

Trend Monitoring Summary: 1994-2009

Robinson Creek upstream of Robinson Creek Road (Morgan County; 34.36462/-86.92713)

BACKGROUND

The 6.3 mile segment of Robinson Creek from Flint Creek to its source was placed on Alabama’s 1998 Clean Water Act (CWA) §303(d) list of impaired waters for not meeting its *Fish & Wildlife (F&W)* water use classification criteria. The segment was added to the list based on results of macroinvertebrate and fish community assessments conducted in 1994 by the Tennessee Valley Authority (TVA). Both assessments rated the stream as “*poor/fair*”. Water quality data collected in 1997 by TVA indicated these impairments to be caused by siltation and organic enrichment/low dissolved oxygen concentrations (OE/DO) from agricultural sources.

The Alabama Department of Environmental Management (ADEM) developed a Total Maximum Daily Load (TMDL) to decrease the sediment load of 22 stream segments within the Lower Tennessee River Basin, including Robinson Creek. A second TMDL was developed to address the OE/DO impairments within Robinson Creek and 16 other OE/DO impaired stream segments within the Flint Creek watershed. Both TMDLs were approved by US Environmental Protection Agency Region 4 (USEPA) in 2003.

A watershed management plan (WMP) was developed to help address the agricultural sources of siltation and organic enrichment identified in the two TMDLs. The WMP was implemented in part using a Clean Water Act (CWA) §319(h) nonpoint source grant provided by USEPA through ADEM’s §319 grant program. As part of the WMP, riparian forest buffers were planted around two segments of Robinson Creek (Figure 1). Figures 2-4 show stream reaches within the Robinson Creek watershed in 2005, before the riparian forest buffer was planted, and in 2011, five years after the project was fully implemented. An alternative watering source was also installed.

In 2009, the ADEM conducted habitat and macroinvertebrate assessments and intensive water quality sampling in Robinson Creek at RBNM -1, approximately 0.25 miles downstream of the reach assessed by TVA in 1994, to document current water quality conditions and to evaluate the effectiveness of BMPs implemented in the Robinson Creek watershed. The site is directly downstream of all BMPs, but a forest riparian buffer was not planted along this reach. A fish IBI community assessment could not be conducted due to no flow conditions within the reach.

WATERSHED CHARACTERISTICS

Table 1 summarizes land cover within the Robinson Creek watershed based on the 1993 and 2006 National Land Cover Datasets (NLCD). Both datasets are included in Table 1 and Figure 1 because they coincide with TVA’s 1994 macroinvertebrate and fish community assessments and full implementation of the WMP in 2006. Although detailed NLCD categories differ, comparison of the two datasets can show trends in land usage throughout the watershed. Since 1993, percent forest cover and row crop have decreased while percent pasture/hay and urban areas have increased. Interstate 65 and US Highway 31 trisect the watershed upstream of ADEM’s monitoring location.

As part of the WMP, a total of 453.4 acres of riparian buffer and 22 acres of trees and shrubs were established throughout the watershed, concentrating on areas within 300 feet of Robinson Creek and its tributaries. In the 2006 map, Figure 1 shows the location of a 44.7 acre and a 233.4 acre forest buffer zone created to decrease sediment and nutrient loading into Robinson Creek.

Table 1. Comparison of watershed characteristics between 1993 and 2006 based on the National Land Cover Datasets (NLCD).

Watershed Characteristics		
NLCD	1993	2006
% Landuse		
Open water	<1	<1
Wetland	Total 2	5
	Woody 1	1
	Herbaceous 1	4
Forest	Total 52	33
	Deciduous 29	29
	Evergreen 6	2
	Mixed 17	2
Other grasses/Shrub/scrub	1	6
Pasture/hay	28	38
Cultivated crops	10	8
Development	4	10
Barren/Quarries/Mining/Transitional	3	1

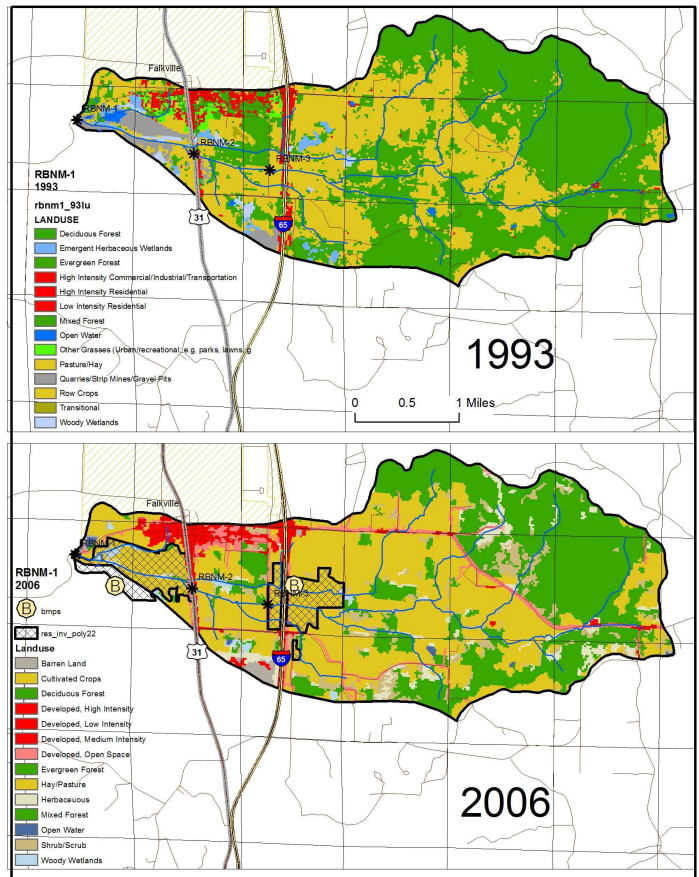


Figure 1. Land cover within the RBNM-1 watershed based on the 1993 and 2006 NLCDs. The 1993 map represents landuses within the watershed one year prior to TVA’s 1994 bioassessments; the 2006 map represents conditions when the watershed management plan was fully implemented.



Figure 2a. Tributary to Robinson Creek, looking towards Robinson Creek, in February of 2005.



Figure 2b. Same location with riparian forest buffer, in April of 2011.



Figure 3a. Tributary to Robinson Creek, in February of 2005.



Figure 3b. Same location with riparian forest buffer, in April of 2011.



Figure 4a. Tributary to Robinson Creek, in February of 2005.



Figure 4b. Same location with riparian forest buffer, in April of 2011.

REACH CHARACTERISTICS

Typical of many watersheds located in the Eastern Highland Rim (71g) subregion of the Interior Plateau, the Robinson Creek watershed is flat and frequently flooded. Reach characteristics at RBNM-1 were estimated by ADEM on May 5, 1998 and June 2, 2009 (Table 2). In 1998, the reach was relatively wide and deep with slow-moving water. Substrates within the reach were dominated by sand, silt, and organic matter deposits. Overall habitat quality was rated as *good* (Table 3).

The 2009 estimates suggest a narrower stream channel overall, which may have created areas of faster moving water. The riparian forest buffers established upstream may also have decreased the amount of siltation inputs from these areas. Percent sand, silt, and organic matter decreased, with a corresponding increase in percent stable substrates. Despite these changes, overall habitat quality was rated as *fair* (Table 3). Scores for bank vegetative stability and riparian zone measurements were both lower in 2009 than in 1998, but an improvement in these parameters would not be expected because forest riparian buffer was not planted within the RBNM-1 reach. Instream habitat quality and sediment deposition scores both improved, reflecting the greater percentage of stable substrates within the stream reach and improved bank stability throughout the watershed.

Table 2. Summary of physical characteristics observed at RBNM-1 in May 1998 and June 2009.

Physical Characteristics			
Date (m/d/yyyy)	5/5/1998	6/2/2009	
Width (ft)	21	15	
Canopy Cover	50/50	Shaded	
Depth (ft)			
	Run	0	1.5
	Pool	2	2.5
% of Substrate			
	Bedrock	0	30
	Boulder	0	20
	Clay	0	10
	Cobble	0	15
	Gravel	0	10
	Mud/muck	10	0
	Sand	45	10
	Silt	25	2
	Organic Matter	20	3

MACROINVERTEBRATE BIOASSESSMENTS

In 2004, TVA sampled benthic macroinvertebrate communities using a Multi-habitat Bioassessment EPT method, which uses the number of families in three pollution-intolerant insect orders as a measure of water quality. Five EPT families were collected, indicating the stream reach to be in *fair/poor* condition using TVA's existing assessment thresholds for streams in this area.

In 2009, benthic macroinvertebrate communities were sampled using ADEM's Multi-habitat Bioassessment EPT method, which is very similar to the method used by TVA. It measures the number of families in the same three pollution-sensitive aquatic insect orders as an indicator of biological conditions. In 2009, seven EPT families were collected, suggesting improved biological conditions.

In 2009, the ADEM also sampled the benthic macroinvertebrate community using ADEM's Intensive Multi-habitat Bioassessment Methodology (WMB-I) (Table 4). The WMB-I is a more precise indicator of community condition that uses measures of taxonomic richness, community composition, and community tolerance to assess the overall health of the macroinvertebrate community. Each metric is scored on a 100 point scale. The final score is an average of seven individual metric scores. Metric results indicated the macroinvertebrate community to be in *fair* condition.

Table 4. Results of the intensive macroinvertebrate bioassessment of RBNM-1 conducted June 2, 2009.

Macroinvertebrate Assessment				
	Results	Scores	Rating	
Taxa richness measures				
# EPT genera	10	40	Fair (38-56)	
Taxonomic composition measures				
% Non-insect taxa	16	47	Poor (30.9-61.8)	
% Plecoptera	1	3	Poor (1.86-3.7)	
% Dominant taxa	22	69	Fair (47.1-70.5)	
Functional composition measures				
% Predators	13	44	Fair (30.2-45.2)	
Tolerance measures				
Beck's community tolerance index	5	23	Fair (21.3-31.8)	
% Nutrient tolerant organisms	11	98	Excellent (>88.1)	
WMB-I Assessment Score	--	46	Fair (38-56)	

Table 3. Results of habitat assessments conducted at RBNM-1 in May 1998 and June 2009.

	5/5/1998	6/2/2009
Habitat Assessment	% Maximum Score	% Maximum Score
Instream habitat quality	45	52
Sediment deposition	58	70
Frequency of riffles	30	35
Bank and vegetative stability	68	36
Riparian buffer	85	50
Habitat assessment score	136	118
% Maximum score	62	54
Habitat Assessment Rating	Good	Fair

WATER CHEMISTRY

Table 5 summarizes water quality data collected in Robinson Creek in 1997, 1998, and 2009. Monthly water quality data was collected June-October, 1997 by TVA to help evaluate the causes of the biological impairment measured in 1994. These data were collected approximately 0.25 miles upstream of RBNM-1. Dissolved oxygen concentrations were below the 5.0 mg/L F&W water quality standard in August and September (4.1 and 0.7 mg/L, respectively). Follow-up sampling was conducted by ADEM at RBNM-1 in May, July, and September, 1998. These data also indicated low dissolved oxygen concentrations.

In 2009, in situ measurements and water samples were collected monthly, March through October at RBNM-1. However, nutrient samples collected March-July (ammonia nitrogen, total Kjeldahl nitrogen (TKN), total nitrogen, and total phosphorus) were excluded from analyses because they did not meet ADEM's quality control requirements.

Dissolved oxygen concentrations were above the 5.0 mg/L F&W water quality standard during all sampling visits. Comparison of the three datasets suggest that median concentrations of total suspended solids, total phosphorus, nitrogen as ammonia, nitrate+nitrite nitrogen, CBOD-5, and specific conductance decreased in 2009, while median total nitrogen and total Kjeldahl nitrogen (TKN) increased. However, only median concentrations of TKN and specific conductivity were higher than background levels, based on least-impaired reference reach data collected by ADEM in ecoregion 71.

SUMMARY

The 6.3 mile segment of Robinson Creek from Flint Creek to its source was placed on Alabama's 1998 CWA §303(d) list of impaired waters for not meeting its F&W water use classification criteria. The segment was added to the list based on results of macroinvertebrate and fish community assessments conducted in 1994, which indicated both communities to be in "poor/fair" condition. Water quality data collected in 1997 by TVA indicated these impairments to be caused by siltation and organic enrichment/low dissolved oxygen concentrations (OE/DO) from agricultural sources.

Two separate TMDLs were developed to decrease siltation and organic enrichment within Robinson Creek and other streams within the Tennessee River basin. Riparian forest buffers and other BMPs were implemented in 2006 to address the agricultural sources of siltation and organic enrichment identified in the two TMDLs.

In 2009, the ADEM conducted habitat and macroinvertebrate assessments and intensive water quality sampling in Robinson Creek to document current water quality conditions and to evaluate the effectiveness of BMPs implemented in the Robinson Creek watershed. Comparison of data collected by TVA and ADEM since 1994 suggest that the forest riparian buffers and other implemented BMPs have resulted in decreased siltation loads, improved instream habitat, and improved biological and water quality conditions.

Monitoring and BMP implementation should continue to identify the sources of increased TKN concentrations and to ensure that specific conductance continues to decline within the reach.

Table 5. Summary of water quality data collected monthly by TVA, June-October, 1997, in May, July, and September, 1998 by ADEM, and monthly by ADEM, March-October, 2009. The 1997 samples were collected from a stream reach approximately 0.25 miles upstream of RBNM-1.

Parameter	Basis of Comparison	TVA 1997	RBNM-1 1998	RBNM-1 2009
Temperature (°C)	Max	23.6	25	24.1
Turbidity (NTU)	Max	8.6	16.9	8.9
Total Suspended Solids (mg/L)	Median	7	10	5.5
Specific Conductance (µmhos)	Median	394	337	327
Stream Flow (cfs)	Min	1.8	0.9	0.6
Dissolved Oxygen (mg/L)	Min	0.7	1.6	6.2
Ammonia Nitrogen (mg/L)	Median	0.04	---	<0.003
Nitrate+Nitrite Nitrogen (mg/L)	Median	0.525	0.659	0.051
Total Kjeldahl Nitrogen (mg/L)	Median	0.37	0.531	0.556
Total Nitrogen (mg/L)	Median	0.68	1.19	1.227
Total Phosphorus (mg/L)	Median	0.05	0.081	0.038
CBOD-5 (mg/L)	Median	<2	1.9	0.5

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