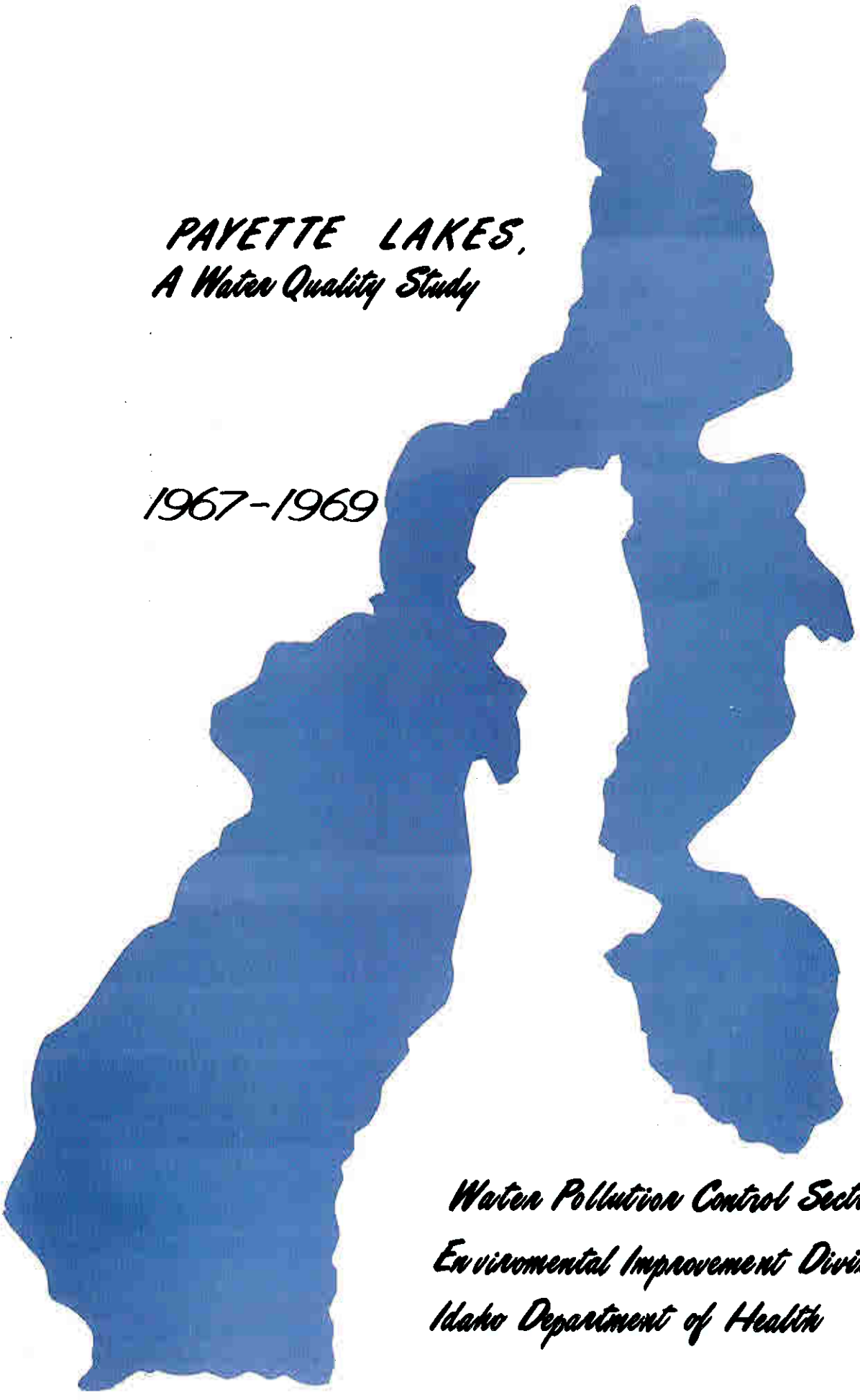
#11

PAYETTE LAKES,
A Water Quality Study

1967-1969



Water Pollution Control Section
Environmental Improvement Division
Idaho Department of Health

PAYETTE LAKE STUDY
1967 - 1969

May - 1970

State of Idaho
Department of Health
Water Pollution Control Section
Environmental Improvement Division

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PAYETTE LAKE STUDY
1967 - 1969

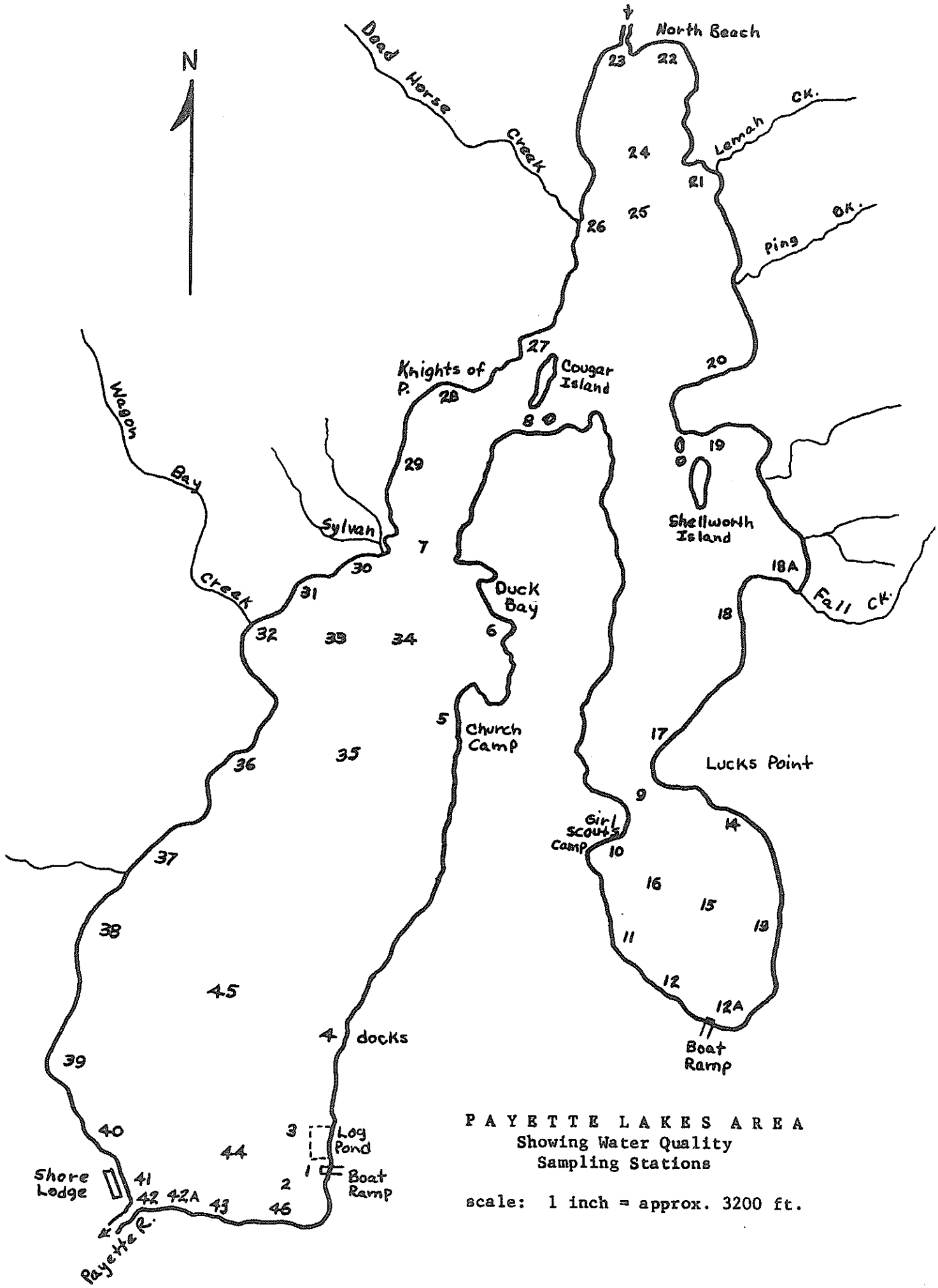
I. Introduction:

In November of 1967 and during the summers of 1968 and 1969, the Water Pollution Control Section of the Idaho Department of Health conducted water quality studies on the main Payette Lake to determine the extent of bacterial contamination, the chemical condition of the lake water, and the general degree of eutrophication. These studies followed a bacteriological and sanitary survey of the Payette Lake area conducted in 1964 which revealed many unsatisfactory sewage disposal facilities in use in the lake shore area as well as several contaminated water supplies. At that time, the water in certain beach areas was found to be of unsatisfactory quality for recreational use. A report entitled "Sanitary and Bacteriological Survey, Payette Lake Area" was prepared by the Idaho Department of Health in 1964. The report pointed out inadequacies in sewage disposal facilities and included that the feasibility of installing a community sewage collection system for the summer home section be studied.

The more recent studies were initiated to monitor the bacteriological quality of the lake at a large number of sampling points, and to examine several chemical and biological parameters. The main objective was to more fully determine the effects of current sewage disposal practices on water quality in the littoral (near-shore) areas.

II. Methods:

Prior to sampling in 1967, 46 sampling stations on Payette Lake were selected for inclusion in the study (see map and description of sampling station on following pages). Most of the stations were located approximately 300 feet from the shoreline at the points indicated on the map. In addition, samples were taken at certain points about 25 feet from shore; results of analyses performed on these samples are denoted by the addition of an "S" to the number assigned to the sampling station.



PAYETTE LAKES AREA
Showing Water Quality
Sampling Stations

scale: 1 inch = approx. 3200 ft.

SAMPLING STATIONS

1. 100 yards from boat landing near log pond.
2. 500 feet from shore, near city water intake.
3. 500 feet from north end of saw mill.
4. 500 yards from public dock; ½ mile north of mill.
5. 500 yards from docks and campground (see map).
6. 500 yards from dock and campground near Duck Bay (see map).
7. Across lake from Simplot pool.
8. Near south end of Cougar Island.
9. Narrows between Girl Scout Camp and Lucks Point.
10. Girl Scout Swimming area.
11. Cabin area in Pilgrim Cove.
12. Near boat ramp and Conoco Gas area, Pilgrim Cove.
13. Camp swimming area.
14. South of Lucks Point.
15. Pilgrim Cove, 1/3 of distance between #13 and #10.
16. Pilgrim Cove, 2/3 of distance between #13 and #10.
17. North of Lucks Point.
18. Near 3 docks in camp area.
19. Between Shellworth Island and sand beach.
20. South of Ping Creek.
21. Near outlet of Lemah Creek.
22. Near north beach picnic area.
23. Mouth of Payette River.
24. Middle of lake off rocky point (see map).
25. Middle of lake between #21 and #26 (see map).
26. Cove near mouth of Dead Horse Creek.

27. Small bay across from Cougar Island.
28. Near dock and camp, Knights of Pythias.
29. Half way between K.P. camp and Simplot pool.
30. Near cabin area south of Simplot pool.
31. Second cove south of Simplot pool (Wagon Wheel Bay).
32. Third cove south of Simplot pool.
33. One-third of distance between #32 and #6.
34. Two-thirds of distance between #32 and #6.
35. Middle of lake between #36 and #5.
36. Large bay (see map).
37. Near mouth of stream south of #36.
38. South of #37 (see map).
39. South of #38 (see map).
40. South of #39 (see map).
41. Off Shore Lodge.
42. Lake outlet to Payette River.
43. Off vacant lot, south end of lake.
44. Half way between Shore Lodge and saw mill.
45. Middle of lake, between #38 and #4.
46. Near Yacht Club.

During each study period, samples were taken for determination of coliform densities at each of the 46 established sampling stations. In 1968 and 1969, samples were also taken at many of the near-shore stations. Bacteria of the coliform group are normal inhabitants of the digestive tract of all warm-blooded animals, including humans. The presence of these organisms in water indicates the possibility of the presence of pathogenic organisms. Coliform densities were determined by use of the "most probable number" method, a statistical calculation based on multiple fermentation tube dilutions. In 1969, the "E.C." test was also applied to certain samples. This test is designed to differentiate between organisms which are truly fecal in origin and those which originate in the soil. Some common soil organisms will produce a positive reaction in the standard M.P.N. test. All samples for bacteriological analysis were transported to the laboratory on the same day they were taken.

Samples of surface water were also collected at selected stations for analysis of various chemical components. The purpose of these analyses was to determine the concentration of nutrients available for algal growth and to establish the general chemical characteristics of the lake. These characteristics reflect, in part, the state of eutrophication (state of enrichment) of the lake. Samples were collected in one-liter containers and were transported to the laboratory on the same day they were taken. Analyses were performed according to procedures outlined in Standard Methods for the Examination of Water and Waste Water (A.P.H.A. 1965).

To further establish the state of eutrophication in Payette Lake, the phytoplankton community was also examined. The method employed was that of measuring the magnitude of the "standing crop," i.e., the numbers of various species of algal cells present in the water at the time of sampling. Results of such plankton counts yield some insight into the primary productivity of the

lake waters; in other words, it is possible to determine quantitatively the response of the algal communities to available concentrations of nutrient materials. The rate of primary production is a partial measure of the rate at which a lake is aging. Samples for phytoplankton counting were collected at selected stations from the surface waters and from a depth of 20 feet. These samples were preserved with five percent formalin and transported to the laboratory for analysis. Various plankton species were identified and enumerated through use of a compound microscope fitted with a Whipple disc. Observations were made with a magnification of 200 diameters.

III. Results and Discussion:

Water Chemistry

The results of chemical analyses are presented in Table 1. It is immediately apparent that the water at all sampling stations contains low concentrations of total and dissolved solids; specific cations and anions are correspondingly low. The major algal nutrients (nitrates and phosphates) are present in concentrations which we consider to be too low to support profuse algal blooms. Surface water temperatures (not included in charted data) ranged from 19.5 to 21.0°C at the various sampling stations in August, 1969. Little difference in chemical quality is exhibited by the results of analysis of water from all parts of the lake. For example, the concentrations of specific ions in samples from Station 23 (lake inlet, Payette River) and from Station 42 (lake outlet, Payette River) are in the same order of magnitude. All of the lake water appears to be fairly homogenous in terms of chemical parameters. Some differences are apparent, however, between results of analyses performed during the first two years (1967, 1968) and those performed in 1969. An increase in dissolved solids and some specific cations was indicated in 1969. The significance of this apparent increase can be determined only by further

testing in the future. The numbers of samples are not sufficient to warrant a definite statement regarding a deterioration of water quality during the study period. Even in 1969, the water quality appears to be quite good at all sampling stations with respect to water chemistry. All chemical parameters examined indicate that the lake should be classed as oligotrophic at this point in time.

The term "oligotrophic" refers to the state of enrichment or state of aging of the lake. A condition of oligotrophy is a state in which the waters are low in nutrients and low in biological productivity. Literally, "oligotrophic" means "poor food," or "poorly nourished" and the term is applied to lakes with high quality water. It is possible to speak of varying trophic levels; such terminology is meant to compare degrees of fertility within or among lakes or reservoirs. The term "eutrophic" means "highly enriched"; "mesotrophic" means "an intermediate degree of enrichment." The eutrophication rate, then, is the rate at which the lake is changing from a state of oligotrophy to a state of eutrophy. This change occurs naturally in all lakes, due to the influence of nutrients added from natural run-off within a watershed. As eutrophication advances, biochemical imbalances so impede the completion of natural food change that the lake approaches a bog condition and is termed "dystrophic" (bad food). Eventually any lake will be filled with organic and inorganic material to the point where it essentially disappears and is considered "dead." Under natural circumstances, the change from oligotrophy to dystrophy occurs over a period of thousands of years, the rate of change depending on the size and geometry of the lake and the type of watershed. However, a lake becomes unsuitable for man's primary uses long before the approach of dystrophy. The process of eutrophication leaves in its wake severe algal blooms, odorous conditions, destroyed fisheries, fouled beaches, reduced dissolved oxygen, and unpalatable water. Man's uncontrolled activities have been shown to greatly

speed eutrophication because these activities directly or indirectly speed the addition of nutrients to lakes.

Analysis of Phytoplankton Community

The results of phytoplankton enumerations bear out the contention that Payette Lake is still in an oligotrophic state. The phytoplankton communities at all sampling stations were dominated by diatoms, a group of organisms characteristic of rather cold, high quality water. The total numbers of organisms were quite low, ranging from 26 to 127 cells per ml in the surface waters. Total counts on samples from a depth of 20 feet were somewhat higher, ranging from 50 to 203 cells per ml. The lower counts in surface samples are to be expected due to the destructive forces of infrared radiation at the water surface. Optimum light intensity and light quality for photosynthesis usually exists at depths of about 10 to 20 feet. The small "standing crop" of phytoplankton organisms is indicative of low primary productivity in the lake. The magnitude and species composition of the phytoplankton communities at all sampling points were quite similar, reflecting a homogeneity comparable to that of the chemical factors examined; no significant differences are apparent from one year to another. On this basis it is assumed that enrichment of the lake was not occurring at a high rate during the course of the study.

Coliform Densities

The presence of the coliform group of bacteria was indicated at many of the sampling stations on each sampling date. More positive tests resulted from the sampling in August, 1967, than on the previous dates. M.P.N. tests indicate that the coliform densities were generally higher on August 19, 1969, than on August 12, 1968. Coliform densities at Stations 1, 2, 3, 5 and 6 in August 1968 and 1969, and Station 28-S in August 1969 were in excess of the value allowed by item 7A of the Idaho Board of Health Rules and Regulations for the Establishment of Standards for Water Quality. The standards state that the average

concentration of coliform bacteria is not to exceed 240 per 100 ml with 20 percent of the samples not to exceed 1000 per 100 ml in waters used primarily for recreation, drinking water supplies, fish and wildlife propogation and/or aesthetic purposes. While these standards were not exceeded at most of the sampling stations, significant concentrations of coliform organisms were found at nearly all stations in August, 1969.

IV. Summary and Conclusions:

Chemical and biological parameters indicate that Payette Lake should be considered oligotrophic in nature at this time. However, there is some evidence that the water quality is deteriorating to some degree. Bacterial contamination is obvious at certain sampling points, although the direct influence of sewage disposal practices along the west shore cannot be fully evaluated on the basis of these limited samples. Conclusions in this regard must still be based primarily on the findings of the 1964 survey of waste disposal practices. At that time, it was determined that many of the subsurface sewage disposal systems were situated such that they posed a hazard to the quality of ground and surface waters. Most of the water supplies tested were contaminated or open to contamination. While the study conducted from 1967 to 1969 did not show areas of gross pollution of surface water, the possibility of health hazards in isolated near-shore areas must be assumed to exist. To protect the oligotrophic condition of the lake and to preclude the possibility of the discharge of pathogenic organisms to the littoral areas and to ground water, it is recommended that a sewage collection system be installed in areas of concentrated habitation. If economically feasible, the sewage from these areas should be removed from the watershed for treatment.

TABLE 1
PAYETTE LAKE SURVEY
CHEMICAL ANALYSIS

Sampling Station	Date	pH	T.S. p.p.m.	T.D.S. p.p.m.	ALK. p.p.m.	HARD. p.p.m.	Ca p.p.m.	Mg p.p.m.	Fe p.p.m.	Mn p.p.m.	Na p.p.m.	Cl p.p.m.	SO_4 p.p.m.	NO_3 p.p.m.	OPO_4 p.p.m.	F p.p.m.
1	11-14-67	7.1	22		10	12	3	3	<0.01	<0.05	1	1	2	1.2	0.03	<0.01
	6-25-68	6.6	13	3	8	<10	<4	<1	0.07	<0.05	6	3	7	0.2	0.02	0.09
	8-19-69	7.6		96	40	48	5	9	0.15	0.12	2	32	5	2.3	<0.01	<0.01
2	11-14-67			15										1.0	0.03	
	8-12-68	7.1	22		8	4	2	0	<0.01	<0.05	0	<1	0	0.6	0.13	0.06
3	6-25-68	7.0	21	10	12	<10	<4	<1	<0.01	<0.05	14	3	85(?)	1.2	0.04	0.09
3 100 Ft.	6-25-68	7.0	14		12	<10	<4	<1	<0.01	<0.05	8	3	6		<0.01	0.44
3	8-12-68	6.9		15										1.3	<0.01	
7	11-14-67			12										1.0	0.03	
	6-25-68			8										1.2	<0.01	
	8-12-68	7.1		14										1.2	0.02	
	8-19-69	7.3		92	28	40	5	7	0.03	0.12	1	40	4	2.2	<0.01	<0.01
9	11-14-67			12										0.8	0.03	
	6-25-68			9										1.2	0.03	
	8-12-68	7.1		13										1.3	<0.01	
12	11-14-67			12										1.0	0.03	
	6-25-68			8										0.9	<0.01	
	8-19-69	7.3		88	28	36	11	2	0.04	0.07	2	38	5	2.1	<0.01	<0.01
16	8-12-68		15		8	4	2	0	<0.01	<0.05	0	<1	0	0.5	0.01	<0.01
18A	8-12-68	7.1	13											1.2	0.01	
19	11-14-67			12										0.8	0.03	
	6-25-68			12										1.0	0.04	

TABLE 1

Sampling Station	Date	pH	T.S. p.p.m.	T.D.S. p.p.m.	ALK. p.p.m.	HARD. p.p.m.	Ca p.p.m.	Mg p.p.m.	Fe p.p.m.	Mn p.p.m.	Na p.p.m.	Cl p.p.m.	SO_4 p.p.m.	NO_3 p.p.m.	OPO_4 p.p.m.	F p.p.m.
23	11-14-67	7.0	14		10	12	3	3	<0.01	<0.05	1	1	2	1.0	0.03	<0.01
	6-25-68				20	<10	<4	<1	<0.01	<0.05	7	3	5	0.8	<0.01	
	8-12-68		14		8	4	2	0	<0.01	<0.05	0	<1	0	0.5	<0.01	<0.01
	8-19-69	7.4		92	32	48	10	6	0.05	0.11	3	29	6	2.1	<0.01	<0.01
33	11-14-67		67		16	16	2	3	0.01	<0.05	1	1	22	2.1	0.03	0.09
	6-25-68	7.2	12		12	<10	<4	<1	<0.01	<0.05	6	3	5		<0.01	0.20
	8-12-68	7.2		15										1.2	0.01	
35	6-25-68			8										1.2	<0.01	
	8-19-69	7.2		88	32	44	5	8	0.06	0.07	2	27	6	2.4	0.10	<0.01
42	11-14-67				30	24	3	4	0.02	<0.05	1	1	3	1.0	0.12	0.02
	6-25-68	7.3			16	<10	<4	<1	<0.01	<0.05	8	3	5		<0.01	0.39
	8-12-68	7.1	14		8	4	2	0	<0.01	<0.05	0	<1	0	0.6	<0.01	<0.01
44	11-14-67		14											0.7	0.03	
	6-25-68			8										1.2	<0.01	
	8-12-68			15										1.4	0.01	
	8-19-69	7.2		92	24	40	6	8	0.07	0.07	1	29	5	2.2	<0.01	<0.01
45	11-14-67			13										0.9	<0.01	
47	6-25-68			8										1.2	<0.01	

TABLE 2

PAYETTE LAKE SURVEY
PHYTOPLANKTON ENUMERATION
(Number of organisms per ml)

A. 11-14-67

Middle of main lake

Asterionella sp.	56
Melosira sp.	45
Ankistrodesmus sp.	5
Tabellaria sp.	17
Unidentified	4
Total	127/ml

Middle of east arm of lake

Asterionella sp.	6
Melosira sp.	33
Ankistrodesmus sp.	4
Tabellaria sp.	4
Cymbella sp.	1
Oocystis sp.	3
Unidentified	1
Total	52/ml

B. 8-12-68

Station 3 (surface)

Asterionella sp.	10
Melosira sp.	13
Tabellaria sp.	3
Unidentified	26
Total	52/ml

Station 3 (20 foot depth)

Asterionella sp.	28
Melosira sp.	110
Tabellaria sp.	39
Ankistrodesmus sp.	15
Unidentified	11
Total	203/ml

Station 6 (surface)

Asterionella sp.	13
Melosira sp.	24
Tabellaria sp.	16
Ankistrodesmus sp.	5
Cymbella sp.	1
Unidentified	8
Total	67/ml

TABLE 2

Station 16 (surface)

Asterionella sp.	1
Melosira sp.	7
Tabellaria sp.	3
Ankistrodesmus sp.	2
Scenedesmus sp.	1
Unidentified	32
Total	46/ml

Station 16 (20 foot depth)

Asterionella sp.	5
Melosira sp.	19
Tabellaria sp.	13
Ankistrodesmus sp.	1
Diatoma sp.	1
Cyclotella sp.	2
Unidentified	28
Total	69/ml

Station 23 (surface)

Asterionella sp.	4
Melosira sp.	19
Tabellaria sp.	11
Unidentified	33
Total	67/ml

Station 23 (20 foot depth)

Asterionella sp.	1
Melosira sp.	22
Tabellaria sp.	17
Staurastrum sp.	2
Navicula sp.	2
Dictyosphaerium sp.	1
Unidentified	27
Total	72/ml

Station 33 (surface)

Asterionella sp.	9
Melosira sp.	31
Tabellaria sp.	6
Ankistrodesmus sp.	5
Unidentified	7
Total	58/ml

TABLE 2

Station 33 (20 foot depth)

Asterionella sp.	23
Melosira sp.	74
Tabellaria sp.	16
Ankistrodesmus sp.	4
Unidentified	11
Total	128/ml

Station 42 (surface)

Asterionella sp.	8
Melosira sp.	12
Tabellaria sp.	2
Ankistrodesmus sp.	6
Cyclotella sp.	4
Anacystis sp.	1
Navicula sp.	1
Unidentified	32
Total	66/ml

C. 8-19-69

Station 1 (surface)

Asterionella sp.	2
Tabellaria fenestrata	2
Cyclotella sp.	7
Melosira varians	8
Glenodinium sp.	2
Euglena sp.	1
Flagellate	4
Total	26/ml

Station 3 (surface)

Melosira varians	18
Cyclotella sp.	17
Tabellaria fenestrata	2
Glenodinium sp.	9
Brown flagellate	1
Total	47/ml

Station 3 (20 foot depth)

Melosira varians	27
Melosira sp.	1
Cyclotella sp.	10
Tabellaria fenestrata	7
Euglena acus	1
Glenodinium sp.	8
Scenedesmus sp.	1
Brown flagellate	4
Total	59/ml

TABLE 2

Station 7 (surface)

Melosira varians	8
Cyclotella sp.	26
Tabellaria fenestrata	9
Glenodinium sp.	7
Brown flagellate	3
Total	53/ml

Station 7 (20 foot depth)

Melosira varians	17
Cyclotella sp.	14
Tabellaria fenestrata	10
Glenodinium sp.	10
Scenedesmus sp.	2
Chroococcus sp.	1
Brown flagellate	6
Total	60/ml

Station 10 (surface)

Melosira varians	10
Cyclotella sp.	20
Tabellaria fenestrata	11
Glenodinium sp.	5
Scenedesmus quadricauda	25
Scenedesmus dimorphus	1
Fragilaria capucina	1
Fragilaria crotonensis	1
Euglena acus	15
Euglena sp.	2
Actinastrum hantzschii	1
Diatoma vulgare	1
Unidentified blue-green	3
Unidentified brown coccoid	1
Total	77/ml

Station 10 (20 foot depth)

Melosira varians	10
Cyclotella sp.	15
Tabellaria fenestrata	18
Glenodinium sp.	4
Navicula sp.	1
Brown flagellate	1
Unidentified blue-green	1
Total	50/ml

TABLE 2

Station 24 (surface)

Melosira varians	8
Cyclotella sp.	39
Tabellaria fenestrata	13
Glenodinium sp.	4
Cymbella lanceolata	1
Nitzschia vermicularis	1
Scenedesmus sp.	2
Unidentified	2
Total	70/ml

Station 24 (20 foot depth)

Melosira varians	16
Cyclotella sp.	7
Tabellaria fenestrata	7
Glenodinium sp.	10
Scenedesmus quadricauda	1
Amphora ovalis	1
Chroococcus sp.	1
Brown flagellate	9
Total	52/ml

Station 35 (surface)

Melosira varians	9
Cyclotella sp.	14
Tabellaria fenestrata	10
Glenodinium sp.	4
Scenedesmus sp.	1
Chrysocapsa sp.	1
Brown flagellate	1
Total	40/ml

Station 35 (20 foot depth)

Melosira varians	27
Cyclotella sp.	12
Tabellaria fenestrata	5
Glenodinium sp.	17
Scenedesmus quadricauda	14
Scenedesmus dimorphus	2
Fragilaria crotonensis	2
Fragilaria capucina	1
Nitzschia palea	1
Navicula sp.	1
Euglena acus	9
Protococcus sp.	1
Brown flagellate	7
Total	99/ml

TABLE 2

Station 44 (surface)

Melosira varians	6
Cyclotella sp.	5
Tabellaria fenestrata	4
Glenodinium sp.	9
Brown flagellate	2
Total	26/ml

Station 44 (20 foot depth)

Melosira varians	16
Cyclotella sp.	7
Tabellaria fenestrata	7
Glenodinium sp.	10
Scenedesmus quadricauda	1
Amphora ovalis	1
Chroococcus sp.	1
Brown flagellate	9
Total	52/ml

TABLE 3
PAYETTE LAKE SURVEY
COLIFORM DENSITIES
(MPN/100 ml)

Sampling Station	DATE 11-14-67 MPN	6-25-68 MPN	8-12-68 MPN	8-19-69 MPN	8-19-69 EC
1	2	1720	40	1410	<20
2	<2	790	20	2210	<20
3	79	1090	130	<20	
4	<2	278	50	49	7
4-S				240	8
4-A			<200		
5	<2	918	130	79	8
5-S				79	<2
6	<2	1600	50	23	
6-S				33	
7	<2	<2	5	5	
8	<2	<2	2		
9	<2	<2	<2		
10	<2	2	<2	11	5
10-S				11	2
11	<2	<2	<2	7	<2
11-S				13	
12	<2	<2	<2		
12-A		5	2	8	
12-AS				7	
12-B			8		
13	<2	<2	<2	2	
13-S				5	
14		<2	<2		
14-S				5	<2
15	<2	<2	<2	2	
16		<2	<2		
17	<2	<2			
18	2	11	2	8	<2
18-S				8	
18-A			<2		
19	2	2	<2	<2	
19-S				13	
20	4	2	8		
21	<2	7	5	<2	
22	2	<2	<2	2	
22-S				2	
23	2	<2	<2	5	
24	<2	<2	<2	2	
25	<2	<2	<2		
26	<2	8	2	<2	<2
26-S				7	2
27	<2	5	5	<2	
28	2	2	2	8	
28-S				542	221
29	<2	<2	5		
29-S				79	8
30	2	50	<20	8	
30-S				33	33

TABLE 3

Sampling Station	DATE				
	11-14-67	6-25-68	8-12-68	8-19-69	
	MPN	MPN	MPN	MPN	EC
31	<2	130	<20	<2	
31-S				49	2
32	5	<20	20	<2	
32-S				11	2
33	5	11	2		
34	<2	5	8		
35	<2	12	23	11	
36	13	170	50	23	
36-S				23	<2
37	13	60	<20	33	
37-S				13	
38	<2	80	<20	49	
38-S				33	5
38-A			<20		
39	8	80	<20	49	
39-S				49	5
40	8	50	20		
40-S				79	23
41	<2	130	<20	13	
41-S				33	
42	23	20	<20		
42-A			20		
42-AS				5	<2
43	<2	20	50	8	
43-S				33	
44	2	175	80	49	
45	<2	79	<20		
46	<2				
46-S				221	<2

5-300-70