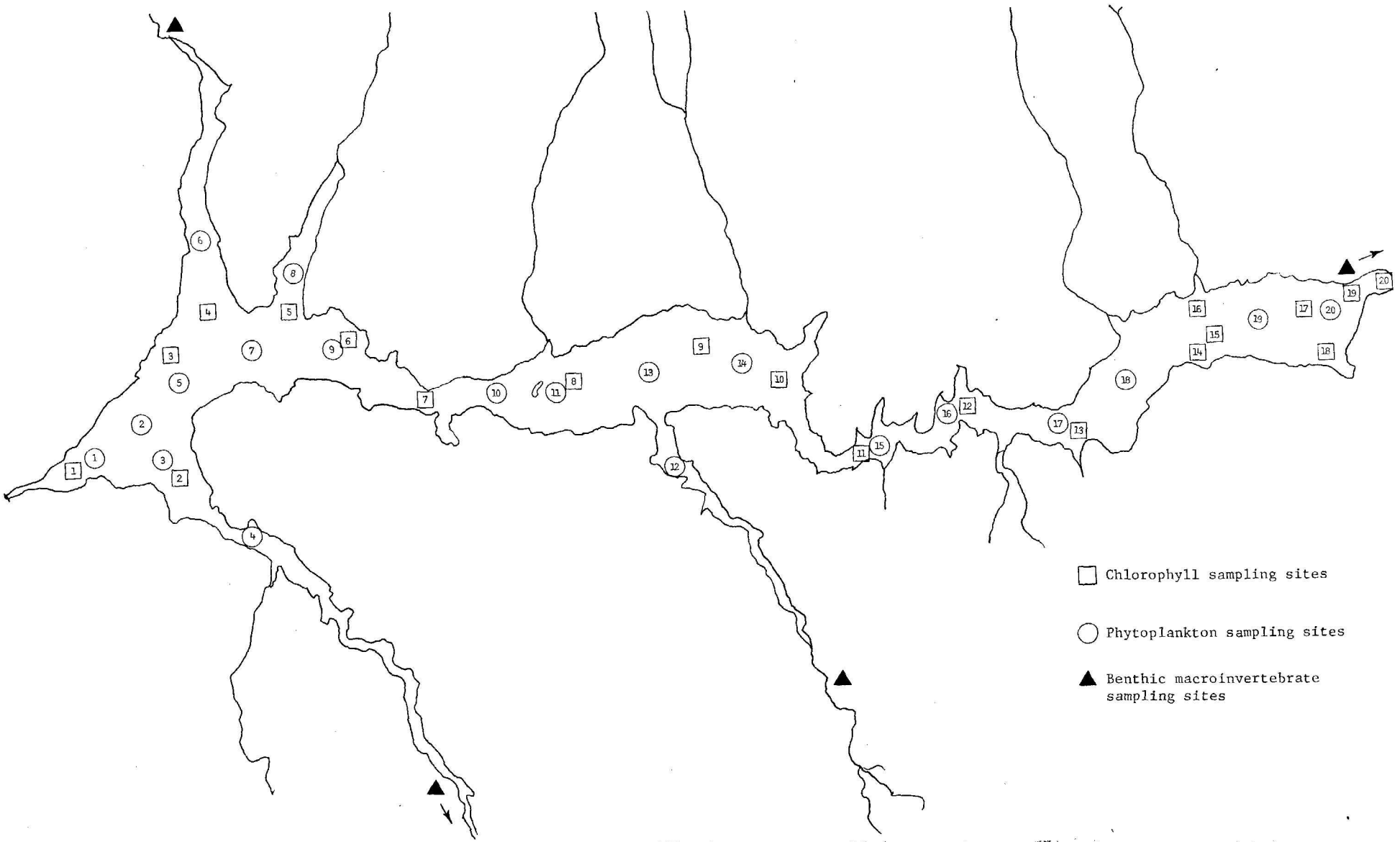
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CURECANTI NATIONAL RECREATION AREA

WATER QUALITY DATA REPORT, 1983-1984

July 1986

National Park Service
Water Resources Division
Colorado State University
Fort Collins, Colorado


Chlorophyll sampling sites
Phytoplankton sampling sites
Benthic macroinvertebrate sampling sites

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FOREWORD

This report is a compilation of data and data reports from several concurrent water quality surveys conducted in Blue Mesa Reservoir and its tributaries, located in Curecanti National Recreation Area in Gunnison, Colorado. The surveys were taken primarily during the summer months in 1983 and 1984. Because analytical techniques and sampling sites varied among the different surveys, no comprehensive analysis of the data was done. However, the data contained herein provides information on background conditions against which future data from similar studies might be compared.

PROJECT PERSONNEL

BENTHIC MACROINVERTEBRATE SURVEY

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PHYTOPLANKTON SURVEY

Paul Kugrens, Professor, Plant Sciences Department, Colorado State University

CHLOROPHYLL SURVEY

Roger Andrascik, Supervisory Park Ranger, Crater Lake National Park (formerly Resource Management Specialist, Curecanti National Recreation Area)

Don Hickman, Park Ranger, Resource Management, Curecanti National Recreation Area

Jim Sartoris, Research Civil Engineer, Bureau of Reclamation, Denver Federal Center

BENTHIC, PHYTOPLANKTON, AND ZOOPLANKTON SURVEY

Aquatic Environmental Services, Inc., Fort Collins, Colorado

Jim Sartoris, Research Civil Engineer, Bureau of Reclamation, Denver Federal Center

LANDSAT SURVEY

James P. Verdin, Civil Engineer, Remote Sensing Section, Bureau of Reclamation, Denver Federal Center

Gary Smillie, Hydrologist, National Park Service Water Resources Division

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INTRODUCTION

INTRODUCTION

The watershed furnishing the major volume of water to Curecanti National Recreation Area is presently subject to influences from proposed energy, mining, and residential development. Deterioration of the existing water resources could adversely affect fisheries, public health, and the recreational experience of Curecanti NRA visitors.

Many of the high mountain streams that form tributaries entering Curecanti's lakes are of excellent quality and support fine fisheries. However, several streams in the upper portion of the basin have been degraded by the effects of past mining activity, naturally occurring mineral contamination, and wastewater discharges. As these waters progress downstream to the valleys, they encounter other potential sources of water contamination. These sources include municipal discharges, treated domestic sewage, diversions for irrigation, agricultural return flows carrying natural and artifical fertilizers from irrigated hay fields, gravel mining, and stream channelization.

Currently, the most significant water quality issue confronting the Gunnison River Basin may be the more subtle growth resulting from increased recreational development and general population movement into the area. Water quality in the basin could deteriorate due to a proliferation of individual septic systems and overloading of existing municipal facilities. Even

at present, the potential for bacteriological contamination of recreational waters is high. The Gunnison River receives treated domestic sewage originating from the East River Valley and the City of Gunnison as well as from individual septic systems. The Lake Fork of the Gunnison River similarly may be affected by Lake City's domestic sewage and by individual septic systems in the drainage.

Hard rock mining in the region historically has fluctuated with cyclic world market conditions. Currently, economic conditions are in a depressed phase and have severely harmed the coal, gold, silver, lead, zinc, and molybdenum operations that have developed in the region. In addition, large mineral deposits of coal, uranium, gold, silver, molybdenum, aluminum, and titanium within the Gunnison River Basin are as yet untapped and could be developed under more favorable economic circumstances. Should conditions improve, the affected mines would once again become more active and would generate further threats to water quality.

Water quality investigations are being conducted at Curecanti NRA by recreation area staff to develop baseline data through the collection, testing, and analysis of biological, chemical, and physical data. Specifically, Curecanti's lakes and streams are being monitored for heavy metals, nutrients, ions, coliform bacteria, pH, conductivity, dissolved oxygen, stream temperature and flow, radiation, and chlorophyll. This information will be used to effect better management decisions and to ascertain and protect against health hazards to visitors and the aquatic resources. The data gathered thus far are included in the subsequent chapters of this report.

During the summer months, Blue Mesa Reservoir develops algal blooms that could threaten water quality through increased nutrient enrichment. Identification of the type, location, and time of these algal blooms was completed during the 1983 season. During the same study period, the Bureau of Reclamation, U.S. Department of the Interior, conducted a chlorophyll analysis and evaluated its results using remote sensing with LANDSAT. Results of this survey are also included in this report. It should be noted that the 1983 water year was one of exceptionally high runoff and flooding throughout the upper Colorado River Basin. It is uncertain what influence this flooding may have had on the results of these investigations. All three power plants on the reservoirs were running at or near full generating capacity. In addition, all three reservoirs spilled: Blue Mesa (high pool elevation 7,519 ft.) spilled June 23-July 19, Morrow Point spilled June 24-July 15, and Crystal spilled June 24-September 16.

It is possible that the impoundment and channelization of the Gunnison River has altered species diversity and productivity of benthic organisms, although it is unknown what changes may have occurred. Studies by Colborn (1981) indicate that streams within the Gunnison River Basin may at times have concentrations of heavy metals, such as cadmium and molybdenum, that accumulate in aquatic insect tissue and may inhibit molting of the giant stonefly (Pteronarcys californica).

One purpose of these studies was to gather baseline information on the status of phytoplankton and benthic organisms for future reference. A second purpose was to assess the current trophic status of the reservoir and its tributaries by comparing

collected phytoplankton and macroinvertebrate samples with species known to indicate pollution. An aquatic study of algae and benthic organisms was needed to complement the existing water quality monitoring program begun by the park in 1982. This report summarizes the results of phytoplankton and chlorophyll collection in Blue Mesa Reservoir and macroinvertebrate collection in selected tributaries that flow into Blue Mesa Reservoir. Data analysis includes algae and benthic species identification and a description of species diversity, density, and productivity since impoundment of the Gunnison River.

Background

Curecanti National Recreation Area lies in the Central Rockies and is administered by the National Park Service, U.S. Department of the Interior. It is located on Colorado's western slope of the Rocky Mountains in Montrose and Gunnison Counties. The recreation area is composed of a chain of three lakes impounded on the Gunnison River. Blue Mesa Reservoir (9,000 acres) is over 26 miles long, has 96 miles of shoreline, and is the largest body of water in the state of Colorado. It is situated in the Gunnison River Valley, which is characterized by bordering steep bluffs and high mesas of volcanic origin. Morrow Point Lake (800 acres), a narrow fjord-like lake situated in precambrian bedrock, is 11 miles long with 24 miles of shoreline. Crystal Lake (300 acres) is similar in character to Morrow Point and is 6 miles long with 19.6 miles of shoreline. The three lakes were formed by the dams of the Wayne N. Aspinall Unit (formerly the Curecanti Unit) of the Colorado River Storage

Project, which are operated by the Bureau of Reclamation. Located within the park boundary are 11 miles of the Gunnison River and 53 miles of tributary streams.

Curecanti manages an additional 32,014 acres of land surrounding the lakes and streams. The recreation area's elevations range from 6527 to 9154 ft. Vegetation includes sheltered stands of Douglas fir, spruce, and aspen; upland meadows at higher elevations; and grasses, shrubs, and sagebrush on the lower slopes. Riparian zones are characterized by cottonwood and willow.

BENTHIC MACROINVERTEBRATE SURVEY

April - November 1983

National Park Service

BENTHIC MACROINVERTEBRATE SURVEY

Sample Locations

All sample locations were chosen to represent different lotic habitats within the boundaries of the Curecanti National Recreation Area (Figure 1). Most sample sites were, therefore, located on the selected tributaries near (but upstream) of the high-water mark for Blue Mesa Reservoir.

The following selected tributaries were sampled for benthic macroinvertebrates:

Cebolla Creek. Sample site located within 1/4 mile upstream from point where power line crosses creek.

Lake Fork of Gunnison River. Sample site located approximately 50 yards upstream of the picnic area at the NRA boundary on the old railroad grade.

Gunnison River. Sample site located at the Neversink picnic area.

Soap Creek. Sample site located at the Soap Creek campground.

Sampling Procedure

Samples were taken in riffle habitats. All samples were obtained by a two-minute kick-sampling method, preserved in 8 ml formaldehyde solution, and stored in a 300 ml plastic sample jar. Organisms were picked live at the sample site with particular emphasis on small and/or criptic instars. The remaining sample material was returned to the laboratory and sorted using a dissecting microscope.

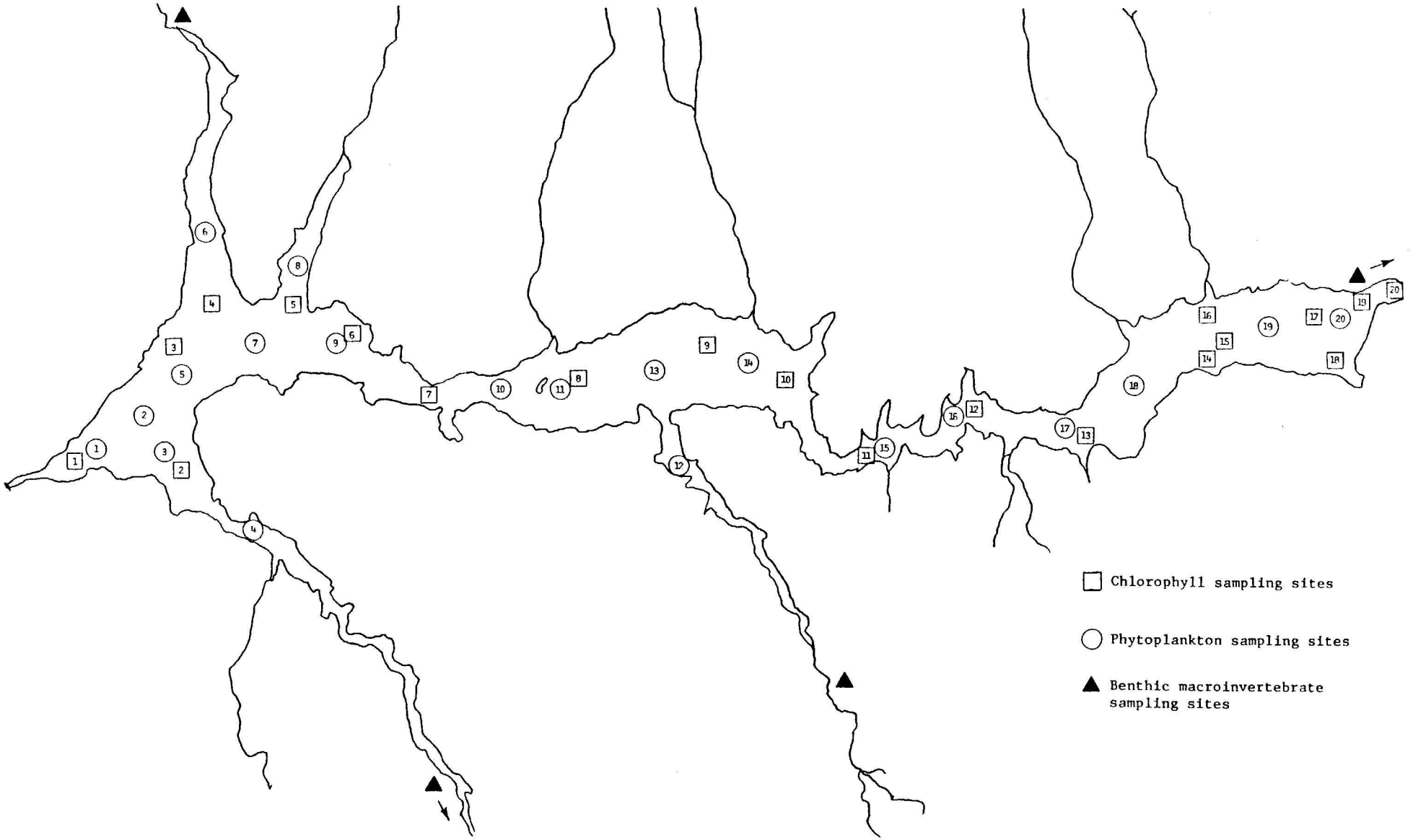


Figure 1. Locations of sampling sites on Blue Mesa Reservoir and its tributaries, Curecanti National Recreation Area.

Organism Identification

Taxonomic identification of organisms obtained from each sample generally followed the methods of Ward and Grey (personal communication, J. V. Ward) (1, 2, 3, 8, 12, 13, 19).

Diversity Indices and Other Mathematical Formulae Used

Shannon-Weaver Diversity Index, D. One way to describe the condition of a macroinvertebrate community is to indicate the community's diversity (9, 11, 14, 18, 20). The diversity of a community is dependent not only on the number of taxa found in a collection but also on the relative abundance of the individuals in each taxa. A community with all of the species or taxa with near equal numbers of individuals in each taxa is more diverse than one in which the numbers of individuals are concentrated into one or two common taxa with a few individuals in rare taxa. Therefore, diversity has two components, the "richness" of the taxa, or number of taxa present, and the "evenness" of the taxa, or the distribution of the individuals amoung the species.

The most commonly used method of analyzing a community's diversity is the use of a diversity index (9, 11, 14, 16, 20, 21). Diversity indices are mathematical expressions used to describe community structure and to summarize large amounts of information about numbers and kinds of organisms.

The diversity index used in this report is the Shannon-Weaver diversity index (15). The index was calculated using log [D(10)], natural log [D(ln)], and log [D(2)]. When observing D(2), values of less than one have been obtained in areas of heavy pollution, values from one to three in areas of

moderate pollution, and values exceeding three in clean water areas.

Percent (%) of Total N. The percent of total N gives the percent of the total number of individuals for a particular taxa.

D(2)-max and D(2)-min. These values represent the theoretical maximum and minumum diversity attainable with a given number of taxa and individuals.

Redundancy (R). Redundancy is an index that measures the dominance of one or more species and is generally inversely proportional to the wealth or evenness of species (6). It is scaled to fall between zero and one, where zero implies that the observed diversity is as large as possible, and one implies that the diversity is as small as possible. Redundancy is also a measure of probability and information. If redundancy is high, then the probability that an individual belongs to a species already recognized is high, and information per individual is low (5).

Evenness (EV). Since a community with few, evenly distributed species may have the same diversity index as one with many, unevenly distributed species, it is desirable to indicate the evenness of the distribution of individuals among the species (14). This index is scaled between zero and one, with the largest value indicating greatest evenness and zero indicating the lowest evenness.

Equitability (E). Equitability is another form of evenness

proposed by Lloyd and Ghelardi in 1957 (10). In using equitability the observed Shannon-Weaver diversity index is compared with a maximum value based on MacArthur's "broken stick" model (18). MacArthur's broken stick model results in a distribution of species that may frequently be observed in nature, with a few abundant species and increasing numbers of species with a few individuals.

Sample data is not expected to conform to MacArthur's model but is only compared with it. Results of the use of equitability will generally yield a number between zero and one. If this number is thought of as a percentage, by multiplying by 100, then one could say, "Our sample community has a species diversity appropriate to a natural community in which only X percent as many species occur," or "Our sample community has a species diversity only X percent as high as could naturally occur." It has been recommended that equitability be used whenever the Shannon-Weaver diversity index is used to determine sample diversity (18).

Discussion

Cebolla Creek. The Shannon-Weaver diversity index (log 2) (15) for this sampling site was 3.425 for the 4/25/83 sample and 3.503 for the 9/15/83 sample. There was no significant difference in the diversity index at this site for the two sampling periods. The diversity was high during both sampling periods, indicating clean water conditions. The number of Plecoptera and Ephemeroptera remained similar. This is a good indicator of little change in the water quality over this period of time

because these Ephemeropterans and Plecopterans are sensitive indicators of pollutant impacts in streams and rivers.

Changes in numbers of individuals collected is due mainly to changes in numbers of Tricoptera and Dipterans. This may be due to emergence or hatching of different organisms, increased productivity, or slight changes in sampling techniques.

The following organisms, found on 25 April and 15 September 1983, are listed as intolerant to facultatively intolerant to pollution (18) and/or reside in high-quality to medium-quality water (7).

Ephemeroptera
- Ephemerellidae
  - Drunella grandis

Plecoptera
- Perlodidae
  - Isogenoides
- Chloroperlidae
  - Alloperla

Tricoptera
- Brachycentridae
  - Brachycentrus
- Hydropsychidae
  - Hydropsyche
- Rhyacophilidae
  - Rhyaphila
- Hydropticidae
  - Lepidostoma
- Glossosomatidae
  - Glossosoma

Simuliidae

Coleoptera
- Elmidae
  - Optioservus

Gunnison River - Neversink. The Shannon-Weaver diversity index (log 2) (15) for this sampling site was 3.425 on 4/25/83 and 3.473 on 9/16/83. There was no significant difference between

the diversity indexes for this site at the two sampling periods. The diversity indexes were high at both sampling times, indicating clean water conditions. The numbers of Ephemeroptera and Plecoptera found at this site increased on the second sampling, September 16th. This could indicate stable or increased water quality where a great reduction in numbers of these groups could indicate a general reduction in water quality.

The increase in numbers of individuals during the second sampling period could be due to emergence or hatching of different organisms, increased productivity, or slight changes in sampling techniques.

The following organisms, found on 25 April and 16 September, 1983, are listed as intolerant to facultatively intolerant to pollution (18) and/or reside in high-quality to medium-quality water (7).

Plecoptera
- Chloroperlidae
  - *Alloperla*

Ephemeroptera
- Ephemerellidae
  - *Drunella grandis*
  - *Ephemerella infrequens*
- Leptophlebiidae
  - *Paraleptophlebia*
- Tricorythidae
  - *Tricorythodes*

Tricoptera
- Brachycentridae
  - *Brachycentrus*
- Hydropsychidae
  - *Hydropsyche*
- Rhyacophilidae
  - *Rhycophila*
- Lepidostomatidae
  - *Lepidostoma*
- Glossosomatidae
  - *Glossosoma*

Diptera
Simulidae
Simulium

Coleoptera
Elmidae
Optioservus

Lake Fork. The Shannon-Weaver diversity index (log 2) (15) for this site on 4/25/83 was 2.710 and on 9/15/83 it was 3.358. On both sampling dates fairly high diversity was noted. There was a slight increase in diversity upon the second sampling. The increased diversity was not due to increased numbers of individuals but due to increased numbers of taxa present in the second sample. An increase in evenness of individuals distributed among the taxa was also seen. The increased evenness was due to decreases in numbers of Ephemeropterans [*Ephemerella* and *Rhithrogena*] and Plecopterans [*Pteronarcella badia*].

The number of Plecopterans dropped in the second sample compared to the first. This may be due to the emergence of *Claassina sabulosa* in the late summer and early autumn (2).

The following organisms found on 25 April and 15 September, 1983, are listed as intolerant to facultatively intolerant to pollution (18) and/or reside in high-quality to medium-quality water (7).

Plecoptera
Perlodidae
Isogenoides

Ephemeroptera
Siphlonuridae
Ameletus
Heptageniidae
Rhithrogena
Ephemerellidae
Drunella grandis

Coleoptera
Elmidae
Optioservus

Soap Creek. The Shannon-Weaver diversity index (log 2) (15) from the sampling period of 9/16/83 was 1.451 and for 11/21/83 was 2.137. These diversity indexes are low, indicating poor species diversity. The number of taxa remained relatively the same, but the number of individuals found on the 9/16/83 sampling was much larger than that found on 11/21/83. These inflated numbers were caused by a large number of the Tricopteran Lepidostoma and the Elmid Parvula. These large numbers of the two organisms resulted in a low evenness value for the samples, resulting in turn in low diversity index values. The large numbers of these organisms may be due to hatching or young larvae or fairly low water quality at this site. A higher productivity of the stream during September than during November could cause a larger number or organisms to be found in the first sample. The failure to find any Plecopterans in the November sample may be due to the emergence of most the the large individuals in the late summer and autumn.

The following organisms, found on 16 September and 21 November, 1983, are listed as intolerant to facultatively intolerant to pollution (18) and/or reside in high- to medium-quality water (7).

Ephemeroptera
Heptageniidae
Rhithrogena
Ephemerellidae
Drunella grandis
Drunella doddsi
Leptophilebiidae
Paraleptophlebia

Tricoptera
Hydropsychidae
Hydropsyche
Lepidostomatidae
Lepidostoma
Brachycentridae
Brachycentrus

Coleoptera
Elmidae
Optioservus

Hierarchy

Hierarchy of benthic macroinvertebrates found in Cebolla Creek, Gunnison River - Neversink area, Lake Fork of the Gunnison River, and Soap Creek during 1983.

Phylum Arthropoda
Class Insecta
Order Plecoptera
Family Pteronarcyidae
Pteronarcella badia
Family Perlidae
Claassina sabulosa
Hesperoperla pacifica
Family Perlodidae
Isogenoides
Skwala
Cultus
Isoperla
Family Chloroperlidae
Alloperla

Order Ephemeroptera
Family Siphlonuridae
Ameletus
Family Heptageniidae
Rhithrogena
Epeorus
Family Baetidae
Baetis insingnificans
Baetis tricaudatus
Baetis sp. A
Family Ephemerellidae
Drunella grandis
Drunella doddsi
Ephemerella infrequens
Family Leptophlebiidae
Paraleptophlebia
Family Tricorythidae
Tricorythodes

Order Trichoptera
- Family Limnephilidae
  - *Hesperophylax*
- Family Brachycentridae
  - *Brachycentrus*
- Family Hydropsychidae
  - *Hydropsyche*
  - *Arctopsyche*
  - *Cheumatopsyche*
- Family Rhyacophilidae
  - *Rhyacophila*
- Family Hydroptilidae
- Family Lepidostomatidae
  - *Lepidostoma*
- Family Glossosomatidae
  - *Glossosoma*

Order Coleoptera
- Family Elmidae
  - *Optioservus*
  - *Zaitzevia parvula*

Order Diptera
- Family Simuliidae
  - *Simulium*
- Family Athericidae
  - *Atherix pachypus*
- Family Psychodidae
  - *Pericoma*
- Family Chironomidae
- Family Tipulidae

Date: 4/25/83 Site: Cebolla Creek River Mile: 0.0
Substrate Type: Not Listed Area Sampled 0 Sq. Ft.

TAXA	% OF TOTAL N	NUMBER (Ni)
A. pachypus	3.33	6
Baetis	12.22	22
Brachycentrus	22.78	41
C. sabulosa	1.11	2
CHIRONOMIDAE	4.44	8
D. grandis	0.56	1
E. infrequens	11.67	21
Glossosoma	1.67	3
HYDROPTILIDAE	0.56	1
Hydropsyche	0.56	1
Isoperla	1.67	3
Lepidostoma	6.11	11
Optioservus	2.78	5
P. badia	12.22	22
Rhyaphila	0.56	1
SIMULIIDAE	10.00	18
TIPULIDAE	0.56	1
Z. parvula	7.22	13

Total No. of Taxa, S = 18 Total No. of Individuals, N = 180
Diversity Index, D(10) = 1.031, D(1n) = 2.374, D(2) = 3.425
D(2)-MIN. = 0.852, D(2)-MAX. = 4.170, Equitability E = 0.855
Redundancy, R = 0.224 Eveness, EV = 0.821

Date: 9/15/83 Site: Cebolla Creek River Mile: 0.0
Substrate Type: Not Listed Area Sampled 0 Sq. Ft.

TAXA	% OF TOTAL N	NUMBER (Ni)
Alloperla	10.34	9
B. insignificans	35.63	31
Baetis	4.60	4
C. sabulosa	1.15	1
D. grandis	1.15	1
E. infrequens	4.60	4
GLOSSOSOMATIDAE	1.15	1
Isogenoides	4.60	4
Optioservus	1.15	1
P. badia	6.90	6
Rhithrogena	5.75	5
SIMULIIDAE	5.75	5
TRICHOPTERA	14.94	13
Z. parvula	2.30	2

Total No. of Taxa, S = 14 Total No. of Individuals, N = 87
Diversity Index, D(10) = 0.919, D(ln) = 2.116, D(2) = 3.053
D(2)-MIN. = 1.189, D(2)-MAX. = 3.813, Equitability E = 0.836
Redundancy, R = 0.290 Eveness, EV = 0.801

Date: 4/25/83 Site: Gunnison R. Neversink River Mile: 0.0
Substrate Type: Not listed Area Sampled 0 Sq. Ft.

TAXA	% OF TOTAL N	NUMBER (Ni)
A. Pachypus	0.27	1
Arctopsyche	2.73	10
Baetis	0.82	3
Brachycentrus	3.01	11
C. sabulosa	2.19	8
CHIRONOMIDAE	3.55	13
Cheumatopsyche	9.29	34
D. grandis	1.37	5
E. infrequens	4.92	18
Ephemerella	9.29	34
Hesperophylax	0.55	2
Hydropsyche	25.68	94
Lepidostoma	11.20	41
Optioservus	17.76	65
P. badia	0.82	3
Paraleptophlebia	0.82	3
Rhyacophila	1.09	4
Simulium	2.19	8
Skwala	0.27	1
TIPULIDAE	0.82	3
TRICOCRYTHIDAE	0.82	3
Z. parvula	0.55	2

Total No. of Taxa, S = 22 Total No. of Individuals, N = 366
Diversity Index, D(10) = 1.031, D(ln) = 2.374, D(2) = 3.425
D(2)-MIN. = 0.576, D(2)-MAX. = 4.462, Equitability E = 0.700
Redundancy, R = 0.267 Eveness, EV = 0.768

Date: 9/16/83 Site: Gunnison R. Neversink River Mile: 0.0
Substrate Type: Not Listed Area Sampled 0 Sq. Ft.

TAXA	% OF TOTAL N	NUMBER (Ni)
A. pachypus	0.25	2
Alloperla	0.25	2
Arctopsyche	2.11	17
B. insignificans	9.45	76
Baetis	7.59	61
Brachycentrus	0.50	4
C sabulosa	0.87	7
CHIRONOMIDAE	2.99	24
Cheumatopsyche	17.54	141
D. grandis	1.24	10
Glossosoma	2.61	21
Hydropsyche	16.79	135
Lepidostoma	15.17	122
Optioservus	5.35	43
P badia	0.37	3
PERLODIDAE	11.69	94
Rhycophila	0.50	4
Skwala	0.87	7
TIPULIDAE	1.24	10
Tricorythodes	1.37	11
Z. parvula	1.24	10

Total No. of Taxa, S = 21 Total No. of Individuals, N = 804
Diversity Index, D(10) = 1.045, D(1n) = 2.407, D(2) = 3.473
D(2)-MIN. = 0.279, D(2)-MAX. = 4.393, Equitability E = 0.759
Redundancy, R = 0.224 Eveness, EV = 0.791

Date: 4/25/83 Site: Lake Fork River Mile: 0.0
Substrate Type: Not Listed Area Sampled 0 Sq. Ft.

TAXA	% OF TOTAL N	NUMBER (Ni)
Baetis	5.00	4
C. sabulosa	21.25	17
CHIRONOMIDAE	2.50	2
D. doddsi	2.50	2
Epeorus	1.25	1
Ephemerella	26.25	21
Isogenoides	1.25	1
Isoperla	6.25	5
P. badia	22.50	18
Rhithrogena	11.25	9

Total No. of Taxa, S = 10 Total No. of Individuals, N = 80
Diversity Index, D(10) = 0.816, D(ln) = 1.879, D(2) = 2.710
D(2)-MIN. = 0.895, D(2)-MAX. = 3.322, Equitability E = 0.905
Redundancy, R = 0.252 Eveness, EV = 0.816

Date: 9/15/83 Site: Lake Fork River Mile: 0.0
Substrate Type: Not Listed Area Sampled 0 Sq. Ft.

TAXA	% OF TOTAL N	NUMBER (Ni)
A. pachypus	8.43	7
Ameletus	2.41	2
Baetis	15.66	13
C. sabulosa	3.61	3
CHIRONOMIDAE	2.41	2
D. grandis	12.05	10
Isogenoides	2.41	2
Optioservus	9.64	8
P. badia	16.87	14
Rhithrogena	3.61	3
Skwala	6.02	5
TRICHOPTERA	2.41	2
Z. parvula	14.46	12

Total No. of Taxa, S = 13 Total No. of Individuals, N = 83
Diversity Index, D(10) = 1.011, D(1n) = 2.328, D(2) = 3.358
D(2)-MIN. = 1.143, D(2)-MAX. = 3.711, Equitability E = 1.128
Redundancy, R = 0.137 Eveness, EV = 0.905

Date: 9/16/83 Site: Soap Creek River Mile: 0.0
Substrate Type: Not Listed Area Sampled 0 Sq. Ft.

TAXA	% OF TOTAL N	NUMBER (Ni)
A. pachypus	0.51	5
Arctopsyche	0.20	2
B. insignificans	0.81	8
Brachycentrus	0.10	1
C. sabulosa	0.30	3
D. doddsi	0.10	1
D. grandis	2.23	22
H. pacifica	0.10	1
Hydropsyche	2.84	28
Lepidostoma	74.16	732
Optioservus	3.85	38
P. badia	0.30	3
Rhithrogena	3.14	31
Skwala	0.61	6
TIPULIDAE	0.20	2
Z. parvula	10.54	104

Total No. of Taxa, S = 16 Total No. of Individuals, N = 987
Diversity Index, D(10) = 0.459, D(1n) = 1.057, D(2) = 1.525
D(2)-MIN. = 0.176, D(2)-MAX. = 4.000, Equitability E = 0.227
Redundancy, R = 0.647 Eveness, EV = 0.381

Date: 11/21/83 Site: Soap Creek River Mile: 0.0
Substrate Type: Not Listed Area Sampled 0 Sq. Ft.

TAXA	% OF TOTAL N	NUMBER (Ni)
A. pachypus	1.47	3
Baetis	1.47	3
CHIRONOMIDAE	2.94	6
D. grandis	1.47	3
E. infrequens	0.98	2
Hydropsyche	5.39	11
Lepidostoma	62.25	127
Optioservus	5.88	12
Paraleptophlebia	0.49	1
Pericoma	0.49	1
Rhithrogena	4.41	9
SIMULIDAE	0.49	1
TIPULIDAE	1.96	4
Z. parvula	10.29	21

Total No. of Taxa, S = 14 Total No. of Individuals, N = 204
Diversity Index, D(10) = 0.643, D(1n) = 1.481, D(2) = 2.137
D(2)-MIN. = 0.591, D(2)-MAX. = 3.811, Equitability E = 0.418
Redundancy, R = 0.520 Eveness, EV = 0.561

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PHYTOPLANKTON SURVEY

June - August 1983

National Park Service

PHYTOPLANKTON SURVEY

Introduction

Phytoplankton studies were undertaken to ascertain whether algal problems exist in Blue Mesa Reservoir. The phytoplankton identifications and counts in this report are a part of a more comprehensive study which includes physical parameters and chlorophyll determinations. The latter were determined by NPS personnel.

Materials and Methods

Twenty collection sites were selected with the concurrence of Roger Andrascik, Resource Manager for Curecanti NRA (Fig. 1). Screening for algal species was conducted using a short tow with a 10 micron mesh-size nanoplankton net to concentrate algae. In addition, three water samples were collected at different depths at each site. One sample was collected from the top five meters using a rigid 1.0 in PVC tubing column sampler. Water from this sample was poured into a bucket and mixed thoroughly, and sub-samples were taken from the mixture. Spot samples were taken at depths of 10 m and 15 m using a Van Doren sampler. Collections were made on a monthly basis in June, July, and August of 1983. Grab samples were also taken from the shore in late April when the reservoir was partially free of ice.

Samples were kept on ice until they were examined in the

laboratory in Fort Collins. Only living samples were used for identification since fixatives would disrupt or destroy some delicate diagnostic features of many of the non-diatomaceous algae. Diatoms were cleared with hydrogen peroxide so that species could be identified correctly. Permanent slides were made of these diatoms after the frustules (cell walls) were mounted in Epon 812. In order to expand the species list and be able to identify most of the algae in a given sample, 100 ml of the concentrated net samples were enriched with Bold's Basal Medium and grown at 18 C for 2-3 weeks. These were examined periodically with an inverted microscope, and any additional species that grew in the enrichment were recorded.

Algal counts were made from thoroughly mixed samples which were placed in a Sedgewick-Rafter counting chamber and examined with a phase-contrast microscope equipped with a Whipple ocular grid. Single cells and colonies were counted as separate units, whereas 50 micron segments were units in filamentous algae. Photomicrographs of many of the algae were taken for future reference.

Temperatures and Secchi Disc readings were taken at each sampling site at the time of collection. These data are provided in Tables 22-24.

Results and Discussion

Even though samples and counts were taken in April, they did not correspond to the sites and sampling techniques used later but merely served to provide some preliminary baseline data. Therefore these data are not reported here.

Relatively few species were identified for Blue Mesa Reservoir even when enrichment data are included. In any given nanoplankton sample usually only 4-10 species could be found, showing the significance of enrichment cultures in obtaining a species list. During the three-month sampling period a total of 85 species was identified consisting of 18 diatoms, 45 green algae, 3 golden-brown algae, 6 cryptomonads, 8 blue-green algae, 2 dinoflagellates, 2 euglenoids, and one yellow-green alga (Table 21). Some new genera and species, which have been described only recently, were found and are marked with an asterisk in the species list.

Population numbers were extremely low throughout the summer (Tables 1-20), indicating low nutrient levels. However, no data on nutrients was received so no correlations could be made. The data presented consist only of the top five meters since the samples at 10 and 15 meters were devoid of any algae except for an occasional cell every 500+ counts. Thus, for all intents and purposes, samples below 5 meters were not necessary. The total numbers in Tables 1-20 represent the total population of individuals per ml. The numbers by some species indicate the percent of individuals present in a given population, while an "X" indicates that the species was present but constituted less than 1 percent of the total population. Table 25 summarizes the phytoplankton by species and their occurrence at each site for the three sampling trips.

Even though algal populations increased during the summer, the numbers remained sufficiently low to prevent meaningful

comparisons between sites. Thus it is not possible to attempt detecting influences of river influxes or human activity.

As seen in Tables 22-24, the Secchi readings remained about the same throughout the summer, corroborating the lack of blooms during the months of collection. The lower readings in June probably represent silt from the influx of large volumes of turbid river waters.

In conclusion, based on the limited data from 1983, it appears that Blue Mesa Reservoir does not have an algal problem. While Aphanizomenon flos-aquae is present and visible as flakes in the reservoir, it likewise does not constitute a nuisance at this time. It may accumulate in larger masses along the shore because of wind action, but again this represents a localized accumulation. Thus, the concern over a potential Aphanizomenon bloom and its attendant toxin-producing problem is exaggerated.

It must be pointed out, however, that 1983 may have been an anomalous year considering the large influx of water, due to heavy snowpack and runoff, into the reservoir. Only a long range study of the biota and physical parameters can properly determine the eutrophic status of Blue Mesa Reservoir.

Future data need to be taken only from the top 5 meters. Additionally, sampling sites could probably be reduced in number to 15 by eliminating sites 2, 10, 13, 17, and 19 and still retain the sensitivity necessary to show possible effects of river and creek contributions to Blue Mesa Reservoir.

Table 1. Species list and counts (ind./mℓ) for site 1.

Genus or species	Dates		
	June	July	August
Anabaena sp.	-	-	X
Ankistrodesmus falcatus	37.5	X	X
Ankistrodesmus gelatiniformis	X	X	7.14
Aphanizomenon flos-aquae	-	X	57.14
Aphanothece nidulans	-	-	7.14
Asterococcus limneticus	12.5	-	7.14
Ceratium hirundinella	-	-	7.14
Chlamydomonas alpinum	-	X	-
Closterium sp.	-	X	-
Cryptomonas sp. 1	X	-	-
Eudorina californica		X	-
Fragilaria crotonensis	X	X	X
Kirchneriella obesa	-	-	X
Melosira granulata	X	X	X
Oocystis lacustris	-	-	X
Oocystis parva	-	X	-
Pediastrum boryanum	-	X	-
Schroederia setigera	37.5	25	-
Sphaerocystis schroederi	X	X	X
Stauvastrum leptocladum	-	X	-
Stephanodiscus asterae	X	X	-
Stephanodiscus niagarae	12.5	75	14.28
Tribonema sp.	X	X	-
Volvox aureus	-	X	-
Total Population	79.65	168.06	294.11

Table 2. Species list and counts (ind./mℓ) for site 2.

Genus or species	Dates		
	June	July	August
Anabaena circinalis	-	X	-
Anabaena spirulinoides	-	-	X
Ankistrodesmus falcatus	27.27	X	-
Ankistrodesmus gelatiniformis	-	X	X
Aphanizomenon flos-aquae	-	X	45.45
Asterionella formosa	X	X	36.36
Asterococcus limneticus	X	6.6	-
Chlamydomonas alpinum	-	X	-
Closteriopsis longissima	-	-	X
Cocconeis placentula	-	X	
Eudorina elegans	-	X	X
Fragilaria construens	X	-	-
Fragilaria crotonensis	X	X	-
Melosira granulata	X	-	-
Nitzschia hungarica	-	X	-
Octosporiella coloradoensis	-	-	X
Octocystis reidii	-	-	X
Oocystis parva	-	-	X
Palmellopsis sp.	-	-	X
Schroederia setigera	45.45	26.67	-
Sphaerocystis schroederi	X	X	X
Staurastrum leptocladum		6.6	X
Stephanodiscus asterae	X	X	9.1
Stephanodiscus niagarae	27.27	60	X
Tribonema sp.	-	X	X
Ulothrix fimbriata	-	-	X
Volvox aureus	-	X	X
Total Population	104.09	208.68	228.79

Table 3. Species list and counts (ind./mℓ) for site 3.

Genus or species	Dates		
	June	July	August
Achnanthes lanceolata	9.09	-	-
Ankistrodesmus falcatus	9.09	6.67	-
Ankistrodesmus gel	X	X	-
Aphanizomenon flos-aquae	-	X	60.00
Aphanothece nidulans	-	-	-
Asterionella formosa	X	X	40.00
Botryococcus braunii	-	X	-
Characium sp.	9.09	-	-
Closteriopsis longissima	-	X	X
Coelastrum microporum	-	X	-
Colacium vesiculosum	-	X	-
Cryptomonas sp. 1	-	13.33	-
Cryptomonas marsonii	18.18	13.33	-
Eudorina elegans	-	X	-
Fragilaria crotonensis	X	6.67	X
Gloeocystis sp.	-	X	-
Gonium sociale	-	-	X
Melosira granulata	X	X	X
Octocystis reidii	X	X	X
Pandorina morum	-	X	-
Pediastrum boryanum	-	X	-
Pediastrum duplex	-	-	X
Schroederia setigera	36.36	6.67	-
Sphaerocystis schroederi	-	X	X
Staurastrum sp.	X	-	-
Staurastrum leptocladum	-	X	X
Stephanodiscus asterae	X	X	X
Stephanodiscus niagarae	9.09	53.33	-
Tribonema sp.	X	X	X
Volvox aureus	-	X	X
Total Population	110.57	208.69	103.99

Table 4. Species list and counts (ind./mℓ) for site 4.

Genus or species	Dates		
	June	July	August
Anabaena sp.	-	X	-
Ankistrodesmus falcatus	9.09	6.25	-
Ankistrodesmus gelatiniformis	X	X	-
Aphanizomenon flos-aquae	-	X	16.67
Aphanothece nidulans	-	-	16.67
Asterionella formosa	218.18	6.25	60.31
Chlamydomonas alpinum	-	6.25	-
Colacium vesiculosum	-	6.25	-
Cryptomonas marsonii	9.09	18.75	X
Cryptomonas ovata	9.09	-	-
Fragilaria crotonensis	X	12.3	X
Gonium sociale	-	-	X
Melosira granulata	X	X	X
Nannochloris sp.	-	X	-
Octocystis reidii	-	X	X
Oocystis lacustris	-	X	X
Schroederia setigera	45.45	X	-
Sphaerocystis schroederi	X	6.25	X
Staurastrum leptocladum	-	X	X
Stephanodiscus asterae	X	X	X
Stephanodiscus niagarae	X	37.5	X
Volvox aureus	-	X	X
Volvulina steinii	X	-	-
Total Population	114.97	224.09	105.04

Table 5. Species list and counts (ind./mℓ) for site 5.

Genus or species	Dates June	July	August
Ankistrodesmus falcatus	38.46	X	-
Ankistrodesmus gelatiniformis	X	X	X
Aphanizomenon flos-aquae	-	X	26.32
Aphanothece nidulans	-	-	10.53
Characium sp.	7.69	-	-
Chromulina sp.	7.69	-	-
Colacium vesiculosum	7.69	-	-
Fragilaria crotonensis	-	X	X
Gloeocystis giges	X	-	-
Melosira granulata	X	X	52.63
Nannochloris sp.	-	X	-
Octosporiella coloradoensis	-	-	X
Pediastrum boryanum	-	X	-
Pediastrum duplex	-	X	-
Pediastrum tetras	-	-	X
Schroederia setigera	23.08	33.3	5.26
Spondylosium planum	-	X	-
Staurastrum leptocladum	X	X	X
Stephanodiscus asterae	X	X	X
Stephanodiscus niagarae	15.38	66.7	X
Tribonema sp.	X	-	-
Volvox aureus	-	X	-
Volvulina steinii	-	-	4.13
Total Population	116.21	126.05	199.58

Table 6. Species list and counts (ind./mℓ) for site 6.

Genus or species	Dates		
	June	July	August
Anabaena circinalis	-	X	-
Anabaena spirulinoides	-	7.14	-
Ankistrodesmus falcatus	15.38	7.14	X
Ankistrodesmus gelatiniformis	X	X	X
Aphanothece nidulans	-	-	20
Asterionella formosa	X	X	80
Chlamydomonas alpinum	-	7.14	-
Chromulina sp.	23.08	-	-
Closterium sp.	-	X	-
Cryptomonas erusa	7.69	X	-
Cryptomonas marsonii	-	-	-
Cryptomonas ovata	-	14.28	-
Eudorina elegans	-	X	X
Fragilaria crotonensis	X	X	X
Mallomonas sp.	15.38	-	-
Melosira granulata	-	X	X
Octocystis reidii	-	X	X
Oocystis parva	-	X	-
Pandorina morum	-	X	-
Pediastrum boryanum	-	X	X
Schroederia setigera	15.38	14.28	X
Sphaerocystis schroederi	-	X	X
Staurastrum leptocladum	-	X	X
Stephanodiscus asterae	X	X	X
Stephanodiscus niagarae	15.38	50.00	X
Synedra ulna	-	X	-
Tribonema sp.	X	X	X
Volvox aureus	-	X	-
Volvulina steinii	-	X	X
Total Population	270.39	140.72	70.03

Table 7. Species list and counts (ind./mℓ) for site 7.

Genus or species	Dates June	July	August
Ankistrodesmus falcatus	7.69	X	X
Ankistrodesmus gelatiniformis	X	X	X
Aphanizomenon flos-aquae	-	X	X
Aphanothece nidulans	-	-	66.67
Asterionella formosa	X	16.67	33.33
Botryococcus braunii	-	X	X
Chlamydomonas alpinum	-	X	-
Chlorogonium carefootii	7.69	-	-
Closterium sp.	-	X	-
Colacium vesiculosum	-	X	-
Cryptomonas marsonii	7.69	5.55	-
Fragilaria crotonensis	23.08	22.22	X
Gloeococcus tetrasporus	-	-	X
Gloeocystis sp.	-	-	X
Mallomonas sp.	X	-	-
Melosira granulata	X	-	-
Nitzschia palea	-	-	X
Octocystis reidii	-	-	X
Octosporiella coloradoensis	-	-	X
Pediastrum boryanum	X	X	-
Pediastrum dupler	-	X	-
Scenedesmus obliguus	-	-	X
Schroederia setigera	7.69	-	-
Sphaerocystis schroederi	X	X	X
Staurastrum leptocladum	-	X	X
Stephanodiscus asterae	X	5.55	-
Stephanodiscus niagarae	38.46	49.5	X
Tribonema sp.	-	X	-
Ulothrix sp.	-	X	X
Volvox aureus	-	X	-
Total Population	178.5	189.07	63.02

Table 8. Species list and counts (ind./mℓ) for site 8.

Genus or species	Dates		
	June	July	August
Ankistrodesmus falcatus	28.57	-	-
Ankistrodesmus gelatiniformis	X	X	-
Asterionella formosa	X	7.69	57.14
Chlamydomonas alpinum	-	-	X
Closteriopsis longissima	-	X	X
Cryptomonas marsonii	X	7.69	-
Cryptomonas ovata	14.29	-	-
Eudorina elegans	-	X	-
Fragilaria crotonensis	X	X	X
Gloeococcus tetrasporus	-	-	X
Gloeocystis sp.	-	X	-
Melosira granulata	X	X	28.57
Octocystis reidii	-	7.69	X
Octosporiella coloradoensis	-	X	X
Oocystis lacustris	-	X	X
Pediastrum boryanum	-	X	-
Pediastrum duplex	-	X	-
Schroederia setigera	42.86	X	-
Sphaerocystis schroederi	X	X	-
Staurastrum leptocladum	X	X	X
Stephanodiscus asterae	X	X	X
Stephanodiscus niagarae	14.29	69.23	X
Stigeoclonium tenue (?)	-	X	-
Tribonema sp.	-	X	X
Volvox aureus	X	X	-
Volvulina steinii	-	-	14.28
Total Population	91.91	136.55	73.53

Table 9. Species list and counts (ind./mℓ) for site 9.

Genus or species	Dates June	July	August
Anabaena circinalis	-	X	-
Anabaena spirulinoides	X	-	-
Ankistrodesmus falcatus	7.69	X	-
Ankistrodesmus gelatiniformis	X	X	X
Aphanothece nidulans	-	-	35.29
Asterionella formosa	X	X	17.65
Chaetophora sp.	-	-	X
Chlamydomonas alpinum	-	X	-
Chlorogonium carefootii	7.69	-	-
Closterium sp.	X	-	-
Cocconeis placentula	-	X	-
Cosmarium sp.	-	-	X
Cryptomonas erosa	23.08	-	-
Cryptomonas marsonii	-	11.11	-
Eudorina elegans	-	-	X
Englena sp.	-	-	X
Fragilaria crotonensis	-	X	X
Gongrosira sp.	-	-	X
Gonium sociale	-	-	X
Melosira granulata	X	X	41.18
Melosira italica	-	-	X
Octocystis reidii	-	X	-
Octosporiella coloradoensis	-	-	X
Oocystis lacustris	-	-	X
Pandorina morum	-	X	-
Pediastrum boryanum	-	-	X
Peridinium cinctum (?)	-	-	X
Schroederia setigera	53.85	-	-
Sphaerocystis schroederi	X	-	X
Staurastrum leptocladum	-	X	X
Stephanodiscus asterae	X	X	-
Stephanodiscus niagrae	X	88.89	5.88
Stigeoclonium tenue (?)	-	X	-
Volvox aureus	-	X	X
Volvulina steinii	X	-	-
Total Population	208.48	94.54	238.09

Table 10. Species list and counts (ind./mℓ) for site 10.

Genus or species	Dates		
	June	July	August
Anabaena circinalis	-	X	-
Ankistrodesmus gelatiniformis	X	X	X
Aphanizomenon flos-aquae	-	X	44.44
Aphanothece nidulans	-	-	22.22
Asterionella formosa	-	X	33.33
Closteriopsis longissima	-	X	-
Closterium sp.	-	X	-
Colacium vesiculosum	X	-	-
Cryptomonas erosa	X	X	-
Cryptomonas marsonii	28.57	-	-
Eudorina elegans	-	X	X
Fragilaria crotonensis	-	X	-
Gonium sociale	-	-	X
Hannea arcus	X	-	-
Melosira granulata	X	X	X
Nannochloris sp.	-	X	-
Octocystis reidii	-	X	-
Octosporiella coloradoensis	-	-	X
Pediastrum boryanum	-	X	-
Pediastrum duplex	-	X	-
Schroederia setigera	42.86	36.36	-
Sphaerocystis schroederi	X	X	X
Staurastrum leptocladum	X	18.18	X
Stephanodiscus asterae	14.28	X	X
Stephanodiscus niagarae	14.28	72.73	X
Tribonema sp.	X	-	-
Ulothrix sp.	-	X	-
Volvox aureus	-	X	X
Total Population	100.04	154.06	94.54

Table 11. Species list and counts (ind./mℓ) for site 11.

Genus or species	Dates June	July	August
Anabaena spirulinoides	-	X	-
Ankistrodesmus falcatus	40	-	-
Ankistrodesmus gelatiniformis	X	X	X
Aphanizomenon flos-aquae	-	X	-
Aphanothece nidulans	-	-	X
Asterionella formosa	X	X	22.22
Characium sp.	-	X	-
Closteriopsis longissima	-	-	-
Cryptomonas sp.	-	11.11	-
Fragilaria crotonensis	-	X	-
Melosira granulata	X	X	77.78
Octocystis reidii	-	X	-
Octosporiella coloradoensis	-	-	X
Oscillatoria sp.	-	X	-
Pandorina morum	-	X	-
Pediastrum boryanum	-	X	X
Pediastrum duplex	-	X	-
Schroederia setigera	60	22.22	-
Sphaerocystis schroederi	X	X	-
Spirogyra sp.	-	X	-
Staurastrum leptocladum	-	X	X
Stephanodiscus asterae	X	-	X
Stephanodiscus niagarae	X	66.67	X
Tribonema sp.	X	-	-
Ulothrix sp.	-	X	-
Volvox aureus	X	-	-
Volvulina steinii	-	-	X
Total Population	100.04	126.05	94.54

Table 12. Species list and counts (ind./mℓ) for site 12.

Genus or species	Dates June	July	August
Amphora ovalis	-	-	X
Ankistrodesmus gelatiniformis	X	X	-
Aphanizomenon flos-aquae	-	X	-
Aphanothece nidulans	-	-	27.27
Asterionella formosa	-	X	-
Closteriopsis longissima	-	X	-
Closterium sp.	-	X	-
Cryptomonas marsonii	85.71	X	-
Cryptomonas platyuris	14.29	-	-
Cryptomonas rostratiformis	X	-	-
Fragilaria crotonensis	X	X	X
Melosira granulata	X	X	63.64
Octocystis reidii	-	X	-
Octosporiella coloradoensis	-	X	X
Octocystis lacustris	-	X	-
Pediastrum boryanum	-	X	X
Pseudoanabaena catenata	-	X	-
Schroederia setigera	-	12.5	-
Staurastrum leptocladum	-	X	X
Stephanodiscus asterae	X	12.5	X
Stephanodiscus niagarae	X	75.0	9.08
Stigeoclonium tenue	-	X	-
Tribonema sp.	X	X	-
Total Population	133.69	84.03	154.06

Table 13. Species list and counts (ind./mℓ) for site 13.

Genus or species	Dates June	July	August
Ankistrodesmus falcatus	X	-	-
Ankistrodesmus gelatiniformis	X	-	X
Aphanizomenon flos-aquae	-	X	27.27
Aphanothece nidulans	-	-	54.55
Asterionella formosa	X	-	18.18
Botryococcus brannii	-	X	-
Closterium sp.	-	X	-
Colacium vesiculosum	X	-	-
Cryptomonas sp.	X	-	-
Cryptomonas marsonii	50.0	7.14	-
Fragilaria crotonensis	-	X	-
Hannea arcus	-	-	X
Melosira granulata	X	28.57	-
Nitzschia linearis	X	-	-
Octocystis reidii	-	X	-
Octosporiella coloradoensis	-	-	X
Pediastrum boryanum	X	X	X
Pediastrum duplex	-	X	-
Pseudoanabaena catenata	-	X	-
Schroederia setigera	50.0	7.14	-
Sphaerocystis schroederi	X	7.14	X
Stephanodiscus asterae	-	7.14	-
Stephanodiscus niagarae	X	42.86	X
Tribonema sp.	X	-	-
Total Population	42.02	196.07	115.54

Table 14. Species list and counts (ind./mℓ) for site 14.

Genus or species	Dates June	July	August
Anabaena circinalis	-	X	-
Anabaena spirulinoides	X	X	-
Ankistrodesmus falcatus	X	-	-
Ankistrodesmus gelatiniformis	X	X	-
Aphanizomenon flos-aquae	-	X	42.86
Asterionella formosa	X	X	28.57
Botryococcus braunii	X	X	-
Colacium vesiculosum	X	X	-
Cryptomonas marsonii	40	13.33	-
Cryptomonas ovata	X	-	-
Fragilaria crotonensis	X	X	X
Hannea arcus	-	X	X
Melosira granulata	-	46.66	X
Microcystis aeruginosa	-	X	-
Nitzschia acicularis	20	-	-
Octocystis reidii	-	X	14.28
Oedogonium sp.	-	6.67	-
Pediastrum boryanum	-	X	-
Schroederia setigera	20	6.67	14.28
Sphaerocystis schroederi	X	X	X
Staurastrum leptocladum	X	X	X
Stephanodiscus asterae	X	-	-
Stephanodiscus niagarae	20	26.67	X
Tribonema sp.	X	-	-
Volvulina steinii	-	-	X
Total Population	105.04	157.56	73.53

Table 15. Species list and counts (ind./mℓ) for site 15.

Genus or species	Dates June	July	August
Ankistrodesmus falcatus	16.67	11.11	-
Ankistrodesmus gelatiniformis	-	X	-
Aphanizomenon flos-aquae	-	X	14.28
Aphanothece nidulans	-	-	X
Asterionella formosa	X	22.22	7.14
Closteriopsis longissima	-	X	-
Closterium lunula	X	-	-
Colacium vesiculosum	-	11.11	-
Fragilaria crotonensis	X	11.11	28.57
Gloeocystis sp.	-	X	-
Hannea arcus	-	X	-
Melosira granulata	-	-	50.00
Oedogonium sp.	-	X	-
Pediastrum boryanum	-	X	-
Pediastrum duplex	-	X	-
Pseudoanabaena catenata	-	X	-
Schroederia setigera	83.33	-	X
Sphaerocystis schroederi	X	X	X
Staurastrum leptocladum	-	X	X
Stephanodiscus asterae	X	11.11	-
Stephanodiscus niagarae	X	33.33	X
Tribonema sp.	-	X	-
Ulothrix sp.	-	X	-
Volvox aureus	-	-	X
Total Population	126.05	94.54	196.07

Table 16. Species list and counts (ind./mℓ) for site 16.

Genus or species	Dates		
	June	July	August
Ankistrodesmus gelatiniformis	X	-	-
Aphanizomenon flos-aquae	-	X	68.75
Aphanothece nidulans	-	-	12.50
Asterionella formosa	X	X	X
Botryococcus braunii	-	X	-
Fragilaria crotonensis	X	20.00	6.25
Gloeocystis sp.	-	X	-
Melosira granulata	X	6.67	12.50
Mougeotia sp.	-	26.67	-
Nitzschia acicularis	25	-	-
Nitzschia palea	-	6.67	-
Octocystis reidii	-	X	-
Pediastrum boryanum	-	X	-
Pediastrum duplex	-	X	-
Scenedesmus quadricauda	-	X	-
Schroederia setigera	75	-	X
Sphaerocystis schroederi	X	X	-
Staurastrum leptocladum	X	6.67	X
Stephanodiscus asterae	X	-	-
Stephanodiscus niagarae	X	33.33	X
Stigeoclonium tenue (?)	-	X	-
Tribonema sp.	X	X	-
Ulothrix sp.	-	X	-
Volvox aureus	-	-	X
Total Population	84.03	210.08	336.13

Table 17. Species list and counts (ind./mℓ) for site 17.

Genus or species	Dates		
	June	July	August
Anabaena spirulinoides	X	-	-
Ankistrodesmus falcatus	X	-	-
Ankistrodesmus gelatiniformis	X	X	-
Aphanizomenon flos-aquae	-	X	46.43
Aphanothece nidulans	-	-	17.86
Asterionella formosa	X	10	3.57
Botryococcus braunii	-	X	-
Ceratium hirundinella	-	-	X
Chaetophora sp.	-	X	-
Chlamydomonas alpinum	-	X	-
Chrysameba sp.	-	-	-
Closteriopsis longissima	-	X	-
Coelastrum microporum	-	-	X
Colacium vesiculosum	-	X	-
Cryptomonas marsonii	X	-	-
Eudorina elegans	-	X	-
Fragilaria crotonensis	X	X	25.00
Hannea arcus	-	X	3.57
Melosira granulata	-	X	3.57
Nannochloris (?) sp.	-	X	-
Navicula cuspidata	X	-	-
Octocystis reidii	-	X	X
Octosporiella coloradoensis	-	-	X
Oocystis parva	-	X	-
Pediastrum boryanum	-	X	-
Pediastrum duplex	-	X	-
Schroederia setigera	X	40	-
Sphaerocystis schroederi	-	X	-
Staurastrum leptocladum	X	X	X
Stephanodiscus asterae	X	-	-
Stephanodiscus niagarae	X	50	X
Tribonema sp.	X	X	-
Volvox aureus	-	X	X
Total Population	0	105.04	294.11

Table 18. Species list and counts (ind./mℓ) for site 18.

Genus or species	Dates June	July	August
Ankistrodesmus falcatus	X	-	X
Ankistrodesmus gelatiniformis	-	X	-
Aphanizomenon flos-aquae	-	X	54.55
Aphanothece nidulans	-	-	9.09
Asterionella formosa	X	-	-
Ceratium hirundinella	X	-	-
Characium limneticum	X	-	-
Colacium vesiculosum	-	X	-
Fragilaria crotonensis	-	16.67	18.18
Hannea arcus	-	X	-
Melosira granulata	-	X	X
Microcystis aeruginosa	-	X	X
Nitzschia hungarica	-	X	-
Octocystis reidii	-	X	-
Pediastrum boryanum	-	X	-
Pediastrum duplex	-	X	-
Quadrigula lacustris	X	-	-
Schroederia setigera	X	33.33	X
Sphaerocystis schroederi	-	X	X
Staurastrum leptocladum	-	X	-
Stephanodiscus asterae	X	X	-
Stephanodiscus niagarae	X	50	9.09
Tribonema sp.	-	X	-
Volvox aureus	-	X	X
Total Population	-	84.03	115.54

Table 19. Species list and counts (ind./mℓ) for site 19.

Genus or species	Dates June	July	August
Ankistrodesmus falcatus	X	50	-
Ankistrodesmus gelatiniformis	X	X	-
Aphanizomenon flos-aguae	-	X	9.09
Aphanothece nidulans	-	-	13.64
Asterionella formosa	X	-	13.64
Botryococcus braunii	-	X	-
Colacium vesiculosum	-	X	-
Eudorina elegans	-	-	X
Fragilaria crotonensis	-	-	27.27
Melosira granulata	-	-	31.82
Microcystis aeruginosa	-	X	-
Octocystis reidii	-	X	X
Pediastrum boryanum	-	X	X
Pediastrum duplex	-	X	-
Pseudoanabaena catenata	-	X	X
Schroederia setigera	X	-	-
Sphaerocystis schroederi	-	X	-
Staurastrum leptocladum	X	X	X
Stephanodiscus asterae	X	-	-
Stephanodiscus niagarae	X	50	X
Stigeoclonium sp.	-	X	-
Tribonema sp.	X	X	-
Volvox aureus	-	X	X
Total Population	-	21.01	462.18

Table 20. Species list and counts (ind./mℓ) for site 20.

Genus or species	Dates June	July	August
Ankistrodesmus falcatus	X	-	-
Aphanizomenon flos-aquae	-	X	66.66
Asterionella formosa	-	-	8.33
Botryococcus braunii	-	X	-
Ceratium hirundinella	-	X	-
Colacium vesiculosum	-	X	-
Fragilaria construens	-	X	X
Fragilaria crotonensis	-	9.09	16.67
Fragilaria vaucheriae	X	-	-
Hannea arcus	-	45.45	-
Microcystis aeruginosa	-	X	X
Nitzschia acicularis	-	18.18	-
Octocystis reidii	X	X	8.33
Pediastrum boryanum	-	X	-
Pediastrum duplex	-	X	X
Schroederia setigera	X	-	X
Sphaerocystis schroederi	-	X	X
Staurastrum leptocladum	-	X	X
Stephanodiscus asterae	X	-	-
Stephanodiscus Niagarae	X	27.27	X
Ulothrix sp.	-	X	-
Total Population	0	115.54	126.05

Table 21. Species list of Blue Mesa Reservoir Phytoplankton listed in their respective Divisions (Phyla). Asterisks indicate new species and/or genera whose descriptions have recently been published or are in various stages of publication.

Division Bacillariophyta

Amphora ovalis
Asterionella formosa
Cocconeis placentula
Fragilaria construens
Fragilaria crotonensis
Fragilaria vaucheriae
Hannea arcus
Melosira granulata
Melosira italica
Navicula cuspidata
Nitzschia acicularis
Nitzschia hungarica
Nitzschia linearis
Nitzschia palea
Stephanodiscus asterae
Stephanodiscus niagarae
Synedra ulna

Division Chlorophyta - Green Algae

Ankistrodesmus falcatus
Ankistrodesmus gelatiniformis
Asterococcus limneticus
Botryococcus braunii
Chaetophora sp.
Characium limneticum
Chlamydomonas sp.
Chlamydomonas alpinum *
Chlorogonium carefootii *
Closteriopsis longissima
Closterium sp.
Closterium lunula
Coelastrum microporum
Eudorina elegans
Gloeococcus tetrasporus *
Gloeocystis sp.
Gongrosira sp.
Gonium sociale
Kirchneriella obesa
Mougeotia sp.

Table 21. Continued.

Nannochloris sp.
Octocystis reidii *
Octosporiella coloradoensis *
Oedogonium sp.
Oocystis lacustris
Oocystis parva
Palmellopsis sp.
Pandorina morum
Pediastrum boryanum
Pediastrum duplex
Pediastrum tetras
Quadrigula lacustris
Scenedesmus obliguus
Scenedesmus quadricauda
Schroederia setigera
Sphaerocystis schroederi
Spirogyra sp.
Spondylosium planum
Staurastrum sp.
Staurastrum leptocladum
Stigeoclonium tenue
Ulothrix sp.
Ulothrix fimbriata
Volvox aureus
Volvulina steinii

Division Chryosophyta - Golden-brown Algae

Chromulina sp.
Chrysameba sp.
Mallomonas sp.

Division Cryptophyta - Cryptomonads

Cryptomonas sp. 1
Cryptomonas erosa
Cryptomonas marsonii
Cryptomonas ovata
Cryptomonas platyuris
Cryptomonas rostratiformis

Division Cyanophyta - Blue-green Algae

Anabaena sp.
Anabaena circinalis
Anabaena spirulinoides
Aphanizomenon flos-aquae
Aphanothece
Microcystis aeruginosa
Oscillatoria sp.
Pseudoanabaena catenata

Table 21. Continued.

Division Euglenophyta	
Colacium vesiculosum	
Euglena sp.	
Division Pyrrophyta - Dinoflagellates	
Ceratium hirundinella	1
Massartia - like	
Division Xanthophyta - Yellow-green Algae	
Tribonema sp.	

Table 22. Physical data for June 1983.

Site	Temperatures				Secchi disc
	A	B	C	S	(meters)
1	16.0	14.0	12.0	16.0	3.25
2	16.0	14.0	12.5	17.0	3.50
3	16.0	13.5	12.0	17.0	3.25
4	16.0	13.5	13.0	16.0	2.50
5	16.0	14.0	12.5	16.5	3.25
6	16.0	13.5	12.0	17.0	2.75
7	16.0	13.5	12.0	17.0	3.50
8	16.0	13.0	12.5	16.5	3.25
9	16.0	14.0	12.0	16.0	3.25
10	16.0	14.5	13.5	16.0	3.25
11	16.0	14.5	13.5	16.0	3.50
12	17.0	15.0	12.5	17.5	3.25
13	15.5	14.0	12.5	15.5	3.50
14	15.5	14.5	13.0	15.5	4.00
15	15.5	14.5	12.5	15.5	4.00
16	15.5	14.0	13.5	15.5	4.00
17	15.5	13.5	13.5	15.5	3.75
18	15.5	13.5	13.5	15.0	3.50
19	15.5	15.0	13.5	15.0	3.00
20	13.5	15.0	13.5	15.0	2.25

A = 0-5 meters
B = 10 meters in depth
C = 15 meters in depth
S = surface

Table 23. Physical data for July 1983.

Site	Temperatures				Secchi disc
	A	B	C	S	(meters)
1	20.0	17.0	15.0	20.0	4.50
2	20.0	16.0	15.0	20.0	2.50
3	20.0	16.0	14.5	20.0	4.00
4	20.0	16.0	15.0	20.0	4.50
5	20.0	15.5	14.5	20.0	5.00
6	20.0	16.0	14.5	20.0	4.00
7	19.5	16.5	15.0	19.5	3.75
8	19.5	18.0	15.0	19.0	3.50
9	19.5	17.0	16.0	18.5	4.00
10	19.5	17.5	15.0	19.5	3.75
11	19.5	17.0	15.0	19.0	4.00
12	19.5	17.5	15.0	19.5	4.00
13	19.5	18.0	15.0	19.0	4.00
14	19.5	17.5	15.0	19.5	3.75
15	19.5	17.5	15.0	19.0	4.00
16	18.5	17.0	16.5	18.5	4.50
17	18.5	18.0	16.0	18.0	4.50
18	18.5	17.5	16.0	18.5	4.50
19	18.5	14.5	16.5	18.5	4.50
20	18.5	17.5	16.0	19.0	4.50

A = 0-5 meters
B = 10 meters in depth
C = 15 meters in depth
S = surface

Table 24. Physical data for August 1983.

Site	Temperatures				Secchi disc
	A	B	C	S	(meters)
1	19.0	19.0	19.0	19.5	4.50
2	18.0	18.0	18.0	20.5	4.75
3	18.5	18.5	18.5	20.0	4.25
4	18.0	18.0	18.0	20.0	4.50
5	19.0	19.0	19.0	19.5	4.25
6	18.5	18.5	18.5	20.0	4.00
7	19.0	19.0	19.0	20.0	4.00
8	18.0	18.0	18.0	20.0	4.25
9	19.0	19.0	19.0	20.0	5.25
10	18.0	18.0	18.0	20.0	4.00
11	19.0	19.0	19.0	19.5	3.50
12	18.5	18.5	18.5	19.0	4.25
13	19.0	19.0	19.0	19.5	4.25
14	18.0	18.0	18.0	20.0	4.00
15	18.5	18.5	18.5	20.5	4.50
16	17.5	17.5	17.5	20.0	4.00
17	18.0	18.0	18.0	19.0	3.25
18	18.0	18.0	18.0	19.0	3.25
19	17.0	17.0	17.0	19.0	4.00
20	17.5	17.5	17.5	19.5	4.00

A = 0-5 meters
B = 10 meters in depth
C = 15 meters in depth
S = surface

Table 25. Occurrence of phytoplankton species by site for Blue Mesa Reservoir.

BACILLARIOPHYTA

A = June
B = July
C = August

SITE	Anchnanthes lanceolata	Amphora ovalis	Asterionella formosa	Cocconeis placentula	Fragilaria construens	Fragilaria crotonensis	Fragilaria vaucheriae	Hannea arcus	Melosira granulata	Melosira italica	Navicula cuspidata	Nitzschia acicularis	Nitzschia hungarica
1						ABC			ABC				
2			ABC	B	A	AB			A				B
3	A		ABC			ABC			ABC				
4			ABC			ABC			ABC				
5						BC			ABC				
6			ABC			ABC			BC				
7			ABC			ABC			A				
8			ABC			ABC			ABC				
9			ABC	B		BC			ABC	C			
10			BC			B		A	ABC				
11			ABC			B			ABC				
12		C	B			ABC			ABC				
13			AC			B		C	AB				
14			ABC			ABC		BC	BC			A	
15			ABC			ABC		B	C				
16			ABC			ABC			ABC			A	
17			ABC			ABC		BC	BC		A		
18			A			BC		B	BC				B
19			AC			C			C				
20			C		BC	BC	A	B				B	

Table 25. Continued.

A = June B = July C = August SITE	BACILLARIOPHYTA					CHLOROPHYTA							
	Nitzschia linearis	Nitzschia palea	Stephanodiscus astraea	Stephanodiscus niagarae	Synedra ulna	Ankistrodesmus falcatus	Ankistrodesmus gelatiniformis	Asterococcus limneticus	Botryococcus braunii	Chaetophora sp.	Characium limneticum	Characium sp.	Chlamydomonas alpinum
1			AB	ABC		ABC	ABC	AC					B
2			ABC	ABC		AB	BC	AB					B
3			ABC	AB		AB	AB		B			A	
4			ABC	ABC		AB	AB						B
5			ABC	ABC		AB	ABC					A	
6			ABC	ABC	B	ABC	ABC						B
7		C	AB	ABC		ABC	ABC		BC				B
8			ABC	ABC		A	AB						C
9			AB	ABC		AB	ABC			C			B
10			ABC	ABC			ABC						
11			AC	ABC		A	ABC					B	
12			ABC	ABC			AB						
13	A		B	ABC		A	AC		B				
14			A	ABC		A	AB		AB				
15			AB	ABC		AB	B						
16		B	A	ABC			A		B				
17			A	ABC		A	AB		B	B			B
18			AB	ABC		AC	B				A		
19			A	ABC		AB	AB		B				
20			A	ABC		A			B				

Table 25. Continued.

CHLOROPHYTA

A = June
B = July
C = August

SITE	Chlamydomonas sp.	Chlorogonium carefootii	Closteriopsis longissima	Closterium lunula	Closterium sp.	Coelastrum microporum	Cosmarium sp.	Eudorina californica	Eudorina elegans	Gloeococcus tetrasporus	Gloeocystis giges	Gloeocystis sp.	Congrosira sp.
1					B			B					
2			C						BC				
3			BC			B			B			B	
4													
5											A		
6					B				BC				
7		A			B					C		C	
8			BC						B	C		B	
9		A			A		C		C				C
10			B		B				BC				
11													
12			B		B								
13					B								
14													
15			B	A								B	
16												B	
17			B			C			B				
18													
19									C				
20													

Table 25. Continued.

CHLOROPHYTA

A = June
B = July
C = August

SITE	Gonium sociale	Kirchneriella obesa	Mougeotia sp.	Nannochloris sp.	Octocystis reidii	Octosporiella coloradoensis	Oedogonium sp.	Oocystis lacustris	Oocystis parva	Palmellopsis sp.	Pandorina morum	Pediastrum boryanum	Pediastrum duplex
1		C						C	B			B	
2					C	C			C	C			
3	C				ABC						B	B	C
4	C			B	BC			BC					
5				B		C						B	B
6					BC				B		B	BC	
7					C	C						AB	B
8					BC	BC		BC				B	B
9	C				B	C		C			B	C	
10	C			B	B	C						B	B
11					B	C					B	BC	B
12					B	BC		B				BC	
13					B	C						ABC	B
14					BC		B					B	
15							B					B	B
16			B		B							B	B
17				B	BC		C		B			B	B
18					B							B	B
19					BC							BC	B
20					ABC							B	BC

Table 25. Continued.

CHOROPHYTA

A = June
B = July
C = August

SITE	Pediastrum tetras	Quadrigula lacustris	Scenedesmus obliguus	Scenedesmus quadricauda	Schroederia setigera	Sphaerocystis schroederi	Spirogyra sp.	Spondylosium planum	Staurastrum leptocladum	Staurastrum sp.	Stigeoclonium tenue	Stigeoclonium sp.	Ulothrix fimbriata
1					AB	ABC			B				
2					AB	ABC			BC				C
3					AB	BC			BC	A			
4					AB	ABC			BC				
5	C				ABC			B	ABC				
6					ABC	BC			BC				
7			C		A	ABC			BC				
8					AB	AB			ABC		B		
9					A	AC			BC		B		
10					AB	ABC			ABC				
11					AB	AB	B		BC				
12					B				BC		B		
13					AB	ABC							
14					ABC	ABC			ABC				
15					AC	ABC			BC				
16				B	AC	AB			ABC		B		
17					AB	B			ABC				
18		A			ABC	BC			B				
19					A	B			ABC			B	
20					AC	BC			BC				

Table 25. Continued.

A = June
B = July
C = August

	CHLOROPHYTA			CHRYOSOPHYTA			CRYPTOPHYTA						
SITE	Ulothrix sp.	Volvox aeurus	Volvulina steinii	Chromulina sp.	Chrysameba sp.	Mallomonas sp.	Cryptomonas erosa	Cryptomonas marsonii	Cryptomonas ovata	Cryptomonas platyuris	Cryptomonas rostratiformis	Cryptomonas sp.	
1		B										A	
2		BC											
3		BC						AB				B	
4		BC	A					ABC	A				
5		B	C	A									
6		B	BC	A		C	AB		B				
7	B	B				A		AB					
8		BC	C					AB	A				
9		BC	A				A	B					
10	B	BC					AB	A					
11	B	A	C									B	
12								AB		A	A		
13								AB				A	
14			C					AB	A				
15	B	C											
16	B	C											
17		BC						A					
18		BC											
19		BC											
20	B												

Table 25. Continued.

	CYANOPHYTA								EUGLENOPHYTA		PYRRHOPHYTA	XANTHOPHYTA	
A = June B = July C = August SITE	Anabaena circinalis	Anabaena spirulinoides	Anabaena sp.	Aphanizomenon flos-aquae	Aphanothece nidulans	Microcystis aeruginosa	Oscillatoria sp.	Psuedoanabaena catenata	Colacium vesiculosum	Euglena sp.	Ceratium hirundinella	Peridinum cinctum	Tribonema sp.
1			C	BC	C						C		AB
2	B	C		BC									BC
3				BC	C				B				ABC
4			B	BC	C				B				
5				BC	C				A				A
6	B	B			C								ABC
7				BC					B				B
8					C								BC
9	B	A			C					C		C	
10	B			BC	C				A				A
11		B		B	C		B						A
12				B	C			B					AB
13		B		BC				B	A				A
14	B	A		BC	C	B			AB				A
15				BC	C			B	B				B
16				BC	C								AB
17		A		BC	C				B				AB
18				BC	C	BC			B		A		B
19				BC	C	B		BC	B				AB
20				BC		BC			B		B		

CHLOROPHYLL AND SECCHI DISK DATA

June-September 1983

National Park Service

Bureau of Reclamation

The following chlorophyll data and Secchi disk readings were collected at Blue Mesa Lake (BML) sites on five different sampling occasions from June to September, 1983. Data on lake chemistry is provided for sites in the Cebolla and Sapinero Basins for the September 23 sampling trip. The chlorophyll a data does not include a phaeophyton correction. Figure 2 shows the sampling sites used in this survey, which are referred to as "CSU sites" in the following tables. (These sites are also included in Figure 1 on page 9.)

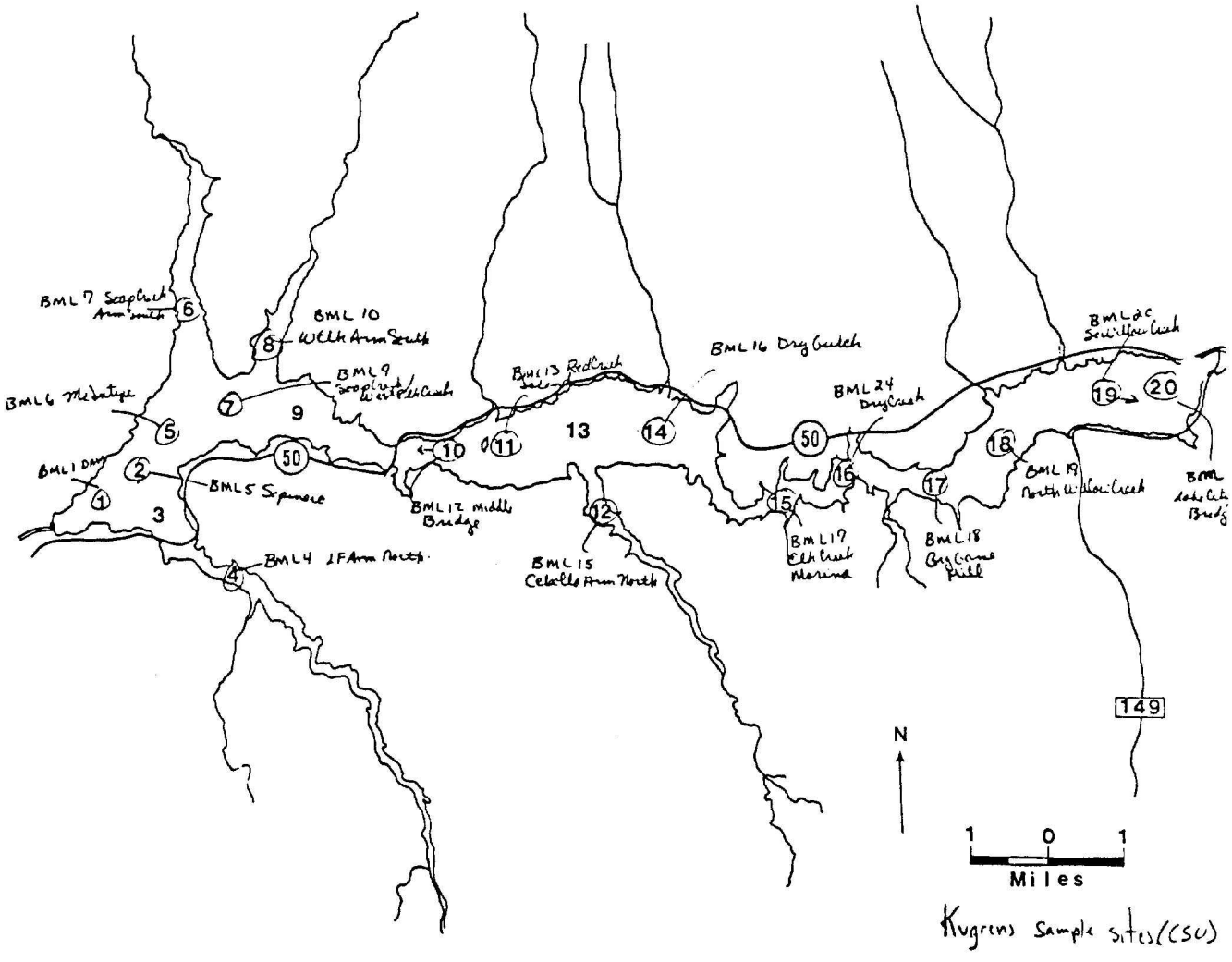


Figure 2. Chlorophyll and Secchi disk sampling sites on Blue Mesa Lake, June-September 1983.

(meters)

Secchi Disk Data, Summer 83

CSU Site	19 June	21 July	22 Aug.	14 Sept.
BML1 Dam, Sapinero	3.25	3.0	5.0	3.5
BML2 Sapinero, Sapinero	No data			
BML3 Lake Fork Arm Bridge	No data			
BML4 Lake Fork Arm-Willow Creek	3.0	4.25	5.0	4.0
BML5 McIntyre Gulch,Sap. Basin	1.75	4.0	6.75	4.0
BML6 Soap Arm - Middle	2.5	3.0	4.25	3.0
BML7 Soap Creek/W. Elk Creek	2.5	4.25	4.25	3.75
BML8 W. Elk Creek Arm South	3.0	4.0	4.25	4.25
BML9 Dillon Pinnacles,Sap.Basin	No data			
BML10 Middle Bridge, Sap.Basin	3.25	3.75	m	4.0
BML11 Red Crk.Is., Ceb. Basin	3.25	3.75	4.75	3.25
BML12 Cebolla Arm North	3.0	3.5	5.0	3.0
BML13 Deep Creek, Ceb. Basin	No data			
BML14 Dry Gulch, Cebolla Basin	3.0	4.0	6.0	3.25
BML15 Elk Creek Marina	3.25	4.0	4.5	3.5
BML16 Dry Creek	3.5	3.75	3.5	4.25
BML17 Big Game Hill	3.5	3.75	3.5	3.5
BML18 N. Willow Crk.,Iola Basin	3.5	4.5	4.25	2.5
BML19 S. Willow Crk.,Iola Basin	3.5	4.0	4.0	2.5
BML20 Lake City Bridge, Iola	3.5	3.75	4.25	2.75

µg/L

CSU Site No.

	6/19/84			7/21/84			8/22/84			9/14/84		
Chl.	A	B	C	A	B	C	A	B	C	A	B	C
1)	1.2			5.37	6.08	18.06	1.4			9.71	0.01	1.97
4)	1.4			3.90	3.05	8.26	1.2			2.02	0.17	0.50
5)	2.4			1.1			1.4			5.7		
6)	1.1			1.4			0.5			1.8		
7)	2.0			1.2			0.6			2.7		
8)	2.5			1.2			0.95	0.42	0.23	1.8		
10)	1.5			1.2			0.77	0.34	1.05	1.2		
11)	1.6			1.3			1.7			2.4		
12)	1.5			1.7			0.6			3.9		
14)	2.58	2.52	7.28	1.8			1.4			3.1		
15)	1.6			1.7			2.9			5.5		
16)	1.1			2.8			1.2			5.1		
17)	1.5			3.6			1.9			9.6		
18)	1.7			0.7			2.2			2.5		
19)	1.3			3.9			1.4			7.6		
20)	1.4			2.6			2.3			5.1		

CSU Site #	Date: 23 Sept. 83 Chlorophyll A	B	C	Secchi (m)
1) Dam, Sapinero Basin	4.68	0.59	2.50	5.0
	3.67	0.14	0.51	
	4.18	0.37	1.51	
2) Sapinero, Sapinero Basin	5.03	0.07	0.17	m
	5.00	0.31	0.69	
	5.02	0.19	0.26	
3) Lake Fork Arm, Bridge	5.00	0.31	0.69	m
	5.95	0.32	1.01	
	5.48	0.32	0.85	
4) Lake Fork Arm, Willow Creek	7.03	0.16	0.33	4.0
	6.34	0.29	0.74	
	6.69	0.23	0.53	
5) McIntyre Gulch, Sapinero Basin	3.97	0.47	1.06	4.0
	4.00	0.19	0.74	
	3.99	0.33	0.90	
6) Soap Arm - Middle	3.89	0.22	1.07	4.0
	3.77	0.25	1.12	
	3.83	0.24	1.10	
7) Soap Creek/West Elk Creek	9.19	0.34	1.42	m
	25.34	0.51	1.16	
	17.27	0.43	1.29	
8) West Elk Arm South	5.28	0.30	0.75	3.5
	2.46	0.98	1.78	
	3.87	0.64	1.27	
9) Dillon Pinnacles, Sapinero Basin	31.64	0.24	0.58	3.5
	39.83	0.55	0.70	
	35.74	0.40	0.64	
10) Middle Bridge, Sapinero Basin	10.84	0.10	0.13	3.75
	11.66	0.20	1.24	
	11.25	0.15	0.69	
11) Red Creek Island, Cebolla Basin	10.26	0.26	0.95	2.7
	9.55	0.13	1.06	
	9.91	0.20	1.01	
12) Cebolla Arm, North	9.77	0.16	0.87	2.6
	11.96	0.12	0.83	
	10.87	0.14	0.85	

CSU Site #	Date: 23 Sept. 83 Chlorophyll	A	B	C	Secchi (m)
13)	Deep Creek, Cebolla Basin	13.92	0.07	0.70	3.5
		18.66	0.12	0.83	
		16.29	0.15	0.82	
14)	Dry Gulch, Cebolla Basin	No Chl. data			3.5
15)	Elk Creek Marina	10.61	0.14	0.78	2.7
		9.72	0.11	0.43	
		10.17	0.13	0.61	
16)	Dry Creek	No Chl. data			4.0
17)	Big Game Hill	10.56	0.09	0.34	3.25
		10.05	0.15	0.93	
		10.31	0.12	0.64	
18)	North Willow Creek Island	14.32	0.04	0.43	3.0
		24.32	0.20	0.11	
		19.32	0.12	0.27	
19)	South Willow Creek (Main Gulch, Iola Basin)	20.22	0.26	0.26	3.0
		20.66	0.37	0.63	
		20.44	0.32	0.45	
20)	Lake City Bridge, Iola Basin	27.19	0.01	0.20	3.0
		11.83	0.25	1.08	
		19.51	0.12	0.64	

September 29, 1983

CSU Site	Chlorophyll (ug/l) A	B	C	Secchi (m)	Depth (m)
1	3.73	0.19	0.95	5.0	1
2	no data	-	-	-	-
3	2.77	0.10	0.91	4.0	1
4	no data	-	-	-	-
5	6.26	0.07	1.22	4.0	1
6	6.97	0.21	1.15	4.0	1
7	no data	-	-	-	-
8	5.53	0.00	1.01	3.5	1
9	12.09	0.00	1.58	3.5	1
10	8.69	0.00	1.31	3.75	1
11	13.86	0.00	1.78	3.75	1
12	no data	-	-	-	-
13	no data	-	-	-	-
14	14.69	0.00	2.17	3.5	1
15	7.77	0.00	0.95	4.0	1
16	7.32	0.00	1.18	4.0	1
17	5.77	0.00	0.96	3.25	1
18	no data	-	-	-	-
19	7.21	0.00	0.76	3.0	1
20	6.58	0.01	1.04	3.0	1

September 23, 1983

Blue Mesa Lake
Cebolla Basin

Depth (m)	DO	PH	COND	TEMP	SECCHI (m)
Surface	7.18	7.92	193	16.1	2.3
1	7.28	7.93	193	16.1	
3	7.33	7.95	192	16.1	
5	7.33	7.92	193	16.1	
7	7.58	7.89	193	16.1	
9	7.49	7.92	193	16.1	
11	7.39	7.93	193	16.0	
13	7.40	7.91	193	16.1	
15	7.34	7.85	193	16.0	
17	6.91	7.77	194	16.0	
19	4.29	7.16	201	15.4	
21	3.44	6.93	204	14.7	
23	3.23	6.83	204	14.5	
25	3.09	6.80	205	14.4	
27	2.52	6.74	206	14.0	
29	3.64	6.73	198	13.7	
31	3.36	6.68	198	13.4	
35	2.44	6.66	292	12.7	
40	1.68	6.62	295	11.5	
45	2.43	6.61	299	9.1	
50	2.50	6.62	303	7.5	
53	2.55	6.57	154	6.9	

September 23, 1983

Blue Mesa Lake
Sapinero Basin - Dam

Depth (m)	DO	PH	COND	TEMP	SECCHI (m)
Surface	7.20	7.30	170	15.4	4
2	6.65	7.20	170	15.4	
4	6.59	7.20	170	15.4	
6	6.44	7.23	170	15.4	
8	6.44	7.25	170	15.4	
10	6.40	7.24	170	15.4	
12	6.29	7.24	170	15.4	
14	6.26	7.23	170	15.4	
18	6.21	7.21	160	15.4	
20	6.19	7.18	160	15.4	
24	5.82	7.12	160	15.3	
28	5.03	6.89	140	14.4	
32	5.13	6.78	140	13.9	
36	5.10	6.74	140	13.4	
40	4.72	6.74	160	12.3	
44	4.62	6.75	170	10.7	
48	4.62	6.83	180	8.7	
50	5.09	6.94	180	7.3	
52	5.55	6.99	180	7.0	
55	5.94	7.02	180	6.6	
60	6.14	7.05	180	6.3	
65	6.07	7.03	180	6.1	
70	6.25	7.04	190	5.9	
75	6.37	7.04	190	5.8	
80	6.43	7.03	190	5.7	
85	6.27	7.01	190	5.6	
90	6.24	7.00	190	5.6	
95	5.86	6.97	190	5.6	

BENTHIC, PHYTOPLANKTON, AND ZOOPLANKTON SURVEY

July-September 1984

Bureau of Reclamation

IOLA BASIN

Sample Date: July 15, 1984

Depth: 27 meters

Secchi depth: 5.33 meters

Depth	D.O. mg/l	Temp. °C	pH	Conductivity uS/cm
Surface	6.95	20.1	7.61	156
1 meter	6.40	19.8	7.91	160
5 meters	5.60	8.5	8.06	163
10 meters	5.60	7.0	7.82	175
15 meters	5.40	5.9	7.65	176
20 meters	5.70	4.8	7.75	175
25 meters	3.60	3.1	7.42	165

BENTHOS:

Mean Density of combined samples:	mean density/m^2
ANNELIDA	
OLIGOCHAETA	
HAPLOTAXIDA	
TUBIFICIDAE	25,618
DIPTERA	
CHIRONOMIDAE	
Chironomus	43

PLANKTON SAMPLES (Cells/L) - JULY 15, 1984

PHYTOPLANKTON

Iola Basin - 0 - 5 Meters

GENERA	A	B
Anabaena	5,488	51,197
Chlamydomonas	82	137
Colacium	15,728	9,829
Fragilaria	16,056	14,881
Hannea	--	546
Melosira	500	--
Octocystis (gen. nov.)	655	--
Oocystis	--	137
Pediastrum	2,621	8,738
Shroederia	<10	
Stephanodiscus	--	273
Tribonema	2,949	479

ZOOPLANKTON

Cyclops	25	40
Daphnia	39	53

Colacium vesiculosum was epizooic on Cyclops.

A represents sample 1 and B is sample 2.

PLANKTON SAMPLES (Cells/L) JULY 15,1984

PHYTOPLANKTON

Iola Basin - 5 - 15 Meters

GENERA	A	B
Asterionella	1,065	--
Chrysochromulina	205	--
Colacium	1,516	14
Fragilaria	12,902	3,768
Melosira	1,147	109
Microcystis	--	7,277
Oocystis	--	68
Pediastrum	2,621	819
Sphaerocystis	451	41
Stephanodiscus	--	<10
Tribonema	--	191
Volvox	41	--

ZOOPLANKTON

Cyclops	6	5
Daphnia	9	21

PLANKTON SAMPLES (Cells/L) - JULY 15, 1984

PHYTOPLANKTON

Iola Basin - 15 - 25 Meters

GENERA	A	B
Anabaena	72	--
Asterionella	--	133
Colacium	61	--
Eudorina	--	<10
Fragilaria	727	645

ZOOPLANKTON

Cyclops	2	1
Daphnia	4	4

CEBOLIA BASIN

Sample Date: July 15, 1984

Depth: 57 meters

Secchi depth: 3.50 meters

Depth	D. O. mg/l	Temp. °C	pH	Conductivity uS/cm
Surface	6.30	21.2	8.07	164
1 meter	6.10	20.9	8.06	165
5 meters	5.90	19.5	7.96	165
10 meters	5.90	15.3	7.76	164
15 meters	5.40	14.3	7.73	164
20 meters	5.40	13.5	7.36	167
25 meters	5.30	13.0	7.63	163
30 meters	5.10	12.4	7.69	167
35 meters	4.90	12.0	7.70	165
40 meters	4.70	11.2	7.58	172
45 meters	4.30	10.6	7.61	171
50 meters	3.40	9.4	7.69	178
55 meters	3.30	9.0	7.75	177

BENTHOS:

Mean Density of combined samples:	mean density/m^2
ANNELIDA	
OLIGOCHAETA	
HAPLOTAXIDA	
TUBIFICIDAE	29,473

July 15, 1984 PLANKTON SAMPLES (Cells/Liter)

CEBOLLA BASIN: 0-5 meter Haul

Genera	A	B
Colacium	7,700	461
Pediastrum	1,434	1,639
Stephanodiscus	41	
Microcystis	9,462	16,178
Fragilaria	7,045	15,002
Melosira		1,875
Botryocorris		2,876
Cyclops	13	5
Daphnia	20	1

CEBOLLA BASIN: 5-15 meter Haul

Genera	A	B
Melosira	1,843	614
Asterionella	3,071	1,311
Fragilaria	13,803	5,100
Octosporiella	1,023	
Tribonema		370
Pediastrum		1,188
Cyclops	7	5
Daphnia	10	1
Keratella	Less than 1	Less than 1

July 15, 1984 PLANKTON SAMPLES (Cells/Liter)

CEBOLLA BASIN: 15-25 meter Haul

Genera	A	B
Asterionella	2,120	420
Fragilaria	2,908	973
Pediastrum		20
Colacium	10	
Melosira	154	
Cyclops	30	6
Daphnia	18	3

CEBOLLA BASIN: 25-50 meter Haul

Genera	A	B
Fragilaria	725	1,360
Asterionella	107	831
Colacium	8	57
Melosira	4	12
Synura	20	
Pediastrum		70
Cyclops	1	4
Daphnia	Less than 1	Less than 1

SAPINERO BASIN

Sample Date: July 15, 1984

Depth: 103 meters

Secchi depth: 3.33 meters

Depth	D. O. mg/l	Temp. °C	pH	Conductivity uS/cm
Surface	6.80	21.1	8.31	163
1 meter	6.60	21.2	8.29	163
5 meters	6.50	18.9	7.97	160
10 meters	6.10	15.1	7.81	141
15 meters	6.00	14.4	7.79	156
20 meters	5.90	13.6	7.84	144
25 meters	5.50	13.2	7.77	158
30 meters	6.40	12.7	7.83	153
35 meters	6.20	12.5	7.76	155
40 meters	5.90	11.6	7.70	157
45 meters	5.80	11.5	7.74	158
50 meters	5.20	9.8	7.68	163
55 meters	5.20	8.9	7.66	172
60 meters	5.60	7.5	7.69	186
65 meters	5.30	6.6	7.55	185
70 meters	5.40	6.5	7.61	178
75 meters	5.40	6.2	7.61	178
80 meters	5.40	6.1	7.71	175
85 meters	5.10	6.1	7.69	173
90 meters	5.00	6.1	7.81	165
95 meters	5.00	6.1	7.66	165
100 meters	4.70	6.1	7.56	167

SAPINERO BASIN (continued)

BENTHOS:

Mean Density of combined samples:	mean density/m^2
ANNELIDA	
OLIGOCHAETA	
HAPLOTAXIDA	
TUBIFICIDAE	25,489

July 15, 1984 PLANKTON SAMPLES (Cells/Liter)

SAPINERO BASIN: 0-5 meter Haul

Genera	A	B
Colacium	541	3,277
Fragilaria	309	1,188
Melosira	425	1,802
Microcystis	13,601	1,914
Anabaena		1,802
Staurastrum		41
Cyclops	8	21
Daphnia	46	20
Keratella	less than 1	

SAPINERO BASIN: 5-15 meter Haul

Genera	A	B
Asterionella	1,638	2,212
Fragilaria	10,644	14,376
Melosira	860	4,095
Colacium	860	
Microcystis		2,212
Stephanodiscus		1,966
Cyclops	6	8
Daphnia	1	1

July 15, 1984 PLANKTON SAMPLES (Cells/Liter)

SAPINERO BASIN: 15-25 meter Haul

Genera	A	B
Asterionella	72	
Fragilaria	399	
Colacium	20	
Chlamydomonas		10
Cyclops	7	7
Daphnia	3	3

SAPINERO BASIN: 25-50 meter Haul

Genera	A	B
Asterionella	682	254
Fragilaria	4,109	1,556
Rhopalodia	96	8
Stephanodiscus		8
Cyclops	2	2
Daphnia	less than 1	less than 1

IOLA BASIN

Sample Date: August 16, 1984

Depth: 27 meters

Secchi depth: 4.0 meters

Depth	D. O. mg/l	Temp. °C.	pH	Conductivity uS/cm
Surface	6.9	21.9	8.41	174
1 meter	6.9	21.3	8.40	175
5 meters	6.9	20.0	8.37	175
10 meters	5.7	17.1	8.20	185
15 meters	5.4	15.9	8.09	190
20 meters	5.1	14.9	8.06	178
25 meters	4.9	14.6	7.61	182

BENTHOS:

Mean Density of combined samples:	mean density/m^2
ANNELIDA	
CLIGOCHAETA	
HAPLOTAXIDA	
TUBIFICIDAE	91,115

PLANKTON SAMPLES (cells/L) - August 16, 1984

Phytoplankton

Iola Basin, 0-5 meter Samples

Genera	A	B
Aphanizomenon	2,951,210	1,673,981
Aphanothece	157,225	---
Asterionella	14,705	129,479
Ceratium	462	462
Colacium	92	370
Eudorina	2,959	---
Euglena	1,156	---
Fragilaria	575,064	1,507,508
Melosira	4,624	27,746
Microcystis	149,132	702,887
Oocystis	8,092	370
Straurastrum	925	739
Stephanodiscus	277	277
Synura	6,936	---
Volvox	47,352	---

Zooplankton

Iola Basin, 0-5 meter Samples

Genera	A	B
Cyclops	9	12
Daphnia	9	9
Keratella	less than 1	less than 1

PLANKTON SAMPLES (cells/L) - August 16, 1984

Phytoplankton

Iola Basin, 5-15 meter samples

Genera	A	B
Aphanizomenon	3,940,075	7,449,854
Asterionella	3,615	1,855
Ceratium	452	181
Colacium	136	45
Fragilaria	359,258	380,071
Melosira	3,619	49,771
Microcystis	818,963	25,790
Staurastrum	588	136
Strephanodiscus	226	---
Volvox	11,583	---
Volvulina	724	---

Zooplankton

Iola Basin, 5-15 meter samples

Genera	A	B
Cyclops	4	4
Daphnia	6	4
Keratella	1	1

PLANKTON SAMPLES (cells/L) - August 16, 1984

Phytoplankton

Iola Basin, 15-25 meter samples

Genera	A	B
Aphanizomenon	1,358	1,267
Asterionella	1,131	2,308
Ceratium	135	45
Colacium	90	---
Fragilaria	153,838	105,424
Melosira	1,267	950
Pediastrum		1,071
Staurastrum	181	90
Stephanodiscus	45	45
Volvox	46,333	34,749
Volvulina	724	---

Zooplankton

Iola Basin, 15-25 meter samples

Genera	A	B
Cyclops	less than 1	1
Daphnia	5	4
Keratella	less than 1	less than 1

CEBOLLA BASIN

Sample Date: August 16, 1984

Depth: 52.0 meters

Secchi depth: 3.9 meters

Depth	D. O. mg/l	Temp. °C.	pH	Conductivity uS/cm
Surface	6.9	22.0	8.21	163
1 meter	6.8	21.8	8.20	163
5 meters	6.6	20.5	8.24	164
10 meters	5.3	17.5	8.26	177
15 meters	5.2	15.9	8.18	174
20 meters	5.3	15.4	8.14	172
25 meters	5.2	13.9	8.24	170
30 meters	5.0	13.6	8.17	169
35 meters	4.4	12.9	8.04	166
40 meters	3.9	11.9	7.99	170
45 meters	3.9	11.9	7.83	173
50 meters	2.4	9.8	7.89	180

BENTHOS:

Mean Density of combined samples:	mean density/m^2
ANNELIDA	
OLIGOCHAETA	
HAPLOTAXIDA	
TUBIFICIDAE	10,076

PLANKTON SAMPLES (cells/L) - August 16, 1984

Phytoplankton

Cebolla Basin, 0-5 meter samples

Genera	A	B
Anabaena	20,813	3,620
Aphanizomenon	124,881	107,686
Asterionella	7,399	17,194
Ceratium	1,810	905
Chrysameba	---	1,809
Dactylococcopsis	8,144	---
Melosira	12,699	7,239
Microcystis	146,599	---
Oocystis	7,239	---
Staurastrum	---	905
Stephanodiscus	905	2,715
Volvox	463,325	463,325

Zooplankton

Cebolla Basin, 0-5 meter samples

Genera	A	B
Cyclops	16	9
Daphnia	2	1
Keratella	1	less than 1

PLANKTON SAMPLES (cells/L) - August 16, 1984

Phytoplankton

Cebolla Basin, 5-15 meter samples

Genera	A	B
Aphanizomenon	11,628	7,632
Aphanothece	28,732	---
Asterionella	8,144	40,496
Ceratium	905	151
Colacium	11,990	76
Dinobryon	859	---
Fragilaria	76,693	42,079
Melosira	24,443	14,026
Microcystis	7,963	104,519
Pediastrum	---	5,882
Staurastrum	905	226
Stephanodiscus	452	38
Volvox	34,749	11,583

Zooplankton

Cebolla Basin, 5-15 meter samples

Genera	A	B
Cyclops	3	4
Daphnia	2	1
Keratella	less than 1	less than 1

PLANKTON SAMPLES (cells/L) - August 16, 1984

Phytoplankton

Cebolla Basin, 15-25 meter samples

Genera	A	B
Asterionella	1,979	1,448
Colacium	23	---
Cryptomonas	---	23
Fragilaria	21,435	9,909
Melosira	5,316	4,660
Staurastrum	23	---
Stephanodiscus	90	23

Zooplankton

Cebolla Basin, 15-25 meter samples

Genera	A	B
Cyclops	1	less than 1
Daphnia	less than 1	less than 1

PLANKTON SAMPLES (cells/L) - August 16, 1984

Phytoplankton

Cebolla Basin, 25-50 meter samples

Genera	A	B
Asterionella	326	1,195
Fragilaria	4,706	7,239
Melosira	6,515	2,317
Microcystis	---	1,656
Stephanodiscus	9	18

Zooplankton

Cebolla Basin, 25-50 meter samples

Genera	A	B
Cyclops	less than 1	less than 1
Daphnia	---	less than 1

SAPINERO BASIN

Sample Date: August 16, 1984

Depth: 103.5 meters

Secchi depth: 2.75 meters

Depth	D. O. mg/l	Temp. °C.	pH	Conductivity uS/cm
Surface	6.2	20.9	7.73	148
1 meter	6.2	20.8	7.69	149
5 meters	6.2	19.9	7.63	150
10 meters	5.4	17.5	7.61	140
15 meters	5.2	15.6	7.59	145
20 meters	5.2	14.7	7.56	129
25 meters	5.3	13.9	7.58	130
30 meters	5.0	12.5	7.53	150
35 meters	5.2	12.8	7.52	153
40 meters	5.0	12.7	7.52	155
45 meters	5.0	11.8	7.58	152
50 meters	4.6	10.6	7.59	154
55 meters	4.6	8.1	7.57	159
60 meters	4.8	7.4	7.55	164
65 meters	5.3	6.8	7.49	166
70 meters	5.3	6.8	7.43	176
75 meters	5.4	6.8	7.43	181
80 meters	5.2	6.4	7.44	185
85 meters	5.1	6.2	7.41	188
90 meters	5.1	6.1	7.50	183
95 meters	5.1	6.1	7.48	191
100 meters	5.0	6.1	7.39	197

SAPINERO BASIN (continued)

BENTHOS:

Mean Density of combined samples:	mean density/m^2
ANNELIDA	
OLIGOCHAETA	
HAPLOTAXIDA	
TUBIFICIDAE	16,643

PLANKTON SAMPLES (cells/L) - August 16, 1984

Phytoplankton

Sapinero Basin, 0-5 meter samples

Genera	A	B
Anabaena	2,262	---
Ankistrodesmus	452	---
Aphanizomenon	120,808	56,105
Aphanothece	37,102	68,775
Asterionella	28,056	31,673
Chrysochromulina	905	---
Cryptomonas	---	452
Fragilaria	96,828	71,489
Gomphonema	---	905
Melosira	36,007	27,148
Microcystis	21,266	47,509
Navicula	---	2,715
Staurastrum	452	905
Stephanodiscus	4,072	
Synedra	---	452

Zooplankton

Sapinero Basin, 0-5 meter samples

Genera	A	B
Cyclops	8	12
Daphnia	less than 1	3

PLANKTON SAMPLES (cells/L) - August 16, 1984

Phytoplankton

Sapinero Basin, 5-15 meter samples

Genera	A	B
Aphanothece	39,365	21,492
Asterionella	20,813	19,682
Ceratium	---	90
Colacium	45	---
Dactylococcopsis	---	362
Fragilaria	59,091	33,256
Melosira	26,243	20,134
Microcystis	57,916	30,269
Pediastrum	---	3,619
Staurastrum	181	136
Stephanodiscus	---	45

Zooplankton

Sapinero Basin, 5-15 meter samples

Genera	A	B
Cyclops	6	6
Daphnia	---	less than 1
Keratella	less than 1	---

PLANKTON SAMPLES (cells/L) - August 16, 1984

Phytoplankton

Sapinero Basin, 15-25 meter samples

Genera	A	B
Asterionella	1,357	609
Fragilaria	9,954	4,438
Melosira	6,976	8,788
Microcystis	---	696
Staurastrum	---	87
Stephanodiscus	---	43
Tribonema	1,093	---

Zooplankton

Sapinero Basin, 15-25 meter samples

Genera	A	B
Cyclops	1	1
Daphnia	---	less than 1

PLANKTON SAMPLES (cells/L) - August 16, 1984

Phytoplankton

Sapinero Basin, 25-50 meter samples

Genera	A	B
Asterionella	136	326
Ceratium	18	18
Fragilaria	1,774	1,366
Melosira	1,710	443
Schroederia	9	---
Stephanodiscus	18	9

Zooplankton

Sapinero Basin, 25-50 meter samples

Genera	A	B
Cyclops	less than 1	less than 1
Daphnia	less than 1	less than 1

IOLA BASIN

Sample Date: September 17, 1984

Depth: 37 meters

Secchi Depth: 3.4 meters

Depth	D. O. mg/l	Temp. °C.	pH	Conductivity uS/cm
Surface	6.8	19.4	8.84	177
1 meter	6.8	18.9	8.81	175
5 meters	6.9	17.7	8.78	175
10 meters	6.5	17.5	8.64	173
15 meters	6.6	17.4	8.50	178
20 meters	4.2	16.0	8.09	194
25 meters	3.5	15.4	8.19	193
30 meters	2.0	15.3	8.30	195
35 meters	0.6	14.5	7.88	195

BENTHOS:

Mean Density of combined samples:	mean density/m^2
ANNELIDA	
OLIGOCHAETA	
HAPLOTAXIDA	
TUBIFICIDAE	50,811

PLANKTON SAMPLES (cells/L) - September 17, 1984

Phytoplankton

Iola Basin, 0-5 meter Samples

Genera	A	B
Aphanizomenon	11,716,154	8,709,971
Aphanothece	39,228	16,469
Asterionella	31,459	24,433
Ceratium	2,488	2,715
Cyclotella	646	45
Endorina	7,239	---
Fragilaria	26,469	70,357
Melosira	17,646	15,836
Microcystis	30,858	13,529
Staurastrum	181	317
Stephanodiscus	407	498
Volvox	23,166	---

PLANKTON SAMPLES (cells/L) - September 17, 1984

Phytoplankton

Iola Basin, 5-15 meter Samples

Genera	A	B
Aphanizomenon	624,403	772,209
Aphanothece	50,315	12,284
Asterionella	32,577	11,538
Ceratium	90	45
Chrysameba	1,131	317
Dinobryon	---	23
Fragilaria	62,602	29,863
Melosira	1,176	724
Oedogonium	---	158
Oocystis	452	204
Staurastrum	226	181
Stephanodiscus	905	113
Tribonema	362	837
Volvulina	362	---

PLANKTON SAMPLES (Cells/L) - September 17, 1984

Phytoplankton

Iola Basin, 15-25 meter Samples

Genera	A	B
Aphanizomenon	9,321	3,845
Aphanothece	2,647	---
Asterionella	204	1,991
Fragelaria	19,909	11,628
Melosira	995	1,900
Mougeotia	---	90
Staurastrum	45	---
Stephanodiscus	---	45
Tribonema	90	---

PLANKTON SAMPLES (cells/L) - September 17, 1984

Phytoplankton

Iola Basin, 25-35 meter Samples

Genera	A	B
Aphanizomenon	72	2,307
Asterionella	54	---
Fragilaria	2,224	4,932
Spirogyra	---	45
Staurastrum	---	90
Stephanodiscus	18	---

Zooplankton

Iola Basin - September 17, 1984

Depth	Genera	CELLS/liter A sample	B sample
0-5 meters	Cyclops	12	8
	Daphnia	1	5
	Bryocamptdis	2	7
	Paramecium		less than 1
5-15 meters	Cyclops	3	2
	Daphnia	less than 1	less than 1
	Bryocamptdis	less than 1	less than 1
15-25 meters	Cyclops	less than 1	2
	Daphnia	2	
	Bryocamptdis		less than 1
25-35 meters	Cyclops	2	2
	Daphnia	2	2
	Bryocamptdis	less than 1	less than 1

CEBOLLA BASIN

Sample Date: September 17, 1984

Depth: 56 meters

Secchi Depth: 4.5 meters

Depth	D. O. mg/l	Temp. °C	pH	Conductivity uS/cm
Surface	5.6	20.4	8.49	168
1 meter	5.9	19.7	8.48	167
5 meters	6.2	17.6	8.46	163
10 meters	5.9	17.5	8.42	169
15 meters	6.4	17.4	8.47	168
20 meters	4.2	15.7	8.09	175
25 meters	5.7	15.2	8.17	175
30 meters	3.7	14.5	8.20	172
35 meters	3.1	14.0	8.13	172
40 meters	2.8	13.6	8.12	170
45 meters	2.4	12.6	8.15	168
50 meters	1.5	11.5	8.08	170
55 meters	1.9	11.5	8.10	171

BENTHOS:

Mean Density of combined samples:	mean density/m^2
ANNELIDA	
OLIGOCHAETA	
HAPLOTAXIDA	
TUBIFICIDAE	37,678

PLANKTON SAMPLES (cells/L) - September 17, 1984

Phytoplankton

Cebolla Basin, 0-5 meter Samples

Genera	A	B
Aphanizomenon	939,319	792,721
Aphanothece	78,277	48,956
Asterionella	16,741	4,809
Ceratium	181	45
Fragilaria	159,268	11,131
Melosira	5,882	1,131
Microcystis	38,007	56,558
Mougeotia	---	---
Navicula	90	---
Pediastrum	---	1,448
Staurastrum	181	226
Stephanodiscus	362	317
Tribonema	13,574	3,303

PLANKTON SAMPLES (cells/L) - September 17, 1984

Phytoplankton

Cebolla Basin, 5-15 meter Samples

Genera	A	B
Ankistrodesmus	90	---
Aphanizomenon	424,564	456,991
Aphanothece	21,786	34,002
Asterionella	18,099	34,839
Ceratium	226	50
Chrysameba	452	679
Cyclotella	---	25
Dinobryon	---	25
Eudorins	7,239	14,479
Fragilaria	42,532	20,135
Gomphosphaeria	17,194	5,304
Melosira	7,013	729
Microscystis	362	---
Staurastrum	68	126
Stephanodiscus	113	101
Tribonema	837	2,689
Ulothrix	769	---
Volvox	5,791	---

PLANKTON SAMPLES (cells/L) - September 17, 1984

Phytoplankton

Cebolla Basin, 15-25 meter Samples

Genera	A	B
Anabaena	---	362
Aphanizomenon	28,505	14,780
Aphanothece	23,754	16,876
Asterionella	13,876	10,557
Ceratium	23	---
Chrysameba	158	---
Dinobryon	23	---
Eudorina	724	---
Fragilaria	31,823	30,767
Melosira	882	724
Microcystis	1,946	---
Staurastrum	68	45
Stephanodiscus	90	90
Tribonema	181	226

PLANKTON SAMPLES (cells/L) - September 17, 1984

Phytoplankton

Cebolla Basin, 25-50 meter Samples

Genera	A	B
Aphanizomenon	1,882	937
Asterionella	1,032	129
Chrysameba	---	9
Eudorina	1,158	---
Fragilaria	4,054	3,801
Melosira	597	54
Staurastrum	---	18
Stephanodiscus	9	27
Tribonema	145	---

Zooplankton

Cebolla Basin - September 17, 1984

Depth	Genera	CELLS/liter A sample	B sample
0-5 meters	Cyclops	12	12
	Daphnia	6	3
	Bryocamptis	2	3
5-15 meters	Cyclops	4	2
	Daphnia	1	less than 1
	Bryocamptis	less than 1	less than 1
15-25 meters	Cyclops	less than 1	less than 1
	Bryocamptis		less than 1
25-50 meters	Cyclops	less than 1	less than 1
	Daphnia	less than 1	less than 1
	Bryocamptis	less than 1	less than 1

SAPINERO BASIN

Sample Date: September 17, 1984

Depth: 103 meters

Secchi Depth: 3.9 meters

Depth	D. O. mg/l	Temp, °C.	pH	Conductivity uS/cm
Surface	5.7	17.8	8.36	166
1 meter	5.7	17.6	8.32	166
5 meters	5.8	17.0	8.36	164
10 meters	5.6	16.8	8.25	164
15 meters	5.4	16.5	8.12	156
20 meters	4.4	15.4	8.12	144
25 meters	4.5	14.8	8.17	146
30 meters	4.4	14.3	8.15	148
35 meters	4.0	13.7	8.24	161
40 meters	4.1	13.3	8.30	159
45 meters	4.4	13.0	7.81	160
50 meters	3.4	11.7	8.17	160
55 meters	3.2	8.7	8.09	175
60 meters	3.7	8.3	8.05	180
65 meters	2.9	7.4	8.11	183
70 meters	4.4	7.2	8.13	185
75 meters	4.3	7.0	8.15	182
80 meters	4.5	6.8	8.24	185
85 meters	4.2	6.5	8.36	185
90 meters	3.7	6.5	8.30	185
95 meters	3.8	6.5	8.61	186
100 meters	3.7	6.9	8.23	184

SAPINERO BASIN continued

BENTHOS:

Mean Density of combined samples:	mean density/m^2
ANNELIDA	
OLIGOCHAETA	
HAPLOTAXIDA	
TUBIFICIDAE	17,009

PLANKTON SAMPLES (cells/L) - September 17, 1984

Phytoplankton

Sapinero Basin, 0-5 meter Samples

Genera	A	B
Aphanizomenon	176,462	122,171
Aphanothece	99,452	30,315
Asterionella	104,972	62,893
Ceratium	45	---
Chrysameba	5,188	6,334
Dinobryon	45	---
Eudorina	---	1,448
Fragilaria	61,535	104,067
Melosira	7,330	11,402
Microcystis	---	10,407
Pediastrum	---	2,896
Staurastrum	226	---
Stephanodiscus	271	452
Tribonema	5,611	6,515

PLANKTON SAMPLES (cells/L) - September 17, 1984

Phytoplankton

Sapinera Basin, 5-15 meter Samples

Genera	A	B
Aphanizomenon	132,711	233,925
Aphanothece	10,859	24,885
Asterionella	22,321	45,247
Chrysameba	---	90
Fragilaria	69,075	112,664
Gomphosphaeria	11,149	19,003
Melosira	4,072	3,619
Pediastrum	2,896	---
Rhopalodia	---	90
Staurastrum	90	136
Stephanodiscus	136	90
Tribonema	---	2,714

PLANKTON SAMPLES (cells/L) - September 17, 1984

Phytoplankton

Sapinera Basin, 15-25 meter Samples

Genera	A	B
Aphanizomenon	905	1,018
Asterionella	15,836	10,746
Ceratium	45	---
Eudorina	---	724
Fragilaria	81,896	34,048
Melosira	16,967	294
Nitzchia	---	23
Oocystis	905	---
Staurastrum	---	68
Stephanodiscus	45	23
Tribonema	2,036	1,109

PLANKTON SAMPLES (cells/L) - September 17, 1984

Phytoplankton

Sapinera Basin, 25-50 meter Samples

Genera	A	B
Asterionella	1,086	2,172
Cyclotella	---	9
Fragilaria	6,696	18,144
Melosira	---	534
Oedogonium	27	---
Pediastrum	289	---
Staurastrum	9	36
Stephanodiscus	18	27
Tribonema	136	---

Zooplankton

Sapinero Basin - September 17, 1984

Depth	Genera	CELLS/liter A sample	B sample
0-5 meters	Cyclops	4	3
	Daphnia		less than 1
	Bryocamptis		less than 1
5-15 meters	Cyclops	3	1
	Daphnia	1	less than 1
	Bryocamptis	less than 1	
15-25 meters	Cyclops	2	less than 1
	Daphnia		less than 1
25-50 meters	Cyclops	less than 1	less than 1

CHLOROPHYLL SURVEY

July-September 1984

National Park Service

Bureau of Reclamation

The chlorophyll data presented on the following pages was collected on Blue Mesa Lake (BML) on four sampling occasions during July, August, and September 1984. All were 0-5 meter composite samples.

The sampling stations used were the following:

BML 1 Blue Mesa Lake - Dam, Sapinero Basin.
BML 2 Blue Mesa Lake - Lake Fork Marina, Sapinero Basin.
BML 3 Blue Mesa Lake - Lake Fork Arm - Bridge.
BML 5 Blue Mesa Lake - Lake Fork Arm - Willow Creek.
BML 6 Blue Mesa Lake - Lake Fork Arm - Middle.
BML 9 Blue Mesa Lake - McIntyre Gulch, Sapinero Basin.
BML 10 Blue Mesa Lake - Soap Arm - South.
BML 11 Blue Mesa Lake - Soap Arm - Middle.
BML 12 Blue Mesa Lake - Soap Arm - North.
BML 13 Blue Mesa Lake - Soap Creek/West Elk Creek, Sapinero Basin.
BML 14 Blue Mesa Lake - West Elk Arm - South.
BML 15 Blue Mesa Lake - West Elk Arm - Middle.
BML 16 Blue Mesa Lake - West Elk Arm - North.
BML 18 Blue Mesa Lake - Lake City Cutoff, Sapinero Basin.
BML 19 Blue Mesa Lake - Middle Bridge, Sapinero Basin.
BML 21 Blue Mesa Lake - Red Creek Slide, Cebolla Basin.
BML 23 Blue Mesa Lake - Cebolla Arm - Ski Beach.
BML 24 Blue Mesa Lake - Cebolla Arm - Lake Bend.
BML 27 Blue Mesa Lake - Dry Gulch, Cebolla Basin.
BML 29 Blue Mesa Lake - Bay of Chickens Beach, Cebolla Basin.
BML 30 Blue Mesa Lake - Narrows.
BML 31 Blue Mesa Lake - Elk Creek Marina.
BML 33 Blue Mesa Lake - Dry Creek.
BML 35 Blue Mesa Lake - Kezar Gulch II.
BML 38 Blue Mesa Lake - Willow Creek Island East, Iola Basin.
BML 39 Blue Mesa Lake - Stevens Creek Gulch, Iola Basin.
BML 40 Blue Mesa Lake - Stevens Channel, Iola Basin.
BML 41 Blue Mesa Lake - Iola Channel, Iola Basin.
BML 42 Blue Mesa Lake - Iola Log Boom, Iola Basin.
BML 43 Blue Mesa Lake - South Willow Creek, Iola Basin.
BML 44 Blue Mesa Lake - South Willow Creek Channel, Iola Basin.
BML 45 Blue Mesa Lake - Main Gulch Channel, Iola Basin.
BML 46 Blue Mesa Lake - Main Gulch, Iola Basin.
BML 47 Blue Mesa Lake - Lake City Bridge, Iola Basin.
BML 48 Blue Mesa Lake - Wilson's Landing.

Total 175 (350)

Phaeophyton corrections were not made on the chlorophyll a data.

Blue Mesa Chlorophyll Concentration
(mg/m^3)

July 31, 1984

Volume: 500 ml Depth: 0 - 5 m Program: Jeffrey-Humphries

Station	Chlorophyll a	Chlorophyll b	Chlorophyll c
BML 1	1.92	0.21	0.49
BML 2	1.49	0.01	0.07
BML 3	2.05	0.02	0.00
BML 5	1.85	0.00	0.04
BML 6	2.58	0.48	0.40
BML 9	2.05	0.22	0.26
BML 10	3.75	0.13	0.90
BML 11	2.39	0.11	0.42
BML 12	4.84	0.74	0.76
BML 13	3.97	0.25	0.22
BML 14	4.28	0.67	0.27
BML 15	4.31	0.30	0.22
BML 16	3.99	0.10	0.00
BML 18	3.21	0.13	0.00
BML 19	3.96	0.44	0.26
BML 21	3.74	0.39	0.00
BML 23	2.61	0.08	0.56
BML 24	3.05	0.21	0.83
BML 27	3.31	0.06	0.38
BML 29	2.83	0.17	0.45
BML 30	2.73	0.09	0.29
BML 31	2.50	0.16	0.33
BML 33	3.41	0.10	0.29
BML 35	3.68	0.00	0.27
BML 38	3.19	0.13	0.64
BML 39	4.09	0.25	0.52
BML 40	4.21	0.09	0.51
BML 41	3.62	0.36	0.59
BML 42	2.97	0.06	0.26
BML 43	3.43	0.00	0.36
BML 44	3.16	0.34	0.98
BML 45	3.53	0.05	0.32
BML 46	3.53	0.08	0.51
BML 47	2.05	0.16	0.30
BML 48	1.02	0.12	0.11

Blue Mesa Chlorophyll Concentration

(mg/m^3)

August 16, 1984

Depth: 5.0 m

Station	Chlorophyll a	Chlorophyll b	Chlorophyll c
BML 1	3.19	0.00	0.89
BML 2	3.19	0.00	0.89
BML 3	2.51	0.00	0.16
BML 5	2.98	0.00	0.58
BML 6	2.48	0.33	0.50
BML 9	2.48	0.27	0.99
BML 10	2.27	0.02	0.68
BML 11	2.51	0.00	0.65
BML 12	2.48	0.33	0.50
BML 13	2.51	0.00	0.16
BML 14	2.72	0.22	0.46
BML 15	2.07	0.00	0.38
BML 16	2.72	0.22	0.46
BML 18	2.72	0.22	0.46
BML 19	3.19	0.06	0.00
BML 21	2.07	0.00	0.38
BML 23	2.75	0.00	0.61
BML 24	3.16	0.37	0.73
BML 27	4.07	0.25	1.43
BML 29	5.23	0.13	1.11
BML 30	2.92	0.48	0.77
BML 31	2.92	0.48	0.77
BML 33	4.76	0.34	1.18
BML 35	5.19	0.44	1.94
BML 38	6.38	0.11	0.00
BML 39	7.09	0.00	0.20
BML 40	6.38	0.00	0.79
BML 41	7.26	0.36	0.84
BML 42	5.94	0.00	1.01
BML 43	5.09	0.00	0.00
BML 44	6.55	0.63	1.43
BML 45	5.63	0.59	2.21
BML 46	7.74	0.14	0.78
BML 47	5.67	0.28	1.38
BML 48	2.85	1.16	1.93

Blue Mesa Chlorophyll Concentration

(mg/m^3)

September 17, 1984

Volume: 500 ml Depth: 0 - 5 m

Station	Chlorophyll a	Chlorophyll b	Chlorophyll c
BML 1	1.87	0.00	0.00
BML 2	2.83	0.18	0.45
BML 3	2.61	0.27	0.80
BML 5	2.36	0.36	0.76
BML 6	2.39	0.08	0.66
BML 9	2.95	0.18	0.67
BML 10	2.72	0.19	0.71
BML 11	1.94	0.09	0.11
BML 12	2.23	0.59	0.94
BML 13	3.05	0.21	0.83
BML 14	3.28	0.34	0.47
BML 15	1.92	0.21	0.49
BML 16	1.07	0.00	0.00
BML 18	3.44	0.00	0.03
BML 19	3.46	0.00	0.03
BML 21	4.62	0.00	0.00
BML 23	3.14	0.00	0.10
BML 24	1.97	0.00	0.19
BML 27	4.04	0.00	0.00
BML 29	6.18	0.08	0.17
BML 30	6.52	0.00	0.10
BML 31	6.86	0.08	0.02
BML 33	6.63	0.00	0.12
BML 35	5.82	0.03	0.34
BML 38	6.18	0.00	0.11
BML 39	6.19	0.00	0.09
BML 40	6.65	0.00	0.06
BML 41	4.58	0.00	0.10
BML 42	7.79	0.00	0.00
BML 43	10.52	0.08	0.00
BML 44	8.00	0.01	0.00
BML 45	6.28	0.00	0.39
BML 46	5.84	0.02	0.37
BML 47	6.38	0.08	0.06
BML 48	3.43	0.00	0.18

Blue Mesa Chlorophyll Concentration

(mg/m^3)

September 24, 1984

Depth: 0 - 5 m

Station	Chlorophyll a	Chlorophyll b	Chlorophyll c
BML 1	4.48	0.04	0.29
BML 2	4.34	0.00	0.81
BML 3	2.98	0.00	0.34
BML 5	1.29	0.00	0.07
BML 6	1.70	0.14	0.35
BML 9	3.07	0.10	0.41
BML 10	1.86	0.00	0.07
BML 11	0.92	0.01	0.00
BML 12	2.05	0.03	0.10
BML 13	1.70	0.23	0.60
BML 14	1.93	0.02	0.34
BML 15	1.37	0.00	0.31
BML 16	1.82	0.08	0.34
BML 18	3.66	0.02	0.33
BML 19	1.86	0.00	0.04
BML 21	3.07	0.06	0.41
BML 23	1.75	0.00	0.17
BML 24	1.63	0.00	0.17
BML 27	1.94	0.14	0.13
BML 29	3.56	0.00	0.67
BML 30	3.06	0.27	0.34
BML 31	2.63	0.06	0.21
BML 33	1.83	0.00	0.00
BML 35	3.73	0.00	0.15
BML 38	5.36	0.02	0.19
BML 39	6.26	0.21	0.32
BML 40	6.28	0.20	0.54
BML 41	6.52	0.00	0.24
BML 42	5.70	0.29	0.46
BML 43	6.38	0.06	0.75
BML 44	6.92	0.31	0.97
BML 45	6.45	0.61	0.55
BML 46	8.27	0.58	1.62
BML 47	8.44	0.70	5.03
BML 48	4.91	0.15	0.00

AIRBORNE MULTISPECTRAL SCANNER DATA

(LANDSAT SURVEY)

September 1983

Bureau of Reclamation

United States Department of the Interior

BUREAU OF RECLAMATION

ENGINEERING AND RESEARCH CENTER

P O BOX 25007
BUILDING 67, DENVER FEDERAL CENTER
DENVER, COLORADO 80225-0007

IN REPLY REFER TO D-1524

OCT 10 198

Mr. Dennis Nelson
Environmental Protection Agency
1860 Lincoln Street
Denver CO 80295

Subject: Digital Processing of Remote Sensing Imagery of Blue Mesa Reservoir

Sir:

On September 28, 1983, through arrangement with your office, airborne multispectral scanner data were acquired over Blue Mesa Reservoir, near Gunnison, Colorado. Computer enhancement of this imagery has been completed. Applied Sciences Referral Memorandum No. AP-84-4-8, which presents the results of this work, is enclosed for your information. Any questions concerning the content of the technical memorandum should be directed to Mr. James Verdin of the Remote Sensing Section, FTS 776-4303.

Very truly yours,

L. O. Timblin Jr.

L. O. Timblin, Jr., Chief
Applied Sciences Branch

Enclosures

Copy to: Mr. Roger Andrascik
National Park Service
PO Box 1040
Gunnison CO 81230
(with enclosure)

Mr. Gary Smillie
NPS Water Resources Laboratory
Aylesworth Hall
Colorado State University
Fort Collins CO 80523
(with enclosure)

OPTIONAL FORM NO. 10
JULY 1973 EDITION
GSA FPMR (41 CFR) 101-11.6

UNITED STATES GOVERNMENT

Memorandum

Memorandum

TO : Head, Remote Sensing Section

Denver, Colorado
DATE: October 2, 1984

FROM : James P. Verdin, Civil Engineer

SUBJECT: Enhancement of Airborne Scanner Imagery of Blue Mesa Reservoir to Reveal Surface Water Quality Patterns

Applied Sciences Referral Memorandum No. AP-84-4-8
Principal Investigator: James P. Verdin

On September 23, 1983, staff from the Environmental Sciences Section (D-1522), the Remote Sensing Section (D-1524), the Upper Colorado Region, and the National Park Service collected water quality measurements and samples on Blue Mesa Reservoir, near Gunnison, Colorado. Fieldwork was carried out on that day in order to be coincident with image acquisition by LANDSAT-4 and the EPA (Environmental Protection Agency) airborne MSS (multispectral scanner). Unfortunately, cloud cover prevailed at the time of the satellite pass, preventing the acquisition of useful imagery. Cloud cover also caused the EPA flight crew to elect not to fly a data collection mission over the reservoir. They did, however, remain ready to fly once the weather cleared.

On September 28, 1983, the EPA crew successfully acquired MSS data of the reservoir under cloud-free conditions. Flying altitude was 20,000 feet above sea level, yielding a nominal pixel size of 30 feet square. No surface data were collected on that date, although in the afternoon of the following day, Mr. Roger Andrascik of the National Park Service was able to collect data at 20 stations on the reservoir. Table 1 presents these data. The locations of these sample sites were noted on 7.5 min. quad maps. Figure 1 is a sketch map showing the sample site locations. Using the annotated 7.5 min. quad maps, the 20 sample sites were located in the digital imagery using an interactive color video display. Digital image values at these locations were extracted and means calculated in each wavelength band for 5-by-5 blocks of pixels. (The spectral channels of the EPA scanner are listed in table 2.) Correlations were then sought between these image values and measurements of water temperature, Secchi transparency, and chlorophyll *a* concentration. Unfortunately, no satisfactory relationships could be found to permit the quantitative spatial extrapolation of the point water quality measurements.

Failure to identify good relationships between the surface and image data sets is attributed to the more than 24-hour lapse between image acquisition and surface sampling. Apparently, circulation patterns in the reservoir changed sufficiently in the intervening period to alter



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the spatial distribution of surface water quality features. The fact that surface water temperature and image counts in the thermal infrared (band 11) do not correlate especially supports this notion. Surface temperature and thermal infrared image counts should exhibit a simple, straight line relationship with one another since they are both measurements of the same physical phenomenon. It is felt that locational errors in recording sample site positions are not responsible for the discrepancy, since the maps used were of a suitable scale and 5-by-5 pixel block averages were used to characterize the image data.

In spite of these difficulties, the image data were processed to reveal patterns of relative water quality variability. Based on earlier experience with airborne MSS imagery, band 6 was selected to show Secchi transparency patterns, band 8 was chosen to show variations in chlorophyll a concentration, and band 11 was processed to show surface temperature. Figure 2 shows a color-coded enhancement of band 6. The trend in colors from blue, light blue, green, yellow, and orange to red indicates increasing turbidity (decreasing Secchi depth). The Lake Fork Arm and Cebolla Creek Arm were not included in the color-coding scheme because bad sun glint was present on these parts of the reservoir. Sun glint was also present on the main body of the reservoir between the Iola and Cebolla basins, requiring data editing to make possible a suitable image for display. It can be seen that the Sapinero basin is by far the most turbid of the three main bodies of the reservoir. The Iola basin is the next most turbid, with the Cebolla basin showing the clearest waters.

Figure 3 shows a color-coded enhancement of band 8. Studies on Flaming Gorge Reservoir with this band have shown it to be related to chlorophyll a concentration indicative of surface blooms of bluegreen algae. The color scheme here was defined to show increasing chlorophyll concentration as one progresses from blue to red, although specific intervals of concentration cannot be associated with them. The bright red and orange areas in the Sapinero basin apparently indicate a large surface algae bloom. The Cebolla basin is apparently least productive, with somewhat more productivity occurring in the Iola basin. It should be borne in mind that figure 3 is a portrayal of conditions in only the first meter of depth from the surface.

Figure 4 presents a color-coded surface temperature map of the reservoir, with increasing temperature following the color progression from blue to red. Assuming that a count of 110 (out of 255), as found above the dam at site 1, is equal to a surface temperature of 15 °C, and that there are four image counts per degree Centigrade (as indicated in the EPA flight log), then the colors and temperatures correspond as follow: dark blue, 15.0-15.75; light blue, 16.0; green, 16.25; yellow, 16.50; orange, 16.75-17.0; and red, 17.25-18.0 and higher in a few isolated spots. In the Sapinero basin, the main body of the reservoir is seen to be warmer than the waters entering in the arms, which apparently plunge below this warm body as they enter the reservoir. An apparent boat wake

is discernible as a linear feature in the Sapinero basin, with cooler waters brought to the surface by the passing of the boat. The bright red areas in the Sapinero basin are at the same locations as the apparent blue-green algae bloom suggested by figure 3. These higher temperatures support the idea that a bloom was present since gas vacuoles in the algae at the very surface would warm in the sun to temperatures higher than the surrounding water. Such conditions have been observed and measured on Flaming Gorge Reservoir. The Cebolla basin is seen to be coolest on the south side, where cool waters enter from Cebolla Creek and where waters are shallowest. The Iola basin is seen to be quite uniformly cool at the surface.

In spite of the failure to establish quantitative relationships between the remote sensing data and the surface measurements, it is hoped that these images of the relative variation of surface water quality will be of value to reservoir managers.

James P. Verdin

Attachments

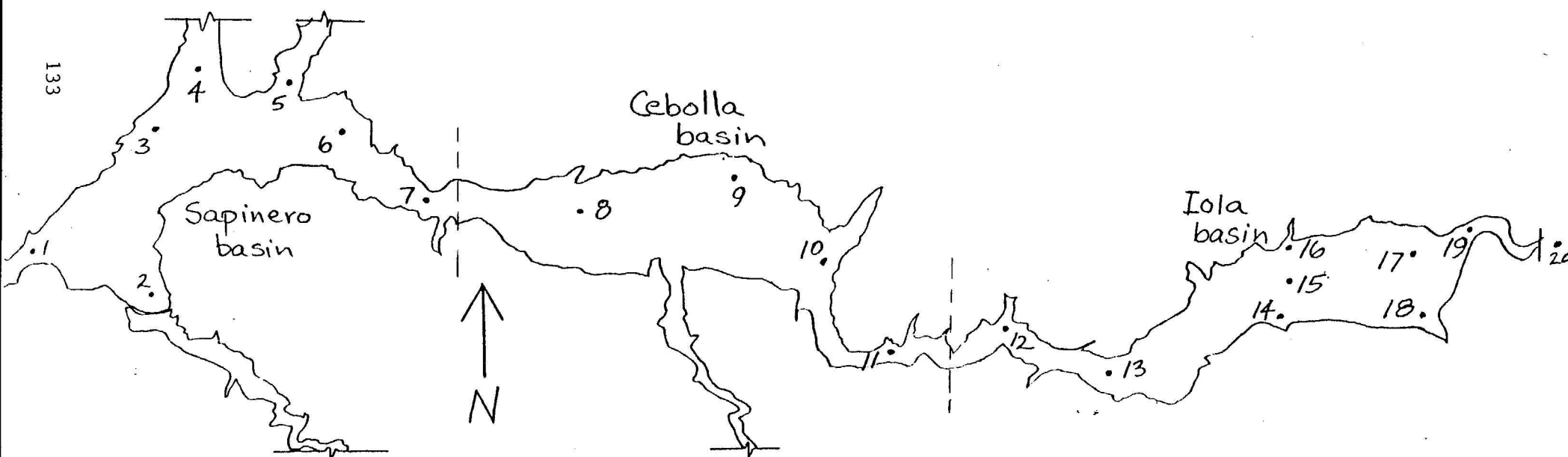


Figure 1. - Sample sites visited on September 29, 1983. Site 20 is upstream from site 19, off the map.

Table 1. - Water quality measurements on Blue Mesa Reservoir, September 29, 1983

Station	Time	Air temp. (°C)	Water temp. (°C)	D.O. (p/m)	Conductivity	Secchi disk (m)	Chlorophyll a (mg/m^3)
Dam	1200	20.0	15.0	7.7	200	5.0	3.73
Lake Fork Arm	1210	20.0	16.0	7.2	212	4.0	2.77
3 McIntyre Gulch	1219	20.0	15.5	6.1	225	4.0	6.26
Soap Creek Arm	1225	20.0	16.0	6.8	220	4.0	6.97
W. Elk Creek Arm	1235	16.0	16.0	7.2	225	3.5	5.53
6 Dillon	1245	14.0	16.0	8.2	225	3.5	12.09
Middle Bridge	1250	17.0	16.0	7.1	225	3.75	8.69
Red Creek	1300	18.0	16.5	7.4	225	3.75	13.86
9 Dry Gulch	1310	18.0	16.5	7.2	220	3.5	14.69
10 E. Elk Creek	1320	18.0	16.5	7.5	225	3.0	8.71
Marina	1330	17.0	16.5	7.6	225	4.0	7.77
Dry Creek	1340	17.5	16.5	6.6	225	4.0	7.32
13 Big Game Hill	1350	17.0	16.5	7.8	225	3.25	5.77
Iola	1400	17.5	16.0	9.7	225	3.0	11.13
Iola Channel	1405	16.0	16.0	7.5	225	3.0	13.68
16 Stevens Creek	1410	16.5	16.5	7.0	225	2.5	11.22
avel Pit	1420	13.0	16.0	7.8	225	2.5	16.42
. Willow Creek	1425	13.0	16.5	8.6	225	3.0	7.21
19 Lake City Bridge	1430	14.0	16.5	9.4	225	3.0	6.58
20 Wilson's Landing	1440	13.0	16.5	8.8	200	3.0	3.62

Table 2. - Spectral identities of the 11 channels of the EPA airborne multispectral scanner

Band	Wavelength (μm)	Color/spectrum
1	0.38- 0.42	Ultraviolet
2	0.42- 0.45	Blue
3	0.45- 0.50	Blue
4	0.50- 0.55	Green
5	0.55- 0.60	Green
6	0.60- 0.65	Red
7	0.65- 0.70	Red
8	0.70- 0.79	Near infrared
9	0.80- 0.89	Near infrared
10	0.92- 1.10	Near infrared
11	8.00-14.00	Thermal infrared

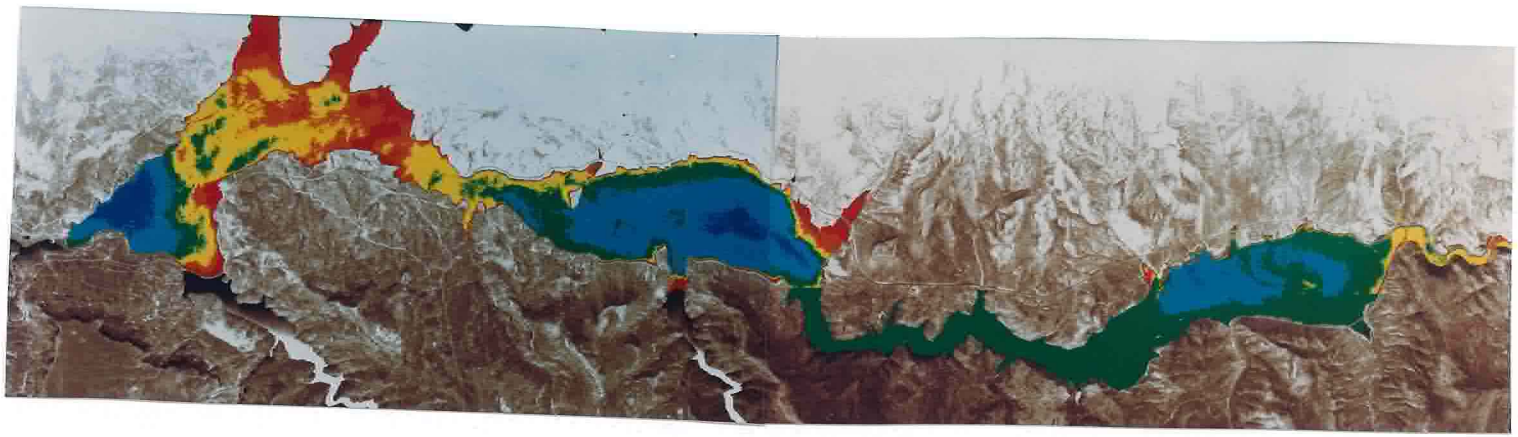


Figure 2. - Turbidity patterns derived from band 6: dark blue, clearest waters; turbidity increasing with progression to light blue, green, yellow, orange, and red.



Figure 3. - Patterns derived from band 8 suggestive of chlorophyll a concentrations: dark blue, lowest concentration, with increasing concentration for light blue, green, yellow, orange, and red.

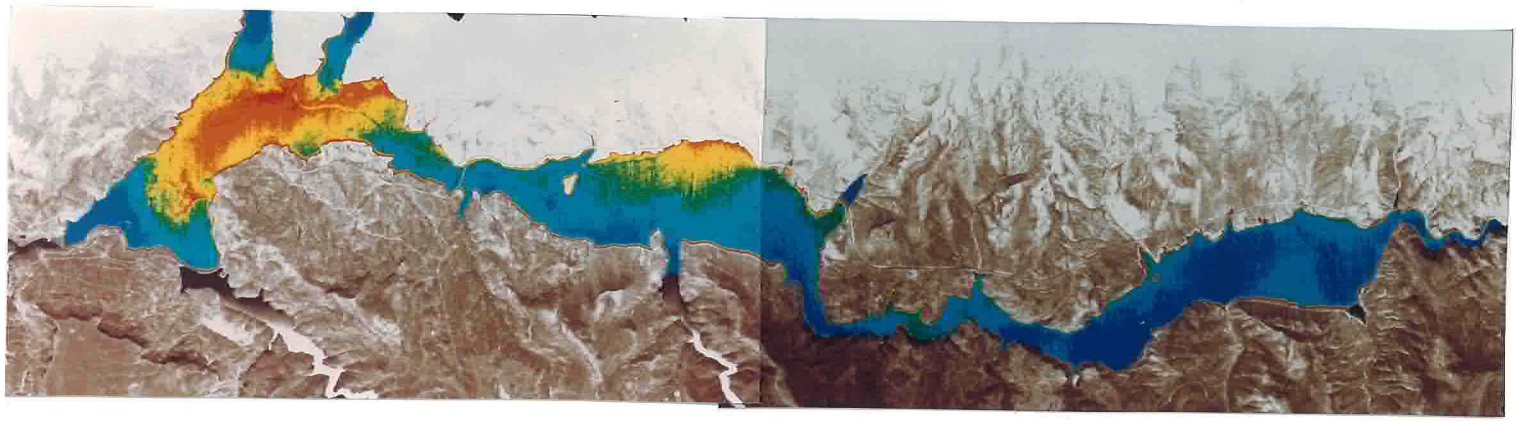


Figure 4. - Color-coded temperature map of Blue Mesa Reservoir, with intervals of 15.0-15.75 °C (dark blue), 16.0 °C (light blue), 16.25 °C (green), 16.5 °C (yellow), 16.75-17.0 °C (orange), and 17.25-18.0 °C (red).