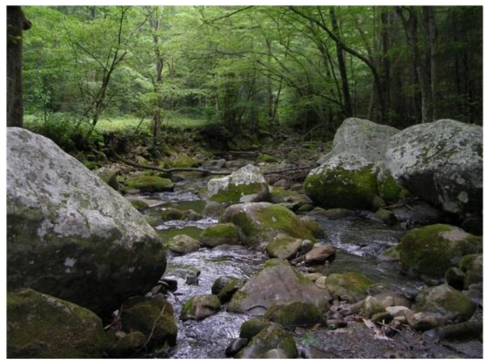
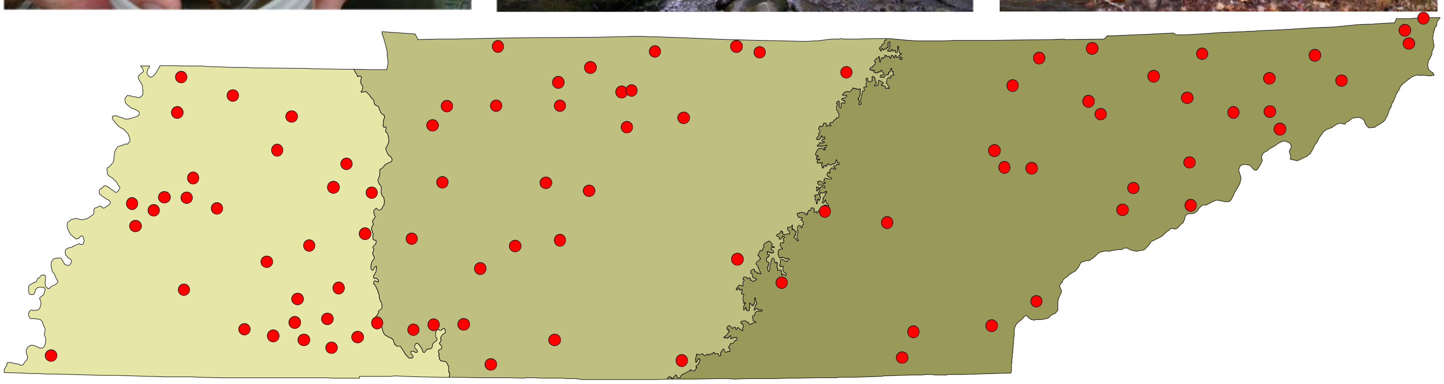
2007-8 PROBABILISTIC MONITORING OF WADEABLE STREAMS IN TENNESSEE

Volume 6: Periphyton

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Volume 6

Periphyton

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Kalina Manoylov, an assistant professor of biology with Georgia College and State University, processed the periphyton samples. Quality Control samples were analyzed by Marina Potapova, with the Academy of Natural Sciences.

Cover photos provided by Water Pollution Control staff biologists.

1. INTRODUCTION

In 2000, the Division of Water Pollution Control (WPC) began to incorporate probabilistic monitoring into its stream assessment program. The 2007 Wadeable Streams Assessment (WSA) study is a probabilistically-based survey of wadeable streams in Tennessee that builds upon EPA's 2004 Wadeable Streams Assessment survey of the nation's streams (USEPA, 2006). Biological, bacteriological, physical, and chemical data from a random sub-sampling of Tennessee streams will be extrapolated to all wadeable streams in Tennessee. These data will provide a baseline to which future efforts can be compared, thus providing an opportunity for scientifically valid trend analysis.

For the purpose of this study, Tennessee was divided into three divisions based on level III ecoregions. A random sample of 30 wadeable streams was selected in each third of the state for a total of 90 sites that were sampled. Results of the study are reported in 6 volumes which are available at http://tn.gov/environment/wpc/publications/. Details of the site selection process and sampling protocols can be found in Volume 2 of this report series.

This volume provides detail on the condition of periphyton. Periphyton sampling is gaining in importance across the Southeast, as it can give valuable information about water quality, especially nutrient enrichment. Periphyton are good biological indicators for several reasons: communities have a naturally occurring high number of species; they respond quickly to environmental changes; and the tolerance of many species to specific environmental conditions, particularly nutrients, is already known.

The periphyton community was surveyed between July and October of 2007 at the majority of the sites. A few samples were surveyed in November and December of 2007, and also April and June of 2008. Algal density and community composition results are presented and compared for each of the three divisions in Tennessee (west, middle, and east). Kentucky's Diatom Bioassessment Index was used to evaluate the diatom communities sampled. Since indices for non-diatom algae and biomass have not been developed, data are presented and summarized in this report. The purpose of this volume is only to present statistical comparisons of data and not assessments of use support which will be presented in Volume 1.

For this project, two protocols were followed. The first was the Rapid Periphyton Survey (RPS), which is an algal field density analysis that provided a measure of biomass. Field staff also collected Multiple-habitat Periphyton Samples (MPS), which were contracted for laboratory analysis by experts in periphyton taxonomy.

2. RAPID PERIPHYTON SURVEY (RPS)

a. RPS Methods

The Rapid Periphyton Survey is composed of several different field based biomass assessment metrics. This technique is a survey of the natural substrate and requires no laboratory processing. The RPS protocols for this study were adapted from the method developed by Stevenson and Bahls (Barbour et. al., 1999).

The modified method provided information on biomass in three broad categories: moss, macroalgae and microalgae. Mosses are members of the division Bryophyta. Macroalgae are long filamentous strands of algae such as *Cladophora* or *Spirogyra spp*. Microalgae are primarily single celled algae that coat the substrate and are generally composed of diatoms and soft algae such as blue-green algae.

At each of the WSA sites, there were five transects within a 100 meter reach surveyed for algal biomass. Each transect had ten evenly spaced points across the stream that were selected for analysis. A gridded square of glass was positioned over the fifty selected locations. The viewing surface of the glass was divided into quadrants for ease of estimation. At each location, the researcher estimated moss cover, macroalgal cover, and microalgal biofilm thickness. These estimations corresponded to the classes listed in Table 1.

Table 1. Percent Cover and Biofilm Thickness Classes

Moss and Macroalgae Cover Classes						
Class Number	0	1	2	3	4	5
Coverage	0%	<5%	5% to 25%	25% to 50%	50% to 75%	>75%
Microalgal Biofilm Thickness Classes						
Class Number	0	1	2	3	4	5
Thickness	0 mm	<0.5 mm	0.5 to 1 mm	1 to 5 mm	5 to 20 mm	>20 mm
Characteristics	rough	Slimy, no visible biofilm	Biofilm visible			

A measure of the percent of canopy cover was also taken at the midpoint of the third (middle) transect of each stream using a spherical densitometer. Areas with low amounts of canopy cover have greater potential for a higher algal biomass than those that are shaded due to increased rates of growth and reproduction. An estimation of the percent of the substrate for each stream that is optimal for periphyton growth was also recorded as part of the Rapid Periphyton Survey. Optimal substrate is defined as substrate particles that are greater than 2 cm in size. Smaller substrate particles are not as suitable for the growth of a stable population of algae due to scouring and shifting.

b. RPS Results

An index has not yet been developed for the RPS, so a variety of metrics were calculated and the results evaluated. A table that contains the RPS metrics for each station can be found in Appendix A.

The first metric was the coverage class for moss and macroalgae, and mean biofilm thickness class for microalgae. For the mosses, east Tennessee had a much higher coverage class range than middle and west Tennessee (Figure 1). The overall coverage class ranges for macroalgae were fairly consistent across the state, although west Tennessee had the least variability (Figure 2). Microalgae biofilm thickness was lowest in west Tennessee, while middle and east Tennessee had similar ranges (Figure 3).

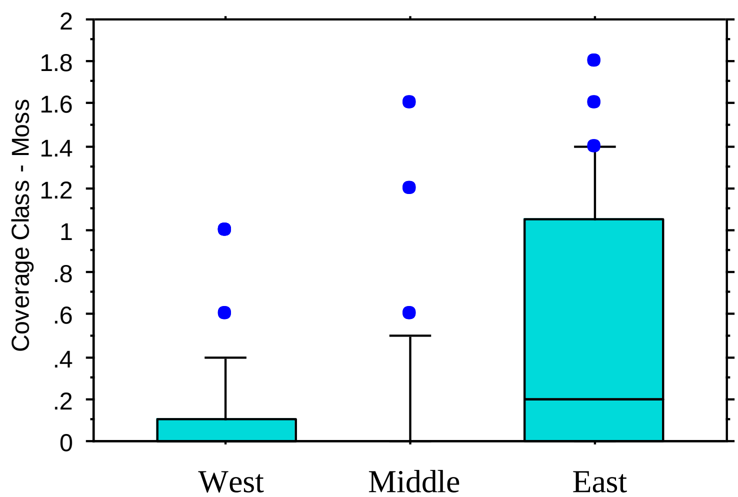


Figure 1: Ranges for the moss coverage class at the WSA sites.

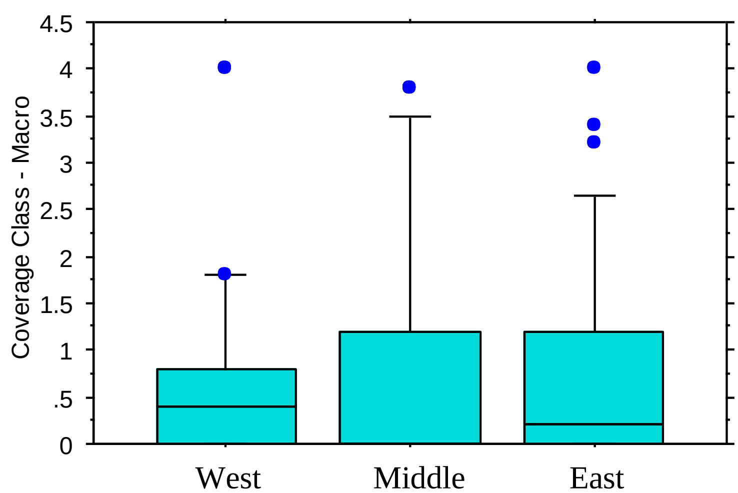


Figure 2: Ranges for the macroalgae coverage class at the WSA sites.

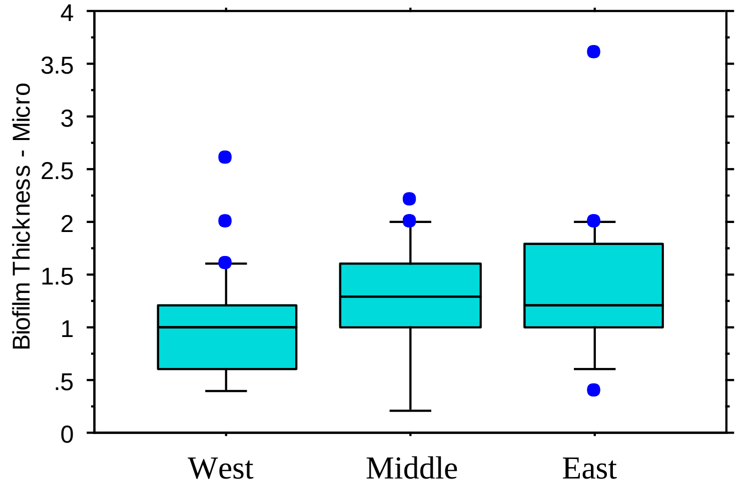


Figure 3: Ranges for the microalgae coverage class at the WSA sites.

The second metric was percent cover by moss, macroalgae, and microalgae. This is calculated by dividing the number of points that had moss, macroalgae, or microalgae by the total number of points evaluated. The differences in percent cover between the three regions can be seen in Figure 4. West Tennessee consistently had greater percent cover of all three types, followed by middle, then east Tennessee. Even though west Tennessee had the most points with algae present, the mean cover and thickness classes were slightly lower than the rest of the state. This means that algae were more evenly spread out and not necessarily greater in biomass.

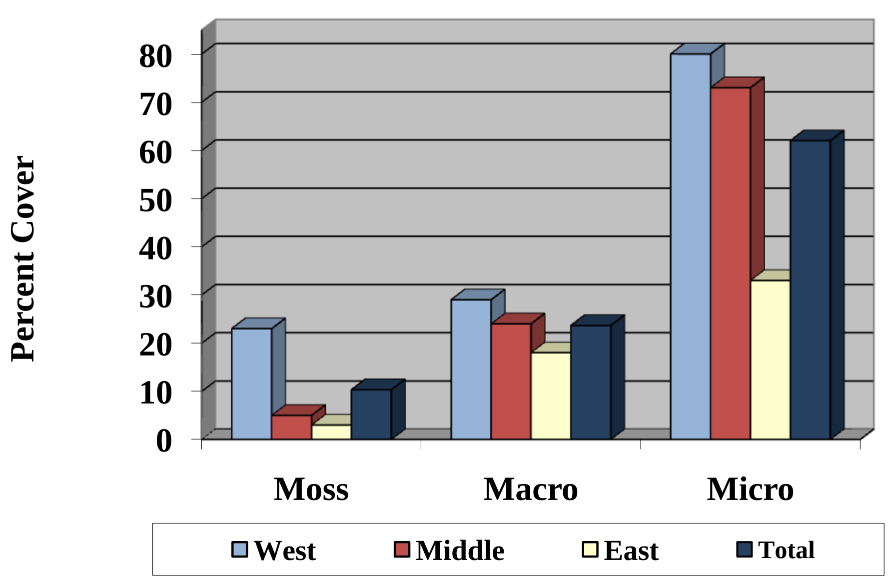


Figure 4: Percent cover by moss, macroalgae, and microalgae at the WSA sites.

The third metric was canopy cover. The mean percent canopy cover was fairly consistent in the three divisions of the state, but the cover between sites varied greatly (Figure 5). Overall, west Tennessee had the most canopy with a median value of 87% cover.

Amy Fritz, Jackson EFO uses a spherical densiometer to estimate overhead canopy cover.

Photo provided by PAS.

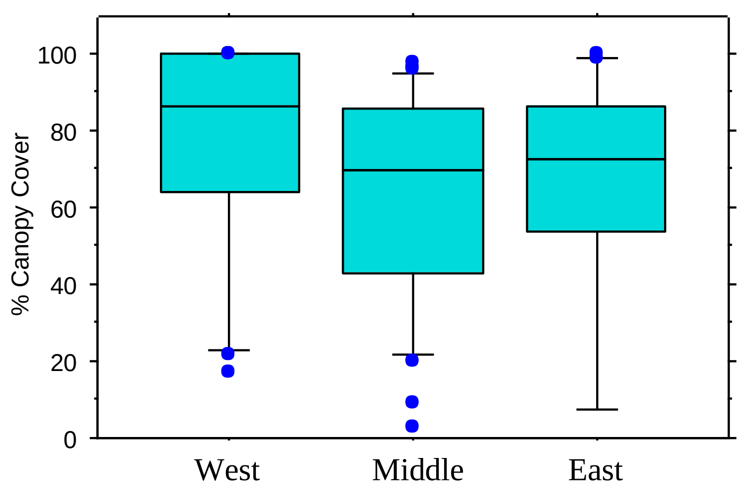


Figure 5: Ranges for percent canopy cover at the WSA sites.

The percent of optimal substrate was the highest in middle and east Tennessee (Figure 6). West Tennessee was much lower than the rest of the state. Only 41% of the substrate in West Tennessee had particles larger than 2 cm in size. Many of these streams had a sand substrate. This may help explain why the biomass was generally lower in this region, especially for microalgae.

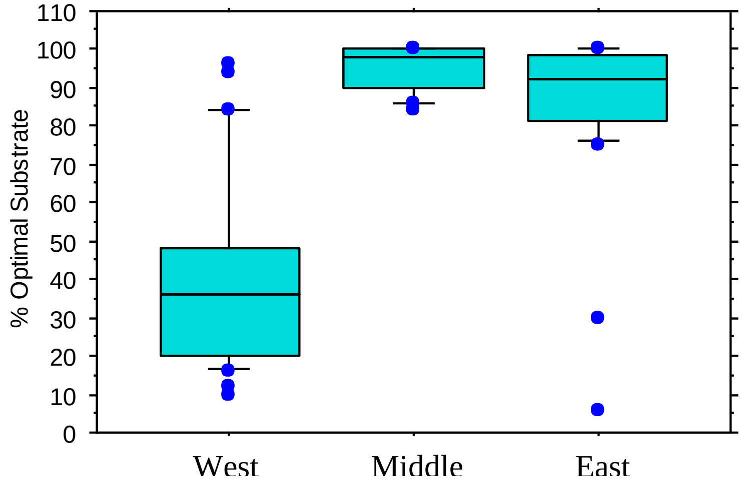


Figure 6: Ranges for percent optimal substrate at the WSA sites

3. MULTIPLE-HABITAT PERIPHYTON SAMPLES

Multiple-habitat periphyton samples (MPS) were collected at each of the WSA sites in conjunction with the field-based RPS. Ten aliquots were taken from available productive habitats at each site and were composited into one sample for laboratory analysis. The composite sample included both diatoms and non-diatoms (soft algae). Examples of productive habitats include riffle rocks, pool rocks, leaf packs, aquatic plants/roots, removable portions of vascular plants, and woody debris that were within an arm's length (0.5m) of the water surface.

a. Diatoms

Diatoms are algae included in the taxonomic division Bacillariophyta. Most species are unicellular, but some exist in colonies. Diatoms are extremely diverse. WPC biologists have collected 788 species so far in Tennessee as part of the periphyton program. A characteristic feature of diatom cells is that they are encased within a frustule, which is a unique glass-like cell wall that is made of silica. The Kentucky Diatom Bioassessment Index (KDBI) was the primary index used to assess the diatom populations in each stream. The KDBI is a multi-metric index that was developed by the state of Kentucky for the purpose of assessing diatom communities (KDEP, 2008). There are six individual metrics used to calculate the final KDBI score. The KDBI score reflects the overall water quality more comprehensively than any of the single metrics alone. The scores were then compared to regional bioassessment guidelines.

Individual KDBI metrics:

1. Total Number of Diatom Taxa (TNDT)

This metric measures the diatom species richness. Species richness is expected to decrease with increasing pollution (KDEP, 2008). However, slight levels of nutrient enrichment may increase species richness in naturally un-productive, nutrient-poor streams (Bahls, 1992). The TNDT was highest in west Tennessee, where the mean was 52 species (Table 2 and Figure 7). East Tennessee had the next greatest TNDT with a mean of 46, followed by middle Tennessee, with a mean of 39.

Table 2: Total Number of Diatom Taxa Summary Statistics

	Min	Max	Mean	Median	Std. Dev.
West	23	74	52	51.5	12.1
Middle	14	68	39	39	11.7
East	19	73	46	47	12.9
TN	14	74	46	46.5	13.3

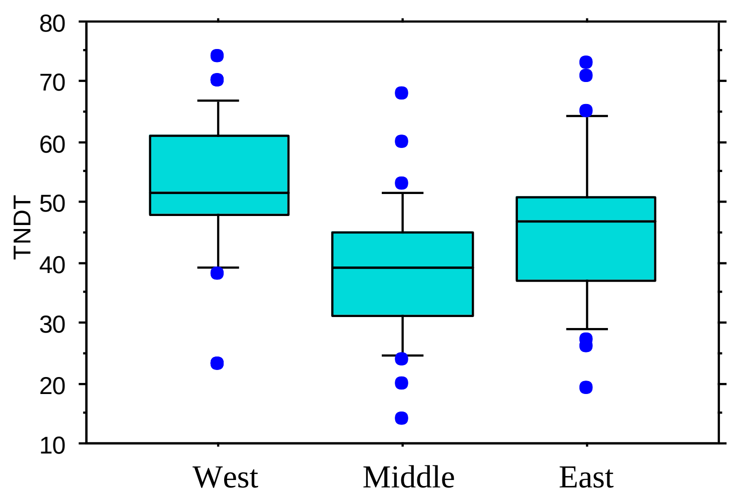


Figure 7: Ranges for Total Number of Diatom Taxa values at the WSA sites.

2. Shannon Diversity Index (H')

The mean Shannon diversity index was chosen primarily because it is commonly used by aquatic biologists, so values are more readily interpreted and compared with other literature values. Using this index, H′= 0 when only one species is present in the collection, and H′ is at a maximum when all individuals are evenly distributed among all species. The mean Shannon Diversity value was also highest in the western division, followed by east and middle Tennessee (Table 3 and Figure 8).

$$H' = -\sum \frac{n_i}{N} \log_{10} \frac{n_i}{N}$$

where:
n_i = number of individuals of species i
N = total number of individuals

Table 3: Shannon Diversity Index Summary Statistics

	Min	Max	Mean	Median	Std. Dev.
West	0.36	1.65	1.38	1.43	0.27
Middle	0.24	1.63	1.17	1.24	0.33
East	0.59	1.74	1.35	1.37	0.23
TN	0.24	1.74	1.3	1.36	0.29

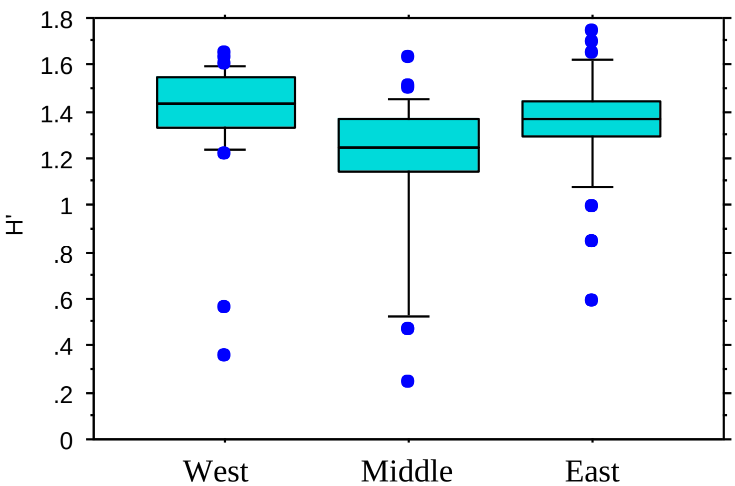


Figure 8: Ranges for Shannon Diversity Index values at the WSA sites.

3. Kentucky Pollution Tolerance Index (KPTI)

Kentucky's Pollution Tolerance Index is a measure of the overall tolerance level of the entire diatom community. A healthy population will include diatoms at all tolerance levels; however, the number of tolerant organisms should be comparatively low. The KPTI measures both the tolerance level of individual taxa and the overall abundance of those taxa. The tolerance values assigned to each taxa ranges from 0 (most tolerant) to 4 (most sensitive). East Tennessee had the highest KDBI values, although ranges were similar for middle Tennessee (Table 4 and Figure 9). The lower KDBI values in west Tennessee may indicate higher levels of nutrient pollution.

$$KPTI = \sum \frac{n_i t_i}{N}$$

Where:
n_i = number of individuals of species i
t_i = tolerance value of species i
N = total number of individuals in sample

Table 4: Kentucky Pollution Tolerance Index Summary Statistics

	Min	Max	Mean	Median	Std. Dev.
West	1.44	2.65	2.06	2.01	0.32
Middle	0.45	3.01	2.27	2.30	0.49
East	1.48	3.58	2.52	2.50	0.41
TN	0.45	3.58	2.28	2.32	0.45

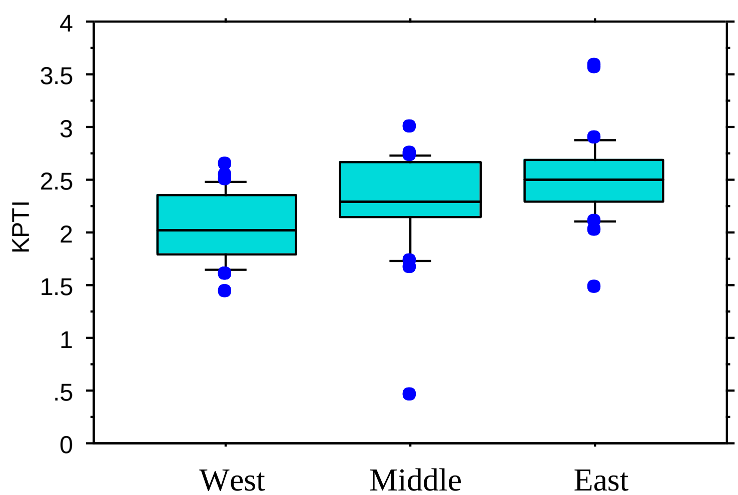


Figure 9: Ranges for Kentucky Pollution Tolerance Index values at the WSA sites.

4. *Fragilaria* Group Richness (FGR)

This metric measures the total number of taxa represented in the sample from the genera *Ctenophora*, *Fragilaria*, *Fragilariforma*, *Pseudostaurosira*, *Punctastriata*, *Stauroforma*, *Staurosira*, *Staurosirella*, *Tabularia*, and *Synedra*. These genera reflect high water quality. As water pollution increases, the FGR is expected to decrease. The FGR for East Tennessee, with a mean of 3.6, was higher than middle and west, which had means of 2.3 and 2.0 respectively (Table 5 and Figure 10).

Table 5: *Fragilaria* Group Richness Summary Statistics

	Min	Max	Mean	Median	Std. Dev.
West	0	5	2.0	2	1.62
Middle	0	5	2.3	2	1.60
East	0	14	3.6	3	3.05
TN	0	14	2.6	2	2.29

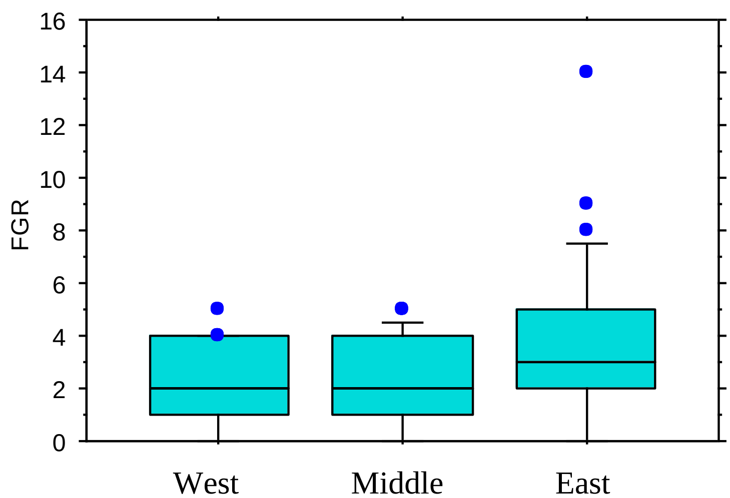


Figure 10: Ranges for *Fragilaria* Group Richness values at the WSA sites.

5. *Cymbella* Group Richness (CGR)

This metric measures the total number of taxa represented in the sample from the genera *Cymbella*, *Cymbopleura*, *Encyonema*, *Encyonopsis*, *Navicella*, *Pseudoencyonema* and *Reimeria*. These genera reflect high water quality. As water pollution increases, the CGR is expected to decrease. Middle Tennessee had the highest mean CGR, followed by east and west, although ranges were similar (Table 6 and Figure 11).

Table 6: *Cymbella* Group Richness Summary Statistics

	Min	Max	Mean	Median	Std. Dev.
West	0	7	2.6	2	1.61
Middle	0	8	3.3	3	2.08
East	0	12	3.0	2.5	2.20
TN	0	12	3.0	3	1.98

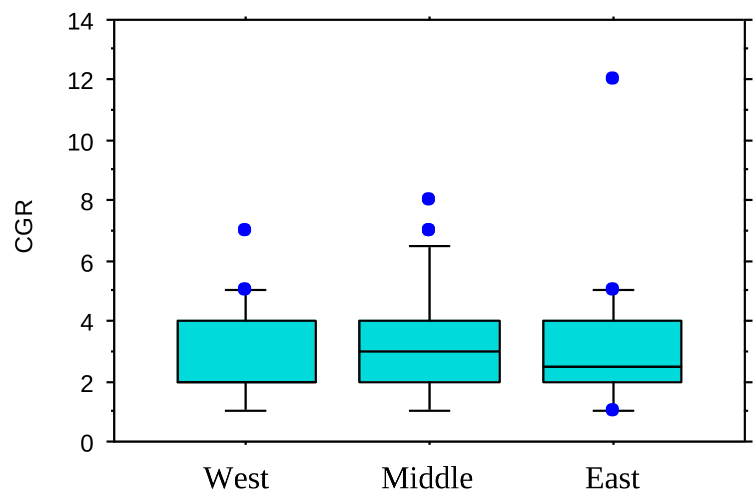


Figure 11: Ranges for *Cymbella* Group Richness values at the WSA sites.

6. % *Navicula, Nitzschia* and *Surirella* (%NNS)

The sum of the relative abundances of all *Navicula* (including *Aneumastus, Cavinula, Chamaepinnularia, Cosmioneis, Craticula, Diadesmis, Fallacia, Fistulifera, Geissleria, Hippodonta, Kobayasia, Luticola, Lyrella, Mayamaia, Muellaria, Placoneis* and *Sellaphora*), *Nitzschia* (including *Psammodictyon* and *Tryblionella*) and *Surirella* taxa reflects the degree of sedimentation at a reach. These genera are motile and are able to slide through sediment if they become covered. Their abundance expresses the frequency and severity of sedimentation. As sedimentation increases, the %NNS is expected to increase (Bahls et al. 1992). West Tennessee had the highest %NNS, which reflects higher levels of sedimentation found in that region (Table 7 and Figure 12). The other two divisions were about even.

Table 7: % *Navicula, Nitzschia* and *Surirella* Summary Statistics

	Min %	Max %	Mean %	Median %	Std. Dev.
West	7.9	80.0	46.9	47.67	17.0
Middle	3.6	67.2	31.5	28.10	16.8
East	1.0	67.0	33.4	33.87	17.3
TN	1.0	80.0	37.3	37.82	18.2

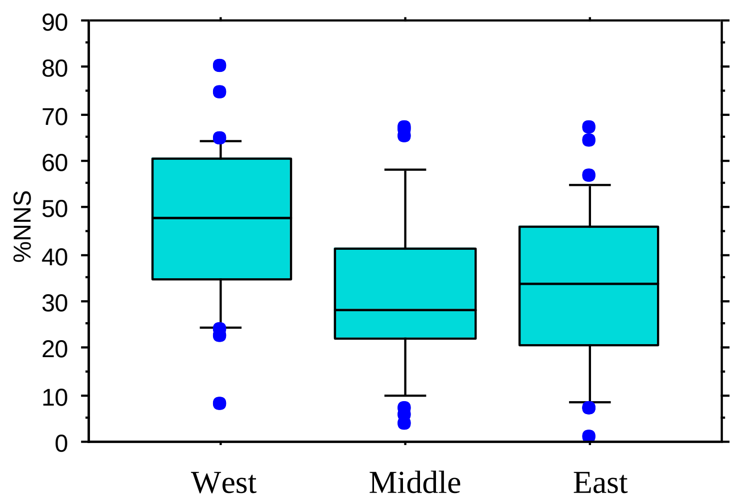


Figure 12: Ranges for % *Navicula, Nitzschia* and *Surirella* at the WSA sites.

Final Kentucky Diatom Bioassessment Index Score.

Each of the six metrics are given a calculated score (0-100) based on the percent of the standard metric value (95^{th} percentile for TNDT, H', KPTI, FGR, and CGR or 5^{th} percentile for %NNS). The values were compared to the entire Kentucky database due to the brevity of Tennessee's periphyton program and an insufficient amount of data collected up to this point. The formulas used to calculate the metric scores are found in Table 8. The mean of the six metrics is the final KDBI score.

Table 8: Metric Scoring Formula for the Kentucky Diatom Bioassessment Index

Metric	**Formula for metric scores**
TNDT	(TNDT/102)*100
H'	(H'/1.43)*100
KPTI	(KPTI/3.46)*100
FGR	(FGR/8)*100
CGR	(CGR/13)*100
%NNS	(100-%NNS)/(100-2.6)*100
KDBI score	**Mean of the 6 metric scores**

The conditions of the diatom populations (KDBI scores) were categorized according to the bioassessment guidelines in Table 9. For comparison purposes, Tennessee was divided into three bioregions based on similarity to the three bioregions used by Kentucky: Mountains (**MT**), Mississippi Valley-Interior Region (**MVIR**), and Pennyroyal (**PN**). The MT region is comprised of Tennessee ecoregions 68a, 68b, 68c, 68d, 69d, 69e, 66d, 66e, 66f, 66g, 66i, 66f, 66k, 67f, 67g, 67h, and 67i. The MVIR region is comprised of ecoregions 73a, 73b, 74b, 65a, 65b, 65e, and 65i. The PN region includes ecoregions 71e, 71f, 71g, 71h, 71i, 65j, and 74a. With the exception of ecoregions 65j and 74a, these correlate to the three divisions of the state: MVIR is west, PN is middle, and MT is east. The streams found in ecoregions 65j and 74a were categorized using the middle Tennessee (PN) guidelines due to similarity of stream characteristics (moderate gradient and cobble/gravel substrate). The bioregions are based on the ones used by Kentucky. Ecoregions 65a, b, e, or i, 66d, e, f, g, i, j, or k, or 67f, g, h, or I are not found in Kentucky and were grouped with the bioregion in Tennessee to which they are most similar. Also, Kentucky has a Bluegrass (**BG**) bioregion that includes ecoregions 71d,k, and l, which are not found in Tennessee.

Table 9: Bioassessment guidelines for Kentucky Diatom Bioassessment scores

	East (MT)	Middle (PN)	West (MVIR)
Excellent	75-100	67-100	57-100
Good	62-74.99	55-66.99	48-56.99
Fair	51-61.99	50-54.99	42-47.99
Poor	0-50.99	0-49.99	0-41.99

The number of sites that fall into each diatom bioassessment category for the three divisions of the state is shown in Figures 13 and 15. The individual metric values as well as the final KDBI score for each of the sites are in Appendix B.

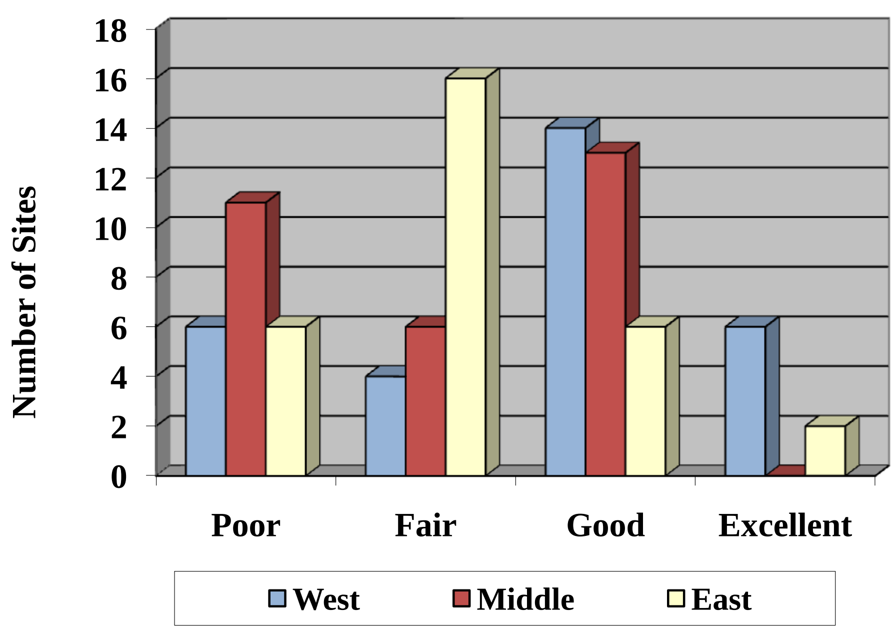


Figure 13: Number of WSA sites that fall into each diatom bioassessment category.

The western division of the state had the most sites that were categorized as good or excellent, however, the bioassessment guidelines as well as the mean KDBI score were the lowest in the state. Middle Tennessee had the greatest number of poor sites and none that were excellent. It is important to note that the bioassessment guidelines are comparing the diatom populations to regional expectations, which were different for each division. Table 10 and Figure 14 represent a direct comparison of scores between the divisions. The highest KDBI scores in the state were in east Tennessee.

Table 10: Kentucky Diatom Bioassessment Index Summary Statistics

	Min	Max	Mean	Median	Std. Dev.
West	26.3	63.9	50.5	51.2	9.1
Middle	22.4	65.4	51.5	53.6	9.6
East	31.0	83.1	57.2	55.5	9.6
TN	22.4	83.1	53.1	53.6	9.8

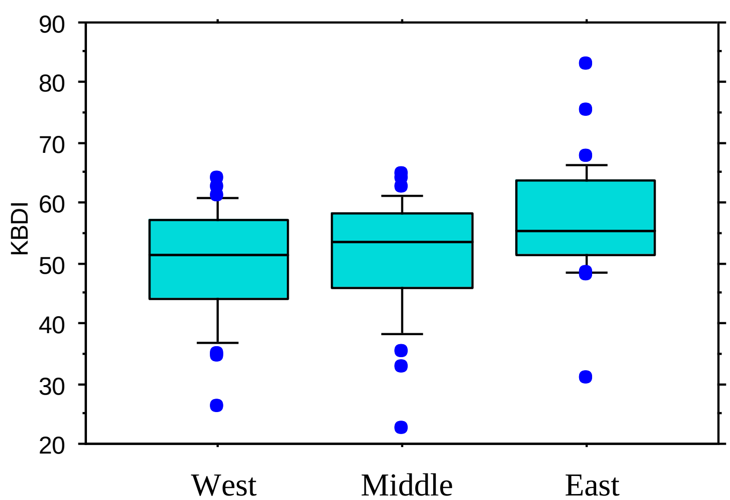


Figure 14: Ranges for Kentucky Diatom Bioassessment Index values at the WSA sites.

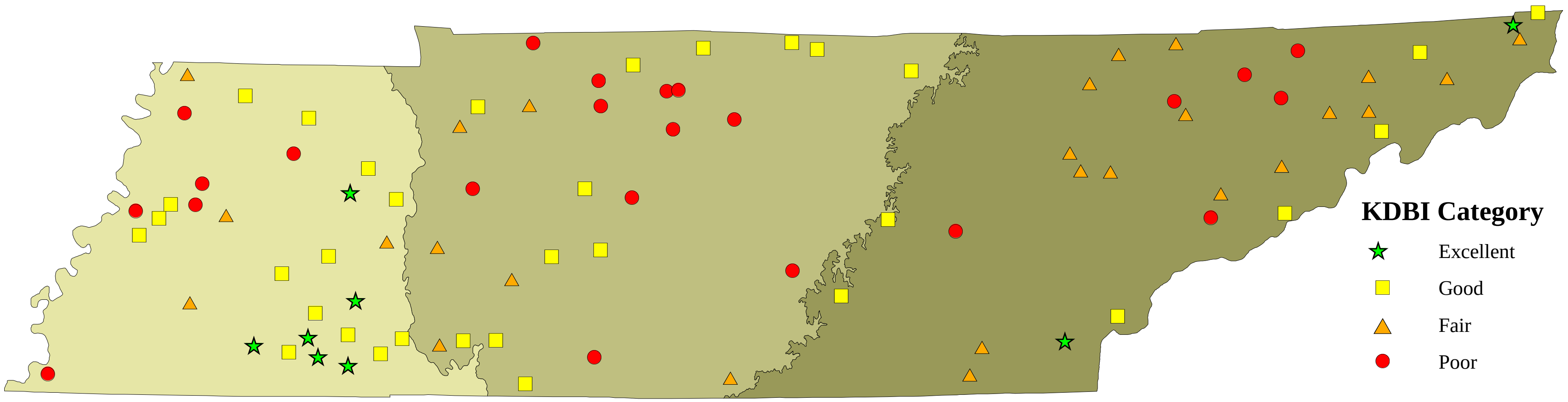


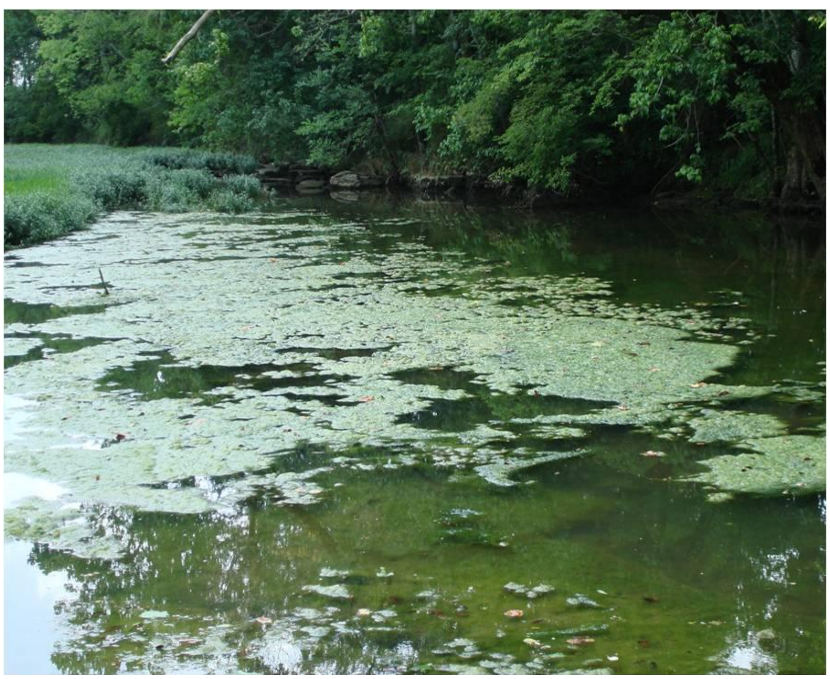
Figure 15: Location of the WSA sites showing the Kentucky Diatom Bioassessment Index category.

b. Non-Diatoms (Soft Algae)

The soft algae collected were not as diverse as the diatoms. The number of genera at the sites throughout the state ranged from one to 12, with a mean of four. The western division had the greatest diversity of soft algae genera. This may be due to greater nutrient enrichment found in this part of the state. The total number of genera for middle and east Tennessee were about even (Figure 16). Tables with the genera richness and total number of non-diatom individuals for each site are in Appendix C.

The most common and abundant genus of soft algae across the state was *Phormidium*, which was present at 77 out of the 90 sites. *Phormidium* is a filamentous blue-green algae (cyanobacteria) and is often found in mats or tufts that are attached to benthic substrates. It can also be found floating on the water surface. *Leptolyngbya* was another genus that was extremely common, found at 73 of the sites. *Homoeothrix* was found at 35 sites. These three genera were so frequent that combined they made up over 70 percent of the individuals (cells, colonies, or filaments) of soft algae that were identified. *Phormidium* comprised 30 percent of individuals statewide, while *Leptolyngbya* was slightly less, with 26 percent, and finally *Homoeothrix*, with 15 percent. These three genera are filamentous cyanobacteria within the taxonomic order Oscillatoriales. Some other genera that were fairly common throughout the state include *Oedogonium*, *Spirogyra*, and *Scenedesmus*, which are green algae.

The total number of non-diatom individuals from each site was highest in west Tennessee, which had a mean of 24.6 individuals per site. Middle Tennessee had a mean of 22.3 individuals per site, while east Tennessee had a mean of 18.5. Figure 17 shows the data ranges for the number of individuals collected at each site.



Spring Creek in Wilson County had floating algal mats of filamentous blue-green algae (cyanobacteria). The only two genera of soft algae collected at this site were *Phormidium* and *Leptolyngbya.*

Photo provided by Nashville EFO

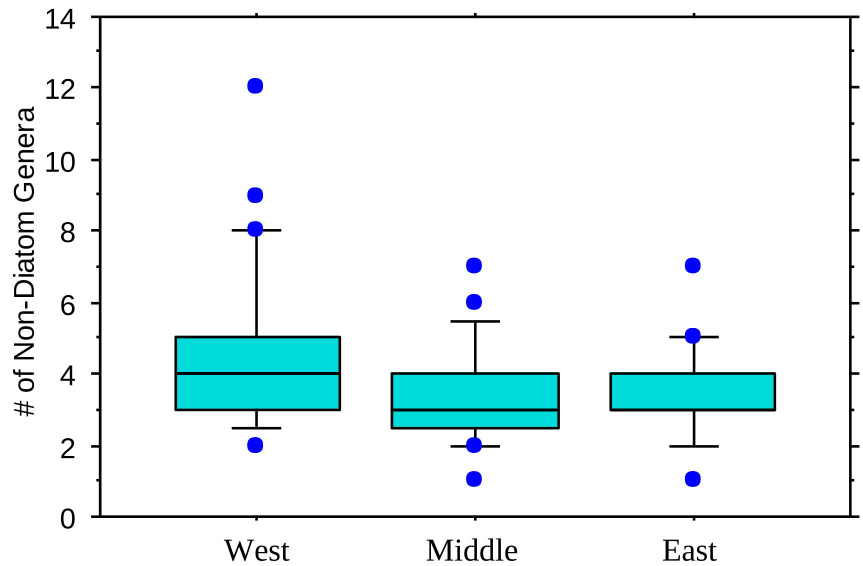


Figure 16: Number of Non-Diatom genera at the WSA sites

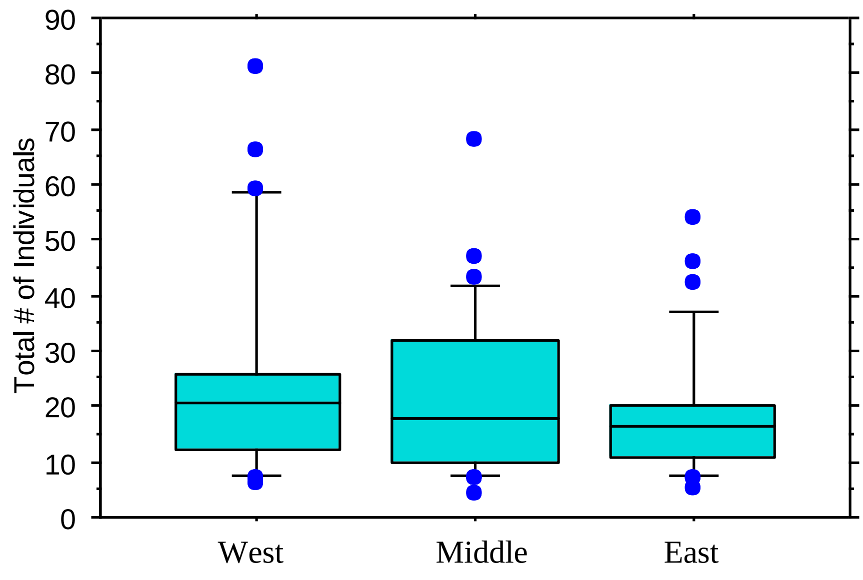


Figure 17: Total number of Non-Diatom individuals collected at the WSA sites.

4. SUMMARY

Periphyton can be useful indicators of water quality and pollution levels. The structure and complexity of periphyton communities can be influenced by a number of factors including: human disturbance, water current, scouring, substrate type, temperature, light, nutrient levels, and benthic grazing (Graham and Wilcox, 2000). Differences in these factors may either limit or promote growth. These associations may help to understand the periphyton differences between regions of the state. The periphyton community in Tennessee can vary greatly between streams and larger regions, making probabilistic surveys difficult.

The Kentucky Diatom Biossessment Index values were highest in east Tennessee. However, the majority of the sites had KDBI scores that were classified as fair. This is because the regional guidelines were higher for east Tennessee. A stream that was classified as fair in the eastern division could be excellent if it were in the western division. East Tennessee also had the highest biomass of mosses and microalgae.

Middle Tennessee had the greatest amount of optimal substrate and the least canopy cover. Although periphyton was plentiful, this division of the state had the lowest diversity in both the diatom and the non-diatom communities. There were no KDBI scores in middle Tennessee that were classified as excellent. Also, this division had the most KDBI scores in the poor category. Middle Tennessee had the lowest percentage of sediment tolerant diatom species, possibly indicating lower levels of sedimentation compared to the other divisions.

West Tennessee had the most diversity in both the diatom and non-diatom communities. Typically, higher diversity is a result of less impairment. However, this may not be the case in this region. There may be some explanations for the greater diversity in west Tennessee. Nutrient enrichment may be causing an increase in diversity. Nutrient levels tend to be higher in this region due to heavy agricultural runoff. Volume 4 shows that nutrients such as total phosphorus and nitrogen (nitrate+nitrite, ammonia, and total Kjeldhahl nitrogen) were highest in the west (Graf and Arnwine, 2009). Higher nutrient levels were also evident in the macroinvertebrate populations (Volume 3, Arnwine et al, 2009).

In the western division, the percent of pollution tolerant diatoms was greater and the overall condition of the community was the poorest. However, the bioassessments were the best because the regional expectations in west Tennessee were lower than the rest of the state. Higher nutrient levels did not seem to increase the overall biomass of the periphyton. This could have been due to factors such as the amount of canopy cover and lack of optimal substrate. The substrate type may also be contributing to the diversity. The diatoms that are well adapted to heavy sedimentation are not found as often in other parts of the state.

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APPENDIX A

Rapid Periphyton Survey Metrics - Mean Coverage Class, Canopy Cover, and Percent Optimal Substrate

(Site location provided in Volume 2 of this report series)

Table A-1: Rapid Periphyton Survey Metrics – West Tennessee

Station ID	Div.	Eco-region	Date Sampled	Avg. Cover Moss	Avg. Cover Macro	Avg. Cover Micro	Avg. Canopy	Avg. % Optimal Substrate
BEAR002.1WY	West	74B	7/3/2007	0	0	0.6	66	20
BIRDS012.3BN	West	65E	7/12/2007	0	0.4	1.2	64	82
CANE001.4SH	West	74B	8/9/2007	0	1.8	2.6	17	94
CLOVE1T0.5OB	West	74B	7/3/2007	0	0.4	1	69	26
COLD006.3LE	West	74A	7/18/2007	0	0	1.6	97	20
CROOK005.0MC	West	65E	7/11/2007	0.2	0.4	1.4	100	44
CYPRE002.1CK	West	74B	7/16/2007	0	0	1.1	100	17
CYPRE005.9OB	West	74B	7/23/2007	0	4	0	98	38
CYPRE023.8MC	West	65E	7/6/2007	0	0.6	1.6	40	52
HALLS001.7LE	West	74B	7/18/2007	0	0	1.4	47	12
HAWKI002.1CR	West	65E	7/15/2007	0	0.6	2	78	44
HAYES003.3HR	West	65E	7/2/2007	0.6	1.2	1.2	80	36
HROCK002.4CR	West	65E	7/23/2007	0	0	1.2	100	32
HURRI007.4HE	West	65E	7/5/2007	0	0.4	0.8	22	36
HYDE002.7LE	West	74B	7/2/2007	0	0	0.4	100	26
KERR000.4HD	West	65J	7/11/2007	1	0.2	0.6	100	84
MFFDE1T1.5HE	West	65E	7/3/2007	0	1.2	0.8	36	36
NREEL000.4OB	West	74A	7/6/2007	0	0	0.6	100	10
OWL003.7HD	West	65E	7/18/2007	0	0.6	1.2	78	96
POND013.8CK	West	74B	7/20/2007	0	4	0	100	38
POPLA014.7HY	West	74B	7/5/2007	0	0	0.8	99	18
ROSE001.3MC	West	65E	7/2/2007	1	0	1.6	93	26
SFCUB009.5DE	West	65E	7/5/2007	0	1.8	1	92	40
SFFDE1T0.7MN	West	65E	7/5/2007	0	0	0.8	100	26
SFMUD003.8MC	West	65E	7/17/2007	0.2	0.8	0.8	89	60
SMITH003.5HD	West	65J	7/31/2007	0.1	0.3	1	99	84
STOKE004.9CK	West	74B	7/20/2007	0	0	0.8	80	18
TAR003.0CS	West	65E	7/20/2007	0.2	1.6	1.2	84	48
THOMP000.2WY	West	74B	7/17/2007	0.2	0.8	0.4	24	44
TISDA1T1.2LE	West	74B	7/2/2007	0	0	0.6	0	16

Table A-2: Rapid Periphyton Survey Metrics – Middle Tennessee

Station ID	Div.	Eco-region	Date Sampled	Avg. Cover Moss	Avg. Cover Macro	Avg. Cover Micro	Avg. Canopy	Avg. % Optimal Substrate
BEAGL008.3OV	Middle	71G	10/4/2007	0	3.8	0	86	86
BRUSH001.1LS	Middle	71F	8/22/2007	0	0	1	77	100
BSPRI003.9CH	Middle	71F	7/5/2007	0.4	1.2	1	92	90
BUNDR000.6WE	Middle	71F	8/27/2007	0	0	1.6	80	100
CANE004.5VA	Middle	71H	9/26/2007	0	3.8	0.9	86	98
CATHE001.5MY	Middle	71H	8/30/2007	0	0	1.6	51	100
CFORK003.4SR	Middle	71G	8/16/2007	0	0	1.4	94	100
CHISH015.4LW	Middle	71F	9/25/2007	0	0	1.6	82	100
DIXON000.4LW	Middle	71F	9/24/2007	0	0	2	23	100
DRAKE011.8SR	Middle	71H	7/16/2007	0	0.4	1	59	96
GREEN016.2WE	Middle	71F	8/27/2007	0	0	2	3	100
LBART006.5DI	Middle	71F	7/3/2007	0	0	2	98	90
LONG004.9MA	Middle	71G	9/19/2007	0	3	1	62	96
MILLE007.3RN	Middle	71E	7/5/2007	0.6	0.2	0.2	97	88
NFLIC002.0PE	Middle	71F	8/30/2007	0	0	2	9	100
PRUN000.1GS	Middle	71H	10/5/2007	0	0	1.6	79	94
ROBIN000.6FR	Middle	71F	10/29/2007	0	0	2	43	100
RUTHE007.4MY	Middle	71H	10/5/2007	0	1.4	1.2	42	100
SCAMP008.3SR	Middle	71H	7/16/2007	0	0.4	2.2	51	100
SCOTT000.9DA	Middle	71H	7/18/2007	0	0	1.6	96	92
SHARP014.4WI	Middle	71F	7/9/2007	0	0.2	1.6	20	98
SPRIN009.0WS	Middle	71I	7/17/2007	0	1.2	1.2	54	86
SULPH036.0RN	Middle	71E	10/26/2007	0	0.2	1	76	100
TRACE003.5CY	Middle	71G	9/19/2007	0	3.2	1.2	69	96
TUMBL003.8HU	Middle	71F	7/23/2007	1.2	0	0.2	41	98
WATSO002.3WI	Middle	71H	7/9/2007	1.6	0	0	73	86
WELLS007.6HO	Middle	71F	7/2/2007	0	0	1.8	32	100
WFHIC007.0CE	Middle	71G	10/25/2007	0	3.8	1.2	91	84
WFRED010.7MT	Middle	71E	7/18/2007	0.2	0	1.4	59	90
WHITE013.5HU	Middle	71H	7/2/2007	0	0	1.2	71	100

Table A-3: Rapid Periphyton Survey Metrics – East Tennessee

Station ID	Div.	Eco-region	Date Sampled	Avg. Cover Moss	Avg. Cover Macro	Avg. Cover Micro	Avg. Canopy	Avg. % Optimal Substrate
BEAVE008.9KN	East	67F	8/24/2007	1.6	1.8	1.8	70	100
BFLAT018.0UN	East	67F	7/31/2007	0	0	1	83	96
BIRCH000.6JO	East	66E	9/5/2007	0.4	0	0.8	100	100
BYRD001.5HS	East	67F	8/22/2007	1.4	0	0.4	99	100
CANDI017.1BR	East	67F	8/30/2007	0	0	1	67	94
CANDI033.1BR	East	67G	9/6/2007	0.2	0.2	0.6	67	78
CLEAR001.3GE	East	67F	7/18/2007	1.2	1.2	1.8	82	88
CORN002.5JO	East	66F	9/5/2007	0.4	0.2	1.8	85	94
COSBY012.2CO	East	66G	7/17/2007	0.6	0	1.6	86	100
COVE003.8SV	East	66G	7/25/2007	0	0	1	96	86
EFPOP007.3RO	East	67F	8/24/2007	1.8	1.2	1.2	54	90
FALL001.5UN	East	67F	7/31/2007	1.4	0	0.8	19	88
FALL003.2HA	East	67F	8/21/2007	0.2	1.2	2	0	92
GAMMO000.7SU	East	67F	7/19/2007	0	1.6	1	99	82
GAP000.1CT	East	67F	8/29/2007	0	4	2	0	98
GRASS005.1GE	East	67F	8/22/2007	0	0.2	1.8	95	30
HICKO008.4CA	East	69D	8/17/2007	1	0	1	34	92
HORSE007.0GE	East	67F	9/17/2007	0	0	2	99	100
INDIA003.7GR	East	67F	11/8/2007	0.34	0.28	1.26	73	92
LAURE002.5GY	East	68A	4/30/2008	0.2	1.2	1	64	84
LAURE006.3JO	East	66E	12/12/07	0	0	3.6	77	100
OTOWN008.9CL	East	69E	7/23/2007	0	0.2	2	89	88
POPLA000.1MG	East	69D	8/1/2007	0	0	1.4	78	80
RIPLE001.5GE	East	67F	7/19/2007	0.4	3.2	0	0	6
SEQUA101.2BL	East	68B	11/9/2007	1.4	0	1.2	72	100
SINKI000.0CO	East	67G	7/17/2007	0	3.4	1.2	68	80
TELLI040.5MO	East	66G	11/9/2007	1.2	0.4	1	50	96
TITUS1T0.1CA	East	69E	7/23/2007	0	0.6	1.6	79	80
TOWEE005.9PO	East	66G	6/12/2008	0.6	0.5	0.6	53.5	75

APPENDIX B

Diatom Metric Values

(Site location provided in Volume 2 of this report series)

Table B-1: Diatom Metric Values – West Tennessee

Station ID	Div.	Eco-region	Sample Date	TNDT	H'	KPTI	FGR	CGR	%NNS	KDBI Score	KDBI Score Category
COLD006.3LE	West	74a	7/18/2007	23	0.56	1.61	1	0	64.0	26.3	Poor
POND013.8CK	West	74b	7/20/2007	23	0.36	2.02	0	1	7.9	34.7	Poor
BEAR002.1WY	West	65e	7/3/2007	40	1.26	1.44	0	2	74.5	35.0	Poor
STOKE004.9CK	West	74b	7/20/2007	50	1.40	1.70	0	2	80.0	38.7	Poor
CANE001.4SH	West	74b	8/9/2007	38	1.22	1.60	1	4	63.3	41.6	Poor
CLOVE1T0.5OB	West	74a	7/3/2007	40	1.26	2.22	0	1	41.6	43.2	Poor*
SFCUB009.5DE	West	65e	7/5/2007	50	1.44	1.77	0	2	53.7	43.8	Fair
CYPRE002.1CK	West	74b	7/16/2007	50	1.36	1.69	2	1	61.8	44.1	Fair
POPLA014.7HY	West	74b	7/5/2007	60	1.44	1.76	0	5	63.2	47.6	Fair
NREEL000.4OB	West	74a	7/6/2007	46	1.27	2.43	1	1	23.9	50.4	Fair*
CYPRE005.9OB	West	74b	7/23/2007	54	1.43	1.92	1	2	49.7	48.0	Good
HYDE002.7LE	West	74b	7/2/2007	60	1.50	1.78	1	3	57.3	48.3	Good
HALLS001.7LE	West	74b	7/18/2007	61	1.57	1.79	1	4	64.8	48.5	Good
SFMUD003.8MC	West	65e	7/17/2007	52	1.47	2.36	1	0	40.0	48.9	Good
SFFDE1T0.7MN	West	65e	7/5/2007	59	1.37	2.08	2	2	51.3	50.7	Good
BIRDS012.3BN	West	65e	7/12/2007	54	1.45	1.98	2	4	57.1	51.7	Good
THOMP000.2WY	West	65e	7/17/2007	45	1.44	1.96	4	2	43.9	54.0	Good
HROCK002.4CR	West	65e	7/23/2007	64	1.55	2.33	3	2	56.4	54.6	Good
MFORK1T1.5HE	West	65e	7/3/2007	50	1.43	2.48	0	7	44.4	55.2	Good
ROSE001.3MC	West	65e	7/2/2007	62	1.56	1.96	4	2	51.5	55.5	Good
TISDA1T1.2LE	West	74b	7/2/2007	70	1.65	2.06	4	2	60.3	55.7	Good
TAR003.0CS	West	65e	8/21/2007	51	1.33	2.53	2	3	29.8	56.0	Good
KERR000.4HD	West	65j	7/11/2007	48	1.33	2.50	4	2	26.6	58.8	Good*
SMITH003.5HD	West	65j	7/31/2007	64	1.55	1.97	4	4	34.5	61.3	Good*
HURRI007.4HE	West	65e	7/5/2007	48	1.41	2.08	3	5	40.9	57.1	Excellent
HAYES003.3HR	West	65e	7/2/2007	63	1.61	2.01	5	2	45.5	59.0	Excellent
OWL003.7HD	West	65e	7/18/2007	49	1.41	2.26	4	3	26.5	60.1	Excellent
HAWKI002.1CR	West	65e	7/5/2007	70	1.57	2.45	3	1	22.3	60.7	Excellent
CROOK005.0MC	West	65e	7/11/2007	74	1.63	2.44	3	5	45.7	62.5	Excellent
CYPRE023.8MC	West	65e	7/6/2007	58	1.44	2.65	4	3	24.9	63.9	Excellent

*Ecoregions 65j and 74a were assessed using the middle TN guidelines due to similar stream characteristics.

TNDT - Total Number Diatom Taxa
H' - Shannon Diversity
KPTI - Kentucky Pollution Tollerance Index
FGR - *Fragilaria* Group Richness
CGR - *Cymbella* Group Richness
%NNS - % *Navicula*, *Nitzschia*, and *Surirella*
KDBI – Kentucky Diatom Bioassessment Index Score

Table B-2: Diatom Metric Values – Middle Tennessee

Station ID	Div.	Eco-region	Sample Date	TNDT	H'	KPTI	FGR	CGR	%NNS	KDBI Score	KDBI Score Category
MILLE007.3RN	Middle	71e	7/5/2007	14	0.24	1.87	0	0	51.3	22.4	Poor
WFRED010.7MT	Middle	71e	7/18/2007	32	0.94	1.74	0	2	66.7	32.8	Poor
WFHIC007.0CE	Middle	71g	10/25/2007	25	0.47	0.45	3	1	5.6	35.4	Poor
SCOTT000.9DA	Middle	71h	7/18/2007	25	1.04	2.55	0	0	26.6	41.1	Poor
SPRIN009.0WS	Middle	71i	7/17/2007	24	0.47	2.69	2	3	16.3	44.7	Poor
DRAKE011.8SR	Middle	71h	7/16/2007	31	1.23	2.15	0	4	41.3	44.9	Poor
BSPRI003.9CH	Middle	71f	7/5/2007	39	1.37	2.14	1	1	42.3	45.9	Poor
SCAMP008.3SR	Middle	71h	7/16/2007	39	1.18	1.66	4	3	67.2	46.0	Poor
TUMBL003.8HU	Middle	71f	7/23/2007	20	0.58	2.74	3	1	3.6	47.3	Poor
PRUN000.1GS	Middle	71h	10/5/2007	38	1.29	2.36	0	2	27.1	47.7	Poor
WATSO002.3WI	Middle	71h	7/9/2007	53	1.50	1.73	4	1	65.1	49.3	Poor
BUNDR000.6WE	Middle	71f	8/27/2007	41	1.15	2.62	1	3	22.5	51.8	Fair
LBART006.5DI	Middle	71f	7/3/2007	35	1.19	1.83	5	3	42.9	52.4	Fair
BRUSH001.1LS	Middle	71f	8/22/2007	44	1.36	2.41	2	2	29.1	53.5	Fair
NFLIC002.0PE	Middle	71f	8/30/2007	39	1.21	2.43	1	6	32.2	53.5	Fair
ROBIN000.6FR	Middle	71f	10/29/2007	68	1.63	2.31	1	3	48.9	53.6	Fair
WHITE013.5HU	Middle	71f	7/2/2007	39	1.34	2.24	2	4	26.2	54.7	Fair
GREEN016.2WE	Middle	71f	8/27/2007	45	1.34	2.28	4	1	32.6	55.1	Good
RUTHE007.4MY	Middle	71h	10/5/2007	40	1.15	2.67	2	3	12.2	55.8	Good
WELLS007.6HO	Middle	71f	7/2/2007	29	1.16	2.73	3	3	14.8	56.0	Good
BEAGL008.3OV	Middle	71g	10/4/2007	32	1.20	1.97	5	3	22.5	56.2	Good
CATHE001.5MY	Middle	71h	8/30/2007	60	1.51	2.24	2	4	38.3	57.1	Good
SULPH036.0RN	Middle	71e	10/31/2007	47	1.32	2.14	5	3	37.5	58.3	Good
TRACE003.5CY	Middle	71g	9/19/2007	45	1.32	2.15	2	6	21.1	58.4	Good
CFORK003.4SR	Middle	71g	8/16/2007	45	1.25	2.70	1	7	21.9	59.4	Good
CANE004.5VA	Middle	71h	9/26/2007	29	1.16	3.01	3	4	7.2	60.0	Good
LONG004.9MA	Middle	71g	9/19/2007	46	1.40	2.18	4	5	34.9	60.2	Good
DIXON000.4LW	Middle	71f	9/24/2007	44	1.41	2.69	2	7	25.0	62.5	Good
CHISH015.4LW	Middle	71f	9/25/2007	50	1.38	2.63	4	5	26.8	64.2	Good
SHARP014.4WI	Middle	71f	7/9/2007	48	1.39	2.75	3	8	34.6	65.0	Good

TNDT - Total Number Diatom Taxa
H' - Shannon Diversity
KPTI - Kentucky Pollution Tollerance Index
FGR - *Fragilaria* Group Richness
CGR - *Cymbella* Group Richness
%NNS - % *Navicula*, *Nitzschia*, and *Surirella*
KDBI – Kentucky Diatom Bioassessment Index Score

Table B-3: Diatom Metric Values – East Tennessee

Station ID	Div.	Eco-region	Sample Date	TNDT	H'	KPTI	FGR	CGR	%NNS	KDBI Score	KDBI Score Category
COVE003.8SV	East	66g	7/25/2007	19	0.59	2.28	0	0	41.3	31.0	Poor
FALL001.5UN	East	67f	7/31/2007	35	1.29	2.62	1	2	42.3	47.9	Poor
SEQUA101.2BL	East	68b	10/17/2007	48	1.31	1.48	2	1	25.6	48.4	Poor
FALL003.2HA	East	67f	8/21/2007	47	1.31	2.47	2	3	67.0	48.5	Poor
INDIA003.7GR	East	67f	11/8/2007	37	1.29	2.63	0	3	25.0	50.4	Poor
BYRD001.5HS	East	67f	8/22/2007	31	1.24	2.36	3	4	50.3	50.7	Poor
CLEAR001.3GE	East	67f	7/19/2007	49	1.37	2.12	4	2	64.4	51.2	Fair
BEAVE008.9KN	East	67f	8/24/2007	64	1.56	2.10	1	3	52.4	51.3	Fair
SINKI003.0CO	East	67g	7/17/2007	48	1.47	2.36	1	3	41.3	51.9	Fair
EFPOP007.3RO	East	67f	8/24/2007	52	1.51	2.28	2	2	47.0	51.9	Fair
POPLA000.1MG	East	69d	8/1/2007	36	1.32	2.36	3	1	27.1	52.6	Fair
BFLAT018.0UN	East	67f	7/31/2007	45	1.43	2.56	0	4	32.6	53.0	Fair
CANDI033.1BR	East	67g	9/19/2007	73	1.70	2.02	2	2	50.3	53.6	Fair
MIDDL001.2SV	East	67g	7/17/2007	32	1.17	2.86	0	5	15.4	53.6	Fair
TITUS1T0.1CA	East	69e	7/23/2007	49	1.43	2.37	2	1	23.7	54.6	Fair
CANDI017.1BR	East	67f	9/19/2007	65	1.59	2.30	3	2	46.1	56.4	Fair
GRASS005.1GE	East	67f	8/22/2007	64	1.65	2.41	4	2	56.9	57.0	Fair
OTOWN008.9CL	East	69e	7/23/2007	46	1.41	2.46	2	5	29.3	58.5	Fair
HICKO008.4CA	East	69e	8/17/2007	43	1.29	2.74	5	1	20.7	60.5	Fair
GAP000.1CT	East	67f	8/29/2007	40	1.36	2.57	5	4	35.2	61.4	Fair
CORN002.5JO	East	66f	9/5/2007	47	1.37	2.16	6	4	42.3	61.5	Fair
RIPLE001.5GE	East	67f	7/19/2007	43	1.40	2.54	4	4	26.1	61.7	Fair
HORSE007.0GE	East	66e	9/17/2007	26	0.85	3.57	7	2	7.2	63.8	Good
TELLI040.5MO	East	66g	11/9/2007	27	0.99	3.58	4	5	1.0	64.0	Good
COSBY012.2CO	East	66g	7/17/2007	41	1.29	2.80	5	2	6.8	64.2	Good
LAURE006.3JO	East	66e	12/12/2007	48	1.36	2.69	8	1	42.4	64.4	Good
GAMMO000.7SU	East	67f	7/19/2007	52	1.42	2.64	5	2	17.9	64.7	Good
LAURE002.5GY	East	68a	4/30/2008	51	1.44	2.89	4	4	9.4	67.9	Good
BIRCH000.6JO	East	66e	9/5/2007	51	1.38	2.86	9	5	16.6	75.6	Excellent
TOWEE005.9PO	East	66g	6/12/2008	71	1.74	2.54	14	12	38.4	83.1	Excellent

TNDT - Total Number Diatom Taxa
H' - Shannon Diversity
KPTI - Kentucky Pollution Tollerance Index
FGR - *Fragilaria* Group Richness
CGR - *Cymbella* Group Richness
%NNS - % *Navicula*, *Nitzschia*, and *Surirella*
KDBI – Kentucky Diatom Bioassessment Index Score

APPENDIX C

Non-Diatom Data

(Site location provided in Volume 2 of this report series)

Table C-1: Non-Diatom Data – West Tennessee

StationID	Division	Ecoregion	Date Sampled	# of non-diatom divisions	# of non-diatom genera	# of non-diatom species	Total # of Individuals (natural units)
BEAR002.1WY	West	65e	7/3/2007	2	4	4	7
BIRDS012.3BN	West	65e	7/12/2007	2	3	4	21
CANE001.4SH	West	74b	8/9/2007	2	5	7	10
CLOVE1T0.5OB	West	74a	7/3/2007	2	4	4	8
COLD006.3LE	West	74a	7/18/2007	2	3	3	7
CROOK005.0MC	West	65e	7/11/2007	2	5	5	19
CYPRE002.1CK	West	74b	7/16/2007	3	4	5	12
CYPRE005.9OB	West	74b	7/23/2007	2	4	4	15
CYPRE023.8MC	West	65e	7/6/2007	4	12	15	58
HALLS001.7LE	West	74b	7/18/2007	3	8	8	25
HAWKI002.1CR	West	65e	7/5/2007	2	4	5	9
HAYES003.3HR	West	65e	7/2/2007	1	4	4	20
HROCK002.4CR	West	65e	7/23/2007	2	3	6	26
HURRI007.4HE	West	65e	7/5/2007	4	6	6	14
HYDE002.7LE	West	74b	7/2/2007	3	5	10	33
KERR000.4HD	West	65j	7/11/2007	3	5	5	9
MFORK1T1.5HE	West	65e	7/3/2007	4	8	12	21
NREEL000.4OB	West	74a	7/6/2007	2	5	8	23
OWL003.7HD	West	65e	7/18/2007	3	9	10	66
POND013.8CK	West	74b	7/20/2007	2	4	5	26
POPLA014.7HY	West	74b	7/5/2007	1	2	3	14
ROSE001.3MC	West	65e	7/2/2007	1	2	3	21
SFCUB009.5DE	West	65e	7/5/2007	2	4	5	46
SFFDE1T0.7MN	West	65e	7/5/2007	3	3	4	6
SFMUD003.8MC	West	65e	7/17/2007	3	6	7	81
SMITH003.5HD	West	65j	7/31/2007	2	4	5	59
STOKE004.9CK	West	74b	7/20/2007	4	8	9	24
TAR003.0CS	West	65e	8/21/2007	2	5	6	26
THOMP000.2WY	West	65e	7/17/2007	2	2	2	15
TISDA1T1.2LE	West	74b	7/2/2007	2	3	3	17

Table C-2: Non-Diatom Data – Middle Tennessee

StationID	Division	Ecoregion	Date Sampled	# of non-diatom divisions	# of non-diatom genera	# of non-diatom species	Total # of Individuals (natural units)
BEAGL008.3OV	Middle	71g	10/4/2007	2	4	6	14
BRUSH001.1LS	Middle	71f	8/22/2007	2	2	2	7
BSPRI003.9CH	Middle	71f	7/5/2007	1	3	5	47
BUNDR000.6WE	Middle	71f	8/27/2007	1	3	5	19
CANE004.5VA	Middle	71h	9/26/2007	2	6	8	32
CATHE001.5MY	Middle	71h	8/30/2007	3	4	4	26
CFORK003.4SR	Middle	71g	8/16/2007	4	7	7	12
CHISH015.4LW	Middle	71f	9/25/2007	1	1	1	4
DIXON000.4LW	Middle	71f	9/24/2007	2	4	8	43
DRAKE011.8SR	Middle	71h	7/16/2007	1	3	4	9
GREEN016.2WE	Middle	71f	8/27/2007	2	4	5	40
LBART006.5DI	Middle	71f	7/3/2007	2	3	5	9
LONG004.9MA	Middle	71g	9/19/2007	1	2	4	10
MILLE007.3RN	Middle	71e	7/5/2007	1	2	3	8
NFLIC002.0PE	Middle	71f	8/30/2007	1	2	3	19
PRUN000.1GS	Middle	71h	10/5/2007	2	4	4	68
ROBIN000.6FR	Middle	71f	10/29/2007	2	6	7	27
RUTHE007.4MY	Middle	71h	10/5/2007	2	3	4	10
SCAMP008.3SR	Middle	71h	7/16/2007	2	5	9	21
SCOTT000.9DA	Middle	71h	7/18/2007	2	4	5	17
SHARP014.4WI	Middle	71f	7/9/2007	2	5	11	38
SPRIN009.0WS	Middle	71i	7/17/2007	1	2	3	7
SULPH036.0RN	Middle	71e	10/26/2007	2	3	5	40
TRACE003.5CY	Middle	71g	9/19/2007	1	3	5	20
TUMBL003.8HU	Middle	71f	7/23/2007	1	4	4	8
WATSO002.3WI	Middle	71h	7/9/2007	3	3	4	17
WELLS007.6HO	Middle	71f	7/2/2007	2	5	5	40
WFHIC007.0CE	Middle	71g	10/25/2007	2	3	4	26
WFRED010.7MT	Middle	71e	7/18/2007	2	3	4	15
WHITE013.5HU	Middle	71f	7/2/2007	1	2	4	15

Table C-3: Non-Diatom Data – East Tennessee

StationID	Division	Ecoregion	Date Sampled	# of non-diatom divisions	# of non-diatom genera	# of non-diatom species	Total # of Individuals (natural units)
BEAVE008.9KN	East	67f	8/24/2007	2	3	4	12
BFLAT018.2UN	East	67f	7/31/2007	2	3	4	20
BIRCH000.6JO	East	66e	9/5/2007	1	2	3	9
BYRD001.5HS	East	67f	8/22/2007	2	3	3	12
CANDI017.1BR	East	67f	9/19/2007	2	4	5	46
CANDI033.1BR	East	67g	9/19/2007	2	4	9	54
CLEAR001.3GE	East	67f	7/19/2007	3	4	4	12
CORN002.5JO	East	66f	9/5/2007	2	5	7	21
COSBY012.2CO	East	66g	7/17/2007	1	5	5	30
COVE003.8SV	East	66g	7/25/2007	2	3	3	10
EFPOP007.3RO	East	67f	8/24/2007	2	5	6	31
FALL001.5UN	East	67f	7/31/2007	2	4	6	18
FALL003.2HA	East	67f	8/21/2007	2	4	5	18
GAMMO000.7SU	East	67f	7/19/2007	2	3	3	10
GAP000.1CT	East	67f	8/29/2007	2	7	9	17
GRASS005.1GE	East	67f	8/22/2007	1	1	3	7
HICKO008.4CA	East	69e	8/17/2007	1	2	2	7
HORSE007.0GE	East	66e	9/17/2007	2	4	6	13
INDIA003.7GR	East	67f	11/8/2007	1	2	3	11
LAURE002.5GY	East	68a	4/30/2008	2	5	7	42
LAURE006.3JO	East	66e	12/12/2007	2	3	4	5
MIDDL001.2SV	East	67g	7/17/2007	2	3	3	8
OTOWN008.9CL	East	69e	7/23/2007	2	3	4	17
POPLA000.1MG	East	69d	8/1/2007	2	2	3	13
RIPLE001.5GE	East	67f	7/19/2007	3	3	5	17
SEQUA101.2BL	East	68b	10/17/2007	2	3	4	32
SINKI003.0CO	East	67g	7/17/2007	2	5	10	16
TELLI040.5MO	East	66g	11/9/2007	1	2	3	11
TITUS1T0.1CA	East	69e	7/23/2007	1	1	1	18
TOWEE005.9PO	East	66g	9/19/2007	2	5	8	18.5