



## Stream Monitoring Information Exchange

### Fall 2009 and Spring 2010 Report

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*"Square Log Cabin Case Caddisfly"*  
(Trichoptera: Brachycentridae)



*"Flattened Scraper Mayfly"*  
(Ephemeroptera: Heptageniidae)

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## **EXECUTIVE SUMMARY**

This report details the fall 2009 and spring 2010 results of the Stream Monitoring Information Exchange (SMIE) volunteer water quality monitoring program in western North Carolina. The spring 2010 sampling season marked the beginning of the SMIE Program's 6<sup>th</sup> year and there are now 30 active sites. 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 are 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 are being shared with DWQ to identify streams in the process of environmental degradation.

Six volunteers attended a training session on October 3, 2009 and 13 attended on March 14, 2010. Monitoring was conducted 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. Twenty-two sites were sampled in the fall and 29 in the spring; some sites were not sampled primarily due to weather and high flow conditions.

The total number of organisms collected varied, with many sites having less than 200 organisms in the sample. Due to low numbers, the results should be interpreted conservatively because of their effect on data interpretation.

Taxa richness ranged from nine to 21 taxa of 43 possible, depending on season but more taxa were generally found in the spring. 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 three to twelve of 19 possible, depending on season. 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 nine to 31; most sites were considered good or excellent. The Virginia Save Our Streams scores ranged from five to twelve with most sites being considered "acceptable". Both metrics did have seasonal variation, though.

The efforts of SMIE Program volunteers appear to show that streams in Buncombe, Haywood, Madison, Mitchell, and Yancey Counties are impacted by rainfall and multiple land use factors. These factors include human encroachment, replacement of native riparian buffer vegetation with impervious surfaces, exotic and invasive species, and erosion that lead to sedimentation of stream substrates.

The SMIE Program continues to work 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 continue (1) building and improving the skills of volunteers, (2) building a database that 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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## **1.0 INTRODUCTION**

This report details the fall 2009 and spring 2010 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 are 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. Tim Forrest from the University of North Carolina-Asheville was instrumental in providing classroom resources for hosting a basic training session on October 3, 2009. Milton Tignor from Haywood Community College assisted in the training session on March 14, 2010. Six volunteers attending the fall event and 13 attended in the spring.

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**

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 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<sup>2</sup> 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<sup>2</sup> 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<sup>3</sup> 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<sup>®</sup> spreadsheet software was used to summarize and manage data. Data were used to calculate several metrics that help interpret the level of water quality and sources of impairment, if any.

Total Taxa Richness: Sites with greater taxa richness are considered to have better water quality (Rosenberg and Resh 1996). There are 43 possible taxa in the SMIE Program methods.

EPT Taxa Richness: It is generally considered that EPT taxa (Ephemeroptera = mayflies, Plecoptera = stoneflies, and Trichoptera = caddisflies) are the most pollution sensitive aquatic invertebrates (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. There are 19 possible EPT taxa in the SMIE Program methods.

Total Number of Organisms: This metric is merely a sum of all the benthic macroinvertebrates collected in the kick and leaf pack samples. With good species diversity, high total numbers can indicate 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 (i.e., chemical contamination, recent flooding). Low numbers may also indicate inadequate sampling techniques or there just happened to be few macroinvertebrates in the collection area. This latter phenomenon is called 'patchiness', a natural property of many living (plant and animal) communities. Low numbers pose a very real problem to the interpretation of data.

Virginia Save Our Streams (VASOS) multi-metric index: The VASOS index calculates six metrics which are then used to produce an 'unacceptable' or 'unacceptable' ecological condition rating. The six metrics are percent EPT (excluding the 'netspinner' caddisflies), percent netspinner (Hydropsychidae) caddisflies, percent lunged snail, percent beetle, percent tolerant organisms, and percent non-insects. The VASOS method scores sites on a scale of 1 to 12 with "acceptable" between 7 and 12 and "unacceptable" between 0 and 6.

Izaak Walton League (IWL) multi-metric index: The IWL rating uses the presence of various macroinvertebrate groups, combined with estimated tolerance values for these groups, to calculate an index of water quality. 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.

P/R (Production/Respiration): 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. Scores greater than 0.75 indicates the stream may be autotrophic or could have significant organic pollution; less than 0.75 indicates stream may be heterotrophic. 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.

Leaf Input: 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. Scores greater than 0.25 in spring and summer and 0.5 in winter and autumn indicate the stream is more heterotrophic. Scores less than those values indicate the stream may be impaired, most likely from riparian buffer alterations. 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.

Top-Down: This metric is calculated as the ratio of predators to shredders, scrapers, collectors and filterers. Lower scores mean more plant eating trophic groups are present and an indication that water quality is better. Ratios greater than 0.15 may indicate predators are controlling macroinvertebrate distributions. Predators that are effective colonizers may potentially limit the colonization of other invertebrates, particularly at sites with severe natural disturbances where 'natural' communities have been altered or destroyed.

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 taxa collected. Low values

suggest pollution or recent benthic macroinvertebrate colonization, such as after flooding or drought. Due to the way the metrics are calculated, taxa density values are lower than Simpson's Diversity. There are no standards for what indicates impairment but values from the SMIE Program in other counties indicate Simpson's Diversity values greater than 0.75 and taxa density values greater than 0.15 are an indication that numbers are fairly well distributed among the taxa collected.

The use of these metrics is widespread. While some metrics may be partially redundant, 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). 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.

### **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 all maintained or improved their basic invertebrate identification skills after completing the training session.

Between both training events, the average taxonomy score on the identification quiz was 10 out of 15 (67%). 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 participants ranged from having little or no prior experience monitoring streams to college-level instruction, and all felt the SMIE training improved their monitoring skills/knowledge. All participants felt they had maintained or improved their knowledge of threats to water quality, and the majority of participants felt more empowered to address threats to water quality.

#### **3.2 Stream Monitoring Summary**

Tables 1 and 2 summarize the collection data. The results from sites where very low numbers were collected should be interpreted conservatively. Low numbers significantly affects data interpretation and can explain much of the discrepancies between metrics. Collecting 200 organisms is generally considered the minimum number for good data interpretation. Recent comparative analysis of SMIE and NC DWQ data showed the predictive power of SMIE data improves considerably when a minimum of 200 organisms are collected.

Monitoring was conducted at 22 sites in the fall. Despite repeated attempts, seven sites were not sampled due to the frequency of rain events and subsequent stream flooding. Better weather was experienced in the spring and 29 sites were sampled. The following descriptions summarize the overall results in each season.

##### Total Taxa Richness and EPT Taxa Richness (Figures 1 and 2)

Fall: Taxa richness ranged from ten (Big Ivy River, Reed Creek) to 21 taxa (Cane Creek #123, Sandymush Creek, Shelton Laurel Creek) of 43 possible. Many sites had high EPT (Ephemeroptera = mayflies,



Plecoptera = stoneflies, and Trichoptera = caddisflies) taxa richness. EPT richness ranged from three (Reed Creek) to twelve (Shelton Laurel Creek) of 19 possible.

Spring: Taxa richness ranged from nine (Newfound Creek, Smith Mill Creek) to 21 taxa (Cane Creek #182) of 43 possible. EPT richness ranged from five (Newfound Creek, North Toe River, Reed Creek, Smith Mill Creek) to twelve (Cane Creek #182) of 19 possible.

Higher taxa diversity was generally observed in the spring, which follows known trends in benthic macroinvertebrate life histories (Allan 1995). Also, even though the sites with the highest diversity had less than half of the total possible, several taxa 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 crane flies, red midges, leeches, sowbugs, scuds, round right-facing snails, clams/mussels). Taxa richness in some of the highest quality SMIE-sampled streams ranges from 15 to 20 and rarely over 20. 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).

#### Total Number of Organisms

Fall: The total number of organisms collected ranged from a high of 290 (Cane Creek #123) to 14 sites having less than 200.

Spring: The total number of organisms collected ranged from a high of 367 (Cane Creek #1481) to nine sites having less than 200.

#### VASOS and IWL

Fall: The IWL scores ranged from 16 (Newfound Creek) to 31 (Reems Creek); nine sites were considered excellent, eleven were good, and two were fair. The VASOS scores ranged from four to twelve, with 20 sites rated as acceptable and two as unacceptable (Newfound Creek, Reed Creek). With one exception (Reed Creek; see site description), the IWL and VASOS scores corresponded to each other. Sites with higher IWL scores tended to have higher VASOS scores.

Spring: The IWL scores ranged from nine (Smith Mill Creek) to 31 (East Fork Bull Creek); eleven sites were considered excellent, nine were good, eight were fair, and one was poor (Smith Mill Creek). The VASOS scores ranged from four to twelve, with 27 sites rated as acceptable and two as unacceptable (Newfound Creek, Pigeon River). With two exceptions (Pigeon River, Smith Mill Creek; see site description), the IWL and VASOS scores corresponded to each other.

It should be noted that IWL and VASOS don't consider the same parameters when calculating the final score. 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.

#### P/R

Fall: All but four sites were characterized as heterotrophic ( $P/R < 0.75$ ). The P/R ratios ranged from 0.00 (Reed Creek) to 2.0 (Big Laurel Creek). Other sites with values greater than 0.75, and thus could be receiving organic enrichment, were Big Ivy River, Little Ivy River, and Reems Creek.

Spring: All sites were characterized as heterotrophic.

Sites with scores of 0.00 indicate at least one trophic group was missing, which were the scrapers at those sites.

### Leaf Input

Fall: Scores ranged from 0.03 (Cane Creek #1481, East Fork Pigeon River) to 1.38 (Little Ivy River). All but five of the samples had scores indicating possible water quality impairment (<0.50).

Spring: Scores ranged from 0.0 (Cane Creek #1481, Newfound Creek, Reed Creek, Swannanoa River @ Bull Creek) to 0.46 (Shelton Laurel Creek). Those sites with scores of 0.00 were due to an absence of shredders. All but one of the samples had scores indicating possible water quality impairment (<0.25).

Scores less than the 0.25 in the spring and 0.50 in the fall suggests leaf litter was limited, either as a result of the leaf inputs being consumed or broken down, or a disruption in riparian buffer zone condition. Sites with scores of 0.00 indicate an absence of shredders.

### Top-Down

Fall: This ratio ranged from 0.02 (Reed Creek) to 0.89 (Swannanoa River @ Beetree Creek). It was considered high (>0.15) at 16 sites and suggests predator abundance may influence the composition of macroinvertebrate assemblages. Sites with scores less than 0.15 indicate more herbivores are present and better water quality.

Spring: This ratio ranged from 0.01 (Newfound Creek) to 1.21 (Bent Creek). It was also considered high at 16 sites.

Sites with scores less than 0.15 indicate more herbivores are present and that water quality is better.

### Simpson's Diversity and Taxa Density

Fall: Simpson values ranged from 0.6 (Reed Creek) to 0.95 (Swannanoa River @ Bull Creek). Taxa density numbers ranged from 0.04 (Reed Creek) to 0.21 (Jonathans Creek @ Coleman Mountain Road, Little Ivy River). Most sites had Simpson values greater than 0.75 and are an indication that the numbers were well distributed among the taxa collected. However, only six sites had comparable taxa density scores.

Spring: Simpson values ranged from 0.29 (Newfound Creek) to 0.85 (Big Ivy River, North Toe River, Shelton Laurel Creek). Taxa density numbers ranged from 0.03 (Newfound Creek) to 0.16 (North Toe River). Similar to the fall scores, most sites had Simpson values greater than 0.75 but only two sites had comparable taxa density scores.

Low values suggest pollution or recent benthic macroinvertebrate colonization, such as after flooding or drought.

## **3.3 Site Descriptions and Sampling Summaries**

The following section describes the location and habitat at each sample site. The SMIE and VWIN programs use the same number where sites overlap; 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 #123 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.

Exotic plant species are present. Substrates are comprised of gravel and cobblestones that are moderately embedded.

The following results were found in the benthic macroinvertebrate data:

- The data were fairly comparable between seasons. It was considered acceptable by VASOS and excellent by IWL in both collections. Two additional EPT taxa were found in the spring which contributed to the higher VASOS score of 11.
- The IWL scores were among the highest IWL scores found among all sampling sites.
- Historical IWL scores have indicated good to excellent conditions in all seasons except the first sample collected in spring 2005. It has been excellent the last seven collection events. It has been acceptable according to VASOS in all events except the falls of 2006 and 2008.
- In the fall, net spinning caddisflies dominated the sample (33%), but small head caddisflies were also abundant (25%). Spiny crawler mayflies dominated the spring sample (72%).
- P/R ratios indicate a heterotrophic site.
- The leaf input metric scores indicate this site has some degree of riparian buffer disruption.
- The top-down metric was high in the fall (0.53), possibly a result of the high number of small-headed caddisflies, but does indicate some level of disturbance.
- The two distribution metrics indicate mixed results. There was a high Simpson's value founding the fall (0.79), but all other scores were low.

#### **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 subsequently 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. The bottom habitat is gravel and cobblestones that are loosely embedded. The forest is relatively intact around the site which provides excellent riparian conditions.

The following results were found in the benthic macroinvertebrate data:

- This site was considered acceptable by VASOS in both seasons. IWL rated it good in the fall and excellent in the spring, probably due to higher taxa richness.
- The EPT taxa included giant shredders, which are one of the most pollution intolerant groups among the SMIE taxa.
- The most abundant organisms in the fall were quick crawling predator stoneflies (27%), net-spinning caddisflies (26%), and small head caddisflies (21%). In the spring, it was small head caddisflies (37%), spiny crawlers (18%), and quick crawling predators (18%)
- Historical IWL scores have ranged from good to excellent (range: 18-28) with the exception of the first event in spring 2005, which had a score of eight. It has always been acceptable according to VASOS.
- P/R ratios indicate a heterotrophic site.
- The leaf input metric scores indicate this site has some degree of riparian buffer disruption.
- The top-down metric was high in both seasons and indicates some level of disturbance.
- The two distribution metrics indicate mixed results. There was a high Simpson's values found in both seasons, but the taxa density scores were lower and likely a result of the high abundances of the taxa indicated above.

#### **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 moderately embedded.

The following results were found in the benthic macroinvertebrate data:

- This site was considered acceptable by VASOS in both seasons. IWL rated it good in the fall and excellent in the spring. Higher taxa richness and EPT diversity in the spring can explain the difference, but it should be noted that less than 200 organisms were collected in both seasons, particularly in fall.
- Quick crawling predator stoneflies (30%) and net-spinning caddisflies (21%) were the most abundant organisms in the fall. Round headed swimmer mayflies (28%) and spiny crawler mayflies (18%) were the most abundant in the spring.
- Historical IWL scores have ranged from fair to excellent (range: 11-26). It has always been acceptable according to VASOS.
- There was a P/R value in the fall (1.12) that suggests this site experiences high organic enrichment at times.
- The leaf input metric scores indicate this site has some degree of riparian buffer disruption.
- The top-down metric was high in both seasons and indicates some level of disturbance.
- The two distribution metrics indicate the numbers were well-distributed among the taxa found.

### **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.

The following results were found in the benthic macroinvertebrate data:

- This site was considered acceptable by VASOS in both seasons. IWL rated it excellent in the fall and good in the spring. Higher taxa richness and EPT diversity in the fall can explain the difference.
- In the fall, net-spinning caddisflies (30%) and small head caddisflies (17%) were the most abundant organisms collected. In the spring, spiny crawler mayflies (60%) dominated the sample.
- Historical IWL scores have ranged from poor to excellent (range: 6-27), but it has rated good or excellent since spring 2007. It has always been acceptable according to VASOS.
- P/R ratios indicate a heterotrophic site.
- The leaf input metric scores indicate this site has some degree of riparian buffer disruption.
- The top-down metric was high in both seasons and indicates some level of disturbance.
- The two distribution metrics indicate mixed results. There was a high Simpson's values found in both seasons, but the taxa density scores were lower and likely a result of the high abundances of the taxa indicated above.

### **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.

No sample was collected in the fall. The following results were found in the spring benthic macroinvertebrate data:

- This site was considered acceptable by VASOS (12) and good by IWL (18).
- There were 21 taxa collected, including 13 EPT taxa. The EPT taxa included giant shredders, which are one of the most pollution intolerant groups among the SMIE taxa.
- Spiny crawler mayflies (27%), round headed swimmer mayflies (25%), and small head caddisflies (17%) were the most abundant organisms collected.
- Historical IWL scores have ranged from good to excellent (range: 18-23). It has always been acceptable according to VASOS.
- The P/R ratio indicates a heterotrophic site

- The leaf input metric scores indicate this site has some degree of riparian buffer disruption.
- The top-down metric was high (0.41) and indicates some level of disturbance.
- The two distribution metrics indicate mixed results. There was a high Simpson's value (0.81), but the taxa density score was lower than expected (0.09) and likely a result of the high abundances of the taxa indicated above.

#### **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 substrate at this site is sand, which is a change from previous years of gravel and cobblestone. The substrates are moderately embedded. Trees and shrubs were the most common plants in the riparian zone, but many grasses and exotic species are also present.

The following results were found in the benthic macroinvertebrate data:

- The number collected (118) is well below the number recommended for proper data analysis (200 individuals).
- This site was considered acceptable by VASOS in both seasons. It was considered good by IWL (19) in the fall but only fair in the spring (15).
- Fragile detritivore stoneflies (46%) and net-spinning caddisflies (31%) were the most abundant organisms in the fall sample. Spring crawler mayflies (25%) and round headed swimmers (25%) were abundant in the spring.
- Historical IWL scores have ranged from poor to excellent (range: 8-28). It has been acceptable according to VASOS in all samples except fall 2007.
- The P/R ratio and leaf input metrics generally indicate a heterotrophic site.
- The top-down metric was high in the spring (0.26) and indicates some level of disturbance.
- The two distribution metrics indicate the numbers were well-distributed among the taxa present.

#### **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 gravel and cobblestones that are moderately embedded. Beavers constructed a dam in the previous year, which has likely changed the substrate composition. The riparian zone consists of mostly trees and shrubs but it has been disturbed by roads and homes.

The following results were found in the benthic macroinvertebrate data:

- The number collected in the fall (159) is below the number recommended for proper data analysis (200 individuals).
- This site was considered unacceptable by VASOS and fair by IWL in both seasons, most likely a result of the high abundance of net-spinning caddisflies and blackflies.
- Net-spinning caddisflies (52%) were the most abundant organisms in the fall sample; blackflies dominated the spring (84%).
- Historical IWL scores have ranged from fair to excellent (range: 11-25). It has been frequently unacceptable according to VASOS; five of the nine samples had scores less than seven.
- The P/R ratio indicates a heterotrophic site.
- The leaf input metric scores indicate this site has some degree of riparian buffer disruption.
- The two distribution metrics generally indicate the numbers are not well-distributed among the taxa present. Only in the fall was a high Simpson's value found (0.70).

#### **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. 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.

The following results were found in the benthic macroinvertebrate data:

- This site had one of the lowest total diversities and EPT diversities in both seasons among all sites.
- Stoneflies were noticeably absent in both seasons.
- In the fall, the site was rated as “good” (19) by IWL but unacceptable (4) by VASOS. The difference can be attributed to the abundance of two tolerant taxa: oligochaetes (59%) and net-spinning caddisflies (21%). The fall VASOS score was the lowest among all sites.
- In the spring it was fair (16) by IWL and acceptable (10) by VASOS.
- Two taxa dominated the spring sample: round headed swimmer mayflies (47%) and chironomid midges (31%).
- This site frequently has the lowest water quality scores each sampling season among all sites. IWL scores have ranged from poor to good (range: 8-19). It has been frequently unacceptable according to VASOS; six of the ten samples had scores less than seven.
- The P/R ratio indicates a heterotrophic site.
- The leaf input metric scores indicate this site has some degree of riparian buffer disruption.
- The two distribution metrics generally indicate the numbers are not well-distributed among the taxa present. Only in the fall was a high Simpson’s value found (0.94).

#### **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 that are moderately embedded. The riparian zone is comprised of trees and shrubs.

The following results were found in the benthic macroinvertebrate data:

- This site was considered acceptable by VASOS in both seasons. IWL rated it excellent in the fall and good in the spring. The fall score (31) was one of the highest among all the sites. The lower spring scores were due to less of the IWL taxonomic groups.
- The EPT taxa included giant shredders, which are one of the most pollution intolerant groups among the SMIE taxa.
- In the fall, no one taxa dominated the sample but net-spinning caddisflies (22%), water pennies (14%) and flattened scraper mayflies (13%) were the most abundant, which resulted in a high Simpsons Diversity index value (0.89).
- The most abundant organisms in the spring were spiny crawler mayflies (47%) and quick crawling predator stoneflies (17%).
- Historical IWL scores have ranged from good to excellent (range: 22-32). It has always been acceptable according to VASOS. This site typically has high ratings compared to the other sites.
- P/R ratios indicate this site periodically experiences organic enrichment.
- The leaf input metric scores indicate this site has some degree of riparian buffer disruption.
- The top-down metric was high in both seasons and indicates some level of disturbance.
- The two distribution metrics indicate mixed results. There was a high Simpson’s values found in both seasons, but the taxa density scores were lower and likely a result of the high abundances of the taxa indicated above.

#### **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 loose gravel and cobblestones. The riparian zone consists of trees and shrub.

The following results were found in the benthic macroinvertebrate data:

- This site was considered acceptable by VASOS in both seasons. IWL rated it excellent in the fall and good in the spring; the lower score can be attributed to less taxa and EPT taxa richness.
- The EPT taxa included giant shredders, which are one of the most pollution intolerant groups among the SMIE taxa.
- Net-spinning caddisflies (35%) and flattened scraper mayflies (20%) were the most abundant organisms. However, very few organisms were collected (142), which is well below the number recommended for proper data analysis (200 individuals).
- The most abundant organisms in the spring were spiny crawler mayflies (49%).
- Historical IWL scores have ranged from fair to excellent (range: 12-26). VASOS has rated it acceptable in recent years but it was considered unacceptable in fall 2005 and 2007.
- P/R ratios and leaf input scores indicate this site is heterotrophic.
- The two distribution metrics indicate this site has a fairly good distribution of individuals among the taxa.

#### **Smith Mill Creek – SMIE Site #146**

This site is located at Louisiana Boulevard and corresponds to a VWIN site (old site 35). It was first sampled in the spring 2009. The substrate is gravel and cobblestones but sand is also abundant and has moderately embedded the substrates. The riparian zone consists of trees and shrub, although grasses, vines and exotic plants are also present.

No benthic sample was collected in the fall. The following results were found in the spring:

- Very few organisms were collected (77), which is well below the number recommended for proper data analysis (200 individuals).
- This site had one of the lowest total diversities and EPT diversities in both seasons among all sites.
- Stoneflies were noticeably absent.
- This site was rated as acceptable by VASOS but poor by IWL. The difference can be attributed to the presence of mayflies and caddisflies that increased the VASOS score.
- Two taxa dominated the sample, both of which are considered tolerant, chironomid midges (47%) and oligochaetes (25%).
- This site has been sampled twice. In the spring 2009 it was unacceptable by VASOS and fair by IWL.
- P/R ratios and leaf input scores indicate this site is heterotrophic.
- The two distribution metrics generally indicate the individuals were fairly well-distributed among the taxa present.

#### **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.

The following results were found in the benthic macroinvertebrate data:

- Very few organisms were collected in both seasons (104 and 132), which are well below the number recommended for proper data analysis (200 individuals).
- This site was considered acceptable by VASOS and fair by IWL in both seasons.
- The EPT taxa included giant shredders, which are one of the most pollution intolerant groups among the SMIE taxa.
- In the fall, round headed swimmer mayflies (21%), net-spinning caddisflies (19%), and oligochaete worms (14%) were the most abundant taxa collected.
- In the spring, net-spinning caddisflies (37%) and spiny crawler mayflies (23%) were the most abundant organisms.

- Historical IWL scores have ranged from poor to excellent (range: 5-25). VASOS has rated it acceptable in all years except fall 2006 and fall 2007.
- P/R ratios indicate this site is heterotrophic.
- The leaf input metric scores indicate this site has some degree of riparian buffer disruption.
- The two distribution metrics indicate this site has a fairly good distribution of individuals among the taxa.

#### **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.

The following results were found in the benthic macroinvertebrate data:

- Few organisms were collected in the fall (158), which is below the number recommended for proper data analysis (200 individuals).
- This site was considered acceptable by VASOS and excellent by IWL in both seasons.
- Stoneflies were noticeably absent in the fall.
- In the fall, the sample was dominated by net-spinning caddisflies (41%). In the spring, spiny crawler mayflies (56%) dominated the sample but net-spinning caddisflies (19%) were also abundant.
- Historical IWL scores have ranged from poor to excellent (range: 8-31). VASOS has rated it acceptable in seven of the eleven sampling seasons.
- P/R ratios indicate this site is heterotrophic.
- The leaf input metric scores indicate this site has some degree of riparian buffer disruption.
- The two distribution metrics indicate this site in the fall had good distribution of individuals among the taxa even with the abundance of net-spinners, but not as much in the spring.

### ***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. Bedrock, boulders, gravel and cobblestones are all abundant, as is sand which has led to the substrates being extremely embedded.

The following results were found in the benthic macroinvertebrate data:

- Few organisms were collected in the fall (110), which is below the number recommended for proper data analysis (200 individuals).
- This site was considered acceptable by VASOS and good by IWL in both seasons.
- The EPT taxa included roach shredder stoneflies, which are one of the most pollution intolerant groups among the SMIE taxa.
- In the fall, filterer mayflies were the most abundant organisms collected (30%). In the spring, it was dominated by net-spinning caddisflies (51%).
- Historical IWL scores have ranged from poor to excellent (range: 9-28). VASOS has rated it acceptable in all samples.
- P/R ratios indicate this site is heterotrophic.
- The leaf input metric scores indicate this site has some degree of riparian buffer disruption.
- The top-down metric scores were high indicating some level of disturbance.
- The two distribution metrics indicate this site has a fairly good distribution of individuals among the taxa. This was particularly demonstrated in the fall.



### **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 following results were found in the benthic macroinvertebrate data:

- This site was considered acceptable by VASOS in both seasons IWL rated it good in the fall and excellent in the spring.
- The EPT taxa included roach shredder stoneflies, which are one of the most pollution intolerant groups among the SMIE taxa.
- In the fall, three taxa comprised most of the sample: net-spinning caddisflies (36%), quick crawling predator stoneflies (17%), and small head caddisflies (14%).
- In the spring, small headed caddisflies (26%) and spiny crawler mayflies (23%) were most abundant.
- Historical IWL scores have ranged from fair to excellent (range: 14-26). VASOS has rated it acceptable in all samples.
- P/R ratios indicate this site is heterotrophic.
- The leaf input metric scores indicate this site has some degree of riparian buffer disruption.
- The top-down metric scores were high indicating some level of disturbance.
- The two distribution metrics indicate this site has a good distribution of individuals among the taxa.

### **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 extremely embedded the substrates.

The following results were found in the benthic macroinvertebrate data:

- Few organisms were collected in the fall (167), which is below the number recommended for proper data analysis (200 individuals).
- This site was considered acceptable by VASOS in both seasons IWL rated it good in the fall and excellent in the spring.
- The EPT taxa included roach shredder stoneflies, which are one of the most pollution intolerant groups among the SMIE taxa.
- In the fall, net-spinning caddisflies (31%) and round headed swimmer mayflies (23%) were the most abundant organisms in the sample.
- In the spring, quick crawling predator stoneflies (30%) and net-spinning caddisflies (25%).
- Historical IWL scores have ranged from fair to excellent (range: 15-28). VASOS has rated it acceptable in all samples.
- P/R ratios indicate this site is heterotrophic.
- The leaf input metric scores indicate this site has some degree of riparian buffer disruption.
- The top-down metric scores were high indicating some level of disturbance.
- The two distribution metrics indicate this site has a good distribution of individuals among the taxa.

### **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.

The following results were found in the benthic macroinvertebrate data:

- Very few organisms were collected in the fall (56), which is well below the number recommended for proper data analysis (200 individuals).
- This site was considered acceptable by VASOS in both seasons IWL rated it good in the fall and fair in the spring.
- In the fall, spiny crawler mayflies were the most abundant organisms in the sample (27%).
- In the spring, round headed swimmer mayflies (42%) and spiny crawler mayflies (36%) dominated the sample.
- Historical IWL scores have ranged from fair to good (range: 15-22). VASOS has rated it acceptable in all samples.
- P/R ratios indicate this site is heterotrophic.
- The leaf input metric scores indicate this site has some degree of riparian buffer disruption.
- The top-down metric score in the fall indicates some level of disturbance.
- The two distribution metrics indicate this site has a fair distribution of individuals among the taxa.

#### **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 and has moderately embedded the substrates.

No sample was collected in the fall. The following benthic results are from the spring.

- Few organisms were collected (145), which is below the number recommended for proper data analysis (200 individuals).
- This site was considered acceptable by VASOS and fair by IWL.
- The EPT taxa included roach shredder stoneflies, which are one of the most pollution intolerant groups among the SMIE taxa.
- Spiny crawler mayflies dominated the sample (63%).
- Historical IWL scores have ranged from fair to good (range: 11-20). VASOS has rated it acceptable in all samples.
- P/R ratio indicates this site is heterotrophic.
- The leaf input metric score indicates this site has some degree of riparian buffer disruption.
- The distribution metrics indicate the numbers were not well distributed among the taxa.

#### **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.

No sample was collected in the fall. The following benthic results are from the spring.

- This site was considered unacceptable by VASOS but good by IWL, which can be attributed to the number of EPT taxa collected.
- Chironomid midges (42%) and net-spinning caddisflies dominated the sample (31%).
- Historical IWL scores have ranged from fair to good (range: 11-21). VASOS has rated it unacceptable in all samples.
- P/R ratio indicates this site is heterotrophic.
- The leaf input metric score indicates this site has some degree of riparian buffer disruption.
- The distribution metrics indicate the numbers were fairly well distributed among the taxa.

### **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 moderately embedded.

No sample was collected in the fall. The following benthic results are from the spring.

- Few organisms were collected (139), which is below the number recommended for proper data analysis (200 individuals).
- This site was considered acceptable by VASOS and fair by IWL.
- The EPT taxa included giant shredder stoneflies and roach shredder stoneflies, which are two of the most pollution intolerant groups among the SMIE taxa.
- Round headed swimmer mayflies dominated the sample (56%).
- Historical IWL scores have ranged from fair to good (range: 11-21). VASOS has rated it acceptable in all samples.
- P/R ratio indicates this site is heterotrophic.
- The leaf input metric score indicates this site has some degree of riparian buffer disruption.
- The top-down metric score in the fall indicates some level of disturbance.
- The distribution metrics indicate the numbers were fairly well distributed among the taxa.

### **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.

No sample was collected in the fall. The following benthic results are from the spring.

- Few organisms were collected (164), which is below the number recommended for proper data analysis (200 individuals).
- This site was considered acceptable by VASOS and fair by IWL.
- Round headed swimmer mayflies dominated the sample (53%).
- Historical IWL scores have ranged from poor to excellent (range: 5-23). VASOS has rated it acceptable in all samples.
- P/R ratio indicates this site is heterotrophic.
- The leaf input metric score indicates this site has some degree of riparian buffer disruption.
- The top-down metric score in the fall indicates some level of disturbance.
- The distribution metrics indicate the numbers were fairly well distributed among the taxa.

## ***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 that are loosely embedded.

The following results were found in the benthic macroinvertebrate data:

- Few organisms were collected in the fall (148), which is below the number recommended for proper data analysis (200 individuals).
- This site was considered acceptable by VASOS in both seasons. IWL rated it excellent in the fall and good in the spring.
- The EPT taxa included roach shredder stoneflies, which is highly pollution intolerant.
- In the fall, the most common organisms were water pennies (32%) and flattened scraper mayflies (29%).
- In the spring, spiny crawler mayflies (48%) dominated the sample.
- Historical IWL scores have ranged from fair to excellent (range: 13-28). VASOS has rated it acceptable in all samples.
- The fall P/R ratio was very high (2.00) and indicate this site periodically experiences organic enrichment.
- The leaf input metric scores indicate this site has some degree of riparian buffer disruption.
- The top-down metric score in the spring indicates some level of disturbance.
- The two distribution metrics indicate this site has a good distribution of individuals among the taxa.

### **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 moderately embedded.

The following results were found in the benthic macroinvertebrate data:

- Few organisms were collected in both seasons and are below the number recommended for proper data analysis (200 individuals).
- This site was considered acceptable by VASOS and excellent by IWL in both seasons.
- In the fall, net-spinning caddisflies dominated the sample (45%) but small head caddisflies were also abundant (20%).
- In the spring, water pennies (29%) and spiny crawler mayflies (20%) were the most abundant.
- Historical IWL scores have ranged from poor to excellent (range: 7-31). VASOS has rated it acceptable in all samples.
- P/R ratio indicates this site is heterotrophic.
- The leaf input metric score indicates this site has some degree of riparian buffer disruption.
- The top-down metric score in the spring indicates some level of disturbance.
- The two distribution metrics indicate this site has a good distribution of individuals among the taxa.

### **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). It was first sampled in spring 2009. The substrate is dominated by gravel and cobblestones that are moderately embedded. The riparian zone consists of trees and shrub, although grasses, vines and exotic plants are also present.

The following results were found in the benthic macroinvertebrate data:

- This site was considered acceptable by VASOS and excellent by IWL in both seasons.
- In the fall, net-spinning caddisflies (34%) and fragile detritivore stoneflies (32%) were most abundant.
- In the spring, spiny crawler mayflies (34%) were the most abundant.
- Historical IWL scores have consistently found excellent water quality (range: 25-31). VASOS has rated it acceptable in all samples.
- P/R ratio indicates this site is heterotrophic.
- Although the fall value was high (0.83), the leaf input metric score indicates this site has some degree of riparian buffer disruption.
- The two distribution metrics indicate this site has a good distribution of individuals among the taxa.

### **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. The substrates are moderately embedded. 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.

No sample was collected in the spring. The following benthic results are from the fall.

- Very few organisms were collected (56), which is well below the number recommended for proper data analysis (200 individuals).
- This site was considered acceptable by VASOS and good by IWL.
- Water worms dominated the sample (32%).
- Historical IWL scores have ranged from poor to excellent (range: 10-2). VASOS has rated it acceptable in all samples.
- P/R ratio indicates this site has periodic organic enrichment.
- The leaf input metric score indicates heterotrophic conditions.
- The top-down metric score indicates some level of disturbance.
- The distribution metrics indicate the numbers were well distributed among the taxa.

### **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. It was first sampled in fall 2007. Substrates are mostly gravel and cobblestones and are moderately embedded; the riparian zone is mostly trees and shrubs with some grasses and vine.

The following results were found in the benthic macroinvertebrate data:

- This site was considered acceptable by VASOS in both seasons. IWL rated it good in the fall and excellent in the spring.
- The EPT taxa included giant shredder stoneflies and roach shredder stoneflies, which are two of the most pollution intolerant groups among the SMIE taxa.
- In the fall, net-spinning caddisflies (36%), small head caddisflies (19%), and quick crawling predator stoneflies (13%) comprised most of the sample.
- In the spring, spiny crawler mayflies (34%) were the most abundant organism in the sample.
- Historical IWL scores have ranged from good to excellent (range: 17-24). VASOS has rated it acceptable in all samples.
- P/R ratio indicates this site is heterotrophic.
- The leaf input metric scores indicate this site has some degree of riparian buffer disruption.
- The top-down metric scores indicate some level of disturbance.
- The two distribution metrics indicate this site has a good distribution of individuals among the taxa.

### **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.

The following results were found in the benthic macroinvertebrate data:

- This site was considered acceptable by VASOS in both seasons. IWL rated it excellent in the fall and good in the spring.

- The EPT taxa included roach shredder stoneflies, which are one of the most pollution intolerant groups among the SMIE taxa.
- In the fall, the most common taxa were fragile detritivore stoneflies (25%), net-spinning caddisflies (20%), and flattened scraper mayflies (16%).
- In the spring, no one organism dominated the sample but spiny crawler mayflies (19%), net spinning caddisflies (18%), stick bait caddisflies (17%), and flattened scraper mayflies were abundant.
- Historical IWL scores have ranged from fair to excellent (range: 15-31). VASOS has rated it acceptable in all samples.
- P/R ratio indicates this site is heterotrophic.
- The leaf input metric scores indicate this site has some degree of riparian buffer disruption.
- The top-down metric scores indicate some level of disturbance.
- The two distribution metrics indicate this site has a good distribution of individuals among the taxa.

### ***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). It was first sampled in spring 2008. Substrates are composed of mostly gravel and cobblestones that are moderately embedded by sand. The riparian zone is mostly trees and shrubs, and grasses, vines, and rip-rap are also present.

The following results were found in the benthic macroinvertebrate data:

- Few organisms were collected in the fall (148), which is below the number recommended for proper data analysis (200 individuals).
- This site was considered acceptable by VASOS and excellent by IWL in both seasons.
- In the fall, the most common taxa were flattened scraper mayflies (25%) and quick crawling predator stoneflies (22%).
- In the spring, spiny crawler mayflies dominated the sample (75%).
- Historical IWL scores have ranged from good to excellent (range: 18-28). VASOS has rated it acceptable in all samples.
- P/R ratio indicates this site is heterotrophic.
- The leaf input metric scores indicate this site has some degree of riparian buffer disruption.
- The top-down metric scores indicate some level of disturbance.
- The spring distribution metrics indicate this site periodically does not have a good distribution of individuals among the taxa.

#### **North Toe River – SMIE Site #1404**

This site is located at the Red Hill Bridge and corresponds to a VWIN site (old site 4). It was first sampled in the spring of 2009. The substrate is dominated by gravel and cobblestones that are extremely embedded by finer substrates. The riparian zone consists of trees and shrubs.

No sample was collected in the fall. The following benthic results are from the spring.

- Few organisms were collected (95), which is below the number recommended for proper data analysis (200 individuals).
- This site was considered acceptable by VASOS and good by IWL.
- The EPT taxa included giant shredder stoneflies, which are one of the most pollution intolerant groups among the SMIE taxa.
- Net spinning caddisflies were the most abundant organism collected (29%).
- Only two samples have historically been collected. The previous sample was considered acceptable by VASOS and fair by IWL.
- P/R ratio indicates this site is heterotrophic.

- The leaf input metric score indicates this site has some degree of riparian buffer disruption.
- The top-down metric score in the fall indicates some level of disturbance.
- The distribution metrics indicate the numbers were well distributed among the taxa.

### *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.

No sample was collected in the fall. The following benthic results are from the spring.

- This site was considered acceptable by VASOS and excellent by IWL.
- The EPT taxa included roach shredder stoneflies, which are one of the most pollution intolerant groups among the SMIE taxa.
- Quick crawling predator stoneflies (32%), flattened scraper mayflies (19%), and net spinning caddisflies (17%) were the most abundant organism collected.
- Historical IWL scores have ranged from good to excellent (range: 16-24). VASOS has rated it acceptable in all samples.
- P/R ratio indicates this site is heterotrophic.
- The leaf input metric score indicates this site has some degree of riparian buffer disruption.
- The top-down metric score in the fall indicates some level of disturbance.
- The distribution metrics indicate the numbers were well distributed among the taxa.

## **4.0 SUMMARY**

The spring 2010 sampling season marked the beginning of the program's 6<sup>th</sup> year; there are now 30 active sites and many sites have been sampled all eleven seasons (spring and fall). Volunteers are collecting 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. 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.

There is a need to improve the collection skills of the volunteer base as evidenced by low sample numbers. Low sample numbers significantly affects data interpretation and samples with low numbers must be interpreted conservatively. The low numbers collected in many of the samples can explain much of the discrepancies between metrics, particularly VASOS and IWL, P/R and Leaf Input ratios, and historical trends. Future efforts need to target collecting 200 organisms per sample.

Discounting inadequate numbers, the efforts of SMIE Program volunteers appear to show that streams in Buncombe, Haywood, Madison, Mitchell, and Yancey Counties are impacted by multiple factors, particularly those related to land use.

One consistent trend is that most riparian zones are less than adequate. 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.

Another variable impacting streams is rainfall. It was a very wet year in 2009, which found frequent high flow events in the sample streams. High flows lead to increased habitat availability, but also substrate scouring if levels are too high. The low top-down metric scores are evidence that many of the streams were recently scoured. 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 stream bank 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 continue (1) building and improving the skills of volunteers, (2) building a database that 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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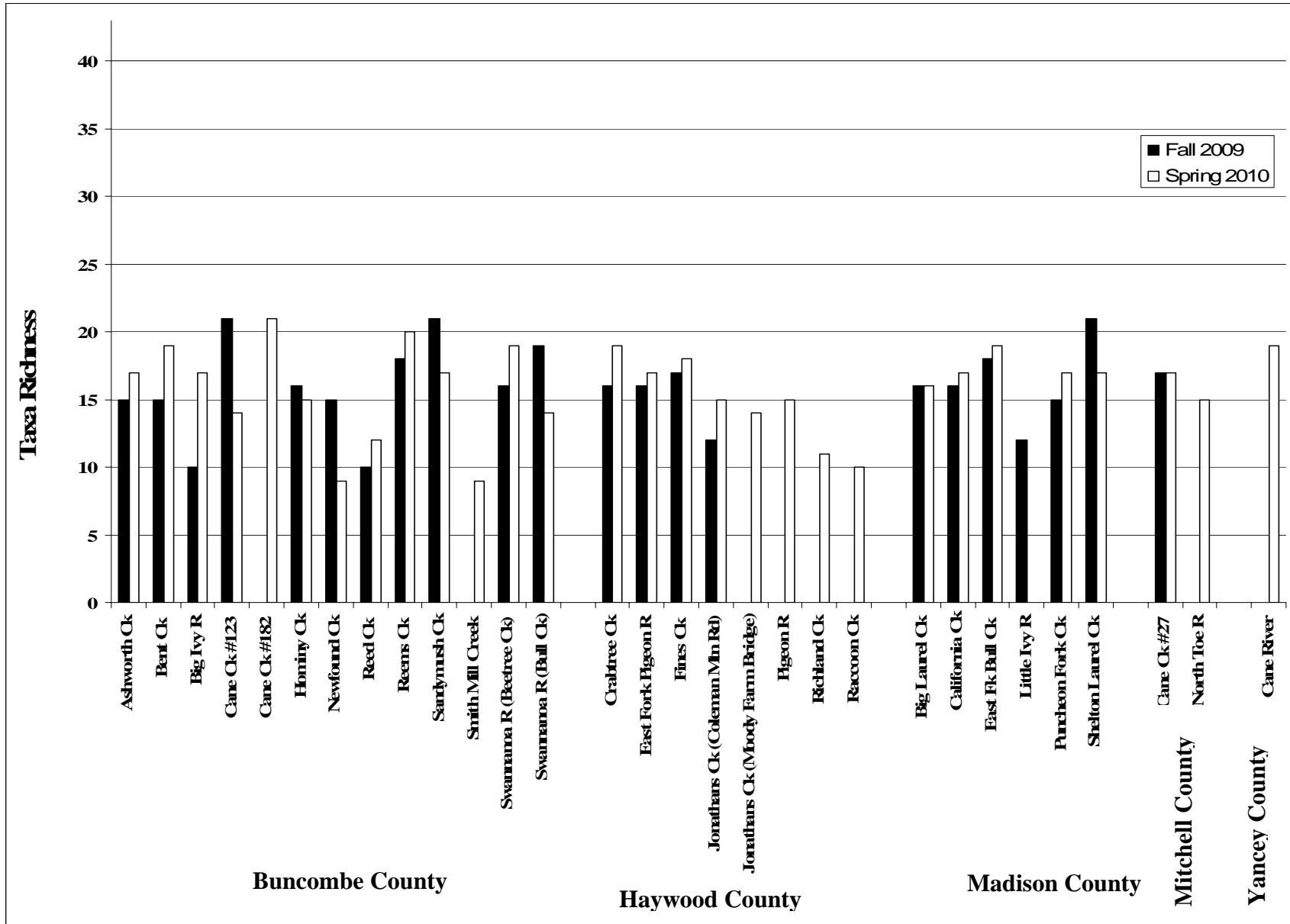


Figure 1. Taxa richness (43 taxa possible; Fall 2009 and Spring 2010).

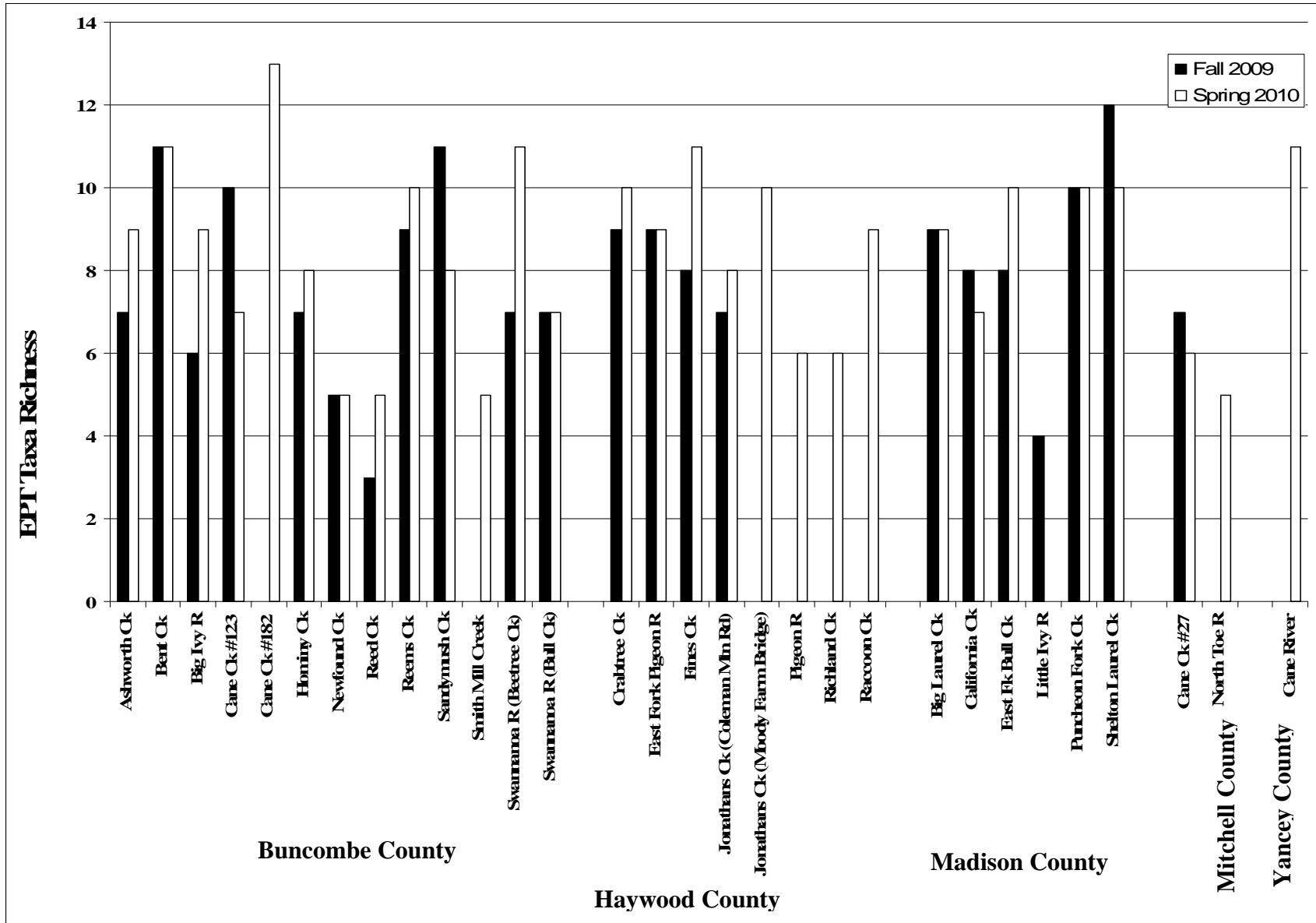


Figure 2. Number of EPT taxa (19 possible; Fall 2009 and Spring 2010).

Table 1. SMIE Program summary site data (Fall 2009 and Spring 2010; richness, abundance, VASOS and Izaak Walton League data)

Site #	Site	Season	Taxa Richness	Total Number Collected	Number of EPT Taxa	VASOS	VASOS Rating	Izaak Walton League	Izaak Walton League Rating
<i>Buncombe County</i>									
101	Big Ivy River	Fall	10	61	6	11	Acceptable	18	Good
		Spring	17	160	9	10	Acceptable	26	Excellent
105	Sandymush Creek	Fall	21	142	11	8	Acceptable	26	Excellent
		Spring	17	232	8	10	Acceptable	20	Good
106	Newfound Creek	Fall	15	159	5	5	Unacceptable	16	Fair
		Spring	9	290	5	6	Unacceptable	11	Fair
115	Swannanoa River @ dws Beetree Ck	Fall	16	104	7	7	Acceptable	18	Fair
		Spring	19	132	11	9	Acceptable	15	Fair
117	Hominy Creek	Fall	16	118	7	9	Acceptable	19	Good
		Spring	15	102	8	11	Acceptable	15	Fair
119	Bent Creek @ Asheville Arboretum	Fall	15	193	11	9	Acceptable	20	Good
		Spring	19	217	11	12	Acceptable	23	Excellent
123	Cane Creek #123	Fall	21	290	10	11	Acceptable	27	Excellent
		Spring	14	296	7	10	Acceptable	20	Good
124	Asheworth Creek	Fall	15	245	7	7	Acceptable	28	Excellent
		Spring	17	271	9	11	Acceptable	27	Excellent
149	Swannanoa River @ ups Bull Ck	Fall	19	158	7	7	Acceptable	25	Excellent
		Spring	14	271	7	10	Acceptable	25	Excellent
180	Reems Creek	Fall	18	226	9	10	Acceptable	31	Excellent
		Spring	20	285	10	12	Acceptable	22	Good
181	Reed Creek	Fall	10	271	3	4	Unacceptable	19	Good
		Spring	12	309	5	10	Acceptable	16	Fair

Table 1 (continued). SMIE Program summary site data (Fall 2009 and Spring 2010; richness, abundance, VASOS and Izaak Walton League data)

Site #	Site	Season	Taxa Richness	Total Number Collected	Number of EPT Taxa	VASOS	VASOS Rating	Izaak Walton League	Izaak Walton League Rating
182	Cane Creek #182	Fall	<i>Not sampled</i>						
		Spring	21	242	13	12	Acceptable	18	Good
146	Smith Mill Creek	Fall	<i>Not sampled</i>						
		Spring	9	77	5	7	Acceptable	9	Poor
<b>Haywood County</b>									
502	East Fk Pigeon River	Fall	16	197	9	8	Acceptable	18	Good
		Spring	17	235	9	11	Acceptable	26	Excellent
507	Fines Creek	Fall	17	167	8	10	Acceptable	19	Good
		Spring	17	218	10	9	Acceptable	25	Excellent
512	Jonathans Ck @ dws Coleman Mtn Rd	Fall	12	56	7	11	Acceptable	20	Good
		Spring	15	243	8	10	Acceptable	15	Fair
525	Raccoon Creek	Fall	<i>Not sampled</i>						
		Spring	10	139	9	10	Acceptable	11	Fair
526	Crabtree Creek	Fall	16	110	9	10	Acceptable	20	Good
		Spring	19	319	10	8	Acceptable	22	Good
527	Jonathans Ck @ ups Moody Farm Bridge	Fall	<i>Not sampled</i>						
		Spring	14	145	10	10	Acceptable	13	Fair
580	Richland Creek @ ups Hyatt Ck Road	Fall	<i>Not sampled</i>						
		Spring	12	164	6	10	Acceptable	15	Fair
581	Pigeon River @ dws Canton	Fall	<i>Not sampled</i>						
		Spring	15	215	6	4	Unacceptable	21	Good

Table 1 (continued). SMIE Program summary site data (Fall 2009 and Spring 2010; richness, abundance, VASOS and Izaak Walton League data)

Site #	Site	Season	Taxa Richness	Total Number Collected	Number of EPT Taxa	VASOS	VASOS Rating	Izaak Walton League	Izaak Walton League Rating
<i>Madison County</i>									
102	Little Ivy River	Fall	12	56	4	10	Acceptable	20	Good
		Spring	<i>Not sampled</i>						
409	Shelton Laurel Creek	Fall	21	267	12	11	Acceptable	25	Excellent
		Spring	17	266	10	9	Acceptable	22	Good
413	California Creek	Fall	16	182	8	9	Acceptable	28	Excellent
		Spring	17	158	7	12	Acceptable	27	Excellent
480	Puncheon Fork Creek	Fall	15	208	10	8	Acceptable	22	Good
		Spring	17	266	10	10	Acceptable	24	Excellent
904	Big Laurel Creek	Fall	16	128	9	12	Acceptable	24	Excellent
		Spring	16	219	9	11	Acceptable	20	Good
404	East Fork Bull Creek	Fall	18	227	8	9	Acceptable	25	Excellent
		Spring	19	294	10	12	Acceptable	31	Excellent
<i>Mitchell County</i>									
1481	Cane Creek #1481	Fall	17	148	7	12	Acceptable	25	Excellent
		Spring	17	367	6	10	Acceptable	28	Excellent
1404	North Toe River	Fall	<i>Not sampled</i>						
		Spring	15	95	5	8	Acceptable	21	Good
<i>Yancey County</i>									
1480	Cane River	Fall	<i>Not sampled</i>						
		Spring	19	326	11	10	Acceptable	24	Excellent

EPT = Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies); VASOS = Virginia Save Our Streams Index  
See Section 2.3 of this report for descriptions of scoring techniques.

Table 2. SMIE Program summary site data (Fall 2009 and Spring 2010; ecological ratios, diversity and density data)

Site #	Site	Season	P/R	Leaf Input	Top-Down	Simpsons Diversity	Taxa Density
<i>Buncombe County</i>							
101	Big Ivy River	Fall	1.12	0.18	0.56	0.82	0.16
		Spring	0.12	0.01	0.30	0.85	0.11
105	Sandymush Creek	Fall	0.47	0.36	0.07	0.80	0.15
		Spring	0.44	0.02	0.05	0.68	0.07
106	Newfound Creek	Fall	0.15	0.19	0.05	0.70	0.09
		Spring	0.03	0.00	0.01	0.29	0.03
115	Swannanoa River @ dws Beetree Ck	Fall	0.13	0.06	0.03	0.89	0.15
		Spring	0.14	0.07	0.15	0.80	0.14
117	Hominy Creek	Fall	0.49	1.16	0.03	0.68	0.14
		Spring	0.05	0.05	0.26	0.81	0.15
119	Bent Creek @ Asheville Arboretum	Fall	0.58	0.55	0.85	0.79	0.08
		Spring	0.19	0.05	1.21	0.79	0.09
123	Cane Creek #123	Fall	0.41	0.41	0.29	0.85	0.07
		Spring	0.08	0.02	0.23	0.62	0.05
124	Asheworth Creek	Fall	0.54	0.16	0.53	0.79	0.06
		Spring	0.12	0.01	0.14	0.47	0.06
149	Swannanoa River @ ups Bull Ck	Fall	0.37	0.06	0.34	0.95	0.11
		Spring	0.05	0.00	0.06	0.64	0.05
180	Reems Creek	Fall	0.97	0.18	0.20	0.89	0.08
		Spring	0.38	0.07	0.33	0.72	0.07
181	Reed Creek	Fall	0.00	0.05	0.02	0.94	0.04
		Spring	0.01	0.00	0.04	0.66	0.04

Table 2 (continued). SMIE Program summary site data (Fall 2009 and Spring 2010; ecological ratios, diversity and density data)

Site #	Site	Season	P/R	Leaf Input	Top-Down	Simpsons Diversity	Taxa Density
182	Cane Creek #182	Fall	<i>Not sampled</i>				
		Spring	0.12	0.05	0.41	0.81	0.09
146	Smith Mill Creek	Fall	<i>Not sampled</i>				
		Spring	0.03	0.05	0.01	0.75	0.12
<b><i>Haywood County</i></b>							
502	East Fk Pigeon River	Fall	0.22	0.03	0.70	0.80	0.08
		Spring	0.23	0.05	0.72	0.84	0.07
507	Fines Creek	Fall	0.22	0.05	0.19	0.82	0.10
		Spring	0.20	0.02	0.67	0.81	0.08
512	Jonathans Ck @ dws Coleman Mtn Rd	Fall	0.42	0.29	0.37	0.85	0.21
		Spring	0.19	0.02	0.04	0.67	0.06
525	Raccoon Creek	Fall	<i>Not sampled</i>				
		Spring	0.11	0.05	0.30	0.64	0.07
526	Crabtree Creek	Fall	0.25	0.09	0.22	0.84	0.15
		Spring	0.05	0.01	0.26	0.67	0.06
527	Jonathans Ck @ ups Moody Farm Brdg	Fall	<i>Not sampled</i>				
		Spring	0.26	0.02	0.05	0.55	0.10
580	Richland Creek @ ups Hyatt Ck Rd	Fall	<i>Not sampled</i>				
		Spring	0.12	0.01	0.53	0.66	0.07
581	Pigeon River @ dws Canton	Fall	<i>Not sampled</i>				
		Spring	0.05	0.02	0.13	0.72	0.07



Table 2 (continued). SMIE Program summary site data (Fall 2009 and Spring 2010; ecological ratios, diversity and density data)

Site #	Site	Season	P/R	Leaf Input	Top-Down	Simpsons Diversity	Taxa Density
<i>Madison County</i>							
102	Little Ivy River	Fall	0.77	1.38	0.37	0.83	0.21
		Spring	<i>Not sampled</i>				
409	Shelton Laurel Creek	Fall	0.68	0.77	0.19	0.85	0.08
		Spring	0.38	0.46	0.18	0.85	0.06
413	California Creek	Fall	0.26	0.06	0.64	0.74	0.09
		Spring	0.66	0.08	0.15	0.84	0.11
480	Puncheon Fork Creek	Fall	0.17	0.16	0.51	0.80	0.07
		Spring	0.37	0.12	0.23	0.80	0.06
904	Big Laurel Creek	Fall	2.00	0.10	0.06	0.78	0.13
		Spring	0.08	0.13	0.28	0.72	0.07
404	East Fork Bull Creek	Fall	0.30	0.83	0.11	0.76	0.08
		Spring	0.40	0.03	0.08	0.82	0.06
<i>Mitchell County</i>							
1481	Cane Creek #1481	Fall	0.73	0.03	0.40	0.85	0.11
		Spring	0.05	0.00	0.10	0.42	0.05
1404	North Toe River	Fall	<i>Not sampled</i>				
		Spring	0.24	0.08	0.49	0.85	0.16
<i>Yancey County</i>							
1480	Cane River	Fall	<i>Not sampled</i>				
		Spring	0.47	0.11	0.57	0.82	0.06

See Section 2.3 of this report for descriptions of scoring techniques.

Table 3. Cumulative SMIE Program data (Spring 2005 – Spring 2010)

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
			Fall 2009	10	6	11	18
			Spring 2010	17	9	10	26
			102	Little Ivy	Buncombe	Spring 2005	13
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
Fall 2009	12	4				10	20
Spring 2010	<i>Not sampled</i>						
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
			Fall 2009	21	11	8	26
			Spring 2010	17	8	10	20
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
			Fall 2009	15	5	5	16
			Spring 2010	9	5	6	11

Table 3 (continued). Cumulative SMIE Program data (Spring 2005 – Spring 2010)

Site #	Site	County	Date	Taxa Richness	EPT Taxa	VASOS Score	Izaak Walton League Score
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
			Fall 2009	16	7	7	18
			Spring 2010	19	11	9	15
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
			Fall 2009	16	7	9	19
			Spring 2010	15	8	11	15
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	<i>Not sampled</i>			
			Fall 2009	15	11	9	20
Spring 2010	19	11	12	23			
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
			Fall 2009	21	10	11	27
			Spring 2010	14	7	10	20

Table 3 (continued). Cumulative SMIE Program data (Spring 2005 – Spring 2010)

Site #	Site	County	Date	Taxa Richness	EPT Taxa	VASOS Score	Izaak Walton League Score
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
			Fall 2009	15	7	7	28
			Spring 2010	17	9	11	27
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
			Fall 2009	18	6	9	22
			Spring 2010	14	7	10	25
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
			Fall 2009	18	9	10	31
			Spring 2010	20	10	12	22
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
			Fall 2009	10	3	4	19
			Spring 2010	12	5	10	16
182	Cane Creek @ Miller Rd	Buncombe	Spring 2008	18	11	11	19
			Fall 2008	14	8	7	23
			Spring 2009	21	11	11	23
			Fall 2009	<i>Not sampled</i>			
			Spring 2010	21	13	12	18

**Table 3 (continued). Cumulative SMIE Program data (Spring 2005 – Spring 2010)**

<b>Site #</b>	<b>Site</b>	<b>County</b>	<b>Date</b>	<b>Taxa Richness</b>	<b>EPT Taxa</b>	<b>VASOS Score</b>	<b>Izaak Walton League Score</b>
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
			Fall 2009	21	12	11	25
			Spring 2010	17	10	9	22
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
			Fall 2009	16	8	9	28
Spring 2010	17	7	12	27			
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
			Fall 2009	15	10	8	22
Spring 2010	17	10	20	24			
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
			Fall 2009	16	9	8	18
Spring 2010	17	9	11	26			

Table 3 (continued). Cumulative SMIE Program data (Spring 2005 – Spring 2010)

Site #	Site	County	Date	Taxa Richness	EPT Taxa	VASOS Score	Izaak Walton League Score
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
			Fall 2009	17	8	10	19
			Spring 2010	17	10	9	15
			512	Jonathans Ck @ Coleman Mtn Rd	Haywood	Spring 2005	11
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
Fall 2009	12	1				11	20
Spring 2010	15	8				10	15
525	Raccoon Creek	Haywood				Spring 2008	11
			Fall 2008	14	7	8	19
			Spring 2009	12	6	11	21
			Fall 2009	<i>Not sampled</i>			
			Spring 2010	10	9	10	11
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
			Fall 2009	16	9	10	20
			Spring 2010	19	10	8	22

Table 3 (continued). Cumulative SMIE Program data (Spring 2005 – Spring 2010)

Site #	Site	County	Date	Taxa Richness	EPT Taxa	VASOS Score	Izaak Walton League Score	
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	
			Fall 2009	<i>Not sampled</i>				
			Spring 2010	14	10	10	13	
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	
			Fall 2009	<i>Not sampled</i>				
			Spring 2010	12	6	10	15	
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	
			Fall 2009	<i>Not sampled</i>				
			Spring 2010	15	6	4	21	
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	
			Fall 2009	16	9	12	24	
			Spring 2010	16	9	11	20	

Table 3 (continued). Cumulative SMIE Program data (Spring 2005 – Spring 2010)

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
			Fall 2009	17	7	12	25
			Spring 2010	17	6	10	28
1480	Cane River	Yancey	Fall 2008	15	6	8	18
			Spring 2009	12	7	9	16
			Fall 2009	<i>Not sampled</i>			
			Spring 2010	19	11	10	24
146	North Toe River	Mitchell	Spring 2009	12	6	9	15
			Fall 2009	<i>Not sampled</i>			
			Spring 2010	15	5	8	21
404	East Fork Bull Ck	Madison	Spring 2009	17	8	12	25
			Fall 2009	18	8	9	25
			Spring 2010	19	10	12	31
1404	Smith Mill Ck	Buncombe	Spring 2009	10	3	5	13
			Fall 2009	<i>Not sampled</i>			
			Spring 2010	9	5	7	9
<i>Discontinued sites</i>							
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	Organism ID Number	Group Name
<b>INSECTS</b>		<b>DIPTERANS</b>	
	<b>STONEFLIES</b>	29	Watersnipe
1	Giant Shredder	30	Water-worm
2	Roach Shredder	31	Fat-head Cranefly
3	Quick Crawling Predator	32	Chironomid Midge
4	Fragile Detritivore	33	Red Midge
		34	Blackfly
	<b>MAYFLIES</b>	<b>NON-INSECTS</b>	
5	Flattened Scrapers	27	Oligochaete
6	Spiny Crawler	28	Leech
7	Round Headed Swimmer		
8	Burrowing Mayflies		
9	Spiny Turtle Mayfly		
10	Filter Mayfly		<b>CRUSTACEAN S</b>
	<b>CADDISFLIES</b>	35	Crayfish
	<b>Free Living</b>	36	Sowbug (Isopod)
11	Net Spinner	37	Scud (Amphipod)
12	Small Head Caddis		
	<b>Vegetated Cases</b>		<b>SNAILS</b>
13	Stick Bait Caddis	38	Coiled Left Face Snail
14	Square Log Cabin Caddis	39	Coiled Right Face Snail
15	Sand and Stick Case Caddis	40	Rounded Right Face Snail
16	Vegetative Case Caddis		
	<b>Mineral Cases</b>	41	Clams and Mussels
17	Gravel Coffin Case Caddis		
18	Sand Snail Case		
19	Sand or Mineral Case Caddis		
	<b>BETLES</b>		
20	Water Penny		
21	Predator Beetle		
22	Adult Riffle Beetle		
23	Larval Riffle Beetle		
	<b>MEGALOPTERANS</b>		
24	Hellgrammite		
25	Fishfly		
26	Alderfly		
	<b>ODONATES</b>		
42	Damselfly		
43	Dragonfly		