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JOB COMPLETION REPORT

RESEARCH PROJECT SEGMENT

As Required By

NAVAJO RESERVOIR RESEARCH CONTRACT

FISHERY INVESTIGATION - NAVAJO UNIT

Fishery Surveys of Navajo Reservoir
and Tailwaters

Section 8 Project

Job Nos. A-2(a) and A-2(b)

By

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JOB COMPLETION REPORT

RESEARCH PROJECT SEGMENT

Segment No.2

State of: NEW MEXICO

Project No.: Section 8 Name: Fisheries Investigations - Navajo Unit

Job No.: A-2(a) Title: Fisheries Survey of Navajo Reservoir

Period Covered: July 1, 1963 through December 31, 1964

Abstract:

Navajo Dam began impounding the waters of the San Juan River on June 27, 1962. At this time the New Mexico Department of Game and Fish initiated a research program under the Section 8 Program of the Bureau of Sport Fisheries and Wildlife. This report includes the data gathered during the second segment of this project.

During 1964, the reservoir level fluctuated between elevations of 5,928.01 ft. and 5,961.36 ft. with the mean elevation at 5,943.47 ft. The lake is expected to remain at this approximate elevation during the next two years.

Thermo and chemical conditions indicate that the reservoir includes waters favorable for trout production, but cannot be considered as optimum. Low dissolved oxygen and high carbon dioxide readings occur in portions of the lake during the summer months.

Fish species collected from the reservoir include rainbow trout, bonytail chub, flannelmouth suckers, white suckers, bluegill, and black bullheads. Two carp and five brown trout were also collected during sampling activities.

No fish were collected below a depth of 30 feet within the lake; however, this not absolute proof that the population is restricted to the epilimnion.

The mean coefficient of condition (K) was 79.55 for rainbow trout, 0.99 for bonytail chub, 0.99 for flannelmouth suckers, and 1.21 for white suckers.

The composition of the fish population changed considerably during the past 18 months. The undesirable species represented a total of 73.78 percent by number and 77.64 percent by weight during 1963 and 1964. During 1964, these undesirables increased 99.97 percent by number and 19.64 percent by weight, indicating a successful spawn and high survival of progeny in 1963. The most important increase was made by the bonytail chub, a serious competitor of the rainbow trout population.

A total of 3,962,067 rainbow trout, 1,103,355 Kamloops, 49,920 kokanee salmon and 244,715 channel catfish have been introduced into the reservoir.

A creel census program indicated that an estimated 19,270 fishermen creeled

57,484 fish. The catch included rainbow trout, bluegill, black bullheads, and bonytail chub.

The catch data indicated a possible environmental influence in the Miller Mesa area causing a decline in angler success.

Monthly plankton collections were conducted. Vertical and horizontal hauls were made using a Wisconsin plankton net with a 12 centimeter opening.

Plankton analysis indicates relatively low production with maximum concentration during late summer and fall. Diatoms were the most abundant phytoplankton found, with genera Fragilaria and Asterionella most common. The most common zooplanktons were Cladocerans and Copepods.

Food habit studies are incomplete because of a delay in obtaining results from the contract analyst.

Objectives:

The objectives of this program are to collect information on the physical, chemical and biological factors that influence the development of a fish population and to identify those areas where specific studies are necessary to provide accurate data for the improvement of the fish management program.

All management recommendations will be made after considering the combined influence indicated by the various phases of this project.

Please note the objectives described for each segment of the project.

Procedures:

Please note the procedures described in the separate segments of this report.

Results:

Please note the results described in the separate segments of this report.

Recommendations:

The physical, chemical and biological data included indicates that the following recommendations should be considered for the fishery management program of Navajo Reservoir and for future studies on this water.

It is recommended that:

1. This project should be continued for a minimum of four more years. Investigation of the fish population, species composition, age-and-growth, length-weight data (K), distribution and a creel census program should be continued throughout a portion, if not all, of the remaining project years. Other phases of this project to continue are, the physical and chemical records and plankton collections and analysis.

2. New programs should include an econonic survey expressing the value of Navajo Reservoir to the economy of San Juan County, evaluation of tributary

streams in respect to being a possible source of trout eggs for our hatchery system, access to the remote areas of the lake shore, evaluation of plankton sampling technique, evaluation of introduced fish species, and studies of fish distribution in epilimnion and hypolimnion using sport-fishing equipment for the purpose of evaluating angling techniques and determining depths producing highest yield. This information when related to thermo and chemical stratification and distributed to local news media is expected to increase the angler success during periods of maximum use by the public.

Specific studies of the life history of all salmonid and competitive species should be initiated in the near future. This will be included with the above mentioned new programs for this project.

3. A fish marking program be initiated to supplement the present age-and-growth information.

4. That aerial fishing pressure counts be considered in conjunction with the creel census program. It is believed that in future years this type of census will give accurate success data with a minimum amount of actual census work by project personnel.

5. That threadfin shad, Dorosoma petenense (Gunther), be introduced into the Navajo Reservoir as a forage fish to supplement the food chain in the pelagic area of the lake.

6. That the largemouth bass, Micropterus salmoides (Lacepede) be introduced in the upper areas of the Pine and San Juan River Canyons.

   The rainbow trout and kokanee salmon releases should be continued.

   The success of the kokanee releases will be determined and future recommendations shall include suggestions for either continuing or discontinuing introductions of this species.

Prepared by: H. F. Olson and W. J. McNall Approved by: Fred A. Thompson

Date: June 3, 1965

INTRODUCTION

The Navajo Dam, 15 miles northeast of Blanco, New Mexico, is part of the Upper Colorado River Storage Project. Water impoundment started on June 27, 1962 and the final phases of the construction program were completed a few weeks after this date.

During 1962 the New Mexico Department of Game and Fish initiated a six year study on the Navajo Reservoir and tailwater area. This program is financed through the Section 8 Program of the U. S. Fish and Wildlife Service. This report includes data from Segment No. 2 of this project.

The original contract with all associated agencies had the project year coinciding with the fiscal year. This created a problem with planning the work schedule and completing a segment report during midsummer. Consequently, Segment No. 2 was amended to extend through December 31, 1964, with the segment report due in February. This report includes data collected over an 18 month period, all future project years will coincide with the calendar year.

DESCRIPTION

Historical records show that as early as 1900 interested individuals and organizations proposed construction of a dam across the San Juan River. Then, as now, the thought of irrigating the surrounding arid land was the main objective for the dam.

The Navajo Dam Project was authorized by the 84th Congress, April 11, 1956. Construction was initiated in July, 1958 and the specifications called for completion by March 19, 1963, with an estimated cost of $42,372,000.00

The Navajo Dam is entirely earth and rock fill, 405 feet high with a crest length of 3,700 feet. At the normal capacity level the reservoir will have a surface area of 15,610 acres and store a volume of 1,709,000 acre-feet.

The reservoir drainage occupies 3,260 square miles of southern Colorado and northern New Mexico. The tributary streams originate in the Alpine region of the Colorado Rockies and enters the reservoir in the semi-arid region of New Mexico (Fig. 1). The lake, when full, will extend 35 and 15 miles up the San Juan and Pine River Canyons respectively. The reservoir will, at that time, inundate approximately 10 miles of the San Juan River in Colorado.

On December 31, 1964 the surface level reached elevation 5,943.22 forming a lake of 4,660 surface acres (Table 1). During 1964 the level fluctuated between elevations 5,928.01 and 5,961.36 msl. The mean elevation for 1964 was 5,943.47 msl, which is 39.79 feet higher than the 1963 mean elevation of 5,903.68 msl. The reservoir fluctuates since impoundments are shown in Table 1 and Figures 2 and 3.

The first phase of the proposed Navajo Irrigation System is now under construction. This consists of digging approximately 2.0 miles of tunnel through the mesa at the south end of the Navajo Dam for water releases. The tunnel outlet will be elevation 5,965.00, therefore, the reservoir level must remain below this point until the construction is completed.

Recreational development on Navajo Reservoir includes plans for construction

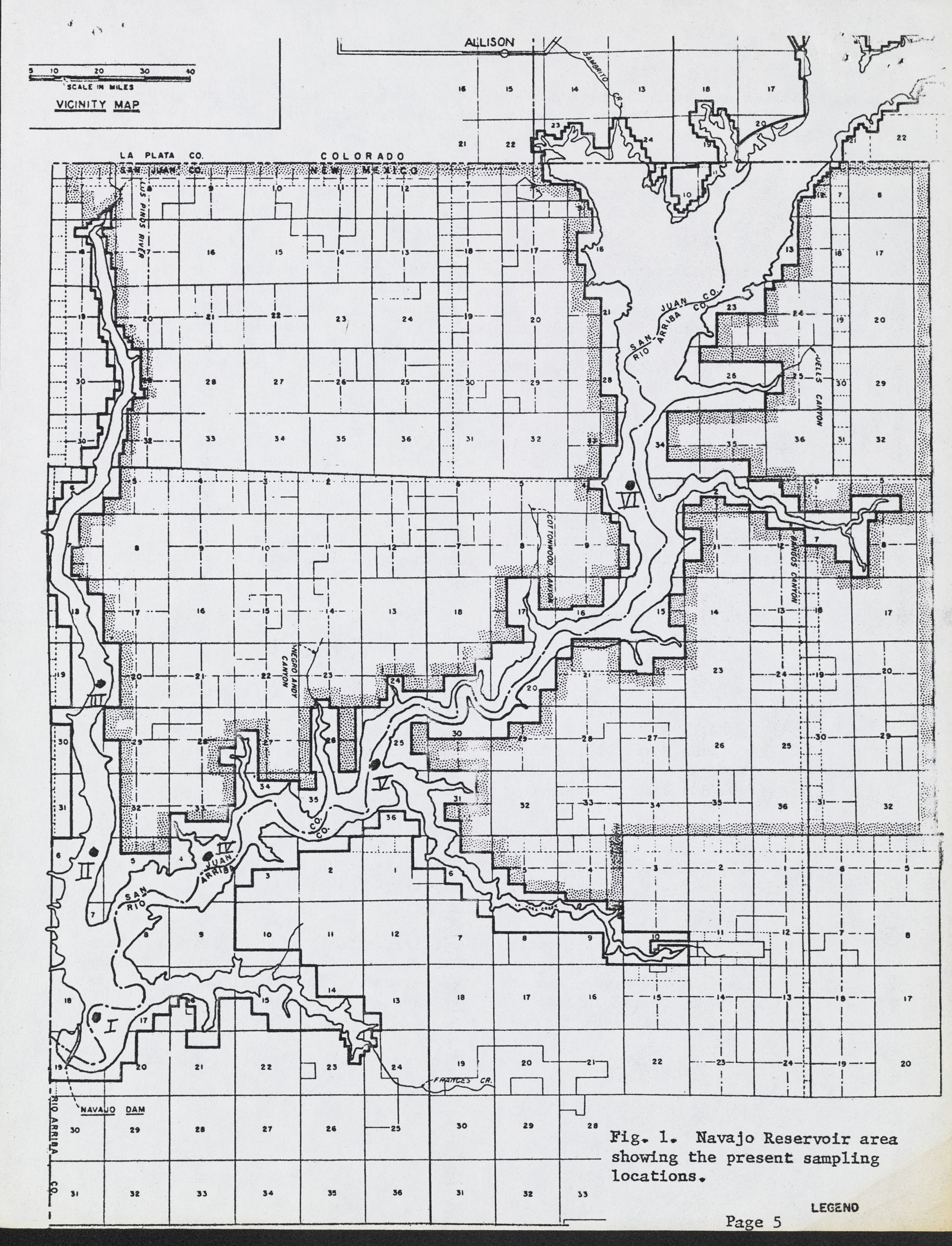


Fig. 1. Navajo Reservoir area showing the present sampling locations.

Table 1. Navajo Reservoir Impoundment and Release Data Since Initial Closure on June 27, 1962 to December 31, 1964*

Date	Elevation	Total	Monthly Change	Monthly Release (A. F.)	Surface Area (A.)	Remarks
6-27-62	5,720	0	0'		0	Impoundment started
6-30-62	5,774.6	12.4	+ 12.4		570	
7-31-62	5,805.2	37.1	+ 24.7	33,757	1,040	
8-30-62	5,800.0	32.0	- 5.1	27,805	960	
9-30-62	5,805.9	37.9	+ 5.9	20,702	1,050	
10-31-62	5,820.8	55.5	+ 17.6	19,684	1,320	
11-30-62	5,826.0	62.6	+ 7.1	15,100	1,410	
12-31-62	5,830.8	69.6	+ 7.0	10,600	1,490	
1-31-63	5,835.2	76.3	+ 6.7	7,800	1,570	
2-28-63	5,850.1	101.6	+ 25.3	8,800	1,880	
3-31-63	5,872.9	150.6	+ 49.0	15,800	2,430	
4-30-63	5,897	217.0	+ 66.4	28,300	3,080	Outlet increased to 1,069 cfs 4-12-63; outlet decreased to 320 cfs 4-19-63
5-31-63	5,930.10	335.3	+118.3	21,600	4,130	
6-30-63	5,936.42	362.2	+ 26.9	20,827	4,385	Gate opening adjusted to allow uniform discharge of 350 cfs.
7-31-63	5,937.06	365.0	+ 2.8	23,663	4,400	Outlet increased to release 450 cfs 7-24-63
8-31-63	5,938.23	370.2	+ 5.2	26,198	4,400	Gate adjusted allowing release of 400 cfs 8-12-63
9-30-63	5,940.05	379.3	+ 9.1	23,802	4,520	
10-31-63	5,939.65	376.6	- 2.7	29,044	4,500	Gate adjusted to release 500 cfs 10-9-63
11-30-63	5,936.46	362.4	- 14.2	29,753	4,385	
12-31-63	5,932.07	343.5	- 18.9	30,744	4,210	
1-31-64	5,929.35	332.2	- 11.3	21,815	4,090	Gate adjusted to release 3000 cfs 1-9-64
2-29-64	5,928.01	326.8	- 5.4	17,256	4,050	
3-31-64	5,928.89	330.3	+ 5.3	16,509	4,080	3-9 through 14. Gate tests, adjusted various releases. Returned to 300 cfs.
4-30-64	5,938.57	371.7	+ 41.1	18,058	4,460	Gate adjusted to release 500 cfs 4-30-64
5-31-64	5,961.36	486.1	+115.1	40,414	5,640	Various gate releases from 500 to 1,500 cfs. Return to 1,000 cfs 5-31-64
6-30-64	5,960.22	479.7	- 7.8	98,637	5,570	Adjusted release 2,000 cfs 6-19-64

Table 1. C O N T I N U E D

7-31-64	5,946.59	408.9	- 70.8	122,977	4,830	
8-31-64	5,950.01	425.7	+ 16.8	50,992	5,000	Outflow varied, stabilize at 500 cfs 8-27-64
9-30-64	5,950.47	428.1	+ 2.4	29,753	5,020	
10-31-64	5,948.37	417.6	- 10.5	30,744	4,910	
11-30-64	5,946.70	409.5	- 8.1	24,314	4,830	
12-31-64	5,943.22	392.9	- 16.1	35,975	4,660	Increased outlet to 1,000 cfs 12-22-64

* Data furnished by the Bureau of Reclamation, Navajo Dam Office.

Table 2. Navajo Reservoir, Area in Acres.

Elevation Feet	0	1	2	3	4	5	6	7	8	9
5720	20	24	28	32	36	40	44	48	52	56
5730	60	65	70	75	80	85	90	85	100	105
40	110	120	130	140	150	160	170	180	190	200
50	210	220	240	250	260	280	290	310	320	340
60	350	370	380	400	410	430	450	460	480	490
70	510	520	540	550	570	580	600	610	630	650
80	670	680	700	710	730	740	750	770	780	800
90	810	820	840	850	870	880	890	910	930	940
5800	960	970	990	1000	1020	1030	1050	1070	1090	1110
10	1130	1140	1160	1170	1190	1210	1230	1250	1270	1290
20	1310	1320	1340	1360	1380	1390	1410	1430	1440	1460
30	1480	1490	1510	1530	1550	1570	1580	1600	1610	1630
40	1640	1670	1690	1710	1730	1750	1770	1800	1820	1850
50	1880	1900	1920	1940	1960	1980	2000	2030	2050	2080
60	2100	2130	2150	2180	2200	2230	2250	2280	2300	2330
70	2360	2380	2410	2430	2460	2480	2510	2540	2570	2590
80	2610	2640	2670*	2690	2720	2740	2770	2800	2820	2850
90	2880	2910	2930	2960	2990	3020	3050	3080	3110	3140
5900	3160	3190	3220	3240	3270	3300	3330	3370	3400	3430
10	3460	3490	3520	3550	3580	3610	3650	3680	3710	3750
20	3780	3810	3840	3880	3910	3940	3980	4010	4050	4090
30	4130	4170	4210	4250	4290	4330	4370	4400	4440	4480
40	4520	4570	4610	4650	4700	4750	4800	4850	4900	4950
50	5000	5050	5110	5160	5220	5280	5340	5400	5460	5510
60	5570	5620	5680	5740	5800	5860	5920	5980	6030	6090
70	6150	6210	6270	6330	6400	6440	6520	6580	6650	6720
80	6780	6840	6900	6960	7020	7080	7140	7210	7280	7340
90	7400	7410	7530	7590	7650	7720	7780	7850	7910	7970
6000	8030	8090	8150	8210	8280	8340	8400	8460	8520	8590
10	8650	8710	8770	8830	8900	8960	9020	9080	9140	9200
20	9270	9330	9390	9460	9530	9590	9660	9730	9800	9870
30	9940	10020	10100	10180	10250	10330	10410	10500	10590	10680
40	10760	10850	10930	11020	11110	11210	11300	11400	11500	11600
50	11700	11790	11890	11990	12090	12190	12290	12390	12500	12590
6060	12690	12800	12900	13010	13120	13230	13340	13450	13560	13670
70	13790	13900	14010	14120	14240	14560	14480	14600	14720	18850
80	14980	15100	15230	15360	15490	15610	15740	15870	16000	16140
90	16280	16410	16540	16670	16810	16940	17080	17220	17370	17510
6100	17650	17800	17960**	18120	18290	18450	18610	18780	18950	19120
10	19300	19470	19640	19800	19960	20120	20300	20460	20620	20780
20	20950	21120	21280	21440	21610	21770	21930	22090	22240	22400
30	22560	22710	22960	23010	23170	23320	23480	23630	23770	23910
40	24040									

* Top of dead storage
** Spillway elevation

Table 3. Navajo Reservoir, Capacity in Hundreds of Acre-Feet.

Elevation Feet	0	1	2	3	4	5	6	7	8	9
5720					1	1	2	2	2	[illegible]
5730	4	4	5	6	6	7	8	9	10	11
5740	12	13	15	16	17	19	21	22	24	26
5750	28	30	33	35	38	40	43	46	49	53
5760	56	60	63	67	71	76	80	84	89	94
5770	90	104	109	115	121	126	132	138	144	151
5780	157	164	171	178	185	198	200	208	215	223
5790	231	240	248	256	265	274	283	292	301	318
5800	320	329	339	349	359	369	380	390	401	412
5810	423	435	446	458	470	482	494	506	519	532
5820	545	558	571	585	598	612	626	640	655	669
5830	684	699	714	729	744	760	776	792	808	824
5840	840	857	874	891	908	925	943	961	979	991
5850	1016	1035	1054	1073	1092	1112	1132	1152	1173	1193
5860	1214	1235	1257	1278	1300	1322	1345	1367	1390	1414
5870	1437	1461	1485	1509	1533	1558	1583	1608	1634	1660
5880	1686	1712	1738*	1765	1792	1819	1847	1875	1903	1931
5890	1960	1989	2018	2048	2077	2107	2138	2168	2199	2231
5900	2262	2294	2326	2358	2391	2424	2457	2490	2524	2558
5910	2593	2627	2662	2698	2733	2769	2806	2842	2879	2917
5920	2954	2992	3030	3069	3108	3147	3187	3227	3267	3308
5930	3349	3390	3432	3475	3517	3560	3604	3648	3692	3737
5940	3782	3827	3873	3919	3966	4013	4061	4109	4158	4207
5950	4257	4307	4358	4409	4461	4514	4567	4621	4675	4730
5960	4785	4841	4998	4955	5012	5071	5130	5189	5249	5310
5970	5371	5433	5495	5558	5622	5686	5751	5816	5882	5949
5970	5371	5433	5495	5558	5622	5686	5751	5816	5882	5949
5980	6017	6085	6154	6223	6293	6363	6434	6506	6579	6652
5990	6725	6800	6875	6950	7027	7103	7181	7259	7338	7417
6000	7497	7578	7659	7741	7823	7906	7990	8074	8159	8245
6010	8331	8418	8505	8593	8682	8771	8861	8952	9043	9134
6020	9227	9320	9413	9508	9603	9698	9794	9891	9989	10087
6030	10186	10286	10387	10488	10590	10693	10797	10901	11007	11113
6040	11220	11329	11437	11547	11658	11769	11882	11995	12110	12225
6050	12342	12459	12578	12697	12818	12939	13061	13185	13309	13435
6060	13561	13689	13817	13947	14077	14209	14342	14476	14611	14747
6070	14884	15023	15162	15303	15445	15588	15732	15877	16024	16173
6080	16321	16471	16623	16776	16930	17086	17242	17401	17560	17721
6090	17883	18046	18211	18377	18544	18713	18883	19055	19228	19402
6100	19578	19755	19934**	20114	20296	20480	20665	20852	21041	21231
6110	21423	21617	21813	22010	22209	22409	22611	22815	23020	23227
6120	23436	23646	23858	24072	24287	24504	24723	24943	25164	25388
6130	25612	25839	26067	26296	26527	26759	26993	27229	27466	27704
6140	27944									

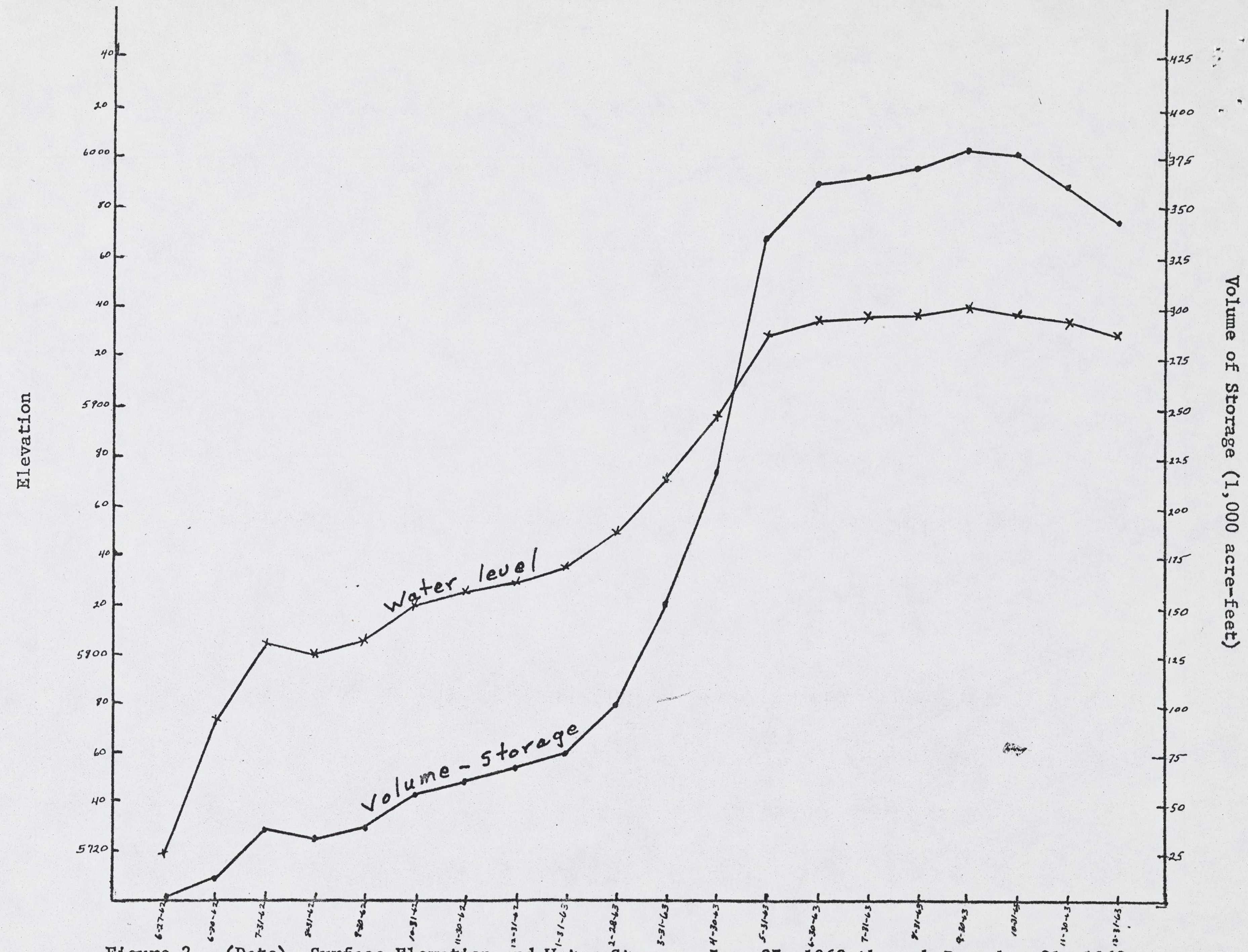


Figure 2. (Date) Surface Elevation and Water Storage, June 27, 1962 through December 31, 1963, Navajo Reservoir, New Mexico.

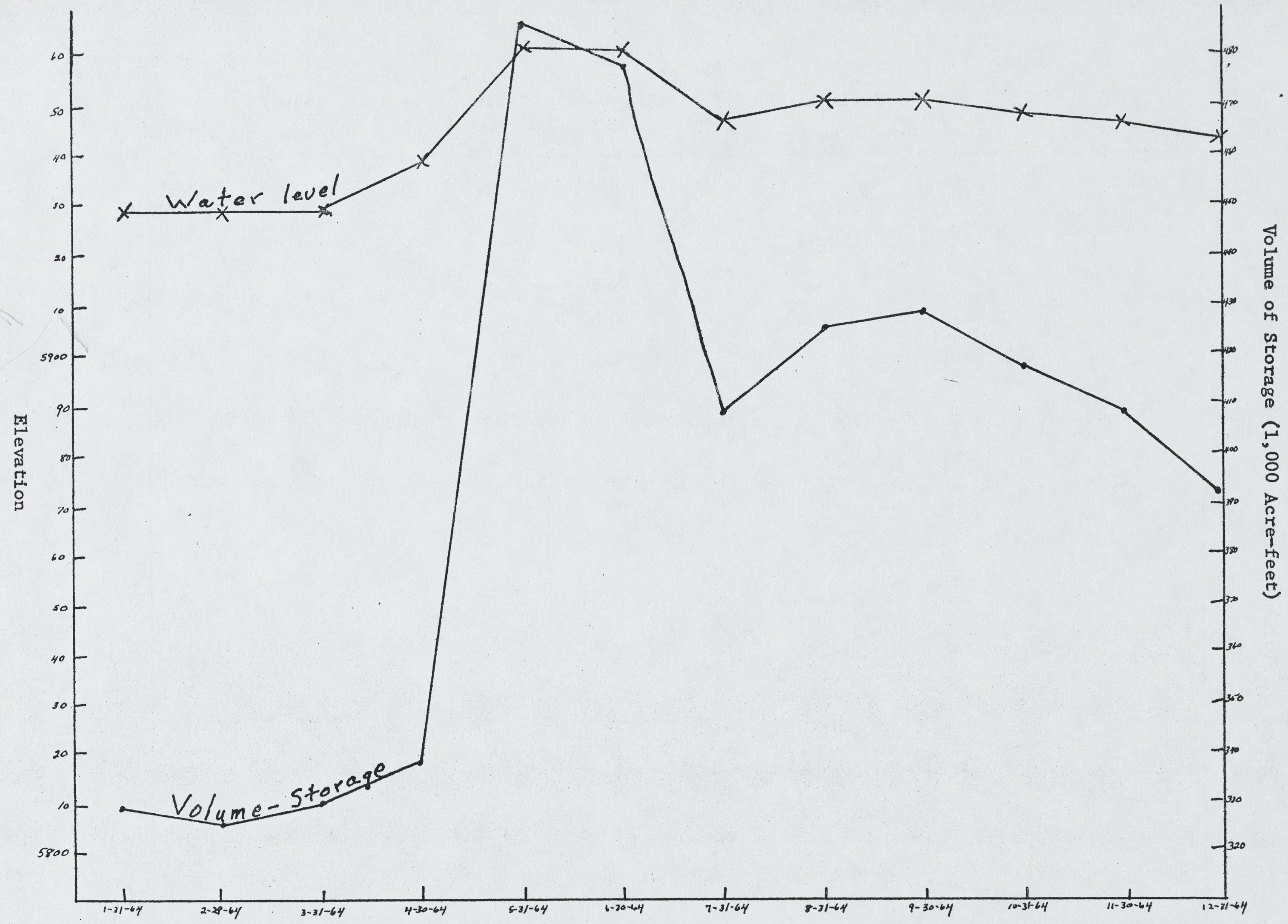


Figure 3. Surface Elevation and Water Storage, 1964, Navajo Reservoir, New Mexico.

of three major sites. They are the Pine River, Sims Mesa and Arboles recreation areas. All of the construction programs are supervised by the National Park Service.

All of the areas are in various stages of development with the Pine River and Arboles sites near completion. Developments at the Pine River site (in New Mexico) includes boat launching, marina, camping areas, domestic quality water, and sanitary facilities.

THERMO AND CHEMICAL

Objectives:

The objectives of this portion of the project are to record the water temperatures and chemical data important to the sport fishery program of Navajo Reservoir. Also, to incorporate this data with that collected during other phases of the project to develop a sound fisheries management program for the reservoir.

Procedures:

A battery operated thermometer, capable of accurate reading to a depth of 300 feet, was used to obtain water temperatures in a vertical series throughout the lake.

Chemical analysis were made according to the procedures described by Welch (1948), Braun Chemical Company and the American Public Health Association (1955). A Kemmerer Sampler was used to collect sub-surface water. A battery operated meter was used to obtain pH readings from the reservoir.

Results:

The water temperatures recorded during the summer of 1963, shows the thermocline development varying between depths of 25 and 35 feet. This stratification was possibly influenced by the reservoir outlet structure, located at a depth of 30 feet most of the summer.

The 1964 data recorded the presence of a dual thermo stratification at depths of 35 to 70 feet. The upper thermocline can be considered as a normal stratification. The lower, located on the same level as the outlet structure, could be a result of the large downstream releases from the reservoir. Refer to figure 10 for illustration of these stratifications.

The importance of the reservoir releases on the thermo stratification will be determined as the reservoir fills. This will, of course, depend on the date and volume of downstream releases along with the surface level of the lake.

Surface temperature extremes recorded were 34° F and 83° F in July, 1964 when it reached a temperature of 77° F and varied slightly through September. The highest temperature of 83° was recorded at the upper end of the San Juan River Canyon.

Figures 4 through 9 show the monthly water temperature fluctuations for each station recorded from the surface and a depth of 25 feet. The netting studies indicate that the present salmonid fishery inhabits this depth strata of the lake.

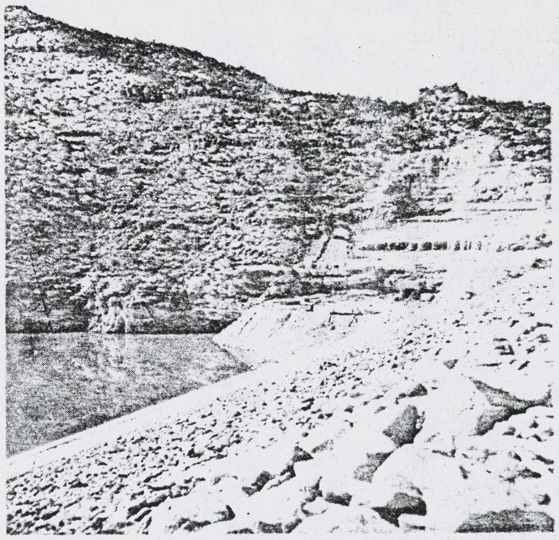


Photo 1. Navajo irrigation outlet tunnel, elevation 5,965 feet, forcing the lake level to remain below this elevation.

Temperatures in the hypolimnion remained relatively stable throughout the summer months. At depths of greater than 100 feet the temperatures reanged from 42° F to 47° F.

The dissolved oxygen and carbon dioxide records collected during the summer months are the most important chemical factors to consider (Table 5). The 1963 data shows a decrease in the dissolved oxygen and an increase in the carbon dioxide at a depth of 50 feet, July through October. This is especially noticeable in the extreme upper station on the Pine and San Juan River Canyons (Station 3 and 6) where the dissolved oxygen dropped to less than 1.0 ppm and the carbon dioxide reached a high of 21.0 ppm.

The 1964 data, although similar, did not have such drastic low dissolved oxygen nor high carbon dioxide readings. Unforcuantely this data is incomplete after August, 1964 when project personnel were unable to continue scheduled collections.

The dissolved oxygen and carbon dioxide recordings from the hypolimnion, during the summer of 1963, were rather low but showed an increase over the data collected at the 50-foot level.

The pH readings varied slightly during the year. The midsummer records show a pH variance of 8.2 to 8.8 in the epilimnion and 7.4 to 8.2 in the hypolimnion. With the absence of the thermocline the pH ranged from 7.4 to 8.0 throughout the lake.

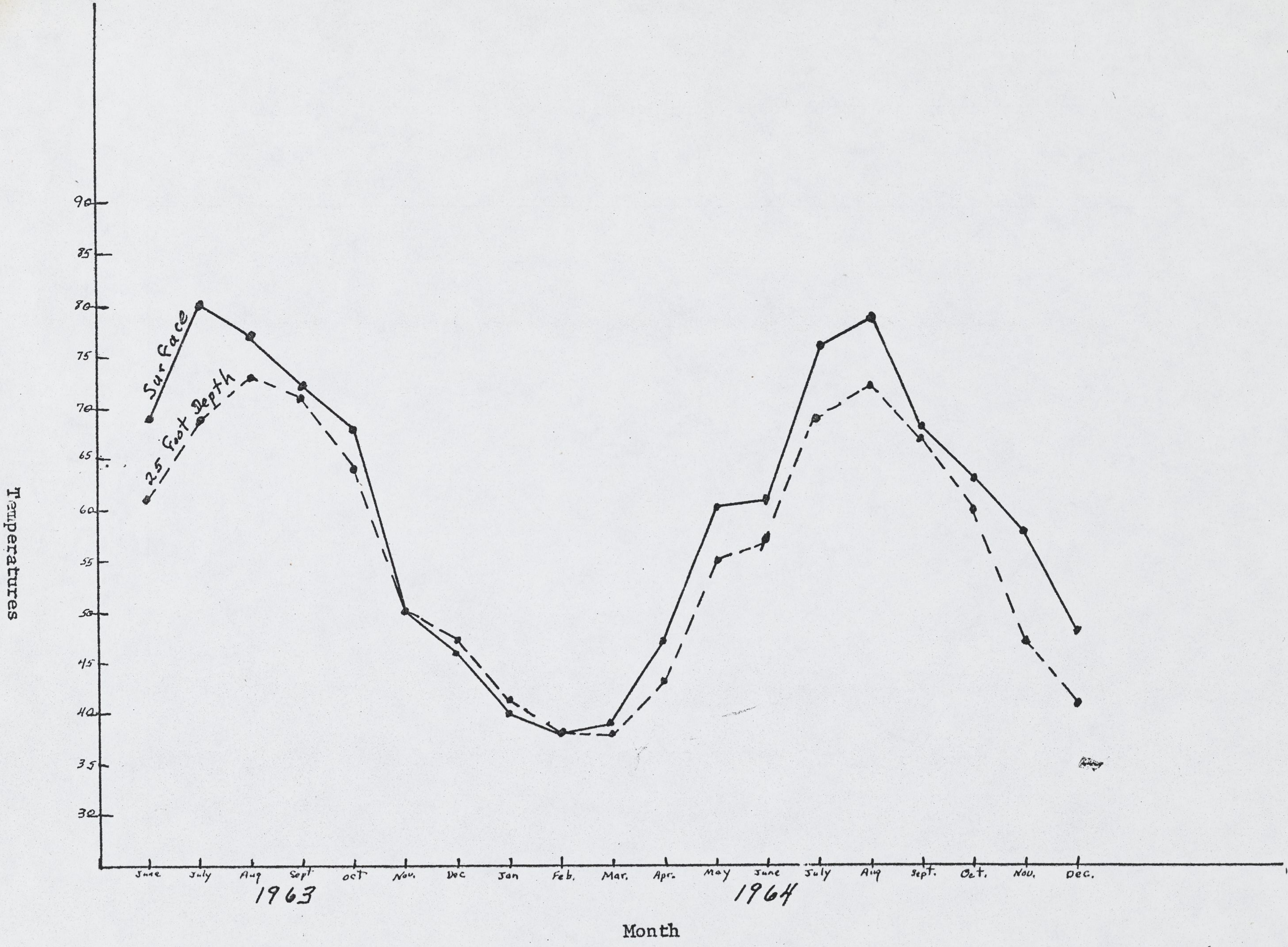


Figure 4. Graph of surface and 25-foot temperature recordings, Navajo Reservoir, Station 1.

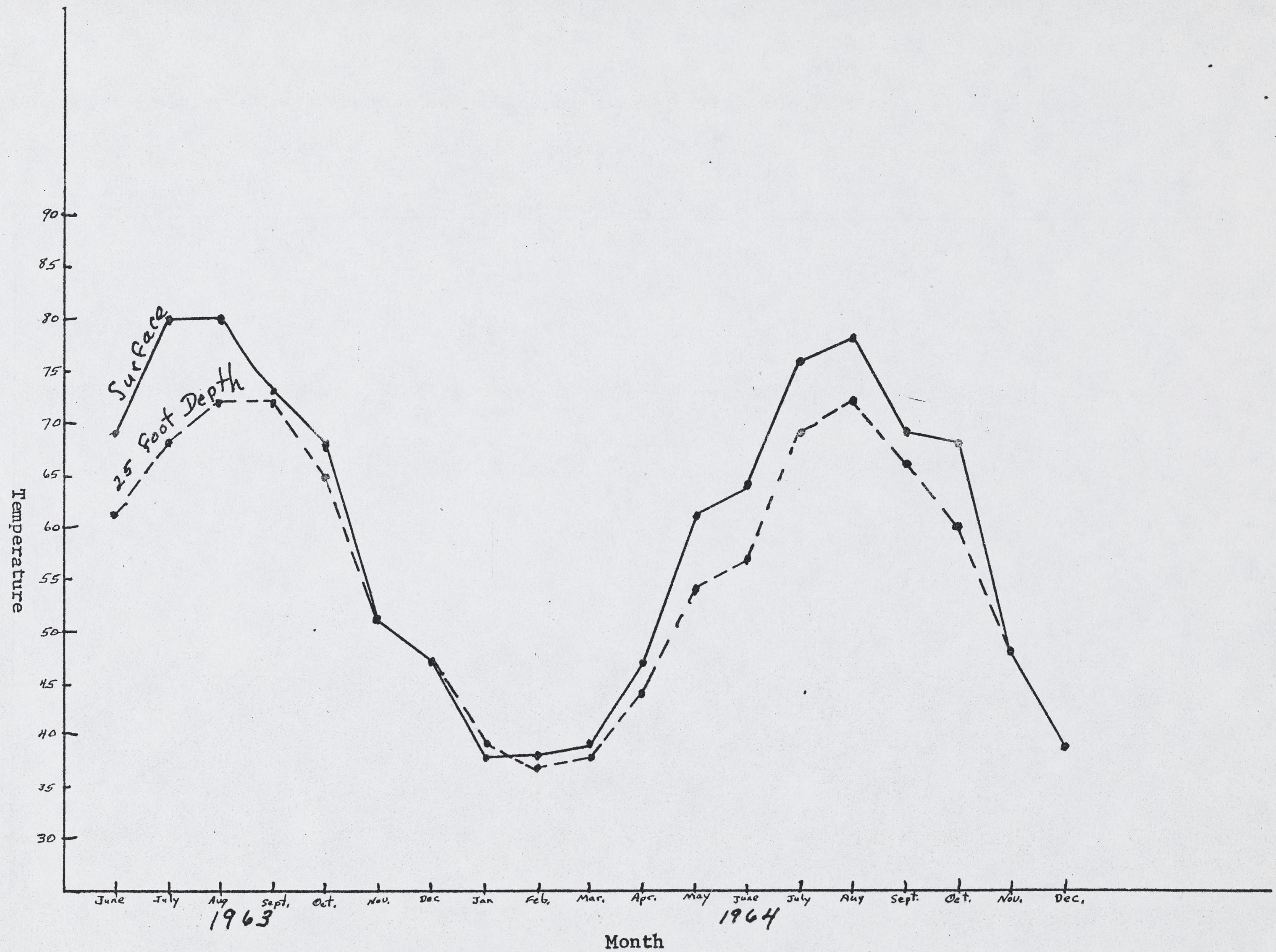


Figure 5. Graph of surface and 25-foot temperatures recorded, Navajo Reservoir, Station 2.

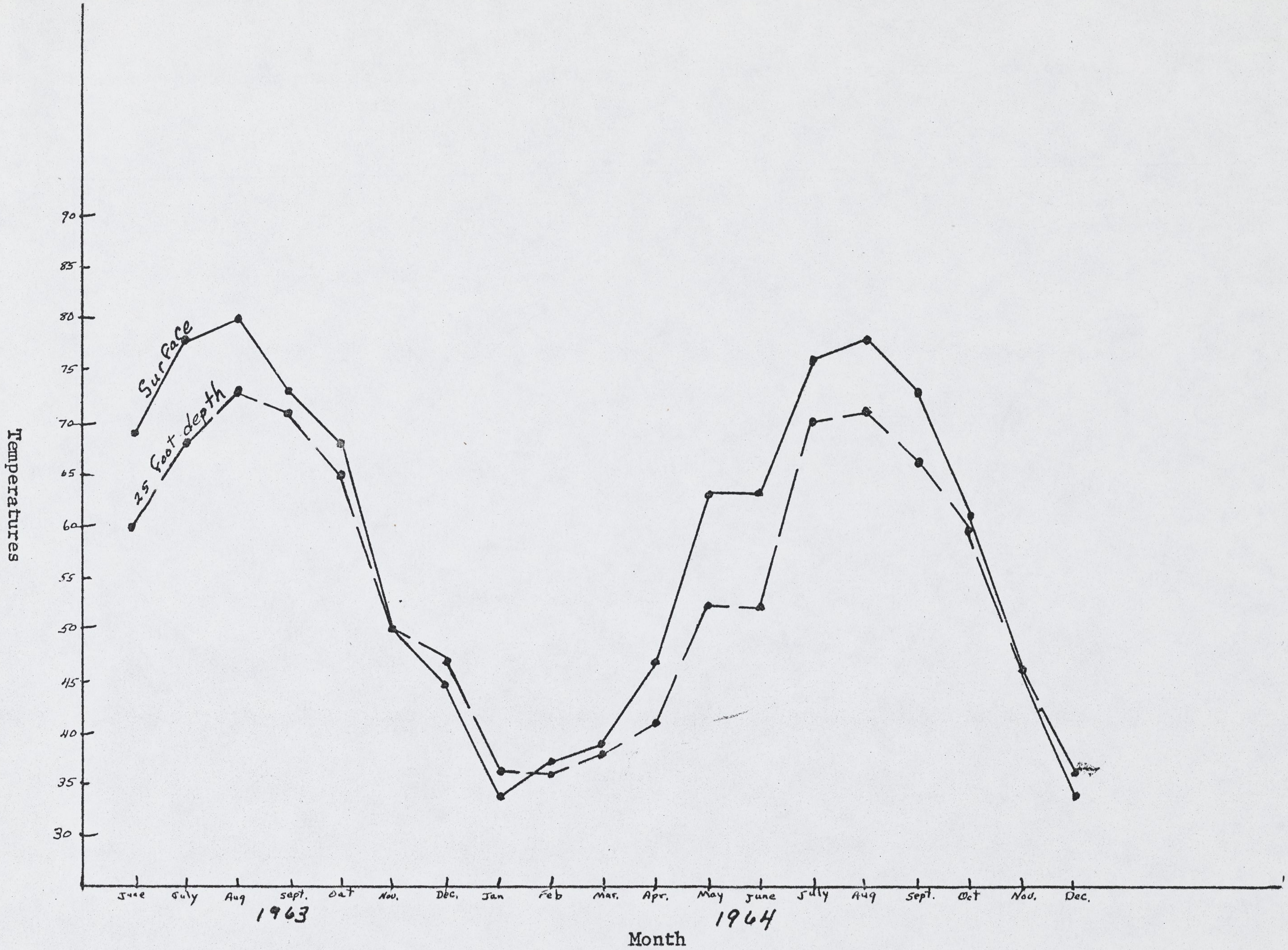


Figure 6. Graph of surface and 25-foot temperature recordings, Navajo Reservoir, Station 3.

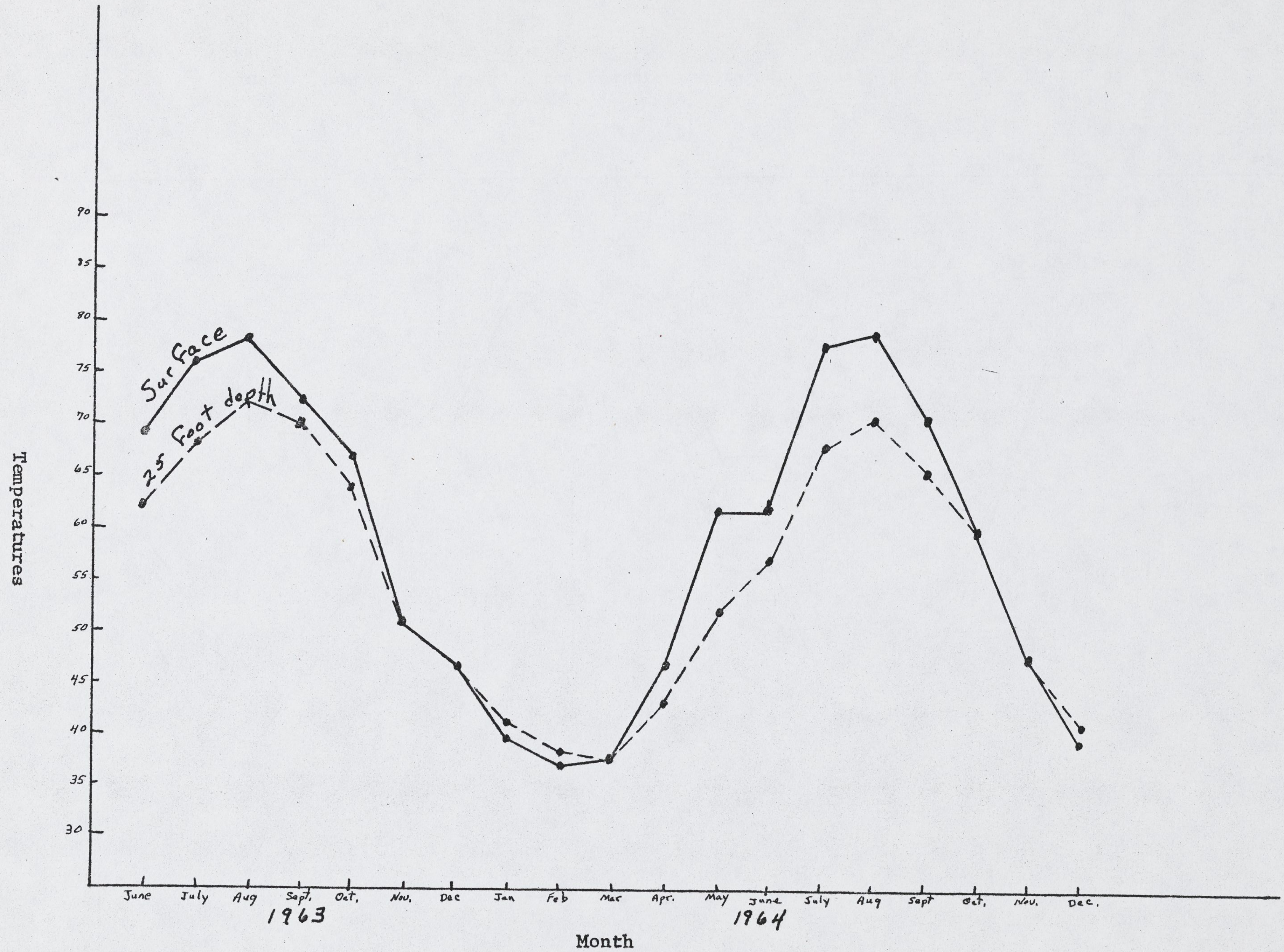


Figure 7. Graph of surface and 25-foot temperature recordings, Navajo Reservoir, Station 4.

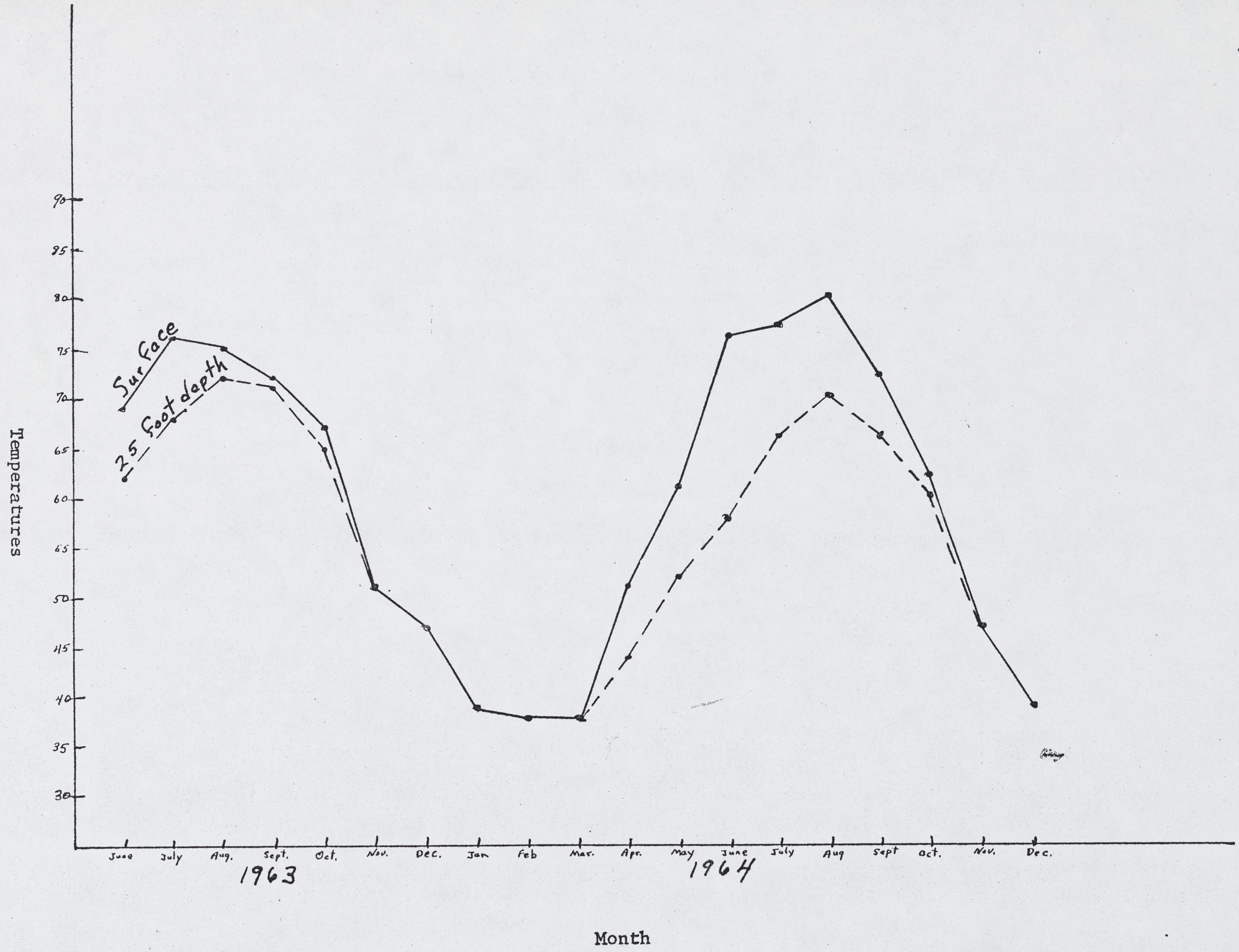


Figure 8. Graph of surface and 25-foot temperatures recorded, Navajo Reservoir, Station 5.

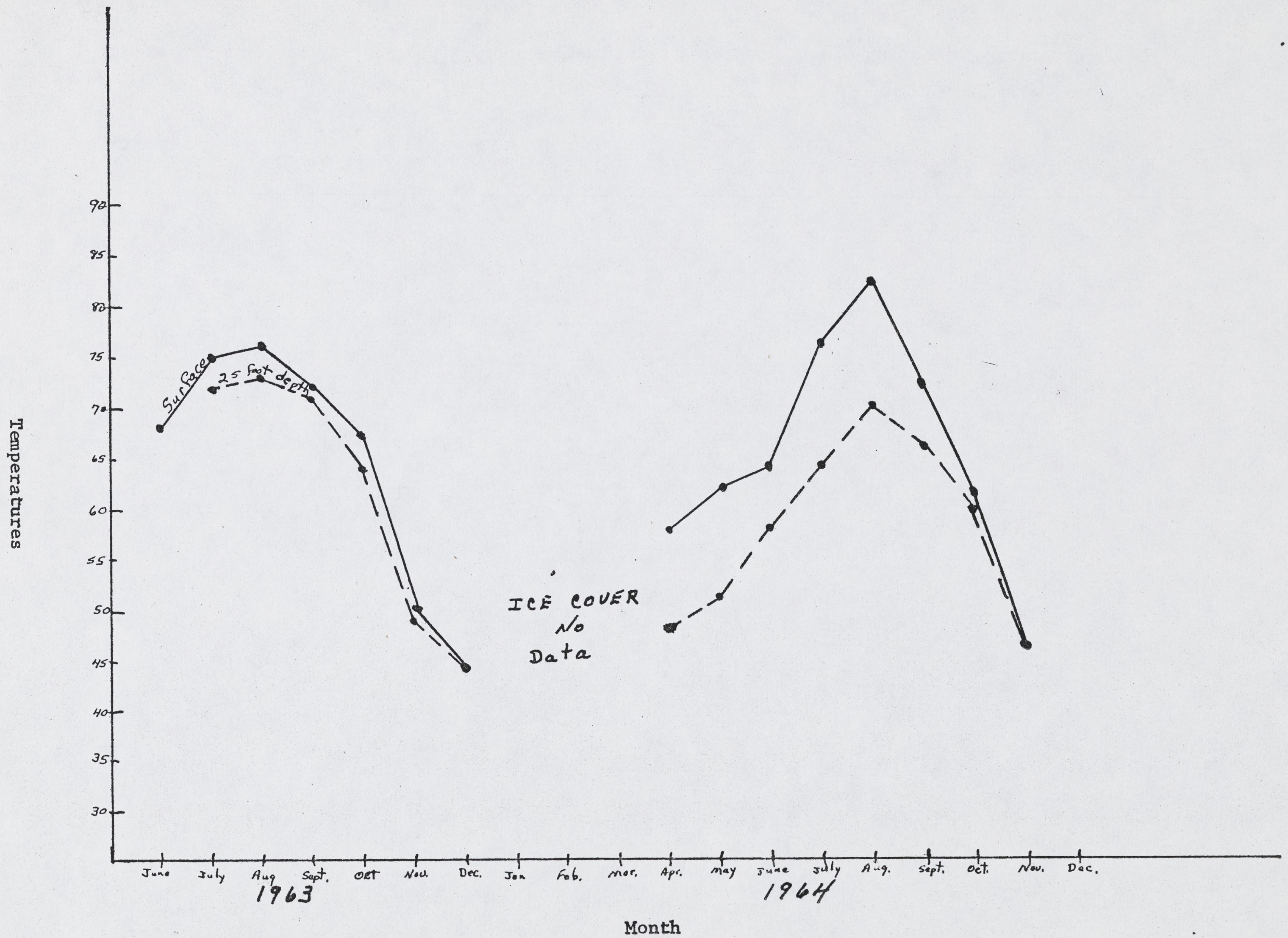


Figure 9. Graph of surface and 25-foot temperatures recorded, Navajo Reservoir, Station 6.

Figure 10. Thermocline depths for each sampling station, 1963 and 1964.

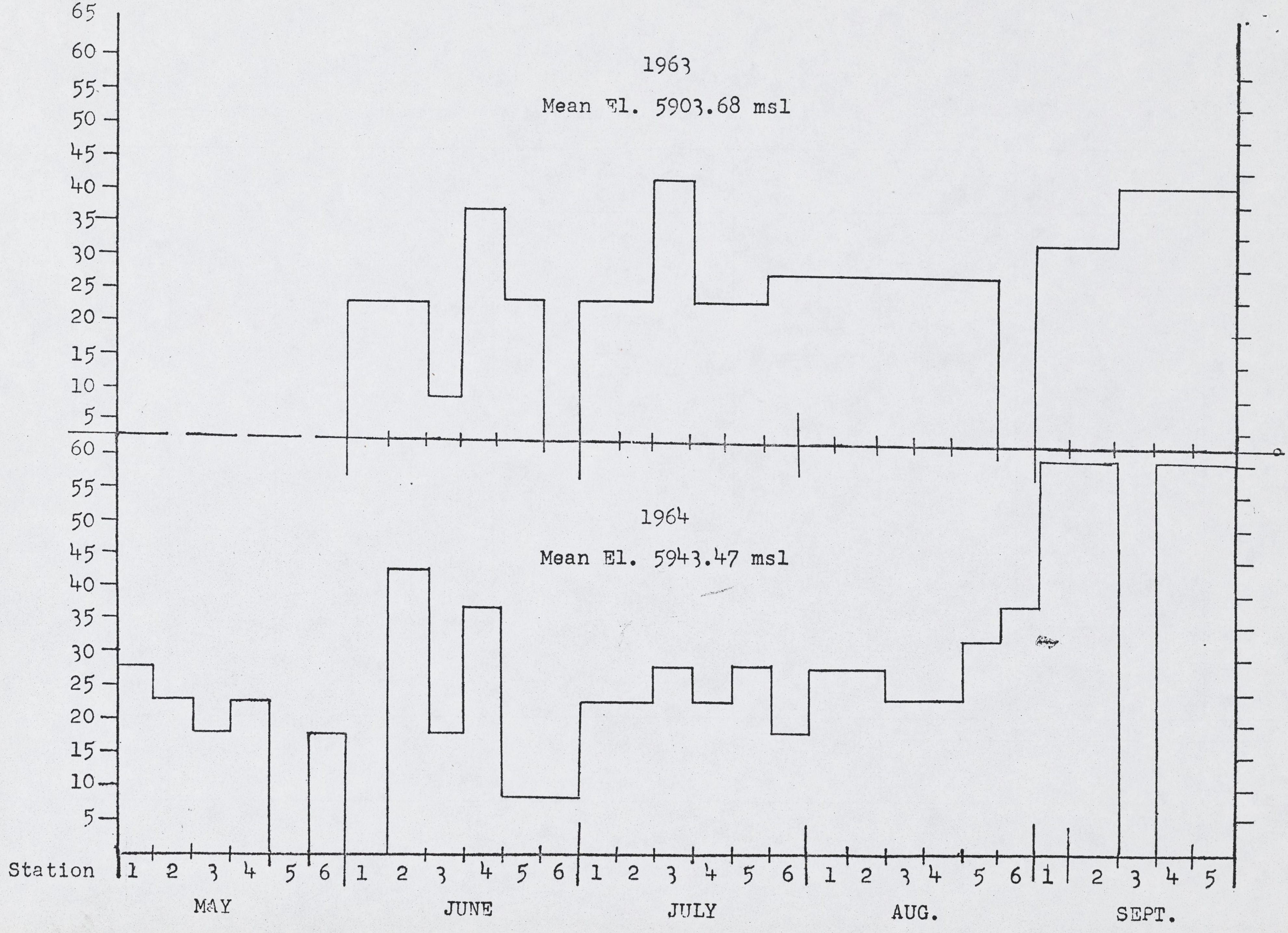


Table 4. Weather Data at the Navajo Dam Station, 1964*

Month	Temperature °F			Total Precipitation (inches)	Evaporation (inches)	Number of Days		
	Maximum	Minimum	Mean			Clear	Partly cloudy	Cloudy
January	50	2	24	.24		24	3	4
February	50	6	25	.18		19	2	8
March	67	17	35	.90		19	4	8
April	73	25	46	1.54	7.03	21	2	7
May	88	27	60	.92	11.20	23	5	3
June	90	43	68	.19	13.30	24	1	2
July	97	57	77	2.06	13.34	24	3	4
August	95	45	72	1.82	11.42	24	2	5
September	88	45	65	1.25	7.29	21	1	8
October	81	31	56		6.35	29	2	
November	66	21	38	1.16	1.25	16	5	9
December	47	24	28	2.07		12	6	13
The Year				12.33	71.18	259	36	71

* Data received from Bureau of Reclamation, Navajo Dam headquarters.

Table 5. Dissolved Oxygen and Carbon Dioxide Levels Recorded at all Stations of the Navajo Reservoir During Segment No. 2 Showing Readings as ppm.

Station	Depth	July DO	July CO_2	August DO	August CO_2	October DO	October CO_2	December DO	December CO_2	January DO	January CO_2	February DO	February CO_2
1	0	7.4	0.0	7.7	0.0	7.6	3.0	6.4	5.0	6.7	4.0	9.9	0.0
	50	4.0	3.0	1.3	6.0	0.2	5.0	6.0	4.0	6.0	4.0	8.8	3.0
	100	6.0	3.0	5.2	4.5	4.6	4.0	3.9	4.0	6.0	4.0	6.8	4.0
	150	5.5	2.0	5.5	4.0	4.4	4.0	2.9	6.0	6.0	4.0	4.3	4.0
2	0	8.9	0.0	7.8	0.0	7.5	5.0	6.0	2.0	7.7	3.0	9.9	1.0
	50	1.6	6.0	.25	7.0	6.5	3.0	6.3	3.0	6.5	3.0	8.9	3.0
	100	2.8	7.0	3.7	5.5	1.6	8.0	6.9	3.5	7.5	4.0	6.8	3.0
3	0	9.1	0.0	9.2	0.0	8.5	3.0	8.4	3.0	8.4	3.0	9.6	2.0
	50	0.3	8.0	0.0	21.0	7.3	3.0	7.8	4.0	8.3	5.0	8.5	3.0
4	0	9.1	0.0	8.25	0.0	6.3	4.0	6.3	5.0	8.5	3.0	9.2	1.0
	50	4.2	5.0	6.9	0.0	6.3	4.0	6.0	5.0	7.5	3.0	9.0	3.0
	100	3.2	7.0	1.5	8.5	0.4	12.0	5.4	5.5	7.5	3.0	8.2	4.0
5	0	9.2	0.0	7.8	9.0	7.5	2.0	7.5	4.0	8.5	3.0	9.2	2.0
	50	2.8	7.0	0.0	9.0	5.0	5.0	6.6	3.0	8.0	6.0	8.8	3.0
	100			.10	10.0	0.3	6.0	7.0	6.0	7.5	8.0	7.8	4.0
6	0	7.5	0.0	9.1	0.0	8.1	1.5	9.2	1.0	Iced - No Data			

Table 5. C O N T I N U E D

Station	Depth	DO	CO_2	DO	CO_2	DO	CO_2	DO	CO_2	DO	CO_2	DO	CO_2
1	0		3.0	10	2.0	7.0	0.0	6.7	0.0	6.8	0.0	6.8	0.0
	50	8.5	3.0	10.2	2.0	6.7	2.0	6.7	1.0	4.3	2.0	4.3	2.0
	100	8.5	3.0	8.5	3.0	6.5	3.0	6.1	2.0	4.5	2.0	4.5	2.0
	150	5.2	4.0	7.4	3.0	6.4	4.0	5.0	2.0	5.2	4.0	5.2	4.0
2	0	7.7	2.0	8.5	2.0	7.0	0.0	6.7	0.0	6.8	0.0	6.8	0.0
	50	7.7	2.0	6.8	2.0	6.5	1.5	5.7	2.0	4.5	2.0	4.5	2.0
	100	7.8	3.0	6.8	2.0	6.4	1.5	5.4	1.0	5.0	2.0	5.2	2.0
3	0	8.4	0.0	7.3	2.0	6.2	0.0	5.5	Trace	6.2	0.0	6.2	0.0
	50	9.0	0.0	5.8	4.0	5.5	2.0	5.3	3.0	3.2	4.0	3.2	4.0
4	0	10.2	1.0	8.8	2.0	6.6	0.0	6.3	Trace	6.0	0.0	6.0	0.0
	50	9.7	2.0	7.8	2.0	6.0	1.0	6.5	2.0	6.0	2.0	5.3	2.0
	100	9.7	2.0	7.0	2.0	5.9	2.0	6.2	2.0	4.2	2.0	3.9	2.0
5	0	10.2	0.0		1.0	7.4	0.0	6.8	Trace	6.1	0.0	6.1	0.0
	50	9.5	2.0	8.2	2.0	5.4	2.0	6.2	2.0	4.3	2.0	4.3	2.0
	100	8.9	2.0	8.9	2.0	5.2	3.0	4.5	2.0	3.5	2.0	3.5	2.0
6				8.8	2.0	6.5	2.0	0.0	2.0	6.0	0.0	6.0	0.0
				8.7	2.0	6.1	2.0	5.5	3.0	3.2	2.0	3.2	2.0

The total hardness (versenate) determinations did not vary significantly between the sampling stations. A vertical variation at the deep water stations was common during the summer months. The largest spread occurred at Station 1, August, 1963, with total hardness reading of 86.0 ppm on the surface and 180.0 ppm at a depth of 190 feet.

As with the total hardness, the methyl orange alkalinity variation occurred in the vertical series with similar recordings at all sampling stations. Readings of 73.0 ppm on the surface and 115.0 ppm at a depth of 190 feet at Station 1 was the largest spread recorded.

Phenolphthalein alkalinities appeared on the surface of the reservoir during the summer months. No indications of this alkalinity were noted in the hypolimnion nor throughout the lake during the fall and winter months.

Discussion:

The thermo and chemical data indicates that a variety of habitat conditions exists within the reservoir. These conditions, of course, vary with seasonal changes and surface elevations of the reservoir.

With the present game fish population of predominantly rainbow trout, these favorable conditions do not exist in all areas of the lake through the summer and early fall months. This is certainly true in the littoral regions of the reservoir and at Stations 3 and 6, where high temperatures, low dissolved oxygen and high carbon dioxide levels were recorded.

The mid-water deficiency of dissolved oxygen (50-foot level) may be a natural phenomenon common to this reservoir. This layer of water located in the upper hypolimnion, was found in all areas of the lake. The cause seems to be related to the inflows of the pine and San Juan Rivers that contain rich, organic materials from the irrigation return water. While discussing this phenomenon with the Section 8 personnel of other states it was discovered that this condition exists in both the Flaming Gorge and Glenn Canyon Reservoirs.

This writer doubts that this layer of water had any adverse effects on the present fish populations. It might possibly have influenced the vertical distribution, but there is no positive evidence of this effect.

The author does not intend to become involved with tolerance levels of the various fish species, but states that much of the temperature and chemical data does not lie within the preferred levels for good trout production.

Future operations of the reservoir will probably cause many changes in the pattern of water quality data. The present schedule is to maintain the reservoir level below the elevation 5,965.0 feet until the first phase of the irrigation system is completed (1967). It seems reasonable to assume that the environmental conditions will follow similar patterns for the next two years. Predictions made in regard to the environmental conditions after the reservoir fills are possible, but cannot be made with any degree of accuracy. It will be interesting to continue this data as the reservoir fills and is maintained above the 5,965.0 feet elevation.

Summary:

The Navajo Reservoir contains water that is favorable for the production of the salmonid species, but cannot be considered as optimum for them.

Low dissolved oxygen and high carbon dioxide levels decreased the value of parts of the reservoir for trout production.

The thermo and chemical conditions should remain nearly the same for the next two years. After that time changes in water quality are expected but no logical predictions are feasible at this time.

POPULATION STUDIES

History:

Prior to impoundment, 23 miles of the Pine River and 35 miles of the San Juan River were eradicated using five percent rotenone in hopes of reducing the undesirable fish population to a minimum, thus enhancing growth and survival conditions of introduced salmonids. The Colorado Department of Game, Fish, and Parks, along with the New Mexico Department of Game and Fish cooperated in dispensing the toxicant. Fish kills were reported to the town of Shiprock, New Mexico, approximately 65 miles below Navajo Dam.

Pre-impoundment investigations of the Navajo Lake watershed, 1961 were initiated prior to eradication. These investigations indicated high numbers of bonytail chub, flannelmouth suckers, white suckers, bluehead mountain suckers, and carp in the watershed.

Post-impoundment studies were initiated during the summer of 1962 and indicated undesirable species constituted 76.7 percent of the total number and 85.1 percent of the weight of all fish collected (Olson, 1962). The conclusion that pre-impoundment eradication had little effect in restricting establishment of undesirable species can be safely made.

Introductions:

Introduction of salmonids was activated during March, 1962, when 533,500 rainbow fry were planted in the San Juan River near the Colorado line some 30 miles above the dam site. The stream bypass at the dam site was plugged June 27, 1962, and the reservoir started its growth. Rainbow trout plantings continued through 1962, with a total of 1,992,301 being planted. Brown trout have not been released by New Mexico in Navajo Lake, however, Colorado has made several releases of browns in their portions of the Navajo Lake drainage (see Table 7) regarding Colorado plantings. Warm-water species other than channel catfish have not been planted in the Navajo Lake drainage during 1964, however, Vallecito Reservoir, located on the Pine River in Colorado, has been planted with walleye pike, northern pike and black bass in previous years.

Objectives:

Fish collections in Navajo Lake during 1963 and 1964 were designed to furnish information concerning (1) relative species abundance, (2) area and depth distribution, (3) age and growth of scaled fish, and (4) length-weight relationships.

Procedures:

Six sampling stations were designated in the early phases of Navajo Lake

Table 6. Navajo Lake fish plantings beginning July, 1962 through December 31, 1964.

Species	Number	Size	Pounds	Date	Hatchery
Rainbow	150,000	1"	60	March-62	Saratoga, Wyoming
Rainbow	17,155	4"	365	March-62	Springville, Utah
Rainbow	100,000	1"	40	March-62	Saratoga, Wyoming
Rainbow	309,000	1"	103	March-62	Leadville, Colorado
Rainbow	186,000	1"	107	April-62	Leadville, Colorado
Rainbow*	153,870	2½"	576	July-62	Lisboa Springs, New Mex.
Rainbow*	173,376	1½"	387	July-62	Parkview, New Mexico
Rainbow*	156,200	1½"	440	July-62	Glenwood, New Mexico
Rainbow	90,800	2"	322	July-62	Leadville, Colorado
Rainbow	75,200	2"	160	July-62	Saratoga, Wyoming
Rainbow	89,600	2"	357	July-62	Leadville, Colorado
Rainbow	168,000	1"	120	July-62	Leadville, Colorado
Rainbow	89,900	2"	373	July-62	Leadville, Colorado
Rainbow	189,000	2"	1,170	August-62	Leadville, Colorado
Rainbow	43,300	3"	506	August-62	Leadville, Colorado
Subtotal	1,992,301		5,086		
Rainbow	242,400	1¼"	600	June-63	Leadville, Colorado
Rainbow	139,000	2¼"	462	June-63	Leadville, Colorado
Rainbow	340,000	1½"	450	June-63	Leadville, Colorado
Rainbow	339,700	3-4"	5,570	October-63 November-63	Leadville, Colorado
Rainbow	14,080	2"	45	August-63	Parkview, New Mexico
Rainbow	110,980	3/4"	24	December-63	Parkview, New Mexico
Subtotal	1,186,160		7,156		
Rainbow	133,416	1½"	163	February-64	Springville, Utah
Rainbow	148,000	1½"	211	March-64	Springville, Utah
Rainbow	45,000	2"	114	March-64	Springville, Utah
Rainbow	50,000	2½"	221	April-64	Springville, Utah
Rainbow	57,680	3"	824	October-64	Leadville, Colorado
Rainbow	59,000	3"	844	October-64	Leadville, Colorado
Rainbow	38,000	3"	907	October-64	Leadville, Colorado
Rainbow	43,000	3"	880	October-64	Leadville, Colorado
Rainbow	40,250	3"	805	October-64	Leadville, Colorado
Rainbow	42,000	3"	840	October-64	Leadville, Colorado
Rainbow	40,000	3"	810	October-64	Leadville, Colorado
Rainbow	25,500	3"	850	October-64	Leadville, Colorado
Rainbow	6,000	3"	200	October-64	Leadville, Colorado
Rainbow	24,000	5"	800	October-64	Leadville, Colorado
Rainbow	11,760	6"	980	November-64	Leadville, Colorado
Rainbow	10,100	6"	1,010	December-64	Leadville, Colorado
Rainbow	9,900	6"	990	December-64	Leadville, Colorado
Subtotal	783,606		11,449		
TOTAL	3,962,067		23,691		

Table 6. C O N T I N U E D
Navajo Lake fish plantings beginning July, 1962 through December 31, 1964.

Species	Number	Size	Pounds	Date	Hatchery
Kamloops	23,001	1¼"	33	September-63	Lisboa Springs (Pecos)
Kamloops	80,384	3/4"	32	March-64	Parkview, New Mexico
Subtotal	103,385		65		
Kokanee	49,920	3/4"	8	December-63	Parkview, New Mexico
Subtotal	49,920		8		
Channel Catfish	95,215	2"	515	October-63	Dexter, New Mexico
Channel Catfish	52,000	3"	520	November-63	Cedar Bluff, Kansas
Channel Catfish	50,000	2-3"	325	September-64 October-64	Dexter, New Mexico
Channel Catfish	20,000	2-3"	130	September-64 October-64	Dexter, New Mexico
Channel Catfish	27,500	3-13"	800	November-64	Dexter, New Mexico
Subtotal	244,715		2,290		
GRAND TOTAL (All Spec.)	4,360,087				

Table 7. Colorado fish plantings made in the Navajo Lake watershed during 1964.

Waters	Species	Number	Size
Vallecito Reservoir	Brown trout	75,000	1½"
	Rainbow trout	100,000	2"
	Rainbow trout (catchables)	75,000	
	Kokanee	250,800	1"
Pine River	Rainbow trout (catchables)	4,500	
	Brook trout	1,800	2"
Piedra River (all forks)	Rainbow trout (catchables)	29,770	
	Rainbow trout	58,280	2"
	Native trout	10,000	1"
San Juan River (all forks)	Rainbow trout (catchables)	32,310	
	Brown trout	18,500	2-3"
	Rainbow trout	25,000	2"

investigations (see Fig. 1). Station one, two, four, and five are all deep water stations with the depth being greater than 150 feet. Stations three and six are less than 150 feet in depth and are located near the mouths of the tributary rivers, the Pine and the San Juan.

Fish were sampled throughout the calendar year with the greatest emphasis placed on spring and summer collections. No attempt was made to collect a given minimum or maximum number at each sampling station or sampling period.

Experimental gill nets 125 feet in length, with mesh bar sizes varying from one-half to one and one-half inches were used for fish collections. Netting areas were located in bays, shallow areas adjacent to shore and deep portions of the reservoir proper. All netting was conducted in close proximity to described stations. Depth of sampling varied from 200 feet to the surface with mid-depth sampling in areas of great depth. All sets are considered 24-hour sets.

Discussion:

Spring turnover occurred during May of 1963 and a relative stable thermocline developed between the 20 and 30-foot depth throughout the reservoir. This thermocline development weakened during September and settled in the 60 to 70-foot depth. This thermocline gradually sank and fall turnover occurred during November. Mean elevation of Navajo Lake in 1963 was 5,903.68 msl.

Dissolved oxygen was adequate for salmonids in the thermocline region. Immediately below the thermocline, 40 to 60 feet, dissolved oxygen dropped to 0 ppm during 1963. Dissolved oxygen gradually increased below the void region and neared 5 ppm in depths greater than 150 feet.

No fish were sampled below 30 feet during 1963. It is believed that the low oxygen area below the thermocline acted as a barrier and discouraged vertical movement of fish below the oxygen depleted region. Anglers reported catches below the 30-foot region.

Spring turnover in 1964 occurred during April. Thermocline development occurred in May at 20 to 30 feet and persisted through August. September thermocline development was similar to that found in 1963 and a gradual weakening of thermo development lasted until fall turnover during November. The mean elevation during 1964 was 5,943, (39.79 feet greater than 1963). Dissolved oxygen remained adequate throughout all depths during 1964 with the minimum being 3.2 ppm. The low oxygen area in 1964 was similar to that found in 1963 and occurred immediately below the thermocline.

No fish were sampled below 30 feet again in 1964, although anglers reported catches below the 30-foot level.

Utilization of the hypolimnion by salmonids and coarse fish is believed to be minimum because food production is low in this region. The reports from anglers stating fish were readily caught at depths to 100 feet are considered unlikely, although possible.

The external parasitic copepod *Lernaea cruciata* occurred on rainbow trout, bluegill, bonytail chub, and flannelmouth suckers during 1963 and 1964. From one to five copepods were found on about 10 percent of the 1963 collections made during August and September. Collections made during August and September, 1964, indicated about 25 percent infection, with copepods numbering as high as 25 on some specimens. Some mortality of rainbow trout was reported during August, 1964, as a result of many copepods on some fish.

The frequency of copepod occurrence dropped during fall and early winter as water temperatures lowered. Rainbow trout examined from angler's creel during December, 1964, showed less than five percent of the rainbow trout with active copepods. Scars caused by copepods on external surfaces occurred on about 50 percent of the specimens examined.

Anglers catching infected fish were sometimes reluctant to utilize these fish for eating purposes.

The development of copepods on fish during 1965 will be closely followed by Section 8 personnel in hopes of determining the magnitude of the epizootic.

Results:

Gill netting in the littoral regions produced the greatest numbers of fish. Surface sets in the epilimnion in the greater depths of the reservoir produced very few fish, however, anglers reported fairly good catches of salmonids trolling shallow running lures in deep areas. The difficulty inherent with setting a surface gill net in 200 feet of water probably accounted for poor catches in the epilimnion and netting data for open water areas probably does not yield a true picture regarding fish utilization.

The following tables and figures include all fish sampled during 1963 and 1964 in Navajo Lake. (See tables 8, 9, 10).

Two carp were collected during 1963 and 1964. Both specimens were mature fish. No young carp were collected or observed during 1963 and 1964. It is believed that carp presently occur in very low numbers in Navajo Lake.

Mention is made to the fact that undesirable species, mainly bonytail chub, flannelmouth sucker, white sucker, carp and black bullhead represented 42.13 percent of the 1963 collection and 84.13 percent of the 1964 collections by occurrence, representing an increase of 99.7 percent occurence in one year.

Undesirable species represented 69.03 percent by weight of the 1963 collection and 81.38 percent by weight of the 1964 collections, representing an increase of 19.64 percent.

An increase of 99.7 percent in number in one year and only 19.64 percent by weight in one year indicated that undesirable species apparently encountered ideal spawning conditions and high progeny survival during 1963.

DISTRIBUTION

Distribution of salmonids and undesirables proved constant throughout the reservoir with the exceptions of brown trout and carp. Brown trout were collected at station 3 and 6; the two carp collected during the reporting period were also collected at stations 3 and 6.

Table 8. Relative species composition in Navajo Lake during 1963.

Species	No.	Weight (ozs.)	Average Weight (ozs.)	Percent by No.	Percent by Wt.
Rainbow	206	816	3.96	57.87	31.97
Flannelmouth sucker	100	1,079	10.80	28.09	42.12
White sucker	38	536	14.11	10.67	20.92
Bonytail chub	11	73	6.63	13.09	2.85
Carp	1	55	.55	0.28	2.14
TOTALS	356	1,843		100.00	100.00

Table 9. Relative species composition in Navajo Lake during 1964

Species	No.	Weight	Average Weight (ozs.)	Percent by No.	Percent by Wt.
Rainbow	167	1,096.0	6.56	15.38	16.86
Brown trout	5	114.5	22.90	0.46	1.76
Flannelmouth sucker	276	2,008.0	7.27	25.41	30.88
White sucker	93	1,272.5	13.68	8.56	19.56
Bonytail chub	460	1,625.0	3.53	42.36	24.99
Black bullhead	82	318.0	3.88	7.56	4.89
Bluegill	2	2.0	1	0.18	0.03
Carp	1	67.0	67	0.09	1.03
TOTALS	1,086	6,503.0		100.00	100.0

Table 10. Relative species composition in Navajo Lake for 1963 and 1964.

Species	No.	Weight	Average Weight (ozs.)	Percent by No.	Percent by Wt.
Rainbow	373	1,912.0	5.13	25.87	21.10
Brown trout	5	114.5	22.90	0.35	1.26
Flannelmouth sucker	376	3,087.0	8.21	26.07	34.07
White sucker	131	1,808.5	13.81	9.08	19.96
Bonytail chub	471	1,698.0	3.61	32.66	18.74
Black bullhead	82	318.0	3.88	5.69	3.51
Bluegill	2	2.0	1.00	0.14	0.02
Carp	2	122.0	61.00	0.14	1.34
TOTALS	1,442	9,062.0		100.00	100.00

Figure 11. Bar graphs representing relative abundance of salmonids compared to undesirable species for 1963-1964 and an average for both years.

	Trout	Undesirable species
1963	No. 206 % 57.87	No. 150 % 42.13
1964	No. 172 % 15.8	No. 912 % 84.2
1963-64 Mean	No. 378 % 26.22	No. 1,062 % 73.78

Figure 12. Bar graphs representing weights of salmonids compared to weights of undesirable species for 1963-1964 and an average for both years.

	Trout	Undesirable species
1963	No. 206 Wt. 816 oz. % 31.97	No. 150 Wt. 1,843 oz. % 68.03
1964	No. 172 Wt. 1,210 oz. % 18.62	No. 912 Wt. 5,292 oz. % 81.38
1963-64 Mean	No. 378 Wt. 2,026 oz. % 22.36	No. 1,062 Wt. 7,035 oz. % 77.64

Frequency of occurrence varied greatly throughout the reservoir. The greatest number of salmonids and undesirables were collected at Station 3 and 6, both near the tributary rivers.

Vertical distribution was limited to the upper 30 feet of strata. Actually, very few specimen were collected below 25 feet. No significant change in species composition occurred as depth increased or decreased.

It is interesting to note that 59.3 percent of all salmonids collected during 1964 were obtained from Station 3 and 37.5 percent of all undesirables were collected at the same station. No fish were sampled at Station 5; no apparent reason exists for the phenomenon.

The bonytail chub appears to have adapted to reservoir environment and represented 18.74 percent of the 1963 through 1964 collections and 2.65 percent by number in the angler's creel during 1964. A review of literature indicated the bonytail chub is primarily a plankton-microorganism consumer and will probably compete directly with certain length classes of salmonids in future years. Most authors reported the bonytail chub as being primarily a stream fish.

The flannelmouth sucker represented 34.07 percent of the 1963-64 collection. The flannelmouth is primarily a vegetarian and is not expected to compete directly with salmonids except for space.

The white sucker represented 19.96 percent of the 1963-64 collections and like the flannelmouth, is primarily a vegetarian.

Black bullheads represented 3.51 percent of the 1963-64 collections and represented 8.2 percent by number in the angler's creel during 1964. Numerous schools of small young-of-year black bullheads were observed during the summer of 1964. This species may in time provide a desirable "undesirable" species to angler's creel.

One carp was collected in 1963 and one in 1964. Carp are not expected to become a serious problem in the reservoir because of poor spawning habitat and scarcity of food.

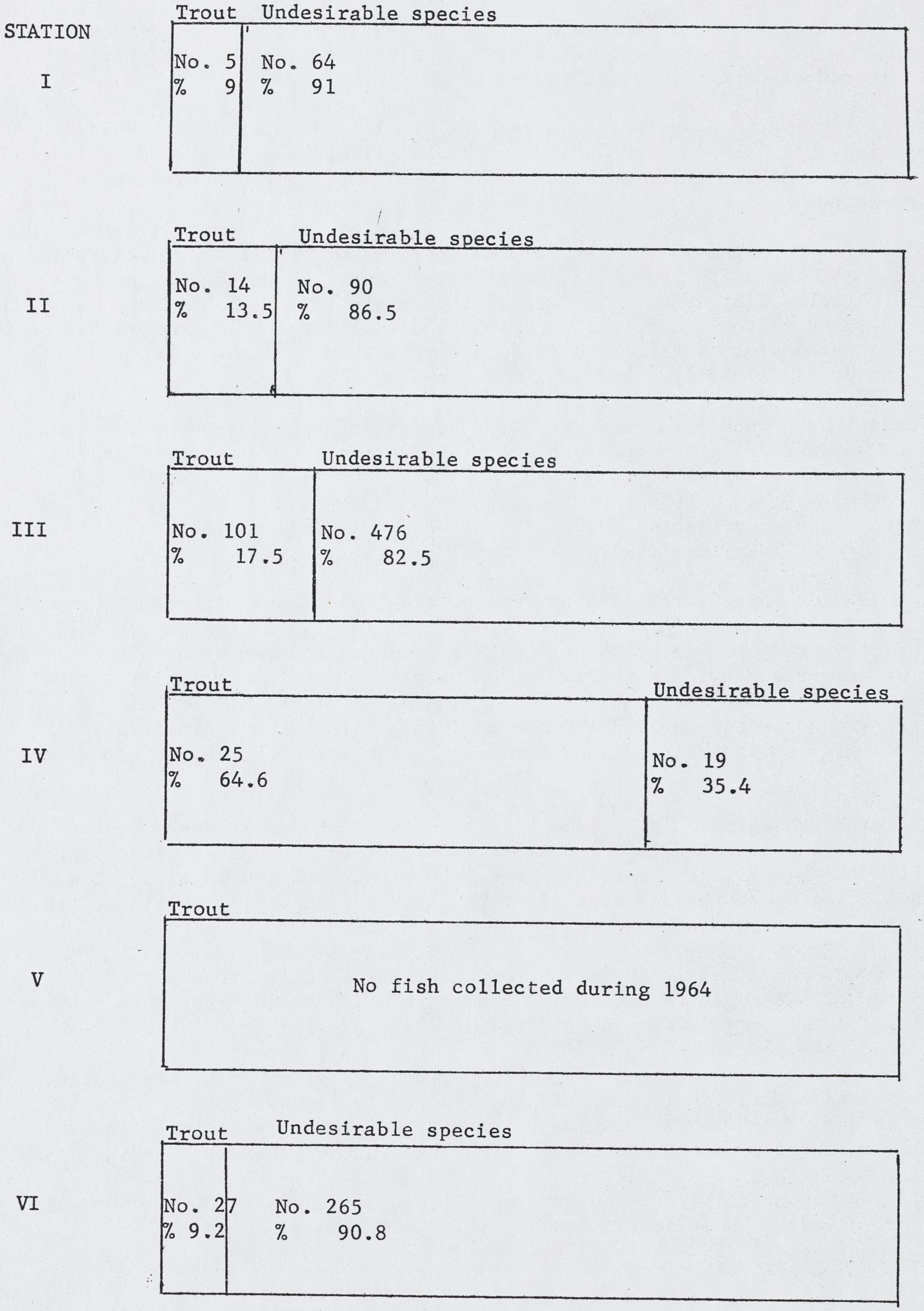
Bluegills gained entry in the 1964 collections and were represented by two individuals. Creel census data, 1964, indicated 6.97 percent by number of the angler's harvest consisted of bluegills. Bluegills were probably introduced to Navajo Lake from stock dams adjacent to the San Juan River in Colorado and will probably add to the shore fishery in years to come.

Rainbow trout comprised 21.10 percent of the 1963-64 collections and 82.16 percent by number of the angler's harvest. Both shore and boat anglers caught rainbows, however, boat anglers were more successful.

Brown trout were collected only in the upper Pine River and San Juan stations and were represented by five individuals in the 1964 collections. This species probably drifted down the Pine and San Juan Rivers from Colorado plantings. Browns entered the angler's creel, although were not recorded in the 1964 creel census.

Channel catfish have not entered netting collections, however, token numbers have been reported caught by anglers. Kamloop trout and kokanee salmon were not sampled due to their small size during 1964.

Figure 13. Bar graphs representing netting summary by station showing relative abundance of salmonids compared to undesirable species during 1964.



Black bass have been reported caught in Navajo Lake, but these catches have not been authenticated by New Mexico Game and Fish personnel. Black bass are probably found in Navajo Lake, but are represented in small numbers that arrived via resident stock dams found adjacent to the San Juan River in Colorado that washed out during excess runoff.

Fathead minnows occur in the reservoir in great numbers and throughout all sections. Spotted dace have been collected, but in small numbers and limited areas. Other minnow species are probably present, but have not been collected since impoundment.

Condition:

Relative plumpness of fishes was measured by condition factor "K" in terms of total length in millimeters and weight in grams. Condition determination is an important tool in analysis of the fishes adaption and utilization of its environment. The following tables include all fish that lengths and weight were recorded during 1963 and 1964. Total length of specimens recorded were rounded to the nearest 10 millimeters and will be reported in 10 millimeter increments. Length frequency may also be obtained from the following tables.

Table 11. Condition factor "K" for Brown trout, 1964.

Total length in mm.	Number	Range	Average
280	1		0.77
354	1		1.08
376	1		1.12
			0.99 Mean

Table 12. Condition factor "K" for Rainbow trout, 1963.

Total length in mm.	Number	Range	Average
160	1		.62
170	4	.52-.74	.66
180	1		.63
190	1		.61
200	2	.89-1.01	.95
210	7	.45-.92	.60
220	10	.48-.88	.71
230	18	.47-1.13	.74
240	12	.58-1.00	.78
250	7	.51-.77	.65
260	9	.60-.95	.73
270	5	.52-.72	.66
280	3	.50-.68	.56
290	2	.57-.90	.74
300	2	1.00-1.5	1.07
310	1		.57
320	1		1.01
330	2	.54-.55	.54
420	1		1.20
366	1		1.09
	90		0.72 Mean

Table 13. Condition factor "K" for Rainbow trout, 1964.

Total length in mm.	Number	Range	Average
220	1		1.18
240	1		.86
260	3	.79-.83	.81
270	2	.89-.99	.94
290	2	.80-.93	.87
310	1		.92
320	1		.78
330	2	.90-.90	.91
340	4	.84-.94	.90
360	1		.80
380	1		.92
	19		0.89 Mean

Table 14. Condition factor "K" for Bonytail chub, 1963.

Total length in mm.	Number	Range	Average
200	1		1.18
210	1		1.14
220	3	.87-1.05	.98
230	3	.62-1.11	.94
240	1		1.03
350	1		1.06
390	1		.95
	11		1.01 Mean

Table 15. Condition factor "K" for Bonytail chub, 1964.

Total length in mm.	Number	Range	Average
200	1		.95
210	6	.84-1.15	1.03
220	2	.92-1.00	.96
230	2	.92-.97	.95
240	3	.81-1.02	.94
320	1		1.17
390	1		.95
	16		0.99 Mean

Table 16. Condition factor "K" for Flannelmouth suckers, 1963.

Ttoal length in mm.	Number	Range	Average
210	1		.92
220	2	.71-.80	.75
230	2	.87-1.12	1.00
240	4	.74-1.10	.88
250	6	.69-1.26	.80
260	5	.64-.96	.77
270	4	.56-.72	.63
290	1		.92
340	1		1.01
350	3	.86-1.19	.98
360	1		1.12
370	1		.94
380	5	.97-1.08	1.01
390	3	.91-1.05	.96
400	2	.90-.97	.94
410	3	.94-.96	.94
420	2	.96-1.02	.99
440	3	.94-.97	.96
	49		0.92 Mean

Table 17. Condition factor "K" for Flannelmouth suckers, 1964.

Total length in mm.	Number	Range	Average
210	1		1.10
240	3	1.02	1.02
250	2	.86-1.05	.95
260	1		.90
310	1		.69
320	2	1.03-1.12	1.07
350	1		1.06
360	1		.94
380	1		.90
390	1		1.01
410	1		1.09
430	1		1.09
	16		0.99 Mean

Table 18. Condition factor "K" for White suckers, 1963.

Total length in mm.	Number	Range	Average
220	1		.99
240	1		1.01
250	1		1.09
280	1		.98
330	1		.91
340	1		1.01
350	1		1.06
360	1		1.05
370	1		1.01
380	4	.93-1.13	1.04
400	2	.93-1.15	1.04
420	1		1.07
	16		1.03 Mean

Table 19. Condition factor "K" for White suckers, 1964.

Total length in mm.	Number	Range	Average
210	1		1.21
230	1		1.09
250	1		.96
300	1		1.41
310	1		1.18
320	1		1.07
330	3	1.23-1.29	1.27
340	3	.96-1.54	1.25
360	1		1.33
380	1		1.13
	14		1.21 Mean

Olson, 1962 reported rainbow trout and bonytail chub mean "K" factor of 0.94 for each species. The 1963 mean "K" for rainbow was 0.73 while the mean "K" for bonytail chub was 1.01. Collections for 1964 indicated mean "K" for rainbow was 0.89 and 0.99 for bonytail chub. It is believed that direct competition for food exists between the bonytail chub and the rainbow trout. If bonytail chub numbers greatly increase in future years, the possibility exists that the mean "K" for rainbow can be used to tax the damage caused by the bonytail chub.

AGE-GROWTH

Scales from 142 fish in 1963 and 69 fish in 1964 were collected to read and determine age-growth statistics. A Bausch-Lomb Micro-Projector was used to protect glass slide mounted scales. Rainbow trout scales were the only ones read from the 1963 collection and amounted to 63 readings. All scales from the 1964 collection were read.

Reliable age data and calculated growth data was obtained from the undesirable species. Salmonids introduced growth patterns that made accurate reading impossible.

Spasmodic growth, varying length of plants, year-round growing conditions and year-round planting caused "growth checks" on rainbow scales to appear as an annulus formation. The author concluded after reading 63 scales from the 1963 collection and 21 from the 1964 collections that little, if any, valid age and growth data could be placed on the readings. The readings obtained are not included in this report. A general statement can be made, however, that rainbows planted as 1-2 inch fry will grow to about 9 inches after one year of reservoir life and about 14 inches after their second year.

Table 20. Age and calculated growth for Bonytail chubs, 1964.

Total length in mm.	Number	Age classes, length given in mm.		
		I	II	III
207	1	161		
210	1	165		
214	1	128		
214	1	260		
216	1	147		
216	1	80	187	
216	1	182		
221	1	111		
224	1	147		
230	1	188		
236	1	190		
240	1	210		
240	1	152		
241	1	102	192	
253	1	120	223	
320	1	116	240	
397	1	174	256	332
240.9	17	154.8	219.6	332

Table 21. Age and calculated growth for Flannelmouth suckers, 1964.

Total length in mm.	Number	Age classes, length given in mm. I	II
217	1	161	
240	1	144	
240	1	159	
248	1	185	
254	1	213	
259	1	191	
266	1	133	250
313	1	130	259
320	1	184	306
329	1	144	257
357	1	124	249
361	1	210	
381	1	181	
395	1	190	273
415	1	172	313
431	1	189	359
314.1	16	169.4	283.3

Table 22. Age and calculated growth for White sucker, 1964.

Total length in mm.	Number	Age classes, length given in mm. I	II
219	1	95	
235	1	201	
254	1	159	
304	1	160	
315	1	165	
325	1	176	264
334	1	153	
339	1	136	
339	1	148	
334	1	158	
345	1	169	302
348	1	129	318
361	1	79	214
380	1	196	323
317.2	14	151.7	284.2

Growth becomes difficult for rainbows during their transition from micro-plankton consumers to macro-plankton, crustacea, invertebrate and vertebrate consumers. This transition is believed to occur at about eight inches. The reservoir, in general is lacking abundant macro-food organisms utilized by rainbows during this transition state. The epilimnion in particularly lacking in macro-organisms. The littoral zones provide varying amounts of snails, minnows and insect instars.

Rainbows sampled from open water areas differ greatly in condition from those collected near shore or near the tributary streams. The small head deep body relationship prevails for 10-12 inch rainbows captured near the periphery of the reservoir. The open-water collections of the same size rainbows reveal poor head:body relationships and an emaciated body condition. The fluctuating reservoir conditions during 1963 and 1964 may have contributed to poor food supply for all sizes of salmonids and a greater degree of water stabilization in future years may correct this condition.

Undesirable species seem to have encountered optimum amounts of food and seem to have flourished under impoundment conditions. Carp are somewhat limited for food and this scarcity will probably continue.

Summary:

Fish were sampled in Navajo Lake during 1963 and 1964 to determine fish distribution throughout the lake, relative species abundance, condition factor "K" and age-growth statistics.

A total of 1,442 fish were collected by means of 125-foot experimental gill nets. All six established stations were netted. No fish were collected at Station 5.

Rainbow trout, flannelmouth sucker, bonytail chubs, white suckers, bluegill, and bullheads were sampled throughout the lake. Carp and brown trout were collected only at Stations 3 and 6. Channel catfish, kokanee salmon and kamloop trout were not sampled.

There appeared to be little, if any fish utilization of the hypolimnion. No fish were collected below 30 feet throughout the sampling period. There was no pronounced change in species composition as depth increased or decreased.

The external parasitic copepod, <u>Lernaea cruciata</u>, occurred on 10 percent and 25 percent of the August and September collections made in 1963 and 1964, respectively. Infestation was as high as 25 copepods on some specimens during 1964 and some rainbow trout mortality was reported. The development of copepods on fish in Navajo Lake will be closely followed during 1965.

Undesirable species represented 73.78 percent by number and 77.64 percent by weight during 1963 and 1964. During 1964, undesirable species increased 99.97 percent by number and 19.64 percent by weight, indicating high progeny survival during 1963.

Condition factor "K" averaged 79.55 for rainbow trout during 1963 and 1964. Growing conditions for rainbows were apparently not optimum during 1963 and 1964.

Transition from micro-plankton consumers to macro-plankton, crustacea, invertebrate, and vertebrate consumers seem to have restricted rainbow adaptation to maximum reservoir utilization. Navajo Lake during 1963 and 1964 lacked sufficient amounts of larger aquatic organisms.

Undesirable species have encountered little, if any difficulty in adapting to reservoir environments.

Age and calculated growth data for rainbow trout was not useable because of numerous growth checks appearing as annulus formation.

Only one three year old bonytail chub was recorded from the 1964 scale collections. All other bonytail chubs, along with flannelmouth suckers and white suckers, indicated either one or two annuli, thus meaning either 1962 or 1963 progeny.

A total of 3,962,067 rainbow trout have been planted in Navajo Lake through December 31, 1964; 103,385 kamloops, 49,920 kokanee and 244,715 channel catfish complete the stockings through December 31, 1964.

Black bass were requested for planting on the 1964-1965 planting recommendations, however, considerable difference of opinions exists regarding the suitability of Navajo Lake for warm-water species. Black bass have been reported caught in Navajo Lake, but these catches have not been authenticated by New Mexico Game and Fish personnel. Black bass are probably found in Navajo Lake, but are represented in small numbers that arrived via resident stock dams found adjacent to the San Juan River in Colorado that washed out during excess runoff.

White crappie, dolly varden, white bass, walleye and threadfin shad have been species considered for stocking, however, further evaluation of habitat and salmonid success will determine introduction of any of the mentioned species.

CREEL CENSUS

Objectives:

The creel census program was initiated on Navajo Reservoir to determine the present fishing pressure and recreational use.

Procedure:

Although, scheduled to cover a larger portion of the calendar year, the shortage of adequate help limited the census to the summer months when student assistants could be employed to do the work.

Two areas of the lake were sampled during this study. The Pine River Recreational area, near the dam and the Miller Mesa area, at the extreme upper end of the San Juan River canyon. Other access roads to the lake are available but the fisherman-use in these areas are negligible and sampling would be nearly impossible.

The creel census schedule was determined after analysis of the 1963 use data, compiled by the New Mexico State Park and Recreation Commission. Through stratification of the days with similar use data it was relatively simple to determine the sample size of each stratification to provide adequate data for the study. The days were stratified into three categories; Sundays and holidays, Fridays and Saturdays, and the remaining week days. Traffic counters were installed in both areas to provide additional use information.

The maintenance of the counters in Miller Mesa area was a problem. Vandalism, weather and the required changes in adjustment caused a bias in the traffic counts. Consequently this data is not included in this report.

In conjunction with traffic counter data, road blocks were set up to determine the proportional amount of each type of recreational use.

Results:

The Navajo Reservoir is entering its third year as a New Mexico trout lake. Trout releases were started in March 1962, prior to impoundment on June 27, 1962.

This creel census program is the beginning of a series of census work to keep accurate records of the reservoir production.

During the tabulation of this data it was noted that the information received from the traffic counter at the Pine River recreation site was more reliable than the projected creel census estimates. Consequently the traffic counter information was combined with the creel census data and used to estimate the total fishing pressure and catch rate.

The combined data from the two areas shows that an estimated 19,270 man-days were spent fishing the Navajo Reservoir during June, July, and August, 1964. Of this pressure, 1,034 man-days gained access to the lake through the Miller Mesa area and the remaining pressure, 18,099 man-days, entered at the Pine River Recreation area. The catch data for both areas is expressed in Table 23.

Table 23. Navajo Reservoir Creel Census Data collected at the Pine River Recreation Area and Miller Mesa Area, 1964.

	Pine River Recreation Area				Miller Mesa Area			
	Months				Months			
Type of Data	June	July	August	Total	June	July	August	Total
Fisherman per car				3.37				2.97
Fish per hour	0.56	0.59	0.55	0.59	0.66	0.71	0.45	0.69
Rainbow per hour	0.45	0.51	0.43	0.49	0.59	0.45	0.25	0.45
Hours per man	5.14	5.05	4.80	5.13	3.60	4.50	1.94	4.08
Fish per man	2.92	3.11	2.82	3.02	2.40	3.23	0.88	2.84
Rainbow per man	2.36	2.64	2.10	2.51	2.13	2.06	0.50	1.87
Percent of catch								
Rainbow	79%	85%	75%	83%	88%	63%	57%	66%
Others	21%	15%	25%	17%	12%	37%	43%	34%

Table 24. Estimated fisherman success, hours fished and fish caught, Navajo Reservoir, 1964.

Area Sampled	Fisherman	Hours	No. Rainbow Caught	Total No. Fish Caught
Pine River Recreation Area	18,099	92,847.9	45,367	54,659
Miller Mesa Area	1,032	3,965.5	1,865	2,825
TOTALS	19,131	96,813.4	47,232	57,484

The rainbow trout were the most abundant species found in the creels checked. Black bullheads, bluegill, and bonytail chub were also found. Rumors of carp and largemouth bass catches were not verified. Most of the anglers fished for trout, but a few stated that the purpose of their trip was to catch the bluegill and black bullheads. Two parties were cheked with numerous bonytail chub and they seemed to be satisfied.

Table 25. Classification and estimated* numbers of each species, Navajo Reservoir, 1964.

		% of Total*	Est. No. Each
Rainbow trout	Salmo gairdneri Richardson	82.16	47,231
Black bullhead	Ameiurus melas (Rafinesque)	8.22	4,724
Bluegill	Lepomis macrochirus Rafinesque	6.97	4,006
Bonytail chub	Gila robusta Baird and Girard	2.65	1,523
TOTALS		100.00	57,484

* Combination of data collected at both sampling areas.

Anglers launching boats at either area have access to the entire lake and probably do not remain in the adjacent areas to fish. The catch data from each sampling point is not conclusive in regard to success of the fishermen at either end of the lake, however, it appears that the catch variation of the two samples suggests that some factor or combination of factors in the Miller Mesa area is influenceing the trout catch. This is noticeable by the drop in the catch rate of 0.59 in June to 0.25 rainbow per hour in August, while the data recorded at the Pine River recreation area show a fairly constant catch rate throughout the summer.

Water temperatures, chemical conditions and competition with other species are possible factors contributing to the variation in the recorded data.

The author does not intend to state definite conclusions as to the contributing factors and solution at this time. With the 1964 creel census as a guide, the future programs will be scheduled to provide more information on the rate and total harvest for various areas of the reservoir.

The reservoir recreational use during this three month period was determined with the traffic counter data with the information obtained from road blocks and interviews with people at the Pine River recreation site.

Table 26. Recreation use at the Navajo Reservoir Pine River Recreation Area during June, July, and August, 1964.

Type Use	No. Cars	People per car	Total use	Remarks
Fishing	5,380	3.37	18,099	Traffic counter
Water Skiing	4,079	4.11	16,764	Damaged
Picnicking	1,224	4.66	5,030	July 4, 5, and 6, 1964
Sight-seeing	8,740	4.07	35,571	
TOTALS	19,423	3.93	75,603	

Summary:

An estimated 19,270 man-days during June, July, and August, 1964 were spent fishing in Navajo Reservoir, resulting in catches of 47,231 rainbow trout, 4,724 black bullheads, 4,006 bluegill, and 1,523 bonytail chub.

The catch data indicates a possible environmental influence in the Miller Mesa area causing a decline in angler success.

Sight-seeing, fishing and water skiing were the three most popular recreational uses of Navajo Reservoir as indicated in Table 9.

PLANKTON STUDIES

Objectives:

Plankton collections were made on Navajo Lake during 1963-64 for purposes of: (1) quanitative analysis for all stations, (2) quanitative analysis for each station, (3) qualitative analysis for each station and (4) evaluation of collection techniques.

Procedures:

Monthly plankton collections from each station was the desired goal, however, this was not achieved. September collections for 1964 are absent along with collections from Station 6, from January, 1964 through March, 1964. Ice formation preventedStation 6 collections during the mentioned period. All statistics presented are from analysis of 160 samples collected from July, 1963 through June, 1964.

Collections were made at each station using a Wisconsin-type plankton net with an opening of 12 cm. This size opening allows a cubic foot of water to pass through every 8.7 feet towed.

Both vertical and horizontal collections were made. Vertical collections were made where maximum depth occurred nearest the designated station. Standard sampling depths for stations were initiated during early phases and are as follows:

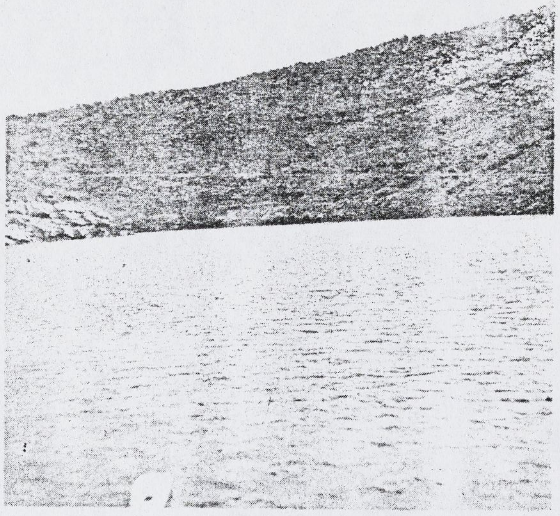


Photo 2. Narrow canyon portion of San Juan River arm, Navajo Reservoir, 10 miles above dam, reservoir level at elevation 5,910 feet.

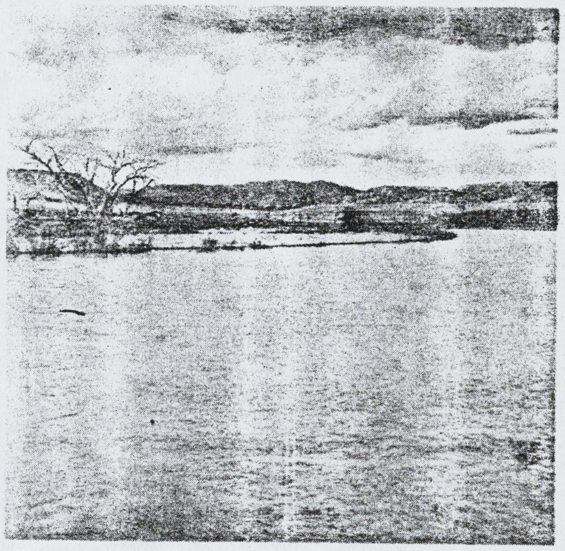


Photo 2. Open area of upper San Juan River canyon.

Station 1 - 150 feet; Station 2, 4, and 5 - 100 feet; Station 3 - 25 feet to 35 feet, and Station 6 - 25 to 30 feet. Fluctuating pool elevations sometimes prevented sampling at standard depths.

Vertical sampling consisted of lowering the Wisconsin plankton net to the desired depth and slowly returning it to the surface.

Horizontal "tows" were standardized to 300 feet during 1963. Again, the Wisconsin plankton net was used and towed from one to two feet below the water surface and along side the boat. Three hundred feet of shore line was marked at each station and the boat would travel adjacent to the marked area about 75 feet from shore.

Collections were "killed" and preserved in 20 percent alcohol. Analysis was performed by a graduate student from the University of Arizona.

Results:

Three hundred and twenty-four samples have been collected for analysis through 1964. Of these, 209 have been analyzed. All statistics reported regarding quanitative and qualitative analysis arrived from collections made from July, 1963 through June, 1964 and represent 160 collections. Plankton summeries for the following tables have been grouped into three-month periods to coincide with the four seasonal periods; winter, spring, summer, and fall.

Table 27 shows that the greatest volume of plankton was collected at Station 3. Station 6 would probably follow Station 3 for the second greatest volume, however, ice formation prevented collections during one sampling period and only 20 samples are represented. (See Fig. 1 for station location).

Stations 1, 2 and 4 are all deep water stations and exhibit similar plankton abundance. Station 5 ranks lowest in plankton production and this can probably be explained by the steep canyons and very limited littoral zone found throughout this station area.

Zooplankton represented 35.5 percent of the horizontal tows and 32.6 percent of the vertical lifts with an overall average of 34.5 percent representation in the collection.

Table 28 indicates that peak plankton production occurred during October, November and December. Plankton production during July, August and September ranked second. The first six months of the calendar year indicated very low plankton production.

Table 29 summarizes horizontal tows from each station where collections measured 5,700 feet. This table indicates that Station 3 ranks highest in both phytoplankton and zooplankton production.

Table 30 indicates volume of plankters per linear foot using a Wisconsin plankton net with a 12 cm opening. The frequency of plankton is reported as milliliters of plankton per foot towed and was derived by dividing total feet towed into milliliters of plankton collected. By using this means for enumerating abundance, both vertical and horizontal collection with varying length of tows can be compared without

Table 27. Plankton volume for each station in Navajo Lake from August, 1963 through June, 1964. (160 samples).

Period	Air Temp.	Water Temp.	Samples	Horiz. Feet	Phyto-plankton	Zoo-plankton	Total	Feet Vert.	Phyto-plankton	Zoo-plankton	Total	TOTALS (ml)
STATION 1												
7/63-9/63	35/93	80/72	3/3	1,800	2.477 ml	.553	3.030	460	1.047	0.683	1.730	
10/63-12/63	80/27	67/42	5/5	2,100	4.353	1.657	6.010	840	1.342	1.058	2.400	
1/64-3/64	46/15	40/39	3/3	900	0.636	0.074	0.710	450	0.607	0.083	0.690	
4/64-6/64	60/72	46/62	3/3	900	0.752	2.668	3.420	450	0.153	0.277	0.430	
TOTALS			14/14	5,700	8.218	4.952	13.170	2,200	3.149	2.101	5.250	18.420
STATION 2												
7/63-9/63	94/75	81/75	3/3	1,800	2.452	1.028	3.480	308	2.941	1.629	4.570	
10/63-12/63	80/35	68/44	5/5	2,100	3.678	1.582	5.260	480	1.321	0.489	1.810	
1/64-3/64	50/16	40/39	3/3	900	0.820	0.030	0.850	280	0.543	0.097	0.640	
4/64-6/64	78/62	65/45	3/3	900	1.053	0.517	1.570	300	0.935	0.415	1.350	
TOTALS			14/14	5,700	8.003	3.157	11.160	1,368	5.740	2.630	8.370	19.530
STATION 3												
7/63-9/63	90/83	80/73	3/3	1,800	3.398	3.252	6.650	126	0.754	0.736	1.490	
10/63-12/63	80/37	68/41	5/5	2,100	5.390	3.560	8.950	210	2.696	1.564	4.260	
1/64-3/64	51/20	38/36	3/3	900	0.410	0.410	0.820	80	0.256	0.014	0.270	
4/64- 6/64	84/62	64/48	3/3	900	2.525	0.405	2.930	85	0.434	0.356	0.790	
TOTALS			14/14	5,700	11.723	7.627	19,350	501	4.140	2.670	6.810	26.160
STATION 4												
7/63-9/63	90/84	78/73	3/3	1,800	2.960	0.940	3.900	396	2.214	0.616	2.830	
10/63-12/63	78/38	66/44	5/5	2,100	3.111	1.499	4.610	530	2.076	0.534	2.610	
1/64-3/64	52/20	40/39	3/3	900	0.936	0.094	1.030	280	0.652	0.058	0.710	
4/64-6/64	78/76	63/43	3/3	900	0.232	2.268	2.500	300	0.210	0.930	1.140	
TOTALS			14/14	5,700	7.239	4.801	12.040	1,506	5.152	2.138	7.290	19.330
STATION 5												
7-63-9-63	87/67	76/74	3/3	1,800	2.373	0.187	2.560	261	0.875	0.785	1.660	
10/63-12/63	80/38	68/44	5/5	2,100	1.818	0.982	2,800	370	2.516	0.504	3.020	
1/64-3/64	52/30	40/38	3/3	900	1.379	0.031	1.410	250	0.443	0.017	0.460	
4/64-6/64	84/66	65/44	3/3	900	1.016	0.624	1.640	300	0.719	0.301	1.020	
TOTALS			14/14	5,700	6.586	1.824	8.410	1,181	4.553	1.607	6.160	14.570
STATION 6												
8/63-9/63	80/72	76/74	2/2	1,200	2.200	0.400	2.600	54	1.111	0.189	1.300	
10/63-12/63	86/39	69/40	5/5	2,100	4.347	3.033	7.380	200	1.924	1.116	3.040	
1/64-3/64	Not Available Due to Ice Formation											
4/64-6/64	85/67	61/49	3/3	900	0.415	0.985	1.400	160	0.450	0.260	0.800	
TOTALS				4,200	6.962	4.418	11.380	414	3.575	1.565	5.140	16.520
GRAND TOTALS			80/80	32,700	48.731	26.779	75.510	7,170	26.309	12.711	39.020	114.530

Table 28. Plankton volume for each period on Navajo Lake from August, 1963 through June, 1964. (160 samples).

Period	Air Temp.	Water Temp.	Samples	Horiz. Feet	Phyto plankton	Zoo-plankton	Total	Feet Vert.	Phyto-plankton	Zoo-plankton	Total	TOTAL (ml)
7/63-9/63												
Station 1	75/93	80/72	3/3	1,800	2.477 ml	.553 ml	3.030 ml	460	1.047 ml	0.683 ml	1.730 ml	
Station 2	94/75	81/72	3/3	1,800	2.452	1.028	3.480	308	2.941	1.629	4.570	
Station 3	90/83	80/73	3/3	1,800	3.398	3.252	6.650	126	0.754	0.736	1.490	
Station 4	90/84	78/73	3/3	1,800	2.960	0.940	3.900	396	2.214	0.616	2.830	
Station 5	87/67	70/84	3/3	1,800	2.373	0.187	2.560	261	0.875	0.785	1.660	
Station 6	80/72	76/74	2/2	1,200	2.200	0.400	2.600	54	1.111	0.189	1.300	
TOTALS			17/17	10,200	15.860	6.360	22.220	1,605	8.942	4.638	13.580	35.8
10/63-12/63												
Station 1	80/27	67/42	5/5	2,100	4.353	1.657	6.010	840	1.342	1.058	2.400	
Station 2	80/35	68/44	5/5	2,100	3.678	1.582	5.260	480	1.321	0.489	1.810	
Station 3	80/37	68/41	5/5	2,100	5.390	3.560	8.950	210	2.696	1.564	4.260	
Station 4	78/38	66/44	5/5	2,100	3.111	1.499	4.610	530	2.076	0.534	2.610	
Station 5	80/38	68/44	5/5	2,100	1.818	0.982	2.800	370	2.516	0.504	3.020	
Station 6	86/39	69/40	5/5	2,100	4.347	3.033	7.380	200	1.924	1.116	3.040	
TOTALS			30/30	12,600	22.697	12.313	35.010	2,630	11.875	5.265	17.140	52.1
1/64-3/64												
Station 1	46/15	40/39	3/3	900	0.636	0.074	0.710	450	0.607	0.083	0.690	
Station 2	50/16	40/39	3/3	900	0.820	0.030	0.850	280	0.543	0.097	0.640	
Station 3	51/20	38/36	3/3	900	0.410	0.410	0.820	80	0.256	0.014	0.270	
Station 4	52/20	40/39	3/3	900	0.936	0.094	1.030	280	0.652	0.058	0.710	
Station 5	52/30	40/38	3/3	900	1.379	0.031	1.410	250	0.443	0.017	0.460	
Station 6	Not Available Due to Ice Formation											
TOTALS			15/15	4,500	4.181	0.639	4.820	1,340	2.501	0.269	2.770	7.5
4/64-6/64												
Station 1	60/72	46/62	3/3	900	0.752	2.668	3.420	450	0.153	0.277	0.430	
Station 2	78/62	65/45	3/3	900	1.053	0.517	1.570	300	0.935	0.415	1.350	
Station 3	84/62	64/48	3/3	900	2.525	0.405	2.930	85	0.434	0.356	0.790	
Station 4	78/76	63/43	3/3	900	0.232	2.268	2.500	300	0.210	0.930	1.140	
Station 5	84/66	65/44	3/3	900	1.016	0.624	1.640	300	0.719	0.301	1.020	
Station 6	85/67	61/49	3/3	900	0.415	0.985	1.400	160	0.540	0.260	0.800	
			18/18	5,400	5.993	7.467	13.460	1,595	2.991	2.539	5.530	18.9
GRAND TOTAL			80/80	32,700	48.731	26.779	75.510	7,170	26.309	12.711	39.020	114.5

Table 29. Quanitative Summary of Horizontal Tows from Station 1 - 5 during the period from 7/63-6/64.

Station	Horizontal Pull	Phytoplankton	Total Zooplankton	Total Plankton	% of Total Phytoplankton	% of Total Zooplankton	% of Total
1	5,700 feet	8.218 ml	4.952 ml	13.170	19.22	22.15	20.57
2	5,700	8.003	3.157	11.160	19.21	14.12	17.43
3	5,700	11.623	7.627	19.250	27.89	34.11	30.06
4	5,700	7.239	4.801	12.040	17.37	21.47	18.80
5	5,700	6.586	1.824	8.410	15.81	8.15	13.14
TOTAL	28,500	41.669	23.361	64.030	100.000	100.00	100.00

Table 30. Frequency of planktonic organisms per linear foot towed using a Wisconsin-type plankton net with a 12 cm opening. Frequency of plankton expressed in milliliters per foot. (Statistics from 160 samples collected from July, 1963 through June, 1964 in Navajo Lake).

Station	Feet	Total Phytoplankton	Milliliters per foot	Total Zooplankton	Milliliters per foot	Total Plankton	Milliliters per foot
HORIZONTAL TOWS							
1	5,700	8.218 ml	0.0014	4.952 ml	0.0009	13.170 ml	0.0023
2	5,700	8.003	0.0014	3.157	0.0006	11.160	0.0020
3	5,700	11.723	0.0021	7.627	0.0013	19.350	0.0034
4	5,700	7.239	0.0013	4.801	0.0008	12.040	0.0021
5	5,700	6.586	0.0012	1.824	0.0003	8.410	0.0015
6	4,200	6.962	0.0017	4.418	0.0010	11.380	0.0027
Subtotal	32,700	48.731	0.0015	26.779	0.0008	75.510	0.0023
VERTICAL LIFT							
1	2,200	3.149	0.0014	2.101	0.0010	5.250	0.0024
2	1,368	5.740	0.0042	2.630	0.0019	8.370	0.0061
3	501	4.140	0.0083	2.670	0.0053	6.810	0.0136
4	1,506	5.152	0.0034	2.138	0.0014	7.290	0.0048
5	1,181	4.553	0.0039	1.607	0.0014	6.160	0.0053
6	414	3.575	0.0086	1.565	0.0038	5.140	0.0124
Subtotal	7,170	26.309	0.0037	12.711	0.0018	39.020	0.0055
TOTAL	39,870	75.040	0.0019	39.490	0.0010	114.530	0.0029

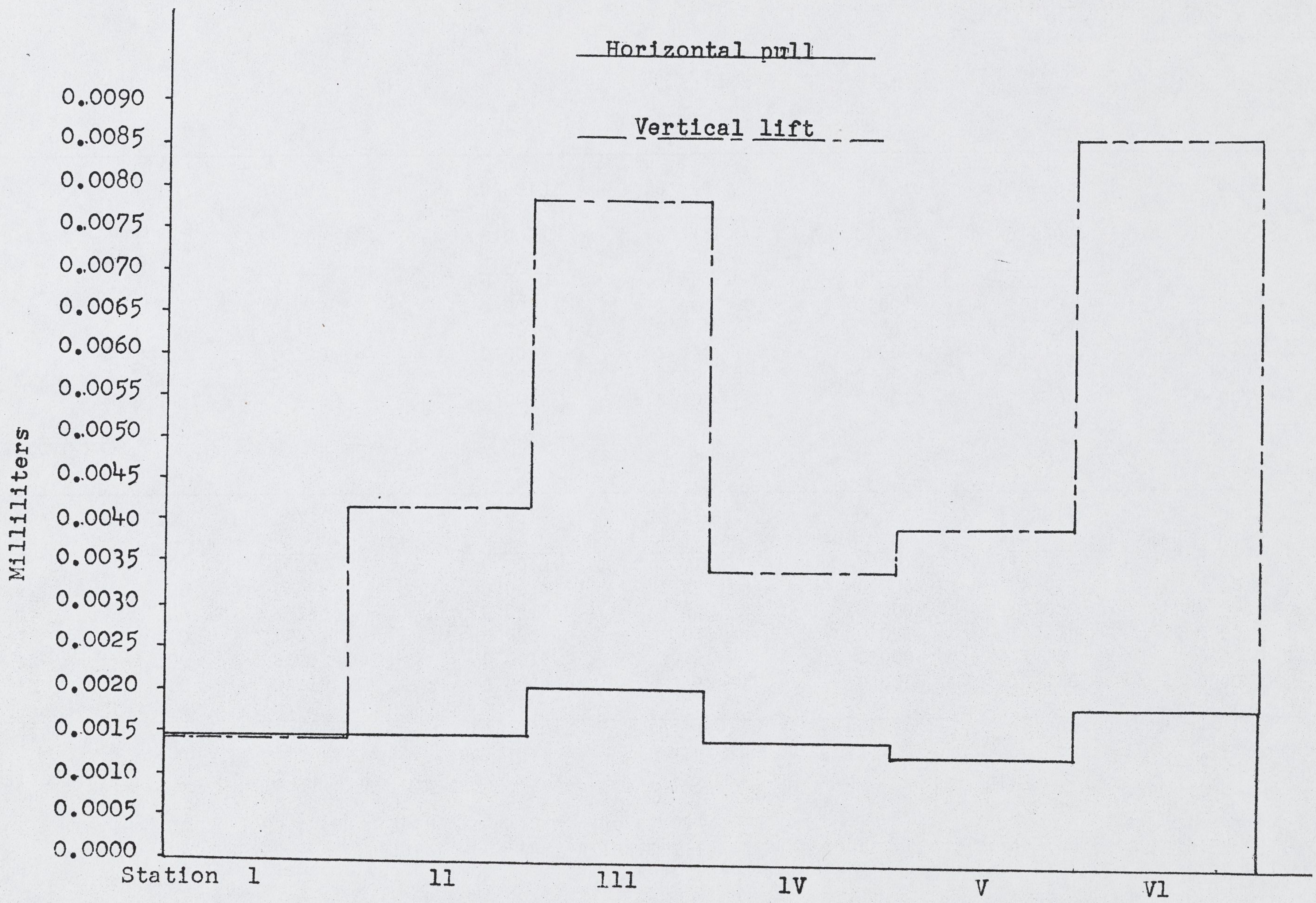


Figure 14. Milliliters phytoplankton per foot towed using a 12 cm opening plankton net on Navajo Lake from July, 1963 through June, 1964. (160 samples)

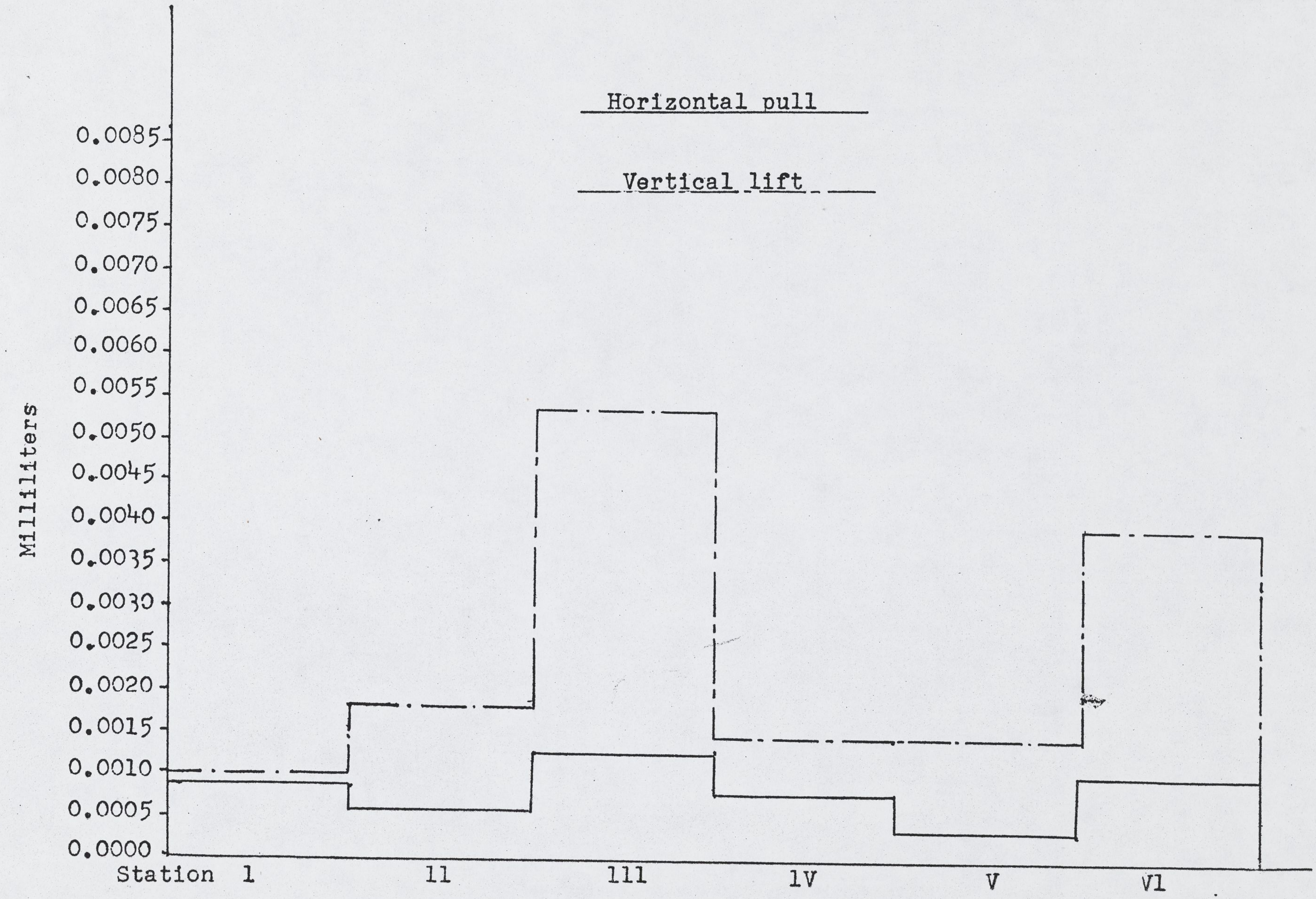


Figure 15. Milliliters zooplankton per foot towed using a 12 cm opening plankton net on Navajo Lake from July, 1963 through June, 1964. (160 samples)

bias. It is interesting to note that vertical lifts had an overall plankton frequency of 0.0055 milliliters per foot and horizontal pulls had an overall frequency of 0.0023 milliliters per foot.

Figure 14 and 15 compares plankton frequency for vertical lifts and horizontal pulls. The author wishes to point out that the frequency for zooplankton and phytoplankton for vertical lifts never fell below horizontal pulls. This phenomenon seems atypical of most reservoirs. This condition might suggest plankters occur in abundance throughout the hypolimnion.

Another possible explanation of this phenomenon could be that plankton production in the depth sampled by horizontal pulls, one to two feet, is not the maximum area of plankton production found in the epilimnion. Further investigation of this condition during 1965 may add insight as to areas of the epilimnion and hypolimnion where maximum plankton production occurs.

Table 31 lists the principal planktons found in Navajo Lake. Cladocerians and Copepods are the most common orders of zooplankton. Diatoms represented the greatest volume of phytoplankton with Fragillaria and Asterionella the most common genera.

Summary:

Plankton studies in Navajo Lake were conducted for qualitative analysis, quanitative analysis and for evaluation of collection techniques.

Monthly samples from six sampling stations were made with the exception of winter samples during 1964 from Station 6 and for all stations during September, 1964. All statistics presented were obtained from 160 samples that were collected from July, 1963 through June, 1964.

Plankton were collected using a Wisconsin-type plankton net with a 12 cm opening. Vertical and horizontal collections were made. The collected plankton were killed and preserved in 20 percent alcohol and analysis was conducted by a graduate student from the University of Arizona.

Quanitative analysis indicated the following: (1) relative low plankton production, (2) Station 3 and 6 are highest in plankton production, (3) maximum plankton production occurred during late summer and fall months, (4) low plankton production during the winter and spring months, and (5) vertical sampling produced the greatest quanity of plankton per foot towed.

Qualitative analysis indicated Cladocerians and Copepods are the most common classes of zooplankton. Diatoms were the most abundant phytoplankters. The genus Fragillaria and genus Asterionella were the most common.

Modifications of sampling techniques will be initiated during 1965 in hopes of further evaluating plankton density and composition from various depths.

FOOD HABIT STUDIES

Objectives:

Fish stomachs were collected from bonytail chubs, flannelmouth suckers, white

Table 31. Abundance of principal plantonic organisms in Navajo Lake from July, 1963 through June, 1964.

Organisms	Abundance	Rank	Organisms	Abundance	Rank
Cladocera	Common	1	Fragillaria	Abundant	1
Copepoda	Common	2	Asterionella	Abundant	2
Gastropoda	Rare	3	Staurastrum	Abundant	3
Rotifera	Rare	4	Chlorophyta (filamentous)	Abundant	4
Difflugia	Rare	5	Cyanophyta	Common	5
			Dinobryon	Common	6
			Volvox	Rare	7
			Chlorophyta (colonial)	Rare	8
			Spiroggra	Rare	9
			Pennales	Rare	10
			Zygnema	Rare	11
			Cyclotella	Rare	12
			Tabellaria	Rare	13

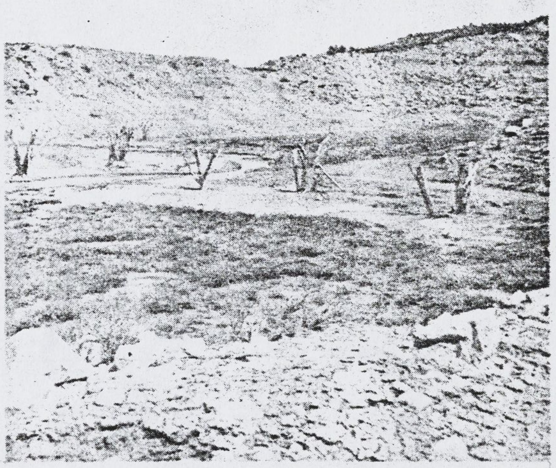


Photo. 3. Typical vegetative cover of inundated area of Navajo Reservoir near Colorado state line.

suckers, and rainbow trout during 1963-64 to determine qualitative and quanitative use of available organisms and to determine inter-species competition for food organism.

Procedures:

Fish were collected from all portions of Navajo Lake using experimental gill nets. Stomachs were collected from varying length fish and preserved in 15 percent formalin. The stomachs were then mailed to a contract analyst attending the University of Arizona.

Results:

To date, results from analyzed stomachs have not been received from the analyst. Contact with the analyst by phone several months prior to the writing of this report indicated that all results from analyzed stomachs would be available by the end of January, 1965. Contact with analyst during February and March indicated that he would be unable to supply necessary information for this section of the report. The author then requested that all samples be returned so Section 8 personnel could complete analysis. To date, no samples have been returned.

Summary:

Fish stomachs from undesirable and desirable species were collected during 1963-64 to supply information regarding qualitative and quanitative utilization of available food organism and to determine the degree of inter-species competition for food organisms.

Stomachs were removed from varying length fish and preserved in 15 percent formalin. The samples were mailed to a contract analyst attending the University of Arizona.

The food habit study is void of any results. The reason is that the contract analyst was unable to fulfill his obligation. Contracting stomach analyst studies and food production studies to "outside" individuals has proven very unsatisfactory to the author, this section and other sections of this report. Future analysis of fish stomachs will be conducted by Section 8 personnel with the feeling that better information can be gained and data will be available when needed.

SUMMARY

Identification of the Navajo Reservoir with a limnological classification might seem rather simple. To state that this lake is typically oligotrophic or temperate (Welch, 1952) would be impractical since it actually includes varying habitat conditions.

The thermo and chemical conditions of mid-summer and early fall indicates a separate classification for the pelagic areas and the littoral regions of the upper San Juan and Pine Canyons (Fig. 1, Station 3 and 6).

High water temperatures and carbon dioxide readings along with minimum amounts of dissolved oxygen were characteristic of the littoral areas during 1963 and 1964. Although the 1964 data was not as drastic as that of the preceeding year, it could be classed as marginal water for good trout production.

Creel census data from the Miller Mesa area located in the upper San Juan River Canyon revealed a progressive decline in the rainbow harvest throughout the summer, whereas the data from the Pine River site showed a stability in the catch per hour during the same period. This data suggests that one or more environmental factors are affecting the salmonid fishery in the Miller Mesa area.

The reappearnace of the undesirable species, after the rotenone treatment in 1961 was merely a function of time. Gill netting records show that the undesirable species increased from 42.13 percent by number in 1963 to 84.13 percent (1964) of the total number collected. This is a great increase to experience in a one-year period.

This increase is especially apparent in the bonytail chub population where the gill net success increased from 11 chub in 1963 to 460 specimens collected in 1964.

Although the food habits study was incomplete it is possible that the bonytail chub will compete directly with the rainbow trout (Olson, 1962). The extent of the competition will be determined and presented during Segment 3 of this project.

Opinions of the importance of the influence of the chub on the rainbow fishery vary. Other fisheries personnel, familiar with both species, believed that the chub would be no problem since they are generally associated with a stream fishery. However, the species composition determined in 1964 shows an increase in the bonytail chub over that expressed in the pre-impoundment survey (Olson, 1962) indicating that they have adapted to the Navajo Reservoir environment.

Food production is, of course, greater in the littoral regions (Station 3 and 6). Since the undesirable species generally appear in greater numbers in these zones, the reason for the high coefficient of condition "K" is obvious. The suckers and bonytail chub have "K" factors of 0.99 or higher, while the rainbow "K" is considerably lower.

Although the food production of the main reservoir area is lower, this portion of the lake is adequate for trout production and will probably remain so in the future.

The writer feels that the introduction of a new fish species is necessary to fully utilize the littoral areas of the lake. Several species were considered including: walleye, Stizostedion vitreum; white bass, Roccus chrysops, (Rafinesque); smallmouth bass, Micropterus dolomieui Lacepede; and largemouth bass, Micropterus salmoides (Lacepede); however, it is believed that all of these species, except the largemouth bass would invade the pelagic areas and possibly add another limiting factor to the maintenance of the salmonid fishery. The thought is that the largemouth bass along with present channel catfish released, will fully utilize the littoral areas and compete more actively with present undesirable species.

There will be a marginal area where the bass-catfish influence is detrimental to the existing trout populations. However, in the overall fish production this should not cause any decrease in the trout harvest from the lake.

As previously mentioned, the food production is rather low in the pelagic areas of the lake. Plankton forms, phytoplankton and zooplankton, are the only fish food organisms available except for isolated communities of invertebrates and fat-head minnows.

Introductions of forage fish adapted to the open water is considered necessary. The threadfin shad, Dorosoma petenense (Gunther) might be suitable. The advantage of trying this species is their temperature tolerance level, so if they are not satisfactory the winter temperatures will eliminate them.

JOB COMPLETION REPORT

RESEARCH PROJECT SEGMENT

Segment No. 2

State of: NEW MEXICO

Project No.: Section 8 Name: Fisheries Investigations - Navajo Unit

Job No.: A-2(b) Title: Fisheries Survey of Navajo Tailwaters

Period Covered: July 1, 1963 through December 31, 1964

Abstract:

A fishery investigation project on the Navajo Reservoir tailwaters was included under the Section 8 program described in Job No. A-2(a).

Since impoundment of the San Juan River by Navajo Dam, the water quality of the lower river area has improved. The thermo and chemical data indicate that the quality of the river water lies within those limits required for good trout production.

The river has been divided into three classes in respect to rainbow trout habitat and production. The upper area, class "A", is excellent rainbow habitat. The lower areas, classes "B" and "C", decrease in value, probably a result of irregular flows of highly turbid water contributed by the tributary canyons and high water temperatures.

Fish introductions have included rainbow and brown trout, classes "A" and "B", and channel catfish have been stocked below stream mile 18, class "C".

The fish collections were made from classes "A" and "B". Collection attempts in the lower river were not successful.

The 1964 data shows excellent growth and length-weight data, with a mean coefficient of condtion "K" of 1.11 for rainbow trout, 1.33 for carp (river class B), 0.82 for the flannelmouth sucker, and 0.80 for bonytail chubs.

As in the reservoir studies, age and growth calculations were difficult. Excellent feeding conditions and ideal temperatures (class A) were conducive to year-round growth, resulting in irregular annuli formation on the scales.

The creel census program was discontinued during 1964. Numerous access roads, along with an acute man-power shortage, resulted in an inadequate sample.

Stream bottom samples indicate abundant fish food organisms in the upper San Juan River with a progressive decline in numbers of invertebrates in the downstream stations.

The most abundant invertebrates were Tendipedidae, Simulidae, and Hydropsychidae. Physid gastropoda were quite common at the upper stations in the San Juan River but did not appear in samples from the downstream stations. The progressive downstream decrease in abundance of invertebrates is attributed to turbidity and shifting sandy bottom in the downstream area.

Results of the food habits study were comparable to this trend in abundance of invertebrates. They also demonstrated that utilization of organisms by trout is based on abundance.

Objectives:

The objectives of this program are to collect basic information on the physical, chemical and biological factors that are characteristic to the San Juan River below Navajo Dam; also, to identify those areas where specific studies are necessary to provide accurate data for the improvement of the fish management program.

All management recommendations will be made after considering the combined influence indicated by the various phases of this project.

Please note the objectives described for each segment of the project.

Procedures:

Please note the procedures described in the separate segments of this report.

Results:

Please note the results described in the separate segments of this report.

Recommendations:

The recommendations submitted for the Navajo Reservoir Tailwater are:

1. That this study be continued for a minimum of four years, continuing the basic data collections included in this report.

   The future program should emphasize the angler success and development of a fishery in the downstream area of the San Juan River.

2. Stream development structures be installed in the area immediately below Navajo Dam to restrict the downstream water flows into a common channel.

3. Fish introductions should include continued rainbow and brown trout releases in river classes "A" and "B" and channel catfish in class "C".

   Smallmouth bass, Micropterus dolomieui, Lacepede, are considered as a favorable species to fill the "vacancy" in the lower area of class "B" and upper section of class "C".

4. That the land status of the river area be evaluated and recommendations made concerning the development of the public lands and right-of-way

easements through private property.

Prepared by: H. F. Olson and W. J. McNall Approved by:________________________

Date________________________

INTRODUCTION

A research project was initiated on the San Juan River in conjunction with the program described in the Navajo Reservoir study.

The ultimate goal of this program is to develop a sound fishery management program for the San Juan River. This will be a result of the present and future studies of water quality, creel census, land status, and investigations of the biological communities of the river.

DESCRIPTION

The San Juan River comes into New Mexico from the southwestern area of Colorado. West of the continental divide, it flows southwest for a short distance, turns to the northwest, crosses into Colorado again and joins the mighty Colorado River in southern Utah.

Prior to impoundment by the Navajo Dam, June 27, 1962, the San Juan River was a highly fluctuating silt laden stream and contributed very little to the sport fishery program of New Mexico. Since that time the volume of flow has been regulated and with the reservoir acting as a settling basin for this river, the area immediately below the dam is rapidly approaching the stage of becoming New Mexico's finest trout stream.

At the time of this writing, the river has produced numerous catches of two and three-pound rainbow trout. The largest fish recorded was a 22-inch rainbow weighing six pounds and four ounces.

The land status along the river varies throughout the length of the stream. The upper area, class "A" (see Fig. 16), is predominantly public land, controlled by the state and federal governments. The class "B" and "C" sections of the river are surrounded by private land with very few small tracts of federal land scattered throughout. Downstream from Farmington, New Mexico, the river enters the Navajo Indian Reservation and remains on Indian land until it leaves the state.

As previously mentioned, the stream flow has been regulated; the volume of release depends on the reservoir requirements and obligations to the downstream water users. The flow data is included with the Navajo Reservoir impoundment and release information (Table 1).

THERMO-CHEMICAL STUDIES

Objectives:

The objectives of this phase are to collect and record those thermo and chemical data that might influence the fishery of the San Juan River. This data, incorporated with the rest of the project data will be used to develop a sound fishery management program for the San Juan River.

Procedures:

A pocket thermometer was used to record the temperature data. Readings were made in conjunction with the stream bottom sampling and chemical analysis.

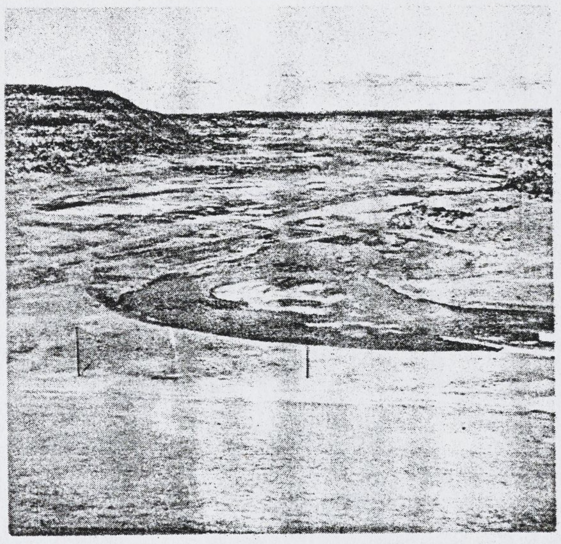


Photo. 4 San Juan River immediately below Navajo Dam

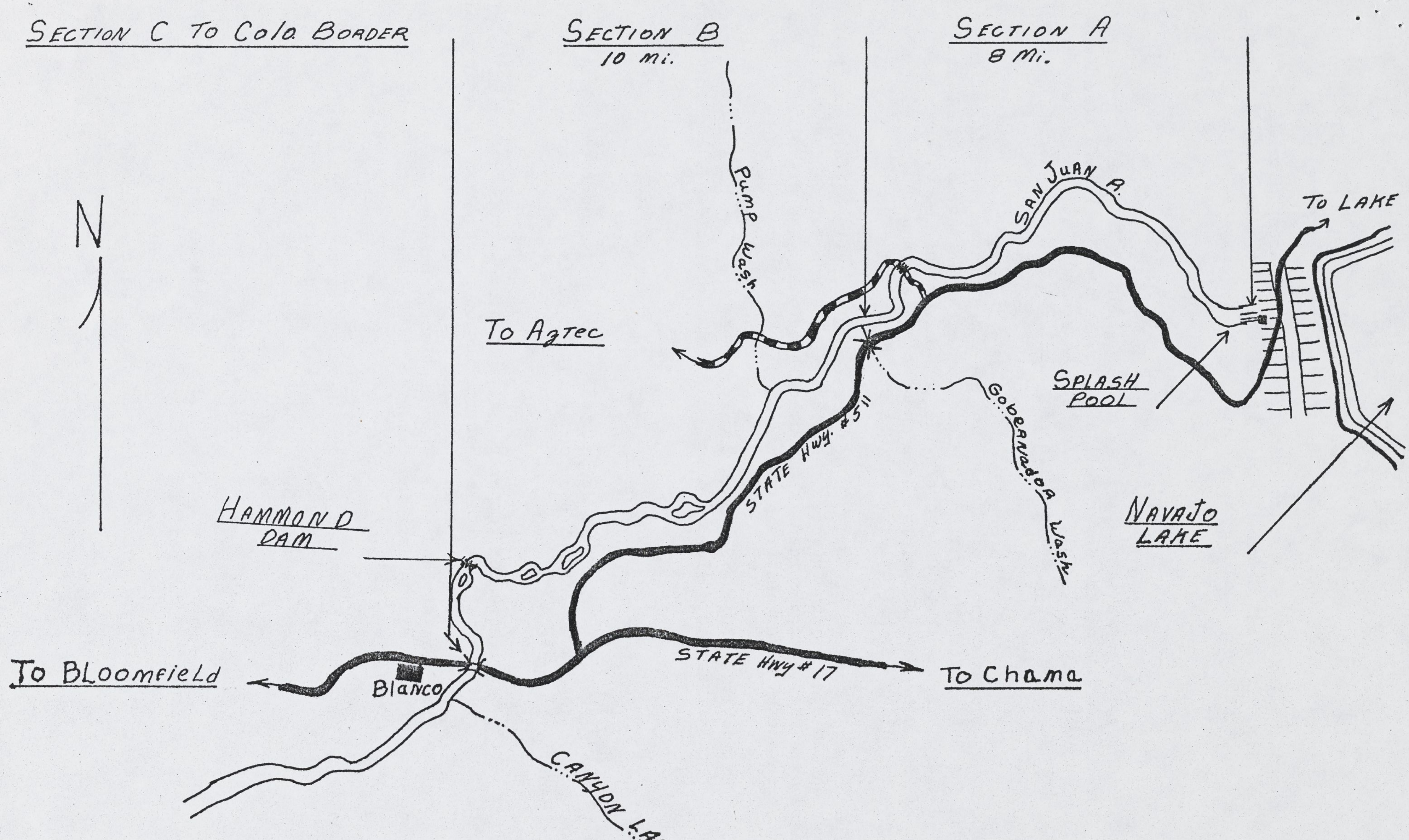


Fig. 16. Map of San Juan River below Navajo Dam, showing stream habitat classifications.

Chemical analysis were made according to the procedures described by Welch, 1948, and the Braun Chemical Company. Data obtained from the San Juan County Health Service were analyzed according to the procedures of the American Public Health Association (1955).

Results:

Water temperatures varied from 33° F to a high of 79° F during the past 18 months. The temperature of the water released from Navajo Dam remain relatively constant throughout the year. Extreme temperatures recorded at the outlet were 36° F and 59° F, however, the lowest temperature recorded at this point during 1964 was 42° F.

There was a considerable difference in the temperatures recorded at the dam and one-half mile downstream, Station A. This variation was noticeable during the winter and mid-summer months. Of course, the temperature of the water released depends on the surface elevation of the lake and the outlet tunnel used. The mean temperature for 1964, at the outlet works was 52° F.

The chemical data (Table 32) did not vary significantly between stations. One exception would be Station H where the alkalinities and total hardness showed an increase over that data recorded at the other stations. The dissolved oxygen, carbon dioxide and pH were relatively stable at all stations.

Chemical analysis by the San Juan County Health Service shows a downstream increase in total dissolved solids, calcium, magnesium, chloride, sulfate and conductance (Table 33).

Discussion:

The writer does not intend to present the voluminous temperature data recorded during the past eighteen months. A portion of this data is expressed in Table 32 with the chemical analysis.

Considering only the water temperatures, the entire river area might be classed as adequate for trout production with a short period of rather warm water in midsummer. However, when this data is incorporated with that collected during other phases of the project, the river was divided into three sections in respect to rainbow trout habitat and production. Please note the description of these areas in the discussion of the fish population study (Fig. 16).

The water temperatures increase progressively downstream from the Navajo Dam. The upper section of the river, class "A" (Fig. 16), fluctuate between 62° F and 74° F throughout the summer months. The highest temperatures were, of course, recorded in the afternoon with daily fluctuations of 4° F to 8° F noted.

The downstream areas of the river classes "B" and "C" reached the high of 79° F. Again, this was a mid-day recording and should not be considered as a constant temperature for a 24-hour period.

To understand the warming tendency of the water in the first one-half mile below the dam, the condition of the stream bed must be considered. Immediately below the outlet is part of the "borrow area" used for fill during the construction of the

Table 32. Chemical and temperature records of San Juan River taken from all sampling stations May, 1963 through December, 1964.

Station	Date	Temperatures		pH	D.O.	CO_2	Total Hardness (ppm)	Alkalinities ppm.	
		Air	Water					Phth.	M.O.
A	5/16/63	74° F	55° F	7.8	5.9	0.0	144.0	15.0	99.0
	6/8/63	75	63	8.6	11.3	0.0	72.0	8.0	59.0
	7/6/63	88	70	9.2	11.3	0.0	96.0	14.0	60.0
	8/17/63	76	66	8.8	12.0	0.0	88.0	15.0	63.0
	9/7/63	85	74	9.2	11.4	0.0	90.0	14.0	68.0
	10/12/63	78	66	8.4	8.0	0.0	96.0	11.0	81.0
	12/20/63	38	42	8.0	11.5	3.0	150.0	0.0	98.0
	1/16/64	39	42	8.0	10.0	0.0	148.0	16.0	100.0
	2/17/64	32	39		11.0	0.0	164.0	4.0	101.0
	3/27/64	43	42		11.2	0.0	156.0	1.0	110.0
	4/22/64	64	59		10.0	0.0	136.0	9.0	107.0
	5/25/64	79	58	8.1	8.6	Trace	134.0	4.0	103.0
	7/2/64	86	60		8.6	1.5	120.0	00.0	90.0
	7/22/64	68	53		7.5	Trace	112.0	0.0	85.0
	8/6/64	76	60		8.9	2.0	108.0	0.0	80.0
	9/25/64	70	60		9.6	0.0	114.0	12.0	83.0
	10/29/64	67	62	8.2	10.1	0.0	120.0	21.0	82.0
	11/19/64	49	51		11.2	0.0	131.0	16.0	92.0
	12/2/64	41	42	8.1	9.8	0.0	129.0	11.0	100.0
D	6/9/63	62	53	8.6	8.4	0.0	78.0	7.5	64.0
	7/7/63	89	70	9.2	12.35	0.0	67.0	13.0	71.0
	8/18/63	86	68	9.3	13.15	0.0	40.0	13.0	57.5
	9/7/63	82	68	9.0	9.7	0.0	84.0	8.0	69.0
	10/12/63	78	62	7.6	8.2	0.0	96.0	6.0	84.0
	12/20/63	38	40	8.0	10.5	2.0	144.0	0.0	98.0
	1/17/64	42	40	8.0	12.0	0.0	170.0	5.0	105.0
	2/17/64	40	37		10.9	2.0	172.0	0.0	102.0
	3/27/64	46	49		10.9	0.0	148.0	1.0	107.0
	4/23/64	56	51		10.9	0.0	142.0	1.5	108.0
	5/25/64	77	57	8.3	8.1	0.0	132.0	1.0	105.0
	7/2/64	84	56		9.2	Trace	108.0	0.0	93.0
	7/22/64	72	54		7.8	Trace	114.0	0.0	86.0
	8/6/64	78	60		7.9	3.0	94.0	0.0	76.0
	9/25/64	73	60		8.9	0.0	101.0	3.2	82.0
	10/29/64	67	59	7.8	10.0	0.0	104.0	9.0	89.0
	11/19/64	49	51		11.0	0.0	113.0	6.0	95.0
	12/2/64	41	41	8.0	11.5	0.0	121.0	11.0	99.0
F	6/9/63	79	70	8.4	8.8	0.0	108.0	5.0	82.0
	7/10/63	91	78	7.7	3.05	0.0	818.0	0.0	123.0
	8/18/63	84	76	8.2	8.15	0.0	204.0	0.0	126.5
	12/20/63	39	39	7.6	9.2	5.0	380.0	0.0	98.0
	1/17/64	42	35	7.7	10.3	Trace	176.0	0.0	116.0
	2/17/64	43	40		10.2	2.0	178.0	0.0	120.0
	3/27/64	48	48		10.5	2.0	198.0	0.0	123.0
	4/23/64	62	60		10.5	0.0	200.0	6.0	128.0
	5/22/64	90	77	8.3	6.8	0.0	186.0	4.0	125.0

Table 32. C O N T I N U E D

Station	Date	Temperatures Air	Temperatures Water	pH	D.O.	CO_2	Total Hardness(ppm)	Alkalinities ppm Phth.	Alkalinities ppm M.O.
F	7/2/64	94° F	64° F		8.3	Trace	126.0	0.0	98.0
	7/22/64	76	58		7.2	Trace	112.0	0.0	92.0
	8/6/64	84	66		7.4	3.0	214.0	0.0	186.0
	9/25/64	74	60		8.3	0.0	168.0	3.1	109.0
	10/29/64	68	58	8.1	9.2	0.0	171.0	5.0	111.0
	11/19/64	59	56		8.4	0.0	165.0	4.0	110.0
	12/2/64	40	50	8.0	9.0	0.0	170.0	4.5	116.0
H	5/16/65	78	62	8.4	4.75	0.0	150.0	9.0	88.0
	6/11/63	76	62	8.4	8.8	0.0	192.0	5.0	110.0
	8/18/63	80	76	8.4	7.75	0.0	164.0	0.0	134.0
	10/12/63	67	58	7.8	8.2	0.0	170.0	0.0	114.0
	12/16/63	35	34	7.6	9.2	3.0	168.0	0.0	107.0
	1/17/64	45	33	7.7	10.0	4.0	200.0	0.0	116.0
	2/17/64	43	40		10.2	3.0	236.0	0.0	128.0
	3/27/64	45	50		11.5	0.0	354.0	9.0	164.0
	4/23/64	65	59		9.7	0.0	266.0	12.0	140.0
	5/22/64	89	72	8.2	7.2	1.0	96.0	0.0	61.0
	7/2/64	97	76		7.2	None	208.0	3.0	114.0
	7/22/64	79	68		6.9	0.0	196.0	3.0	123.0
	8/6/64	87	66		7.5	2.0	214.0	0.0	146.0
	9/25/64	75	62		8.1	0.0	262.0	3.9	152.0
	10/29/64	72	58	7.8	8.5	0.0	334.0	9.0	174.0
	11/19/64	60	59		9.1	0.0	298.0	5.0	168.0
	12/2/64	41	52	7.8	9.4	0.0	312.0	11.0	173.0

Table 33. Chemical analysis from four stations of the San Juan River, 1964.

Station	pH	Conductivity (Microms)	Total Dissolved Solids (ppm)	Ca. (ppm)	Mg. (ppm)	Chlorides (ppm)	Sulfates (ppm)
A	8.1	350	262	102	48	11	73
D	8.3	380	285	106	62	19	72
F	8.3	550	382	160	48	22	120
H	8.2	730	546	264	68	38	176

dam. As the water leaves the reservoir outlet it spreads out and flows over much of this area. The water is very shallow, except for a portion of the main river channel, and absorbs a considerable amount of heat, causing a 10° F to 18° F temperature increase during the summer.

A series of small dikes installed in this area would restrict the water to the deeper channel and reduce the heat absorption in this short section of stream.

During the winter waters released from the depths of the Navajo Reservoir are warmer than those temperatures recorded further downstream and on the lake surface. Consequently temperatures in the class "A" portion of the river are ideal for year-round fish growth.

The chemical composition of the river is within the acceptable limits for trout production. The sampling location of station "H" was changed January, 1964, to give a better picture of the influence of the Animas River. This change caused an obvious increase in the total hardness and alkalinity readings for this station (Table 32).

The total dissolved solids and conductance are the most obvious factors causing a decline in the quality of the river water. This is a result of the tributaries to the lower San Juan River, specifically Canyon Largo, Gallegos Wash and the Animas River.

The Animas River is the only tributary with continuous flows, the others are dry during most of the year. During the past year many of these so called "dry canyons" flowed quite often, increasing the turbidity and forming large alluvial deposits extending out into the main channel of the San Juan River. When these canyons finally dried, the eroding action of the river on the silt deposits prolonged the periods of increased turbidities.

As mentioned in the fish population section, very few game fish were collected in the lower areas of the river. The silt load carried by the lower river area is undoubtedly an important factor contributing to the reduced trout population.

Introductions of other game fish species might help fill the "vacancy" in classes "B" and "C" of the lower river area. This will be discussed later in the report.

Summary:

Thermo and chemical records indicate that the water quality of the upper San Juan River lies within the required limits for trout production with marginal areas in the downstream sections.

Tributaries to the lower river area contributed irregular flows of highly turbid water during 1964. These flows are probably the most important factor influencing the biological communities throughout river classes "B" and "C" (Fig. 16).

The upper section of the river, class "A", can be considered as excellent trout water. With the reservoir acting as a settling basin, this stretch of river has low turbidities and the temperatures and chemical composition are adequate for

Photo. 5. Gobernador Wash showing contributions of sand and silt along with delta deposited in the San Juan River during 1964.

most Salmonid species.

Stream improvement structures in the first one-half mile below Navajo Dam would probably result in cool water temperatures during the summer months.

POPULATION STUDIES

History:

Prior to impoundment the San Juan River was a highly turbid, varying flow river that collected water from about 3,260 square miles of drainage above Navajo Dam. Salmonids were present during pre-impoundment times, however, were struggling for existence. Undesirable species occupied the river in high numbers. After impoundment in June of 1962, suspended matter found in the San Juan River precipitated to the bottom leaving clear water available for release from Navajo Lake. The lake in effect has created a settling basin for incoming turbid water and the clear water from the release structures has created about 18 miles of habitat suitable for salmonids that did not exist prior to impoundment.

Introduction:

Pre-impoundment eradication of the San Juan River and Pine River practically annihilated all resident fish populations and introduction of salmonids and desirable species followed soon after impoundment.

Rainbow trout were first introduced to the "newly groomed" San Juan River below Navajo Lake during December, 1962 when 540 nine-inch trout were released in the first eight miles of river below the lake. Periodic stocking of rainbows has continued since and the introduction of brown trout and channel catfish has been initiated (See Table 34).

Discussion:

The chemical, physical and biological characteristics vary greatly throughout the San Juan River below Navajo Lake. The river is divided into three biological niches for reporting purposes, mainly section "A", "B", and "C".

Section "A" waters exist from the release structures at the lake downstream eight miles to Gobernador Wash and comprises about 120 surface acres. Clear water, deep pools, summer water temperatures seldom exceeding 72° F, high food production and 90 percent of adjacent river bank in public ownership characterize this section of the San Juan River (See Fig. 16 for location).

Section "B" begins at stream mile eight or Gobernador Wash and continues downstream to State Highway 17 bridge crossing the San Juan River, one mile east of Blanco. About 10 miles of water representing about 180 surface acres is included in section "B".

Moderate to high turbidity, silt laden pools, water temperatures exceeding 72° F during the summer, low food production and 90 percent of the river bank in private ownership characterizes section "B". Gobernador and Pump Washes contribute great amounts of silt to the river in section "B" during heavy runoffs and several weeks are required to wash silt deposits further downstream after these washes "run".

Table 34. San Juan River fish plantings beginning November, 1962 through December 31, 1964.

Species	Number	Size (Ins.)	Pounds	Date	Hatchery
Rainbow	540	9-3/4	200	Dec. - 62	Parkview Hatchery
Subtotal	540		200		
Rainbow	1,380	8¼	300	Mar. - 63	"
Rainbow	13,838	3¼	334	Mar. - 63	"
Rainbow	944	8-3/4	255	Apr. - 63	"
Rainbow	780	8½	200	May - 63	"
Rainbow	1,110	8-3/4	300	June - 63	"
Rainbow	3,400	9	1,000	June - 63	"
Rainbow	936	8½	240	June - 63	"
Rainbow	1,550	9¼	500	July - 63	"
Rainbow	38,400	2	120	Aug. - 63	"
Rainbow	2,000	10-3/4	1,000	Aug. - 63	"
Rainbow	1,330	11	700	Oct. - 63	"
Rainbow	1,360	12	850	Dec. - 63	"
Subtotal	67,028		5,799		
Rainbow	200	15	550	Jan. - 64	"
Rainbow	122	15	250	Feb. - 64	"
Rainbow	1,350	9-3/4	500	Feb. - 64	"
Rainbow	2,200	10½	1,000	Apr. - 64	"
Rainbow	818	6¼	87	May - 64	"
Rainbow	4,200	8½	1,000	May - 64	"
Rainbow	1,900	8-3/4	500	June - 64	"
Rainbow	3,300	9½	1,000	July - 64	"
Rainbow	86,177	2¼	337	July - 64	"
Rainbow	3,600	9	1,000	Aug. - 64	"
Rainbow	3,400	9	1,000	Sept. - 64	"
Rainbow	2,700	9-3/4	1,000	Oct. - 64	"
Rainbow	78,240	1	30	Dec. - 64	"
Subtotal	188,207		8,254		
T O T A L	255,775				
Brown trout	55,680	3/4	12	Jan. - 64	"
T O T A L	55,680		12		
Channel cat.	44,000	2½	220	Nov. - 62	Santa Rosa Hatchery
Channel cat.	75,000	3	505	Nov. - 63	"
Channel cat.	40,000	2½	350	Oct. - 64	Dexter Hatchery
T O T A L	159,000		1,075		
Summary:					
Catchables	39,120		13,432		
Fingerling	272,335		833		

Section "C" beginsat the State Highway 17 brodge crossing and continues through the remaining course of the San Juan River in New Mexico. This section is characterized by perennial high turbidity, summer temperatures exceeding 72° and low food production. Almost all adjacent land is privately owned.

Water releases from Navajo Lake are controlled by the Bureau of Reclamation and vary throughout the year. Minimum releases vary from 120 cfs during the winter to 360 cfs during the summer. Water releases ranged from 0 cfs to 1,081 cfs during 1963 and 50 cfs to 2,500 cfs in 1964. The mean flow for 1963 and 1964 was 367 and 697 cfs respectively. Two hundred and sixty-six thousand and seventy-six (266,076) acre-feet of water flowed through release structures during 1963 and 507,440 acre-feet during 1964. Zero releases from outlet structures at Navajo Dam occur when tests are being conducted by the Bureau of Reclamation and last only a few minutes.

Objectives:

Population studies on the San Juan River were designed to supply the following information: (1) Species composition; (2) Area distribution; (3) Length-weight relationships; (4) Age-growth of scaled fish; and (5) evaluation of sampling techniques.

Procedures:

Sampling was conducted at random throughout section "A" and "B". Collections in section "C" consisted of one sample immediately below section "B". Further attempts to collect fish in section "C" were unsuccessful. Fish were collected using experimental gill nets with mesh sizes form 1/2 to 1-1/2-inch bar mesh and by electrofishing. A three horsepower gasoline motor was equipped with a 110 volt, 1,000 watt generator and this was connected to a varying volt rectifier that concerts AC current into DC.

Results:

Inadequate sampling means restricted fish collections from the San Juan River during the period covered by this report. Gill netting in deep pools resulted in poor catches and fouled nets. Electrofishing was restricted because of low conductivity of the San Juan River water, large volumes of flow with swift current, temperamental generator and an acute manpower shortage. Modifications of sampling techniques have been studied and will be initiated during 1965 in hopes of obtaining greater collections with less risk of injury to personnel.

Fish collections are summarized in the following tables. The author wishes to emphasize that Tables 35 and 36 do not show a valid relative abundance, but do show species composition.

Carp represented 33.9 percent of the 1964 collection. Most of the carp collected were taken from gill net sets in the Hammond Irrigation Diversion Dam located in section "B" and immediately below section "B".

DISTRIBUTION

The purpose in defining distribution is to determine the lower limits of salmonid utilization and the areas occupied by carp, flannelmouth sucker, white

Table 35. Species composition in San Juan River during 1963.

Species	Number	Weight (Ounces)	Average Weight	Percent by Number	Percent by Weight
Rainbow	19	401.8	21.14	32.2	68.4
Bluegill	2	3.0	1.50	3.4	0.5
Bonytail chub	23	66.4	2.89	39.0	11.4
Flannelmouth sucker	6	62.5	10.41	10.1	10.6
White sucker	7	47.4	6.77	11.0	8.1
Bluehead Mt. sucker	2	6.0	3.00	3.4	1.0
T O T A L S	59	587.1		100.0	100.0

Table 36. Species composition in San Juan River during 1964.

Species	Number	Weight (Ounces)	Average Weight	Percent by Number	Percent by Weight
Rainbow	137	1,482.86	10.82	45.1	37.4
Bluegill	1	1.0	1.0	0.3	
Bonytail chub	1	6.5	6.5	0.3	0.2
Flannelmouth sucker	57	550.4	9.66	18.8	14.9
Carp	103	1,816.0	17.57	33.9	45.7
Bullhead	3	5.5	1.83	1.0	0.1
Channel catfish	1	84.0	94.0	0.3	2.1
Black bass	1	23.4	23.40	0.3	0.6
T O T A L S	304	3,969.66		100.0	100.0

sucker, bonytail chubs, bluegill, black bass, bullheads and channel catfish. No attempt was made to arrive at a population estimate for each species collected.

Rainbow trout have been collected from the stilling basin below Navajo Lake to one mile below the State Highway 17 Bridge, crossing approximately 19 stream-miles.

Rainbows have been planted extensively throughout section "A" and two plants have been made in section "B". Rainbows presently occur in greatest numbers in section "A", however, they have been collected throughout section "B" and in the upper portions of section "C". Rainbow occurrence below section "B" is believed to be minimum due to high turbidity and low food production.

Brown trout were introduced in section "B" during 1964, in hopes that they would utilize this salmonid marginal water. No specimens were collected during 1964, however, anglers reported catches up to stream mile six, three miles above their release point. Their distribution downstream is not known.

Carp were collected throughout section "B" and occur in greatest numbers in Hammond Irrigation Diversion Dam, a five surface acre lake at stream mile 16. Carp occur in all of section "C". No specimens were collected in section "A".

Flannelmouth suckers were collected through all sections of the river and occur in increasing numbers in section "B". Only two specimens were collected in section "A".

White suckers were not collected in section "A", but occurred in moderate numbers in sections "B" and "C". Hammond Irrigation Diversion Dam contains high populations of white suckers. Bonytail chubs were collected only in sections "B" and "C", however their occurrence in section "A" is suspected.

Black bullheads occur throughout all sections and first appear in high numbers in the Hammond Irrigation Diversion Dam. Black bullheads contribute little, if any, to anglers' creel. One channel catfish weighing 84 ounces was sampled at stream mile 20 in the upper portion of section "C". This specimen appeared to have been a veteran of the river for many years. Channel catfish have been planted in section "C" since 1962 between Blanco and Farmington, New Mexico.

Bluegills were sampled from the stilling basin to stream mile 20. They occur most frequently in slow moving water and bay areas adjacent to the river. Bluegills occur below stream mile 20, but not in substantial numbers.

One black bass weighing 23.4 ounces and three years old was collected at stream mile 20 in section "C" waters. Black bass occur below stream mile 20 and probably above that point, but are not numerous.

Fathead minnows are numerous throughout the New Mexico portion of the San Juan River below Navajo Lake. Other minnow species are believed present, however, have not been collected.

CONDITION

Condition factor "K" was calculated for all fish sampled during 1963-64. No attempt was made to separake "K" for sexes. Total length of all fish reported is rounded to the nearest increment where "0" appears as the final digit.

Attention is made to the mean "K" for rainbow trout in Navajo Lake during 1964 was 0.89 and 1.11 for mean in the San Juan River. The 340 mm rainbows from Navajo Lake had a mean "K" of .90 while those from the river had a mean of 1.16. The author does not wish to formulate a definite conclusion by these differences because of varying environments, however, the "K" comparisons from these two environments suggest more favorable trout habitat is found in the San Juan River than in Navajo Lake.

Growing conditions for salmonids in section "A" are optimum. Food is readily available and water temperatures are favorable for year-round growth. Head:body relationships and condition factor "K" indicate good utilization of habitat by rainbows. Creel census studies conducted by conservation officers during 1963 indicate 0.83 trout per hour effort. The 1964 catch per hour effort is not yet available.

Table 37. Condition factor "K" for Rainbow trout, 1963

Table length in mm	Number	Range	Average
170	1		0.77
190	2	1.13-1.26	1.19
200	5	.94-1.24	1.04
210	11	.81-1.41	1.15
220	12	.88-1.33	1.17
230	5	.99-1.20	1.15
240	12	.77-1.41	1.15
250	10	.93-1.54	1.15
260	3	1.01-1.23	1.09
270	6	1.01-1.37	1.17
280	4	.79-1.22	0.98
290	4	.80-1.11	0.89
300	2	.99-1.14	1.07
310	2	1.11-1.14	1.12
320	4	.78-1.13	1.00
330	2	1.13-1.13	1.13
340	6	1.03-1.38	1.16
350	5	.90-1.20	1.06
360	3	1.05-1.23	1.13
370	3	1.02-1.24	1.14
380	5	.97-1.20	1.07
390	3	.93-1.13	1.02
400	3	.91-1.15	1.07
410	1		1.26
420	3	1.06-1.16	1.12
450	1		1.22
460	1		1.16
470	1		1.27
490	2	.95-1.16	1.05
Total	122		1.112 Ave.

Table 38. Condition factor "K" for angler catch of hatchery rainbows soon after release, 1964

Table length in mm	Number	Range	Average
170	1		.77
180	1		.63
190	2	.59-.83	.71
200	1		.71
210	3	.57-.81	.66
220	1		.65
230	3	.49-.85	.70
240	3	.74-.81	.77
250	2	.54-.67	.61
260	1		.66
Total	18		0.69 Ave.

Table 39. Condition factor "K" for Rainbow trout, 1963

Table length in mm	Number	Range	Average
210	3	1.35-1.47	1.43
220	1		.76
240	2	1.01-1.50	1.25
250	2	.81-1.09	.95
260	1		.81
270	1		1.21
290	1		1.08
310	1		1.55
330	1		1.11
370	1		1.30
380	1		1.29
450	1		.95
480	1		1.40
520	1		1.45
550	1		1.15
Total	19		1.22 Ave.

Table 40. Condition factor "K" for Bonytail chub, 1963-64

Table length in mm	Number	Range	Average
190	1		.72
200	4	.62-1.00	.72
210	10	.61-.87	.79
220	6	.77-.99	.83
230	2	.86-.92	.89
250*	1		1.14
Total	24		.80 Ave.

* Collected in 1964

Table 41. Condition factor "K" for Flannelmouth sucker, 1963

Table length in mm	Number	Range	Average
230	1		1.09
240	1		.92
260	1		.76
300	1		.84
380	1		.86
400	1		.96
Total	6		0.91 Ave.

Table 42. Condition factor "K" for Flannelmouth sucker, 1964

Table length in mm	Number	Range	Average
220	1		.88
230	4	.75-.85	.79
240	5	.85-.93	.90
250	4	.78-.87	.82
270	2	.84-1.01	.92
280	1		.88
290	4	.77-.81	.80
310	6	.71-.84	.78
320	5	.80-.89	.83
330	3	.79-.87	.82
340	9	.77-.90	.85
350	4	.76-.84	.80
360	3	.57-.99	.82
370	1		.56
380	2	.71-.77	.74
410	2	.79-.91	.85
430	1		.91
Total	57		0.82 Ave.

Table 43. Condition factor "K" for Carp, 1964

Table length in mm	Number	Range	Average
210	1		1.28
230	2	1.31-1.38	1.35
240	3	1.21-1.41	1.32
250	14	1.15-1.48	1.25
260	7	1.14-1.35	1.25
270	9	.99-1.62	1.27
280	6	1.12-1.30	1.25
290	8	1.20-1.39	1.28
300	4	1.28-1.41	1.35
310	1		1.38
320	8	1.28-1.57	1.39
330	7	1.21-1.64	1.43
340	3	1.24-1.44	1.33
350	4	1.27-1.43	1.31
360	4	1.25-1.59	1.39
370	2	1.27-1.37	1.32
380	7	1.21-1.55	1.40
390	3	1.11-1.46	1.32
400	1		1.55
410	1		1.44
420	1		1.47
430	3	1.47-1.69	1.59
460	1		1.40
470	1		1.15
530	1		1.48
550	1		1.19
Total	103		1.33 Ave.

Table 44. Condition factor "K" for miscellaneous species, 1963

Table length in mm			Number	Range	Average
Bluegill	160		1		1.39
	103		1		2.56
		Total	2		1.97
White sucker	210		1		.83
	226		1		.86
	230		3	.91-.93	.92
	240		1		.99
	383		1		1.21
		Total	7		0.95
Blue Mt. sucker	220		2	.72-.78	.75
		Total	2		0.75

Table 45. Condition factor "K" for miscellaneous species, 1964

Table length in mm			Number	Range	Average
Bluegill	124		1		1.466
		Total	1		1.466 Ave.
Black bullhead	167		1		1.22
	145		1		1.38
	150		1		1.68
		Total	3		1.43 Ave.
Largemouth bass	363		1		1.39
		Total	1		1.39 Ave.
Channel catfish	550		1		1.43
		Total	1		1.43 Ave.

Condition factor "K" for undesirable species indicates favorable enviornmental conditions exists.

Environmental conditions for salmonids in section "B" leaves much to be desired, however, it is hoped that brown trout planted in 1964 can utilize this marginal section.

AGE-GROWTH

Scales from 59 fish in 1963 and 305 in 1964 were collected; of these, 19 rainbow scales were read from the 1963 collection and all scales from the 1964 collection. A Bausch-Lomb micro-projector was used for scale projection.

Reliable data was obtained for age and calculated growth of undesirable species. Accurate age determination for salmonids presented similar problems encountered in ageing rainbows from Navajo Lake.

Spasmodic growth, varying size of stockings, year round plantings, varying water releases and year-round growing conditions caused growth checks to appear as annulus formation on rainbow scales. Generally speaking, a rainbow planted as a 3-4-inch fingerling in section "A" would grow to 12-14 inches after one year in the San Juan River, and from 15-19 inches after a lapse of two years. Brown trout, although not collected since their release, have been caught by angling and are about 10 inches in length after one year of river environment. These browns were one-inch fry when planted.

The following tables include age and calculated growth of representative size classes of the 1963-64 collections. Rainbow trout are not included because of erratic annulus formation.

One hundred and three carp scales were collected and read during 1964. All specimens indicated one year; 90 specimens indicated two years; 42 specimens indicated three years; six specimens indicated four years; two specimens indicated five years; and two specimens were six years old.

SUMMARY

Studies on the San Juan River below Navajo Lake have been conducted in hopes of determining: (1) Species composition; (2) Distribution of salmonids and undesirable species; (3) "K" condition factors; (4) Age-growth statistics and, (5) Evaluation of collection techniques.

Results indicate three definite habitats and populations occurring in the San Juan River below Navajo Dam. The class "A" section begins at the splash pool below Navajo Dam and continues downstream for eight miles. This section is characterized by clear water, deep pools, maximum summer temperatures, seldom exceeding 72° F and optimum habitat for salmonids. Salmonids occur in this section in greatest numbers. Utilization of class "A" habitat by undesirable species is presently at a minimum.

Marginal salmonid habitat exist throughout section "B" beginning at stream mile 8 and continuing to stream mile 18. This section is characterized by moderate to high turbidity, silt laden pools and maximum summer temperatures exceeding 72° F.

Table 46. Representative specimens for age and calculated growth for flannelmouth sucker, 1964.

Total length in mm		Number	Age classes, length given in mm: I	II
224		1	73	
232		1	86	218
235		1	147	
242		1	88	201
252		1	81	201
255		1	133	194
273		1	94	
276		1	110	236
295		1	111	214
298		1	119	248
310		1	103	230
312		1	121	252
318		1	129	249
320		1	103	241
327		1	80	247
330		1	102	228
339		1	113	252
340		1	117	267
248		1	108	216
355		1	116	279
357		1	138	277
360		1	134	301
365		1	116	292
371		1	154	263
382		1	122	296
385		1	146	312
410		1	205	342
432		1	135	270
	Totals	28	3,284	6,326
	Mean		117	227

Table 47. Representative specimens for age and calculated growth for carp, 1964.

Total length in mm	Number	Age classes, length given in mm: I	II	III
215	1	64		
235	1	115		
255	1	116		
260	1	112	211	
271	1	119		
272	1	116	228	
274	1	111	237	
284	1	89	203	266
290	1	185		

Table 47. C O N T I N U E D

Total length in mm		Number	Age classes, length given in mm					
			I	II	III	IV	V	VI
296		1	161	250				
304		1	153	246				
307		1	98	184	236			
310		1	113	275				
324		1	149	249				
324		1	107	165	296			
332		1	159	262				
335		1	95	224	305			
340		1	91	162	252			
340		1	121	190	281			
352		1	141	253	327			
352		1	81	193	292			
355		1	112	210	285			
361		1	106	305				
368		1	166	277				
382		1	177	263	328			
387		1	114	231	317			
395		1	106	224	326	386		
400		1	78	204	315	255		
410		1	91	228	350			
431		1	110	170	266	320	366	420
432		1	142	237	340			
477		1	170	259	368	468		
551		1	185	263	350	418	488	540
	Totals	33	4,053	6,403	5,500	1,847	854	960
	Mean		123	229	306	369	427	480

Table 48. Age and calculated growth for miscellaneous species, 1964

Total length in mm			Number	Age classes, length given in mm		
				I	II	III
Largemouth bass	363		1	114	168	278
		Totals	1	114	168	278
Bluegill	124		1	48	93	
		Totals	1	48	93	

Salmonids and undesirable species are represented in low numbers in this section.

Salmonids, for all management purposes, are non existent below stream mile 18. The San Juan River from stream mile 18 until it enters Colorado is characterized by large quantities of silt, summer temperatures exceed 72° F, a shifting sand bottom, and undesirable species occurring in moderate numbers. Channel catfish are common in this section along with some bluegills, and some black bass.

Introduction of salmonids has been limited to class "A" and "B" sections with the greatest number of salmonids being planted in section "A". Brown trout have been introduced in section "B". Channel catfish have been stocked below stream mile 18 between Blanco and Farmington.

Rainbow trout appear in substantial numbers in section "A", moderate numbers in section "B" and very low numbers in section "C". Brown trout appear in section "A" and "B" and probably in low numbers in section "C".

Undesirable species occupy almost all sections of the river in varying numbers. Very few undesirable species were collected in section "A".

The condition factor "K" averaged 1.22 for rainbow trout for 1963 and 1.11 in 1964. An abundant food supply in class "A" waters should maintain ideal growing conditions for salmonids in future years.

Angler rate of catch for rainbow trout was over 0.83 fish per hour in 1963. The largest rainbow taken to date weighed six pounds and four ounces.

Spasmodic growth caused growth checks on salmonid scales to appear as annulus formation and accurate age data could not be obtained. Age classes I and II were most common for undesirable species. Two carp indicated six years of age.

Evaluation of sampling techniques indicated fish collections were restricted due to large volumes of water, manpower shortage and low conductivity of San Juan River water. Improved electrofishing techniques will be employed during 1965 in hopes of securing larger collections with greater ease.

CREEL CENSUS STUDY

Creel census on the San Juan River during 1964 was conducted by New Mexico Conservation Officers and assisted by Section 8 personnel.

Section 8 personnel attempted a creel census program without assistance from Conservation officers, however, lack of personnel, a creel census on Navajo Lake by Section 8 personnel, and other Section 8 activities lead to discontinuing a scheduled creel census on the San Juan River. Creel census on the San Juan River during 1964 amounted to several random scheduled road blocks set up on main access roads for the following purposes: (1) obtaining license information; (2) securing hours fished; (3) counting fish in anglers' creel. Harvest information and rate of catch is being analyzed by Dingell-Johnson personnel in Santa Fe and is not available at this reporting date.

A comprehensive creel census study has been scheduled for 1965 with hopes of obtaining an economic evaluation of the San Juan fishery along with needed creel information.

BOTTOM ORGANISM STUDIES

Objectives:

Plankton and aquatic organism studies on the San Juan River were conducted during 1963 and 1964 in hopes of determining the following: (1) quantitative analysis; (2) qualitative analysis; (3) quanitative and qualitative distribution; (4) evaluation of collection techniques.

Procedures:

Eight sampling stations were selected for study. Stations "A", "B", and "C" are located in section "A" and are respectively one, four, and eight miles below Navajo Dam. Stations "D", "E", are located in section "B" and occur 10 to 16 miles respectively below Navajo Dam. Stations "F", "G", and "H" are located in section "C". Station "F" is located about 24 miles below Navajo Dam; station "G", about 30 miles and station "H" about 41 miles below Navajo Dam.

Weekly plankton collections were to be made using a Wisconsin-type plankton net and allowing water to pass through for five minutes and by allowing water to pass through a one square-foot Surber bottom sampler for five minutes.

Bottom organisms were to be sampled weekly using a one square foot Surber bottom sampler and collecting material from four square feet.

Basic water chemistry usually accompanied collections along with air temperatures, water temperatures and other environmental conditions that might affect collections.

Collections were killed and preserved in 20 percent alcohol. Analysis was performed by a graduate student attending the University of Arizona and by students attending Highland University of Las Vegas, New Mexico.

Results:

Collections from stations "B", "C", "E", and "G" were discontinued soon after sampling began because variations between stations in the same section seemed slight. Stations "A", "D", "F" and "H" were continued and modified collection techniques were employed. Modifications from original collections included eliminating the five minute plankton net drift, eliminating the five minute Surber drift, reducing the Surber bottom sample from four square feet to two square feet and collecting monthly samples instead of weekly.

Table 49 is a qualitative and quanitative summary obtained from 123 analyzed bottom samples collected during 1963 and 1964. This is by no means a complete list of organisms present, but was included to give the reader a general idea of organisms found in the San Juan River and their abundance.

Qualitative and quantitative analysis of the samples revealed that section

"A" contains the greatest quantities and greatest variety of organisms. Bottom organism in section "B" occur in lower numbers when compared to section "A" and quality of organism begins to drop in section "B". This is particularly noted in dipterans. Bottom organism in section "C" show a drastic reduction in quanity and quality when compared to sections "A" and "B". Highly turbid waters and a shifting sand bottom probably account for this deterioration in section "C".

Contracting analysis of collections to "outside" individuals proved to be most undesirable to the author and to the completeness of this report. Very few sample results have been returned to the author at this report date.

Contact by mail and phone with the analyst revealed conflicting appropriation of time between thesis work and analysis of San Juan River collections with thesis work receiving precedent.

All collections mailed to the contract analyst will be returned and analyzed by Section 8 personnel during 1965. The author could make several general statements regarding the returned analyzed samples, however, most of these statements would be assertions with insufficient statistical backing. Bottom organism studies from the beginning of this segment will be included in the 1965 Section 8 report.

Summary:

Completion of this section of this report is not possible because most samples have not been analyzed by the contract analyst. Bottom organism analyzed in table 49 indicate section "A" waters rank highest in food production, section "B" indicates moderate food production and in section "C" very low food production.

Section 8 personnel will analyze bottom organism samples that were collected prior to this report and those collected in the future.

FOOD HABITAT STUDIES

Objectives:

Stomachs from rainbow trout were collected during 1963-1964 to furnish qualitative information concerning primary food organisms consumed.

Procedures:

Fish stomachs were collected throughout the calendar year using electrofishing gear and gill nets. Removed stomachs were placed in cloth bags and preserved in 15 percent formalin. The collections were then mailed to a contract analyst attending the University of Arizona.

Results:

The author has not received any results from the contract analyst as of this report date. Contact by phone with the analyst several months prior to the writing of this report indicated all samples would be completed by the last of January, 1965. Contact with the analyst during February and early March, 1965 indicated that stomach analysis along with other contracted analysis would not be available for this report.

Table 49. Relative abundance and species composition of bottom organism found in the San Juan River, stations A, D. F, and H, during 1963-1964.

	A	D	F	H
Cl. Protozoa				
Unidentified	O			
Cl. Turbellaria				
O. Tricladia				
F. Planariidae	O			
Cl. Rotatoria				
Unidentified	R			
Cl. Annelida				
Unidentified	O	O		
Cl. Crustacea				
SC. Ostracoda	C			
SC. Cladocera	A	C		
SC. Copepoda	C	C		
SC. Hydracarina	R	O		O
Cl. Insecta				
O. Diptera				
F. Tendipedidae	A	A	A	C
F. Simulidae	A	A	R	R
F. Ceratopogonidae	A	C		
F. Ephydridae	A			
F. Tabanidae	A			
F. Culicidae	C			
F. Anthemyiidae	R			
F. Rhagionidae		O		
F. Psychodidae			O	
O. Ephemoptera				
F. Baeidea	A	A		
F. Heptageniidae	A	A	R	
F. Ephemeridae	R			
O. Hemiptera				
F. Corixidae	C			
F. Naucoridae			O	
F. Mesoveliidae		O		
F. Macroveliidae		O		O
O. Plecoptera				
F. Perlidae	C			O
F. Nemouridae	O			
F. Chloroperlidae		O		
O. Coleoptera				
F. Chrysomelidae		O		
F. Hydrophilidae	O		O	
O. Trichoptera				
F. Hydropsychidae	A	A	R	R
O. Odonata				
SO. Anisoptera				
Unidentified	O	O	O	
Cl. Gastropoda				
F. Planorbidae	O			
F. Physidae	A	C		
F. Lymnaeidae	A	O		O
F. Ancylidae	C			
Algae				
Spirogyra	C	C	O	
Nostocaceae	A	A	O	O
Chara	O	O		
Various green	C	C		
Misc. Diatoms			O	O
Higher plants				
Zannichellia	A	C		
Potamogeton	C			

Totals - A 34
D 23
F 11
H 9

NOTE: Cl. = Class
SC. = Subclass
O. = Order
F. = Family
SO. = Suborder

A. = Abundant
C. = Common
R. = Rare
O. = Occur

The author then requested that all samples not analyzed be returned so Section 8 personnel could complete analysis. To date no samples have been returned.

The author made a "hurried" appraisal of 50 rainbow stomachs that were not mailed to the analyst after notification that the contract analyst would be unable to supply stomach content information. The author wishes to emphasize that the discussion in the following paragraphs does not represent "quality" information that a thorough food study should contain. This information was included only to indicate a general summary of organisms being utilized by rainbow trout.

Dipterans belonging to families Tendipedidae and Simulidae occurred in high numbers in 41 stomachs. Family Tendipedidae ranked number one in occurrence of all organisms; Simulidae ranked third. The order Trichopters was represented by the family Hydropsychidae and ranked second in abundance.

Orders Emphemoptera, Orthroptera, Coleoptera, Plecoptera, Hemiptera, and both suborders of Odonata occurred in low numbers.

Gastropods occurred in 50 percent of the stomachs with the family Physidae most common. Remains of fish were found in two stomachs; one fish was identified as a rainbow trout and one Hirudinea was observed.

Filamentous algae completely occupied three stomachs and found in varying amounts in others. Six stomachs were empty.

Summary:

Rainbow trout stomachs were collected from the San Juan River during 1963 and 1964 to determine utilization of available food organism.

Collected stomachs were sent to a graduate student attending the University of Arizona for analysis. To date, no results have been forwarded to Section 8 personnel. The author requested return of all unanalyzed samples so Section 8 personnel could complete analysis.

Contracting analysis to "outside" sources has proven very unsatisfactory in food habitat studies and food production studies. The completeness of this section of this report was restricted due to the contract analyst not fulfilling his obligation. Section 8 personnel made a "hurried" analysis of 50 rainbow stomachs that were not mailed to the contract analyst and the results are as follows:

Dipterans occurred in greatest numbers with families Tendipedidae and Simulidae occurring most frequently; Trichoptera were abundant in 41 analyzed stomachs with family Hydropsychidae the only family represented. Orders Ephemoptera, Orthroptera, Coleoptera, Hemiptera, Plecoptera and both suborders of Odonata occurred in low numbers; Gastropods occurred in 50 percent of the samples; filamentous algae completely occupied three stomachs. Fish remains were found in two stomachs and six stomachs were empty.

The author wishes to emphasize that the quality of information presented in this section is far from the standard hoped for. Stomach analysis will be conducted by Section 8 personnel in 1965 in hopes of securing better information and having

it available when needed.

SUMMARY

The water released from the Navajo Reservoir is adequate for trout production with temperatures at the outlet varying between 42° F and 52° F during the summer months. However, as the water moves downstream it flows over a wide area that is very shallow and absorbs a large amount of heat during midsummer. Temperature increases up to 18° F were recorded at station "A", only one-half mile below the outlet. This is not of primary importance in the immediate area but this writer is confident that it does influence the temperature extremes in the downstream sections of the river. This problem could be solved by restricting the water into a common channel.

The three river classes that are discussed in this report seem to be supported by most of the data collected.

The upper section, class "A" is excellent trout water with adequate feed available, suitable water quality, and supports a large population of the salmonid species. Although the creel census program was not satisfactory, it was obvious that this section of the river received more fishing pressure than the other two areas.

Contributions of highly turbid water by the tributary canyons seems to be the primary factor causing a decline in the quality of the lower river. This is noticeable in the invertebrate and fish populations along with the chemical composition of the water. Slightly higher temperatures also contribute to this condition but are not of primary importance.

Rainbow presently occur in greatest numbers in class "A" and the numbers decrease drastically in classes "B" and "C". Collections from the lower areas show a high number of carp and suckers that are virtually nonexistent in the class "A" portion of the river.

Channel catfish are relatively abundant in class "C" waters, however, there seems to be a vacancy in the upper portion of class "C" and most of the class "B" waters. Although rainbow and brown trout have been released at all access points in section "B" and channel catfish in section "C" this "vacancy" is very obvious and indicates that the habitat does not meet the requirements of each species.

This author believes that introductions of new fish species would be desirable in an attempt to fully utilize the class "B" and "C" areas of the river.

Some difficulty was experienced with getting all of the analysis completed through contracting the work to two different individuals. The project now has adequate equipment and qualified personnel who will do most, if not all of the analysis work.

The land status of the upper river is predominantly public land controlled by the State and Federal governments (river class "A"). The lower sections (class "B" and "C") are surrounded by private land with very few small tracts of federal land scattered throughout.

As the sport fishery develops in the San Juan River, it would be advantageous to develop the suitable federal property and possibly obtain right-of-way easements through some of the private land.

Literature Cited:

American Public Health Association
1955. Standard Methods, APHA, New York

Brenner, W. W., and J. D. Seery
1959. Navajo Storage Unit, Colorado River Storage Project. Bureau of Reclamation, Farmington, New Mexico, 12pp.

Braun Chemical Company
____. Determining hardness in water by direct colorometric titration, Tech. Ser. Bul.

Flowers, Seville
1961. Vegetation of the Navajo Reservoir Basin in Colorado and New Mexico. Anthropological papers No. 55, Univ. Utah. pp. 115-46.

Jensen, Loren D., et al
1961. Anthropods found in the Navajo Reservoir Basin, Colorado and New Mexico Anthropological papers No. 55, Univ. Utah pp. 95-117.

Koster, William J.
1962. The Fishes of the Navajo Reservation Area. Report to the laboratory of anthropology, Santa Fe, N. M.

____
1957. Guide to the fishes of New Mexico, Univ. N. Mex. Press., Albuquerque.

Lagler, Karl F.
1956. Freshwater Fishery Biology, W. C. Brown, Dubuque, pp. 401.

Lemons, David G.
1965. Fish introduction in San Juan River Drainage, Colorado Game, Fish and Parks, correspondence.

Olson, Harold F.
1962. Rehabilitation of the San Juan River, D-J, F-22-R-3, New Mexico Dept. of Game and Fish, Santa Fe, New Mex. Multilithed.

____
1962. A Pre-Impoundment Study of Navajo Reservoir, New Mexico, D-J, F-22-R-3, N. M. Dept. Game and Fish, Santa Fe, multilithed.

____
1963. Fisheries survey of Navajo Reservoir, Section 8, N. M. Dept. of Game and Fish, Santa Fe, multilithed.

____
1963. Fisheries Survey of Navajo Reservoir Tailwaters, Section 8, N. M. Dept. Game and Fish, Santa Fe, multilithed.

____
1963. Fisheries Study of Navajo Reservoir, D-J, F-22-R-4, N. M. Dept. Game and Fish, Santa Fe, multilithed.

Pennak, Robert W.
1953. Freshwater Invertebrates of the United States, Ronald Press, New York, New York.

Rawson, D. S.
1953. The standing crop of net plankton in lakes. J. fish res. Bd. Canada, 10(5).

____
1956. The Net Plankton of Great Slave Lake. J. Fish Res. Bd., Canada, pp. 53-127.

Welch, Paul S.
1948. Limnological Methods. Blakiston, Philadelphia. pp. 199-227.

United States Bureau of Reclamation
1963. Weather station data, Navajo Dam, New Mexico.

____
1964. Weather station data, Navajo Dam, New Mexico.