they felt they were more likely to become involved in local watershed politics because of their experience. Slightly more than half of the volunteers responded "represents me" or "closely represents me." (Figure 12)

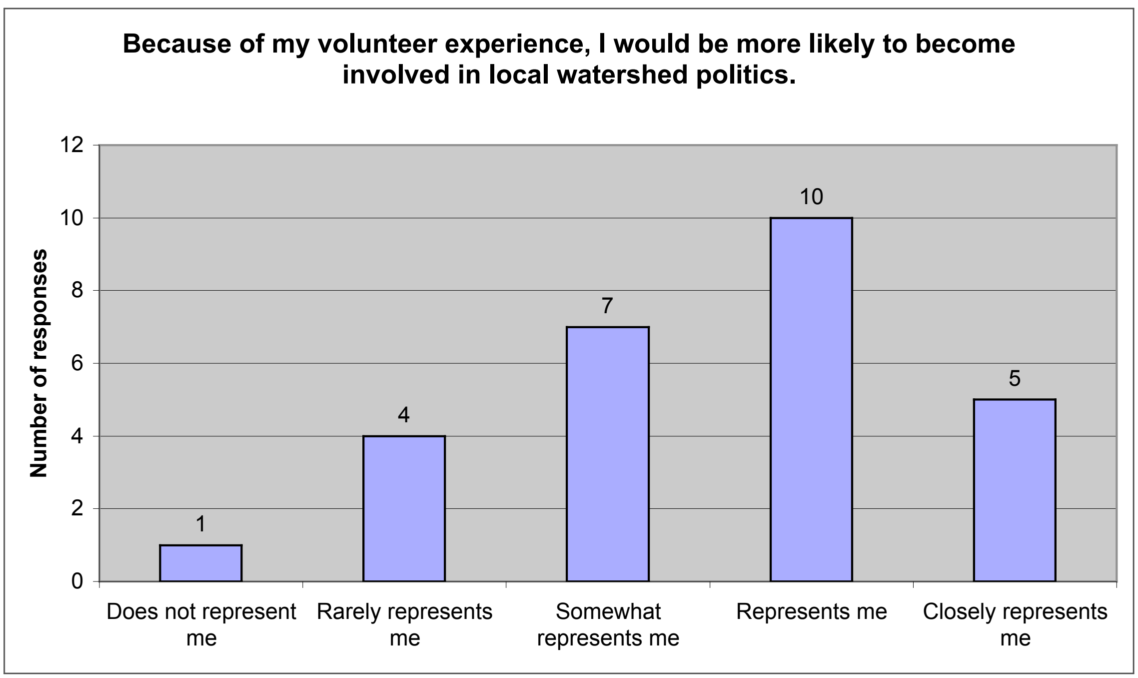

Figure 12. *Volunteers' Likert scale responses to whether they would be more likely to become involved in local watershed politics.*

However, in response to the question "Has your participation in SHEP given you the confidence needed to present water quality issues to decision makers?" the results were less confident. (Figure 13)

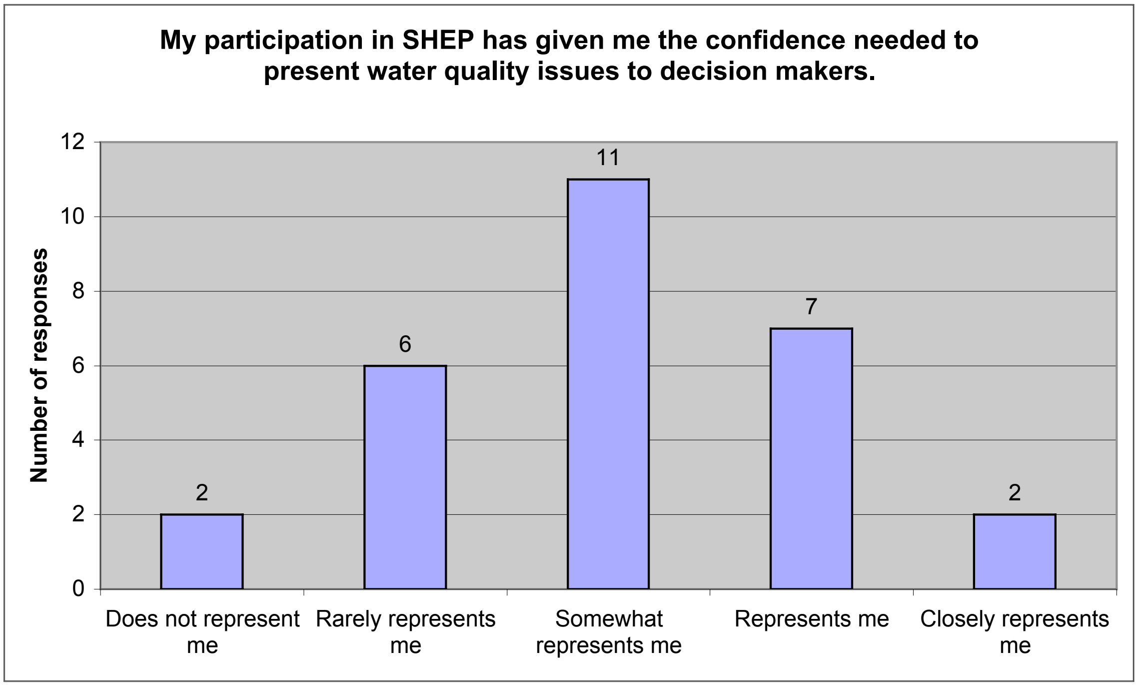

Figure 13. *Volunteers' Likert scale responses to whether their participation in SHEP gave them confidence to present water quality issues to decision makers.*

Compared with the two previous survey responses that show that a majority of volunteers are able to see themselves becoming involved in watershed politics and are willing to assist SHEP representatives, they do not feel as strongly that SHEP has given them enough confidence to present data concerning water quality issues. From interviews, it appears that this question was interpreted by the volunteers as presented data *on their own* to water quality decision makers. These results are echoed in comments from the open-ended post survey questions and the interviews. For example, two people who were not willing to present data and one who was willing to present data mentioned that they did not feel informed enough to be a primary presenter. However, as is clear from the number of volunteers willing to assist SHEP,

From these data, it is evident that volunteers are not comfortable making the first step in applying their SHEP experience to a wider setting but would be willing to assist SHEP in with presentations, if approached. However, volunteers need to be asked to help rather than expected to begin on their own, and they need to have some professional support from the start.

Though volunteers may not feel the confidence to take an initial step in direct interaction with water quality decision makers, they do feel more aware of and engaged in promoting water quality since their involvement in SHEP. (Figure 14)

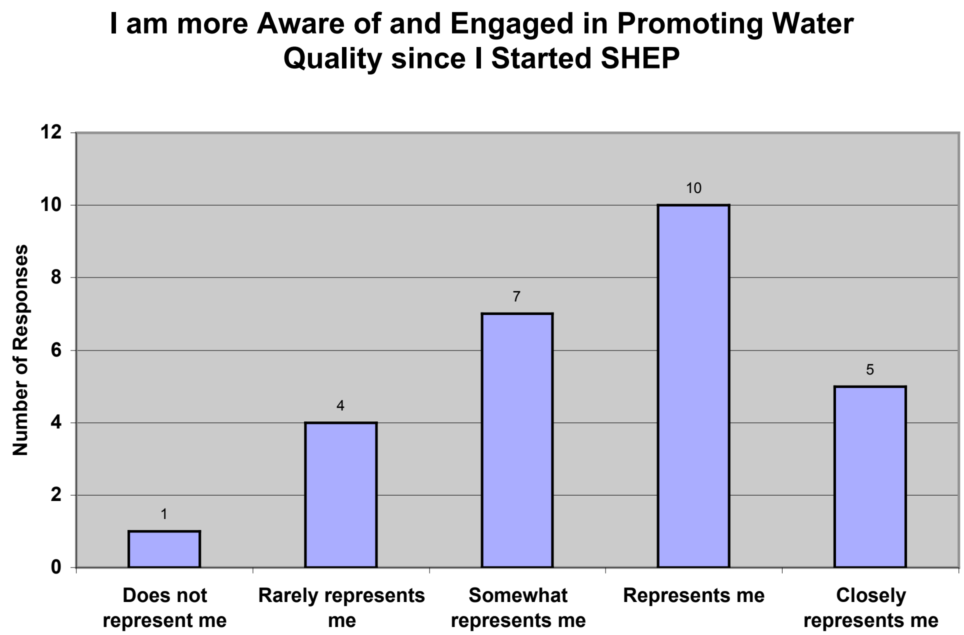

Figure 14. *Volunteers' Likert scale responses to whether they are more aware of and engaged in promoting water quality since they started SHEP.*

This is another success for SHEP in achieving its goals of a more aware and engaged citizen interest in water

Technical Efficacy of SHEP Data

Technical methods

The technical evaluation assessed both the accuracy and utility of data collected by SHEP volunteers. Was the data collected in 2006 able to help SHEP meet the goals of accurate and useful data? This group performed a literature review of both professional and volunteer macroinvertebrate monitoring techniques and examined three case studies of successful macroinvertebrate monitoring programs in California, Michigan, and Washington State.

Semi-structured in person, phone, and email interviews of seven Twin Cities water resources professionals were conducted. Email surveys of eight water resource professionals with open-ended questions specific to various monitoring methods were sent out after review of initial results. Surveys asked respondents to rate the following methods: transparency tube, temperature, nutrients (e.g. Nitrogen and Phosphorous), conductivity, macroinvertebrates, habitat assesment, and fecal colifrom and *E. coli* with regards to: cost and time, ease of use, utility to water resource professionals, legislative applicability, and suitability for SHEP. (See Appendix B for survey instrument.) Interviews were transcribed, and interviews and surveys were coded for emerging themes.

Students also observed four of the six in-stream monitoring days, examining volunteer field monitoring for replicability and accuracy.

Technical Efficacy

Literature Review and Case Studies

Volunteers provide necessary and vital macroinvertebrate data to water resources professionals nationwide. Contrary to notions of questionable volunteer data, the literature reports very little difference in professional versus volunteer monitoring and the outcome of their data (Fore and Crawford, 2001). Volunteer data is used as baseline data or a screening tool for watershed long term goals.

Volunteer data has also been used to:

- help choose restoration sites
- develop a data management system for water resources
- support existing water resource projects
- produce comparable data to other local and regional data
- present physicochemical data to be compared to state standards
- educate local communities on water quality issues
- improve volunteering stream monitoring protocol methods.

We examined three case studies from across the nation to provide examples of successful volunteer monitoring projects. Case studies from California, Washington, and Michigan were chosen based on methodology similar to SHEP.

Friends of Deer Creek of Nevada City, California, have monitored Deer Creek for over five years using macroinvertebrate monitoring and also measures nutrient levels and pH. This group gathers every other week of the entire year to identify preserved macroinvertebrates from samplings. Volunteers also attend special training events taught by professional biologists throughout the year. These events cover sampling, identification, general water chemistry, and habitat assessment techniques. Similar to SHEP, Deer Creek has professionals present at the identifying session for volunteer support. All samples are rechecked by a professional taxonomist, and twenty percent of the samples are sent to the California Department of Fish and Game for additional recheck.

The data that Friends of Deer Creek initially collected was treated as baseline data for background information of the creek. Through building reliability with systematic techniques and accurate data, results from Deer Creek have been used for choosing restoration sites. Friends of Deer Creek currently monitors the chosen sites for changes in macroinvertebrate colonies. Potential new projects for this organization include the study of mercury levels in macroinvertebrates and the creation of a "Bug Book" identification guide.

In Ann Arbor, Michigan, the Huron River Watershed Council volunteer monitoring group also monitors their waters macroinvertebrate sampling. This program started monitoring in 1992 and the program continues to attract volunteers, due in part to its "family-friendly" methods that allow untrained volunteers to take part in the program.

The Huron River Watershed Council program works over two days. All samples are collected on one intensive day called the "River RoundUp." Approximately 150 volunteers grouped into teams collect approximately 100 macroinvertebrates at each of over 70 sites. All teams have at least two trained volunteer leaders on hand to supervise specimen collection and on-site preservation. "ID Day" makes up the second day of work. Seven to eight professional volunteers assist in identification. Volunteers sort the collections into "look-alike" groups and then the professional volunteers sort these groups down to the taxonomic family level of macroinvertebrates. These sorted families are then handed back to the volunteers to be counted and recorded.

This group uses its identification data to examine pollution-sensitivity of macroinvertebrates in each creek. The data has been used by citizen groups and counties, and has been requested by consultants during development, floodplains mapping, and planning stream restoration projects.

Several researchers from Washington State conducted a study of the accuracy of volunteer macroinvertebrate data as compared to professionally collected data. (Fore et al 2001) Researchers performed trained a volunteer crew in the Seattle, WA area of the Puget Sound basin. Volunteer crews and professional crews separately collected data on seven creek sites identified as impaired, using the same protocols and equipment.

No significant differences in collection of field samples between the volunteers and the professionals were found. Volunteer identification was accurate to the family level.

<u>In-stream observation</u>
Observations of SHEP's in-stream monitoring protocol showed consistent and confident macroinvertebrate collection methods. During collection, volunteers paid close attention to detail, randomness, and replicability, a great success and positive indicator for the SHEP protocol.

However, methodological consistency of the physical habitat assessment varied widely from group to group. One group worked more systematically and consistently, utilizing all equipment available. For this group, observers noted that the habitat assessment worksheets were followed closely, with volunteers asking clarification questions and making systematic sweeps of the area. Stream depth was measured with a measuring tape, and detailed notes were taken on the physical habitat description.

Another observed group was found to be less systematic, measuring stream depth by estimating the depth of a volunteers knee, making broader guesses at the physical habitat assessment, and demonstrating less consistent and systematic examination and description of the surroundings. This observation from the technical group is supported by feedback from the volunteers on their surveys.

The accuracy of the macroinvertebrate identification by the volunteers was extremely high: quality control by professionals showed greater than 99.5% of 1,477 samples were correctly identified to family by the volunteers. This is a remarkable accuracy rate for a pilot program and a great success.

The Family Biotic Index (FBI) for each site is summarized in Table 1:

	Above Restoration	*Below Restoration*
Rice Creek	8.8	8.3
Locke Lake	5.0	5.3
Hardwood Creek	7.6	5.1

Table 1: *FBIs for each location above and below restoration sites.*

As illustrated, Rice Creek and Locke Lake show little difference this season, while Hardwood Creek demonstrates some positive change. Water resources professionals indicated that differences between above and below restoration sites may take several seasons to demonstrate change in the biotic community, and it is likely that SHEP methods will track those changes.

<u>Interviews and surveys</u>
Interviews with water resource professionals indicated that we can expect SHEP to provide baseline data on stream quality. Professionals are confident that volunteer data is valid as a screening tool and for providing such baseline data. Impairment trends can be detected over time and taken to water resource professionals for possible further study. In

both interviews and surveys professionals agreed that macroinvertebrate monitoring provides some of the most important overall metrics for stream health, and gives an important picture of stream quality.

Whether the program will be able to expand from baseline data use remains to be seen. The higher the accuracy, replicability, and variety of the data, the more likely it will be to be used. As stated, the accuracy of the macroinvertebrate identification was extremely high.

Several of the interviewees stressed that macroinvertebrate sampling methods need to take into consideration what type of stream is being sampled, and thus making accurate habitat assessment should be an important component of program because it complements and reinforces the validity of the biological data. In both surveys and interviews professionals mentioned habitat assessment as a useful and appropriate accessory to biological monitoring, especially over a long time scale where substrate changes can be correlated to biotic variation. Some professionals expressed doubt over the replicability of the habitat assessment as it currently stands. One person even commented that the habitat assessment portion of the SHEP protocol needs serious modification if it is to become useful to the program. This is a finding echoed by the direct observations of the monitoring, and demonstrated in the volunteer portion as well.

In interviews, professionals also commented that adding water chemistry information to a more standardized habitat assessment would make the macroinvertebrate data more robust. This was echoed by comments from decision-makers in the broader context interviews as well as volunteer survey responses. Without water quality aspects included in the study, some direct conclusions about the source of the biotic impairment cannot be drawn. Without a variety of methods, it is unknown whether the biotic community is impacted by habitat degradation or water quality issues.

Interviewees also mentioned that, in SHEP's monitoring of above and below restoration sites, it is possible that a few years may pass before the restoration takes root and demonstrates an effect on the macroinvertebrate community. A greater variety of analysis methods would allow for a more specific explanation of biotic index results, as well as provide for more immediate data on potential differences between restored and unrestored stream sites.

Professional responses from surveys and interviews on various volunteer methods are summarized in Table 2. Survey respondents and interview comments were largely in agreement. In "Suitability for SHEP," respondents took into account what methods would be most appropriate for a small-budgeted adult volunteer program.

As shown in the table, macroinvertebrate monitoring and transparency tube methods were recommended as appropriate, for nearly opposite reasons. Respondents mentioned that macroinvertebrates can be time-consuming and require a lot of effort, but volunteers tend to enjoy the experience. Valuable overall ecological data is gathered from macroinvertebrate monitoring if accurate results can be assured. (This appears to be the case with SHEP.) Transparency tubes provide quick, easy data that pinpoints one stream ecology factor: water clarity, a factor that implies important erosion and runoff effects.

Methods that were recommended in conjunction with other methods are temperature and habitat assessment. While *E. coli* and fecal coliform bacteria are very useful to scientists and decision-makers, these methods may be too time-consuming and/or costly for a group such as SHEP.

	Cost and Time	Ease of Use	Utility to Water Resource Professionals	Applicability to Decision Makers	Suitability for SHEP
Transparency Tube	**Cheap and but demands regular time commitment** Can plug into current MPCA program.	**Easy.**	**Moderate;** shows immediate effect, regularly gathered data most valuable.	**Moderate;** Water clarity may be important in disturbed areas.	**Moderate to high;** cheap and easy, but readings taken throughout season most useful.
Temperature	**Cheap and but demands regular time commitment**	**Easy.**	**Low** if only single measurement; **moderate** for measurements throughout season.	**Low** if not a trout stream; **Moderate to high** if a trout stream.	**Moderate;** Cheap, quick and easy, useful only in addition to other methods.
Nutrients (e.g. N and P)	**Very costly** if accurate probe is purchased; **Moderate cost** for Hach kits, but require **moderate time** for training.	**Easy** with probe, **Moderately easy** with Hach kits.	**Moderate to high** for accurate probe, **low to moderate** for Hach kit.	**Moderate to high**; most important in agricultural or sewage/septic tank areas.	**Low to moderate;** very useful, but costly and not exciting for most volunteers.
Conductivity	**Costly** for initial probe purchase and maintenance	**Easy.**	**Moderate.**	**Moderate**; depends on if road runoff is an important issue, data is somewhat uncharismatic.	**Low;** useful, but costly and not exciting for most volunteers.
Macro-invertebrates	**High initial time investment** for training, **Moderate** cost for equipment.	**Moderately difficult;** requires training.	**Moderate to high;** very important for overall stream health, need other methods to explain impairment.	**Moderate to high;** data can be compelling, but reasons for impairment aren't clear from this method alone.	**Moderate to high;** useful with QA/QC, most likely to interest volunteers, requires strong professional support.
Habitat Assesment	**Cheap and moderately quick;** standardized worksheets may take some time; photos are quick.	**Moderately easy.**	**Moderate;** requires consistency and detail to be useful, worksheets are the most useful.	**Moderate;** photos of changes over time are compelling, descriptions alone are not.	**Moderate;** best when used in conjunction with other methods.
Fecal Colifrom and *E. coli*	**Costly and moderately time-consuming.**	**Easy** (but more expensive) if samples sent to lab, **Moderate** using test kits—requires training**.**	**High;** depending on accuracy and quality control.	**Very high;** public health issue.	**Moderate;** high utility, interesting to volunteers, expensive.

Table 2. *Coded results from interviews and surveys for eight monitoring methods.*

Utility of SHEP Data in the Public Policy Arena

The broader context group found that decision-makers were most influenced by watershed data when data demonstrates impacts on health, recreation, valued wildlife, or finances. Hard, visual evidence such as changes in water clarity and visible pollution are more compelling than other sorts of evidence such as statistical metrics. Decision-makers are likely to consider citizen concerns about water quality. These concerns tend to be two-fold in relation to development:

1) during construction, soil displacement, compaction and erosion can affect water clarity, impacting wildlife and recreational enjoyment; and
2) after development is completed, new impervious surfaces increase storm water runoff, disrupting stream flow and adding contaminants from roads and stressed storm sewer drainage.

Though decision-makers value both data and citizen concerns, they expressed that an engaged, educated citizenry has a much greater influence than data alone, and that they believed a program such as SHEP would produce such a group of educated citizen advocates.

The problems that rise to the surface and become the ignition source for getting people to act usually come in the form of a threat to resources, recreation, or public health. The disappearance of popular game grabs the attention of hunters; the spread of a common illness found in those that swim or eat fish from a river or stream grabs the attention of recreational activities that utilize that particular impaired resource; these are among some of the examples that got the attention of communities along the Vermillion Watershed. The threat of one out of only two trophy trout streams in an urban area in the nation due to the poor water quality of a stream became the incentive for community action in the City of Farmington along with the Empire Township in Dakota County. Similarly, poor drinking water quality due to poisoned wells creating widespread illness, no doubt, was quickly answered by community action in the Vermillion Watershed area.

A community's tendency to act often arises only after a problem becomes a direct threat that they can understand. According to decision makers, it is hard, visual evidence that motivates a community to act. As one interviewee mentioned "if you tie [the problem] into something you can visualize and give them a picture of what it means then politically you are going to make a statement." Science alone can not tell the story. If it has been established scientifically that, for example, a stream is impaired or a certain species of waterfowl is threatened, the initial response from the community might be to shrug the issue off. Once that impaired stream is brown and thick with mud, or once the community notices that the waterfowl are missing, they begin to ask "what is going on?" It is at this point that community concerns usually leads to the first wave of action.

Conclusions and Recommendations

From these findings, we identified several areas of potential growth for SHEP, as well as several areas of success. It must be kept in mind that this was the first year of the SHEP program, and many recommendations (especially from the volunteer experience) focus on how things could go better for a pilot program in the future.

First, we recommend **increasing targeted portions of the training**. From both volunteer and technical results, deeper understanding and stricter methodology on the **physical habitat assessment** would be useful for all volunteers. SHEP volunteers have demonstrated that they are enthusiastic and committed, and are interested in ensuring that their commitment to the program is used appropriately. In the second year, SHEP could add some training in physical habitat assessment to strengthen the value of macroinvertebrate data.

Though volunteers were outstanding at macroinvertebrate collection, their survey and interview responses showed that they were less confident about collecting quality physical habitat data. Increasing training to ensure more methodological data would address volunteer concerns of ensuring their work is worthwhile. Also, while volunteers obviously excelled at macroinvertebrate identification, several comments point to an initial lack of confidence in this area. For future new volunteers, adding an additional (optional) identification training would allow those less confident in this area to feel more comfortable, giving volunteers a better experience. Returning volunteers may benefit from a brush-up to boost confidence; however, it is clear that their identification skills are meticulously accurate, and time saved from more efficient identification could be put towards other activities.

Finally, providing an extra training specifically for group leaders would give those leaders more confidence and information to enforce the scientific method and answer questions when needed. For the second year of SHEP, it is likely that returning group leaders will seek each other out from the start in order to plan for equipment and scheduling. However, even returning group leaders would benefit from a pre-organized meeting with SHEP. New group leaders would reap the most benefits from such a meeting, which would ensure greater communication and organization from the start.

Second, we recommend an **expansion of the monitoring focus** to include simple water quality and physical habitat parameters that would give the option for volunteers to be active year round and give the SHEP program data that can be more immediately related to the expansion of development in the watershed.

The technical evaluation found that to be most useful to water resources professionals and provide a range of applicable data additional metrics should be added, and the physical habitat assessment of the protocol should be improved. Volunteers were incredibly thoughtful in their feedback on their data, are deeply invested and want to see their data used. Their experience with the physical assessment mirrors the questions posed by technical professionals. It is likely that, with such enthusiastic volunteers, the groups would be eager to take on additional simple tasks that would make the macroinvertebrate data more robust. Interviews with decision makers indicated that by producing data that could directly relate to public health or recreational threats, SHEP might provide more compelling evidence by illustrating how their data is connected to potential hot-button issues.

Both the technical and broader context results support broadening SHEP protocols to include the collection of more data that can be used to assess the immediate impact of development on in-stream water quality and public health. Volunteer leaders also expressed an interest in expanding monitoring activities so that they can keep their group active throughout the year. Adding a component to the SHEP program that is simple, inexpensive, and enhances the immediacy of the biotic data would be valuable across all areas of interest. For example, turbidity tubes are an inexpensive and simple way to measure water clarity, and taking a photo of the physical habitat in addition to the assessment ensures more consistent results.

Finally, we recommend **greater communication and organization between all audiences**: SHEP organizers, volunteers, water resources professionals, decision-makers, and the broader community.

Greater communication and organization can avoid equipment confusion and scheduling difficulties, ensuring a better experience for volunteers and greater accuracy in data collection.

Greater communication between SHEP organizers, volunteers, water resource professionals, and local decision-makers can help SHEP choose whether and how to grow their data collection. It is clear the macroinvertebrate data is an incredibly vital metric in stream assessments, and the one most likely to keep volunteers interested and enthusiastic. However, water resource professionals and decision makers indicate that some additional metrics would be valuable to have the greatest potential legislative effect. Also, with the volunteer enthusiasm over having their work be used, ensuring that their product is as robust as possible would be positive for them.

Facilitating communication between SHEP volunteers and the broader community can keep the enthusiastic momentum of the program going strong even outside of the field season, and can harness the deeper feelings of engagement that volunteers feel because of SHEP. Volunteers are incredibly supportive of the SHEP program (20/27 respondents are interested in helping SHEP with a presentation or some way). Offer volunteers the opportunity for further involvement, and find out what is most interesting and engaging for them during the off season. Volunteers have come away with a deeper appreciation for water resources and are committed to ensuring their work is used. However, they are still not as confident in taking first steps—this is where SHEP can come in and foster new engaging experiences for them.

The situation with the landowner illustrates how vital it is for SHEP to be plugged in to the local community. Without landowner buy in and understanding, at best there are some confused private property owners, and at worse the community feeling towards SHEP would grow cool. This is an important recommendation both for the efficacy of

SHEP engaging the broader community, and for ensuring that volunteers have a good experience which they enjoy and to which they would like to return.

In order to ensure the most effective engagement in local watershed issues, SHEP should consider where individuals live in the selection of new volunteers. While even those volunteers living outside of the RCWD felt a stronger connection to the RCWD and its issues, those volunteers will have less of an impact on RCWD decision makers, since they are not part of the constituency.

Overall, we feel that this first year of SHEP was a great success. We find the outstanding macroinvertebrate identification accuracy to be a reflection of the commitment and interest of the 28 volunteers participating. The enormous volunteer enthusiasm and support this program fostered is outstanding. Volunteers made it very clear that they had lots of fun and a very enjoyable experience, and indicated a strong desire for future participation. Not only did this program provide baseline data on streams, but it also developed a great group of volunteers, who came back with a deeper appreciation for the watershed and a willingness to let others know about it.

It is likely that with continued commitment of this outstanding group of volunteers, SHEP will last long into the future. With some small and simple additions, SHEP data can be more robust and effective for water resource professionals and decision makers alike.

This first year is a valuable and fortuitous foundation on which SHEP can build an even better season than the first. Something great happened, and it can also be used to effect change in and engage the broader community.

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