WATER QUALITY STATUS REPORT NO. 86

ANNUAL SUMMARY
North Idaho
1988

Citizen's Volunteer Monitoring Program

Prepared by
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Coeur d'Alene, Idaho 83814

Idaho Department of Health and Welfare
Division of Environmental Quality
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GLOSSARY

Aerobic - living or active only in the presence of molecular oxygen; with oxygen.

Algae - small aquatic plants lacking stems, roots and leaves; often filaments, single cells, or colonies of single cells.

Anaerobic - living or active in the absence of molecular oxygen; without oxygen.

Anoxia - a condition of no oxygen in the water.

Benthos - organisms living in and on the bottom sediments of lakes and streams.

Biomass - the weight of biological matter.

Biota - all plant and animal species occurring in a specified area.

Chlorophyll a - a plant pigment necessary for plant photosynthesis; an indicator of algal biomass.

Cultural eutrophication - an accelerated rate of lake aging induced by human sources of nutrients, sediment, and organic matter.

Dissolved oxygen - molecular oxygen dissolved in water and readily available to aquatic organisms.

Ecosystem - a system of interrelated organisms and their physical-chemical environment.

Epilimnion - the upper waters of a thermally stratified lake.

Euphotic zone - the depth to which light penetrates; the lighted zone of a waterbody.

Eutrophic - a well-nourished aquatic ecosystem.

Eutrophication - the physical, biological, and chemical changes associated with nutrient, organic matter, and silt enrichment of a lake or reservior; the natural aging process of a waterbody;

Flushing rate - the proportion of lake volume exchanged per year (also known as exchange rate; the reciprocal of residence time).

Gram - the mass of a substance equivalent to .035 ounces.

Hypolimnion - the bottom waters of a thermally stratified lake.

Kjeldahl nitrogen - the sum organic and ammonia nitrogen in a water sample.

Limnology - the study of inland waters.

Liter - the volume of a substance equivalent to 1.057 quarts.

Littoral zone - that portion of a water body extending from the shoreline lakeward to the greatest depth occupied by rooted plants

Macrophytes - large aquatic plants.

Mesotrophic - a moderately nourished aquatic ecosystem; the middle range between oligotrophic and eutrophic.

Metalimnion - the layer of water between the epilimnion and the hypolimnion in a stratified lake; delimited as the zone with the maximum rate of temperature change; synonymous with thermocline.

Meter - a linear measurement equivalent to 3.281 feet.

Microgram - the mass of a substance equal to one-millionth of a gram (.000001 gram).

Microgram per liter (ug/l) - mass per unit volume, equivalent to milligram per cubic meter (mg/m^3).

Milligram - the mass of a substance equal to one one-thousandandth of a gram (.001 gram)

Milligram per liter (mg/l) - mass per unit volume, roughly equivalent to parts per million (ppm).

Nitrogen - an essential nutrient for aquatic organisms, comprising 80% of the earth's atmosphere.

Nonpoint source - water pollution emanating from a spatially diffuse source.

Oligotrophic - a poorly nourished aquatic ecosystem.

Orthophosphate - a soluble form of inorganic phosphorus; biologically available.

Pelagic zone - the open area of a lake, from the littoral zone to the center of the lake.

Phosphorus - an essential nutrient for aquatic organisms; derived from weathered rock and human sources.

Plankton - a community of plants (phytoplankton) and animals (zooplankton), swimming or suspended in water, nonmotile or insufficiently motile to overcome transport by currents.

Residence time - the amount of time required to replace current lake volume with an equal volume of inflowing water (reciprocal of flushing rate).

Secchi Depth - a standardized measure of water transparency obtained by lowering a weighted circular plate, 20 centimeters in diameter into water until it is no longer visible.

Thermal stratification - a seasonal process where lakes stratify into a warm upper layer (epilimnion), a thermocline (metalimnion), and a cool and dense lower layer (hypolimnion); caused by temperature-created differences in water density.

Thermocline - the layer of water between the epilimnion and the hypolimnion in a thermally stratified lake; delimited as a zone with the maximum rate of temperature change; synonymous with metalimnion.

Total nitrogen - the sum of kjeldahl, nitrite, and nitrate nitrogen in a water sample.

Total phosphorus - the sum of organic and inorganic phosphorus in a water sample.

Trophic status- characterizing the degree of eutrophication of an aquatic ecosystem.

Turnover - a seasonal process of lake transition from thermal stratification to complete circulation (mixing); caused by temperature changes and wind derived energy.

Turbidity - an expression of the optical property of water that causes light to be scattered and absorbed, rather than transmitted in straight lines; influenced by suspended matter, such as clay, silt, plankton, and other microscopic organisms; expressed in terms of nepholemetric turbidity units (ntu) or Jackson turbidity units (jtu).

Watershed - a drainage area or basin in which all land and water areas drain or flow toward a central collector such as a stream, river, or lake at a lower elevation.

INTRODUCTION

The Citizen's Volunteer Monitoring Program (CVMP) was initiated by the Division of Environmental Quality (DEQ) in the summer of 1987. The Program was designed to meet an increased need for water quality monitoring of Idaho lakes and to allow for public participation in the water quality data gathering process.

Currently, the CVMP is a statewide program encompassing six lakes, one reservoir, and a stretch of the Spokane River. In 1989 we expect to add Hauser Lake, Rose Lake, and the Coeur d'Alene River to this growing list of monitoring sites. Most of the monitoring volunteers are shoreline property owners or Idaho Lake Association Coalition (ILAC) members.

Following are the primary objectives of this program:

1. Collect water quality data in a cost-effective manner, using volunteer support;

2. Use water quality monitoring data to verify long-term water quality trends and trophic status;

3. Improve community awareness of water quality protection and related issues.

METHODS

The citizen volunteers begin each monitoring season by attending a water quality training session. This outdoor workshop provides the volunteers with an opportunity to learn how to properly use their water quality sampling equipment and practice sampling protocol. Citizen-purchased Kemmerer sampling bottles, secchi disks, sampling probes, and dissolved oxygen kits are used to take measurements from specific open-water locations, usually the deepest point of a lake or river. Samples are collected at six week intervals, from April through October, and once through the ice in mid-February.

Two sets of water quality samples are taken at each location: one from below the surface (at secchi disk transparency depth) and the other from 1 meter off the bottom. These samples are stored and preserved in cubitainers and transported to the Idaho Bureau of Laboratories for nutrient and chlorophyll a analyses. The nutrients quantified include total phosphorus, orthophosphorus, nitrite and nitrate nitrogen, total kjeldahl nitrogen, and total ammonia. Chlorophyll a is an algal pigment used to quantify the amount of algae present in water.

Additionally, volunteers obtain readings for maximum depth, secchi disk transparency depth (water clarity), and water quality profiles of dissolved oxygen and water temperature. The dissolved oxygen and temperature readings are taken at equal interval depths and indicate if the the water column is thermally stratified into layers, continually mixed, or low in dissolved oxygen (anoxic).

Quality assurance also plays an important role in the water quality monitoring program. A DEQ staff member accompanies each of the monitoring teams on a least one occasion during the sampling season, collecting duplicate samples and emphasizing the need to collect accurate and reproducible water quality data.

The following discussion is a brief summary of the results obtained during the 1988 CVMP sampling season. Please keep in mind that water quality can show a wide range of seasonal variation. There is no doubt that interpretations of these results could benefit from several more years of accumulated trend monitoring data.

Sampling site maps, data compilations, graphical displays, and other supportive materials can be found in the appendices at the end of this text.

LOWER TWIN LAKE

In 1986, Lower Twin Lake was assessed by researchers Falter and Hallock (1987) as a phosphorus-limited, mesotrophic or oligotro-mesotrophic system. This classification was based on relative secchi disk tranparency depths, chlorophyll a concentrations, and phosphorus loadings from internal and watershed sources. They also found especially low levels of dissolved oxygen and high nutrient concentrations in the bottom waters during summer stratification.

The results from 1987 and 1988 CVMP sampling confirm this mesotrophic classification. Water quality samples of Lower Twin Lake were collected from a single location at approximately 17.6 meters (m) depth (see Appendix A). All sampling dates had nitrogen to phosphorus ratios greater than 10 : 1 by weight, verifying a phosphorus limitation. Average secchi disk transparency depths and phosphorus levels have remained about the same since the 1986 study, however, there have been significant reductions in average ammonia and kjeldahl nitrogen concentrations from 1987 to 1988. These reductions probably correspond to decreases in average chlorophyll a concentrations (algae) found in 1988.

CVMP profiles indicate that the water below 10 meters depth in Lower Twin Lake is relatively anoxic (lacking oxygen) from July until October. This condition is relatively predictable and greatly influences the amounts of biologically available phosphorus in bottom waters during the late summer and winter months. We will need to continue monitoring these profiles to determine the extent of anoxia and its associated effects.

Future attempts to control the amount of shoreline burning, use construction best management practices (BMP's) and improve septic systems should go a long way toward reducing phosphorus loading to Lower Twin Lake. The DEQ is currently working with members of the Twin Lakes Improvement Association (TLIA) to evaluate the feasibilty of constructing a sewer system near Twin Lakes.

Table 1. Lower Twin Lake CVMP Water Quality Data Summary for 1988

	Lower Twin	Lower Twin	Lower Twin	
Date	1988 CVMP Min	1988 CVMP Max	1988 CVMP Avg.	
Deep sample depth (m)	16.9	18.3	17.6	
Secchi Disk (m)	3.3	5.5	4.7	
T. Ammonia as N mg/l (euphotic)	0.0015	0.09	.038	
T. Ammonia as N (deep)	0.067	0.566	.298	
T. NO2+NO3 as N (euphotic)	0.002	0.037	.012	
T. NO2+NO3 as N (deep)	0.0005	0.068	.013	
T.Kjeldahl as N mg/l (euphotic)	0.17	0.3	.243	
T. Kjeldahl as N (deep)	0.23	0.99	.565	
T. Phosphorus as P mg/l (euphotic)	0.009	0.012	.011	
T. Phosphorus as P (deep)	0.012	0.26	.136	
Ortho phosphate as P mg/l (euphotic)	0.0005	0.002	.001	
Ortho phosphate as P (deep)	0.002	0.22	.119	
Chlorophyll a (ug/l)	1.6	3	2.2	
Lower Twin Lake Temperature Profile (C)	Depth (m)	1988 Minimum	1988 Maximum	1988 Average
	0	9.0	21.0	15.9
	2	8.5	20.5	15.4
	4	8.0	20.0	15.0
	6	7.0	20.0	14.0
	8	6.0	12.5	9.3
	10	5.0	9.0	7.1
	12	4.5	8.0	6.6
	14	4.0	8.0	6.4
	16	4.0	7.0	6.0
	18	4.0	7.0	5.9
Lower Twin Lake Dissolved Oxygen Profile (mg/l)	Depth (m)	1988 Minimum	1988 Maximum	1988 Average
	0	8.6	10.2	9.7
	2	8.6	10.2	9.7
	4	8.6	10.2	9.6
	6	7.8	9.8	9.2
	8	2.6	9.2	6.7
	10	1.0	9.0	5.5
	12	.0	9.0	4.7
	14	.0	9.0	4.3
	16	.0	8.8	4.0
	18	.0	8.3	3.1

Table 2. Comparison of Average Annual CVMP Values for Lower Twin Lake

	Lower Twin	Lower Twin
Date	1987 CVMP Average	1988 CVMP Average
Secchi Disk (m)	4.8	4.7
T. Ammonia as N mg/l (euphotic)	.110	.038
T. Ammonia as N (deep)	.720	.298
T. NO2+NO3 as N (euphotic)	.030	.012
T. NO2+NO3 as N (deep)	.004	.013
T.Kjeldahl as N mg/l (euphotic)	.380	.243
T. Kjeldahl as N (deep)	1.090	.565
T. Phosphorus as P mg/l (euphotic)	.017	.011
T. Phosphorus as P (deep)	.313	.136
Ortho phosphate as P mg/l (euphotic)	.004	.001
Ortho phosphate as P (deep)	.223	.119
Chlorophyll a (ug/l)	8.65	2.20

UPPER TWIN LAKE

Researchers Falter and Hallock (1987) characterized Upper Twin Lake as a mesotrophic or oligo-mesotrophic system, based on their 1986 water quality assessment. Although Upper Twin Lake has a larger surface area than Lower Twin Lake, it has a relatively shallow average depth of 3.2 meters (m) and a uniform distribution of nutrients, algae, and dissolved oxygen. This lack of thermal stratification (mixed conditions) prevent the anoxia and internal phosphorus loading evident in Lower Twin Lake.

Water quality samples of Upper Twin Lake were collected from a single location at approximately 3.8 meters (m) depth (see Appendix B). Average 1988 values for secchi disk transparency depth, total ammonia, kjeldahl nitrogen, total phosphorus, orthophosphorus, and chlorophyll a in Upper Twin Lake were very similar to those found in the 1986 and 1987 surveys. The only noticeable change was reduction in average nitrite and nitrate nitrogen from .025 mg/l in 1987 to .008 mg/l in 1988.

Upper Twin Lake's shallow depth and relatively fast flushing rate (.30 year) have probably been advantageous for maintaining stable nutrient and lake productivity levels. Improvements to shoreline septic systems and watershed best management practices (BMP's) would still be appropriate for both Upper and Lower Twin Lakes. The DEQ is currently conducting an ongoing study to quantify changes in stream sediment storage, stream discharge, and sediment/nutrient contributions to Upper Twin Lake during road building and timber harvest. This evaluation, which should be complete in 1989, will provide information to the Forest Practices Advisory Committee on instream monitoring methods and the effectiveness of BMP's to protect beneficial uses (Skille 1988).

The DEQ is also working in a cooperative manner with the Easterday Ranch and the Inland Empire Paper Company to implement some watershed BMP's for cattle grazing and road reclamation. These changes would benefit the water quality of Upper Twin Lake and the receiving waters of Lower Twin Lake.

Table 3. Upper Twin Lake CVMP Water Quality Data Summary for 1988

	Upper Twin Lake	Upper Twin Lake	Upper Twin Lake	
Date	1988 CVMP Min	1988 CVMP Max	1988 CVMP Avg.	
Deep sample depth (m)	3	5	3.8	
Secchi Disk (m)	2	5	3.8	
T. Ammonia as N mg/l (euphotic)	0.0005	0.081	.033	
T. Ammonia as N (deep)	0.003	0.061	.027	
T. NO2+NO3 as N mg/l (euphotic)	0.0005	0.029	.008	
T. NO2+NO3 as N (deep)	0.0005	0.004	.002	
T.Kjeldahl as N mg/l (euphotic)	0.18	0.32	.248	
T. Kjeldahl as N (deep)	0.18	0.33	.225	
T. Phosphorus as P mg/l (euphotic)	0.01	0.018	.014	
T. Phosphorus as P (deep)	0.008	0.014	.011	
Ortho phosphate as P mg/l (euphotic)	0.0001	0.001	.001	
Ortho phosphate as P (deep)	0.0001	0.001	.001	
Chlorophyll a (ug/l	2	3.1	2.5	
Upper Twin Lake Temperature Profile (C)	Depth (m)	1988 Minimum	1988 Maximum	1988 Averag
	0	8.8	22	16.7
	1	8.8	22	16.5
	2	7	22	16.0
	3	6	22	15.5
	4	6	21	15.0
	5	6	13	9.5
Upper Twin Lake Dissolved Oxygen Profile (mg	Depth (m)	1988 Minimum	1988 Maximum	1988 Averag
	0	8.8	10.2	9.5
	1	9	10.2	9.5
	2	9	10.2	9.4
	3	8.8	10.2	9.3
	4	8.8	10.2	9.3
	5	8.8	9	8.9

Table 4. Comparison of Average Annual CVMP Values for Upper Twin Lake

	Upper Twin Lake	Upper Twin Lake
Date	1987 CVMP Average	1988 CVMP Average
Secchi Disk (m)	3.9	3.8
T. Ammonia as N mg/l (euphotic)	.040	.033
T. Ammonia as N (deep)	.060	.027
T. NO2+NO3 as N mg/l (euphotic)	.025	.008
T. NO2+NO3 as N (deep)	.026	.002
T.Kjeldahl as N mg/l (euphotic)	.350	.248
T. Kjeldahl as N (deep)	.340	.225
T. Phosphorus as P mg/l (euphotic)	.015	.014
T. Phosphorus as P (deep)	.014	.011
Ortho phosphate as P mg/l (euphotic)	.002	.001
Ortho phosphate as P (deep)	.002	.001
Chlorophyll a (ug/l)	2.29	2.53

COCOLALLA LAKE

In 1986, Cocolalla Lake was assessed by Falter and Good (1987) as a phosphorus-limited, meso-eutrophic system. This was based on reduced water clarity, hypolimnetic anoxia (low in dissolved oxygen), and algae bloom conditions caused by shoreline development, agricultural land use, antitquated septic systems, and internal phosphorus loading from bottom sediment sources.

Water quality samples of Cocolalla Lake were collected from a single location at approximately 11 meters depth (see Appendix C). In 1988, Cocolalla Lake had an average secchi disk transparency depth of 1.65 meters (m), the poorest water clarity of all north Idaho lakes in the volunteer monitoring program. This is probably correlated to the algae bloom conditions prevalent during the late summer and early fall months. Chlorophyll a samples averaged almost 40 micorgrams per liter (ug/l), a three-fold increase from the previous 1987 CVMP survey. Lakeshore residents also spotted ubiquitous quantities of the blue-green algae Anabaena spp. and its associated aqua-blue pigment.

Euphotic zone and deep water concentrations of nitrite and nitrate nitrogen, kjeldahl nitrogen, and total phosphorus have remained about the same since 1986. Amounts of soluble inorganic orthophosphorus near the lake bottom, however, have increased from .017 milligrams per liter (mg/l) in 1987 to .056 mg/l in 1988. Although stratification appears to relatively weak, this increase might be related to internal phosphorus loading at the sediment-water interface.

Interagency efforts are currently being implemented to prevent nonpoint source pollution along Cocolalla Creek. Members of the Cocolalla Lake Association have also done a commendable job of looking into water quality improvement options and educating the public on appropriate watershed use.

Table 5. Cocolalla Lake CVMP Water Quality Data Summary for 1988

	Cocolalla	Cocolalla	Cocolalla	
Date	1988 CVMP Min	1988 CVMP Max	1988 CVMP Avg.	
Deep sample depth (m)	10	12.75	10.85	
Secchi Disk (m)	1	2.5	1.65	
T. Ammonia as N mg/l (euphotic)	.015	.038	.026	
T. Ammonia as N (deep)	.016	.291	.163	
T. NO2+NO3 as N mg/l (euphotic)	.001	.036	.015	
T. NO2+NO3 as N (deep)	.001	.027	.009	
T.Kjeldahl as N mg/l (euphotic)	.420	.960	.676	
T. Kjeldahl as N (deep)	.550	.690	.606	
T. Phosphorus as P mg/l (euphotic)	.028	.041	.031	
T. Phosphorus as P (deep)	.027	.195	.092	
Ortho phosphate as P mg/l (euphotic)	.000	.001	.000	
Ortho phosphate as P (deep)	.000	.170	.056	
Chlorophyll a (ug/l)	35	46	39.67	
Cocolalla Lake Temperature Profile (C)	Depth (m)	1988 Minimum	1988 Maximum	1988 Average
	1	8.0	19.0	13.9
	2	7.5	19.0	13.6
	3	7.5	19.0	13.5
	4	7.5	18.8	13.4
	5	7.5	18.8	13.2
	6	7.3	18.8	13.1
	7	7.3	18.3	13.0
	8	7.3	18.0	12.8
	9	7.3	18.0	12.6
	10	7.3	18.0	11.8
Cocolalla Lake Dissolved Oxygen Profile (mg/l)	Depth (m)	1988 Minimum	1988 Maximum	1988 Average
	1	8.8	12.2	10.2
	2	8.7	12.2	10.3
	3	8.0	12.2	9.5
	4	6.3	12.0	8.4
	5	6.2	12.0	8.3
	6	5.9	11.4	7.8
	7	4.8	11.2	7.3
	8	3.6	10.4	6.2
	9	1.6	9.6	5.0
	10	1.5	7.4	4.0
	11			

Table 6. Comparison of Average Annual CVMP Values for Cocolalla Lake

	Cocolalla	Cocolalla
Date	1987 CVMP Average	1988 CVMP Average
Deep sample depth (m)		10.85
Secchi Disk (m)	1.8	1.65
T. Ammonia as N mg/l (euphotic)	.050	.026
T. Ammonia as N (deep)	.310	.163
T. NO2+NO3 as N mg/l (euphotic)	.010	.015
T. NO2+NO3 as N (deep)	.020	.009
T.Kjeldahl as N mg/l (euphotic)	.610	.676
T. Kjeldahl as N (deep)	.810	.606
T. Phosphorus as P mg/l (euphotic)	.028	.031
T. Phosphorus as P (deep)	.100	.092
Ortho phosphate as P mg/l (euphotic)	.005	.000
Ortho phosphate as P (deep)	.017	.056
Chlorophyll a (ug/l)	12.17	39.67

SPIRIT LAKE

In 1984, Spirit Lake was assessed by researchers Soltero and Hall (1985) as a mesotrophic, or moderately enriched aquatic ecosystem. They also concuded, unlike most other north Idaho lakes, that the biological productivity of Spirit Lake is primarily controlled by nitrogen, rather than phosphorus.

Water quality samples of Spirit Lake were collected from a single location at approximately 23 meters (m) depth (see Appendix D). Results of the 1987 and 1988 CVMP verify this mesotrophic classification, based on anoxia (low levels of dissolved oxygen) and elevated concentrations of deep water nutrients. Nitrogen limitation, however, was not well defined. CVMP total nitrogen to phosphorus ratios indicated that Spirit Lake might also be phosphorus limited, depending on the season. N to P ratios by weight for the euphotic zone were consistently greater than 16 : 1. Most limnologists consider phosphorus to be limiting at N : P ratios above 10 by weight.

The average secchi disk transparency depth for Spirit Lake has not appreciably changed in the past 35 years, despite some other water quality changes. Average euphotic zone concentrations of nutrients and chlorophyll a have either decreased or remained the same in the past two years. The same is true for average deep water values of nutrients, except total kjeldahl nitrogen, which increased slightly from .480 milligrams per liter (mg/l) to .647 mg/l.

Water quality profiles of dissolved oxygen and temperature indicate that Spirit Lake is stratified into an upper (epilimnion) and lower (hypolimnion) layer from June until October. The water below 12 meters depth is typically cool, dense, and anaerobic from July until October.

Although there have not been any remedial attempts to improve the in-lake water quality of Spirit Lake, the DEQ and the Soil Conservation Service (SCS) are currently negotiating with the Hohman Ranch to cost-share some watershed improvements along lower Brickel Creek. These improvements could help prevent some nutrient loading and sedimentation to Brickel Creek, the marsh, and Spirit Lake.

Table 7. Spirit Lake CVMP Water Quality Data Summary for 1988

	Spirit	Spirit	Spirit	
Date	1988 CVMP Min	1988 CVMP Max	1988 CVMP Avg	
Deep sample depth (m)	21.25	25.1	22.86	
Secchi Disk (m)	3.35	6.67	5.03	
T. Ammonia as N mg/l (euphotic)	.005	.140	.046	
T. Ammonia as N mg/l (deep)	.029	.426	.165	
T. NO2+NO3 as N mg/l (euphotic)	.011	.070	.027	
T. NO2+NO3 as N mg/l (deep)	.001	.057	.022	
T.Kjeldahl as N mg/l (euphotic)	.150	.320	.231	
T. Kjeldahl as N mg/l (deep)	.260	2.430	.647	
T. Phosphorus as P mg/l (euphotic)	.008	.021	.014	
T. Phosphorus as P mg/l (deep)	.019	.260	.112	
Ortho phosphate as P mg/l (euphotic)	.001	.001	.001	
Ortho phosphate as P mg/l (deep)	.001	.116	.060	
Chlorophyll a (ug/l)	1.2	2.3	1.6	
Spirit Lake Temperature Profile (C)	Depth (m)	1988 Minimum	1988 Maximum	1988 Average
	2	3.5	19.0	11.7
	4	5.9	18.8	13.2
	6	3.5	14.5	9.6
	8	3.5	14.2	9.7
	10	3.5	14.0	8.6
	12	3.5	10.0	6.2
	14	4.0	7.0	6.0
	16	4.0	6.5	5.5
	18	5.2	6.0	5.8
	20	3.5	6.0	5.3
	22	3.5	6.0	5.2
	24	5.0	5.1	5.1
	26			
	28			
	30			
Spirit Lake Dissolved Oxygen Profile (mg/l)	Depth (m)	1988 Minimum	1988 Maximum	1988 Average
	2	6.3	13.6	10.4
	4	6.2	13.6	10.3
	6	6.1	13.4	10.1
	8	5.9	13.2	9.4
	10	4.7	13.2	8.6
	12	1.8	13.0	7.3
	14	0.0	13.0	5.2
	16	0.0	13.0	5.8
	18	0.0	12.7	3.5
	20	0.0	12.7	5.3
	22	0.0	9.8	3.7
	24	0.0	7.6	2.6
	26			
	28			
	30			

Table 8. Comparison of Average Annual CVMP Values for Spirit Lake

	Spirit	Spirit
Date	1987 CVMP Average	1988 CVMP Average
Secchi Disk (m)	5.1	5.0
T. Ammonia as N mg/l (euphotic)	.040	.046
T. Ammonia as N mg/l (deep)	.250	.165
T. NO2+NO3 as N mg/l (euphotic)	.030	.027
T. NO2+NO3 as N mg/l (deep)	.080	.022
T.Kjeldahl as N mg/l (euphotic)	.240	.231
T. Kjeldahl as N mg/l (deep)	.480	.647
T. Phosphorus as P mg/l (euphotic)	.014	.014
T. Phosphorus as P mg/l (deep)	.160	.112
Ortho phosphate as P mg/l (euphotic)	.002	.001
Ortho phosphate as P mg/l (deep)	.096	.060
Chlorophyll a (ug/l)	4.23	1.58

HAYDEN LAKE

In 1985, researchers from Eastern Washington University (Soltero et al. 1986) completed a water quality assessment characterizing Hayden Lake as a phosphorus-limited meso-oligotrophic aquatic system. Hayden Lake is considered to be a high quality lake, despite continued influence from shoreline development, antiquated septic systems, and other watershed land use activities accelerating the eutrophication (lake aging) process.

Water quality samples for Hayden Lake were collected from two representative locations: station 279 at approximately 50 meters (m) depth and station 282 at 1 m depth (see Appendix E). Nutrient and chlorophyll a concentrations, water clarity readings, and dissolved oxygen profiles collected by the volunteers verify the meso-oligotrophic classification.

Although average secchi disk transparency depths at station 279 decreased from 11.3 m in 1987 to 9.5 m in 1988, average values for all euphotic and deep water nutrients were slightly decreased. Chlorophyll a concentrations also decreased in 1988. These reductions might be related to the low water and drought conditions evident throughout the region in 1988.

Dissolved oxygen and temperature profiles for station 279 indicate a relatively well-defined upper (epilimnion) and a lower (hypolimnion) layers separated by a thermocline. Dissolved oxygen was available throughout the water column and there was no evidence of internal phosphorus loading.

Shallow station 282 exhibited considerably more productive waters with extensive macrophyte and algal growth. The shallow nature of this area permits sunlight to reach the bottom and create an ideal environment for aquatic plant life. Although several attempts have been made to temporarily remove the weeds, sediment controls might be the best long-term preventative cure.

Currently, DEQ and the United States Forest Service (USFS) are conducting a study on Hayden Creek to quantify contributions of nutrients and sediment to Hayden Lake and evaluate the effectiveness of forestry best management practices (BMP's).

Table 9. Hayden Lake Sampling Site 279 CVMP Water Quality Data Summary for 1988

	Hayden 279	Hayden 279	Hayden 279	
Date	CVMP 1988 Min	CVMP 1988 Max	CVMP 1988 Avg.	
Deep sample depth (m)	49	50	49.4	
Secchi Disk (m)	5.5	11	9.5	
T. Ammonia as N mg/l (euphotic)	0.0005	0.089	.024	
T. Ammonia as N (deep)	0.009	0.07	.026	
T. NO2+NO3 as N mg/l (euphotic)	0.003	0.016	.008	
T. NO2+NO3 as N (deep)	0.015	0.111	.048	
T.Kjeldahl as N mg/l (euphotic)	0.12	0.24	.176	
T. Kjeldahl as N (deep)	0.12	0.17	0.14	
T. Phosphorus as P mg/l (euphotic)	0.003	0.012	.007	
T. Phosphorus as P (deep)	0.006	0.01	.008	
Ortho phosphate as P mg/l (euphotic)	0.0005	0.001	.001	
Ortho phosphate as P (deep)	0.001	0.006	.003	
Chlorophyll a ug/l	0.7	1.4	1.0	
Hayden Lake 279 Temperature Profile (C)	Depth (m)	1988 Minimum	1988 Maximum	1988 Average
	1	13.0	22.0	18.5
	5	11.0	22.0	17.7
	10	9.2	21.0	14.5
	15	5.0	9.5	7.5
	20	3.5	5.9	4.9
	25	3.0	5.0	4.3
	30	3.0	5.0	4.2
	35	3.0	4.9	4.1
	40	2.7	4.7	3.9
	45	2.5	4.6	3.8
	50	4.4	4.4	4.4
Hayden Lake 279 Dissolved Oxygen Profile (mg/l)	Depth (m)	1988 Minimum	1988 Maximum	1988 Average
	1	8.7	12.6	10.4
	5	8.6	13.6	10.6
	10	8.8	14.0	11.9
	15	12.8	15.6	14.0
	20	11.2	15.4	12.7
	25	9.8	15.0	12.0
	30	9.6	15.0	11.8
	35	9.4	15.2	11.8
	40	9.3	16.0	11.9
	45	9.4	17.0	12.2
	50	6.4	9.8	8.1

Table 10. Comparison of Average Annual CVMP Values for Hayden Lake Sampling Site 279

	Hayden 279	Hayden 279
Date	CVMP 1987 Average	CVMP 1988 Average
Secchi Disk (m)	11.3	9.5
T. Ammonia as N mg/l (euphotic)	.030	.024
T. Ammonia as N (deep)	.040	.026
T. NO2+NO3 as N mg/l (euphotic)	.014	.008
T. NO2+NO3 as N (deep)	.072	.048
T.Kjeldahl as N mg/l (euphotic)	.200	.176
T. Kjeldahl as N (deep)	.170	.140
T. Phosphorus as P mg/l (euphotic)	.009	.007
T. Phosphorus as P (deep)	.016	.008
Ortho phosphate as P mg/l (euphotic)	.002	.001
Ortho phosphate as P (deep)	.004	.003
Chlorophyll a ug/l	5.14	1.03

PRIEST LAKE

Water quality samples of Priest Lake were collected by the Priest Lake Monitors at six representative locations: site I is near Soldier Creek; site II is near Kalispell Creek; site III is near Hunt Creek; site IV is near Pinto Point; site V is near Two Mouth Creek; and site VI is near Beaver Creek (see Appendix F).

The phosphorus and nitrogen concentrations listed in Table 11 indicate that Priest Lake is an exceptionally high quality lake. Average values for all six sites show that Priest Lake would qualify as an oligotrophic system. In fact, many of the nutrient concentrations are close to laboratory detection limits.

The oligotrophic status, however, is not without its challenges. Nitrogen to phoshorus ratios indicate that Priest Lake is decidedly phosphorus-limited. The extent of this phosphorus limitation can imply that Priest Lake would be sensitive to even the slightest increase in phosphorus loading.

Since August 1987, the Priest Lake Monitors have also been collecting secchi disk transparency depths on a bi-weekly basis from 19 different Priest Lake locations. Table 12 is a summary of the data collected during their 1988 survey (see Appendix F, also). Most of the water clarity values for Priest Lake average above 8 to 10 meters, except for Two Mouth Creek, Huckleberry Bay, Reeder Creek, and Cape Horn. Land use activities and boating traffic probably contribute to these lower water clarity values. Interestingly, water clarity averages seem to increase as the water travels down-lake, from the Thorofare to Outlet Bay.

Maintaining the high quality integrity of Priest Lake will require the application of best management practices (BMP's) to prevent excessive nutrient loading and sedimentation. The nutrient data and secchi disk surveys collected by the monitoring volunteers will provide a valuable baseline for gauging these changes.

Table 11. Average Values of Priest Lake CVMP Sampling Sites for 1988

Priest Lake							
CVMP 1988							
SITE	I	II	III	IV	V	VI	1988 Average For All Sites
SECCHI DEPTH (M)	11.0	11.4	11.1	11.4	11.3	11.0	11.2
TEMPERATURE (F) @ SECCHI DEPTH	68.0	62.0	66.0	62.0	60.0	64.0	63.7
TOTAL AMMONIA AS N (MG/L)	.027	.010	.007	.006	.006	.002	.010
TOTAL NO2+NO3 AS N (MG/L)	.015	.030	.005	.008	.005	.007	.012
TOTAL KJELDAHL NITROGEN AS N(MG/L)	.077	.097	.120	.107	.097	.063	.093
TOTAL PHOSPHORUS AS P (MG/L)	.003	.003	.002	.003	.004	.003	.003

Table 12. 1988 Average Secchi Disk Transparency Depths for Priest Lake

	1988 Average Secchi Disk Transparency Depths *
SITE 13 A (Mosquito Bay)	9.2
SITE14 A (Tango Creek)	8.2
SITE 12 A (Two Mouth Creek)	7.3
SITE 11 C (Huckleberry Bay)	7.7
SITE 15 A (Copper Bay)	8.9
SITE 16 A (Reeder Creek)	7.6
SITE 10 A (Cape Horn)	7.3
SITE 9 A (Indian Creek Bay)	9.6
SITE 17 A (Indian Rock)	9.8
SITE 18 A (Kalispell Island)	9.6
SITE 7 A (Hunt Creek)	10.1
SITE 19 C (Baritoe Island)	9.7
SITE 6 A (Fenton Creek)	9.5
SITE 5 A (4 mile Island)	10.0
SITE 4 A (Outlet Bay)	10.6
SITE 2 A (Soldier Creek)	8.6
SITE 3 A (Mid-lake, Soldier to Outlet)	9.7
SITE 1 A (Coolin Bay)	
* in meters	

SPOKANE RIVER

Water quality samples for the Coeur d'Alene to Post Falls stretch of the Spokane River were collected at three representative sites: the Cedars, located adjacent to Coeur d'Alene Lake; Harbor Island; and the Post Falls Bridge (see Appendix G).

The Cedars site is approximately 2.6 meters (m) deep and is representative of baseline water quality flowing out of Coeur d'Alene Lake. The water column is completely mixed and contains relatively low average concentrations of nitrogen and phosphorus. Dissolved oxygen is generally above 7 milligrams per liter (mg/l). However, when dissolved oxygen dropped to 4 mg/l on June 27, 1988, the concentration of zinc more than doubled. Trace elements, such as zinc, can move into the water column from the sediments when anaerobic conditions exist at the sediment- water interface.

The Harbor Island site, which is downstream of the Coeur d'Alene Wastewater Treatment Facility, lumber processing mills, and residential areas, consistently showed higher concentrations of nutrients than the Cedars location. The average concentration of ammonia increased from .019 mg/l at the Cedars site to .033 mg/l at Harbor Island. Total phosphorus levels increased from an average of .009 mg/l to .023 mg/l and the proportion of bioavailable orthophosphorus also increased from 22% to 52%.

The Post Falls Bridge site has an average depth of 8.6 meters. Average values for water temperature, water clarity, levels of dissolved oxygen, and concentrations of nutrients were very similar to those found at the Harbor Island site. This seems to indicate that most of the water quality changes that take place along this stretch of the Spokane River probably occur between the Cedars and Harbor Island sites.

The Environmental Protection Agency (EPA) conducted an intensive survey of the Spokane River during the summer of 1988 and the results from this survey might help explain some the reasons for these water quality changes. In addition, the EPA is also coordinating the development of an interstate phosphorus management plan to control phosphorus discharges and protect downstream uses.

Table 13. Spokane River CVMP Water Quality Data Summary for 1988

SPOKANE RIVER CVMP CEDARS SITE	1988 Minimum	1988 Maximum	1988 Average
MAXIMUM DEPTH (M)	2.5	2.75	2.6
SECCHI DEPTH (M)	2.5	2.75	2.6
TEMPERATURE (C)@ 1M DEPTH	13.3	21	17.7
TEMPERATURE (C)@ 1M OFF BOTTOM	12.2	21	17.5
DISSOLVED OXYGEN (MG/L)@ 1M	4	12	8.2
DISSOLVED OXYGEN (MG/L)@ 1M OFF BOTTOM	4	12	7.7
TOTAL AMMONIA (MG/L)	0.007	0.05	.019
TOTAL NO2+NO3 (MG/L)	0.008	0.02	.015
TOTAL KJELDAHL (MG/L)	0.05	0.13	.106
TOTAL PHOSPHORUS (MG/L)	0.007	0.011	.009
ORTHOPHOSPHORUS (MG/L)	0.001	0.002	.002
SPECIFIC CONDUCTANCE (UMHOS)	45	54	50.6
CHLOROPHYLL a (UG/L)	0.7	1.7	1.1
ZINC (UG/L)	30	220	84.8
SPOKANE RIVER CVMP HARBOR ISLAND SITE	1988 Minimum	1988 Maximum	1988 Average
MAXIMUM DEPTH (M)	5.75	5.8	5.8
SECCHI DEPTH (M)	2.75	4.5	3.7
TEMPERATURE (C)@ 1M DEPTH	13.3	21	17.6
TEMPERATURE (C)@ 1M OFF BOTTOM	13.3	21	17.7
DISSOLVED OXYGEN (MG/L)@ 1M	4	12	8.3
DISSOLVED OXYGEN (MG/L)@ 1M OFF BOTTOM	6	12	8.8
TOTAL AMMONIA (MG/L)	0.011	0.053	.033
TOTAL NO2+NO3 (MG/L)	0.009	0.036	.023
TOTAL KJELDAHL (MG/L)	0.12	0.19	.146
TOTAL PHOSPHORUS (MG/L)	0.014	0.037	.023
ORTHOPHOSPHORUS (MG/L)	0.001	0.022	.012
SPECIFIC CONDUCTANCE (UMHOS)	46	56	51.9
CHLOROPHYLL a (UG/L)	0.6	6.5	2.0
ZINC	30	140	67.5
FECAL COLIFORM (#/100 ML)	10	10	10.0
SPOKANE RIVER CVMP POST FALLS BRIDGE	1988 Minimum	1988 Maximum	1988 Average
MAXIMUM DEPTH (M)	8.5	9	8.6
SECCHI DEPTH (M)	2.75	4.75	4.0
TEMPERATURE (C)@ 1M DEPTH	14	22.5	18.0
TEMPERATURE (C)@ 1M OFF BOTTOM	13.4	22	17.9
DISSOLVED OXYGEN (MG/L)@ 1M	5	13	8.8
DISSOLVED OXYGEN (MG/L)@ 1M OFF BOTTOM	5	13	8.5
TOTAL AMMONIA (MG/L)	0.01	0.038	.024
TOTAL NO2+NO3 (MG/L)	0.003	0.034	.020
TOTAL KJELDAHL (MG/L)	0.12	0.18	.144
TOTAL PHOSPHORUS (MG/L)	0.014	0.028	.022
ORTHOPHOSPHORUS (MG/L)	0.002	0.018	.011
SPECIFIC CONDUCTANCE (UMHOS)	48	56	45.143
CHLOROPHYLL a (UG/L)	0.9	3.4	2.4
ZINC (UG/L)	30	220	82.0

REGIONAL COMPARISONS

Regional comparisons of lake and river water quality can provide a relative index of environmental quality in areas with similar geological, hydrological, and vegetative characteristics. The water quality of a lake or river is essentially a reflection of these variables and the activities in its surrounding watershed. Table 14 summarizes the average value of water quality parameters for Cocolalla, Hayden, Upper Twin, Lower Twin, Spirit, and Priest Lakes.

Secchi disk transparency depths are usually good indicators of general water quality. Figure 1 depicts Priest and Hayden Lakes with the greatest water clarity, averaging almost 11 meters (36.1 feet) depth. Lower Twin Lake, Upper Twin Lake, Spirit Lake, and the Spokane River have secchi disk transparency depths which are considerably less than Hayden or Priest Lakes, averaging less than 5 meters (16.4 feet) depth. Cocolalla Lake had the lowest average water clarity, with 1.7 meters (5.6 feet) depth.

Figure 2 might help explain some of these water clarity differences. Cocolalla Lake had an average total phosphorus concentration of 31 micrograms per liter (ug/l) in the epilimnion (the warm, upper layer) and 92 ug/l in the hypolimnion (the cooler, bottom water). Compare these values with Priest or Hayden Lake; there is almost a ten-fold difference. Lakes and rivers with a high nutrient concentration (phosphorus and/or nitrogen) equate to high algal productivity and low water clarity.

Figure 2 also shows Cocolalla, Spirit, and Lower Twin Lakes have internal, as well as external, nutrient sources entering the water column. This occurs during the summer and winter when inorganic phosphorus enters the hypolimnion from the sediment-water interface. These high concentrations of phosphorus are redistributed to the rest of the lake during lake overturn (spring and fall) and tend to accelerate the eutrophication (lake aging) process. Completely mixed systems, such as the Spokane River or Upper Twin Lake rarely have internal loading because they are well oxygenated from top to bottom.

It is important to remember that not all lakes and/or rivers were created equal. A relatively shallow lake, such as Cocolalla, will be at a different "trophic" level (productivity) than a Hayden or Priest Lake. Table 15 provides a brief summary of the literature values for secchi depth, chlorophyll a, and total phosphorus at different trophic levels.

Table 14 1988 Summary of Average Water Quality Values for North Idaho Lakes

	Cocolalla	Hayden 279	Upper Twin Lake	Lower Twin	Spirit	Priest Lake
Date	1988 CVMP Avg.	CVMP 1988 Avg	1988 CVMP Avg.	1988 CVMP Avg.	1988 CVMP Avg	1988 CVMP Avg.
Deep sample depth (m)	10.9	49.4	3.8	17.6	22.9	
Secchi Disk (m)	1.7	9.5	3.8	4.7	5.0	11.2
T. Ammonia as N mg/l (euphotic)	.026	.024	.033	.038	.046	0.01
T. Ammonia as N (deep)	.163	.026	.027	.298	.165	
T. NO2+NO3 as N mg/l (euphotic)	.015	.008	.008	.012	.027	0.012
T. NO2+NO3 as N (deep)	.009	.048	.002	.013	.022	
T.Kjeldahl as N mg/l (euphotic)	.676	.176	.248	.243	.231	0.093
T. Kjeldahl as N (deep)	.606	.140	.225	.565	.647	
T. Phosphorus as P mg/l (euphotic)	.031	.007	.014	.011	.014	0.003
T. Phosphorus as P (deep)	.092	.008	.011	.136	.112	
Ortho phosphate as P mg/l (euphotic)	.000	.001	.001	.001	.001	
Ortho phosphate as P (deep)	.056	.003	.001	.119	.060	
Chlorophyll a (ug/l)	39.67	1.03	2.53	2.20	1.58	

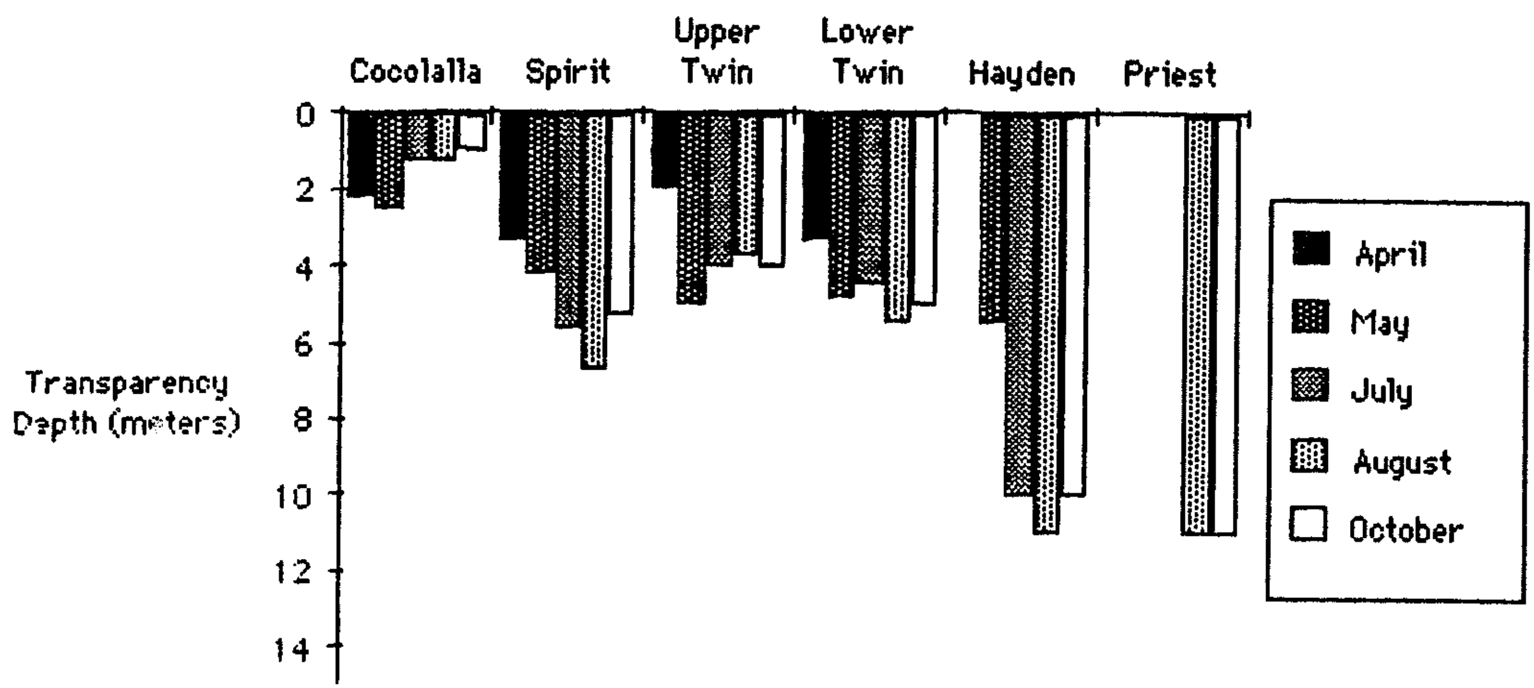
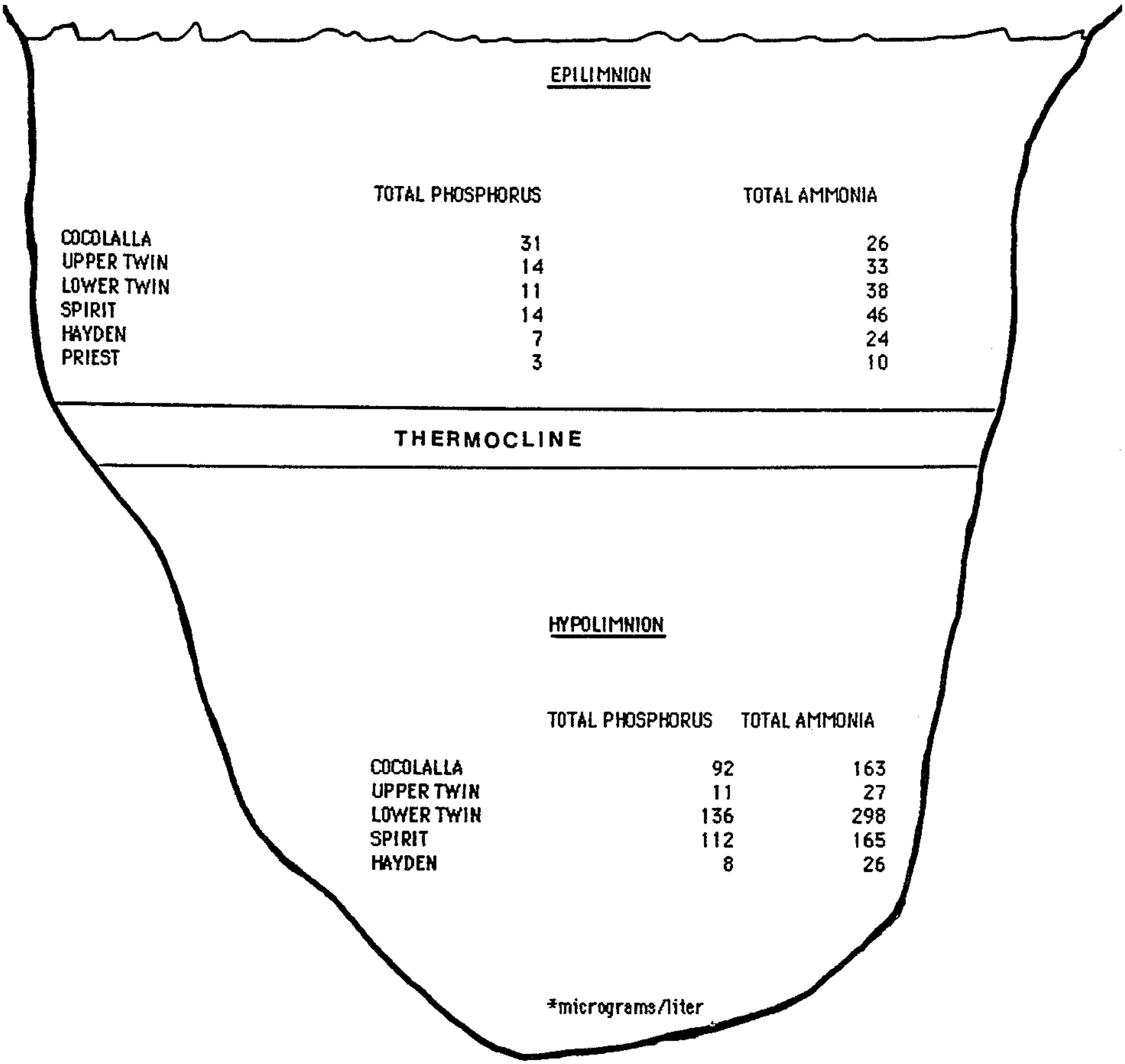


Figure 1   Secchi Disk Transparency Depths for North Idaho Lakes



EPILIMNION

	TOTAL PHOSPHORUS	TOTAL AMMONIA
COCOLALLA	31	26
UPPER TWIN	14	33
LOWER TWIN	11	38
SPIRIT	14	46
HAYDEN	7	24
PRIEST	3	10

HYPOLIMNION

	TOTAL PHOSPHORUS	TOTAL AMMONIA
COCOLALLA	92	163
UPPER TWIN	11	27
LOWER TWIN	136	298
SPIRIT	112	165
HAYDEN	8	26

Figure 2 1988 Averages of Total Phosphorus and Total Ammonia for North Idaho Lakes (*micrograms per liter)

Table 15. Representative Values of Chlorophyll a, Secchi Disk Transparency Depth, and Total Phosphorus for Lake Classifications (Source: Falter and Hallock 1987)

Classification	Chlorophyll a (mg/m^3)	Secchi Depth (m)	Total Phosphorus (ug/l)
From Jones and Lee (1982)			
Oligotrophic	<2.0	>4.6	<7.9
Oligo-mesotrophic	2.1-2.9	4.5-3.8	8-11
Mesotrophic	3.0-6.9	3.7-2.4	12-27
Meso-Eutrophic	7.0-9.9	2.3-1.8	28-39
Eutrophic	>10	<1.7	>40
From OECD (1982)			
Oligotrophic	0.3-4.5	5.4-28.3	3.0-17.7
Mesotrophic	3.0-11	1.5-8.1	10.9-95.6
Eutrophic	2.7-38	0.8-7.0	16.2-386

CONCLUSIONS

The results of the 1988 volunteer monitoring program were similar to those found during 1987 surveys and in previous water quality assessments. There were no glaring inconsistencies or water quality changes beyond what would be expected from natural variability.

The water quality data and information collected by volunteers in 1988 was more consistent and reliable than in 1987. The volunteers made a conscientious effort to properly collect, label, and preserve water quality samples; complete laboratory forms; and deliver the samples in a timely manner.

The CVMP will continue to be a viable lake management tool, especially if we can maintain quality assurance standards, good communications, and program continuity. In 1989, we will focus on quantifying nutrients, water clarity, chlorophyll a, and dissolved oxygen as primary indicators of general water quality. Hopefully, we can learn to tailor the CVMP to meet the individual monitoring needs of a lake or river.

Citizen monitoring programs have also been successfully organized in several other northern tier states, including Minnesota, Wisconsin, Michigan, Illinois, Maine, and New York (U.S. EPA 1988). Idaho's CVMP, however, is more comprehensive than most of these other environmental quality monitoring programs. Volunteer monitoring is not only valuable for developing water quality data bases and as a public education tool, it also has potential for locating sources of nonpoint pollution and directing watershed planning.

ACKNOWLEDGMENTS

The Citizen's Volunteer Monitoring Program would not be a success without the dedicaton and support of a few, conscientious volunteers. They sacrifice their time, energy, and other resources to help monitor our lakes and other water resources. The staff at the Idaho Bureau of Laboratories should also be commended for their spirit and professionalism supporting this volunteer effort.

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APPENDIX A

LOWER TWIN LAKE

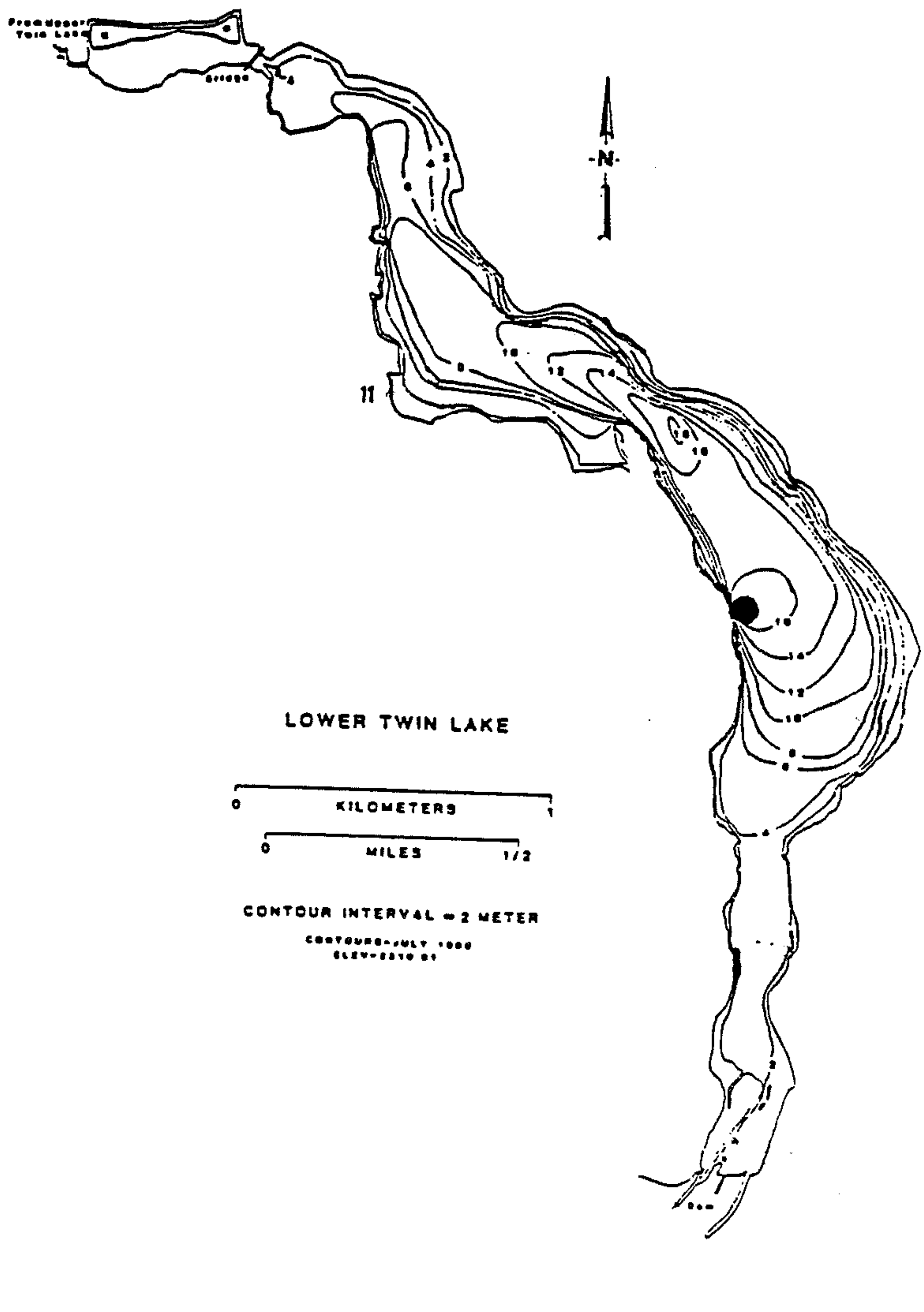

Figure 3 CVMP Water Quality Sampling Site Location for Lower Twin Lake, Idaho

Table 16 Lower Twin Lake CVMP Water Quality Data for 1988

Investigator	CVMP	CVMP	CVMP	CVMP	CVMP	CVMP DEQ DUPE
Date	4/13/88	6/2/88	7/19/88	8/31/88	10/5/88	10/5/88
Deep sample depth (m)	18.1	18.3	17.4	16.9	17.4	17.4
Secchi Disk (m)	3.3	4.8	4.5	5.5	5	5
T. Ammonia as N mg/l (euphotic)	0.078	0.09	0.031	0.011	0.017	0.0015
T. Ammonia as N (deep)	0.067	0.166	0.196	0.364	0.566	0.431
T. NO2+NO3 as N (euphotic)	0.008	0.037	0.007	0.011	0.006	0.002
T. NO2+NO3 as N (deep)	0.004	0.068	0.0005	0.001	0.002	0.002
T.Kjeldahl as N mg/l (euphotic)	0.26	0.24	0.17	0.25	0.3	0.24
T. Kjeldahl as N (deep)	0.23	0.3	0.41	0.74	0.99	0.72
T. Phosphorus as P mg/l (euphotic)	0.01	0.009	0.012	0.01	0.012	0.01
T. Phosphorus as P (deep)	0.012	0.037	0.093	0.216	0.26	0.2
Ortho phosphate as P mg/l (euphotic)	0.002		0.0005	0.002	0.001	0.001
Ortho phosphate as P (deep)	0.002		0.078	0.174	0.22	0.12
Chlorophyll a (ug/l)			1.6		3	2
N : P (euphotic)	26.8 : 1	30.8 : 1	14.8 : 1	26.1 : 1	25.5 : 1	24.2 : 1

Table 17 Lower Twin Lake CVMP Temperature and Dissolved Oxygen Profiles for 1988

Lower Twin Lake Temperature Profile (C)	Depth (m)	4/13/88	6/2/88	7/19/88	8/31/88
	0	9	12.5	21	21
	2	8.5	12	20.5	20.5
	4	8	12	20	20
	6	7	11.5	17.5	20
	8	6	6.5	12	12.5
	10	6	5	8.5	9
	12	6	4.5	8	8
	14	6	4	7.5	8
	16	6	4	7	7
	18	5.5	4	7	7
Lower Twin Lake Dissolved Oxygen Profile (mg/l)	Depth (m)	4/13/88	6/2/88	7/19/88	8/31/88
	0	9.8	10	10.2	8.6
	2	9.8	10	10.2	8.6
	4	9.5	10	10.2	8.6
	6	9.4	9.8	9.8	7.8
	8	9.2	8	6.8	2.6
	10	9	7.2	4.6	1
	12	9	6.4	3.4	0.001
	14	9	6.2	2	0
	16	8.8	6.2	1	0
	18	8.3	3.6	0.4	0

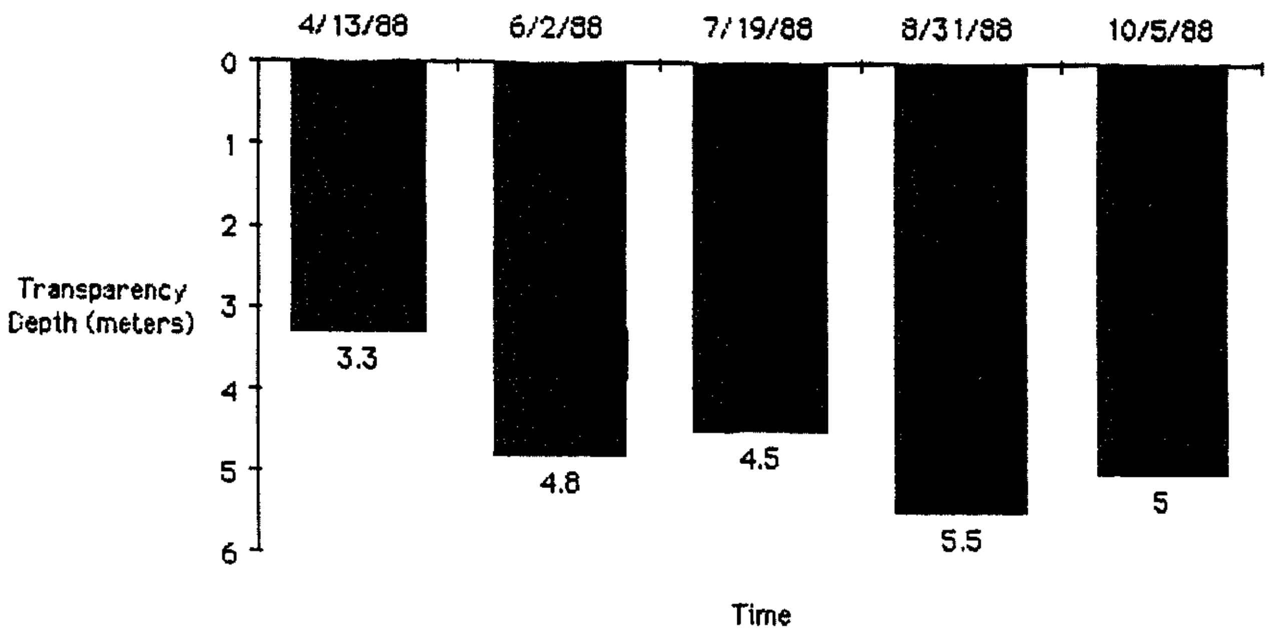

Figure 4 Lower Twin Lake Secchi Disk Transparency Depths for 1988

Table 18 Data Summary of Lower Twin Lake for 1987

Parameters	1987 Averages Secchi	1987 Averages 1m off bottom	Falter's Study Average over May-Oct. 1985 sampling season
Total ammonia as N (mg/l)	0.11	0.72	
Total NO_2 + NO_3 as N (mg/l)	0.03	0.004	
Total Kjeldahl as N (mg/l)	0.38	1.09	0.29
Total phosphorus as P (mg/l)	0.017	0.313	0.012
Ortho phosphate as P (mg/l)	0.004	0.223	
Conductance (umhos/cm):			
field	26	49	
lab.	25	39	23
Hardness as $CaCO_3$ (mg/l)	8	11	
Alkalinity as $CaCO_3$ (mg/l)	10	20	13.8
pH: field	7.4	6.7	6.3-7.3
lab.	6.7-7.1	6.5-7.1	
Chlorophyll a (mg/m^3)	8.65		2.76
Secchi disc (m)	4.8		
Temperature (C)	16.1	9.3	15.6

Comments:

- higher nutrient concentrations at the 1m off bottom level due to anoxic conditions

- results similar to Falter's 1985 study

APPENDIX B

UPPER TWIN LAKE

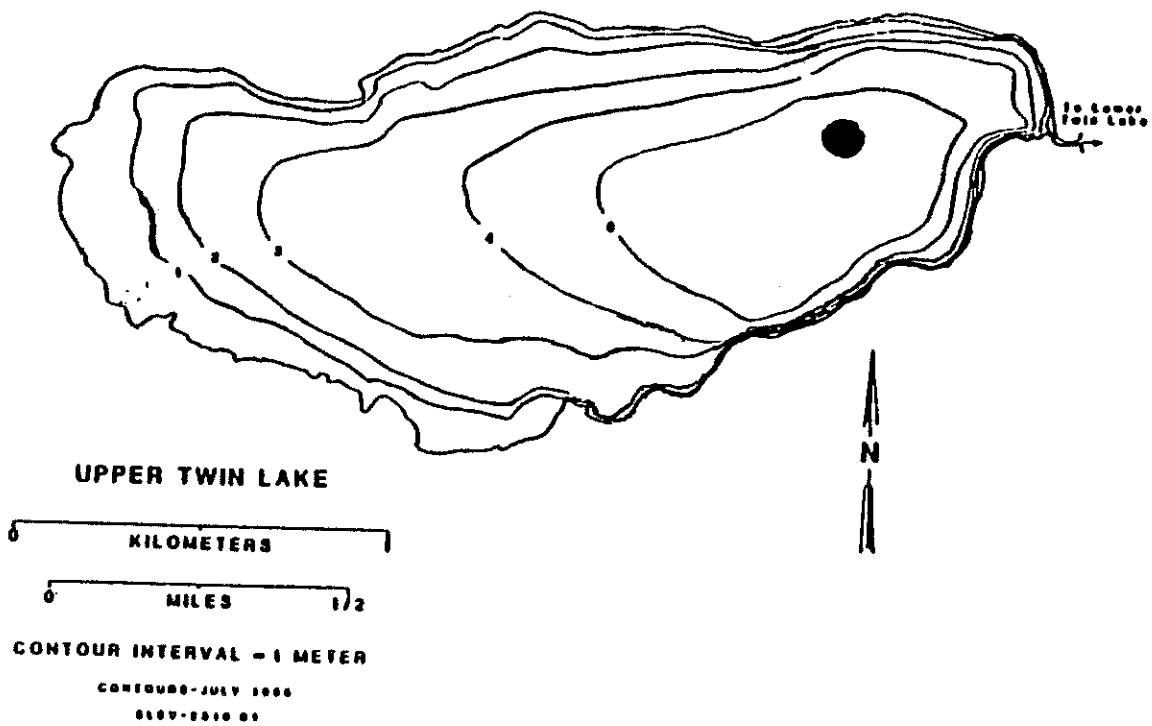

Figure 5 CVMP Water Quality Sampling Site Location for Upper Twin Lake, Idaho.

Table 19 Upper Twin Lake CVMP Water Quality Data for 1988

Investigator	CVMP	CVMP	CVMP	CVMP	CVMP	CVMP DEQ D
Date	4/13/88	6/2/88	7/19/88	8/31/88	10/5/88	10/5/88
Euphotic DVM (m)	2	5	4	3.8	4	4
Deep sample depth (m)	5	4.5	4	3.5	3	3
Secchi Disk (m)	2	5	4	3.8	4	4
T. Ammonia as N mg/l (euphotic)	0.081	0.0005	0.071	0.009	0.011	0.023
T. Ammonia as N (deep)	0.061	0.003	0.037	0.005		
T. NO2+NO3 as N mg/l (euphotic)	0.006	0.0005	0.029	0.003	0.002	0.008
T. NO2+NO3 as N (deep)	0.004	0.0005	0.0005	0.004		
T.Kjeldahl as N mg/l (euphotic)	0.24	0.18	0.22	0.26	0.32	0.27
T. Kjeldahl as N (deep)	0.18	0.18	0.21	0.33		
T. Phosphorus as P mg/l (euphotic)	0.018	0.01	0.017	0.012	0.014	0.014
T. Phosphorus as P (deep)	0.008	0.008	0.014	0.014		
Ortho phosphate as P mg/l (euphotic)	0.0001		0.001	0.001	0.001	0.0005
Ortho phosphate as P (deep)	0.0001		0.0005	0.001		
Chlorophyll a (ug/l)			3	3.1	2	2
N : P (euphotic)	13.7 : 1	18.1 : 1	14.6 : 1	21.9 : 1	23:01	19.9 : 1

Table 20 Upper Twin Lake CVMP Temperature and Dissolved Oxygen Profiles for 1988

Upper Twin Lake Temperature Profile (C)	Depth (m)	4/13/88	6/2/88	7/19/88	8/31/88
	0	8.8	14	22	22
	1	8.8	13.5	22	21.5
	2	7	13.5	22	21.5
	3	6	13	22	21
	4	6	13	20	21
	5	6	13		
Upper Twin Lake Dissolved Oxygen Profile (mg/l)	Depth (m)	4/13/88	6/2/88	7/19/88	8/31/88
	0	9.4	9.4	10.2	8.8
	1	9.5	9.2	10.2	9
	2	9.2	9	10.2	9
	3	8.8	9	10.2	9
	4	8.8	9	10.2	9.1
	5	8.8	9		

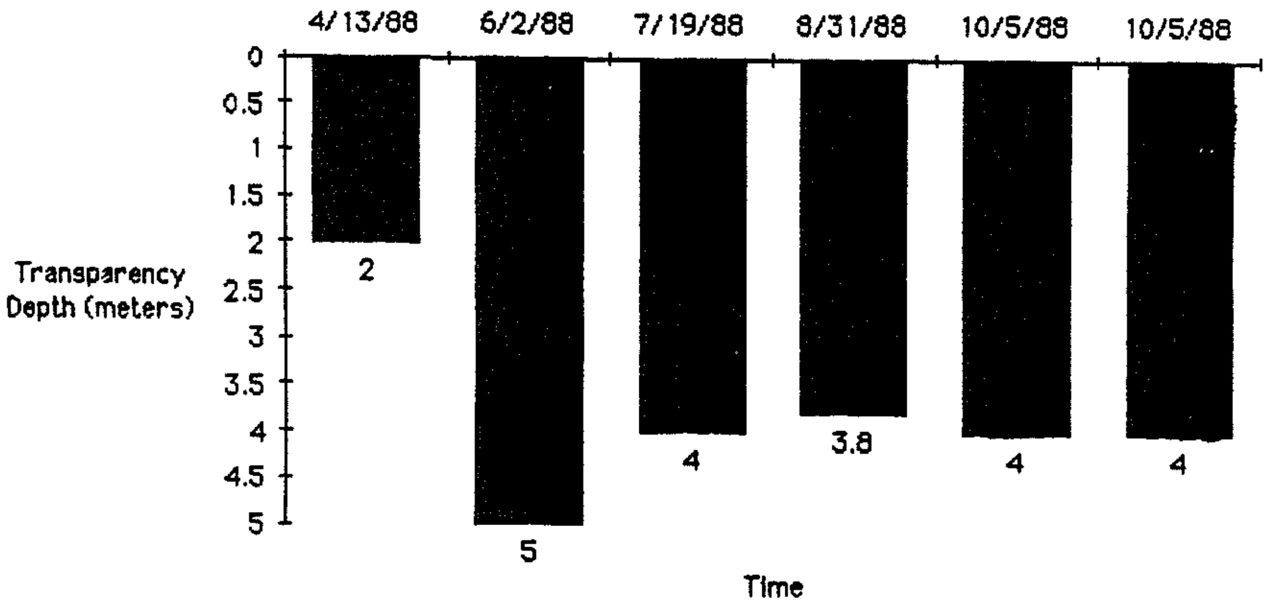

Figure 6 Upper Twin Lake Secchi Disk Transparency Depths for 1988

Table 21 Data Summary of Upper Twin Lake for 1987

Parameters		1987 Averages Secchi	1987 Averages 1m off bottom	Falter's Study Average over May-Oct., 1985 sampling season
Total ammonia as N (mg/l)		0.04	0.06	
Total NO_2 + NO_3 as N (mg/l)		0.025	0.026	
Total Kjeldahl as N (mg/l)		0.35	0.34	0.29
Total phosphorus as P (mg/l)		0.015	0.014	0.021
Ortho phosphate as P (mg/l)		0.002	0.002	
Conductance (umhos/cm):	field	28	28	
	lab.	28	27	23
Hardness as $CaCO_3$ (mg/l)		8	8	
Alkalinity as $CaCO_3$ (mg/l)		12	11	13.8
pH:	field	6.8-7.4	6.8-7.4	6.7-7.7
	lab.	7.0-7.2	7.0-7.3	
Chlorophyll a (mg/m^3)		2.29		2.89
Secchi disc (m)		3.9		
Temperature (C)		15.6	15.6	15.4

Comments:

- continuous mixing indicated by lack of a themocline, average temperature at Secchi depth the same as at 1m off bottom, and nutrient concentrations similar throughout the water column
- low chlorophyll a concentrations indicate that continuous mixing may be inhibiting productivity
- continuous mixing also is preventing nutrients from being released from sediments and adding to production

APPENDIX C

COCOLALLA LAKE

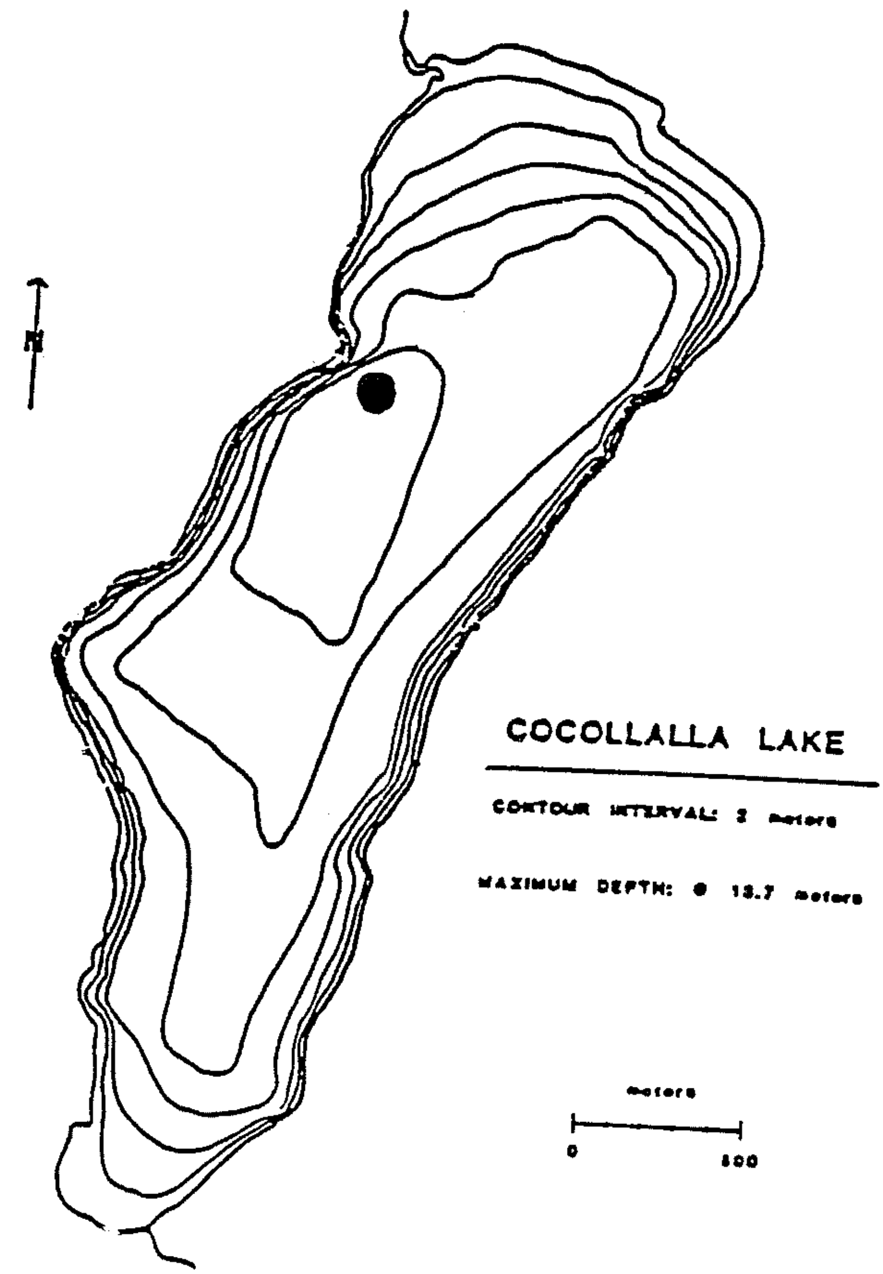

Figure 7 CVMP Water Quality Sampling Site Location for Cocolalla Lake, Idaho.

Table 22 Cocolalla Lake CVMP Water Quality Data for 1988

Investigator	CVMP	CVMP	CVMP	CVMP (DEQ Dupe	CVMP
Date	4/13/88	5/24/88	7/20/88	7/20/88	10/13/88
Deep sample depth (m)	12.75	11.5	10	10	10
Secchi Disk (m)	2.25	2.5	1.25	1.25	1
T. Ammonia as N mg/l (euphotic)	0.024	0.038	0.027	0.026	0.015
T. Ammonia as N (deep)	0.023	0.016	0.206	0.279	0.291
T. NO2+NO3 as N mg/l (euphotic)	0.025	0.008	0.007	0.0005	0.036
T. NO2+NO3 as N (deep)	0.027	0.0005	0.0005	0.005	0.013
T.Kjeldahl as N mg/l (euphotic)	0.42	0.48	0.8	0.72	0.96
T. Kjeldahl as N (deep)	0.55	0.59	0.59	0.61	0.69
T. Phosphorus as P mg/l (euphotic)	0.028	0.029	0.0285	0.028	0.041
T. Phosphorus as P (deep)	0.028	0.054	0.154	0.195	0.027
Ortho phosphate as P mg/l (euphotic)	0.0001	0.0001	0.0001	0.0001	0.0005
Ortho phosphate as P (deep)	0.0001	0.0001	0.106	0.17	0.004
Chlorophyll a (ug/l)			35	38	46
N : P (euphotic)	15.8 : 1	16.8 : 1	28.3 : 1	25.7 : 1	24.3 : 1

Table 23 Cocolalla Lake CVMP Temperature and Dissolved Oxygen Profiles for 1988

Cocolalla Lake Temperature Profile (C)	Depth (m)	4/14/88	5/24/88	9/8/88	10/13/88
	1	8	13	19	15.5
	2	7.5	12.75	19	15.25
	3	7.5	12.5	19	15
	4	7.5	12.5	18.75	15
	5	7.5	11.5	18.75	15
	6	7.25	11.25	18.75	15
	7	7.25	11.5	18.25	15
	8	7.25	11	18	14.75
	9	7.25	10.5	18	14.5
	10	7.25	7.4	18	14.5
	11	7			
Cocolalla Lake Dissolved Oxygen Profile (mg/l)	Depth (m)	4/14/88	5/24/88	9/8/88	10/13/88
	1		12.2	8.8	9.5
	2	11.4	12.2	8.7	9
	3		12.2	8.3	8
	4		12	6.8	6.3
	5		12	6.6	6.2
	6		11.4	6.2	5.9
	7		11.2	4.8	5.8
	8		10.4	3.6	4.7
	9		9.6	1.6	3.9
	10		7.4	1.5	3.2

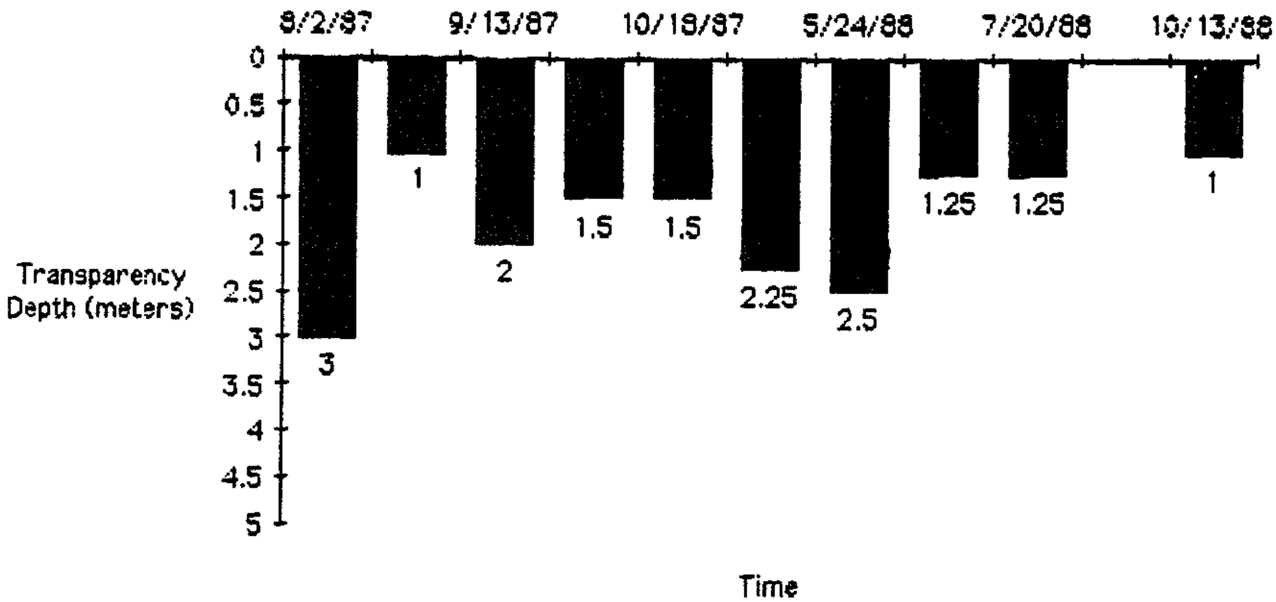

Figure 8 Cocolalla Lake Secchi Disk Transparency Depths for 1988

Table 24 Data Summary of Cocolalla Lake for 1987

Parameters	1987 Averages: Secchi	1987 Averages: 1m off bottom	Falter's Study Average over Apr.-Oct., 1986 season: Epilimnion	Falter's Study Average over Apr.-Oct., 1986 season: Hypolimnion
Total ammonia as N (mg/l)	0.05	0.31		
Total NO_2 + NO_3 as N (mg/l)	0.01	0.02		
Total Kjeldahl as N (mg/l)	0.61	0.81	0.46	0.44
Total phosphorus as P (mg/l)	0.028	0.100	0.019	0.027
Ortho phosphate as P (mg/l)	0.005	0.017		
Conductance (umhos/cm): field	36	39		
lab.	64	67	46	50
Hardness as $CaCO_3$ (mg/l)	25	25		
Alkalinity as $CaCO_3$ (mg/l)	26	30	26	25
pH: field	7.0-8.0	6.9-7.8	7.4-9.0	7.0-7.7
lab.	7.2-7.7	7.0-7.5		
Chlorophyll a (mg/m^3)	12.17		7.69	4.47
Secchi disc (m)	1.8		1.5	
Temperature (C)	16.6	15.3	14.0	9.6

Comments:

- Falter observed stratification, anoxic bottom waters, and subsequent nutrient release from sediments in 1986
- during the August-November sampling period the lake was not stratified (only weak stratification in October)
- bottom waters had low oxygen concentrations but not anoxic and only slightly higher nutrients at the 1m off bottom level
- chlorophyll a was higher (based on five samples) than Falter's 1986 measurements
- other parameters were similar to those in the 1986 study

APPENDIX D

SPIRIT LAKE

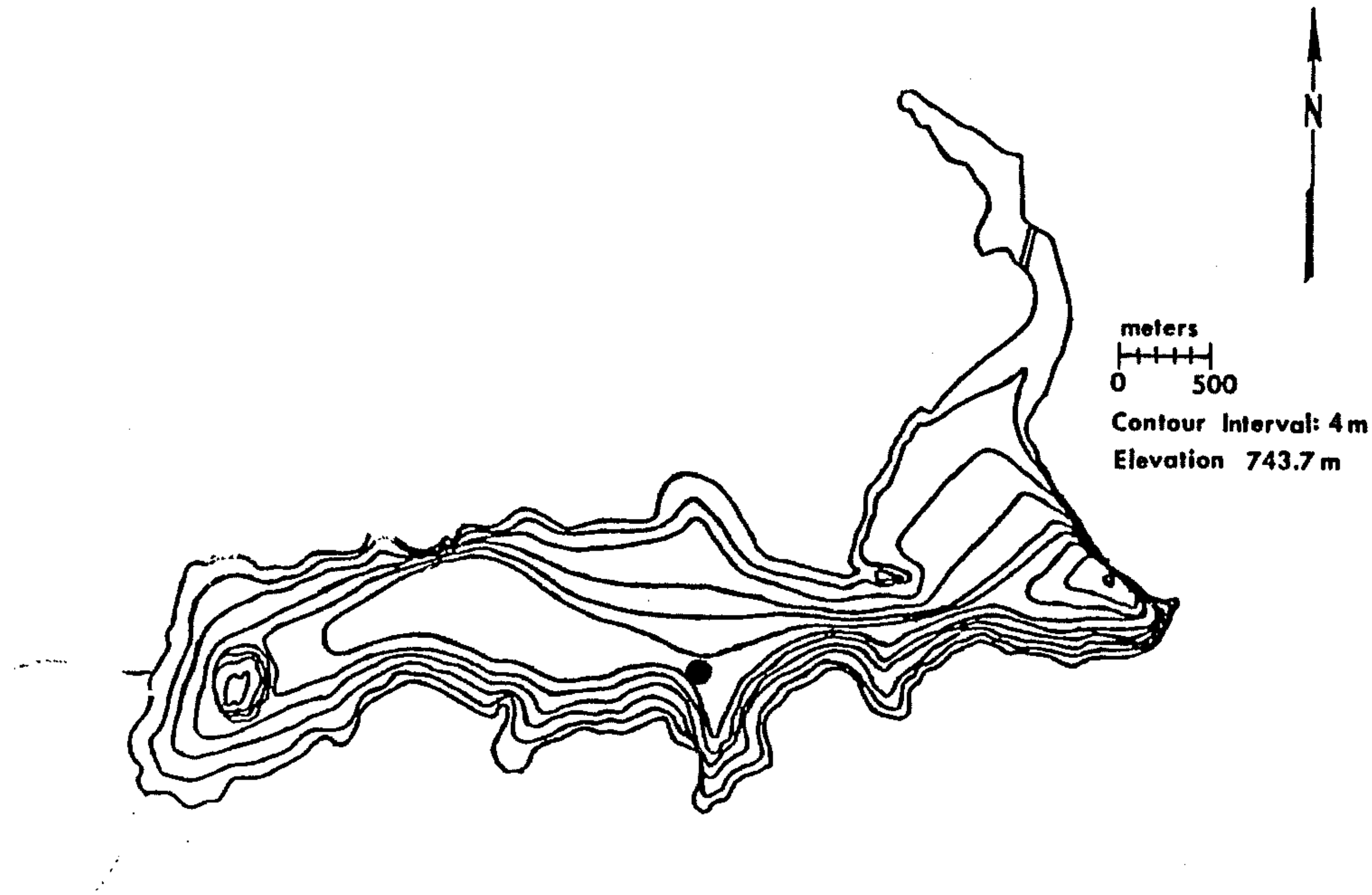

Figure 9 CVMP Water Quality Sampling Site Location for Spirit Lake, Idaho.

Table 25 Spirit Lake CVMP Water Quality Data for 1988

Investigator	CVMP	CVMP	CVMP	CVMP	CVMP	CVMP DEQ DU	CVMP
Date	2/28/88	4/11/88	5/25/88	7/18/88	8/25/88	8/25/88	10/3/88
Deep sample depth (m)	25.1	23.4	21.25	23	22.8	22.8	21.7
Secchi Disk (m)	3.5	3.35	4.2	5.6	6.67	6.6	5.26
T. Ammonia as N mg/l (euphotic)	.025	.068	.026	.025	.031	.005	.140
T. Ammonia as N mg/l (deep)	.426	.060	.029	.143	.209	.085	.206
T. NO2+NO3 as N mg/l (euphotic)	.032	.012	.037	.013	.015	.011	.070
T. NO2+NO3 as N mg/l (deep)	.016	.008	.057	.055	.001	.001	.019
T.Kjeldahl as N mg/l (euphotic)	.310	.320	.240	.190	.210	.150	.200
T. Kjeldahl as N mg/l (deep)	2.430	.260	.270	.350	.450	.290	.480
T. Phosphorus as P mg/l (euphotic)	.021	.019	.016	.012	.008	.010	.010
T. Phosphorus as P mg/l (deep)	.260	.025	.019	.089	.160	.092	.136
Ortho phosphate as P mg/l (euphotic)	.001	.001	.001	.001			.001
Ortho phosphate as P mg/l (deep)	.100	.001	.001	.080			.116
Chlorophyll a (ug/l)				1.4	1.4	1.2	2.3
N : P (euphotic)	16.3 : 1	17.5 : 1	17.3 : 1	16.9 : 1	28.1 : 1	16.0 : 1	27.0 : 1

Table 26 Spirit Lake CVMP Temperature and Dissolved Oxygen Profiles for 1988

Spirit Lake Temperature Profile (C)	Depth (m)	2/8/88	4/11/88	5/25/88	7/18/88	10/3/88	10/17/88
	2	3.5	6	12.5	19	15	14
	4		5.9	12.5	18.8	14.75	14
	6	3.5	5.8	10		14.5	14
	8	3.5	5.4	9	12	14.2	14
	10	3.5	5.2	5.5	9.5	14	14
	12	3.5	5.2	4.5		8	10
	14	4	5.2		7	6.9	7
	16		5.2	4		6.2	6.5
	18		5.2		6	6	6
	20		5.1	3.5	6	6	6
	22		5.1	3.5	6		6
	24	5	5.1				
	26						
	28						
	30						
Spirit Lake Dissolved Oxygen Profile (mg/l)	Depth (m)	2/8/88	4/11/88	5/25/88	7/18/88	10/3/88	10/17/88
	2	10.4	13.6	11.8	10.1	10.2	6.3
	4		13.6	11		10.2	6.2
	6	10.8	13.4	11.2	9.2	10	6.1
	8		13.2	11	8.1	8.6	5.9
	10	10.5	13.2	10		4.75	4.7
	12	10.6	13	9	6.9	2.2	1.8
	14		13	9	3.1	0.75	0
	16	7.2	13	9		0	0
	18		12.7		1.3	0	0
	20		12.7	8.5		0	0
	22		9.8	8.5	0.2	0	0
	24		7.6		0.2		0
	26						
	28						
	30						

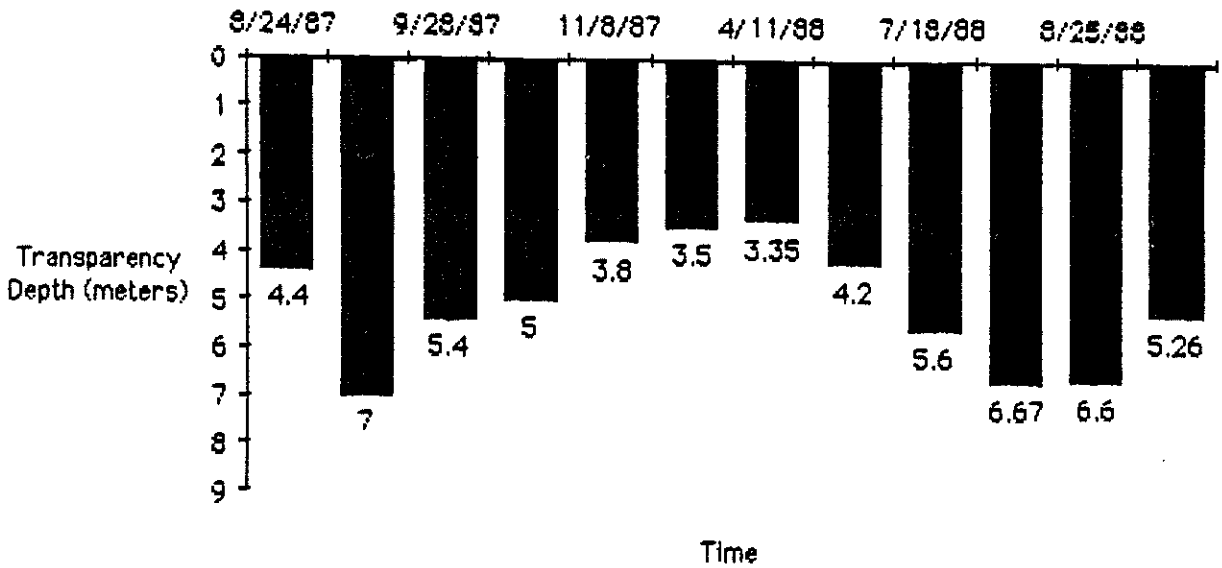

Figure 10 Spirit Lake Secchi Disk Transparency Depths for 1988

Table 27 Data Summary of Spirit Lake for 1987

Parameters	1987 Averages Secchi	1987 Averages 1m off bottom	Soltero's Study Water column average over Apr.- Nov., 1984
Total ammonia as N (mg/l)	0.04	0.25	0.03
Total NO_2 + NO_3 as N (mg/l)	0.03	0.08	0.03
Total Kjeldahl as N (mg/l)	0.24	0.48	0.36
Total phosphorus as P (mg/l)	0.014	0.160	0.13
Ortho phosphate as P (mg/l)	0.002	0.096	0.09
Conductance (umhos/cm):			
field	51	54	
lab.	22	26	23
Hardness as $CaCO_3$ (mg/l)	8	8	5.5
Alkalinity as $CaCO_3$ (mg/l)	9	11	19
pH: field	7.3-8.4	6.4-6.8	4.8-7.4
lab.	6.8-7.2	6.4-6.9	
Chlorophyll a (mg/m^3)	4.23		4.84
Secchi disc (m)	5.1		4.7
Temperature (C)	15.7	7.8	9.6

Comments:

- high nutrient concentrations at the 1m off bottom level indicates oxygen depletion -- dissolved oxygen profiles confirmed this
- all parameters compared closely to Soltero's 1984 study
- Soltero concluded that nitrogen was the limiting factor to algal growth -- the nitrogen contribution from sediments during DO depletion undoubtedly promotes algal growth

APPENDIX E

HAYDEN LAKE

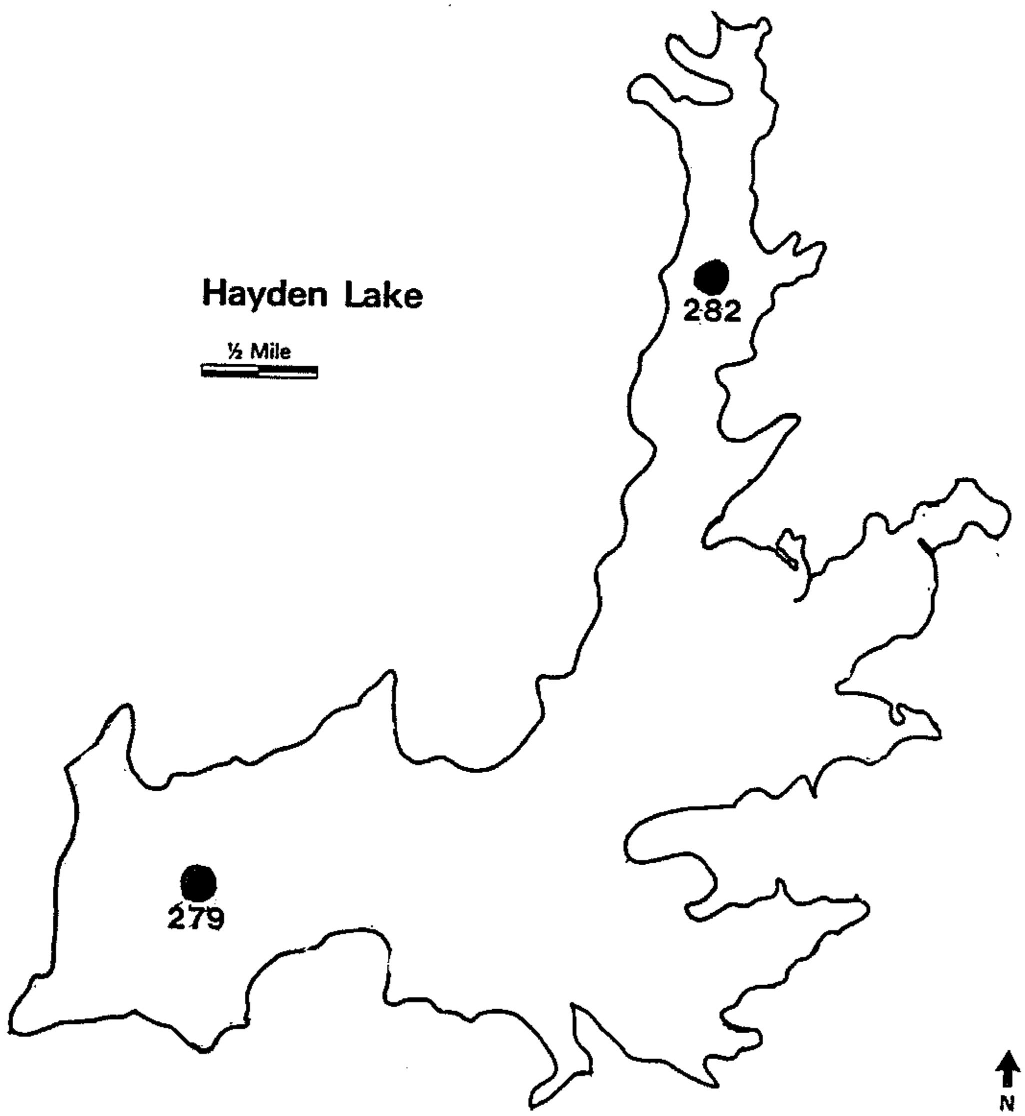

Figure 11 CVMP Water Quality Sampling Site Locations for Hayden Lake, Idaho.

Table 28 Hayden Lake Sampling Site 279 CVMP Water Quality Data for 1988

Investigator	CVMP	CVMP	CVMP	DEQ DUPE	CVMP
Date	5/25/88	7/20/88	8/29/88	8/29/88	10/3/88
Deep sample depth (m)	49	50	49.5	49.5	49
Secchi Disk (m)	5.5	10	11	11	10
T. Ammonia as N mg/l (euphotic)	0.001	0.089	0.012	0.0005	0.017
T. Ammonia as N (deep)	0.013	0.022	0.07	0.009	0.015
T. NO2+NO3 as N mg/l (euphotic)	0.003	0.008	0.004	0.008	0.016
T. NO2+NO3 as N (deep)	0.023	0.021	0.071	0.015	0.111
T.Kjeldahl as N mg/l (euphotic)	0.19	0.19	0.24	0.12	0.14
T. Kjeldahl as N (deep)	0.14	0.14	0.17	0.12	0.13
T. Phosphorus as P mg/l (euphotic)	0.012	0.009	0.006	0.005	0.003
T. Phosphorus as P (deep)	0.009	0.006	0.01	0.006	0.009
Ortho phosphate as P mg/l (euphotic)	0.001	0.001	0.001	0.001	0.0005
Ortho phosphate as P (deep)	0.001	0.002	0.004	0.001	0.006
Chlorophyll a ug/l		1.4	1	0.7	1
N : P (euphotic)	16.1 :1	22.0 :1	40.1 :1	25.6 :1	10.0 : 1

Table 29 Hayden Lake Sampling Site 279 CVMP Temperature and Dissolved Oxygen Profiles for 1988

Hayden Lake 279 Temperature Profile (C)	Depth (m)	5/25/88	7/20/88	8/29/88
	1	13	20.5	22
	5	11	20.2	22
	10	9.2	13.4	21
	15	5	8	9.5
	20	3.5	5.2	5.9
	25	3	5	4.9
	30	3	5	4.5
	35	3	4.9	4.3
	40	2.7	4.7	4.2
	45	2.5	4.6	4.2
	50		4.4	
Hayden Lake 279 Dissolved Oxygen Profile (mg/l)	Depth (m)	5/25/88	7/20/88	8/29/88
	1	12.6	9.8	8.7
	5	13.6	9.5	8.6
	10	14	12.8	8.8
	15	15.6	13.6	12.8
	20	15.4	11.4	11.2
	25	15	11.2	9.8
	30	15	10.8	9.6
	35	15.2	10.9	9.4
	40	16	10.4	9.3
	45	17	10.2	9.4
	50		9.8	6.4

Table 30 Hayden Lake Sampling Site 282 CVMP Water Quality Data for 1988

Investigator	CVMP	CVMP DEQ Dupe	CVMP
Date	8/29/88	8/29/88	10/3/88
Deep sample depth (m)	1	1	1
Secchi Disk (m)	1	1	1
T. Ammonia as N mg/l (euphotic)	0.014	0.012	0.017
T. NO2+NO3 as N mg/l (euphotic)	0.0005	0.004	0.011
T.Kjeldahl as N mg/l (euphotic)	0.87	0.81	0.32
T. Phosphorus as P mg/l (euphotic)	0.035	0.03	0.015
Ortho phosphate as P mg/l (euphotic)	0.001	0.001	0.005
Chlorophyll a (ug/l)	19.6	18.6	3.9
N : P	24.8 : 1	27.1 : 1	22.1 : 1

Figure 12 Hayden Lake Secchi Disk Tranparency Depths for 1988

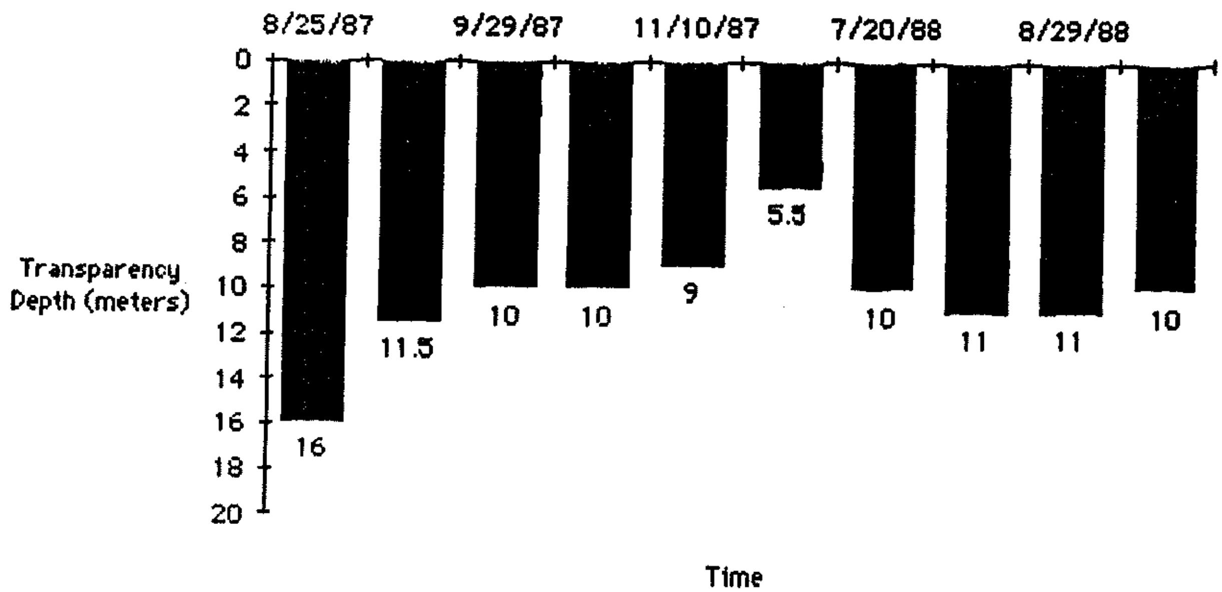

Table 31 Data Summary of Hayden Lake for 1987

Parameters	1987 Averages Secchi	1987 Averages 1m off bottom	Soltero's Study Water column average over Apr.-Nov. 1985 sampling season
Total ammonia as N (mg/l)	0.03	0.04	0.01
Total $NO_2 + NO_3$ as N (mg/l)	0.014	0.072	0.031
Total Kjeldahl as N (mg/l)	0.20	0.17	0.34
Total phosphorus as P (mg/l)	0.009	0.016	0.02
Ortho phosphate as P (mg/l)	0.002	0.004	0.01
Conductance (umhos/cm):			
field	68	62	
lab.	57	56	50
Hardness as $CaCO_3$ (mg/l)	25.6	23.2	23.0
Alkalinity as $CaCO_3$ (mg/l)	26.6	26.2	53.0
pH: field	8.4-9.4	6.8-8.4	5.6-8.2
lab.	7.1-8.1	6.7-7.5	
Chlorophyll a (mg/m^3)	5.14		2.10
Secchi disc (m)	11.3		7.3
Temperature (C)	13.6	7.3	8.3

Comments:

- results at this site are very similar to those at the shallower 281 site
- no oxygen deficit -- 6 mg/l O_2 at the bottom indicates some oxygen consumption but far from a problem
- low nutrient concentration throughout the water column and no contribution from sediments due to high oxygen concentrations in bottom waters
- results for most parameters similar to Soltero's 1985 findings

APPENDIX F

PRIEST LAKE

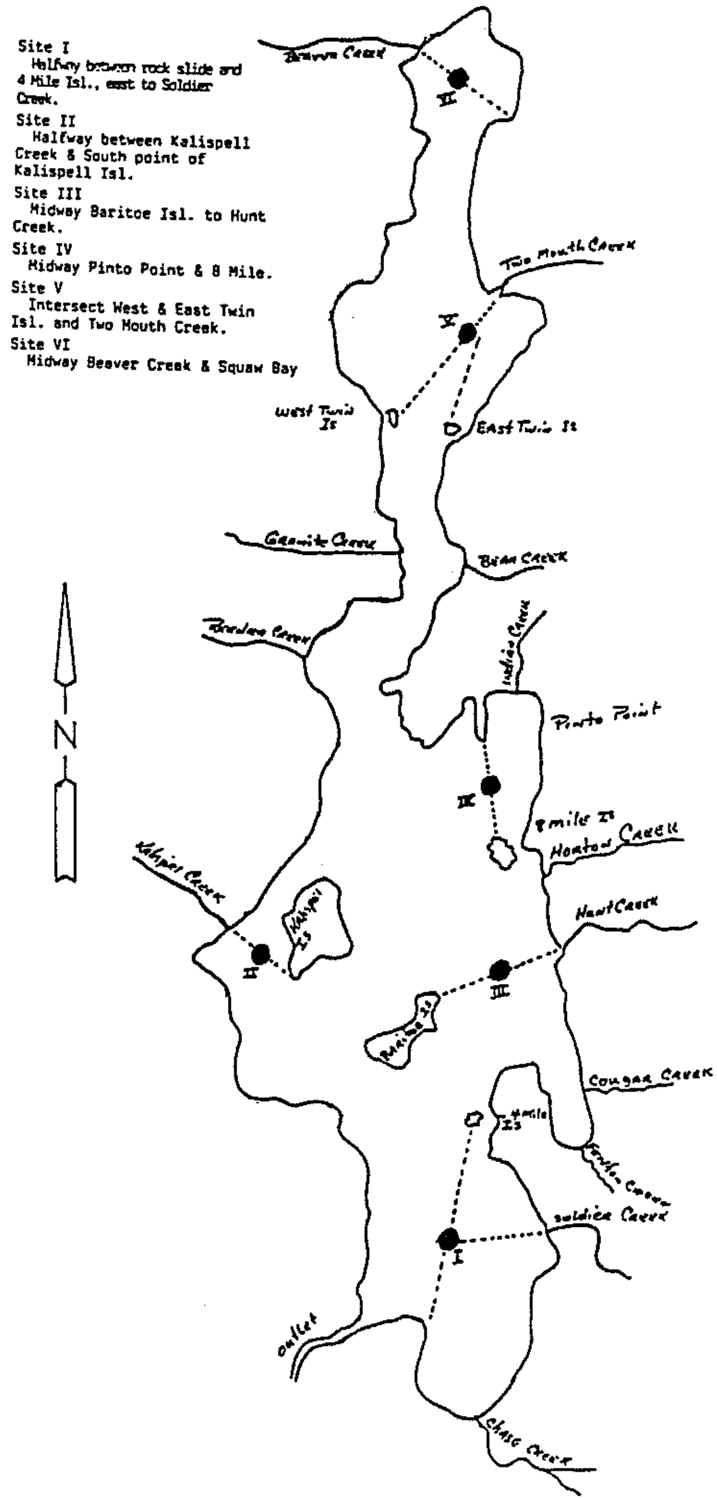

Figure 13 CVMP Water Quality Sampling Site Locations for Priest Lake, Idaho.

Table 32 Priest Lake CVMP Water Quality Data for 1988

Priest Lake						
CVMP 1988						
Coolin Bay (Site I)			DEQ DUPE			
DATE	8/24/88	10/5/88	10/5/88	1988 Minimim	1988 Maximum	1988 Average
SECCHI DEPTH (M)	11	11	11	11	11	11
TEMPERATURE (F)@ Secchi Depth	68			68	68	68
TOTAL AMMONIA AS N (MG/L)	0.048	0.014	0.02	0.014	0.048	0.027
TOTAL NO2+NO3 AS N (MG/L)	0.038	0.004	0.004	0.004	0.038	0.015
TOTAL KJELDAHL NITROGEN AS N(MG/L)	0.07	0.08	0.08	0.070	0.080	0.077
TOTAL PHOSPHORUS AS P (MG/L)	0.003	0.003	0.004	0.003	0.004	0.003
N : P	36.0 : 1	28.0 : 1	21.0 : 1			
Priest Lake						
CVMP 1988						
Kalispell Creek (Site II)			DEQ DUPE			
DATE	8/24/88	10/5/88	10/5/88	1988 Minimum	1988 Maximum	1988 Average
SECCHI DEPTH (M)	12	11.2	11	11	12	11.4
TEMPERATURE (F)@ Secchi Depth	62			62	62	62
TOTAL AMMONIA AS N (MG/L)	0.028	0.0015	0.0015	0.002	0.028	0.010
TOTAL NO2+NO3 AS N (MG/L)	0.087	0.002	0.002	0.002	0.087	0.030
TOTAL KJELDAHL NITROGEN AS N(MG/L)	0.13	0.07	0.09	0.070	0.130	0.097
TOTAL PHOSPHORUS AS P (MG/L)	0.002	0.004	0.004	0.002	0.004	0.003
N : P	108.5 : 1	18.0 : 1	23.0 : 1			

Table 33 Priest Lake CVMP Water Quality Data for 1988

Priest Lake						
CVMP 1988						
Hunt Creek (Site III)			DEQ DUPE			
DATE	8/24/88	10/5/88	10/5/88	1988 Minimum	1988 Maximum	1988 Average
SECCHI DEPTH (M)	11	11.2	11	11	11	11
TEMPERATURE (F)@ Secchi Depth	66			66	66	66
TOTAL AMMONIA AS N (MG/L)	0.011	0.009	0.0015	0.002	0.011	0.007
TOTAL NO2+NO3 AS N (MG/L)	0.012	0.002	0.002	0.002	0.012	0.005
TOTAL KJELDAHL NITROGEN AS N(MG/L)	0.11	0.12	0.13	0.110	0.130	0.120
TOTAL PHOSPHORUS AS P (MG/L)	0.002	0.002	0.003	0.002	0.003	0.002
N : P	61.0 : 1	61.0 : 1	44.0 : 1			
Priest Lake						
CVMP 1988						
Indian Creek (Site IV)			DEQ DUPE			
DATE	8/24/88	10/5/88	10/5/88	1988 Minimum	1988 Maximum	1988 Average
SECCHI DEPTH (M)	12	11.2	11	11	12	11.4
TEMPERATURE (F)@ Secchi Depth	62			62	62	62
TOTAL AMMONIA AS N (MG/L)	0.009	0.006	0.0015	.002	.009	.006
TOTAL NO2+NO3 AS N (MG/L)	0.02	0.002	0.002	.002	.020	.008
TOTAL KJELDAHL NITROGEN AS N(MG/L)	0.16	0.08	0.08	.080	.160	.107
TOTAL PHOSPHORUS AS P (MG/L)	0.002	0.002	0.005	.002	.005	.003
N : P	90.0 : 1	41.0 : 1	16.4 : 1			

Table 34 Priest Lake CVMP Water Quality Data for 1988

Priest Lake						
CVMP 1988						
Huckleberry Bay (Site V)			DEQ DUPE			
DATE	8/24/88	10/5/88	10/5/88	1988 Minimum	1988 Maximum	1988 Average
SECCHI DEPTH (M)	12	11	11	11	12	11.3
TEMPERATURE (F)@ Secchi Depth	60			60	60	60
TOTAL AMMONIA AS N (MG/L)	0.009	0.006	0.0015	.002	.009	.006
TOTAL NO2+NO3 AS N (MG/L)	0.01	0.002	0.002	.002	.010	.005
TOTAL KJELDAHL NITROGEN AS N(MG/L)	0.12	0.09	0.08	.080	.120	.097
TOTAL PHOSPHORUS AS P (MG/L)	0.003	0.004	0.005	.003	.005	.004
N : P	43.3 : 1	23.0 : 1	16.4 : 1			
Priest Lake						
CVMP 1988						
Mosquito Bay (Site VI)			DEQ DUPE			
DATE	8/24/88	10/5/88	10/5/88	1988 Minimum	1988 Maximum	1988 Average
SECCHI DEPTH (M)	11	11	11	11	11	11
TEMPERATURE (F)@ Secchi Depth	64			64	64	64
TOTAL AMMONIA AS N (MG/L)	0.005	0.00015	0.0015	.000	.005	.002
TOTAL NO2+NO3 AS N (MG/L)	0.016	0.002	0.002	.002	.016	.007
TOTAL KJELDAHL NITROGEN AS N(MG/L)	0.08	0.06	0.05	.050	.080	.063
TOTAL PHOSPHORUS AS P (MG/L)	0.002	0.004	0.002	.002	.004	.003
N : P	48.0 : 1	15.5 : 1	26.0 : 1			

Table 35 Priest Lake Secchi Disk Transparency Depths

	August 17-30, 1987	September 3-12, 1987	September 17-24,1987
SITE 13 A (Mosquito Bay)	7.9	10.2	11.9
SITE14 A (Tango Creek)	14.6		
SITE 12 A (Two Mouth Creek)	12.2	12.8	13.7
SITE 11 C (Huckleberry Bay)	10.6		11.5
SITE 15 A (Copper Bay)	10.3	11.2	11.2
SITE 16 A (Reeder Creek)	13.7	14.3	14.3
SITE 10 A (Cape Horn)	11.1	10.9	11.9
SITE 9 A (Indian Creek Bay)	11	12.2	15.2
SITE 17 A (Indian Rock)	11.4	12.3	13.8
SITE 18 A (Kalispell Island)	11.3	13.6	12.7
SITE 7 A (Hunt Creek)	12.2	13.4	
SITE 19 C (Baritoe Island)	10.4		13.6
SITE 6 A (Fenton Creek)	8.7		11.7
SITE 5 A (4 mile Island)	12.1	12.4	13.9
SITE 4 A (Outlet Bay)	11.8	12.7	12.2
SITE 2 A (Soldier Creek)	10	12.1	
SITE 3 A (Mid-lake, Soldier to Outlet)	11.2	10	
SITE 1 A (Coolin Bay)	11.5	11.5	
* in meters			

Table 36 Priest Lake Secchi Disk Transparency Depths

	September 24- October 3, 1987	May 9-June 2,1988	June 5-16,1988
SITE 13 A (Mosquito Bay)		7.3	6.4
SITE14 A (Tango Creek)			6.3
SITE 12 A (Two Mouth Creek)			6.1
SITE 11 C (Huckleberry Bay)	11.9		6.1
SITE 15 A (Copper Bay)		5.6	
SITE 16 A (Reeder Creek)			7.3
SITE 10 A (Cape Horn)		5.9	6.1
SITE 9 A (Indian Creek Bay)	14.6	7.3	6.4
SITE 17 A (Indian Rock)	14.7		6.6
SITE 18 A (Kalispell Island)			6.7
SITE 7 A (Hunt Creek)	13.4		
SITE 19 C (Bartoe Island)	12	6.6	9.7
SITE 6 A (Fenton Creek)	13.5		7.2
SITE 5 A (4 mile Island)			
SITE 4 A (Outlet Bay)			7.2
SITE 2 A (Soldier Creek)	12.2	5.4	7.3
SITE 3 A (Mid-lake, Soldier to Outlet)	11.9	8.2	9.1
SITE 1 A (Coolin Bay)		7.3	9.1
* in meters			

Table 37 Priest Lake Secchi Disk Transparency Depths

	June 21 - July 4,1988	July 6-9,1988	July 15-31, 1988	August 4-15,1988
SITE 13 A (Mosquito Bay)	7.3	7.3	9.2	9.7
SITE14 A (Tango Creek)	6.4	7.3	7.3	9.1
SITE 12 A (Two Mouth Creek)	7.3	8.5		
SITE 11 C (Huckleberry Bay)	5.5	6.7		8.2
SITE 15 A (Copper Bay)			7.3	11.2
SITE 16 A (Reeder Creek)	6.4		9.1	
SITE 10 A (Cape Horn)	5.7	5.6	11.4	
SITE 9 A (Indian Creek Bay)	8.2	7.3	9.1	10.3
SITE 17 A (Indian Rock)	7.3		10.6	
SITE 18 A (Kalispell Island)	5.9	8.2	9.1	10
SITE 7 A (Hunt Creek)	6.9	9.1	10	
SITE 19 C (Baritoe Island)	7.9	8.5	8.8	11.2
SITE 6 A (Fenton Creek)	6.4	7.3	10	11.7
SITE 5 A (4 mile Island)	7.3	8.5	9.9	10.5
SITE 4 A (Outlet Bay)	7.9		11.6	13.1
SITE 2 A (Soldier Creek)	7.3	7.6	8.2	10.3
SITE 3 A (Mid-lake, Soldier to Outlet)	7.3		9.7	10
SITE 1 A (Coolin Bay)			10.9	
* in meters				

Table 38 Priest Lake Secchi Disk Transparency Depths

	August 22-31,1988	September 2-3,1988	September 7-13,1988
SITE 13 A (Mosquito Bay)	11.9	11.2	11.2
SITE14 A (Tango Creek)	10.3		9.4
SITE 12 A (Two Mouth Creek)			
SITE 11 C (Huckleberry Bay)	8.5		8.9
SITE 15 A (Copper Bay)	8.8		10.2
SITE 16 A (Reeder Creek)			
SITE 10 A (Cape Horn)			9.1
SITE 9 A (Indian Creek Bay)	12.2		12.2
SITE 17 A (Indian Rock)	11.4	13.1	
SITE 18 A (Kalispell Island)	12.7		10.9
SITE 7 A (Hunt Creek)	10.9	10.9	
SITE 19 C (Baritoe Island)	12.5		12.2
SITE 6 A (Fenton Creek)	9.1	12.8	11.2
SITE 5 A (4 mile Island)	12.1		11.7
SITE 4 A (Outlet Bay)	10		13.7
SITE 2 A (Soldier Creek)	10		12.2
SITE 3 A (Mid-lake, Soldier to Outlet)	10		11.2
SITE 1 A (Coolin Bay)	9.7		10.9
* In meters			

Table 39 Priest Lake Secchi Disk Transparency Depths

	September 22-October 3, 1988
SITE 13 A (Mosquito Bay)	10.9
SITE14 A (Tango Creek)	9.4
SITE 12 A (Two Mouth Creek)	
SITE 11 C (Huckleberry Bay)	10
SITE 15 A (Copper Bay)	10
SITE 16 A (Reeder Creek)	
SITE 10 A (Cape Horn)	
SITE 9 A (Indian Creek Bay)	13.7
SITE 17 A (Indian Rock)	
SITE 18 A (Kalispell Island)	13.6
SITE 7 A (Hunt Creek)	12.8
SITE 19 C (Baritoe Island)	10.3
SITE 6 A (Fenton Creek)	
SITE 5 A (4 mile Island)	
SITE 4 A (Outlet Bay)	10.9
SITE 2 A (Soldier Creek)	9.4
SITE 3 A (Mid-lake, Soldier to Outlet)	11.9
SITE 1 A (Coolin Bay)	
* in meters	

APPENDIX G

SPOKANE RIVER

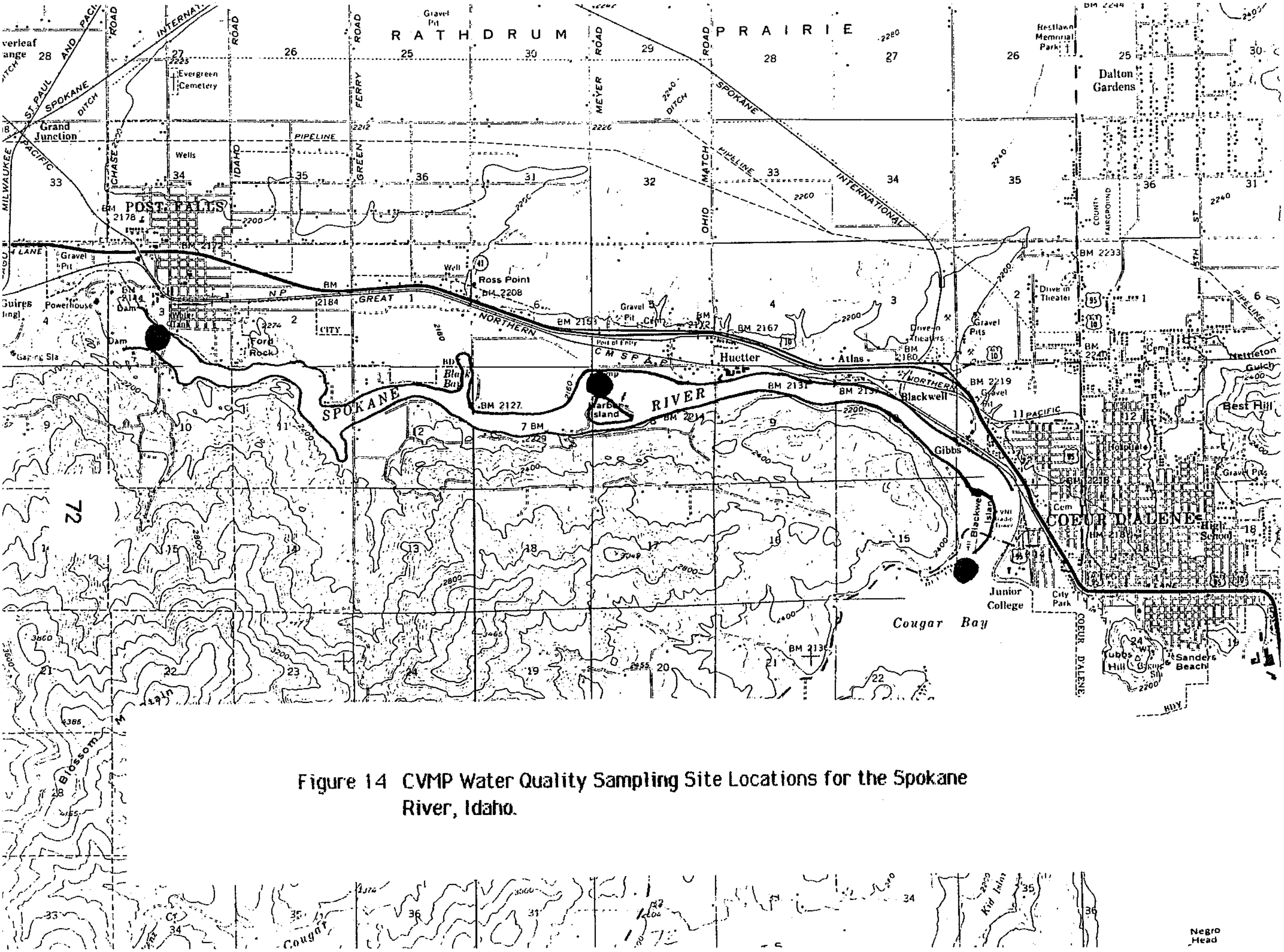

Figure 14 CVMP Water Quality Sampling Site Locations for the Spokane River, Idaho.

Table 40 Spokane River CVMP Water Quality Data for 1988

SPOKANE RIVER							
CVMP 1988						DEQ DUPE	
CEDARS SITE							
DATE	5/25/88	6/27/88	7/19/88	8/23/88	9/27/88	9/27/88	10/18/88
TIME	1100	1100	930	1000	1000	1000	1000
MAXIMUM DEPTH (M)	2.75	2.75	2.75	2.6	2.5	2.5	
SECCHI DEPTH (M)	2.75	2.75	2.75	2.6	2.5	2.5	
TEMPERATURE (C)@ 1M DEPTH	13.3	20	21	20	16	16	
TEMPERATURE (C)@ 1M OFF BOTTOM	12.2	21	20	20	16	16	
DISSOLVED OXYGEN (MG/L)@ 1M	12	4	8	7	9	9	
DISSOLVED OXYGEN (MG/L)@ 1M OFF BOTTOM	12	4	8	8	7	7	
TOTAL AMMONIA (MG/L)	0.013	0.014	0.05	0.007	0.018	0.021	0.007
TOTAL NO2+NO3 (MG/L)	0.014	0.008	0.018	0.02	0.02	0.016	0.012
TOTAL KJELDAHL (MG/L)	0.11	0.13	0.05	0.09	0.12	0.11	0.13
TOTAL PHOSPHORUS (MG/L)	0.011	0.009	0.008	0.009	0.007	0.008	0.008
ORTHOPHOSPHORUS (MG/L)		0.001	0.001	0.002	0.002	0.002	0.001
SPECIFIC CONDUCTANCE (UMHOS)	52	45	48	51	51	53	54
CHLOROPHYLL a (UG/L)		1.1	1.1	1.7	1	1	0.7
ZINC (UG/L)	90	220	60	30	59		50
N : P	11.3 : 1	15.3 : 1	8.5 : 1	12.2 : 1	20.0 : 1	15.8 : 1	17.8 : 1

Table 41 Spokane River CVMP Water Quality Data for 1988

SPOKANE RIVER							
CVMP 1988						DEQ DUPE	
HARBOR ISLAND							
DATE	5/25/88	6/27/88	7/19/88	8/23/88	9/27/88	9/27/88	10/18/88
TIME	1300	1200	1100	1030	1140	1140	
MAXIMUM DEPTH (M)	5.75	5.75	5.75	5.8	5.8	5.8	
SECCHI DEPTH (M)	3.25	3.75	3.25	2.75	4.5	4.5	
TEMPERATURE (C)@ 1M DEPTH	13.3	20	21	21	15	15	
TEMPERATURE (C)@ 1M OFF BOTTOM	13.3	21	21	21	15	15	
DISSOLVED OXYGEN (MG/L)@ 1M	12	9	9	4	8	8	
DISSOLVED OXYGEN (MG/L)@ 1M OFF BOTTOM	12	9	6	8	9	9	
TOTAL AMMONIA (MG/L)	0.011	0.027	0.045	0.026	0.053	0.045	0.024
TOTAL NO2+NO3 (MG/L)	0.019	0.017	0.009	0.027	0.036	0.027	0.025
TOTAL KJELDAHL (MG/L)	0.14	0.13	0.12	0.19	0.17	0.14	0.13
TOTAL PHOSPHORUS (MG/L)	0.014	0.017	0.018	0.037	0.029	0.027	0.02
ORTHOPHOSPHORUS (MG/L)	0.001	0.007	0.003	0.022	0.017	0.018	0.013
SPECIFIC CONDUCTANCE (UMHOS)	50	46	50	55	53	53	56
CHLOROPHYLL a (UG/L)		1.6	1.7	6.5	0.8	1	0.6
ZINC	70	140	60	30	55		50
FECAL COLIFORM (*/100 ML)			10		10		
N : P	11.3 : 1	8.6 : 1	7.2 : 1	5.9 : 1	7.1 : 1	6.2 : 1	7.8 : 1

Table 42 Spokane River CVMP Water Quality Data for 1988

SPOKANE RIVER							
CVMP 1988						DEQ DUPE	
POST FALLS BRIDGE							
DATE	5/25/88	6/27/88	7/19/88	8/23/88	9/27/88	9/27/88	10/18/88
TIME	1430	1200	1030	1115	1240	1240	
MAXIMUM DEPTH (M)	9	8.6	8.5	8.6	8.5	8.5	
SECCHI DEPTH (M)	3.25	3.5	2.75	4.75	4.75	4.75	
TEMPERATURE (C)@ 1M DEPTH	14	19.7	22.5	22	15	15	
TEMPERATURE (C)@ 1M OFF BOTTOM	13.4	21	21	22	15	15	
DISSOLVED OXYGEN (MG/L)@ 1M	13	5	9	10	8	8	
DISSOLVED OXYGEN (MG/L)@ 1M OFF BOTTOM	13	5	9	8	8	8	
TOTAL AMMONIA (MG/L)	0.013	0.019	0.028	0.01	0.035	0.038	0.024
TOTAL NO2+NO3 (MG/L)	0.017	0.021	0.003	0.016	0.033	0.034	0.018
TOTAL KJELDAHL (MG/L)	0.14	0.12	0.13	0.12	0.16	0.18	0.16
TOTAL PHOSPHORUS (MG/L)	0.014	0.016	0.017	0.028	0.027	0.027	0.023
ORTHOPHOSPHORUS (MG/L)		0.005	0.002	0.01	0.017	0.018	0.014
SPECIFIC CONDUCTANCE (UMHOS)		48	50	55	54	53	56
CHLOROPHYLL a (UG/L)		2.6	3.4	3.1	2.4	1.9	0.9
ZINC (UG/L)	80	220	60	30	52		50
N : P	11.2 : 1	8.8 : 1	7.8 : 1	4.9 : 1	7.1 : 1	7.9 : 1	7.7 : 1