

Current Understanding of Caddo Lake and its Watershed

Figure 1 is a map showing the watershed of Caddo Lake, which consists of four major subwatersheds drained by Big Cypress Creek (Segment 0402), Little Cypress Creek Segment 0409), Black Cypress Bayou (Segment 4042A) and James Bayou (Segment 0407). The first three of these watersheds have USGS streamflow gaging stations located near Caddo Lake, but James Bayou, which enters Caddo Lake through a large embayment on the northern shore in Louisiana, does not. These four watersheds provide most of the inflows to the lake, but three smaller creeks (e.g., Kitchen Creek, Haggerty Creek, Harrison Bayou) also enter the main body of the lake directly. Big Cypress Creek alone accounts for 953 mi² (35.4%) of the 2,694 mi² Caddo Lake watershed, while the three gaged streams together drain 2092 mi², about 77.6% of Caddo Lake's drainage area. James Bayou and the minor drainages respectively account for 338 and 264 mi² (12.6% and 9.8%) of the total drainage area.

Figure 2 summarizes daily average streamflows during the period of record (1924-2004) in Big Cypress Creek at USGS Gauge 07346000 located near Ferrells Bridge Dam upstream of Jefferson, Texas. The relatively low, uniform flows in Big Cypress Creek following 1979 result from the closure of Ferrells Bridge Dam, creating Lake O' the Pines, which has a maximum controlled release rate of about 3,000 cfs. Although the range and variance of Big Cypress Creek discharge is diminished substantially by Lake O' the Pines, average discharge (total amount of water per year) is not significantly different (Students T, unequal variance, P<0.05) during the uncontrolled (before 1959) and controlled (after 1979) periods, averaging 687 and 666 cfs, respectively.

Streamflow in Black Cypress Bayou, which joins Big Cypress Creek downstream from the City of Jefferson, has been monitored near its mouth at USGS Gauge 07346045 since October, 1968. Little Cypress Creek enters Big Cypress Creek below the city of Jefferson and the confluence of Black Cypress Bayou. Streamflow has been monitored near its mouth at USGS Gage 07346070 since 1946.

Figure 3 shows the combined daily average inflow from all three gaged streams during their common periods of record (October, 1979 through September, 2004, (water year 1999 missing for Black and Little Cypress). During this period gaged inflows averaged 1,546 cfs (1,120,000 acre feet annually), but even with the flow regulation exerted by Lake O' the Pines, large seasonal inflow differences occur annually, resulting in a Pronounced winter-spring wet period and a summer low flow season. James Bayou is not gaged, nor are the minor drainages, but based on the relative sizes of their drainage basins, total average annual inflow to Caddo Lake is about 1,990 cfs (1,441,680 acre feet/year).

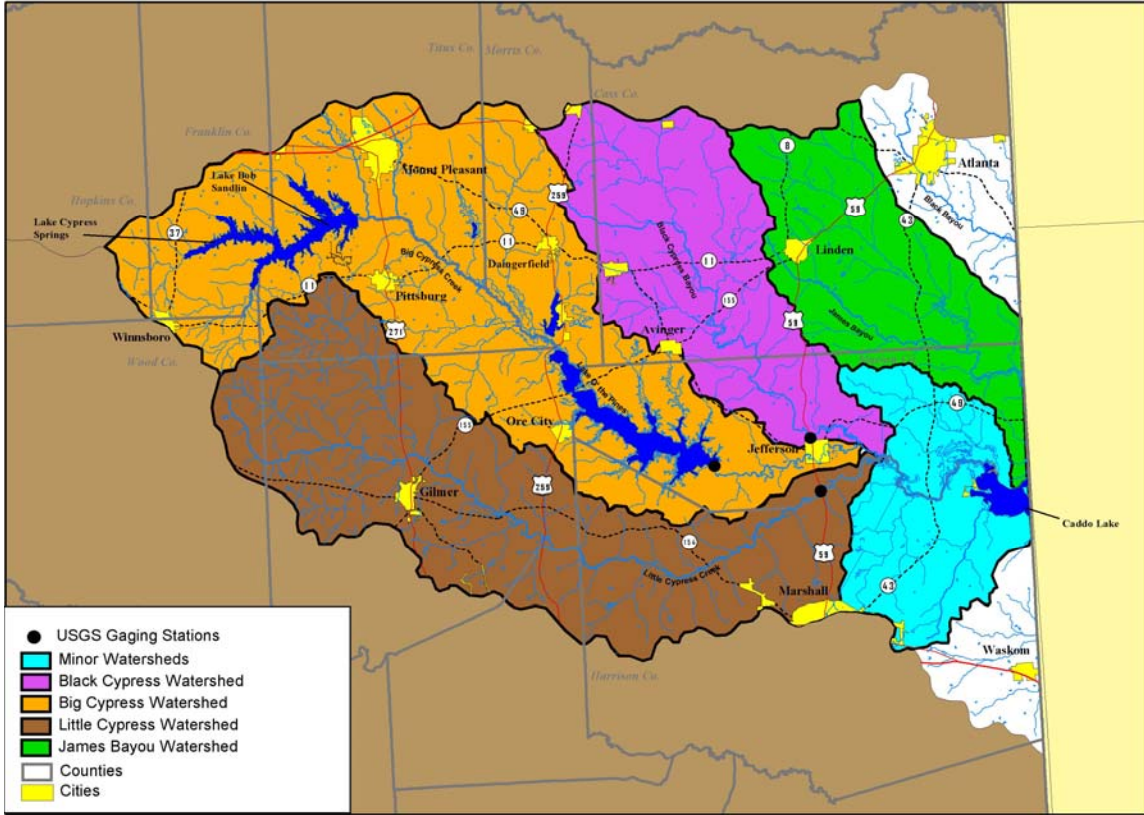
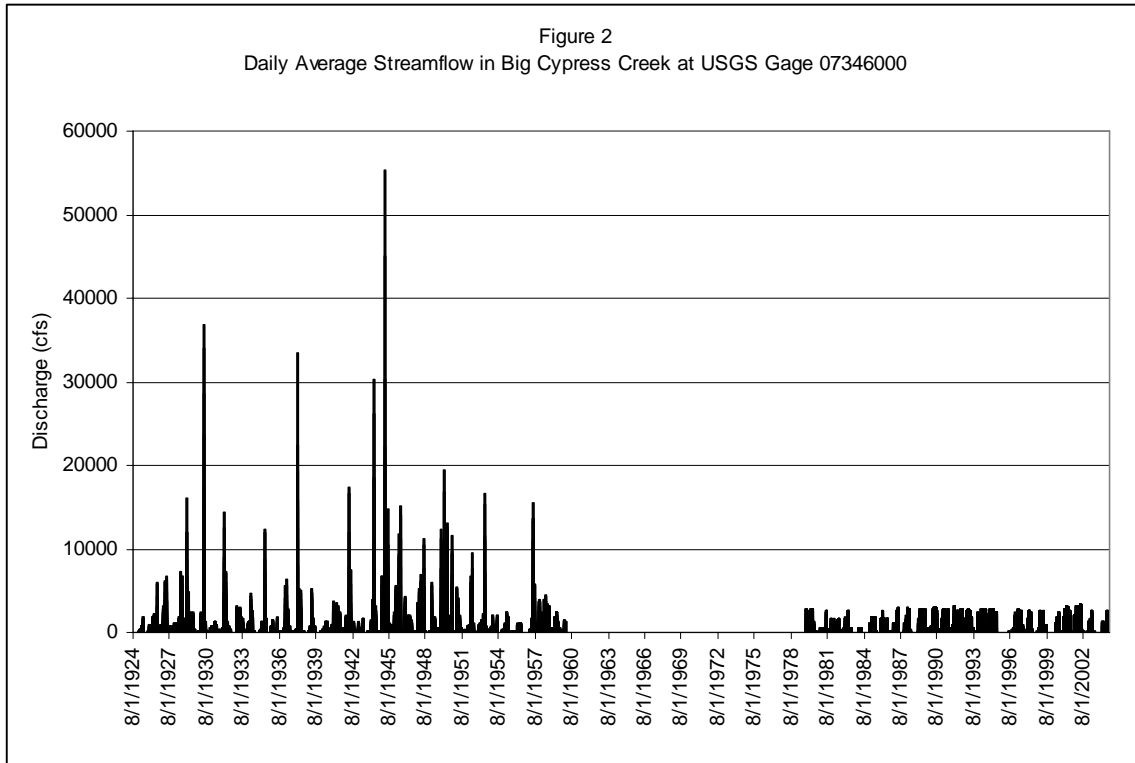
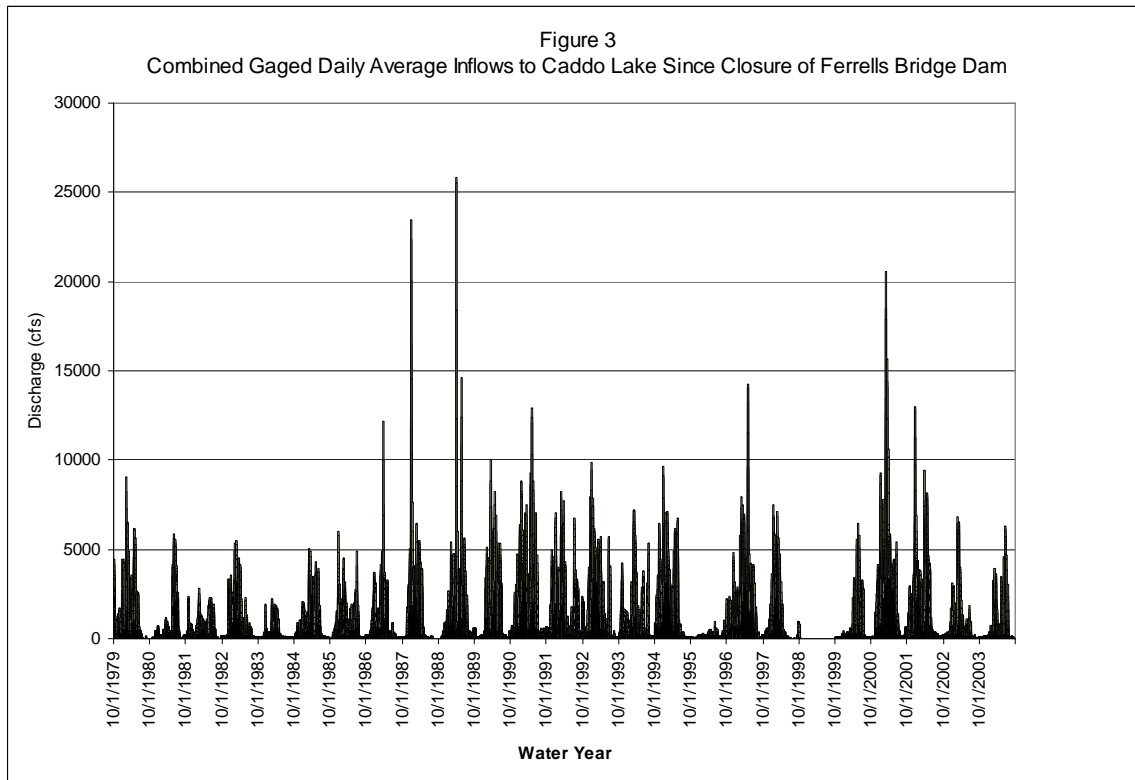


Figure 1
Caddo Lake Watersheds





In the reach of Big Cypress Creek from Lake O' the Pines to the backwaters of Caddo Lake, dissolved oxygen concentrations in grab samples exhibit a weak tendency, with respect to both average and minimum values, to decline in a downstream direction while ammonia and total phosphorus concentrations increase to relatively high levels. Total phosphorus concentrations, for example, exhibited five-year (1997-2002) average total phosphorus concentrations of 40 $\mu\text{gP/l}$ just below Ferrells Bridge Dam, 120 $\mu\text{g/l}$ near the Marshall intake, and 260 $\mu\text{gP/l}$ at the state park boat ramp. Average total phosphorus concentrations and other parameters at the lowermost stations on the Caddo Lake tributaries are summarized in Table 1. This table, modified from the Cypress Creek Basin Summary Report (August 2004), includes monitoring results from 1997-2002, but only a few samples are available for some streams, particularly the minor drainages.

Using an average combined inflow from Big Cypress Creek and its tributaries of 1500 cfs (1,086,694 acre feet/year) and an average total phosphorus concentration of 260 g/l , provides a loading estimate of about 350,000 kgTP/year from that source alone. James Bayou, with an estimated discharge of 250 cfs and an average total phosphorus concentration of 40 g/l contributes an annual phosphorus load of 8935 kgTP/year and the much more enriched minor drainages together contribute an estimated 34,848 kgTP/year to Caddo Lake (Table 1). The estimated total annual total phosphorus loading to Caddo Lake of 394,000 kgTP/year from this data should be considered preliminary and probably low because quarterly sampling (at best) is not sufficient to characterize the dissolved and suspended nutrient concentrations at the higher flow regimes when non-point source loads are most important.

Table 1

Water Quality of Streams Tributary to Caddo Lake, 1997-2002					
	n	Average	Maximum	Minimum	Screening Level
<i>10332-Little Cypress Creek at US 59</i>					
Alkalinity (mg/l)	28	15.37	35.00	5.00	NA
Total Suspended Solids (mg/l)	1	35.00	35.00	35.00	NA
Chloride (mg/l)	28	15.84	29.00	5.00	100
Sulfate (mg/l)	28	11.72	18.00	6.00	50
Total Suspended Solids (mg/l)	28	11.29	36.00	2.00	NA
Total Dissolved Solids (mg/l)	27	862.22	20300.00	50.00	300
Ammonia-N (mg/l)	27	0.01	0.31	0.05	0.17
TKN (mg/l)	27	0.65	1.18	0.42	NA
Nitrate/Nitrite-N (mg/l)	1	0.10	0.10	0.10	2.76
Total Phosphorus (mg/l)	27	0.14	0.87	0.01	0.8
Total Organic Carbon (mg/l)	26	10.31	18.00	5.00	NA
Chlorophyll-a (ug/l)	27	2.10	14.20	1.00	11.6
Pheophytin (ug/l)	27	4.53	38.80	1.00	NA
Fecal coliform (CFU/100ml)	12	281.67	500.00	23.00	Geometric Mean >200
<i>15022-Big Cypress Creek at State Park Boat Ramp</i>					
Alkalinity (mg/l)	4	11.25	16.00	6.00	NA
Total Suspended Solids (mg/l)	No Data	No Data	No Data	No Data	NA
Chloride (mg/l)	4	12.21	15.70	7.85	100
Sulfate (mg/l)	4	20.50	29.00	11.00	50
Total Suspended Solids (mg/l)	4	4.25	6.00	3.00	NA
Total Dissolved Solids (mg/l)	4	81.00	110.00	62.00	300
Ammonia-N (mg/l)	4	0.16	0.36	0.02	0.17
TKN (mg/l)	4	1.07	1.60	0.42	NA
Nitrate/Nitrite-N (mg/l)	No Data	No Data	No Data	No Data	2.76
Total Phosphorus (mg/l)	4	0.26	0.56	0.12	0.8
Total Organic Carbon (mg/l)	4	12.93	26.90	6.20	NA
Chlorophyll-a (ug/l)	4	7.93	16.00	2.00	11.6
Pheophytin (ug/l)	4	3.15	6.60	2.00	NA
Fecal coliform (CFU/100ml)	3	52.17	80.00	2.50	Geometric Mean >200

Table 1 Continued

<i>10245-Black Cypress Bayou at US59</i>					
	n	Average	Maximum	Minimum	Screening Level
Alkalinity (mg/l)	22	13	27	5	NA
Hardness (mg/l)	No Data	No Data	No Data	No Data	NA
Chloride (mg/l)	22	7	12	2	100
Sulfate (mg/l)	22	8	63	2	50
Total Suspended Solids (mg/l)	22	8	26	2	NA
Total Dissolved Solids (mg/l)	22	77	159	21	300
Ammonia-N (mg/l)	22	0.04	0.13	0.05	0.17
TKN (mg/l)	22	0.57	1.27	0.03	NA
Nitrate/Nitrite-N (mg/l)	No Data	No Data	No Data	No Data	2.76
Total Phosphorus (mg/l)	22	0.09	0.13	0.05	0.8
Total Organic Carbon (mg/l)	22	10	17	6	NA
Chlorophyll-a (ug/l)	22	1.7	4.8	1.0	11.6
Pheophytin (ug/l)	22	3.2	17.4	1.0	NA
Fecal coliform (CFU/100ml)	9	164	820	28	Geometric Mean >200
<i>10319-James Bayou Bridge</i>					
Alkalinity (mg/l)	4	12	17	5	NA
Hardness (mg/l)	4	21	26	10	NA
Chloride (mg/l)	4	10	11	8	80
Sulfate (mg/l)	4	6	13	1	50
Total Suspended Solids (mg/l)	4	11	21	2	NA
Total Dissolved Solids (mg/l)	4	51	72	36	300
Ammonia-N (mg/l)	4	0.13	0.23	0.08	0.17
TKN (mg/l)	4	0.58	0.78	0.30	NA
Nitrate/Nitrite-N (mg/l)	4	0.04	0.10	0.01	2.76
Total Phosphorus (mg/l)	4	0.04	0.09	0.02	0.8
Total Organic Carbon (mg/l)	3	9	13	6	NA
Chlorophyll-a (ug/l)	4.0	6.8	16.0	3.3	11.6
Pheophytin (ug/l)	4.0	3.5	5.5	2.0	NA
Fecal coliform (CFU/100ml)	4	32	58	16	Geometric Mean >200

Table 1 continued

<i>16253-Haggerty Creek at SH 134</i>					
Alkalinity (mg/l)	4	20.00	38.00	9.00	NA
Total Suspended Solids (mg/l)	No Data	No Data	No Data	No Data	NA
Chloride (mg/l)	4	10.04	14.10	6.89	50
Sulfate (mg/l)	4	12.32	21.90	2.46	50
Total Suspended Solids (mg/l)	4	29.50	50.00	18.00	NA
Total Dissolved Solids (mg/l)	4	77.00	90.00	66.00	200
Ammonia-N (mg/l)	4	0.10	0.19	0.03	0.106
TKN (mg/l)	4	0.81	1.90	0.18	NA
Nitrate/Nitrite-N (mg/l)	No Data	No Data	No Data	No Data	2.76
Total Phosphorus (mg/l)	4	0.20	0.46	0.05	0.8
Total Organic Carbon (mg/l)	4	9.88	16.20	5.50	NA
Chlorophyll-a (ug/l)	4	16.50	56.00	2.00	11.6
Pheophytin (ug/l)	4	2.00	2.00	2.00	NA
Fecal coliform (CFU/100ml)	No Data	No Data	No Data	No Data	Geometric Mean >200
<i>14998-Kitchen Creek at Marion CR 3616</i>					
Alkalinity (mg/l)	4	14.25	27.00	5.00	NA
Total Suspended Solids (mg/l)	No Data	No Data	No Data	No Data	NA
Chloride (mg/l)	4	12.91	17.80	8.47	50
Sulfate (mg/l)	4	2.40	4.60	1.00	50
Total Suspended Solids (mg/l)	4	9.00	14.00	6.00	NA
Total Dissolved Solids (mg/l)	4	77.00	88.00	52.00	200
Ammonia-N (mg/l)	4	0.21	0.49	0.07	0.106
TKN (mg/l)	4	1.03	1.90	0.27	NA
Nitrate/Nitrite-N (mg/l)	No Data	No Data	No Data	No Data	2.76
Total Phosphorus (mg/l)	4	0.20	0.34	0.10	0.8
Total Organic Carbon (mg/l)	4	14.95	29.20	7.10	NA
Chlorophyll-a (ug/l)	4	19.58	61.00	2.00	11.6
Pheophytin (ug/l)	4	2.20	2.80	2.00	NA
Fecal coliform (CFU/100ml)	No Data	No Data	No Data	No Data	Geometric Mean >200

Table 1 continued

<i>15507-Harrison Bayou at FM 1998</i>					
	n	Average	Maximum	Minimum	Screening Level
Alkalinity (mg/l)	4	66.25	84.00	54.00	NA
Total Suspended Solids (mg/l)	No Data	No Data	No Data	No Data	NA
Chloride (mg/l)	4	34.00	44.60	27.00	50
Sulfate (mg/l)	4	42.15	72.90	13.80	50
Total Suspended Solids (mg/l)	4	9.25	21.00	4.00	NA
Total Dissolved Solids (mg/l)	4	217.50	280.00	180.00	200
Ammonia-N (mg/l)	4	0.10	0.12	0.04	0.106
TKN (mg/l)	4	2.14	6.70	0.34	NA
Nitrate/Nitrite-N (mg/l)	No Data	No Data	No Data	No Data	2.76
Total Phosphorus (mg/l)	4	0.21	0.44	0.10	0.8
Total Organic Carbon (mg/l)	4	4.63	6.80	1.90	NA
Chlorophyll-a (ug/l)	5	7.80	20.00	2.00	11.6
Pheophytin (ug/l)	5	2.64	5.20	2.00	NA
Fecal coliform (CFU/100ml)	No Data	No Data	No Data	No Data	Geometric Mean >200

Assuming an annual inflow of 1,440,000 a lake area of 29,000 acres (117,363,000 m²), and a volume on the order of 160,000 acre feet (197,344,000 m³) at an average elevation of 169.5 feet msl, results in an annual turnover (annual inflow/lake volume), or lake volume replacement of about 9/year. Using Vollenweiders method gives a total areal loading rate of about 375 mg/m²/year. Areal loading refers to the annual amount of a constituent added to a unit area of lake surface. This is effectively about half of the areal loading estimated for Lake O' the Pines in that recently completed TMDL project. With respect to nutrient levels within Caddo Lake itself, average total phosphorus concentrations tend to be high, and variable, ranging from 50 to 330 µg/l, reflecting limited horizontal mixing in the lake. The stations exhibiting the highest total phosphorus concentrations are all located in embayments at the mouths of drainages; in ascending order: Stations 15021 (Big Cypress Creek), 15275 (Goose Prairie Arm), and 10286 (Harrison Bayou).