Somerville Reservoir Water Quality Study

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December 2004

Water Quality Technical Series
WQTS-2004-02

SUMMARY

Significant fish kills occurring in Somerville Reservoir in Central Texas led to Texas Parks and Wildlife Department (TPWD) staff interest in investigating in-lake water quality conditions possibly contributing to them. During the summer of 2001, TPWD's Water Quality Program collected 24-hour data at a location near the Birch Creek Unit of Lake Somerville State Park. Standard field parameters were measured, including dissolved oxygen, temperature, pH and conductivity. The data indicate temporal dissolved oxygen swings and elevated pH values at the monitoring point. A review of existing data is also presented.

BACKGROUND

Somerville Reservoir is controlled by the U.S. Army Corps of Engineers (USACE or Corps) and was constructed in 1967 for the purposes of flood control, conservation and other beneficial uses. It is an impoundment of the Yegua Creek watershed, part of the Brazos River Basin in Burleson, Washington, and Lee Counties about 48 kilometers (km) west of Bryan College-Station and 161 km from Houston. The lake encompasses 4,638 hectares and depths range from a maximum of about 9 meters (m) at the dam, to shallow areas less than 2 m. There has historically been oil and gas related activity in the watershed, with approximately 166 wells and 135 miles of pipeline on Corps and adjacent lands (USACE, 2004). Figure 1 illustrates the major areas of interest around the reservoir.

The reservoir and adjacent lands are used extensively for recreational purposes including hiking, fishing, boating, camping, hunting, biking, horseback riding and all-terrain vehicle operation. Public parks with various facilities are operated by the Corps, Texas Parks and Wildlife Department (TPWD), and the City of Somerville. There are also several private campgrounds and marinas. The state park complex operated by TPWD consists of four units: Birch Creek, Nails Creek, Lake Somerville Trailway and the Somerville Wildlife Management Area (TPWD, 2004, Parks Division). The lake is considered to have an excellent fishery for white bass (*Morone chrysops*), palmetto bass, also called hybrid striped bass (*Morone chrysops* ? X *M. saxatilis* ?), and channel catfish (*Ictalurus punctatus*). The largemouth bass (*Micropterus salmoides*), and crappie (*Pomoxis* sp.) fisheries are considered good (TPWD, 2004, Inland Fisheries Division). A variety of species have been collected by the Inland Fisheries Division during their survey activities. Stocking activities from the 1960's through the 1990's have included channel catfish, blue catfish (*Ictalurus furcatus*), white crappie (*Pomoxis annularis*), largemouth bass, black crappie (*Pomoxis nigromaculatus*), walleye (*Stizostedion vitreum*) and palmetto bass. Stocking activities in the 1990's have concentrated on palmetto bass with some Florida largemouth bass stocked (TPWD, 2004). Park personnel report bow hunting for gar (*Lepisosteus* sp.) as a popular activity in some areas of Yegua Creek that feed into the reservoir. The fish are typically shot from bridges but are not kept. This may explain some gar mortality observed either concurrently with or independently of other species mortality.

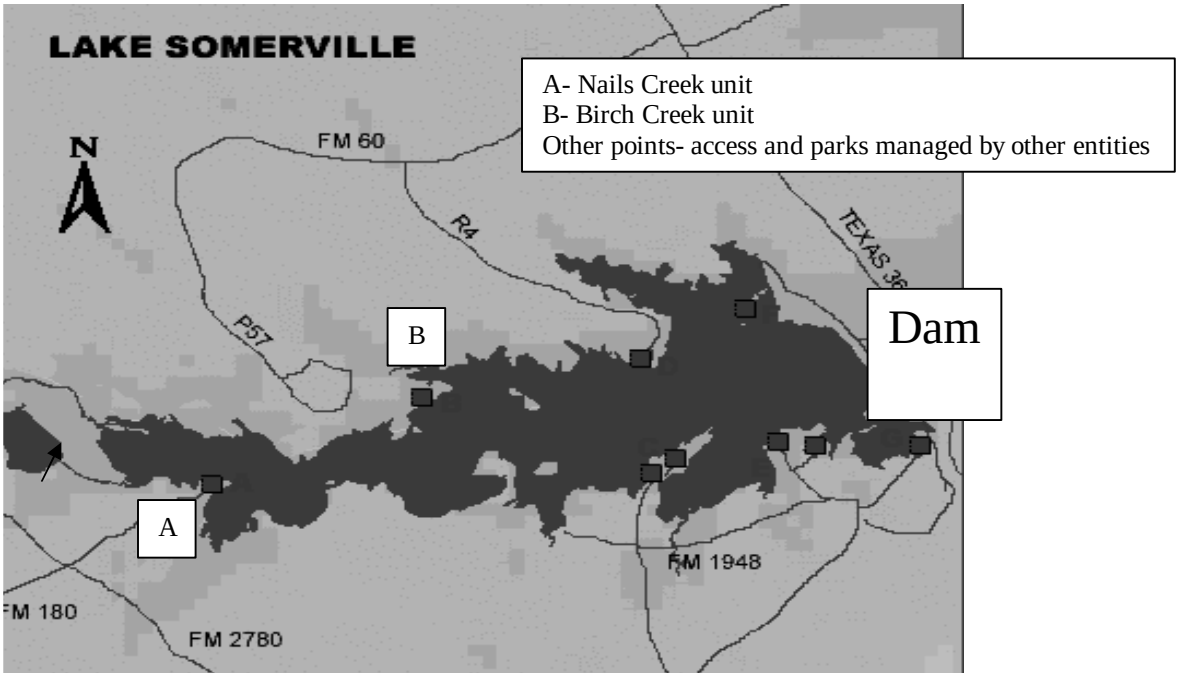

Figure 1. Map of Somerville Reservoir with various points of interest labeled. Source: Modified from Texas Parks and Wildlife Dept. web page (2001)

Somerville reservoir is included, for both low and high pH at the eastern end of the reservoir near the dam, in the *Draft 2004 State List of Impaired Water Bodies* (303(d) list) developed by the Texas Commission on Environmental Quality (TCEQ, 2004). Fish kills in recent years call into question whether the reservoir is actually supporting its designated high aquatic life use (TPWD Pollution Response Inventory Species Mortality database, 2001). These fish kills have centered around the Birch Creek Unit of the state park, although they may occur in other areas of the reservoir with prevailing winds blowing them to the park. Such events can have significant impact on recreational use and public perception of the desirability of recreation at these locations.

FISH KILL DATA

Texas Parks and Wildlife Department staff have investigated several fish kills in Somerville Reservoir. Queries of the Pollution Response Inventory and Species Mortality (PRISM) database yield reports of five fish kills in Lake Somerville or immediately adjacent contributing streams during the years from 1985 to the present. Many additional kills occurred in other parts of the watershed with the same TCEQ segment number (1212), primarily in Lake Alcoa. It is possible that some fish kills have gone unreported; for instance, one a couple of weeks old was discovered incidentally by TPWD staff in April of 2001 (no counts were possible but multiple species were involved) at the Birch Creek Unit of the state park. Tables 1 and 2 summarize the data available in PRISM on the recent fish kills.

Table 1. Summary of Somerville Reservoir Fish Kill, August 1998

Species	**Expanded count**
black crappie	53
channel catfish	1,849
freshwater drum (*Aplodinotus grunniens*)	12,148
gizzard shad (*Dorosoma cepedianum*)	4,170
bluegill (*Lepomis macrochirus*)	159
threadfin shad (*Dorosoma petenense*)	169,860
white bass	953
white crappie	1692
common carp (*Cyprinus carpio*)	1638
smallmouth buffalo (*Ictiobus bubalus*)	1429
Estimate of total number killed	**193,953**
Estimated value	**$ 47, 875.86**

Source: Texas Parks and Wildlife Department's Pollution Response Inventory and Species Mortality database.

Table 2. Summary of Somerville Reservoir Fish Kill, June 2000

Species common name	Expanded count
alligator gar (*Lepisosteus spatula*)	3,960
channel catfish	2,200
freshwater drum	13,557
gizzard shad	3,520
striped bass (*Morone saxatilis*)	1,100
threadfin shad	220
white bass	7,306
white crappie	220
common carp	440
smallmouth buffalo	220
Estimate of total number killed	**32,523**
Estimated value	**$ 128,259.64**

Source: Texas Parks and Wildlife Department's Pollution Response Inventory and Species Mortality database.

The kills affected multiple species and size classes of fish, and were attributed to dissolved oxygen (DO) problems in the reservoir. The results reported here represent an initial study to provide 24-hour dissolved oxygen data for the reservoir, previously unavailable in any of the State's water quality monitoring records. Oxygen analyses in surface waters of productive lakes undergoing rapid diurnal changes, when taken only at one time of day, show only one stage of a much more complex situation. Also, in reservoirs, the structure of DO distribution becomes highly variable horizontally, vertically and seasonally (Wetzel, 1983). This study collected data at only one depth and one location in the reservoir. More complicated monitoring schemes, requiring additional resources, would no doubt further illuminate the DO dynamics in this reservoir. It was also hoped that, had there been a kill event during the summer of 2001 (which did not occur), TPWD would have had a datasonde deployed during that time to allow for more accurate characterization of any water quality changes.

EXISTING WATER QUALITY DATA

Table 3 summarizes data available from various sources around the time of the major 1998 fish kill. The data support the TPWD staff conclusion that the fish kill was likely caused by a major storm moving through the area which caused mixing of low DO water throughout the water column. Eleven days before the kill, the Brazos River Authority (BRA) recorded a distinct DO gradient in the headwater near the state park. At the time of the kill, DO in the same area was low (< 4 mg/L) throughout the water column.

Table 3. Water quality conditions in Somerville Reservoir at the time of the 1998 fish kill

Date	Depth (m)	DO (mg/L)	Temp. (°C)	pH	Collector	Location
8/20/98	0.30	9.14	30.62	9.00	Brazos River Authority	Headwaters near state park
	4.70	1.93	29.75	7.30		
8/31/98	Surface	3.3	U	U	TPWD	Swim beach near state park
	1.5	2.9				
8/31/98	Surface	<4	U	U	TPWD	Offshore state park
	Bottom	<4				
8/31/98	Surface	5.1	U	U	TPWD	South of Snake Island
	1	3.9	U	U		
	4.5	3.9				

Source: Texas Parks and Wildlife Department's (TPWD) Pollution Response Inventory and Species Mortality (PRISM) database; Texas Commission on Environmental Quality's Regulatory Activities and Compliance System (TRACS) database

Table 4 summarizes data available from various sources around the time of the 2000 fish kill. This data does not present as clear a picture for support of DO problems causing the fish kill. A month before the kill (in early May), DO looked acceptable even near the bottom of the reservoir, and DO ranges were reported normal by TPWD personnel at the time of the kill. By early August, the DO profile often considered "typical" of summer months was observed, with marked DO decreases with increasing depth. This occurred even at very shallow depths, and in the absence of any dramatic thermal stratification. Roelke et al. (2004) report that Somerville reservoir generally has a well-mixed water column due to wind patterns and shallow depths, and we concur. However, DO levels may change rapidly and capturing data relevant to fish kills may sometimes be difficult.

Table 4. Water quality conditions in Somerville Reservoir at the time of the 2000 fish kill

Date	Depth (m)	DO (mg/L)	Temp (°C)	pH	Collector	Location
5/03/00	0.30	9.64	23.14	8.35	Brazos River Authority (BRA)	Headwaters near state park
	2	8.12	21.67	8.02		
6/03/00	Profiles	all reported	in normal	ranges	TPWD	Various points
8/10/00	0.30	10.93	30.14	9.05	BRA	Headwaters near state park
	2	2.71	27.94	7.37		

Source: Texas Parks and Wildlife Department's (TPWD) Pollution Response Inventory and Species Mortality (PRISM) database; Texas Commission on Environmental Quality Regulatory Activities and Compliance System (TRACS) database

There is significant historical water quality data on Somerville Reservoir. A variety of water quality parameters have been measured for decades by the TCEQ and its predecessor agencies and by the BRA. Although the BRA maintains routine sampling sites on Lake Somerville, the level of intensity of sampling has decreased from years past (Clean Rivers Program Partners, 2001). The higher level of sampling effort in the past may have been due to concerns with the oil and gas activity in the watershed. Much of the routine data (collected by the TCEQ and the BRA) is available through the TCEQ's Regulatory Activities and Compliance System (TRACS) database. The USACE and Texas A&M University researchers have historical as well as recent data pertaining to plankton succession in Lake Somerville(Roelke et al. 2004).

The Texas Water Quality Control Board (a predecessor agency to the TCEQ) conducted an intensive surface water monitoring survey of Lake Somerville which resulted in a report describing the area and assessing various water quality parameters (Petrick, 1974). In the "water quality problems" section of the report, it was concluded that the data collected during the survey indicated that the reservoir had good water quality, with the exception of some elevated coliform levels perhaps related to flow in tributaries and migratory waterfowl on the lake. Conclusions of the report include: no eutrophic conditions observed at any lake stations, pH values were acceptable, nutrient levels low, plankton characteristic of clean water, and no significant metals or pesticide values were observed. Although the reservoir has almost certainly changed since this report was published, caution must be exercised in making the general conclusion that the reservoir water quality was good then, and has deteriorated in the subsequent three decades. It should be noted that the report is based on short term, intensive data collected during one (non-critical) season and during daytime hours. Observations reported by field staff in the report indicate that the upper lake may have been excessively eutrophic at times, even in the 1970's less than 10 years after its impoundment.

In preparation for this study, 27 years worth of instantaneous field measurements (1973-2000) from TCEQ's TRACS database were evaluated. Particular attention was paid to DO and pH measurements taken in the headwaters near the state park. One hundred and forty-one grab DO measurements were found, but no 24- hour or long-term DO data was available. The minimum DO recorded was 1.0 mg/L at a depth of 2.8 m in December of 1999 and a maximum of 15 mg/L

at a depth of 0.30 m. The mean was 8.0 mg/L, with a 2.6 standard deviation and 33% coefficient of variation (CV). The 135 pH values collected ranged from 6.0 to 9.3, with a standard deviation of 0.6 and CV of 7.1%. No obvious trends in the field measurements are apparent upon examination of the records. Analyzing the data by calculating yearly averages and performing some formal trend analyses is a potentially worthwhile exercise that could yield useful information. Such analyses were beyond the scope of this study.

The TCEQ uses Carlson's Trophic State Index (TSI) values for ranking purposes in the State of Texas Reservoir and Lake Use Support Assessments. Secchi depth (SD), total phosphorous (TP) and /or chlorophyll a (chl a) averages are used to assign an index value to a reservoir, as shown in **Table 5**. These three variables are highly correlated and are considered estimators of algal biomass. For each halving of SD or doubling of TP, a change in 10 on the scale results. The relationship of chl a to the other variables is not linear, so a doubling of chl a results in about an increase of 7 on the TSI scale. The use of the TSI allows for comparison of trophic states of reservoirs across the state.

Table 5. Carlson's Trophic State Index

Trophic State Index	Secchi Disk (m)	Total phosphorous (mg/m^3)	Chlorophyll a (mg/m^3)
0	64	0.75	0.04
10	32	1.5	0.12
20	16	3	0.34
30	8	6	0.94
40	4	12	2.6
50	2	24	6.4
60	1	48	20
70	0.5	96	56
80	0.25	192	154
90	0.12	384	427
100	0.062	768	1,183

Source: 2002 Reservoir and Lake Use Support Assessment, TCEQ

For Somerville Reservoir, the following values are reported: TSI chl a 51.38 (mean chl a value= 17.39 mg/m3), TSI TP 66.27 (mean TP= 77.50 mg/m3), TSI SD 64.28 (mean SD= 0.78 m). The TCEQ ranks reservoirs by TSI chl. Somerville Reservoir ranked 81st out of 102 reservoirs assessed for Chl a, 77th in terms of TP, and 70th according to SD. Since the data for the assessment is from dam locations of reservoirs, it may not be representative of areas of the lake where heavier algal blooms are more likely to occur, such as the headwaters area where this study was conducted.

The Texas Surface Water Quality Standards (TSWQS) do not currently specify numeric values for nutrient parameters. **Table 6** was compiled to allow a comparison of nutrient values for Lake Somerville from various sources to screening criteria that do exist. The data indicate TP values reported for samples collected and analyzed by TCEQ personnel during the 1998 fish kill represent an exceedance of the TCEQ's secondary concern level, and chl a values seem to consistently exceed the secondary concern level. The Environmental Protection Agency's (EPA) guidance for lakes and reservoirs in the nutrient ecoregion that includes Somerville Reservoir are based on 25th percentile values and so tend to be even more stringent.

Table 6. Comparison of measurements of nutrient variables for Somerville Reservoir to screening criteria

Nutrient parameter or variable	TCEQ secondary concern screening level *(1)*	EPA range of level III subecoregions reference conditions *(2)*	Somerville Reservoir measurements
Total phosphorous (µg/L)	180	10- 62.5	200 ***(3),*** 62.33 ***(4)***
Total nitrogen (mg/L)	0.106 (NH_3-N) 0.32 (NO_2-N + NO_3-N)	0.30- 0.96	1.7 (Total Kjeldahl Nitrogen) ***(3),*** 0.6-1.0 ***(5)***
Chlorophyll a (µg/L)	19.2	1.87-12.95	19.9 ***(3)***, 19.52 ***(4),*** 6-19 ***(5)***
Secchi depth (m)	--	0.46- 2.04	0.73 ***(4)***, 0.3-0.75 ***(6),***

Sources:
(1) TCEQ Guidance for Assessing Surface and Finished Drinking Water Quality Data, 2002; screening level = 85th percentile
(2) Environmental Protection Agency (EPA) Ambient Water Quality Criteria Recommendations for Lakes and Reservoirs in Nutrient Ecoregion IX, 2000; reference values are based on 25th percentile only
(3) TCEQ Laboratory Analysis of sample collected by TCEQ personnel during 8/31/98 fish kill
(4)1998 State of Texas Reservoir Water Quality Assessment, TCEQ
(5)Intensive Surface Water Monitoring Survey for Segment 1212, 1974, Petrick, TCEQ
(6)Data collected by TCEQ and Texas Parks and Wildlife Department (TPWD) field personnel during summer 2001

MATERIALS AND METHODS

This study was conducted during the summer of 2001. Fieldwork was executed primarily by the TPWD Water Quality (WQ) Program, at times coordinating with TPWD Inland Kills and Spills Program (IKASP), TPWD Law Enforcement (LE), and with TCEQ Waco regional staff. The work was conducted in conjuction, when possible, with TCEQ Waco regional office routine monitoring of the reservoir. During some deployments, TCEQ staff deployed a datasonde at the dam and this data will be available in their TRACS database. TCEQ Surface Water Quality Monitoring procedures (TCEQ, 1999) were followed.

A Hydrolab Datasonde 3 was deployed at a monitoring location just off the point at the Birch Creek Unit of Lake Somerville State Park several times during the summer. **Figure 2** shows the monitoring location with GPS coordinates. Routine maintenance was performed on the datasonde and it was calibrated prior to, as well as following, each deployment for DO, pH and conductivity. Permission was obtained from the USACE to attach the datasonde to a buoy maintained by the Corps. The datasonde was deployed for lengths of time ranging from 24 hours to 7 days. Standard field parameters (temperature, D.O., pH, conductivity) were recorded every 30 minutes.

Figure 2. Digital Orthophoto Quarter Quad (DOQQ) image of Somerville Reservoir, showing sampling station for this study

Since the DO criteria specified in the TSWQS applies to the mixed surface layer of an impoundment when thermal stratification exists, TCEQ Surface Water Quality Monitoring protocols call for 24-hour measurements to be taken in the middle of the mixed surface layer. Depth of measurement was in reality dictated by the flotation of the buoy and the length of the datasonde. The sonde was attached to the bottom of the buoy as close to the surface as was possible, with the result that the probes were taking measurements at approximately a 1.5-m depth. At this shallow location, where the bottom was approximately 3 m, vertical profile measurements indicated that the entire water column was fairly well mixed much of the time as defined by temperature change. Vertical profile measurements were taken with other quality-assured multiprobe instruments when available, including a Hydrolab minisonde and a YSI 650 XLM.

RESULTS

Vertical profile measurements are presented in **Tables 7 and 8** and DO measurements from the deployed datasonde in **Figure 3** for the May deployment.

Table 7. Vertical profile from Somerville Reservoir off point of Birch Creek Unit 05/29/01 1600 hrs.

Depth (m)	Temperature (°C)	pH	DO (mg/L)	Conductivity (µmhos/cm)
0.3	27.0	8.49	10.43	443
1	27.8	8.50	10.08	445
2	27.8	8.50	9.83	449
2.7 (0.3 m off bottom)	27.8	8.50	9.60	449

Source: TCEQ Waco regional office staff. Secchi depth 0.55 m.

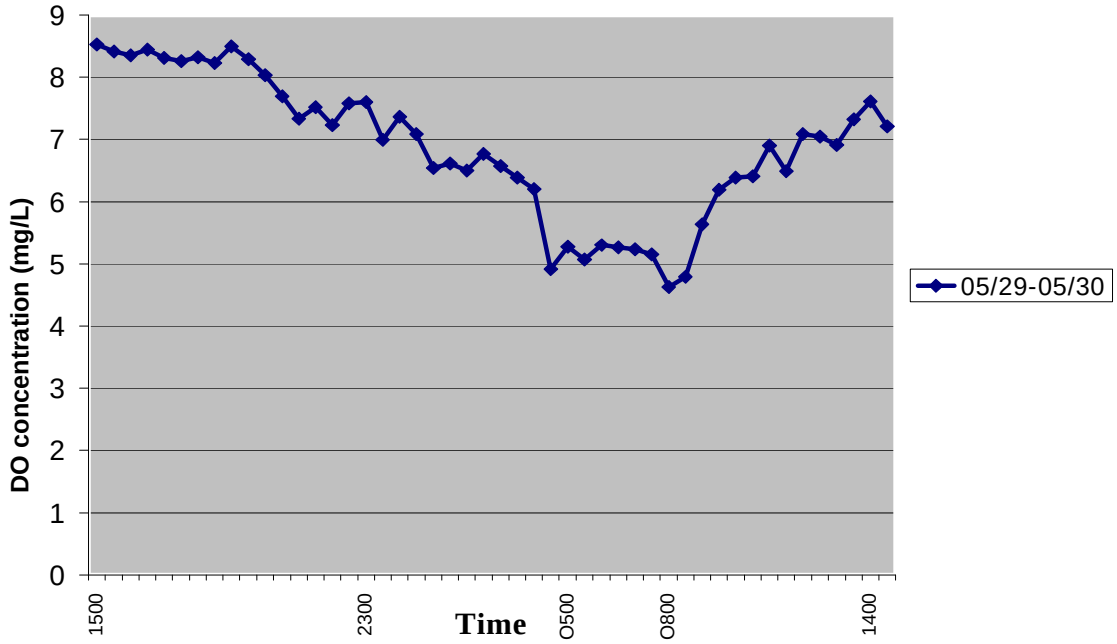

Figure 3. Dissolved oxygen (DO) data collected off the point of the Birch Creek Unit in Somerville Reservoir during May 2001.

Table 8. Vertical profile from Somerville Reservoir off point of Birch Creek Unit 05/30/01 1417 hrs.

Depth (m)	Temperature (°C)	pH	DO (mg/L)	Conductivity (µmhos/cm)
0.3	27.8	8.14	8.45	457
1	27.89	8.17	8.22	460
2	27.8	8.17	8.11	459
2.7 (0.3 m off bottom)	27.8	8.16	8.0	459

Note: Secchi depth 0.5 m.

Vertical profile measurements are presented in **Tables 9 and 10** and DO measurements from the deployed datasonde in **Figure 4** for the June 26 to July 3 deployment.

Table 9. Vertical profile from Somerville Reservoir off point of Birch Creek Unit 06/26/01 1201 hrs

Depth (m)	Temperature (°C)	pH	DO (mg/L)	Conductivity (µmhos/cm)
0.2	31.57	7.46	10.46	422
1	31.36	7.9	10.18	420
2	30.10	7.9	7.72	426
2.8	29.90	7.67	3.87	435

Notes: Bottom at a little over 3 m. @ 2.5 m, D.O. = 6.3 mg/L then dropped to 4 mg/L at 2.7 m.

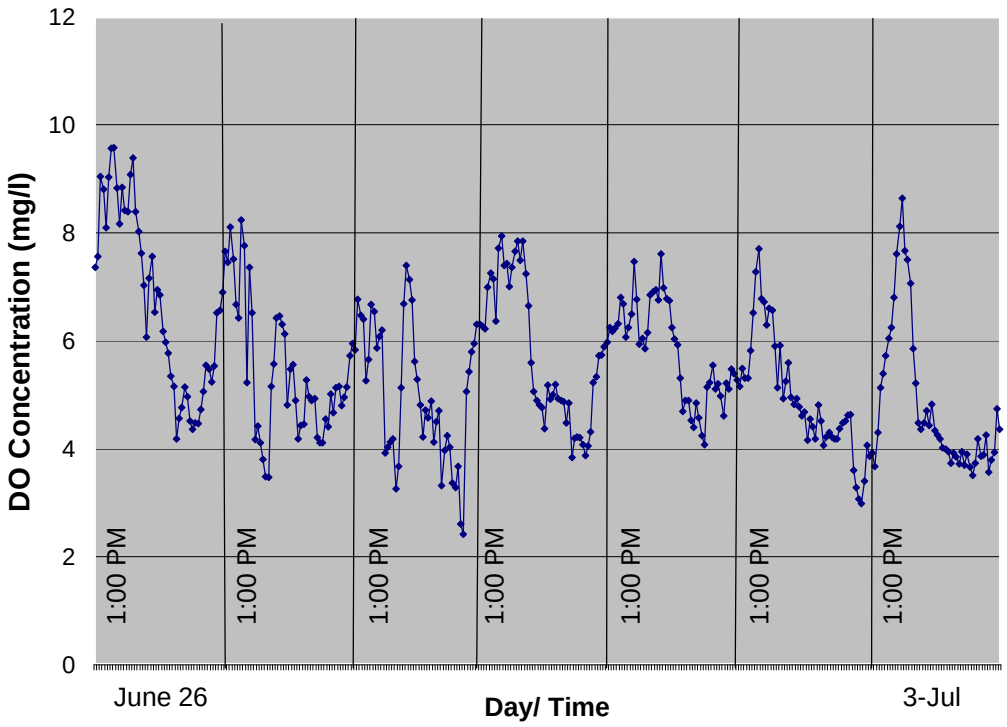

Figure 4. Dissolved oxygen (DO) data collected off the point of the Birch Creek Unit in Somerville Reservoir during June and July 2001.

Table 10. Vertical profile from Somerville Reservoir off point of Birch Creek Unit 07/03/01 1156 hrs

Depth (m)	Temperature (°C)	pH	DO (mg/L)	Conductivity (µmhos/cm)
0.3	30.47	8.06	10.81	428
1	29.68	8.18	10.06	432
2	29.09	7.91	7.16	452
2.5	29.07	7.81	6.26	452

Vertical profile measurements are presented in **Tables 11 and 12** and DO measurements from the deployed datasonde in **Figure 5** for the July 31 to August 2 deployment.

Table 11. Vertical profile from Somerville Reservoir off point of Birch Creek Unit 07/31/01 1150 hrs

Depth (m)	Temperature (°C)	pH	DO (mg/L)	Conductivity (µmhos/cm)
0.2	30.82	6.70	7.96	451
1	30.79	7.10	7.86	452
2	30.79	7.26	7.81	452
2.5	30.76	7.41	7.27	453

Figure 5. Dissolved oxygen (DO) data collected off the point of the Birch Creek Unit in Somerville Reservoir during July and August 2001.

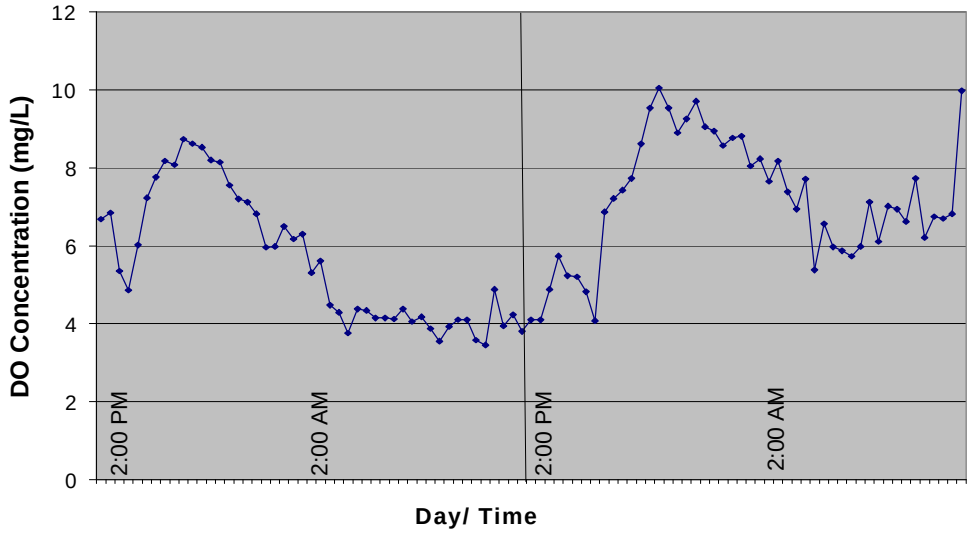

Table 12. Vertical profile from Somerville Reservoir off point of Birch Creek Unit 08/02/01 1320 hrs

Depth (m)	Temperature (°C)	pH	DO (mg/L)	Conductivity (µmhos/cm)
0.3	32.79	9.40	11.62	432
1	32.65	9.33	10.83	435
2	31.35	8.43	6.48	460
2.7	31.20	8.45	6.23	459

Source: Texas Natural Resource Conservation Commission (TNRCC) Waco regional office staff. Bottom at 3 m. Secchi depth 0.37 m.

Vertical profile measurements are presented in **Table 13** and DO measurements from the deployed datasonde in **Figure 6** for the August 20 through August 23 deployment.

Table 13. Vertical profile from Somerville Reservoir off point of Birch Creek Unit 08/20/01 1609 hrs

Depth (m)	Temperature (°C)	pH	DO (mg/L)	Conductivity (µmhos/cm)
0.3	31.56	7.37	11.65	468
1	31.4	7.72	11.07	469
2	30.43	7.68	6.9	481
2.5	29.63	7.47	2.94	481

Note: bottom at 2.8 m.

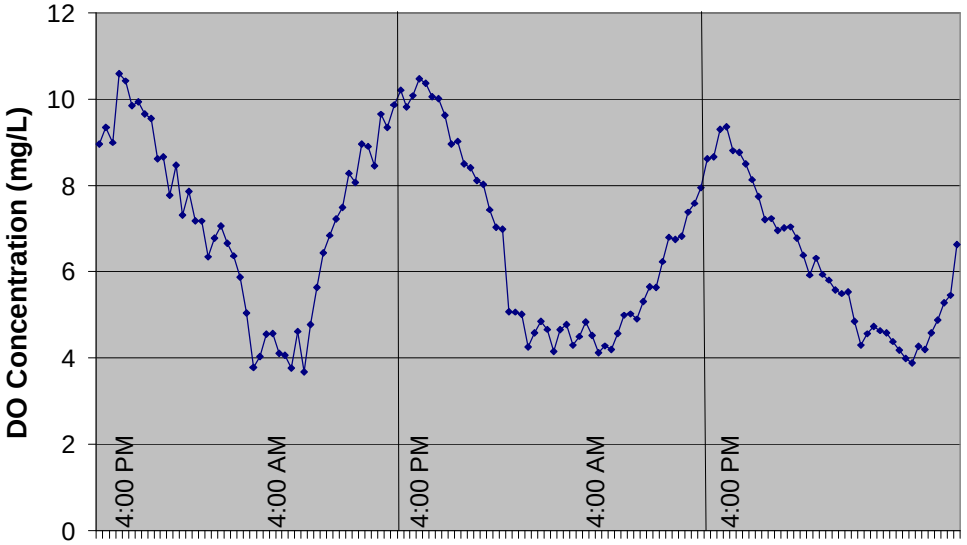

Figure 6. Dissolved oxygen (DO) data collected off the point of the Birch Creek Unit in Somerville Reservoir during August 2001.

Vertical profile measurements are presented in **Table 14** and DO data from the deployed datasonde in **Figure 7** for the September 4 through September 7 deployment.

Table 14. Vertical profile from Somerville Reservoir off point of Birch Creek Unit 09/04/01 1150 hrs

Depth (m)	Temperature (°C)	pH	DO (mg/L)	Conductivity (µmhos/cm)
0.3	28.42	7.31	9.39	442
1	28.1	7.39	7.15	444
2	27.95	7.41	6.25	444
2.5	27.96	7.39	5.31	446

Note: Bottom at 2.8 m

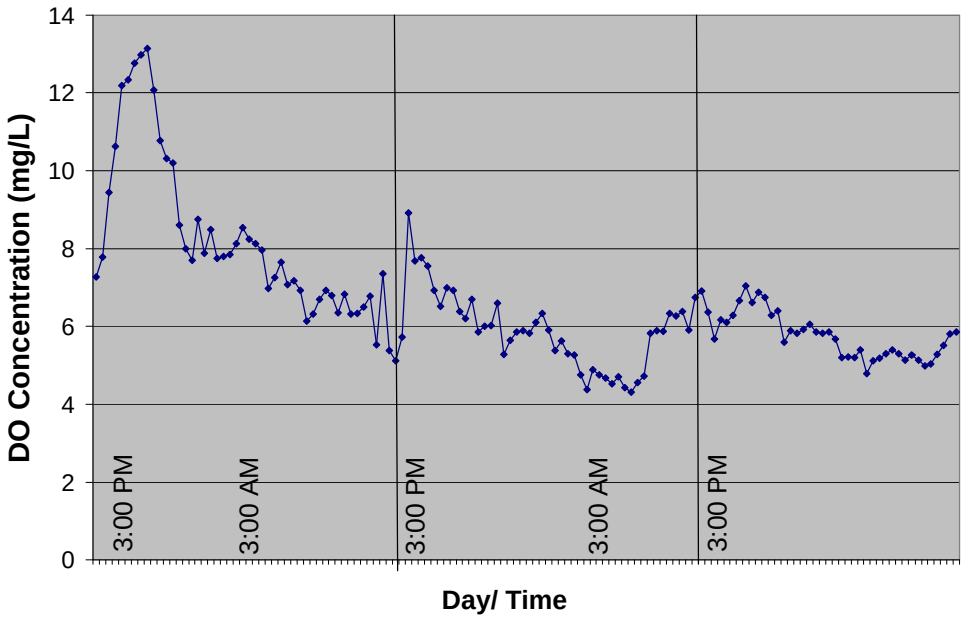

Figure 7. Dissolved oxygen (DO) data collected off the point of the Birch Creek Unit in Somerville Reservoir during September 2001.

Table 15 is a summary of all the data collected with the deployed datasonde over the course of the study, broken down into 24-hour units (in most cases 24-hours with 48 measurements; some days may have had fewer measurements taken).

Table 15. Summary of Somerville Reservoir unattended monitoring data collected at Birch Creek Unit sampling station 2001

DATE	MIN DO (mg/L)	MAX DO (mg/L)	Mean DO (mg/L)	pH RANGE
5/29- 5/30	4.63	8.52	6.88	7.81-8.85
6/26-6/27	4.18	9.57	6.74	8.83-9.47
6/27-6/28	3.47	8.24	5.46	8.21-9.26
6/28- 6/29	2.42	7.4	5.02	7.56- 9.1
6/29-6/30	3.84	7.94	5.76	8.04-9.05
6/30- 7/01	4.08	7.61	5.75	8.22- 9.05
7/01- 7/02	2.99	7.7	4.90	7.76-8.79
7/02- 7/03	3.51	8.64	4.84	7.88-9.21
7/31- 8/01	3.45	8.73	5.57	7.9- 9.09
8/01- 8/02	4.08	10.05	7.25	8.04- 9.44
8/20- 8/21	3.68	10.59	7.33	7.84- 9.26
8/21- 8/22	4.12	10.47	6.56	7.88- 9.28
8/22- 8/23	3.88	9.36	6.10	7.91- 9.02
09/04- 05	5.11	13.14	8.21	8.72- 9.57
09/05- 06	4.31	8.91	5.92	8.27- 9.05
09/06- 07	4.79	7.04	5.75	8.39- 8.79

Conductivity varied little throughout the course of the study, generally measuring in the mid- 400 µmhos/cm range.

DISCUSSION

The TSWQS designate a high aquatic life use for Segment 1212, Lake Somerville. Site specific criteria related to protection of this aquatic life designation include a pH range of 6.5 to 9.0, a minimum 24-hour mean DO level of 5 mg/L and a daily minimum DO of 3.0 mg/L.

Past State of Texas Water Quality Inventories (305(b) Assessment) have identified a use impairment for the eastern end of the reservoir near the dam, which only partially supports its general use due to low and high pH (TCEQ, 2002). A general use concern due to low and high pH has been listed for the western end of the reservoir near the upper segment boundary, as well. The reservoir is listed as fully supporting aquatic life, contact recreation and public water supply uses. No 24-hour DO measurements were available for the assessment, and there was no concern listed for overall nutrient enrichment.

The draft 2002 State of Texas List of Impaired Waters (303(d) list) listed Lake Somerville for pH problems and ranked it medium for Total Maximum Daily Load (TMDL) development. The Methodology for Developing the Texas List of Impaired Water Bodies says a water body should be ranked medium when additional data is needed to verify the extent and/or severity of the

problem, and when general use is not supported due to exceedances of a numeric criteria (in this case, pH).

The data collected by TPWD's Water Quality program during the summer of 2001 illustrate swings in DO both temporally and vertically and support the pH concern. These phenomena are likely related. When photosynthesis is at a peak, oxygen is being produced so that the water may become super-saturated. Photosynthetic utilization of CO_2 tends to reduce CO_2 content and to increase pH. Historically, the entities that monitor the reservoir (TCEQ and BRA) have arrived at the lake sometime in the middle of the day. Thus, the instantaneous DO levels they measure tend to meet the criteria although the pHs may be elevated. Low pH values have apparently been recorded as well. Decreases in pH can occur vertically and temporally due to respiratory generation of CO_2 throughout the water column and sediments, and the combination of decompositional processes (Wetzel, 1983).

The data collected by TPWD indicate violations of the TSWQS for Somerville Reservoir. Additional data must be collected to meet requirements for regulatory assessment of DO/ aquatic life use. The data requirements for assessment in the Water Quality Inventory are at least ten 24-hour monitoring events at a site within a five-year period. The events must occur during the index period (March 15 – Oct. 15) and at least ½ to 2/3 must be during the critical period (July 1-Sept. 30). A period of one month must separate the events. The TCEQ Waco regional office began 24-hour data collection events for Somerville Reservoir beginning with the index period of 2002, and concluded the study in 2004. Ten 24-hour monitoring events were conducted at each of three sites. The data is available in TCEQ's TRACS database and a summary report is pending.

Work should continue to identify other potential causes of fish kills (such as cyanotoxins, sediment or water toxicity, contaminants or disease) in Somerville Reservoir. Identifying water quality problems does not preclude the possibility of other causes or contributors to the kills.

Finally, integrating data from multiple sources, Somerville Reservoir appears to meet the regulatory definition of a eutrophic system, particularly in the upper end where the fish kills have been centered. Eutrophication in the strictest sense is a natural process which occurs in all lakes; however, Somerville Reservoir is a young impounded system, and the conditions in the reservoir may indicate cultural eutrophication. Assessing natural or anthropogenic sources of nutrients and eutrophication was beyond the scope of this study, but land use and land cover studies of the watershed will no doubt be a critical part of the TMDL process. Discharges into the system include the City of Rockdale's municipal wastewater treatment plant and ALCOA's Rockdale plant. A public water supply intake for the City of Brenham is located near the dam, and so changes in water quality which can result in changes in the phytoplankton community may have implications for drinking water treatment as well as for aquatic life use.

ACKNOWLEDGEMENTS

The Water Quality Program wishes to thank all who assisted in field work and document preparation. Thanks to the staff of the Lake Somerville State Park. Joan Glass and Justin Swanson of TPWD's IKASP assisted with field work, as did Game Warden Sophia Hiatt. Thanks to Wilson Snyder of TCEQ's Waco office for working with us closely on this project, and for taking up the burden of additional 24-hour monitoring on the reservoir. Thanks to TPWD's Rivers Studies program for the loan of equipment, and thanks to Gordon Linam for editorial comments on the paper. Thanks additionally to Wilson Snyder for helpful comments to improve the manuscript.

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