Stream Monitoring Information Exchange

Spring 2009 Report

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"Fragile Detritivore Stonefly"
(Plecoptera: Capniidae)

"Chironomid Midge"
Pagastia partica (Diptera: Chironomidae)

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EXECUTIVE SUMMARY

This report details the spring 2009 results of the Stream Monitoring Information Exchange (SMIE) volunteer water quality monitoring program in western North Carolina. The SMIE Program is a collaboration between various nonprofit organizations, educational institutions and local, state and federal agencies with an interest in water quality issues. The SMIE Program uses volunteers to collect benthic macroinvertebrate data to evaluate water quality. Volunteer stream monitoring data is being increasingly used by government agencies for planning and review purposes. The SMIE benthic macroinvertebrate protocol is designed to closely mimic NC Division of Water Quality (DWQ) collection techniques to facilitate more precise comparisons between those data. The data is being shared with DWQ to identify streams in the process of environmental degradation.

The spring 2009 sampling season marked the beginning of the SMIE Program's fifth year; there are now 30 active sites and many sites have been sampled all seven seasons (spring and fall). Three sites were added this season.

Thirteen volunteers attended a training session in April, 2009. Monitoring was conducted at 29 sites in Buncombe, Haywood, Madison, Mitchell and Yancey Counties in streams ranging from third to fifth order. Sites were selected, when possible, as Volunteer Water Information Exchange (VWIN) sites or DWQ sampling sites (as identified from DWQ's French Broad Basinwide Assessment reports). Samples were collected using kick net, leaf pack and visual search methods.

Taxa richness ranged from nine to 21 taxa of 43 possible. Sites with greater taxa richness are considered to have better water quality. The EPT taxa (Ephemeroptera = mayflies, Plecoptera =stoneflies, and Trichoptera = caddisflies) richness ranged from one to eleven of 19 possible. It is generally considered that the EPT taxa are the most pollution sensitive, thus sites with greater number of EPT taxa are considered to have better water quality.

The Izaak Walton League (IWL) scores ranged from seven to 31; eleven sites were considered excellent, nine were good, seven were fair, and two were poor. The Virginia Save Our Streams scores ranged from five to twelve, with 26 sites rated as "acceptable" and threeas "unacceptable". Those sites with ecological ratios indicating environmental degradation suggest that invertebrates are influenced by organic pollution and limited habitat resources (particularly woody debris).

The efforts of SMIE Program volunteers appear to show that streams in Buncombe, Haywood, Madison, Mitchell, and Yancey Counties are impacted by multiple land use factors at different scales in space and time. These factors include human encroachment, replacement of native riparian buffer vegetation with impervious surfaces, exotic and invasive species, erosion that leads to sedimentation of stream substrates, and possibly residual affects from a drought in 2007 and 2008.

SMIE Program staff are working with DWQ's Biological Assessment Unit staff to understand the data and develop an effective evaluation tool to rate the sampling streams. The next steps in development of the SMIE Programs are to (1) continue building a volunteer base, (2) continue building a database that monitors changes in the benthic communities and strengthens data anslysis, and (3) working with DWQ's Biological Assessment Unit to develop an index that is user-friendly for volunteers and accurately reflects water quality condition.

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1.0 INTRODUCTION

This report details the spring 2009 results of the Stream Monitoring Information Exchange (SMIE) volunteer water quality monitoring program in western North Carolina. Protocols were developed by Jason Robinson (Kanugalihi Biological Consulting), the NC Division of Water Quality (DWQ) and the SMIE Program, a collaboration between various nonprofit organizations, educational institutions and local, state and federal agencies with an interest in water quality issues. The SMIE, coordinated by Clean Water for North Carolina, seeks to increasing regional communication about water quality issues, and has assumed responsibility for designing and implementing a program to train volunteers to engage in standardized protocols for benthic macroinvertebrate monitoring in western North Carolina.

Volunteer stream monitoring data is being increasingly used by government agencies for planning and review purposes. This protocol is specifically designed to closely mimic DWQ collection techniques to facilitate more precise comparisons between those data. The advanced level of identification (often to species) used by DWQ precludes anything but general comparisons with SMIE data, as the volunteer monitoring protocol identifies only to the family levels (at best). The volunteer monitoring dataset is being used to analyze the performance of the ecological metrics included in the SMIE protocols, and this information will be used to make decisions about data presentation in the future. The data are being shared with DWQ to identify streams in the process of environmental degradation. This information is valuable to researchers as well as other volunteer monitoring groups. It will also be submitted for publishing in peer-reviewed journals.

2.0 METHODS

2.1 Instruction and Training

Volunteers were solicited through participating SMIE organizations as well as through public outreach. Milton Tignor, professor at Haywood Community College, was instrumental in providing a place and classroom resources for hosting a basic training session on April 4, 2009. Thirteen volunteers attending the event to learn how to use the SMIE protocols. Volunteers were instructed in general stream ecology principles, the theory behind sampling streams for water quality, and the common groups of insects used in the protocol. Microscopes greatly facilitated this process, but the protocol is designed such that microscopic evaluation is not necessary for field identifications. Microsoft PowerPoint©, chalkboards and video microscopes all were valuable instructional tools. Volunteers received packets containing information on basic stream ecology (including a dichotomous key), the SMIE sampling protocol, and a laminated identification sheet.

The effectiveness of the training sessions was evaluated using several methods: (1) a brief five question pre- and post-survey of general knowledge of stream biology and sampling concepts; (2) after several hours of identification training, a 15-question quiz to test identification skills; and (3) an evaluation of the instructor methods and materials, as well as of individual performance and overall efficacy of the training.

2.2 Sampling

Monitoring was conducted at 26 established SMIE sites and three new ones (Table 1). All stream sampling and habitat descriptions followed the SMIE stream monitoring protocols (Robinson 2004). At least one group leader or the SMIE biologist was in charge of leading each group. Sites were selected, when possible, as Volunteer Water Information Exchange (VWIN) sites (a water quality monitoring program coordinated by the University of North Carolina – Asheville, Environmental Quality Institute) or the DWQ sampling sites

(as identified from DWQ's French Broad Basinwide Assessment reports). Samples were collected using kick net, leaf pack and visual search methods.

Riffles were the primary habitat for benthic macroinvertebrate collection. Riffles are loosely defined as areas greater than 15 ft^2 with relatively shallow water depth (5-40 cm) and visible current. Benthic macroinvertebrates were collected using a kick net (mesh size 500 μm). Sampling consisted of overturning stones (by feet or hands) for one minute within a 15 ft^2 area upstream of the net. All organisms were picked from the net, identified and recorded separately from the leaf pack and visual collections.

Leaf packs were collected at each site within riffle habitats. Volunteers collected about 600 to 700 cm^3 of leaf material in a leaf pack sample. This material was washed and poured through a kick net several times to remove insects and reduce the volume of material to be searched. All organisms were picked from the net or leaf material, identified and recorded separately from the kick net and visual collections.

The visual survey is performed by someone with a working knowledge of different types of habitats and insects; in most instances this will be the group leader. Searchable habitats include pools, riffles, runs, aquatic macrophytes, submerged mosses, undercut banks, large logs and boulders and sand bars. This method often yields taxa not collected in the other two samples and provides a total estimate of taxa richness at a site. These organisms were identified and recorded separate from the riffle and leaf pack collections.

Several habitat characteristics are evaluated as part of each sampling event, including:

- What type of barriers to fish movement may be present (i.e., waterfalls, culverts);
- The location of leaf packs, which gives an indication of riparian buffer quality and quantity;
- What substrates are available for aquatic invertebrates to inhabit (i.e., bedrock, boulder, cobble, gravel, sand, clay, algae, woody debris);
- Water color to give an indication of such problems as sedimentation or nuisance algal blooms;
- The composition of streambank vegetation; a healthy riparian buffer of trees and shrubs provides good shade to keep water temperatures cool and a supply of leaf litter inputs that are important for the base of the food chain;
- If any litter or trash is observed; and
- The effort it took to sample the riffle habitat. If a lot of effort was made, this is an indication of the severe sedimentation. Substrates that are extremely embedded are poor habitat for aquatic organisms. Many organisms inhabit the underside of rocks for protection, searching for food, or predation. The undersides of rocks cannot be accessed if the spaces between the rocks are filled in with sediment. Excess sediment also inhibits fish and amphibian reproduction by covering the area where many of those organisms lay their eggs, or may smother the eggs themselves.

This habitat data helps interpret what natural or man-made factors are affecting the benthic macroinvertebrate community. The presence or absence of fish is also noted. A stream that supports a greater diversity of organisms is generally considered to be a healthier stream.

2.3 Information Output

Microsoft Excel© spreadsheet software was used to summarize and manage data. Several metrics were calculated, including an Izaak Walton League (IWL) rating, Virginia Save Our Streams (VASOS) multi-metric index, several taxa richness metrics, and ecological metrics calculated as ratios of trophic groups (identified at family level). The use of many of these metrics is widespread. The SMIE Program is working with DWQ's- Biological Assessment Unit to develop a biological index that includes those metrics that best explain DWQ's own evaluation of water quality. A summary of standard ecological metrics can be found in Hauer and Lamberti (2000) and Rosenberg and Resh (1996). It should be noted that the SMIE protocol was designed to include VASOS and IWL collection strategies nested within the collection procedure, but slight

deviations from those procedures are necessarily expected (e.g., the relaxing of the requirement that the kick net collect >200 organisms).

3.0 RESULTS and DISCUSSION

3.1 Training Sessions

The pre- and post-survey of the SMIE training found all participants either maintained or improved (by at least one question) their comprehension of basic stream ecology and water quality assessment, and most (92%) maintained or improved their basic invertebrate identification skills after completing the training session.

The average taxonomy score on the identification quiz was 10.6 out of 15 (71%). Participants typically have the most difficulty distinguishing between the two free-living caddisflies, quick crawling predator stoneflies vs. fragile detritivore stoneflies, and round-headed swimmer mayflies vs. spiny crawler mayflies.

Training participants completed an evaluation of the instructor methods and materials, as well as of individual performance and overall efficacy of the training. Evaluations showed that seven participants had no prior experience monitoring streams, while others had at least some college-level instruction, and one had professional experience sampling as a contract technician work. All participants felt the SMIE training improved their monitoring skills/knowledge, as well as their knowledge of threats to water quality. One participant brought along a 13 year old boy who stayed engaged throughout the day.

3.2 Stream Monitoring

Twenty-nine sites were sampled in Buncombe, Haywood, Madison, Mitchell, and Yancey Counties in streams generally ranging from third to fifth order. Relationships between the metrics calculated are being explored in an effort to determine which metrics best explain water quality and habitat quality at each site.

Tables 1 and 2 summarize the collection data. Taxa richness ranged from nine (Reed Creek) to 21 species (Cane Creek [SMIE Site #182], Shelton Laurel Creek**)** of 43 possible (Figure 1). Sites with greater taxa richness are considered to have better water quality (Rosenberg and Resh 1996). Even though the site with the highest diversity had less than half of the total possible, it should be noted that several species are rare and/or hard to find (i.e., roach shredder stoneflies, sand and stick cased caddisflies, sand snail case caddisflies, alderflies, predator beetles, fat-head craneflies, red midges, leeches, sowbugs, scuds, round right-facing snails, clams/mussels). Also, not finding tolerant taxa typical of only poorer water quality can be a sign of good water quality (i.e., oligochaetes, leeches, clams, some damselflies, blackflies, red midges, coiled left-facing snails).

The total number of organisms collected ranged from a high of 404 (Sandymush Creek) to four sites having less than 100 (North Toe River, Reed Creek, Smith Mill Creek, Swannanoa River dws Beetree Creek,; Table 1). Abundant organisms were also collected at many other sites. With good species diversity, high total numbers can indicated good water quality. If total numbers are high but species diversity low, the stream may be impaired and only those species that can tolerate the pollutant(s) are flourishing. The stream may also be impaired if low numbers are collected, but low numbers may also indicate inadequate sampling techniques and thus, not a good indication of true water quality conditions.

The IWL narrative score ranges are <11 “poor”; 11-16 “fair”; 17-22 “good,” and >22 “excellent”. There is no upper limit for the “excellent” range. The IWL scores ranged from 7 (Richland Creek) to 31 (California Creek; Table 1); eleven sites were considered excellent, nine were good, seven were fair, and two were poor.

The VASOS method scores sites on a scale of 1 to 12. Sites either pass or fail, receiving narrative ratings of either "acceptable" or "unacceptable". The VASOS scores ranged from five to twelve, with 26 sites rated as acceptable and three as unacceptable.

With three exceptions (Newfound Creek, Pigeon River dws Canton, and Reed Creek; see site descriptions for explanation), the IWL and VASOS scores corresponded to each other. Sites that were in "excellent" condition tended to have the highest VASOS scores. It should be noted that IWL and VASOS don't consider the same parameters when calculating the final number. For example, stoneflies, mayflies and caddisflies are separated in the IWL calculation but are lumped together for VASOS. In addition, both calculate their metrics using only the kick net data, so additional organisms collected in leaf packs or visually, particularly EPT taxa, are not included, which can explain discrepancies with other metrics.

Many sites had high EPT (Ephemeroptera = mayflies, Plecoptera =stoneflies, and Trichoptera = caddisflies) taxa richness (Figure 2). EPT richness ranged from one (Reed Creek) to 11 (East Fork Pigeon River) of 19 possible. It is generally considered that EPT taxa (mayflies, stoneflies and caddisflies) are the most pollution sensitive (Resh 1993), thus sites with greater number of EPT taxa are considered to have better water quality. It is important to note that many EPT taxa exhibit natural trends in their life cycle, such that many organisms observed in spring may not be observed in fall, and vice versa.

Ecological metrics showed several interesting trends. All but two sites were characterized as heterotrophic (P/R < 0.75; East Fork Pigeon River and Shelton Laurel Creek; Table 2). This metric is calculated as the ratio of 'scrapers', which scrape algae off rocks, to 'filterers' and 'collectors', which filter organic matter floating in the water column. Heterotrophic sites may be receiving less nutrients (i.e., nitrogen or phosphorus from agricultural activities or leaking septic systems) than autotrophic sites, and thus could be "respiring" communities, meaning they are using up the available nutrients before they build up and cause nuisance plant and algae blooms. Collector-gatherers and filterers tend to be abundant in these cases. Nutrient pollution can lead to significant environmental degradation (Laws 1993) and conditions unsuitable for healthy benthic macroinvertebrate and fish communities, such as low dissolved oxygen, high temperature and lack of suitable substrate.

The leaf input metric evaluates the importance of woody vegetation inputs to stream food webs; it's calculated as the ratio of 'shredders', which feed on decomposing leaves, to 'filterers' and 'collectors', which filter organic matter floating in the water column. The spring 2009 data suggests leaf litter was limited at most sites, either as a result of the previous fall's inputs being consumed or broken down, or a disruption in riparian buffer zone condition. All sites had leaf input metrics less than 0.25. Values less than 0.25 in spring and summer (0.5 in winter and autumn) may be considered impaired. The riparian buffer can be disrupted by human encroachment (i.e., road, homes, agriculture). Healthy streams have good supplies of woody vegetation inputs to support a healthy macroinvertebrate population.

The top-down (predator-prey) ratios were low at all sites and indicate the benthic community is influenced by bottom-up controls (i.e., the available food resources). The ratio was high (>0.5) at one site (Reems) and suggests predator abundance may also infrequently influence the composition of macroinvertebrate assemblages. This metric is calculated as the ratio of predators to shredders, scrapers, collectors and filterers.

The Simpson's Diversity and Taxa Density indices are designed to evaluate how the total numbers of organisms found in the sample are evenly distributed among the number of species collected. Polluted sites tend to have greater abundances among fewer taxa, thus these indices would be low. Low values suggest pollution or recent benthic macroinvertebrate colonization, such as after flooding or drought. Simpson values ranged from 0.38 (Big Ivy River) to 0.93 (Smith Mill Creek). Most sites had values between 0.65 and 0.85. Taxa density numbers were low and ranged from 0.03 (Sandymush Creek) to 0.24 (Reed Creek).

3.3 Site descriptions and sampling summaries

The following section describes the location and habitat at each sample site. The SMIE and VWIN programs now use a revised site numbering system; both programs use the same number where sites overlap. Site numbers are listed next to the site name; corresponding DWQ site identifications are also listed, if available. A general description of the benthic macroinvertebrate data is also provided. References to the right and left side of the stream correspond to the right and left stream sides when facing downstream. Overall water quality patterns for many of the streams or their parent watersheds are described in the DWQ French Broad Basinwide Plan (2005; (http://h2o.enr.state.nc.us/basinwide/documents/Chapter4Subbasin04-03-04.pdf).

Buncombe County

Asheworth Creek – SMIE Site #124
This site is located approximately 30 meters upstream of the confluence with Cane Creek #1 at the US 74 bridge. It corresponds with a VWIN site (old site 15B) and was first sampled in spring 2005. The riparian zone is mostly trees and shrubs but a road has disturbed the riparian zone on the right side of the stream. Substrates are comprised of gravel and cobblestones that are loosely embedded, although they have been moderately embedded in the past.

Nineteen taxa were collected at this site, nine of those were EPT taxa. Spiny crawler mayflies dominated the sample (45%), but small head caddisflies were also abundant (18%). There was good distribution of abundances among the species represented as indicated by the Simpson's Diversity value (0.74). IWL rated this site "excellent" (27) and it was "acceptable" by VASOS (12). The IWL score is one of the highest IWL score observed this sampling season.

Bent Creek - SMIE Site #119
This site is located in the Asheville Arboretum near the Hard Times trailhead parking lot. It was approximately 10 meters upstream of the trail bridge before a debris dam changed the habitat to a pool. It was moved approximately 100 yards upstream of the trail bridge. The original site corresponded to a VWIN site (old site 12A) and was first sampled in spring 2005. The SMIE Program typically holds its Group Leader and refresher courses here. No samples were collected in the spring 2009; the following results are from the fall 2008. The bottom habitat is gravel and cobblestones but is moderately embedded. The forest is relatively intact around the site which provides excellent riparian conditions.

Fourteen taxa were collected at this site. Eight of those were EPT taxa, including giant shredders, which are one of the most pollution intolerant groups among the SMIE taxa. The most abundant organisms in the sampler were quick crawling predator stoneflies (40%) and fragile detritivore stoneflies (22%). The IWL score is indicative of "good" water quality (19). The VASOS rating also considers this site "acceptable" (10). However, very few organisms were collected (92), which is below the number recommended for proper data analysis (200 individuals).

Big Ivy River - SMIE Site #101
This site is located in the Forks of Ivy area north of Asheville. It corresponds to a VWIN site (old site 1A) and DWQ site 2 and was first sampled in spring 2005. The riparian buffer zone is stable but has been disturbed by the construction of a road and several houses. It consists of mostly trees and shrubs. Gravel and cobble comprise the majority of the substrates and are loosely embedded. Sand has been abundant in the past, also.

Fifteen total taxa and eight EPT taxa were collected at this site. Spiny crawler mayflies dominated the sample (78%), which resulted in a low Simpson's Diversity Index value (0.38). This site was rated "good" by IWL (19) and "acceptable" by VASOS (10).

Cane Creek - SMIE Site #123
This site is located approximately 50 meters upstream of the US 74 bridge. It corresponds with a VWIN site (old site 15A) and was first sampled in spring 2005. The riparian zone is mostly trees and shrubs but a parking lot and driveway have disturbed the riparian zones on both sides of the stream. Substrates are comprised of gravel and cobblestones that are moderately embedded by sand.

Fifteen taxa were collected at this site; eight of those were EPT taxa. Spiny crawler mayflies dominated the sample (52%), and net-spinning caddisflies (16%) and quick crawling predator stoneflies (11%) were also abundant. IWL rated this site "good" (21) and it was "acceptable" by VASOS (11).

Cane Creek - SMIE Site #182
This site is less than a mile upstream of the SMIE sites on Cane and Asheworth Creeks, near Cane Creek cemetery and Fairview School. The sample is collected off of US-74 near the bridge where Miller Road crosses Cane Creek (below where Ballard Creek comes in). The site is a DWQ monitoring site. The riparian zone is mostly trees and shrubs. Substrates are comprised of gravel and cobblestones that are loosely embedded by sediment.

Twenty-one taxa were collected at this site, including eleven EPT taxa. Spiny crawler mayflies dominated the sample (48%), and net-spinning caddisflies (15%) and quick crawling predator stoneflies (11%) were also abundant. IWL rated this site "excellent" (23) and it was "acceptable" by VASOS (11).

Hominy Creek - SMIE Site #117
This site is located approximately 100 meters upstream of the confluence with South Hominy Creek. It corresponds to a VWIN site (old site 11A) and DWQ site 7. It was first sampled in spring 2005. The substrates at this site are gravel and cobblestone, but sand is also prevalent. Trees and shrubs were the most common plants in the riparian zone, but many grasses and exotic species are also present.

Eighteen species were collected at this site, including ten EPT taxa. Spiny crawler mayflies and net-spinning caddisflies were the most abundant organisms in the sample, each comprised approximately 17% of the sample, but this site had a high Simpson's Diversity Index (0.88). This site was considered in "good" condition by IWL (19) and "acceptable" (9) by VASOS. It should be noted that the number collected (138) is below the number recommended for proper data analysis (200 individuals).

Newfound Creek - SMIE Site #106
This site is located approximately 50 meters upstream of the Rymer Road bridge and corresponds to a VWIN site (old site 4). It was first sampled in fall 2005. The substrates at this sample site are bedrock and boulders, but gravel, cobblestones and sand/silt are also abundant. The prevalence of sand and silt has led to the substrates being moderately embedded. Beavers constructed a dam between the spring and fall sampling seasons, which will likely change the substrate composition in future sampling events. The riparian zone consists of mostly trees and shrubs but it has been disturbed by roads and homes.

Sixteen taxa were collected, including six EPT taxa. The sample was dominated by net-spinning caddisflies (61%), which resulted in a low Simpson's Diversity value (0.59). The site was considered "good" (18) by IWL. However, it was "unacceptable" (6) by VASOS, most likely a result of the high abundance of net-spinning caddisflies. It should be noted that the number collected (184) is below the number recommended for proper data analysis (200 individuals).

Reed Creek - SMIE Site #181
This site is located in the Botanical Gardens of Asheville near UNCA below the confluence with Glenn Creek. It corresponds to a VWIN site (old site 7A). Substrates are composed of mostly gravel and cobblestones that are loosely embedded, although sand is also abundant. Because it is in the Botanical

Gardens, the riparian zone is comprised of trees and shrubs. However, it is surrounded by an urban setting and is a popular recreation area for nature hikes.

This site had the lowest total diversity (nine taxa) and EPT diversity (one taxa). This site also had the lowest number of organisms collected (37), which is low for the spring season when aquatic organisms are their most abundant compared to other seasons. Stoneflies and mayflies were noticeably absent. This site was rated as "poor" (8) by IWL but acceptable (8) by VASOS. The IWL score is the lowest found this sampling season. Net-spinning caddisflies dominated the sample (59%). The low number is below the number recommended for adequate data analysis (200 individuals).

Reems Creek - SMIE Site #180

This site is located just below the confluence of Reems and Ox Creeks in Weaverville (just behind the residence at 23 Ox Creek Rd.) and is just downstream of two VWIN sites (old sites 5A & 5B). Sampling started in the fall 2007 at this site. Substrates are composed of mostly gravel and cobblestones with abundant sand. The riparian zone is comprised of trees and shrubs.

There were 13 taxa collected at this site, including eight EPT taxa. Spiny crawler mayflies (56%) and quick crawling predators (36%) dominated the sample, which resulted in a low Simpsons Diversity index value (0.55). This site was rated "excellent" (25) by IZL; VASOS rated it "acceptable" (11).

Sandymush Creek - SMIE Site #105

This site is located approximately 50 meters downstream of the Willow Road bridge and corresponds to a VWIN site (old site 3B). It was first sampled in fall 2005. The substrate consists of boulders, gravel and cobblestones although sand is also prevalent that has resulted in the substrates being moderately embedded. The riparian zone consists of trees and shrub.

This site was rated "good" by IWL (18) and "acceptable" by VASOS (10). Fourteen taxa were collected, including seven EPT taxa. Spiny crawler mayflies dominated the sample (71%), which resulted in a low Simpson's Diversity Index value (0.47). However, net-spinning caddisflies were also abundant (13%).

Smith Mill Creek – SMIE Site #146

This site is located at Louisiana Boulevard and corresponds to a VWIN site (old site 35). This was the first year it was sampled. The substrate is dominated by sand that has extremely embedded the substrates. The riparian zone consists of trees and shrub, although grasses, vines and exotic plants are also present.

Only ten total taxa were collected, including very few EPT taxa (3). Stoneflies were noticeably absent. This site was rated as "fair" (13) by IWL and unacceptable (5) by VASOS. The IWL score is among the lowest found this sampling season. These low ratings can be explained by the dominance of oligochaete worms (55%) and chironomid midges (23%). Both of these groups are generally considered two of the most tolerant taxa of pollution. There were also very few organisms collected (88), which is low for the spring season when aquatic organisms are their most abundant compared to other seasons. The low number is below the number recommended for adequate data analysis (200 individuals).

Swannanoa River near the confluence of Beetree Creek - SMIE Site #115

This site is located at Charles D. Owen Park below the confluence with Beetree Creek. It corresponds to a VWIN site (old site 9B) and was first sampled in spring 2005. The riparian zone is mostly trees and shrubs but it has been highly disturbed by a public park on the right side and residential areas on the left. The substrates are mostly gravel and cobblestones but sand is also abundant, which has resulted in moderately embedded substrates.

Twelve taxa were collected at this site, including six EPT taxa. Oligochaete worms (44%) and spiny crawler mayflies (30%) were the most abundant taxa collected. This site was rated "fair" (15) by IWL and

"acceptable" by VASOS (9). There was a high Simpson's Diversity Index value (0.89) but there were also very few organisms collected (73), which is low for the spring season when aquatic organisms are their most abundant compared to other seasons. The low number is below the number recommended for adequate data analysis (200 individuals).

Swannanoa River near the confluence of Bull Creek - SMIE Site #149
This site is located at Old Farm School Road just above the confluence with Bull Creek. It corresponds to a VWIN site (old site 38) and was first sampled in spring 2005. The substrate is mostly gravel and cobblestones with sand moderately embedding it in place. The riparian zone consists of trees and shrubs.

Thirteen taxa were collected at this site; six of those were EPT taxa. Spiny crawler mayflies (39%) and oligochaete worms (19%) comprised most of the sample but the organisms were well-distributed among the species as indicated by the Simpson's Diversity Index value (0.81). IWL scored this site as "fair" (16) and it was "acceptable" (10) by VASOS. Stoneflies and caddisflies were not well-represented, which can help explain the low IWL score. However, it should be noted that the number collected (124) is below the number recommended for proper data analysis (200 individuals).

Haywood County

Crabtree Creek - SMIE Site #526
This site is located approximately fifty meters below the first bridge on Upper Crabtree Creek Road, which is less than a mile upstream of where Crabtree Creek flows under Hwy 20. This site corresponds to a VWIN site (old site 26) and DWQ site F2 and was first sampled in spring 2005. The riparian zone for the most part consists of mostly trees and shrubs, but grasses, honeysuckle, multiflora rose and privet are also common upstream of the site. Bedrock, boulders, gravel and cobblestones are all abundant, as is sand which has led to the substrates being moderately embedded.

Sixteen taxa were collected at this site; including seven EPT taxa. The sample was dominated by spiny crawler mayflies (57%) but flattened scraper mayflies (12%) were also common. This site is considered "excellent" by IWL (23) and acceptable (10) by VASOS.

East Fork of the Pigeon River - SMIE Site #502
This site is located approximately 100 meters upstream of the SR 276 bridge over the East Fork of the Pigeon River. This site corresponds to DWQ site 1A and was first sampled in fall 2005. The riparian zone at this site is comprised of mostly trees and shrubs. A road lies in close proximity to the stream. Gravel and cobblestones dominate the substrate but bedrock is prevalent. The abundance of sand has also led the substrates to being moderately embedded.

Eighteen taxa were collected, including eleven EPT taxa, which is among the highest EPT diversity collected this season. It is considered "acceptable" by VASOS (10), but only "fair" by IWL (14). This may partially be explained by the high P/R ratio of 1.20, which can be an indication of organic pollution. Three taxa comprised most of the sample: flattened scraper mayflies (37%), quick crawling predator stoneflies (24%), and spiny crawler mayflies (17%), but there was a moderately high Simpson's Diversity value (0.77). It should be noted that the number collected (133) is below the number recommended for proper data analysis (200 individuals).

Fines Creek - SMIE Site #507
This site is located near the Fines Creek (Lower Fines Creek) bridge on SR 1335 near the junction with SR 1338. It corresponds to a VWIN site (old site 7) and was first sampled in spring 2005. The riparian zone is mostly trees and shrubs on the right side of the stream, but the road lies close to left side of the stream and has limited that side to mostly grasses. Stream habitat is comprised of gravel and cobblestones, although sand is also abundant and has moderately embedded the substrates.

Nineteen taxa were found in the sample, eight of which were EPT taxa. Spiny crawler mayflies dominated the sample (49%), but net-spinning caddisflies (18%) and small head caddisflies (13%) were also common. IWL rated this site "excellent" (28) and it was "acceptable" by VASOS (10).

Jonathans Creek (downstream of Coleman Mountain Road) - SMIE Site #512
This site is located approximately 50 meters downstream of the Coleman Mountain Rd. (SR 1364) bridge near the junction with SR 276. It corresponds with a VWIN site (old site 12) and is very close to DWQ sites 27 and 28. It was first sampled in spring 2005. The riparian zone has been highly disturbed and is in poor condition. Mobile homes and commercial properties border both sides of the stream and the riparian buffer consists of mostly grasses. Very few trees are present. Substrates are comprised of gravel and cobblestones but sand is also abundant and has moderately embedded the substrates.

Fourteen taxa were collected at this site, including ten EPT. Spiny crawler mayflies dominated the sample (48%). Flattened scraper mayflies were also abundant (25%). IWL rated this site "good" (18) and it was "acceptable" by VASOS (11).

Jonathans Creek (downstream of Moody Farm Road bridge) - SMIE Site #527
This site is located in Maggie Valley approximately 50 meters downstream of the first bridge on Moody Farm Road (SR 1307). This site is near the junction with SR 19 and across from the Maggie Valley Country Club golf course. It corresponds with VWIN site (old site 27) and DWQ site 26 and was first sampled in spring 2005. The riparian buffer consists of mostly trees and shrubs providing good shade, but the left buffer is paralleled by a road and the right by houses. The dominant substrates are gravel and cobblestones. Sand is also abundant but does not appear to be affecting substrate embeddedness.

Fifteen taxa were collected at this site; eleven were EPT taxa. The most abundant organisms were spiny crawler mayflies (57%) but flattened scraper mayflies were also common (19%). The IWL score indicated this site was in "good" condition (20) and it was "acceptable" by VASOS (10).

Pigeon River - SMIE Site #581
This site is located downstream of the Blue Ridge Paper Products Mill in Canton. It is very close to a VWIN site (old site 4) and was first sampled in the fall 2006. Bedrock is abundant. Gravel and cobble habitat is present but limited and moderately embedded. The riparian zone is mostly trees and shrubs but roads parallel both sides of the river. Water temperature is consistently warmer than normal for any season.

Fifteen total taxa and six taxa were collected, which are higher than typically found at this site. However, of the 275 organisms collected, 183 (67%) were blackflies, which is a group typically considered tolerant of organic pollution. The abundance of this organism along with the high FPOM/CPOM ratio (5.28) are evidence of organic enrichment. The dominance of blackflies can also partially explain the low diversity index scores (Simpson's Diversity and taxa density). The VASOS score supports this finding with an "unacceptable" rating (6), but IWL rated this site as "good" (20).

Raccoon Creek - SMIE Site #525
This site was located in Waynesville downstream of the first bridge on Howell Mill Road at the intersection with Business 23 (Old Asheville Highway). It corresponded with a VWIN site (old site 25). Due to safety issues, the site was moved 400 yards upstream of the Business 23 bridge at Jonathan Valley Elementary School. The riparian buffer consists of grasses and vines. The dominant substrates are gravel and cobblestones that are loosely embedded.

Twelve taxa were collected at this site; six of those were from the EPT groups. Spiny crawler mayflies (32%) comprised most of the sample, but flattened scraper mayflies and small headed caddisflies were also

abundant (15% each). The IWL score indicated this site was in "good" condition (21) and it was "acceptable" by VASOS (11).

Richland Creek - SMIE Site #580
This site is located approximately 200 meters upstream of Hyatt Creek Road at Exit 98 on US 23/74. It corresponds to DWQ site 19 and was first sampled in spring 2005. The stream resembles a long straight channel with little riffle formation or bank heterogeneity. The riparian zone on the right side of the stream is mostly a parking lot with some large trees and shrubs. Upstream of the parking lot and all along the left side of the stream, the riparian zone has been highly disturbed by residential homes. The stream substrates consist of cobble and gravel with abundant sand also present that have moderately embedded the substrates.

Only eight taxa were collected at this site, six of those were EPT taxa. This was the lowest diversity found in this sample season. Spiny crawler mayflies dominated the sample (83%), which led to the lowest Simpson's Diversity Index score for the spring (0.30) and the lowest IWL rating (7, "poor"). However, it is "acceptable" by VASOS methods (10).

Madison County

Big Laurel Creek - SMIE Site #904
This site is located approximately 200 meters downstream of the bridge at the Hwy 25/70 and NC 208 junction. It corresponds to a VWIN site (old site 10) and was first sampled in fall 2005. This is a popular recreation area for the community. A trail follows the stream to its confluence with the French Broad River, and it is a popular kayaking/rafting and trout fishing destination. The riparian zone of the right side is disturbed by a small campground and a parking lot borders the left side of the stream upstream of the site. Even with these disturbances, there are abundant large trees and shrubs in the riparian zone. The stream substrates are mostly cobble and gravel, but sand is becoming increasingly abundant, which has moderately embedding the substrates.

The IWL score (13) is "fair" and the VASOS rating is "acceptable" (12). It should be noted that the number collected (129) s below the number recommended for proper data analysis (200 individuals). The fair rating may be attributed to low diversity with only eleven species being collected. Six of those were EPT taxa. There was a high Simpson's Diversity Index value (0.85) but the most common organisms were quick crawling predator stoneflies (22%), spiny crawler mayflies (18%), round headed swimmer mayflies (15%), and net spinning caddisflies (14%).

California Creek - SMIE Site #413
This site is located approximately 50 meters upstream of the bridge at Radford Road, which is just downstream of US 19. It was first sampled in spring 2005. It corresponds with a VWIN site (old site 13). Road, pasture and residential areas have disturbed the natural condition of the riparian zone. Riparian vegetation is mostly trees and shrubs. Gravel and cobblestones comprise the majority of the stream bottom, which are loosely embedded.

Seventeen taxa were collected at this site, including six EPT taxa. Spiny crawler mayflies dominated the sample (60%), which attributed to the low Simpson's Diversity Index (0.60). However, this site received the highest IWL rating (31); it was also "acceptable" (7) by VASOS standards.

East Fork Bull Creek – SMIE Site #404
This site is located approximately ¼ mile upstream from the East Fork Road bridge and corresponds to a VWIN site (old site 4). This was the first year it was sampled. The substrate is dominated by gravel and cobblestones. The riparian zone consists of trees and shrub, although grasses, vines and exotic plants are also present.

Seventeen taxa were collected, including eight EPT taxa. This site was rated as "excellent" (25) by IWL and acceptable by VASOS (12). Spiny crawler mayflies were the most abundant organisms collected (38%) and net spinning caddisflies (16%) and quick crawling predator stoneflies (13%) were also common. There was a high Simpson's Diversity Index value (0.80) but it should be noted that the number collected (139) is below the number recommended for proper data analysis (200 individuals).

Little Ivy River - SMIE Site #102
This site is located in the Forks of Ivy area north of Asheville and was first sampled in spring 2005. It is approximately 100 meters upstream of the confluence with Big Ivy River and corresponds to a VWIN site (old site 1B) and DWQ site 4. The substrates at this site are mostly gravel and cobblestones but bedrock and sand are also abundant. Some trees are found in the riparian zone but it has been highly disturbed and grasses and vines dominate. A road closely parallels the stream on the left side.

Eighteen taxa were collected with seven of those being EPT taxa. Net-spinning caddisflies (33%) and spiny crawler mayflies (21%) comprised most of the sample. IWL scored this site as "excellent" (25) and VASOS ranked it as "acceptable" (10). There was a high Simpson's Diversity Index value (0.82) but it should be noted that the number collected (187) is below the number recommended for proper data analysis (200 individuals).

Puncheon Fork Creek - SMIE Site #480
This site is located near Ebbs Chapel at the junction of Laurel Valley Road and Puncheon Fork Road. It is just upstream of the culvert under Laurel Valley Road and is a DWQ monitoring site. Substrates are mostly gravel and cobblestones and are not embedded; the riparian zone is mostly trees and shrubs.

There were seventeen taxa collected at this site. Nine of the taxa were EPT groups, including giant shredders and roach shredder, which are two of the most pollution intolerant groups among the SMIE taxa. Spiny crawler mayflies dominated the sample (73%), which can explain the low Simpson's Diversity value (0.46). This site is rated "excellent" (23) by IWL and "acceptable" (10) by VASOS.

Shelton Laurel Creek - SMIE Site #409
This site is located adjacent to the Bela Baptist Church parking lot on Guntertown Road. It was first sampled in spring 2006. The right riparian zone is bordered by a road and the left side by a church parking lot. Very little vegetation is present, although riparian conditions greatly improve upstream of the sample site as natural vegetation increases. Vegetation along the road bank consists of shrubs, grasses and herbs consistent with roadside habitat. Large trees and shrubs are present on the left bank and help to protect the stream bank from erosion. The stream habitat consists of gravel and cobblestones.

There were 21 taxa collected at this site; ten of those were EPT taxa. Diversity was well-distributed among the taxa collected (Simpson's diversity index = 0.85), but the most common taxa were water pennies (25%), flattened scraper mayflies (18%), and net spinning caddisflies (17%). This site is rated "good" (21) by IWL and "acceptable" (12) by VASOS. There is evidence of organic pollution as indicated by the high P/R ratio (1.10).

Mitchell County

Cane Creek - SMIE Site #1481
This sample is collected just upstream of South Mitchell Avenue bridge, near the intersection of Hwy. 226 (Crimson Laurel Way) and Mitchell Avenue. This corresponds to a VWIN site (old site T1). Substrates are composed of mostly gravel and cobblestones but sand is also abundant that have moderately embedded the substrates. The riparian zone is mostly trees and shrubs, and grasses, vines, and rip-rap are also present.

There were 14 taxa collected at this site; seven of those were EPT taxa. Spiny crawler mayflies dominated the sample (73%), which contributed to the low Simpson's Diversity Index value (0.44). This site was rated "excellent" (25) by IWL and "acceptable" (10) by VASOS.

North Toe River – SMIE Site #1404
This site is located at the Red Hill Bridge and corresponds to a VWIN site (old site 4). This was the first year it was sampled. The substrate is dominated by gravel and cobblestones that are extremely embedded by finer substrates. The riparian zone consists of trees and shrubs.

Twelve taxa were collected, including six EPT taxa. This site was rated as "fair" (15) by IWL and acceptable by VASOS (9). Chironomid midges dominated the sample (46%) but the remaining organisms were well distributed among the taxa as indicated by the Simpson's Diversity Index value (0.75). It should be noted that the number collected (61) is below the number recommended for proper data analysis (200 individuals).

Yancey County

Cane River - SMIE Site #1480
This sample is collected by the Mountain Heritage High School practice football field and corresponds to a VWIN site (old site T5). Sampling at this site began in the fall 2008. The stream bottom is mostly gravel and cobble. The riparian zone is mostly trees, with some clearing close to the left bank where river rocks are intermittently mined.

There were twelve taxa collected at this site; seven of those were EPT taxa. The most prevalent organisms collected were flattened scraper mayflies (33%), net-spinning caddisflies (26%), and quick crawling predator stoneflies (14%), but the Simpson's Diversity Index was high (0.79). This site was rated "fair" (16) by IWL and "acceptable" (9) by VASOS. It should be noted that the number collected (135) is below the number recommended for proper data analysis (200 individuals).

In the spring of 2008, SMIE volunteers and local residents noted a strange color and odor prior to sampling and helped push for state regulators to investigate the upstream Burnsville Waste Water Treatment Plant. Multiple toxic discharges (very low pH, high chlorine and very high bacteria counts) occurred killing endangered Appalachian Elktoe mussel and other organisms. The Yancey County Health Department eventually posted "no swimming" signs.

4.0 SUMMARY

The spring 2009 sampling season marked the beginning of the Program's fifth year; there are now 30 active sites and many sites have been sampled all seven seasons (spring and fall). Two sites have been discontinued (Flat Creek and Christian Creek) but three new sites were added, Smith Mill Creek in Yancey County, East Fork Bull Creek in Madison County, and the North Toe River in Mitchell County. The sampling protocols are consistent with DWQ protocols but data analysis issues are still being resolved with help from the NC DWQ Biological Assessment Unit. SMIE Program staff are working with Assessment Unit staff to understand the data and develop an effective evaluation tool to rate the sampling streams. Assessment Unit staff are currently reviewing the data to develop a biotic index that reflects their evaluations of water quality at each site.

Overall, the efforts of SMIE Program volunteers appear to show that streams in Buncombe, Haywood, Madison, Mitchell, and Yancey Counties are impacted by land use. Volunteers collected samples from streams that have some of the best water quality in western North Carolina. However, they're also collecting from some of the worst streams. One consistent trend is that most riparian zones are less than adequate for multiple reasons. Human encroachment leads to increased impervious surfaces and reduces naturally vegetated landscapes, which leads to increased stream flows and subsequent erosion and flooding

downstream, as well as reduced inputs of leaves and woody debris that serve as the base of the food chain. Exotic and invasive species are present in almost every watershed and are an indicator of how disturbed the ecological processes are in these systems. Another consistent trend is the presence of excess sediment. Few sites had substrates that were loose and easily moved. Embedded substrates reduce the quantity and quality of benthic habitats, and lead to leaf pack and woody debris removal by high flow events.

A drought impacted western North Carolina for most of 2007 and 2008 that directly impacted the biological communities of streams. While it appears the benthic macroinvertebrate communities have recovered in many streams, a few streams may still be recovering, as indicated by the low number of organisms collected. During the drought, many folks witnessed dried up springs and wells, and many streams and rivers were at their lowest levels on record. The French Broad River saw its lowest recorded water levels since such monitoring began in the late 19th century! When water levels are low, more substrates become exposed, which means less habitat for fish and benthic macroinvertebrates. The lower flow also means less dissolved oxygen and warmer temperatures. The streams of western North Carolina support many organisms adapted to high dissolved oxygen levels and cold temperatures, such as stoneflies, darters, and trout.

With the higher rainfalls that have been falling in western NC the last two seasons, higher flows have been observed in streams which leads to increased habitat availability, but also substrate scouring if levels are too high. Higher rainfalls also means more non-point source pollutants (i.e, dirt, fertilizers, pesticides, oil, trash) washing off the landscape and a higher potential for flooding and streambank erosion, which can partially explain water quality impacts.

The quality of the resources available to benthic macroinvertebrate communities is a function of many ecological processes (pollutant loads, flow, seasonality), which affect the distribution and abundance of aquatic invertebrates. Since the SMIE approach uses benthic macroinvertebrate data to evaluate ‘water quality’, it must include those factors in our evaluation. The next steps in development of the SMIE Programs are to (1) continue building a volunteer base, (2) continue building a database that monitors changes in the benthic communities and strengthens data analysis, and (3) working with DWQ’s Biological Assessment Unit to develop a user-friendly index that accurately reflects water quality condition.

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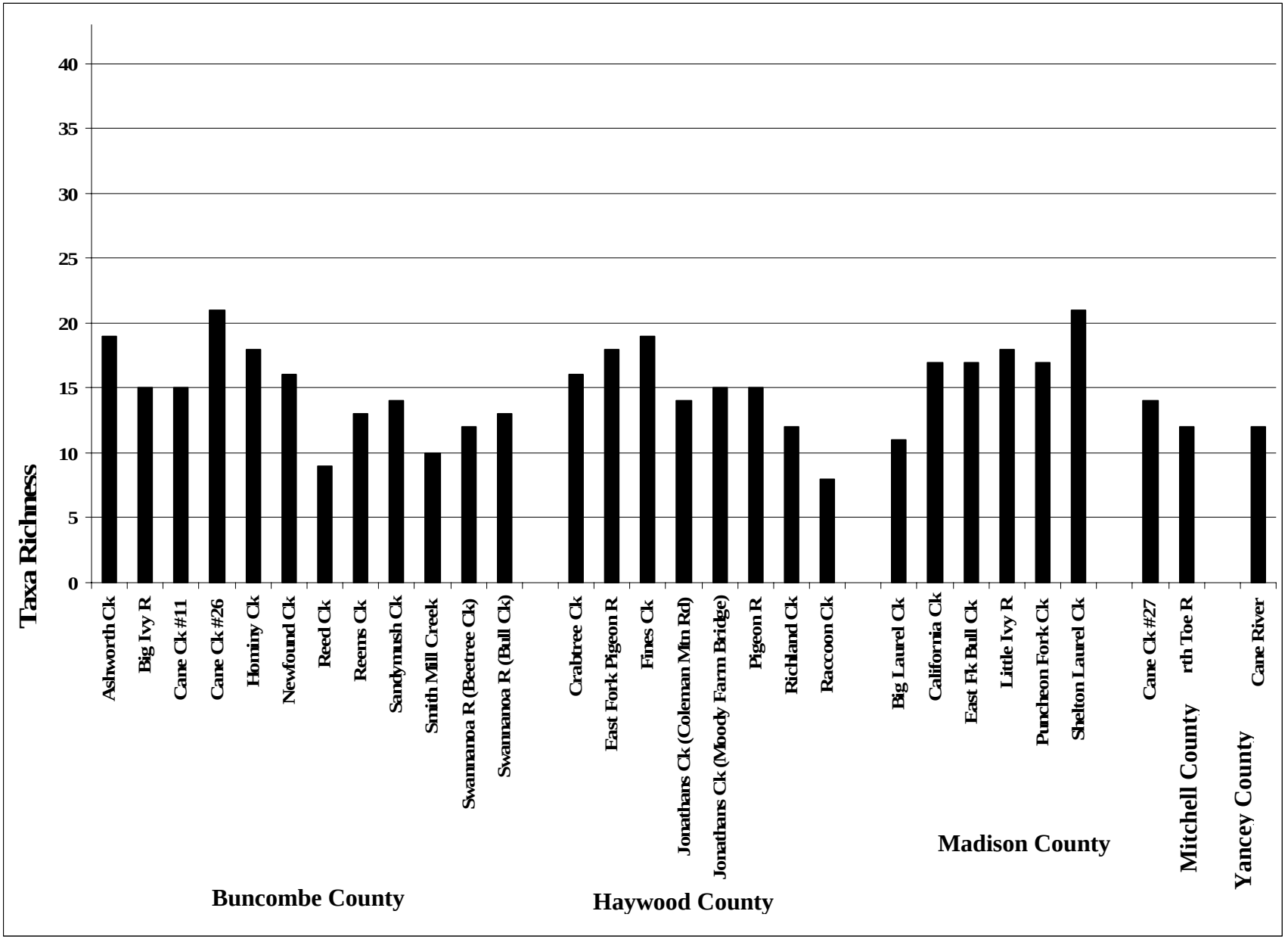

Figure 1. Taxa richness at all SMIE sample sites (43 taxa possible; Spring 2009).

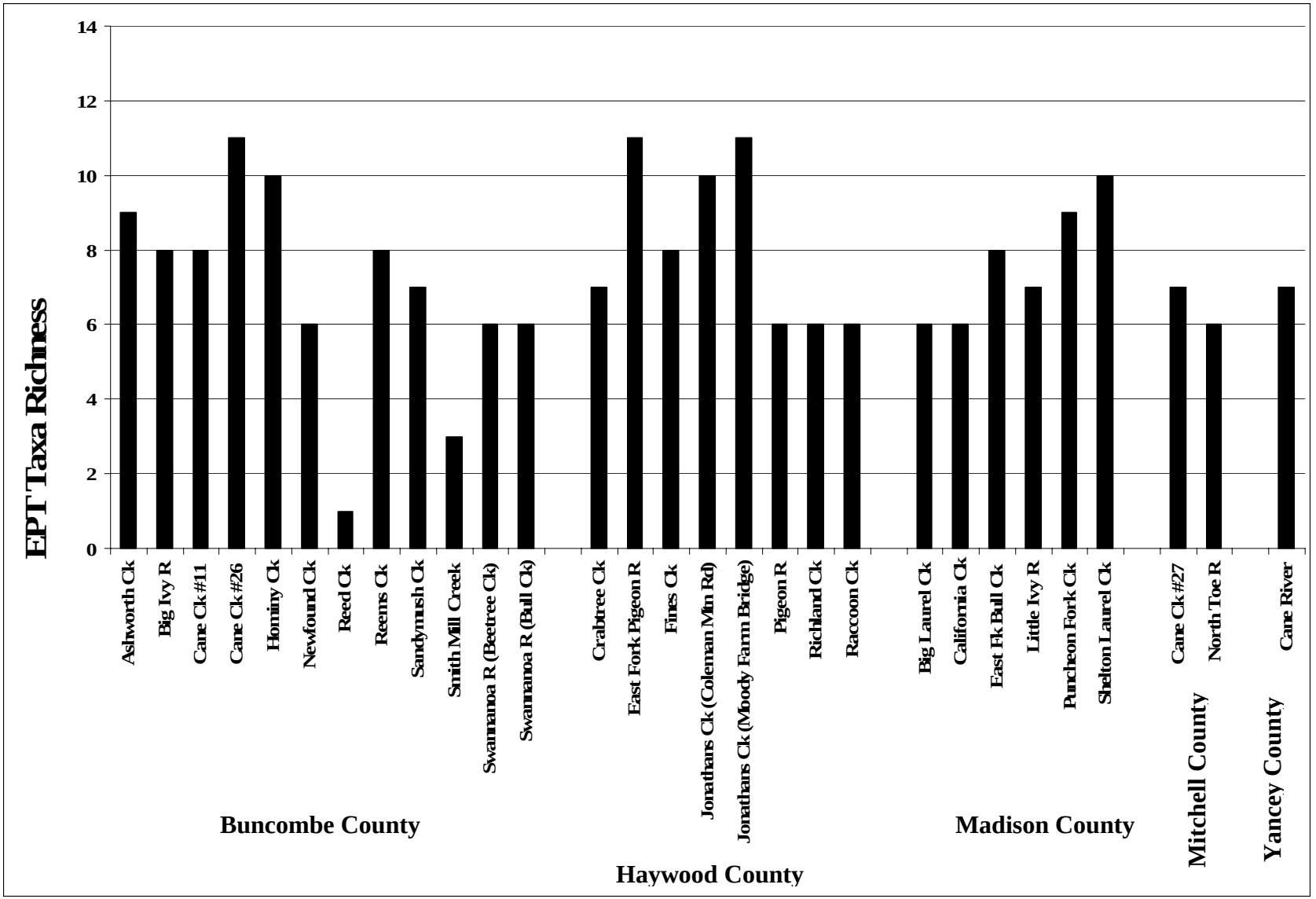

Figure 2. Number of EPT taxa at all SMIE sample sites (19 possible; Spring 2009).

Table 1. SMIE Program summary site data (Spring 2009; richness, abundance, VASOS and Izaak Walton League data)

Site #	Site	Taxa Richness	Total Number Collected	Number of EPT Taxa	VASOS	VASOS Rating	Izaak Walton League	Izaak Walton League Rating
	Buncombe County							
101	Big Ivy River	15	319	8	10	Acceptable	19	Good
105	Sandymush Creek	14	404	7	10	Acceptable	18	Good
106	Newfound Creek	16	181	6	6	Unacceptable	18	Good
115	Swannanoa River @ dws Beetree Ck	12	73	6	9	Acceptable	15	Fair
117	Hominy Creek	18	138	10	9	Acceptable	19	Good
119	Bent Creek @ Asheville Arboretum	*Not sampled*						
123	Cane Creek #11	15	336	8	11	Acceptable	21	Good
124	Asheworth Creek	19	348	9	12	Acceptable	27	Excellent
149	Swannanoa River @ ups Bull Ck	13	124	6	10	Acceptable	16	Fair
180	Reems Creek	13	343	8	11	Acceptable	25	Excellent
181	Reed Creek	9	37	1	8	Acceptable	8	Poor
182	Cane Creek #26	21	339	11	11	Acceptable	23	Excellent
146	Smith Mill Creek	10	88	3	5	Unacceptable	13	Fair
	Haywood County							
502	East Fk Pigeon River	18	133	11	10	Acceptable	14	Fair
507	Fines Creek	19	341	8	10	Acceptable	28	Excellent
512	Jonathans Ck @ dws Coleman Mtn Rd	14	343	10	11	Acceptable	18	Good
525	Raccoon Creek	12	79	6	11	Acceptable	21	Good
526	Crabtree Creek	16	312	7	10	Acceptable	23	Excellent
527	Jonathans Ck @ ups Moody Farm Bridge	15	203	11	10	Acceptable	20	Excellent
580	Richland Creek @ ups Hyatt Ck Road	8	120	6	10	Acceptable	7	Poor
581	Pigeon River @ dws Canton	15	275	6	6	Unacceptable	20	Good

Table 1 (continued). SMIE Program summary site data (Spring 2009; richness, abundance, VASOS and Izaak Walton League data)

Site #	Site	Taxa Richness	Total Number Collected	Number of EPT Taxa	VASOS	VASOS Rating	Izaak Walton League	Izaak Walton League Rating
	Madison County							
102	Little Ivy River	18	187	7	10	Acceptable	25	Excellent
409	Shelton Laurel Creek	21	209	10	12	Acceptable	21	Good
413	California Creek	17	364	6	11	Acceptable	31	Excellent
480	Puncheon Fork Creek	17	253	9	10	Acceptable	23	Excellent
904	Big Laurel Creek	11	129	6	12	Acceptable	13	Fair
404	East Fork Bull Creek	17	139	8	12	Acceptable	25	Excellent
	Mitchell County							
1481	Cane Creek #27	14	368	7	10	Acceptable	25	Excellent
1404	North Toe River	12	61	6	9	Acceptable	15	Fair
	Yancey County							
1480	Cane River	12	135	7	9	Acceptable	16	Fair

EPT = Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies)
VASOS = Virginia Save Our Streams Index

What do the scores mean?

- Total Taxa Richness = the higher the better
- EPT Taxa Richness = the higher the better
- VASOS Rating: Acceptable = 7-12; Unacceptable = 0-6
- Izaak Walton League Rating: Excellent > 22; Good = 17-22; Fair = 11-16; Poor <11

Table 2. SMIE Program summary site data (Spring 2009; ecological ratios, diversity and density data)

Site #	Site	P/R	Leaf Input	Top-Down	Simpsons Diversity	Taxa Density
	Buncombe County					
101	Big Ivy River	0.05	0.01	0.05	0.38	0.05
105	Sandymush Creek	0.11	0.01	0.05	0.47	0.03
106	Newfound Creek	0.04	0.02	0.06	0.59	0.09
115	Swannanoa River @ dws Beetree Ck	0.04	0.00	0.06	0.89	0.16
117	Hominy Creek	0.16	0.01	0.21	0.88	0.13
119	Bent Creek @ Asheville Arboretum	*Not sampled*				
123	Cane Creek #11	0.21	0.00	0.18	0.68	0.04
124	Asheworth Creek	0.31	0.02	0.34	0.74	0.05
149	Swannanoa River @ ups Bull Ck	0.16	0.02	0.01	0.81	0.10
180	Reems Creek	0.07	0.01	0.60	0.55	0.04
181	Reed Creek	0.03	0.03	0.03	0.62	0.24
182	Cane Creek #26	0.13	0.02	0.25	0.72	0.06
146	Smith Mill Creek	0.02	0.05	0.01	0.93	0.11
	Haywood County					
502	East Fk Pigeon River	1.20	0.07	0.40	0.77	0.14
507	Fines Creek	0.15	0.01	0.21	0.70	0.06
512	Jonathans Ck @ dws Coleman Mtn Rd	0.49	0.05	0.06	0.69	0.04
525	Raccoon Creek	0.32	0.04	0.21	0.74	0.15
526	Crabtree Creek	0.19	0.00	0.13	0.64	0.05
527	Jonathans Ck @ ups Moody Farm Brdg	0.30	0.09	0.09	0.63	0.07
580	Richland Creek @ ups Hyatt Ck Rd	0.26	0.08	0.00	0.30	0.07
581	Pigeon River @ dws Canton	0.02	0.00	0.10	0.54	0.05

Table 2 (continued). SMIE Program summary site data (Spring 2009; ecological ratios, diversity and density data)

Site #	Site	P/R	Leaf Input	Top-Down	Simpsons Diversity	Taxa Density
	Madison County					
102	Little Ivy River	0.22	0.04	0.06	0.82	0.10
409	Shelton Laurel Creek	1.10	0.00	0.20	0.85	0.10
413	California Creek	0.06	0.01	0.09	0.60	0.05
480	Puncheon Fork Creek	0.06	0.07	0.10	0.46	0.07
904	Big Laurel Creek	0.38	0.00	0.31	0.85	0.09
404	East Fork Bull Creek	0.14	0.02	0.22	0.80	0.12
	Mitchell County					
1481	Cane Creek #27	0.16	0.00	0.13	0.44	0.04
1404	North Toe River	0.06	0.00	0.19	0.75	0.20
	Yancey County					
1480	Cane River	0.48	0.03	0.17	0.79	0.09

Ecological Ratios

- P/R (Prod/Resp): > 0.75 indicates stream may be autotrophic or could have significant organic pollution; < 0.75 indicates stream may be heterotrophic
- Leaf Input: Heterotrophic streams >0.25 in spring and summer; > 0.5 in winter and autumn
- Top-Down: The lower the better, means more of the vegetable eating trophic groups are present
- Simpson's Diversity (1-D): the greater the value, the greater the sample diversity
- Taxa Density: the higher the better, lower numbers indicate large numbers of fewer taxa

Table 3. Cumulative SMIE Program data (Spring 2005 – Spring 2009)

Site #	Site	County	Date	Taxa Richness	EPT Taxa	VASOS Score	Izaak Walton League Score
101	Big Ivy	Madison	Spring 2005	17	7	9	11
			Fall 2005	17	7	7	26
			Spring 2006	14	8	9	22
			Fall 2006	8	3	12	16
			Spring 2007	13	6	12	11
			Fall 2007	18	8	6	17
			Spring 2008	15	7	9	23
			Fall 2008	18	7	7	22
			Spring 2009	15	8	10	19
102	Little Ivy	Buncombe	Spring 2005	13	5	9	10
			Fall 2005	11	5	7	18
			Spring 2006	16	8	12	21
			Fall 2006	13	4	10	17
			Spring 2007	12	5	11	17
			Fall 2007	15	6	7	24
			Spring 2008	13	6	9	17
			Fall 2008	14	5	10	16
			Spring 2009	18	7	10	25
105	Sandymush Ck	Buncombe	Fall 2005	12	6	6	19
			Spring 2006	14	6	7	12
			Fall 2006	13	7	8	16
			Fall 2007	15	8	6	18
			Spring 2008	15	7	10	16
			Fall 2008	15	8	8	18
			Spring 2009	14	7	10	18
106	Newfound Ck	Buncombe	Fall 2005	17	7	6	20
			Spring 2006	18	7	7	19
			Fall 2006	18	6	8	25
			Fall 2007	11	4	7	13
			Spring 2008	19	7	9	17
			Fall 2008	15	4	5	21
			Spring 2009	16	6	6	18
115	Swannanoa River @ dws of Beetree Ck	Buncombe	Spring 2005	11	6	9	5
			Fall 2005	10	6	8	15
			Spring 2006	17	9	8	15
			Fall 2006	12	4	5	18
			Spring 2007	13	8	10	14
			Fall 2007	12	2	6	14
			Spring 2008	17	8	9	25
			Fall 2008	16	6	7	22
			Spring 2009	12	6	9	15

Table 3 (continued). Cumulative SMIE Program data (Spring 2005 – Spring 2009)

Site #	Site	County	Date	Taxa Richness	EPT Taxa	VASOS Score	Izaak Walton League Score
117	Hominy Ck	Buncombe	Spring 2005	12	7	9	8
			Fall 2005	12	8	7	18
			Spring 2006	13	8	9	14
			Fall 2006	15	7	7	20
			Fall 2007	12	8	6	17
			Spring 2008	15	7	10	28
			Fall 2008	18	10	7	23
			Spring 2009	18	10	9	19
119	Bent Creek @ the Arboretum	Buncombe	Spring 2005	15	7	9	8
			Fall 2005	16	9	8	20
			Spring 2006	17	11	8	18
			Fall 2006	17	8	9	28
			Spring 2007	22	11	11	24
			Fall 2007	13	7	7	23
			Spring 2008	17	10	10	24
			Fall 2008	14	8	10	19
			Spring 2009	*Not sampled*			
123	Cane Ck	Buncombe	Spring 2005	12	8	9	6
			Fall 2005	11	7	9	12
			Spring 2006	17	11	8	14
			Fall 2006	16	10	8	12
			Spring 2007	16	9	9	20
			Fall 2007	17	8	7	25
			Spring 2008	15	8	11	21
			Fall 2008	13	7	9	22
			Spring 2009	15	8	11	21
124	Asheworth Ck	Buncombe	Spring 2005	15	8	7	12
			Fall 2005	15	8	7	20
			Spring 2006	16	7	10	20
			Fall 2006	14	8	6	20
			Spring 2007	17	8	10	26
			Fall 2007	19	8	10	30
			Spring 2008	17	8	12	28
			Fall 2008	17	7	6	27
			Spring 2009	19	9	12	27

Table 3 (continued). Cumulative SMIE Program data (Spring 2005 – Spring 2009)

Site #	Site	County	Date	Taxa Richness	EPT Taxa	VASOS Score	Izaak Walton League Score
149	Swannanoa River @ ups of Bull Ck	Buncombe	Spring 2005	13	9	9	13
			Fall 2005	11	4	7	14
			Spring 2006	17	6	6	21
			Fall 2006	13	4	5	8
			Spring 2007	16	6	9	8
			Fall 2007	14	4	5	23
			Spring 2008	17	5	11	31
			Fall 2008	15	3	5	21
			Spring 2009	13	6	10	16
180	Reems Creek	Buncombe	Fall 2007	17	8	11	32
			Spring 2008	18	11	12	24
			Fall 2008	18	10	11	23
			Spring 2009	13	8	11	25
181	Reed Ck @ Asheville Botanical Gardens	Buncombe	Spring 2005	10	7	9	9
			Fall 2005	7	2	5	16
			Spring 2006	14	3	5	18
			Fall 2006	7	3	6	10
			Fall 2007	9	3	9	17
			Spring 2008	10	2	6	13
			Fall 2008	10	2	6	13
			Spring 2009	9	1	8	8
182	Cane Creek @ Miller Rd	Buncombe	Spring 2008	18	11	11	19
			Fall 2008	14	8	7	23
			Spring 2009	21	11	11	23
409	Shelton Laurel Ck	Madison	Spring 2006	24	13	11	15
			Fall 2006	19	11	9	30
			Spring 2007	19	9	12	23
			Fall 2007	20	10	11	23
			Spring 2008	22	12	10	31
			Fall 2008	18	10	12	22
			Spring 2009	21	10	12	21
413	California Ck	Madison	Spring 2005	13	6	8	7
			Fall 2005	16	8	7	22
			Spring 2006	16	6	10	22
			Fall 2006	12	5	9	20
			Fall 2007	11	6	8	11
			Spring 2008	17	8	11	24
			Fall 2008	16	7	7	25
			Spring 2009	17	6	11	31

Table 3 (continued). Cumulative SMIE Program data (Spring 2005 – Spring 2009)

Site #	Site	County	Date	Taxa Richness	EPT Taxa	VASOS Score	Izaak Walton League Score
480	Puncheon Fork Ck	Madison	Fall 2007	11	9	11	17
			Spring 2008	17	10	9	18
			Fall 2008	17	10	11	21
			Spring 2009	17	9	10	23
502	East Fk Pigeon River	Haywood	Fall 2005	21	13	9	20
			Spring 2006	13	8	9	15
			Fall 2006	16	8	12	20
			Spring 2007	21	12	10	22
			Fall 2007	14	6	11	20
			Spring 2008	17	12	10	19
			Fall 2008	20	13	10	21
			Spring 2009	18	11	10	14
507	Fines Ck	Haywood	Spring 2005	20	12	10	19
			Fall 2005	14	9	7	19
			Spring 2006	11	9	10	15
			Fall 2006	14	7	9	21
			Spring 2007	20	12	10	22
			Fall 2007	17	8	8	21
			Spring 2008	17	9	10	26
			Fall 2008	17	8	8	25
			Spring 2009	19	8	10	28
512	Jonathans Ck @ Coleman Mtn Rd	Haywood	Spring 2005	11	7	10	15
			Fall 2005	14	8	8	17
			Spring 2006	17	9	10	20
			Fall 2006	13	7	10	17
			Spring 2007	13	8	10	18
			Fall 2007	16	9	8	17
			Spring 2008	14	8	10	17
			Fall 2008	17	10	10	22
			Spring 2009	14	10	11	18
525	Raccoon Creek	Haywood	Spring 2008	11	5	9	15
			Fall 2008	14	7	8	19
			Spring 2009	12	6	11	21

Table 3 (continued). Cumulative SMIE Program data (Spring 2005 – Spring 2009)

Site #	Site	County	Date	Taxa Richness	EPT Taxa	VASOS Score	Izaak Walton League Score
526	Crabtree Ck	Haywood	Spring 2005	14	8	9	9
			Fall 2005	18	11	7	14
			Spring 2006	16	10	10	21
			Fall 2006	17	7	7	22
			Spring 2007	15	6	9	22
			Fall 2007	18	8	7	28
			Spring 2008	17	9	9	21
			Fall 2008	15	10	10	19
			Spring 2009	16	7	10	23
527	Jonathans Ck @ Moody Farm Bdge	Haywood	Spring 2005	12	9	9	11
			Fall 2005	13	7	7	19
			Spring 2006	17	10	10	16
			Fall 2006	16	9	11	18
			Spring 2007	16	10	10	15
			Fall 2007	16	9	9	20
			Spring 2008	15	10	10	12
			Fall 2008	13	8	9	18
			Spring 2009	15	11	10	20
580	Richland Ck @ ups Hyatt Ck Road	Haywood	Spring 2005	14	8	9	5
			Fall 2005	12	6	8	17
			Spring 2006	10	7	10	12
			Fall 2006	9	6	8	15
			Spring 2007	16	8	10	19
			Fall 2007	14	7	9	19
			Spring 2008	11	7	10	15
			Fall 2008	17	8	10	23
			Spring 2009	8	6	10	7
581	Pigeon River @ dws Canton	Haywood	Fall 2006	12	2	2	14
			Spring 2007	15	7	4	20
			Fall 2007	12	2	2	11
			Spring 2008	10	3	4	14
			Fall 2008	8	2	3	11
			Spring 2009	15	6	6	20
904	Big Laurel Ck	Madison	Fall 2005	18	11	8	25
			Spring 2006	18	10	12	25
			Fall 2006	16	9	11	19
			Spring 2007	17	9	12	16
			Fall 2007	15	10	11	20
			Spring 2008	17	19	11	28
			Fall 2008	14	7	9	14
			Spring 2009	11	6	12	13

Table 3 (continued). Cumulative SMIE Program data (Spring 2005 – Spring 2009)

Site #	Site	County	Date	Taxa Richness	EPT Taxa	VASOS Score	Izaak Walton League Score
1481	Cane Creek (Mitchell County)	Mitchell	Spring 2008	21	9	12	24
			Fall 2008	12	7	11	18
			Spring 2009	14	7	10	25
1480	Cane River	Yancey	Fall 2008	15	6	8	18
			Spring 2009	12	7	9	16
146	North Toe River	Mitchell	Spring 2009	12	6	9	15
404	East Fork Bull Ck	Madison	Spring 2009	17	8	12	25
1404	Smith Mill Ck	Buncombe	Spring 2009	10	3	5	13
	Discontinued sites						
9	Flat Creek	Buncombe	Spring 2005	12	9	8	5
24	Christian Creek	Buncombe	Fall 2007	11	4	7	23

What do the scores mean?

Total Taxa Richness	= the higher the better	
EPT Taxa Richness	= the higher the better	
Izaak Walton Score	Excellent	> 22
	Good	17-22
	Fair	11-16
	Poor	<11

Note: IWL modified their index calculation; the SMIE Program used the revised methods in spring 2008, all previous years data were calculated using the old methods.

VA SOS Rating	Acceptable	7-12
	Unacceptable	0-6

Appendix A

Taxa list for the Stream Monitoring Information Exchange Program

Organism ID Number	Group Name
	INSECTS
	STONEFLIES
1	Giant Shredder
2	Roach Shredder
3	Quick Crawling Predator
4	Fragile Detritivore
	MAYFLIES
5	Flattened Scrapers
6	Spiny Crawler
7	Round Headed Swimmer
8	Burrowing Mayflies
9	Spiny Turtle Mayfly
10	Filter Mayfly
	CADDISFLIES
	Free Living
11	Net Spinner
12	Small Head Caddis
	Vegetated Cases
13	Stick Bait Caddis
14	Square Log Cabin Caddis
15	Sand and Stick Case Caddis
16	Vegetative Case Caddis
	Mineral Cases
17	Gravel Coffin Case Caddis
18	Sand Snail Case
19	Sand or Mineral Case Caddis
	BEETLES
20	Water Penny
21	Predator Beetle
22	Adult Riffle Beetle
23	Larval Riffle Beetle
	MEGALOPTERANS
24	Hellgrammite
25	Fishfly
26	Alderfly
	ODONATES
42	Damselfly
43	Dragonfly

Organism ID Number	Group Name
	DIPTERANS
29	Watersnipe
30	Water-worm
31	Fat-head Cranefly
32	Chironomid Midge
33	Red Midge
34	Blackfly
	NON-INSECTS
27	Oligochaete
28	Leech
	CRUSTACEAN S
35	Crayfish
36	Sowbug (Isopod)
37	Scud (Amphipod)
	SNAILS
38	Coiled Left Face Snail
39	Coiled Right Face Snail
40	Rounded Right Face Snail
41	Clams and Mussels