

# **Caddo Lake Intensive Water Quality and Vegetation Study During August 2012**

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#### **Study Objectives**

During the summer of 1997, I conducted an intensive water quality study at Caddo Lake. The study design was based on EPA's EMAP protocol which was developed to provide a statistically acceptable method to collect water quality data and then be able to make generalizations and conclusions about the data. To implement my study, Caddo Lake was divided into three habitat types: riverine, wetland, and lake. Using a GIS program, the area was divided into 90 equal-sized hexagons with each of the three habitat types covered by 30 hexagons. A random number generator then chose a specific location with each hexagon to sample. The study period lasted 25 days during mid-July to early August. This period is within the TCEQ established critical water quality period which is from July 1 to September 30. During the critical period, it is expected that many water quality parameters, especially dissolved oxygen, are to be at their lowest levels of the year.

The objectives of the current study were to:

1. obtain water quality and vegetation data across all of Caddo Lake during a short period of time so that the influence of weather and changing lake levels would be minimized;
2. monitor *E. coli* concentrations in areas where there is a high density of housing;
3. determine areas of the lake where anoxia is occurring;
4. compare the current results with results obtained during the previous study during the summer of 1997.

#### **Sites**

Between August 6-9, 2012, a total of 90 potential sites were scheduled to be monitored. These were the same sites that were visited during the summer of 1997. A total of 70 of the 90 sites (78%) were monitored during the study. Ninety percent of the riverine sites were monitored. Three of the riverine sites, which are located in the upper part of James Bayou, were not visited because the sites were not assessable due to large floating mats of giant salvinia. Only 13 (43%) of the wetland sites were monitored. Of the 17 wetland sites not monitored, 16 sites were dry while one site (Bird Roost) was too shallow for boat access. All 30 (100%) of the lake sites were monitored.

#### **Weather, Flow, and Lake Level**

Weather during the study period was the typical hot and dry East Texas summer. On the first day of the sampling there had been no significant precipitation during the previous 21 days, nor was there precipitation during the four study days. Daytime high temperatures were between 95 and 100°F. The wind was either calm or light on each of the sample days. According to the USGS flow gage which is located a few miles upstream of the SH43 bridge, the inflow during the four day study period averaged 30.7 cfs. As a result of the constant inflow, the lake elevation was also stable. The average lake level during 2012 has been 168.17 feet, and the annual precipitation level has been slightly below normal. The last day prior to the current study that water went over the spillway was on July 15. The average lake level during the four study days was 167.91 feet. The Caddo Lake spillway level is 168.50 ft, therefore the lake was on average seven inches below the spillway.

In comparison, during 1997 the mean lake level was 169.73 feet. During the 1997 study, lake elevation at the beginning of the study was slightly above the spillway level and fell to just below the spillway level at the end of the study. The 1997 year was an average rainfall year, but only about 0.1 inch of rain fell at the lake during the study period.

#### **Vegetation**

Aquatic vegetation was found at almost all sites. The average coverage at the riverine, wetland, and lake sites was 29%, 97%, and 17%, respectively. In the riverine habitat, aquatic vegetation was generally limited to the shallow areas along the bank and mostly consisted of native water lilies. However, several riverine sites had a high percent coverage. For example, the mouth of James Bayou, two sites in Alligator Bayou, Slumpy Slough, and several boat roads had percent coverage of greater than 90%. Vegetation was found at all wetland sites with most sites having 100% coverage with perhaps only the boat road free of vegetation. The lowest coverage recorded at a wetland site (Pine Island Pond) was 75%. Eleven of the 13 wetland sites had giant salvinia with largest amounts seen in the

Clinton Lake, Carter Lake, and James Bayou areas. The other sites had smaller amounts of giant salvinia. *Hydrilla* was seen at 7 of the 13 wetland sites. Water hyacinth was seen at only four wetland sites. The two wetland sites in Harrison Bayou were the most diverse in that eight different aquatic vegetation species were seen. Fifteen of the lake sites had aquatic vegetation with bald cypress and native water lilies the most common species. A couple of the lake sites, for example Goose Prairie near Cripp's Camp, were really more of a wetland site and had very high coverage of aquatic vegetation.

### **Water Temperature**

The TCEQ standard for temperature in segment 0402 (Big Cypress Bayou) is less than 93°F (33.9°C), while the standard for segment 0401 (Caddo Lake) is 90°F (32.2°C). The mean water temperature at all sites combined was 30.7°C. The wetland habitat had the lowest mean water temperature (27.7°C), while the lake habitat had the highest mean water temperature (31.9°C).

### **Dissolved Oxygen**

The TCEQ standard for dissolved oxygen in segment 0402 (Big Cypress Bayou) and for segment 0401 (Caddo Lake) is 5.0 mg/L. The average dissolved oxygen for all sites combined was 4.9 mg/L with a range of dissolved oxygen of 0.3 to 13.1 mg/L. There was a significant difference in the dissolved oxygen concentrations at the three habitat types: riverine – 4.0 mg/L, wetland – 1.7 mg/L, and lake – 7.0 mg/L. In the riverine habitat, there were 13 sites that had dissolved oxygen less than 5.0 mg/L. None of these sites were in the main channel of Big Cypress Bayou, but were in smaller channels like Alligator Bayou and Stumpy Slough where the coverage of aquatic vegetation was often high. Seven of the lake sites had dissolved oxygen less than 5.0 mg/L. Of these sites was in the mouth of James Bayou and was near a large mass of aquatic vegetation. One site was close to the Caddo Lake dam and was in an aquatic vegetation bed. One site was in Goose Prairie which should be classified as a wetland. One site was near Sand and Twin Islands and was also in an aquatic vegetation bed. Two lake sites, along the South Shore and near Tar Island, had low dissolved oxygen. The low values cannot be explained by the presence of high coverage by aquatic vegetation. The total depths at these sites were about 1.5m, so these sites have lake-like characteristics.

If anoxia is defined as dissolved oxygen concentrations of 0.5 mg/L or less, then 50% of the wetland sites were anoxic, 1 riverine site (in the boat road near Mossy Brake) was anoxic, and none of the lake sites were anoxic. Thus, most of the anoxia is occurring in the wetland areas of Caddo Lake. The riverine sites that had low oxygen concentrations also were characterized as having high aquatic vegetation coverage. The wetland sites that were anoxic had greater than 90% aquatic vegetation cover. These plants are mostly the floating type which block sunlight from entering the water column and thus decreases algae photosynthesis. The wetland sites also experience a high level of BOD from decaying vegetation which removes oxygen from the water column. It was somewhat surprising to find only medium levels of oxygen at the riverine sites. One reason for this finding might be due to low inflow into the lake. Also, many of the riverine sites had significant amounts of floating aquatic vegetation which limits oxygen production by photosynthesis and oxygen input from the atmosphere. Thirteen of the lake sites had oxygen percent saturations above 100%. The lake water was a dark green color indicating that an algal bloom was occurring. A pH value of greater than 8.0 in the lake also support this conclusion as high photosynthesis rates increase pH values.

### **pH**

The TCEQ standard for pH in segment 0402 (Big Cypress Bayou) is 5.5-8.0, while the standard for segment 0401 (Caddo Lake) is 5.5-9.0. The average pH during the study was 7.2, and pH ranged from a minimum of 5.8 to a maximum of 9.1. The mean pH for the three habitat types was riverine – 6.6, wetland – 6.2, and lake – 8.1. Thus, the wetland sites had the lowest pH values on average. Riverine sites and wetland sites had very consistent pH values; the riverine sites had pH values between 6.3 and 6.9 and the wetland sites had pH values between 5.8 and 6.7. The lake sites had the highest pH range of 6.5 to 9.1. The higher pH at the lake sites was due to high photosynthesis levels by algae.

There was one pH exceedance in the lake. A pH of 9.1 was measured at site along the north shore of the lake. There were no exceedances in the riverine habitat.

### ***E. coli***

A total of 18 *E. coli* samples were taken during from riverine areas where there was a high density of housing. *E. coli* results ranged from less than 1/100 mL to 29.5/100 mL. The mean *E. coli* count was 7.5/100 mL. None of the *E. coli* samples violated State of Texas criteria for Caddo Lake which is 126/100 mL.

### **Comparison of Results between the Sampling Event 1997 and 2012**

The following table shows a comparison of means for dissolved oxygen, pH, and bacteria from the two sampling years. During 1997 the fecal coliform test was run, while the *E. coli* test was run during 2012. While these two tests are not directly comparable, the *E. coli* bacteria are a subset of the fecal coliform family of bacteria so the two tests do have some comparability.

<b>Habitat type</b>	<b>Dissolved Oxygen (mg/L)</b>		<b>pH (S.U.)</b>		<b>Fecal coliform /<i>E. coli</i> (#/100 mL)</b>	
	1997	2012	1997	2012	1997	2012
Riverine	2.0	4.0	6.4	6.6	134	7.5
Wetland	0.8	1.7	6.3	6.2	574	
Lake	4.8	7.0	7.1	8.1	292	

In summary, the data indicate that the dissolved oxygen concentrations have slightly improved since 1997, the pH has remained about the same, and the bacteria levels have improved. Unfortunately, during the 1997 study aquatic vegetation coverage was not approximated so no comparison can be made with the current study results.