

Suspended Sediment Concentrations in Three Tributaries of the Little River

A senior thesis presented for
the Chancellor's Honors Program
The University of Tennessee, Knoxville

Chaney Swiney
2013

Acknowledgements

Dr. Carol Harden,

for all her guidance, assistance, insight, and enthusiasm in this project

Kathryn Webb and Nathan Foust,

for being admirable field assistants

Abstract

Crooked, Ellejoy, and Nails Creeks are tributaries of the Little River, a river that drains parts of Blount, Knox, and Sevier Counties. These creeks, and the watershed, have been a part of previous studies focusing on water quality and sediment loads due to their inclusion on the Tennessee Department of Environment and Conservation's 303(d) list.

The purposes of this study were to 1) determine the suspended sediment concentration (SSC) in these three streams during the rising stages of storm events, 2) determine if there is a connection between SSC values and rainfall amounts, 3) compare the SSC of the three streams, and 4) compare current values of SSC to SSC/TSS values found in past studies. Using passive samplers installed in previous studies, samples were gathered after significant rain events from September 2012 to January 2013. After filtration, SSC values were established for each sample.

Results were mixed, with some correlation between higher rainfall amounts and higher SSC values. However, sample depth was low, so definitive conclusions were difficult to make. In comparison to past data, SSC increased at Crooked and Ellejoy Creeks and decreased at Nails Creek. Many factors could have contributed to these results. Sporadic rainfall and equipment malfunctions created uncertainty in the findings. It seems apparent, though, that SSC levels are higher than they should be, likely due to agricultural activity in the area. Further study could give greater insight into the problem and provide evidence to support adjustments to land and water use in the area.

Table of Contents

Introduction.....	1
Chapter 1: Study Area	5
1.1 Little River Watershed	5
1.2 Crooked, Ellejoy, and Nails Creeks	7
Chapter 2: Methods	9
2.1 Field work and sample collection	9
2.2 Laboratory procedures	12
2.3 Rainfall data	14
Chapter 3: Results	
3.1 Data from samples collected September 19 through January 21	16
3.2 Comparison of SSC to rainfall	17
3.3 Comparison of Crooked, Ellejoy, and Nails Creeks	18
3.4 Comparison of new and past results	19
Chapter 4: Discussion	
4.1 Factors affecting suspended sediment concentrations	21
4.2 Potential improvements	24
Chapter 5: Conclusion	26
References	27

Tables and Figures

Tables

Table 1: Statistics for 2006-2007 TSS samples, by site (mg/L)	4
Table 2: Daily precipitation totals from TYS, 2012-2013	15
Table 3: SSC for each collection from each sample site, in mg/L	16
Table 4: Statistics for 2012-2013 SSC data by site (mg/L)	17
Table 5: Daily precipitation totals from TYS, 2006-2007	24

Figures

Figure 1: Little River Watershed map	6
Figure 2: Crooked, Ellejoy, and Nails Creeks subwatersheds map	8
Figure 3: Rising stage samplers	11
Figure 4: SSC and rainfall by collection date	20

Introduction

Crooked, Ellejoy, and Nails Creeks are not prominent East Tennessee streams.

There are no songs about them, they have no signs marking their names, and they quietly make their way into the Little River, which then carries their water to the Tennessee River and beyond. However, prominence does not equate to importance. These streams, along with the rest of the Little River Watershed, drain a significant portion of Blount County, Tennessee. The watershed encompasses sections of Great Smoky Mountains National Park along with rural and developed areas outside of the Park boundaries. The three creeks on which this study focuses drain land that is largely split between residential and agricultural use. The water quality in the upper levels of the watershed, within the Park boundaries, is much better than the water quality farther down in the drainage basin and is classified as a hydrologic benchmark, providing “long-term measurements of streamflow and water quality in areas that are minimally affected by human activities” (HBN 2013). Quality drops downstream where human activities have made their contributions to the runoff that feeds the streams. Suspended solids, or sediments within the water column, are a non-point source pollutant that affects the water quality of these streams by their varying levels, or suspended sediment concentrations (SSC). As SSC goes up, a stream’s capacity to host and sustain life goes down. Implications of increased SSC include reducing the amount of available aquatic habitat and clogging gills in aquatic organisms (Terrell 2011). SSC is

measured in mg/L. This incorporates any particles suspended in the water column, whether they be organic or mineral in nature (Hart 2006).

All three streams are currently on the Tennessee Department of Environment and Conservation (TDEC) draft 303(d) list, a “compilation of streams and lakes that are ‘water quality limited’ or expected to exceed water quality standards in the next two years and need additional pollution controls” (TDEC 2012). Each of the streams in this study has at least 13 miles that TDEC classifies as “impaired,” and all three are due to high levels of *Escherichia coli*, resulting from pasture grazing nearby. However, on the 2008 final 303(d) list, Crooked and Ellejoy Creeks were listed as impaired because of “loss of biological integrity due to siltation” in addition to the presence of *E. coli* (TDEC 2008). Since siltation results from sediment deposition, one could hypothesize that SSC has dropped in these streams from 2008 to 2012, as siltation is no longer listed as a cause for categorization as “impaired.” Multiple studies by the Tennessee Valley Authority (TVA), Environmental Protection Agency (EPA), and University of Tennessee at Knoxville (UTK) have been conducted in the past, and their findings serve as good comparisons for the data collected in this project. In a 2006-2007 study by TVA, samples were collected from 22 sites in the Little River watershed and measured for total suspended solids (TSS). TSS and SSC are both measures of the suspended sediment concentration of stream waters. TSS measures a sub-sample of predetermined volume while SSC measures the entire sample. The 2006-2007 TSS

geometric mean values for each of the three creeks observed in this study can be seen in Table 1.

This study in the Little River watershed was intended to answer four questions:

1. How much sediment is suspended in the storm flows of Crooked, Ellejoy, and Nails Creeks?
2. Is the amount of suspended sediment during stormflow related to the amount of rainfall?
3. Do the three different streams have different SSC values?
4. Are SSC values in 2012 less than those from earlier years?

For the final question, the following hypothesis was tested:

H = Suspended sediment concentrations occurring in these streams today are lower than those in the past.

H_0 = There is no difference between current and past suspended sediment concentrations.

The following chapters address the major parts of the study. Chapter One describes at the study area, the Little River Watershed, with particular focus on the three creeks sampled. Chapter Two details the methods used in the project. Chapter Three presents the results, and Chapter Four provides discussion based on those results.

Table 1: Statistics for 2006-2007 TSS samples, by site (mg/L)

	NC1A	NC1B	CRC1A	CRC1B	EC2
n	9	1	9	2	7
Geomean	25.31	472	13.37	114.54	43.47
Max	5972	472	124	164	444
Med	36	472	16	122	48
Min	1.0	472	1	80	1
Range	5791	472	123	84	443

Note: NC1A and B = Nails Creek, CRC1A and B = Crooked Creek, EC2 = Ellejoy Creek; NC1A and B are no longer in use. The current RSS at Nails Creek is a few meters further upstream. “B” samplers are higher in the stream channel than “A” samplers.

Source: *personal communication, K. Chartrand, TVA*

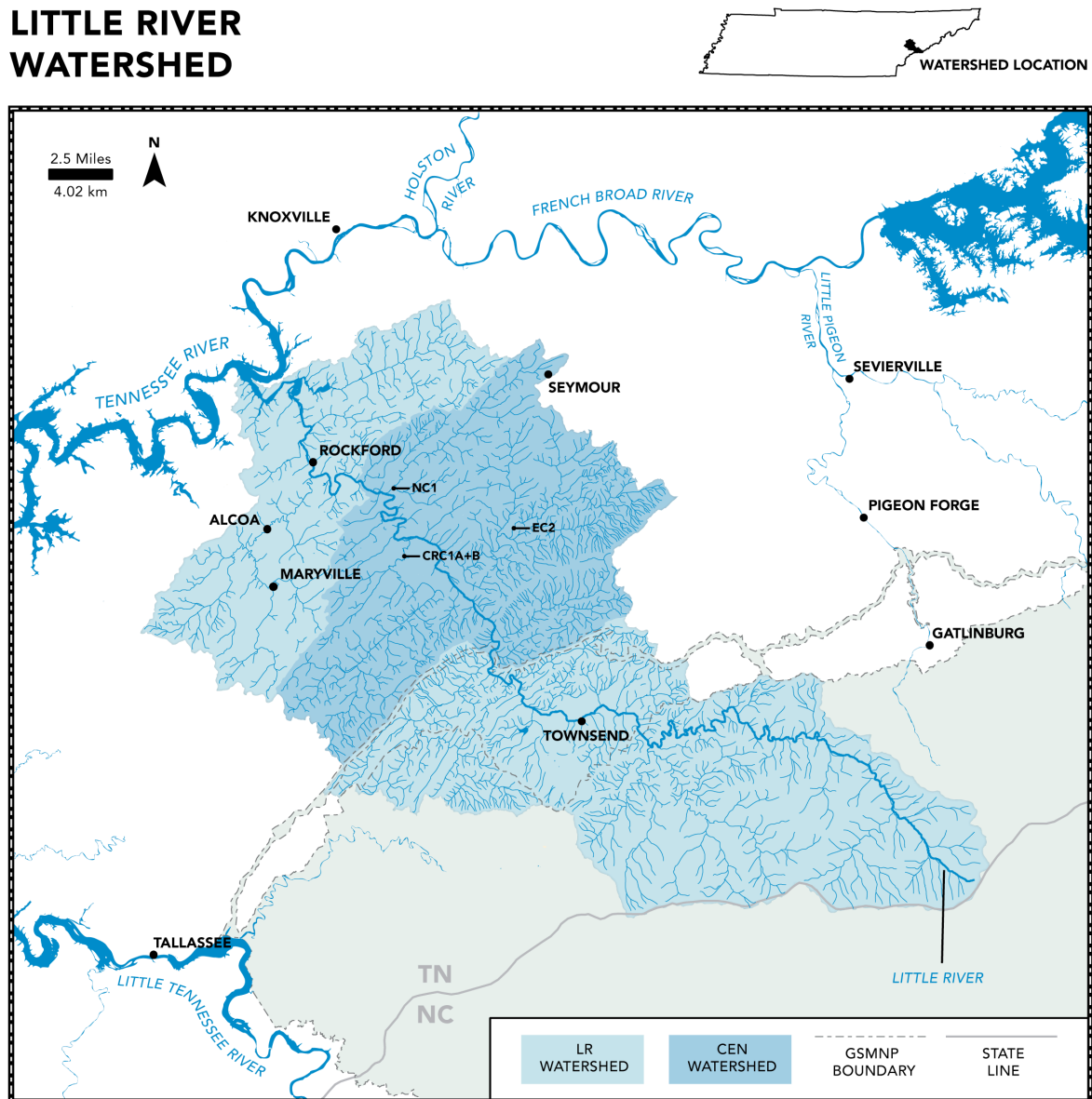
Chapter 1: Study Area

1.1 Little River Watershed

The Little River begins on the north slope of Clingmans Dome on the Tennessee side of Great Smoky Mountains National Park. It flows 96 km (60 mi) through Sevier and Blount Counties and then briefly into Knox County before emptying into Fort Loudoun Lake on the Tennessee River (LRWA 2013). The Little River runs mostly within the Blue Ridge ecoregion (66) before transitioning into the Ridge and Valley ecoregion (67) (TDEC 2000). The elevation of the watershed ranges from just over 2000 m above sea level at its headwaters on Clingmans Dome to just below 250 m above sea level at its mouth in Fort Loudoun Lake. Altogether, the watershed drains an area of approximately 929 km² (Hart 2006). Within the National Park boundaries, its geology is largely Precambrian sedimentary and metamorphic. Further downstream in Blount County, the geology shifts in favor of Ordovician and Cambrian shale, limestone, dolomite, sandstone, claystone, siltstone, and chert (TDEC 2013). Figure 1 shows the location of the Little River Watershed within the region.

Figure 1: Little River Watershed map

LITTLE RIVER WATERSHED



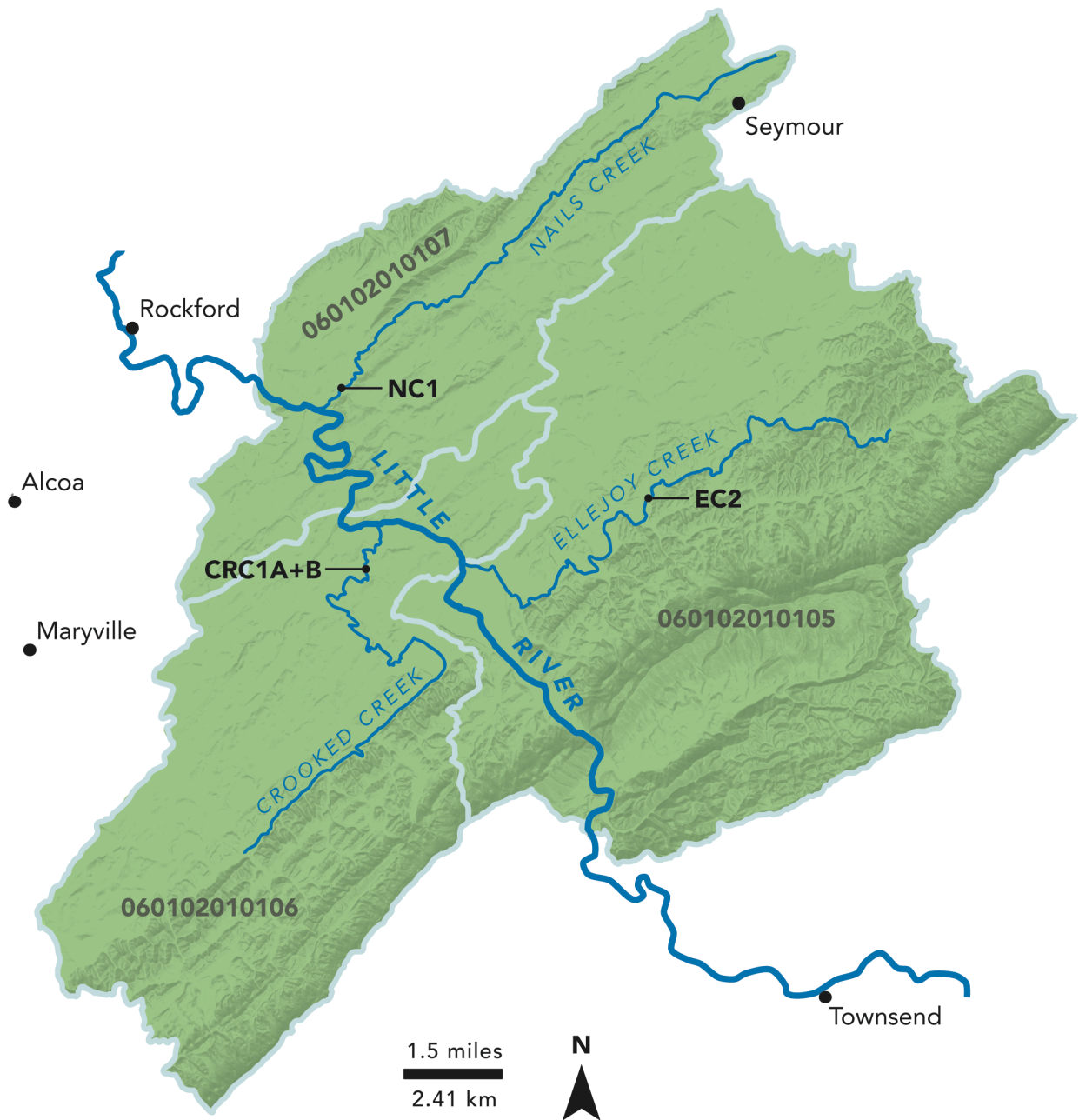
Note: “CEN Watershed” refers to the subwatershed consisting of the Crooked, Ellejoy, and Nails Creeks subwatersheds

Data sources: USGS National Map, National Park Service, USGS National Atlas

1.2 Crooked, Ellejoy, and Nails Creeks

The three creeks of this study run through the rural countryside of Blount County, entering the Little River upstream of the cities of Maryville and Alcoa. They flow through forests, residential areas, and agricultural land (TVA, 2003). The lengths of Crooked, Ellejoy, and Nails Creeks are, respectively, 16.54 km, 17.61 km, and 16.91 km (USGS National Map). Crooked and Ellejoy Creeks begin on the northern edge of the foothills of the Smokies, while Nails Creek originates near Seymour, Tennessee before flowing southwest towards the Little River. Figure 2 shows a closer look at the three subwatersheds of the streams in this study.

Figure 2: Crooked, Ellejoy, and Nails Creeks subwatersheds map



Note: The 12-digit numbers are the USGS hydrologic unit codes for the three subwatersheds. The pale blue lines show the boundaries for each subwatershed.

Data Source: USGS National Map

Chapter 2: Methods

2.1 Field work and sample collection

The water samples for this study were collected during the 2012-2013 academic year, from September 19 to January 21, from three sites in Blount County, Tennessee. Rising Stage Samplers (RSS) were used in all three locations. These passive samplers had been built and placed prior to the beginning of this study. The RSS at Crooked Creek (CRC1) is located downstream from the Davis Ford Road bridge, which crosses the creek between the intersections with Coulter and Hitch Roads. At Ellejoy Creek (EC2), it is located downstream of the bridge at McKenry Road. At Nails Creek (NC1), it is located downstream of the bridge at Andy Harris Road. Samples were collected as soon as possible after major rain events. The RSS at Crooked and Ellejoy Creeks were of the same type, while the RSS at Nails Creek used a slightly different model to accomplish the same goal (see Figure 3). For the purposes of this study, accumulation of 7 mm or more over a 1-4 day period merited a trip to each site to check whether or not a sample had been captured.

The components of the samplers consisted of five main members:

1. A sample container. At Crooked and Ellejoy Creeks, the container was a 500 ml wide-mouth Nalgene bottle. At Nails Creek, the container was a 1000 ml wide-mouth Nalgene bottle.

2. An intake tube. At Crooked and Ellejoy Creeks, this was a copper tube, 5 mm in diameter that was horizontally oriented and pointing upstream. At Nails Creek, the tube was plastic and was held firmly in place by zip ties.
3. An exhaust tube. At Crooked and Ellejoy Creeks, this was again a copper tube. Its position relative to the water level was higher than the intake tube, as its purpose was to vent the sample. At Nails Creek, this tube was plastic.
4. A bottle lid. At Crooked and Ellejoy Creeks, a hole had been cut in the bottle lids and the void was filled with a rubber stopper with holes in it for the copper tubing to run in and out of the bottle. A tight fit ensured that the only way for water to enter the sample container was via the intake tube. At Nails Creek, there were two small holes in the bottle lid, lined with o-rings that the intake and exhaust tubes passed through, again to control the avenues through which water could be collected.
5. An anchor. In all three creeks, metal signposts were used to hold the RSS stationary. At Crooked and Ellejoy Creeks, the sample containers were held in containers fashioned from PVC pipes, consisting of a cap on the bottom, a segment of pipe in the middle, and another cap on top with a slot cut in the middle for the intake and exhaust tubes to extrude up and out for collection. To access the sample container, the top cap was removed and the bottle could then be extracted. The PVC containers were bolted to the signpost. At Nails Creek, the sample container was held to the signpost by two band clamps, tightened and loosened by a screwdriver when collecting samples.

Figure 3: Rising Stage Samplers

The photo at right shows the sampler at Nails Creek (NC1). The photo below shows the samplers at Crooked Creek (CRC1A and B). CRC1A (the lowest) is partially submerged while CRC1B (the middle) is completely above the water. The top container would have held CRC1C, but it was not maintained during this study due to doubts that water level would ever reach that height.



After significant rain events, samples were collected and a log sheet was filled out for each station, recording the following information:

- Precipitation in the last 72 hours
- Water height on staff gauge (feet)
- Time of visit
- Sample collected (yes/no)
- Sample ID and date (yes/no)
- Comments/Observations
- Distance of sampler base from water surface (cm)

Once collected, samples were brought back to the Burchfiel Geography Building (BGB) and stored in a refrigerator until laboratory testing.

2.2 Laboratory procedures

Each filter (47 mm glass fiber, 1.5 μm) to be used was weighed to an accuracy of 0.0001 g using a scientific scale in the Environmental Dynamics Lab in BGB and placed in an aluminum dish (also weighed, separately) labeled with a unique identification number. Filters were handled by tweezers and were not touched by human hands. Filters and dishes were stored in ziploc bags until further use. Coarser filters (110 mm, 20 μm) had to be used for two of the samples and were weighed in the same manner. These filters were too large for the aluminum dishes and were instead held in 200 mL beakers.

The entirety of each sample was filtered in the Particle Size Analysis Lab, part of the Laboratory of Paleoenvironmental Research at the University of Tennessee at Knoxville.

The sample bottles were shaken by hand to re-suspend the sediments that had settled out in storage. The total volume of the sample was then measured using a graduated cylinder.

Accuracy was limited by sample size, as the 1 L graduated cylinder was accurate to every 10 mL while the 250 mL graduated cylinder was accurate to each mL. The sample was then poured back into the original bottle, and the graduated cylinder was rinsed into the bottle with deionized water to ensure all sediment would be filtered.

The samples were filtered using a Millipore glass flask filtration system consisting of six parts:

- 1) A 250 mL glass funnel
- 2) The pre-weighed filter
- 3) A glass stopper with a porous membrane, on which the filter was placed
- 4) A 1 L vacuum flask to collect the filtered water
- 5) A vacuum hose to help pull the sample through the filter and into the flask
- 6) A clamp to hold the funnel, filter, and stopper on the flask.

The quantity of sediment required multiple filters to be used for most samples. Once a filter became too clogged to filter more of a sample, it was removed, placed back in its unique dish, and stored in a plastic box. This process was repeated until the entire sample

had been poured into the filtration system, and the bottle and funnel had been rinsed into the filter with deionized water. With the two coarser filters, the sample was poured through to catch the larger sediment particles and the filtrate was collected in a beaker and poured back into the original bottle. Then, the filtrate was re-filtered through a 1.5 μm filter.

After all samples had been filtered, the dishes and filters were brought back to the Environmental Dynamics Lab and placed in an oven at 105° C for at least three hours, cooled in a desiccator, and re-weighed (filter and dish together) for their post-filtration weights, with an accuracy of 0.0001 g.

2.3 Rainfall data

Daily precipitation data, as recorded at McGhee Tyson Airport (TYS) in Alcoa, Tennessee (9-16 km northwest of the sample sites) were collected from the National Oceanic and Atmospheric Administration's (NOAA 2013a) Online Climate Data Directory. All precipitation totals for days leading up to collections, the days for which samples represent rising water levels, are shown in Table 2.

Table 2: Daily precipitation totals from TYS, 2012-2013

<u>Collection Date</u>	<u>millimeters (inches)</u>
September 19	9/18 - 143.03 (5.71) 9/19 - 9.91 (0.39)
November 7	11/4 - 0.25 (0.01) 11/6 - 1.02 (0.04) 11/7 - 6.35 (0.25)
December 11	12/10 - 2.79 (0.14) 12/11 - 23.62 (0.93)
December 19	12/16 - 13.72 (0.54) 12/17 - 20.32 (0.80) 12/18 - 11.94 (0.47)
January 10	12/21 - 26.92 (1.06) 12/24 - 20.57 (0.81) 12/25 - 10.67 (0.42) 12/26 - 17.27 (0.68) 12/27 - 4.83 (0.19) 12/29 - 5.33 (0.21) 12/30 - 1.78 (0.07) 1/1 - 9.14 (0.36) 1/2 - 22.10 (0.87) 1/3 - 0.76 (0.03) 1/6 - 2.79 (0.11) 1/7 - 0.76 (0.03)
January 21	1/14 - 41.15 (1.62) 1/15 - 63.00 (2.48) 1/16 - 59.18 (2.33) 1/17 - 3.05 (0.12) 1/18 - 37.08 (1.46)

Source: NOAA Online Climate Data Center

Chapter 3: Results

3.1 Data from samples collected September 19 through January 21

The SSC values for each collection at each sample site are shown in Table 3, and statistics for those data are shown in Table 4. Results were mixed with respect to the original hypothesis. The collections shown for 9/19/12 and 9/26/12 show results from the same rain event. During the 9/19 collection, water at EC2 was too high and the sample could not be collected until 9/26. At EC2, the RSS sits low in the stream channel and is submerged with only 7 mm of rainfall. NC1 is stationed higher in the channel and thus requires more rainfall to begin collecting water.

Table 3: SSC for each collection from each sample site, in mg/L

	9/19/12	9/26/12	11/7/12	12/11/12	12/19/12	1/10/13	1/21/13
NC1	587.27	-	-	-	-	-	150.19
CRC1B	219.3	-	-	-	-	251.16	167.93
CRC1A	1843.09	-	-	166.67	14.63	41.45	14457.2*
EC2	-	195.33	40.57	54.32	115	37.55	142.55

* Disregarded. Does not reflect SSC during water level rise during rain event. Sample was contaminated when stopper came out underwater during collection

Table 4: Statistics for 2012-2013 SSC data by site (mg/L)

	NC1	CRC1A	CRC1B	EC2
n	2	4	3	6
Geomean	296.99	116.83	116.83	80.14
Max	587.27	1843.09	251.16	195.33
Med	368.73	104.06	219.3	84.66
Min	150.19	14.63	167.93	37.55
Range	437.08	1828.46	251.16	157.78

3.2 Comparison of SSC to rainfall

There is some correlation between precipitation amounts and SSC in these streams. Higher SSC values are associated with high precipitation events, particularly at CRC1. NC1 shows this same trend, but its record is incomplete because it lacks data for low precipitation events. Figure 3 shows SSC for each RSS and rainfall by collection date. Rainfall reflects accumulation over the period believed to have raised water levels enough to fill the samplers.

3.3 Comparison of Crooked, Ellejoy, and Nails Creeks

Disparities between sample amounts are likely the result of the varied heights of the RSSs between the creeks. Of the three creeks sampled, Ellejoy provided the most samples because of its lower elevation in the stream channel. Its statistics are also less extreme. EC2 had the lowest geomean, maximum, minimum, and range of the four samplers. This is again likely due to its relatively lower elevation. EC2 captured samples from low- and high-precipitation events, and caught them as the water level was rising rather than while it was near or at peak stormflow. NC1, CRC1A, and CRC1B were gathering their samples later in the storm, a factor contributing to both their higher SSC values and lower sample numbers. At the times when NC1, CRC1A, and CRC1B were collecting, the streams were carrying greater sediment loads due to longer storm activity, and EC2 was already filled and submerged.

CRC1A showed the greatest range and both the highest maximum and lowest minimum SSC value. Samples gathered during low precipitation events were very low in volume, suggesting that the water level barely and briefly reached sufficient height to cover the intake tube. CRC1B only collected samples in three of the storms collected by CRC1A.

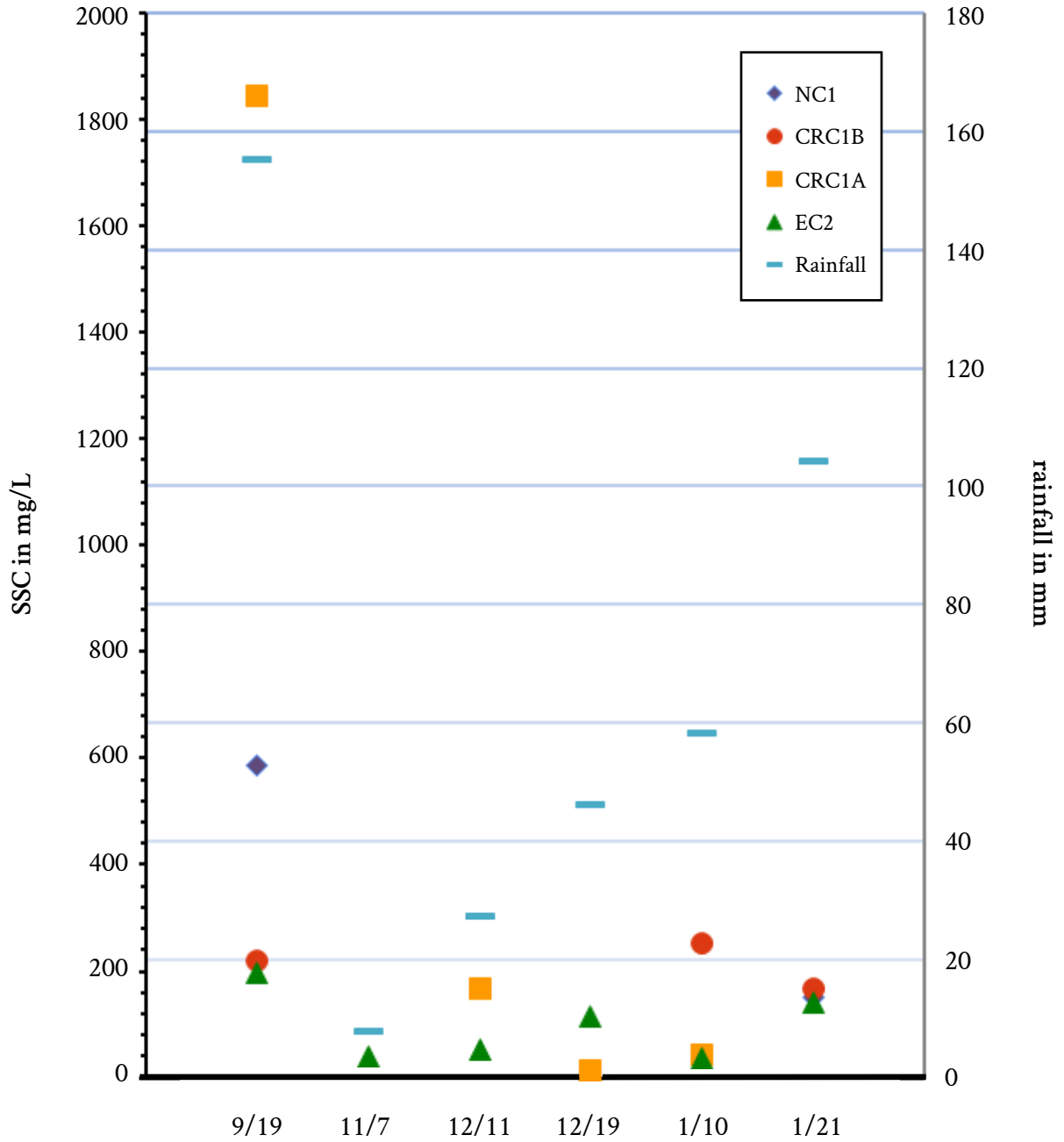
NC1 only gathered samples during the two heaviest precipitation events, giving it the greatest geomean and median values. The difference between its SSC values for the September 19 and January 21 collections can be attributed to the greater amount of single-

day rainfall that likely led to the submersion of the intake tube (143.03 mm on Sept. 18 vs. 41.15mm on Jan. 14 and 63 mm on Jan. 15).

3.4 Comparison of new and past results

The results from 2012-2013 are mixed in comparison with those from 2006-2007 (Table 1). Table 4 shows the geometric means from 2012-2013, and a comparison to the data in Table 1 reveals an increase in SSC in three of the streams and a decrease in one. SSC increased dramatically by 1570% at CRC1A, a significantly smaller 1.99% at CRC1B, and 84.78% at EC2. At NC1, which is slightly higher in elevation than the old NC1B, SSC decreased by 37.08%.

Figure 4: SSC and rainfall by collection date



Note: Rainfall totals reflect a range of dates:

9/19 = 9/18-19

11/7 = 11/4-7

12/11 = 12/10-11

12/19 = 12/16-18

1/10 = 12/21-25

1/21 = 1/14-15

Chapter 4: Discussion

4.1 Factors affecting suspended sediment concentrations

The data collected are not only the result of rainfall and sediment availability. Results demonstrate that the positions of the sample bottles in the streams were at elevations that respond differently to storm flows. As previously stated, the RSS at EC2 is much lower in the stream channel than at NC1 and CRC1. Smaller amounts of rain are enough to submerge the intake tube and collect water at EC2, which is why there are more samples from EC2 than from the other sites. Conversely, NC1 sits significantly higher in the channel, and thus it only collected samples during the two rain events with the highest accumulations. At normal stage, CRC1A sits generally as high above Crooked Creek as EC2 sits above Ellejoy Creek, but Crooked Creek is wider than Ellejoy Creek at the sample site so it takes more rainfall to raise the water level above the intake tube. Different heights also mean that water is being collected at different points during the rain event. EC2 likely fills early, when sediment levels may be lower due to the earlier timing in the storm. CRC1A and B fill later because of their relative height, perhaps collecting water with higher SSC because the storm has had more time to erode the surrounding area and drain sediment into the stream.

Rain was sporadic over the relatively short collection period. Two major rain events (September 18 and January 14-16) bookended nearly four months of generally lower

precipitation amounts. Thus, data from NC1 only reflect the more severe storms and are silent on SSC during more normal rain events. In addition, the general lack of significant rain over this period meant there were fewer samples to collect. Had the precipitation been more evenly distributed, more samples could have been collected and the greater sample depth might have yielded clearer results. This could explain some of the disparity between the 2006-2007 and 2012-2013 levels. During the 2006-2007 collection period (256 days) there were only three days when total precipitation exceeded one inch, and none greater than 30.48 mm (1.2 inches) (Table 5). During the 2012-2013 collection period (124 days) there were six days when total precipitation exceeded 25.4 mm (one inch), three days where it exceeded 50.8 mm (two inches), and one day with over 127 mm (five inches) of rainfall. So, in a shorter amount of time there were more heavy rain events and fewer opportunities to collect samples (according to Dr. Carol Harden, the 2006-07 study found that, generally, 10 mm (0.4 inches) of rain were necessary to raise water level enough to capture a sample).

In addition, some of these storms were low frequency precipitation events. Based on information from the NOAA Hydrometeorological Design Studies Center Precipitation Frequency Data Server (NOAA 2013b), the storm of September 18 (143.03 mm) was a precipitation event with a 50-year recurrence interval for a 24 hour period, and the January 15 event (63 mm) had a one-year recurrence interval. Over a period of two days, the rains of September 18 and 19 (152.94 mm) constituted a 25-year frequency precipitation event, and

the rain during the three-day period of January 14-16 (163.33 mm) also had a frequency of 25 years (NOAA 2013b).

Another factor affecting the results is the equipment itself. The intake tube openings are small and can clog during events with high SSC. If they clog early in the event, any further collection is made impossible and the sample will yield data that accurately reflects conditions only up to the time of clogging. It was not feasible to be out in the streams monitoring the samplers during rain events, so it is conceivable that clogging occurred, whether partial or total, that affected the samples gathered. The tubes were checked during each collection, but clogs could have dissolved or been forced out prior to the collection and thus appeared not to have been an issue.

There was also a major equipment malfunction that compromised the January 21 sample from CRC1A. While removing the sampler from the PVC case, both of which were still completely underwater, the stopper came out of the lid and the collected sample was inadvertently mixed with new water and sediment that did not reflect conditions during rising stages. At that point, post-rainfall, Crooked Creek was flowing at an elevated level and carrying significantly more sediment than it would early in a rain event. This produced an SSC value that does not reflect the conditions this study is focused on, and the result is one fewer sample from which to draw conclusions.

Table 5: Daily precipitation totals from TYS, 2006-2007

<u>Collection date</u>	<u>millimeters (inches)</u>
October 5	10/5 - 26.92 (1.06)
October 19	10/16 - 10.41 (0.41) 10/17 - 14.73 (0.58) 10/19 - 14.48 (0.57)
October 27	10/27 - 33.02 (1.30)
November 15	11/15 - 23.88 (0.94)
November 30	11/30 - 1.02 (0.04)
December 12	12/12 - 2.79 (0.11)
January 21	1/21 - 17.78 (0.70)
March 1	3/1 - 24.64 (0.97)
April 3	4/1 - 11.68 (0.46) 4/2 - trace 4/3 - 20.83 (0.82)
April 15	4/14 - 24.64 (0.97) 4/15 - 22.10 (0.87)
May 5	5/5 - 30.48 (1.20)
June 18	6/18 - 5.59 (0.22)

Source: NOAA Online Climate Data Center

4.2 Potential improvements

Were this research to be continued, a few changes could improve the reliability of the data collected. First, a longer collection period would likely increase the number of samples collected, tempering the effects of extreme events and yielding a more accurate average among the samples. This was simply not an option for this study, where only a little over one semester could be allotted for field work and sample collection. Uniformity between sampler heights at each stream could also provide more cohesive data, potentially eliminating the disparity between samples from Nails and Ellejoy Creeks. Basing heights on average water levels, channel capacity, and flow data could help determine comparable heights for samplers across the three streams. Uniformity between the samplers themselves could also be beneficial. The simpler RSS at NC1 could be implemented at CRC1 and EC2 to ensure that each RSS is gathering samples in the same way. The simpler RSS is also easier to access, has fewer individual parts, and could be less susceptible to an issue like CRC1A experienced on January 21.

Chapter 5: Conclusion

Though the results of this study were not definitive, they do suggest that SSC levels in the three streams surveyed are still an issue that needs to be addressed. Part of the problem appears to be due to the agricultural activity in the watershed. Only a few meters upstream from EC2 there are clear tracks left by cattle coming down from the field above Ellejoy Creek. This is an extremely erosive activity, transferring sediment from the banks down into the stream and increasing SSC. Livestock tracks were not apparent near the samplers at Crooked and Nails Creeks, but it would not be surprising to find them elsewhere along those streams, given their routes through farmland. Increased controls on livestock activity, such as limiting stream access with fences or creating designated animal crossings, could help limit the erosion and waste deposition that result from unrestricted access. Other agricultural practices, like no-till farming, could also help keep sediments in the fields and out of the streams.

Further study using the recommendations mentioned in Chapter 4.2 could help clarify the present situation and provide more insight into how large of a problem SSC really is in these three streams. A better understanding of conditions would help get the right information into the hands of the people who live around these streams, helping them live in concert with the streams and the watershed whose services they rely on every day.

References

Chartrand, K. TVA. Personal communication.

Hart, Heather. (2006). *Effect of Land use on Total Suspended Solids and Turbidity in the Little River Watershed, Blount County, Tennessee* (Masters thesis, University of Tennessee, Knoxville).

HBN. 2013. "The USGS Hydrologic Benchmark Network". Retrieved from <http://ny.cf.er.usgs.gov/hbn/index.cfm>

NOAA. 2013a. National Climatic Data Center. *Daily Observational Data, Knoxville McGhee-Tyson Airport*. Retrieved from <http://www.ncdc.noaa.gov>

NOAA. 2013b. *PDS-based precipitation frequency estimates with 90% confidence intervals*. Retrieved from http://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html?bkmrk=tn

Terrell, James (2011). *Evaluating Substrate Metrics for Monitoring Sediment Impairment of East Tennessee Streams*. (Masters thesis, University of Tennessee, Knoxville).

TDEC. (2000) *Tennessee Ecoregion Project, 1994-1999*. Nashville, Tennessee. Retrieved from <http://www.tn.gov/environment/wpc/publications/pdf/Ecoregion.pdf>

TDEC. (2008). *Final Year 2008 303(d) List*. Nashville, Tennessee. Retrieved from http://www.tn.gov/environment/wpc/publications/pdf/2008_303d.pdf

TDEC. (2012). *Proposed Final Year 2012 303(d) List*. Nashville, Tennessee. Retrieved from http://www.tn.gov/environment/wpc/publications/pdf/2012_pf_303d_list.pdf

TDEC. (2013). *Generalized Geologic Map of Tennessee*. Retrieved from http://tn.gov/environment/tdg/images/geolog_1.jpg

TVA. (2003). *Blount County and Little River Basin Nonpoint Source Pollution Inventories and Pollutant Load Estimates*. Lenoir City, Tennessee. Retrieved from <http://216.119.90.50/asp/pdf/IPSIreport.pdf>

USGS National Map. 2013. Data retrieved from <http://viewer.nationalmap.gov/viewer/>

USGS National Atlas. 2013. Data retrieved from <http://www.nationalatlas.gov/atlasftp.html>