

Biological Condition of Nine Albemarle County Priority Stream Sites, with Associated Land Use Information

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1 - Background

1.1 - Scope of work.

In March 2003, Albemarle County contracted with StreamWatch to:

- Conduct benthic macroinvertebrate sampling in spring and fall of 2004 at nine sites on *priority streams* in designated development areas.
- Use the sampling data to assess the condition of benthic communities in priority streams relative to other streams in the watershed.
- Compare the results of biological sampling to the results of previously conducted habitat evaluations.
- Describe noteworthy characteristics of the benthic community at each site.
- Engage citizens in the stream sampling project for the purpose of public education.

The March 2003 contract was satisfied with a report submitted to Albemarle County dated December 10, 2003. In January 2004, Albemarle again requested stream sampling services from StreamWatch, with a scope of work similar to that of 2003, but covering nine sites rather than seven. The nine biomonitoring sites and their associated watersheds are depicted in a map appended to this report. This report interprets data generated over both contract periods.

In conjunction with a fall 2004 report on the biological condition of streams throughout the Rivanna basin, StreamWatch prepared an analysis of land use and land cover in watersheds draining to biomonitoring sites. Geospatial information associated with Albemarle County priority streams sites is included in this report.

In winter of 2003, StreamWatch began to identify all organisms in biological samples to the taxonomic level of family, allowing the application of a professional multimetric biological index.

Both family-level identification and land use/land cover analysis are beyond the scope of work contracted between StreamWatch and Albemarle County. The data, information, and interpretation associated with these efforts are provided as a courtesy.

1.2 – StreamWatch.

StreamWatch is an ecological monitoring program governed by the following six partners: Albemarle County, The Nature Conservancy, Thomas Jefferson Planning District Commission, Thomas Jefferson Soil and Water Conservation District, Rivanna Conservation Society, and Rivanna Water and Sewer Authority.

StreamWatch purpose is to provide the community with high-quality scientific data and information about stream conditions throughout the Rivanna watershed. The scope of activities undertaken by StreamWatch partners includes land conservation, technical assistance for land management, sewage treatment, enforcement of environmental regulations, planning, conservation advocacy, water supply management, and conservation education. To serve its various partners, StreamWatch's activity is restricted to science-based environmental monitoring, assessment, and reporting.

1.3 - Albemarle priority streams.

The term priority streams is applied by Albemarle County to selected streams located in the Development Areas, as designated in the County's Comprehensive Plan. The Development Areas are fully or partially developed and, in most cases, are undergoing further development. Priority streams are not necessarily the most important streams in the County, but they are resources that may be threatened by development pressure. As part of a comprehensive watershed management framework, and in keeping with EPA requirements under Phase II of the National Pollutant Discharge Elimination System storm water program, the priority stream designation is an attempt to proactively protect the most valuable stream resources within the Development Areas.

1.4 – Regional context.

During the two years proscribed by the Albemarle priority streams project, StreamWatch was also engaged in the collection of biological samples throughout the Rivanna watershed. StreamWatch's comprehensive dataset provides Albemarle with an opportunity to compare the condition of priority streams to a representative set of Rivanna basin streams.

1.5 – Site identification codes.

In 2003, Stephen Bowler, then Watershed Manger for Albemarle County and Rivanna Water and Sewer Authority, assembled a master list of sampling sites for the Rivanna watershed—including portions of the watershed outside of Albemarle County. The list includes site names, general locations, site descriptions, geographical coordinates, and references to the types of sampling conducted at each site. The master sites list is now being maintained by StreamWatch, and the site identification codes given in this report follow the conventions established by Mr. Bowler.

StreamWatch proposes to continue to maintain and update this list and offer it to all agencies and organizations conducting all types of water sampling in the Rivanna basin. This will allow all investigators a common reference to site locations.

2 - Community Participation

The 18 sampling events commissioned by Albemarle County in 2004 generated 116 hours of volunteer community participation. Volunteers participated in sampling sessions at all nine sites.

3 – Methods

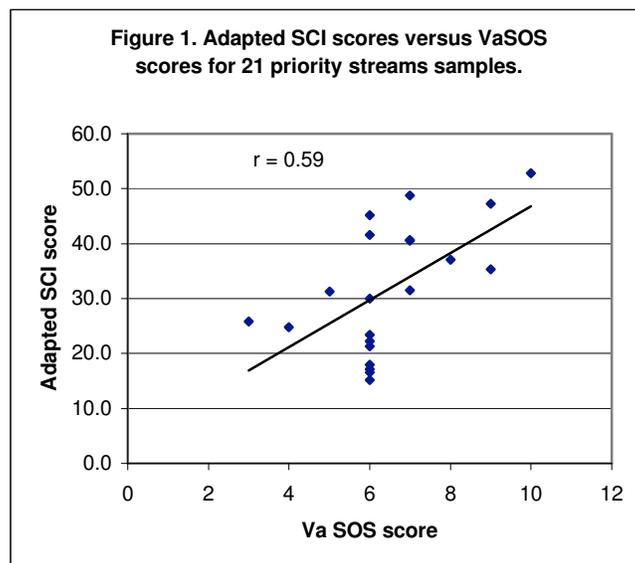
3.1 - Benthic sampling protocols and benthic condition indices.

The benthic monitoring protocol used during the first year of this project was the Virginia Save Our Streams modified method. Virginia Save Our Streams (SOS) is a statewide citizen water-quality monitoring program that engages community volunteers in stream monitoring.

In 2004 StreamWatch incorporated a second tool for interpreting biological data—the Stream Condition Index (SCI), recently developed for the Virginia Department of Environmental Quality (DEQ). Our collection method remained the same, but for each sample we calculated an SCI score in addition to the SOS score. The SCI, designed for professional biologists, entails identifying organisms to finer taxonomic levels than volunteer methods. Finer taxonomic resolution produces more information and greater precision.

StreamWatch's field technique differs from the DEQ's. However, in several StreamWatch/DEQ side-by-side concurrent sampling tests, results generated by the respective methods have been very similar. We believe StreamWatch benthic results using SCI are similar to results obtained by DEQ biologists, but we nevertheless qualify our results by calling them "adapted SCI scores."

In a representative dataset comprising streams throughout the Rivanna basin, correlation between SOS and adapted SCI results was very strong ($r=0.76$, $p<0.01$, $n=47$). For Albemarle priority streams the correlation was not as strong ($r=0.59$, see figure 1).



The priority streams, located in designated development areas, tend to be more biologically degraded than the “average” Rivanna basin stream. Because the SOS system loses sensitivity at the lower end of the gradient of biological conditions, there is less correlation between SOS and adapted SCI scores in datasets from degraded streams than in datasets from representative streams.

StreamWatch has found that the SCI index produces stronger correlations with known predictors of biological condition than does the SOS index. In cases where assessments implied by SOS and SCI index values diverge, StreamWatch places greater confidence in adapted SCI.

3.2 - Quality assurance, quality control.

StreamWatch’s SOS monitoring is subject to Virginia Save Our Streams’ rigorous quality assurance/quality control program, which includes a training and certification process to insure volunteers’ mastery of field techniques. SOS’s benthic method was developed at Virginia Tech and is the subject of published research that documents the protocol’s effectiveness as an assessment and monitoring tool.

StreamWatch’s work with SCI is not yet subject to any “official” QA/QC program, but is nevertheless scientifically rigorous. John Murphy, director and staff ecologist for StreamWatch, participated in the collection of 37 of the 38 samples comprising the records for this report, and performed specimen identification for all samples identified to the family level. He is a certified Virginia Save Our Streams trainer, and has completed two courses in aquatic biomonitoring through the U.S. Fish and Wildlife Service.

3.3 - Sampling frequency and technique.

All priority streams were sampled two times per year for a total of at least four samples. Samples were collected in spring and fall. Four Albemarle priority streams sites are also StreamWatch core program sites; these were sampled three times each year in accordance with the StreamWatch core program study design.

Per the SOS protocol, a 1500-micron mesh kick net was used to capture benthic macroinvertebrates in stream riffles. Most organisms were identified, classified, and counted in the field. However, substantial portions of many samples were preserved for microscope-assisted inspection to permit family-level identification needed for application of the SCI index.

3.4 - Assessment methodology.

In the SOS system, the raw data are interpreted via an index composed of six measures (metrics) of the faunal sample. All six metrics are based on the percentage of the total sample comprised by the number of organisms in the category proscribed by the metric. Some organisms decrease proportionally in response to stress, while others increase (see Table 1). Each metric produces a score ranging from 0 to 2, with lower scores indicating higher stress. The scores from all six metrics are summed, and the total Save Our Streams (SOS) score ranges from 0 to 12. Samples producing a score of "7" or

greater are classified as "ecologically acceptable". Samples that score less than "7" are classified as "unacceptable".

Table 1. Metrics of the Virginia Save Our Streams index						
METRIC	% mayflies, stoneflies, and caddisflies other than net-spinners	% net-spinning caddisflies	% lunged snails	% beetles	% tolerant	% non-insects
STRESS RESPONSE OF ORGANISMS IN THIS METRIC	numbers decrease ↓	numbers increase ↑	numbers increase ↑	numbers decrease ↓	numbers increase ↑	numbers increase ↑

The principles underlying the SCI system are similar, but there are eight metrics, including measures of diversity (numbers of families of organisms and evenness of the families' abundance distribution). The score for each metric can range from 0 to 100. Scores for the eight metrics are averaged to produce a final score with a potential range of 0 to 100. TetraTech, the consulting firm that developed SCI for DEQ, recommends that samples scoring less than 61.3 be classified as impaired for aquatic life. However, DEQ is still testing SCI, and has not yet "set the bar" that will demarcate "unimpaired" and "impaired."

In the 2003 priority streams report, assessments were based on results of two sampling events, scored by the SOS system. When the SOS classifications (acceptable/unacceptable) from the two seasons were consistent, (e.g. "unacceptable" in both the fall and spring), that classification was adopted as the StreamWatch assessment. A StreamWatch assessment of "unacceptable" indicated significant impairment. Sites rated as "unacceptable" would almost certainly be considered impaired by DEQ standards. In cases where SOS classifications were inconsistent, a StreamWatch assessment label of "borderline" was applied. In the author's opinion, these sites would also be considered impaired if DEQ were to assess them.

For the current report, StreamWatch follows the assessment method used in its fall 2004 Rivanna watershed report, *Our Water's Life – The Biological Health of Streams and Rivers of the Rivanna Basin*. Four health assessment tiers are defined, based on ranges of average SOS and SCI scores (Table 2).

Table 2. Numeric assessment criteria.		
Ranges of average scores		Assessment category
Virginia SOS	Adapted SCI	
10 and over	61.3 and over	Very good
7.0 - 9.9	40.0 - 61.2	Fair
6.0 - 6.9	20.0 - 39.9	Poor
Under 6	Under 20	Very poor

Regulatory agencies have several ways of treating variations in scores and classifications. In the past, some agencies have elected to base assessments on average scores. The current guidance from the U.S. Environmental Protection Agency states that if recent samples within an assessment period indicate impairment, the site should be considered impaired (VanWart 2003). StreamWatch is not a regulatory agency, but we do strive to employ standard methods in order to permit approximate comparability of data and assessments. As such, we apply the current EPA guidance in respect to assessment methodology. Average and minimum scores are examined. The average score directs initial placement into a tier, but a pointedly or repeatedly low minimum score triggers demotion to a lower tier. Similarly, scores reflecting a strong recovery trend trigger promotion.

In the author's opinion, all sites assessed as "poor" or "very poor" by StreamWatch would be considered impaired by DEQ. Some sites assessed as "fair" by StreamWatch would be considered impaired by DEQ.

According to the U.S. Environmental Protection Agency (EPA), health at a site is usually representative of health for several miles above and below the site. The EPA perspective is supported by the strong link between land use and stream health documented in StreamWatch's fall 2004 Rivanna basin report, and in the author's opinion, biological condition at Albemarle priority streams sampling sites represents biological condition of the entire stream unless otherwise noted in section 4.1.

3.4 - Index of Land Use Intensity (LUI)

StreamWatch analyzed land use in watersheds defined by biomonitoring sites. We aggregated four parameters—equivalent impervious surface, watershed forest cover, forest cover in the riparian zones of , and population density) to create an index of land use intensity (LUI). The values for each of the four parameters were standardized, then summed and mathematically converted to scores on a zero to 100 scale, with higher scores indicating lower intensity of land use. Each parameter was equally weighted.

The index is designed to show *relative* land use intensity. The ranges of parameter values that define the index scale are derived from analysis of land use in 34 subwatersheds of the Rivanna basin, including watersheds defined by Albemarle priority streams sites and StreamWatch core program sites.

4 - Results and Discussion

4.1 – Sampling results, assessments, associated LUI values, and comments for all sites.

Table 3. StreamWatch biological sampling results and assessments of nine Albemarle County priority streams, based on sampling conducted in 2003 and 2004.							
Station ID	Site	Date	SOS score	Adapted SCI score	Average SOS Score	Average adapted SCI score	Biological condition
BSC01	Biscuit Run west of Southern Pkwy	04/24/03	5		5.75	26.7	Poor
		10/10/03	6				
		04/16/04	6	30.0			
		11/22/04	6	23.4			
CRL01	Carroll Creek in Glenmore	05/08/03	7		6.4	40.3	Poor
		10/30/03	6				
		02/01/04	5	31.3			
		04/17/04	7	40.7			
		11/09/04	7	48.8			
FLT01	Flat Branch @ Lewis & Clark Dr	04/29/03	6		6.5	29.3	Poor
		09/30/03	7				
		04/20/04	6	18.0			
		12/03/04	7	40.5			
LKN01	Lickinghole Creek south of Fairwinds Lane	04/28/03	7		7.5	46.5	Fair
		09/29/03	8				
		10/20/03	8				
		01/31/04	6	45.2			
		03/29/04	10	52.8			
		10/07/04	6	41.6			
MWC03	Meadow Creek west of Locust Ct	03/24/03	5		5.75	20.2	Very Poor
		02/09/04	6	22.2			
		03/24/04	6	17.1			
		11/14/04	6	21.3			
MSC04	Moore's Creek near Woolen Mills	03/24/03	3		3	21.2	Very Poor
		10/08/03	3				
		05/07/04	6	16.5			
		10/18/04	3	25.8			
MRY01	Morey Creek south of Bellair	03/27/03	6		7.25	34.3	Poor
		09/28/03	8				
		03/23/04	7	31.5			
		12/05/04	8	37.0			
PWL01	Powell Creek @ Ashwood Blvd	05/02/03	5		5	20.0	Very Poor
		10/06/03	5				
		04/16/04	6	15.2			
		12/03/04	4	24.8			
SLB01	Slabtown Branch @ 240	04/15/03	12		9.75	41.2	Fair
		09/26/03	9				
		03/26/04	9	35.3			
		12/05/04	9	47.2			

Biological sampling results and health assessments are given in Table 3. The comprehensive dataset generated by these samples is being delivered with this report, but under separate cover.

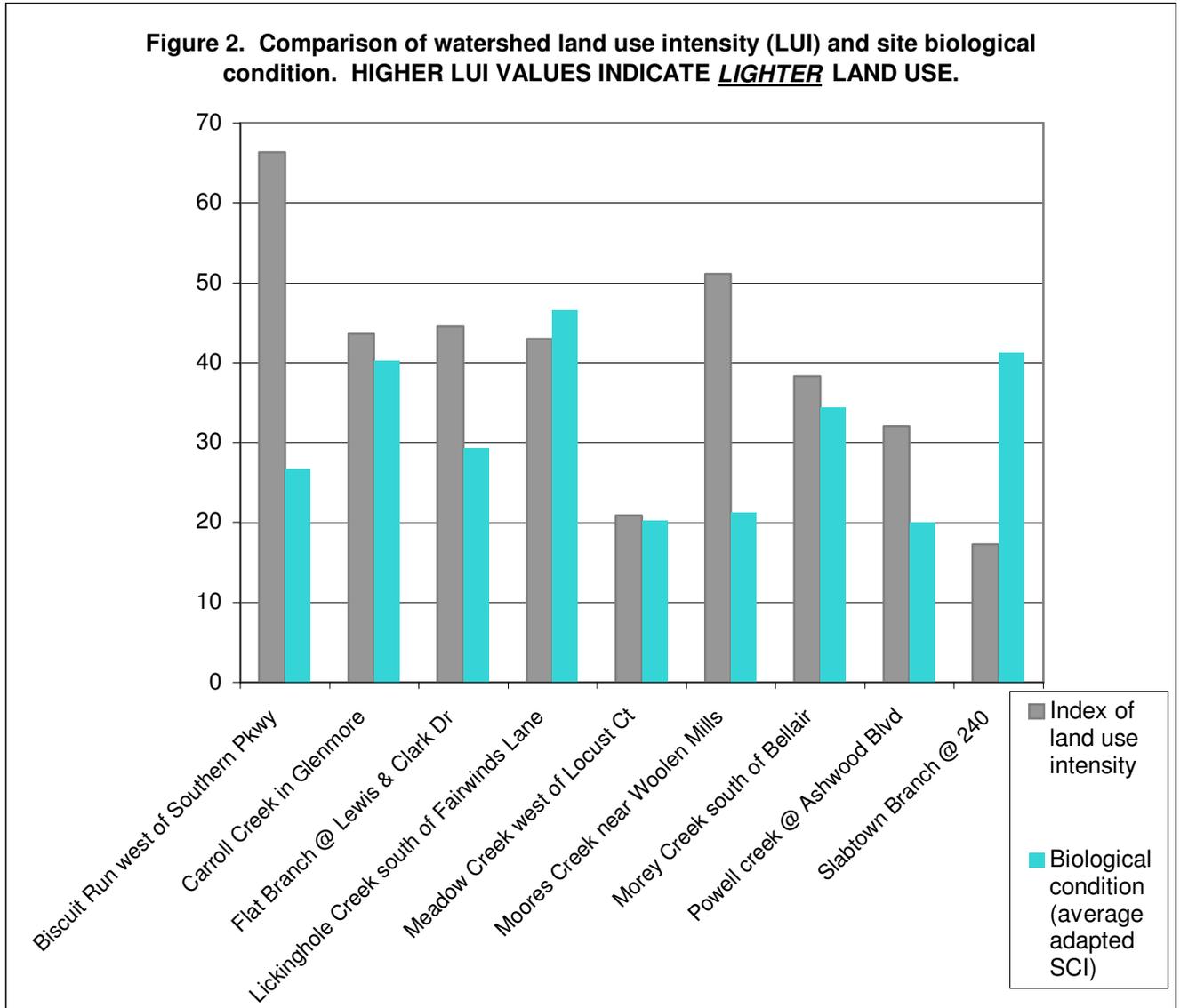


Figure 2 provides comparisons between biological condition at monitoring sites and land use intensity (LUI) in watersheds draining to the sites. *Higher LUI values indicate lower intensity of land use.*

In the Rivanna basin as a whole, and in many studies of land-stream relationships, biological condition is strongly influenced by land use. In the priority streams dataset, there is no statistically demonstrable correlation between LUI and biological health. This does not mean that LUI is not an important driver of health in these streams. Rather, a number of confounding factors interrupt the general pattern. Each site is discussed below.

Biscuit Run west of Southern Parkway - POOR

Results at the Biscuit Run site have been consistently poor over two years of sampling.

Land use proximate to the sampling site (residential subdivisions) is much more intensive than land use throughout the Biscuit Run watershed. Additionally, the site may be experiencing enrichment stress from faulty sewage treatment infrastructure at a mobile home park upstream of the site. Either or both of these factors may be depressing biological health to a level lower than watershed LUI would predict. Biological health in Biscuit Run may be better in reaches upstream of these influences.

Carroll Creek in Glenmore - POOR

Biological condition at this site is consistent with watershed land use. The Carroll Creek drainage contains substantial residential development and a golf course.

The riparian area upstream of Carroll Creek is recovering from significant disturbance due to installation of a utility line. The improvement of riparian habitat may be contributing to slight improvement of biological condition at the monitoring site.

A culvert upstream of the monitoring site is subject to frequent clogging, creating an impoundment reaching several hundred meters upstream.

Flat Branch @ Lewis & Clark Drive - POOR

Biological health at the Flat Branch site is within the range predicted by LUI. However, the Flat Branch drainage is very small. This creates potential for significant error in StreamWatch's geospatial analysis. We place less confidence in the accuracy of the LUI for watersheds of this size.

Riparian habitat in the area near the site is very good. Several hundred meters upstream and up-watershed, however, land use is dominated by a large office park.

Lickinghole Creek South of Fairwinds Lane - FAIR

Biological health scores at Lickinghole Creek have been quite consistent over the two-year period, and lie within the range predicted by LUI. The variance in SOS scores during 2004 is somewhat misleading. Adapted SCI scores vary less; their relatively consistent values probably better represent this site's range of conditions over time.

There is a significant bank erosion problem in the reach proximate to this site.

Meadow Creek west of Locust Court – VERY POOR

Meadow Creek drains the most heavily urbanized watershed of the either the priority streams or core program sets. Sampling results consistently fall within the very poor to poor range.

Moore's Creek near Woolen Mills – VERY POOR

Results at Moore's Creek have been consistently poor over two years of sampling. Land use proximate to the sampling site (high-density residential/commercial) is much more intensive than land use in the Moore's Creek watershed as a whole. Additionally, the site may be affected by the wastewater treatment plant located approximately ¼ mile upstream of the site. One or both of these factors may be depressing biological health to a lower level than watershed LUI would predict. Biological health in Moore's Creek may be better in reaches upstream of these influences.

Morey Creek south of Bellair – POOR

This site's fairly small watershed contains a golf course and substantial residential development. These features are reflected in marginal biological sampling results, which lie within the range predicted by LUI.

Powell Creek @ Ashwood Boulevard – VERY POOR

In the author's opinion, Powell Creek is the most severely biologically degraded of all the priority streams and core program streams. Scores fall within the range predicted by LUI, however this watershed is subject to error in LUI analysis due to its very small size.

The Powell Creek site drains high-density residential subdivisions, and biological condition scores consistently reflect this land usage.

A large-scale construction project west of Route 29 near Airport Road has resulted in very substantial land disturbance in the upper reaches of this watershed over the past year.

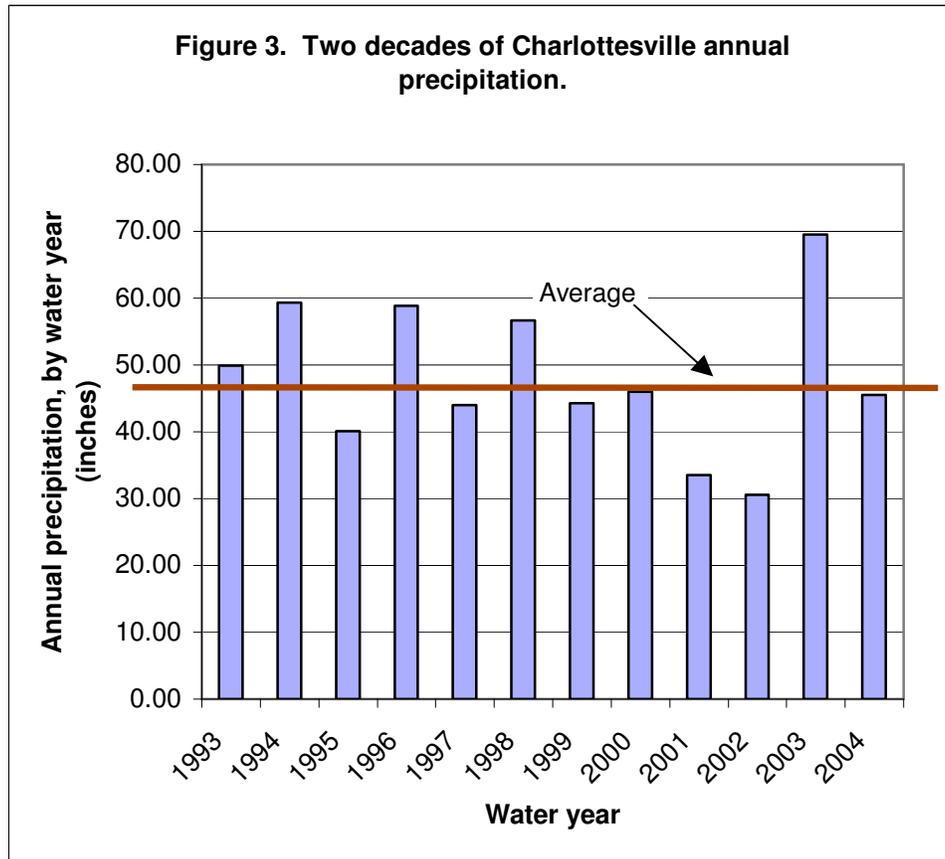
Slabtown Branch @ 240 – FAIR

In last year's priority streams report, StreamWatch reported that the Slabtown Branch site was probably in "extremely good shape." With further monitoring, and with more precise information afforded by SCI, that assessment needs to be retracted. The biological condition of Slabtown Branch is fair. The change in StreamWatch's characterization of the stream is the result of more and better information, not degradation.

Biological health scores are sharply higher than LUI would predict. This is very probably the result of error in land use analysis for this very small watershed.

4.2 – Responses to precipitation variation.

Stream conditions during the first year of the priority streams biomonitoring project were subject to highly unusual climatological conditions: a severe and prolonged drought ended in the fall of 2002, and was followed by unusually high precipitation in 2003, including intense rainfall and flooding from hurricane Isabel in fall 2003. Annual precipitation in 2004 was about average (Figure 3).



Biological conditions in StreamWatch core program streams improved noticeably in 2004, increasing from an average SOS score of 7.8 in 2003 to an average of 8.9 in 2004. This average improvement was statistically significant (Mann-Whitney $p < 0.02$) and, in the author's view, tangible from the perspective of a field biologist.

Albemarle priority streams, however, did not show improvement. The average SOS scores for priority streams in 2003 and 2004 were 6.4 and 6.6, respectively.

The differential responses of the two sets may reflect a defining element of ecosystem health—namely, resilience. Healthier ecological systems are able to recover from intermittent stress (*eg.* drought) more readily and more thoroughly than unhealthy systems.

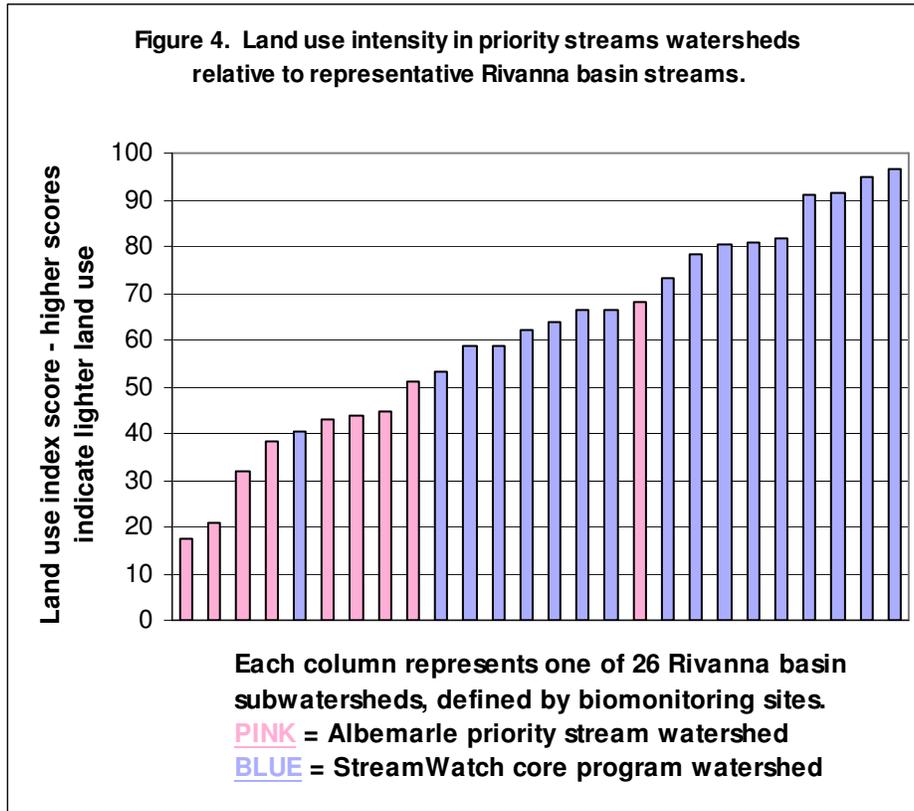
4.3 - Biological conditions of priority streams relative to other streams of the Rivanna basin.

Table 4. Average StreamWatch biological sampling results and provisional assessments of 21 Rivanna basin streams, based on sampling conducted in 2003 and 2004.					
County	Site	Date	Average SOS Score	Number of Samples	Biological Condition (Provisional)
Fluvanna	Ballinger Creek @ 625	03/18/03	9.0	8	Fair
Albemarle	Buck Island Creek @ 729	03/18/03	8.6	5	Fair
Albemarle	Buck Mountain Creek @ 665	10/02/03	8.3	4	Fair
Albemarle	Buck Mountain Creek west of 666, A	03/19/03	10.6	5	Very Good
Albemarle	Carroll Creek in Glenmore	05/08/03	6.4	5	Poor
Fluvanna	Cunningham Creek @ 15	04/06/03	9.0	7	Fair
Fluvanna	Cunningham Creek Middle Fork @ Bells Farm Rd	10/05/03	10.5	4	Very Good
Albemarle	Doyles River @ 674	03/16/03	8.0	5	Fair
Albemarle	Ivy Creek @ 601	03/17/03	6.4	5	Poor
Albemarle	Lickinghole Creek south of Fairwinds Lane	04/28/03	7.5	6	Fair
Fluvanna	Long Island Creek @ 601	03/28/03	9.3	6	Fair
Albemarle	Lynch River @ 603	04/17/03	9.0	5	Fair
Albemarle	Meadow Creek west of Locust Ct	03/24/03	5.8	4	Very Poor
Albemarle	Mechums River @ 601	04/28/03	7.6	8	Fair
Fluvanna	Mechunk Creek @ 759	04/16/03	8.8	5	Fair
Albemarle	Moores Creek near Woolen Mills	03/24/03	3.8	4	Very Poor
Albemarle	Moormans River @ 601	03/17/03	8.2	6	Fair
Albemarle	North Fork @ Advance Mills	05/06/03	8.8	5	Fair
Albemarle	North Fork @ Forks of Rivanna	05/09/03	9.0	4	Fair
Fluvanna	Raccoon Creek @ 15	04/16/03	9.8	5	Fair
Albemarle	Swift Run @ 605	04/01/03	7.3	6	Fair

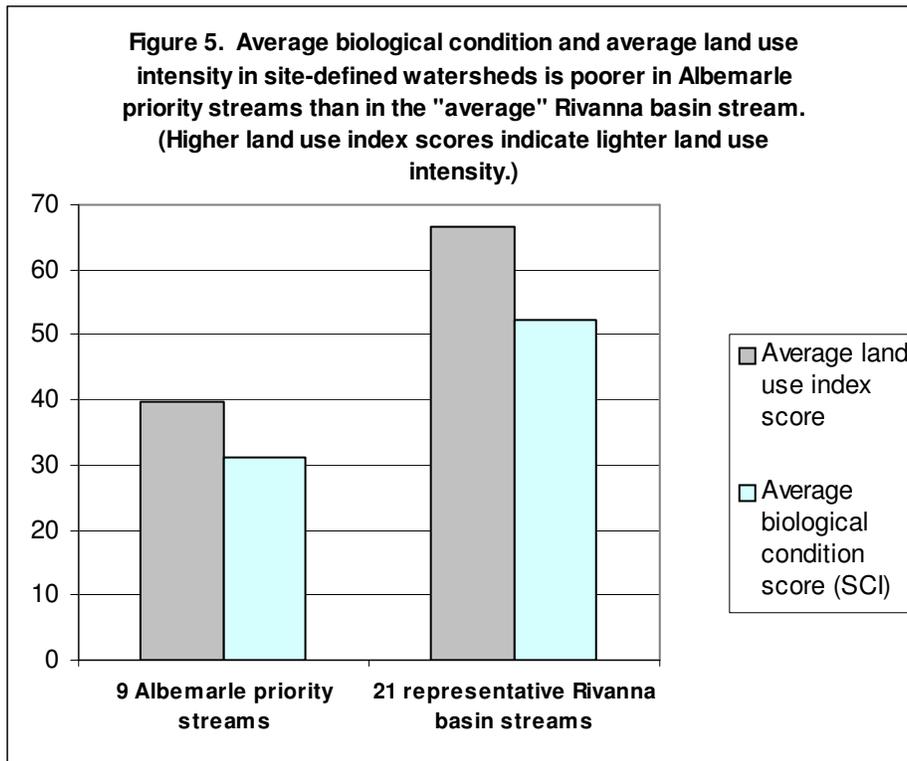
Table 4 gives average results and provisional assessments from samples taken at 21 StreamWatch core program tributary stations during the same time period as that of the priority streams project. (Assessments will remain provisional until fall 2004 SCI results become available for all core program sites). The core program set was assembled to achieve representativeness in respect to hydrogeography and land use, as well as

comprehensive coverage of the Rivanna basin. The 21 core sites include 4 Albemarle priority streams sites.

The core program set, as a whole, is composed of sites that are considerably less subject to stresses associated with medium and high-density development than the priority streams set (Figure 4).

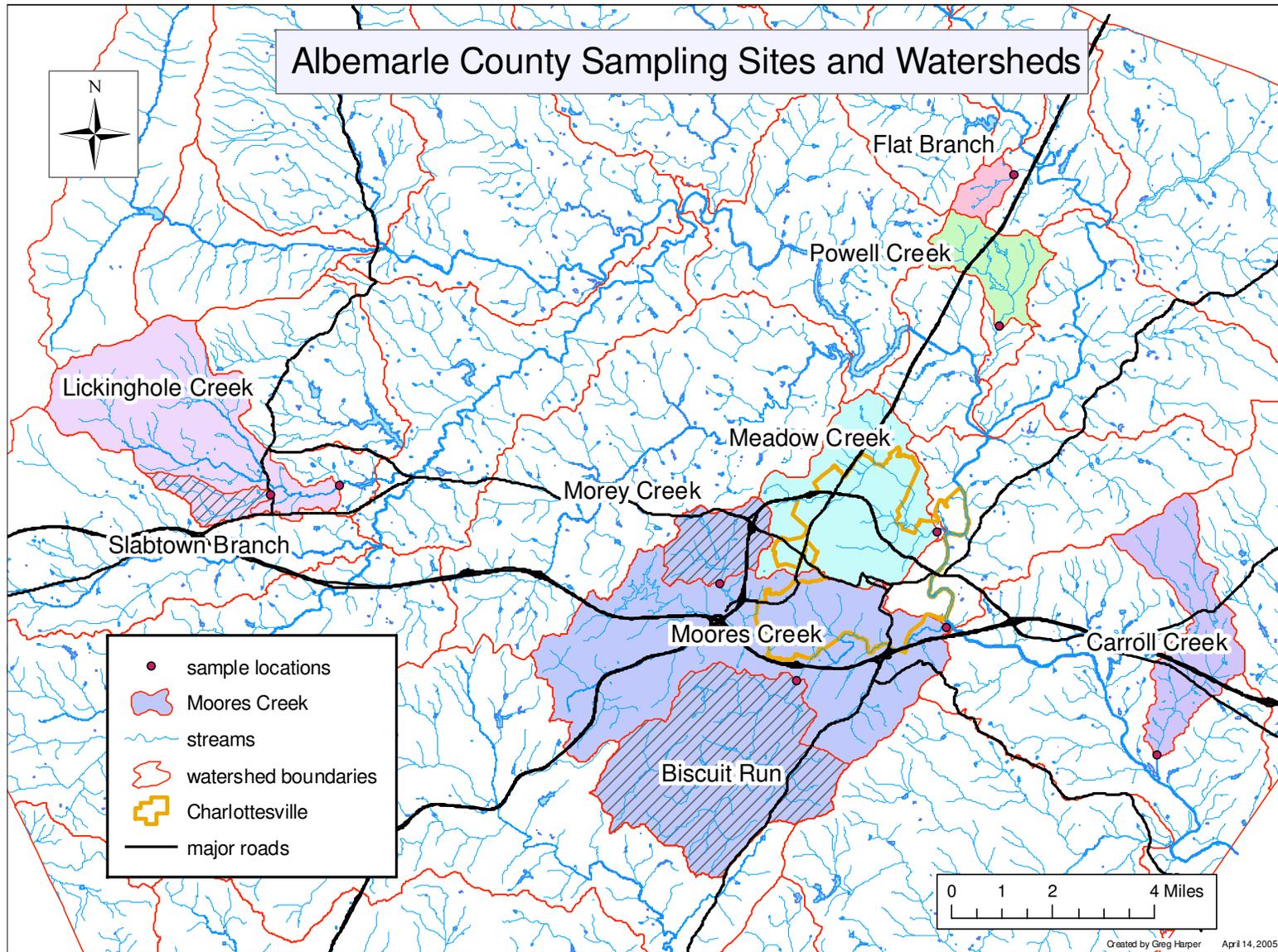


A comparison of biological index scores across the two groups suggests that biological conditions are distinctly poorer in the priority streams than in the “average” Rivanna basin tributary stream. The average SOS score for samples taken from priority streams was 6.3 while the average SOS score for core program tributary streams was 8.2. These averages represent statistically separable populations (Mann-Whitney $p=0.01$). In terms of assessment classifications, 78% of priority streams fall into the “poor” or “very poor” categories, compared with 24% of core program streams. StreamWatch’s assessment of the general condition of Albemarle priority streams, as a group, is poor. The general condition of Rivanna basin tributaries is assessed as fair.



The disparity in biological health is apparent also in average SCI scores (see blue columns, figure 5). The average SCI scores for priority stream sites and core program sites were 31.1 and 52.3, respectively. It should be noted that fall 2004 SCI data were not available for core program sites at the time of this report was written. The SCI averages shown in figure 5 for core program streams were calculated from samples taken in winter 2003/2004, while averages for priority streams were calculated from samples taken in spring and fall 2004. Stream condition scores do not vary by season, but, as noted in section 4.2, core program sites improved in 2004. Were fall 2004 data included in the average SCI scores for core sites, the average would probably be somewhat higher, and the disparity between core and priority sites would probably be somewhat greater.

Figure 5 also gives average LUI scores for the two sets (gray columns). The average LUI scores for priority stream watersheds and core program watersheds were 39.7 and 66.6, respectively



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