Swamp River Watershed

Dutchess County, NY

Biological Stream Assessment

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Prepared for

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Background

Biological stream assessments using aquatic macroinvertebrate communities were conducted at seven locations within the Swamp River Watershed (Figure 1) in Dutchess County, NY, in 2010 on behalf of Friends of the Great Swamp (FRoGS). Swamp River Watershed serves as a source of drinking water, flood control, recreation, and wildlife habitat; it comprises part of the Great Swamp, one of the largest freshwater wetlands in New York State.

Although the Swamp River Watershed is approximately 70% forested (based on 2001 National Land Cover Data), pasture and cultivated crop land within the watershed, as well as increased impervious surfaces due to recent community growth, have potential to exert significant impacts.

In order to document water quality and potential impact sources, biological assessments were performed in seven locations. Biological assessments have been widely implemented as a useful, cost-effective method of providing information on degree and potential source of impact on a waterbody. These assessments use population attributes of biological communities (e.g., taxa richness, abundance, tolerance) to detect or infer ecologic condition.

Although biological assessments may utilize a variety of organisms, the use of aquatic macroinvertebrate communities is advantageous for several reasons. Benthic macroinvertebrates are abundant in most streams, relatively easy and inexpensive to sample, and relatively sensitive to a wide range of environmental stressors, including non-chemical impacts to the surrounding habitat. Their life span is short enough that sensitive life stages will be affected by stressors, but long enough that any impairment is measurable in the assemblage. Because they are relatively stationary, changes both within the organisms and their community structure reliably convey local conditions, allowing comparison of sites that are in close proximity. Changes in a macroinvertebrate community structure are indicative of impacts at, or upstream, of a given collection site, and frequently provide insight into the type of impact affecting the community. Benthic communities serve as indicators of overall, integrated water quality, including effects of intermittent discharges and lapses in treatment, synergistic effects, and effects of substances in lower than detectable levels (Smith et al. 2009). Furthermore, macroinvertebrate collection and processing protocols have been standardized, proficiency in taxonomic identification has been established through a North American Benthological Society certification process, and state and federal agencies routinely use community metrics; all of these factors contribute to more accurate, reproducible data for comparison to historical data.

Aquatic macroinvertebrate biological monitoring data may also be used to support documentation to establish a waterbody on the NYS 305(b) priority waterbodies list or 303(d) impaired waterbodies list, or be used in permit compliance.

The most recent Swamp River Watershed water quality assessments by the New York State Department of Environmental Conservation (NYS DEC) at Swamp River (GRSW01) in 2008 and Mill River (GRSW06) in 2007 indicated slightly impacted water quality

conditions. In this study, the previously studied DEC sites and five additional sites throughout the watershed were selected to assess overall water quality of the Swamp River Watershed and document if any rare, endangered, or special concern species were present.

Methods

Site Selection

Of the 7 locations assessed in this study, two were previously assessed by the NYS DEC Stream Biomonitoring Unit (SBU). GRSW01 (NYS DEC Station: SWMP 01 Swamp River) has been assessed periodically since 1992 (1992, 2002, 2007, and 2008) and GRSW06 (NY DEC station: MLLL 01 Mill River) was assessed in 2002 and 2007. The remaining stations were selected to assess upstream on Swamp River (above GRSW01) and to assess smaller sub-basins draining into the Swamp River. One site (GRSW07), located in Edward R. Murrow Memorial Park, also served as a collection demonstration site for members of Friends of the Great Swamp and the public.

See Figure 1 for maps of site locations.

Field Collection

Benthic surveys were conducted on July 24, 2010 in accordance with the NYS DEC SBU sampling season (July- September). The protocols established by NYS DEC SBU for the collection of benthic macroinvertebrates, physical habitat evaluation, and collection of basic water quality parameters for kick (riffle) and sandy stream samples (Smith et al. 2009) were followed. For kick riffles, an aquatic kick net was positioned in the water about 0.5 m downstream and the stream bottom was disturbed by foot so that the dislodged organisms were carried into the net. Sampling was continued for 5 minutes for a distance of 5 meters in a diagonal transect of the stream. The net contents were emptied into a pan of stream water and larger debris, once devoid of organisms, removed. The contents of the pan were sieved with a US number 30 standard sieve and transferred to a jar for preservation with ethyl alcohol. For the sandy stream samples, jab technique was used, which consisted of jabbing (or thrusting) the net into the target aquatic habitat for a distance of approximately 1 meter at a depth of 1-2 inches 5 times. This was followed by 2-3 sweeps above the same area to collect dislodged organisms. (Unpublished NYS DEC 2003 screening sampling document, confirmed personal communication, A.J. Smith, NYS DEC SBU).

The following parameters were obtained from each station using a YSI 556™ following the manufacturer calibration guidelines: water temperature (accuracy ± 0.15°C); specific conductance (range 0 -200,000 µS/cm with an accuracy of ± 0.5% of reading); pH, with a range of 0 to 14 units (accuracy ± 0.2 units); dissolved oxygen, with a range of 0 to 50 mg/L (accuracy ± 0.2 mg/L); and percent oxygen saturation, with a range of 0-500% (accuracy ± 2%) .

The following physical habitat attributes were documented: estimated stream width, depth, velocity, substrate embeddedness, and substrate composition.

See Appendix II for description of rationale.

Sorting and Organism Identification

Sample sorting and identification adhered to the NYS DEC laboratory methods (Smith et al. 2009). The samples were rinsed with tap water in a U.S. number 40 standard sieve to remove fine particles and then examined under a dissecting microscope to separate 100 organisms from the sample matrix. All specimens were identified to genus/species, or lowest practical taxonomic level, and enumerated using a dissecting microscope. Oligochaetes and Chironomids were slide-mounted in CMCP-10 mounting medium and viewed using a compound microscope.

See Appendix II for description of rationale.

Habitat Assessment

Ten different habitat characteristics are assessed using the Rapid Habitat Assessment Field Sheet and given a score: seven of the habitat characteristics are scored on a scale of 0- 20, and three are scored on a scale of 0-10. The score is totaled, then converted into a single Habitat Model Affinity score (HMA) that places the habitat into one of four impact categories: natural, altered, moderate, or severe (Unpublished; personal communication, A.J. Smith, NYS DEC SBU). The HMA is currently only calculated for high gradient stream assessments. The results may be used to better understand if biological response is related to habitat disturbance or water quality conditions (Smith et al. 2009). Impacted habitats have the potential to affect biological stream communities.

See Appendix II, Table 9 for a summary of habitat score range.

Macroinvertebrate Community Metrics

Standard NYS DEC standard kick community metrics [species richness, EPT richness, biotic index (BI), and percent model affinity (PMA)] were calculated for six of the subsamples. Sandy stream community metrics [species richness, EPT richness, biotic index (BI), and number of non Chironomidae and Oligochaeta (NCO)] was calculated for one of the subsamples (Smith et al. 2009) (Table 1;).

The metric values are scaled to a common value between 0-10 and averaged to calculate the standard NYS biological assessment profile (BAP) score. The impact category scales for individual metrics change between sample and collection habitat types, but the final impact scale (BAP) is the same for each sample type and collection habitat.

The BAP indicates the water quality condition in response to low oxygen saturation, organic enrichment, and industrial pollutants based on four impact categories: non-impact 10-7.51, slight impact 7.5-5.01, moderate impact 5-2.51, and severe impact 2.5-0. The boundary between slight and moderate impact category is considered the decision threshold for designated use impairment based on biological data (NY DEC 2008).

The acidBAP index is a measure of water quality response to acidification, and results from the combination of two metrics: percent mayfly richness (PMR), which is the percentage of alkaliphilous Ephemeroptera in a sample, and acid tolerant index (ATI),

which is the percentage of individuals in a sample belonging to 10 specified genera, all of which contain one or more acidophilous species. PMR and ATI results are scaled to a common value between 0-10 and averaged to calculate the acidBAP score. A score of 10 indicates no adverse affect from acidification whereas a score of 0 indicates a potentially severe effect (Baldigo et al. 2009). The acidBAP may be applied if the macroinvertebrate community indicates a preponderance of taxa expected to be found in an acidified environment.

See Appendix II, Tables 5 and 6 for a descriptive summary of metrics used, and Table 7 for a summary of water quality categories.

Impact Source Determination

Impact Source Determination (ISD) compares the sample community structure to a series of benthic model communities that are indicative of various sources of impact to help identify a likely source of impact affecting the sample community. The model that exhibits the highest similarity to the sample community denotes the likely impact source; alternatively, the sample community may be most similar to a "natural" or non-impacted community. If the sample community does not exhibit greater than 50% similarity to any model community, the determination is inconclusive (Novak and Bode, 1992).

ISD is applicable to benthic samples collected from wadeable stream systems only; the methods were developed for data derived from 100-organism subsamples of traveling kick samples from riffles of NYS streams.

Nutrient Biotic Index

Nutrient Biotic Index is a measure of nutrient enrichment based on responses of the macroinvertebrate community to effects of increasing nutrient levels for nitrate (NBI-N) and phosphorus (NBI-P). Taxa rate of occurrence at changing nutrient concentrations has enabled the identification of taxa-specific nutrient optima using a method of weighted averaging. Tolerance values have been assigned to taxa based on these nutrient optima, enabling the development of a linear scale of eutrophication (oligotrophic to eutrophic) using the macroinvertebrate community data.

Each taxon is assigned a tolerance value for phosphorus and a tolerance value for nitrate, enabling the calculation of two different biotic indices. Results are reported in a common 10-scale of eutrophication: oligotrophic 0-5, mesotrophic 5-6, and eutrophic 6-10 (Smith et al. 2009).

NBI is applied only to samples collected by kick method (not sandy bottom samples).

See Appendix II, Table 8 for a summary of NBI range.

Results

Macroinvertebrate Community Metrics and Community Structure

Benthic macroinvertebrate community metrics indicated non-impacted to severely impacted water quality at the stations assessed (Figure 1, Table 1). EPT richness ranged from 0-13; biotic index values ranged from 2.5-9.03; species richness ranged from 12-25; percent model affinity ranged from 46-60%; non-Chironomidae and Oligochaeta taxa was 3. Biological assessment profile scores ranged from 2.04-9.04 (adjusted).

No rare, endangered, or species of special conservation concern were noted within the samples collected.

Station GRSW01. The BAP at this site was 6.85, indicating slightly impacted water quality. ISD indicated that nonpoint source nutrients are impacting the site. Species richness, EPT and BAP have declined at this site since 1992, but improved slightly since 2008; BAP in 1992 indicated non-impacted water quality condition (Table 3).

Station GRSW02. The BAP at this site was 5.91, indicating slightly impacted water quality. ISD was most similar to a community affected by nonpoint source nutrient enrichment. The site is an isolated riffle below slack water; these conditions may influence the community structure.

Station GRSW03. This headwater tributary had a BAP of 7.07, indicating slight impact to water quality; ISD was inconclusive. Because the site contained an abundance of acidophilous taxa, the acidBAP was calculated; the acidBAP result of 3.75 indicated that acidification may potentially be affecting the site.

Station GRSW04. Burton Brook water quality assessment by BAP indicated severe impact (BAP = 2.04). The habitat available at this station was a low gradient sandy stream; the community was largely composed of the Chironomidae *Chironomus sp.*; this genus is tolerant of low oxygen levels and is often found in abundance in heavily organic substrate. The NCO (value of 3) indicated moderate impaction.

Station GRSW05. Cooperstown Brook had the highest water quality assessment score (BAP = 8.08), indicating non-impacted conditions. There was a diverse community of macroinvertebrates present at the site, including the cold water taxa *Rhyacophila minor, Dolophilodes sp.,* and *Tallaperla sp.*

Station GRSW06. The Mill River station community composition was well-balanced and contained the cold water taxa *Dolophilodes sp., Tallaperla sp.,* and *Dixa sp.* Water quality assessment indicated non-impact (BAP = 7.64); ISD was most similar to a community affected by natural conditions. Comparison with previous BAP scores of 2.85 (moderately impacted) in 2002 and 5.44 (slightly impacted) in 2007 indicates that water quality condition has improved at this site since 2002 (Table 4).

Station GRSW07. This station, on an un-named tributary to the Swamp River, had two notable indicators of good water quality present in the subsample, *Eccoptura xanthenes*

and *Diplectrona sp.* Two other indicators of good water quality, *Rhyacophila carolina* and *Tallaperla sp*, were observed in the field.

BAP results initially indicated slight impact to water quality conditions (6.54), but the BAP score was adjusted because this site was within a headwater tributary meeting the following NYS DEC criteria for adjustment to the BAP determination: headwater within 3 miles of the stream source, presence of several intolerant headwater taxa (*Epeorus sp., Leuctra sp., Eccoptura xanthenes, Diplectrona sp., Dolophilodes sp., Polypedilum aviceps,* and *Parametriocnemus sp.*), and observation of two other intolerant taxa in the field (*Rhyacophila carolina* and *Tallaperla sp)* (Bode et al 2002, Novak and Bode 1992). The adjusted BAP was 9.04, indicating non-impacted water quality.

The acidBAP was also applied to this site because of an abundance of acidophilic taxa; acidBAP was 3, indicating that the site may be affected by acidification. The ISD indicated a community most similar to one affected by nonpoint source nutrients.

Nutrient Biotic Index

Nutrient Biotic Index (NBI) results indicate half of the stations are nutrient enriched, though only marginally; values were just over the threshold into the eutrophic range (Table 1).

Physical and Basic Water Quality

Habitat assessment results ranged from 108 to 167; the corresponding habitat model affinity (HMA) scores ranged from 62 - 92 (Table 2). Sites GRSW01 (Swamp River), GRSW05 (Cooperstown Brook), and GRSW06 Mill River) exhibited "natural" conditions; site GRSW03 (Hiller Brook) exhibited "altered" condition, and site GRSW07 (Un-named tributary) exhibited "moderate impact". Low gradient streams are not assessed using this metric.

Dissolved oxygen ranged from 5.8 to 9.4 mg/L; DO saturation ranged from 70 to 119%; specific conductivity ranged from 124 to 648 µS/cm ($\bar{x}$= 360 µS/cm); water temperature ranged from 20 to 27°C; and pH was circumneutral for all sites (Table 2).

Discussion

The standard NYS benthic macroinvertebrate community assessments indicate water quality conditions to be non- to slightly impacted for all but one of the stations surveyed; the Burton Brook (GRSW04) assessment indicated severely impacted water quality conditions. Additionally, acidBAP values for two stations, GRSW03 and GRSW07, indicated potential effects of acidification.

A comparison of the historical biotic metrics with current biotic metrics at station GRSW01 (Swamp River) reveals the community metrics have notably changed among the years sampled (1992, 2002, 2007, 2008, and 2010) with a decline in species richness, EPT richness, and BAP, with slight improvement of each in 2010. The BAP score declined from non-impact (1992) to slightly impacted thereafter (Table 3). However, there is a statistically significant similarity among the taxa lists for each year the station was

assessed (Figure 2). Agricultural land use in proximity to station GRSW01 may be contributing nonpoint source nutrients that are affecting water quality.

Swamp River (GRSW02) BAP analysis indicated slight impact to water quality condition, which is not unexpected in view of the wetland area upstream, presence of developed land near the station, and the physical attributes of the reach. The presence of slack water above the riffle collection site produced an impoundment effect and has the potential to influence the macroinvertebrate community structure. Impoundments may alter food resources in the downstream water column thereby altering dominant organisms at a downstream reach (Hynes 1970).

Hiller Brook (GRSW03) contained an abundance of acidophilus taxa, and therefore the acidBAP was applied to the site. Common NYS metrics identify biological impacts secondary to low dissolved oxygen, organic enrichment, or industrial pollutants such as heavy metals, but do not reflect impacts caused by acidification (Baldigo et al. 2009, Bode et al 2004, Smith and Bode 2004). Nevertheless, acidification has been a significant problem in NYS streams affected by acid rain, and may occur sporadically in streams after rain events (Baldigo et al. 2009) or intermittent discharges. The resultant changes in pH and inorganic aluminum concentrations that occur under these conditions are often acutely toxic to aquatic species, but such effects may not be reflected in common NYS metric analysis (Baldigo et al. 2009).

An acid biological assessment profile (acidBAP), developed from taxa that are abundant in acidic NYS headwater streams but relatively uncommon in other reference streams throughout the state, has been developed to assess streams in relation to acidification impacts (Burns et al. 2008, Baldigo et al. 2009). It employs a combination of two metrics, percent mayfly richness (percent Ephemeroptera, excluding the more acid-tolerant *Epeorus*, in a sample), and macroinvertebrate acid tolerance index (percent of total sample abundance of individuals belonging to 10 genera that contain acidophilous species) normalized on a 10-scale and combined to yield a 0-10 scale of acid impact (10 is no acid impact and 0 is severe acid impact). The acidBAP score of 3.75 at the Hiller Brook Station (GRW03) indicated that benthic macroinvertebrate community is affected by acidification.

The pH measured at the station (7.78) does not indicate acid conditions, but the stream may be affected periodically (e.g. after a rain event, spring snow melt, or discharge) by acidification. Additionally, the acidBAP metrics were derived from benthic community structure in relation to base cation surplus values (BCS), inorganic aluminum concentrations, and critical aluminum thresholds; the impact values are not based on pH, and pH cannot be used to predict impacts from acid deposition (Baldigo et al. 2009).

Collection of replicate samples at this site may help to elucidate the acidification impact to the macroinvertebrate community. Water analysis following rain events, including determination of acid neutralizing capacity and aluminum concentration (which is beyond the scope of a screening survey), would provide further insight into possible intermittent acidification at GRSW03.

Burton Brook (GRSW04) benthic community metrics indicated the site to be severely impacted. Nutrient input from upstream agricultural land use may be affecting water quality at the site. Collection of replicate benthic samples and sampling for E. coli, nitrogen, and phosphorus levels (particularly after stormwater events, to capture spikes in runoff) will provide a more robust analysis of impact sources. Enhancement of the riparian habitat within 100 ft of the stream would help to buffer the impacts from run-off.

Cooperstown Brook (GRSW05) had the highest habitat score, representing a natural condition. The community composition at this site was composed of abundant EPT taxa and the BAP indicated non-impacted water quality. The surrounding land cover is forest and there are no point source discharges into the waterbody based on NYS DEC discharge compliance records.

Mill River (GRSW06) BAP indicated non-impacted (7.64) water quality conditions and the ISD indicated that natural conditions were influencing the aquatic community. The DEC found moderate impact (BAP 2.85) at this site in 2002 and slight impact (BAP 5.44) in 2007, indicating that water quality condition has improved. Of note is that the 2002 DEC subsample contained a significant number of Enchytraeidae and Lumbricina (aquatic worms) and Polydesmida (semi-aquatic millipede) that were not present in the 2010 sample. The 2007 subsample contained only 73 organisms; a full sort of the sample in 2010 produced a 100 organism subsample (indicating a generally low number of organisms at the site). Although the land cover is predominantly forested, several impoundments surround the stream near the study reach; the impoundments may be exerting an influence on the macroinvertebrate community at the site, but determination of this is beyond the scope of the present study. Establishing a sampling site further downstream, before Mill River enters Swamp River, will help to better understand the potential impacts from impoundments to the stream.

Although station GRSW07 was slightly impacted, the benthic community composition of the subsample and field observations indicated better condition. Based on professional judgment and NYS DEC guidance documentation (Bode et al. 2002), the water quality assessment was adjusted up one category, from slightly impacted to non-impacted. The adjustment was justified because the site is a headwater within 3 miles of the stream source, there were several intolerant headwater taxa present in the sub-sample and two additional intolerant taxa were observed in the field during the public demonstration. The acidBAP score of 3 at this station indicates that there is an acidification effect on the benthic macroinvertebrate community here, but further evaluation (replicate sampling, water analysis following rain events and spring snow melts, including determination of acid neutralizing capacity and aluminum concentration) would provide further insight into possible intermittent acidification at the site.

The habitat was assessed as moderate impact due to the landscape features adjacent to the stream within the Edward R. Murrow Memorial Park; riparian habitat improvement should be considered at this site.

Impact source determination (ISD) suggests that non-point source nutrient additions (runoff) are a probable source of impact to the majority of the aquatic communities assessed within the Swamp River watershed. Nonpoint source additions are the result of

stormwater runoff from a variety of sources, including fertilizer, livestock, and impervious surfaces (paved areas).

Water chemistry results were not remarkably different among the sites. Low base flows due to low precipitation during 2010 may have contributed to specific conductance values >300 µS/cm for most stations (GRSW01, GRSW02, GRSW03, GRSW04, GRSW07). The lowest specific conductance (124 µS/cm) was measured at the most pristine site (GRSW05). The highest specific conductance, at GRSW02, may, in part, be a reflection of a lack of riparian habitat and surrounding land use, including slack water proximal to the site.

The results obtained from this study are considered a water quality screening, or Rapid Assessment Survey (RAS) by the NYS DEC; more detailed and intensive assessments using replicate sampling would be needed to definitively assess water quality issues and to identify sources of water quality impact. Nevertheless, the biological water quality assessments suggest that these Swamp River watershed stations have severely to non-impacted water quality; the likely sources of impact are from agricultural land cover or other non-point sources, and perhaps acidification.

Figure 1. Map of Swamp River Watershed and benthic survey stations. (A) GRSW01, Great Swamp; (B) GRSW02, Swamp River; (C) GRSW03, Hiller Brook; (D) GRSW04, Burton Brook; (E) GRSW05, Cooperstown Brook; (F) GRSW06, Mill River; (G) GRSW07, Unnamed Tributary.

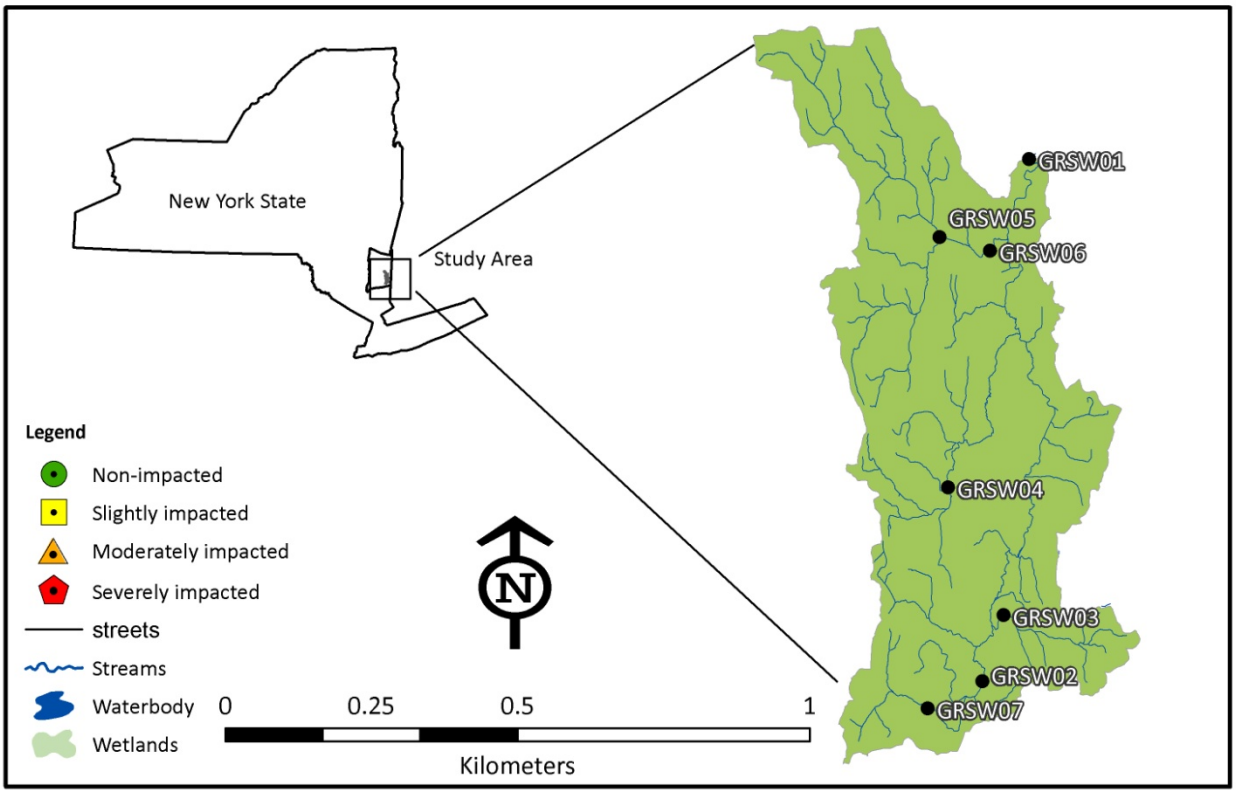
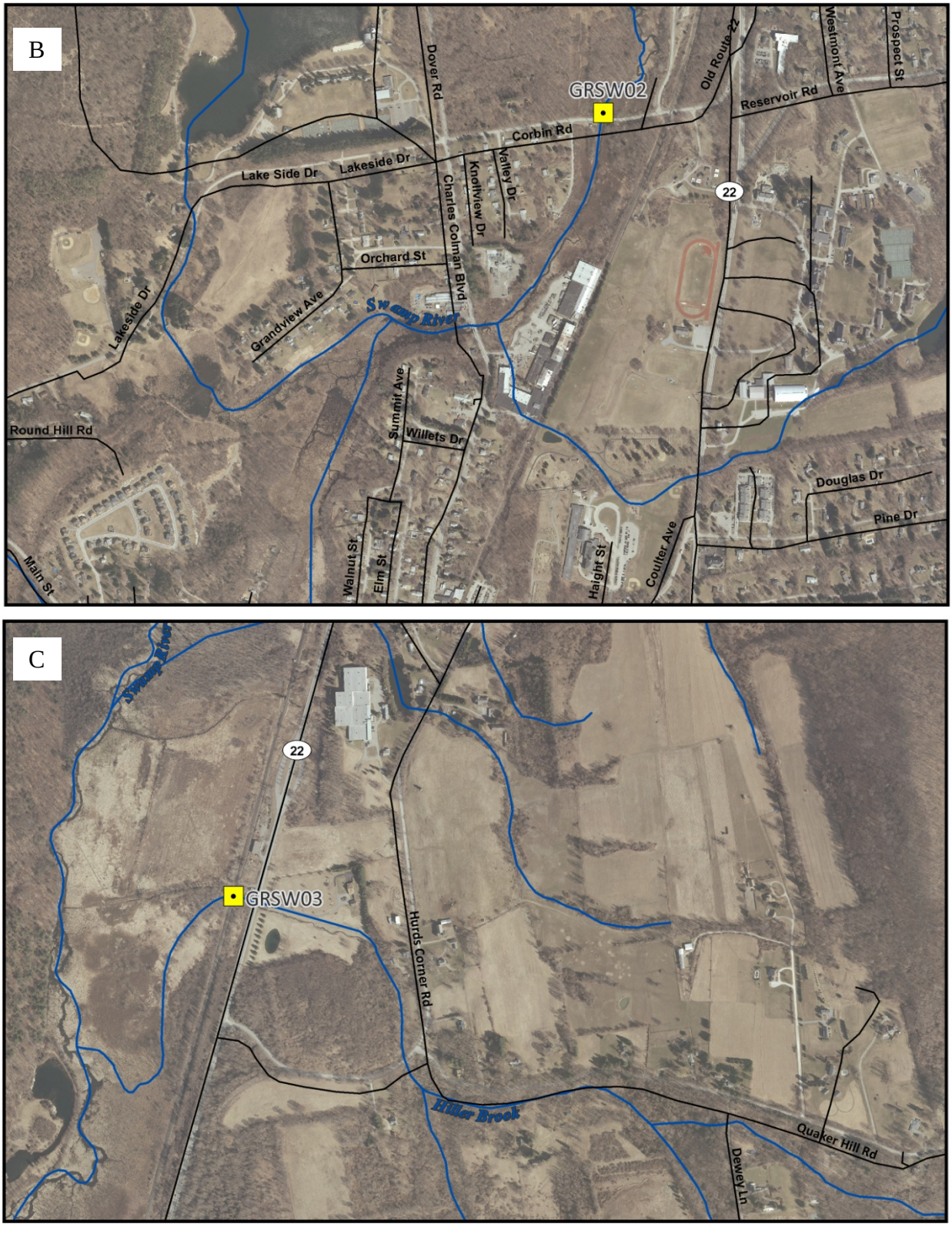


Figure 1. Continued



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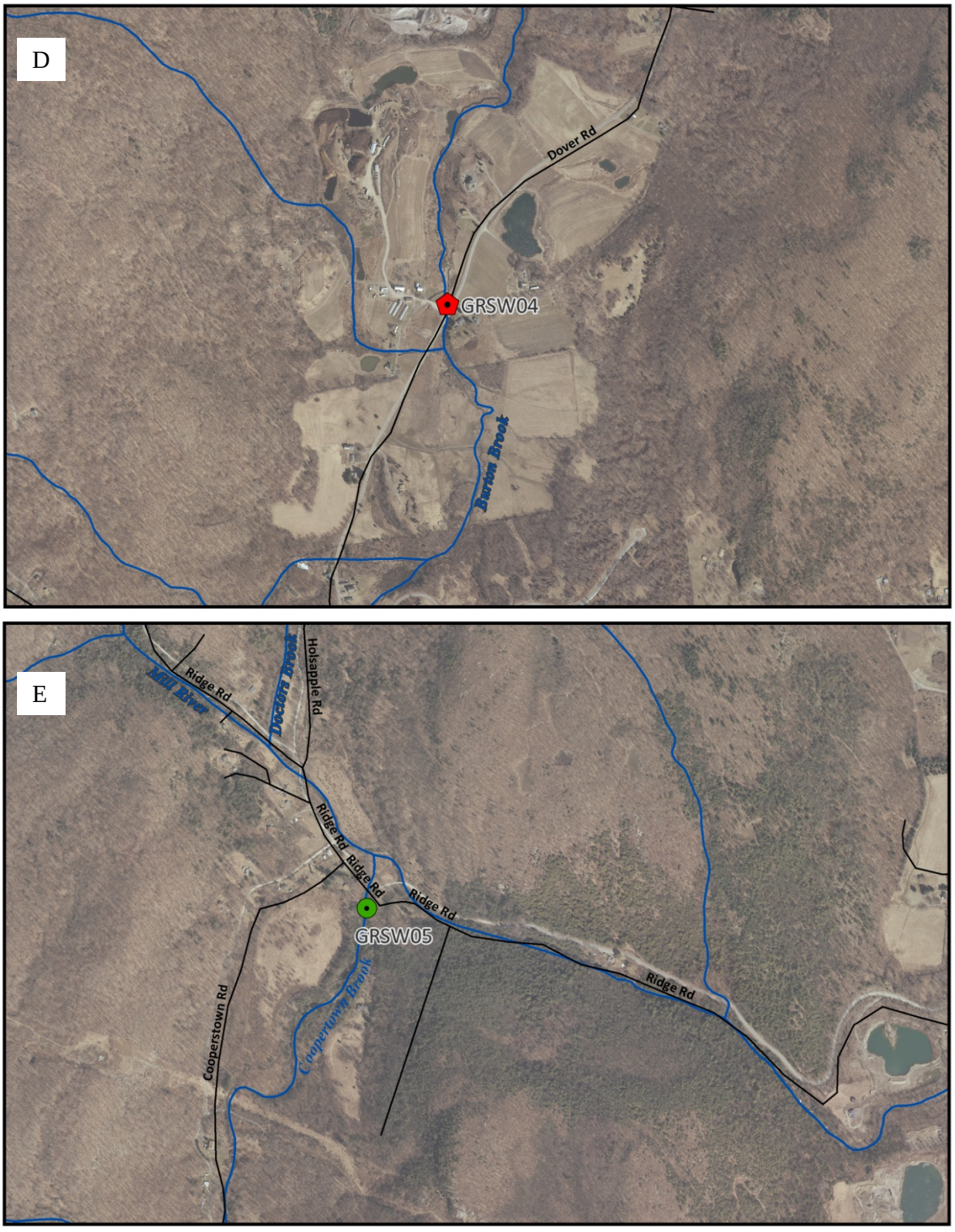


Figure 1. Continued

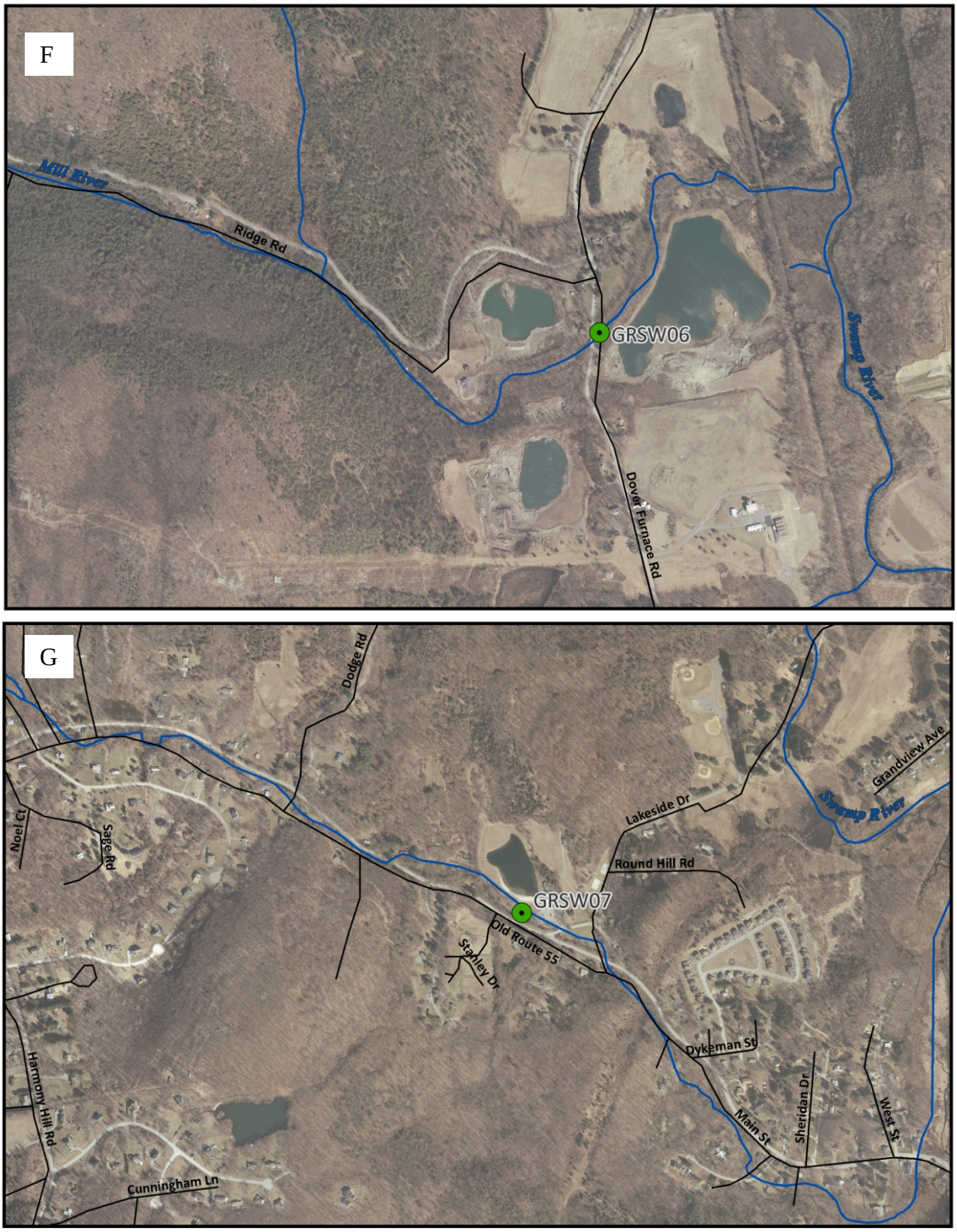


Figure 2. Cluster analysis of 100 specimen benthic macroinvertebrate subsamples using the Bray-Curtis resemblance matrix generated dendograms with significant relationships identified using the Similarity Profile (SIMPROF) test.

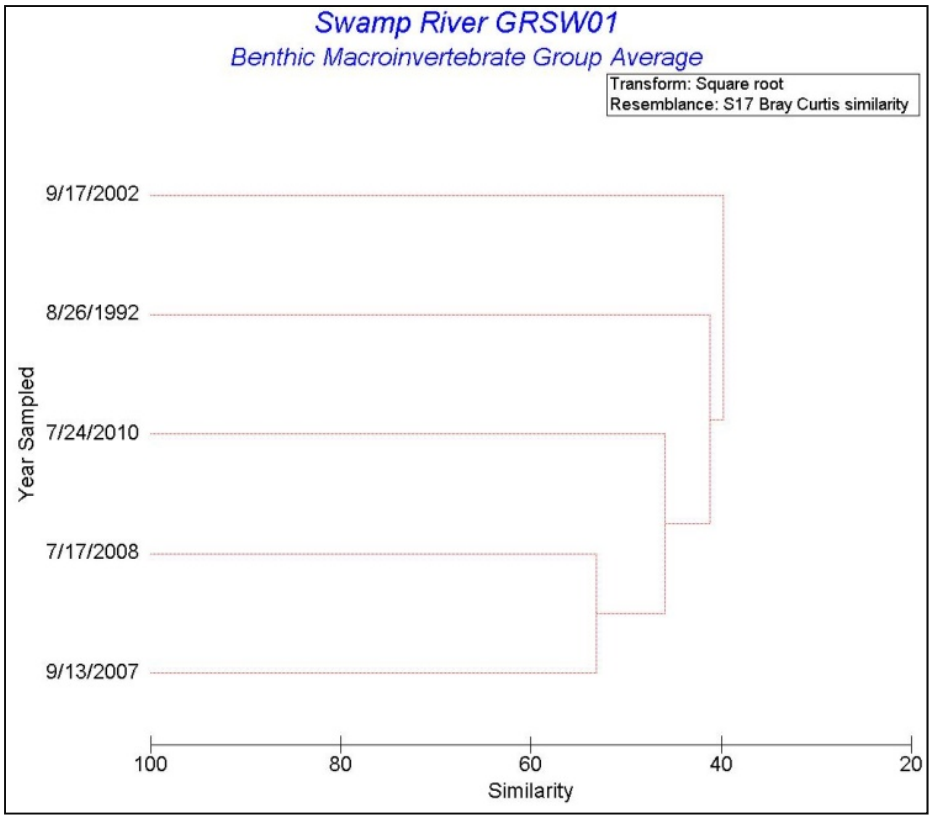


Table 1. Benthic macroinvertebrate metric scores and impact source determination percentages for the 7 stream sites sampled in 2010 throughout Swamp River Watershed. Bolded numbers indicate the most likely source of impact to the stream community. SR= species richness; BI= biotic index; EPT = Ephemeroptera-Plecoptera-Trichoptera taxa; PMA= percent model affinity; NCO = non-Chironomidae Oligochaeta (*sandy kick samples only); BAP = Biological Assessment Profile; WQA= water quality assessment category; NBI-N=nutrient biotic index for nitrogen; NBI-B=nutrient biotic index for phosphorus; NAT=natural; NPN = non-point nutrient; ORG = organic inputs; COMPLEX= municipal/industrial; SILT = siltation; IMP= impoundment.

			Biotic Metrics										Impact Source Determination (ISD)						
Stream Name	**Sample ID**	**Sample Type**	**SR**	**BI**	**EPT**	**PMA**	**NCO**	**BAP**	**Acid BAP**	**WQA**	**NBI-N**	**NBI-P**	**NAT**	**NPN**	**TOXIC**	**ORG**	**COMPLEX**	**SILT**	**IMP**
Swamp River	GRSW01	Kick	20	4.49	12	54	--	6.85	--	Slight	4.89	6.01	57	**69**	47	44	41	46	52
Swamp River	GRSW02	Kick	20	4.71	7	49	--	5.91	--	Slight	6.19	6.21	53	**63**	46	57	47	52	57
Hiller Brook	GSRW03	Kick	25	3.87	10	54	--	7.07	4	Slight	6.91	6.38	45	33	34	23	24	27	32
Burton Brook	GRSW04	Sandy Kick	12	9.03	0	--	3	2.04	--	Severe	--	--	--	--	--	**--**	--	--	--
Cooperstown Brook	GRSW05	Kick	25	2.5	13	60	--	8.08	--	Non	5.27	4.24	46	33	23	33	23	40	37
Mill River	GRSW06	Kick	24	2.99	12	57	--	7.64	--	Non	5.12	5.16	**50**	34	36	25	27	26	34
Un-named Tributary	GRSW07	Kick	22	3.27	9	46	--	9.04‡ (6.54)	3	Non†	6.55	5.72	48	**53**	37	32	42	36	45

†Biotic Assessment Profile; ‡BAP score adjusted based on professional judgment of community composition, see discussion for explanation.

Table 2. Summary of physical habitat and in-field benthic community composition. Completed high and low gradient habitat assessment field sheets are available upon request.

Waterbody	SWAMP RIVER	SWAMP RIVER	HILLER BROOK	BURTON BROOK	COOPERSTOWN BROOK	MILL RIVER	UN-NAMED TRIB
Station	GRSW01	GRSW02	GRSW03	GRSW04	GRSW05	GRSW06	GRSW07
Physical stream attributes							
Depth (meters)	0.2	0.2	0.2	0.4	0.2	0.2	0.2
Width (meters)	11	2	1.5	6	2	3	2.5
Current (cm/sec)	50	35	50	20	65	65	45
Canopy (%)	40	30	60	10	80	75	40
Rock (%)	0	0	0	0	50	5	0
Rubble (%)	50	30	5	0	20	30	40
Gravel (%)	20	30	50	20	15	25	30
Sand (%)	15	15	25	40	10	25	15
Silt (%)	15	15	20	40	5	15	15
Embeddedness (%)	30	40	40	75	25	25	50
High gradient habitat score	154	--	129	--	167	149	112
Low gradient habitat score	--	125	--	108	--	--	--
Habitat model affinity (HMA)	85	--	71	--	92	82	62
Water quality parameters							
DO (mg/L)	7.12	5.77	9.4	7.21	8.2	8.72	8.3
DO sat. (%)	78	70	119	83	90	96	91
Temperature (C)	19.8	25.2	27	22.7	19.7	19.82	20.13
Spec. Conduct. (µS/cm)	375	648	367	376	124	142	497
pH	6.7	7.49	7.78	7.82	7.31	7.32	7.49
In-field biological community observations (presence/absence)							
Algae suspended							
Algae filamentous	X						X
Macrophytes							
OTHER							
Ephemeroptera	X				X	X	X
Plecoptera	X		X		X	X	X
Trichoptera	X	X	X		X	X	X
Coleoptera		X			X	X	
Megaloptera					X		
Odonata							X
Chironomidae			X	X			
Simuliidae							
Decapoda							
Gammaridae							
Mollusca							
Oligochaeta							
Other macros							
In-field faunal and habitat condition							
Faunal Condition	Very good	Good	Very good	Poor	Very good	Very good	Very good
Habitat	Good	Good	Good	Poor	Good	Good	Good

Table 3. Swamp River (GRSW01) historical and current biological community metric results. EPT = Ephemeroptera-Plecoptera-Trichoptera taxa; PMA= percent model affinity; BAP = Biological Assessment Profile; WQA= water quality assessment category.

Year	Species Richness	Biotic Index	EPT Richness	PMA	BAP	WQA	Date Collected
1992	27	4.39	14	72	8.29	Non	8/26/1992
2002	18	4.41	7	61	6.32	Slightly	9/17/2002
2007	24	4.14	7	57	6.71	Slightly	9/13/2007
2008	16	4.06	7	44	5.56	Slightly	7/17/2008
2010	20	4.49	12	54	6.85	Slightly	7/24/2010

Table 4. Mill River Station (GRSW06) historical and current biological community metric results. EPT = Ephemeroptera-Plecoptera-Trichoptera taxa; PMA= percent model affinity; BAP = biological assessment profile; WQA= water quality assessment category.

Year	Species Richness	Biotic Index	EPT Richness	PMA	BAP	WQA	Date Collected
2002	11	6.88	2	26	2.85	Moderately	8/26/1992
2007	21	5.78	8	41	5.44	Slightly	9/13/2007
2010	24	2.99	12	57	7.64	Non	7/24/2010

Appendix I: Field Datasheets & Taxa Lists

Field Data Summary

Watershed Assessment Associates
Environmental Services / Biomonitoring / Invertebrate Taxonomy / Professional Training

Waterbody: **Swamp River**
River Basin: **Swamp River**
County: **Dutchess**
State: **NY**

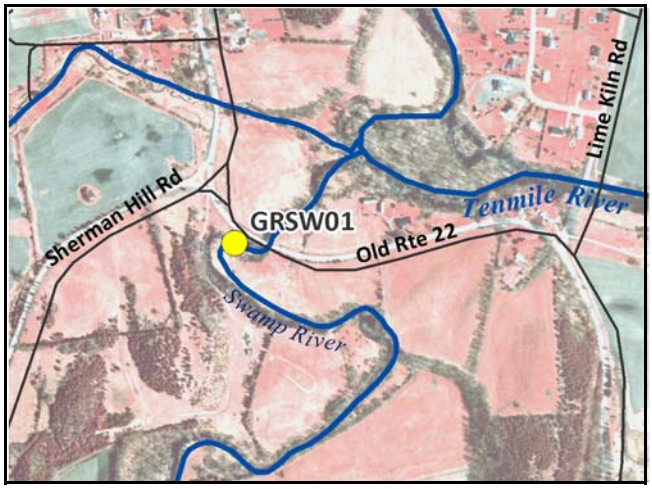
Station: **GRSW01**
WAA Site ID: **WAA00009**
Coll Date: **7/24/2010**
Site description: **50m above Old Rt. 22 Bridge**

Latitude: **41.71557**
Longitude: **-73.57643**
Field Crew: **jkn, cmf**

Physical Characteristics	
Depth (meters):	**0.2**
Width (meters):	**11**
Current (cm/sec):	**50**
Canopy (%):	**40**
Substrate	
Rock (%):	**0**
Rubble (%):	**50**
Gravel (%):	**20**
Sand (%):	**15**
Silt (%):	**15**
Embeddedness (%):	**30**

Chemical Measurements	
DO (mg/L):	**7.12**
DO sat. (%):	**78**
Temperature (C):	**19.8**
Spec. Conduct. (umhos):	**375**
Baro pressure:	**749**
pH:	**6.7**
Salinity (PSS):	**0.18**

Biological Attributes	
Aquatic vegetation	
Macrophytes:	**No**
Diatoms:	**Yes**
Algae-suspended:	**No**
Algae-filamentous:	**Yes**
Occurance of macroinvertebrates	
Ephemeroptera:	**Yes**
Plecoptera:	**Yes**
Trichoptera:	**Yes**
Coleoptera:	**No**
Megaloptera:	**No**
Odonata:	**No**
Chironomidae:	**No**
Simuliidae:	**No**
Decapoda:	**No**
Gammaridae:	**No**
Mollusca:	**No**
Oligochaeta:	**No**
Other macro's:	
Field Faunal Condition:	**Very good**
Overall Habitat:	**Good**



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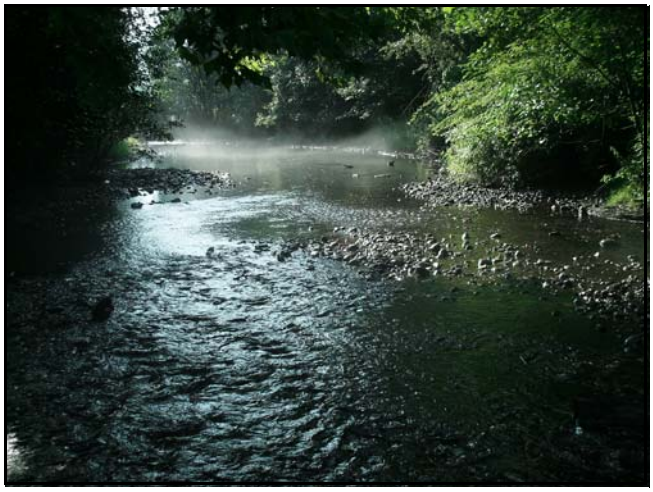

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Lab Data Summary

Watershed Assessment Associates
Environmental Services / Biomonitoring / Invertebrate Taxonomy / Professional Training

Waterbody: **Swamp River** | Station: **GRSW01** | Latitude: **41.71557**
River Basin: **Swamp River** | WAA Site ID: **W00009** | Longitude: **-73.57643**
County: **Dutchess** | Coll Date: **7/24/2010** | Coll Method: **kick**
State: **NY** | Sample Type: **Benthic sample** | WAA Lab #: **10503**

Order	Family	Final Determination	Total #
		Turbellaria	3
Ephemeroptera	Baetidae	Baetis intercalaris	2
	Ephemerellidae	Teloganopsis deficiens	2
	Heptageniidae	Leucrocuta sp.	1
		Maccaffertium sp.	3
	Isonychiidae	Isonychia bicolor	10
Plecoptera	Perlidae	Paragnetina media	2
		Perlesta sp.	1
Coleoptera	Elmidae	Macronychus glabratus	1
		Optioservus trivittatus	14
		Stenelmis sp.	20
	Psephenidae	Psephenus herricki	2
Trichoptera	Hydropsychidae	Ceratopsyche bronta	3
		Ceratopsyche morosa	10
		Cheumatopsyche sp.	2
		Hydropsyche betteni	2
	Philopotamidae	Chimarra aterrima	12
Diptera	Chironomidae	Polypedilum flavum gr.	8
		Orthocladiinae	1
	Tipulidae	Antocha sp.	1

Metric Results

Taxa Richness: **20**
EPT Richness: **12**
Biotic Index: **4.49**
PMA: **54**
BAP Score: **6.85**

Field Data Summary

Watershed Assessment Associates
Environmental Services / Biomonitoring / Invertebrate Taxonomy / Professional Training

Waterbody: **Swamp River**
River Basin: **Swamp River**
County: **Dutchess**
State: **NY**

Station: **GRSW02**
WAA Site ID: **WAA00010**
Coll Date: **7/24/2010**
Site description: **Just below Corbin Rd Bridge**

Latitude: **41.57489**
Longitude: **-73.59612**
Field Crew: **jkn, cmf**

Physical Characteristics	
Depth (meters):	**0.2**
Width (meters):	**2**
Current (cm/sec):	**35**
Canopy (%):	**30**
Substrate	
Rock (%):	**0**
Rubble (%):	**30**
Gravel (%):	**30**
Sand (%):	**15**
Silt (%):	**15**
Embeddedness (%):	**40**

Chemical Measurements	
DO (mg/L):	**5.77**
DO sat. (%):	**70**
Temperature (C):	**25.2**
Spec. Conduct. (umhos):	**648**
Baro pressure:	**747.7**
pH:	**7.49**
Salinity (PSS):	**0.31**

Biological Attributes	
Aquatic vegetation	
Macrophytes:	**No**
Diatoms:	**Yes**
Algae-suspended:	**No**
Algae-filamentous:	**No**
Occurance of macroinvertebrates	
Ephemeroptera:	**No**
Plecoptera:	**No**
Trichoptera:	**Yes**
Coleoptera:	**Yes**
Megaloptera:	**No**
Odonata:	**No**
Chironomidae:	**No**
Simuliidae:	**No**
Decapoda:	**No**
Gammaridae:	**No**
Mollusca:	**No**
Oligochaeta:	**No**
Other macro's:	
Field Faunal Condition:	**Good**
Overall Habitat:	**Good**

Flow

Flow

Lab Data Summary

Watershed Assessment Associates
Environmental Services / Biomonitoring / Invertebrate Taxonomy / Professional Training

Waterbody: **Swamp River** | Station: **GRSW02** | Latitude: **41.57489**
River Basin: **Swamp River** | WAA Site ID: **W00010** | Longitude: **-73.59612**
County: **Dutchess** | Coll Date: **7/24/2010** | Coll Method: **kick**
State: **NY** | Sample Type: **Benthic sample** | WAA Lab #: **10504**

Order	Family	Final Determination	Total #
Lumbriculida	Lumbriculidae	Lumbriculidae	1
Ephemeroptera	Heptageniidae	Maccaffertium modestum	12
Plecoptera	Leuctridae	Leuctra sp.	1
Coleoptera	Elmidae	Macronychus glabratus	1
		Optioservus ovalis	11
		Optioservus trivittatus	2
		Stenelmis sp.	8
Trichoptera	Hydropsychidae	Cheumatopsyche sp.	12
		Hydropsyche betteni	21
	Hydroptilidae	Hydroptila sp.	1
	Philopotamidae	Chimarra aterrima	4
		Chimarra obscura	11
Diptera	Chironomidae	Polypedilum flavum gr.	5
		Rheotanytarsus sp.	1
		Tanytarsus sp.	1
		Tvetenia paucunca	1
		Thienemannimyia gr. spp.	3
	Simuliidae	Simulium sp.	2
	Tipulidae	Dicranota sp.	1
	Empididae	Hemerodromia sp.	1

Metric Results

Taxa Richness: **20**
EPT Richness: **7**
Biotic Index: **4.71**
PMA: **49**
BAP Score: **5.91**

Field Data Summary

Watershed Assessment Associates
Environmental Services / Biomonitoring / Invertebrate Taxonomy / Professional Training

Waterbody: **Hiller Brook**
River Basin: **Swamp River**
County: **Dutchess**
State: **NY**

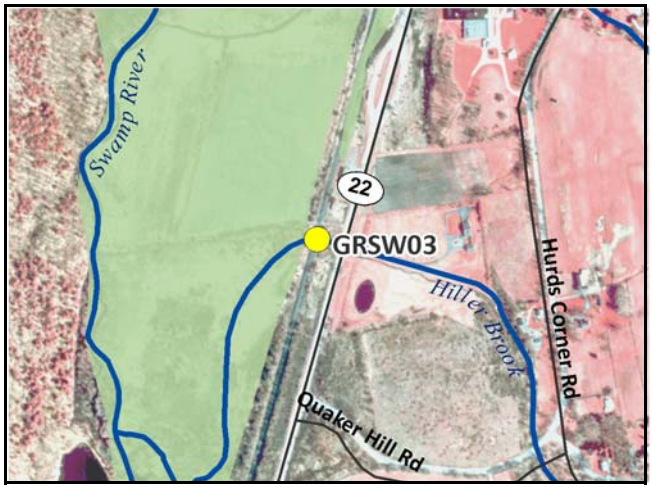
Station: **GRSW03**
WAA Site ID: **WAA00011**
Coll Date: **7/24/2010**
Site description: **Just above RR tracks off Rt. 22**

Latitude: **41.59249**
Longitude: **-73.588**
Field Crew: **jkn, cmf**

Physical Characteristics	
Depth (meters):	**0.2**
Width (meters):	**1.5**
Current (cm/sec):	**50**
Canopy (%):	**60**
Substrate	
Rock (%):	**0**
Rubble (%):	**5**
Gravel (%):	**50**
Sand (%):	**25**
Silt (%):	**20**
Embeddedness (%):	**40**

Chemical Measurements	
DO (mg/L):	**9.4**
DO sat. (%):	**119**
Temperature (C):	**27**
Spec. Conduct. (umhos):	**367**
Baro pressure:	**747.8**
pH:	**7.78**
Salinity (PSS):	**0.19**

Biological Attributes	
Aquatic vegetation	
Macrophytes:	**No**
Diatoms:	**No**
Algae-suspended:	**No**
Algae-filamentous:	**No**
Occurance of macroinvertebrates	
Ephemeroptera:	**No**
Plecoptera:	**Yes**
Trichoptera:	**Yes**
Coleoptera:	**No**
Megaloptera:	**No**
Odonata:	**No**
Chironomidae:	**Yes**
Simuliidae:	**No**
Decapoda:	**No**
Gammaridae:	**No**
Mollusca:	**No**
Oligochaeta:	**No**
Other macro's:	
Field Faunal Condition:	**Very good**
Overall Habitat:	**Good**



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Lab Data Summary

Watershed Assessment Associates
Environmental Services / Biomonitoring / Invertebrate Taxonomy / Professional Training

Waterbody: **Hiller Brook**
River Basin: **Swamp River**
County: **Dutchess**
State: **NY**

Station: **GRSW03**
WAA Site ID: **W00011**
Coll Date: **7/24/2010**
Sample Type: **Benthic sample**

Latitude: **41.59249**
Longitude: **-73.588**
Coll Method: **kick**
WAA Lab #: **10505**

Order	Family	Final Determination	Total #
		Turbellaria	4
Basommatophora	Physidae	Physa sp.	1
Isopoda	Asellidae	Caecidotea sp.	5
Ephemeroptera	Ephemerellidae	Ephemerella sp.	1
	Heptageniidae	Maccaffertium sp.	4
	Leptohyphidae	Tricorythodes sp.	4
Odonata	Aeshnidae	Boyeria vinosa	1
Plecoptera	Leuctridae	Leuctra sp.	28
	Perlidae	Agnetina capitata	1
		Perlesta sp.	1
Coleoptera	Elmidae	Optioservus ovalis	6
		Optioservus trivittatus	2
	Psephenidae	Psephenus herricki	1
Trichoptera	Hydropsychidae	Hydropsyche betteni	14
	Hydroptilidae	Hydroptila sp.	3
	Leptoceridae	Mystacides sepulchralis	1
	Philopotamidae	Chimarra aterrima	1
Diptera	Ceratopogonidae	Bezzia/Palpomyia sp.	2
	Chironomidae	Micropsectra sp.	3
		Tanytarsus sp.	2
		Thienemannimyia gr. spp.	6
	Tipulidae	Hexatoma sp.	2
		Dicranota sp.	3
		Tipula sp.	2
	Empididae	Hemerodromia sp.	2

Metric Results

Taxa Richness: **25**
EPT Richness: **10**
Biotic Index: **3.87**
PMA: **54**
BAP Score: **7.07**

Field Data Summary

Watershed Assessment Associates
Environmental Services / Biomonitoring / Invertebrate Taxonomy / Professional Training

Waterbody: **Burton Brook**
River Basin: **Swamp River**
County: **Dutchess**
State: **NY**

Station: **GRSW04**
WAA Site ID: **WAA00012**
Coll Date: **7/24/2010**
Site description: **Just below County Rt. 20 Bridge**

Latitude: **41.62731**
Longitude: **-73.60733**
Field Crew: **jkn, cmf**

Physical Characteristics	
Depth (meters):	**0.4**
Width (meters):	**6**
Current (cm/sec):	**20**
Canopy (%):	**10**
Substrate	
Rock (%):	**0**
Rubble (%):	**0**
Gravel (%):	**20**
Sand (%):	**40**
Silt (%):	**40**
Embeddedness (%):	**75**

Chemical Measurements	
DO (mg/L):	**7.21**
DO sat. (%):	**83**
Temperature (C):	**22.7**
Spec. Conduct. (umhos):	**376**
Baro pressure:	**746**
pH:	**7.82**
Salinity (PSS):	**0.18**

Biological Attributes	
Aquatic vegetation	
Macrophytes:	**No**
Diatoms:	**Yes**
Algae-suspended:	**No**
Algae-filamentous:	**No**
Occurance of macroinvertebrates	
Ephemeroptera:	**No**
Plecoptera:	**No**
Trichoptera:	**No**
Coleoptera:	**No**
Megaloptera:	**No**
Odonata:	**No**
Chironomidae:	**Yes**
Simuliidae:	**No**
Decapoda:	**No**
Gammaridae:	**No**
Mollusca:	**No**
Oligochaeta:	**No**
Other macro's:	
Field Faunal Condition:	**Poor**
Overall Habitat:	**Poor**

Lab Data Summary

Watershed Assessment Associates
Environmental Services / Biomonitoring / Invertebrate Taxonomy / Professional Training

Waterbody: **Burton Brook**
River Basin: **Swamp River**
County: **Dutchess**
State: **NY**

Station: **GRSW04**
WAA Site ID: **W00012**
Coll Date: **7/24/2010**
Sample Type: **Benthic sample**

Latitude: **41.62731**
Longitude: **-73.60733**
Coll Method: **Sandy kick**
WAA Lab #: **10506**

Order	Family	Final Determination	Total #
Veneroida	Pisidiidae	Pisidium sp.	1
Basommatophora	Lymnaeidae	Pseudosuccinea columella	1
Haplotaxida	Naididae	Limnodrilus hoffmeisteri	5
Coleoptera	Elmidae	Dubiraphia sp.	1
Diptera	Chironomidae	Chironomus sp.	68
		Cryptotendipes sp.	5
		Endochironomus subtendens	1
		Paratendipes albimanus	11
		Phaenopsectra/Tribelos	1
		Stictochironomus sp.	4
		Tanytarsus sp.	3
		Polypedilum illinoense gr.	1

Metric Results

Taxa Richness: **12**
EPT Richness: **0**
Biotic Index: **9.04**
NCO: **3**
BAP Score: **2.04**

Field Data Summary

Watershed Assessment Associates
Environmental Services / Biomonitoring / Invertebrate Taxonomy / Professional Training

Waterbody: **Cooperstown Brook**
River Basin: **Swamp River**
County: **Dutchess**
State: **NY**

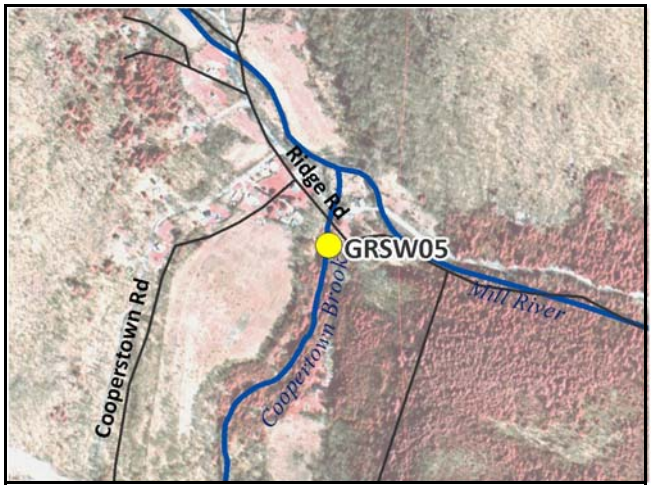
Station: **GRSW05**
WAA Site ID: **WAA00013**
Coll Date: **7/24/2010**
Site description: **Approx. 20m above Ridge Rd Bridge**

Latitude: **41.69516**
Longitude: **-73.60895**
Field Crew: **jkn, cmf**

Physical Characteristics	
Depth (meters):	**0.2**
Width (meters):	**2**
Current (cm/sec):	**65**
Canopy (%):	**80**
Substrate	
Rock (%):	**50**
Rubble (%):	**20**
Gravel (%):	**15**
Sand (%):	**10**
Silt (%):	**5**
Embeddedness (%):	**25**

Chemical Measurements	
DO (mg/L):	**8.2**
DO sat. (%):	**90**
Temperature (C):	**19.7**
Spec. Conduct. (umhos):	**124**
Baro pressure:	**743.9**
pH:	**7.31**
Salinity (PSS):	**0.06**

Biological Attributes	
Aquatic vegetation	
Macrophytes:	**No**
Diatoms:	**Yes**
Algae-suspended:	**No**
Algae-filamentous:	**No**
Occurance of macroinvertebrates	
Ephemeroptera:	**Yes**
Plecoptera:	**Yes**
Trichoptera:	**Yes**
Coleoptera:	**Yes**
Megaloptera:	**Yes**
Odonata:	**No**
Chironomidae:	**No**
Simuliidae:	**No**
Decapoda:	**No**
Gammaridae:	**No**
Mollusca:	**No**
Oligochaeta:	**No**
Other macro's:	
Field Faunal Condition:	**Very good**
Overall Habitat:	**Good**



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Lab Data Summary

Watershed Assessment Associates
Environmental Services / Biomonitoring / Invertebrate Taxonomy / Professional Training

Waterbody: **Cooperstown Brook** Station: **GRSW05** Latitude: **41.69516**
River Basin: **Swamp River** WAA Site ID: **W00013** Longitude: **-73.60895**
County: **Dutchess** Coll Date: **7/24/2010** Coll Method: **kick**
State: **NY** Sample Type: **Benthic sample** WAA Lab #: **10507**

Order	Family	Final Determination	Total #
Lumbriculida	Lumbriculidae	Lumbriculidae	3
Ephemeroptera	Heptageniidae	Epeorus sp.	1
		Maccaffertium modestum	16
	Isonychiidae	Isonychia sp.	3
Plecoptera	Leuctridae	Leuctra sp.	2
	Peltoperlidae	Tallaperla sp.	23
	Perlidae	Paragnetina media	1
Coleoptera	Elmidae	Macronychus glabratus	3
		Optioservus ovalis	1
		Oulimnius latiusculus	1
		Stenelmis sp.	3
	Psephenidae	Ectopria sp.	1
		Psephenus herricki	3
Trichoptera	Hydropsychidae	Ceratopsyche morosa	2
		Ceratopsyche sparna	2
		Diplectrona sp.	12
		Hydropsyche betteni	1
	Philopotamidae	Dolophilodes sp.	1
	Rhyacophilidae	Rhyacophila fuscula	7
		Rhyacophila minor	2
Diptera	Chironomidae	Stictochironomus sp.	1
		Parametriocnemus sp.	3
		Tvetenia paucunca	4
	Simuliidae	Simulium sp.	1
	Athericidae	Atherix sp.	3

Metric Results

Taxa Richness: **25**
EPT Richness: **13**
Biotic Index: **2.50**
PMA: **60**
BAP Score: **8.08**

Field Data Summary

Watershed Assessment Associates
Environmental Services / Biomonitoring / Invertebrate Taxonomy / Professional Training

Waterbody: **Mill River**
River Basin: **Swamp River**
County: **Dutchess**
State: **NY**

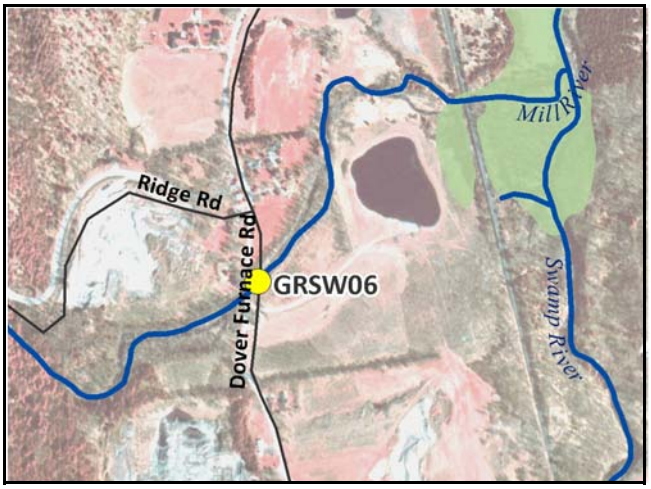
Station: **GRSW06**
WAA Site ID: **WAA00014**
Coll Date: **7/24/2010**
Site description: **At Dover Furance Rd Bridge**

Latitude: **41.69065**
Longitude: **-73.59134**
Field Crew: **jkn, cmf**

Physical Characteristics	
Depth (meters):	**0.2**
Width (meters):	**3**
Current (cm/sec):	**65**
Canopy (%):	**75**
Substrate	
Rock (%):	**5**
Rubble (%):	**30**
Gravel (%):	**25**
Sand (%):	**25**
Silt (%):	**15**
Embeddedness (%):	**25**

Chemical Measurements	
DO (mg/L):	**8.72**
DO sat. (%):	**96**
Temperature (C):	**19.82**
Spec. Conduct. (umhos):	**142**
Baro pressure:	**748.1**
pH:	**7.32**
Salinity (PSS):	**0.07**

Biological Attributes	
Aquatic vegetation	
Macrophytes:	**No**
Diatoms:	**Yes**
Algae-suspended:	**No**
Algae-filamentous:	**No**
Occurance of macroinvertebrates	
Ephemeroptera:	**Yes**
Plecoptera:	**Yes**
Trichoptera:	**Yes**
Coleoptera:	**Yes**
Megaloptera:	**No**
Odonata:	**No**
Chironomidae:	**No**
Simuliidae:	**No**
Decapoda:	**No**
Gammaridae:	**No**
Mollusca:	**No**
Oligochaeta:	**No**
Other macro's:	
Field Faunal Condition:	**Very good**
Overall Habitat:	**Good**



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Lab Data Summary

Watershed Assessment Associates
Environmental Services / Biomonitoring / Invertebrate Taxonomy / Professional Training

Waterbody: **Mill Brook**
River Basin: **Swamp River**
County: **Dutchess**
State: **NY**

Station: **GRSW06**
WAA Site ID: **W00014**
Coll Date: **7/24/2010**
Sample Type: **Benthic sample**

Latitude: **41.69065**
Longitude: **-73.59134**
Coll Method: **kick**
WAA Lab #: **10508**

Order	Family	Final Determination	Total #
Haplotaxida		Lumbricina	4
Ephemeroptera	Heptageniidae	Epeorus sp.	2
		Maccaffertium modestum	2
	Isonychiidae	Isonychia bicolor	2
Plecoptera	Leuctridae	Leuctra sp.	4
	Peltoperlidae	Tallaperla sp.	16
	Perlidae	Paragnetina immarginata	1
		Paragnetina media	5
Coleoptera	Elmidae	Macronychus glabratus	2
	Psephenidae	Psephenus herricki	3
Trichoptera	Glossosomatidae	Glossosoma sp.	1
	Hydropsychidae	Ceratopsyche morosa	6
		Ceratopsyche sparna	11
	Philopotamidae	Dolophilodes sp.	10
	Rhyacophilidae	Rhyacophila fuscula	1
Diptera	Chironomidae	Polypedilum aviceps	19
		Parametriocnemus sp.	1
		Thienemanniella xena	2
		Tvetenia paucunca	1
	Dixidae	Dixa sp.	1
	Tipulidae	Hexatoma sp.	1
		Dicranota sp.	1
	Athericidae	Atherix sp.	2
	Empididae	Hemerodromia sp.	2

Metric Results

Taxa Richness: **24**
EPT Richness: **12**
Biotic Index: **2.99**
PMA: **57**
BAP Score: **7.64**

Field Data Summary

Watershed Assessment Associates
Environmental Services / Biomonitoring / Invertebrate Taxonomy / Professional Training

Waterbody: **Un-named Tributary**
River Basin: **Swamp River**
County: **Dutchess**
State: **NY**

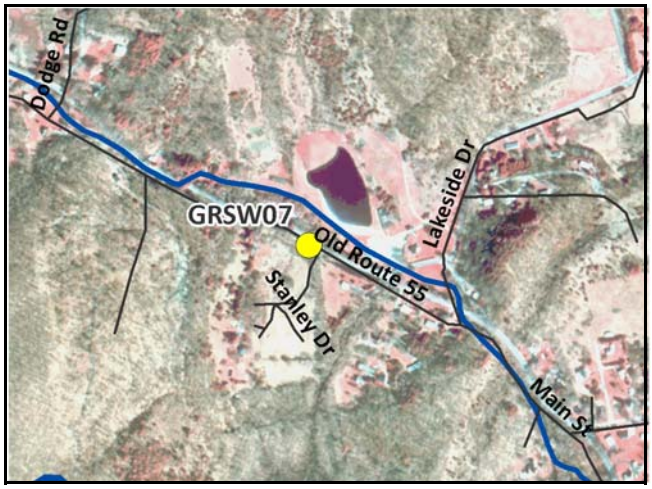
Station: **GRSW07**
WAA Site ID: **WAA00015**
Coll Date: **7/24/2010**
Site description: **East side of Edward R. Murrow Memorial Park**

Latitude: **41.56759**
Longitude: **-73.61518**
Field Crew: **jkn, cmf**

Physical Characteristics	
Depth (meters):	**0.2**
Width (meters):	**2.5**
Current (cm/sec):	**45**
Canopy (%):	**40**
Substrate	
Rock (%):	**0**
Rubble (%):	**40**
Gravel (%):	**30**
Sand (%):	**15**
Silt (%):	**15**
Embeddedness (%):	**50**

Chemical Measurements	
DO (mg/L):	**8.3**
DO sat. (%):	**91**
Temperature (C):	**20.13**
Spec. Conduct. (umhos):	**497**
Baro pressure:	**746.3**
pH:	**7.49**
Salinity (PSS):	**0.24**

Biological Attributes	
Aquatic vegetation	
Macrophytes:	**No**
Diatoms:	**Yes**
Algae-suspended:	**No**
Algae-filamentous:	**Yes**
Occurance of macroinvertebrates	
Ephemeroptera:	**Yes**
Plecoptera:	**Yes**
Trichoptera:	**Yes**
Coleoptera:	**No**
Megaloptera:	**No**
Odonata:	**Yes**
Chironomidae:	**No**
Simuliidae:	**No**
Decapoda:	**No**
Gammaridae:	**No**
Mollusca:	**No**
Oligochaeta:	**No**
Other macro's:	
Field Faunal Condition:	**Very good**
Overall Habitat:	**Good**



Lab Data Summary

Watershed Assessment Associates
Environmental Services / Biomonitoring / Invertebrate Taxonomy / Professional Training

Waterbody: **Un-named Trib** Station: **GRSW07** Latitude: **41.56759**
River Basin: **Swamp River** WAA Site ID: **W00015** Longitude: **-73.61518**
County: **Dutchess** Coll Date: **7/24/2010** Coll Method: **kick**
State: **NY** Sample Type: **Benthic sample** WAA Lab #: **10509**

Order	Family	Final Determination	Total #
Ephemeroptera	Baetidae	Baetis tricaudatus	4
	Heptageniidae	Epeorus sp.	1
Odonata	Aeshnidae	Boyeria vinosa	1
Plecoptera	Leuctridae	Leuctra sp.	22
	Perlidae	Eccoptura xanthenes	1
Coleoptera	Elmidae	Optioservus sp.	4
	Psephenidae	Psephenus herricki	1
Trichoptera	Hydropsychidae	Ceratopsyche sparna	18
		Diplectrona sp.	1
		Hydropsyche betteni	10
	Philopotamidae	Dolophilodes sp.	16
	Rhyacophilidae	Rhyacophila fuscula	1
Diptera	Chironomidae	Polypedilum aviceps	3
		Polypedilum sp. A	2
		Paratanytarsus sp.	3
		Rheotanytarsus sp.	1
		Parametriocnemus sp.	1
		Tvetenia paucunca	3
		Thienemannimyia gr. spp.	1
	Simuliidae	Simulium sp.	1
	Tipulidae	Dicranota sp.	4
	Athericidae	Atherix sp.	1

Metric Results

Taxa Richness: **22**
EPT Richness: **9**
Biotic Index: **3.27**
PMA: **46**
BAP Score: **9.04 (adjusted)**

Physical

The physical survey is essential to a stream study because aquatic fauna often have specific habitat requirements independent of water composition, and alterations in these conditions affect the overall quality of a water body (Giller and Malmqvist, 1998). Additionally, the physical characteristics of a stream affect stream flow, volume of water within the channel, water temperature, and absorbed radiant energy from the sun.

Low gradient sites are evaluated for: epifaunal substrate/available cover, pool substrate characterization, pool variability sediment deposition, channel flow status, channel alteration, frequency of riffles, bank stability, vegetative protection, and riparian vegetative zone width.

High gradient sites are evaluated for: epifaunal substrate/available cover, embeddedness, velocity/depth regime, sediment deposition, channel flow status, channel alteration, channel sinuosity, bank stability, vegetative protection, and riparian vegetative one width.

Site photos were taken of the upstream and downstream area and are included with the physical and chemical data.

Water temperature directly affects both the nature of aquatic fauna and species diversity; temperature tolerance is organism specific, and the reproductive cycle (including timing of insect emergence and annual productivity) will vary within different temperature ranges. Temperature can also affect organisms indirectly as a consequence of oxygen saturation levels. As water temperature rises, the metabolism of aquatic organisms' increases with an attendant increases in their oxygen requirements. At higher water temperatures, however, the oxygen carrying capacity of water decreases because of a diminished affinity of the water for oxygen.

Optimal water temperature ranges and lethal limits of water temperature vary among different organisms. The ratio of Plecoptera to Ephemeroptera (individuals and numbers of species) has been found to drop as the annual range of temperature increases (Hynes, 1970). The optimal temperature range for Brook trout is 11-16 0 Celsius with an upper lethal limit of 240 Celsius (Hynes, 1970). The NYS Department of Environmental Conservation (NYS DEC) does not have a water quality standard for water temperature. Temperature is recorded using an YSI 556TM probe.

Velocity is calculated at the time of macroinvertebrate collection because an optimal macroinvertebrate collection site has a velocity between 0.45 and 0.75 meter/second. Velocity is determined by timing a floating object a given distance or using a Global Water® Flow Probe.

Chemical

Dissolved Oxygen (DO) level is a function of water turbulence, diffusion, and plant respiration. The EPA recommends that dissolved oxygen levels remain above 11 mg/l during embryonic and larval stages of salmonid production and above 8 mg/l during other life stages (EPA, 1987). The NYS DEC standard for dissolved oxygen for class C(T) and C(TS) stream is 6 mg/L and 7 mg/L respectively. A significant drop in DO concentration can occur over a 24-hour period, particularly if a waterbody contains a large amount of plant growth. Oxygen is released into the water as a result of plant photosynthesis during daylight;

dense plant growth within a stream can therefore elevate the DO level significantly. At night photosynthesis ceases and DO may drop to levels maintained by diffusion and turbulence. A pre-dawn DO level will, in this case, reflect the lowest DO concentration in a 24 hour period and thus provide important data on the overall health of the system. DO is measured using an YSI 556™ probe.

Percent oxygen saturation is reported since dissolved oxygen levels vary inversely with water temperature. Percent saturation is the maximum level of dissolved oxygen that would be present in the water at a specific temperature in the absence of other influences, and is determined by calculating the ratio of measured dissolved oxygen to maximum dissolved oxygen for a given temperature. (The calculation is also standardized to altitude or barometric pressure.) Percent oxygen saturation falls when something other than temperature, such as dissolved solids or bacterial decomposition, affects oxygen levels. A healthy stream contains near 100 percent oxygen saturation at any given temperature (Hynes, 1970). Trout are particularly sensitive to even a slight drop in oxygen saturation and will migrate away from streams when oxygen saturation falls. Similarly, certain macroinvertebrates are sensitive to varying oxygen saturation levels and because the ability of these organisms to migrate away from changing conditions is limited, a drop in saturation can be lethal. NYS DEC has not adopted percent oxygen saturation as a water quality standard.

Specific Conductance or Conductivity is a measure of the ability of an electrical current to pass through a stream; it is dependent on both the concentration of dissolved electrolytes within the water and water temperature. Conductivity increases when inorganic ions are dissolved in water. Organic ions, such as phenols, oil, alcohol and sugar, can decrease conductivity (EPA, 1997). Warmer water is also more conductive and, therefore conductivity is reported for a standardized water temperature of 25 degrees Celsius. Measurements are reported in microsiemens per centimeter (µS/cm). In the United States, freshwater stream conductivity readings vary greatly from 50-1,500µS/cm. The conductivity of most streams remains relatively constant, however, unless an extraneous source of contamination is present. A failing septic system would raise conductivity because of its chloride, phosphate, and nitrate content, while an oil spill would lower conductivity. A YSI 556TM probe was used to measure conductivity.

The pH is a measure of a stream's acidity. A desirable pH for salmonid is 6.5-8.5. A YSI 556TM probe used to obtain pH. The NYS DEC standard for pH is 6.5-8.5.

Biological

Macroinvertebrates are collected by kick net and the specimens are preserved. Pollution-sensitive macroinvertebrates, a food source for trout, require similar chemical parameters as trout. The relative numbers of different macroinvertebrate groups indicate the overall health of an ecosystem. Perhaps more importantly, macroinvertebrate data demonstrate the effects of problems that may not be detected by chemical testing. The NYS DEC Stream Biomonitoring Unit has utilized stream biological monitoring for water quality analysis since 1972 but the biological profiles and water quality assessments are not a part of New York State's standards. They serve as a "decision threshold" to determine the need for further studies. The Environmental Protection Agency recommends that states and tribes with biomonitoring experience adopt biological criteria into water quality standards to provide a quantitative assessment of a waterway's designated and supportive use. Currently only several states have done so; NY is not one of these states.

Table 5. Descriptions of the common NYS metrics calculated (adapted from Smith et al. 2009).

Metric	Description	Sample Type	Predicted response to impact
Species Richness (SR)	Species richness is the total number of unique species or taxa found in the subsample. Higher species richness indicates higher water quality.	Kick/Sandy	Decrease
Ephemeroptera-Trichoptera-Plecoptera (EPT) Richness	EPT Richness is the total number of taxa of mayflies (Ephemeroptera), stoneflies (Plecoptera), and caddisflies (Trichoptera) found in a subsample. These are considered to be mostly clean-water organisms, and their presence may indicate good water quality.	Kick/Sandy	Decrease
Hilsenhoff's Biotic Index (BI)	Biotic index is calculated by multiplying the number of individuals of each species or taxa by its assigned tolerance value, summing these products, and dividing by the total number of individuals. Tolerance values range from intolerant (0) to tolerant (10). High biotic index values are suggestive of organically enriched condition, while low values indicate naturally occurring, ambient communities.	Kick/Sandy	Increase
Percent Model Affinity (PMA)	This is a measure of similarity to a model non-impacted community based on percent abundance in 7 major groups to measure similarity to a kick sample community of 40% Ephemeroptera, 5% Plecoptera, 10% Trichoptera, 10% Coleoptera, 20% Chironomidae, 5% Oligochaeta, and 10% Other. The lower the similarity value the greater the impact.	Kick	Decrease
Non-Chironomidae and Oligochaeta (NCO) Richness	NCO Richness is the total number of taxa excluding the groups Chironomidae and Oligochaeta. Generally, in impacted communities, Chironomidae and Oligochaeta are the most abundant groups. NCO taxa are considered to be less pollution tolerant, and their presence may indicate good water quality. This measure is the Sandy Stream counterpart of EPT richness (Smith et al. 2009).	Sandy	Decrease
Standard NYS Biological Assessment Profile (BAP)	BAP is the assessed impact for each station. The BAP score is the mean value of the above metrics after converting each metric score to a common scale of 0-10. The higher the BAP score, the better the assessed impact category. There are four impact categories in NYS: non-, slight, moderate, or severe impact.	Kick/Sandy	Decrease

Table 6. Descriptions of the NYS AcidBAP metrics calculated (adapted from Baldigo, et al. 2009).

Metric	Description	Sample Type	Expected Response to Impact
Percent Mayfly Richness (PMR)	The percentage of alkaliphilous taxa that belong to the order Ephemeroptera (excluding one acidobiontic genus *Epeorus*)	Kick	Decrease
Acid Tolerant Index (ATI)	The percentage of individuals belonging to the following genera: *Epeorus* (Ephemeroptera); *Amphinemura*, *Leuctra*, and *Isoperla* (Plecoptera); *Rhyacophila* (Trichoptera); and *Simulium*, *Conchapelopia*, *Cricotopus*, *Eukiefferiella*, and *Heterotrissocladius* (Diptera)	Kick	Increase
Acid Biological Assessment Profile (AcidBAP)	AcidBAP is the assessed impact of acid on a station. The acidBAP is the average of the above metrics after converting each metric score to a common scale of 0-10. The higher the score, the less likely the impact from acidification	Kick	Decrease

Table 7. Abridged NYS DEC Water Quality Category Definitions

Abridged NYS DEC Water Quality Category Definitions	
Non-impacted	Indices reflect very good water quality. The macroinvertebrate community is diverse. Water quality should not be limiting to fish survival or propagation. This level of water quality includes both pristine habitats and those receiving discharges which minimally alter the biota.
Slightly impacted	Indices reflect good water quality. The macroinvertebrate community is slightly but significantly altered from the pristine state. Water quality is usually not limiting to fish survival, but may be limiting to fish propagation.
Moderately impacted	Indices reflect poor water quality. The macroinvertebrate community is altered to a large degree from the pristine state. Water quality often is limiting to fish propagation, but usually not to fish survival.
Severely impacted	Indices reflect very poor water quality. The macroinvertebrate community is limited to a few tolerant species. The dominant species are almost all tolerant, and are usually midges and worms. Often 1-2 species are very abundant. Water quality is often limiting to both fish propagation and fish survival.

Table 8. Nutrient Biotic Index (NBI) Ranges

Trophic state for NBI	NBI
Eutrophic	6-10
Mesotrophic	5-6
Oligotrophic	0-5

Table 9. Habitat Model Affinity (HMA) Categories

Impact Category	HMA score
Natural	80-100
Altered	70-79
Moderate	60-69
Severe	Below 60

Glossary

Assessment: a diagnosis or evaluation of water quality

Benthic: located on the bottom of a body of water or in the bottom sediments or pertaining to bottom-dwelling organisms

Benthos: organisms occurring on or in the bottom substrate of a waterbody

Biomonitoring: the use of biological indicators to measure water quality

Community: a group of populations of organisms interacting in a habitat

Eutrophic: very enriched with dissolved nutrients, resulting in increased growth of algae and other microscopic plants.

Fauna: the animal life of a particular habitat

Habitat: the type of environment in which an organism or group normally lives or occurs

Impact: a change in the physical, chemical, or biological condition of a waterbody

Impairment: a detrimental effect caused by an impact

Impoundment: a body of water formed by constructing a dam or embankment, or by excavating a pit or dugout

Index: a number, metric, or parameter derived from sample data used as a measure of water quality

Intolerant: unable to survive poor water quality

Macroinvertebrate: a larger-than-microscopic invertebrate animal that lives at least part of its life in aquatic habitats

Mesotrophic: moderately enriched with dissolved nutrients, resulting in increased growth of algae and other microscopic plants.

Non point source: diffuse pollution sources (i.e., without a single point of origin or not introduced into a receiving stream from a specific outlet)

Oligotrophic: few nutrients and relatively few plants and algae.

Point source: a stationary location or fixed facility from which pollutants are discharged or emitted. Also, any single identifiable source of pollution, e.g., a pipe, ditch, ship, ore pit, factory smokestack

Riffle: wadeable stretch of stream usually with a rubble bottom and sufficient current to have the water surface broken by the flow; rapids

Slack water: a stretch of water without current or movement

Station: a sampling site on a waterbody

Survey: a set of sampling conducted in succession along a stretch of stream

Tolerant: able to survive poor water quality

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