Jollyville Salamander Data Analysis: 1997 – 2003

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Abstract

The Jollyville Plateau salamander, *Eurycea tonkawae*, inhabits springs and spring-runs in tributaries draining the Jollyville Plateau area of Travis and Williamson counties, Texas. The species is considered a "species of concern" by the U.S. Fish and Wildlife Service, and as such, it may be in need of concentrated conservation actions. A previous 2-year study by the City of Austin provided baseline water chemistry, sediment chemistry, habitat, and ecological data at salamander sites. Examination of 6 years of data at five salamander sites shows that salamander counts are declining at two sites. The declining counts appear to be related to habitat degradation due to urban development in the assumed watershed of the springs. Chemical water quality at the salamander sites has also degraded over this period. Data obtained during this period also indicate a detectable seasonal reproductive cycle that may be regulated by rainfall or springflow.

Introduction

The Jollyville Plateau salamander, *Eurycea tonkawae*, occurs in springs and spring-runs in tributaries draining the Jollyville Plateau area of Travis and Williamson counties, Texas. A two-year intensive study in 1998 and 1999 collected baseline information about these salamanders. Results of that study are documented in the Jollyville Plateau Water Quality and Salamander Assessment (COA, 2001). After the initial study ended, additional data collection was conducted at some of the original salamander sites. In this report, data from the original study have been combined with the more recent data and examined for time trends, site differences, and seasonal variations in flow and reproduction.

Sites

The current data analysis is limited to the five sites where salamanders were counted in the original Jollyville Salamander study and to subsequent monitoring through 2003. Table 1 lists the location and characterization of each site. A map of the sites is provided as Figure 1.

Salamander counts require that data-collectors have a considerable amount of experience to maintain consistency and accuracy throughout the data collection period and among sites included in these surveys. At four of the sites, staff biologists conducted the salamander counts. However, at Spicewood Tributary volunteer high school students conducted the recent counts and were supervised by staff biologist Sara Heilman. Therefore; the recent Spicewood Tributary counts are considered in the data analysis, but they are not accorded the same level of confidence as the other sites.

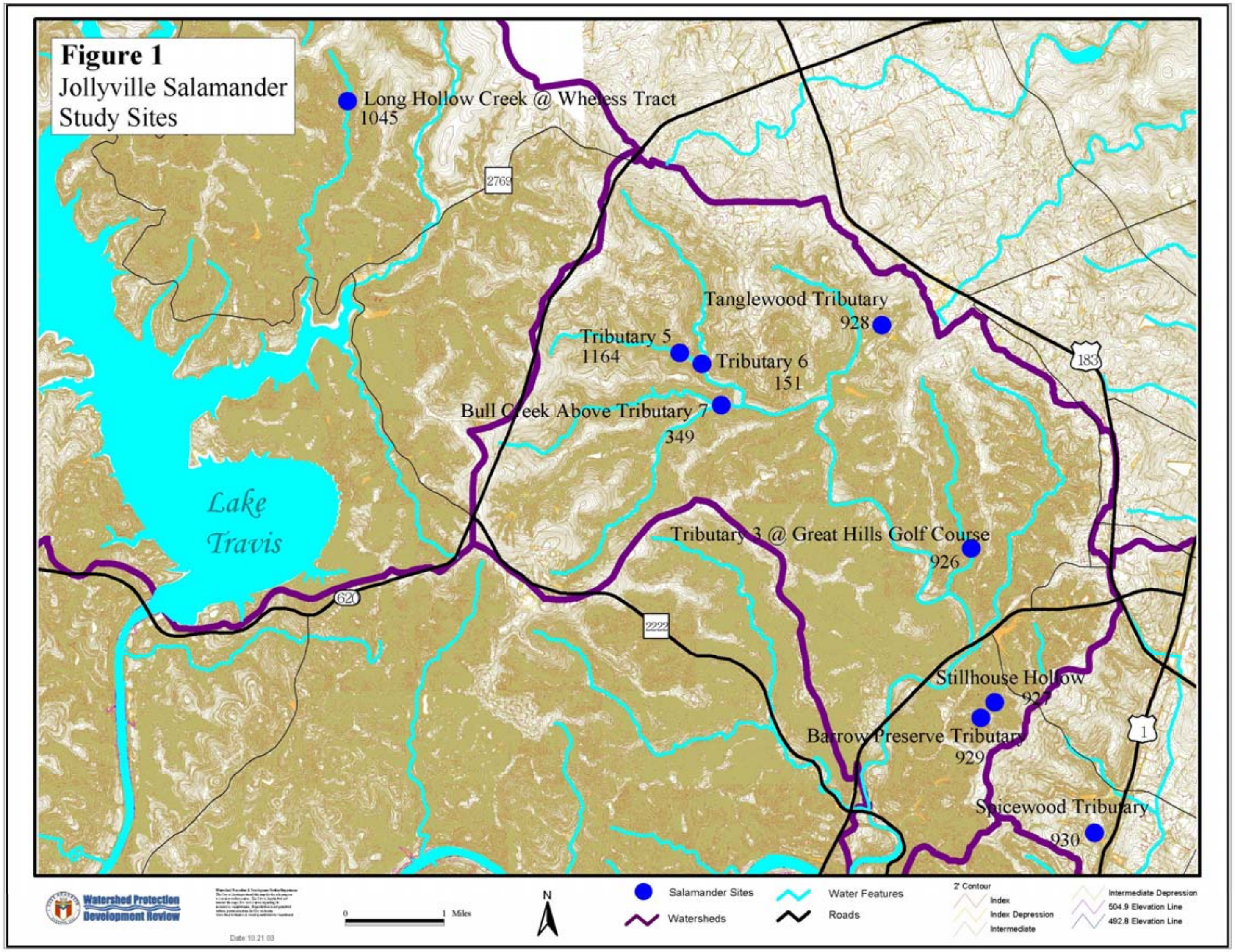


Figure 1
Jollyville Salamander Study Sites

Table 1 Jollyville Salamander Study Sites

Original Study Sites with Follow-up Study Sites Highlighted				
Spring Site		**Salamander Survey Site**		**Site Characteristics**
Site Number	**Site Name**	**Site Number**	**Site Name**	
25	Barrow Preserve Spring	929	Barrow Preserve Tributary Below Barrow Spring	Urban - old development
582	Spicewood Spring (USGS)	930	Spicewood Tributary Below Spicewood Spring	Urban - old development
24	Stillhouse Hollow Spring	927	Stillhouse Hollow Below Stillhouse Hollow Spring	Urban - old development
30	Fire Oak Spring	995	Hog Hollow Tributary below Fire Oak Spring	Urban - recent development
31	Tanglewood Spring	928	Tanglewood Tributary Below Tanglewood Spring	Urban - recent development
		926	Tributary 3 @ Great Hills Golf Course	Urban - recent development
		151	Tributary 6 @ Bull Creek (EG)	Urban - recent and continuing development
		1164	Tributary 5 Below Hanks Tract Property Line	Rural at start of study - now developing
34	Pit Spring	349	Bull Creek Above Tributary 7	Rural
1044	Long Hollow Creek Spring @ Wheless Tract	1045	Long Hollow Creek @ Wheless Tract	Rural

Jollyville Salamander Counts over Time

Figures 2 through 6 show the counts of small (< 1 inch), medium (1-2 inches) and large (>2 inches) salamanders from January 1997 through the spring of 2003. Flow records at each site are also included in the figures. Regression analysis with total count as the dependent variable and date as the independent variable, found significant trends for two of the five sites. Salamander counts decreased significantly at Tributaries 5 and 6. Results of the regressions for these two sites are included in Table 2. Construction including site clearing and preparation was ongoing in the watersheds of these two sites during the monitoring period. While the slopes of the regressions are significant, the r^2 values are not high, indicating that other factors affecting salamander abundance were present besides the construction impacts associated with development, or increased impervious cover post-development.

Figure 2. Salamander Counts and Flow at Tributary 6 @ Bull Creek

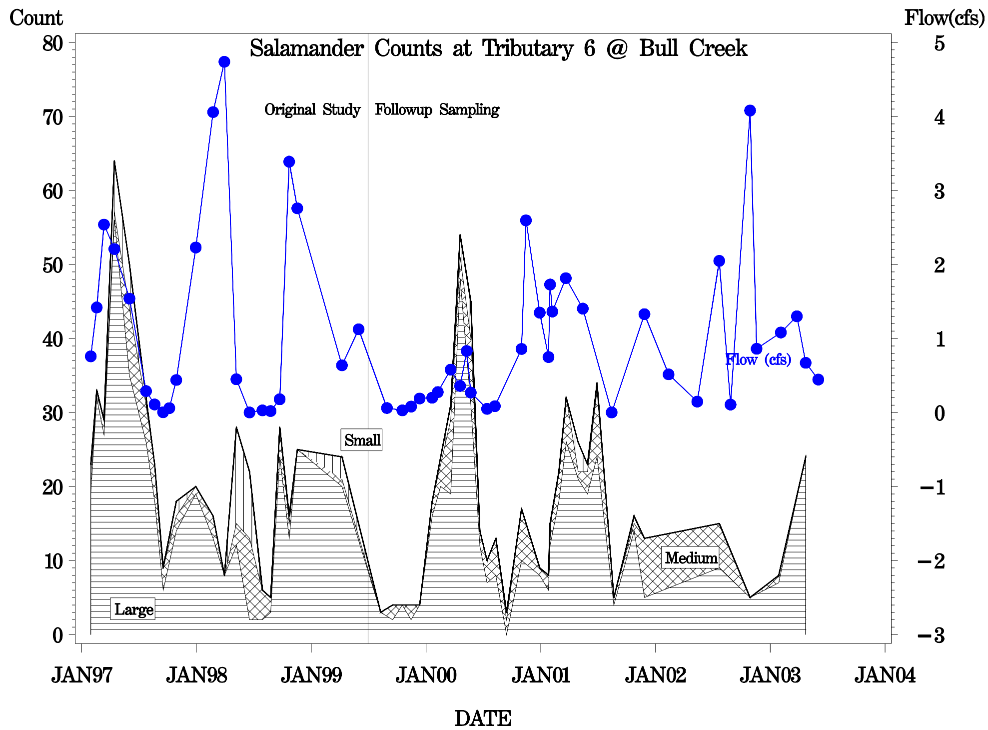


Figure 3. Salamander Counts and Flow at Tributary 5 below Hanks Tract Property Line

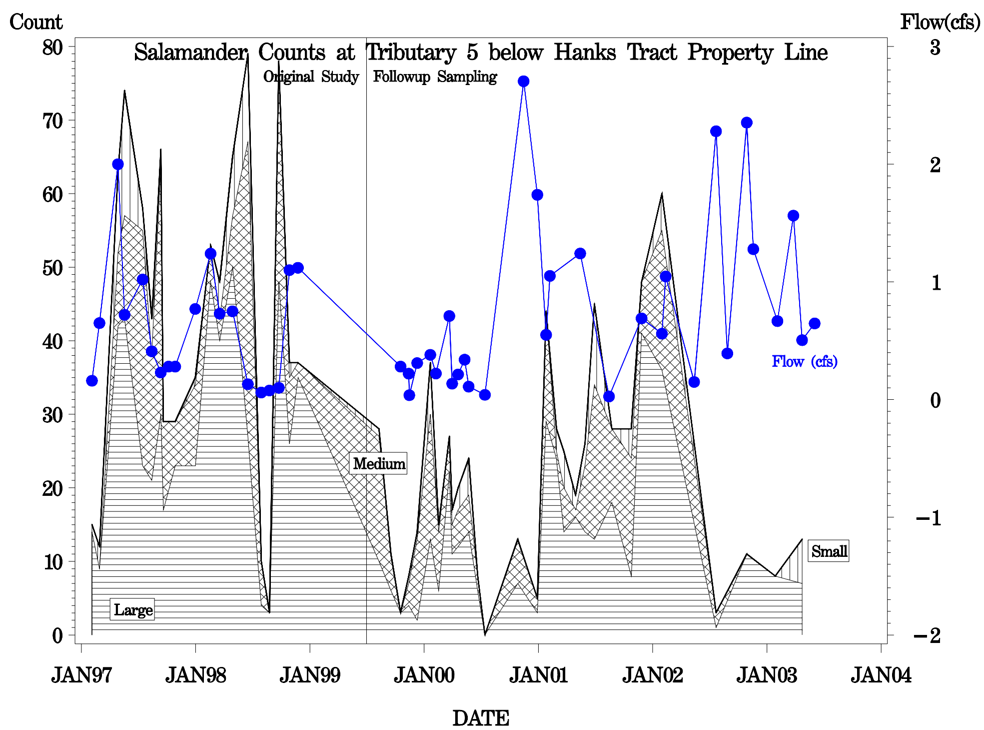


Figure 4. Salamander Counts and Flow at Bull Creek above Tributary 7

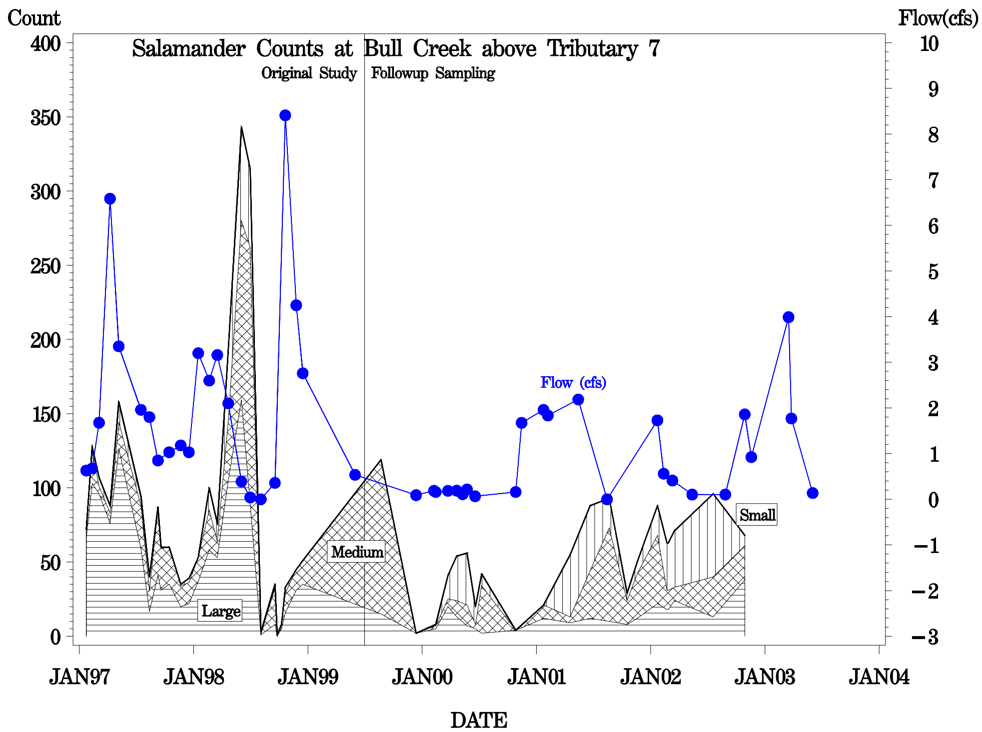


Figure 5. Salamander Counts and Flow at Stillhouse Hollow

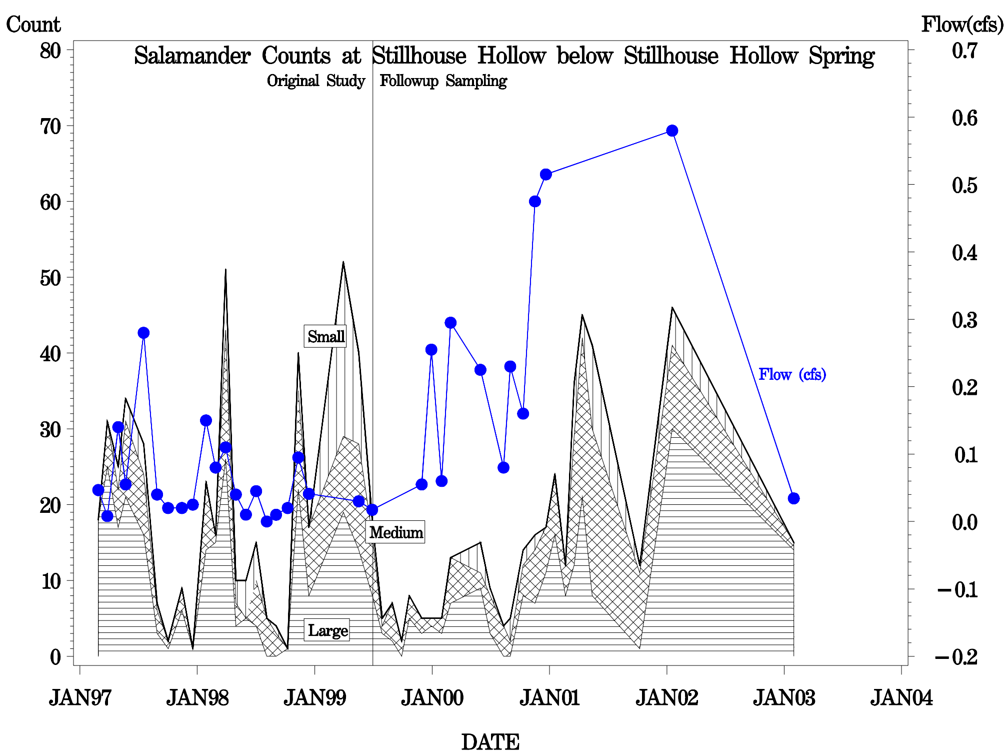


Figure 6. Salamander Counts and Flow at Spicewood Tributary

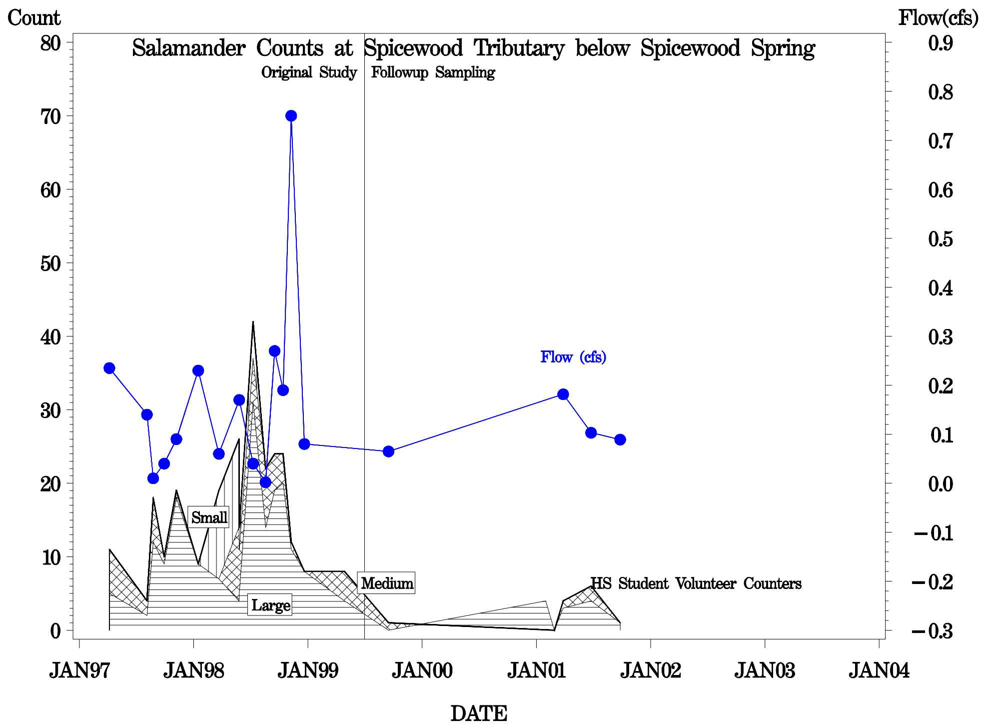


Table 2
Sites with Statistically Significant Changes in Total Salamander Counts over Time

Site	Pr>F	R^2	Direction	Average 1997 Count	Average 2002 Count
Tributary 6 @ Bull Creek (EG)	0.0286	0.0941	decreasing	30	10
Tributary 5 Below Hanks Tract Property Line	0.0040	0.1665	decreasing	42	25

Water Quality and Habitat Measurements

Water quality and habitat parameters were investigated to see if changes had occurred during the monitoring period at the five sites. Water quality parameters monitored under baseflow conditions were nitrate, orthophosphorus, total suspended solids, chloride, sulfate, and sodium. Habitat parameter that were considered included those that had shown significant correlation to salamander counts in the original Jollyville Salamander study: bank condition, embeddedness, sediment deposition, bank vegetative protection, channel flow status, and frequency of riffles. The habitat parameters were measured on a scale of 1 to 20 (poor to optimal). As indicated in Table 3, five parameters were significantly worse over time.

Table 3 Parameters Indicating Statistically Significant Degradation over Time

Parameter	Site	Pr>F	R^2	Direction	Average 1997 Value	Average 2002 Value
Sediment Deposition	Tributary 6 @ Bull Creek (EG)	0.0207	0.429	Increasing	19.5 rating	14 rating
Sediment Deposition	Tributary 5 Below Hanks Tract Property Line	0.0010	0.9485	Increasing	19.3 rating	9 rating *
Nitrate	Tributary 6 @ Bull Creek (EG)	0.0409	0.0916	Increasing	0.44 mg/L	0.66 mg/L
Sulfate	Tributary 6 @ Bull Creek (EG)	0.0052	0.2077	Increasing	63.1 mg/L	81.7 mg/L
Sodium	Tributary 6 @ Bull Creek (EG)	0.0090	0.1947	Increasing	38.4 mg/L	44.1 mg/L
Sodium	Tributary 5 Below Hanks Tract Property Line	0.0050	0.3794	Increasing	7.1 mg/L	9.4 mg/L

In each case the sites with significant declines in water quality or habitat levels also had significant declines in salamander counts. Figures 7 through 10 show the changes in these parameters over time.

Nitrate, sodium and sulfate concentrations are known to increase with urbanization, and the watersheds for Tributaries 5 and 6 are currently being developed. However, the current concentrations of nitrate, sodium and sulfate at these two sites are not considered by biologists to be a toxicological threat to salamanders. However, the increase in sediment deposition may be related to the decline in salamander counts.

Figure 7. Sediment Deposition

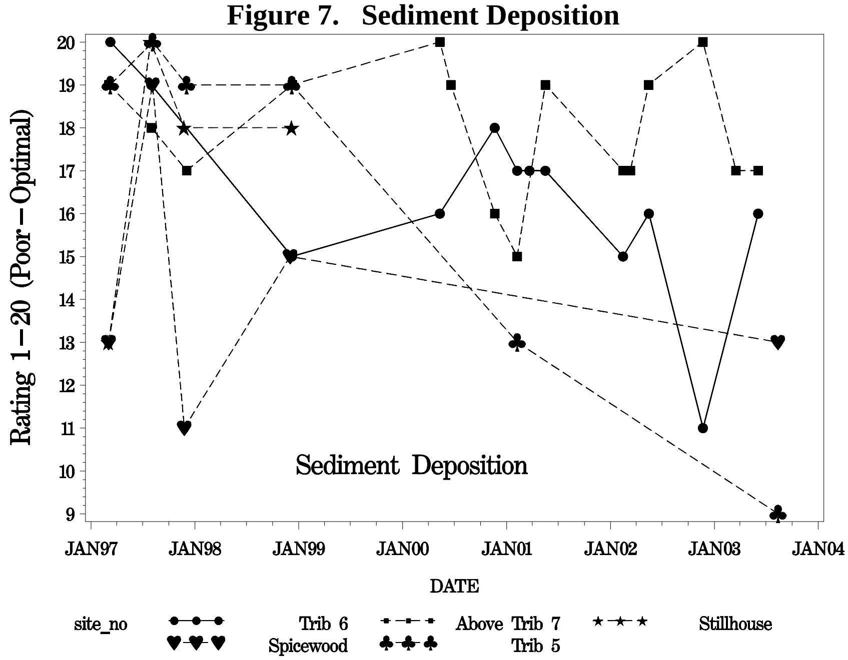


Figure 8. Nitrate

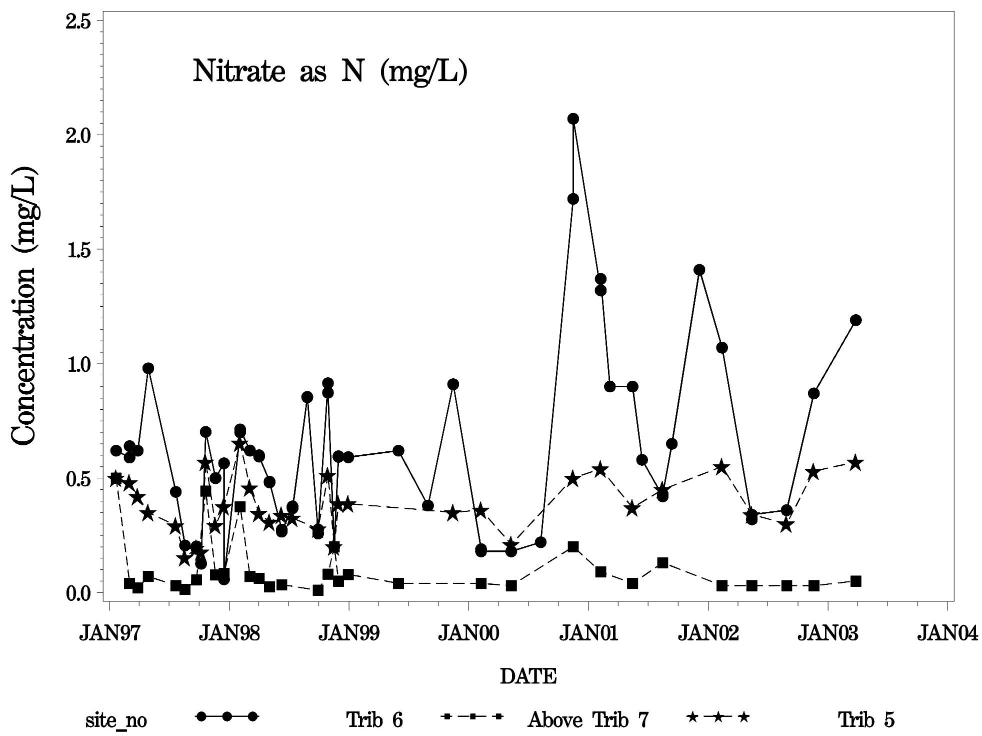


Figure 9. Sulfate

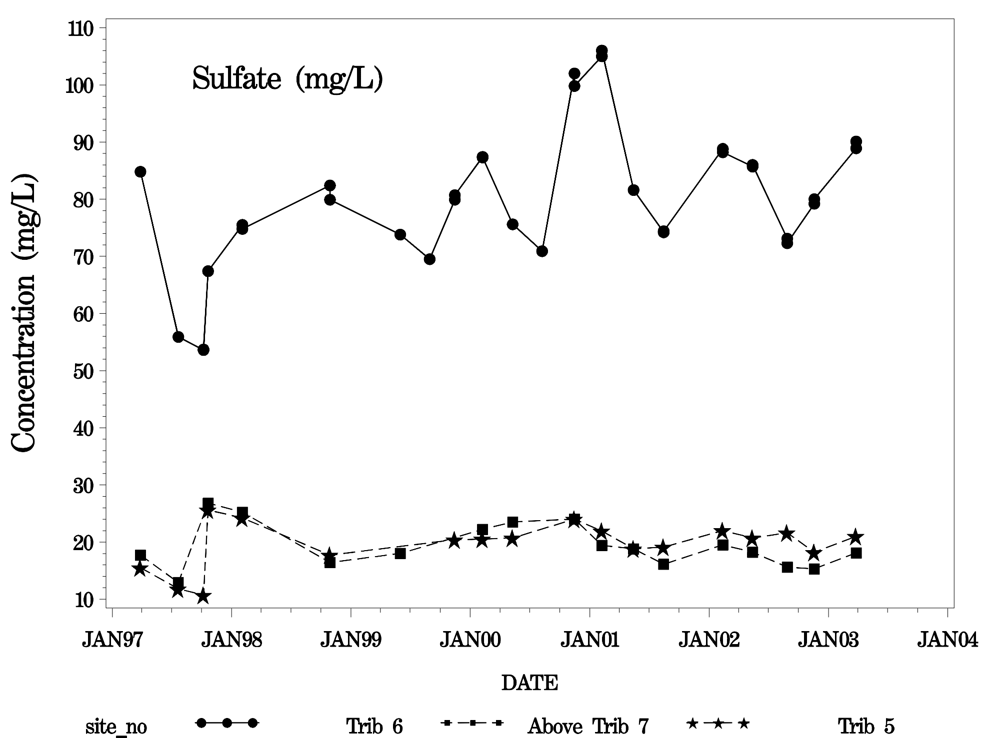


Figure 10. Sodium

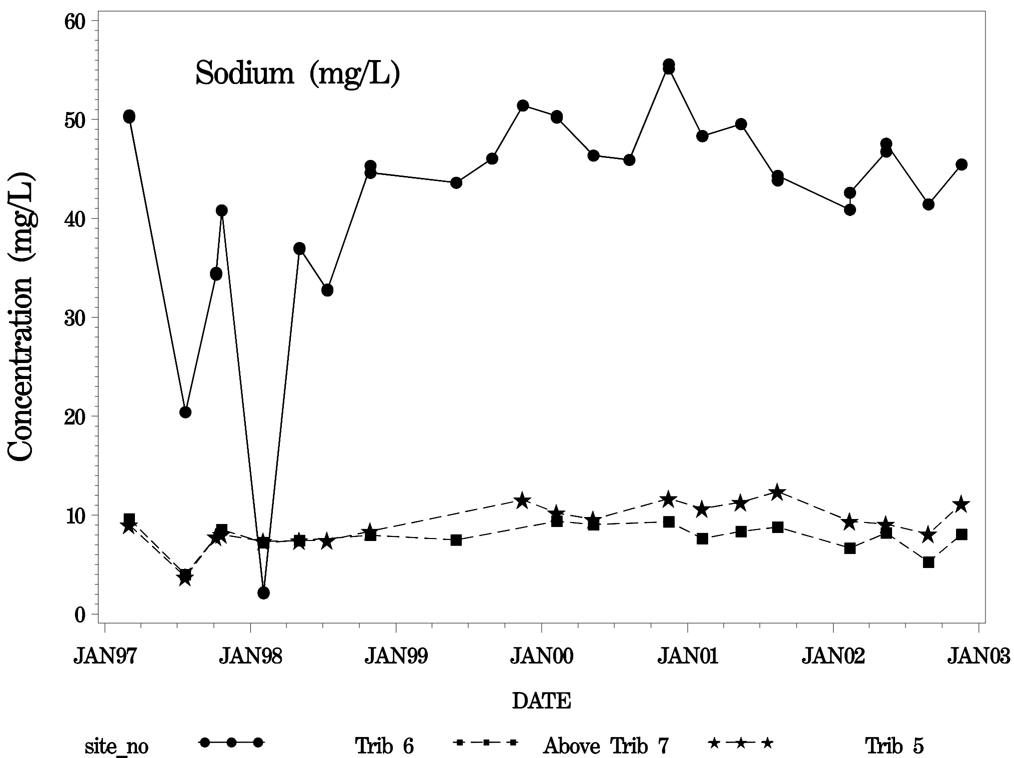


Figure 11. Embeddedness

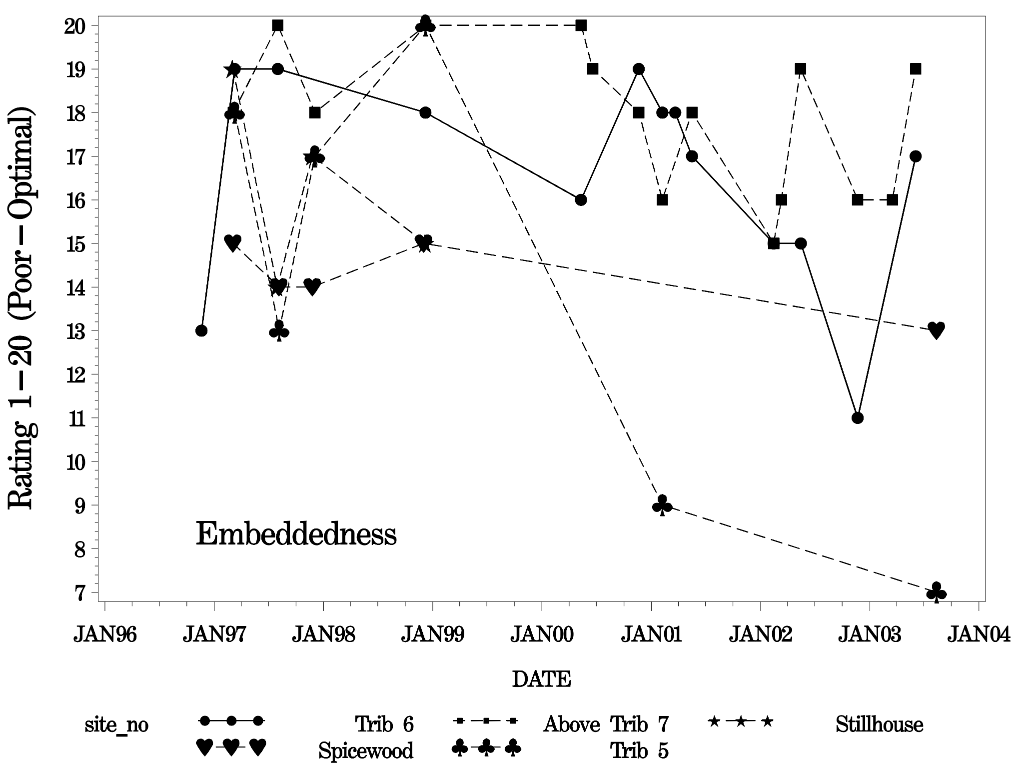


Figure 12. Chloride at Tributary 5 and above Tributary 7

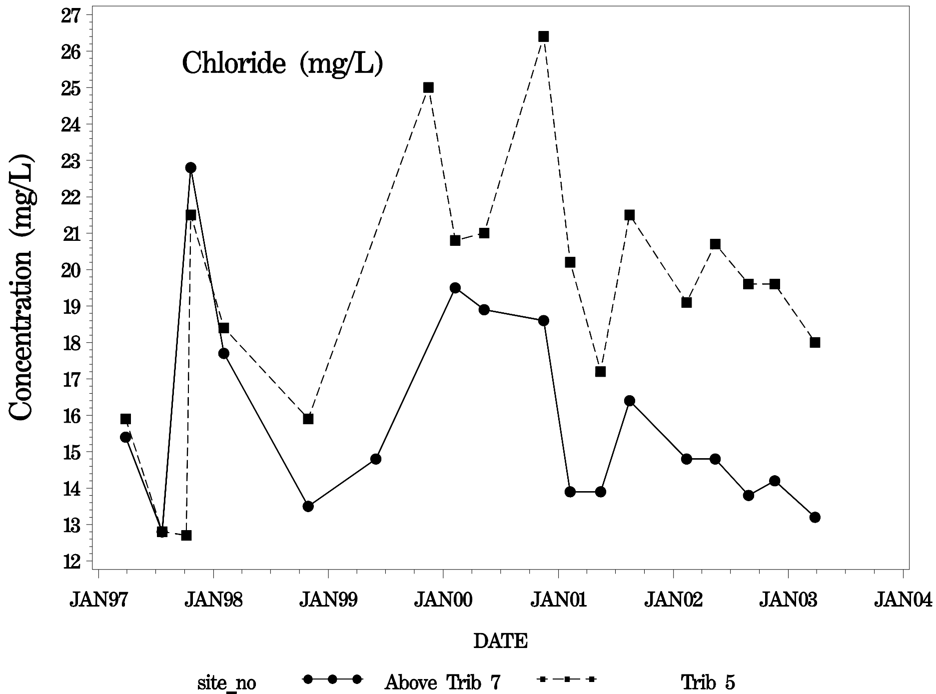


Figure 13. Sodium at Tributary 5 and above Tributary 7

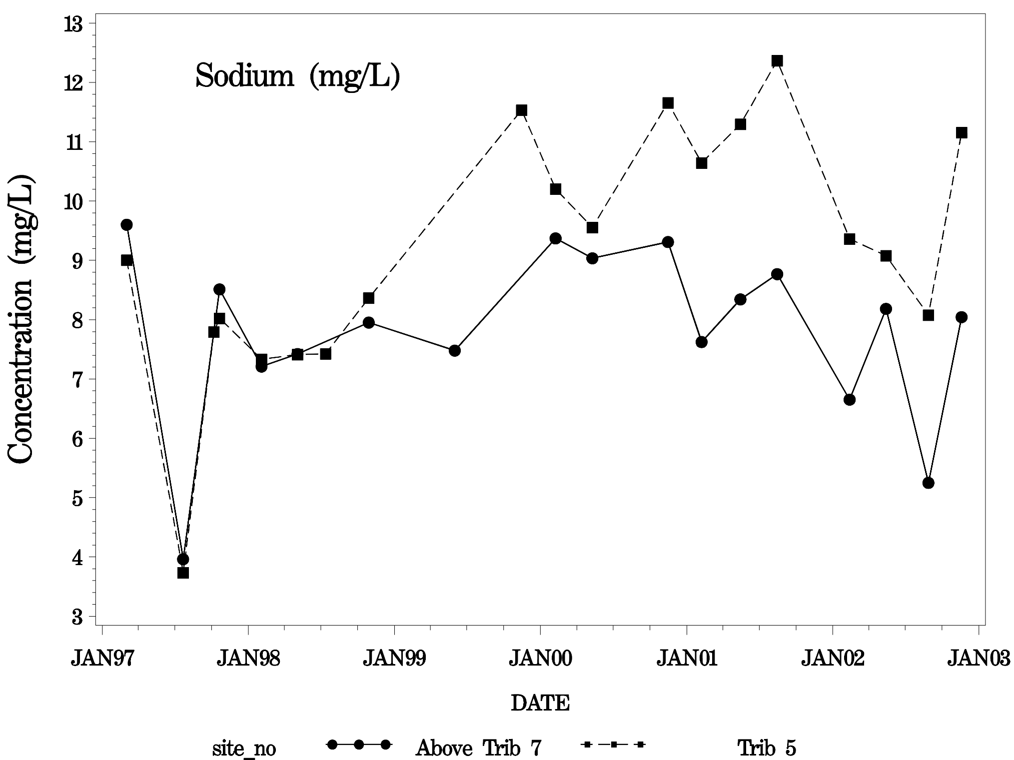
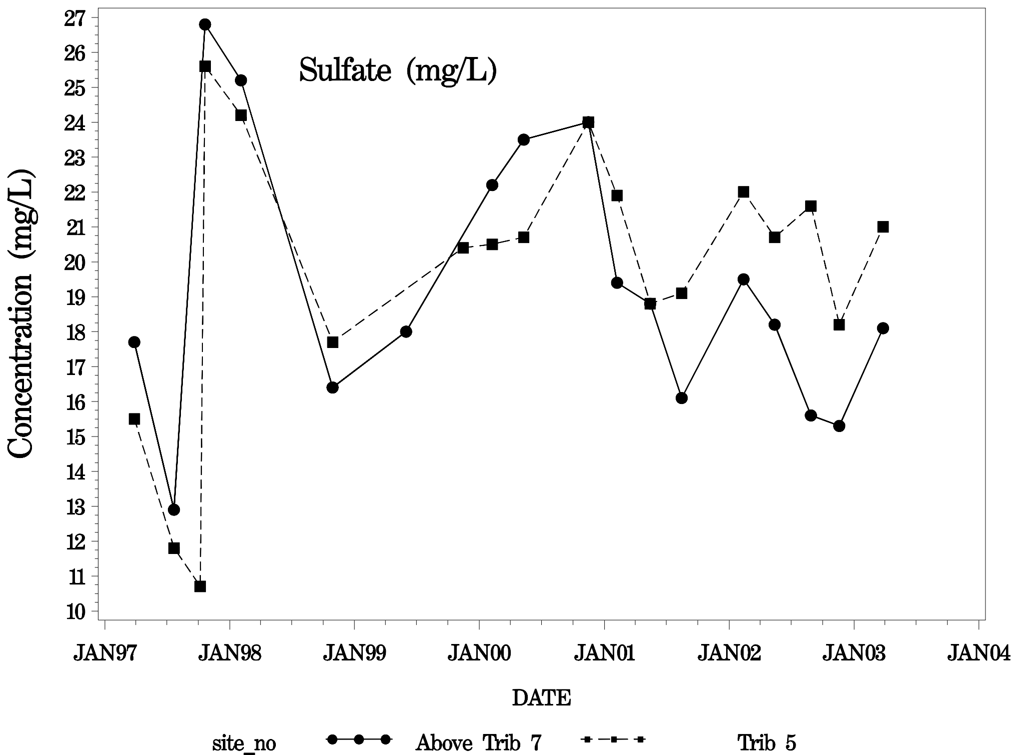


Figure 14. Sulfate at Tributary 5 and above Tributary 7



In addition some parameters appear to be changing for the worse that are not yet statistically significant. Among the habitat parameters, embeddedness appears visually to be getting worse at Tributaries 5 and 6 (Figure 11). Chloride, sulfate, and sodium appear to be increasing at Tributary 5 above the baseline of the levels at Bull Creek above Tributary 7. When the concentrations of these parameters are compared to those at Bull Creek above Tributary 7, the least developed site, the two sites overlap for the first several years and then there is complete separation, with the higher concentrations occurring at the developing site on Tributary 5 (Figures 12-14).

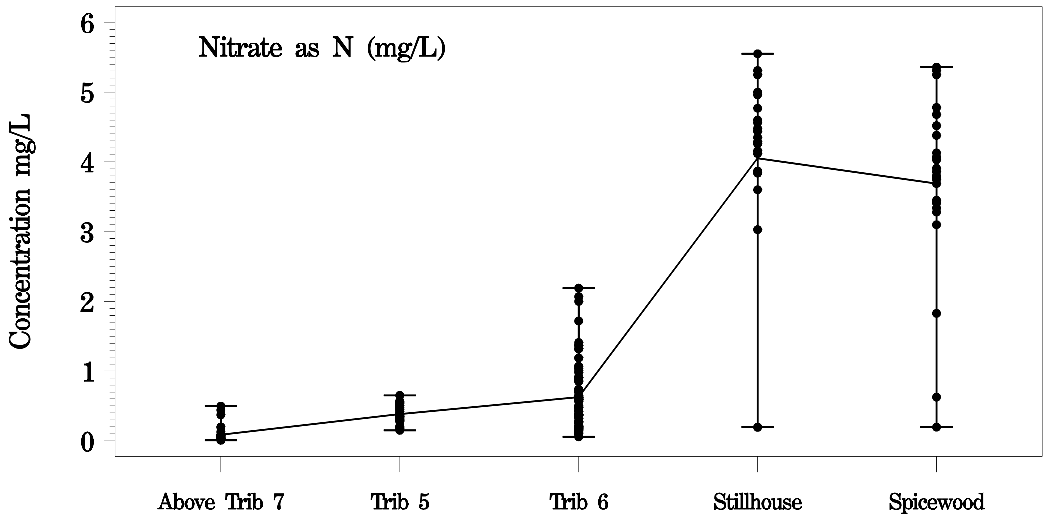
Site Differences

In order to document the differences between the five sites, plots were made of the following parameters: Nitrate, orthophosphorus, total suspended solids, chloride, sodium, sulfate, salamander counts, flow, wetted area, the number of benthic macroinvertebrate taxa, percentage dominance of the top three benthic macroinvertebrate taxa, the number of crayfish, and the number of fish. In each of these plots (Figures 15-21) the sites are arranged from the least developed to the most developed. From these plots, it appears that salamander counts and flow decrease with increasing urbanization, whereas nutrients and ions increase. The other biotic variables are not linearly related to urbanization. No relationship was found between crayfish (a potential predator) or macroinvertebrate (a food source) counts and salamander counts.

Reproductive Cycles

In the original Jollyville salamander study, seasonal reproductive cycles were identified. Analysis of recent data confirms the seasonal pattern. Salamander counts from the five sites were summed and the percent of the total count in each size class (<1 inch, 1-2 inches, >2 inches) was calculated for each

Figure 15. Nutrients at the Salamander Sites



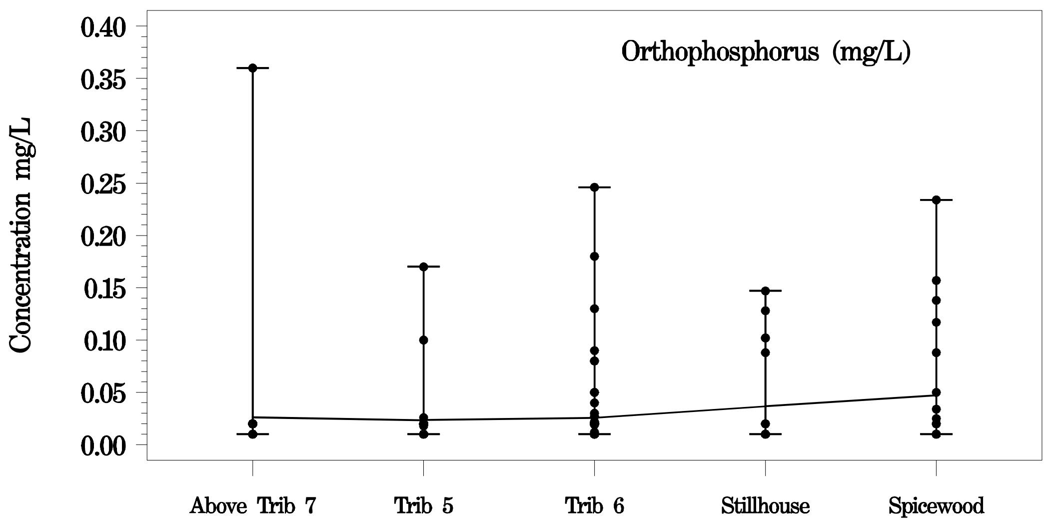
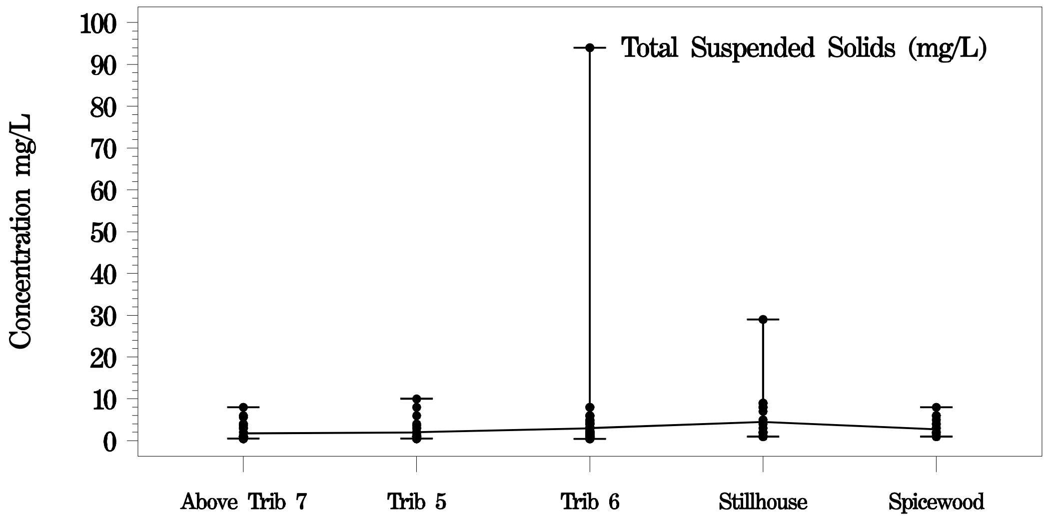


Figure 16. Total Suspended Solids at the SalamanderSites



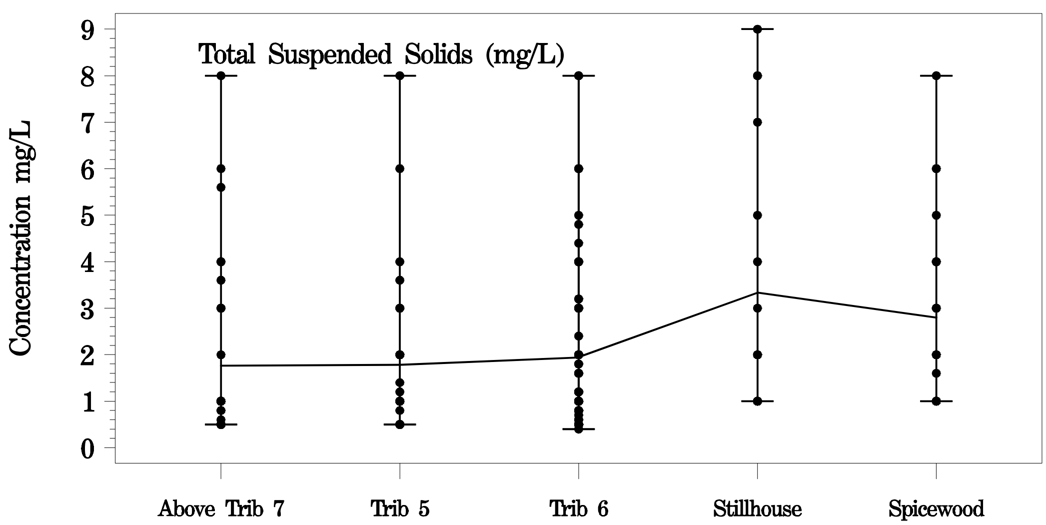
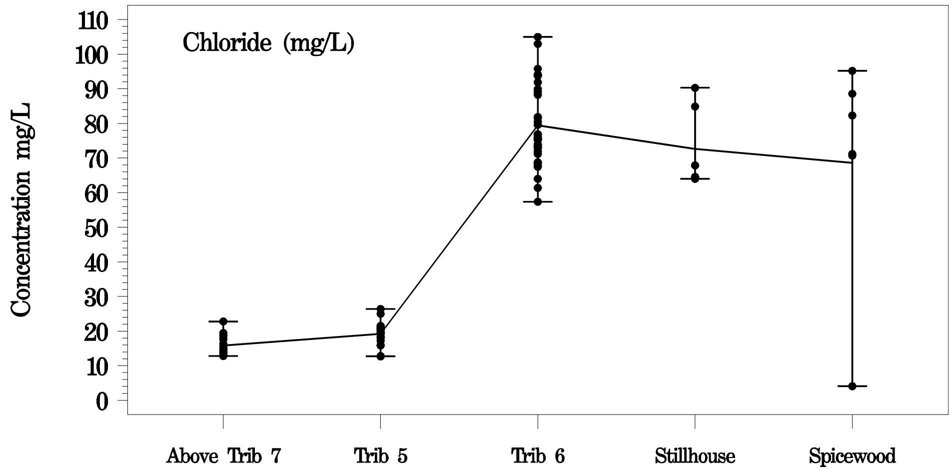
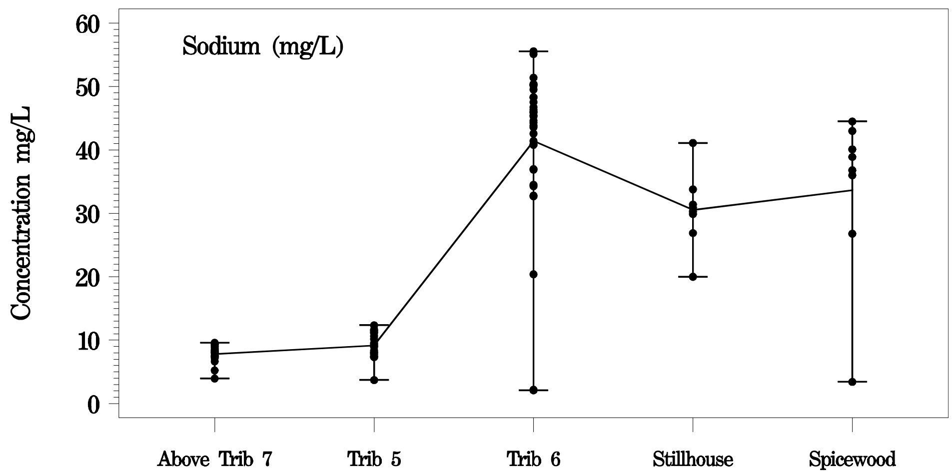


Figure 17. Ions at the Salamander Sites





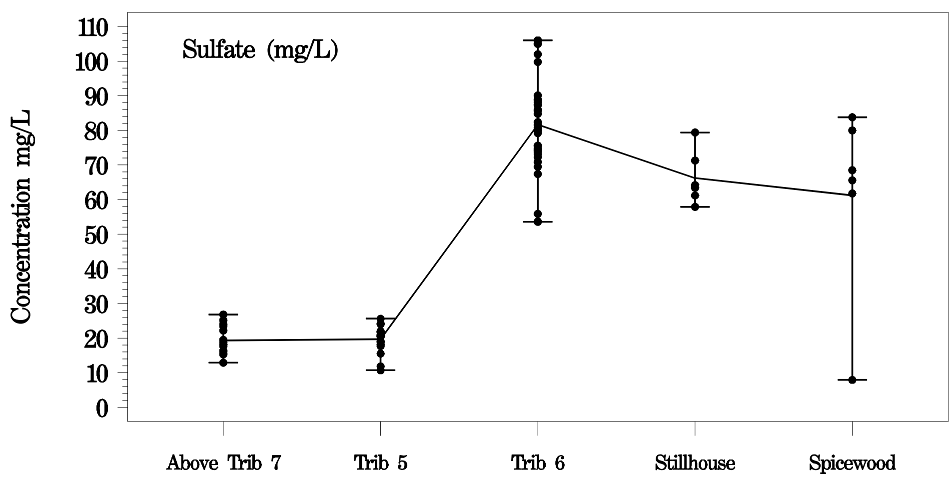


Figure 18. Salamander Counts by Size Class at the Salamander Sites

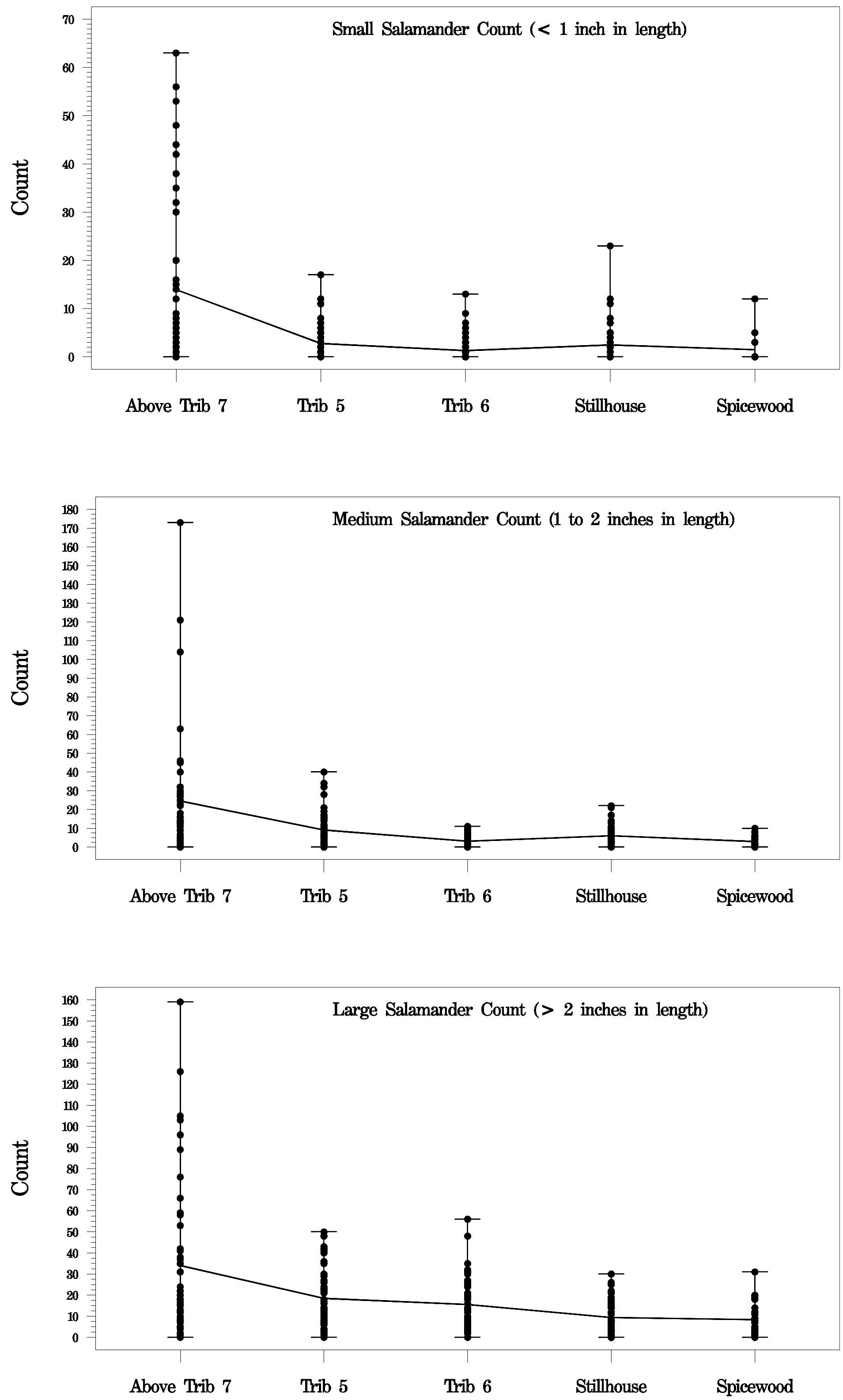
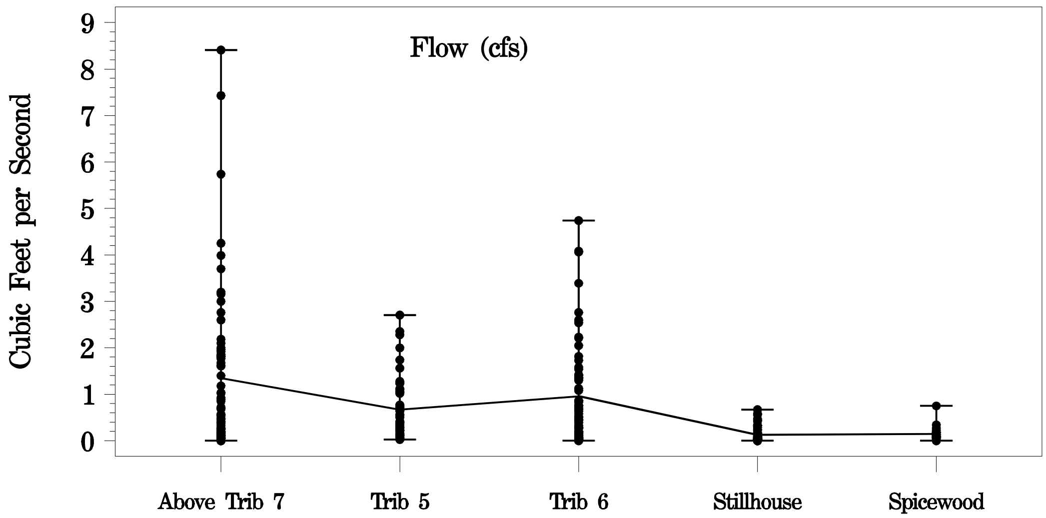


Figure 19. Flow and Wetted Area at the Salamander Sites



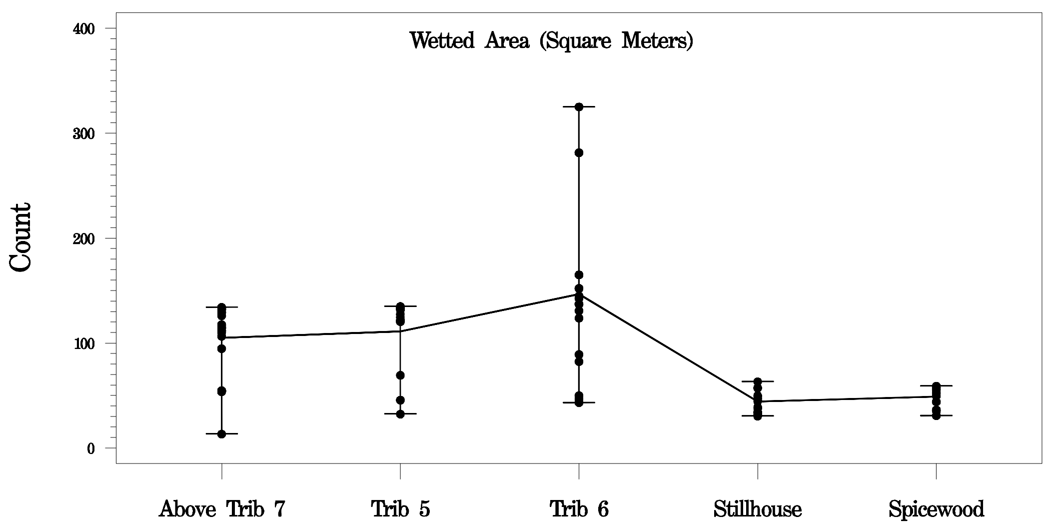
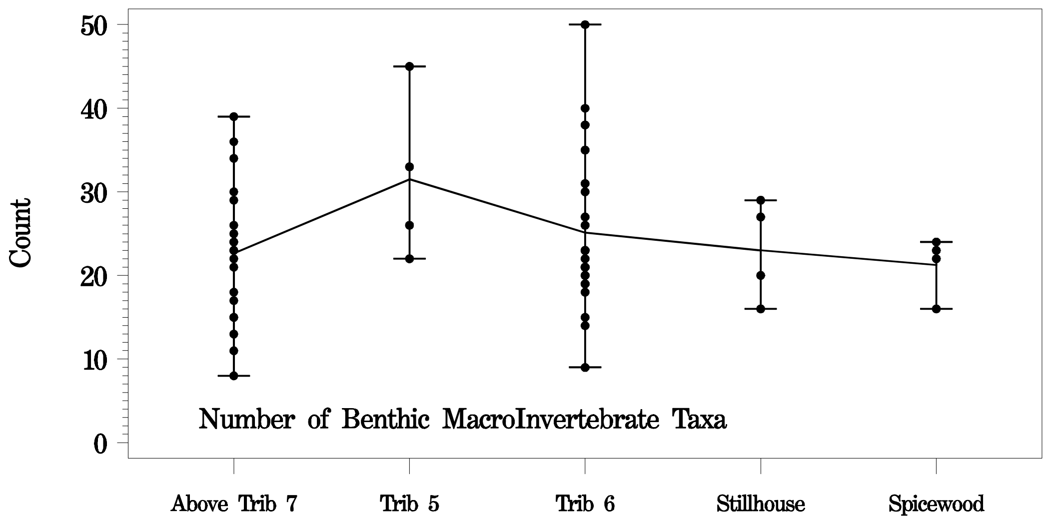


Figure 20. Macroinvertebrates at the Salamander Sites



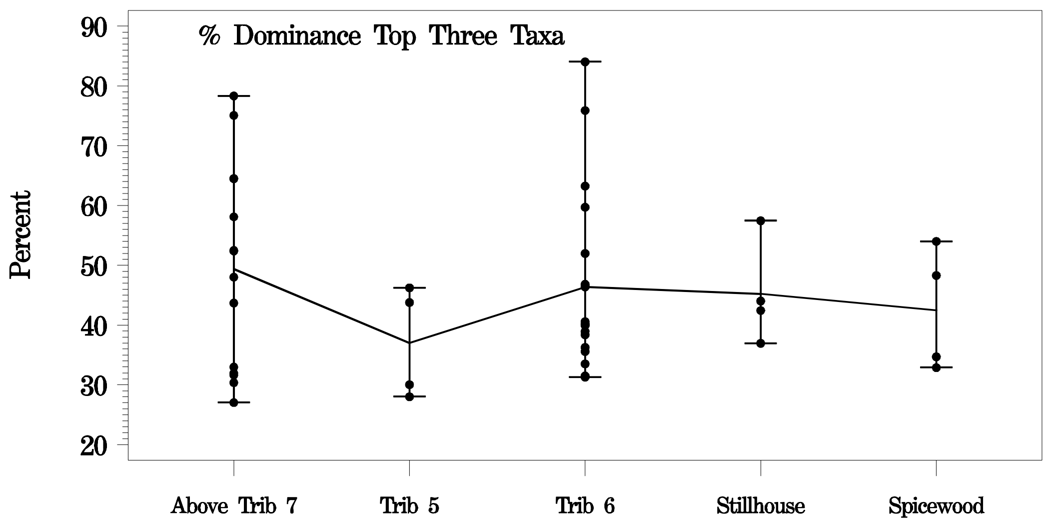
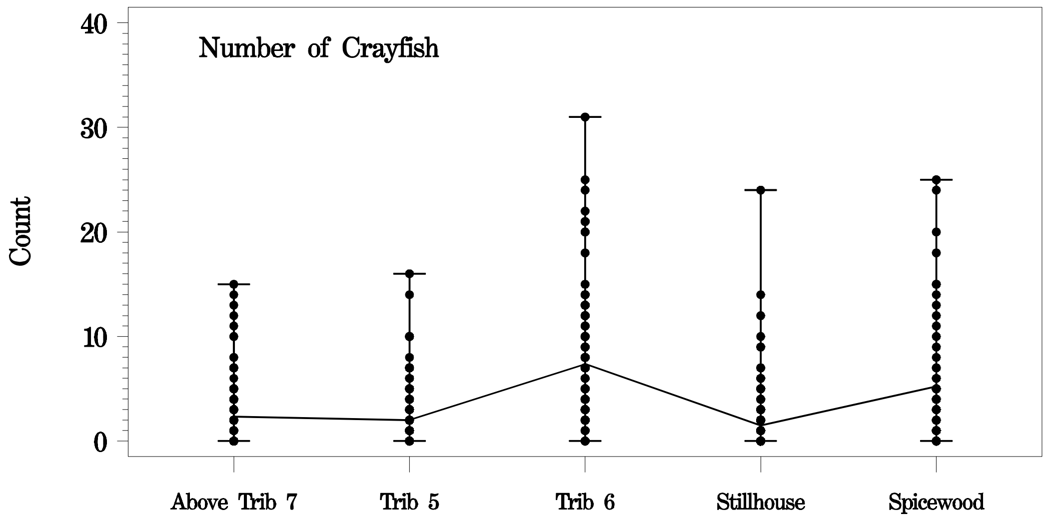
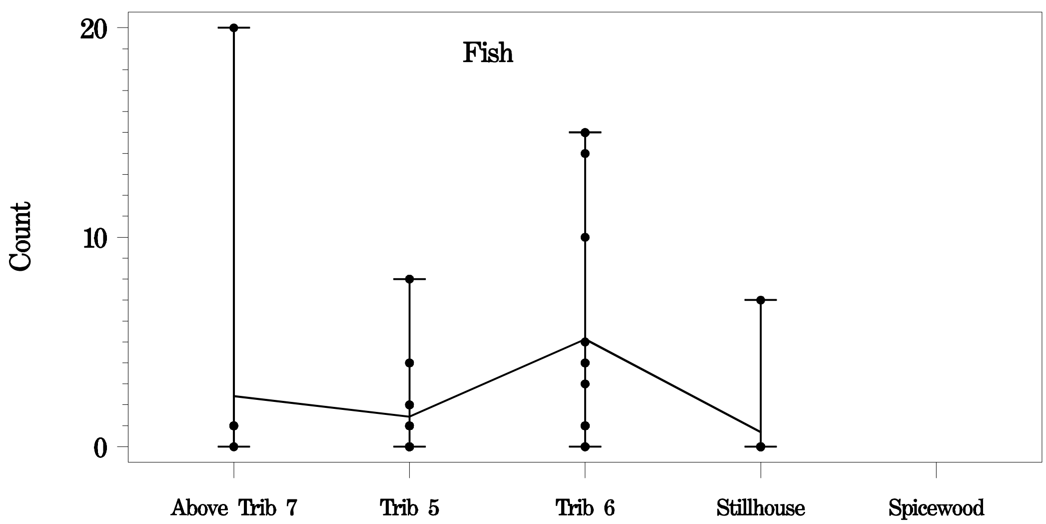


Figure 21. Other Biota at the Salamander Sites





month. Figure 22 shows the cyclical nature of the percent in the smallest size class. The percents and the counts in each size class from 7 years of sampling are combined and plotted by month in Figures 23-25. The percent of salamanders in the smallest size class peaks in May, with moderately high values from March through July. The percent in this class is low from August through February. The middle size class, 1-2 inches in length, peaks in August, 3 months after the smallest size class peaks. The percent in the largest size class does not peak in a single month but is high from October through April and low from May through September.

Flow

The relationship between flow, and salamander counts and reproductive cycles, was investigated. As with the Barton Springs salamander there is not a direct significant relationship between flow and counts. The seasonal patterns in flow were investigated by calculating the mean flow at three sites (#151, #349, and #1164) for each year and month and summing these mean flows. The other two sites were not included because their flow measurements were sporadic in recent years. The summed flows are plotted by month in Figure 25. Flows are lowest in the months of August and September. The rest of the year has flows that are higher but quite variable, with the highest median flow in March. The percent and number of the smallest size class of salamanders are very low from August through February. It is possible that the low flows in August and September are related to the low counts of the smallest salamanders from August through February. When the time series of monthly flow and monthly percent of small salamanders were overlaid, the patterns appear similar but offset from one another (Figure 26). The lag is approximately 4 months. Figure 27 shows the percent of small salamanders together with the flow from 4 months before and the patterns are similar.

Figure 22. Cycles in the Percent of the Smallest Salamanders (< 1 inch)

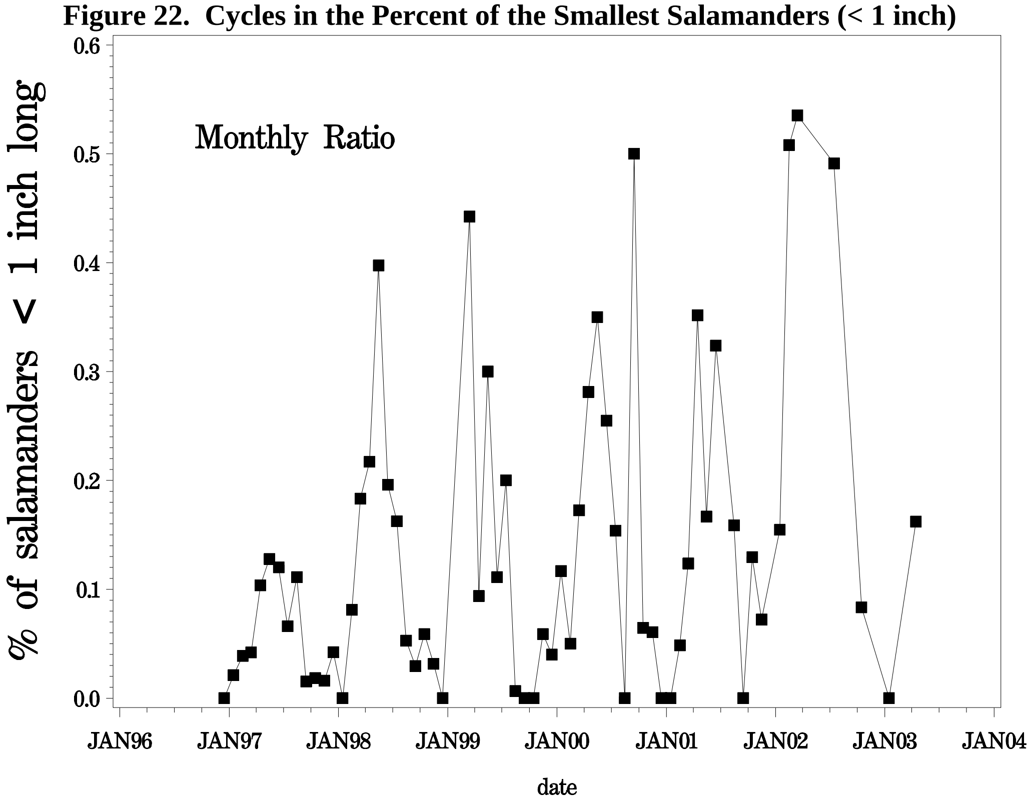
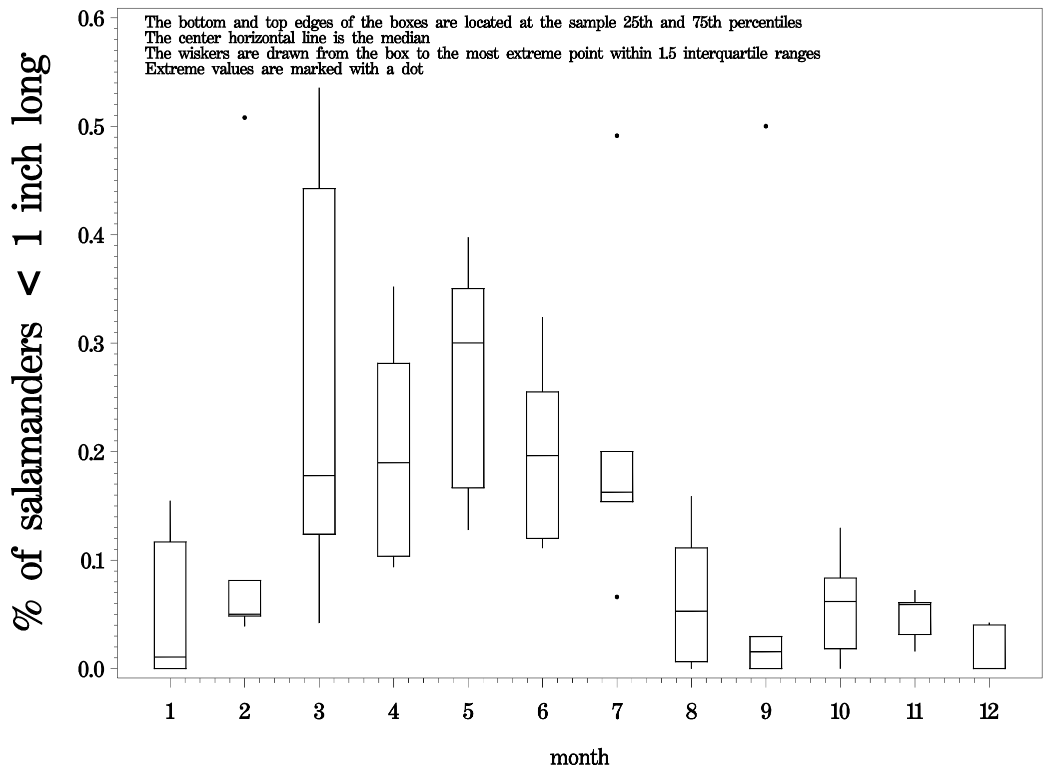


Figure 23. Percent of the Count, and the Count in the < 1 inch Salamander Size Class



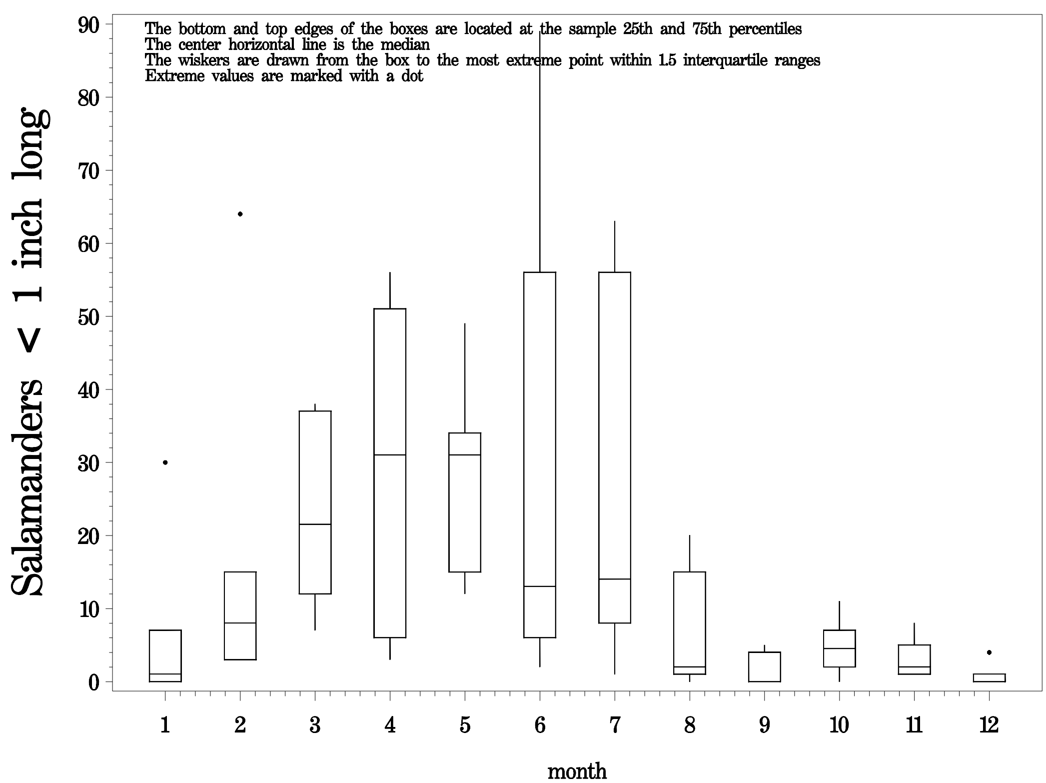


Figure 24. Percent of the Count, and the Count in the 1-2 inch Salamander Size Class

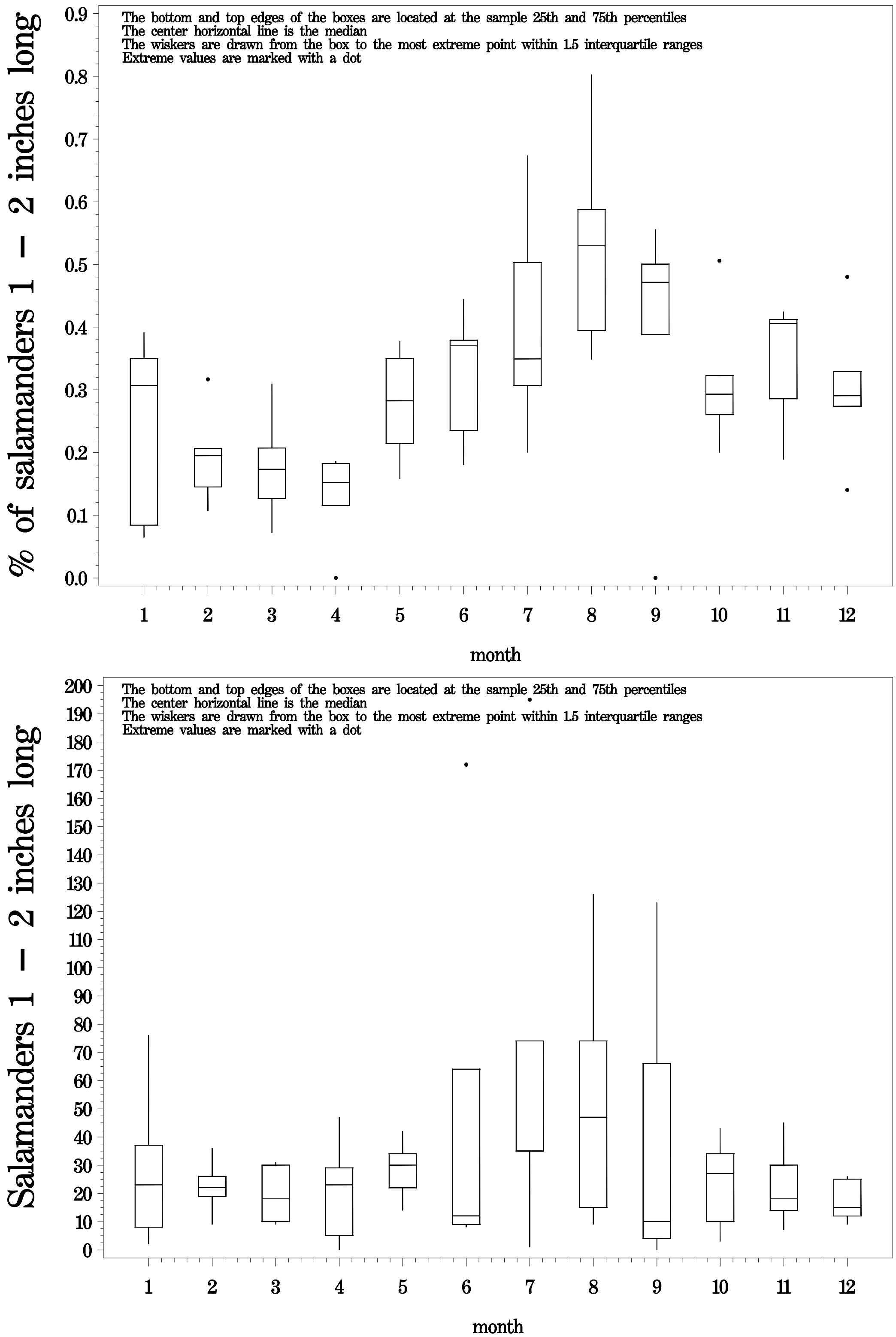
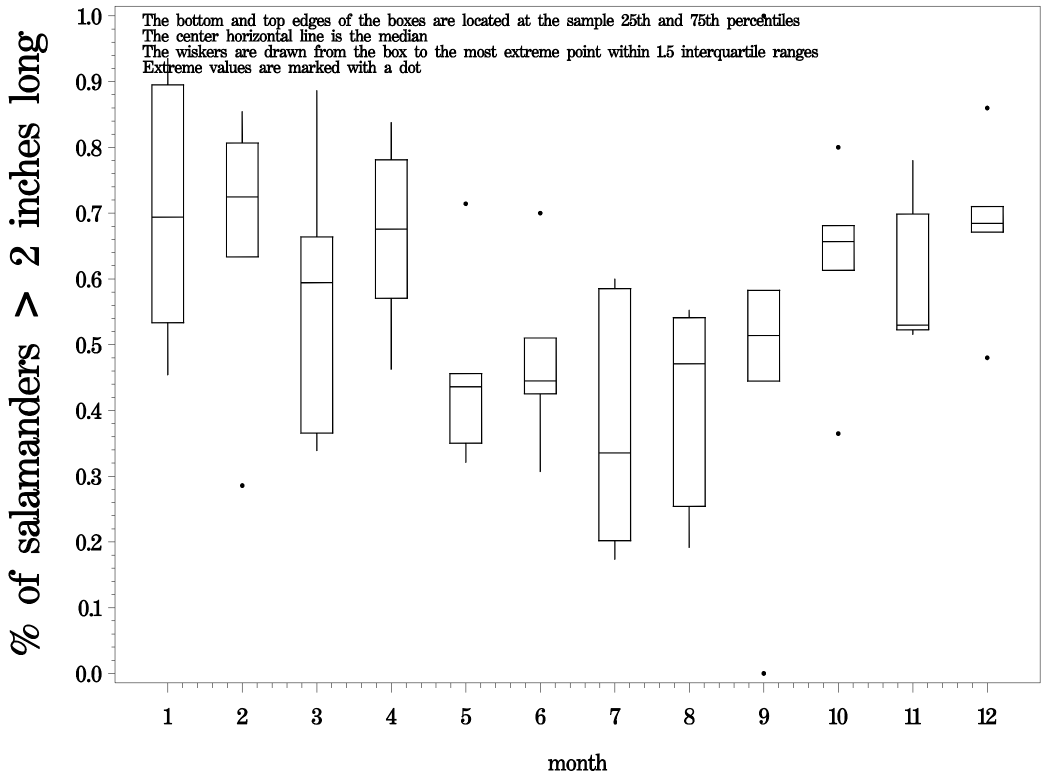


Figure 25. Percent of the Count, and the Count in the >2 inch Salamander Size Class



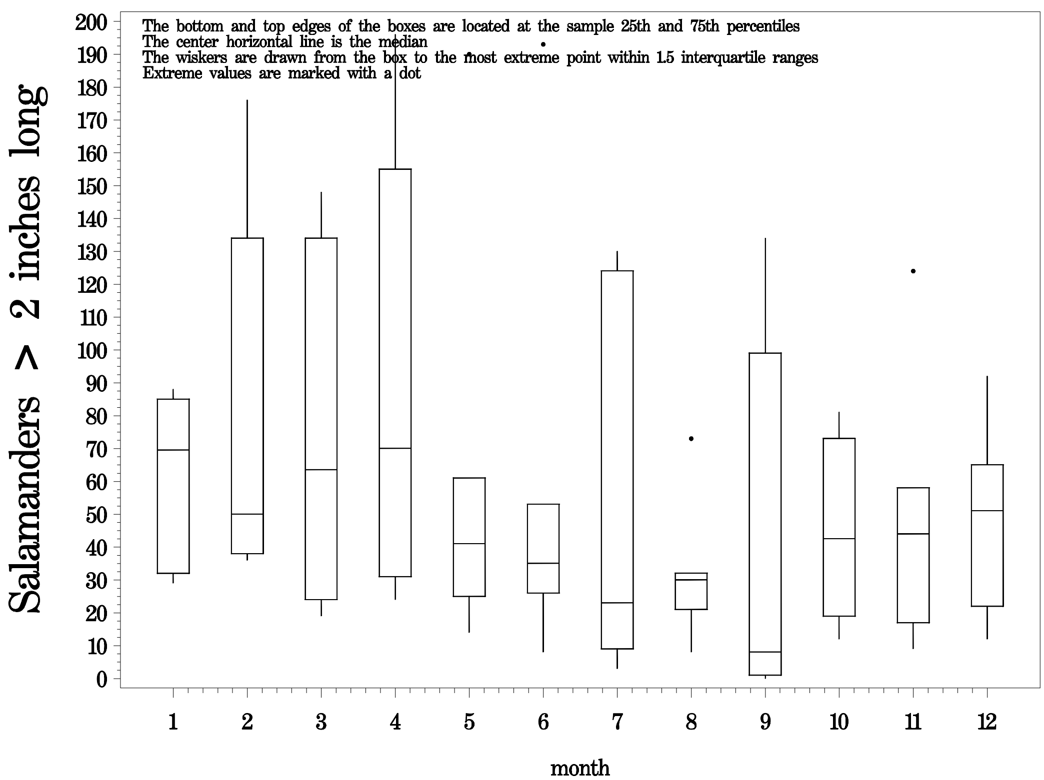


Figure 26. Monthly Flow Patterns

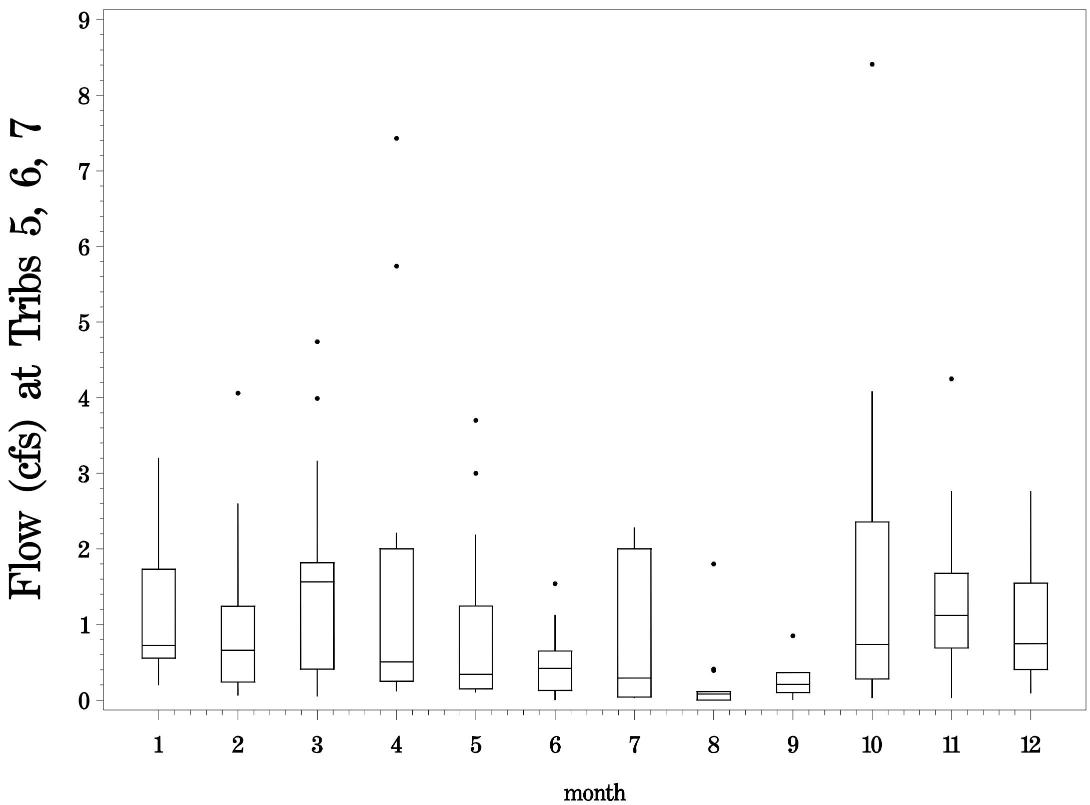


Figure 27. Comparison of Percentage of Small Salamanders and Flow

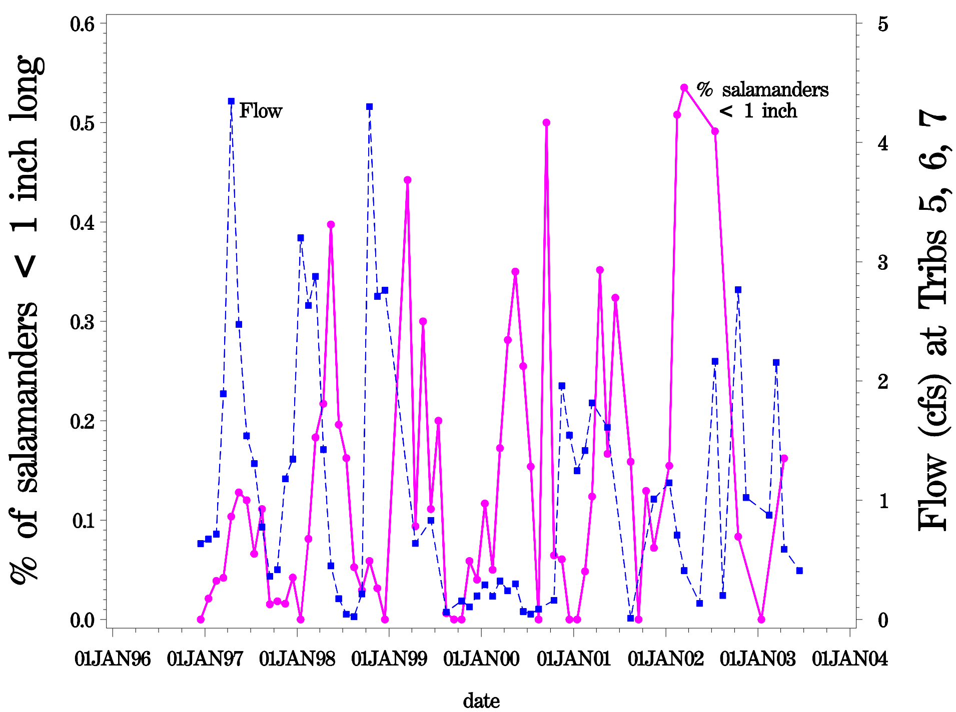
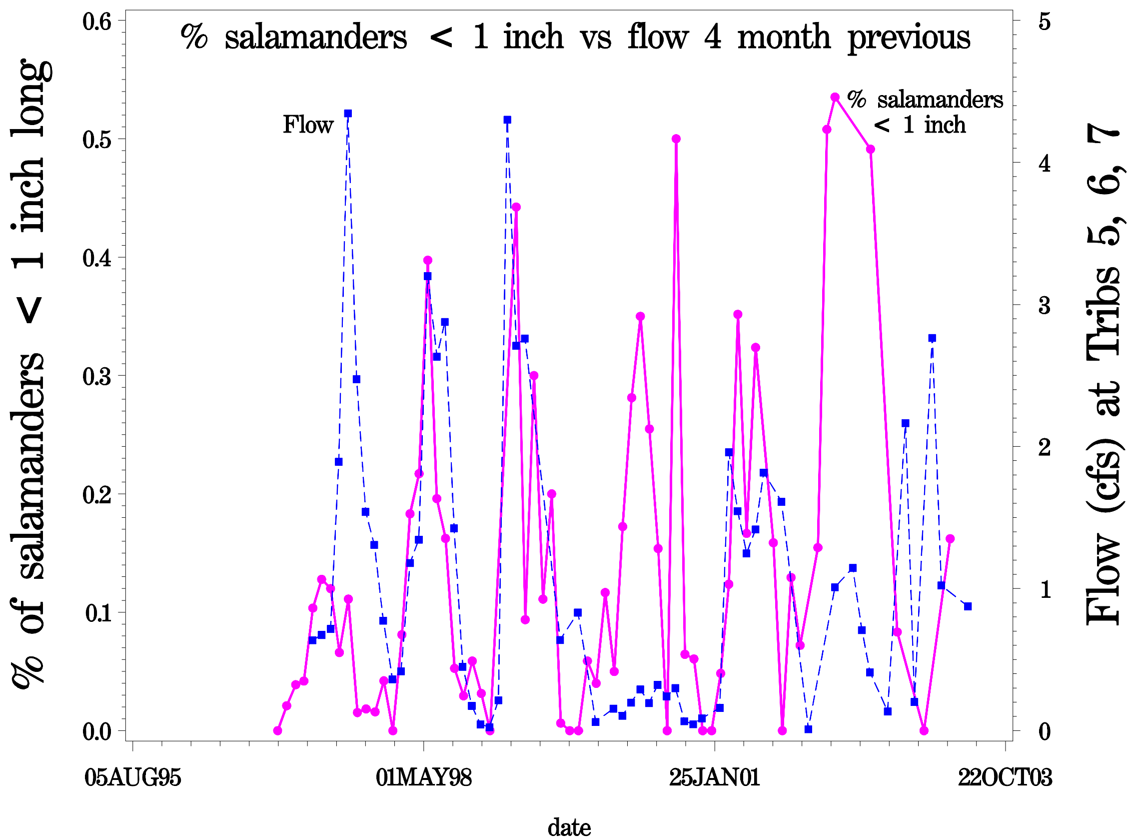


Figure 28. Comparison of Percentage of Small Salamanders and Flow 4 Months Before



Summary

Two main conclusions are derived from this analysis:

- Salamander counts are declining at two sites; and the declines appear to be related to measured habitat degradation that has occurred as the watersheds of the sites have developed. Water quality has also declined at these sites.
- The Jollyville salamander seasonal reproductive cycles indicated in previous analyses were verified, and these cycles may be regulated by rainfall via spring flow.

The habitat degradation from increased sediment loads provided by construction runoff or runoff from developed areas seems to be related to the decline in salamander counts. If construction sediment loads are the main cause, the habitat changes should lessen as construction is completed and site vegetation is established. Increased inspection and enforcement of sedimentation and erosion controls for sites during construction could also reduce these temporary loads. If developed area sediment loads are the cause, retrofit water quality controls may be the only way to reduce this impact. In either case, the opportunity to correlate salamander recovery to non-point source pollution control may be present if sediment loads can be reversed and if the salamander counts would respond in kind. However, if habitat is already altered significantly, restoration of bed sediments through hand removal or the flushing action of major flood events may be required to promote salamander recovery.

Monitoring Plan Recommendations

Recommendations for ongoing sampling include the following:

- Conduct annual habitat surveys at the five sites, with possibly more frequent habitat measurements at the sites with significant decreases in salamander counts.
- Match the schedule for salamander counts at Tributary 5, Tributary 6, and Bull Creek above Tributary 7 to the peaks in abundance for each size class – sample in May, August, and February.
- Conduct annual counts at Stillhouse Hollow and Spicewood Springs sites during the winter from December to February to verify reproduction patterns.
- Take flow measurements with each salamander count.
- Take water quality samples annually at the five sites. Coordinate with surface water quality and spring monitoring to obtain parallel samples with counts. Include parameters that have been identified as degrading at sites where the salamander counts are declining, including nitrate, sodium, sulfate, and chloride.
- Perform data analysis again in two years after implementing the above changes in monitoring.