2005 Buxahatchee Creek Report

Results of Macroinvertebrate and Periphyton Community Assessments

3 October 2006

Environmental Indicators Section –
Field Operations Division

Background

Buxahatchee Creek, a tributary of the Coosa River basin, drains approximately 70 mi^2 in Chilton and Shelby Counties. A 13-mile segment of Buxahatchee Creek has been included on Alabama's biennial §303(d) lists since 1996 for impairments caused by nutrient enrichment. Municipal and urban runoff/storm sewers were identified as the sources of the impairment on the 2000 §303(d) list.

Objectives

At the request of the Water Quality Section of ADEM's Water Division, macroinvertebrate community bioassessments were conducted at three segments of Buxahatchee Creek. The objectives of these assessments were twofold:

1. To assess the condition of the macroinvertebrate communities in Buxahatchee Creek using ADEM's intensive-level macroinvertebrate bioassessment (MB-I) method; and,
2. To provide baseline macroinvertebrate bioassessment data that can be used to measure any changes in water quality due to development and implementation of Total Maximum Daily Load(s) (TMDL).

Methods

Buxahatchee Creek 2005 Assessment Database: To assist with data analysis and reporting, all information and data associated with the 2005 Buxahatchee Creek assessment was compiled into one ACCESS database. The five tables contain all field parameters, chemical samples, and habitat assessment results. The four forms can be used to view and print station descriptions, requested parameters and sampling frequency, Habitat Assessment/Physical Characterization information, and results of laboratory analyses.

Station Locations: Water samples were requested at two stations upstream and five locations downstream of the Calera WWTP outfall. Samples could not be collected at BXHS-1, the most upstream station, however, due to a lack of flow. Samples could also not be collected at BXHS-5 and BXHS-6, the two downstream-most locations.

Water quality sample collection: Field parameters, flows, and intensive water quality sampling was conducted March, April, May, July, and August at BXHS-2, BXHS-3, BXHS-3A, and BXHS-4. Samples were also collected during June and October at BXHS-4. At the request of ADEM's Director, samples were not collected during September due to the gasoline shortage caused by Hurricane Katrina. Duplicate field parameters were collected during 10% of the sampling events. Duplicate water quality samples were collected during 5% of the sampling events.

Chemical analyses of water samples were conducted by ADEM's Central Laboratory in Montgomery. Water quality samples for laboratory analysis were collected, preserved, and transported to ADEM's Laboratory as described in ADEM Field Operations Standard Operating Procedures and Quality Control Assurance Manual, Volume I - Physical/Chemical (ADEM 2000c). Laboratory analyses were conducted in accordance with ADEM's Quality Assurance Manual for the Alabama Department of Environmental Management Central Laboratory (ADEM 1999d).

Sample handling and chain-of-custody procedures were used for all biological and chemical samples as outlined in ADEM Field Operations Standard Operating Procedures and Quality Control Assurance Manual, Volumes I and II to ensure the integrity of all samples collected (ADEM 1999a, 2000c).

Water Quality Assessment guidelines: The four Buxahatchee Creek stations are located within the Piedmont (45a) and Ridge and Valley (67g) ecoregions. Median and average values of water quality parameters were assessed as *exceeding* or *not exceeding* background levels as defined by the 90th percentile of data collected at least-impaired ecoregional reference reaches within that subecoregion from 1991-2001 (ADEM 2004a). The 5th and 95th percentile were treated as outliers and removed before analysis. These values are provided in Table 1.

Table 1. Ecoregional reference guidelines (90th percentile of ecoregional reference reach data minus 5th and 95th percentiles)

Subecoregion	**67g**					**45a**	
	Final 90th	**Final N**	**Min**	**Max**	**Median**	**Final 90th**	**Final N**
F COL (col/100ml)	360	17	41	1110	130	573	20
Chl a (mg/m^3)	1.924	19	0.270	2.400	1.000	1.070	1
Alk, total (mg/l)	55.0	22	18.0	56.0	34.5	21.8	27
Hard (mg/l)	50.0	21	20.0	56.0	34.0	21.3	31
CBOD-5 (mg/l)	2.5	14	0.2	5.3	0.9	1.5	9
COD (mg/L)	7.5	9	2.0	10.0	2.0	2.0	4
TSS (mg/l)	17.0	23	1.0	28.0	7.0	16.0	27
TDS (mg/l)	102.0	21	59.0	116.0	78.0	66.0	21
TOC (mg/l)	9.179	20	2.267	12.678	4.957	3.125	20
Total-P (mg/l)	0.073	22	0.020	0.106	0.050	0.050	34
NO2+NO3-N (mg/l)	0.158	23	0.003	0.229	0.060	0.158	33
NH3-N (mg/l)	0.058	23	0.015	0.079	0.015	0.033	33
TKN (mg/l)	0.629	22	0.150	0.726	0.335	0.278	32
DRP (mg/l)	0.025	23	0.004	0.029	0.011	0.017	15
AL-T (mg/l)	1.590	10	0.200	2.070	0.748	0.200	6
AL, Dis (mg/l)	0.200	10	0.100	0.200	0.200	0.108	2
Fe-T (mg/l)	1.820	10	0.358	2.170	1.109	0.981	12
Fe, Dis (mg/l)	0.482	10	0.123	0.507	0.324	0.241	2
Mn-T (mg/l)	0.082	3	0.058	0.087	0.062	0.124	12
Mn, Dis (mg/l)	0.050	4	0.042	0.050	0.048		0

Macroinvertebrate bioassessment sample collection and processing: Habitat and macroinvertebrate assessments were conducted at three locations on Buxahatchee Creek (BXHS-4, BXHS-3A, and BXHS-2). Station descriptions are provided in the Station

Locations Table of the 2005 Buxahatchee Creek Database. Assessments were conducted May 12th, 2005 using ADEM's Standard Operating Procedures and Quality Assurance Manual, Volume II-Freshwater Macroinvertebrate Biological Assessment (ADEM 1999). Macroinvertebrate samples were also processed and identified in accordance with ADEM 1999.

Macroinvertebrate assessments: Macroinvertebrate bioassessments were based on ADEM's 2005 Ecoregional Guidelines (ADEM 2005) for Piedmont (45; BXHS-3A and BXHS-4) and Ridge and Valley (BXHS-2) streams. Description of metrics and criteria are provided in Tables 2-4.

Table 2. Interpretation of metrics

Metric	ADEM 2005	Description
Total taxa richness	X	Total number of taxa (genera or lowest taxonomic level) collected at a site. Generally decreases with decreasing water quality, but can increase at low levels of nutrient enrichment.
EPT taxa richness	X	EPT taxa richness is the total number of distinct taxa (genera) within the generally pollution-sensitive orders Ephemeroptera, Plecoptera, and Trichoptera. This metric generally increases with increasing water quality, but may also increase due to low-level organic enrichment.
% EPT organisms	X	Percent of organisms collected at a site that are members of the EPT orders (see above). Generally decreases with decreasing water quality; but can increase at low levels of nutrient enrichment.
NCBI	X	Index between 1 and 10 calculated by multiplying the number of organisms within a single taxon by the tolerance value of that taxon (also 1-10). ADEM's tolerance values are based on those developed by North Carolina (Lenat 1993), but calibrated to ADEM's method and level of taxonomic identification (ADEM 1999, ADEM 2005). The biotic index increases as water quality decreases.
% Dominant taxon	X	Percent contribution of the numerically dominant taxon. This metric generally increases with decreasing water quality.
% Nutrient-tolerant taxa		Percent contribution of 13 taxa generally found to be tolerant of nutrient enriched conditions, including *Baetis*, *Stenacron*, *Cheumatopsyche*, *Chironomus*, *Polypedilum*, *Rheotanytarsus*, *Cricotopus*, *Simulium*, *Psephenus*, *Stenelmis*, *Lirceus*, *Physella*, *Elimia*, Oligochaeta (Brumley et al. 2003). ADEM modified this metric by using percent contribution of the families Baetidae, Simuliidae, and Physidae. Percent nutrient tolerant taxa is generally 44% or lower at ADEM's ecoregional reference reaches.

Table 3. Scoring criteria for ADEM's Ridge and Valley (67) bioregion.

Bioregion 67				
Score	**0**	**1**	**3**	**5**
Total taxa richness	<28	28-55	56-65	>65
EPT taxa richness	<8	8-15	16-19	>19
% EPT organisms	<18	18-37	38-52	>52
NCBI	>7.65	5.30-7.65	4.50-5.30	<4.5
% Dominant taxon	>48	24-48	14-24	<14
Final Assessment	**Poor**	**Fair**	**Good**	**Excellent**
Final Score	<10	11-15	16-21	>21

Table 4. Scoring criteria for ADEM's Piedmont (45) bioregion.

Bioregion 45				
Score	**0**	**1**	**3**	**5**
Total taxa richness	<24	24-47	48-57	>58
EPT taxa richness	<7	7-13	14-18	>18
% EPT organisms	<14	14-27	28-37	>37
NCBI	>7.6	5.2-7.6	5.2-4.9	<4.9
% Dominant taxon	>65	33-65	22-32	13-22
Final Assessment	**Poor**	**Fair**	**Good**	**Excellent**
Final Score	<12	12-16	17-20	>20

Periphyton bioassessment sample collection and processing: Periphyton bioassessments were conducted at BXHS-4, BXHS-3A and BXHS-2. Station descriptions are provided in the Station Locations Table of the 2005 Buxahatchee Creek Database. Assessments were conducted using ADEM's 2005 Standard Operating Procedures and Quality Assurance Manual (ADEM 2005b). Rapid periphyton surveys (RPSs) were conducted at BXHS-2 and BXHS-3a on May 12th. Periphyton biomass as chlorophyll *a* and an RPS was collected at BXHS-4 during April, May, and October of 2005.

Periphyton assessments: Periphyton bioassessments of the bioassessments conducted in May were based on ADEM's 2002 Periphyton Bioassessment Guidelines (ADEM 2004). Description of metrics and criteria are provided in Table 5.

Table 5. Interpretation of periphyton metrics.

Metric	75th %ile of Ecoregional Reference Sites (ADEM 2004)	**Description**
Periphyton Biomass as Chlorophyll *a*	33	One of the four variables currently recommended to initiate nutrient criteria development (USEPA 2000). Measured as mg/m2 using standard methods. Generally increases with increasing nutrient enrichment. It can difficult to accurately measure in streams due to the patchy distribution, scouring, and occurrence on non-uniform stream bottoms. It is also possible to miss peak biomass.
% Cover Filamentous Algae	29	% of stream bottom covered with filamentous (nuisance) algae (visually estimated). Also subject to scouring.
Periphyton Thickness	0.8	Visual estimate of periphyton thickness in mm. Increases with increasing nutrient enrichment.

Results

Macroinvertebrate assessment results are summarized in Table 6. Periphyton assessment results are summarized in Table 7.

BXHS-2: Buxahatchee Creek at BXHS-2, located upstream of the Calera WWTP, drains the city of Calera. The stream reach was estimated to be 100% pool habitat. Flows and stream velocity were generally low. The site was characterized by sand (45%), gravel (25%), and silt (17%) substrates and a lack of riparian buffer.

The macroinvertebrate community at BXHS-2 appeared to be in worse condition than the downstream sites, with the highest NCBI value (8.0) and an EPT taxa richness score of 0.

These results may be at least partly attributed to low flow and the lack of riffle-run habitat.

Periphyton bioassessment results indicated percent cover as filamentous algae and periphyton thickness to be higher than expected at ADEM's ecoregional reference reaches. However, these results may also be due in part to the slower velocities and lack of scouring at the site.

Median and average nutrient concentrations at the site were generally similar to the 90th percentile of nutrient concentrations at ADEM's ecoregional reference reaches in Ecoregion 67g. The chlorophyll *a* concentration in May was 9.08 mg/L in May, however, and median and average chlorophyll *a* values were higher than values expected at ADEM's reference reaches. Fecal coliform was measured at 3,200 colonies/100mL during a high-flow event in April.

BXHS-3: Buxahatchee Creek at BXHS-3 is located downstream of the Calera WWTP. The stream reach was characterized by 70% cobble substrate and 95% run habitat. The habitat assessment rated habitat quality as *good* using the riffle-run habitat assessment matrix.

A macroinvertebrate assessment was not conducted at the site.

Median and average nutrient concentrations at the site exceeded values expected at ADEM's reference reaches located in Ecoregion 67g. The dissolved oxygen concentration in July was measured at 4.3 mg/L. Flow was not measured during any of the site visits. Fecal coliform was measured at 2,800 colonies/100mL during a high-flow event in April. Total suspended solids, total dissolved solids, alkalinity, and hardness were also elevated at the site.

BXHS-3A: Buxahatchee Creek at BXHS-3A is located downstream of the Calera WWTP. The stream reach was dominated by run habitat with some riffle areas. Bottom substrates were composed of 43% sand and silt and 57% stable substrates. The habitat assessment rated habitat quality as *good* using the riffle-run habitat assessment matrix.

The macroinvertebrate community at BXHS-3A was assessed as *poor*, based on ADEM's 2005 Ecoregional Assessment Guidelines. Eighty percent of the organisms collected were classified as nutrient tolerant taxa, suggesting that nutrient enrichment is affecting the diversity and composition of the macroinvertebrate community. Conditions were improved from BXHS-2, however, due to increased flow and aeration of water through the riffle areas.

Periphyton bioassessment results also suggest nutrient enrichment. Filamentous algae was estimated to cover 65% and 43% of the stream bottom within the macroinvertebrate and periphyton bioassessment sampling reaches, respectively. Average periphyton thickness was 13.5mm.

Median and average nutrient concentrations at the site exceeded values expected at ADEM's reference reaches located in Ecoregion 45a. Flow was not measured during any of the site visits. Total dissolved solids, alkalinity, and hardness were also elevated at the site.

BXHS-4: Buxahatchee Creek at BXHS-4, the downstream-most site, was estimated to be 30% riffle and 40% run habitat. Bedrock (40%), sand (20%) boulder (15%), and cobble (15%) were the dominant substrate types. The habitat assessment rated habitat quality as *excellent* using the riffle-run habitat assessment matrix.

The macroinvertebrate community at BXHS-4 was improved from BXHS-2 and BXHS-3a, probably due to the improved habitat conditions. The macroinvertebrate community was assessed as *poor*, however, based on ADEM's 2005 Ecoregional Assessment Guidelines. Close to 65% of the organisms collected were classified as nutrient tolerant taxa.

Percent filamentous algal cover and periphyton biomass as chlorophyll a were similar to ecoregional reference conditions.

Median and average nutrient concentrations at the site exceeded values expected at ADEM's reference reaches located in Ecoregion 45a. Total dissolved solids, alkalinity, and hardness were also elevated at the site.

Table 6. Summary of macroinvertebrate assessment results.

Metric	BXHS-2	BXHS-3a	BXHS-4
Total Taxa Richness	33	36	39
EPT Taxa Richness	0	5	6
% EPT Organisms	0	21	30
% Dominant Taxon	32	22	26
NC Biotic Index	8.0	7.3	6.0
% Nutrient Tolerant	67	80	64
EPT Families	0	4	5
Assessment Score	2	7	8
Final Assessment	Poor	Poor	Poor

Table 7. Summary of periphyton assessment results.

Metric	75^{th} %ile of Ecoregional Reference Sites (ADEM 2004)	BXHS-2	BXHS-3a	BXHS-4
Sampling Date		5/12/2005	5/12/2005	5/11/2005
Periphyton Biomass as Chlorophyll a (mg/m^2)	33	---	---	41.9
% Cover Filamentous Algae	29	53	43	22
Average Periphyton Thickness (mm)	0.8	7.5	13.5	4.7

Conclusions

Macroinvertebrate assessment results indicated the macroinvertebrate communities above and below the Calera WWTP to be in *poor* condition. The poor conditions at BXHS-2 may be at least partly attributed to low flow and the lack of riffle-run habitat. Results of water quality sampling and periphyton bioassessments conducted during 2005 suggest that nutrient enrichment is also affecting the macroinvertebrate communities at BXHS-3a, and, to a lesser extent, BXHS-4.

References

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