



Limnological studies on Bighorn Lake (Yellowtail Dam) and its tributaries
by Raymond Arthur Soltero

A thesis submitted to the Graduate Faculty in partial fulfillment of the requirements for the degree of
DOCTOR OF PHILOSOPHY in Botany

Montana State University

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Abstract:

The phytoplankton community of Bighorn Lake in relation to its physical and chemical environment was studied during 1968, 1969 and 1970. Samples and in situ measurements were taken at six permanent sampling stations on the reservoir during 56 cruises.

Characterization of the influent and effluent waters of the reservoir revealed that Bighorn Lake was fertilized by the Bighorn and Shoshone Rivers. The relationships of conductivity, turbidity, nitrogen and phosphate to tributary discharge have been examined.

Under average conditions total visible light was reduced to 1% of surface intensity at a depth of approximately 10 meters near the dam, but only 1 meter at station 5 (80.5 km upstream from the dam). Various effects of light penetration on chlorophyll a. and phytoplankton standing crops have been discussed. A turbidity current was established at the depth of the power penstock during 1968. A nitrate nitrogen and ortho-phosphate maxima as well as the oxygen and pH minima were associated with the turbidity current.

Temperature and conductance in Bighorn Lake are described with respect to both the seasonal and longitudinal distribution of heat and electrolytes. The spring warming process is depicted. The development of a distinct thermocline for any given year of sampling was not detected.

Results of chemical analyses showed Bighorn Lake to be predominantly a calcium-sodium-sulfate-bicarbonate water. Nitrate nitrogen and ortho-phosphate as well as the other chemical constituents determined were relatively high and appeared not to be limiting.

Standing crops of the phytoplankton taxa were determined by direct count. *Fragilaria crotonensis*, *Cryptomonas ovata*, *Stephano-discus niagarae* and *Asterionella formosa* reached the largest standing crops according to absolute mean cell volumes, whereas *Rhodomonas lacustris*, *Cryptomonas ovata*, *Asterionella formosa* and *Fragilaria crotonensis* were more important on a presence basis. Mean total algal standing crops for the reservoir ranged from 2.3 to 23.2 mm³/l. Measurements of mean chlorophyll a. for the reservoir ranged from 0.6 to 10.4 mg/m³.

The chlorophyll to algal cell volume ratio was 3.4 µg chlorophyll a. to 1.0 mm³ of algal cells. A definite algal succession was observed for all three years.

Net primary productivity was calculated and a mean for all stations showed a range of 0.51 g C/m²/day to 1.42 g C/m²/day during 1968 and 1970, respectively.

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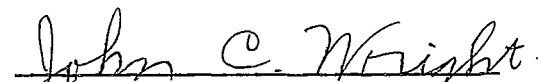
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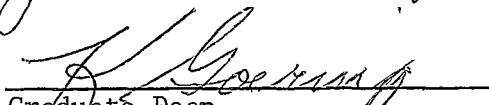
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Botany

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Bozeman, Montana

June, 1971

ACKNOWLEDGEMENTS

The author would like to express his sincere gratitude to Dr. John C. Wright for the guidance in the preparation of this manuscript and his assistance throughout every phase of this study. Sincere thanks are also due to Drs. W. E. Booth and I. K. Mills for the time spent in reviewing the manuscript.

Thanks are given to Mrs. Jo Wilson and Mrs. Gail Hill for their assistance in the laboratory. Thanks are also due to Abe Horpestad, Dr. Ken Tuinstra, Chad Martin and John W. Wright for their aid in the collection of field data. The cooperation extended by Dr. James M. Pickett and James M. Ness in various aspects of the study is greatly appreciated.

Sincere thanks are due to my wife, Pam, for her patience, understanding and encouragement during the course of this study. Finally, the author would like to thank fellow hydrobiology students, both for their technical assistance in various aspects of the work, and for their discussions of topics both germane and irrelevant.

This project was supported by Federal Water Pollution Control Administration Research Project 18050 DBW, Dr. John C. Wright, Principal Investigator and Federal Water Pollution Control Administration Training Grant 1T1-WP-228, Dr. John C. Wright, Director.

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ABSTRACT

The phytoplankton community of Bighorn Lake in relation to its physical and chemical environment was studied during 1968, 1969 and 1970. Samples and in situ measurements were taken at six permanent sampling stations on the reservoir during 56 cruises.

Characterization of the influent and effluent waters of the reservoir revealed that Bighorn Lake was fertilized by the Bighorn and Shoshone Rivers. The relationships of conductivity, turbidity, nitrogen and phosphate to tributary discharge have been examined.

Under average conditions total visible light was reduced to 1% of surface intensity at a depth of approximately 10 meters near the dam, but only 1 meter at station 5 (80.5 km upstream from the dam). Various effects of light penetration on chlorophyll a and phytoplankton standing crops have been discussed. A turbidity current was established at the depth of the power penstock during 1968. A nitrate nitrogen and ortho-phosphate maxima as well as the oxygen and pH minima were associated with the turbidity current.

Temperature and conductance in Bighorn Lake are described with respect to both the seasonal and longitudinal distribution of heat and electrolytes. The spring warming process is depicted. The development of a distinct thermocline for any given year of sampling was not detected.

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The chlorophyll to algal cell volume ratio was 3.4 µg chlorophyll a to 1.0 mm³ of algal cells. A definite algal succession was observed for all three years.

Net primary productivity was calculated and a mean for all stations showed a range of 0.51 g C/m²/day to 1.42 g C/m²/day during 1968 and 1970, respectively.

INTRODUCTION

The decline in "productivity" of newly impounded reservoirs is almost universal (Bennett, 1971; Carlander et al., 1963; Neel, 1963). Productivity in this context refers to the successful establishment and maintenance of a large population of preferred fishes. The initial high productivity has been attributed to the organic matter and nutrients resulting from the flooded soil and vegetation, thus entering the trophic cycle of the reservoir. Although the above enrichment process may have some validity in humid regions it is rather doubtful if this is applicable to semi-arid regions.

Whether or not this loss of fish production is related to a decline in primary or secondary productivity, or both has not been established.

A comprehensive investigation of the physical, chemical and biological limnology of Bighorn Lake and its tributaries was initiated in the fall of 1967 to determine if a decline in primary or secondary productivity, or both of this new impoundment would occur. The study specifically encompassed the heat budget, salinity regime, internal currents and biological productivity (phytoplankton and zooplankton) of the reservoir.

The three-year study was undertaken to relate the physical and chemical environment of the reservoir to primary production and to determine what changes in the primary production took place over the

entire study. An effort was also made to assess the physical and chemical characteristics of the influent and effluent waters of the reservoir.

The theoretical points of the above approach to primary production are best summarized by Findenegg (1965) as follows:

"It is a well known fact that primary production in lakes is controlled by the interaction of many factors which usually are divided into three groups: (1) Physical factors originating directly or indirectly from solar radiation, such as light conditions, temperature, mixing and turbulence by the action of the wind; (2) The content of the nutrients in the euphotic zone of the lakes, and (3) The interaction of the organisms present in the plankton community which may promote or hamper the production of certain species".

The cause(s) of the decline in reservoir fish production must be known before formulation of better and more feasible fisheries management (both preventive and corrective) can be applied.

DESCRIPTION OF THE STUDY AREA

Bighorn Lake is a new impoundment (Yellowtail Dam) of the Bighorn River approximately 80.5 kilometers (50 miles) southeast of Billings, Montana. Yellowtail Dam is in Bighorn County at lat. $45^{\circ}18'27''$, long. $107^{\circ}57'26''$, in SW1/4 SE1/4 Sec.18, T6 S. and R. 31 E. At normal operating level the reservoir extends from the dam at Fort Smith, Montana, into Wyoming for a distance of 98.4 kilometers (61 miles). The water is used for power production, flood control, irrigation and recreation.

Construction of the dam by the Bureau of Reclamation began in 1961 and was completed in 1967. Storage began 4 November 1965. The reservoir has a usable capacity (Fig. 1) of $169 \times 10^7 \text{ m}^3$ (1,375,000 acre-ft) below elevation 1,114.6 m (3,657 ft). Normal operating capacity is $144 \times 10^7 \text{ m}^3$ (1,097,000 acre-ft) at elevation 1,109.5 m (3,640 ft) and minimum operating level is $60 \times 10^7 \text{ m}^3$ (483,400 acre-ft) at elevation 1,081.1 m (3,547 ft). Dead storage amounts to $234 \times 10^5 \text{ m}^3$ (18,970 acre-ft) below elevation 1,005.8 m (3,296 ft). Maximum daily content since construction occurred on 6 July 1967 with $166 \times 10^7 \text{ m}^3$ (1,346,000 acre-ft) at elevation 1,114.5 m (3,656 ft), while the minimum since first filling occurred on 22 May 1968 and was $82 \times 10^7 \text{ m}^3$ (667,400 acre-ft) at elevation 1,093.0 m (3,586 ft). Other morphometric data for the reservoir are given in Table I.

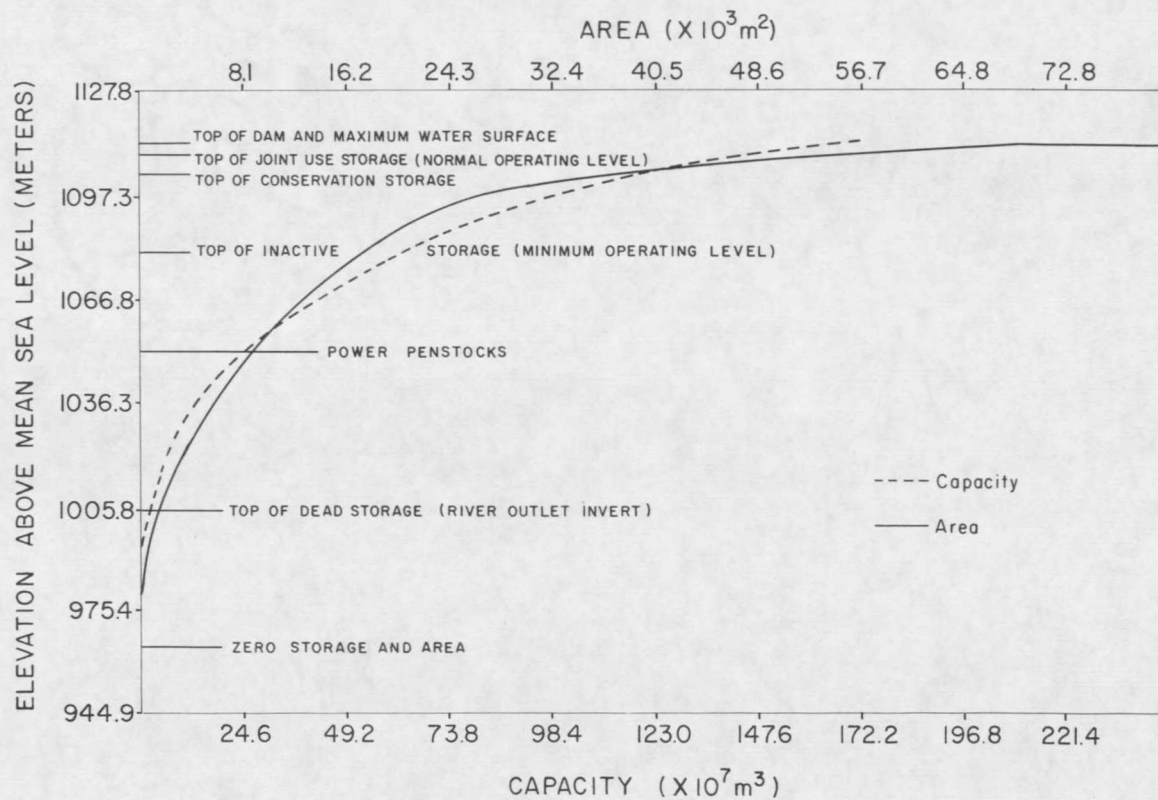


Figure 1.

Water levels of Bighorn Lake as related to area (10^3 m^2) and capacity (10^7 m^3) with operational zones delineated (Bureau of Reclamation Data).

Table I. Additional morphometric data for Bighorn Lake at maximum capacity (elevation 1,115.5 m).

Maximum Length	98.4 km (61 mi)
Maximum Effective Length	9.8 km (6.1 mi)
Maximum Width	3.2 km (2.0 mi)
Maximum Effective Width	3.2 km (2.0 mi)
Mean Width	739 m (2,425 ft)
Maximum Depth	140 m (459 ft)
Mean Depth	24 m (80 ft)
Area	$727 \times 10^5 \text{ m}^2$ (17,958 acres)
Volume	$176 \times 10^7 \text{ m}^3$ (1,427,840 acre-ft)
Length of Shoreline	206 km (128 mi)
Shoreline Development	11.8
Slope of Basin	0.14%

Details of the structure of the thin concrete-arch dam are shown in Figure 2. Water can be discharged from the reservoir through three outlets; (1) the spillway--elevation 1,095.1 m (3,593 ft); (2) the power penstocks--elevation 1,051.6 m (3,450 ft), and (3) the river outlet invert--elevation 1,005.8 m (3,296 ft). Unless it is necessary to discharge water through the spillway or river outlet invert, all water is discharged from the reservoir through the power penstocks. The depth of water overlying the power penstocks would be 63.1 m (207 ft) at maximum usable capacity, 57.9 m (190 ft) at normal operating level and 29.6 m (97 ft) at minimum operating level. Discharge through the river outlet invert would come from very deep water; 109.9 m (360 ft) at maximum usable capacity, 96.8 m (317 ft) at normal operating level and 76.4 m (250 ft) at minimum operating level.

Six permanent sampling stations were established on the reservoir during the course of the study (Fig. 3). Kilometer 0 (Station 0) was located at the dam site with the remaining stations at approximately 16.1 kilometer (10 mile) intervals from each other up the reservoir for 80.5 kilometers to station 5.

The major tributaries to the reservoir, as can be seen from Figure 3, are the Bighorn and Shoshone Rivers. The average discharge for the Bighorn River was $63.9 \text{ m}^3/\text{sec}$ (2,256 cfs) for a 41 year period (U.S.G.S., 1969). The discharge normally fluctuates between a fall

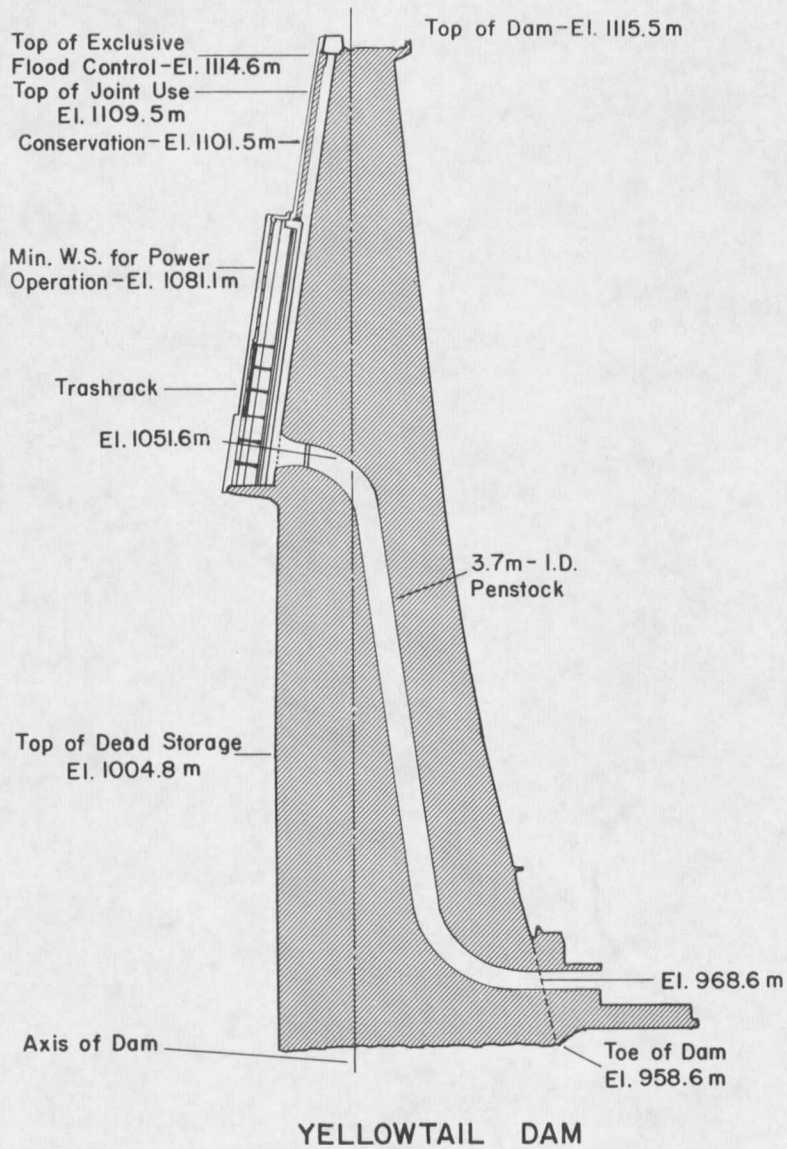


Figure 2. Detailed structure of Yellowtail Dam. Diagram was furnished through the courtesy of the Bureau of Reclamation.

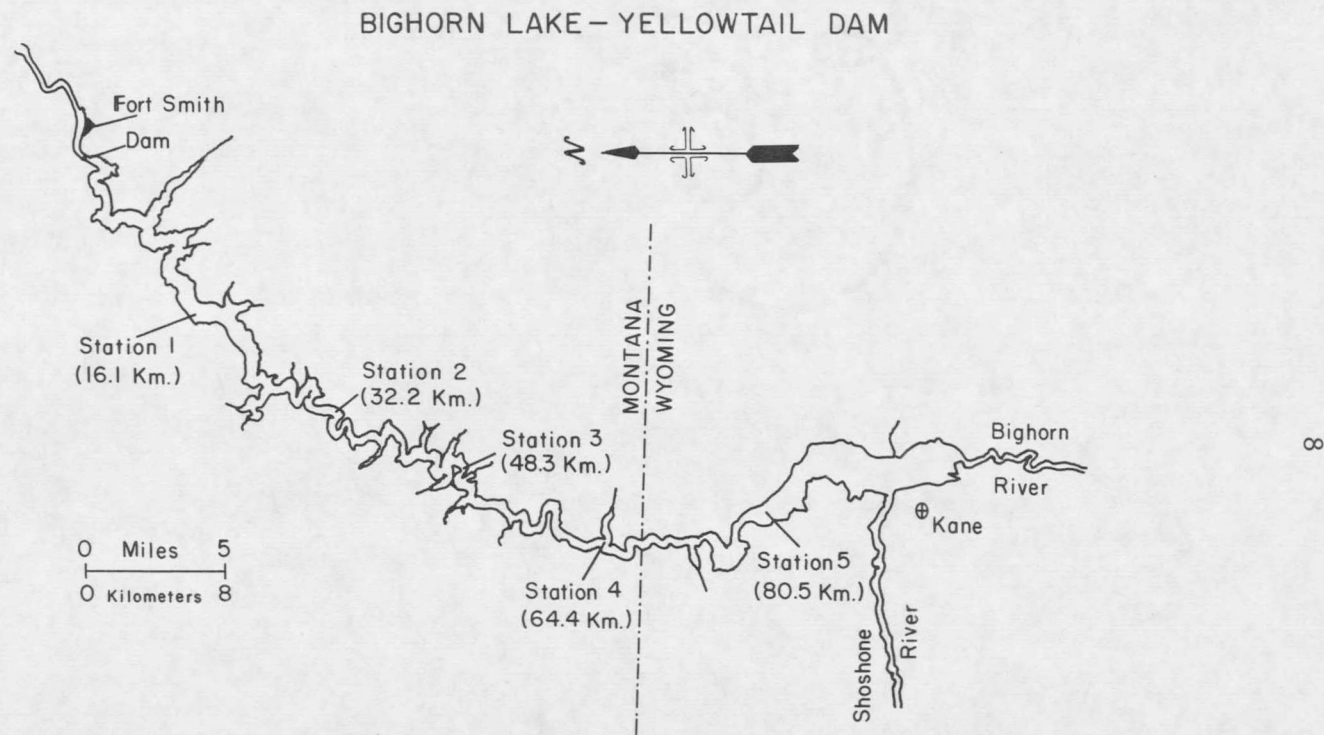


Figure 3. Map of Bighorn Lake (Bureau of Reclamation) showing location of the six permanent sampling stations.

minimum of approximately $21.2 \text{ m}^3/\text{sec}$ (750 cfs) and a spring maximum of $339.8 \text{ m}^3/\text{sec}$ (12,000 cfs). Maximum recorded discharge was $712.7 \text{ m}^3/\text{sec}$ (25,000 cfs) on 16 June 1935 and the minimum was $5.1 \text{ m}^3/\text{sec}$ (179 cfs) on 22 July 1934. The drainage area of this river comprises $40,831 \text{ km}^2$ ($15,765 \text{ mi}^2$) at an elevation greater than 1,115.6 m (3,660 ft) above mean sea level.

The average discharge from the Shoshone River was $32.3 \text{ m}^3/\text{sec}$ (1,141 cfs) for an 11 year period (U.S.G.S., 1968). The discharge normally fluctuates between a fall minimum of approximately $12.8 \text{ m}^3/\text{sec}$ (430 cfs) and a spring maximum of $195.4 \text{ m}^3/\text{sec}$ (6,900 cfs). Maximum recorded discharge was $373.8 \text{ m}^3/\text{sec}$ (13,200 cfs) on 19 September 1961 and the minimum was $3.4 \text{ m}^3/\text{sec}$ (120 cfs) on 21-23 January 1959. The drainage area of this river comprises $7,742 \text{ km}^2$ ($2,989 \text{ mi}^2$) at an elevation greater than 1,117.9 m (3,635 ft) above mean sea level.

Permanent sampling stations were established during the study for each of the above tributaries. The Bighorn sampling site was located at lat. $44^\circ 45' 31''$, long. $108^\circ 10' 51''$, in NW1/4 NE1/4 SW1/4 Sec.9, T.55 N., R.94 W., off the right bank and 10.5 kilometers (6.5 miles) south of Kane, Wyoming. The location of the Shoshone River sampling station was lat. $44^\circ 51' 45''$, long. $108^\circ 12' 30''$, in E1/2 Sec.6, T.56 N., R.95 W., off the right bank, 1.6 kilometers

(1 mile) north of Kane, Wyoming and 2.4 kilometers (1.5 miles) upstream from its mouth.

A sampling station at the base of the dam was also established for the characterization of the effluent waters from the reservoir during the course of the study.

METHODS AND MATERIALS

Influent and Effluent Waters

Water samples and field measurements were taken at the various river stations at biweekly intervals for 1968 and weekly intervals for 1969, when possible, throughout the duration of this part of the study. Table II shows the dates and the rivers which were sampled.

All samples were obtained by lowering an 8-liter polyethylene bucket into the main current of the river. The container was rinsed well with the surface water prior to sampling. Upon collection, two 1-liter aliquots were collected in glass-stoppered Pyrex bottles. Immediately, one of the samples, to be used for heavy metal analyses, was preserved with 2 ml of 50% HCl (Rainwater and Thatcher, 1959). All storage bottles were rinsed twice before being filled with the water sample.

Water Chemistry

After returning to the laboratory, a portion (700 ml) of the untreated sample was filtered through Millipore[®] filters with a pore size of 0.45 microns. After filtering, the sample was placed back in the glass-stoppered Pyrex bottle, which had been rinsed with a small quantity of the filtrate. The remaining unfiltered water was placed in a 300 ml glass-stoppered Pyrex bottle and used in some of the subsequent analyses.

Measurement of hydrogen ion concentration was determined in the field and in the laboratory with an Orion specific ion meter

Table II.

The date and the river where water samples were collected (+) during the 1968 and 1969 sampling periods.

1968				1969			
Date	Bighorn Influent	Shoshone Influent	Discharge	Date	Bighorn Influent	Shoshone Influent	Discharge
2/22	+	+	+	1/ 3	*	*	+
3/ 7	+	+	+	1/18	*	+	+
3/28	+	+	+	2/ 1	*	+	+
4/11	+	+	+	2/15	*	+	+
5/ 4	+	+	+	3/ 1	*	+	+
5/18	+	+	+	3/17	+	+	+
6/ 1	+	+	+	3/31	+	+	+
6/12	+	+	+	4/ 7	+	+	+
6/24	+	+	+	4/14	+	+	+
7/15	+	+	+	4/21	+	+	+
8/ 1	+	+	+	4/28	+	+	+
8/19	+	+	+	5/ 5	+	+	+
9/23	+	+	+	5/12	+	+	+
10/ 7	+	+	+	5/22	+	+	+
10/19	+	+	+	5/28	+	+	+
11/ 9	+	+	+	6/ 3	+	+	+
11/23	+	+	+	6/10	+	+	+
12/ 7	+	+	+	6/17	+	+	+
12/20	*	+	+	6/24	+	+	+
				7/ 1	+	+	+
				7/ 8	+	+	+
				7/14	+	+	+
				7/21	+	+	+
				7/29	+	+	+
				8/ 5	+	+	+
				8/11	+	+	+
				8/18	+	+	+

* Samples were not collected because of ice cover.

(Model 401) and a Beckman Expanded Scale pH meter (Model 76), respectively.

Total alkalinity, chloride, fluoride, nitrate, nitrite, ammonia, total and soluble nitrogen, total phosphate, soluble and inorganic phosphate, sulfate, silica, calcium, magnesium, copper and turbidity determinations were made as described by the American Public Health Association (1965).

Total iron determinations were made according to the method of Collins and Diehl (1960). Manganese was determined by the leuco-base method as described by Strickland and Parsons (1968). The colorimetric equipment used in the various analyses was either a Bausch and Lomb "Spectronic 20" (Serial No. 4848 UB) or a Klett-Summerson (Model 800-3) colorimeter.

Total and soluble carbon fractions were determined by employing a Beckman Laboratory Carbonaceous Analyzer (Serial No. PI 1114).

Sodium and potassium were determined by flame emission with a Beckman DU Flame Spectrophotometer. Zinc was determined by atomic absorption spectroscopy employing a Perkin-Elmer Atomic Absorption Unit (Model 303).

All of the above mentioned analyses were made within 96 hours after collection. Total alkalinity, the various forms of carbon, the various forms of phosphorus, total and soluble nitrogen, ammonia,

nitrate, nitrite and laboratory pH determinations were made within 48 hours after collection.

Temperature and Conductivity

The temperature of the water sample upon collection was measured with a Gemware bucket thermometer (No. 297WA100).

The electrical resistance of each sample was measured with a YSI Conductivity Bridge (Model 31). An Industrial Instruments dipping cell (Model CEL 4) was used with the above conductivity bridge. The cell constant of the dipping cell was approximately 2.1 throughout the study.

The specific conductance of the water at 25 C was computed from the observed resistance and corrected for temperature and cell resistance.

Hydrology

Discharge measurements for the Bighorn and Shoshone Rivers were supplied by the U. S. Geological Survey. The gaging stations are located in the same areas where water samples were collected.

Records of the total discharge from the dam were furnished by the Bureau of Reclamation.

Reservoir

During the study all water samples and in situ measurements were taken during one of the fifty-six cruises at each station on Bighorn

Lake. The length of the sampling season was usually five months (Table III). This study was carried out over three years (1968, 1969, and 1970). Due to the late date of receipt of the grant award it was not possible to sample the reservoir intensively in 1967. When possible, sampling periods were spaced at weekly intervals.

In 1968 and 1969 both "short cruises" and "long cruises" were made. A long cruise was made once a month and short cruises the rest of the month. On short cruises, transmissivity, temperature and conductivity measurements were made from the surface to the bottom of the reservoir at 5 meter intervals at all sampling stations. In situ light measurements at depth intervals of 1 meter were obtained. Water samples were collected from the surface to the lower limit of the euphotic zone usually at 1 meter intervals. The pH of each sample was determined. Equal volumes of the euphotic zone samples were then composited and this composite was used for chlorophyll, nitrate, nitrite, ammonia, ortho-phosphate, total iron, manganese, copper, and zinc determinations. Also, a sample was taken from the composite for phytoplankton enumeration.

Everything determined on a short cruise was duplicated on a long cruise, but additional water samples for a more detailed chemistry study of the reservoir were collected at 10 meter intervals from the surface to the bottom of the reservoir. These samples were taken

Table III. The dates for each cruise and type of cruise made during the study period.

1968			1969			1970	
Cruise	(Type)	Date	Cruise	(Type)	Date	Cruise	Date
1	(L)	5/ 5	27	(L)	4/15	43	6/11
2	(S)	5/13	28	(S)	4/21	44	6/18
3	(S)	5/20	29	(S)	4/28	45	6/24
4	(S)	5/27	30	(S)	5/ 5	46	7/ 2
5	(L)	6/ 7	31	(L)	5/12	47	7/ 8
6	(S)	6/12	32	(S)	5/21	48	7/16
7	(S)	6/20	33	(S)	5/27	49	7/23
8	(S)	6/27	34	(S)	6/ 3	50	7/29
9	(S)	7/ 2	35	(S)	6/13	51	8/ 4
10	(L)	7/ 8	36	(L)	6/18	52	8/10
11	(S)	7/15	37	(S)	6/24	53	8/18
12	(S)	7/23	38	(S)	6/30	54	8/24
13	(S)	7/29	39	(S)	7/22	55	9/ 1
14	(L)	8/ 5	40	(L)	7/28	56	9/ 8
15	(S)	8/12	41	(S)	8/ 4		
16	(S)	8/19	42	(S)	8/11		
17	(S)	8/26					
18	(L)	9/ 3					
19	(S)	9/ 9					
20	(S)	9/17					
21	(S)	9/23					
22	(L)	10/ 2					
23	(S)	10/ 8					
24	(S)	10/14					
25	(S)	10/22					
26	(L)	11/ 2					

S = short cruise

L = long cruise

every 16.1 km starting with station 0 and analyzed for dissolved oxygen, pH, total alkalinity, chloride, fluoride, sulfate, nitrite, nitrate, ammonia, ortho-phosphate, silica, turbidity, potassium, sodium, calcium, and magnesium concentrations.

In 1970, transmissivity, temperature and conductivity were determined as for preceding years. Sampling procedures in the euphotic zone were similar to that of 1968 and 1969, but pH, oxygen, ortho-phosphate, nitrate, nitrite and ammonia concentrations were determined from the surface to the bottom of the reservoir at 10 meter intervals for all stations on all cruises.

Light

Vertical profiles of light attenuation were obtained by measuring in situ light intensities with a Gemware Photometer (Model No. 268WA310). This instrument included a gimbal-mounted deck photocell and an underwater photocell (both had matched photocells). Light intensity was measured from the surface and at 1 meter intervals until a depth at which only 1% of the total surface radiation was obtained.

A number of field and laboratory studies have shown that the compensation point for various phytoplankton organisms is reached at light intensities of about 1% total surface radiation (Verduin, 1964). Therefore, by definition the compensation point sets the lower limit of the euphotic zone.

The mean vertical extinction coefficients were computed as described by Hutchinson (1957). The extinction coefficient units are common log units per meter (k/m).

Light transmission was measured at 5 meter intervals from the surface with 1 meter and/or 10 centimeter Hydro Products transmissometer columns.

Kimball's (1928) tables of average radiation data for selected dates and latitudes were used in the calculations of primary productivity.

Temperature and Conductivity

Vertical in situ measurements for conductivity and temperature were made with a Beckman RB3-3341 Solu Bridge, calibrated for use with conductivity cell CEL-S02-VH20-KP-X9. The latter incorporates a thermistor which serves a dual function as a component of an automatic temperature compensator for all conductivity ranges and as a primary element for temperature measurement.

Water Chemistry

A 3-liter Van Dorn Bottle was used to collect all water samples. All storage containers were rinsed with sample prior to filling.

One-liter samples were filtered through Millipore[®] filters with a pore size of 0.45 microns. After filtering, the samples were placed back in the storage containers, which were rinsed with a small

quantity of the filtrate.

The methodology for the chemistry of the reservoir was the same as that used in characterizing the influent and effluent waters.

A YSI Model 54 Oxygen Meter was used for the determination of dissolved oxygen. The instrument was calibrated by allowing the electrode system to equilibrate in a sample of known oxygen content.

Phytoplankton Standing Crop, Chlorophyll and Primary Productivity

The total cell volume per unit volume of water (mm^3/liter) was determined for each taxon in the phytoplankton community as follows. A 125 ml sample of the euphotic zone composite was preserved with Lugol's solution. Later in the laboratory, the algae were uniformly suspended in the solution, and a 10 ml settling chamber was filled with the phytoplankton sample. After 24 hours the sediment was examined with a Zeiss-Winkel inverted microscope. Morphological units representing each taxon were counted and linear dimensions measured with a Whipple micrometer disk. By assuming an appropriate geometrical shape, (i.e., sphere, prolate spheroid, etc.), the average cell volume per morphological unit was computed. A series of ratios involving sample volume, magnification and the number of fields counted were used to compute the cell volume per liter (Schwoerbel, 1970). Lund et al. (1958) have discussed the statistical validity of such direct count methods.

Identification of the phytoplankton was carried out to the species level where possible, but in some cases only generic designations were made. Algae were identified from both living and preserved material using the keys of Smith (1950), Prescott (1962), Hustedt (1930), Tiffany and Britton (1952) and Drouet (1959).

Fresh algal weight, in mg, was considered to be equivalent to cell volume in mm^3 (Strickland, 1960).

Chlorophyll a concentrations were determined by filtering (0.45 micron Millipore ^(R) filters) a known volume (usually 500 ml) of the euphotic zone composite water. The membrane was then dissolved in 5 ml of 90% acetone and allowed to stand in the dark for 24 hours. The solution was then centrifuged and the optical density of the supernatant was measured at 665 millimicrons using the Bausch and Lomb "Spectronic 20" colorimeter. The milligrams of chlorophyll a per cubic meter were calculated according to Odum et al. (1958).

The method of Ryther and Yentsch (1957) as modified by Martin (1967) was used to estimate primary productivity. This method assumes an average ratio between chlorophyll and productivity at light saturation and requires data on: (1) the average chlorophyll a concentration of the euphotic zone; (2) total solar radiation; (3) the extinction coefficient of the water column; and (4) average temperature of the euphotic zone for that day.

Hydrology

Stage, net inflow, total discharge and storage records for the reservoir were supplied by the Bureau of Reclamation.

Water exchange rates for the reservoir were computed by dividing the mean storage for a month by the mean monthly outflow.

RESULTS

Influent and Effluent Waters

Hydrology

Fluctuations in the discharge for the Bighorn River are more apparent than for the Shoshone River (Table IV). The natural flow of the Shoshone is regulated by Buffalo Bill reservoir while the Bighorn receives some regulation by Boysen reservoir. Both rivers are affected by diversions for irrigation and return flow from irrigated areas.

During 1968 and 1969, the Bighorn River had a mean monthly discharge of $2,191 \text{ m}^3/\text{sec}$ (77,342 cfs) while the discharge for the Shoshone River was $941 \text{ m}^3/\text{sec}$ (32,158 cfs). Winter months usually had the lowest flows, whereas peak streamflows occurred in the spring (Table V). The peak inflows during June accounted for 13-19% of the total net inflow to the reservoir. The Bighorn River made up approximately 70% of the net inflow.

The major portion of the discharge from the dam was released through the power penstocks. Greater quantities of water were discharged during 1968 than any of the other years.

Temperature and Conductivity

The mean monthly temperatures for the influent and effluent waters are given in Figure 4. The cycle of temperature in the discharge water lagged behind the influent water temperature.

Table IV.

Discharge (m^3/sec) for the influent and effluent waters of Bighorn Lake during 1968 and 1969 sampling periods.

1968				1969			
Date	Bighorn Influent	Shoshone Influent	Discharge	Date	Bighorn Influent	Shoshone Influent	Discharge
2/22	59.4	22.6	114.5	1/ 3	42.5	25.5	129.8
3/ 7	79.2	24.1	148.6	1/18	42.5	25.5	95.9
3/28	68.2	32.3	107.8	2/ 1	56.6	22.6	92.5
4/11	63.4	30.0	98.1	2/15	76.4	17.0	102.5
5/ 4	53.8	15.6	86.8	3/ 1	76.4	24.1	133.9
5/18	59.7	20.7	167.8	3/17	79.0	34.2	139.4
6/ 1	92.5	23.0	141.3	3/31	74.1	27.3	95.4
6/12	205.05	49.0	300.7	4/ 7	74.7	31.7	79.0
6/24	181.4	20.2	154.0	4/14	78.4	26.3	76.9
7/15	47.5	19.7	91.1	4/21	65.1	22.6	39.4
8/ 1	35.9	20.7	59.4	4/28	78.4	28.3	48.4
8/19	82.9	58.6	46.3	5/ 5	77.0	15.6	70.1
9/23	58.9	37.1	113.2	5/12	57.7	16.8	43.4
10/ 7	58.9	27.7	97.7	5/22	62.3	24.9	62.7
10/19	64.2	25.7	87.5	5/28	91.4	25.5	36.7
11/ 9	66.5	35.7	94.7	6/ 3	44.1	19.9	50.7
11/23	70.8	24.2	111.8	6/10	60.6	65.7	44.4
12/ 7	73.0	35.4	113.8	6/17	65.6	43.0	56.4
12/20	42.5	28.9	110.4	6/24	71.3	20.2	50.1
				7/ 1	169.8	28.9	122.8
				7/ 8	101.3	20.4	168.3
				7/14	62.3	19.4	165.6
				7/21	52.6	18.2	145.3
				7/29	43.0	18.6	104.3
				8/ 5	23.2	24.9	110.4
				8/11	22.1	47.3	102.5
				8/18	25.0	70.8	97.0

Table V. Total monthly discharge (m^3/sec) for the influent and effluent waters of Bighorn Lake during 1968 and 1969 sampling periods.

Month	1968			Month	1969		
	Bighorn Influent	Shoshone Influent	Discharge		Bighorn Influent	Shoshone Influent	Discharge
Jan	1,572	753	4,714	Jan	1,373	880	3,136
Feb	1,873	591	3,434	Feb	2,018	640	2,943
Mar	2,214	888	3,820	Mar	2,370	739	3,665
Apr	1,851	808	3,064	Apr	2,085	751	1,846
May	1,848	670	3,589	May	2,102	485	1,492
June	5,582	983	7,010	June	2,918	1,200	2,605
July	1,791	609	2,405	July	2,206	1,148	4,233
Aug	1,918	1,325	1,905	Aug	741	527	3,135
Sept	2,023	1,035	3,110	Sept	937	692	2,739
Oct	1,780	874	2,997	Oct	2,935	1,598	2,838
Nov	2,014	973	3,445	Nov	3,665	1,386	2,635
Dec	1,818	1,025	3,425	Dec	2,969	1,292	3,292

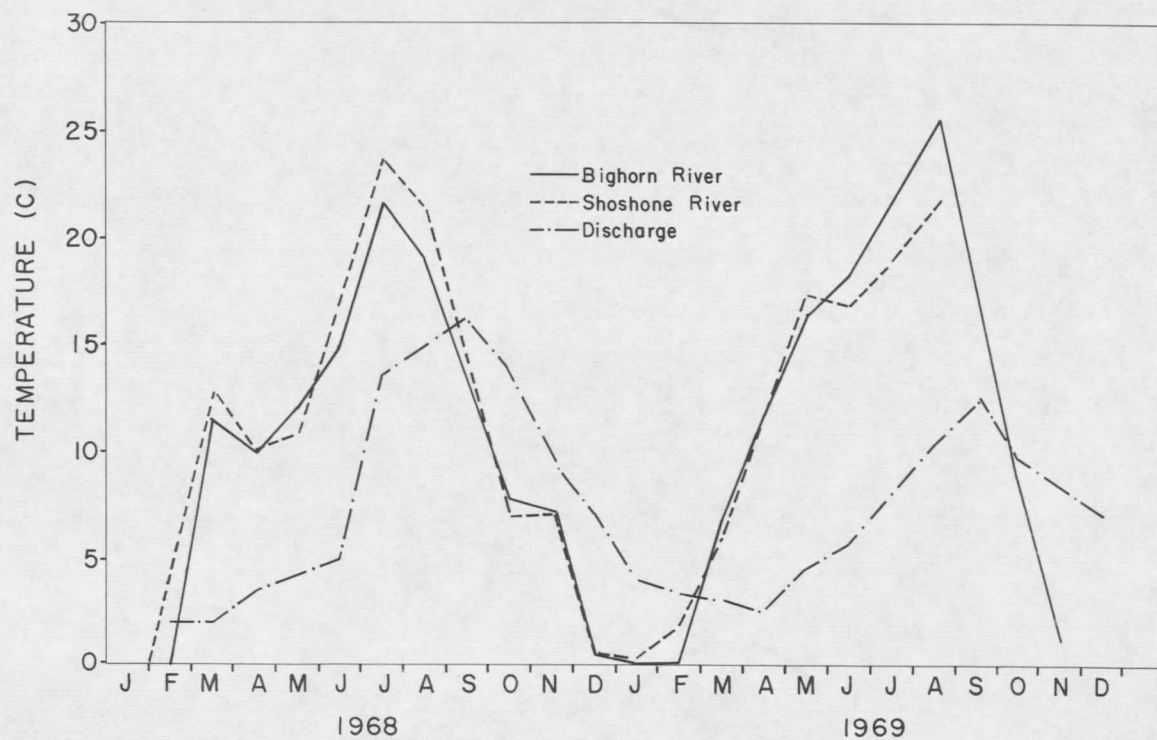


Figure 4. Monthly average of temperatures (C) for the influent and effluent waters of Bighorn Lake during the 1968 and 1969 sampling periods (September - December values supplied by the U.S.G.S.).

Temperatures of the influent streams were at or near freezing through most of December, usually all of January and most of February. From the latter part of February there was a rise in temperature until maximal temperatures were attained in July and August. The highest recorded temperature was 28.2 C for the Bighorn River on 5 August 1969.

In contrast, the effluent water temperature never reached freezing. Minimum temperatures appeared in March and April (2.5 C) followed by a maximum in September (16.0 C, 1968; 12.5 C, 1969).

The effect of impoundment and deep water withdrawal was to displace the maximum and minimum temperatures two to four months behind the influent temperatures and to increase the minimum temperatures above those of the influents.

Figure 5 compares the conductivity of the influent waters with that of the discharge. Conductivity of the Bighorn River never exceeded 1,250 micromhos while 1,500 micromhos was the high recorded for the Shoshone River.

Extremely large fluctuations in conductivity were noted for the Shoshone River whereas most of the values for the Bighorn River were around 900 micromhos. Values were minimal in the Bighorn River during periods of high streamflow in May and June. Maximal conductivity values for the Bighorn River occurred in late summer and early

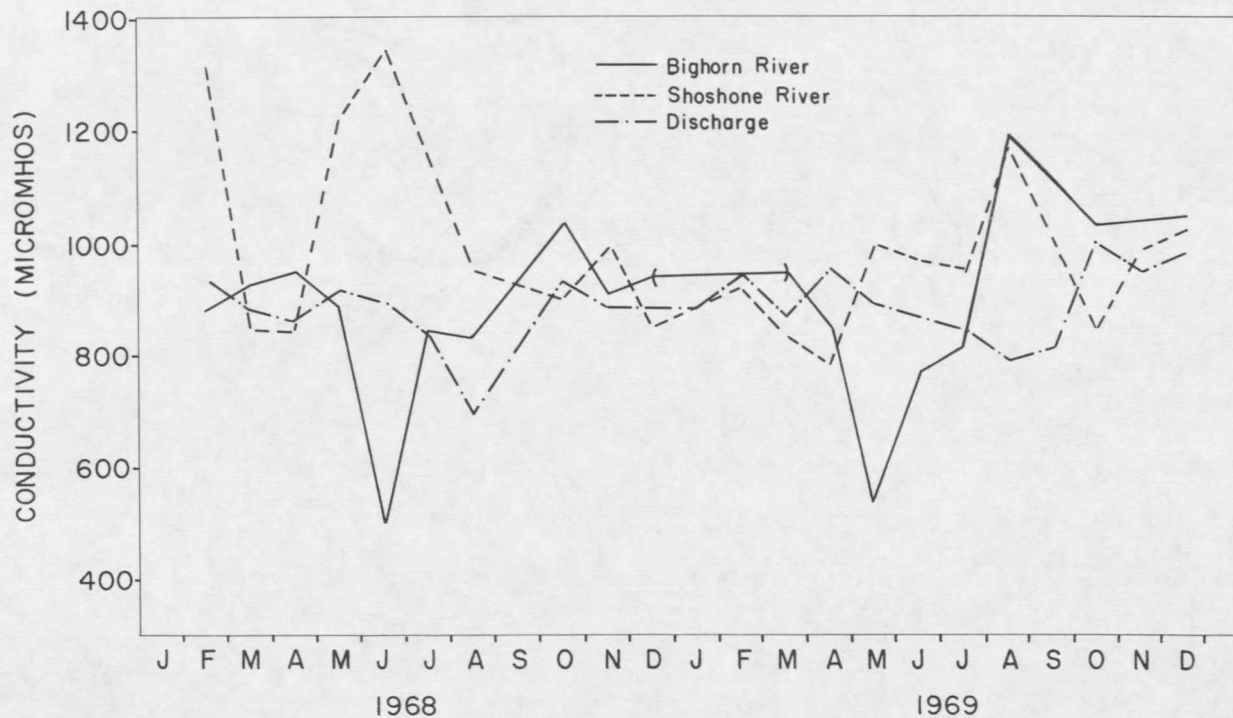


Figure 5. Monthly average of specific conductance (micromhos) for the influent and effluent waters of Bighorn Lake during the 1968 and 1969 sampling periods (September - December values supplied by the U.S.G.S.).

fall periods. The relationship between specific conductance and discharge is illustrated in Figure 6.

The two to four month lag is again evident between minimum and maximum values of conductivity when influent waters (particularly the Bighorn River) and the discharge are compared (Fig. 5).

Water Chemistry

The composition of the influent waters is what would be expected from rivers draining sedimentary rocks under semi-arid conditions (Hem, 1959). The range and mean water chemistry are presented in Tables VI and VII. The cations in highest concentration, calcium and sodium, were approximately equal in concentration followed by magnesium and potassium. Sulfate was the anion in highest concentration followed by bicarbonate and chloride.

Discharge-weighted means (for 1968 and 1969) of the major ions of the influent streams and the discharge are given in Table VIII. Discharge-weighted means were computed by multiplying the discharge for a given sampling period by the concentrations of individual constituents for the period and dividing the sum of the products by the sum of the discharges. Overall, water discharge from the dam was slightly lower in dissolved solids than the weighted average of the influents. Sodium, potassium, chloride and sulfate appeared to behave in a conservative manner. The downstream decrease in

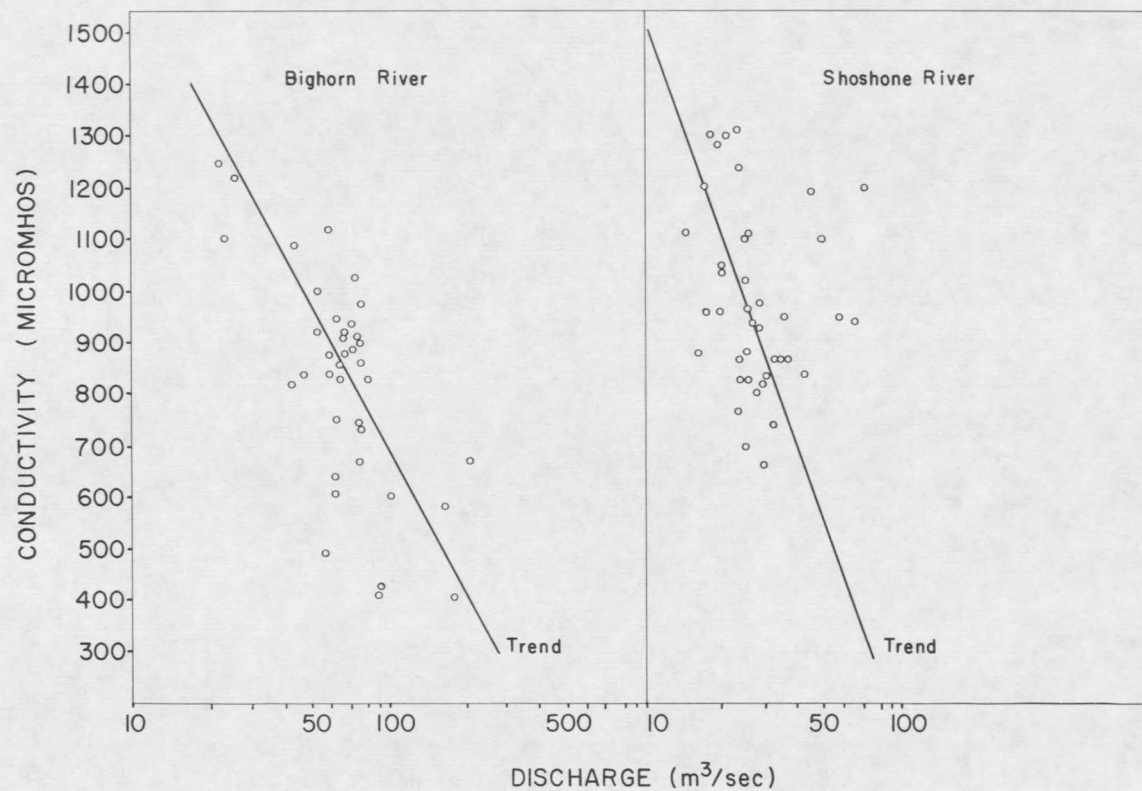


Figure 6. Relationship between specific conductance (micromhos) and mean discharge (m³/sec) for the influent waters of Bighorn Lake during the 1968 and 1969 sampling periods.

Table VI.

Range and mean of water chemistry for the
influent and effluent waters of Bighorn Lake
during the 1968 sampling periods.

	Bighorn Influent	Shoshone Influent	Discharge
Ca ⁺⁺ (meq/l)	1.45-4.66 3.66	1.40-7.62 4.76	2.00-4.98 3.82
Mg ⁺⁺ (meq/l)	0.49-5.17 2.09	1.34-3.84 2.42	0.91-2.60 1.86
Na ⁺ (meq/l)	1.12-4.75 3.35	1.72-6.84 4.84	1.99-4.25 3.23
K ⁺ (meq/l)	0.06-0.27 0.14	0.09-0.22 0.15	0.08-0.42 0.15
HCO ₃ ⁻ (meq/l)	1.92-3.82 3.03	3.24-4.76 3.90	2.81-3.97 3.18
Cl ⁻ (meq/l)	0.12-0.57 0.35	0.13-0.52 0.30	0.20-0.41 0.29
SO ₄ ⁼ (meq/l)	1.04-8.28 5.95	3.75-13.54 8.35	5.25-7.42 6.17
F ⁻ (meq/l)	0.02-0.11 0.04	0.02-0.11 0.05	0.02-0.10 0.04
Soluble Organic C (mg/l)	1.2 -14.2 7.7	1.5- 11.4 6.7	0.0 -10.3 6.4
Particulate C (mg/l)	0.8 -31.7 7.0	0.3 - 7.4 3.7	0.0 - 3.9 2.0
NO ₃ ⁻ -N (mg/l)	0.09-0.79 0.35	0.08-1.67 0.85	0.25-0.83 0.54
NO ₂ ⁻ -N (mg/l)	0.003-0.028 0.008	0.003-0.029 0.011	0.001-0.017 0.005
NH ₃ -N (mg/l)	0.00-1.36 0.35	0.00-0.66 0.28	0.00-0.50 0.17
Soluble Organic NH ₃ -N (mg/l)	0.00-0.95 0.33	0.02-1.49 0.52	0.00-1.50 0.47
Particulate NH ₃ -N (mg/l)	0.00-1.88 0.34	0.00-0.45 0.06	0.00-1.18 0.09
Ortho-PO ₄ ⁼⁼⁼ (mg/l)	0.00-0.40 0.11	0.00-0.64 0.12	0.00-0.16 0.04
Soluble Organic PO ₄ ⁼⁼⁼ (mg/l)	0.00-0.35 0.04	0.00-1.10 0.06	0.00-0.16 0.02
Particulate PO ₄ ⁼⁼⁼ (mg/l)	0.00-3.39 1.90	0.00-2.08 0.47	0.00-0.21 0.04

Table VI. (Cont'd)

	Bighorn Influent	Shoshone Influent	Discharge
Turbidity (J.T.U.)	30-4,900 816	36-2,220 434	4-30 13
Silica (mg/l)	6.3-12.9 9.4	7.6-18.5 13.8	6.7-14.0 10.0
Total Iron (mg/l)	0.004-0.885 0.138	0.016-0.440 0.129	0.003-0.022 0.009
Mn ⁺⁺ (mg/l)	0.004-0.119 0.021	0.001-0.077 0.025	0.000-0.009 0.004
Cu ⁺⁺ (µg/l)	0.70-3.80 1.60	0.80-2.80 1.40	0.80-1.70 1.10
Zn ⁺⁺ (mg/l)	0.007-0.232 0.094	0.010-0.260 0.084	0.006-0.258 0.057
Conductance (micromhos)	412-1,125 837	818-1,684 1,062	669-932 870
pH Range	7.49-8.55	7.78-8.46	6.98-8.10

Table VII.: Range and mean of water chemistry for the influent and effluent waters of Bighorn Lake during the 1969 sampling periods.

	Bighorn Influent	Shoshone Influent	Discharge
Ca ⁺⁺ (meq/l)	2.08-5.48 3.43	1.82-4.67 3.76	2.88-4.43 3.71
Mg ⁺⁺ (meq/l)	0.49-2.80 1.69	0.86-2.73 1.95	1.46-3.38 2.02
Na ⁺ (meq/l)	1.77-6.80 3.51	2.19-6.20 4.16	2.73-4.50 3.53
K ⁺ (meq/l)	0.06-0.17 0.12	0.06-0.16 0.12	0.06-0.16 0.12
HCO ₃ ⁻ (meq/l)	1.41-3.45 2.52	1.81-4.60 3.15	2.25-3.70 3.05
Cl ⁻ (meq/l)	0.17-0.56 0.35	0.14-0.69 0.31	0.27-0.45 0.34
SO ₄ ⁼ (meq/l)	2.42-7.50 5.03	3.10-8.44 5.83	4.33-6.21 5.47
F ⁻ (meq/l)	0.02-0.05 0.03	0.02-0.06 0.04	0.02-0.06 0.04
Soluble Organic C (mg/l)	4.4 -20.0 9.6	4.8 -24.9 9.7	5.3 -23.0 9.5
Particulate C (mg/l)	0.0 -39.6 10.5	0.0 -27.0 8.1	0.0 -30.8 5.0
NO ₃ ⁻ -N (mg/l)	0.12-0.78 0.40	0.00-1.53 0.79	0.00-0.74 0.55
NO ₂ ⁻ -N (mg/l)	0.002-0.011 0.005	0.000-0.019 0.011	0.000-0.015 0.004
NH ₃ -N (mg/l)	0.04-0.71 0.25	0.07-0.71 0.26	0.02-0.55 0.21
Soluble Organic NH ₃ -N (mg/l)	0.00-0.87 0.19	0.00-0.87 0.26	0.01-0.56 0.18
Particulate NH ₃ -N (mg/l)	0.04-2.18 0.67	0.00-2.24 0.46	0.00-0.75 0.21
Ortho-PO ₄ ⁼ (mg/l)	0.00-1.55 0.11	0.00-0.28 0.08	0.00-0.17 0.04
Soluble Organic PO ₄ ⁼ (mg/l)	0.00-0.04 0.00	0.00-0.12 0.00	0.00-0.14 0.00
Particulate PO ₄ ⁼ (mg/l)	0.00-3.22 0.68	0.00-1.30 0.55	0.00-0.16 0.05

Table VII. (Cont'd)

	Bighorn Influent	Shoshone Influent	Discharge
Poly- $\text{PO}_4^{\equiv}$ (mg/l)	0.00-0.43 0.02	0.00-0.18 0.05	0.00-0.35 0.05
Turbidity (J.T.U.)	59-3,600 631	22-2,540 371	0-36 10
Silica (mg/l)	6.3-19.4 9.1	8.3-17.6 13.8	6.0-12.8 10.5
Total Iron (mg/l)	0.001-4.015 1.290	0.001-3.900 1.390	0.000-0.463 0.052
Mn ⁺⁺ (mg/l)	0.000-2.145 0.265	0.001-0.560 0.182	0.000-0.300 0.030
Cu ⁺⁺ (µg/l)	0.5-22.0 3.1	0.5-21.0 2.6	0.0-6.0 1.3
Zn ⁺⁺ (mg/l)	0.000-0.178 0.048	0.004-0.169 0.038	0.004-0.058 0.022
Conductance (micromhos)	427-1,247 826	507-1,315 941	692-971 877
pH Range	7.33-8.63	7.35-8.56	6.81-8.31

Table VIII. Discharge-weighted chemical composition (meq/l) of the influent and effluent waters of Bighorn Lake during 1968 and 1969.

	1968								
	Ca	Mg	Na	K	HCO ₃	Cl	SO ₄	F	Sum
Bighorn (B.H.)	3.64	2.10	3.22	0.13	2.94	0.33	5.37	0.04	17.77
Shoshone (Shos.)	4.69	2.32	4.72	0.15	3.91	0.30	8.00	0.04	24.13
Weighted Average of B.H. & Shos.	3.94	2.17	3.65	0.14	3.22	0.33	6.12	0.04	19.61
Discharge	3.89	1.91	3.27	0.14	3.18	0.30	6.11	0.03	18.83
Percent change	-1.3	-11.9	-10.4	0.0	-1.3	-9.1	-0.2	-25.0	-4.0

	1969*								
	Ca	Mg	Na	K	HCO ₃	Cl	SO ₄	F	Sum
Bighorn (B.H.)	3.80	1.90	3.61	0.10	2.94	0.37	5.65	0.02	18.39
Shoshone (Shos.)	4.02	2.06	3.87	0.11	3.62	0.33	5.83	0.03	19.87
Weighted Average of B.H. & Shos.	3.87	1.95	3.69	0.11	3.16	0.36	5.70	0.03	18.87
Discharge	3.74	2.05	3.70	0.11	3.14	0.31	5.79	0.03	18.87
Percent change	-3.4	+4.9	+0.3	0.0	-0.6	-13.9	+1.6	0.0	0.0

* September-December data supplied by the U.S.G.S.

concentration of these ions, particularly sodium, probably was due to dilution by rainfall and/or run-off from snow-fed tributaries. In 1969, there was a decrease in calcium concentration in the discharge compared to an increase in magnesium, but a decrease in both ions occurred in 1968. These elements were determined using a complexometric titration which, because of the inherent errors of the method (A.P.H.A., 1965), could possibly account for the different results between the two years.

Table IX presents values of the various carbon, nitrogen and phosphorus fractions averaged from 22 samples collected between 19 August 1968 and 18 August 1969 from the influent and effluent waters.

Of the total amount of nitrogen that entered the reservoir 75% was discharged. A large decrease in particulate nitrogen was evident from a comparison of influent and effluent concentrations. The concentration of total inorganic nitrogen leaving the reservoir was essentially the same as that entering. More nitrate was discharged than entered, which indicates nitrification and nitrogen fixation were in excess of nitrogen assimilation and denitrification.

Only 14% of the phosphorus that entered the reservoir was discharged. The greatest loss was in particulate phosphorus.

Significant correlations existed between high turbidity and high total phosphorus for both the Bighorn ($r = 0.79$; $P = 0.01$) and

Table IX. The carbon (mg/l C), nitrogen (mg/l N) and phosphate (mg/l PO_4^{III}) balances of Bighorn Lake for the period between 19 August 1968 and 18 August 1969.

	Total Organic -N	Particulate Organic -N	Soluble Organic -N	NH_3 -N	NO_2 -N	NO_3 -N	Total In- organic -N	Total In- organic + Organic -N
Bighorn (B.H.)	0.91	0.68	0.23	0.30	0.006	0.40	0.71	1.62
Shoshone (Shos.)	0.75	0.47	0.29	0.28	0.01	0.89	1.18	1.93
Weighted Average of B.H. & Shos.	0.86	0.62	0.25	0.29	0.007	0.55	0.85	1.71
Discharge	0.44	0.23	0.21	0.23	0.004	0.61	0.84	1.28
Percentage change	-49	-63	-16	-20	-43	+11	-1	-25
	Total - PO_4	Particulate - PO_4	Ortho- - PO_4					
Bighorn (B.H.)	0.926	0.625	0.104					
Shoshone (Shos.)	0.792	0.553	0.077					
Weighted Average of B.H. & Shos.	0.886	0.603	0.096					
Discharge	0.123	0.040	0.031					
Percentage change	-86	-93	-68					
	Total Organic -C	Particulate Organic -C	Dissolved Organic -C					
Bighorn (B.H.)	18.75	9.82	8.93					
Shoshone (Shos.)	16.50	7.20	9.30					
Weighted Average of B.H. & Shos.	16.57	7.22	9.27					
Discharge	12.51	3.79	8.72					
Percentage change	-24	-47	-6					

Shoshone ($r = 0.71$; $P = 0.01$) Rivers. A positive correlation was also found between turbidity and total nitrogen for the Bighorn ($r = 0.66$; $P = 0.01$), however, this relationship for the Shoshone River was not statistically significant.

Figure 7 presents a comparison of streamflows and turbidities for the influent and effluent waters. When run-off into the reservoir was high, especially in the case of the Bighorn River, a corresponding increase in turbidity was observed, but turbidity for the discharge never exceeded 30 Standard Jackson Turbidity Units.

High values of ortho-phosphate as well as total phosphate are associated with high turbidity (Fig. 8). This may indicate that a base exchange equilibrium occurred between the water and the suspended sediments, releasing ortho-phosphate from the sediments.

The most significant change in the carbon balance of the influent and effluent waters (Table IX) was the decrease in particulate carbon. Dissolved organic carbon was essentially the same in the discharge as in the influent streams.

Data concerning the heavy metal analyses are given in Table X. There was a decrease in concentration of these elements in the discharge compared to the influent streams. The greatest decrease was in iron followed by manganese. Copper appeared to be the most mobile of all the heavy metals. The ratio of iron to manganese was less in

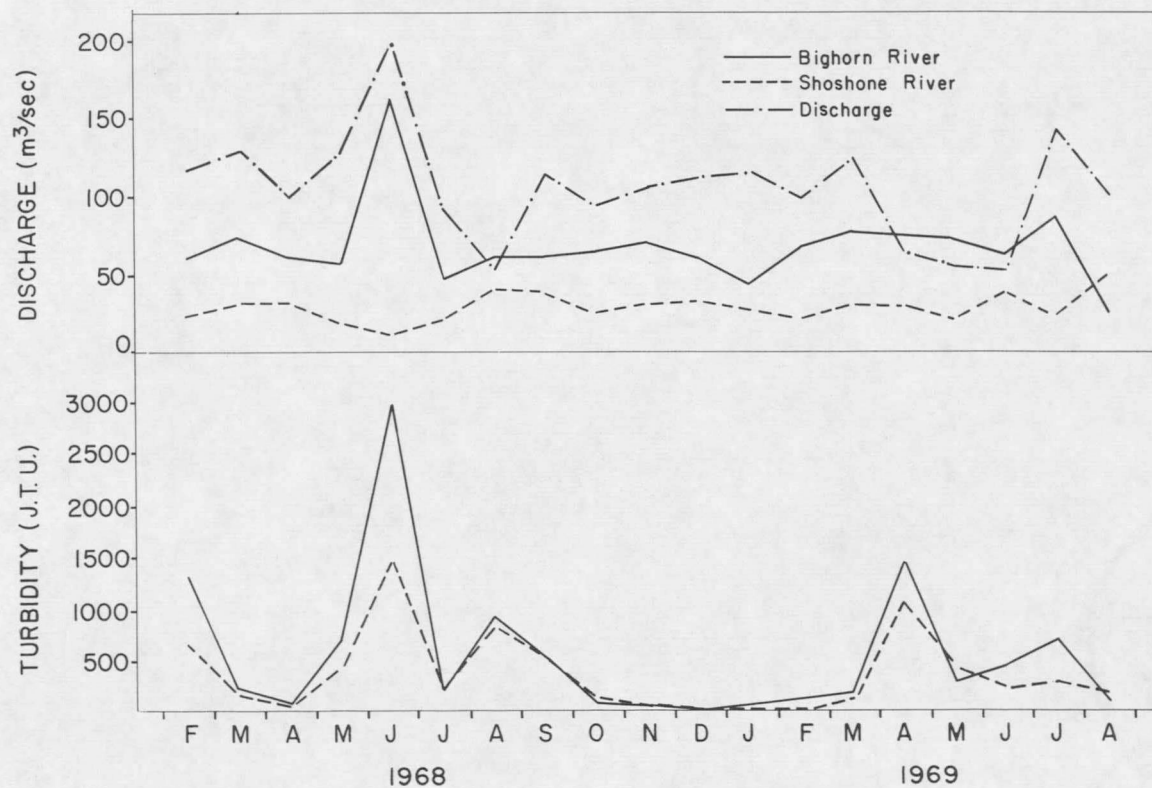


Figure 7. Seasonal fluctuations of mean discharge (m^3/sec) and turbidity (Standard Jackson Turbidity Units) for the influent and effluent waters of Bighorn Lake during the 1968 and 1969 sampling periods.

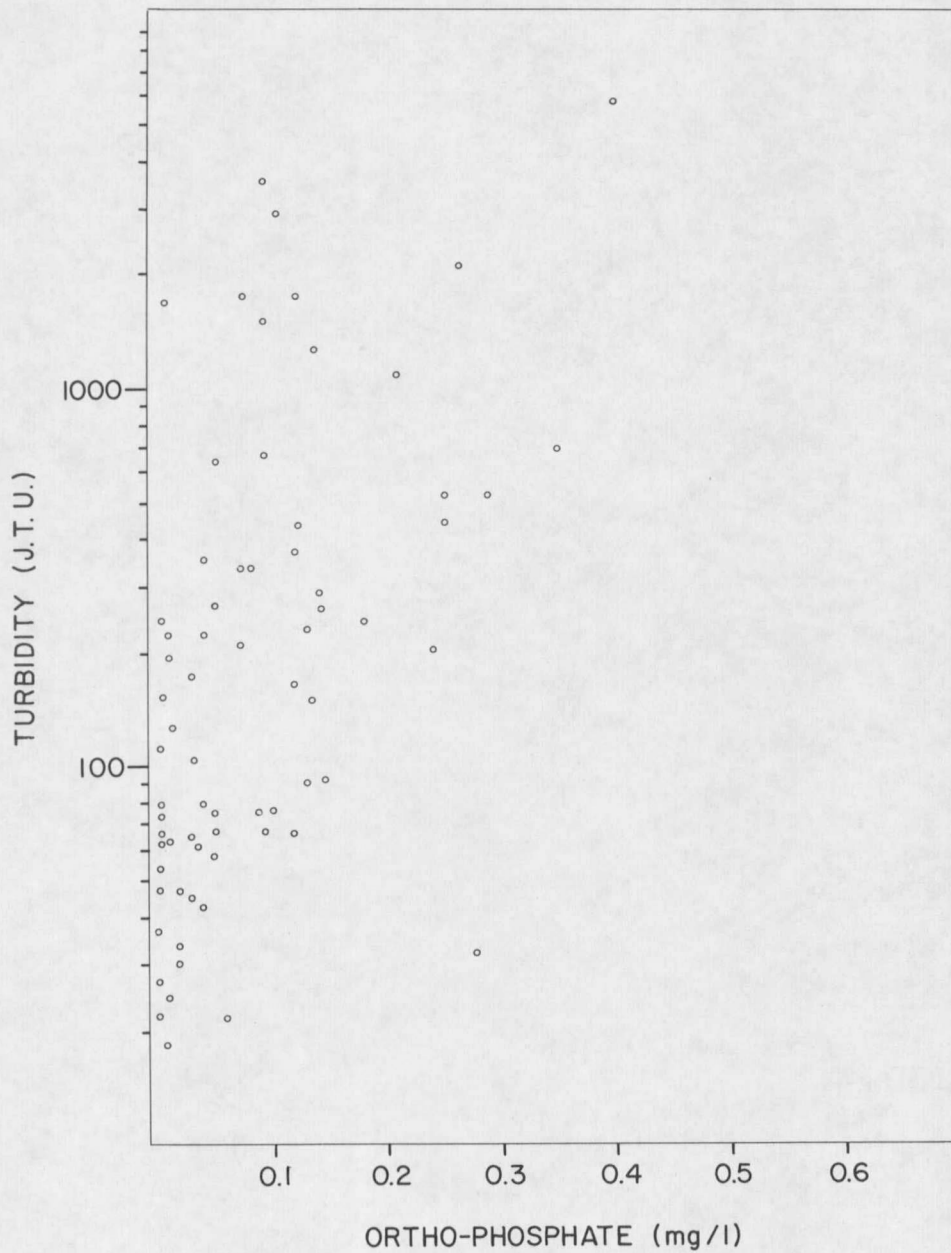


Figure 8. Relationship between turbidity (Standard Jackson Turbidity Units) and ortho-phosphate (mg/l PO_4^{3-}) for the Bighorn and Shoshone Rivers.

the discharge than in the influents. The ratio of copper to zinc was higher in the discharge than in the influent water. The major cause of decrease in concentration of these metals was attributed to the settling out of suspended sediments that were carried into the reservoir.

Table X. Iron, manganese, copper and zinc (mg/l) budget of Bighorn Lake during the 1968 and 1969 sampling periods.

	Fe	Mn	Fe/Mn	Cu	Zn	Cu/Zn
Bighorn (B.H.)	1.052	0.152	6.92	0.0025	0.086	0.03
Shoshone (Shos.)	1.000	0.124	8.67	0.0023	0.067	0.03
Weighted Average of B.H. and Shos.	1.036	0.144	7.19	0.0024	0.080	0.03
Discharge	0.034	0.022	1.55	0.0015	0.023	0.07
Percentage Change	-97	-86		-40	-71	

Reservoir

Hydrology

Due to excessive inflow to the reservoir, Bighorn Lake was filled to maximum capacity in 1967. Sixty-one percent of the total net inflow for 1967 occurred during May, June and July. Twenty percent of the total discharge for the year was diverted through the spillway

in July because of the excessive run-off to the reservoir in the preceding months. These high discharges caused damage to the spillway tunnel.

Inflow, discharge and storage change data for water years 1968, 1969 and 1970 are given in Table XI. Two extremes are illustrated, with a negative storage value for 1968 and positive storage values for 1969 and 1970. The negative value in 1968 was due to the fact that the total discharge had to be greater than the total inflow in order to attain and maintain water levels below the spillway elevation to facilitate repair of the spillway tunnel.

Reservoir water level fluctuations for 1969 and 1970 were fairly constant. There was a spring rise of 20 meters (66 ft) to reach a maximum in July followed by receding water levels to a minimum in February and March (Fig. 9). However, the reservoir was in a filling stage during the study and water levels were not indicative of normal operation until 1970.

The annual water exchange rates for Bighorn Lake were 0.3 in 1968, 0.4 in 1969 and 0.5 in 1970 (Table XII). This illustrates that as water levels increased, the retention time of a given mass of water within the reservoir became greater.

Table XI. Inflow, discharge and storage change ($\times 10^5 \text{ m}^3$) in Bighorn Lake for the water years ending 30 September 1968, 30 September 1969 and 30 September 1970.

1968													
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Total
Net													
Inflow	2,375	2,580	2,466	2,329	2,628	2,853	2,408	2,490	6,542	2,354	2,794	2,686	34,505
Total													
Discharge	2,240	2,703	3,835	4,064	2,960	3,268	2,638	3,094	6,043	2,074	1,643	2,681	37,243
Storage													
Change	+135	-123	-1,369	-1,735	-332	-415	-230	-604	+499	+280	+1,151	+5	-2,738
1969													
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Total
Net													
Inflow	2,662	2,840	2,483	2,034	2,389	2,861	2,625	2,615	4,018	3,320	1,561	1,837	31,245
Total													
Discharge	2,587	2,970	2,953	2,704	2,537	3,159	1,592	1,286	2,266	3,157	2,703	2,361	30,275
Storage													
Change	+75	-130	-470	-670	-148	-298	+1,033	+1,329	+1,752	+163	-1,142	-524	+970
1970													
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Total
Net													
Inflow	2,407	2,334	1,880	1,719	2,286	2,439	1,945	3,448	5,863	3,643	1,334	1,906	31,204
Total													
Discharge	2,450	2,272	2,838	2,919	2,487	1,453	795	1,681	3,856	5,032	1,781	1,383	28,947
Storage													
Change	-43	+62	-958	-1,200	-201	+986	+1,150	+1,767	+2,007	-1,389	-447	+523	+2,257

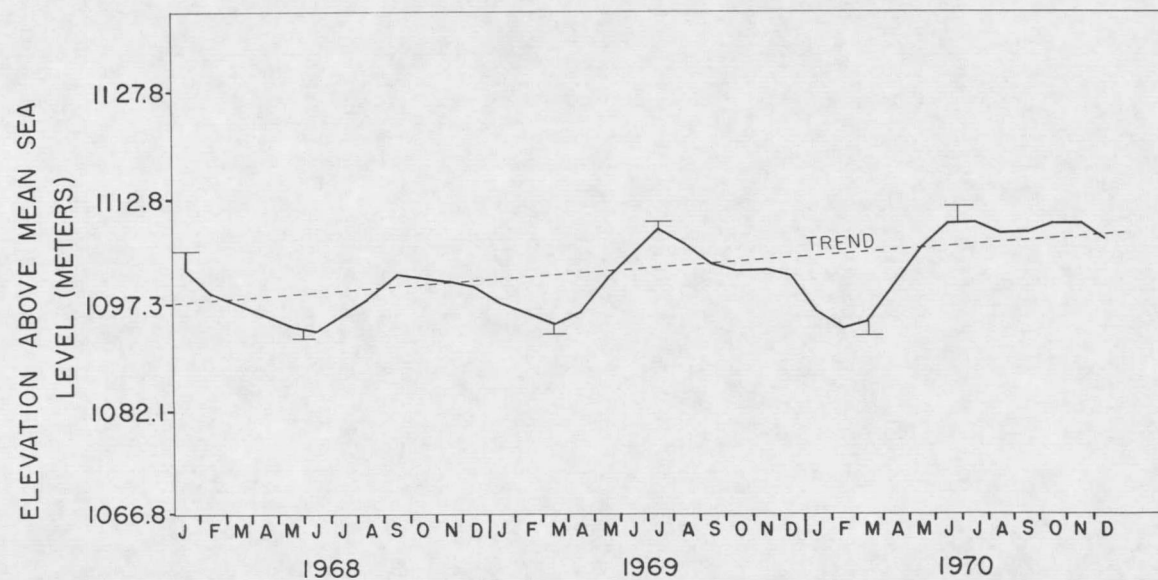


Figure 9. Range and mean water levels of Bighorn Lake during 1968, 1969 and 1970 (Bureau of Reclamation Data).

Table XII. Water exchange rates (days) in Bighorn Lake for 1968, 1969, and 1970.

Month	1968		
	Average Storage ($\times 10^6 \text{ m}^3$)	Average Discharge ($\times 10^6 \text{ m}^3/\text{day}$)	Exchange Rate (days)
January	1,071.7	13.1	81.9
February	982.7	10.2	96.4
March	952.4	8.7	109.4
April	922.9	8.8	105.0
May	877.1	10.0	88.0
June	866.9	20.1	43.1
July	927.8	6.9	134.5
August	968.7	5.5	177.2
September	1,053.1	8.9	118.1
October	1,043.9	8.3	125.5
November	1,046.8	9.9	105.9
December	1,027.4	9.5	108.0
Mean			107.8
Monthly			3.6
Annual			0.3
Month	1969		
	Average Storage ($\times 10^6 \text{ m}^3$)	Average Discharge ($\times 10^6 \text{ m}^3/\text{day}$)	Exchange Rate (days)
January	951.5	8.7	109.3
February	921.5	9.1	101.9
March	882.8	10.2	86.8
April	917.8	5.3	173.3
May	1,044.2	4.1	252.2
June	1,175.9	7.5	156.0
July	1,298.8	11.8	110.5
August	1,198.4	8.7	137.7
September	1,105.5	7.9	140.7
October	1,091.3	7.9	138.5
November	1,085.6	7.6	143.6
December	1,049.5	9.1	114.9
Mean			138.8
Monthly			4.6
Annual			0.4

Table XII. (Cont'd)

Month	1970		
	Average Storage ($\times 10^6$ m ³)	Average Discharge ($\times 10^6$ m ³ /day)	Exchange Rate (days)
January	925.8	9.4	98.5
February	865.2	8.9	97.6
March	875.9	4.7	187.2
April	1,022.4	2.6	386.5
May	1,152.7	5.4	213.0
June	1,323.2	12.8	103.1
July	1,346.1	16.2	83.1
August	1,281.3	5.7	223.5
September	1,281.3	4.6	278.5
October	1,332.9	6.2	215.9
November	1,331.6	7.5	177.3
December	1,296.6	9.3	139.0
Mean			183.6
Monthly			6.1
Annual			0.5

Light

The transmittance of light in Bighorn Lake ranged from 3 to 100% T/10 cm column. The influent waters had the lowest clarity, but as the water flowed toward the dam the clarity increased (Fig. 10). The mean turbidity was 10 and 414 J.T.U. at stations 0 and 5, respectively, while transmission of light was 92 and 59%.

The significant correlation ($r = -0.99$; $P = 0.01$) between transmission and turbidity is evident (Fig. 11). The regression equation between transmission and turbidity was calculated:

$$\text{Transmission (\% T/10 cm)} = -20.9T + 112.1 \quad R^2 = 0.98$$

where T equals the common log of the turbidity expressed as J.T.U.

It has been pointed out by many workers, including Neel et al. (1963), that because of impoundment there is a striking reduction of turbidity as the water mass flows through the reservoir. More detailed patterns of water clarity, utilizing transmission data for 1969, are depicted in Figure 12. Turbidity for the influent streams was significantly reduced within the upper 32.2 km (20 mi) of the reservoir. Seasonal changes in the clarification process are given with peak inflow occurring in June, and minimal inflow during August.

Figure 13 gives the average euphotic zone extinction coefficients of total visible light measured at each station for each year of sampling. It is noted that stations 0, 1, 2, 3 and 4 have

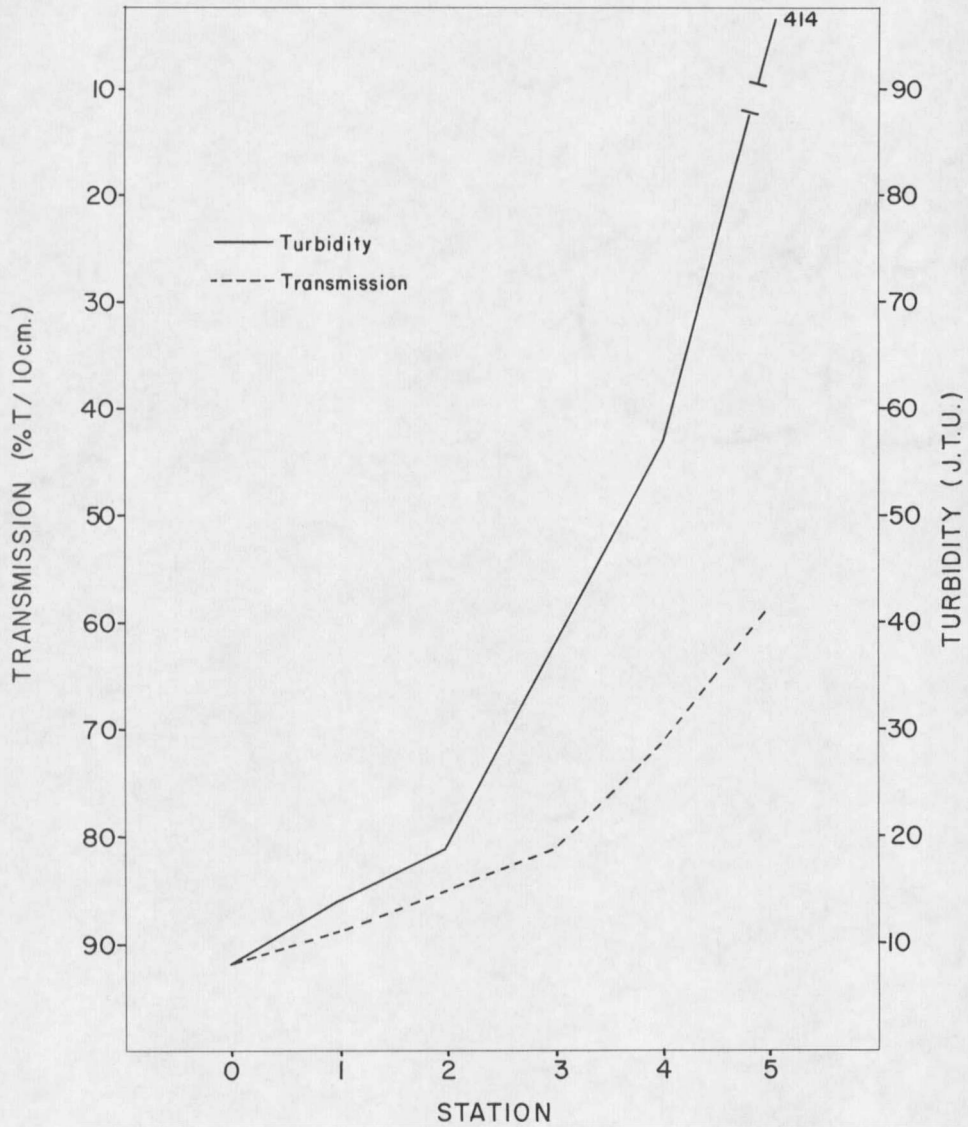


Figure 10. Water clarity in Bighorn Lake expressed as the mean turbidity (Standard Jackson Turbidity Units) and light transmittance (% T/10 cm) at each sampling station during the study.

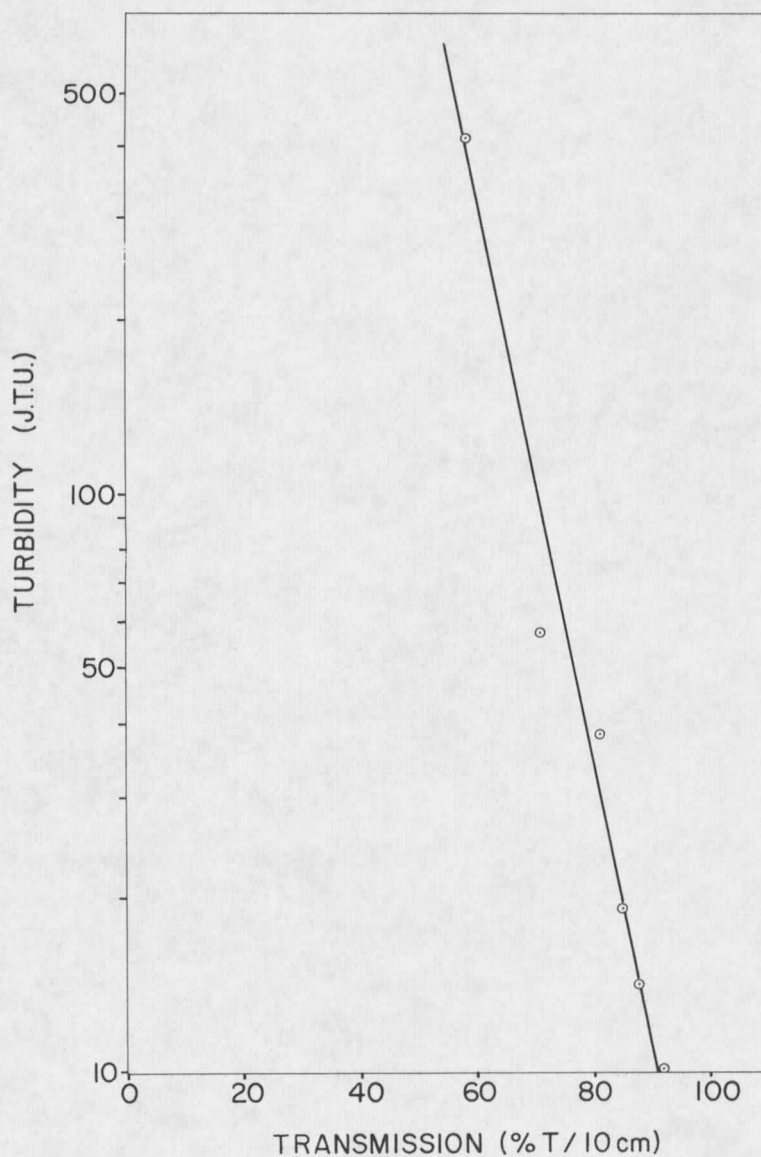


Figure 11. Relationship between turbidity (Standard Jackson Turbidity Units) and light transmittance (% T/10 cm). A point represents a mean of all data at a given station, Bighorn Lake.

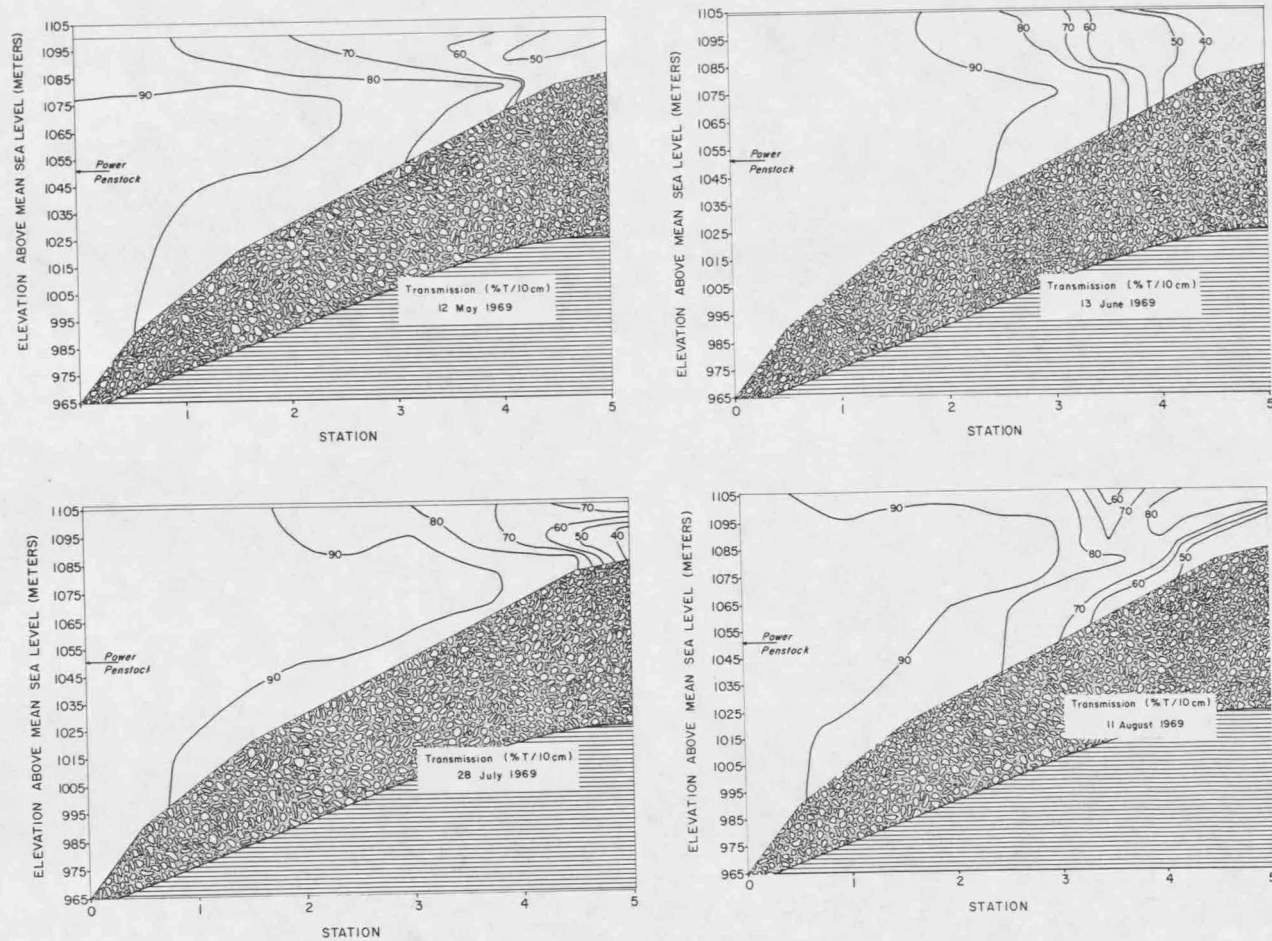


Figure 12. Seasonal and longitudinal distribution of suspended sediment, utilizing transmission data (% T/10 cm) for Bighorn Lake during 1969.

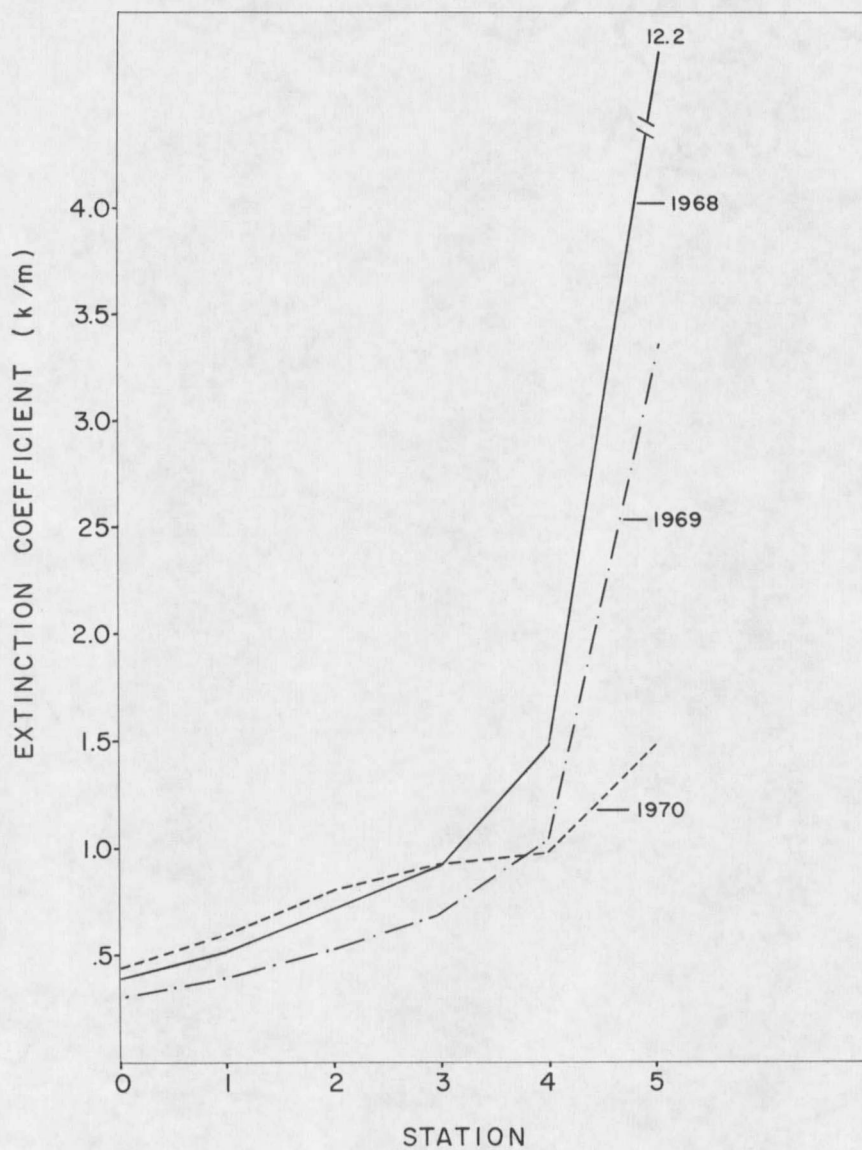


Figure 13. Average extinction coefficients (k/m) at each station for each year, Bighorn Lake.

coefficients ranging between 0.35 and 1.50, but the range between stations 4 and 5 is of a greater magnitude for all years except 1970. Station 5 consistently attenuated light at a much greater rate than any of the other sampling stations.

A t-test was used to compare the average extinction coefficients of the six stations. Between 13 and 25 degrees of freedom were available for each test between each of the possible 12 pairs of stations within a given year. The statistical analyses showed a significant difference in the average transparency conditions among all stations, except for stations 2, 3 and 4 during 1970.

A t-test was also used to compare the 1968, 1969 and 1970 average transparencies for all stations. Between 178 and 250 degrees of freedom were available for each test. A significant difference was found between the mean extinction coefficients for all years except between 1969 and 1970.

When all the data ($n = 336$) are used, the correlation ($r = -0.19$; $P = 0.01$) between extinction and reservoir stage indicated that as water levels rose, light extinction became less.

A summary of underwater light conditions at all sampling stations during the study is presented in Figure 14.

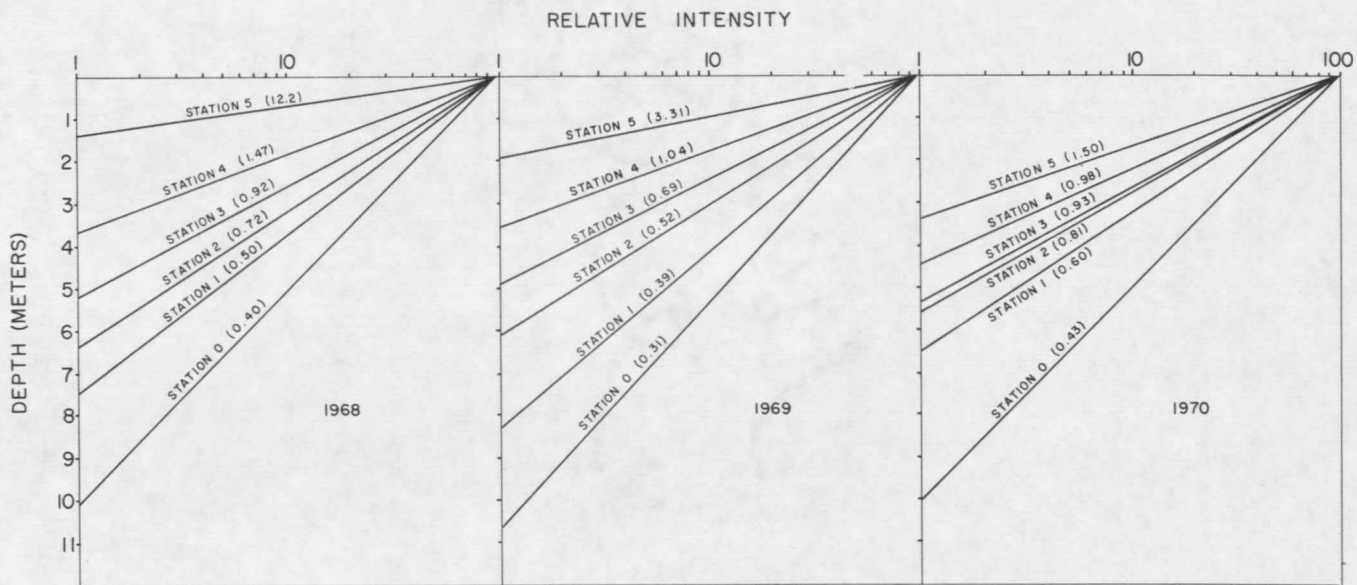


Figure 14. Penetration of total visible light and average extinction coefficients (k/m) for each sampling station during 1968, 1969 and 1970, Bighorn Lake.

Temperature and Conductivity

Figure 15 shows the thermal regime at station 0 during the 1968, 1969 and 1970 sampling periods. In general, spring temperatures were lower during 1969 than on comparable dates for 1968 and 1970. Mid-summer surface temperatures for all years were greater than 21.0 C.

On 5 May 1968, the surface temperature was 7.8 C. Only slight thermal stratification was evident as the temperature declined with depth to 3.3 C at elevation 1,025. Below 995 meters there was an increase in temperature near the bottom attributed to heat exchange with the bottom of the reservoir. Warmer water was also found on the bottom of the reservoir from the latter part of April to the end of June in 1969.

A rapid spring warming of the reservoir was evident for all three years. During 1968 this process occurred until 27 June, after which the isotherms were horizontal and there was a temperature difference of 14.4 C between the surface and the bottom. Although thermally stratified through November, a sharply defined thermocline was not evident. After 29 July, there was a gradual cooling of the upper portion of the reservoir and by 2 November thermal stratification was greatly weakened.

The degree of thermal stratification that occurred during 1970 was stronger than that of 1969. Again the development of a sharply

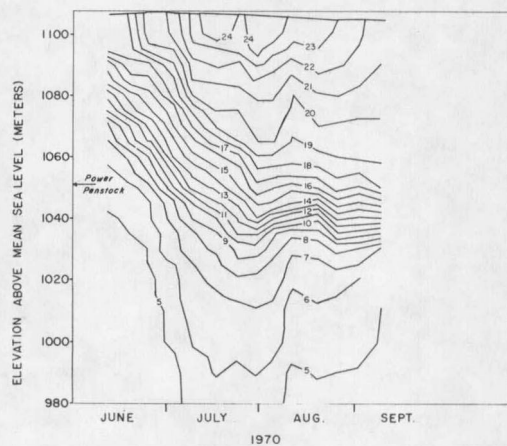
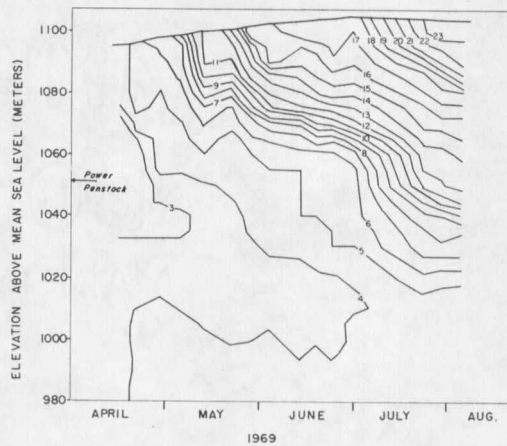
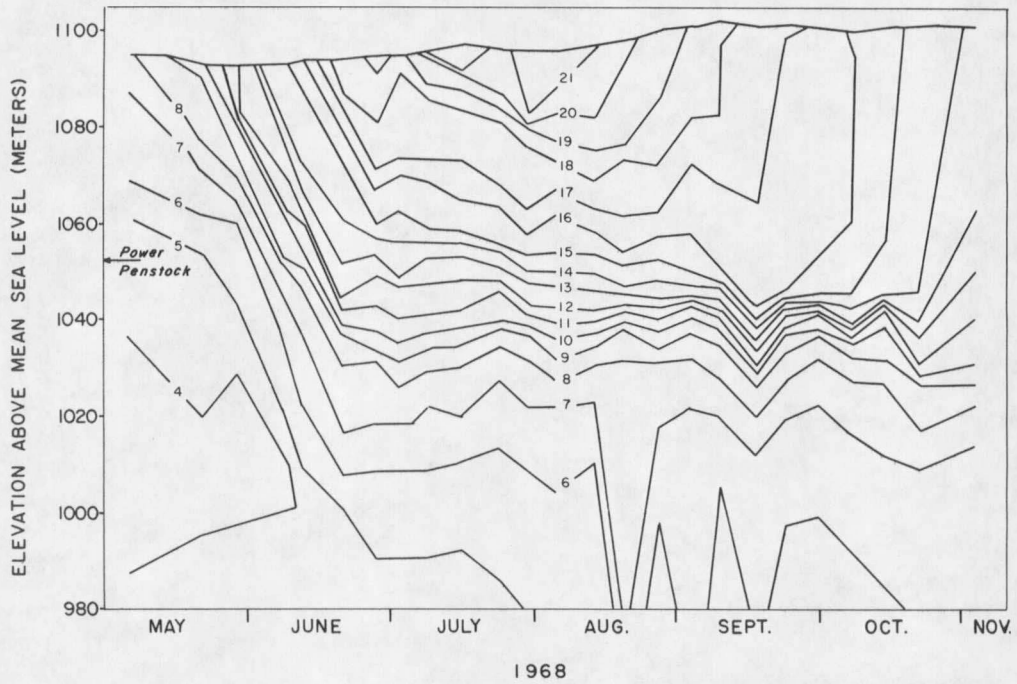


Figure 15. Isotherms (C) at station 0 during 1968, 1969 and 1970, Bighorn Lake.

defined thermocline for either of the above years was not evident.

A significant fact was the change of temperature at the depth of the power penstocks (1,051 meters). During 1968, from 5 May to 27 June the temperature increased at this depth from 4.4 to 13.0 C. A much slower increase of temperature followed reaching 16.8 C on 7 September. After 7 September, temperature at the power penstock elevation decreased, attaining a value of 12.0 C on 2 November. Similar trends in temperature fluctuations at the penstock elevation were observed for the 1969 and 1970 sampling periods, although they were not as well defined as in 1968.

Figure 15 also illustrates the fact that the greatest rate of temperature decline with depth was in the stratum of water immediately above and below the power penstock. For 1968 this occurred from 20 June through 10 September.

Longitudinal and seasonal changes in temperature for 1968 are portrayed in Figure 16. The warming process began in the upper end of Bighorn Lake and then advanced downstream and to greater depths during the summer. By 5 May, the 4.0 C isotherm had advanced to the dam and the 13.0 C isotherm was in the upper end of the reservoir.

By 7 June, the surface waters at station 3 had warmed to 18.0 C and the 4.0 C isotherm had almost disappeared. The cell of cold water at station 4 was attributed to run-off into the reservoir from a

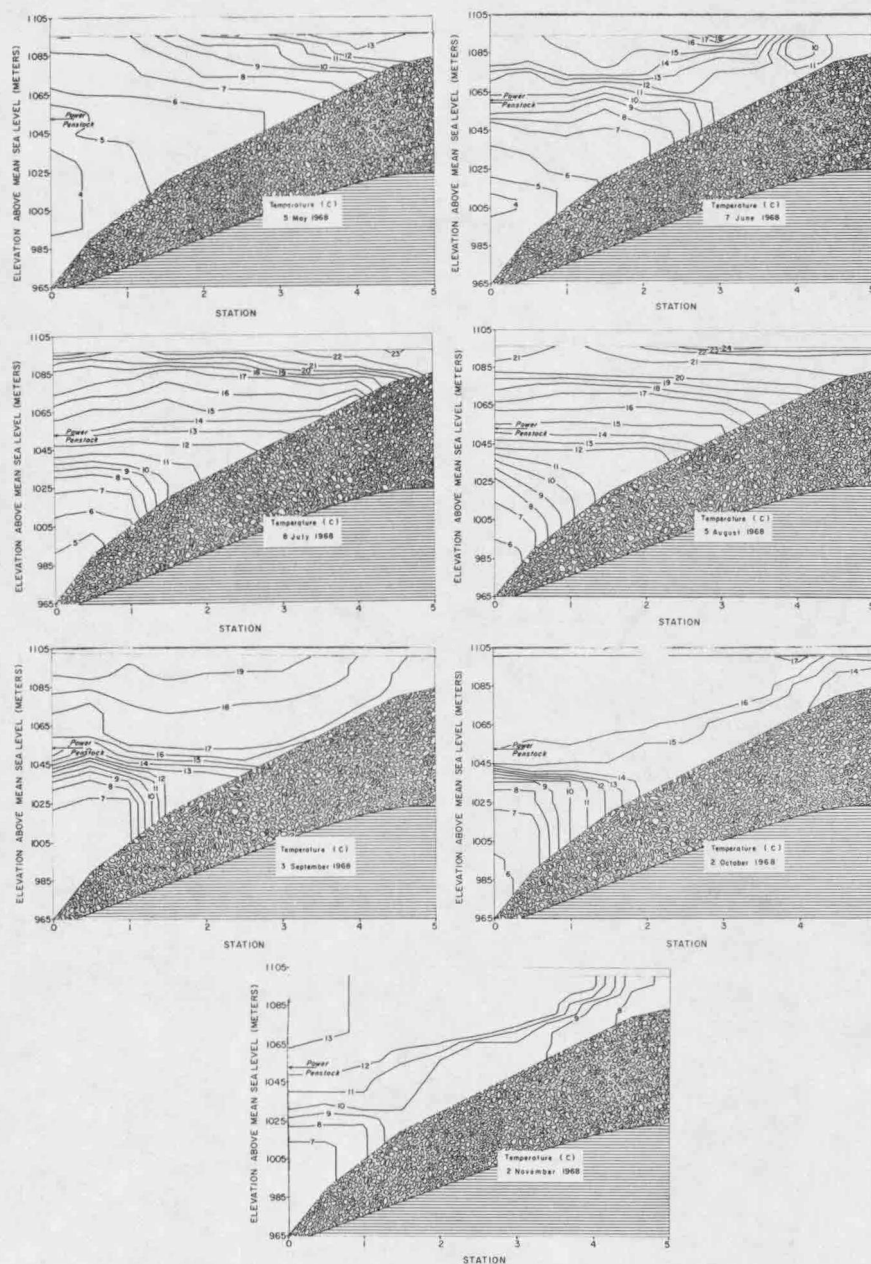


Figure 16. Distribution of 1°C isotherms in Bighorn Lake during 1968.

small, snow-fed tributary in that area.

On 8 July, the entire surface was at or above 20.0 C and the 22.0 C isotherm had started to develop in the upper end. By 3 September, a rather distinct stratification developed between elevations 1,060 and 1,035.

By 2 October, the surface water was 17.0 C or lower and a 14.0 C isotherm had developed in the upper end. As of 2 November, no temperature greater than 14.0 C was evident.

The above discussion illustrates the effectiveness of Bighorn Lake as a heat trap. Because of deep water withdrawal, summer influent temperatures are consistently warmer than those of the effluent. Therefore, during the summer the reservoir stored advected heat in addition to heat absorbed from solar radiation.

Isolines of conductivity at station 0 are portrayed in Figure 17. On 5 May 1968, a slight degree of chemical stratification was evident ranging from 900 micromhos at the surface to 1,120 micromhos at the bottom. Above elevation 1,070 a marked change in conductivity occurred after 3 July as flood water flowing along the surface layers of the reservoir reached this station. A drop in conductivity from 850 to less than 650 micromhos occurred between 3 and 25 July. Water of conductivity between 650 and 600 micromhos persisted at the surface from 25 July to 27 September following which the conductivity

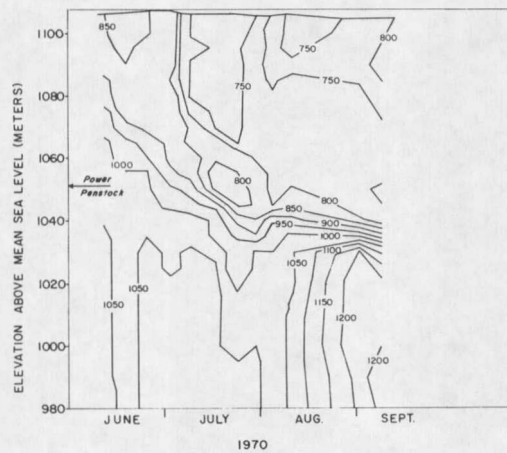
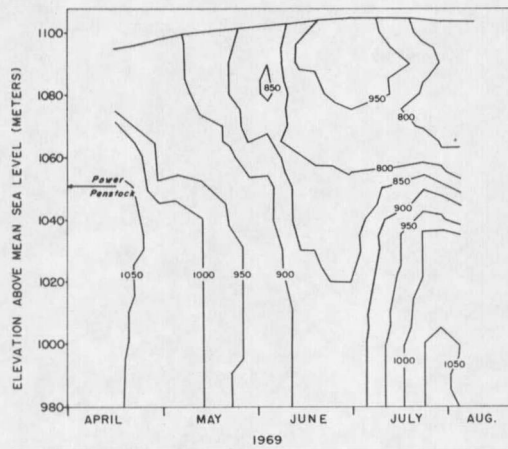
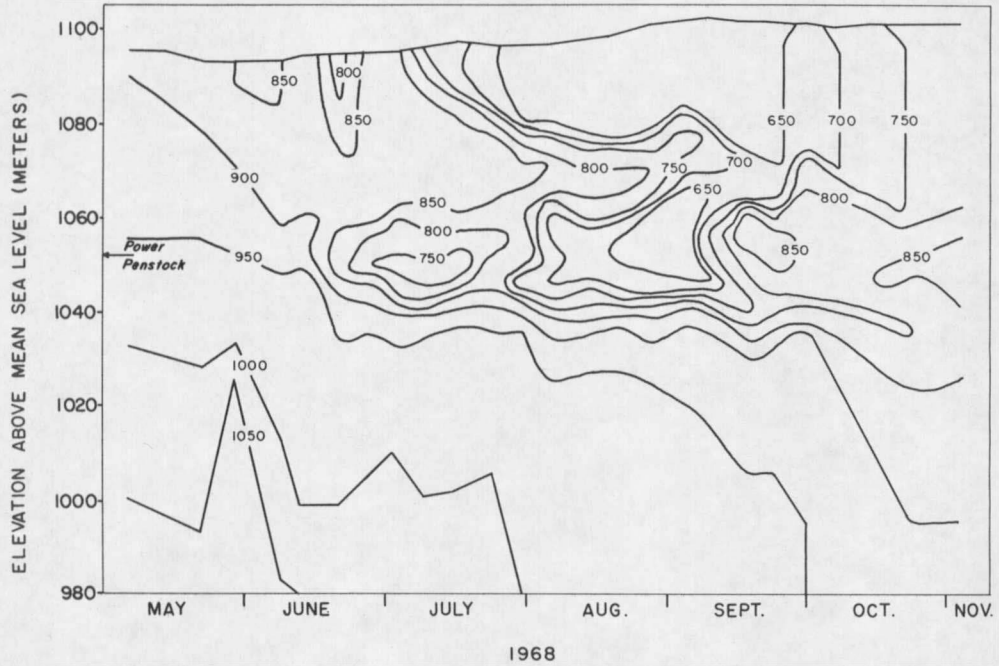


Figure 17. Isolines of conductivity (micromhos) at station 0 during 1968, 1969 and 1970, Bighorn Lake.

increased to 760 micromhos on 2 November. This increase in conductivity was partly due to down-reservoir flow of higher conductive water associated with low flow conditions and partly due to mixing with the deeper water of higher conductivity as a result of the breakdown of thermal stratification.

The most striking aspect of the 1968 data was the tongue of water between elevation 1,070 and 1,035 exhibiting a conductivity minimum from 18 June to 7 September. The centerline through the tongue occurred at the depth of the power penstock. Wright (1969) showed that the position of the tongue of low conductive water was similar in position to a well defined density layer.

During 1969 and 1970 there appeared to be a progressive increase in conductivity from the surface to the bottom. Chemical stratification was observed for both years, but the development of low conductivity water masses at the power penstock elevation was less distinct.

Longitudinal and seasonal changes in conductance are presented in Figure 18. On 5 May 1968, water of conductivity less than 900 micromhos was overriding water of higher conductivity from stations 2 to 3. The downward bending of the 900 and 950 micromho isolines between stations 1 and 0, in contrast to the horizontal isoline of 1,000 micromhos, indicates that penstock withdrawal of water was

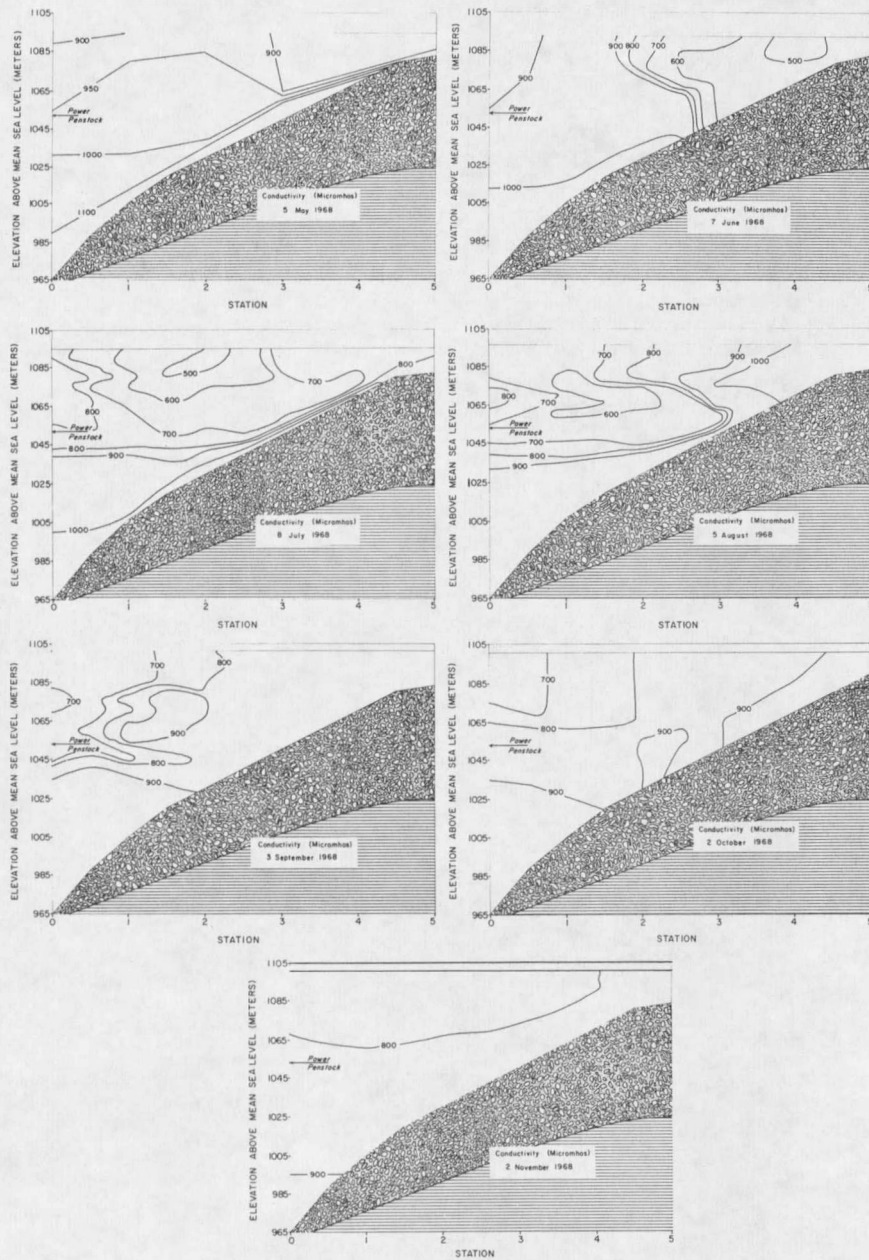


Figure 18. Distribution of 100 micromho isolines of conductivity in Bighorn Lake during 1968.

occurring above elevation 1,032.

By 7 June, peak runoff had begun and water of conductivity ranging from less than 500 micromhos to 900 micromhos had filled the upper end of the reservoir. Water of conductance higher than 1,000 micromhos, that occupied the bottom at the upper end, had been displaced down-reservoir to almost station 2.

By 8 July, water having a conductivity above 800 micromhos had been split into two separate masses. One mass occurred as a discrete body between the dam and 9.6 km (6 mi) from the dam and above the power penstock elevation. The other mass occupied the lower portion of the reservoir below the power penstock elevation. By the above date large inflows had diminished and water of higher conductivity had entered the upper end of the reservoir displacing the 600 micromho water downstream by 32.2 km (20 mi).

On 5 August, it was evident that the water of greater conductance had been separated into two masses above and below the power penstock elevation. As a result of withdrawal and the influx of higher conductive water associated with low stream flow, water having a conductivity of less than 600 micromhos had been isolated at elevations 1,085 and 1,055 between stations 1 and 3.

By 2 October, the pattern described above had been eliminated and water of conductivity between 800 and 900 micromhos was being

discharged. Influent water of higher conductance flowed along the bottom, instead of surface or sub-surface because of the cooler water temperatures at this time of year.

On 2 November, as a result of vertical mixing due to breakdown of thermal stratification, there had virtually been an elimination of vertical chemical stratification.

Water Chemistry

Concentrations of the major cations and anions found in Bighorn Lake are given in Table XIII. This table gives the range and mean of a given element for the complete strata of water sampled at the indicated sampling station for that year.

Calcium, magnesium, sodium and potassium, as well as bicarbonate, sulfate and chloride have previously been demonstrated to act in a relatively conservative manner (Table VIII). A comparison of the mean concentration of a given element at any station gives additional evidence to support this fact. In general, the vertical and horizontal distribution of each of the above constituents stayed relatively homogeneous as indicated by the similar seasonal averages for each station (Table XIII). Comparisons by means of a t-test for paired observations showed that there was no significant difference in the mean concentrations of these elements for any pair of stations during 1968 and 1969.

Table XIII.

Range and mean water chemistry at each station of Bighorn Lake during the study.

	Station 0								
	1968			1969			1970		
	Maximum	Mean	Minimum	Maximum	Mean	Minimum	Maximum	Mean	Minimum
Ca ⁺⁺ (meq/l)	9.05	4.38	2.74	4.64	4.08	3.12			
Mg ⁺⁺ (meq/l)	4.66	2.13	0.84	2.40	1.96	1.19			
Na ⁺ (meq/l)	4.15	3.34	2.10	4.25	3.59	2.46			
K ⁺ (meq/l)	0.15	0.11	0.03	0.15	0.12	.08			
HCO ₃ ⁻ (meq/l)	4.53	3.21	2.00	3.80	3.27	2.55			
Cl ⁻ (meq/l)	0.38	0.29	0.17	0.41	0.35	0.25			
SO ₄ ⁼ (meq/l)	8.35	5.74	2.67	7.25	5.66	3.92			
F ⁻ (meq/l)	0.19	0.05	0.01	0.06	0.04	0.02			
NO ₃ ⁻ -N (mg/l)	0.90	0.51	0.22	0.79	0.50	0.14	0.79	0.57	0.01
NO ₂ ⁻ -N (mg/l)	0.035	0.006	0.000	0.013	0.004	0.001	0.059	0.005	0.000
NH ₃ -N (mg/l)	0.25	0.07	0.00	0.60	0.20	0.00	0.15	0.02	0.01
Ortho-PO ₄ ⁼ (mg/l)	0.80	0.08	0.00	0.15	0.04	0.00	0.14	0.05	0.00
Turbidity (J.T.U.)	22	11	4	12	8	4			
Silica (mg/l)	12.4	9.9	6.4	15.8	10.4	5.8			
Dissolved Oxygen (mg/l)	11.6	5.6	0.6	10.0	6.4	4.2	10.9	6.4	3.4
Conductance (micromhos)	1300	866	600	1064	918	685	1282	942	692
pH	8.77		7.55	8.70		7.53	8.80		7.50

Table XIII. (Cont'd)

	Station 1								
	1968			1969			1970		
	Maximum	Mean	Minimum	Maximum	Mean	Minimum	Maximum	Mean	Minimum
Ca ⁺⁺ (meq/l)	8.26	3.99	2.55	4.49	3.86	2.99			
Mg ⁺⁺ (meq/l)	4.33	2.10	0.75	3.84	1.98	1.12			
Na ⁺⁺ (meq/l)	4.40	3.14	1.90	4.40	3.59	2.50			
K ⁺ (meq/l)	0.27	0.11	0.07	0.13	0.11	0.08			
HCO ₃ ⁻ (meq/l)	4.55	2.97	2.09	3.40	3.05	2.36			
Cl ⁻ (meq/l)	0.37	0.26	0.17	0.41	0.33	0.22			
SO ₄ ⁼ (meq/l)	8.83	5.62	2.83	6.75	5.54	4.12			
F ⁻ (meq/l)	0.18	0.05	0.00	0.06	0.04	0.03			
NO ₃ ⁻ -N (mg/l)	0.89	0.52	0.11	0.76	0.49	0.23	0.74	0.56	0.08
NO ₂ ⁻ -N (mg/l)	0.051	0.008	0.000	0.043	0.006	0.001	0.065	0.007	0.001
NH ₃ -N (mg/l)	0.00	0.08	0.33	0.46	0.21	0.01	0.08	0.03	0.01
Ortho-PO ₄ ⁼ (mg/l)	0.63	0.08	0.00	0.10	0.04	0.00	0.14	0.07	0.00
Turbidity (J.T.U.)	44	17	8	12	8	4			
Silica (mg/l)	14.6	10.2	6.7	13.4	10.0	5.4			
Dissolved Oxygen (mg/l)	10.7	6.2	1.4	10.8	7.3	4.7	9.1	6.0	3.6
Conductance (micromhos)	1000	798	540	1050	880	590	1077	916	566
pH	8.78		7.65	8.63		7.90	8.65		7.00

Table XIII. (Cont'd)

	Station 2								
	1968			1969			1970		
	Maximum	Mean	Minimum	Maximum	Mean	Minimum	Maximum	Mean	Minimum
Ca ⁺⁺ (meq/l)	7.28	4.00	2.18	5.76	3.87	2.92			
Mg ⁺⁺ (meq/l)	3.81	1.99	0.81	2.44	1.79	1.08			
Na ⁺⁺ (meq/l)	4.65	3.18	1.50	4.65	3.69	2.40			
K ⁺ (meq/l)	0.18	0.12	0.06	0.13	0.11	0.08			
HCO ₃ ⁻ (meq/l)	3.52	2.93	1.29	3.50	2.92	2.22			
Cl ⁻ (meq/l)	0.36	0.25	0.13	0.44	0.32	0.18			
SO ₄ ⁼ (meq/l)	8.64	5.50	3.00	7.21	5.52	3.12			
F ⁻ (meq/l)	0.16	0.05	0.00	0.08	0.04	0.03			
NO ₃ ⁻ -N (mg/l)	0.95	0.52	0.11	0.15	0.49	0.12	0.88	0.53	0.05
NO ₂ ⁻ -N (mg/l)	0.038	0.009	0.000	0.019	0.006	0.001	0.039	0.009	0.001
NH ₃ -N (mg/l)	0.31	0.08	0.00	0.31	0.25	0.00	0.07	0.03	0.01
Ortho-PO ₄ ⁼ (mg/l)	0.85	0.15	0.00	0.13	0.05	0.00	0.30	0.09	0.00
Turbidity (J.T.U.)	68	24	4	16	10	4			
Silica (mg/l)	14.7	10.6	7.3	14.6	10.2	6.7			
Dissolved Oxygen (mg/l)	11.2	6.8	2.5	11.1	7.3	4.1	9.8	5.1	0.5
Conductance (micromhos)	1370	816	430	1298	869	531	526	799	1092
pH	8.74		7.61	8.70		7.61	8.65		7.00

Table XIII. (Cont'd)

	Station 3								
	1968			1969			1970		
	Maximum	Mean	Minimum	Maximum	Mean	Minimum	Maximum	Mean	Minimum
Ca ⁺⁺ (meq/l)	8.83	4.11	2.74	4.24	3.73	3.13			
Mg ⁺⁺ (meq/l)	2.32	2.01	0.92	2.32	1.76	0.92			
Na ⁺ (meq/l)	4.25	3.11	1.95	4.78	3.63	2.50			
K ⁺ (meq/l)	0.18	0.12	0.08	0.13	0.11	0.07			
HCO ₃ ⁻ (meq/l)	3.49	2.86	2.08	3.45	2.84	2.32			
Cl ⁻ (meq/l)	0.33	0.24	0.14	0.40	0.31	0.20			
SO ₄ ⁼ (meq/l)	7.94	5.57	2.65	6.89	5.46	3.62			
F ⁻ (meq/l)	0.15	0.06	0.01	0.06	0.04	0.02			
NO ₃ ⁻ -N (mg/l)	0.83	0.49	0.10	1.46	0.52	0.21	0.80	0.51	0.08
NO ₂ ⁻ -N (mg/l)	0.033	0.011	0.001	0.043	0.011	0.003	0.065	0.012	0.003
NH ₃ -N (mg/l)	0.66	0.08	0.00	0.44	0.25	0.13	0.44	0.04	0.01
Ortho-PO ₄ ⁼ (mg/l)	0.78	0.10	0.00	0.18	0.07	0.00	0.77	0.11	0.00
Turbidity (J.T.U.)	217	49	4	34	18	6			
Silica (mg/l)	17.6	10.5	7.6	12.4	10.2	8.3			
Dissolved Oxygen (mg/l)	10.0	7.3	3.1	9.9	7.4	5.2	10.3	5.0	0.5
Conductance (micromhos)	1320	828	450	1628	843	531	1105	729	143
pH	8.75		7.40	8.56		7.91	8.80		7.05

Table XIII. (Cont'd)

	Station 4								
	1968			1969			1970		
	Maximum	Mean	Minimum	Maximum	Mean	Minimum	Maximum	Mean	Minimum
Ca ⁺⁺ (meq/l)	8.92	4.38	2.92	4.16	3.64	2.96			
Mg ⁺⁺ (meq/l)	4.82	1.96	0.19	2.40	1.64	0.84			
Na ⁺ (meq/l)	4.30	3.24	0.90	4.95	3.59	2.90			
K ⁺ (meq/l)	0.14	0.12	0.06	0.14	0.11	0.08			
HCO ₃ ⁻ (meq/l)	3.54	3.02	2.12	3.55	2.82	2.39			
Cl ⁻ (meq/l)	0.34	0.24	0.07	0.44	0.34	0.16			
SO ₄ ⁼ (meq/l)	7.87	5.63	2.75	7.37	5.57	3.02			
F ⁻ (meq/l)	0.14	0.04	0.00	0.07	0.04	0.03			
NO ₃ ⁻ -N (mg/l)	0.66	0.44	0.09	0.72	0.47	0.29	0.74	0.44	0.10
NO ₂ ⁻ -N (mg/l)	0.029	0.009	0.001	0.018	0.013	0.004	0.046	0.019	0.005
NH ₃ -N (mg/l)	0.76	0.12	0.00	0.53	0.35	0.18	0.39	0.05	0.03
Ortho-PO ₄ ⁼ (mg/l)	1.00	0.11	0.00	0.21	0.10	0.00	0.25	0.11	0.00
Turbidity (J.T.U.)	350	67	12	83	40	16			
Silica (mg/l)	13.9	10.7	8.2	12.8	10.6	9.0			
Dissolved Oxygen (mg/l)	9.6	7.9	5.4	10.7	7.7	6.0	11.8	5.8	2.9
Conductance (micromhos)	1300	858	405	1369	818	407	1199	711	511
pH	8.80		7.57	8.58		7.90	8.75		7.00

Table XIII.(Cont'd)

	Station 5								
	1968			1969			1970		
	Maximum	Mean	Minimum	Maximum	Mean	Minimum	Maximum	Mean	Minimum
Ca ⁺⁺ (meq/l)	8.96	4.62	3.48	4.01	3.66	3.18			
Mg ⁺⁺ (meq/l)	4.75	2.13	0.52	2.00	1.56	1.31			
Na ⁺ (meq/l)	4.55	3.50	1.97	5.05	3.42	2.11			
K ⁺ (meq/l)	0.18	0.13	0.11	0.13	0.11	0.08			
HCO ₃ ⁻ (meq/l)	3.38	3.10	2.16	3.00	2.77	2.41			
Cl ⁻ (meq/l)	0.35	0.27	0.14	0.39	0.30	0.25			
SO ₄ ⁼ (meq/l)	7.54	6.39	3.54	6.25	5.42	4.25			
F ⁻ (meq/l)	0.17	0.06	0.00	0.06	0.04	0.03			
NO ₃ ⁻ -N (mg/l)	0.73	0.44	0.13	0.89	0.44	0.02	0.72	0.50	0.09
NO ₂ ⁻ -N (mg/l)	0.030	0.011	0.004	0.023	0.011	0.010	0.029	0.019	0.007
NH ₃ -N (mg/l)	0.22	0.06	0.00	0.49	0.42	0.31	0.12	0.04	0.01
Ortho-PO ₄ ⁼ (mg/l)	0.72	0.18	0.00	0.24	0.16	0.16	0.30	0.11	0.00
Turbidity (J.T.U.)	3350	558	44	875	211	36			
Silica (mg/l)	12.9	11.4	9.8	14.4	11.2	9.2			
Dissolved Oxygen (mg/l)	12.6	8.3	6.2	13.0	9.3	6.4	12.1	6.7	3.7
Conductance (micromhos)	1070	882	460	1133	833	697	1008	731	500
pH	8.72		8.10	8.71		8.31	8.90		7.55

Concentrations of nitrogen, phosphate, silica, dissolved oxygen and hydrogen ion are highly non-conservative and rather large fluctuations in the concentration of these elements were often observed (Table XIII). Silica was never recorded less than 5.4 mg/l, which is well above the minimum requirements for most diatoms (Lund, 1954; 1964).

The greatest vertical range of dissolved oxygen was from 0.6 to 11.6 mg/l at station 0. The lower oxygen values were observed in the hypolimnetic waters during summer stagnation, while the higher values were usually associated with periods of large phytoplankton standing crop.

The mean concentrations of certain elements occurring in the euphotic zone are presented in Table XIV. Total inorganic nitrogen (primarily nitrate nitrogen), ortho-phosphate, iron, manganese and zinc were usually in higher concentrations at station 5 than any other station; but no significant differences in concentration were found between stations 0, 1 and 2. These higher concentrations were attributed to the larger amount of suspended sediment at station 5 carried into the reservoir by the Bighorn and Shoshone Rivers.

Euphotic zone pH ranged from 7.60 to 8.88 during the study. The majority of the higher pH values occurred during the summer.

Table XIV. Mean water chemistry (mg/l) of the euphotic zone at each station of Bighorn Lake during the study.

	Station					
	0	1	2	3	4	5
1968						
pH Range	7.80-8.69	8.02-8.75	8.01-8.78	8.16-8.81	8.00-8.70	8.00-8.72
NO ₃ ⁻ -N	0.35	0.30	0.37	0.40	0.50	0.59
NO ₂ ⁻ -N	0.009	0.007	0.008	0.012	0.011	0.014
NH ₃ -N	0.09	0.08	0.09	0.09	0.12	0.16
Ortho-PO ₄ ^{III}	0.08	0.07	0.08	0.13	0.09	0.15
1969						
pH Range	8.03-8.70	8.05-8.73	8.15-8.86	8.23-8.88	8.17-8.75	8.17-8.79
NO ₃ ⁻ -N	0.40	0.38	0.32	0.35	0.39	0.49
NO ₂ ⁻ -N	0.008	0.008	0.007	0.008	0.007	0.009
NH ₃ -N	0.19	0.20	0.19	0.20	0.25	0.34
Ortho-PO ₄ ^{III}	0.06	0.04	0.04	0.07	0.04	0.09
Total Iron	0.030	0.030	0.038	0.050	0.086	0.135
Mn ⁺⁺	0.013	0.014	0.013	0.007	0.015	0.036
Cu ⁺⁺	0.001	0.001	0.001	0.001	0.001	0.001
Zn ⁺⁺	0.011	0.010	0.008	0.009	0.009	0.020
1970						
pH Range	8.00-8.70	8.15-8.60	7.60-8.65	7.90-8.80	7.85-8.50	7.55-8.75
NO ₃ ⁻ -N	0.34	0.30	0.28	0.25	0.30	0.44
NO ₂ ⁻ -N	0.010	0.011	0.010	0.010	0.014	0.018
NH ₃ -N	0.02	0.03	0.03	0.04	0.04	0.05
Ortho-PO ₄ ^{III}	0.03	0.06	0.07	0.08	0.10	0.10

In relation to average natural waters, the content of total inorganic nitrogen and inorganic phosphate in Bighorn Lake is relatively high. Mackenthun (1965) showed that nuisance blooms of algae may be expected when inorganic phosphate and nitrogen reach average concentrations exceeding 0.01 mg/l and 0.30 mg/l, respectively. The above levels were usually exceeded in Bighorn Lake.

The complex interaction of thermal stratification, density flow and seasonal inflow and outflow not only exhibited an effect on the distribution of conductivity, but also altered the depth distribution of nitrate, ortho-phosphate, dissolved oxygen, pH and turbidity concentrations during 1968. The distribution of turbidity with depth at station 0 is portrayed in Figure 19. From the end of June through the middle of October there was a turbidity maximum present at the power penstock elevation. This turbidity maximum was associated with water of minimum conductivity characteristic of the high flow conditions in June. Apparently a current was established that was strong enough to retain some of the suspended silt that entered the reservoir in June.

There was also an ortho-phosphate maximum (Fig. 20) present during August of 1968 at the penstock elevation. This sub-surface maximum of phosphate was attributed to the phosphate being associated with the sediment washed into the reservoir by the heavy run-off in

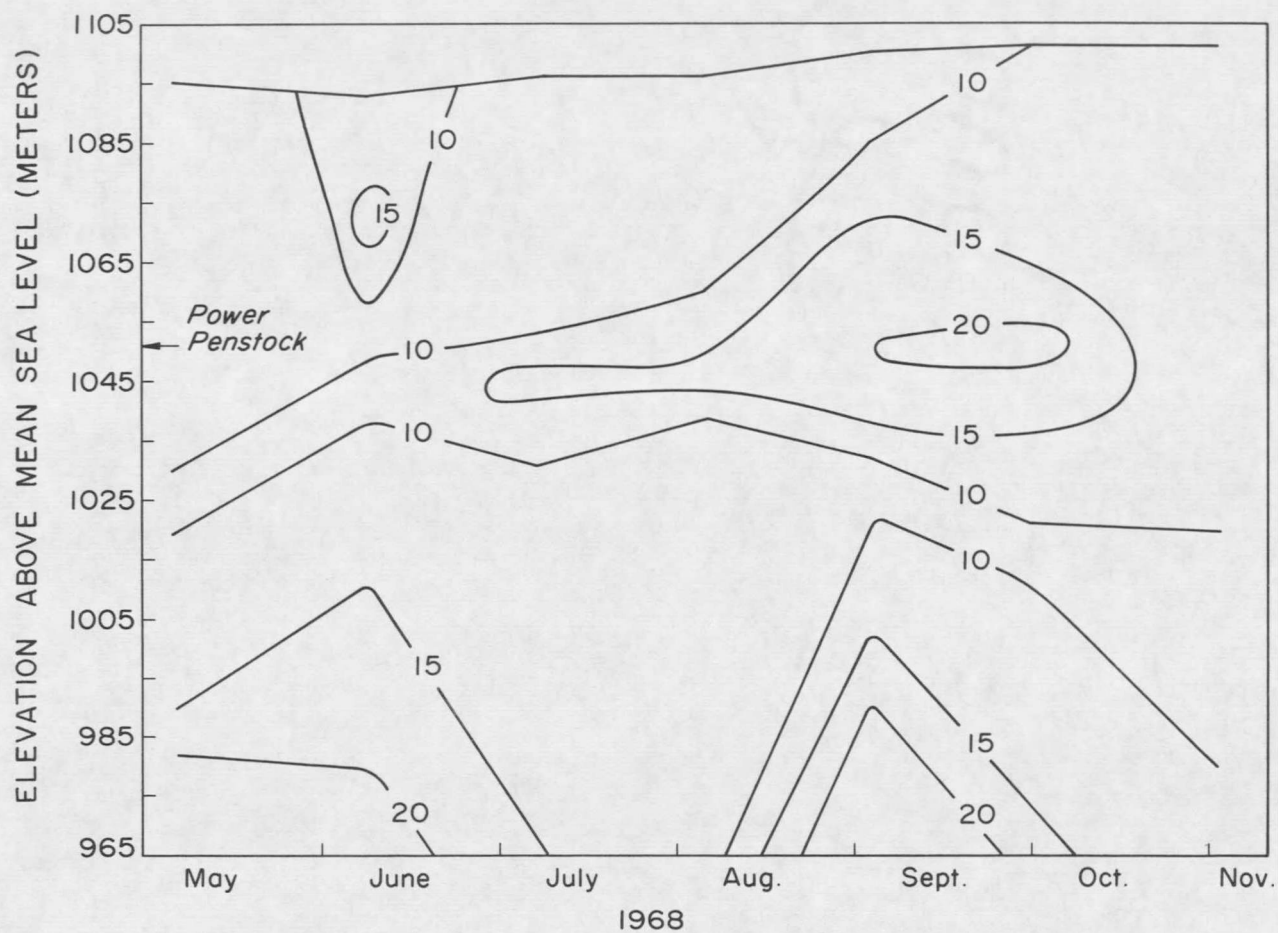


Figure 19. Distribution of turbidity (Standard Jackson Turbidity Units) with depth at station 0 of Bighorn Lake during 1968.

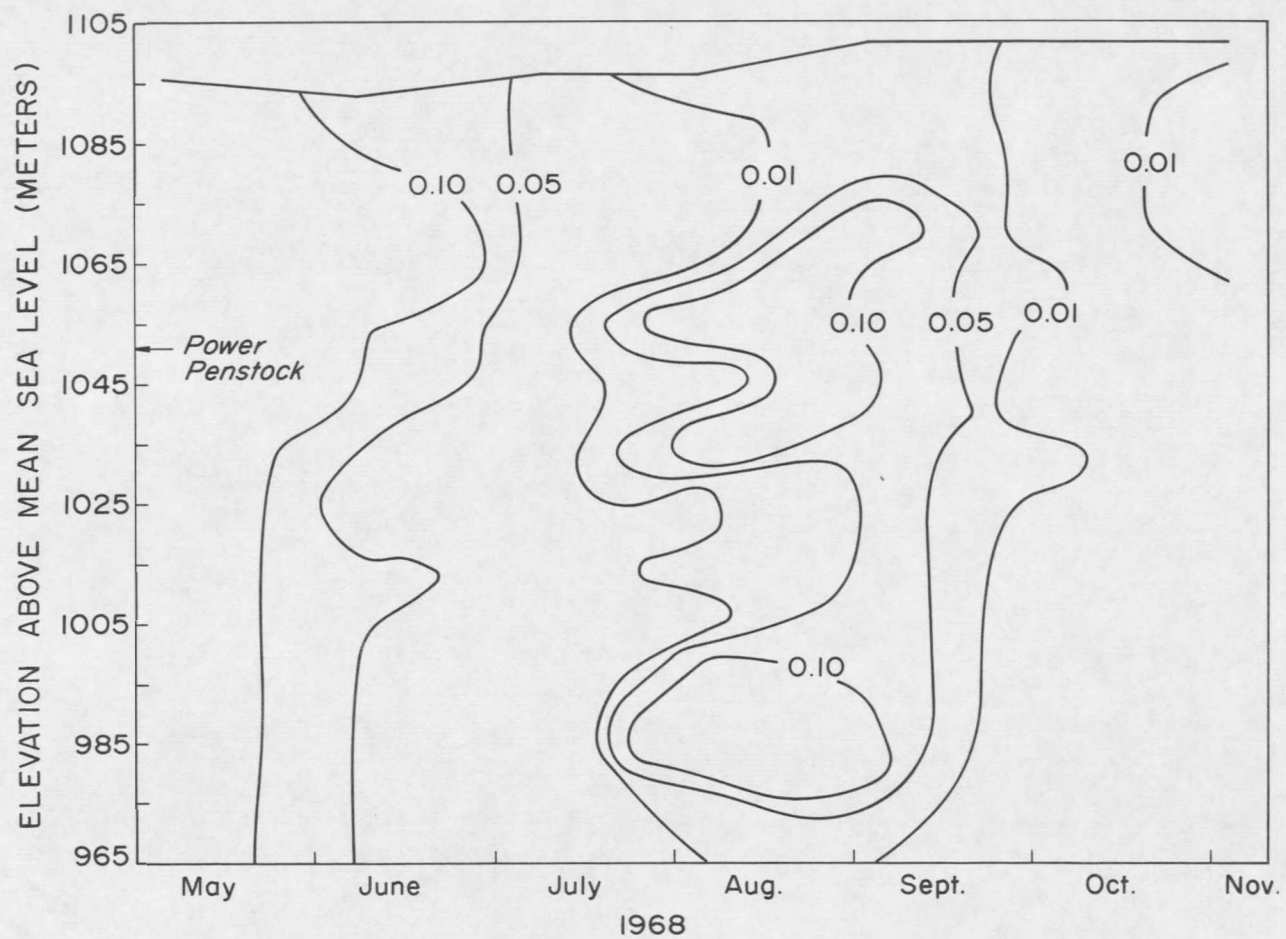


Figure 20. Distribution of ortho-phosphate (mg/l PO_4^{3-}) with depth at station 0 of Bighorn Lake during 1968.

June. Being below the euphotic zone it was not utilized by phytoplankton and thus was discharged through the penstock. It will be noted that there was phosphate depletion in the surface layers of the reservoir from May to August. Slightly increased values of phosphate in surface waters during August and September were also associated with low conductivity water that originated from high flow conditions again in June.

A similar pattern is shown in nitrate (Fig. 21) with a tongue of high nitrate nitrogen water at the power penstock elevation from June to September. From September to November water of lower nitrate content was at this elevation. In contrast to phosphate, there was no decline in nitrate in the euphotic zone; instead, the concentrations increased during September and October.

Figure 22 presents data for oxygen and Figure 23 for pH. It is evident that a layer of water with minimum oxygen and pH was at the power penstock elevation. The low oxygen and hydrogen ion concentrations were probably due to respiratory processes. However, it does not seem possible that respiration in situ was responsible for the decreased oxygen and pH values as the water mass moved downstream away from the bottom. It will be noted that the oxygen and pH values both are similar to those of the stagnant bottom water at station 0. This suggests that oxygen depletion and carbon dioxide increase

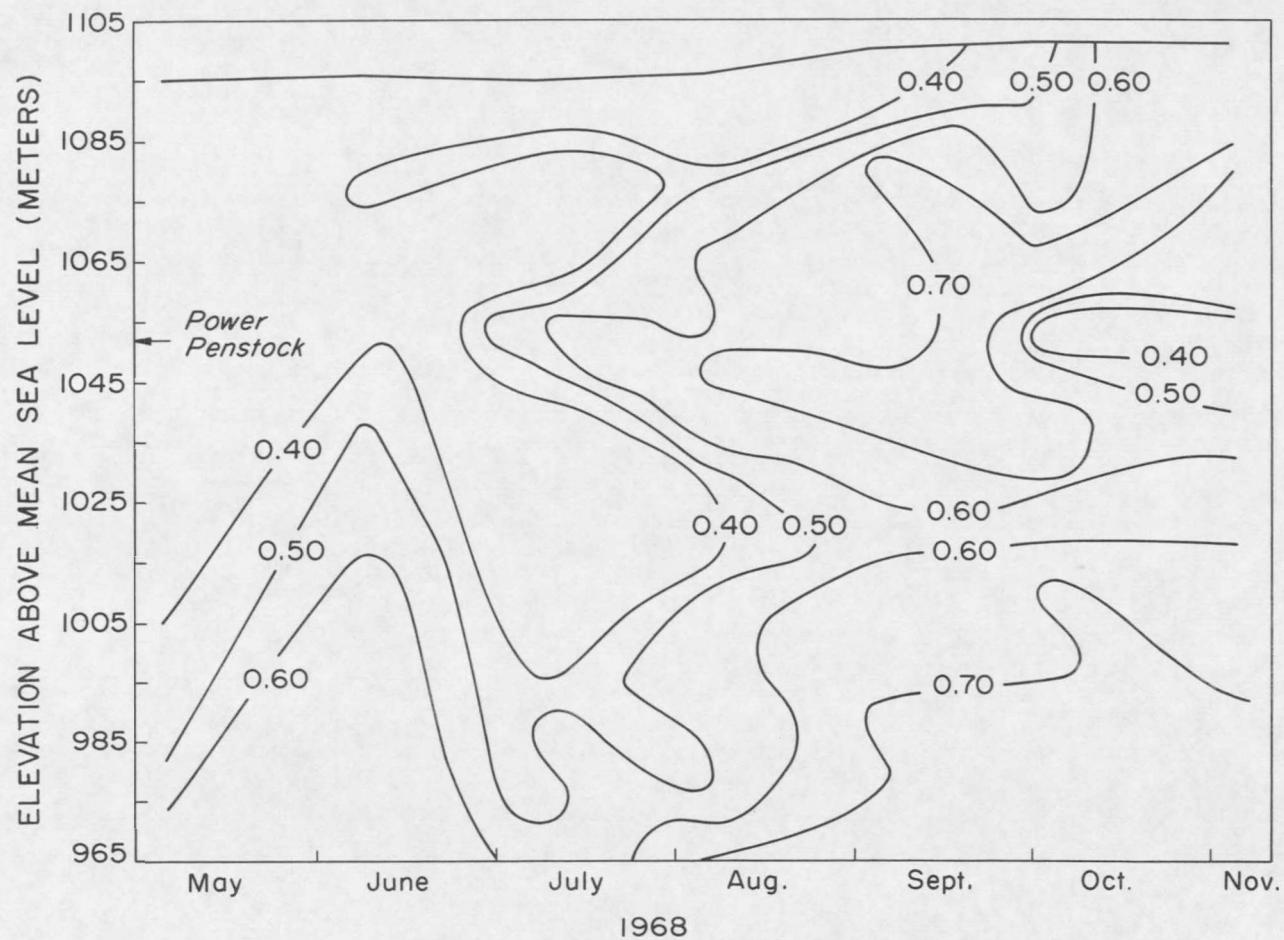


Figure 21. Distribution of nitrate nitrogen (mg/l NO_3^- -N) with depth at station 0 of Bighorn Lake during 1968.

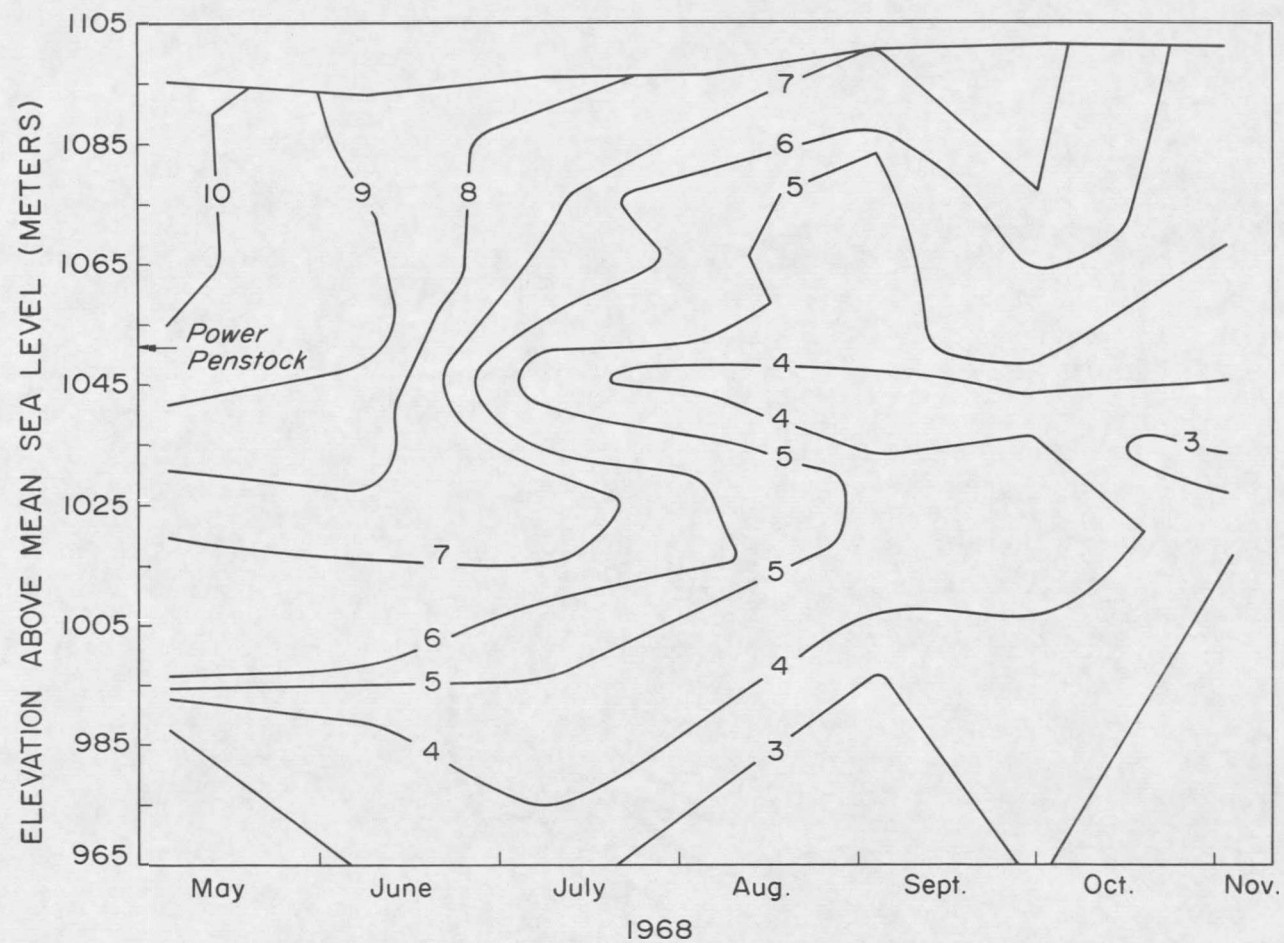


Figure 22. Distribution of dissolved oxygen (mg/l) with depth at station 0 of Bighorn Lake during 1968.

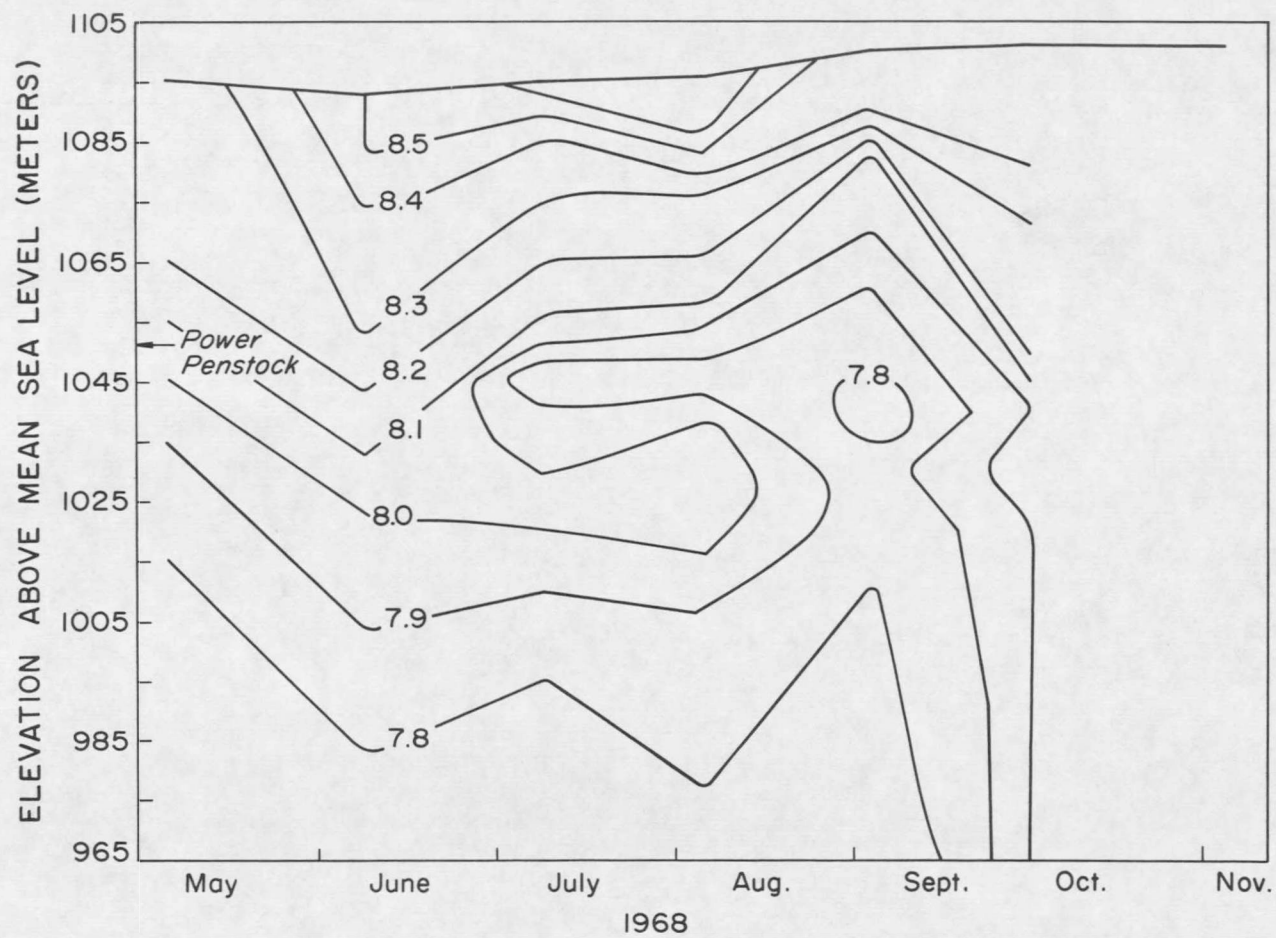


Figure 23. Distribution of pH with depth at station 0 of Bighorn Lake during 1968.

occurred while the water was on the bottom of the reservoir upstream from station 0 and the water mass preserved these characteristics as it moved down the reservoir toward the power penstock.

If a line perpendicular to the dam (parallel to the water's surface) is drawn from the power penstock elevation upstream from the dam, this line would intersect the bottom of the reservoir approximately 48.3 km (30 mi) from the dam.

Phytoplankton Standing Crop and Chlorophyll

Table XV lists all the phytoplankton taxa identified from the composited euphotic zone samples. This list of the Bighorn Lake flora contains 51 genera and 58 species of algae.

It is important to remember that from year to year the early and late sampling periods do not coincide and there may exist a built-in bias in the presentation of the phytoplankton data.

The Bacillariophyceae were the dominant class of phytoplankton comprising 58.8, 71.5 and 42.9% of the total cell volume during 1968, 1969 and 1970, respectively. Fragilaria crotonensis was the most important organism of the phytoplankton on a cell volume basis (Table XVI), but ranked fourth according to presence (Table XVII). Presence is the number of stands of occurrence of a species expressed as a percentage of the total number of stands examined. Throughout the study, Asterionella formosa contributed more to the total cell

Table XV. Phytoplankton species observed from all sampling stations of Bighorn Lake during the study with some calculated volumes of individual cells or colonies.

	μ^3
DIVISION CHLOROPHYTA (Green Algae)	
Class Chlorophyceae	
<u>Actinastrum</u> <u>Hantzschii</u> Lagerheim.	213
<u>Ankistrodesmus</u> <u>Braunii</u> (Naeg.) Brunnthaler.	200
<u>Ankistrodesmus</u> <u>falcatus</u> (Corda) Ralfs.	35
<u>Carteria</u> sp. Diesing.	68
<u>Characium</u> sp. A. Braun.	252
<u>Chlamydomonas</u> sp. Ehr.	41
<u>Chlorella</u> spp. Beijernick.	
<u>Cløsterium</u> sp. Nitzsch.	2,312
<u>Cosmarium</u> <u>subcostatum</u> Nordstedt.	
<u>Crucigenia</u> sp. Morren.	34
<u>Pandorina</u> <u>morum</u> Bory.	132
<u>Pediastrum</u> <u>duplex</u> Meyen. (Col.)	44,792
<u>Oöcystis</u> sp. Naegeli.	403
<u>Scenedesmus</u> <u>acuminatis</u> (Lag.) Chodat.	362
<u>Scenedesmus</u> <u>quadricauda</u> (Turp.) deBrebisson.	152
<u>Schroederia</u> <u>setigera</u> (Schroed.) Lemmermann.	321
<u>Staurastrum</u> <u>paradoxum</u> Meyen.	11,521
<u>Stichococcus</u> <u>bacillaris</u> Nageli.	31
<u>Tetraëdron</u> sp. Kütz.	
<u>Westella</u> <u>botryoides</u> (W. West) deWildemann.	
<u>Westella</u> <u>linearis</u> Cr. M. Smith.	
DIVISION CRYSOPHYTA (Yellow-green Algae)	
Class Bacillariophyceae (Diatoms)	
<u>Achnanthes</u> <u>lanceolata</u> Breb.	171
<u>Asterionella</u> <u>formosa</u> Hassall.	761
<u>Galoneis</u> <u>amphisbaena</u> (Bory) Clève.	23,024
<u>Cocconeis</u> spp. Ehr.	
<u>Cyclotella</u> spp. Kütz.	
<u>Cymbella</u> <u>affinis</u> Kütz.	3,717
<u>Diatoma</u> <u>elongatum</u> Agardh.	875
<u>Diatoma</u> <u>hiemale</u> (Lyngbye) Heiberg.	2,985
<u>Diatoma</u> <u>vulgare</u> Bory.	974

Table XV. (Cont'd)

	μ^3
<u>Diatomella Balfouriana</u> Greville.	1,006
<u>Eunotia</u> sp. Ehr.	295
<u>Fragilaria capucina</u> Desmazieres.	385
<u>Fragilaria crotonensis</u> Kitton.	1,057
<u>Gomphonema</u> spp. Agardh.	
<u>Gyrosigma Spencerii</u> (W. Smith) Cleve.	16,896
<u>Hanneae arcus</u> (Ehr.) Patr.	1,414
<u>Melosira granulata</u> (Ehr.) Ralfs.	492
<u>Melosira italica</u> (Ehr.) Kütz.	520
<u>Navicula</u> spp. Bory.	
<u>Nitzschia</u> spp. Hassall.	
<u>Stephanodiscus niagarae</u> Ehr.	41,700
<u>Surirella ovata</u> Kütz.	7,120
<u>Synedra ulna</u> (Nitzsch) Ehr.	9,567
Class Chrysophyceae	
<u>Chrysococcus</u> sp. Klebs.	25
<u>Dinobryon sertularia</u> Ehr.	1,236
Class Xanthophyceae (Heterokontae)	
<u>Botryococcus sudeticus</u> Lemmermann.	263
DIVISION CYANOPHYTA (Blue-green Algae)	
Class Myxophyceae	
<u>Anabaena</u> sp. Bory. (1 mm)	12,570
<u>Aphanizomenon flos-aquae</u> (L.) Ralfs. (1 mm)	12,570
<u>Coelosphaerium Nagelianum</u> Unger. (col.)	177,500
<u>Coccochloris peniocyctis</u> Sprengel.	11
<u>Merismopedia punctata</u> Meyen.	
<u>Microcystis aeruginosa</u> Kuetz. (col.)	25,695
DIVISION PYRRHOPHYTA (Dinoflagellates)	
Class Dinophyceae (Dinokontae)	
<u>Ceratium hirundinella</u> (O.F.M.) Schrank.	108,307
<u>Peridinium</u> sp. Ehr.	2,340
DIVISION CRYPTOPHYTA (Blue and Red Flagellates)	
Class Cryptophyceae	
<u>Cryptomonas ovata</u> Ehr.	2,473
<u>Rhodomonas lacustris</u> Pasch. & Ruttn.	65

Table XVI.

Rank of the major phytoplankton species from Bighorn Lake according to absolute mean cell volumes (mm^3/l) based on collections from all stations during the study.

Rank	Taxon	Cell Volume
1	<u>Fragilaria crotonensis</u>	1.222
2	<u>Cryptomonas ovata</u>	0.658
3	<u>Stephanodiscus niagarae</u>	0.518
4	<u>Asterionella formosa</u>	0.513
5	<u>Aphanizomenon flos-aquae</u>	0.487
6	<u>Melosira granulata</u>	0.173
7	<u>Cyclotella</u> spp.	0.165
8	<u>Pediastrum duplex</u>	0.143
9	<u>Rhodomonas lacustris</u>	0.105
10	<u>Ceratium hirundinella</u>	0.088
11	<u>Navicula</u> spp.	0.087
	<u>Microcystis aeruginosa</u>	0.087
12	<u>Melosira italica</u>	0.073
13	<u>Diatoma vulgare</u>	0.060
14	<u>Synedra ulna</u>	0.052

Table XVII. Rank of the major phytoplankton species of Bighorn Lake according to presence (%) as described by Curtis (1959). Values are based upon collections from all stations over the entire study.

Rank	Taxon	Presence
1	<u>Rhodomonas lacustris</u>	85.4
2	<u>Cryptomonas ovata</u>	84.8
3	<u>Asterionella formosa</u>	53.9
4	<u>Fragilaria crotonensis</u>	52.7
5	<u>Stephanodiscus niagarae</u>	36.3
6	<u>Cyclotella</u> spp.	33.7
7	<u>Navicula</u> spp.	32.7
8	<u>Ankistrodesmus falcatus</u>	31.3
9	<u>Aphanizomenon flos-aquae</u>	30.9
10	<u>Oocystis</u> spp.	26.8
11	<u>Melosira italica</u>	25.9
12	<u>Scenedesmus quadricauda</u>	25.7
13	<u>Melosira granulata</u>	23.5
14	<u>Diatoma vulgare</u>	20.6
15	<u>Schroederia setigera</u>	18.8
16	<u>Pandorina morum</u>	17.9
17	<u>Scenedesmus acuminatis</u>	15.5
18	<u>Ankistrodesmus Braunii</u>	14.6
19	<u>Anabaena</u> sp.	12.2
	<u>Synedra ulna</u>	12.2
20	<u>Diatoma elongatum</u>	10.7

volume than either Stephanodiscus niagarae or Melosira granulata. In 1970, S. niagarae and M. granulata had similar total cell volumes, but in 1968 and 1969, S. niagarae contributed four times the volume that M. granulata did to the total standing crop. Diatoma vulgare, Navicula spp., Cyclotella spp. and Melosira italica at times contributed large cell volumes even though presence was low compared to the previously mentioned diatoms. Synedra ulna and Diatoma elongatum were encountered in the samples but contributed little to the cell volume.

The Chlorophyceae were not an important class on a cell volume basis as they only contributed 6.4, 4.2 and 7.5% of the total cell volume of phytoplankton for 1968, 1969 and 1970, respectively. The green algae were represented by many genera, none of which showed a dominance in cell volume except Pediastrum duplex, a large colonial form (Table XVI). Ankistrodesmus falcatus ranked the highest according to presence of the chlorophytes (Table XVIII), but contributed little to the cell volume. Oocystis sp., Scenedesmus quadricauda, Schroederia setigera, Pandorina morum, Scenedesmus acuminatis and Ankistrodesmus Braunii were also frequently encountered.

The class Myxophyceae comprised 13.3, 6.4 and 17.5% of the total cell volume in 1968, 1969 and 1970, respectively. The blue-greens appeared in July and were present the remainder of the sampling

season. Aphanizomenon flos-aquae was the most important representative of this class on a presence and cell volume basis. Other important members of this group were Anabaena sp. according to presence and Microcystis aeruginosa according to cell volume.

The dinoflagellates, Dinophyceae, were represented by Ceratium hirundinella and Peridinium sp., but C. hirundinella distinctly dominated this class on a cell volume basis (Table XVI).

Of the Cryptophyceae, Rhodomonas lacustris was the more frequently occurring phytoplankter (Table XVII). However, Cryptomonas ovata contributed most of the cell volume of this class as can be seen from Table XVI. The Cryptophyceae comprised 14.4, 14.9 and 28.6% of total cell volume in 1968, 1969 and 1970, respectively.

Chrysococcus sp. and Dinobryon sertularia, the only representatives of the Chrysophyceae, appeared in trace amounts as did Botryococcus sudeticus, the only representative of the Xanthophyceae.

The longitudinal phytoplankton distributions during the study are portrayed in Figure 24. The total standing crops of Chlorella sp.; Tetraëdron sp., Chlamydomonas sp., Stichococcus bacillaris, Carteria sp., Coccochloris peniocyctis, Merismopedia punctata and Chrysococcus sp. appear under the title of "Microplankton". This consolidation was necessary because distortion of cells, caused by preservation, made positive identification impossible much of the time and many of the

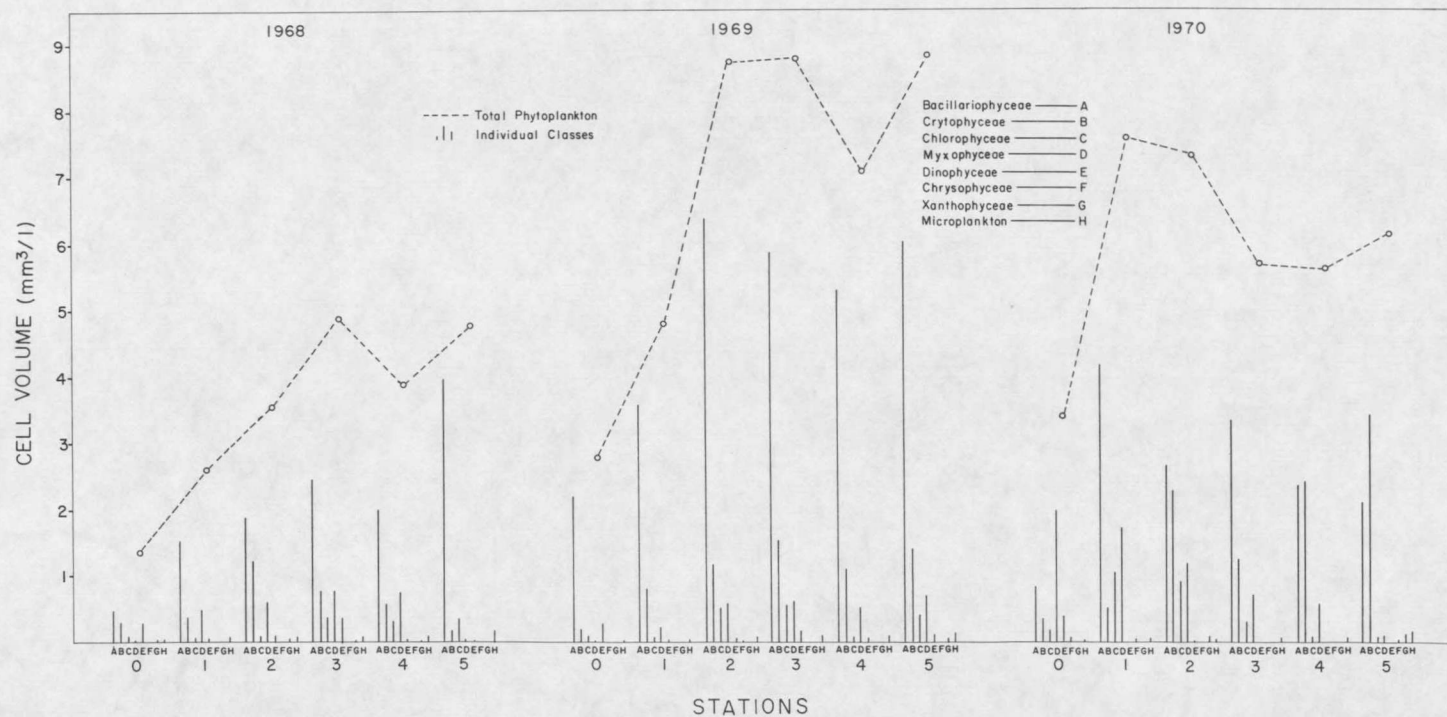


Figure 24. Yearly mean cell volumes (mm³/l) of the phytoplankton at each station of Bighorn Lake during 1968, 1969 and 1970.

above taxa were only encountered in a few samples.

In general, phytoplankton cell volumes increased from the dam to the upper end of Bighorn Lake and larger standing crops were observed in 1970 than in 1968 (Fig. 24).

The 1968 distribution of phytoplankton was represented by relatively small cell volumes at stations 0, 1 and 2 while stations 3, 4 and 5 were higher and had annual means of 4.90, 3.85 and 4.80 mm^3/l , respectively. The progressive increase in cell volume from stations 0 and 3 is evident with station 0 having an annual mean cell volume of 1.33 mm^3/l (Fig. 24).

The longitudinal distribution pattern of phytoplankton in 1969 was similar to that of 1968. The progressive increase in cell volume from station 0 to station 3 was again evident, but station 2 was almost equal in cell volume to station 3. Stations 2, 3, 4 and 5 all had cell volumes between 7.10 and 8.80 mm^3/l whereas station 0 had an annual mean cell volume of 2.79 mm^3/l .

In 1970, the cell volumes were higher at stations 1 and 2 with volumes of 7.65 and 7.40 mm^3/l respectively, whereas station 0 exhibiting the lowest volume of 3.48 mm^3/l (Fig. 24).

It is also apparent from Figure 24 that the Bacillariophyceae were the major contributors to the estimated cell volumes at each station during the study. However, in 1970 the Cryptophyceae were

of equal or of greater importance in their contribution to the cell volumes at stations 4 and 5. The Myxophyceae are another class of organisms that accounted for substantial volumes at stations 2, 3 and 4 during 1968 and 1969, and stations 0, 1 and 2 during 1970.

Matched t-tests at the 95% confidence level demonstrated that there was a significant difference in the amount of phytoplankton at any particular station versus the phytoplankton volume at any adjacent station, except for stations 2 and 3 for 1969, and stations 3 and 4 for 1970. A significant difference in the mean phytoplankton volumes was found between all years except for 1969 and 1970.

The seasonal distribution of the monthly mean phytoplankton standing crops is depicted in Figure 25. Again the progressive increase in cell volumes from 1968 to 1970 was evident. Overall, the larger standing crops on a volume basis were observed in the earlier part of the sampling season.

In 1968, the phytoplankton reached the seasonal peak in July with Fragilaria crotonensis accounting for 26.8% by volume of the total cell volume during this month. Stations 1 and 2 exhibited the highest mean cell volumes of 2.96 and 3.67 mm³/l, respectively. As the season progressed the amount of phytoplankton diminished to 1.05 mm³/l, with the Bacillariophyceae becoming minimal in September corresponding to a maximum in the Myxophyceae. The Cryptophyceae and

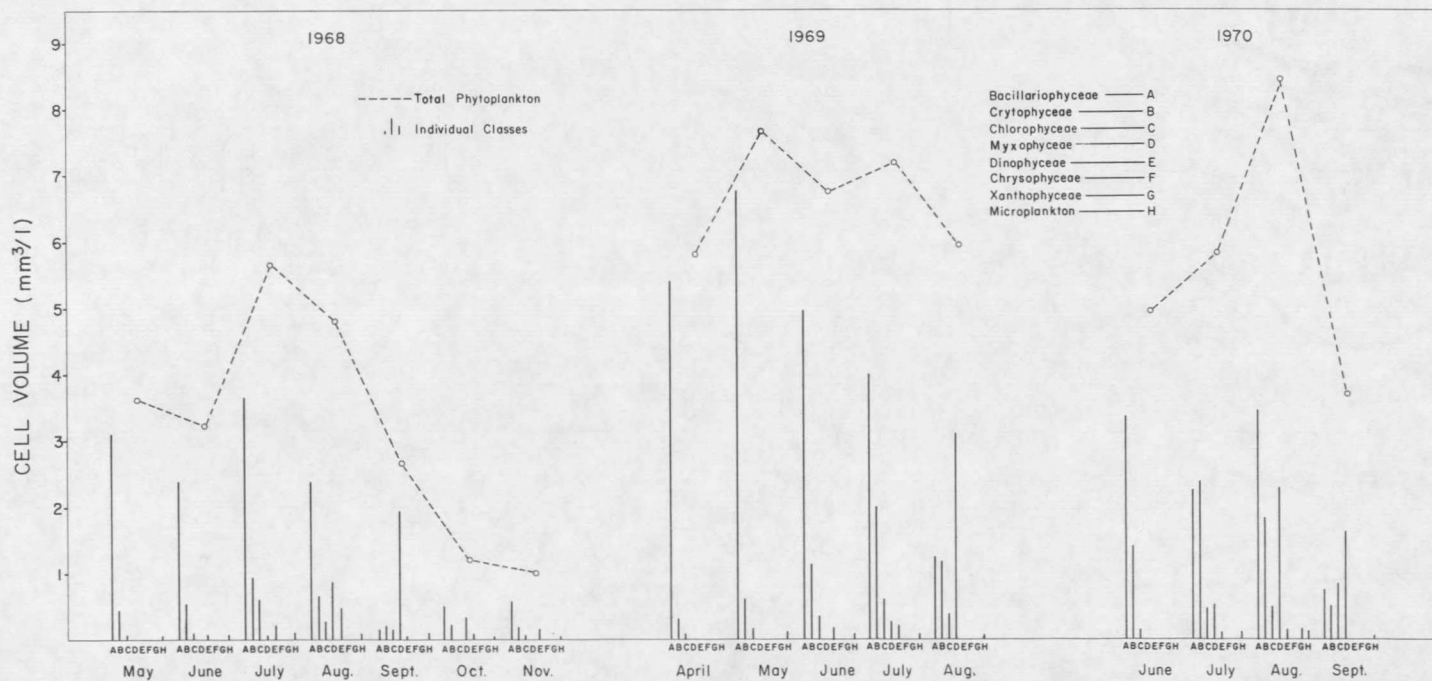


Figure 25. Monthly mean cell volumes (mm³/l) of the phytoplankton in Bighorn Lake during 1968, 1969 and 1970.

Dinophyceae both reached maxima in June and July.

It should be noted that the cell volumes of the Dinophyceae may be misrepresented. Ceratium hirundinella contributed primarily to this class and accurate volume determinations are difficult because of its large and irregular shape.

The amount of phytoplankton in April of 1969 was the recorded low ($5.82 \text{ mm}^3/\text{l}$) for the season but increased to the seasonal peak of $7.65 \text{ mm}^3/\text{l}$ in May (Fig. 25). Asterionella formosa dominated the plankton during this peak. From May, the phytoplankton decreased and then increased to a second peak in July when Fragilaria crotonensis, Melosira granulata and Stephanodiscus niagarae were dominant. The Bacillariophyceae were maximal in May, then progressively decreased through the season as the Myxophyceae reached peak volumes in August.

The monthly mean cell volume in June of 1970 was $4.95 \text{ mm}^3/\text{l}$ and followed by an increase to the seasonal high of $8.45 \text{ mm}^3/\text{l}$ in August. June to August was dominated by the Bacillariophyceae and Cryptophyceae. The Myxophyceae were at a maximum in August ($2.28 \text{ mm}^3/\text{l}$) then decreased to $1.63 \text{ mm}^3/\text{l}$ in September.

The phytoplankton successions observed during the course of the study are presented in Figures 26, 27 and 28. The indicated organisms comprised 64.1, 85.3 and 84.6% of the total cell volume during 1968, 1969 and 1970, respectively. Species succession was similar for all

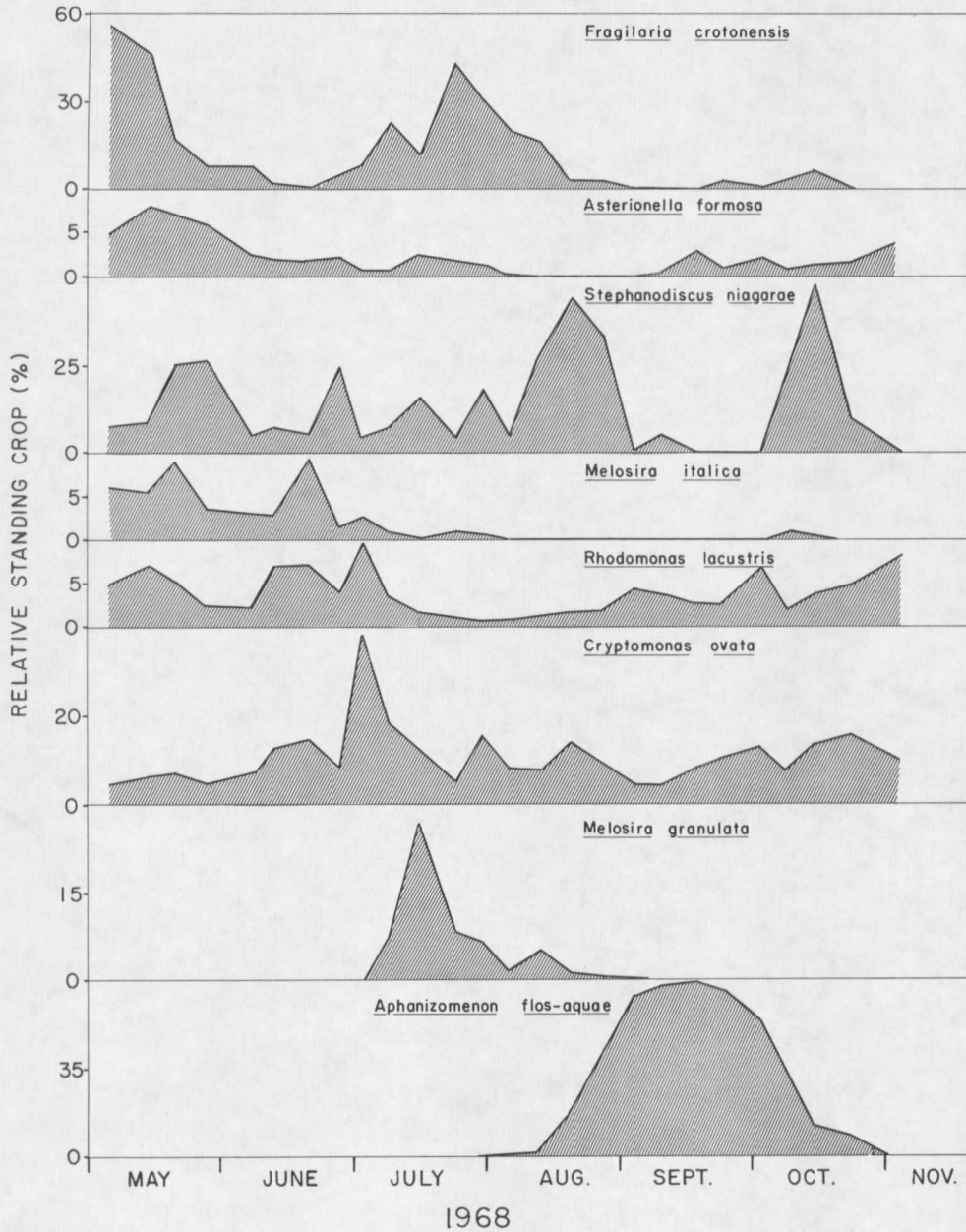


Figure 26. Mean relative standing crop (%) of the eight most abundant phytoplankton species for all sampling stations on Bighorn Lake during 1968.

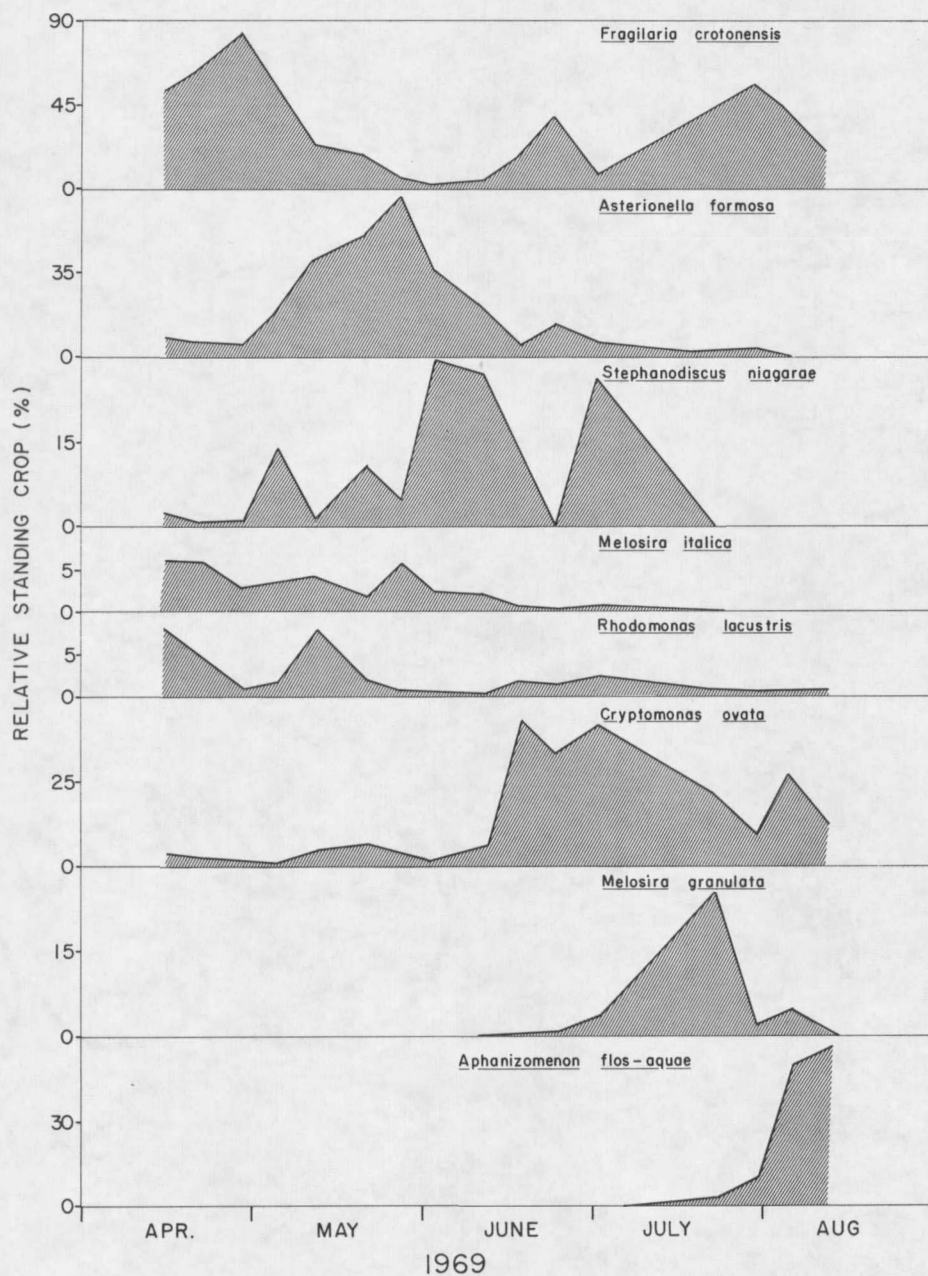


Figure 27. Mean relative standing crop (%) of the eight most abundant phytoplankton species for all sampling stations on Bighorn Lake during 1969.

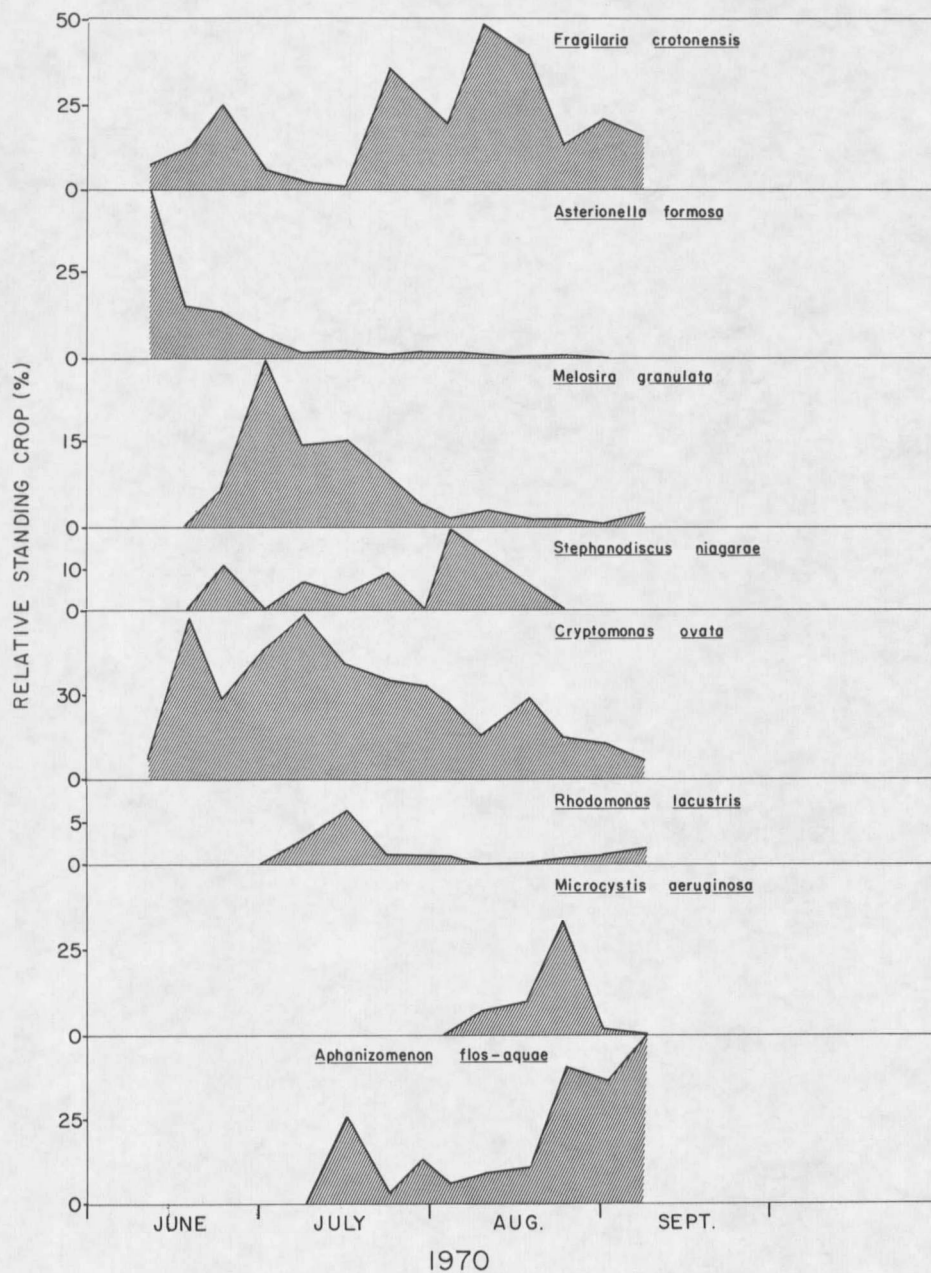


Figure 28. Mean relative standing crop (%) of the eight most abundant phytoplankton species for all sampling stations on Bighorn Lake during 1970.

three years with a larger part of the standing crop made up of diatoms found in the spring and early summer. The latter was somewhat followed by the flagellates, Cryptomonas ovata and Rhodomonas lacustris. The flagellates were succeeded by the blue-greens, with Aphanizomenon flos-aquae reaching "bloom" proportions in September. Another diatom maximum in the fall was less distinct.

In summary, conditions of phytoplankton standing crop and species succession were similar for all years. The same species shown in Figures 26, 27, and 28 became dominant and declined as demonstrated by the above figures. Minor variations were found with respect to the dates and absolute values of standing crop attained.

As previously shown (Fig. 24), phytoplankton standing crop expressed on a volume basis (mm^3/l), decreased downstream from station 5 to station 0. When standing crop was expressed as the volume under a square meter of reservoir surface to a depth at which light was sufficient for photosynthesis the picture was altered. Table XVIII shows that standing crop increased down-reservoir reaching a maximum at station 3 for 1968 and 1969 and station 2 for 1970.

A similar pattern was observed with chlorophyll a concentrations (Table XVIII). Chlorophyll a (mg/m^2) increased down-reservoir and attained a maximum at station 2 for 1968 and 1969, and station 3 for 1970.

Table XVIII. Mean total phytoplankton standing crop ($\times 10^3 \text{ mm}^3 / \text{m}^2$) and chlorophyll a concentrations (mg/m^2) at each station during the study.

1968	Station					
	0	1	2	3	4	5
Standing Crop	13.55	20.46	21.46	24.40	15.19	4.82
Chlorophyll <u>a</u>	31.0	34.9	42.8	37.9	38.3	13.5
1969						
	0	1	2	3	4	5
Standing Crop	32.73	39.59	32.60	42.61	25.93	16.90
Chlorophyll <u>a</u>	30.4	30.5	43.3	41.8	42.1	25.4
1970						
	0	1	2	3	4	5
Standing Crop	31.65	56.37	39.90	37.15	26.54	22.39
Chlorophyll <u>a</u>	34.5	40.7	56.1	60.0	59.7	43.2

Chlorophyll a concentrations (mg/m^3) in the euphotic zone during the study are given in Table LXVI of Appendix C. These values represent the mean chlorophyll a concentration of the profile taken through the euphotic zone assuming a homogeneous vertical distribution of phytoplankton. In general, chlorophyll concentrations (mg/m^3) were highest at the upper end of the reservoir and decreased downstream to station 0. Mean daily chlorophyll a concentration was 8.3 mg/m^3 in 1968 and 1969, and 10.1 mg/m^3 in 1970, or 21.6% greater in 1970.

The maximum concentration of chlorophyll a was 77.0 mg/m^3 on 9 September 1968, 39.7 mg/m^3 on 4 August 1969 and 34.5 mg/m^3 on 29 July 1970, and occurred during a period of large standing crops of Aphanizomenon for 1968 and 1969.

Figure 29 presents the relationship between average chlorophyll a concentrations and total cell volumes in the euphotic zone during the study. Chlorophyll a concentrations followed phytoplankton volumes and the correlation coefficients were $r = 0.28$ ($P = 0.01$) for 1968, $r = 0.37$ ($P = 0.01$) for 1969, $r = 0.12$ ($P = > 0.05$) for 1970 and $r = 0.27$ ($P = 0.01$) for all years taken together.

The regression equation using mean chlorophyll a concentrations and total standing crops at each station for each year was calculated:

$$\text{Chlorophyll } (\text{mg/m}^3) = 0.97V + 3.47 \quad R^2 = 28\%$$

where V equals the mean phytoplankton standing crop (mm^3/l). The

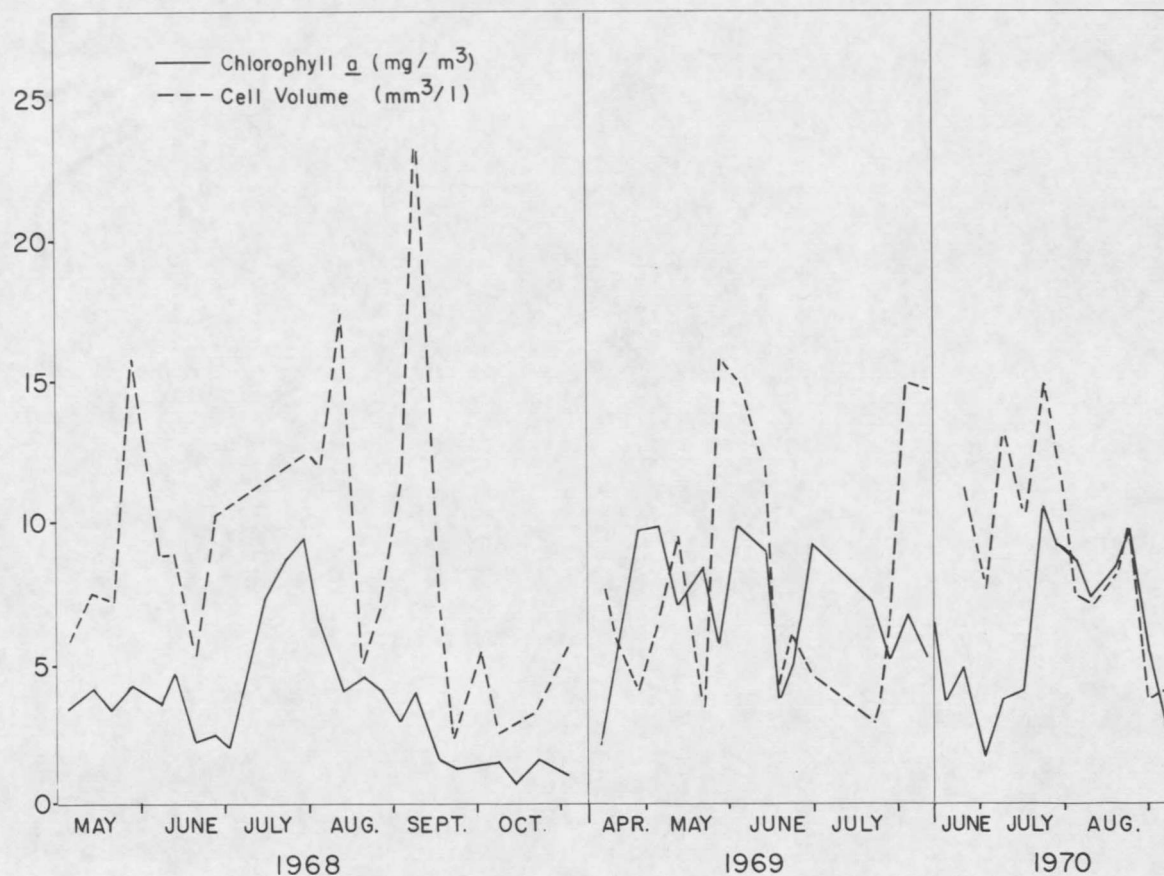


Figure 29. Relationship between mean total phytoplankton standing crop (mm^3 / l) and chlorophyll a concentrations (mg / m^3) for all stations during the study, Bighorn Lake.

equation indicates that the relationship between chlorophyll and cell volume was non-linear.

The histograms portrayed in Figure 30 show the frequency at which certain ratios of chlorophyll a and total cell volume occurred during the sampling periods for the indicated year. Over 57% in 1968, 88% in 1969 and 69% in 1970 of the ratios occurred within the interval 0-4 μg chlorophyll a/ mm^3 of cells. The mean ratios, medians and modes of μg chlorophyll a/ mm^3 of cells are given in Figure 30. On the basis of the presented data, the average relationship between chlorophyll a and cell volume would be 3.4 μg chlorophyll a is equivalent to 1.0 mm^3 of cells. Similar values were obtained by Martin (1967), Peterka and Knutson (1970) and Wright (1959).

Although the average ratio (μg chlorophyll a/ mm^3 of phytoplankton) was 3.4, ratios differed somewhat depending upon the season in which the samples were taken (Fig. 31). The ratio of chlorophyll/phytoplankton volume of the samples collected from April to July primarily composed of diatoms, was 3.8. The ratio for the samples taken in July composed primarily of diatoms and flagellates, was 3.1. The ratio of samples taken from August to November when Aphanizomenon was dominant, was 4.5 μg chlorophyll a/ mm^3 of cells.

The multiple linear regression equation, utilizing mean euphotic zone data over each year at each station, best explaining the observed

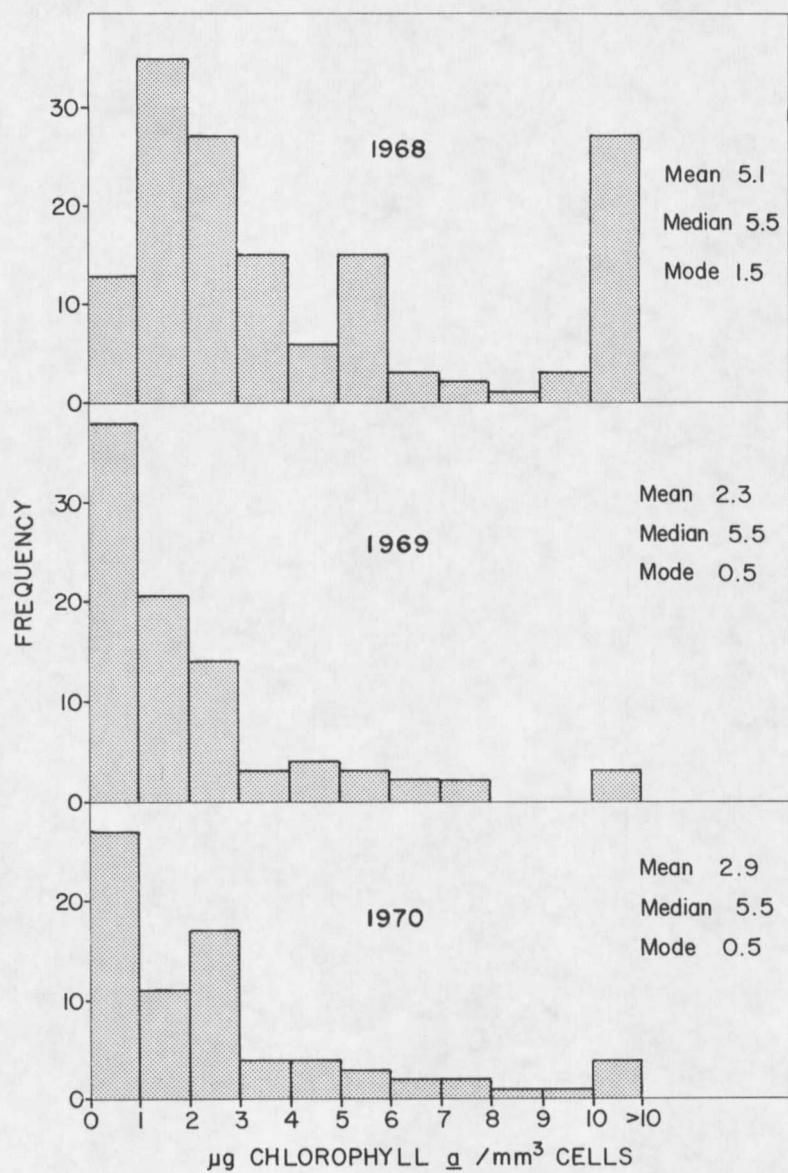


Figure 30. Frequency of the ratios of chlorophyll a to cell volume ($\mu\text{g}/\text{mm}^3$) during the study, Bighorn Lake.

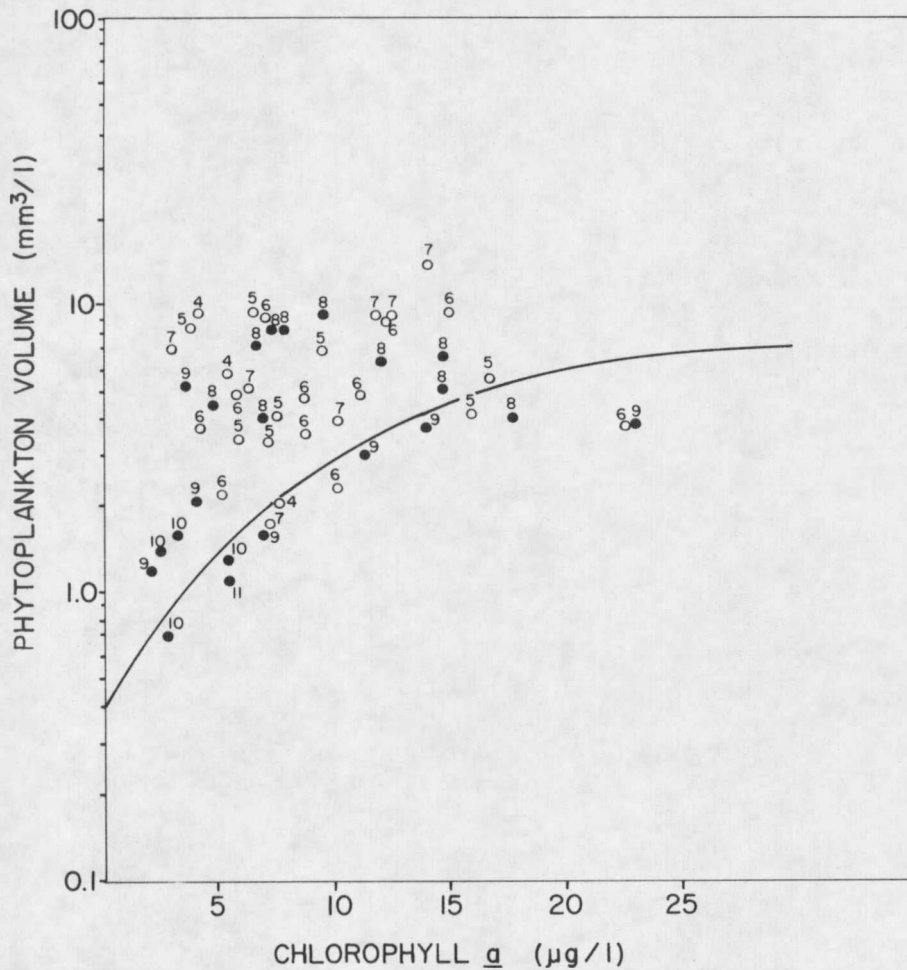


Figure 31. Seasonal relationship between mean chlorophyll a concentration (µg/l) and algal cell volume (mm³/l) for all stations during the Bighorn Lake study. Open circles represent samples which contained virtually no blue-green algae while closed circles represent samples which contained predominately blue-green algae. The solid line represents a 3.42:1.00 ratio of chlorophyll a to phytoplankton volume. Month of sample is shown by the number near the circle.

variations in the ratio of chlorophyll a to total phytoplankton standing crop during the study is:

$$\text{Chlorophyll } a / \text{total phytoplankton standing crop } (\mu\text{g}/\text{mm}^3) = \\ 6.13 - 0.07E + 0.26N + 7.76P - 0.01R \quad R^2 = 74\%$$

where E = euphotic zone depth (m)
 N = nitrate nitrogen (mg/l)
 P = ortho-phosphate (mg/l)
 R = solar radiation (g cal/cm²)

The most significant variables, in decreasing order of significance, were ortho-phosphate ($r = 0.80$; $P = 0.01$), solar radiation ($r = -0.66$; $P = 0.01$), euphotic zone depth ($r = 0.53$; $P = 0.05$) and nitrate nitrogen ($r = 0.48$; $P = 0.05$).

Primary Productivity

Accurate daily photosynthesis predictions based on environmental factors cannot be made because of the unpredictable fluctuations in these factors from day to day. However, averaging of these factors over longer periods of time reduces fluctuations and permits their use in calculating photosynthesis.

The method of Ryther and Yentsch (1957) uses the equation:

$$P = \frac{R}{k} \times C \times 3.7 \quad (1)$$

where P is the productivity in grams carbon per square meter per day, R is a variable, relative rate of photosynthesis--the value of which is fixed by the amount of solar radiation, k is the extinction

coefficient of the water column, C is the average chlorophyll concentration and 3.7 is an average assimilation ratio at light saturation--the units of which are grams carbon per gram chlorophyll per hour. The weakest point of this method was the fixed average assimilation ratio of 3.7.

Curl and Small (1965) obtained better comparisons between the chlorophyll-light method and C^{14} measured values by using a locally obtained ratio.

Wright (1959) replaced the constant in equation (1) with variables characterizing the local situation. The resultant equation was:

$$P = \frac{4.6}{k} \times F \times T \times C \times R_{opt} \quad (2)$$

where $4.6/k$ sets the lower limit of the euphotic zone, F is the ratio of photosynthesis at light saturation to total euphotic zone photosynthesis, T is the number of hours of photosynthesis, C is chlorophyll concentration, and R_{opt} is the assimilation ratio at light saturation.

Martin (1967) demonstrated that over a wide range of light conditions the assimilation ratio at light saturation is independent of the amount of sunlight falling on the water surface. There was also the relationship between the assimilation ratios obtained by both gross O_2 and C^{14} fixation measurements, and average temperature of the euphotic zone.

Utilizing the observed relationship between temperature and assimilation ratios, Martin modified equation (1) as follows:

$$P = \frac{R}{k} \times C \times A_t \quad (3)$$

where all variables are the same as in equation (1) and A_t is the temperature dependent assimilation ratio.

Peterka and Reid (1968) made an attempt to show the influence of various environmental factors that significantly influenced photosynthetic rates in Lake Ashtabula, North Dakota. A multiple linear regression analysis of their data revealed that chlorophyll, water temperature and Secchi disk transparency were the only significant variables affecting photosynthesis. Chlorophyll and water temperature together explained 65% of the variation in photosynthesis.

The methods of Wright (1959) and Martin (1967) appear to be approaches in the right direction. Wright's method takes into account seasonal variation in the vertical productivity profiles and Martin's method utilizes a variable assimilation ratio based on knowledge of the euphotic zone temperature.

Mean values of net primary productivity (calculated by using Martin's method of prediction) at each station and seasonal fluctuations of primary production during the study are presented in Figure 32. A photosynthetic quotient (PQ) of unity was assumed in converting carbon measurements into units of oxygen. Ryther (1956a)

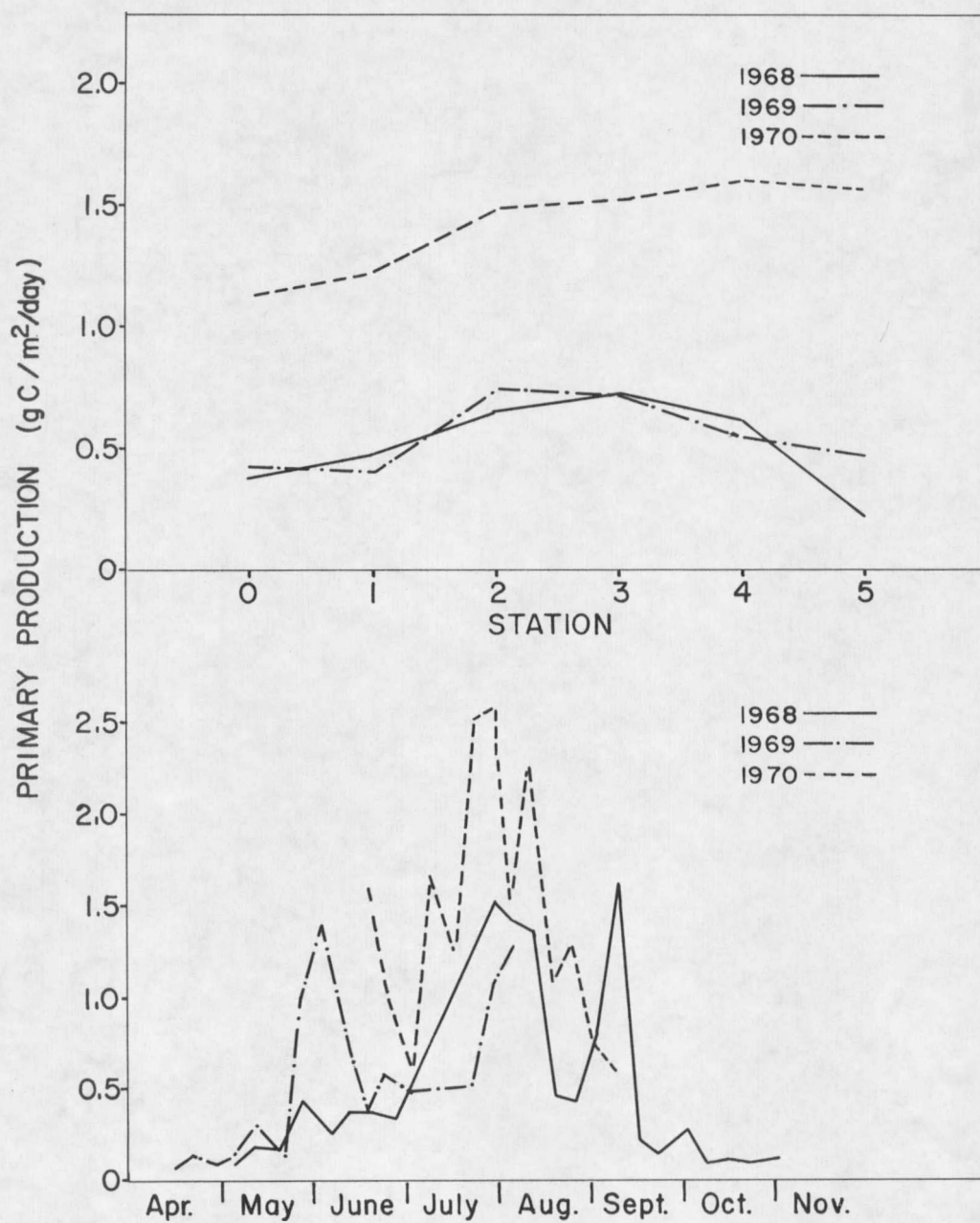


Figure 32. Mean primary productivity (g C/m²/day) at each station and seasonal fluctuations of primary production during the study, Bighorn Lake.

and Strickland (1960) have reviewed a number of experiments designed to determine PQ of various planktonic algae and found values ranging from less than unity to 1.6 or greater in a nitrate containing medium.

Average daily primary production was $0.51 \text{ g C/m}^2/\text{day}$ (1.36 g O_2), $0.55 \text{ g C/m}^2/\text{day}$ (1.46 g O_2) and $1.42 \text{ g C/m}^2/\text{day}$ (3.78 g O_2) for 1968, 1969 and 1970, respectively. Maximum production occurred on 29 July 1970, $6.96 \text{ g C/m}^2/\text{day}$ (18.51 g O_2).

An attempt was made to determine how much of the variation in the predicted production rates was accounted for by the various parameters used in the calculations. A multiple linear regression equation was calculated using the means of all data at each station for each year. The equation expressing the relationship is:

$$\begin{aligned} \text{Primary Productivity (g C/m}^2/\text{day)} = \\ -3.8 - 0.04E + 0.02C + 0.01R + 0.14T \quad R^2 = 90\% \quad (4) \end{aligned}$$

where E = mean extinction coefficient of the euphotic zone (k/m)
 C = mean chlorophyll concentration of the euphotic zone (mg/m^3)₂
 R = solar radiation incident to the reservoir surface (g cal/cm^2)
 T = mean temperature of euphotic zone (C)

The above equation (4) demonstrates that the linear regression equation accounted for most of the observed variation in the mean production rates calculated using a non-linear combination of independent variables, equation (3).

In the future, it would be desirable to make actual primary production estimates (preferably using C^{14}) and sample the euphotic

zone for the parameters needed to predict primary production. A complete multiple correlation and regression analysis of the collected data would not only reveal the degree of similarity between estimates, but would strengthen (or possibly weaken) the assumptions made in the many models of predicting primary productivity.

Many authors (Manning and Juday, 1941; Edmondson, 1955; Ryther, 1956b) have observed a rather constant relationship between chlorophyll a and photosynthesis. By using the mean euphotic zone data at each station for each year, it was found that chlorophyll a (mg/m^2) accounted for 67% of the calculated variation in primary productivity, while phytoplankton standing crop ($\text{X}10^3 \text{ mm}^3/\text{m}^2$) only accounted for 21% of the observed variation in the calculated production rates during the study.

Relationships of Physical and Chemical Parameters to Chlorophyll and Total Phytoplankton Standing Crop

Multiple linear regression analysis was used to predict standing crops of chlorophyll a and phytoplankton using 14 independent variables (Table XIX). Chlorophyll a and total phytoplankton standing crop were not used as independent variables, because they are strongly interrelated. The various multiple regression equations were calculated using mean euphotic zone data over each year at each station.

Table XIX. Variables used for multiple linear regression analysis of chlorophyll a and total phytoplankton standing crops for 1968, 1969 and 1970, Bighorn Lake.

Dependent variables:

1. Chlorophyll a (mg/m^3)
2. Chlorophyll a (mg/m^2)
3. Total phytoplankton standing crop (mm^3/l)
4. Total phytoplankton standing crop ($\times 10^3 \text{ mm}^3/\text{m}^2$)

Independent variables:

1. Euphotic zone depth (m)
 2. Extinction coefficient (k/m)
 3. Nitrate nitrogen ($\text{mg}/\text{l NO}_3^- \text{-N}$)
 4. Nitrite nitrogen ($\text{mg}/\text{l NO}_2^- \text{-N}$)
 5. Ammonia nitrogen ($\text{mg}/\text{l NH}_3 \text{-N}$)
 6. Total inorganic nitrogen ($\text{mg}/\text{l N}$)
 7. Ortho-phosphate ($\text{mg}/\text{l PO}_4^{3-}$)
 8. Ortho-phosphate to nitrate nitrogen ratio
 9. Total iron (mg/l)
 10. Manganese ($\text{mg}/\text{l Mn}^{++}$)
 11. Copper ($\text{mg}/\text{l Cu}^{++}$)
 12. Zinc ($\text{mg}/\text{l Zn}^{++}$)
 13. Temperature ($^{\circ}\text{C}$)
 14. Conductivity (micromhos)
-

The equation best expressing the observed variation in chlorophyll a on an areal basis during the study is:

$$\begin{aligned} \text{Chlorophyll } \underline{a} \text{ (mg/m}^2\text{)} = \\ 24.26 - 95.62N + 1.66T + 0.28K \quad R^2 = 65\% \quad (5) \end{aligned}$$

where N = nitrate nitrogen (mg/l)
T = temperature (C)
K = conductivity (micromhos)

The most significant variables, in decreasing order of significance, were nitrate nitrogen ($r = -0.74$; $P = 0.01$), conductivity ($r = -0.67$; $P = 0.01$) and temperature ($r = 0.58$; $P = 0.05$). Therefore, it can be shown that 44% (0.67×0.65) of the observed variation in the calculated mean primary productivity can be accounted for by the above environmental variables.

The equation best expressing the variations observed for phytoplankton standing crop on an areal basis is:

$$\begin{aligned} \text{Total phytoplankton standing crop (X10}^3 \text{ mm}^3/\text{m}^2\text{)} = \\ -34.24 - 80.54N - 4.30P + 0.23R + 0.03K \quad R^2 = 65\% \quad (6) \end{aligned}$$

where N = nitrate nitrogen (mg/l)
P = ortho-phosphate (mg/l)
R = solar radiation (g cal/cm^2)
K = conductivity (micromhos)

The most significant variables, in decreasing order of significance, were nitrate nitrogen ($r = -0.67$; $P = 0.01$), solar radiation ($r = 0.60$; $P = 0.01$), ortho-phosphate ($r = 0.57$; $P = 0.05$) and conductivity ($r = -0.43$; $P = 0.05$). Phytoplankton standing crop and

the above environmental factors would only account for 14% (0.21×0.65) of variation in the calculated mean primary productivity.

Variations in chlorophyll a (mg/m^3) observed during the course of the study are best expressed by the following equation:

$$\begin{aligned} \text{Chlorophyll } \underline{a} \text{ (mg/m}^3\text{)} = \\ 13.03 - 1.38E - 2.48N + 9.56P + 0.23T \quad R^2 = 93\% \quad (7) \end{aligned}$$

where E = euphotic zone depth (m)
 N = nitrate nitrogen (mg/l)
 P = ortho-phosphate (mg/l)
 T = temperature ($^{\circ}\text{C}$)

The most significant variables, in decreasing order of significance, were euphotic zone depth ($r = -0.94$; $P = 0.01$), ortho-phosphate ($r = 0.59$; $P = 0.01$), nitrate nitrogen ($r = 0.38$; $P = > 0.05$) and temperature ($r = 0.32$; $P = > 0.05$).

The equation best explaining the observed variations in phytoplankton standing crop on a volume basis during the study is:

$$\begin{aligned} \text{Total phytoplankton standing crop (mm}^3\text{/l)} = \\ -16.10 - 0.52E - 2.65N + 0.06R \quad R^2 = 76\% \quad (8) \end{aligned}$$

where E = euphotic zone depth (m)
 N = ammonia nitrogen (mg/l)
 R = solar radiation ($\text{g cal}/\text{cm}^2$)

The most significant variables, in decreasing order of significance, were solar radiation ($r = 0.63$; $P = 0.01$), euphotic zone depth ($r = -0.57$; $P = 0.05$) and ammonia nitrogen ($r = 0.34$; $P = > 0.05$).

Equations (7) and (8) point out that light appears to be the major variable controlling the density of organisms. It is also apparent by comparing equations (5) and (6) with (7) and (8) that the measured independent variables are much more efficient predictors on a volume basis than on an areal basis.

DISCUSSION

The chemical budget of the major ions (Table VIII) demonstrated that there was a slight decrease in the total dissolved solids (salinity) as the water moved down-reservoir. Hence, the reservoir was acting as a salinity trap. Because of the extensive development of irrigation projects and reuse of water along a series of impoundments, salinity often poses a major pollution problem.

Neel (1963) found with the impoundment of the Missouri River by Fort Randall Dam, the water quality of the reservoir was considerably altered by carbonate precipitation, resulting in the increased ratio of sodium to calcium. In Bighorn Lake, the above ratio was essentially the same for the weighted average of the influent streams versus that of the reservoir discharge for both 1968 and 1969. Since these ratios were of the same magnitude, it was concluded that biogenic precipitation of calcium was not evident.

The entrance of flood waters into reservoirs creates currents which vary in magnitude due to the physical and chemical parameters found in the reservoir (Wiebe, 1938, 1939, 1940, 1941; Lyman, 1944; Anderson and Pritchard, 1951). The 1968 Bighorn Lake data reveal that a turbidity current was established in the reservoir due to subsurface withdrawal through the power penstocks (Fig. 19). The development of the current was attributed to the excessive withdrawal of water from the reservoir during 1968 and was thought to extend most of the length of the reservoir. This current was not detectable

during the 1969 and 1970 sampling periods.

A tongue of ortho-phosphate (Fig. 20) and nitrate nitrogen (Fig. 21) rich water, which was associated with the turbidity current, developed in Bighorn Lake at station 0 during the summer and early fall of 1968 at the elevation of the power penstock. The discharge of such nutrient rich water should have had a marked influence on downstream production (downstream eutrophication). Neel (1963) discusses several cases of greatly increased downstream production following impoundment.

Also at the depth of the power penstock during 1968, a layer of water with minimum oxygen content (Fig. 22) and pH (Fig. 23) developed. Kittrell (1959) cites several cases in which effluents of low oxygen content from dams have resulted in problems (i.e., oxygen concentrations are low enough that downstream biochemical oxygen demand cannot be met).

Deep water withdrawal in a reservoir tends to deplete the reservoir system of nutrients since the effluent will be carrying away the nutrients that would otherwise tend to accumulate in the deep water of a natural lake during summer stagnation (Ruttner, 1963). However, for Bighorn Lake it has been shown that some of the nutrients that entered the reservoir were retained (Table IX). Of the total nitrogen that entered the system, 75% was discharged. The largest

inorganic nitrogen loss was in ammonia, while an 11% increase of nitrate nitrogen occurred. Only 14% of the total phosphorus that entered the reservoir was discharged from it. A 32% decrease in ortho-phosphate was observed.

It was apparent that when streamflows were high for the Bighorn and Shoshone Rivers, the reservoir was fertilized with the nutrients associated with the suspended sediments.

Important nutrients in many natural waters are often limiting to phytoplankton production (Hutchinson, 1957; Fogg, 1965; Lund et al., 1963). Various workers have discussed the concentrations of nitrogen and phosphorus that are needed for an algal bloom. The National Technical Advisory Committee on Water Quality (Anon., 1968) suggests that a concentration of at least 0.015 mg/l of phosphorus is necessary for algal growth. Hutchinson (1957) states that Asterionella can take up phosphorus where it is present at less than 0.001 mg/l. Mackenthun (1965) showed that nuisance blooms of algae may be expected when inorganic phosphate and nitrogen reach average concentrations exceeding 0.01 mg/l and 0.30 mg/l, respectively. Wright (unpublished data) found from his studies on Canyon Ferry Reservoir, Montana, that a large increase in phosphate resulted in a strikingly large increase in blue-green populations. The above levels for nitrogen and phosphate were usually exceeded at all stations of Bighorn Lake and

were not considered limiting to algal growth.

Wright (1960) suggested carbon dioxide to be limiting in reservoirs during dense phytoplankton blooms. Talling (1960b) found little reduction of the nutrient in relation to natural rates of photosynthesis. Lewin (1962) discusses various other elements (e.g., iron, manganese, etc.) and their importance to phytoplankton productivity. In general, the concentration of these nutrients in Bighorn Lake are high enough to be considered non-limiting.

The steady depletion of nutrients from the epilimnion during the summer leaves two alternatives of replenishment of nutrients for continued algal growth: (1) nutrients must be added from external sources or (2) the nutrients present must be rapidly recycled.

There was an ortho-phosphate depletion of the surface waters of the reservoir from May to August during the 1968 sampling periods at station 0 (Fig. 20). This loss of phosphate was attributed to uptake by phytoplankton. Slightly increased concentrations of phosphate in the surface waters during August and September were associated with low conductive water that originated from the high flow conditions in June. The levels of phosphate observed during the period of depletion were still above the minimal levels described by the literature to be limiting.

Epilimnetic phosphate regeneration has also been shown to be mediated by zooplankton. Barlow and Bishop (1965) showed that Daphnia liberated about 80% of the assimilated phosphorus back into the epilimnion during a period of strong stratification. Environmental conditions (e.g., temperature) would affect the rate of such a recycling process. Pomeroy et al. (1963) found turnover times for total phosphorus as low as eight days.

In contrast to ortho-phosphate there was no decline in nitrate nitrogen in the euphotic zone (Fig. 21); instead, concentrations increased during September and October of 1968, which corresponds to a period of maximum development of blue-greens.

Dugdale and Dugdale (1962) have stressed the importance of nitrogen fixation in the overall nitrogen metabolism of freshwaters. Most workers agree that species of Anabaena are the principle nitrogen fixers in the phytoplankton community. However, other authors (Krauss, 1958; Sawyer and Ferullo, 1961) have reported fixation of nitrogen by Aphanizomenon, which comprised the largest standing crop of the blue-green group in Bighorn Lake.

Ryther (1956b) and Edmondson (1956) have both stressed the importance of sunlight as a limiting factor to phytoplankton production. The direct effect of light as it penetrates the water is to increase the standing crop of phytoplankton assuming other

environmental factors are not limiting.

Chlorophyll a (mg/m^3) and total phytoplankton standing crops (mm^3/l) for Bighorn Lake decreased from stations 5 to 0. However, reference to Figure 13 shows that water clarity increased down-reservoir as the result of the settling out of silt. Therefore the effective depths at which photosynthesis could occur increased down-reservoir. The picture is altered when account is taken of this factor, and chlorophyll a and phytoplankton standing crop are expressed as the concentrations and volumes under a square meter of reservoir surface to a depth at which light is sufficient for photosynthesis. Table XVIII shows if chlorophyll a (mg/m^2) and phytoplankton standing crops ($\text{X}10^3 \text{ mm}^3/\text{m}^2$) are expressed on a areal basis, then the two measures of the phytoplankton community increased down-reservoir and attained maximums between stations 1 and 3. More effective light penetration is obviously important to the explanation of this situation. The lower chlorophyll a (mg/m^2) and phytoplankton standing crops ($\text{X}10^3 \text{ mm}^3/\text{m}^2$) at stations 1 and 0 for 1968 and 1969, and station 0 for 1970 cannot be explained in this manner since the water was more transparent (Fig. 14).

When nutrient conditions for all three years are compared with the euphotic zone chlorophyll a concentrations (mg/m^2), it will be noted that total inorganic nitrogen and ortho-phosphate concentrations

(Table XIV) are greatest at the upper end of the reservoir, but no significant difference was found between stations 2, 1 or 0 to explain the decrease in chlorophyll a (mg/m^2) at the latter two stations.

Zooplankton densities must be considered as an important influence on phytoplankton standing crops and thus chlorophyll a concentrations, and may be the factor responsible for the lower phytoplankton production at stations 1 and 0. Wright (1954, 1958, 1965) and many other workers (Anderson et al., 1955; Comita and Anderson, 1959; Edmondson et al., 1962; Richman, 1966) have found declines in phytoplankton standing crops due to heavy predation by zooplankton. However, Edmondson (1962, 1965) demonstrated that zooplankton preferred the microplankton portion of the standing crop. Tappa (1965) has shown that Daphnia exhibits a degree of food selectivity.

It is quite possible that organisms such as Cryptomonas, Rhodomonas and other microplankton would be heavily grazed as food species in Bighorn Lake. The food value of such organisms as Aphanizomenon which comprise the bulk of the phytoplankton standing crop in late summer and early fall, is questionable. Knutson (1970) showed that Daphnia numbers were high during almost uni-algal blooms of Aphanizomenon and concluded that Daphnia were grazing upon this blue-green alga. He also pointed out that the frequent periods of large rotting stands of Aphanizomenon would invite the growth of

protozoans and bacteria which could serve as food.

Blue-green algae are often the dominant algae in eutrophic lakes, probably because they are free from grazing by zooplankters (Lund, 1969). Aphanizomenon comprised about 70% of the total phytoplankton volume during the late summer and early fall in Bighorn Lake. Large stands of this blue-green have been recorded for other eutrophic lakes (Hammer, 1964; Hrbaeck, 1964; Martin, 1967; Olive et al., 1969).

As the concentration of algal cells increases, light penetration decreases, so that the phytoplankters become self-shading. Inverse correlations between plankton density and light penetration have been described (Fogg, 1965; Javornicky, 1966), but in the field it is usually difficult to establish the direct causal relationships due to unknown effects of detritus and other non-algal forms of turbidity. Talling (1960a) however, has reported a case of self-shading in a field study of an Asterionella population. The appearance of Aphanizomenon in Bighorn Lake may have limited the growth of other algae, particularly Melosira granulata, Fragilaria crotonensis and Stephanodiscus niagarae (Figs. 26, 27 and 28) due to its characteristic waterbloom and resulting shading effect (Verduin, 1951).

Temperature is considered to be a causative agent of phytoplankton succession. Different species may predominate at different times because of the interaction between prevailing temperature and other

environmental factors. Aphanizomenon development in Bighorn Lake started while water temperatures were about 18 C, with blooms appearing shortly thereafter. Most of the summer blooms occurred at water temperatures of 20 to 25 C, which was close to the temperature range for Aphanizomenon waterblooms in several Canadian lakes (Hammer, 1964).

Nutrient concentrations not only affect total phytoplankton productivity, but also the species composition of the phytoplankton community. The seasonal succession of phytoplankton cannot be entirely related to the concentration of a single inorganic nutrient nor to any combination of nutrients. However, the occurrence of diatoms usually coincides with higher levels of nutrients present in the spring. The position of the blue-greens in the successional pattern is usually accompanied by low levels of nitrate nitrogen and/or high phosphate to nitrate ratio (Hutchinson, 1967).

The spring phytoplankton peaks were dominated by Fragilaria crotonensis, Asterionella formosa, Melosira italica and Rhodomonas lacustris. The successional pattern for most of the above organisms (Figs. 26, 27 and 28) was similar to what Lund (1965) observed for the succession of algae in Windermere Lake.

Predicted primary productivity values fluctuated greatly from day to day with peak production rates occurring during the summer

months. These short time variations of production are perhaps not only the result of daily insolation changes but also the quantity and quality of the phytoplankton standing crop and its horizontal distribution in the reservoir (Rhode, 1958). Bighorn Lake is moderately productive with calculated mean daily net primary productivity values of $1.36 \text{ g O}_2/\text{m}^2/\text{day}$, $1.46 \text{ g O}_2/\text{m}^2/\text{day}$ and $3.78 \text{ g O}_2/\text{m}^2/\text{day}$ for 1968, 1969 and 1970, respectively. Most of the above productivity rates are low when compared to other eutrophic lakes: $3.0 \text{ g O}_2/\text{m}^2/\text{day}$ in Canyon Ferry Reservoir, Montana (Wright, 1965), $6.9 \text{ g O}_2/\text{m}^2/\text{day}$ during the summer in western Lake Erie (Verduin, 1956). Unproductive waters yielded values less than $0.3 \text{ g O}_2/\text{m}^2/\text{day}$ and the most productive saline and fresh waters may yield 1.3 to $8.0 \text{ g O}_2/\text{m}^2/\text{day}$ (Steeman-Nielsen, 1954; Rhode, 1958). Rhode (1958) arbitrarily considered daily production rates of about $0.3 \text{ g O}_2/\text{m}^2/\text{day}$ as the dividing point between oligotrophic and eutrophic lakes.

The relationship of chlorophyll a concentration to cell volume was shown to be about $3.4 \text{ } \mu\text{g chlorophyll a}/1.0 \text{ mm}^3$ of algal cells for all data. A range of values derived from the literature is 0.5 (Strickland, 1960) to $7.6 \text{ } \mu\text{g chlorophyll a}/\text{mm}^3$ of cells (Cushing, 1958).

SUMMARY

Bighorn Lake, an impoundment of the Bighorn River, has a maximum useable capacity of $169 \times 10^7 \text{ m}^3$ (1,375,000 acre-ft) and a surface area of $700 \times 10^5 \text{ m}^2$ (17,298 acres). The principal purposes of the reservoir are flood control, power production, irrigation and recreation.

The reservoir became thermally stratified for all three years of the study. Surface water temperatures were greater than 20 C in late July and August. Bighorn Lake acquired an ice cover for a period of approximately 60 days in 1969. The spring warming process began in the upper end of the reservoir and advanced toward the dam and to greater depths as the season progressed. The development of a distinct thermocline for any given year of the study was not detectable.

Conductivity ranged from 430 to 1,628 micromhos. Differences in conductivity by season and location are depicted for the 1968 sampling periods. Reservoir regulation delayed normal trends in conductivity. Water of minimal conductance (salinity) was discharged from the dam between July and September, which corresponds to the periods of heavy downstream irrigation.

Calcium, sodium, sulfate and bicarbonate are the most common constituents of the dissolved solids present in Bighorn Lake. Photosynthetic reduction of alkalinity was not detected.

A turbidity current was established at the depth of the power penstock during 1968. Nitrate nitrogen and ortho-phosphate maxima as well as the oxygen and pH minima were associated with the above turbidity current.

Turbidities were drastically reduced, thus improving water quality. A comparison of the mean turbidities for the Bighorn and Shoshone Rivers with that of the reservoir discharge during the study reveals approximately a 60-fold decrease. Euphotic zone depth averaged 1 m at station 5, but reached 10 m near the dam.

It was apparent that Bighorn Lake was fertilized with nutrients from the major tributaries. The relationships of conductivity, turbidity, nitrogen and phosphate to the rate of tributary flow have been examined. It does not appear that any of the determined essential ions for biological production are lacking in this reservoir.

Maximum phytoplankton volumes were found in the spring and early summer months. A definite algal succession pattern was established for all three years. Phytoplankton volumes increased from the dam to the upper end of Bighorn Lake.

Comparison of sampling periods (June-September) common to all years of the study showed that the estimated net primary production increased 84% in 1970 over 1968. The above increase in productivity

related well with the 44% increase of mean total phytoplankton standing crop (mm^3/m^2) in 1970 over 1968 as well as the 49% increase in mean chlorophyll a concentrations (mg/m^2) in 1970 and 33% increase in mean phytoplankton biomass (g/m^2).

APPENDICES

Appendix A

Influent and Effluent Water Data

Table XX. Temperatures (C) for the influent and effluent waters of Bighorn Lake during 1968 and 1969 sampling periods.

1968				1969			
Date	Bighorn Influent	Shoshone Influent	Discharge	Date	Bighorn Influent	Shoshone Influent	Discharge
2/22	0.0	5.0	1.8	1/ 3		0.4	4.5
3/ 7	5.0	6.3	1.8	1/18		0.3	3.0
3/28	18.0	19.0	14.7	2/ 1		3.0	4.0
4/11	10.0	10.0	3.5	2/15		4.3	2.9
5/ 4	11.8	10.9		3/ 1		5.0	3.0
5/18				3/17	5.7	9.7	3.3
6/ 1	14.2	14.7	5.0	3/31	9.8	9.6	2.8
6/12	14.6	19.0		4/ 7	11.6	13.0	2.2
6/24	15.4	16.8		4/14	14.5	14.5	2.2
7/15	21.4	23.5	13.6	4/21	14.5	13.9	3.1
8/ 1	19.0	21.3	15.0	4/28	11.4	17.1	3.9
8/19				5/ 5	17.3	19.0	3.4
9/23			16.2	5/12	18.0	17.4	4.2
10/ 7				5/22	15.7	15.6	6.0
10/19	7.7	7.0	13.9	5/28	16.0	20.0	4.5
11/ 9	5.2	5.0	10.1	6/ 3	19.9	13.0	6.7
11/23	8.5	8.5	8.2	6/10	16.3	17.8	5.3
12/ 7	0.5	0.5	8.0	6/17	19.0	15.5	4.8
12/20		0.0	6.3	6/24	18.0	17.2	5.2
				7/ 1	18.0	17.3	6.3
				7/ 8	20.3	19.6	6.7
				7/14	23.7	19.0	7.0
				7/21	22.8	19.9	9.7
				7/29	23.6	25.0	10.5
				8/ 5	28.2	21.7	
				8/11	26.1	18.0	10.3
				8/18	22.0		

Table XXI. Conductivities (micromhos) at 25° C for the influent and effluent waters of Bighorn Lake during 1968 and 1969 sampling periods.

1968				1969			
Date	Bighorn Influent	Shoshone Influent	Discharge	Date	Bighorn Influent	Shoshone Influent	Discharge
2/22	880	1312	932	1/ 3			891
3/ 7	971	825	907	1/18		935	881
3/28	878	868	859	2/ 1		869	923
4/11	950	843	859	2/15		962	955
5/ 4	924	1141	917	3/ 1		832	868
5/18	840	1305	910	3/17	856	863	860
6/ 1	413	1240	923	3/31	1035	799	870
6/12	673	1121	914	4/ 7	913	739	919
6/24	412		844	4/14	895	696	969
7/15	842	1684	829	4/21	865	768	971
8/11			726	4/28	736	926	933
8/19	830	949	669	5/ 5	664	877	887
9/23				5/12	489	1190	871
10/ 7	1125	984	932	5/22	605	1027	926
10/19	907	974	915	5/28	427	876	875
11/ 9	920	951	910	6/ 3	822	1047	840
11/23	894	1100	851	6/10	638	937	844
12/ 7	937	871	877	6/17	815	835	887
12/20		818	881	6/24	783	1043	918
				7/ 1	591	662	926
				7/ 8	603	507	768
				7/14	755	958	692
				7/21	998	1315	903
				7/29	1098	1290	919
				8/ 5	1109	1116	749
				8/11	1247	1186	826
				8/18	1227	1213	806

Table XXII. Calcium concentrations (meq/l Ca^{++}) for the influent and effluent waters of Bighorn Lake during 1968 and 1969 sampling periods.

1968				1969			
Date	Bighorn Influent	Shoshone Influent	Discharge	Date	Bighorn Influent	Shoshone Influent	Discharge
2/22	3.34	6.02	4.38	1/ 3			3.58
3/ 7	4.17	5.96	4.18	1/18		4.62	4.05
3/28	4.00	3.98	3.93	2/ 1		4.48	3.68
4/11	3.95	3.76	3.74	2/15		4.40	4.01
5/ 4	4.03	3.60	3.76	3/ 1		4.20	3.88
5/18	3.68	3.99	4.07	3/17	5.48	4.16	4.00
6/ 1	3.71	6.02	4.58	3/31	3.55	3.50	3.76
6/12	3.60	5.35	4.32	4/ 7	3.70	1.82	2.88
6/24	2.40	6.96	4.98	4/14	4.70	3.84	4.04
7/15	3.99	7.62	3.68	4/21	3.64	3.88	4.04
8/ 1	4.20	7.45	3.16	4/28	3.00	3.10	4.00
8/19	1.45	1.40	2.00	5/ 5	2.64	3.29	3.60
9/23	4.09	4.07	3.59	5/12	2.08	4.28	3.66
10/ 7	4.66	3.80	3.86	5/22	2.37	3.63	3.65
10/19	3.25	3.80	3.80	5/28	2.22	3.37	4.43
11/ 9	3.78	3.88	3.56	6/ 3	3.40	3.84	3.75
11/23	3.72	4.80	3.63	6/10	2.67	3.44	3.40
12/ 7	3.81	4.28	3.57	6/17	4.39	3.76	4.31
12/20		3.66	3.77	6/24	2.92	3.74	3.80
				7/ 1	2.36	2.48	3.72
				7/ 8	2.41	2.03	3.05
				7/14	3.24	3.53	3.80
				7/21	3.85	4.65	3.68
				7/29	3.60	4.67	3.64
				8/ 5	3.93	4.07	2.97
				8/11	4.46	4.44	3.30
				8/18	4.75	4.65	3.52

Table XXIII. Magnesium concentrations (meq/l Mg^{++}) for the influent and effluent waters of Bighorn Lake during 1968 and 1969 sampling periods.

1968				1969			
Date	Bighorn Influent	Shoshone Influent	Discharge	Date	Bighorn Influent	Shoshone Influent	Discharge
2/22	2.82	3.37	2.28	1/ 3			2.36
3/ 7	2.07	2.98	2.00	1/18		2.02	1.57
3/28	1.88	2.14	2.13	2/ 1		1.64	2.24
4/11	2.37	2.13	2.03	2/15		0.96	1.96
5/ 4	2.18	3.84	2.02	3/ 1		2.00	1.92
5/18	1.67	2.82	0.91	3/17	1.16	1.74	2.02
6/ 1	0.55	3.42	1.97	3/31	2.00	1.88	1.96
6/12	0.49	1.53	2.00	4/ 7	2.22	2.14	3.38
6/24	5.17	3.32	2.60	4/14	2.52	2.24	2.28
7/15	1.64	1.34	2.22	4/21	2.00	0.86	2.40
8/ 1	2.04	2.27	1.15	4/28	1.42	1.82	2.16
8/19	1.52	1.64	0.96	5/ 5	1.42	1.78	1.94
9/23	2.10	2.07	1.66	5/12	1.00	2.60	1.92
10/ 7	2.30	2.20	1.38	5/22	1.31	2.00	2.08
10/19	2.52	2.28	2.00	5/28	0.49	1.94	1.46
11/ 9	1.99	2.04	1.94	6/ 3	1.86	2.14	1.68
11/23	2.22	2.80	2.01	6/10	1.31	1.85	2.08
12/ 7	2.03	2.16	2.03	6/17	0.63	1.34	1.57
12/20		1.72	1.99	6/24	1.56	2.38	2.16
				7/ 1	1.16	1.30	2.20
				7/ 8	1.27	1.02	2.32
				7/14	1.78	2.07	2.04
				7/21	2.15	2.66	1.96
				7/29	1.82	2.73	1.96
				8/ 5	2.59	2.38	1.52
				8/11	2.80	2.42	1.92
				8/18	2.62	2.68	1.52

Table XXIV. Sodium concentrations (meq/l Na^+) for the influent and effluent waters of Bighorn Lake during 1968 and 1969 sampling periods.

1968				1969			
Date	Bighorn Influent	Shoshone Influent	Discharge	Date	Bighorn Influent	Shoshone Influent	Discharge
2/22	4.75	6.45	4.25	1/ 3			3.50
3/ 7	4.75	6.45	3.60	1/18		3.15	3.78
3/28	4.00	4.00	3.85	2/ 1		2.40	4.50
4/11	3.68	3.28	3.24	2/15		3.25	3.55
5/ 4	3.52	4.96	3.52	3/ 1		3.03	3.70
5/18	3.12	5.64	3.52	3/17	3.78	3.55	3.55
6/ 1	1.28	6.12	3.48	3/31	5.00	3.65	4.00
6/12	2.56	5.44	3.52	4/ 7	4.51	4.30	4.06
6/24	1.12	6.84	3.20	4/14	6.80	5.30	4.35
7/15	2.52	5.84	2.56	4/21	4.18	3.59	4.35
8/ 1	3.48	6.08	2.68	4/28	3.25	5.05	3.60
8/19	3.95	5.25	2.92	5/ 5	3.65	4.23	3.81
9/23	3.85	4.35	3.35	5/12	1.77	6.20	3.70
10/ 7	4.05	4.25	3.50	5/22	2.15	3.86	3.75
10/19	3.25	3.70	3.05	5/28	1.77	4.55	3.60
11/ 9	3.45	3.00	2.95	6/ 3	3.20	4.75	3.38
11/23	3.70	5.47	3.85	6/10	2.60	4.40	3.09
12/ 7	3.26	3.05	2.32	6/17	2.88	3.09	2.88
12/20		1.72	1.99	6/24	3.00	4.05	3.05
				7/ 1	2.34	2.55	3.20
				7/ 8	2.15	2.19	3.10
				7/14	2.59	3.86	3.20
				7/21	3.31	5.60	3.20
				7/29	3.20	5.30	3.00
				8/ 5	3.58	4.93	2.73
				8/11	5.86	5.56	3.36
				8/18	5.68	5.86	3.38

Table XXV. Potassium concentrations (meq/l K^+) for the influent and effluent waters of Bighorn Lake during 1968 and 1969 sampling periods.

1968				1969			
Date	Bighorn Influent	Shoshone Influent	Discharge	Date	Bighorn Influent	Shoshone Influent	Discharge
2/22	0.11	0.19	0.13	1/ 3			0.13
3/ 7	0.14	0.17	0.12	1/18		0.14	0.13
3/28	0.12	0.10	0.13	2/ 1		0.15	0.13
4/11	0.09	0.09	0.09	2/15		0.15	0.13
5/ 4	0.10	0.10	0.11	3/ 1		0.16	0.14
5/18	0.08	0.11	0.09	3/17	0.15	0.13	0.14
6/ 1	0.10	0.22	0.09	3/31	0.12	0.13	0.13
6/12	0.18	0.21	0.09	4/ 7	0.12	0.13	0.13
6/24	0.06	0.11	0.08	4/14	0.16	0.11	0.13
7/15	0.12	0.18	0.12	4/21	0.13	0.11	0.15
8/ 1	0.12	0.15	0.09	4/28	0.13	0.13	0.13
8/19	0.19	0.15	0.18	5/ 5	0.11	0.12	0.16
9/23	0.18	0.18	0.17	5/12	0.06	0.14	0.12
10/ 7	0.21	0.18	0.42	5/22	0.08	0.14	0.13
10/19	0.16	0.15	0.40	5/28	0.09	0.13	0.12
11/ 9	0.27	0.15	0.15	6/ 3	0.10	0.06	0.06
11/23	0.12	0.14	0.12	6/10	0.09	0.12	0.11
12/ 7	0.14	0.14	0.08	6/17	0.11	0.11	0.10
12/20		0.12	0.16	6/24	0.13	0.11	0.12
				7/ 1	0.09	0.11	0.12
				7/ 8	0.11	0.06	0.11
				7/14	0.10	0.10	0.11
				7/21	0.14	0.15	0.12
				7/29	0.14	0.14	0.14
				8/ 5	0.12	0.12	0.11
				8/11	0.17	0.12	0.10
				8/18	0.16	0.12	0.10

Table XXVI. Total alkalinities (meq/l) for the influent and effluent waters of Bighorn Lake during 1968 and 1969 sampling periods.

1968				1969			
Date	Bighorn Influent	Shoshone Influent	Discharge	Date	Bighorn Influent	Shoshone Influent	Discharge
2/22	2.90	4.68	3.41	1/ 3			3.18
3/ 7	3.40	4.45	3.24	1/18		4.60	3.60
3/28	3.35	3.54	3.32	2/ 1		4.30	3.10
4/11	3.27	3.45	3.28	2/15		3.74	3.24
5/ 4	3.32	3.68	2.81	3/11		4.20	3.40
5/18	3.00	4.00	3.45	3/17	3.20	4.10	3.40
6/ 1	2.28	4.25	3.40	3/31	2.60	2.90	2.90
6/12	2.34	3.26	3.97	4/ 7	3.00	3.30	2.80
6/24	1.92	4.18	3.01	4/14	3.45	3.29	3.50
7/15	2.92	4.76	2.88	4/21	3.10	2.85	3.00
8/ 1	3.37	4.65	3.14	4/28	2.25	2.60	3.70
8/19	3.46	3.49	3.05	5/ 5	2.20	2.68	2.85
9/23	3.00	4.18	3.03	5/12	1.69	2.94	2.98
10/ 7	3.82	3.37	3.11	5/22	1.90	2.87	3.12
10/19	2.80	3.41	3.18	5/28	1.41	2.59	3.11
11/ 9	2.90	3.24	2.86	6/ 3	2.51	2.89	2.93
11/23	3.27	4.09	3.12	6/10	1.89	2.60	2.82
12/ 7	3.25	3.95	3.00	6/17	2.69	2.71	3.12
12/20		3.50	3.15	6/24	2.40	3.01	3.16
				7/ 1	1.89	2.11	3.16
				7/ 8	2.00	1.81	2.86
				7/14	2.61	2.76	3.12
				7/21	2.78	3.31	3.00
				7/29	2.85	3.61	3.00
				8/ 5	2.46	3.14	2.45
				8/11	3.09	3.41	2.70
				8/18	3.42	3.58	2.25

Table XXVII. Chloride concentrations (meq/l Cl^-) for the influent and effluent waters of Bighorn Lake during 1968 and 1969 sampling periods.

1968				1969			
Date	Bighorn Influent	Shoshone Influent	Discharge	Date	Bighorn Influent	Shoshone Influent	Discharge
2/22	0.46	0.52	0.41	1/ 3			0.27
3/ 7	0.50	0.44	0.37	1/18		0.69	0.30
3/28	0.45	0.26	0.33	2/ 1		0.30	0.31
4/11	0.44	0.24	0.31	2/15		0.39	0.45
5/ 4	0.37	0.37	0.35	3/ 1		0.37	0.32
5/18	0.33	0.40	0.36	3/17	0.40	0.31	0.30
6/ 1	0.12	0.42	0.35	3/31	0.49	0.31	0.34
6/12	0.15	0.36	0.35	4/ 7	0.40	0.28	0.37
6/24	0.41	0.13	0.26	4/14	0.54	0.28	0.35
7/15	0.29	0.35	0.24	4/21	0.37	0.41	0.27
8/ 1	0.35	0.32	0.21	4/28	0.35	0.35	0.39
8/19	0.36	0.25	0.23	5/ 5	0.28	0.32	0.36
9/23	0.39	0.27	0.29	5/12	0.18	0.36	0.34
10/ 7	0.57	0.23	0.29	5/22	0.21	0.28	0.34
10/19	0.26	0.22	0.27	5/28	0.17	0.28	0.38
11/ 9	0.33	0.17	0.20	6/ 3	0.30	0.28	0.35
11/23	0.25	0.33	0.24	6/10	0.21	0.22	0.32
12/ 7	0.26	0.19	0.28	6/17	0.33	0.27	0.36
12/20		0.22	0.22	6/24	0.34	0.31	0.36
				7/ 1	0.23	0.19	0.36
				7/ 8	0.26	0.14	0.34
				7/14	0.29	0.25	0.36
				7/21	0.41	0.35	0.34
				7/29	0.41	0.33	0.38
				8/ 5	0.51	0.31	0.30
				8/11	0.56	0.28	0.30
				8/18	0.54	0.34	0.27

Table XXVIII. Sulfate concentrations (meq/l SO_4^{--}) for the influent and effluent waters of Bighorn Lake during 1968 and 1969 sampling periods.

1968				1969			
Date	Bighorn Influent	Shoshone Influent	Discharge	Date	Bighorn Influent	Shoshone Influent	Discharge
2/22	6.35	10.31	6.35	1/ 3			6.17
3/ 7	7.39	10.52	6.46	1/18		4.75	4.87
3/28	7.50	7.31	7.29	2/ 1		3.96	6.21
4/11	8.28	7.08	7.19	2/15		5.25	5.37
5/ 4	5.73	8.12	6.14	3/ 1		5.46	5.75
5/18	5.00	10.21	5.83	3/17	5.33	5.46	5.91
6/ 1	1.67	11.46	6.04	3/31	6.27	4.79	5.33
6/12		13.54	5.62	4/ 7	6.00	3.79	5.50
6/24	1.04	13.54	6.25	4/14	7.50	6.25	6.04
7/15	5.78	6.07	5.38	4/21	5.12	4.46	5.83
8/ 1	6.94	12.50		4/28	4.21	5.66	5.71
8/19	7.02	7.27	5.31	5/ 5	3.46	5.50	5.08
9/23	6.16	6.77	5.52	5/12	3.08	8.37	5.21
10/ 7	7.27	6.04	7.42	5/22	3.12	6.29	5.62
10/19	6.20	7.19	6.77	5/28	2.42	5.75	5.50
11/ 9	7.42	6.75	6.10	6/ 3	5.21	6.75	5.29
11/23	5.83	5.17	5.94	6/10	3.12	5.60	5.14
12/ 7	5.64	5.00	5.25	6/17	5.50	5.90	6.06
12/20		3.75	6.21	6/24	4.29	6.60	5.48
				7/ 1	3.75	4.27	6.14
				7/ 8	3.71	3.10	5.29
				7/14	5.31	6.14	5.62
				7/21	5.21	8.44	5.62
				7/29	5.54	7.81	5.14
				8/ 5	7.08	7.50	4.33
				8/11	8.12	7.46	5.16
				8/18	7.39	6.31	4.37

Table XXIX. Fluoride concentrations (meq/l F⁻) for the influent and effluent waters of Bighorn Lake during 1968 and 1969 sampling periods.

1968				1969			
Date	Bighorn Influent	Shoshone Influent	Discharge	Date	Bighorn Influent	Shoshone Influent	Discharge
2/22	0.03	0.04	0.02	1/ 3			0.03
3/ 7	0.03	0.04	0.02	1/18		0.06	0.06
3/28	0.02	0.02	0.02	2/ 1		0.02	0.02
4/11	0.04	0.02	0.04	2/15		0.04	0.03
5/ 4	0.04	0.05	0.05	3/ 1		0.04	0.03
5/18	0.03	0.05	0.04	3/17	0.04	0.04	0.04
6/ 1	0.03	0.06	0.04	3/31	0.04	0.04	0.04
6/12	0.03	0.07	0.04	4/ 7	0.05	0.04	0.05
6/24	0.03	0.05	0.03	4/14	0.04	0.04	0.04
7/15	0.05	0.06	0.05	4/21	0.03	0.03	0.04
8/ 1	0.02	0.04	0.02	4/28	0.04	0.04	0.04
8/19	0.04	0.04	0.02	5/ 5	0.03	0.04	0.04
9/23	0.02	0.03	0.02	5/12	0.02	0.06	0.06
10/ 7	0.04	0.04	0.03	5/22	0.03	0.04	0.03
10/19	0.03	0.04	0.03	5/28	0.02	0.05	0.04
11/ 9	0.03	0.03	0.03	6/ 3	0.04	0.05	0.04
11/23	0.06	0.08	0.07	6/10	0.02	0.04	0.03
12/ 7	0.11	0.11	0.10	6/17	0.04	0.04	0.04
12/20		0.03	0.03	6/24	0.03	0.03	0.04
				7/ 1	0.03	0.03	0.04
				7/ 8	0.03	0.03	0.04
				7/14	0.03	0.04	0.04
				7/21	0.04	0.05	0.03
				7/29	0.04	0.05	0.04
				8/ 5	0.04	0.05	
				8/11	0.03	0.04	0.02
				8/18	0.04	0.04	0.03

Table XXX. Total organic carbon concentrations (mg/l C) for the influent and effluent waters of Bighorn Lake during 1968 and 1969 sampling periods.

1968				1969			
Date	Bighorn Influent	Shoshone Influent	Discharge	Date	Bighorn Influent	Shoshone Influent	Discharge
2/22				1/ 3			23.0
3/ 7				1/18		13.5	26.2
3/28				2/ 1		7.3	37.3
4/11				2/15		9.6	10.5
5/ 4				3/ 1		38.6	13.5
5/18				3/17	34.8	18.6	17.7
6/ 1				3/31	23.0	24.9	19.2
6/12				4/ 7	20.0	32.1	20.4
6/24				4/14	5.8	5.0	5.3
7/15				4/21	10.2	6.2	5.7
8/ 1				4/28	11.2	6.8	10.1
8/19	45.9	18.8	12.4	5/ 5	22.0	20.0	28.6
9/23				5/12	25.5	28.4	10.8
10/ 7	9.8	12.2	10.1	5/22	22.8	29.1	27.5
10/19	7.5	8.6	7.6	5/28	50.2	29.8	9.6
11/ 9	8.1	12.7	7.1	6/ 3	13.1	18.0	12.5
11/23	13.3	7.7	12.3	6/10	27.0	21.3	10.4
12/ 7	8.3	7.6	6.9	6/17	14.9	14.8	10.5
12/20		11.1	10.0	6/24	13.0	14.6	5.6
				7/ 1	34.1	23.4	11.9
				7/ 8	15.7	17.0	14.1
				7/14	23.6	21.4	16.5
				7/21	20.7	15.7	8.8
				7/29			
				8/ 5			
				8/11	8.3	4.9	8.3
				8/18	7.1	5.6	7.8

Table XXXI. Soluble organic carbon concentrations (mg/l C) for the influent and effluent waters of Bighorn Lake during 1968 and 1969 sampling periods.

1968				1969			
Date	Bighorn Influent	Shoshone Influent	Discharge	Date	Bighorn Influent	Shoshone Influent	Discharge
2/22				1/ 3			23.0
3/ 7				1/18		10.8	11.0
3/28				2/ 1		7.0	6.5
4/11				2/15		9.0	9.5
5/ 4				3/ 1		11.6	13.3
5/18				3/17	12.8	16.0	12.5
6/ 1				3/31	20.0	24.9	14.5
6/12				4/ 7	8.7	10.4	9.9
6/24				4/14	5.2	5.0	5.3
7/15				4/21	4.4	4.8	5.3
8/ 1				4/28	11.2	6.8	10.1
8/19	14.2	11.4	9.1	5/ 5	7.1	6.4	6.1
9/23				5/12	12.7	7.2	8.1
10/ 7	5.5	6.8	6.2	5/22	10.9	5.8	5.9
10/19	1.2	1.5	0.0	5/28	10.6	9.4	7.0
11/ 9	7.1	5.8	5.0	6/ 3	7.0	6.7	8.1
11/23	10.4	6.6	10.3	6/10	5.0	7.8	6.9
12/ 7	7.5	7.3	5.5	6/17	10.2	8.1	7.0
12/20		7.5	8.4	6/24	10.3	12.0	5.5
				7/ 1	8.9	11.4	11.9
				7/ 8	8.3	8.3	7.9
				7/14	13.9	19.0	16.5
				7/21	10.0	13.0	8.8
				7/29			
				8/ 5			
				8/11	8.3	4.9	8.3
				8/18	7.1	5.6	7.8

Table XXXII. Particulate carbon concentrations (mg/l C) for the influent and effluent waters of Bighorn Lake during 1968 and 1969 sampling periods.

1968				1969			
Date	Bighorn Influent	Shoshone Influent	Discharge	Date	Bighorn Influent	Shoshone Influent	Discharge
2/22				1/ 3			0.0
3/ 7				1/18		2.7	15.2
3/28				2/ 1		0.3	30.8
4/11				2/15		0.6	1.0
5/ 4				3/ 1		27.0	0.2
5/18				3/17	21.9	2.6	5.2
6/ 1				3/31	3.0	0.0	4.7
6/12				4/ 7	11.3	21.7	0.5
6/24				4/14	0.6	0.0	0.0
7/15				4/21	5.8	1.3	0.3
8/ 1				4/28	0.0	0.0	0.0
8/19	31.7	7.4	3.3	5/ 5	14.9	13.6	22.5
9/23				5/12	12.8	21.2	2.6
10/ 7	4.3	5.4	3.9	5/22	11.8	23.2	21.6
10/19	1.2	1.5	0.0	5/28	39.6	20.4	2.6
11/ 9	1.0	6.9	2.0	6/ 3	6.1	11.2	4.4
11/23	2.9	1.1	2.0	6/10	22.0	13.5	3.5
12/ 7	0.8	0.3	1.4	6/17	4.7	6.7	3.5
12/20		3.5	1.5	6/24	2.7	2.6	0.1
				7/ 1	25.2	12.1	0.0
				7/ 8	7.4	8.7	6.2
				7/14	9.7	2.4	0.0
				7/21	10.7	2.7	0.0
				7/29			
				8/ 5			
				8/11	0.0	0.0	0.0
				8/18	0.0	0.0	0.0

Table XXXIII. Nitrate concentrations (mg/l NO_3^- -N) for the influent and effluent waters of Bighorn Lake during 1968 and 1969 sampling periods.

1968				1969			
Date	Bighorn Influent	Shoshone Influent	Discharge	Date	Bighorn Influent	Shoshone Influent	Discharge
2/22	0.54	0.77	0.33	1/ 3			0.06
3/ 7	0.27	0.57	0.35	1/18		0.00	0.00
3/28	0.32	0.43	0.34	2/ 1		0.01	0.01
4/11	0.21	0.08	0.26	2/15		0.65	0.65
5/ 4				3/ 1		0.44	0.48
5/18	0.37	1.01	0.39	3/17	0.32	0.45	0.64
6/ 1	0.34	0.78	0.32	3/31	0.49	0.27	0.60
6/12	0.79	1.09		4/ 7	0.36	0.81	0.67
6/24	0.30	1.09		4/14	0.51	0.70	0.67
7/15	0.29	1.39	0.80	4/21	0.17	0.42	0.56
8/ 1	0.63	1.67		4/28	0.42	0.57	0.56
8/19	0.41	0.53	0.42	5/ 5	0.46	0.99	0.58
9/23	0.39	0.96	0.73	5/12	0.23	1.38	0.61
10/ 7	0.21	0.78	0.70	5/22	0.48	1.37	0.65
10/19	0.09	1.05	0.72	5/28	0.48	1.35	0.66
11/ 9	0.23	0.80	0.67	6/ 3	0.27	0.80	0.65
11/23	0.26	0.96	0.67	6/10	0.58	0.85	0.63
12/ 7	0.22	0.79	0.51	6/17	0.50	0.85	0.66
12/20		0.55	0.83	6/24	0.53	0.98	0.56
				7/ 1	0.39	0.68	0.74
				7/ 8	0.42	0.68	0.73
				7/14	0.20	0.90	0.70
				7/21	0.78	0.52	0.17
				7/29	0.29	1.53	0.70
				8/ 5	0.12	1.20	0.55
				8/11	0.32	1.13	0.67
				8/18	0.50	1.08	0.71

Table XXXIV. Nitrite concentrations (mg/l NO_2^- -N) for the influent and effluent waters of Bighorn Lake during 1968 and 1969 sampling periods.

1968				1969			
Date	Bighorn Influent	Shoshone Influent	Discharge	Date	Bighorn Influent	Shoshone Influent	Discharge
2/22	0.006	0.018	0.006	1/ 3			0.001
3/ 7	0.006	0.011	0.006	1/18		0.000	0.000
3/28	0.003	0.003	0.003	2/ 1		0.010	0.005
4/11				2/15		0.010	0.010
5/ 4				3/ 1		0.008	0.010
5/18	0.013	0.019	0.005	3/17	0.005	0.007	0.006
6/ 1	0.006	0.010	0.001	3/31	0.005	0.006	0.007
6/12	0.026	0.029		4/ 7	0.004	0.010	0.005
6/24	0.005	0.015		4/14	0.008	0.011	0.005
7/15	0.008	0.010	0.017	4/21	0.003	0.008	0.003
8/ 1	0.005	0.010		4/28	0.005	0.015	0.001
8/19	0.028	0.008	0.001	5/ 5	0.005	0.012	0.004
9/23	0.005	0.008	0.003	5/12	0.011	0.008	0.005
10/ 7	0.005	0.011	0.005	5/22	0.003	0.018	0.001
10/19	0.003	0.007	0.001	5/28	0.003	0.013	0.000
11/ 9	0.003	0.005	0.003	6/ 3	0.005	0.015	0.005
11/23	0.006	0.010	0.003	6/10	0.006	0.010	0.001
12/ 7	0.003	0.005	0.005	6/17	0.003	0.008	0.005
12/20		0.003	0.008	6/24	0.007	0.008	0.001
				7/ 1	0.010	0.011	0.015
				7/ 8	0.003	0.008	0.003
				7/14	0.002	0.010	0.006
				7/21	0.004	0.018	0.002
				7/29	0.005	0.019	0.003
				8/ 5	0.002	0.009	0.005
				8/11	0.009	0.012	0.003
				8/18	0.010	0.013	0.006

Table XXXV. Free ammonia concentrations (mg/l $\text{NH}_3\text{-N}$) for the influent and effluent waters of Bighorn Lake during 1968 and 1969 sampling periods.

1968				1969			
Date	Bighorn Influent	Shoshone Influent	Discharge	Date	Bighorn Influent	Shoshone Influent	Discharge
2/22	0.52	0.56	0.40	1/ 3			0.12
3/ 7	0.35	0.41	0.37	1/18		0.35	0.11
3/28	0.04	0.01	0.09	2/ 1		0.29	0.33
4/11				2/15		0.47	0.24
5/ 4				3/ 1		0.41	0.55
5/18	0.07	0.09	0.00	3/17	0.19	0.19	0.19
6/ 1	0.15	0.00	0.00	3/31	0.30	0.14	0.24
6/12	1.36	0.66		4/ 7	0.26	0.33	0.30
6/24	0.09	0.12		4/14	0.16	0.16	0.22
7/15	0.00	0.17	0.00	4/21	0.26	0.29	0.25
8/ 1	0.40	0.61		4/28	0.27	0.19	0.16
8/19	0.84	0.66	0.33	5/ 5	0.04	0.07	0.04
9/23	0.05	0.12	0.04	5/12	0.18	0.26	0.16
10/ 7	0.22	0.16	0.01	5/22	0.30	0.24	0.36
10/19	0.06	0.04	0.05	5/28	0.25	0.23	0.15
11/ 9	0.38	0.21	0.17	6/ 3	0.04	0.08	0.02
11/23	0.33	0.25	0.18	6/10	0.19	0.22	0.04
12/ 7	0.76	0.34	0.50	6/17	0.32	0.29	0.32
12/20		0.29	0.29	6/24	0.37	0.33	0.25
				7/ 1	0.28	0.23	0.31
				7/ 8	0.28	0.21	0.28
				7/14	0.15	0.13	0.15
				7/21	0.23	0.22	0.09
				7/29	0.71	0.71	0.31
				8/ 5	0.35	0.44	0.21
				8/11	0.23	0.20	0.11
				8/18	0.17	0.15	0.12

Table XXXVI. Total nitrogen concentrations (mg/l $\text{NH}_3\text{-N}$) for the influent and effluent waters of Bighorn Lake during 1968 and 1969 sampling periods.

1968				1969			
Date	Bighorn Influent	Shoshone Influent	Discharge	Date	Bighorn Influent	Shoshone Influent	Discharge
2/22	1.16	1.13	1.18	1/ 3			0.50
3/ 7	1.11	1.45	1.09	1/18		0.03	0.06
3/28	1.40	1.30	1.40	2/ 1		0.09	0.95
4/11	1.50	1.30	1.20	2/15		1.44	0.92
5/ 4	0.70	0.94		3/ 1		1.05	0.70
5/18	0.96	0.98	0.38	3/17	0.17	0.15	0.18
6/ 1	0.95	0.53	0.38	3/31	1.03	0.92	1.02
6/12	1.05	0.73	0.14	4/ 7	0.79	0.61	0.84
6/24	1.20	0.56	0.42	4/14	2.52	2.82	0.58
7/15	0.62	0.93	0.89	4/21	0.81	1.20	0.83
8/ 1	0.96	1.16	0.29	4/28	1.78	1.19	0.56
8/19	2.82	0.92	0.46	5/ 5	1.49	1.41	1.13
9/23	0.37	0.34	1.43	5/12	0.60	0.94	0.38
10/ 7	0.38	0.58	0.16	5/22	1.17	1.14	0.73
10/19	1.06	0.84	0.56	5/28	1.72	1.41	0.86
11/ 9	0.77	1.09	1.10	6/ 3	0.48	0.75	0.34
11/23	1.07	0.94	1.36	6/10	1.44	1.21	0.27
12/ 7	0.22	0.15	0.27	6/17	0.80	1.55	0.61
12/20		0.47	0.48	6/24	1.88	1.12	0.79
				7/ 1	1.67	0.79	0.53
				7/ 8	0.68		0.47
				7/14	0.45	0.40	0.40
				7/21	1.22	0.88	0.26
				7/29	1.57	1.06	1.31
				8/ 5	0.65	0.99	0.11
				8/11	0.33	0.26	0.28
				8/18			

Table XXXVII. Total soluble nitrogen concentrations (mg/l $\text{NH}_3\text{-N}$) for the influent and effluent waters of Bighorn Lake during 1968 and 1969 sampling periods.

1968				1969			
Date	Bighorn Influent	Shoshone Influent	Discharge	Date	Bighorn Influent	Shoshone Influent	Discharge
2/22	1.02	0.69	0.91	1/ 3			0.43
3/ 7	0.76	1.32	0.82	1/18		0.00	0.04
3/28				2/ 1		0.17	0.67
4/11				2/15		1.34	0.64
5/ 4				3/ 1		0.56	0.66
5/18				3/17	0.13	0.13	0.15
6/ 1				3/31	0.27	0.21	0.27
6/12				4/ 7	0.37	0.38	0.67
6/24				4/14	0.34	0.58	0.16
7/15				4/21	0.46	0.75	0.55
8/ 1				4/28	0.88	0.84	0.50
8/19	0.94	0.68	0.44	5/ 5	0.91	0.68	0.60
9/23	0.83	0.46	0.72	5/12	0.43	0.60	0.20
10/ 7	0.20	0.13	0.16	5/22	0.53	0.36	0.44
10/19	0.84	0.84	0.76	5/28	0.71	0.97	0.60
11/ 9	0.03	1.70	1.67	6/ 3	0.13	0.41	0.21
11/23	1.28	1.44	.18	6/10	0.10	0.32	0.03
12/ 7	0.24	0.22	0.24	6/17	0.72	0.90	0.47
12/20		0.53	0.46	6/24	0.65	0.82	0.53
				7/ 1	0.44	0.26	0.44
				7/ 8	0.40	0.36	0.37
				7/14	0.17	0.05	0.25
				7/21	0.24	0.44	0.22
				7/29	0.67	1.03	0.86
				8/ 5	0.36	0.41	0.11
				8/11	0.28	0.48	0.04
				8/18			

Table XXXVIII. Ortho-phosphate concentrations (mg/l $\text{PO}_4^{\equiv}$) for the influent and effluent waters of Bighorn Lake during 1968 and 1969 sampling periods.

1968				1969			
Date	Bighorn Influent	Shoshone Influent	Discharge	Date	Bighorn Influent	Shoshone Influent	Discharge
2/22	0.14	0.04	0.02	1/ 3			0.01
3/ 7	0.05	0.14	0.07	1/18		0.01	0.03
3/28	0.05	0.04	0.01	2/ 1		0.28	0.17
4/11	0.00	0.00	0.00	2/15		0.00	0.00
5/ 4	0.17	0.64	0.02	3/ 1		0.02	0.02
5/18	0.35	0.25	0.05	3/17	0.00	0.00	0.00
6/ 1	0.10	0.12	0.06	3/31	0.01	0.02	0.01
6/12	0.40	0.26	0.16	4/ 7	0.00	0.00	0.00
6/24	0.12	0.07	0.10	4/14	0.09	0.00	0.00
7/15	0.06	0.24	0.05	4/21	0.01	0.09	0.08
8/ 1	0.00	0.07	0.00	4/28	0.01	0.04	0.02
8/19	0.15	0.08	0.06	5/ 5	0.12	0.14	0.11
9/23	0.23	0.29	0.08	5/12	0.04	0.07	0.00
10/ 7	0.03	0.00	0.03	5/22	0.03	0.21	0.06
10/19	0.00	0.00	0.00	5/28	1.55	0.18	0.00
11/ 9	0.00	0.00	0.00	6/ 3	0.01	0.12	0.06
11/23	0.05	0.05	0.02	6/10	0.04	0.08	0.03
12/ 7	0.02	0.03	0.00	6/17	0.01	0.00	0.00
12/20		0.00	0.00	6/24	0.12	0.13	0.08
				7/ 1	0.05	0.04	0.04
				7/ 8	0.05	0.09	0.04
				7/14	0.06	0.19	0.07
				7/21	0.07	0.10	0.01
				7/29	0.00	0.14	0.09
				8/ 5	0.01	0.06	0.04
				8/11	0.05	0.11	0.02
				8/18	0.07	0.05	0.04

Table XXXIX. Total phosphate concentrations (mg/l PO_4^{3-}) for the influent and effluent waters of Bighorn Lake during 1968 and 1969 sampling periods.

1968				1969			
Date	Bighorn Influent	Shoshone Influent	Discharge	Date	Bighorn Influent	Shoshone Influent	Discharge
2/22	0.78	0.72	0.26	1/ 3			0.28
3/ 7	0.38	0.38	0.24	1/18		0.16	0.14
3/28	0.21	0.53	0.08	2/ 1		0.34	0.24
4/11	0.22	0.38	0.04	2/15		0.02	0.00
5/ 4	0.48	0.96	0.07	3/ 1		0.13	0.04
5/18	0.77	0.89	0.02	3/17	0.64	0.49	0.00
6/ 1	10.59	1.00	0.05	3/31	0.63	0.05	0.14
6/12	16.83	2.23	0.12	4/ 7	0.37	0.76	0.01
6/24	2.17	1.64	0.00	4/14	3.24	1.30	0.04
7/15	0.01	0.03	0.05	4/21	0.42	0.46	0.07
8/ 1	0.00	0.15	0.35	4/28	1.48	0.81	0.07
8/19	3.56	2.18	0.17	5/ 5	0.21	0.22	0.09
9/23	0.13	0.21	0.13	5/12	0.44	0.74	0.04
10/ 7	0.17	0.46	0.14	5/22	0.59	0.82	0.05
10/19	0.06	0.05	0.08	5/28	1.41	1.03	0.06
11/ 9	0.00	0.00	0.00	6/ 3	0.18	0.71	0.11
11/23	0.32	0.26	0.07	6/10	1.10	1.26	0.20
12/ 7	0.18	0.24	0.04	6/17	0.51	0.79	0.09
12/20		0.02	0.00	6/24	1.39	0.66	0.13
				7/ 1	1.98	1.14	0.14
				7/ 8	0.63	0.81	0.18
				7/14	0.39	0.93	0.08
				7/21	1.11	0.34	0.00
				7/29	0.21		
				8/ 5	0.24	0.77	0.05
				8/11	0.02	0.29	0.14
				8/18	0.20	0.62	0.00

Table XL. Total soluble phosphate concentrations (mg/l PO_4^{3-}) for the influent and effluent waters of Bighorn Lake during 1968 and 1969 sampling periods.

1968				1969			
Date	Bighorn Influent	Shoshone Influent	Discharge	Date	Bighorn Influent	Shoshone Influent	Discharge
2/22	0.23	0.10	0.05	1/ 3			0.15
3/ 7	0.07	0.12	0.06	1/18		0.00	0.00
3/28	0.08	0.05	0.03	2/ 1		0.40	0.20
4/11	0.00	0.00	0.00	2/15		0.00	0.02
5/ 4				3/ 1		0.05	0.03
5/18				3/17	0.00	0.00	0.00
6/ 1				3/31	0.05	0.00	0.02
6/12				4/ 7	0.00	0.00	0.00
6/24				4/14	0.02	0.00	0.00
7/15				4/21	0.03	0.12	0.05
8/ 1				4/28	0.02	0.02	0.02
8/19	0.17	0.10	0.07	5/ 5	0.13	0.16	0.09
9/23	0.36	0.41	0.13	5/12	0.07	0.06	0.00
10/ 7	0.16	0.03	0.19	5/22	0.02	0.05	0.00
10/19	0.35	1.10	0.11	5/28	1.51	0.20	0.01
11/ 9	0.03	0.09	0.01	6/ 3	0.03	0.14	0.02
11/23	0.09	0.09	0.06	6/10	0.07	0.10	0.07
12/ 7	0.06	0.05	0.00	6/17	0.00	0.00	0.00
12/20		0.00	0.00	6/24	0.09	0.01	0.04
				7/ 1	0.07	0.02	0.02
				7/ 8	0.07	0.11	0.02
				7/14	0.06	0.15	0.05
				7/21	0.03	0.12	0.02
				7/29	0.00	0.10	0.00
				8/ 5	0.01	0.08	0.02
				8/11	0.03	0.11	0.16
				8/18	0.06	0.13	0.05

Table XLI. Poly-phosphate and ortho-phosphate concentrations (mg/l PO_4^{3-}) for the influent and effluent waters of Bighorn Lake during 1968 and 1969 sampling periods.

1968				1969			
Date	Bighorn Influent	Shoshone Influent	Discharge	Date	Bighorn Influent	Shoshone Influent	Discharge
2/22				1/ 3			
3/ 7				1/18		0.12	0.08
3/28				2/ 1		0.46	0.36
4/11				2/15		0.01	0.00
5/ 4				3/ 1		0.04	0.00
5/18				3/17	0.00	0.00	0.05
6/ 1				3/31	0.08	0.00	0.05
6/12				4/ 7	0.00	0.02	0.00
6/24				4/14	0.00	0.00	0.02
7/15				4/21	0.00	0.11	0.00
8/ 1				4/28	0.05	0.06	0.14
8/19				5/ 5	0.16	0.30	0.14
9/23				5/12	0.06	0.07	0.05
10/ 7				5/22	0.46	0.31	0.16
10/19				5/28	1.23	0.20	0.01
11/ 9				6/ 3	0.18	0.22	0.18
11/23				6/10	0.00	0.00	0.00
12/ 7				6/17	0.05	0.00	0.00
12/20				6/24	0.09	0.29	0.07
				7/ 1	0.01	0.01	0.01
				7/ 8	0.13	0.21	0.11
				7/14	0.13	0.25	0.25
				7/21	0.00	0.00	0.36
				7/29	0.00	0.31	0.00
				8/ 5	0.05	0.13	0.10
				8/11	0.06	0.13	0.05
				8/18	0.09	0.13	0.04

Table XLII. Turbidities (Standard Jackson Turbidity Units) for the influent and effluent waters of Bighorn Lake during 1968 and 1969 sampling periods.

1968				1969			
Date	Bighorn Influent	Shoshone Influent	Discharge	Date	Bighorn Influent	Shoshone Influent	Discharge
2/22	1,280	660	6	1/ 3			8
3/ 7	265	153	16	1/18		24	0
3/28	175	164	12	2/ 1		32	36
4/11	80	54	4	2/15		22	8
5/ 4				3/ 1		34	20
5/18	700	444	4	3/17	261	350	6
6/ 1	2,900	376	4	3/31	125	32	12
6/12	4,900	2,220	4	4/ 7	258	2,540	12
6/24	670	1,750	4	4/14	3,600	965	10
7/15	209	200	12	4/21	180	500	6
8/ 1	265	211		4/28	1,700	355	2
8/19	1,600	610	26	5/ 5	430	269	6
9/23	512	512	20	5/12	222	335	8
10/ 7	104	153	22	5/22	174	1,140	12
10/19	65	111	30	5/28	412	240	8
11/ 9	47	62	20	6/ 3	73	164	8
11/23	68	59	16	6/10	790	335	4
12/ 7	30	44	16	6/17	188	222	8
12/20		36	12	6/24	1,710	228	4
				7/ 1	1,225	320	8
				7/ 8	300	265	4
				7/14	123	245	12
				7/21	1,680	262	12
				7/29	106	211	22
				8/ 5	71	200	0
				8/11	59	186	12
				8/18	188	164	20

Table XLIII. Silica concentrations (mg/l SiO_2) for the influent and effluent waters of Bighorn Lake during 1968 and 1969 sampling periods.

1968				1969			
Date	Bighorn Influent	Shoshone Influent	Discharge	Date	Bighorn Influent	Shoshone Influent	Discharge
2/22				1/ 3			10.9
3/ 7	10.3	15.4	14.0	1/18		13.4	10.2
3/28	10.2	12.3	11.4	2/ 1		16.0	11.0
4/11		12.3	12.0	2/15		14.1	12.3
5/ 4	7.0	7.6	9.4	3/ 1		10.6	10.9
5/18	6.3	14.0	8.1	3/17	8.9	8.3	11.1
6/ 1	12.9	11.2	8.8	3/31	11.1	10.2	11.2
6/12	9.7	13.0	9.6	4/ 7	8.7	12.3	11.8
6/24	10.1	12.5	6.7	4/14	8.8	12.7	12.3
7/15	7.5	17.2	7.8	4/21	7.2	13.3	12.8
8/ 1				4/28	6.6	12.6	12.2
8/19	11.0	14.2	8.2	5/ 5	8.4	11.2	10.0
9/23	8.7	14.6	10.5	5/12	8.4	12.7	10.9
10/ 7	8.6	13.8	10.0	5/22	7.6	14.2	10.9
10/19	8.0	12.8	9.6	5/28	6.3	12.1	9.9
11/ 9	9.0	12.8	9.2	6/ 3	7.0	13.0	10.6
11/23	10.5	18.5	11.3	6/10	8.0	13.6	9.9
12/ 7	11.4	16.4	11.4	6/17	10.2	15.8	11.0
12/20		16.8	11.8	6/24	12.1	16.3	11.0
				7/ 1	9.3	14.9	10.7
				7/ 8	8.7	13.3	9.1
				7/14	19.4	17.6	10.6
				7/21	10.6	16.3	8.8
				7/29	9.2	16.6	10.4
				8/ 5	9.5	15.0	7.2
				8/11	7.8	16.4	8.8
				8/18	6.4	17.0	6.0

Table XLIV. Total iron concentrations (mg/l Fe^{++}) for the influent and effluent waters of Bighorn Lake during 1968 and 1969 sampling periods.

1968				1969			
Date	Bighorn Influent	Shoshone Influent	Discharge	Date	Bighorn Influent	Shoshone Influent	Discharge
2/22	0.149	0.169	0.007	1/ 3			0.005
3/ 7	0.146	0.078	0.003	1/18		0.006	0.016
3/28	0.125	0.153	0.009	2/ 1		0.002	0.008
4/11	0.071	0.065	0.005	2/15		0.017	0.025
5/ 4				3/ 1		0.009	0.001
5/18	0.328	0.258	0.022	3/17	0.001	0.001	0.001
6/ 1	0.885	0.440	0.015	3/31	0.024	0.010	0.001
6/12	0.016	0.210	0.008	4/ 7	2.300	3.900	0.010
6/24	0.203	0.153	0.018	4/14			0.019
7/15	0.203	0.258	0.007	4/21	2.830	3.630	0.290
8/ 1	0.083	0.175	0.007	4/28	3.060	2.650	0.093
8/19	0.004	0.043	0.013	5/ 5	3.510	3.900	0.060
9/23	0.047	0.039	0.007	5/12	0.473	0.529	0.030
10/ 7	0.018	0.107	0.009	5/22	0.925	1.900	0.463
10/19	0.010	0.061	0.009	5/28	1.600	0.960	0.076
11/ 9	0.020	0.027	0.007	6/ 3	0.412	0.960	0.028
11/23	0.028	0.034	0.003	6/10	1.456	1.492	0.047
12/ 7	0.014	0.040	0.010	6/17	1.700	3.315	0.000
12/20		0.016	0.007	6/24	1.873	1.865	0.000
				7/ 1	4.015	3.095	0.051
				7/ 8	0.768	1.263	0.002
				7/14	0.363	1.100	0.000
				7/21	0.960	0.960	0.032
				7/29	0.273	1.169	0.120
				8/ 5	0.273	0.956	0.013
				8/11	0.123	0.704	0.001
				8/18	0.158	0.360	0.003

Table XLV. Manganese concentrations (mg/l Mn^{++}) for the influent and effluent waters of Bighorn Lake during 1968 and 1969 sampling periods.

1968				1969			
Date	Bighorn Influent	Shoshone Influent	Discharge	Date	Bighorn Influent	Shoshone Influent	Discharge
2/22	0.006	0.022	0.008	1/ 3			0.001
3/ 7	0.011	0.021	0.007	1/18		0.004	0.005
3/28	0.007	0.014	0.006	2/ 1		0.007	0.000
4/11	0.004	0.010	0.000	2/15		0.004	0.002
5/ 4				3/ 1		0.006	0.000
5/18	0.025	0.016	0.007	3/17	0.014	0.015	0.001
6/ 1	0.015	0.018	0.009	3/31	0.005	0.003	0.001
6/12	0.075	0.050	0.007	4/ 7	0.000	0.001	0.001
6/24	0.018	0.031	0.001	4/14	2.145	0.500	0.045
7/15	0.012	0.021	0.004	4/21	0.158	0.388	0.049
8/ 1	0.015	0.016	0.000	4/28	0.396	0.221	0.040
8/19	0.119	0.077	0.003	5/ 5	0.261	0.189	0.300
9/23	0.009	0.013	0.002	5/12	0.073	0.349	0.075
10/ 7	0.009	0.013	0.007	5/22	0.300	0.560	0.097
10/19	0.005	0.010	0.003	5/28	0.217	0.165	0.027
11/ 9	0.007	0.011	0.000	6/ 3	0.113	0.122	0.011
11/23	0.014	0.007	0.000	6/10	0.283	0.475	0.013
12/ 7	0.004	0.001	0.007	6/17	0.110	0.164	0.000
12/20		0.003	0.003	6/24	0.430	0.164	0.000
				7/ 1	0.374	0.250	0.055
				7/ 8	0.207	0.180	0.054
				7/14	0.090	0.195	0.019
				7/21	0.299	0.147	0.005
				7/29	0.082	0.093	0.005
				8/ 5	0.120	0.149	0.000
				8/11	0.076	0.190	0.001
				8/18	0.079	0.186	0.001

Table XLVI. Copper concentrations (mg/l Cu^{++}) for the influent and effluent waters of Bighorn Lake during 1968 and 1969 sampling periods.

1968				1969			
Date	Bighorn Influent	Shoshone Influent	Discharge	Date	Bighorn Influent	Shoshone Influent	Discharge
2/22	0.0015	0.0012	0.0010	1/ 3			0.0009
3/ 7	0.0015	0.0008	0.0008	1/18		0.0011	0.0011
3/28	0.0017	0.0013		2/ 1		0.0012	0.0011
4/11	0.0008	0.0009	0.0008	2/15		0.0014	0.0060
5/ 4				3/ 1		0.0018	0.0012
5/18	0.0019	0.0012	0.0010	3/17	0.0220	0.0210	0.0016
6/ 1	0.0022	0.0017	0.0011	3/31	0.0136	0.0052	0.0000
6/12	0.0018	0.0015	0.0016	4/ 7	0.0040	0.0040	0.0060
6/24	0.0038	0.0028	0.0011	4/14	0.0010	0.0012	0.0006
7/15	0.0030	0.0026	0.0015	4/21	0.0008	0.0008	0.0009
8/ 1	0.0016	0.0020		4/28	0.0010	0.0012	0.0009
8/19	0.0008	0.0015	0.0009	5/ 5	0.0017	0.0011	0.0004
9/23	0.0012	0.0013	0.0017	5/12	0.0012	0.0019	0.0010
10/ 7	0.0013	0.0016	0.0012	5/22	0.0011	0.0022	0.0013
10/19	0.0012	0.0012	0.0012	5/28	0.0005	0.0006	0.0011
11/ 9	0.0007	0.0011	0.0008	6/ 3	0.0005	0.0005	0.0004
11/23	0.0008	0.0008	0.0008	6/10	0.0014	0.0014	0.0008
12/ 7	0.0008	0.0014	0.0010	6/17	0.0015	0.0018	0.0012
12/20		0.0010	0.0009	6/24	0.0022	0.0010	0.0010
				7/ 1	0.0013	0.0007	0.0007
				7/ 8	0.0011	0.0010	0.0010
				7/14	0.0016	0.0021	0.0009
				7/21	0.0024	0.0027	0.0007
				7/29	0.0019	0.0025	0.0019
				8/ 5	0.0026	0.0039	0.0020
				8/11	0.0020	0.0032	0.0009
				8/18	0.0033	0.0028	0.0007

Table XLVII. Zinc concentrations (mg/l Zn^{++}) for the influent and effluent waters of Bighorn Lake during 1968 and 1969 sampling periods.

1968				1969			
Date	Bighorn Influent	Shoshone Influent	Discharge	Date	Bighorn Influent	Shoshone Influent	Discharge
2/22				1/ 3			.029
3/ 7				1/18		.004	.012
3/28	.058	.118		2/ 1		.016	.004
4/11	.063	.034	.050	2/15		.015	.030
5/ 4				3/ 1		.037	.018
5/18	.052	.063	.042	3/17	.030	.026	.024
6/ 1	.232	.173	.023	3/31	.007	.004	.007
6/12	.182	.164	.011	4/ 7	.025	.132	.042
6/24	.122	.056	.020	4/14	.178	.054	.017
7/15	.126	.142	.110	4/21	.029	.037	.030
8/ 1	.130	.128	.070	4/28	.072	.046	.033
8/19	.130	.104	.022	5/ 5	.047	.008	.000
9/23	.027	.029	.025	5/12	.010	.020	.018
10/ 7	.020	.026	.018	5/22	.027	.028	.033
10/19	.022	.018	.022	5/28	.024	.015	.052
11/ 9	.023	.023	.018	6/ 3	.000	.012	.001
11/23	.023	.010	.006	6/10	.018	.020	.019
12/ 7	.007	.018	.006	6/17	.069	.169	.019
12/20		.010	.008	6/24	.080	.043	.025
				7/ 1	.050	.042	.058
				7/ 8			
				7/14	.018		.007
				7/21	.153	.054	.028
				7/29	.043	.008	.058
				8/ 5	.037	.038	.007
				8/11	.054	.050	.008
				8/18	.046	.031	.004

Table XLVIII. Field pH measurements for the influent and effluent waters of Bighorn Lake during 1968 and 1969 sampling periods.

1968				1969			
Date	Bighorn Influent	Shoshone Influent	Discharge	Date	Bighorn Influent	Shoshone Influent	Discharge
2/22	7.98	8.25	7.72	1/ 3			8.13
3/ 7	8.25	8.32	7.81	1/18		8.11	8.08
3/28	8.42	8.46	8.10	2/ 1		7.66	7.78
4/11	8.39	8.45	7.55	2/15		8.11	7.99
5/ 4	8.55	8.32		3/ 1		7.74	7.44
5/18				3/17	7.33	7.36	7.05
6/ 1	7.49	8.00		3/31	8.10	8.32	6.81
6/12	7.98	8.00		4/ 7	7.82	8.25	8.02
6/24	8.08	8.20		4/14	7.99	8.21	8.03
7/15	8.08	7.88	6.98	4/21	8.60	8.55	8.10
8/ 1	8.13	8.37		4/28	8.30	8.56	8.04
8/19				5/ 5	8.21	8.39	7.72
9/23				5/12	8.17	8.50	8.20
10/ 7				5/22	8.23	8.50	8.31
10/19	8.49	8.22	8.10	5/28	7.34	7.35	7.98
11/ 9	8.41	7.78	7.94	6/ 3	8.36	8.47	7.88
11/23				6/10	8.20	8.40	7.71
12/ 7	8.38	8.21	8.02	6/17	8.32	8.17	8.02
12/20		8.19	7.85	6/24	8.08	8.16	7.89
				7/ 1	8.02	8.33	7.82
				7/ 8	7.70		
				7/14	8.50	8.23	8.02
				7/21	8.28	8.20	8.01
				7/29	8.63	8.42	8.16
				8/ 5	8.50	8.40	
				8/11	8.51	8.38	8.10
				8/18			

Table XLIX. Laboratory pH measurements for the influent and effluent waters of Bighorn Lake during 1968 and 1969 sampling periods.

1968				1969			
Date	Bighorn Influent	Shoshone Influent	Discharge	Date	Bighorn Influent	Shoshone Influent	Discharge
2/22	7.95	8.17	7.80	1/ 3			8.40
3/ 7	7.83	7.85	7.77	1/18		8.20	8.40
3/28	8.21	7.80	8.00	2/ 1		8.30	8.40
4/11	8.20	8.10	8.05	2/15		7.71	8.11
5/ 4	8.30	8.26	7.10	3/ 1		7.74	7.44
5/18	7.90	7.80	8.00	3/17	8.35	8.40	8.30
6/ 1	8.30	8.20	7.90	3/31	8.00	8.50	8.25
6/12	8.00	8.36	8.21	4/ 7	8.50	8.21	8.40
6/24	7.68	8.02	7.10	4/14	8.35	8.40	8.20
7/15	8.10	8.00	7.58	4/21	8.49	8.45	8.10
8/ 1			7.70	4/28	8.39	8.35	8.14
8/19	8.49	8.37	8.09	5/ 5	8.40	8.45	8.10
9/23				5/12	8.30	8.41	8.25
10/ 7	8.25	8.10	8.00	5/22	8.24	8.41	8.15
10/19	8.35	8.38	8.20	5/28	8.14	8.35	8.15
11/ 9	8.30	8.29	8.25	6/ 3	8.52	8.35	8.15
11/23	8.30	8.33	8.27	6/10	8.29	8.33	8.30
12/ 7	8.30	8.40	8.09	6/17	8.50	8.41	8.34
12/20		8.40	8.25	6/24	8.20	8.24	8.20
				7/ 1	8.37	8.35	8.25
				7/ 8	8.31	8.32	8.20
				7/14	8.44	8.38	8.19
				7/21	8.03	8.32	8.24
				7/29	8.32	8.34	8.11
				8/ 5	8.39	8.48	8.36
				8/11	8.43	8.42	8.30
				8/18	8.49	8.37	8.26

Appendix B

Reservoir Data

Table L. Reservoir stage (meters above mean sea level) and storage ($\times 10^6 \text{ m}^3$) for Bighorn Lake during the indicated sampling period.

1968			1969			1970		
Date	Stage (m)	Storage ($\times 10^6 \text{ m}^3$)	Date	Stage (m)	Storage ($\times 10^6 \text{ m}^3$)	Date	Stage (m)	Storage ($\times 10^6 \text{ m}^3$)
5/ 5	1,095.5	903.0	4/15	1,095.5	903.0	6/11	1,107.7	1,289.4
5/13	1,095.3	903.0	4/21	1,096.6	931.7	6/18	1,108.6	1,328.4
5/20	1,094.0	867.1	4/28	1,098.2	974.1	6/24	1,109.5	1,375.1
5/27	1,093.1	846.4	5/ 5	1,099.2	1,000.0	7/ 2	1,110.6	1,431.8
6/ 7	1,093.4	853.2	5/12	1,100.0	1,024.0	7/ 8	1,109.3	1,361.6
6/12	1,093.6	860.1	5/21	1,101.5	1,063.0	7/16	1,108.7	1,332.7
6/20	1,093.9	867.1	5/27	1,102.3	1,092.9	7/23	1,108.5	1,322.5
6/27	1,095.1	895.7	6/ 3	1,103.3	1,123.1	7/29	1,108.3	1,313.1
7/ 2	1,095.6	903.0	6/13	1,104.6	1,167.6	8/ 4	1,108.0	1,301.8
7/ 8	1,096.4	925.5	6/18	1,105.3	1,190.2	8/10	1,107.7	1,289.4
7/14	1,097.2	948.9	6/23	1,104.8	1,175.4	8/18	1,107.4	1,275.3
7/23	1,096.5	926.5	6/30	1,107.7	1,289.4	8/24	1,107.3	1,268.8
7/29	1,096.4	925.5	7/22	1,107.6	1,281.8	9/ 1	1,107.1	1,262.7
8/ 5	1,096.5	926.5	7/28	1,107.2	1,267.0	9/ 8	1,107.1	1,262.7
8/12	1,097.0	941.0	8/ 4	1,106.6	1,243.4			
8/19	1,098.3	976.6	8/11	1,105.9	1,212.3			
8/26	1,100.2	1,027.6						
9/ 3	1,101.0	1,048.4						
9/ 9	1,101.4	1,183.2						
9/17	1,101.4	1,183.2						
9/23	1,101.0	1,048.4						
10/12	1,100.7	1,039.9						
10/ 8	1,100.5	1,037.2						
10/14	1,100.8	1,043.4						
10/21	1,101.0	1,048.4						
11/ 2	1,101.1	1,052.4						

Table LI. Turbidity profiles (Standard Jackson Turbidity Units) of Bighorn Lake at all stations for all cruises.

Depth (m)	Station 0					
	Cruise 1	Cruise 5	Cruise 10	Cruise 14	Cruise 18	Cruise 22
S	4		8	12	12	10
10	8	12	4	8	8	10
20	8	20	8	8	12	10
30	8	12	4	8	16	14
40	8	8	8	12	16	16
50	8	12	16	16	20	22
60	8	8	12	8	16	18
70	12	8	4	4	8	12
80	8	8	4	8	12	10
90	8	22	4	8	12	10
100	8	16	8	8	16	12
110	12	20	8	8	20	14
120	22	12	8	8	22	12
Depth (m)	Cruise 26	Cruise 27	Cruise 31	Cruise 36	Cruise 40	
S	12	8	12	4	8	
10	12	8	12	4	8	
20	10	6	8	4	4	
30	12	6	8	8	6	
40	8	6	4	8	8	
50	12	8	8	8	8	
60	12	10	8	8	8	
70	8	10	6	8	8	
80	6	12	6	8	4	
90	4	12	8	8	8	
100	8	12	8	8	8	
110	12	12	4	12	4	
120	12	12	10	12	8	

Table LI. (Cont'd)

Station 1						
Depth (m)	Cruise 1	Cruise 5	Cruise 11	Cruise 14	Cruise 18	Cruise 22
S	12	26	16	16	12	10
10	16	26	20	16	10	10
20	16	30	16	12	16	8
30	20	20	16	12	20	10
40	8	16	22	22	22	20
50	8	22	20	20	30	30
60	12	30	12	12	16	44
70		39	20	8	20	12
80				12	18	20
90						

	Cruise 26	Cruise 27	Cruise 31	Cruise 36	Cruise 40
S	8	6	8	8	8
10	8	8	8	8	12
20	8	10	12	4	8
30	10	6	4	4	8
40	12	8	4	4	10
50	16	10	10	6	8
60	22	12		8	8
70	14	10			8
80	16	10			8
90					

Table LI. (Cont'd)

Station 2						
Depth (m)	Cruise 1	Cruise 5	Cruise 10	Cruise 14	Cruise 18	Cruise 22
S	16	32	20	12	21	18
10	20	30	20	8	20	12
20	8	51	20	20	16	10
30	8	32	36	16	20	12
40	16	32	16	20	22	32
50	12	65	36	8	64	43
60		39			56	68
70						

	Cruise 26	Cruise 27	Cruise 31	Cruise 36	Cruise 40
S	6	10	6	16	12
10	8	12	14	16	14
20	4	10	6	12	10
30	6	12	10	8	6
40	22	12	4	8	8
50	31	10	4	8	8
60	41	12	12	4	8
70					

Table LI. (Cont'd)

Station 3						
Depth (m)	Cruise 1	Cruise 5	Cruise 10	Cruise 14	Cruise 18	Cruise 22
S	44	71	26	16	32	12
10	22	114	20	20	12	18
20	26	193	20	30	16	14
30	30	217	61	36	42	47
40	30		114	144	54	125
Cruise 26 Cruise 27 Cruise 31 Cruise 36 Cruise 40						
S	8	16	34	16	16	
10	12	26	28	20	16	
20	8	20	21	26	12	
30	30	16		8	16	
40	4	20	14	6	20	
Station 4						
	Cruise 1	Cruise 5	Cruise 10	Cruise 14	Cruise 18	Cruise 22
S	61	273	44	22	36	18
10	65	350	61	22	47	16
20	39		47	49	56	39
30	92					
Cruise 26 Cruise 27 Cruise 31 Cruise 36 Cruise 40						
S	12	64	16	20	22	
10	12	64	44	22	24	
20	36	83	60	36	20	
30						

Table LI. (Cont'd)

Station 5						
Depth (m)	Cruise 1	Cruise 5	Cruise 10	Cruise 14	Cruise 18	Cruise 22
S	240	3,350	97	73	59	48
10						
Cruise 26 Cruise 27 Cruise 31 Cruise 36 Cruise 40						
S	44	875	39	36	39	
10					64	

Table LII. Transmission profiles (% T/10 cm) of Bighorn Lake at all stations for all cruises.

Station 0						
Depth (m)	Cruise 19	Cruise 20	Cruise 23	Cruise 24	Cruise 26	Cruise 27
8	90	94	98	97	97	89
5	91	94	99	95	98	89
10	91	94	100	95	98	89
15	91	95	100	95	98	88
20	91	94	99	95	98	88
25	89	94	98	95	98	87
30	88	93	97	91	98	89
35	89	93	96	92	81	88
40	88	91	93	90	93	88
45	86	89	90	89	96	88
50	84	87	88	88	93	85
55	82	81	88	88	92	84
60	85	79	92	89	92	83
65	87	88	96	91	96	83
70	89	91	97	91	99	83
75	88	91	97	92	99	81
80	88	91	97	92	100	84
85	88	91	96	91	100	84
90	87	90	97	90	100	83
95	85	89	96	90	100	82
100	84	86	96	89	98	83
105	81	87	95	89	98	83
110	80	86	95	88		82
115	78	85				81
120	76					81

Table LII. (Cont'd)

Station 0 (Cont'd)						
Depth (m)	Cruise 30	Cruise 31	Cruise 32	Cruise 33	Cruise 34	Cruise 35
S	90	89	85	94	96	94
5	90	89	91	93	96	95
10	90	88	89	93	97	95
15	91	88	92	93	96	96
20	91	89	90	93	96	95
25	92	91	93	94	95	95
30	92	92	94	93	95	95
35	92	93	94	91	95	95
40	92	92	94	91	95	95
45	92	92	94	92	94	95
50	91	91	94	92	94	95
55	92	91	94	92	93	95
60	92	91	93	91	93	94
65	91	91	93	91	93	94
70	91	91	93	91	93	94
75	91	91	93	91	93	93
80	91	90	92	90	92	93
85	90	90	91	90	92	93
90	90	90	91	90	92	92
95	89	90	91	89	91	91
100	90	90	90	88	91	91
105	89	90	78	89	91	91
110	89	89	74	89	90	91
115	90	90		89	90	90
120	90	89				

Table LII. (Cont'd)

Station 0 (Cont'd)						
Depth (m)	Cruise 36	Cruise 37	Cruise 38	Cruise 39	Cruise 40	Cruise 41
5	96	95	96	94	91	89
5	95	95	95	93	90	88
10	95	95	95	93	90	90
15	95	96	95	95	94	92
20	94	95	91	95	95	94
25	94	95	94	94	96	94
30	94	94	95	93	95	95
35	94	94	94	91	94	95
40	94	94	95	90	94	94
45	94	94	95	90	92	93
50	94	94	95	92	92	92
55	94	94	94	93	93	92
50	94	94	94	91	92	92
65	94	94	94	90	91	91
70	93	94	94	90	91	91
75	93	93	94	91	91	91
80	93	93	93	92	93	93
85	92	93	93	93	94	93
90	91	92	93	94	94	93
95	91	91	93	94	94	93
100	91	91	92	93	94	92
105	90	91	92	93	93	91
110	90	91	91	93	92	91
115	90	89	91	91	92	90
120	90	88			92	

Table LII. (Cont'd)

Station 0 (Cont'd)						
Depth (m)	Cruise 42	Cruise 44	Cruise 45	Cruise 46	Cruise 47	Cruise 48
5	91	90	95	96	94	92
5	90	90	94	96	93	90
10	90	90	94	95	93	92
15	90	91	94	94	93	92
20	93	91	94	94	91	91
25	94	91	94	95	92	91
30	94	91	94	95	94	92
35	94	90	94	95	93	95
40	95	90	93	94	94	95
45	94	90	93	94	94	95
50	94	90	93	94	94	95
55	93	90	92	93	93	95
60	93	90	92	93	90	94
65	92	90	92	92	88	89
70	92	90	91	92	89	87
75	91	90	91	91	90	86
80	92	90	91	91	90	87
85	93	90	91	91	90	89
90	93	90	91	91	90	90
95	93	89	91	90	90	90
100	94	88	90	90	90	90
105	92	85	88	90	90	90
110	91		87	90	90	90
115	91			89		90
120						

Table LII. (Cont'd)

Station 0 (Cont'd)						
Depth (m)	Cruise 49	Cruise 50	Cruise 51	Cruise 52	Cruise 53	Cruise 54
8	91	90	90	90	91	93
5	90	90	89	90	91	93
10	92	90	92	92	91	93
15	92	92	93	93	93	93
20	91	92	93	93	94	94
25	91	92	93	93	94	94
30	92	91	93	93	94	94
35	92	92	93	93	94	93
40	93	92	93	93	94	93
45	94	93	94	93	94	93
50	94	94	93	93	93	92
55	94	93	92	91	91	90
60	94	94	92	90	91	90
65	92	93	94	92	93	92
70	90	91	93	93	93	93
75	89	90	93	92	93	93
80	87	90	91	91	93	93
85	87	90	91	92	93	93
90	84	90	91	92	93	93
95	90	91	92	92	93	93
100	90	91	92	92	93	92
105	91	91	92	92	93	92
110	91	91	92	90	93	92
115	90	90	91	91	93	91
120						

Table LII. (Cont'd)

Depth (m)	Station 0 (Cont'd)	
	Cruise 55	Cruise 56
S	94	94
5	95	95
10	95	95
15	95	95
20	96	95
25	96	96
30	96	96
35	96	96
40	95	96
45	95	96
50	94	95
55	90	91
60	90	88
65	94	92
70	94	95
75	94	95
80	94	95
85	94	95
90	94	95
95	94	94
100	94	95
105	92	94
110	93	94
115	93	94
120		

Table LII. (Cont'd)

Depth (m)	Station 1					
	Cruise 19	Cruise 20	Cruise 21	Cruise 23	Cruise 24	Cruise 27
8	92.	93	92	96	97	87
5	92.	93	92	98	97	87
10	92.	92	92	98	97	87
15	91.	92	92	98	97	87
20	92	92	92	98	97	88
25	91.	92	92	98	96	87
30	88.	91	92	98	96	87
35	87	91	92	97	95	87
40	85.	88	88	92	88	86
45	82.	80	82	83	81	86
50	73.	91	73.	76	75	86
55		83	68	74	68	85
60	76.	63	63	70	60	85
65	84	76		90	85	84
70	84.	84			88	84
75	83.	84			89	84
80	82.	84			90	84
85		84			90	84
90		81				

Table LII. (Cont'd)

Station 1 (Cont'd)						
Depth (m)	Cruise 30	Cruise 31	Cruise 32	Cruise 33	Cruise 34	Cruise 35
5	81	79	82	81	87	94
5	85	79	83	76	88	94
10	87	84	86	80	90	94
15	90	87	87	91	93	95
20	91	90	93	91	94	95
25	91	91	95	92	94	95
30	91	91	95	94	94	95
35	91	91	95	94	94	95
40	90	90	95	93	94	94
45	90	90	92	93	93	93
50	90	90	92	93	92	91
55	90	90	93	92	91	91
60	90	89	93	91	91	90
65		89	93	91	91	90
70			91	90	90	
75				87		

Table LII. (Cont'd)

Station 1 (Cont'd)						
Depth (m)	Cruise 36	Cruise 37	Cruise 38	Cruise 39	Cruise 40	Cruise 41
S	94	94	89	90	91	90
5	93	94	87	91	93	90
10	93	94	90	91	94	91
15	93	93	90	92	94	93
20	94	93	78	92	93	94
25	94	93	76	92	94	94
30	93	93	90	91	94	94
35	94	94	91	91	92	93
40	94	94	91	91	91	93
45	93	93	91	90	92	93
50	92	91	90	91	91	91
55	90	90	88	91	91	89
60	90	90	86	91	90	87
65	91	91	85	90	90	86
70		90	83		90	
75		88			90	
80		88			90	
85		88			89	
90		86			88	

Table LII. (Cont'd)

Station 1 (Cont'd)						
Depth (m)	Cruise 42	Cruise 44	Cruise 45	Cruise 46	Cruise 47	Cruise 48
8	89	90	87	90	89	88
5	89	90	87	87	84	87
10	90	90	90	84	87	86
15	90	89	90	85	89	81
20	93	88	90	86	80	82
25	94	91	90	90	90	88
30	94	91	92	91	92	89
35	94	91	92	91	92	91
40	92	91	92	92	92	93
45	91	91	92	93	90	94
50	90	91	91	86	89	94
55	90	90	90	83	90	93
60	90	90	90	79	85	92
65	90	90	90	76	84	91
70	90	90	90	76	85	90
75	91	89	87	74	87	90
80	90		86	73	81	89
85	89		84	71	79	85
90	87		82	71	76	83

Table LII. (Cont'd)

Station 1 (Cont'd)						
Depth (m)	Cruise 49	Cruise 50	Cruise 51	Cruise 52	Cruise 53	Cruise 54
8	89	86	88	90	90	91
5	89	85	89	90	90	91
10	90	87	89	90	90	91
15	90	88	85	90	92	92
20	90	90	89	89	92	91
25	90	90	88	90	92	90
30	90	90	89	89	90	90
35	90	91	88	89	90	88
40	92	91	87	86	88	86
45	93	92	86	84	79	84
50	93	91	84	86	81	70
55	93	91	81	83	79	68
60	93	92	85	84	84	73
65	92	91	90	89	88	86
70	90	90	89	90	90	89
75	90	90	90	90	90	90
80	89	89	90	90	90	89
85	87	88	90	90	89	
90	87	88	89	89	88	
95			88	87	87	

Table LII. (Cont'd)

Station 1 (Cont'd)		
Depth (m)	Cruise 55	Cruise 56
S	92	94
5	91	94
10	92	94
15	92	94
20	92	94
25	91	93
30	90	91
35	90	90
40	89	90
45	88	88
50	81	82
55	59	63
60	59	
65	76	84
70	88	90
75	90	90
80	89	90
85	87	90
90	84	87

Table LII. (Cont'd)

Station 2						
Depth (m)	Cruise 19	Cruise 20	Cruise 21	Cruise 23	Cruise 24	Cruise 25
S	82	92	97	93	97	96
5	91	94	97	93	97	97
10	91	94	97	94	97	97
15	92	94	98	94	97	97
20	92	94	99	96	97	96
25	77	92	98	96	97	96
30	73	88	98	97	69	96
35	58	84	78	98	59	89
40	75	74	68	62	54	70
45	69	70	67	54	47	63
50	66	73	57	52		58
55	43	50	28	44		55
60		41	64	34		53
	Cruise 26	Cruise 27	Cruise 28	Cruise 30	Cruise 31	Cruise 32
S	97	85	76	79	71	74
5	98	84	79	80	73	76
10	98	84	81	79	76	79
15	98	84	84	76	79	83
20	98	84	85	84	89	89
25	98	84	84	91	91	91
30	98	84	84	91	91	93
35	88	83	83	91	91	93
40	74	83	83	91	91	92
45	70	83	82	91	90	91
50	70	83	82	91	90	90
55	71	82	81	91	90	90
60	68		78		87	87
65						

Table LII. (Cont'd)

Station 2 (Cont'd)						
Depth (m)	Cruise 33	Cruise 34	Cruise 35	Cruise 36	Cruise 37	Cruise 38
8	70	79	88	87	91	88
5	74	78	87	90	91	88
10	84	83	87	91	92	89
15	87	84	89	92	90	89
20	88	91	91	92	87	90
25	90	92	94	94	90	91
30	91	93	94	94	93	91
35	91	93	94	94	94	92
40	91	93	93	94	94	66
45	91	91	92	93	93	63
50	90	90	91	92	92	58
55	90	90	91	92	92	56
60		90	90	91	91	48
65			90	90	90	46
	Cruise 39	Cruise 40	Cruise 41	Cruise 42	Cruise 44	Cruise 45
8	88	89	91	86	83	87
5	89	88	91	92	83	86
10	90	88	92	93	84	86
15	91	90	92	91	83	78
20	92	91	94	93	89	77
25	92	91	95	94	92	89
30	91	91	95	94	93	92
35	91	91	95	93	93	92
40	91	91	92	90	93	92
45	91	91	92	88	92	92
50	90	90	91	87	92	91
55	89	90	90	87	91	91
60	88	89		86	91	91
65	88	89			91	91
70						91

Table LII. (Cont'd)

Station 2 (Cont'd)						
Depth (m)	Cruise 46	Cruise 47	Cruise 48	Cruise 49	Cruise 50	Cruise 51
S	84	92	74	81	88	87
5	84	93	74	87	91	86
10	84	87	87	84	91	90
15	84	86	63	84	92	90
20	84	84	68	82	92	87
25	86	90	68	81	87	84
30	84	89	85	88	89	83
35	87	89	87	93	92	86
40	92	90	89	94	95	84
45	92	92	90	94	96	80
50	92	91	90	93	95	79
55	90	90	90	92	93	76
60	90	88	88	91	94	76
65	90	89	88	90	91	76
70	90	89	86	87	88	76
Cruise 52 Cruise 53 Cruise 54 Cruise 55 Cruise 56						
S	90	90	94	58	91	
5	90	90	94	70	92	
10	90	91	94	76	93	
15	90	90	91	78	93	
20	90	89	90	85	93	
25	87	88	90	88	90	
30	85	87	90	85	90	
35	85	85	89	82	87	
40	82	84	84	83	84	
45	74	79	73	80	81	
50	76	66	59	76	71	
55	76	59		74	59	
60	76	71	73	79		
65	79	79	81	89	68	
70	79				74	

Table LII. (Cont'd)

Station 3						
Depth (m)	Cruise 19	Cruise 20	Cruise 23	Cruise 24	Cruise 25	Cruise 26
S	74	91	95	96	97	96
5	87	91	98	96	99	96
10	91	92	99	96	99	96
15	91	91	100	96	98	96
20	81	92	100	94	98	96
25	65	92	98	94	96	96
30	54	78	59	58	66	72
35	57	94	53	53	64	61
40	46	82	50		55	60
45		67				
	Cruise 27	Cruise 28	Cruise 29	Cruise 30	Cruise 31	Cruise 32
S	68	85	59	74	59	74
5	68	85	73	79	63	79
10	63	77	87	81	63	82
15	63	79	96	81	76	85
20	76	90	100	82	84	87
25	79	92	100	84	85	90
30	80	93	100	87	85	89
35	79	90	100	86	84	89
40	79	85	100	86	82	88
	Cruise 33	Cruise 34	Cruise 35	Cruise 36	Cruise 37	Cruise 38
S	63	71	76	88	88	70
5	70	74	79	89	88	72
10	78	79	78	87	90	68
15	76	84	79	78	86	63
20	84	89	84	73	84	63
25	87	91	87	84	85	60
30	84	90	91	90	91	78
35	78	87	89	90	90	81
40	80	86		90	90	67
45	84	85		90		

Table LII. (Cont'd)

Station 3 (Cont'd)						
Depth (m)	Cruise 40	Cruise 41	Cruise 42	Cruise 44	Cruise 45	Cruise 46
S	80	88	87	86	86	68
5	83	89	89	88	84	71
10	89	87	90	76	73	72
15	94	85	87	87	69	72
20	99	90	86	76	59	74
25	99	92	90	85	59	86
30	100	93	90	90	86	91
35	97	90	76	91	90	98
40	94	78	68	91	90	100
45		73		90	89	100
50				90	88	99
	Cruise 47	Cruise 48	Cruise 49	Cruise 50	Cruise 51	Cruise 52
S	86	81	88	92	89	81
5	78	86	88	93	89	84
10	72	87	81	93	90	87
15	69	79	77	92	87	84
20	64	78	73	92	84	76
25	62	75	75	91	78	73
30	91	73	79	90	85	79
35	91	70	90	86	58	68
40	91	78	88	75	80	42
45	92	68	80	75	75	
50	93	83	71	69		

Table LII. (Cont'd)

Station 3 (Cont'd)				
Depth (m)	Cruise 53	Cruise 54	Cruise 55	Cruise 56
8	68	91	73	83
5	82	91	84	84
10	84	93	88	86
15	81	86	88	87
20	79	78	92	88
25	79	80	90	86
30	80	75	85	77
35	63	79	81	52
40	63	55	61	69
45	59	51	41	58
50	27	21	27	40

Station 4						
	Cruise 19	Cruise 20	Cruise 21	Cruise 22	Cruise 23	Cruise 24
8	82	81	79	100	96	97
5	87	81	80	100	100	97
10	82	79	79	100	100	97
15	68	80	64	98	95	86
20	84	79	60	79	78	67
25	82	78	45	70	66	62
	Cruise 25	Cruise 27	Cruise 28	Cruise 29	Cruise 30	Cruise 31
8	98	26	60	35	66	59
5	98	23	60	35	67	57
10	98	23	55	34	65	50
15	80	23	51	35	59	35
20	72	12	32	29	43	83
25	70					73

Table LII. (Cont'd)

Station 4 (Cont'd)						
Depth (m)	Cruise 32	Cruise 33	Cruise 34	Cruise 35	Cruise 36	Cruise 37
S	68	63	79	32	98	81
5	68	68	83	54	99	82
10	70	68	81	56	99	80
15	73	70	88	58	98	78
20	74	68	91	59	97	74
25	75	63	85	53	97	76
30					98	
	Cruise 38	Cruise 40	Cruise 41	Cruise 42	Cruise 44	Cruise 45
S	68	67	65	77	100	94
5	72	67	82	84	100	94
10	66	67	73	84	84	89
15	63	70	70	83	76	86
20	55	89	82	75	69	65
25	49	88	82	71	62	87
30	42	88		62	96	99
35					91	
	Cruise 46	Cruise 48	Cruise 49	Cruise 50	Cruise 51	Cruise 52
S	75	73	79	84	99	94
5	73	76	86	94	100	95
10	73	73	77	86	93	92
15	73	63	60	76	72	86
20	73	57	51	82	59	74
25	81	59	68	85	53	70
30	88	58	67	85	51	71
35	89	19		27		12

Table LII. (Cont'd)

Station 4 (Cont'd)				
Depth (m)	Cruise 53	Cruise 54	Cruise 55	Cruise 56
S	78	88	94	53
5	77	89	95	54
10	77	89	95	55
15	77	75	91	56
20	74	81	76	54
25	47	60	58	53
30	39	34	43	37

Station 5						
	Cruise 19	Cruise 21	Cruise 22	Cruise 23	Cruise 25	Cruise 27
S	62	59	100	66	32	3
5	62	53	61	68	32	
10		54	48			

	Cruise 28	Cruise 29	Cruise 30	Cruise 31	Cruise 32	Cruise 33
S	20	30	54	39	40	50
5		21	43	55	42	49
10			34			

	Cruise 34	Cruise 35	Cruise 36	Cruise 37	Cruise 38	Cruise 39
S	72	29	80	42	66	25
5	77	35	75	54	63	22
10					51	21

Table LII. (Cont'd)

Station 5 (Cont'd)						
Depth (m)	Cruise 40	Cruise 41	Cruise 42	Cruise 44	Cruise 45	Cruise 46
S	82	84	85	17	78	42
5	66	80	80	3	85	42
10	37	77	43		91	35
15					80	12
	Cruise 47	Cruise 48	Cruise 49	Cruise 50	Cruise 51	Cruise 52
S	67	87	88	73	97	97
5	66	85	81	82	85	81
10	65	70	75	58	74	67
15	39				23	
	Cruise 53	Cruise 54	Cruise 55	Cruise 56		
S	79	96	72	29		
5	75	95	84	26		
10	51	86	77	28		

Table LIII. Temperature (C) profiles of Bighorn Lake at all stations for indicated cruises.

Station 0						
Depth (m)	Cruise 1	Cruise 3	Cruise 4	Cruise 5	Cruise 6	Cruise 7
8	7.8	10.0	12.2	14.7	16.1	18.9
5	7.8	8.9	12.2	14.4	15.3	18.9
10	6.4	8.9	12.2	14.2	14.4	17.8
15	6.1	8.1	10.0	14.2	14.4	16.1
20	6.1	7.5	8.9	12.5	14.2	15.0
25	6.1	6.7	7.8	11.7	13.6	14.4
30	5.8	6.1	6.7	11.1	12.8	14.4
35	5.0	5.6	5.6	9.7	11.1	13.9
40	4.4	5.0	5.6	9.2	10.3	13.3
45	4.4	4.7	5.6	6.9	8.6	12.8
50	4.4	4.4	5.0	6.7	7.5	12.2
55	4.2	4.4	4.7	6.1	7.2	10.0
60	3.9	4.4	4.4	5.8	6.7	8.9
65	3.6	4.2	3.9	5.5	6.4	7.8
70	3.3	4.2	3.9	5.3	6.1	7.8
75	3.3	3.9	3.6	4.7	5.8	7.2
80	3.3	3.6	3.3	4.2	5.6	6.7
85	3.3	3.5	3.6	3.6	5.3	6.1
90	3.3	3.5	3.6	3.6	4.4	5.6
95	3.3	3.5	3.6	4.2	4.2	4.4
100	3.3	4.4	4.2	4.2	4.2	4.4
105	3.6	4.4	4.4	4.4	4.4	4.4
110	4.4			4.4	4.4	4.4
115	4.7			4.4	4.4	4.4
120	4.7			4.4		

Table LIII. (Cont'd)

Depth (m)	Station 0 (Cont'd)					
	Cruise 8	Cruise 9	Cruise 10	Cruise 11	Cruise 12	Cruise 13
S	19.4	18.9	21.4	22.5	20.8	21.7
5	18.9	17.8	19.2	21.1	20.5	21.4
10	18.9	17.8	18.0	18.9	19.7	21.4
15	17.8	17.5	17.8	17.8	18.0	20.5
20	17.8	17.5	17.5	17.5	17.8	18.0
25	16.7	16.1	16.4	16.9	17.5	17.8
30	15.5	15.5	15.8	16.4	16.7	17.5
35	15.0	14.4	15.3	15.5	15.8	16.7
40	13.3	13.9	14.2	14.4	15.0	15.5
45	12.2	13.3	12.5	12.8	13.0	14.4
50	11.7	11.7	11.9	11.9	11.1	12.2
55	10.6	11.1	11.1	11.1	10.3	11.1
60	9.4	10.0	9.7	9.4	8.3	8.9
65	7.8	8.9	8.1	8.3	7.5	7.8
70	7.8	7.8	7.5	7.5	6.9	7.2
75	7.2	7.2	6.9	7.2	6.7	6.9
80	6.7	6.7	6.7	6.7	6.4	6.7
85	6.1	6.1	6.1	6.1	5.8	6.1
90	5.6	5.8	5.8	5.8	5.6	5.8
95	5.6	5.6	5.6	5.6	5.6	5.8
100	5.6	5.3	5.3	5.6	5.6	5.6
105		5.0	5.0	5.0	5.6	5.6
110	5.0	5.0	5.0	5.0	5.3	5.3
115	5.0	5.0	5.0	5.0	5.0	5.3
120	4.7			5.0	5.3	5.0

Table LIII. (Cont'd)

Depth (m)	Station 0 (Cont'd)					
	Cruise 14	Cruise 15	Cruise 16	Cruise 17	Cruise 18	Cruise 19
8	21.9	20.8	20.5	19.7	18.9	18.6
5	21.4	20.3	19.5	19.7	18.9	18.3
10	20.8	20.3	19.4	19.4	18.9	18.3
15	19.7	20.0	19.4	18.9	18.9	18.0
20	18.3	19.4	19.2	18.9	17.8	18.0
25	17.8	18.3	18.0	18.3	17.8	17.8
30	16.9	17.8	17.8	17.8	16.9	17.5
35	15.8	16.9	17.2	17.5	16.7	16.9
40	15.3	15.8	16.6	16.7	16.1	16.7
45	14.2	14.7	15.3	15.5	15.8	16.7
50	12.8	13.3	14.3	14.4	15.3	16.4
55	11.7	11.9	12.2	13.3	13.6	15.0
60	10.0	10.0	8.9	11.1	10.8	11.7
65	8.9	8.1	8.1	9.2	8.9	9.4
70	7.8	7.8	7.8	7.8	7.8	8.6
75	6.9	6.9	7.8	7.8	7.5	7.8
80	6.7	6.7	7.8	7.2	6.9	7.2
85	6.4	6.1	7.8	6.7	6.7	6.7
90	6.1	5.8	7.8	6.7	6.7	6.7
95	5.8	5.8	7.8	6.4	6.4	6.1
100	5.6	5.6	7.8	6.1	6.4	6.1
105	5.6	5.6	7.8	5.8	6.4	5.6
110	5.6	5.6	7.8	5.6	6.4	5.6
115	5.6	5.6	7.8	5.6	6.4	5.6
120		5.6	7.8	5.6	6.4	5.6

Table LIII. (Cont'd)

Station 0 (Cont'd)						
Depth (m)	Cruise 20	Cruise 21	Cruise 22	Cruise 23	Cruise 24	Cruise 25
8	17.5	17.5	16.7	15.5	15.5	14.4
5	17.8	16.9	16.7	16.1	15.5	14.4
10	17.8	16.9	16.7	16.1	15.5	14.4
15	17.8	16.9	16.7	16.1	15.5	14.4
20	17.8	16.9	16.7	16.1	15.5	14.4
25	17.8	16.9	16.7	16.1	15.5	14.4
30	17.2	16.9	16.9	16.1	15.5	14.4
35	16.7	16.9	16.9	16.1	15.5	14.4
40	16.7	16.9	16.7	16.1	15.3	14.4
45	16.7	16.9	16.4	15.5	15.0	14.4
50	16.7	16.9	15.8	15.0	14.7	13.9
55	15.5	16.4	15.5	15.0	14.4	13.3
60	13.0	12.2	11.1	13.9	10.8	12.2
65	10.3	9.7	8.9	10.0	9.7	11.1
70	8.9	8.6	7.8	8.3	8.9	8.9
75	8.1	7.8	7.5	7.8	7.8	8.9
80	7.5	7.2	6.9	7.8	7.8	7.8
85	6.9	6.7	6.7	6.7	7.2	7.2
90	6.7	6.7	6.4	6.7	6.9	6.7
95	6.4	6.7	6.1	6.7	6.7	6.7
100	6.1	6.4	6.1	6.7	6.7	6.7
105	6.1	5.9	5.8	6.1	6.4	6.7
110	6.1	5.8	5.8	6.1	6.1	6.4
115	6.1	5.8	5.6		6.1	6.1
120	6.1	5.6	5.6		5.8	6.1

Table LIII. (Cont'd)

Station 0 (Cont'd)						
Depth (m)	Cruise 26	Cruise 27	Cruise 28	Cruise 29	Cruise 30	Cruise 31
8	13.9	4.4	6.7	6.7	8.9	11.7
5	13.3	4.4	5.6	6.1	6.9	11.4
10	13.3	4.4	5.6	5.6	6.7	11.1
15	13.3	4.4	5.6	5.6	6.1	10.0
20	13.3	4.4	5.6	5.0	5.6	8.6
25	13.3	3.9	5.3	4.7	5.6	6.9
30	13.3	2.2	4.7	4.4	5.0	6.1
35	13.3	2.2	3.1	4.4	4.7	5.6
40	12.8	2.2	2.5	4.4	4.4	5.0
45	12.2	2.2	2.2	4.4	4.2	4.4
50	12.2	2.2	2.2	3.3	3.3	3.9
55	11.7	2.2	2.2	3.1	3.3	3.3
60	11.1	2.2	2.2	2.8	2.8	3.3
65	10.6	2.8	2.8	2.8	2.8	3.3
70	10.0	3.3	3.3	3.3	3.3	3.3
75	8.9	3.3	3.3	3.3	3.3	3.3
80	7.8	3.3	3.6	3.3	3.3	3.3
85	7.2	3.3	3.9	3.9	3.6	3.3
90	6.7	3.3	4.4	4.4	3.9	3.6
95	6.7	3.3	4.4	4.4	4.4	3.9
100	6.7	3.3	4.4	4.4	4.4	4.2
105	6.4	2.8	4.4	4.4	4.4	4.4
110	6.4	2.8	4.4	4.4	4.4	4.4
115	6.4	3.3	4.4	4.4	4.4	4.4
120	6.4	3.3	4.4	4.4	4.4	4.4

Table LIII. (Cont'd)

Station 0 (Cont'd)						
Depth (m)	Cruise 32	Cruise 33	Cruise 34	Cruise 35	Cruise 36	Cruise 37
S	12.2	17.5	16.7	17.8	18.3	18.0
5	11.7	14.4	16.7	16.1	16.4	17.2
10	10.8	13.3	16.4	15.3	15.5	16.9
15	9.7	12.2	13.3	14.2	15.0	15.5
20	7.5	10.3	12.2	13.0	13.9	14.5
25	5.8	8.6	10.8	11.9	12.2	12.5
30	5.6	6.7	7.8	8.3	10.0	10.3
35	4.4	5.8	6.1	6.7	7.5	7.2
40	4.4	5.0	5.6	5.6	5.6	5.8
45	4.4	4.7	5.0	5.0	5.6	5.6
50	4.2	4.4	5.0	5.0	5.3	5.6
55	3.9	4.4	4.7	5.0	5.3	5.6
60	3.3	4.4	4.4	5.0	5.0	5.3
65	3.3	4.2	4.4	4.4	4.7	5.0
70	3.3	3.9	4.2	4.4	4.4	5.0
75	3.3	3.9	3.9	3.9	4.2	4.4
80	3.3	3.6	3.9	3.9	3.9	3.9
85	3.3	3.6	3.9	3.6	3.6	3.9
90	3.6	3.6	3.9	3.3	3.6	3.6
95	3.9	3.6	3.9	3.6	3.9	3.6
100	3.9	3.9	4.2	3.6	3.9	3.6
105	4.2	4.4	4.4	3.9	4.2	3.9
110	4.2	4.4	4.4	4.2	4.2	4.2
115	4.2	4.4	4.4	4.2	4.2	4.2
120	4.2	4.4	4.4		4.2	3.9

Table LIII. (Cont'd)

Station 0 (Cont'd)						
Depth (m)	Cruise 38	Cruise 39	Cruise 40	Cruise 41	Cruise 43	Cruise 44
S	16.9	22.8	23.9	23.3	17.5	18.0
5	16.7	21.7	22.2	22.8	17.5	17.8
10	16.1	19.4	21.1	22.2	14.4	16.7
15	15.5	17.8	18.9	20.5	13.6	15.5
20	14.2	16.9	17.8	18.0	11.4	13.5
25	13.0	15.8	16.7	16.7	10.0	12.5
30	11.7	15.3	15.5	15.5	7.8	10.0
35	8.9	14.4	14.4	15.0	6.9	9.2
40	6.7	13.3	13.6	14.2	6.4	7.2
45	5.6	13.0	13.3	13.6	5.6	6.7
50	5.6	12.2	12.8	13.6	5.6	5.6
55	5.6	10.0	11.4	12.2	5.6	5.6
60	5.6	8.6	8.9	10.0	4.7	5.3
65	5.3	7.8	8.3	8.1	4.6	5.0
70	5.0	7.5	7.8	7.5	4.6	4.7
75	4.4	6.7	6.4	6.7	4.6	4.6
80	4.2	5.6	5.6	5.3	4.4	4.4
85	3.9	5.0	4.7	4.7	4.4	4.4
90	3.9	4.4	4.4	4.4	4.4	4.4
95	4.2	4.4	4.4	4.4	4.4	4.4
100	4.2	4.4	4.4	4.2	4.4	4.4
105	4.2	4.4	4.4	4.2	4.4	4.4
110	4.2	4.4	4.4	4.2	4.4	4.4
115	4.2	4.4	4.4	4.2	4.4	4.4
120	4.2		4.4	4.2	4.2	4.4

Table LIII. (Cont'd)

Depth (m)	Station 0 (Cont'd)					
	Cruise 45	Cruise 46	Cruise 47	Cruise 48	Cruise 49	Cruise 50
8	20.5	21.1	23.3	25.0	23.3	25.0
5	19.7	20.0	22.8	22.8	23.3	24.4
10	16.7	18.9	21.4	22.2	21.7	23.3
15	15.8	17.8	21.1	21.1	21.1	22.2
20	14.6	17.2	20.0	20.5	20.8	21.1
25	13.9	15.5	18.3	20.0	20.0	20.8
30	11.9	15.0	16.9	19.2	19.7	20.3
35	11.1	13.9	15.8	17.5	18.9	20.0
40	8.9	13.3	14.7	15.8	16.7	18.9
45	8.1	11.1	13.3	14.4	15.5	17.8
50	6.7	10.0	12.2	13.3	15.0	16.7
55	5.8	7.8	10.0	11.9	13.3	15.3
60	5.6	7.5	8.9	10.0	12.2	13.9
65	5.3	6.7	7.8	8.9	11.1	11.1
70	5.0	6.4	7.8	8.1	9.2	9.7
75	5.0	5.8	6.9	7.8	8.9	8.3
80	4.7	5.6	6.7	7.2	7.8	7.8
85	4.7	5.6	6.7	6.9	7.2	7.5
90	4.4	5.3	6.7	6.7	6.7	6.9
95	4.4	5.3	6.4	6.7	6.7	6.7
100	4.4	5.3	6.1	6.7	6.4	6.7
105	4.4	4.7	5.8	6.1	6.1	6.1
110	4.4	4.4	5.6	6.1	5.8	6.1
115	4.4	4.4	5.6	5.8	5.6	5.6
120	4.4	4.3	5.6	5.6	5.6	5.6

Table LIII. (Cont'd)

Depth (m)	Station 0 (Cont'd)					
	Cruise 51	Cruise 52	Cruise 53	Cruise 54	Cruise 55	Cruise 56
S	24.4	23.3	23.5	22.9	22.2	21.2
5	23.3	22.8				
10	22.5	21.4	22.5	22.1	21.7	21.0
15	21.4	20.8				
20	21.1	20.0	20.9	21.0	20.7	21.0
25	20.8	19.7				
30	20.3	19.2	20.0	19.9	19.8	19.7
35	20.0	18.9				
40	18.9	18.3	18.8	19.0	19.2	19.2
45	17.5	17.5				
50	16.1	15.3	16.1	17.5	17.0	18.1
55	15.0	14.2				
60	12.2	11.1	10.2	13.3	12.8	13.0
65	9.2	8.3				
70	8.6	7.2	7.1	8.3	8.0	6.9
75	7.8	6.7				
80	7.8	6.4	6.8	6.3	6.0	6.0
85	7.2	5.8				
90	6.7	5.6	5.8	5.8	5.8	5.0
95	6.7	5.6				
100	6.4	5.6	5.2	5.5	5.7	4.9
105	6.1	5.3				
110	5.8	4.7	5.1	5.0	4.9	4.4
115	5.8	4.7				
120	5.6	4.7	4.6	4.8	4.4	4.6

Table LIII. (Cont'd)

Depth (m)	Station 1					
	Cruise 1	Cruise 3	Cruise 4	Cruise 5	Cruise 6	Cruise 7
8	7.8	11.1	13.3	15.5	16.7	18.3
5	7.5	11.1	12.8	15.3	16.4	17.8
10	7.2	10.0	11.1	14.7	15.5	15.5
15	6.9	8.9	10.6	14.4	14.4	14.7
20	6.7	7.8	9.4	14.2	13.9	14.4
25	6.4	7.2	8.9	12.2	13.3	14.4
30	6.1	6.7	8.3	11.1	12.5	13.9
35	5.6	6.1	7.8	10.0	12.2	12.2
40	5.6	6.1	6.7	8.9	11.7	11.7
45	5.6	5.6	6.7	8.1	10.8	11.1
50	6.3	5.6	6.4	7.2	10.3	10.6
55	5.0	5.6	5.8	6.7	8.6	10.0
60	5.0	5.6	5.6	6.7	8.3	10.0
65			5.6	6.7	7.8	10.0
70			5.0	6.4	8.0	9.4
75			4.7	5.6	6.9	10.0
80			4.4	5.3	7.8	10.0
85					6.7	10.6
90					6.4	10.6

Table LIII. (Cont'd)

Depth (m)	Station 1 (Cont'd)					
	Cruise 8	Cruise 9	Cruise 10	Cruise 11	Cruise 12	Cruise 13
8	18.0	18.9	19.2	21.4	21.4	22.5
5	17.8	17.8	19.2	20.0	20.8	21.1
10	16.9	17.2	17.8	18.0	18.9	20.8
15	16.7	16.9	16.9	17.2	17.2	18.3
20	15.5	16.7	16.4	16.7	16.9	17.5
25	15.0	16.1	15.5	15.8	16.7	16.7
30	14.4	15.5	15.0	15.3	15.5	16.1
35	14.4	14.7	14.4	14.7	15.3	15.3
40	14.4	14.4	13.3	14.4	14.4	14.7
45	14.0	13.3	12.2	13.0	13.3	14.2
50	11.7	12.2	11.7	12.2	12.5	12.8
55	11.1	11.4	10.8	11.4	12.2	11.7
60	10.6	10.0	10.0	10.3	8.9	9.4
65	10.0	8.1	8.1	8.9	8.1	8.3
70	7.8	7.8	7.8	7.8	7.8	7.8
75	7.2	7.2	6.9	6.9	7.5	6.9
80	6.7	7.2	6.7	6.7	7.5	6.7
85	6.7	7.2	6.4	6.1	7.5	6.7
90	6.1	7.2	5.8	5.8	7.5	

Table LIII. (Cont'd)

Depth (m)	Station 1 (Cont'd)					
	Cruise 14	Cruise 15	Cruise 16	Cruise 17	Cruise 18	Cruise 19
8	20.8	21.1	19.5	19.2	19.4	18.6
5	20.5	20.3	19.5	19.2	18.9	18.3
10	20.5	20.0	19.2	18.9	18.6	18.0
15	20.0	20.0	19.2	18.9	18.6	17.8
20	17.8	18.0	19.0	18.9	18.6	17.8
25	16.9	17.2	17.8	17.8	18.0	17.8
30	16.7	16.7	16.7	16.7	17.5	17.8
35	15.5	16.1	16.6	16.4	17.5	17.8
40	15.0	15.3	15.5	16.1	17.5	17.8
45	14.4	14.4	14.7	15.5	17.2	17.5
50	13.3	13.3	13.6	14.7	15.8	16.7
55	12.2	12.2	12.1	13.3	14.2	14.7
60	12.2	10.0	9.4	11.1	11.1	11.4
65	12.2	8.1	9.4	11.1	8.9	8.9
70		7.8	9.4	11.4	7.8	7.8
75			9.4		6.7	7.5
80			9.7		6.7	6.5
85						6.7

Table LIII. (Cont'd)

Station 1 (Cont'd)						
Depth (m)	Cruise 20	Cruise 21	Cruise 22	Cruise 23	Cruise 24	Cruise 26
8	18.0	16.7	16.7	15.5	15.5	12.8
5	17.5	16.9	16.7	15.8	15.5	12.8
10	17.5	16.9	16.7	15.8	15.3	12.8
15	17.5	16.9	16.7	15.8	15.3	12.8
20	17.5	16.9	16.7	15.8	15.3	12.8
25	17.5	16.9	16.7	15.8	15.3	12.8
30	17.5	16.9	16.7	15.8	15.3	12.8
35	17.8	16.9	16.7	15.8	15.3	12.8
40	17.5	16.9	16.7	15.5	15.3	12.8
45	16.9	16.9	16.1	15.5	14.7	12.2
50	16.7	16.7	15.5	15.3	14.4	11.7
55	16.4	16.4	15.0	15.0	13.9	11.1
60	14.2	13.6	13.9	14.4	13.6	11.1
65	9.7	10.8	10.0	12.3	10.0	10.6
70	8.6	10.6			8.3	10.0
75	7.8	10.6			7.8	8.3
80	7.2	10.6			7.5	7.8
85	6.9	10.8			7.2	7.8
90	6.9	10.8			7.2	

Table LIII. (Cont'd)

Station 2						
Depth (m)	Cruise 1	Cruise 3	Cruise 4	Cruise 5	Cruise 6	Cruise 7
S	11.1	11.7	13.3	15.5	16.7	17.8
5	10.0	11.9	13.3	15.3	16.4	17.2
10	8.9	12.2	12.2	14.7	15.5	16.1
15	8.3	11.1	11.7	14.4	14.4	15.5
20	8.3	9.7	8.9	14.2	13.9	14.4
25	7.2	7.8	7.8	12.2	13.3	14.4
30	6.7	7.2	7.2	11.1	12.5	13.3
35	6.1	6.7	7.2	10.0	12.2	12.2
40	5.6	6.1	6.1	8.9	11.7	12.2
45	5.6	6.1	6.1	8.1	10.8	11.7
50	5.6	5.8	6.1	7.2	10.3	11.1
55	5.6	5.8		6.7	8.6	11.1
60			7.8	6.7	8.3	11.1
65			7.2	6.7	7.8	
70				6.4	8.0	
	Cruise 8	Cruise 9	Cruise 10	Cruise 11	Cruise 12	Cruise 13
S	17.8	18.9	21.4	22.8	21.4	23.3
5	17.8	16.7	19.7	21.9	21.4	21.9
10	17.2	16.7	17.2	19.4	21.4	21.1
15	16.7	16.4	16.7	16.7	18.9	20.0
20	15.5	15.8	16.1	16.1	16.7	16.7
25	14.4	15.0	15.5	15.5	15.8	16.1
30	13.3	14.4	15.3	15.0	15.5	15.5
35	12.8	13.3	14.4	14.4	15.0	15.3
40	12.2	12.2	13.3	13.6	14.4	14.4
45	12.2	12.2	12.5	12.5	13.3	13.3
50	11.7	11.7	11.9	12.2	12.2	12.5
55	11.1	11.1	11.1	11.1	11.4	11.4
60	11.1	11.1		11.1	11.1	11.1
65		10.6		10.0		

Table LIII. (Cont'd)

Station 2 (Cont'd)						
Depth (m)	Cruise 14	Cruise 15	Cruise 16	Cruise 17	Cruise 18	Cruise 19
S	22.2	23.3	20.3	20.3	19.7	21.1
5	21.4	21.1	20.3	19.7	19.4	19.2
10	20.8	20.5	19.7	19.4	18.9	18.3
15	20.5	20.5	19.7	19.4	18.9	18.3
20	18.6	20.0	19.7	19.2	18.9	18.0
25	16.9	17.8	19.2	18.9	18.3	17.8
30	16.1	16.1	18.3	18.6	17.8	17.8
35	15.8	15.5	16.7	17.8	17.8	17.5
40	15.3	15.3	15.5	17.8	17.5	17.5
45	14.4	14.4	15.3	17.5	17.2	16.9
50	13.3	13.0	14.4	15.5	16.9	16.9
55	11.4	12.2	12.2	14.4	14.7	15.5
60	11.1	11.1	11.4	13.6	13.0	13.3
65		10.0	10.0	11.4	11.9	12.5
	Cruise 20	Cruise 21	Cruise 22	Cruise 23	Cruise 24	Cruise 25
S	17.8	16.9	16.7	15.0	15.0	14.4
5	17.8	17.2	16.7	15.5	15.3	14.4
10	17.8	17.2	16.7	16.1	15.3	14.4
15	17.8	17.2	16.7	16.1	15.3	14.4
20	17.8	17.2	16.7	16.1	15.3	14.4
25	17.8	17.2	16.7	16.1	15.3	14.4
30	17.8	17.2	16.7	16.1	15.3	14.4
35	17.5	17.2	16.7	15.5	15.3	14.4
40	16.9	16.9	15.5	15.5	15.0	12.2
45	16.7	16.7	15.0	15.0	13.3	12.2
50	16.4	16.7	14.7	15.0	12.5	12.2
55	16.4	16.4	14.7	15.0	12.5	12.2
60	14.4	13.9	14.4	15.0	12.2	12.2
65					12.2	12.2

Table LIII. (Cont'd)

Station 2 (Cont'd)						
Depth (m)	Cruise 26					
S	12.8					
5	12.8					
10	12.8					
15	12.8					
20	12.8					
25	12.8					
30	12.8					
35	12.2					
40	11.1					
45	10.0					
50	10.0					
55	12.8					
60	10.0					
65	10.0					
70	10.0					
Station 3						
Depth (m)	Cruise 1	Cruise 2	Cruise 3	Cruise 4	Cruise 5	Cruise 6
S	12.2	13.3	12.5	14.4	18.6	15.5
5	10.0	12.2	12.5	13.6	16.7	13.3
10	10.0	11.7	12.2	13.0	13.3	12.2
15	9.7	10.6	12.2	12.2	12.5	12.2
20	8.1	8.9	11.1	11.1	11.9	11.9
25	7.8	7.8	8.9	8.6	11.7	11.9
30	6.7	7.2	7.8	8.3	11.4	11.9
35	6.1		7.2		11.4	12.2
40	6.1		6.7			11.9

Table LIII. (Cont'd)

Station 3 (Cont'd)						
Depth (m)	Cruise 7	Cruise 8	Cruise 9	Cruise 10	Cruise 11	Cruise 12
S	18.3	17.8	20.0	21.9	21.9	21.7
5	18.3	17.8	17.2	21.1	21.9	21.7
10	17.8	16.7	16.7	20.0	20.8	21.1
15	17.8	15.5	16.4	16.9	17.8	20.3
20	16.7	15.5	15.8	16.7	16.7	18.3
25	14.4	15.0	15.5	15.5	15.8	16.7
30	13.3	14.4	15.5	15.3	15.5	15.8
35	12.8	12.8	13.3	14.4	14.4	15.3
40	12.2	12.2	12.8	13.6	13.6	14.4
45	12.2		11.7	12.5	13.0	13.3
	Cruise 13	Cruise 14	Cruise 15	Cruise 16	Cruise 17	Cruise 18
S	23.3	25.0	22.2	20.5	20.5	19.7
5	21.9	21.4	21.4	20.0	20.0	19.2
10	21.1	20.8	20.8	19.7	19.4	18.9
15	20.5	20.5	20.8	19.4	19.4	18.9
20	19.7	19.4	20.0	19.2	18.6	18.6
25	16.7	18.6	18.9	18.3	18.0	17.8
30	15.5	16.9	17.8	18.0	17.8	17.8
35	15.0	16.1	16.1	17.8	17.5	17.8
40	14.4	15.3	15.0	17.8	16.9	17.8
45	12.8	14.2	13.9	15.5	16.7	17.2
50					15.5	15.5

Table LIII. (Cont'd)

Station 3 (Cont'd)						
Depth (m)	Cruise 19	Cruise 20	Cruise 21	Cruise 22	Cruise 23	Cruise 24
S	20.3	17.8	17.2	17.2	14.4	15.0
5	18.9	18.0	17.5	16.7	15.5	15.0
10	18.5	18.0	17.2	16.7	15.5	15.3
15	18.3	18.0	17.2	16.7	15.5	15.3
20	17.8	18.0	16.9	16.7	15.5	15.3
25	17.8	18.0	17.2	16.7	15.5	15.3
30	16.9	17.8	16.1	15.3	14.4	14.4
35	16.7	16.9	15.5	14.7	13.9	12.2
40	16.4	16.7	15.5	14.7	13.3	
45	16.1	16.7	15.5	14.4	13.3	
50	15.3					
Cruise 25 Cruise 26						
S	14.4	12.2				
5	14.4	12.8				
10	14.4	12.8				
15	14.4	12.8				
20	14.4	12.8				
25	14.4	12.8				
30	12.2	10.6				
35	11.7	10.0				
40	11.1	9.4				
45	11.1	9.4				
Station 4						
	Cruise 1	Cruise 2	Cruise 3	Cruise 4	Cruise 5	Cruise 6
S	14.4	13.3	11.1	15.3	10.6	15.8
5	13.3	12.8	12.2	14.7	8.9	15.8
10	12.8	11.1	12.2	14.4	8.9	15.5
15	10.8	10.8	12.2	13.3	10.8	15.0
20	8.9	10.6	11.7	12.2	11.1	13.3
25	8.1			13.9		14.7
30						14.4

Table LIII. (Cont'd)

Station 4						
Depth (m)	Cruise 7	Cruise 8	Cruise 9	Cruise 10	Cruise 11	Cruise 12
S	17.8	16.7	18.0	22.2	21.7	21.1
5	17.8	16.7	15.8	21.9		20.8
10	17.8	16.7	15.5	20.5		20.8
15	17.2	16.7	14.4	17.2		20.8
20	16.1	16.7	14.4	16.1		20.5
25	14.4	13.3		14.7		18.6
30	13.3					18.0
35	13.3					
	Cruise 13	Cruise 14	Cruise 15	Cruise 16	Cruise 17	Cruise 18
S	21.7	23.9	20.5	20.0	20.0	18.0
5	21.7	21.7	20.5	19.4	19.4	17.8
10	21.7	21.1	19.2	17.8	18.6	17.8
15	21.7	20.8	18.9	16.9	17.2	17.5
20	20.0	20.0	18.6	16.9	16.7	17.5
25	20.0	18.9	18.0	16.9	16.7	17.5
30		18.9		16.7	16.1	16.1
35				16.7		
40				16.7		
	Cruise 19	Cruise 20	Cruise 21	Cruise 22	Cruise 23	Cruise 24
S	17.8	16.6	16.1	17.8	13.3	14.4
5	17.8	16.9	16.4	16.7	14.4	14.4
10	17.5	16.9	16.1	16.1	14.4	14.4
15	16.7	16.9	15.3	14.7	13.9	12.5
20	16.1	16.9	14.7	14.4	12.8	11.4
25	15.8	16.9	14.7	14.2	12.2	10.8
30	15.5					11.1

Table LIII. (Cont'd)

Station 4 (Cont'd)						
Depth (m)	Cruise 25	Cruise 26				
S	13.3	12.2				
5	13.3	12.2				
10	13.0	11.7				
15	11.1	8.9				
20	10.0	8.3				
25	9.4	8.3				
Station 5						
Depth (m)	Cruise 1	Cruise 2	Cruise 3	Cruise 4	Cruise 5	Cruise 6
S	12.2	12.5	14.4	15.5	11.4	15.8
	Cruise 7	Cruise 8	Cruise 9	Cruise 10	Cruise 11	Cruise 12
S	17.5	16.7	18.9	22.2	22.2	22.2
5				22.2		18.9
	Cruise 13	Cruise 14	Cruise 15	Cruise 16	Cruise 17	Cruise 18
S	21.7	23.9	18.9	16.9	19.2	15.3
5	21.7	21.1	18.9	16.9	18.3	15.3
	Cruise 19	Cruise 20	Cruise 21	Cruise 22	Cruise 23	Cruise 24
S	17.8	14.2	13.6	16.1	11.1	11.1
5	16.7	13.9	13.0	14.4	11.1	11.1
10			12.8	13.3		11.1
	Cruise 25	Cruise 26				
S	8.9	7.8				
5	8.9	7.8				

Table LIV. Specific conductivity profiles (micromhos) of
Bighorn Lake at all stations for indicated cruises.

Station 0						
Depth (m)	Cruise 1	Cruise 3	Cruise 4	Cruise 5	Cruise 6	Cruise 7
8	895	870	850	850	870	780
5	900	870	850	850	870	800
10	905	880	860	850	860	800
15	905	900	860	860	870	830
20	905	900	880	850	870	825
25	905	900	910	860	875	860
30	910	900	910	860	875	875
35	940	940	940	900	905	870
40	950	960	950	910	925	830
45	960	970	970	950	950	825
50	975	970	980	960	975	900
55	980	980	980	960	980	940
60	995	980	1000	970	980	950
65	1005	1000	1000	970	980	970
70	1020	1005	1100	975	980	975
75	1020	1010	1150	980	980	980
80	1025	1010	1200	1000	980	980
85	1030	1020	1250	1020	990	980
90	1040	1020	1250	1020	1000	990
95	1050	1020	1300	1020	1010	1000
100	1050	1050	1300	1020	1030	1010
105	1060		1300	1030	1030	1020
110	1110			1050	1040	1020
115	1120			1050	1050	1030
120	1130			1050		

Table LIV. (Cont'd)

Depth (m)	Station 0 (Cont'd)					
	Cruise 8	Cruise 9	Cruise 10	Cruise 11	Cruise 12	Cruise 13
8	880	875	750	720	660	620
5	880	880	795	710	660	620
10	890	890	850	780	670	630
15	900	890	880	845	800	645
20	875	890	880	880	860	800
25	880	900	890	880	880	850
30	880	900	890	895	860	865
35	875	800	825	855	830	810
40	790	775	790	800	780	840
45	750	730	750	740	830	840
50	870	780	750	750	840	740
55	910	880	880	880	900	860
60	950	940	940	950	950	950
65	960	960	970	965	970	950
70	970	975	975	975	970	955
75	975	975	975	980	970	960
80	970	980	975	980	980	970
85	980	1000	975	980	980	975
90	1000	1000	995	995	1000	980
95	1000	1000	1000	1000	1000	990
100	1000	1010	1005	1000	1000	990
105	1010	1010	1005	1000	1000	995
110	1010	1000	1010	1005	1000	995
115	1010	1000	1020	1010	1010	1000
120	1020			1010	1010	1000

Table LIV. (Cont'd)

Depth (m)	Station 0 (Cont'd)					
	Cruise 14	Cruise 15	Cruise 16	Cruise 17	Cruise 18	Cruise 19
8	620	600	610	610	620	615
5	610	600	600	610	610	615
10	630	600	610	600	610	615
15	645	620	610	600	620	615
20	775	655	620	610	720	620
25	850	780	760	730	780	740
30	815	830	820	800	720	740
35	700	775	790	760	650	675
40	700	655	690	690	615	655
45	720	670	640	620	600	755
50	700	700	660	640	605	735
55	800	795	750	680	670	645
60	890	890	890	840	850	790
65	920	940	930	890	905	895
70	950	950	950	930	940	910
75	960	950	950	950	945	925
80	960	960	960	950	950	940
85	970	960	960	950	950	950
90	975	975	970	950	950	950
95	980	980	970	960	950	950
100	980	980	970	970	950	955
105	990	980	970	970	950	965
110	990	990	970	980	950	970
115	990	860	970	980	955	970
120		860	970	980	960	970

Table LIV. (Cont'd)

Depth (m)	Station 0 (Cont'd)					
	Cruise 20	Cruise 21	Cruise 22	Cruise 23	Cruise 24	Cruise 25
8	625	610	670	730	620	770
5	625	645	670	700	620	750
10	625	645	670	700	620	750
15	625	645	670	700	620	750
20	625	650	670	700	620	750
25	630	650	670	700	620	750
30	700	650	790	700	680	750
35	660	650	800	790	700	750
40	850	775	830	820	730	750
45	875	860	840	820	730	830
50	825	860	840	840	740	850
55	770	840	830	850	730	860
60	740	780	800	800	690	870
65	825	860	900	830	710	800
70	890	910	910	870	750	820
75	910	920	925	890	750	840
80	930	930	925	900	760	870
85	930	940	930	900	760	870
90	940	945	940	900	770	880
95	950	950	940	910	770	890
100	950	950	940	910	780	890
105	925	950	950	910	780	900
110	930	950	950	910	780	900
115	940	955	950		780	900
120	940	955	950		780	900

Table LIV. (Cont'd)

Depth (m)	Station 0 (Cont'd)					
	Cruise 26	Cruise 27	Cruise 28	Cruise 29	Cruise 30	Cruise 31
S	770	944	932	926	909	885
5	760	944	920	915	909	874
10	760	944	932	915	909	874
15	760	944	932	915	909	874
20	760	944	944	920	915	885
25	760	950	944	932	932	897
30	760	1027	944	944	932	909
35	820	1038	1003	944	932	909
40	860	1038	1027	944	944	932
45	850	1050	1038	944	944	944
50	850	1062	1050	956	985	956
55	850	1062	1056	1003	1003	986
60	850	1062	1062	1015	1003	1003
65	840	1062	1062	1032	1027	1003
70	830	1062	1062	1032	1027	1003
75	850	1062	1050	1032	1027	1003
80	870	1062	1050	1032	1027	1003
85	870	1062	1050	1032	1027	1003
90	870	1062	1044	1032	1021	1003
95	890	1062	1044	1015	1021	1003
100	890	1062	1044	1015	1021	1003
105	900	1062	1033	1015	1021	1003
110	900	1062	1038	1015	1015	1003
115	900	1062	1038	1015	1015	1003
120	900	1062	1038	1015	1015	1003

Table LIV. (Cont'd)

Depth (m)	Station 0 (Cont'd)					
	Cruise 32	Cruise 33	Cruise 34	Cruise 35	Cruise 36	Cruise 37
S	868	826	850	768	732	727
5	856	826	850	738	732	709
10	850	826	850	738	744	709
15	850	826	862	768	756	721
20	850	826	862	768	768	738
25	885	826	838	780	768	768
30	897	826	838	780	768	768
35	897	850	862	780	768	768
40	909	874	885	802	768	780
45	915	897	897	814	826	814
50	932	909	915	826	826	826
55	944	909	915	826	826	826
60	944	915	920	826	838	826
65	956	932	932	838	838	826
70	962	944	944	850	850	826
75	962	944	944	856	856	838
80	962	944	944	868	862	850
85	962	944	956	879	874	856
90	962	944	956	885	885	862
95	962	944	956	885	885	862
100	962	944	956	885	885	862
105	962	944	956	885	885	862
110	962	868	956	885	885	862
115	962	868	956	885	885	862
120	962	868	956		885	862

Table LIV. (Cont'd)

Depth (m)	Station 0 (Cont'd)					
	Cruise 38	Cruise 39	Cruise 40	Cruise 41	Cruise 43	Cruise 44
S	709	814	806	821	865	825
5	697	791	806	821	865	833
10	697	760	806	821	873	851
15	697	798	806	821	908	868
20	685	806	806	798	925	833
25	750	821	829	821	960	868
30	756	806	829	821	978	911
35	756	775	806	814	1012	963
40	768	775	791	775	1012	981
45	798	837	806	775	1030	1005
50	814	898	867	829	1047	1005
55	814	914	933	898	1047	1005
60	814	988	958	914	1047	1024
65	826	1003	1019	1003	1065	1024
70	826	1003	1019	1019	1065	1024
75	838	1003	1019	1003	1065	1024
80	850	1003	1019	1019	1065	1024
85	850	1019	1049	1033	1065	1024
90	856	1027	1049	1033	1065	1024
95	856	1033	1049	1041	1065	1024
100	856	1049	1064	1049	1065	1024
105	856	1049	1064	1049	1065	1024
110	856	1049	1064	1033	1065	1024
115	856	1049	1064	1033	1082	1024
120	856		1064	1049	1082	1024

Table LIV. (Cont'd)

Depth (m)	Station 0 (Cont'd)					
	Cruise 45	Cruise 46	Cruise 47	Cruise 48	Cruise 49	Cruise 50
8	843	885	747	748	735	761
5	880	885	757	748	746	773
10	862	885	747	748	746	761
15	890	847	747	748	746	761
20	862	904	747	748	746	761
25	890	904	786	738	746	761
30	890	885	845	748	746	761
35	937	885	835	829	746	773
40	955	885	884	809	840	784
45	1012	914	884	768	798	829
50	1012	962	933	789	756	840
55	1030	981	963	930	786	806
60	1030	1039	1032	991	882	851
65	1049	1039	1032	991	945	905
70	1068	1039	1061	1031	966	1008
75	1068	1039	1061	1062	924	1030
80	1068	1058	1061	1062	987	1030
85	1068	1058	1061	1062	1016	1030
90	1068	1058	1061	1062	1016	1052
95	1068	1058	1061	1062	1016	1052
100	1068	1058	1061	1062	1016	1052
105	1068	1058	1061	1062	1050	1064
110	1068	1058	1061	1062	1050	1064
115	1068	1058	1061	1062	1050	1064
120	1068	1058	1061	1062	1050	1064

Table LIV. (Cont'd)

Depth (m)	Station 0 (Cont'd)			
	Cruise 51	Cruise 52	Cruise 55	Cruise 56
S	721	771	737	720
5	732	771		
10	732	735	700	811
15	743	771		
20	755	759	779	692
25	743	759		
30	755	759	785	764
35	732	759		
40	755	771	782	773
45	777	771		
50	777	806	757	745
55	799	830		
60	943	925	811	763
65	988	1008		
70	999	1043	1202	1107
75	999	1043		
80	943	1043	1249	1217
85	988	1067		
90	999	1067	1282	1195
95	999	1067		
100	999	1067	1249	1202
105	999	1067		
110	999	1067	1218	1173
115	999	1067		
120	999	1067	1210	1195

Table LIV. (Cont'd)

Depth (m)	Station 1					
	Cruise 1	Cruise 3	Cruise 4	Cruise 5	Cruise 6	Cruise 7
S	900	930	950	970	925	825
5	910	930	950	970	925	780
10	930	930	930	950	950	750
15	950	950	940	940	920	725
20	955	950	950	910	890	700
25	955	950	950	950	880	880
30	955	950	950	960	880	725
35	955	960	950	950	925	675
40	960	960	960	960	950	720
45	970	970	970	960	960	850
50	975	980	975	980	960	910
55	975	980	980	990	950	925
60	980	1000	980	990	950	900
65			980	990	960	930
70			990	990	975	950
75			1000	990	980	900
80			1000	990	980	900
85						900
90						900

Table LIV. (Cont'd)

Depth (m)	Station 1 (Cont'd)					
	Cruise 8	Cruise 9	Cruise 10	Cruise 11	Cruise 12	Cruise 13
8	640	600	585	570	585	600
5	610	600	585	555	575	580
10	620	620	565	555	540	585
15	640	640	640	675	650	550
20	700	640	590	645	690	645
25	710	745	655	580	650	695
30	760	720	700	695	580	620
35	870	720	720	700	665	600
40	870	850	755	760	685	660
45	760	700	720	710	725	695
50	750	720	800	740	720	710
55	870	870	895	850	750	800
60	900	920	940	920	930	820
65	940	960	960	955	940	840
70	960	960	980	965	750	960
75	970	970	980	975	750	970
80	975	980	980	975	750	950
85	980	980	990	990	760	950
90	975	980	995	990	760	

Table LIV. (Cont'd)

Depth (m)	Station 1 (Cont'd)					
	Cruise 14	Cruise 15	Cruise 16	Cruise 17	Cruise 18	Cruise 19
S	610	660	660	660	650	670
5	610	650	660	660	640	665
10	610	650	650	660	650	670
15	590	650	660	650	655	675
20	560	575	660	640	725	685
25	685	660	600	690	855	800
30	655	650	620	600	790	865
35	575	590	620	590	890	900
40	610	600	578	590	920	910
45	660	645	630	610	900	910
50	710	680	650	650	740	840
55	735	770	660	700	695	685
60	720	910	900	710	840	825
65	720	940	910	730	900	890
70		950	910	730	930	910
75			910		930	925
80			910		930	935
85						940

Table LIV. (Cont'd)

Depth (m)	Station 1 (Cont'd)					
	Cruise 20	Cruise 21	Cruise 22	Cruise 23	Cruise 24	Cruise 26
8	720	730	720	750	600	750
5	730	730	720	720	620	740
10	730	730	720	710	620	750
15	735	740	720	710	620	750
20	735	740	720	720	620	750
25	740	735	720	720	620	750
30	795	735	730	720	620	750
35	910	745	740	720	630	750
40	880	800	810	790	650	800
45	855	855	840	830	710	830
50	850	855	850	850	720	830
55	850	850	850	870	750	830
60	765	770	850	860	750	850
65	860	690	870	800	700	850
70	900	730			750	850
75	915	730			760	850
80	925	725			760	860
85	895	730			690	870
90	900	735			700	

Table LIV. (Cont'd)

Depth (m)	Station 2					
	Cruise 1	Cruise 3	Cruise 4	Cruise 5	Cruise 6	Cruise 7
S	950	980	950	970	925	630
5	950	980	950	970	925	630
10	950	980	950	950	950	620
15	960	960	960	940	920	635
20	960	950	975	910	890	650
25	970	970	975	950	880	700
30	970	980	980	960	880	710
35	980	980	980	950	925	750
40	980	990	990	960	950	790
45	990	1000	1000	960	960	875
50	990	1000	1000	980	960	900
55	1000	1000		990	950	900
60			1100	990	950	1000
65				990	960	
70				990	975	
	Cruise 8	Cruise 9	Cruise 10	Cruise 11	Cruise 12	Cruise 13
S	450	430	495	710	770	770
5	440	450	485	750	770	750
10	440	450	495	690	770	780
15	460	460	530	500	680	810
20	580	480	595	540	550	560
25	600	520	650	625	590	550
30	620	610	660	655	655	615
35	620	675	670	650	660	655
40	730	720	700	670	650	650
45	800	780	755	710	640	670
50	860	860	825	770	750	750
55	900	880	1080	870	860	850
60	1010	1060		900	1110	1020
65		1290		1250		

Table LIV. (Cont'd)

Depth (m)	Station 2 (Cont'd)					
	Cruise 14	Cruise 15	Cruise 16	Cruise 17	Cruise 18	Cruise 19
8	790	790	840	810	780	805
5	790	780	840	800	775	770
10	820	810	850	820	785	805
15	855	820	850	830	795	805
20	720	950	980	1000	800	820
25	560	700	1020	960	900	855
30	545	570	930	950	900	860
35	630	625	690	950	900	860
40	660	650	650	960	890	865
45	660	660	660	950	880	870
50	690	720	680	740	875	870
55	860	810	770	790	835	835
60	1100	875	850	820	850	820
65		1320	1370	1300	1125	1125
	Cruise 20	Cruise 21	Cruise 22	Cruise 23	Cruise 24	Cruise 25
8	815	810	810	850	650	770
5	805	810	810	800	650	760
10	800	815	810	800	650	760
15	800	815	810	800	650	760
20	805	815	810	790	650	760
25	850	815	810	790	650	760
30	850	825	810	790	650	760
35	850	845	810	800	650	780
40	850	850	870	830	690	830
45	855	850	900	850	750	850
50	860	855	900	850	750	860
55	860	855	900	850	700	860
60	810	825	900	850	700	860
65					900	900

Table LIV. (Cont'd)

Station 2 (Cont'd)						
Depth (m)	Cruise 26					
8	750					
5	750					
10	750					
15	750					
20	750					
25	750					
30	750					
35	810					
40	820					
45	840					
50	850					
55	850					
60	850					
65	800					
70	800					
Station 3						
	Cruise 1	Cruise 2	Cruise 3	Cruise 4	Cruise 5	Cruise 6
8	890	980	1090	975	650	610
5	890	980	1090	975	650	610
10	900	960	1080	975	540	620
15	900	960	1090	975	530	660
20	900	980	1090	980	530	690
25	900	970	1100	1000	530	750
30	900		1100	1000	530	800
35	1000		1100		530	810
40	1300					1200

Table LIV. (Cont'd)

Depth (m)	Station 3 (Cont'd)					
	Cruise 7	Cruise 8	Cruise 9	Cruise 10	Cruise 11	Cruise 12
8	600	450	470	770	780	800
5	600	450	450	760	780	800
10	600	460	500	755	750	825
15	600	460	600	620	660	815
20	590	475	620	670	625	700
25	550	475	620	690	680	670
30	700	700	620	670	675	690
35	775	770	650	670	675	680
40	950	780	700	870	695	675
45	950		1050	1010	940	1250
	Cruise 13	Cruise 14	Cruise 15	Cruise 16	Cruise 17	Cruise 18
8	820	860	920	940	910	880
5	800	840	925	940	900	870
10	860	885	940	940	920	870
15	895	950	960	980	920	875
20	850	1000	990	970	920	875
25	640	970	980	950	920	855
30	680	940	860	950	900	855
35	675	675	720	960	900	850
40	675	680	700	960	890	850
45	1300	1230	1320	1200	860	855
50					1230	1300

Table LIV. (Cont'd)

Station 3 (Cont'd)						
Depth (m)	Cruise 19	Cruise 20	Cruise 21	Cruise 22	Cruise 23	Cruise 24
S	870	855	860	840	850	700
5	865	850	855	840	830	700
10	865	850	845	840	820	700
15	875	850	850	840	820	700
20	850	850	855	840	820	700
25	850	850	850	840	820	700
30	850	850	845	880	850	750
35	860	830	855	890	870	750
40	870	840	860	890	875	
45	870	850	870	890	875	
50	1300					
Cruise 25 Cruise 26						
S	800	770				
5	800	770				
10	800	770				
15	800	770				
20	800	770				
25	800	770				
30	850	820				
35	850	840				
40	860	850				
45	860	850				
Station 4						
	Cruise 1	Cruise 2	Cruise 3	Cruise 4	Cruise 5	Cruise 6
S	890	950	600	990	405	770
5	850	950	950	990	500	770
10	850	950	980	990	350	755
15	900	950	980	850	540	675
20	900	950	920	800	540	560
25	1300			990		940
30						925

Table LIV. (Cont'd)

Depth (m)	Station 4 (Cont'd)					
	Cruise 7	Cruise 8	Cruise 9	Cruise 10	Cruise 12	Cruise 13
S	460	660	710	790	890	1005
5	470	650	655	795	890	1005
10	475	650	470	720	910	1005
15	470	640	475	585	910	1005
20	480	550	460	600	905	1200
25	860	960		1040	950	1200
30	850				1000	
35	850					
	Cruise 14	Cruise 15	Cruise 16	Cruise 17	Cruise 18	Cruise 19
S	1000	1080	1000	950	895	900
5	1005	1070	1000	940	870	890
10	1010	1030	930	910	870	865
15	1020	1040	930	840	850	840
20	1020	1050	950	850	845	850
25	1110	1380	950	850	845	855
30	1130		950	1270	1250	1185
35			990			
40			1000			
	Cruise 20	Cruise 21	Cruise 22	Cruise 23	Cruise 24	Cruise 25
S	870	855	850	900	700	810
5	855	855	850	850	700	810
10	850	850	860	850	700	800
15	850	860	900	860	700	840
20	850	870	910	900	750	880
25	850	880	910	920	760	880
30					1020	

Table LIV. (Cont'd)

		Station 4 (Cont'd)					
Depth		Cruise 26					
(m)							
S		790					
5		790					
10		790					
15		830					
20		870					
25		870					
		Station 5					
		Cruise 1	Cruise 2	Cruise 3	Cruise 4	Cruise 5	Cruise 6
S		900	980	1000	990	540	695
		Cruise 7	Cruise 8	Cruise 9	Cruise 10	Cruise 11	Cruise 12
S		460	750	510	800	875	930
5					800		950
		Cruise 13	Cruise 14	Cruise 15	Cruise 16	Cruise 17	Cruise 18
S		1070	1050	960	900	870	890
5		1070	1050	970	900	840	880
		Cruise 19	Cruise 20	Cruise 21	Cruise 22	Cruise 23	Cruise 24
S		840	880	955	900	1000	750
5		830	880	955	910	1030	760
10				970	920		950
		Cruise 25	Cruise 26				
S		910	870				
5		900	870				

Table LV. Ortho-phosphate profiles (mg/l PO_4^{3-}) of Bighorn Lake at station 0 for indicated cruises, 1968.

Station 0						
Depth (m)	Cruise 1	Cruise 5	Cruise 10	Cruise 14	Cruise 18	Cruise 22
S	0.25	0.05	0.00	0.03	0.03	0.01
10	0.16	0.09	0.00	0.00	0.03	0.00
20	0.16	0.23	0.00	0.00	0.04	0.00
30	0.16	0.20	0.00	0.00	0.14	0.01
40	0.11	0.11	0.00	0.16	0.09	0.02
50	0.18	0.09	0.00	0.03	0.10	0.01
60	0.18	0.02	0.00	0.13	0.09	0.01
70	0.20	0.02	0.00	0.00	0.06	0.02
80	0.23	0.07	0.80	0.03	0.06	0.00
90	0.29	0.05	0.00	0.00	0.06	0.00
100	0.23		0.00	0.14	0.07	0.00
110	0.23		0.00	0.26	0.09	0.00
120	0.23		0.00	0.00	0.10	0.00
Cruise 26						
S	0.00					
10	0.02					
20	0.02					
30	0.02					
40	0.01					
50	0.02					
60	0.01					
70	0.01					
80	0.00					
90	0.00					
100	0.04					
110	0.00					
120	0.00					

Table LVI. Nitrate nitrogen profiles (mg/l NO_3^- -N) of Bighorn Lake at station 0 for indicated³ cruises, 1968.

Station 0						
Depth (m)	Cruise 1	Cruise 5	Cruise 10	Cruise 14	Cruise 18	Cruise 22
S	0.26	0.31	0.28	0.22	0.34	0.48
10	0.32	0.31	0.42	0.26	0.37	0.53
20	0.28	0.42	0.22	0.53	0.71	0.57
30	0.26	0.34	0.29	0.61	0.68	0.60
40	0.31	0.38	0.60	0.57	0.62	0.90
50	0.26	0.43	0.45	0.72	0.65	0.42
60	0.34	0.52	0.29	0.62	0.87	0.72
70	0.35	0.60	0.39	0.41	0.65	0.73
80	0.42	0.59	0.26	0.41	0.57	0.58
90	0.38	0.66	0.23	0.56	0.65	0.71
100	0.45		0.39	0.58	0.63	0.63
110	0.58		0.57	0.48	0.70	
120	0.67		0.27	0.48	0.68	0.52
Cruise 26						
S	0.64					
10	0.63					
20	0.71					
30	0.63					
40	0.65					
50	0.46					
60	0.58					
70	0.61					
80	0.54					
90	0.65					
100	0.69					
110	0.71					
120	0.65					

Table LVII. Dissolved oxygen profiles (mg/l O_2) of Bighorn Lake at station 0 for indicated cruises, 1968.

Station 0						
Depth (m)	Cruise 1	Cruise 5	Cruise 10	Cruise 14	Cruise 18	Cruise 22
S	11.6	8.7	8.7	7.6	7.0	7.1
10	10.5	8.4	7.2	6.9	6.9	7.1
20	10.6	9.0	7.1	5.4	4.5	7.2
30	10.6	9.1	6.9	5.8	4.8	6.8
40	10.0	9.2	6.0	5.4	4.7	5.8
50	9.2	8.6	4.2	3.6	4.4	5.3
60	8.4	8.3	5.5	5.0	2.5	3.2
70	7.4	7.8	7.1	6.6	4.6	5.3
80	6.7	6.8	7.1	6.1	4.5	4.9
90	6.8	6.2	5.6	4.7	4.1	4.5
100	6.2	4.8	5.0	4.3	3.2	3.5
110	1.6	2.7	4.7	5.8	2.6	3.5
120	0.6	3.6	4.1	3.1	2.5	3.5

Cruise 26	
S	5.5
10	5.3
20	5.2
30	5.2
40	4.5
50	4.4
60	3.5
70	2.8
80	3.2
90	2.4
100	2.0
110	1.5
120	1.1

Table LVIII. pH profiles of Bighorn Lake at station 0 for indicated cruises during 1968.

Depth (m)	Station 0					
	Cruise 1	Cruise 5	Cruise 10	Cruise 14	Cruise 18	Cruise 22
S	8.20	8.50	8.65	8.77	8.38	8.45
10	8.20	8.51	8.40	8.62	8.40	8.40
20	8.20	8.40	8.31	8.28	8.01	8.40
30	8.20	8.40	8.23	8.22	8.00	8.30
40	8.10	8.30	8.09	8.06	7.91	8.30
50	8.00	8.20	7.80	7.88	7.83	8.25
60	7.90	8.10	7.97	8.02	7.73	8.00
70	7.85	8.00	8.04	8.10	7.84	8.08
80	7.80	7.95	7.98	8.00	7.85	8.00
90	7.78	7.90	7.72	7.89	7.78	8.00
100	7.70	7.82	7.80	7.85	7.71	8.00
110	7.55	7.80	7.72	8.20	7.64	8.00
120	7.55		7.72	7.79	7.66	8.00
Cruise 26						
S	8.20					
10	8.14					
20	8.15					
30	8.13					
40	8.12					
50	8.09					
60	7.97					
70	7.85					
80	7.80					
90	7.75					
100	7.69					
110	7.99					
120	7.62					

Appendix C

Euphotic Zone Data

Table LIX.

Range and mean cell volumes (mm^3/l) for the phytoplankton species present at each sampling station of Bighorn Lake during the study.

Taxon	Station					
	0	1	2	3	4	5
Class Chlorophyceae						
<u>Actinastrum Hantzschii</u>	0.00-0.02 t	0.00- t t	0.00-0.01 t	0.00-0.00 0.00	0.00-0.04 t	0.00-0.16 t
<u>Ankistrodesmus Braunii</u>	0.00-0.46 0.02	0.00-0.03 t	0.00-0.03 t	0.00-0.05 t	0.00-0.01 t	0.00-0.07 t
<u>Ankistrodesmus falcatus</u>	0.00-0.11 0.01	0.00-0.05 t	0.00-0.03 t	0.00-0.06 0.01	0.00-0.04 t	0.00-0.13 0.01
<u>Characium</u> sp.	0.00-0.00 0.00	0.00-0.02 t	0.00-0.02 t	0.00-0.06 t	0.00-0.04 t	0.00-0.29 0.01
<u>Closterium</u> sp.	0.00-0.00 0.00	0.00-0.00 0.00	0.00-0.00 0.00	0.00-0.00 0.00	0.00-0.00 0.00	0.00-0.17 0.01
<u>Cosmarium subcostatum</u>	0.00-0.00 0.00	0.00-0.00 0.00	0.00-2.83 0.05	0.00-0.00 0.00	0.00-0.40 0.01	0.00-0.00 0.00
<u>Crucigenia</u> sp.	0.00-0.00 0.00	0.00-0.00 0.00	0.00-0.00 0.00	0.00-0.00 0.00	0.00-0.00 0.00	0.00-0.05 t
<u>Pandorina morum</u>	0.00-0.23 0.02	0.00-0.11 0.01	0.00-0.11 0.01	0.00-0.07 0.01	0.00-0.16 0.01	0.00-0.45 0.03
<u>Pediastrum duplex</u>	0.00-0.65 0.02	0.00-2.07 0.14	0.00-7.91 0.29	0.00-4.98 0.29	0.00-2.27 0.06	0.00-3.58 0.06
<u>Oocystis</u> sp.	0.00-0.71 0.05	0.00-0.15 0.01	0.00-0.23 0.03	0.00-1.34 0.04	0.00-0.54 0.03	0.00-0.15 0.01
<u>Scenedesmus acuminatis</u>	0.00-0.00 0.00	0.00-0.11 t	0.00-0.35 0.01	0.00-0.44 0.03	0.00-0.34 0.03	0.00-0.60 0.04
<u>Scenedesmus quadricauda</u>	0.00-0.02 t	0.00-0.02 t	0.00-0.45 0.03	0.00-0.31 0.02	0.00-0.42 0.03	0.00-1.89 0.10
<u>Schroederia setigera</u>	0.00-0.06 t	0.00-0.01 t	0.00-0.04 t	0.00-0.02 t	0.00-0.09 0.01	0.00-0.24 0.02

Table LIX. (Cont'd)

Taxon	Station					
	0	1	2	3	4	5
<u>Staurostrum paradoxum</u>	0.00-0.65 0.01	0.00-8.06 0.16	0.00-0.00 0.00	0.00-0.00 0.00	0.00-0.00 0.00	0.00-0.00 0.00
<u>Westella botryoides</u>	0.00-0.00 0.00	0.00-0.00 0.00	0.00-0.10 t	0.00-0.24 0.01	0.00-0.26 0.01	0.00-0.22 t
<u>Westella linearis</u>	0.00-0.00 0.00	0.00-0.00 0.00	0.00-0.00 0.00	0.00-0.03 t	0.00-0.00 0.00	0.00-0.00 0.00
Class Bacillariophyceae						
<u>Achnanthes lanceolata</u>	0.00-0.00 0.00	0.00-0.00 0.00	0.00-0.07 t	0.00-0.07 t	0.00-0.11 t	0.00-0.04 t
<u>Asterionella formosa</u>	0.00-2.43 0.08	0.00-5.09 0.44	0.00-16.94 1.14	0.00-7.43 0.63	0.00-5.19 0.48	0.00-3.69 0.31
<u>Caloneis amphisbaena</u>	0.00-0.00 0.00	0.00-0.00 0.00	0.00-0.00 0.00	0.00-0.00 0.00	0.00-8.82 0.16	0.00-0.00 0.00
<u>Cocconeis</u> spp.	0.00-0.08 t	0.00-0.20 t	0.00-0.17 0.01	0.00-0.00 0.00	0.00-0.22 0.01	0.00-1.31 0.06
<u>Cyclotella</u> spp.	0.00-0.20 0.01	0.00-1.48 0.05	0.00-0.47 0.11	0.00-1.68 0.21	0.00-3.10 0.21	0.00-6.35 0.40
<u>Cymbella affinis</u>	0.00-0.00 0.00	0.00-0.00 0.00	0.00-0.09 t	0.00-0.04 t	0.00-0.49 0.00	0.00-2.75 0.18
<u>Diatoma elongatum</u>	0.00-0.03 t	0.00-0.07 0.01	0.00-0.11 0.01	0.00-0.02 t	0.00-0.11 t	0.00-0.18 0.01
<u>Diatoma hiemale</u>	0.00-0.04 t	0.00-0.00 0.00	0.00-0.00 0.00	0.00-0.00 0.00	0.00-0.00 0.00	0.00-0.00 0.00
<u>Diatoma vulgare</u>	0.00-0.13 0.02	0.00-0.17 0.02	0.00-0.17 0.01	0.00-0.35 0.02	0.00-0.80 0.03	0.00-4.53 0.26
<u>Diatomella Balfouriana</u>	0.00-0.00 0.00	0.00-0.00 0.00	0.00-0.00 0.00	0.00-0.03 t	0.00-0.00 0.00	0.00-0.00 0.00

Table LIX. (Cont'd)

Taxon	Station					
	0	1	2	3	4	5
<u>Eunotia</u> sp.	0.00-0.00 0.00	0.00-0.00 0.00	0.00-0.05 t	0.00-0.00 0.00	0.00-0.49 0.01	0.00-0.13 t
<u>Fragilaria capucina</u>	0.00-0.29 0.01	0.00-0.67 0.02	0.00-0.08 0.01	0.00-0.59 0.01	0.00-0.06 t	0.00-0.54 0.01
<u>Fragilaria crotonensis</u>	0.00-10.59 0.85	0.00-18.95 1.74	0.00-9.83 1.24	0.00-10.98 1.35	0.00-9.35 0.78	0.00-23.48 1.37
<u>Gomphonema</u> spp.	0.00-0.03 t	0.00-0.09 t	0.00-0.08 t	0.00-0.09 t	0.00-0.05 t	0.00-2.56 0.13
<u>Gyrosigma</u> <u>Spencerii</u>	0.00-0.00 0.00	0.00-0.00 0.00	0.00-0.65 0.01	0.00-0.00 0.00	0.00-0.00 0.00	0.00-0.00 0.00
<u>Hanneae</u> <u>arcus</u>	0.00-0.00 0.00	0.00-0.00 0.00	0.00-0.00 0.00	0.00-0.00 0.00	0.00-0.18 t	0.00-0.00 0.00
<u>Melosira</u> <u>granulata</u>	0.00-0.38 0.01	0.00-2.44 0.12	0.00-4.62 0.21	0.00-5.91 0.31	0.00-2.67 0.25	0.00-1.92 0.14
<u>Melosira</u> <u>italica</u>	0.00-0.46 0.01	0.00-0.30 0.03	0.00-0.68 0.10	0.00-0.94 0.10	0.00-1.01 0.12	0.00-0.60 0.08
<u>Navicula</u> spp.	0.00-0.16 0.01	0.00-0.09 t	0.00-0.11 0.01	0.00-0.07 0.01	0.00-0.98 0.08	0.00-5.43 0.41
<u>Nitzschia</u> spp.	0.00-0.08 0.01	0.00-0.39 0.01	0.00-0.00 0.00	0.00-0.11 t	0.00-0.25 0.01	0.00-3.77 0.08
<u>Stephanodiscus</u> <u>niagarae</u>	0.00-0.55 0.02	0.00-3.61 0.34	0.00-4.41 0.49	0.00-8.43 0.97	0.00-8.59 0.78	0.00-13.85 0.51
<u>Surirella</u> <u>ovata</u>	0.00-0.11 t	0.00-0.00 0.00	0.00-0.55 0.02	0.00-0.06 t	0.00-0.78 0.04	0.00-0.68 0.03
<u>Synedra</u> <u>ulna</u>	0.00-0.37 0.02	0.00-0.35 0.01	0.00-0.28 0.02	0.00-0.75 0.04	0.00-1.71 0.07	0.00-3.23 0.15

Table LIX. (Cont'd)

Taxon	Station					
	0	1	2	3	4	5
Class Chrysophyceae						
<u>Dinobryon sertularia</u>	0.00-0.14 t	0.00-0.34 0.01	0.00-0.23 0.01	0.00-0.08 t	0.00-0.21 t	0.00-0.21 t
Class Xanthophyceae						
<u>Botryococcus sudeticus</u>	0.00-0.29 0.01	0.00-0.03 t	0.00-1.70 0.04	0.00-0.30 0.01	0.00-0.14 t	0.00-1.98 0.04
Class Myxophyceae						
<u>Anabaena</u> sp.	0.00-0.02 t	0.00-0.20 0.07	0.00-0.40 0.02	0.00-0.50 0.01	0.00-0.13 0.01	0.00-0.09 t
<u>Aphanizomenon flos-aquae</u>	0.00-6.72 0.31	0.00-6.22 0.40	0.00-3.95 0.67	0.00-8.07 0.71	0.00-4.21 0.62	0.00-5.43 0.21
<u>Coelosphaerium Nagelianum</u>	0.00- t t	0.00-1.56 0.05	0.00-0.00 0.00	0.00-0.10 t	0.00-0.30 0.01	0.00-0.00 0.00
<u>Microcystis aeruginosa</u>	0.00-7.96 0.22	0.00-7.83 0.21	0.00-2.64 0.07	0.00- t t	0.00-1.26 0.02	0.00-0.01 t
Class Dinophyceae						
<u>Geratium hirundinella</u>	0.00-2.97 0.33	0.00-1.03 0.02	0.00-1.16 0.04	0.00-2.83 0.14	0.00-0.00 0.00	0.00-0.00 0.00
<u>Peridinium</u> sp.	0.00-0.02 t	0.00-0.36 0.01	0.00-0.46 0.03	0.00-1.83 0.08	0.00-0.82 0.05	0.00-2.15 0.04

Table LIX. (Cont'd)

Taxon	Station					
	0	1	2	3	4	5
Class Cryptophyceae						
<u>Dryptomonas ovata</u>	0.00-1.41	0.00-6.06	0.00-7.66	0.00-7.39	0.00-7.21	0.00-11.15
	0.22	0.45	1.13	1.01	1.10	0.37
<u>Rhodomonas lacustris</u>	0.00-0.40	0.00-0.48	0.00-0.85	0.00-0.64	0.00-0.49	0.00-2.65
	0.06	0.09	0.14	0.12	0.09	0.13
Microplankton	0.00-0.23	0.00-0.39	0.00-0.42	0.00-0.48	0.00-0.65	0.00-1.01
	0.04	0.06	0.06	0.07	0.09	0.18

t = less than 0.01 mm³/l

Table LX. Total phytoplankton standing crops (mm^3/l) in the euphotic zone of Bighorn Lake during the study.

1968	Station					
	0	1	2	3	4	5
5/ 5	1.398	0.908	2.236	5.126	2.347	8.195
5/13	0.422	2.248	4.489	2.248	4.503	10.848
5/20	1.355	1.644	7.791	2.973	0.964	5.023
5/27	0.607	3.844	4.304	2.262	1.572	12.521
6/ 7	1.900	3.094	1.842	1.264	0.806	12.609
6/12	0.615	5.525	3.011	3.504	10.063	5.405
6/20	0.246	0.700	3.853	0.476	2.067	5.658
6/27	3.068	0.872	0.838	0.754	0.476	8.082
7/ 2	1.378	1.570	2.542	3.781	1.853	0.951
7/ 8	6.207	3.119	2.562	8.536	3.794	2.657
7/15	1.362	12.776	10.253	11.117	4.562	3.842
7/23	1.624	9.547	13.395	7.019	15.324	5.103
7/29	1.927	9.838	6.244	20.743	7.152	10.505
8/ 5	3.977	2.012	3.383	10.515	6.316	11.864
8/12	1.285	3.464	4.927	8.066	5.048	1.373
8/19	1.740	3.502	5.152	11.765	4.529	0.895
8/26	0.809	1.911	3.875	4.711	12.178	0.716
9/ 3	2.185	1.325	3.342	4.624	4.815	1.212
9/ 9	0.563	3.598	4.345	8.516	2.270	4.025
9/17	0.356	2.776	2.453	1.599	0.858	1.833
9/23	0.234	1.198	0.528	1.396	3.507	0.506
10/ 2	0.343	0.277	0.301	2.175	2.784	1.601
10/ 8	0.407	0.295	0.061	0.254	2.877	4.436
10/14	0.099	1.336	0.082	0.459	1.016	1.296
10/22	0.174	0.369	0.127	1.988	3.471	3.524
11/ 2	0.114	0.402	0.105	1.181	2.251	2.325
1969						
4/15	2.119	1.652	3.273	4.228	0.894	0.000
4/21	3.922	3.778	10.646	2.953	3.608	10.127
4/28	4.774	8.885	4.490	9.187	5.491	25.623
5/ 5	11.117	13.859	8.189	7.771	12.968	4.612
5/12	6.229	9.365	10.313	4.583	5.442	5.966
5/21	4.811	9.305	19.736	5.226	6.858	4.328

Table LX. (Cont'd)

		Station				
1969 (Cont'd)	0	1	2	3	4	5
5/27	1.505	4.635	10.388	8.713	5.165	2.714
6/ 3	0.366	1.598	11.104	13.638	9.991	22.363
6/13	1.040	0.386	6.417	11.159	15.152	19.097
6/18	0.415	0.286	9.513	3.045	3.995	5.315
6/24	3.351	3.003	8.396	6.771	3.868	4.303
6/30	3.765	8.190	5.213	20.812	16.380	1.109
7/22	0.141	4.326	9.556	20.960	3.943	4.003
7/28	0.241	2.511	9.805	10.768	3.290	4.202
8/ 4	0.108	4.078	5.382	4.901	9.798	15.859
8/11	0.193	0.554	7.479	4.957	6.602	11.394
1970						
6/11	3.158	4.147	6.917	6.845	5.218	11.704
6/18	1.982	1.756	10.398	1.767	3.495	2.780
6/24	0.243	4.651	8.597	4.643	7.053	4.104
7/ 2	0.780	1.730	4.506	0.933	1.355	0.689
7/ 8	0.827	4.902	5.624	1.244	5.539	4.105
7/16	7.254	2.091	5.725	2.958	2.143	4.023
7/23	6.616	26.232	2.340	6.810	7.881	12.688
7/29	10.978	16.287	9.075	6.366	5.344	7.244
8/ 4	2.926	5.695	22.240	6.957	5.210	8.747
8/10	3.590	8.412	4.344	18.893	4.940	3.674
8/18	1.832	3.531	7.370	11.587	17.376	7.882
8/24	11.086	14.482	11.626	5.885	5.074	9.320
9/ 1	0.682	10.025	1.482	4.294	6.105	9.122
9/ 8	2.209	3.090	3.193	1.349	2.205	0.520

Table LXI. Bacillariophyceae standing crops (mm^3/l) in the euphotic zone of Bighorn Lake during the study.

1968	Station					
	0	1	2	3	4	5
5/ 5	0.571	0.582	1.769	4.819	2.316	8.195
5/13	0.414	1.904	3.302	1.304	3.740	8.078
5/20	1.110	1.206	6.775	2.136	0.461	4.984
5/27	0.282	3.652	3.229	1.202	0.964	11.981
6/ 7	0.787	2.430	0.788	0.748	0.698	12.521
6/12	0.021	3.374	0.689	1.711	9.840	5.099
6/20	0.095	0.275	1.291	0.314	1.798	5.544
6/27	0.402	0.405	0.285	0.265	0.176	7.859
7/ 2	1.030	1.013	0.459	1.585	0.271	0.771
7/ 8	3.865	1.301	1.379	2.344	2.672	1.981
7/15	1.097	0.600	7.282	8.832	3.095	1.964
7/23	0.833	8.134	10.906	5.582	3.401	4.326
7/29	0.171	9.201	3.136	9.954	5.867	9.236
8/ 5	0.007	1.421	2.833	5.584	1.610	7.936
8/12	0.094	0.704	2.911	6.645	3.111	1.268
8/19	0.016	0.085	1.807	9.360	2.180	0.670
8/26	0.621	0.021	0.106	0.000	8.195	0.000
9/ 3	0.045	0.094	0.018	0.000	0.068	0.138
9/ 9	0.052	1.080	0.083	0.000	0.000	0.411
9/17	0.008	0.000	0.000	0.000	0.397	0.368
9/23	0.000	0.432	0.000	0.020	0.130	0.168
10/ 2	0.050	0.085	0.195	0.617	0.086	0.264
10/ 8	0.309	0.024	0.038	0.062	0.020	3.144
10/14	0.064	1.186	0.000	0.339	0.000	1.217
10/22	0.000	0.203	0.033	0.100	0.958	3.160
11/ 2	0.041	0.250	0.069	0.020	1.070	2.043
1969						
4/16	1.915	1.258	2.540	4.013	0.894	0.000
4/22	3.483	2.935	9.831	2.310	3.335	9.841
4/29	4.460	8.636	3.639	7.618	5.435	25.560
5/ 5	10.771	13.423	7.891	6.940	12.810	4.579
5/12	5.986	8.489	10.163	4.136	3.755	1.442
5/21	4.729	8.637	18.670	2.791	5.782	1.106
5/27	1.354	4.584	9.623	7.344	4.551	2.672

Table LXI. (Cont'd)

		Station				
1969 (Cont'd) 0		1	2	3	4	5
6/ 3	0.068	1.355	9.986	12.429	9.585	18.053
6/11	0.226	0.204	5.775	9.645	13.993	14.861
6/18	0.045	0.030	3.175	2.256	1.531	1.519
6/24	0.194	1.181	5.537	2.824	2.066	2.975
7/ 1	1.409	1.494	2.957	8.619	8.775	0.553
7/22	0.027	2.972	5.139	15.208	3.026	3.783
7/29	0.000	1.773	5.516	5.439	2.472	2.953
8/ 5	0.000	0.417	1.096	0.000	3.826	3.664
8/12	0.000	0.000	0.429	0.000	2.827	2.771
1970						
6/11	2.573	3.628	5.844	6.027	4.326	10.806
6/18	0.934	1.463	2.704	0.864	1.831	0.181
6/24	0.102	2.868	5.390	2.446	6.017	2.288
7/ 2	0.226	0.786	2.215	0.746	0.780	0.030
7/ 8	0.442	1.968	0.452	0.000	1.276	1.382
7/16	0.132	1.395	1.226	1.344	1.046	0.725
7/23	2.260	25.360	1.753	3.622	0.446	0.075
7/29	2.178	13.612	1.284	0.160	0.000	0.727
8/ 4	0.632	4.853	10.943	4.617	0.000	0.000
8/10	0.552	2.722	3.651	17.645	4.041	0.113
8/18	0.076	0.000	2.423	9.285	11.507	1.156
8/24	0.020	0.000	0.000	0.000	1.542	6.484
9/ 1	0.000	0.000	0.000	0.211	0.300	5.982
9/ 8	1.835	0.133	0.000	0.066	0.202	0.072

Table LXII. Chlorophyceae standing crops (mm^3/l) in the euphotic zone of Bighorn Lake during the study.

1968	Station					
	0	1	2	3	4	5
5/ 5	0.000	0.000	0.004	0.000	0.000	0.000
5/13	0.000	0.007	0.024	0.004	0.081	0.188
5/20	0.000	0.011	0.078	0.173	0.207	0.000
5/27	0.010	0.022	0.083	0.348	0.367	0.000
6/ 7	0.000	0.010	0.476	0.179	0.049	0.000
6/12	0.148	0.163	0.110	0.318	0.170	0.000
6/20	0.084	0.003	0.146	0.075	0.055	0.000
6/27	0.231	0.002	0.030	0.050	0.252	0.050
7/ 2	0.122	0.009	0.025	0.026	0.242	0.136
7/ 8	0.601	0.065	0.121	2.026	0.654	0.220
7/15	0.011	0.003	0.514	0.266	0.116	1.199
7/23	0.008	1.078	0.398	0.766	3.186	0.538
7/29	0.381	0.111	0.182	5.038	0.409	0.466
8/ 5	0.758	0.013	0.039	0.539	0.855	2.730
8/12	0.000	0.565	0.002	0.078	0.513	0.000
8/19	0.034	0.000	0.005	0.149	0.000	0.025
8/26	0.000	0.002	0.000	0.036	0.022	0.453
9/ 3	0.665	0.000	0.000	0.000	0.000	0.233
9/ 9	0.000	0.045	0.000	0.000	0.000	2.204
9/17	0.001	0.013	0.000	0.000	0.057	0.114
9/23	0.023	0.000	0.038	0.009	0.020	0.161
10/ 2	0.009	0.055	0.000	0.000	0.000	0.181
10/ 8	0.004	0.001	0.000	0.000	0.000	0.261
10/14	0.002	0.019	0.004	0.000	0.000	0.030
10/22	0.049	0.002	0.000	0.000	0.000	0.349
11/ 2	0.000	0.000	0.001	0.000	0.401	0.063
1969						
4/16	0.000	0.000	0.000	0.027	0.000	0.000
4/22	0.000	0.000	0.000	0.000	0.000	0.000
4/29	0.000	0.000	0.000	0.058	0.000	0.063
5/ 5	0.000	0.009	0.063	0.031	0.034	0.000
5/12	0.000	0.009	0.029	0.249	0.496	0.517
5/21	0.031	0.123	0.040	0.745	0.138	0.854
5/27	0.088	0.000	0.269	0.111	0.029	0.035

Table LXII. (Cont'd)

		Station				
1969 (Cont'd)	0	1	2	3	4	5
6/ 3	0.011	0.000	0.017	0.175	0.112	3.608
6/11	0.761	0.005	0.000	0.161	0.070	0.550
6/18	0.017	0.000	0.101	0.077	0.205	0.519
6/24	0.005	0.001	0.092	1.363	0.171	0.036
7/ 1	0.006	0.150	0.833	4.670	0.023	0.029
7/22	0.019	0.855	0.207	0.180	0.046	0.123
7/29	0.178	0.047	3.512	0.070	0.020	0.138
8/ 5	0.024	0.050	0.090	0.156	0.000	0.205
8/ 2	0.000	0.000	2.845	0.748	0.000	0.100
1970						
6/11	0.034	0.046	0.039	0.036	0.000	0.000
6/18	0.464	0.010	0.000	0.000	0.012	0.000
6/29	0.000	1.136	0.133	0.013	0.247	0.122
7/ 2	0.000	0.007	0.031	0.003	0.130	0.224
7/ 8	0.016	1.966	0.032	0.048	0.024	0.124
7/16	0.416	0.039	0.050	0.030	0.013	0.018
7/23	0.000	0.256	0.002	0.137	0.015	0.522
7/29	0.294	2.183	4.648	3.230	0.052	0.103
8/ 4	0.740	0.067	8.089	0.637	0.134	0.275
8/10	0.344	0.192	0.133	0.003	0.084	0.048
8/18	0.292	0.064	0.004	0.048	0.003	0.047
8/24	0.046	0.000	0.164	0.064	0.194	0.035
9/ 1	0.000	8.065	0.108	0.040	0.560	0.126
9/ 8	0.242	0.834	0.000	0.000	0.000	0.000

Table LXIII. Myxophyceae standing crops (mm^3/l) in the euphotic zone of Bighorn Lake during the study.

1968	Station					
	0	1	2	3	4	5
5/ 5	0.000	0.000	0.000	0.000	0.000	0.000
5/13	0.000	0.000	0.004	0.000	0.002	0.000
5/20	0.000	0.000	0.000	0.000	0.004	0.000
5/27	0.000	0.000	0.000	0.000	0.000	0.000
6/ 7	0.000	0.000	0.000	0.020	0.000	0.000
6/12	0.000	0.000	0.000	0.000	0.000	0.000
6/20	0.000	0.000	0.000	0.000	0.000	0.000
6/27	0.000	0.000	0.000	0.000	0.000	0.000
7/ 2	0.000	0.075	0.000	0.000	0.000	0.000
7/ 8	0.031	0.000	0.035	0.196	0.022	0.000
7/15	0.042	1.123	0.038	0.000	0.000	0.000
7/23	0.138	0.033	0.041	0.000	0.000	0.000
7/29	0.191	0.114	0.070	0.017	0.000	0.000
8/ 5	0.279	0.369	0.272	0.135	0.063	0.000
8/12	0.540	1.726	0.670	0.550	0.000	0.000
8/19	0.078	1.489	3.054	0.393	0.228	0.000
8/26	0.043	1.490	3.160	2.710	3.714	0.230
9/ 3	0.145	1.012	2.704	4.473	4.486	0.000
9/ 9	0.123	2.204	3.644	8.073	2.117	0.023
9/17	0.239	2.632	2.258	0.989	0.202	0.756
9/23	0.071	0.585	0.416	1.226	2.745	0.053
10/ 2	0.000	0.000	0.020	1.461	2.388	0.185
10/ 8	0.000	0.001	0.000	0.026	2.596	0.000
10/14	0.000	0.000	0.000	0.000	0.538	0.003
10/22	0.000	0.000	0.000	0.000	0.836	0.000
11/ 2	0.000	0.000	0.000	0.000	0.022	0.000
1969						
4/16	0.000	0.000	0.000	0.000	0.000	0.000
4/22	0.000	0.000	0.000	0.000	0.000	0.000
4/29	0.000	0.000	0.000	0.000	0.000	0.000
5/ 5	0.000	0.000	0.000	0.000	0.000	0.000
5/12	0.000	0.000	0.000	0.000	0.000	0.000
5/21	0.000	0.000	0.000	0.000	0.000	0.000
5/27	0.000	0.000	0.000	0.000	0.000	0.000

Table LXIII. (Cont'd)

		Station				
1969 (Cont'd)	0	1	2	3	4	5
6/ 3	0.000	0.000	0.000	0.000	0.000	0.000
6/11	0.000	0.000	0.000	0.000	0.000	0.000
6/18	0.004	0.000	0.000	0.000	0.000	0.029
6/24	0.000	0.000	0.000	0.011	0.000	0.000
7/ 1	0.000	0.000	0.000	0.000	0.000	0.000
7/22	0.000	0.001	1.323	0.041	0.477	0.008
7/29	0.001	0.089	0.018	1.939	0.212	0.609
8/ 5	0.018	3.078	3.855	4.320	3.760	4.863
8/12	0.027	0.431	0.946	3.783	3.686	5.426
1970						
6/11	0.000	0.000	0.063	0.000	0.000	0.000
6/18	0.000	0.000	0.000	0.000	0.000	0.000
6/24	0.000	0.000	0.000	0.000	0.000	0.000
7/ 2	0.000	0.000	0.000	0.000	0.000	0.000
7/ 8	0.022	0.000	0.027	0.000	0.000	0.000
7/16	6.140	0.032	0.063	0.000	0.000	0.000
7/23	1.806	0.000	0.161	0.000	0.066	0.000
7/29	6.720	0.115	0.155	0.000	0.000	0.000
8/ 4	1.220	0.086	2.093	0.021	0.000	0.000
8/10	2.334	3.458	0.353	0.639	0.000	0.000
8/18	1.168	3.209	3.931	1.161	0.079	0.030
8/24	8.034	14.050	5.579	4.386	2.544	0.052
9/ 1	0.296	1.388	1.204	3.117	4.212	1.311
9/ 8	0.000	2.019	3.028	1.009	1.598	0.295

Table LXIV. Cryptophyceae standing crops (mm^3/l) in the euphotic zone of Bighorn Lake during the study.

1968	Station					
	0	1	2	3	4	5
5/ 5	0.827	0.326	0.463	0.307	0.023	0.000
5/13	0.008	0.337	1.124	0.924	0.610	0.031
5/20	0.238	0.372	0.904	0.635	0.221	0.000
5/27	0.311	0.069	0.867	0.391	0.198	0.000
6/ 7	0.865	0.540	0.393	0.283	0.044	0.000
6/12	0.127	1.869	2.029	1.413	0.006	0.000
6/20	0.047	0.340	2.331	0.054	0.075	0.000
6/27	0.377	0.455	0.506	0.420	0.020	0.000
7/ 2	0.213	0.454	1.861	1.997	1.203	0.000
7/ 8	0.497	1.422	0.903	2.513	0.282	0.257
7/15	0.145	0.102	1.954	1.463	0.952	0.230
7/23	0.294	0.263	0.700	0.517	1.043	0.101
7/29	1.131	0.358	2.756	3.932	0.601	0.530
8/ 5	0.656	0.168	0.179	1.390	3.069	0.971
8/12	0.630	0.290	0.144	0.767	0.499	0.000
8/19	0.108	0.820	0.232	1.015	2.087	0.059
8/26	0.107	0.329	0.550	1.653	0.165	0.020
9/ 3	0.030	0.172	0.483	0.093	0.195	0.593
9/ 9	0.384	0.158	0.202	0.443	0.114	0.706
9/17	0.091	0.051	0.163	0.400	0.124	0.307
9/23	0.103	0.135	0.009	0.105	0.572	0.047
10/ 2	0.237	0.077	0.067	0.028	0.266	0.816
10/ 8	0.038	0.208	0.010	0.131	0.182	0.977
10/14	0.026	0.095	0.067	0.116	0.420	0.000
10/22	0.023	0.126	0.061	0.126	1.627	0.000
11/ 2	0.062	0.120	0.022	0.130	0.661	0.196
1969						
4/16	0.153	0.354	0.699	0.168	0.000	0.000
4/22	0.427	0.602	0.776	0.530	0.072	0.256
4/29	0.301	0.246	0.817	0.448	0.000	0.000
5/ 5	0.309	0.392	0.193	0.683	0.090	0.020
5/12	0.167	0.814	0.120	0.167	1.039	3.829
5/21	0.017	0.429	0.752	1.534	0.820	1.358
5/27	0.028	0.031	0.401	0.844	0.385	0.000

Table LXIV. (Cont'd)

		Station				
1969 (Cont'd)	0	1	2	3	4	5
6/ 3	0.264	0.217	0.407	0.472	0.203	0.151
6/11	0.029	0.145	0.165	1.300	0.456	1.384
6/18	0.344	0.241	6.179	0.700	2.228	2.735
6/24	0.546	1.797	2.714	2.245	1.602	1.199
7/ 1	0.216	6.348	1.359	7.485	7.469	0.510
7/22	0.090	0.482	2.809	5.466	0.220	0.000
7/29	0.027	0.552	0.719	1.418	0.543	0.333
8/ 5	0.065	0.165	0.316	0.362	2.177	7.096
8/12	0.158	0.030	0.228	0.476	0.000	3.053
1970						
6/11	0.341	0.122	0.793	0.664	0.591	0.684
6/18	0.554	0.275	7.660	0.902	1.642	2.582
6/24	0.134	0.646	3.052	2.148	0.762	1.694
7/ 2	0.516	0.923	2.205	0.167	0.421	0.291
7/ 8	0.340	0.937	4.667	1.196	4.198	2.287
7/16	0.538	0.584	4.383	1.523	1.062	3.191
7/23	0.022	0.588	0.419	3.050	7.319	11.384
7/29	1.584	0.297	2.961	2.914	4.693	6.357
8/ 4	0.304	0.657	0.966	1.647	5.074	6.042
8/10	0.234	1.868	0.174	0.603	0.809	2.765
8/18	0.278	0.254	0.972	1.004	5.608	6.617
8/24	0.000	0.046	4.086	0.951	0.639	2.582
9/ 1	0.314	0.499	0.150	0.731	0.974	1.641
9/ 8	0.006	0.097	0.163	0.270	0.386	0.147

Table LXV.

Microplankton standing crops (mm^3/l) in the euphotic zone of Bighorn Lake during the study.

1968	Station					
	0	1	2	3	4	5
5/ 5	0.000	0.000	0.000	0.000	0.008	0.000
5/13	0.000	0.000	0.037	0.016	0.070	0.128
5/20	0.007	0.064	0.034	0.029	0.071	0.039
5/27	0.004	0.101	0.125	0.246	0.043	0.540
6/ 7	0.093	0.114	0.062	0.021	0.015	0.088
6/12	0.026	0.119	0.183	0.042	0.047	0.306
6/20	0.011	0.082	0.087	0.033	0.139	0.114
6/27	0.016	0.010	0.017	0.019	0.008	0.173
7/ 2	0.013	0.019	0.060	0.173	0.133	0.039
7/ 8	0.000	0.133	0.054	0.129	0.144	0.199
7/15	0.033	0.031	0.046	0.138	0.116	0.336
7/23	0.083	0.039	0.071	0.082	0.417	0.102
7/29	0.231	0.054	0.103	0.058	0.195	0.273
8/ 5	0.022	0.041	0.060	0.041	0.647	0.227
8/12	0.021	0.281	0.044	0.026	0.109	0.105
8/19	0.033	0.077	0.054	0.040	0.034	0.141
8/26	0.038	0.069	0.059	0.312	0.082	0.013
9/ 3	0.010	0.047	0.141	0.058	0.016	0.248
9/ 9	0.004	0.111	0.416	0.000	0.039	0.781
9/17	0.017	0.080	0.032	0.116	0.078	0.288
9/23	0.037	0.046	0.065	0.036	0.040	0.124
10/ 2	0.047	0.060	0.040	0.069	0.044	0.155
10/ 8	0.056	0.041	0.013	0.035	0.079	0.054
10/14	0.007	0.036	0.011	0.004	0.058	0.046
10/22	0.040	0.038	0.033	0.023	0.050	0.015
11/ 2	0.013	0.032	0.013	0.062	0.097	0.023
1969						
4/15	0.051	0.040	0.003	0.020	0.000	0.000
4/21	0.012	0.011	0.006	0.113	0.201	0.030
4/28	0.013	0.003	0.034	0.043	0.056	0.000
5/ 5	0.037	0.035	0.042	0.117	0.034	0.013
5/12	0.076	0.053	0.001	0.000	0.152	0.000
5/21	0.034	0.169	0.274	0.156	0.089	1.010
5/27	0.005	0.020	0.067	0.134	0.085	0.007

Table LXV. (Cont'd.)

		Station				
1969 (Cont'd)	0	1	2	3	4	5
6/ 3	0.023	0.026	0.045	0.200	0.091	0.551
6/13	0.024	0.032	0.017	0.053	0.094	0.068
6/18	0.005	0.015	0.058	0.012	0.031	0.102
6/23	0.036	0.024	0.053	0.033	0.029	0.093
6/30	0.044	0.038	0.064	0.038	0.113	0.017
7/22	0.005	0.016	0.078	0.065	0.066	0.089
7/28	0.035	0.050	0.040	0.068	0.043	0.169
8/ 4	0.001	0.006	0.025	0.063	0.035	0.031
8/11	0.008	0.093	0.031	0.050	0.089	0.044
1970						
6/11	0.067	0.015	0.027	0.042	0.007	0.054
6/18	0.030	0.008	0.034	0.001	0.010	0.017
6/24	0.007	0.001	0.022	0.014	0.027	0.000
7/ 2	0.038	0.014	0.055	0.017	0.024	0.144
7/ 8	0.007	0.031	0.231	0.000	0.041	0.103
7/16	0.028	0.041	0.003	0.061	0.022	0.089
7/23	0.058	0.028	0.005	0.001	0.035	0.707
7/29	0.202	0.080	0.027	0.000	0.599	0.057
8/ 4	0.030	0.032	0.149	0.035	0.002	0.288
8/10	0.126	0.172	0.033	0.003	0.006	0.748
8/18	0.018	0.004	0.040	0.089	0.043	0.032
8/24	0.016	0.386	0.099	0.484	0.155	0.167
9/ 1	0.072	0.073	0.010	0.195	0.059	0.062
9/ 8	0.126	0.007	0.002	0.004	0.019	0.006

Table LXVI. Chlorophyll a standing crops (mg/m^3) in the euphotic zone of Bighorn Lake during the study.

1968	Station					
	0	1	2	3	4	5
5/ 5	3.2	1.4	9.9	6.4	4.8	9.3
5/13	5.1	2.9	13.8	6.6	8.5	8.0
5/20	5.1	6.6	8.5	7.7	3.5	11.6
5/27	6.7	7.8	12.0	9.4	18.2	40.0
6/ 7	2.1	6.7	7.8	4.9	6.9	24.8
6/12	3.6	9.7	11.7	9.0	5.3	14.2
6/20	4.1	4.3	8.1	2.4	3.5	8.8
6/27	4.3	5.8	7.8	6.0	8.0	29.0
7/29	4.2	7.7	8.5	8.3	21.6	24.8
8/ 5	1.9	3.7	5.0	10.7	12.6	38.1
8/12	3.7	7.7	8.8	11.7	23.8	48.0
8/19	2.8	3.6	4.7	7.3	8.1	2.8
8/26	0.0	2.8	9.7	5.0	0.6	24.2
9/ 3	3.6	7.7	7.3	15.5	24.8	9.3
9/ 9	1.8	5.8	22.8	77.0	25.8	5.9
9/17	0.7	4.3	3.6	3.9	5.8	3.5
9/23	0.7	0.0	2.1	2.1	7.7	1.2
10/ 2	3.6	3.9		5.8	8.5	5.8
10/ 8	2.1	0.7	1.4	1.1	6.6	2.9
10/14	1.4	1.8	2.1	2.5	5.8	3.5
10/21	2.2	2.0	2.2	2.8	6.2	3.5
11/ 2	3.6	3.9	3.6	3.2	5.5	12.9
1969						
4/15	4.3	3.6	8.9	5.0	6.2	17.6
4/21	5.8	6.6	6.6	3.6	5.9	5.3
4/28	2.8	3.2	4.3	3.9	2.9	7.0
5/ 5	2.1	3.2	7.3	7.3	9.3	10.6
5/12	2.8	3.6	4.3	9.7	11.6	25.2
5/21	1.8	2.1	4.3	4.3	3.5	4.4
5/27	6.7	9.7	19.1	25.6	29.5	9.8
6/ 3	2.5	2.5	17.3	27.8	15.5	24.2
6/13	2.1	1.4	5.4	21.0	21.9	20.2
6/18	2.1	2.1	2.8	2.8	5.8	9.8
6/24	2.1	3.7	5.8	6.9	6.9	9.8

Table LXVI. (Cont'd)

		Station				
1969 (Cont'd)	0	1	2	3	4	5
6/30	1.4	7.7	3.9	5.8	6.6	1.8
7/22	1.1	1.8	4.3	2.1	2.5	4.7
7/28	3.2	2.1	8.5	4.7	7.3	10.9
8/ 4	3.4	2.7	4.7	6.2	31.8	39.7
8/11	2.2		8.5	5.8	31.0	25.8
1970						
6/11						
6/18	5.3	20.2	26.2	28.2	32.3	
6/24	1.8	0.0	3.5	24.2	28.2	8.9
7/ 2	1.8	7.1	10.8	5.3	8.9	9.8
7/ 8	8.9	10.8	22.2	10.8	8.9	22.2
7/16	3.5	8.9	12.6	20.2	5.3	10.8
7/23	3.5	12.6		11.7	18.3	28.2
7/29	3.5	7.1	8.9	5.3	10.8	34.5
8/ 4	7.1	5.3	7.1	7.1	12.6	5.3
8/10	1.8	3.5	7.1	10.8	8.9	10.8
8/18	3.5	1.8	7.1	12.6	14.5	8.9
8/24	3.5	5.3	7.1	12.6	16.4	12.6
9/ 1	5.3	1.8	5.3	1.8	3.5	5.3
9/ 8	0.0	1.8	12.6	3.5	3.5	3.5

Table LXVII. Euphotic zone depths (m) of Bighorn Lake during the study.

1968	Station					
	0	1	2	3	4	5
5/ 5	10.0	10.0	7.0	4.0	2.0	0.3
5/13	10.0	8.0	5.0	4.0	3.0	1.4
5/20	10.0	8.0	5.0	3.0	2.0	0.9
5/27	10.0	8.0	6.0	4.0	2.0	0.3
6/ 7	18.0	7.0	3.0	2.0	1.0	0.1
6/12	16.0	7.0	3.0	2.0	2.0	0.1
6/20	18.0	10.0	3.0	2.0	1.0	0.1
6/27	12.0	4.0	2.0	3.0	1.0	0.3
7/ 2	11.0	6.0	3.0	2.0	2.0	1.0
7/ 8	10.0	6.0	6.0	4.0	2.0	1.0
7/15	9.0	6.0	4.0	4.0	3.0	1.0
7/23	8.0	6.0	8.0	6.0	3.0	1.0
7/29	10.0	7.0	7.0	5.0	3.0	0.5
8/ 5	10.0	10.0	10.0	10.0	6.0	1.3
8/12	8.0	6.0	8.0	5.0	3.0	0.5
8/19	8.0	6.0	8.0	6.0	4.0	1.0
8/26	8.0	8.0	8.0	4.0	4.0	1.2
9/ 3	8.0	8.0	5.0	4.0	4.0	2.0
9/ 9	8.0	6.0	4.0	2.0	4.0	2.0
9/17	8.0	6.0	8.0	8.0	4.0	3.0
9/23	9.0	9.0	9.0	9.0	6.0	3.0
10/ 2	9.0	9.0	9.0	8.0	6.0	3.0
10/ 8	9.0	9.0	9.0	9.0	6.0	3.0
10/14	8.0	8.0	9.0	9.0	8.0	3.0
10/22	9.0	8.0	6.0	6.0	6.0	3.0
11/ 2	9.0	9.0	9.0	9.0	9.0	3.0
1969						
4/15	12.0	10.0	8.0	6.0	3.0	0.3
4/21	10.0	10.0	8.0	6.0	3.0	1.3
4/28	11.0	10.0	8.0	5.0	2.0	1.4
5/ 5	12.0	10.0	8.0	6.0	4.0	1.6
5/12	14.0	8.0	6.0	4.0	3.0	1.3
5/21	14.0	8.0	6.0	6.0	4.0	2.0
5/27	10.0	8.0	7.0	4.0	4.0	2.0

Table LXVII. (Cont'd)

		Station				
1969 (Cont'd)	0	1	2	3	4	5
6/ 3	10.0	10.0	4.0	4.0	4.0	3.0
6/13	10.0	10.0	6.0	6.0	4.0	1.8
6/18	12.0	8.0	6.0	6.0	4.0	2.0
6/24	10.0	8.0	6.0	6.0	4.0	3.0
6/30	12.0	6.0	6.0	4.0	4.0	3.0
7/22	10.0	6.0	6.0	6.0	6.0	3.0
7/28	8.0	6.0	6.0	4.0	4.0	3.0
8/ 4	8.0	6.0	3.0	2.0	2.0	1.1
8/11	8.0	8.0	4.0	4.0	3.0	1.5
1970						
6/11	13.0	8.0	5.0	4.0	4.0	4.0
6/18	13.0	7.0	5.0	5.0	4.0	3.0
6/24	14.0	6.0	5.0	5.0	4.0	3.0
7/ 2	13.0	5.0	5.0	2.0	3.0	2.0
7/ 8	7.0	5.0	3.0	3.0	4.0	2.0
7/16	7.0	5.0	3.0	3.0	4.0	3.0
7/23	15.0	6.0	5.0	4.0	4.0	3.0
7/29	6.0	5.0	4.0	11.0	5.0	4.0
8/ 4	7.0	6.0	5.0	6.0	4.0	3.0
8/10	10.0	13.0	12.0	10.0	11.0	4.0
8/18	7.0	6.0	6.0	5.0	4.0	4.0
8/24	9.0	6.0	6.0	5.0	5.0	4.0
9/ 1	9.0	6.0	7.0	5.0	6.0	4.0
9/18	9.0	7.0	7.0	7.0	4.0	2.0

Table LXVIII. Extinction coefficients (k/m) of the euphotic zone of Bighorn Lake during the study.

1968	Station					
	0	1	2	3	4	5
5/ 5	0.39	0.41	0.55	1.18	2.58	15.30
5/13	0.34	0.40	0.60	0.95	1.01	3.18
5/20	0.30	0.39	0.60	1.20	1.67	5.20
5/27	0.33	0.44	0.65	0.86	1.71	5.20
6/ 7	0.23	0.46	0.89	1.73	3.68	79.70
6/12	0.26	0.47	0.98	1.29	2.49	79.60
6/20	0.21	0.43	1.54	2.29	5.00	51.20
6/27	0.34	0.94	2.29	1.22	4.05	17.36
7/ 2	0.34	0.78	1.39	1.62	1.22	4.69
7/ 8	0.34	0.57	0.63	0.85	1.22	2.78
7/15	0.40	0.59	0.59	0.89	0.92	4.77
7/23	0.39	0.52	0.48	0.58	1.20	2.64
7/29	0.42	0.52	0.49	0.67	1.13	8.69
8/ 5	0.42	0.57	0.45	0.61	0.84	3.52
8/12	0.51	0.58	0.46	0.68	1.22	10.00
8/19	0.51	0.49	0.47	0.69	0.99	4.80
8/26	0.46	0.47	0.64	0.95	0.88	3.77
9/ 3	0.39	0.49	0.83	0.96	1.19	2.14
9/ 9	0.49	0.67	1.04	1.36	0.49	1.99
9/17	0.42	0.62	0.53	0.70	1.07	1.56
9/23	0.47	0.32	0.46	0.52	0.76	1.40
10/ 2	0.44	0.41	0.36	0.56	0.74	1.50
10/ 8	0.46	0.47	0.48	0.31	0.57	1.40
10/14	0.54	0.46	0.45	0.41	0.47	1.85
10/21	0.44	0.39	0.46	0.51	0.59	1.87
11/ 2	0.43	0.39	0.38	0.35	0.43	1.50
1969						
4/15	0.32	0.36	0.41	0.66	2.03	16.55
4/21	0.34	0.39	0.53	0.64	0.94	3.36
4/28	0.34	0.38	0.46	1.04	1.42	3.22
5/ 5	0.33	0.39	0.64	0.84	1.22	2.85
5/12	0.31	0.40	0.62	1.03	1.63	3.58
5/21	0.31	0.44	0.59	0.69	1.58	2.14
5/27	0.27	0.35	0.51	0.89	1.06	2.22

Table LXVIII. (Cont'd)

		Station				
1969 (Cont'd) 0		1	2	3	4	5
6/ 3	0.23	0.33	0.55	0.73	0.90	1.48
6/13	0.27	0.31	0.58	0.66	0.80	2.58
6/18	0.25	0.36	0.48	0.54	0.57	2.04
6/24	0.28	0.34	0.49	0.49	0.67	1.51
6/30	0.29	0.51	0.58	0.58	0.78	1.48
7/22	0.31	0.41	0.43	0.56	0.78	1.49
7/28	0.38	0.38	0.52	0.60	0.88	1.40
8/ 4	0.40	0.41	0.45	0.56	0.53	4.01
8/11	0.30	0.47	0.47	0.54	0.80	3.08
1970						
6/11	0.31	0.49	0.88	1.16	1.14	0.67
6/18	0.29	0.52	0.91	0.93	1.14	1.46
6/24	0.26	0.69	0.85	0.89	1.21	1.66
7/ 2	0.32	0.43	0.93	1.99	1.80	2.88
7/ 8	0.60	0.81	1.50	1.36	0.82	2.25
7/16	0.57	0.85	1.34	1.37	1.20	1.32
7/23	0.26	0.73	0.83	1.12	0.79	1.57
7/29	0.65	0.79	0.58	0.36	0.76	1.00
8/ 4	0.60	0.63	0.86	0.66	0.99	1.23
8/10	0.35	0.29	0.21	0.38	0.34	1.08
8/18	0.54	0.66	0.70	0.87	1.05	1.24
8/24	0.46	0.52	0.70	0.84	0.79	0.99
9/ 1	0.38	0.48	0.48	0.66	0.66	1.15
9/ 8	0.44	0.44	0.51	0.47	0.96	2.45

Table LXIX.

Nitrate nitrogen concentrations (mg/l NO_3^- -N) in the euphotic zone of Bighorn Lake during the study.

1968	Station					
	0	1	2	3	4	5
5/ 5	0.29	0.14	0.14	0.37	0.41	0.13
5/13	0.29	0.33	0.31	0.47	0.75	0.51
5/20	0.41	0.32	0.41	0.68	0.76	0.82
5/27	0.42	0.32	0.56	0.73	1.09	1.03
6/ 7	0.31	0.34	0.52	0.57	0.42	0.36
6/12	0.16	0.48	0.40	0.29	0.48	0.42
6/20	0.29	0.36	0.41	0.23	0.16	0.17
6/27	0.54	0.23	0.26	0.26	0.32	0.52
7/ 2	0.29	0.21	0.15	0.14	0.27	0.30
7/ 8	0.30	0.22	0.13	0.18	0.17	0.38
7/15	0.30	0.14	0.07	0.13	0.43	0.51
7/23	0.26	0.13	0.17	0.23	0.41	0.56
7/29	0.15	0.11	0.09	0.16	0.17	0.65
8/ 5	0.22	0.13	0.18	0.20	0.23	0.61
8/12	0.19	0.11	0.21	0.29	0.53	0.90
8/19	0.55	0.38	0.43	0.48	0.85	1.17
8/26	0.44	0.32	0.46	0.66	0.75	1.23
9/ 3	0.33	0.32	0.40	0.59	0.75	0.97
9/ 9	0.27	0.26	0.30	0.28	0.44	0.59
9/17	0.20	0.40	0.40	0.30	0.46	0.47
9/23	0.36	0.32	0.40	0.20	0.38	0.62
10/ 2	0.33	0.47	0.79	0.62	0.51	0.62
10/ 8	0.40	0.31	0.62	0.45	0.51	0.42
10/14	0.58	0.44	0.57	0.63	0.51	0.58
10/21	0.60	0.52	0.65	0.66	0.64	0.47
11/ 2	0.64	0.57	0.54	0.62	0.54	0.35
1969						
4/15	0.51	0.53	0.49	0.74	0.34	0.86
4/21	0.47	0.40	0.38	0.51	0.30	0.32
4/28	0.53	0.45	0.45	0.32	0.25	0.30
5/ 5	0.48	0.36	0.29	0.31	0.35	0.47
5/12	0.42	0.29	0.20	0.47	0.67	0.22
5/21	0.38	0.25	0.28	0.39	0.49	0.70
5/27	0.27	0.21		0.29	0.24	0.55

Table LXIX. (Cont'd)

		Station				
1969 (Cont'd)	0	1	2	3	4	5
6/ 3	0.29	0.21	0.20	0.32	0.42	0.66
6/13	0.29	0.26	0.25	0.36	0.27	0.24
6/18	0.26	0.24	0.35	0.37	0.31	0.68
6/24	0.27	0.31	0.40	0.44	0.65	0.72
6/30	0.91	1.03	1.03	0.69	0.78	0.71
7/22	0.37	0.31	0.16	0.19	0.62	0.65
7/28	0.35	0.53	0.15	0.00	0.24	0.35
8/ 4	0.30	0.41	0.14	0.13	0.19	0.10
8/11	0.32	0.31	0.09	0.07	0.08	0.37
1970						
6/11	0.61	0.62	0.73	0.63	0.54	0.50
6/18	0.10	0.64	0.45	0.33	0.49	0.53
6/24	0.27	0.61	0.45	0.49	0.51	0.64
7/ 2	0.29	0.52	0.58	0.52	0.49	0.53
7/ 8	0.29	0.47	0.52	0.29	0.29	0.27
7/16	0.55	0.17	0.07	0.11	0.18	0.09
7/23	0.55	0.17	0.09	0.15	0.10	0.33
7/29	0.47	0.14	0.13	0.14	0.20	0.25
8/ 4	0.44	0.20	0.07	0.10	0.20	0.29
8/10	0.20	0.08	0.08	0.10	0.21	0.44
8/18	0.18	0.09	0.05	0.09	0.49	0.57
8/24	0.20	0.08	0.05	0.08	0.11	0.53
9/ 1	0.27	0.15	0.18	0.10	0.21	0.51
9/ 8	0.38	0.20	0.45	0.36	0.41	0.66

Table LXX.

Nitrite nitrogen concentrations (mg/l NO_2^- -N) in
the euphotic zone of Bighorn Lake during the study.

1968	Station					
	0	1	2	3	4	5
5/ 5	0.002	0.010	0.010	0.020	0.020	0.030
5/13	0.000	0.010	0.010	0.010	0.010	0.040
5/20	0.010	0.010	0.010	0.010	0.010	0.030
5/27	0.010	0.010	0.010	0.010	0.020	0.020
6/ 7	0.010	0.010	0.000	0.010	0.010	0.010
6/12	0.050	0.010	0.010	0.010	0.010	0.010
6/20	0.010	0.010	0.010	0.000	0.000	0.010
6/27	0.030	0.020	0.020	0.050	0.020	0.030
7/ 2	0.010	0.010	0.010	0.010	0.010	0.010
7/ 8	0.020	0.020	0.010	0.010	0.010	0.010
7/15	0.020	0.010	0.010	0.010	0.010	0.010
7/23	0.000	0.010	0.000	0.010	0.020	0.010
7/29	0.010	0.010	0.010	0.010	0.010	0.010
8/ 5	0.010	0.010	0.010	0.010	0.010	0.010
8/12	0.010	0.010	0.020	0.010	0.010	0.010
8/19	0.010	0.000	0.010	0.020	0.010	0.020
8/26	0.010	0.000	0.010	0.020	0.010	0.010
9/ 3	0.010	0.000	0.010	0.010	0.010	0.010
9/ 9	0.000	0.000	0.000	0.010	0.010	0.010
9/17	0.000	0.000	0.000	0.000	0.000	0.000
9/23						
10/ 2	0.000	0.010	0.010	0.010	0.010	0.010
10/ 8	0.000	0.000	0.010	0.020	0.010	0.010
10/14	0.000	0.000	0.000	0.010	0.030	0.000
10/22	0.000	0.000	0.000	0.000	0.010	0.010
11/ 2	0.000	0.000	0.000	0.000	0.000	0.010
1969						
4/15	0.000	0.000	0.000	0.000	0.010	0.010
4/21	0.010	0.010	0.010	0.010	0.010	0.010
4/28	0.000	0.010	0.010	0.010	0.000	0.020
5/ 5	0.010	0.010	0.010	0.010	0.010	0.010
5/12	0.005	0.008	0.007	0.008	0.008	0.008
5/21	0.004	0.006	0.001	0.006	0.008	0.010
5/27	0.005	0.006		0.010	0.008	0.007

Table LXX. (Cont'd)

		Station				
1969 (Cont'd)	0	1	2	3	4	5
6/ 3	0.006	0.009	0.012	0.008	0.008	0.010
6/13	0.004	0.006	0.006	0.008	0.008	0.010
6/18	0.005	0.007	0.008	0.008	0.010	0.013
6/24	0.008	0.008	0.006	0.011	0.010	0.008
6/30	0.012	0.003	0.011	0.004	0.005	0.001
7/22	0.040	0.008	0.006	0.010	0.001	0.009
7/28	0.006	0.014	0.009	0.001	0.003	0.010
8/ 4	0.008	0.016	0.010	0.007	0.011	0.004
8/11	0.010	0.013	0.004	0.010	0.006	0.002
1970						
6/11	0.003	0.009	0.018	0.016	0.014	0.012
6/18	0.004	0.009	0.020	0.017	0.013	0.007
6/24	0.008	0.014	0.017	0.015	0.015	0.015
7/ 2	0.007	0.014	0.015	0.017	0.015	0.023
7/ 8	0.013	0.017	0.014	0.013	0.013	0.013
7/16	0.013	0.018	0.008	0.008	0.010	0.007
7/23	0.013	0.017	0.008	0.011	0.008	0.017
7/29	0.014	0.013	0.013	0.011	0.017	0.020
8/ 4	0.014	0.010	0.005	0.009	0.019	0.018
8/10	0.014	0.007	0.007	0.007	0.017	0.018
8/18	0.011	0.008	0.001	0.005	0.026	0.026
8/24	0.009	0.005	0.002	0.004	0.007	0.026
9/ 1	0.009	0.004	0.001	0.004	0.005	0.019
9/ 8	0.007	0.004	0.004	0.007	0.010	0.026

Table LXXI.

Ammonia nitrogen concentrations (mg/l $\text{NH}_3\text{-N}$) in the euphotic zone of Bighorn Lake during the study.

1968	Station					
	0	1	2	3	4	5
5/ 5	0.18	0.09	0.00	0.00	0.00	0.10
5/13	0.00	0.00	0.00	0.00	0.00	0.00
5/20	0.02	0.00	0.00	0.00	0.00	0.00
5/27	0.00	0.00	0.00	0.18	0.24	0.42
6/ 7	0.00	0.00	0.00	0.00	0.00	0.00
6/12	0.04	0.04	0.06	0.04	0.18	0.15
6/20	0.59	0.64	0.37	0.56	0.33	0.59
6/27	0.00	0.00	0.00	0.00	0.00	0.00
7/ 2	0.00	0.00	0.00	0.00	0.00	0.00
7/ 8	0.00	0.00	0.41	0.00	0.00	0.00
7/15	0.00	0.00	0.00	0.00	0.00	0.00
7/23	0.00	0.00	0.00	0.00	0.00	0.00
7/29	0.00	0.00	0.00	0.00	0.00	0.00
8/ 5	0.00	0.00	0.00	0.00	0.33	0.00
8/12	0.00	0.00	0.00	0.00	0.00	0.00
8/19	0.24	0.22	0.24	0.26	0.24	0.26
8/26	0.11	0.11	0.08	0.08	0.12	0.22
9/ 3	0.08	0.08	0.11	0.08	0.23	0.33
9/ 9	0.29	0.24	0.18	0.19	0.20	0.16
9/17	0.18	0.08	0.18	0.16	0.23	0.18
9/23	0.18	0.13	0.10	0.16	0.16	0.26
10/ 2			0.08	0.11	0.21	0.06
10/ 8						
10/14	0.08	0.03	0.08	0.12	0.18	0.08
10/22	0.08	0.09	0.09	0.09	0.08	0.19
11/ 2	0.11	0.10	0.26	0.14	0.34	1.04
1969						
4/15	0.11	0.13	0.17	0.26	0.25	0.48
4/21	0.17	0.19	0.16	0.25	0.61	0.52
4/28	0.14	0.14	0.12	0.10	0.22	0.10
5/ 5	0.01	0.00	0.11	0.03	0.00	0.18
5/12	0.28	0.23	0.22	0.20	0.22	0.24
5/21	0.40	0.24	0.16	0.20	0.25	0.32
5/27	0.26	0.03		0.16	0.15	0.33

Table LXXI. (Cont'd)

		Station				
1969 (Cont'd)	0	1	2	3	4	5
6/ 3	0.25	0.08	0.11	0.12	0.18	0.17
6/13	0.13	0.22	0.20	0.21	0.24	0.36
6/18	0.33	0.30	0.32	0.26	0.39	0.34
6/23	0.24	0.26	0.27	0.33	0.29	0.37
6/30	0.26	0.28	0.29	0.22	0.31	0.45
7/22	0.10	0.10	0.11	0.09	0.12	0.35
7/28	0.47	0.65	0.31	0.36	0.30	0.33
8/ 4	0.15	0.16	0.17	0.19	0.22	0.56
8/11	0.16	0.25	0.19	0.20	0.25	0.30
1970						
6/11	0.02	0.03	0.03	0.04	0.05	0.05
6/18	0.05	0.01	0.07	0.08	0.12	0.29
6/24	0.01	0.03	0.03	0.04	0.03	0.03
7/ 2	0.02	0.03	0.03	0.05	0.05	0.01
7/ 8	0.03	0.03	0.04	0.05	0.05	0.05
7/16	0.02	0.03	0.04	0.05	0.04	0.03
7/23	0.03	0.03	0.03	0.03	0.03	0.04
7/29	0.03	0.03	0.02	0.02	0.03	0.04
8/ 4	0.03	0.02	0.02	0.02	0.03	0.03
8/10	0.02	0.03	0.02	0.03	0.03	0.03
8/18	0.01	0.02	0.02	0.03	0.03	0.03
8/24	0.03	0.02	0.03	0.02	0.03	0.03
9/ 1	0.01	0.02	0.02	0.02	0.03	0.03
9/ 8	0.02	0.02	0.03	0.02	0.03	0.05

Table LXXII. Ortho-phosphate concentrations ($\text{mg/l PO}_4^{\text{III}}$) in the euphotic zone of Bighorn Lake during the study.

1968	Station					
	0	1	2	3	4	5
5/ 5	0.16	0.25	0.02	0.72	0.15	0.72
5/13	0.09	0.00	0.00	0.00	0.00	0.09
5/20	0.29	0.28	0.20	0.28	0.34	0.20
5/27	0.32	0.23	0.27	0.32	0.27	0.68
6/ 7	0.05	0.02	0.23	0.07	0.02	0.11
6/12	0.18	0.20	0.29	0.20	0.14	0.14
6/20	0.27	0.16	0.00	0.02	0.30	0.54
6/27	0.07	0.16	0.09	0.27	0.07	0.05
7/ 2	0.00	0.00	0.00	0.18	0.00	0.00
7/ 8	0.00	0.00	0.27	0.00	0.00	0.00
7/15	0.00	0.05	0.05	0.20	0.19	0.09
7/23	0.05	0.03	0.01	0.00	0.03	0.01
7/29	0.00	0.05	0.00	0.00	0.00	0.00
8/ 5	0.02	0.00	0.00	0.00	0.00	0.00
8/12	0.10	0.05	0.01	0.00	0.00	0.13
8/19	0.04	0.00	0.00	0.03	0.05	0.01
8/26	0.00	0.01	0.00	0.03	0.00	0.03
9/ 3	0.03	0.03	0.03	0.06	0.25	0.45
9/ 9	0.02	0.01	0.04	0.05	0.01	0.08
9/17	0.06	0.05	0.35	0.18	0.17	0.10
9/23	0.00	0.00	0.00	0.00	0.00	0.00
10/ 2	0.00	0.06	0.07	0.22	0.12	0.14
10/ 8	0.01	0.00	0.01	0.00	0.00	0.00
10/14	0.28	0.04	0.04	0.45	0.01	0.03
10/22	0.09	0.09	0.09	0.09	0.09	0.09
11/ 2	0.00	0.00	0.01	0.05	0.03	0.10
1969						
4/15	0.05	0.00	0.02	0.12	0.05	0.15
4/21	0.07	0.00	0.04	0.04	0.03	0.00
4/28	0.02	0.03	0.05	0.35	0.03	0.04
5/ 5	0.02	0.02	0.04	0.04	0.05	0.09
5/12	0.01	0.05	0.04	0.01	0.05	0.01
5/21	0.02	0.07	0.03	0.01	0.04	0.13
5/27	0.00	0.00		0.00	0.00	0.07

Table. LXXII. (Cont'd)

		Station				
1969 (Cont'd)	0	1	2	3	4	5
6/ 3	0.04	0.15	0.07	0.06	0.03	0.35
6/13	0.04	0.01	0.01	0.01	0.03	0.06
6/18	0.36	0.01	0.01	0.01	0.01	0.08
6/24	0.10	0.05	0.05		0.16	0.18
6/30	0.08	0.08	0.12	0.11	0.05	0.19
7/22	0.00	0.01	0.00	0.01	0.00	0.00
7/28	0.01	0.01	0.01	0.01	0.01	0.01
8/ 4	0.04	0.05	0.04	0.23	0.08	0.09
8/11	0.03	0.04	0.01	0.03	0.01	0.01
1970						
6/11						
6/18						
6/24						
7/ 2	0.05	0.05	0.11	0.14	0.19	0.30
7/ 8	0.05	0.11	0.15	0.18	0.21	0.18
7/16	0.05	0.08	0.14	0.11	0.11	0.10
7/23	0.05	0.10	0.11	0.10	0.10	0.10
7/29	0.05	0.08	0.08	0.08	0.10	0.11
8/ 4	0.05	0.05	0.05	0.05	0.08	0.05
8/10	0.00	0.05	0.05	0.05	0.05	0.00
8/18	0.05	0.05	0.00	0.08	0.10	0.08
8/24	0.00	0.00	0.00	0.08	0.05	0.00
9/ 1	0.00	0.05	0.05	0.00	0.00	0.05
9/ 8	0.00	0.05	0.05	0.05	0.05	0.10

Table LXXIII. Total iron concentrations (mg/l) in the euphotic zone of Bighorn Lake during 1969.

	Station					
	0	1	2	3	4	5
4/15						
4/21						
4/28						
5/ 5	0.001	0.004	0.010	0.040	0.090	0.170
5/12	0.004	0.007	0.013	0.053	0.123	0.013
5/21	0.004	0.007	0.007	0.013	0.120	0.186
5/27	0.152	0.192	0.068	0.138	0.124	0.291
6/ 3	0.142	0.052	0.291	0.223	0.341	0.210
6/13	0.028	0.057	0.043	0.057	0.086	0.242
6/18	0.005	0.007	0.015	0.019	0.030	0.029
6/24	0.005	0.009	0.005	0.019	0.053	0.125
6/30	0.001	0.001	0.001	0.012	0.003	0.082
7/22	0.019	0.019	0.012	0.022	0.071	0.111
7/28	0.019	0.005	0.005	0.008	0.013	0.183
8/ 4	0.013	0.023	0.018	0.033	0.043	0.072
8/11	0.001	0.004	0.004	0.007	0.016	0.043

Table LXXIV. Manganese concentrations (mg/l Mn^{++}) in the euphotic zone of Bighorn Lake during 1969.

	Station					
	0	1	2	3	4	5
4/15	0.046	0.053	0.103	0.043	0.056	0.299
4/21	0.037	0.067	0.034	0.013	0.033	0.046
4/28	0.025	0.035	0.007	0.016	0.022	0.023
5/ 5	0.066	0.020	0.013	0.017	0.010	0.035
5/12	0.014	0.014	0.005	0.009	0.056	0.066
5/21	0.002	0.001	0.000	0.001	0.005	0.005
5/27	0.001	0.016	0.042	0.001	0.032	0.001
6/ 3	0.001	0.001	0.001	0.001	0.001	0.001
6/13	0.001	0.003	0.001	0.003	0.003	
6/18	0.002	0.001	0.001	0.001	0.002	0.005
6/24	0.001	0.001	0.001	0.001	0.003	0.005
6/30	0.001	0.001	0.001	0.001	0.001	0.000
7/22	0.001	0.002	0.001	0.002	0.005	0.020
7/28	0.001	0.000	0.000	0.000	0.000	0.001
8/ 4	0.002	0.002	0.002	0.002	0.007	0.019
8/11	0.002	0.001	0.001	0.002	0.010	0.014

Table LXXV. Copper concentrations (mg/l Cu^{++}) in the euphotic zone of Bighorn Lake during 1969.

	Station					
	0	1	2	3	4	5
4/15	0.000	0.001	0.001	0.001	0.002	0.001
4/21	0.001	0.002	0.001	0.001	0.001	0.001
4/28	0.001	0.001	0.001	0.001	0.001	0.001
5/ 5	0.002	0.001	0.001	0.001	0.001	0.003
5/12	0.001	0.001	0.001	0.001	0.002	0.001
5/21	0.001	0.001	0.001	0.001	0.002	0.001
5/27	0.000	0.001	0.001	0.001	0.001	0.001
6/ 3	0.001	0.001	0.001	0.001	0.001	0.001
6/13	0.001	0.001	0.001	0.001	0.001	0.002
6/18	0.001	0.001	0.001	0.001	0.001	0.001
6/24	0.000	0.000	0.000	0.000	0.000	0.000
6/30	0.001	0.001	0.001	0.001	0.001	0.001
7/22	0.001	0.001	0.001	0.001	0.001	0.002
7/28	0.001	0.001	0.001	0.001	0.001	0.001
8/ 4	0.001	0.001	0.002	0.002	0.002	0.002
8/11	0.001	0.002	0.001	0.002	0.001	0.001

Table LXXVI. Zinc concentrations (mg/l Zn^{++}) in the euphotic zone of Bighorn Lake during 1969.

	Station					
	0	1	2	3	4	5
4/15	0.008	0.007	0.007	0.006	0.016	0.084
4/21	0.012	0.023	0.002	0.004	0.002	0.024
4/28	0.012	0.011	0.014	0.012	0.018	0.035
5/ 5	0.026	0.002	0.004	0.024	0.011	0.024
5/12	0.006	0.002	0.002	0.000	0.000	0.000
5/21	0.003	0.003	0.004	0.003	0.004	0.008
5/27	0.002	0.003	0.003	0.008	0.000	0.008
6/ 3	0.004	0.002	0.003	0.003	0.000	0.000
6/13	0.000	0.000	0.000	0.000	0.025	0.020
6/18	0.021	0.021	0.016	0.020	0.021	0.024
6/24	0.027	0.015	0.021	0.021	0.020	0.021
6/30	0.042	0.006	0.002	0.024	0.004	0.006
7/22	0.006	0.006	0.019	0.011	0.008	0.004
7/28	0.004	0.040	0.011	0.007	0.003	0.028
8/ 4	0.002	0.002	0.010	0.003	0.009	0.014
8/11	0.003	0.018	0.002	0.005	0.004	0.014

Table LXXVII. pH of the Bighorn Lake euphotic zone composites during the study.

1968	Station					
	0	1	2	3	4	5
5/ 5	8.25	8.10	8.35	8.20	8.30	8.32
5/13						
5/20	8.40	8.50	8.50	8.30		8.22
5/27	8.42	8.75	8.61	8.33	8.15	8.30
6/ 7	8.52	8.50	8.30	8.22		8.10
6/12	8.55	8.43	8.39	8.40	8.20	8.28
6/20	8.25	8.30	8.30	8.16	8.00	8.00
6/27	8.55	8.20	8.05	8.50	8.40	8.41
7/ 2	8.36	8.10	8.25	8.40	8.30	8.20
7/ 8	8.47	8.60	8.60	8.73	8.57	8.50
7/15	8.32		8.70	8.52		8.45
7/23	8.57	8.70	8.78	8.70	8.70	8.59
7/29	8.64	8.70	8.73	8.81		8.48
8/ 5	8.69	8.73	8.71	8.67	8.58	8.72
8/12	8.53	8.60	8.64	8.65	8.59	8.48
8/19	8.54	8.62	8.63	8.64	8.50	8.37
8/26	8.41	8.50	8.60	8.55	8.50	
9/ 3	8.40	8.50	8.60	8.65	8.50	8.37
9/ 9	8.41	8.51	8.77	8.80	8.56	8.50
9/17	8.20	8.45	8.53	8.65	8.46	8.50
9/23	8.00	8.40	8.50	8.60	8.58	8.45
10/ 2	8.40	8.60	8.60	8.72	8.80	8.60
10/ 8		8.20	8.34	8.48	8.52	8.13
10/14	8.13	8.30	8.33	8.40	8.48	8.42
10/22	8.21	8.26	8.30	8.21	8.46	8.30
11/ 2	7.80	8.02	8.01	8.49	8.51	8.50
1969						
4/15	8.08	8.10	8.15	8.40	8.40	8.31
4/21	8.03	8.05	8.30	8.23	8.17	8.20
4/28	8.23	8.29	8.50	8.50	8.58	8.49
5/ 5	8.30	8.43	8.50	8.56	8.50	8.50
5/12	8.30	8.51	8.60	8.53	8.50	8.65
5/21	8.30	8.54	8.71	8.59	8.50	8.47
5/27	8.45	8.73	8.24	8.78	8.75	8.79

Table LXXVII. (Cont'd)

		Station				
1969 (Cont'd)	0	1	2	3	4	5
6/ 3	8.28	8.54	8.86	8.88	8.60	8.66
6/13	8.48	8.52	8.70	8.70	8.48	8.35
6/18	8.47	8.43	8.51	8.48	8.40	8.39
6/24	8.37	8.45	8.53	8.36	8.35	8.17
6/30	8.14	8.53	8.17	8.41	8.29	
7/22	8.51	8.59	8.58	8.40	8.35	8.40
7/28	8.70	8.64	8.70	8.54	8.44	8.58
8/ 4	8.70	8.55	8.52	8.55	8.60	8.60
8/11	8.68	8.62	8.62	8.64	8.63	8.63
1970						
6/11						
6/18	8.00	8.30	7.60	8.25	7.90	7.90
6/24			8.60	8.38	7.85	8.50
7/ 2	8.40	8.35	8.20	7.90		7.55
7/ 8	8.40	8.35	8.30	8.40	8.10	8.50
7/16	8.50	8.30	8.50	8.65	8.30	8.25
7/23	8.30	8.40	8.20	8.40	8.50	8.75
7/29	8.05	8.15	8.00	7.90	8.30	8.50
8/ 4	8.40	8.40	8.65	8.35	8.40	8.60
8/10	8.55	8.50	8.40	8.45	8.40	8.50
8/18	8.70	8.50	8.50	8.55	8.33	8.40
8/24						
9/ 1	8.70	8.60	8.60	8.80	8.50	8.20
9/ 8	8.50	8.45	8.35	8.40	8.50	8.30

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