Grand Lake

Grand Lake was sampled for four quarters, from October 2000 through July 2001. Water quality samples were collected at 13 sites to represent the riverine, transition, and lacustrine zones and arms of the reservoir. Samples were collected from the lake surface at all sites and 0.5 meters from the lake bottom at site 1, the dam. The lake-wide annual turbidity value was 45 NTU (Plate 17), true color was 41 units, and secchi disk depth was 62 centimeters in 2001. Based on these three parameters, Grand Lake had poor to average water clarity in 2001. In the summer of 1998, based on samples from the 13 designated sites, the water clarity was good, much better than the annual assessment for 2001. The assessment of clarity for 2001 is most likely a more accurate depiction of lake conditions as this was based on four sampling events throughout the year (n=52). The trophic state index, using Carlson's TSI (chlorophyll-a), was calculated using values collected at all sites for four quarters (n=51; one outlier chlorophyll-a value was not used in the TSI calculation). The average TSI was 59 (Plate 17), classifying the lake as eutrophic, indicative of high levels of productivity and nutrient rich conditions. This value is slightly lower than the one calculated in the summer of 1998 (TSI=61), although it is more accurate of trophic conditions throughout the year. Chlorophyll-a values were variable at this reservoir, between sites and seasons, and only one sampling event would not be adequate or representative. The TSI values ranged from oligotrophic (8%) to hypereutrophic (31%), although most values were in the eutrophic category (49%) (see Figure 40). As expected, the lowest TSI average was at the lower end of the lake (sites 1, 2, and 3) as well as site 10, and the most productive sites were in the tributary arms, Honey Creek (site 6) and Spring/Neosho River arm (sites 13 and 12). Turbidity values were also extremely variable between sites and seasonally. Twenty-three of the 52 turbidity values exceeded the OWQS of 25 NTU constituting a listing as "not supporting" the FWP beneficial use (see Figure 41a). According to USAP (OAC 785:46-15-5), a beneficial use is considered not supported if ≥25% of the samples exceed the screening level prescribed in OWQS (25 NTU for turbidity). In the fall and summer very few samples exceeded the criteria; however in the spring, 12 of the 13 sites were above 25 NTU. In the winter, high turbidity values (above 150 NTU) were recorded at sites 9, 12 and 13, increasing the annual lake-wide turbidity average from 23 NTU to 45 NTU. Regardless of the extraordinary values in the winter, Grand Lake would still be considered "not supporting" the FWP beneficial use based on high turbidity. Seasonal true color values are also displayed in Figure 41b.

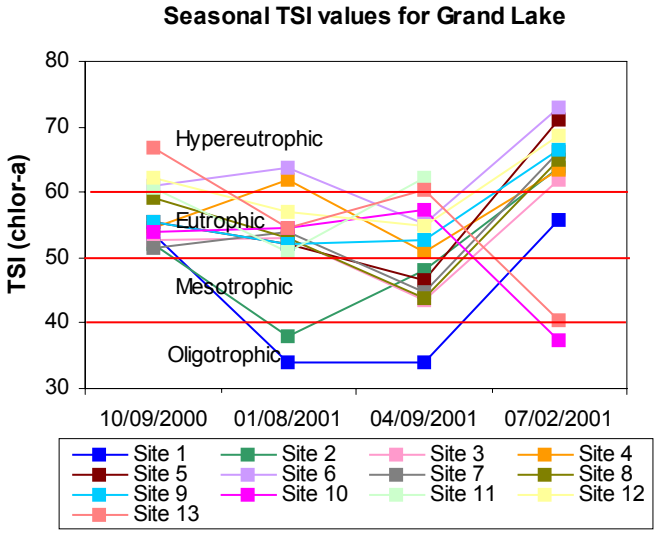


Figure 40. TSI values for Grand Lake.

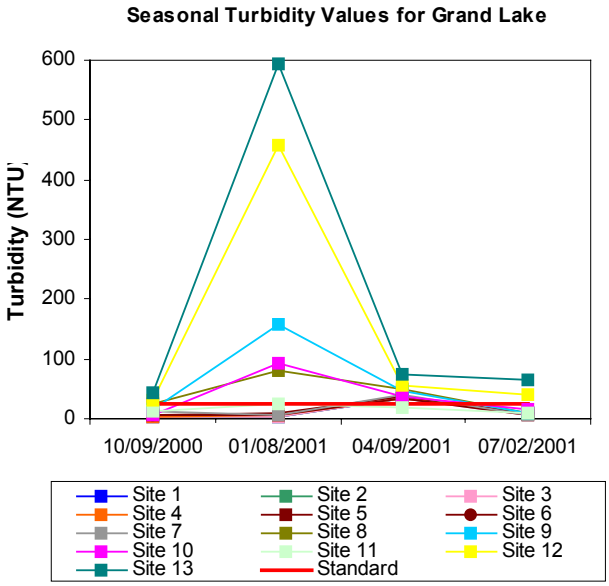
Only 3 of the 52 true color values exceeded the numeric criteria of 70 units, therefore, the Aesthetics beneficial use is considered fully supported. For most sites, true color was highest in the spring and lowest in the winter, which is the common pattern for most lakes.

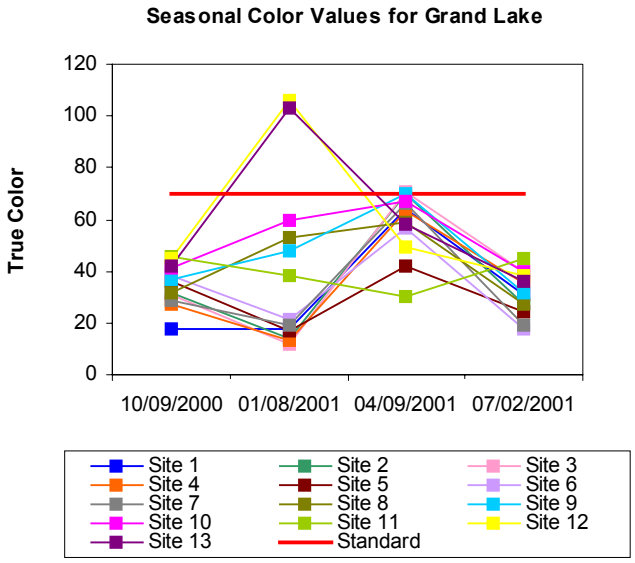
Vertical profiles for dissolved oxygen, pH, temperature, specific conductance, oxidation-reduction potential, and salinity were recorded at all 13 sites during the study period. Winter profiles were recorded on two separate days during the sampling quarter as the upper end of the lake was frozen during the first sampling attempt. Salinity ranged from 0.06 at several sites in the summer to 0.2 parts per thousand (ppt) at site 13 in the spring, within the expected range of values reported for Oklahoma lakes. Specific conductivity ranged from 0.140mS/cm in the summer to 0.393mS/cm in the winter, indicating low concentrations of electrical conducting compounds (salts) were present in the water column, complimenting the low salinity values. In general, pH values were neutral to alkaline, ranging from 6.9 in the summer to 8.8 units in the winter. Oxidation-reduction potentials ranged from 153 mV near the sediment-water interface in the fall to 460mV in the spring, indicating that reducing conditions were not present in the water column during any season. In fact, most ORP values throughout the year were above 260 mV. The lake was not thermally stratified in the fall with D.O. concentrations above 4 mg/L throughout the water column except at site 3 at the lake bottom (see Figure 41c). Stratification was not present in the winter and D.O. values were above 8 mg/L throughout the water column, at all sites (see Figure 41d). In the spring, the lake was only stratified at sites 4 (between 10 and 11 meters), 5 (between 6 and 7 meters) and 6 (between 4 and 5 meters). Dissolved oxygen concentrations were above 5 mg/L throughout the lake except at site 12, where hypolimnetic anoxia was present. In the summer, the lake was not thermally stratified at most sites although a decreasing trend in temperature from the surface to the bottom was evident (see Figure 41f). Anoxic conditions were present at most sites ranging from 10% to over 60% of the water column. Anoxic conditions were not present at sites 8, 9, 12, and 13 as all of these sites are shallower than the others, all less than 10 meters deep. If dissolved oxygen values are less than 2 mg/L for greater than 70% of the lake volume, the FWP beneficial use is deemed not supported (USAP 785:46-15-5). If D.O. concentration is less than 2 mg/L for 50 to 70% of the water column, the FWP beneficial use is deemed partially supported. According to USAP, the FWP beneficial use is partially supported at Grand Lake.

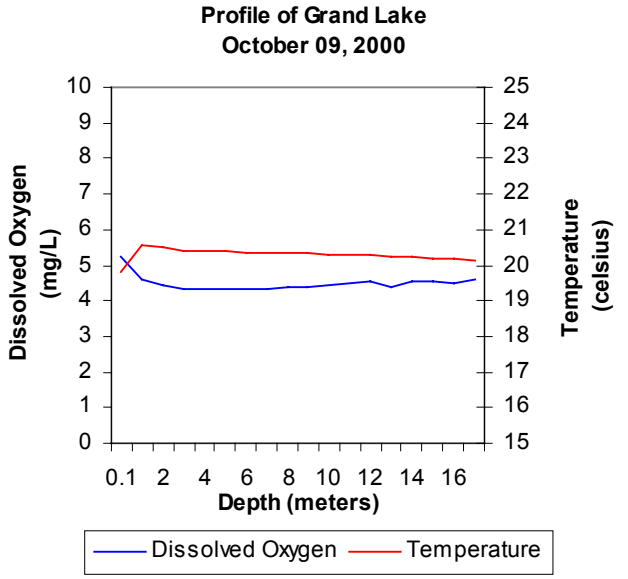
Collected water samples were analyzed for nutrients, including total nitrogen and total phosphorus, although there are currently no numerical OWQS for these parameters. The lake-wide total nitrogen (TN) average for sample year 2001 was 1.46 mg/L at the surface and 1.48 mg/L on the lake bottom. The surface TN average at Grand Lake was the second highest for sample year 2001. The TN at the surface ranged from 0.30 mg/L to 3.81 mg/L and from 0.42 to 1.49 mg/L on the lake bottom. The highest surface TN value and the lowest were in the winter quarter. The lake-wide total phosphorus (TP) average for sample year 2001 was 0.135 mg/L on the surface and 0.159 mg/L on the lake bottom. The TP ranged from 0.042 mg/L to 0.411 mg/L and from 0.066 to 0.259 mg/L on the lake bottom. The highest surface TP value was reported in the winter and the lowest was in the summer. The winter surface TP value was the highest value reported for this sample year. The nitrogen to phosphorus ratio (TN:TP) was 11:1 for sample year 2001. This value is greater than 7:1, characterizing the lake as phosphorus-limited (Wetzel, 1983).

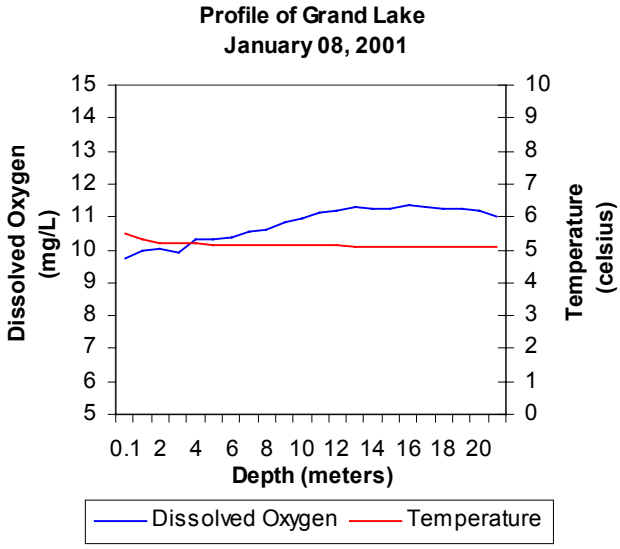
In summary, Grand Lake was classified as eutrophic in 2001, indicating high primary productivity and nutrient rich conditions. The annual surface TN average at Grand Lake was the highest for sample year 2001. The surface TP value (0.411 mg/L) reported in the winter was the highest TP reported in 2001. Because 44% of the turbidity values were above the OWQS of 25 NTU, Grand Lake is not supporting the FWP beneficial use (USAP 785:46). Based on anoxic

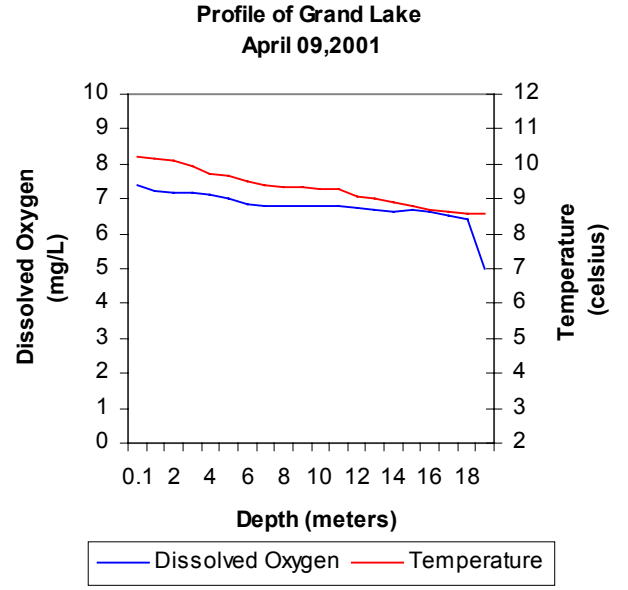
conditions in the summer, the FWP beneficial use is only partially supported at Grand Lake. Grand Lake, the third largest Oklahoma reservoir based on surface area and volume, is quite variable from one end of the lake to the other and seasonally, based on the tributary influence for each part of the lake. It is truly difficult to quantify such a large lake without splitting up the lake based on tributaries, although defining this split would also be a difficult task. The information presented in this report should be seen as an overview and if more detailed information is needed, please contact the OWRB to obtain data records. Grand Lake was scheduled to be sampled by the ODEQ for metals and toxic compounds in 2001 although data is not available at this time. A confirmed fish kill at the stateline on Cave Springs Branch was reported in December 2000 possibly due to low D.O. values reported at the site. The Grand River Dam Authority (GRDA) constructed Grand Lake primarily for flood control and hydroelectric power purposes but is also utilized for recreational purposes. This reservoir is a popular recreational lake for Oklahomans as well as people from neighboring states. The Grand Lake Association is the largest citizen monitoring group affiliated with the Oklahoma Water Watch, the OWRB's citizen monitoring program.











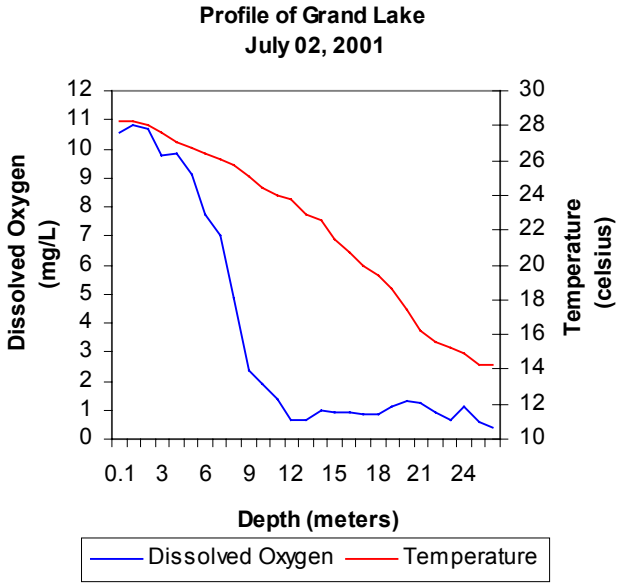
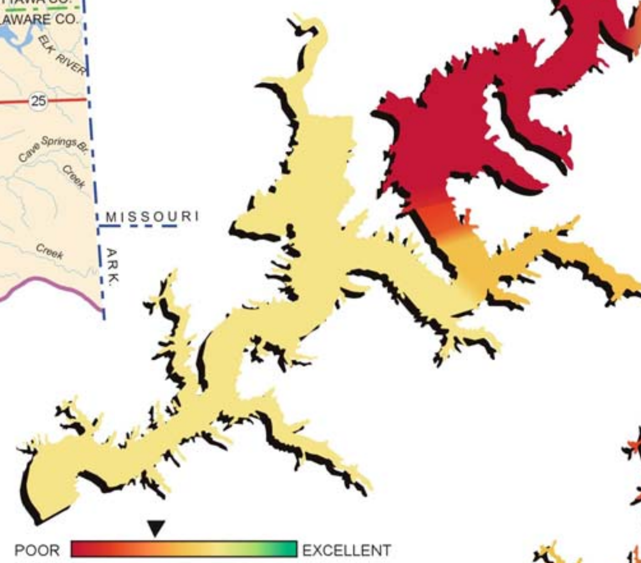


Figure 41a-41f. Graphical representation of data results for Grand Lake.

Grand Lake and Watershed

Grand Lake Location

Lake Data	
Constructed by	Corps of Engineers
County	Mayes (Dam)
Constructed	1940
Surface Area	46,500 acres
Volume	1,672,000 acre/feet
Shoreline Length	1,300 miles
Mean Depth	35.96 feet
Watershed Area	10,298 square miles



Turbidity 2001

Trophic State 2001

Plate 17 - Lake Water Quality for

Grand Lake