TREND ANALYSIS OF WATER QUALITY MONITORING DATA FOR COBB COUNTY, GA

Brenda Rashleigh[1] and Robert Bourne[2]

AUTHORS: [1] Ecologist, U.S. Environmental Protection Agency, 960 College Station Road, Athens, Georgia, 30605, [2]Supervisor, Environmental Compliance Division, Cobb County Water System, 660 S Cobb Drive, Marietta, GA 30060

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Abstract. The Cobb County Water Protection Division Water Quality Laboratory has conducted quarterly chemical monitoring from 1995-2005. Here we analyze these data for temporal trends at 45 sites in 10 Piedmont streams in the Chattahoochee and Etowah river basins. The strongest overall trend was for increases in conductivity, chlorides, TKN, and NOx. Some sites showed a decrease in turbidity, TSS, and percent dissolved oxygen saturation. To the extent that the changes in water quality have resulted from land use change and increasing urbanization and development in the watershed, the best indicators of land use change in Cobb County may be conductivity and TKN. This dataset provides a unique opportunity to examine water quality trends for a rapidly developing region of Georgia.

INTRODUCTION AND BACKGROUND

Stream water quality is a concern in Georgia (GA DNR, 2002). Water quality affects the quality of drinking water and the capacity of the rivers to support wildlife and healthy ecosystems. Water quality can be degraded by many different stressors in the watershed, including poor development practices and sprawl, poor stormwater management, destruction of wetlands, runoff from agricultural areas, and point source pollution (River Network, 2005, Chadwick et al, 2006). This is particularly significant for rapidly developing area, such as the greater Atlanta area.

Monitoring is often conducted to examine the status and trends of streams within a region. This allows managers to detect specific problems and identify areas of concern. The Cobb County Water Protection Division Water Quality Laboratory has conducted quarterly chemical monitoring from 1995-2005 (Figure 1). The drainage in Cobb County supplies two major river systems, the Chattahoochee and the Coosa. The Chattahoochee basin includes: Willeo, Sope, Sewell Mill, Little Nancy, Rottenwood, Nickajack and Sweetwater Creeks. The vast Sweetwater Creek basin includes: Ward, Mud, Noses, Powder Springs, Olley and Buttermilk Creeks. The Coosa basin includes: Butler, Allatoona, Little Allatoona, Proctor, Tanyard, Rubes, Noonday and Little Noonday Creeks. The streams supplying the Chattahoochee tend to flow south while those supplying the Coosa tend to flow north.

The Cobb County dataset provides a unique opportunity to examine water quality trends for a rapidly developing region of Georgia. Here we consider temporal trends in 10 Piedmont streams in the Chattahoochee and Etowah river basins. The detection of trends in interest can identify sites where potential impacts are occurring and can help to identify which water quality variables are the best indicators of change for Cobb County.

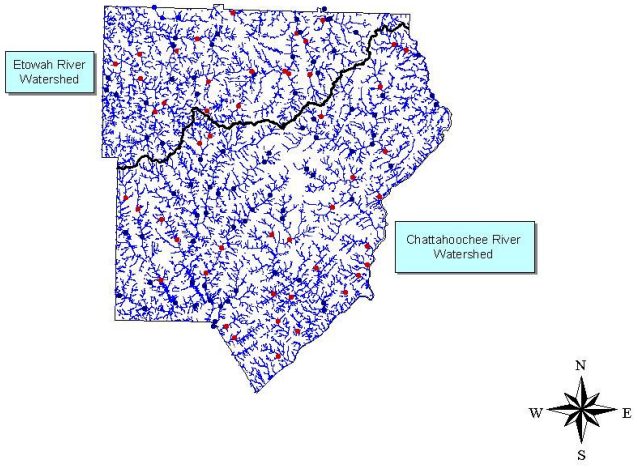

Figure 1. Location of sites sampled in Cobb County, Ga., 1995-2005. Sites in red were sampled for water quality.

METHODS

The data examined in this study was collected by the Cobb County Water Protection Division Water Quality Laboratory from 1995 -2005 in dry weather. Samples are collected from 80 sites distributed over all of Cobb County's major streams. Sites are located both in upper reaches and main stem sections of these streams.

Sampling and analysis are done in accordance with EPA and Standard Methods (Franson et al., 1995). Parameters measured include dissolved oxygen (DO), biochemical and chemical oxygen demand (BOD, COD), total suspended solids (TSS), nitrate/nitrite, total phosphorous, ammonia, total kjeldahl nitrogen (TKN), chlorides, conductivity, metals (zinc, copper, lead, and cadmium), hardness, pH, temperature, and fecal coliform. To assure the highest quality of sampling, quality control samples are collected, and stream monitoring personnel train in the laboratory. This maintains the same standards and quality for sampling, preservation, analysis and subsequent interpretation of the results.

Here we analyzed data at 45 selected sites (sites with more complete data records) for temporal trends in 10 Piedmont streams in the Chattahoochee and Etowah river basins (Table 1). Statistical analysis was conducted with the SAS statistical program (SAS, 1989). A linear regression model was used with year and temperature as the explanatory variables. Temperature was used as a variable to account for seasonal influences on the response variable. Model results were assumed to constitute a trend when the coefficient on the year variable was significant at $p<0.05$.

RESULTS AND DISCUSSION

The regression results are presented in Table 2. Three of the initial set of variables examined -- pH, COD, and total phosphorus showed almost no significance at any of the sites, and were dropped. Metals (Cadmium, Copper, Lead, and Zinc) showed a significant negative trend at nearly every site, however, this is likely due to changes in methods. The lab was moved in 1998, which might have had an effect on methods for metals, so these numbers are not considered representative. Also, DO in mg/L showed a nearly identical response to DO % saturation, so only DO % saturation is presented here.

Table 1. Cobb County water sampling sites used in the analysis (N= number of samples available at each site).

Stream	N	Sampling Locations
Butler Creek	31	Pine Mountain Road (BT1), Mack Dobbs Road (BT2), Jim Owens Road (BT3), Nance Road (BT4)
Noonday Creek	33	Kurtz Road (ND1), Duncan Road (ND2), New Chastain Road (ND3), Shallowford Road (ND4) Highway 92 (ND5)
Noses Creek	33	Mt. Calvary Rd. (NS1) Irwin Road (NS2) Macland Road (NS3) Macedonia Road (NS4), Clay Road (NS5)
Proctor Creek	34	Baker Road (PC1), Giles Road (PC2), Highway 293 (PC3)
Rottenwood Creek	35	Aviation Road (RT1), Barclay Road (RT2), Franklin Road (RT3), Terrell Mill Road (RT4), Akers Mill Road (RT5)
Sewell Mill Cr	34	Casteel Road (SL1), Holly Springs Road (SL2), Sewell Mill Road (SL3), Robinson Road (SL4)
Sope Creek	32	Cobb Industrial Drive (SP1), Allgood Road (SP2), Barnes Mill Road (SP3), Holt Road (SP4), Indian Hills Drive (SP5) Paper Mill Road (SP6)
Sweetwater Creek	29	Brownsville Road (SW1),Holloman Road (SW2), Westside Road (SW3), Austell-Powder Springs Rd (SW4), Perkenson Mill Road (SW5), Old Alabama Road (SW6)
Tanyard Creek	34	Cowan School Road (T1), Cherokee School Road (T2), Highway 92 (T3)
Ward Creek	33	Highland Avenue (WR1), Kirkpatrick Drive (WR2), Cheatham Hill Road (WR3), John Ward Road (WR4)

Table 2. Results of regression analysis for multiple water quality variables for Cobb County (BOD=biochemical oxygen demand, TSS=total suspended solids, fc=fecal coliform, con=conductivity, chl=chlorides, tur=turbidity, tkn= total keljhal nitrogen, NOx=nitrate/nitrite, and do = % dissolved oxygen saturation). Only significant results (p<0.05), either positive (+) or negative (--) are shown.

Site	BOD	TSS	fc	Con	Chl	tur	tkn	NOx	do
BT1				+	+		+		
BT2				+	+		+		
BT3				+	+		+		
BT4				+	+		+		--
ND1									--
ND2				+	+			+	
ND3		--		+	+				
ND4		--		+	+				
ND5				+	+		+		
NS1				+	+				
NS2				+			+		
NS3				+	+		+		
NS4				+	+		+		
NS5							+		
PC1	+								
PC2				+	+	--	+		--
PC3		--		+	+	--	+		--
RT1			--	+					--
RT2		--		+				+	
RT3		--		+				+	
RT4		--		+				+	--
RT5				+	+			+	
SL1		--			+	--	+		
SL2		--		+	+	--	+		
SL3		--		+	+	--	+		
SL4		--	--	+	+				
SP1							+		
SP2						--	+		
SP3		--			+		+	+	
SP4		--		+	+		+	+	
SP5				+	+		+	+	
SP6				+	+		+	+	
SW1		--			--		+	+	
SW2							+	+	
SW3	--	--					+		
SW4	--	--	--				+		
SW5	--	--							
SW6	--	--					+		
T1		--		+		--			
T2	--	--	--	+	+		+		
T3	--	--		+	+		+	+	
WR1									
WR2			--	+			+		
WR3		--	--	+	+		+		
WR4		--			+		+		--

Significant trends occurred for conductivity and chlorides at most sites. Increases in conductivity and chlorides are expected changes resulting from land use change. The signal in conductivity has been demonstrated in other studies (e.g., Wenner et al, 2005); this finding supports the importance of conductivity as in indicator of water quality for Cobb County as well. Chlorides represent inorganic ions present in water, which are higher in wastewater than in normal surface water. This is true for all animal waste including human and most industrial waste and leachate from landfills. The significance of chlorides is interesting – this is rarely reported as an indicator for water quality in Georgia, and has potential to be used more commonly in monitoring. However, it is highly correlated with conductivity at all sites ($r=0.64$, $p<0.001$, $N=1405$), so the two measures are not unique.

The pattern of increasing TKN, as well as NOx, in several streams is interesting. A high TKN could be due to domestic sewage, runoff from pastures, or ammonia containing fertilizers. This finding is consistent with Calhoun et al. (2003), who found that nitrate nitrogen

has increased over a similar time period in the Upper Chattahoochee River basin, which may be due to a combination of an increase in effluent volume from wastewater treatment plants with an increase in tertiary treatment that oxidizes ammonia to produce nitrate. Surprisingly, there was no significant relationship between TKN and NOx ($r=0.003$, $p=0.9151$, $N=1465$); the patterns in both of these variables should be investigated further.

Additional variables showed some significant patterns. Some decreases in dissolved oxygen were observed – this often occurs as a result of urbanization. Surprisingly, some sites exhibited improvements, in terms of decreasing BOD, TSS, fecal coliform, and turbidity. TSS and turbidity are highly correlated with one another ($r=0.57$, $p<0.0001$, $N=1461$); the decrease in these measures may be due to the reduction in construction projects within the last ten years. The reduction in BOD and fecal coliform may be due to improvements in sewage and septic tank conditions within the county over this time period.

CONCLUSIONS AND RECOMMENDATIONS

The trends in water quality identified here for Cobb County are most likely due to non-point source pollution from stormwater runoff. Development poses a much greater threat to the long term health of a stream than domestic point source pollution. A point source, once identified and remediated or eliminated, may cease to impact a stream, allowing the possibility of full recovery. For example, if a stream is exposed to severe domestic sewage discharge, there will be certain predictable effects. The dissolved oxygen will drop, biochemical oxygen demand will increase, anaerobic conditions will develop, sludge deposits will form, and toxic malodorous gases will be produced and all but the hardiest life forms will be absent. If, however, the point source is eliminated, the stream will recover rapidly to pre-discharge conditions.

Damage to streams due to changes in land use, however, is more difficult to address and remedy than domestic point source pollution. Urbanization results in permanent changes in the watershed. Changes in land use following the land disturbing activities cause new problems due to increases in impervious surfaces, reduction in vegetative cover, and an increase in nonpoint sources of pollution. Changes to water quality are often associated with increases in population. Water quality can suffer if a larger portion of the annual discharge originates from runoff instead of clean, soil-filtered water. This can impact the quality of drinking water, as well as the biota living in the stream.

Protecting the stream environment is no longer a simple matter of eliminating a point discharge; a more comprehensive approach must be taken. The whole community shares the responsibility of protecting surface water. This is especially pertinent to Cobb County and all metro counties because these areas are being built on the very watershed they depend on for drinking water. The Atlanta metro area is the largest upstream urban area in the country. The comprehensive Stream Monitoring Program implemented by Cobb County is an example of the County's dedication to the goal of protecting surface water quality for its own citizens and those downstream.

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