NMED/SWQ-06/1

WATER QUALITY ASSESSMENTS FOR SELECTED NEW MEXICO LAKES

2003

Danny R. Davis

Monitoring and Assessment Section
Surface Water Quality Bureau
New Mexico Environment Department
1190 St. Francis Drive - P.O. Box 26110
Santa Fe, New Mexico 87502

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LAKE WATER QUALITY MONITORING, TROPHIC STATE EVALUATION, AND STANDARDS ASSESSMENT FOR:

Brantley Reservoir, Sumner Reservoir, Bonito Lake, and Grindstone Canyon Reservoir

Danny R. Davis

2003

EXECUTIVE SUMMARY

Water quality surveys and assessments were completed in fulfillment of work-plan commitments of the *FY 2003-2004 Section 106 Work Program for Water Quality Management.* This program was partially funded by a grant from the U.S. Environmental Protection Agency.

Bonito Lake, 2003

During 2003, the New Mexico Environment Department / Surface Water Quality Bureau (NMED/ SWQB) conducted water quality and biological assessment surveys of of four lacustrine systems. Brantley Reservoir, Sumner Reservoir, Bonito Lake and Grindstone Canyon Reservoir were studied concurrently with an intensive Total Maximum Daily Load (TMDL) watershed study conducted on the Pecos River and its tributaries and within the Rio Hondo, Rio Bonito, Rio Ruidoso, and Rio Penasco watersheds, which drain to the Pecos River. Studying lakes in this way helps to insure a timely return to the lake system as watersheds are revisited, and also adds to the understanding of surface waters within the drainage basin. Water quality sampling methods were in accordance with the *Quality Assurance Project Plan for Water Quality Management Programs* (NMED 2003).

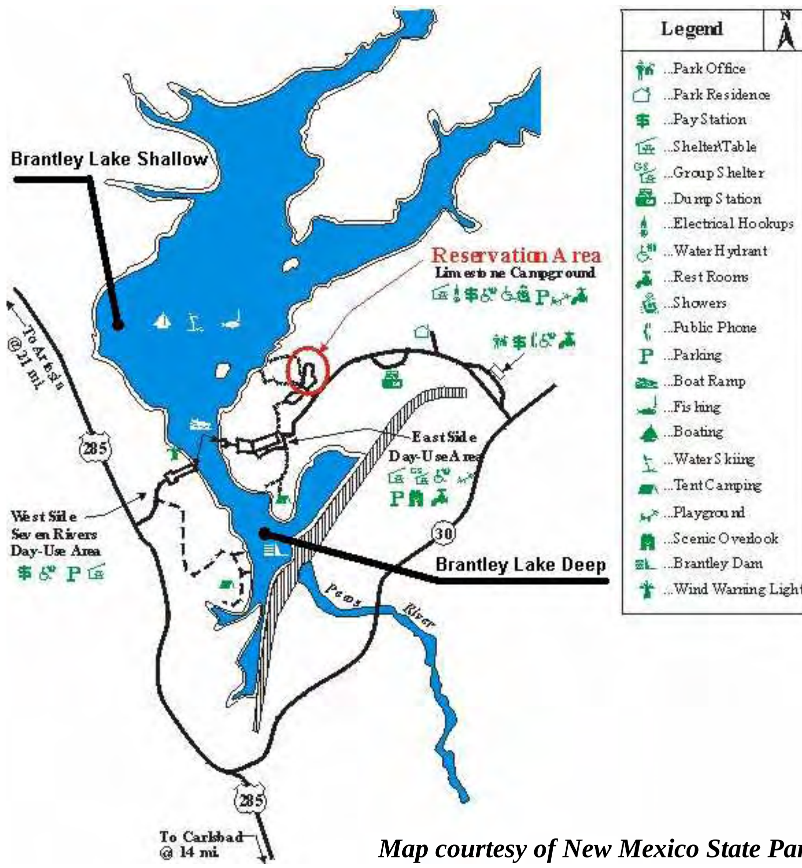
The following assessments provide information pertaining to water quality, biological integrity, trophic state, limiting nutrients, water quality criteria exceedences, and water quality standards specific to the designated, existing, or attainable uses in the State of New Mexico Standards for Interstate and Intrastate Surface Waters (NMED 2005). Water chemistry sampling at lake stations includes total and dissolved nutrients, total and dissolved metals, major ions including total dissolved solids (TDS), hardness, and alkalinity, radionuclides, organic scans, cyanide, and microbiological collections. Phytoplankton and benthic diatom samples were also collected for analysis. The following assessments do not include all data results, except for those specifically related to the general physical nature, trophic state, limiting nutrient, or criteria exceedences and consequent standards violations. All data are available upon request.

TABLE OF CONTENTS

LAKE SURVEYS

Water Quality and Biological Assessment Survey of Brantley Reservoir, Eddy County, March 25, July 8 and October 28, 2003.
Danny R. Davis, Principal Investigator

Brantley Reservoir, located in southeast New Mexico, was the last major mainstem reservoir built in New Mexico and began impounding the lower Pecos River in August of 1988. At completion, this reservoir had a storage capacity of 966,360 acre-feet (ac-ft), though this has deminished to 348,540 ac-ft from the capacity table dated June 2001 (USGS 2002). The reservoir storage varied from 20,800 ac-ft in the spring to 6,022 ac-ft in the fall reflecting the extreme and persistent drought that existed during this time in the Southwestern United States. The contributing drainage area is 17,650 square miles (mi^2) and begins in the Sangre De Cristo and Sacramento Mountains of north and south central New Mexico, respectively. The purpose for the construction of Brantley Reservoir was to relieve pressure on two aging reservoirs; Avalon, directly above the city of Carlsbad and Lake McMillan, which used to be located a few miles northeast of Brantley Reservoir. In both cases, sediment had filled the basins resulting in limited flood control and irrigation storage. The Reservoir is located in Level III Ecoregion 24 (the Chihuahuan Deserts) contained within Aggregate Ecoregion III (the Xeric West) (Omernik 1987) and receives an average of 29.2 cm (11.5 in) of precipitation per year with evaporation averaging 139 cm (54.7 in) resulting in a water deficit of 109 cm (43 in) (Gabin and Lesperance 1977).



Map courtesy of New Mexico State Parks

Brantley Lake State Park manages the recreational activities and provides camping areas, nature trails, and an interpretive visitors center. Two boat ramps are provided for recreational boating and for fishing the warm water species that populate the lake. Water quality standards (WQS) for Brantley Reservoir are set forth in section 20.6.4.205 of the *New Mexico Standards for Interstate and Intrastate Surface Waters* (NMAC 2005). Designated uses of Brantley Reservoir include irrigation storage, livestock watering, wildlife habitat, primary contact, and warmwater aquatic life (NMAC 2005). Principal fish species consist of white bass, walleye, white crappie, and channel catfish.

Table 1. Physical Characteristics for Brantley Reservoir, 2003.

Physical Characteristics	Deep Station		Shallow Station	
Secchi (m)	Sp	0.80	Sp	0.80
	Su	1.1	Su	0.8
	Fall	1.0	Fall	0.75
Forel Ule Color	Sp	15	Sp	14
	Su	15	Su	11
	Fall	14	Fall	15
Maximum Depth (m)	Sp	12.3	Sp	1.5
	Su	6.9	Su	3.65
	Fall	9.06	Fall	2.0
Euphotic Zone (m)	Sp	3.0	Sp	>1.5
	Su	4.0	Su	>3.65
	Fall	4.0	Fall	>2.0
Surface Area (Acres)	Sp	1,841	Sp	1,841
	Su	1,421	Su	1,421
	Fall	698	Fall	698
Storage Capacity (Ac. Ft.)	Sp	20,800	Sp	20,800
	Su	14,424	Su	14,424
	Fall	6,022	Fall	6,022

Physical Characteristics	Deep Station		Shallow Station	
Anoxic Hypolimnion (Y/N)	Sp	No	Sp	No
	Su	Yes	Su	No
	Fall	Yes	Fall	No
Stratified (Y/N) @ depth (m)	Sp	Yes @ 8 meters	Sp	No
	Su	Yes @ 3 meters	Su	No
	Fall	Yes @ 4 meters	Fall	No
PH (SUs)	Sp	7.5	Sp	7.8
	Su	8.46	Su	8.3
	Fall	8.1	Fall	8.2
Conductivity (µS)	Sp	7245	Sp	7270
	Su	3650	Su	2330
	Fall	3290	Fall	3470
Turbidity (NTUs)	Sp	7.92	Sp	6.99
	Su	4.71	Su	10.7
	Fall	4.71	Fall	8.39
Integrated Sample surface to (m)	Sp	11.0	Sp	1.0
	Su	6.0	Su	3.0
	Fall	8.5	Fall	1.5
Dissolved Oxygen Surface (mg/L)	Sp	8.49	Sp	8.84
	Su	7.00	Su	5.72
	Fall	7.73	Fall	8.11

Table 1. con't.

Dissolved Oxygen Bottom (mg/L)	Sp	3.68	Sp	8.66
	Su	0.31	Su	4.45
	Fall	0.04	Fall	8.06
Temperature Surface (°C)	Sp	14.2	Sp	15.6
	Su	26.3	Su	26.8
	Fall	16.6	Fall	16.5
Temperature Bottom (°C)	Sp	12.5	Sp	15.6
	Su	23.9	Su	26.2
	Fall	20.14	Fall	16.0
Chlorophyll *a* (µg/L)	Sp	31.4	Sp	28.97
	Su	17.76	Su	8.09
	Fall	11.59	Fall	15.70

MDP = missing data point; (Q) = questionable result.

Table 2.

Trophic State (Carlson, 1977)	**Deep Station**		**Shallow Station**	
Secchi depth	Sp	Eutrophic	Sp	Eutrophic
	Su	Eutrophic	Su	Eutrophic
	Fall	Eutrophic	Fall	Eutrophic
Chlorophyll *a*	Sp	Eutrophic	Sp	Eutrophic
	Su	Eutrophic	Su	Eutrophic
	Fall	Eutrophic	Fall	Eutrophic
Total Phosphorus	Sp	Oligotrophic	Sp	Oligotrophic
	Su	Oligotrophic	Su	Oligotrophic
	Fall	Oligotrophic	Fall	Oligotrophic

Overall Trophic Condition	**Mesoeutrophic**

Table 3.

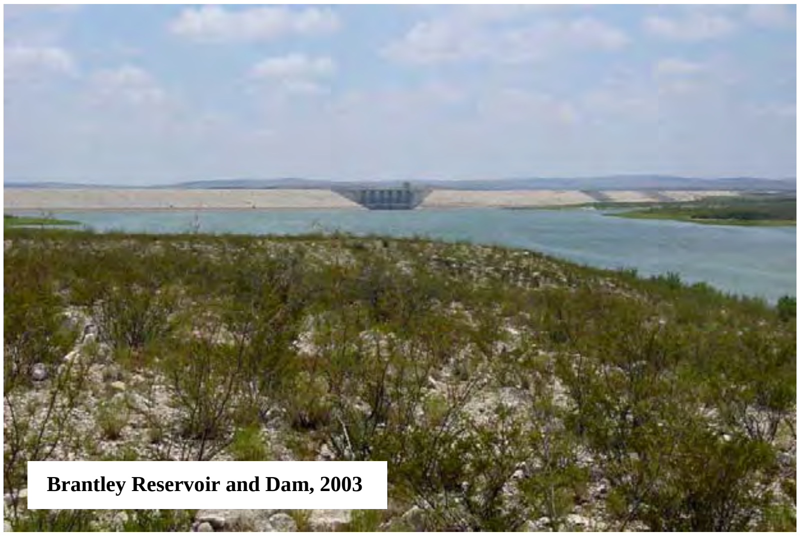
Nitrogen/Phosphorus Ratio	**Deep Station**		**Shallow Station**	
Limiting Nutrient	Sp	P	Sp	P
	Su	P	Su	P
	Fall	P	Fall	P

Table 4.

Designated or Attainable Use	**Criteria Exceedence**	**Attainment Status**
Primary Contact	None	Fully Supporting
Irrigation Storage	None	Fully Supporting
Warm water Fishery	Fish Tissue Mercury	Not Supporting
Wildlife Habitat	None	Fully Supporting
Livestock Watering	None	Fully Supporting

Water Quality Assessment

Physical characteristics of Brantley Reservoir were measured and are listed in Table 1. Table 2 shows the trophic state variation observed both seasonally and between stations for secchi depth, chlorophyll *a*, and total phosphorus. The overall trophic condition of Brantley Reservoir in 2003, according to Carlson (1977) and Likens (1975), is mesoeutrophic with phosphorus being the limiting nutrient at all stations and during all seasons (Tables 2 and 3). During the previous SWQB surveys in 1990 and 1997, the overall trophic conditions were mesotrophic and eutrophic, respectively, with phosphorous being the limiting nutrient during all seasons and across all years.



Brantley Reservoir and Dam, 2003

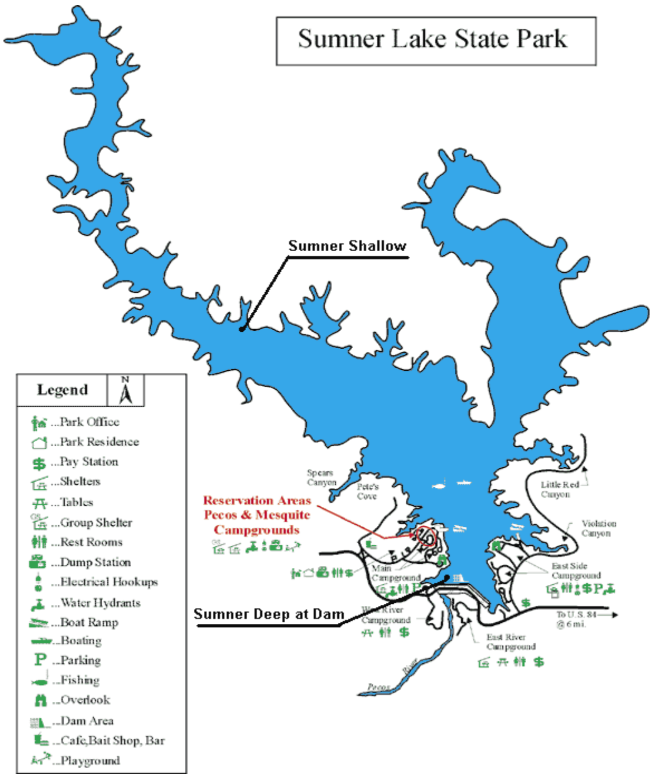
Phytoplankton and diatom community composition are lacking at this time and are therefore unavailable to evaluate overall trophic condition. However, another concern involving a resident alga must be mentioned. ***Prymnesium parvum***, a naturally occurring microscopic flagellated alga common in estuaries and brackish waters, has been observed in the Rio Grande basin of Texas for 30 years. Within the past few years, it has been blamed for severe fish kills in the lower Pecos River of New Mexico, including Brantley Reservoir. This golden alga continues to be studied to determine if measures exist that may control its populations and lesson the severity of fish kills caused by its presence.

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 4 and discussed below.

Table 4 indicates that all designated uses were fully supported except for the warmwater aquatic life use. Past analyses for mercury in fish tissue collected from Brantley Reservoir resulted in non-support for this designated use. This non-attainment status will remain until mercury in fish tissue is reduced to acceptable levels. Though eutrophic conditions due to nutrient enrichment seem common for Brantley Reservoir, it is deemed reasonable considering the 17, 650 mi^2 watershed that supplies the nutrient load to this oasis in the desert.

Water Quality and Biological Assessment Survey of Sumner Reservoir,
De Baca County, March 26, July 9 and October 29, 2003.
Danny R. Davis, Principal Investigator

Sumner Reservoir is located in east-central New Mexico, approximately 26 kilometers (16 mi) north of Fort Sumner via NM State Highway 84. The reservoir is managed by the Bureau of Reclamation and it impounds 11,370 km^2 (4,390 mi^2) of the Pecos River watershed and Alamogordo Creek creating a lake with a maximum storage capacity of 94,750 ac-ft, by the most recent capacity calculations. Earlier storage capacity calculations for maximum storage gave 132,200 ac-ft capacity suggesting that significant storage capacity has been lost due to sedimentation. Sumner Reservoir is located in Level III Ecoregion 26 (the Southwestern Tablelands) contained within Aggregate Ecoregion III (the Xeric West) (Omernik, 1987) and receives an average of 31.8 cm (12.5 in) of precipitation per year with pan evaporation averaging 122 cm (48 in) resulting in a water deficit of 90 cm (35.5 in) (Gabin and Lesperance 1977). Maximum depth reported during a study conducted by EPA (1977) was 19.8 meters (65 ft) while maximum depth during this study was 10.5 meters (34.5 ft) at the Dam, or deepest station. Diminishing depth due to sedimentation and a serious drought that has persisted throughout the southwestern U.S. are causes of the shrinking pool size.



Sumner Lake State Park was completed in 1960 and is named after Colonel Edmond Vose Sumner, a commander of New Mexico's 9th Military District and the man responsible for building many forts during the 1800's (Julyan 1996). Sumner Reservoir was originally designed for water and irrigation storage, but also provides recreational activities such as boating, camping, picnicking, and fishing for bass, bluegill, walleye, catfish, and white bass. Extreme variability in lake levels due to irrigation draw-down is common. There is still no minimum pool established for protection of the fishery, habitat, or recreational activities. Carlsbad Irrigation District owns all but 2,500 ac-ft of Sumner Reservoir Storage. The remaining storage is reserved for the Sumner Irrigation District for use during irrigation season. During 2003, irrigators called for a delivery from Sumner Reservoir while the lake was extremely low due to the drought. Tons of fish spilled through the dam and into the stilling well as a result. A conservation pool would have prevented this.

Water quality standards for Sumner Reservoir are set forth in section 20.6.4.210 of the *New Mexico Standards for Interstate and Intrastate Surface Waters* (NMAC 2005). Designated uses of Sumner Reservoir include irrigation storage, livestock watering, wildlife habitat, primary contact, and warmwater aquatic life (NMAC 2005).

Table 1. Physical Characteristics for Sumner Reservoir, 2003.

Physical Characteristics	Deep Station		Shallow Station	
Secchi (m)	Sp	2.5	Sp	2.4
	Su	0.8	Su	0.45
	Fall	0.6	Fall	0.5
Forel Ule Color	Sp	8	Sp	7
	Su	15	Su	15
	Fall	15	Fall	15
Maximum Depth (m)	Sp	10.5	Sp	4.25
	Su	7.85	Su	2.1
	Fall	8.4	Fall	1.9
Euphotic Zone (m)	Sp	10	Sp	>4.2
	Su	3.0	Su	1.5
	Fall	3.0	Fall	>1.9
Surface Area (Acres)	Sp	1,281	Sp	1,281
	Su	415	Su	415
	Fall	547	Fall	547
Storage Capacity (Ac. Ft.)	Sp	13,852	Sp	13,852
	Su	3,426	Su	3,426
	Fall	5,557	Fall	5,557

Table 1. con't.

Physical Characteristics	Deep Station		Shallow Station	
Anoxic Hypolimnion (Y/N)	Sp	No	Sp	No
	Su	No	Su	No
	Fall	No	Fall	No
Stratified (Y/N) @ depth (m)	Sp	No	Sp	No
	Su	Yes @ 4 meters	Su	Yes @ 1 meter
	Fall	No	Fall	No
PH (SUs) Surface	Sp	8.04	Sp	8.03
	Su	8.23	Su	8.16
	Fall	7.72	Fall	7.94
Conductance (µS) Surface	Sp	3006	Sp	3095
	Su	1458	Su	1492
	Fall	1908	Fall	1864
Turbidity (NTUs)	Sp	2.08	Sp	2.03
	Su	16.6	Su	17.0
	Fall	13.8	Fall	12.0
Integrated Sample surface to (m)	Sp	10.0	Sp	4.0
	Su	7.0	Su	1.5
	Fall	3.0	Fall	1.5
Dissolved Oxygen Surface (mg/L)	Sp	8.19	Sp	7.58
	Su	5.95	Su	5.46
	Fall	7.73	Fall	8.25
Dissolved Oxygen Bottom (mg/L)	Sp	7.32	Sp	5.82
	Su	3.93	Su	4.42
	Fall	6.56	Fall	8.09
Temperature Surface (°C)	Sp	11.83	Sp	12.72
	Su	27.24	Su	27.9
	Fall	14.37	Fall	16.03
Temperature Bottom (°C)	Sp	11.30	Sp	12.49
	Su	24.13	Su	24.44
	Fall	14.02	Fall	15.06
Chlorophyll *a* (µg/L)	Sp	0.997	Sp	0.561
	Su	2.74	Su	6.23
	Fall	MDP	Fall	2.275

MDP = missing data point; (Q) = questionable result.

Table 2.

Trophic State (Carlson, 1977)	Deep Station		Shallow Station	
Secchi depth	Sp	Mesotrophic	Sp	Mesotrophic
	Su	Eutrophic	Su	Hypereutrophic
	Fall	Eutrophic	Fall	Eutrophic
Chlorophyll *a*	Sp	Oligomeso	Sp	Oligotrophic
	Su	Mesotrophic	Su	Mesotrophic
	Fall	MDP	Fall	Oligomeso
Total Phosphorus	Sp	Oligotrophic	Sp	Oligotrophic
	Su	Oligotrophic	Su	Oligotrophic
	Fall	Eutrophic	Fall	Eutrophic

Overall Trophic Condition	Mesoeutrophic

Table 3.

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

Table 4.

Designated or Attainable Use	Criteria Exceedence	Attainment Status
Primary Contact	None	Fully Supporting
Warm water Aquatic Life	Fish Tissue Mercury	Not Supporting
Irrigation Storage	None	Fully Supporting
Livestock Watering	None	Fully Supporting
Wildlife Habitat	None	Fully Supporting

Water Quality Assessment

Physical characteristics of Sumner Reservoir were measured and are listed in Table 1. Table 2 shows the trophic state variation observed both seasonally and between stations for secchi depth, chlorophyll *a*, and total phosphorus. The overall trophic condition of Sumner Reservoir in 2003, according to Carlson's (1977) indices and algal community composition (Likens 1975), is mesoeutrophic (Table 2). During the previous SWQB surveys in 1989 and 1997, mesotrophic conditions persisted, probably due to the higher lake levels and absence of drought conditions.

Chrysophyceae dominated the phytoplankton community composition in the spring, while Chlorophyceae dominated community composition in the summer and fall sampling events. Likens (1975) states that the Chrysophyceae are commonly associated with lower nutrient conditions while Chlorophyceae become dominant in high nutrient conditions. Co-limitation of phosphorus and nitrogen was observed during the spring and fall, whereas phosphorus was the limiting nutrient during the summer (Table 3). Diatom community composition is unavailable at this time though analytical results of epiphytic scrapes collected during the summer sampling visit will be available in the near future.

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 4 and discussed below.

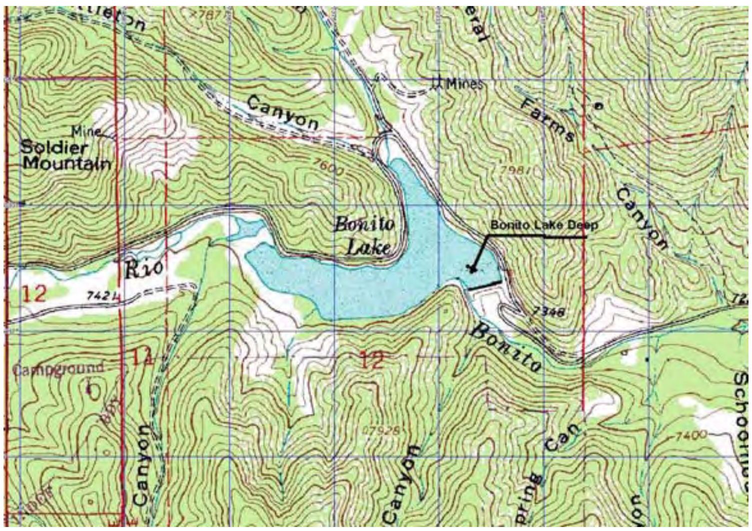
Sumner Reservoir was not stratified during either the spring or fall sampling runs, however a pronounced thermocline was present at both the deep and shallow stations during the summer visit. All physical parameters including temperature, dissolved oxygen, pH, and total ammonia were well above the criteria. Chemical analyses for nutrients, heavy metals, and organics were well below criteria, including human health criteria, or were not detected by the analytical laboratory.

Sumner Reservoir near boat ramp, 2003

Results indicate that all designated uses were fully supported during the study except for the warmwater aquatic life use (Table 4). Past analyses for mercury in fish tissue collected from Sumner Reservoir resulted in non-support for this designated use. This non-attainment status will remain until mercury in fish tissue is reduced to acceptable levels.

Water Quality and Biological Assessment Survey of Bonito Lake, Lincoln County, June 25, 2003.
Danny R. Davis, Principal Investigator

Bonito Lake is located in south-central New Mexico, approximately 32 kilometers (20 mi) northwest of Ruidoso. Bonito Lake has a mean surface area of 24.3 hectares (60 ac) with a corresponding elevation of 2,248 meters (7,377 ft)and a drainage area of 8,700 hectares (33.6 mi^2). The lake is located in Level III Ecoregion 23 (the Arizona/New Mexico Mountains) contained within Aggregate Ecoregion II (Western Forested Mountains) (Omernik, 1987) and has an average annual precipitation of 52.8 centimeters (20.8 in) (Gabin and Lesperance 1977). Pan evaporation averages 75.5 centimeters (29.74 in) resulting in a yearly deficit of 28 centimeters (11.01 in). The Southern Pacific Railroad created Bonito Lake in 1931 by impounding the Rio Bonito with a concrete dam. Various entities use the water stored in Bonito Lake including Holloman Air Base, Fort Stanton, Alamogordo, Carrizozo, and the Nogal Water Users Association. The lake is located on land that is owned by the city of Alamogordo and is adjacent to the Lincoln National Forest. Both the Forest Service and the city of Alamogordo operate campgrounds near the lake. Bonito Lake is managed by the New Mexico Department of Game and Fish and is stocked with rainbow trout. The lake has breeding populations of brook trout as well as carp and catfish (Joseph 1999).



Bonito 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. Recreational activities at the lake include camping, fishing, hiking, hunting, and horseback riding. In addition, a riding stable located three miles upstream from Bonito Lake drains its corrals directly into the Rio Bonito. Gold mining and livestock grazing are common activities in the watershed as well. A number of inactive mines are located in the area however, where mineral extraction permits are current, mining operations could increase as the market improves. Heavy metals especially mercury continue to be of concern considering the history of this watershed, though to date, no metals exceedences have occurred.

Water quality standards for Bonito Lake are set forth in section 20.6.4.209 of the *New Mexico Standards for Interstate and Intrastate Surface Waters* (NMAC 2005). Designated uses of Bonito Lake include domestic water supply, fish culture, high quality coldwater aquatic life, irrigation, livestock watering, municipal and industrial water supply, secondary contact, and wildlife habitat (NMAC 2005).

Table 1. Physical Characteristics for Bonito Lake, 2003.

Physical Characteristics	
Secchi Depth (m)	2.9
Forel Ule Color	9
Maximum Depth (m)	14.9
Euphotic Zone (m)	9.0
Surface Area (Acres)	60
Anoxic Hypolimnion (Y/N)	Yes
Stratified (Y/N) @ (m)	Yes @ 8 meters
Ph units (SUs) Surface	6.59
Conductivity (µS) (Surface)	424
Turbidity (NTUs)	1.89
Integrated sample surface to (m)	14
Dissolved Oxygen Surface (mg/L)	6.89
Dissolved Oxygen Bottom (mg/L)	0.18
Temperature Surface (°C)	18.84
Temperature Bottom (°C)	11.19
Chlorophyll *a* (µg/L)	5.109

Table 2. Trophic State (Carlson, 1977)

Trophic State Indices	Deep Station	
Secchi depth	Su	Mesotrophic
Chlorophyll *a*	Su	Mesotrophic
Total Phosphorus / Total Nitrogen	Su	Mesotrophic

Overall Trophic Condition	**Mesotrophic**

Table 3. Nitrogen/Phosphorus Ratio

	Deep Station
Limiting Nutrient	**N/P**

Table 4. Use Attainment

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

Water Quality Assessment

Physical characteristics of Bonito Lake were measured and are listed in Table 1. Table 2 shows trophic variation observed during the single summer visit for secchi depth, chlorophyll *a*, and total phosphorus. The overall trophic condition of Bonito Lake in 2003, according to Carlson's (1977) indices and algal community composition (Likens 1975), is mesotrophic (Table 2).

The N/P ratio indicated nitrogen and phosphorous were co-limiting on the day of sampling (Table 3). Of the 10 phytoplankton genera identified from the sample, 80 percent were members of Chrysophyta and Cryptophyta. Chlorophyta represented the remaining identified taxa with the blue-greens making up the smallest percentage of the algal community. The dominance of these members of the community supports the mesotrophic determination. A benthic diatom sample was collected, however, results from this sample have not been forthcoming. Phytoplankton and chlorophyll data from 2003 are available upon request.

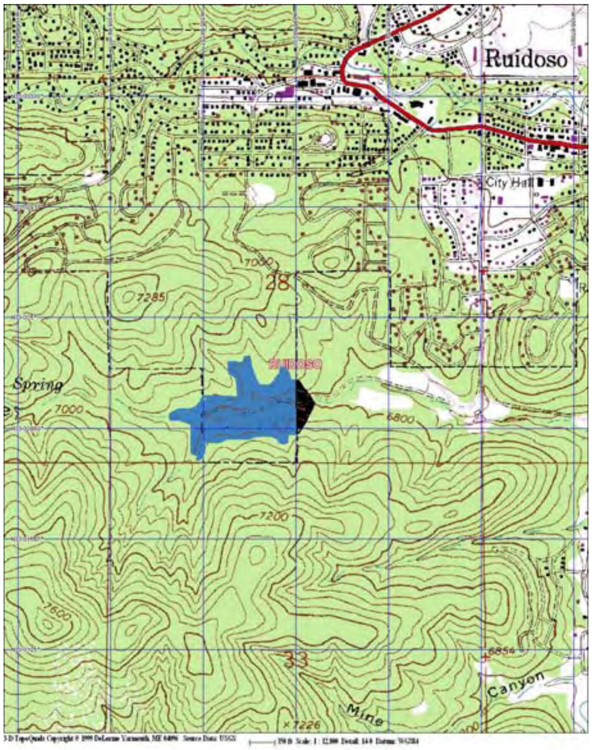
Considering the extended drought that persisted during the Bonito Lake study, and the warm, long day-length time of the year, the intermediate trophic condition seems very acceptable and understandable. The lack of precipitation may have limited nutrient input from the watershed, but lower water levels also caused the concentration of nutrients already present in the reservoir. Funds that had been appropriated from section 319 of the Clean Water Act successfully resulted in many measures to stabilize bank areas and access points to the lake. These measures have reduced the input of shoreline sediment and runoff.

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 4 and discussed below.

Bonito Lake, June 2003

There were no exceedances of criteria and all designated uses were fully attained during the sampling visit. Continued management of the public use areas and continued work to limit watershed sources of nutrients will help insure that Bonito Lake remains a useful and beautiful mountain lake.

Water Quality and Biological Assessment Survey of Grindstone Canyon Reservoir,
Lincoln County, June 25, 2003.
Danny R. Davis, Principal Investigator



Grindstone Canyon Reservoir, in south-central New Mexico was completed in 1987, and is located within the Ruidoso city limits. The roll-compacted dam was designed to store Rio Ruidoso and Grindstone Canyon Creek as a community water supply. The lake is located in Lincoln County at an elevation of 2,108 meters (6,918 ft) above sea level. The lake has a surface acreage of 16 hectares (40 ac) with the deepest station, located in front of the dam, at 35 meters (115 ft). The lake is located in Level III Ecoregion 23 (the Arizona/New Mexico Mountains) contained within Aggregate Ecoregion II (Western Forested Mountains) (Omernik, 1987) and has an average annual precipitation of 54 centimeters (21 in) (Gabin and Lesperance 1977). Pan evaporation averages 75.4 centimeters (29.7 in) resulting in a yearly deficit of 21.4 centimeters (8.7 in).

Grindstone Canyon Reservoir provides recreational activities as well as a community water supply. Recreational opportunities include picnicking, hiking, boating, and fishing primarily for stocked rainbow trout. The city of Ruidoso has acquired a substantial amount of land within the Grindstone Canyon basin to protect against future urban development within the watershed. Lincoln National Forest manages the remainder of the small 1.2 mi^2 watershed (Davis 1999).

The reservoir has experienced some problems subsequent to its completion. Shortly after the dam was completed, structural problems that caused the leaching of lime from within and through the dam, resulting in a serious deposition of calcium carbonate precipitate. Both Grindstone Canyon Creek and Carrizo Creek, which are tributaries to the Rio Ruidoso, were coated as a result impacting stream biota and representing a serious impact on the stream habitats. Eventually, the interior of the dam stabilized and this problem has been largely abated. An added concern within the reservoir is the use of copper sulfate to reduce algae in this drinking water supply. The use of copper sulfate became evident when exceedences for dissolved copper were measured from samples collected during the 1997 and 2005 SWQB sampling runs. This problem has yet to be resolved.

Water quality standards for Grindstone Canyon Reservoir are set forth in section 20.6.4.209 of the *New Mexico Standards for Interstate and Intrastate Surface Waters* (NMAC 2005). Designated uses of Grindstone Canyon Reservoir include domestic water supply, fish culture, high quality coldwater aquatic life, irrigation, livestock watering, municipal and industrial water supply, secondary contact, and wildlife habitat (NMAC 2005).

Table 1. Physical characteristics for Grindstone Canyon Reservoir

Physical Characteristics	Grindstone Canyon Reservoir
Secchi Depth (m)	1.0
Forel Ule Color	7.0
Maximum Depth (m)	26.0
Euphotic Zone (m)	3.5
Surface Area (Acres)	40
Anoxic Hypolimnion (Y/N)	N
Stratified (Y/N) @ (m)	Y
Ph units (SUs) Surface	7.48
Conductivity (µS) (Surface)	225
Turbidity (NTUs)	3.59
Integrated sample surface to (m)	25
Dissolved Oxygen Surface (mg/L)	7.23
Dissolved Oxygen Bottom (mg/L)	2.12
Temperature Surface (°C)	20.10
Temperature Bottom (°C)	7.74
Chlorophyll *a* (µg/L)	0.47

Table 2. Trophic State (Carlson, 1977)

Trophic State Indices	Deep Station	
Secchi depth	Su	Eutrophic
Chlorophyll *a*	Su	Oligotrophic
Total Phosphorus / Total Nitrogen	Su	Oligotrophic/Eutrophic

Overall Trophic Condition	**Mesotrophic**

Table 3. Nitrogen/Phosphorus Ratio

	Deep Station
Limiting Nutrient	P

Table 4. Use Attainment

Designated or Attainable Use	Criteria Exceedence	Attainment Status
Domestic Water Supply	None	Fully Supporting
Fish Culture	None	Fully Supporting
High Quality Coldwater Aquatic Life	Acute & Chronic (Cu)	Not Supporting
Industrial Water Supply	None	Fully Supporting
Irrigation	None	Fully Supporting
Livestock watering	None	Fully Supporting
Municipal Water Supply	None	Fully Supporting
Secondary Contact	None	Fully Supporting
Wildlife Habitat	None	Fully Supporting

FS = Full Support; FSIO = Full Support Impacts Observed; PS = Partial Support; NS = Not Supported.

Water Quality Assessment

Physical characteristics of Grindstone Canyon Reservoir were measured and are listed in Table 1. Table 2 shows trophic variation observed during the single summer visit for secchi depth, chlorophyll *a*, and total phosphorus. The overall trophic condition of Bonito Lake in 2003, according to Carlson's (1977) indices and algal community composition (Likens 1975), is mesotrophic (Table 2).

The N/P ratio indicated that phosphorus was the limiting nutrient on the day of sampling (Table 3). Three phytoplankton genera dominated the sample, but the Chrysophyta, specifically the diatoms, represented over 85 percent of the community identified. These genera represent an algal community that is typical of moderately enriched waterbodies and support the mesotrophic determination. Phytoplankton, diatom, and chlorophyll data from 2003 are available upon request.

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 4 and be discussed below.

As earlier stated, copper sulfate is regularly used to control nuisance algae, however, the application of this regulated algaecide has caused fish kills on numerous occasions. The most recent reported fish kill occurred in mid-November of 2005 (Shawn Denny, pers. comm.). Elevated levels of dissolved copper were also measured during the study conducted by the author in 1997, though assessment protocols did not result in an impairment listing. Levels of copper measured from the 2003 study were roughly 3 times the acute criteria and over 4 times the chronic resulting in a non-support attainment status for the high quality coldwater aquatic life use. A sample collected by the N.M. Department of Game and Fish during the November 2005 fish-kill had copper concentrations that exceeded the acute and chronic criteria by 8.5 and 12 times, respectively.

All other uses were fully supported. The *2004-2006 State of New Mexico Integrated Clean Water Act §303(d)/§305(b) Report* states that this reservoir should be reclassified into its own water quality segment because fish culture and high quality aquatic life are not attainable uses at Grindstone Canyon Reservoir.

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