

WATER QUALITY ASSESSMENTS FOR SELECTED NEW MEXICO LAKES

2000



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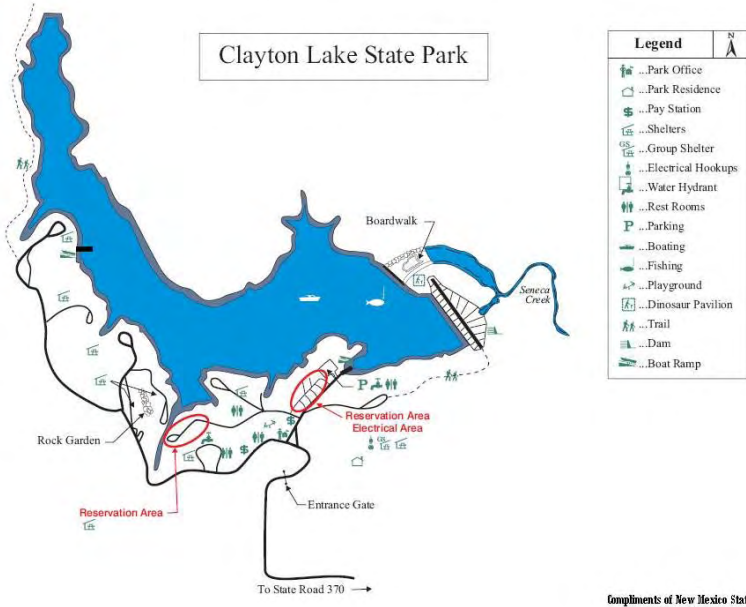
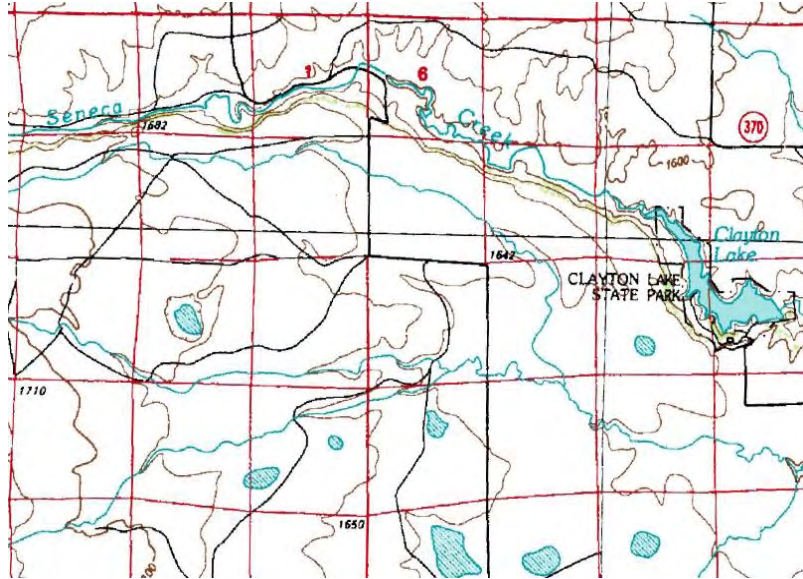
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LAKE SURVEYS

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**Water Quality and Biological Assessment Survey of Clayton Lake,
Union County, March 28, July 18 and October 3, 2000.
Danny R. Davis, Principal Investigator**

Clayton Lake, located in the northeast corner of New Mexico, is located approximately 12 miles (19 km) north of the city of Clayton and is accessed via state highway 370. Clayton Lake State Park consists of 471 acres of recreational land surrounding the reservoir, and provides picnicking, camping, fishing, boating and wildlife viewing. Clayton Lake is located at an elevation of 5,040 ft. (1,536 meters) above mean sea level, and receives an average of 15 inches (38 cm) per year with evaporation averaging 102 cm (40.5 in) resulting in a water deficit of 64 cm (25.3 in) (Gabin and Lesperance 1977).



Clayton Lake is a reservoir formed by a compacted earth dam, which began impounding water in 1956 and took about 10 years to reach full pool. Seneca Creek supplies water to Clayton Lake and drains a watershed approximately 119 square miles (30,820 Ha) which results in a watershed to lake size ratio of 448/1. The Clayton Lake State Park Management Plan explains that Seneca Creek is actually a series of seeps and springs, which runs only seasonally.

The seeps and springs are not adequate to keep the lake at full pool due to evaporation, so the largest contribution to the lake is from run-off from storms. The New Mexico Department of Game and Fish manages the sports fishery, and New Mexico State Parks operates the recreational facility at the lake. The lake and park are located on the western edge of the Great Plains where rolling grasslands, volcanic rocks and sandstone bluffs provide added character to the area. Clayton Lake is located in Level III Ecoregion 26 (Southwestern Tablelands) contained within Aggregate Ecoregion III (the Xeric West) (Omernik 1987), and is characterized by prairie grasslands where grazing is prominent with some cropland use as well.

Water quality standards (WQS) for Clayton Lake are set forth in section 20.6.4.99 of the *New Mexico Standards for Interstate and Intrastate Surface Waters* (NMAC 2006). The designated uses are aquatic life, livestock watering, wildlife habitat, and secondary contact (NMAC 2006). A site specific temperature criterion of 34°C applies. In addition, SWQB staff note existing uses of primary contact, warmwater aquatic life, and marginal coldwater aquatic life.



Clayton Lake Shallow, July, 2000.
Note algal mat in background.

Principal fish species consist of walleye, channel catfish, bass and trout. Four state record walleyes have been caught since 1981 with the current record of 16 pounds 9 ounces that was taken in 1989. During the winter months, thousands of geese and various waterfowl and Bald Eagles reside. Many other species of wildlife such as deer, bear, turkey, coyote, bobcat, and occasional elk and mountain lions are common.

Table 1A. Physical Characteristics for Clayton Lake, 2000.

Physical Characteristics	Deep Station		Shallow Station	
Secchi (m)	Sp	3.0	Sp	2.0
	Su	2.5	Su	2.0
	Fall	1.75	Fall	0.80
Forel Ule Color	Sp	10	Sp	8
	Su	15	Su	12
	Fall	14	Fall	12
Maximum Depth (m)	Sp	8.65	Sp	2.0
	Su	9.0	Su	3.5
	Fall	8.5	Fall	2.5
Euphotic Zone (m)	Sp	7.0	Sp	>2.0
	Su	5.6	Su	>3.5
	Fall	MDP	Fall	>2.5
Surface Area (Acres)	Sp	170	Sp	170
	Su	170	Su	170
	Fall	170	Fall	170
Storage Capacity (Ac. Ft.)	Sp	MDP	Sp	MDP
	Su	MDP	Su	MDP
	Fall	MDP	Fall	MDP
Anoxic Hypolimnion (Y/N)	Sp	No	Sp	No
	Su	Yes	Su	No
	Fall	No	Fall	No
Stratified (Y/N) @ depth (m)	Sp	No	Sp	No
	Su	Yes @ 1 meter	Su	Yes @ 1 meter
	Fall	No	Fall	No
pH (s.u.)	Sp	7.97	Sp	8.13
	Su	9.0	Su	8.85
	Fall	8.60	Fall	8.51
Conductivity (µS)	Sp	393	Sp	392
	Su	371	Su	368
	Fall	389	Fall	391
Turbidity (NTUs)	Sp	1.93	Sp	7.40
	Su	1.97	Su	2.57
	Fall	3.47	Fall	8.03
Integrated Sample surface to (m)	Sp	7.0	Sp	2.0
	Su	8.0	Su	3.0
	Fall	0.2	Fall	2.0
Dissolved Oxygen Surface (mg/L)	Sp	9.1	Sp	8.8
	Su	7.91	Su	5.94
	Fall	8.4	Fall	6.6
Dissolved Oxygen Bottom (mg/L)	Sp	8.7	Sp	8.9
	Su	0.35	Su	3.79
	Fall	3.8	Fall	6.5

Physical Characteristics	Deep Station		Shallow Station	
Temperature Surface (°C)	Sp	9.7	Sp	10.0
	Su	26.7	Su	26.5
	Fall	17.4	Fall	17.5
Temperature Bottom (°C)	Sp	7.5	Sp	9.8
	Su	19.8	Su	23.6
	Fall	17.2	Fall	17.2
Chlorophyll <i>a</i> (µg/L)	Sp	0.467	Sp	0.685
	Su	MDP	Su	4.11
	Fall	MDP	Fall	4.20

Sp = Spring; Su = Summer; MDP = missing data point; (Q) = questionable result.

Table 2A. Trophic State for Clayton Lake, 2000. (Carlson, 1977)

Trophic State Indices	Deep Station		Shallow Station	
Secchi depth	Sp	Mesotrophic	Sp	Eutrophic
	Su	Mesotrophic	Su	Eutrophic
	Fall	Eutrophic	Fall	Eutrophic
Chlorophyll <i>a</i>	Sp	Oligotrophic	Sp	Oligotrophic
	Su	MDP	Su	Mesotrophic
	Fall	Eutrophic	Fall	Mesotrophic
Total Phosphorus	Sp	Oligotrophic	Sp	Oligotrophic
	Su	Oligomeso	Su	Oligotrophic
	Fall	Mesotrophic	Fall	Oligomeso
Overall Trophic Condition	Mesoeutrophic			

Table 3A.

Nitrogen (N)/Phosphorus (P) Ratio	Deep Station		Shallow Station	
Limiting Nutrient	Sp	P	Sp	N/P
	Su	P	Su	N
	Fall	N/P	Fall	N

Table 4A.

Designated or Existing Use	Criteria Exceedence	Attainment Status
Primary and Secondary Contact	None	Fully Supporting
Marginal Coldwater Aquatic Life	Mercury	Fully Supporting
Warm water Aquatic Life	Mercury	Not Supporting
Wildlife Habitat	None	Fully Supporting
Livestock Watering	None	Fully Supporting

Water Quality Assessment

Physical characteristics of Clayton Lake were measured and are listed in Table 1A. Table 2A shows the trophic state variation observed both seasonally and between stations for Secchi depth, chlorophyll *a*, and total phosphorus. The overall trophic condition of Clayton Lake in 2000, according to Carlson (1977) and Likens (1975), is mesoeutrophic with phosphorus and nitrogen being co-limiting when averaged for the multiseasonal study (Tables 2A and 3A). During the



previous SWQB survey in 1987, the overall trophic condition was oligomesotrophic during the single September sampling run where phosphorus was the limiting nutrient. All algal samples were dominated by blue-green algae during this study where 90 to 95 percent of the total community composition consisted of a single species, *Aphanizomenon flos-aquae* with a few Cryptophyta, Chlorophyta and chrysophyta making up the balance of

algal members present. Forty-three percent of the diatom community analyzed consisted of *Cocconeis pediculus* Ehr. var. *pediulus* and *Cocconeis placentula* Ehr. var. *placentula*. Twenty-nine species were counted in the formal count and a total of forty-five species were identified overall. Diversity according to Shannon-Wiener was high.

Lake chemistry sampling consisted of total, dissolved, and calculated nutrients, anions and cations, total and dissolved heavy metals, synthetic organics, radionuclides, and cyanide, which cover all criteria pertinent to the protection of all designated uses. These data are available upon request, though any criteria exceedences are listed in Table 4A and discussed below.



Table 4A indicates that all designated and existing uses were fully supported during the three season study of Clayton Lake except for the use of warmwater aquatic life. Warmwater species were analyzed for mercury in fish tissue resulting in the nonsupport designation, and the inclusion of these warmwater species in a State issued consumption advisory. No coldwater species, specifically trout, were tested for mercury, therefore the use of marginal coldwater aquatic life remains supported.

The non-attainment status for warmwater aquatic life will remain until mercury in fish tissue is reduced to acceptable levels. Clayton Lake is moderately enriched due to the paucity of perennial water and the large watershed to lake size ratio. However, this lake and associated State Park provides an oasis in the desert plains for an average of over 25,000 recreating visitors per year.

**Water Quality and Biological Assessment Survey of Santa Cruz Reservoir,
Santa Fe County, April 4, July 12 and September 26, 2000.
Danny R. Davis, Principal Investigator**

Santa Cruz Reservoir is located in north-central New Mexico, approximately 48 kilometers (30 mi) north of Santa Fe via U.S. 285 to NM State Highway 503, and then to State road 596, which ends at the lake. The reservoir recreational facilities are managed by the Bureau of Land Management while the water stored at the lake is managed by the Santa Cruz Irrigation District. Two mountain streams, the Rio En Medio and the Rio Frijoles, merge to form the Rio Santa Cruz a short distance upstream from the lake. The watershed supplying the lake is about 98 mi² (25,252 Ha) in size, which results in a 624/1 watershed to lake size ratio. The elevation at Santa Cruz Reservoir is 1,916 meters (6,285 ft) above sea level and has an estimated capacity of about 3,000 ac. ft. according to recent figures (Joe Maestas, pers com). Originally, the reservoir had a capacity of about 12,000 acre-feet, held by the concrete dam, which was completed in 1928. Over the years, sediment from the watershed has reduced storage, and recent fires which occurred in the watershed in 2003, further loaded the lake with ash and sediment. In 1989, the dam was rebuilt and reinforced resulting in a height of almost 100 feet.



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The Bureau of Land Management recreational facility consists of about 600 acres of which 121 acres are considered lake surface area, though some surface area is believed to be lost to sedimentation. The lake is located within the Level III Ecoregion 22 (the Arizona/New Mexico Plateau) contained within Aggregate Ecoregion III (the Xeric West) (Omernik, 1987) and receives an average of 23.1 cm (9.1 in) of precipitation per year based on a 13 year record (Gabin and Lesperance 1977). Maximum depth reported during this study



occurred during the spring sampling run and was 19.5 meters (64 ft) measured at the deep station near the dam. By the fall run, the depth at the deep station had dropped to 13.25 meters (43.5 ft). Diminishing capacity due to sedimentation, irrigation demands by users, and a serious drought that has persisted throughout the southwestern U.S. are causes for the shrinking pool size.

A boat ramp is provided to serve non-motorized craft. The New Mexico Department of Game and Fish lists Santa Cruz Reservoir as a rainbow and brown trout fishery. Water quality

standards for Santa Cruz Reservoir are set forth in section 20.6.4.121 of the *New Mexico Standards for Interstate and Intrastate Surface Waters* (NMAC 2006), where designated uses of domestic water supply, high quality coldwater aquatic life, irrigation, livestock watering, wildlife habitat, municipal and industrial water supply, secondary contact and primary contact are recognized.

Table 1B. Physical Characteristics for Santa Cruz Reservoir, 2000.

Physical Characteristics	Deep Station		Shallow Station	
Secchi (m)	Sp	5.0	Sp	4.5
	Su	3.5	Su	1.5
	Fall	1.45	Fall	Dry
Forel Ule Color	Sp	10	Sp	7
	Su	12	Su	14
	Fall	15	Fall	Dry
Maximum Depth (m)	Sp	19.5	Sp	5.5
	Su	15.5	Su	1.5
	Fall	8.4	Fall	Dry
Euphotic Zone (m)	Sp	7.9	Sp	>5.0
	Su	6.3	Su	>1.5
	Fall	2.7	Fall	Dry
Surface Area (Acres)	Sp	± 100	Sp	± 100
	Su	± 100	Su	± 100
	Fall	± 100	Fall	MDP
Storage Capacity (Ac. Ft.)	Sp	MDP	Sp	MDP
	Su	MDP	Su	MDP
	Fall	MDP	Fall	MDP

Sp = Spring; Su = Summer; MDP = missing data point; (Q) = questionable result;
 "Dry" = Shallow station on high ground.

Table 1B. con't.

Physical Characteristics	Deep Station		Shallow Station	
Anoxic Hypolimnion (Y/N)	Sp	No	Sp	No
	Su	Yes	Su	No
	Fall	No	Fall	Dry
Stratified (Y/N) @ depth (m)	Sp	No	Sp	No
	Su	Weak at 6 meters	Su	No
	Fall	No	Fall	Dry
pH (s.u.) Surface	Sp	7.55	Sp	7.68
	Su	8.44	Su	8.42
	Fall	7.39	Fall	Dry
Conductance (μS) Surface	Sp	92	Sp	92
	Su	125	Su	124
	Fall	187	Fall	Dry
Turbidity (NTUs)	Sp	1.40	Sp	1.62
	Su	1.35	Su	1.59
	Fall	6.83	Fall	Dry
Integrated Sample surface to (m)	Sp	8.0	Sp	5.0
	Su	15.0	Su	1.0
	Fall	13.0	Fall	Dry
Dissolved Oxygen Surface (mg/L)	Sp	9.8	Sp	9.55
	Su	7.0	Su	7.05
	Fall	7.61	Fall	Dry
Dissolved Oxygen Bottom (mg/L)	Sp	8.0	Sp	9.7
	Su	0.6	Su	7.05
	Fall	2.11	Fall	Dry
Temperature Surface ($^{\circ}$C)	Sp	8.7	Sp	9.9
	Su	24.2	Su	23.4
	Fall	18.0	Fall	Dry
Temperature Bottom ($^{\circ}$C)	Sp	6.0	Sp	8.3
	Su	16.4	Su	23.5
	Fall	17.5	Fall	Dry
Chlorophyll <i>a</i> (μg/L)	Sp	2.47	Sp	0.47
	Su	3.92	Su	1.82
	Fall	15.05	Fall	Dry

MDP = missing data point; (Q) = questionable result, "Dry" = Shallow station on high ground.

Table 2B. Trophic State for Santa Cruz Reservoir, 2000. (Carlson, 1977)

Trophic State Indices	Deep Station		Shallow Station	
Secchi depth	Sp	Oligomeso	Sp	Oligomeso
	Su	Mesotrophic	Su	Eutrophic
	Fall	Eutrophic	Fall	MDP
Chlorophyll <i>a</i>	Sp	Oligomeso	Sp	Oligotrophic
	Su	Mesotrophic	Su	Oligomeso
	Fall	Eutrophic	Fall	MDP
Total Phosphorus	Sp	Oligotrophic	Sp	Oligotrophic
	Su	Oligotrophic	Su	Oligotrophic
	Fall	Oligotrophic	Fall	MDP
Overall Trophic Condition	Oligomesotrophic			

Table 3B.

Nitrogen (N) /Phosphorus (P) Ratio	Deep Station		Shallow Station	
Limiting Nutrient	Sp	P	Sp	N/P
	Su	P	Su	P
	Fall	P	Fall	MDP

MDP = missing data point

Table 4B.

Designated or Existing Use	Criteria Exceedence	Attainment Status
Domestic water supply	None	Fully Supporting
High Quality Coldwater Aquatic Life	Temperature*	Not Supporting
Irrigation	None	Fully Supporting
Livestock Watering	None	Fully Supporting
Wildlife Habitat	None	Fully Supporting
Municipal and industrial water supply	None	Fully Supporting
Primary Contact	None	Fully Supporting
Secondary Contact	None	Fully Supporting

*NOTE: See "Water Quality Assessment" Section for further details on this exceedence.

Water Quality Assessment

Physical characteristics for Santa Cruz Reservoir were measured and are listed in Table 1B. Table 2B shows the trophic state variation observed both seasonally and between stations for secchi depth, chlorophyll *a*, and total phosphorus. The overall trophic condition of Santa Cruz Reservoir in 2000, according to Carlson's (1977) indices and algal community composition (Likens 1975), is oligomesotrophic (Table 2B). It is encouraging to note that though water levels were down and input to the lake greatly reduced, nutrient driven productivity was low resulting in the oligomesotrophic evaluation. Phosphorus was the limiting nutrient during the spring, summer and fall visits (Table 3B).

During both summer and fall phytoplankton samples, the Chlorophyta comprised about 75 percent of the community composition with lesser numbers of golden, bluegreen and bacillariophyta. Spring phytoplankton was not collected. Diatom community composition from multiple substrate periphyton composites resulted in 24 species identified in the formal count with a total of 38 species listed overall. Diversity according to Shannon-Wiener was high.



Lake chemistry sampling consisted of total, dissolved, and calculated nutrients, anions and cations, total and dissolved heavy metals, synthetic organics, radionuclides, and cyanide, which cover all criteria pertinent to the protection of all designated uses. These data are available upon request, though any criteria exceedences are listed in Table 4B and discussed below.



Santa Cruz Reservoir was weakly stratified during the summer sampling visit at the deep station. The physical parameters of dissolved oxygen, pH, specific conductance and total ammonia were well within acceptable limits; however summer temperatures at both deep and shallow stations exceeded the criterion associated with the High Quality Cold Water Aquatic Life (HQCWAL) use. This use is written for the streams that supply the reservoir, and should not apply to Santa Cruz Lake as it does not and cannot act like a stream. During warm summer months, temperature, and potentially other parameters, may exceed the current criteria and should be expected. Also, a HQCWAL use supports propagation of trout species. This is not possible in a reservoir where irrigation demand causes lake levels to change drastically.

It is recommended that further discussion with regard to the aquatic life designation for Santa Cruz Reservoir include consideration for changing the HQCWAL use to a Cold Water Aquatic Life Use. This use would be more aligned with the natural attributes of this lake.

A sign is posted at the boat ramp which says, "No Swimming Allowed." Though this activity is prohibited, the WQS include a designated use of primary contact because full body contact in the Santa Cruz reservoir is likely and has been observed.

Chemical analyses for nutrients, heavy metals, and organics were well within acceptable limits, including human health criteria, or were not detected by the analytical laboratory. Results indicate that all designated uses except for the use of High Quality Cold Water Aquatic Life, were fully supported during the study (Table 4B).



Water Quality and Biological Assessment Survey of Monastery Lake,
San Miguel County, July 11, 2000.
Danny R. Davis, Principal Investigator

Monastery Lake is a small 2.4 hectare (6 ac) lake located about 3.2 kilometers (2 mi) north of the village of Pecos, New Mexico, and accessed by State highway 63. This off channel impoundment is leased by the New Mexico Department of Game and Fish from the adjacent Benedictine Monastery. The Department stocks the lake with rainbow trout where the public enjoy bank fishing, however, no swimming or boating is permitted. The lake is located at an elevation of approximately 2,146 meters (7,040 ft) above mean sea level where annual precipitation averages 40 centimeters (15.7 in), Pan evaporation averages 80.3 centimeters (31.6 in) resulting in a yearly deficit of 42.3 centimeters (16.7 in) (Gabin and Lesperance 1977). The lake is located in Level III Ecoregion 21 (Southern Rockies) contained within Aggregate Ecoregion II (Western Forested Mountains) (Omernik, 1987)



The Monastery Lake watershed is located within a forested mountain environment of an arid region where the presence of recreational waters is a substantial attraction for visitors. The watershed above this off-channel lake is about 466 km² (180 mi²), which results in a 19,200/1 watershed to lake surface area ratio. This measurement provides some insight into potential nutrient inputs supplied by a watershed.

Water quality standards for Monastery Lake are set forth in section 20.6.4.99 of the *New Mexico Standards for Interstate and Intrastate Surface Waters* (NMAC 2006). This standards section was newly created for those lakes that are considered off channel and therefore not specifically included within the segment descriptions for classified waters of the state (20.6.4.101 through 20.6.4.806 NMAC). Under the new segment 20.6.4.99 NMAC, the uses of aquatic life, livestock watering, wildlife habitat, and secondary contact are listed as designated uses. Existing uses for Monastery Lake include domestic water supply, fish culture, high quality cold water aquatic life (HQCWAL), and irrigation. The temperature criterion under 20.6.4.99 NMAC is

listed at 34 degrees C (93.2 °F), however for a HQCWAL use the temperature criterion is listed as 20 degrees C (68 °F). Existing uses are noted in the SWQB Assessment Database in order to afford these waters more protection than that given by the standards specified within 20.6.4.99 NMAC. According to NM's Antidegradation Policy (20.6.4.8 NMAC), "Existing instream water uses and the level of water quality necessary to protect the existing uses shall be maintained and protected in all surface waters of the state." Therefore, during assessment procedures, the use with the most stringent criteria is used. For example, in the temperature case the *existing* use of high quality coldwater aquatic life would be used in the assessment because it is more protective than the *designated* use of aquatic life.

Table 1C. Physical Characteristics for Monastery Lake, 2000.

Physical Characteristics	Deep Station
Secchi Depth (m)	1.1
Forel Ule Color	9
Maximum Depth (m)	3.7
Euphotic Zone (m)	>3.7
Surface Area (Acres)	6
Anoxic Hypolimnion (Y/N)	No
Stratified (Y/N) @ (m)	No
pH units (s.u.) (Surface)	8.24
Conductivity (μS) (Surface)	211
Turbidity (NTUs)	6.59
Integrated sample surface to (m)	3.0
Dissolved Oxygen Surface (mg/L)	7.05
Dissolved Oxygen Bottom (mg/L)	6.6
Temperature Surface ($^{\circ}$C)	21.2
Temperature Bottom ($^{\circ}$C)	20.8
Chlorophyll <i>a</i> (μg/L)	3.74

Table 2C. Trophic State for Monastery Lake, 2000 (Carlson, 1977)

Trophic State Indices	Season	Deep Station
Secchi depth	Su	Eutrophic
Chlorophyll <i>a</i>	Su	Mesotrophic
Total Phosphorus / Total Nitrogen	Su	Oligotrophic/Oligomeso
Overall Trophic Condition	Mesotrophic	

Su = Summer

Table 3C. Nitrogen (N) /Phosphorus (P) Ratio

	Deep Station
Limiting Nutrient	P

Table 4C. Use Attainment

Designated or Existing Use	Criteria Exceedence	Attainment Status
Domestic Water Supply	None	Fully Supporting
Fish Culture	None	Fully Supporting
High Quality Coldwater Aquatic Life	None	Fully Supporting
Irrigation	None	Fully Supporting
Livestock Watering	None	Fully Supporting
Secondary Contact	None	Fully Supporting
Wildlife Habitat	None	Fully Supporting

Water Quality Assessment

Physical characteristics for Monastery Lake were measured and are listed in Table 1C. Table 2C shows trophic variation observed during the single summer visit for secchi depth, chlorophyll *a*, and total phosphorus. The overall trophic condition of Monastery Lake in 2000, according to Carlson's (1977) indices and algal community composition (Likens 1975), is mesotrophic (Table 2C). The N/P ratio indicated that phosphorous was the limiting nutrient on the day of sampling (Table 3C).

Of the 10 phytoplankton genera identified from the sample, 80 percent were members of Chlorophyta while the remaining were representatives of the Chrysophyta and Cryptophyta. The dominance of these members of the community supports the mesotrophic determination. A benthic diatom sample was collected from multiple substrates. Thirty-two species were identified in the formal count with an added five species identified. Diversity was good according to Shannon-Wiener (1949). Phytoplankton and chlorophyll data from 2000 are available upon request.

Monastery Lake is a highly used fishing attraction and provides an excellent put-and-take trout fishery. The lake is an off-channel lake where most of what enters, stays within the lake. This suggests a propensity toward nutrient loading especially during times of drought where there is little chance of flushing.



Lake chemistry sampling consisted of total and dissolved nutrients, anions and cations, total and dissolved heavy metals, synthetic organics, radionuclides, and cyanide, which cover all criteria pertinent to the protection of all designated uses. These data are available upon request, though any criteria exceedences are listed in Table 4C and discussed below.

There were no exceedences of criteria and all designated uses were fully attained during the sampling visit. Though a slight exceedence of the temperature criterion for the existing high quality coldwater aquatic life use was measured during the visit, current assessment protocols for temperature do not consider this use impairment. Continued management of the public use areas and continued work to limit watershed sources of nutrients will help insure that Monastery Lake remains a useful and beautiful recreational destination.

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