SEYMOUR LAKE: 1984
DATA SUMMARY AND RECOMMENDATION

by D. B. Maclean
Waste Management Branch, Smithers

Northern Region
Report No. 85-02

Skeena Zone

SEYMOUR LAKE 1984 -- DATA SUMMARY

The 1984 sampling program for Seymour Lake was designed to provide nutrient loading data for the lake such that a management prescription for the lake and watershed management guidelines could be proposed. Unfortunately inlet streams on the North and North West end of the lake were dry at all times visited for sampling during 1984 so the possibility of excessive nutrient loading suspected from a July 21/82 sampling in the North West inflow could not be determined. Water quality sampling of the lake, however, did show that phosphorus is being released from the sediments in high concentrations during anoxic periods with negative oxidation reduction potentials (ORP). This internal recycling of phosphorus is the principal source of phosphorus to the lake.

The 1984 sampling program gave the following results:

Water Quality:

Temperature and dissolved oxygen profiles are shown in Figure 1.

Surface water temperature approached 20°C during mid-summer (18.7°C on 84/07/18) and below the thermocline the water temperature remained warm (12.1°C on 84/09/04). After spring overturn the lake developed a strong thermocline (1.5°C/m). Because of the strong thermocline, fairly small fetch and light summer winds it is assumed that the lake remains stratified throughout the summer and early fall. On September 4/84 the lake was weakly stratified near the bottom (1.1°C/m for the bottom 2 metres) and essentially isothermal above, indicating that the stratification was breaking down at the time of sampling.

During winter surface temperature was 0-1°C below the ice and 4°C at the bottom. Dissolved oxygen was typically high at the surface - ranging from

72% saturation under ice in February to 103% in September. The hypolimnion was always anoxic (less than 1 ppm dissolved oxygen) except during spring overturn.

Spring overturn total phosphorus was .039 mg/l on April 17/84 (compare .052 mg/l on 82/05/11), this defines the lake as eutrophic. The sampling program was able to demonstrate that phosphorus is being released from the sediments. This is evidenced by the higher concentration of total phosphorus and ortho-phosphorus at depth when the lake is stratified. (Table 1 presents the water chemistry data results for the deepest site on the lake for 1984.) Orthophosphorus is released from the sediments under negative oxidation reduction conditions at the sediment water interface as shown in Figure 2. Significant concentrations of ortho-phosphorus are found above the sediment-water interface on July 18 and September 4 indicating that internal cycling of phosphorus is occurring in Seymour Lake. Total Phosphorus concentration is lowest in the epilimnion of July 18 probably as a result of biological uptake. On the September 14 sampling total phosphorus has increased again in the epilimnion. This is probably due to the deterioration of the thermocline allowing phosphorus to be transferred from the hypolimnion into the epilimnion.

Nitrogen concentrations presented in Table 1 show that ammonia-nitrogen concentration follows the fluctuations in ortho-phosphorus release during anoxic periods with a negative oxidation reduction potential.

Nitrate/Nitrite concentrations varied seasonally reflecting biological utilization during the growing season. Concentrations ranged from a high of .31 mg/l at the surface under ice in February (indicating little photosynthetic activity) to below detection limits during the growing season.

Table 6 summarizes the water quality for Seymour Creek. Ammonia, orthophosphorus and total phosphorus peak during July and tend to indicate that some hypolimnetic water is being withdrawn.

Phytoplankton Chlorophyll a:

Phytoplankton analysis was done for numerical dominance and taxonomy. Tables 2-4 present the data for the 3 samples taken on April 17, July 18 and September 4. On April 17 the standing crop collected was unusually low at 407 cells/ml when compared to the chlorophyll a concentration of 9.1 ug/l taken at the same time. The algal association was dominated by diatoms (65%) and flagellates (35%). By the July 18 sample the algal association was dominated by a single blue-green algae. Aphanizomenon flos-aquae (98%) which is typical of moderately productive eutrophic lakes. Total cell count on July 18 was 4961 cells/ml. Aphanizomenon flos-aquae continued to dominate (96%) on September 4 and the standing crop had increased dramatically to 75,300 cells/ml.

Chlorophyll a concentrations were relatively high throughout the growing season. The May to September mean chlorophyll a concentration was 9.3 ug/L (n=3). Based on Figure 3 the chlorophyll a concentration was that expected from the spring overturn phosphorus concentration of .039 mg/l.

Sediment Analysis

Table 5 summarizes the analysis of Seymour Lake sediments. Values show no unusual characteristics. Calcium concentration is well below the provincial mean which is expected for a well flushed lake with mostly volcanic bedrock throughout the watershed.

Lake Restoration

Although inflow creeks were not sampled during 1984, it is assumed that the major phosphorus load to the lake is a result of internal recycling from the sediments.

The restoration of Seymour Lake hinges on managing phosphorus release from the sediments by lake aeration or hypolimnetic withdrawal of phosphorus rich water. Liming as a method of nutrient inactivation will not be discussed as present research is indicating that shallow lakes do not respond adequately to the addition of lime.

1. Lake Aeration

Seymour Lake is too shallow to be restored by a destratification aeration system. Phosphorus does not seem to be released from the sediments during the winter (February 27/84) when the lake could be aerated. This is atypical, most lakes which release phosphorus in the summer also release phosphorus in the winter. Destratification aeration during the summer would result in too warm a lake temperature, deteriorating sport fish habitat. Increasing the hypolimnetic temperature can also lead to a dramatic increase in the metabolic (decomposition) rate of the sediments.

Hypolimnetic aeration is a possible method of lake restoration. Seymour Lake is at the absolute minimum depth (9.1 metres, maximum depth, 6.0 metres, mean depth) for hypolimnetic aeration to work efficiently. This method would prevent any large increase in hypolimnetic temperature.

2. Hypolimnetic Withdrawal

Hypolimnetic withdrawal by a siphon is a lake restoration method with some merit. The provincial Fisheries Branch has installed a pipeline 180 metres from shore at a depth of 4.5 metres to provide water for their steelhead holding facility. The quality of this water during anoxic periods is not known at the time of writing but if nutrient rich water is found from July to September this line could be used to preferentially withdraw water from the hypolimnion. The Fisheries Branch at present only uses the pipeline during spring and fall when holding steelhead trout.

The method of hypolimnetic withdrawal would be very cost effective when compared to hypolimnetic aeration. A major drawback to this method is that the outflow from Seymour Lake is minimal June to September. It may not be possible to withdraw enough water to have an appreciable effect on spring overturn phosphorus.

Watershed Management Guidelines

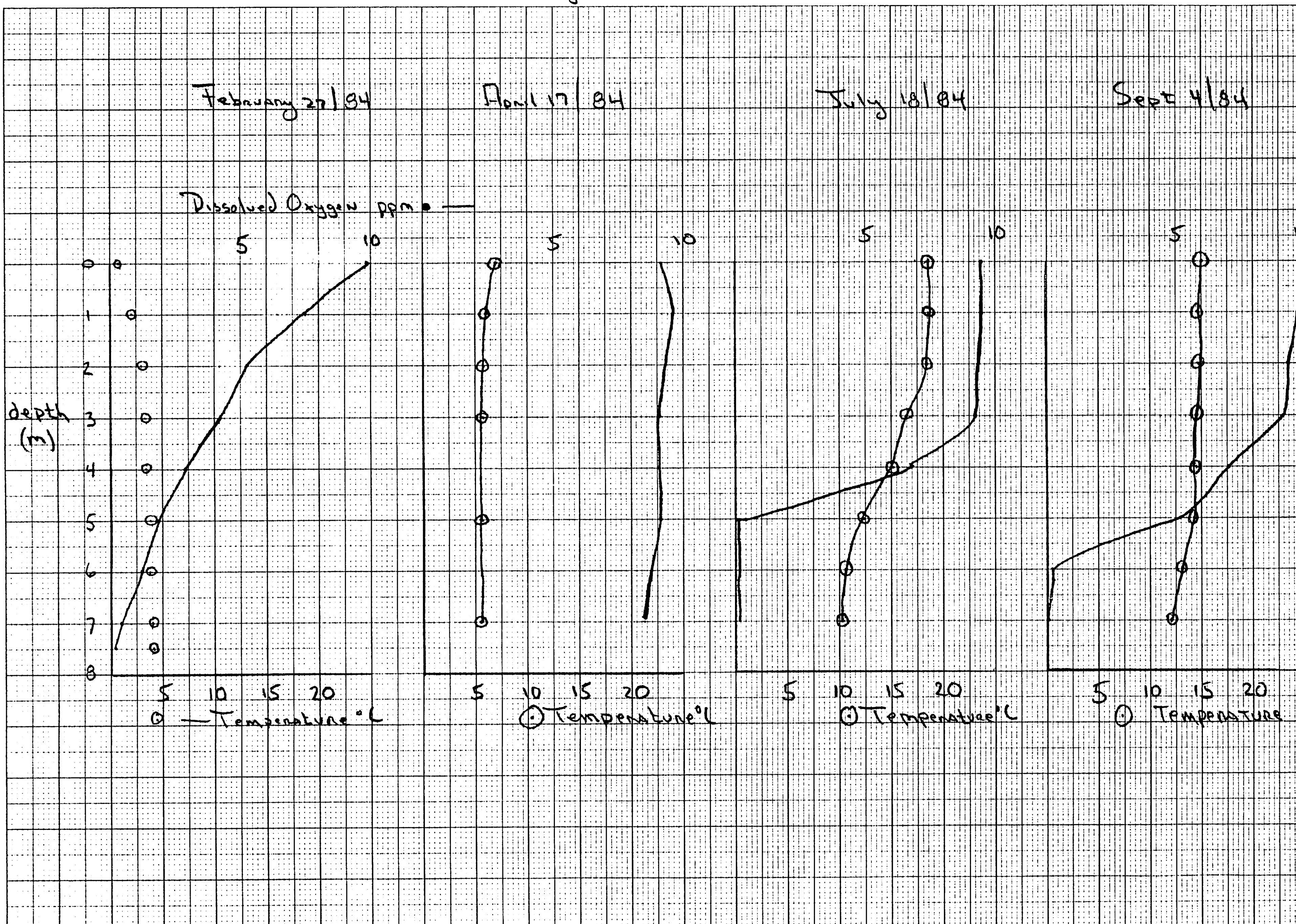
Acceptable watershed development and management guidelines are those outlined in the Kathlyn, Seymour, Round and Tyhee Lakes: Water Quality Assessment and Objectives (Boyd et al 1984). Recommendations in the above report are a freeze on watershed development until the present eutrophic conditions are controlled by a restoration technique. When additional development is permitted, stringent emphasis should be placed on the control of phosphorus movement to the lake. Control would be necessary on the correct setback of septic tank tile field and the number of residences and "hobby farms". After lake restoration is implemented, Seymour Lake could withstand a maximum of 45 homes on septic tank but only 4 - 5 "hobby farms". This is based on the additional phosphorus loading expected from livestock on a hobby farm.

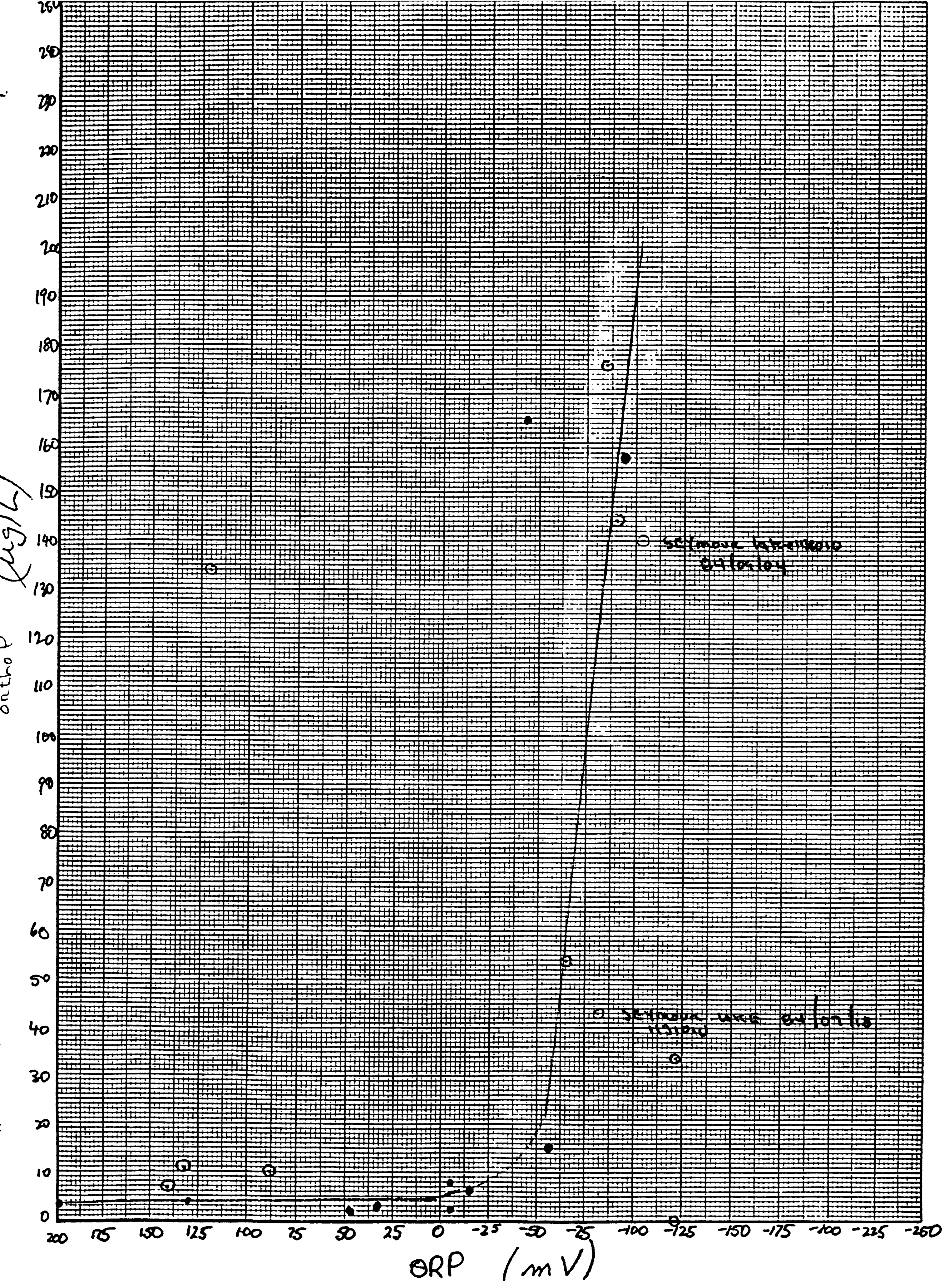
REFERENCES CITED

Boyd, I.T., McKean, C.J.P., Nordin, R.N., Wilkes, B. D. 1984 Kathlyn, Seymour, Round and Tyhee Lakes: Water Quality Assessment and Objectives. Water Management Branch, Ministry of Environment, Victoria, B.C.

Nordin, R.N., McKean, C.J.P., A Review of Lake Aeration as a Technique for Water Quality Improvement, Aquatic Studies Branch, Ministry of Environment, Victoria, B.C.

Figure 1


February 27/84
April 17/84
July 18/84
Sept 4/84
Dissolved Oxygen ppm
depth (m)
⊙ — Temperature °C
⊙ Temperature °C
⊙ Temperature °C
⊙ Temperature



ortho P (ug/L)
260
250
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
200
175
150
125
100
75
50
25
0
-25
-50
-75
-100
-125
-150
-175
-200
-225
-250
ORP (mV)

Figure 3

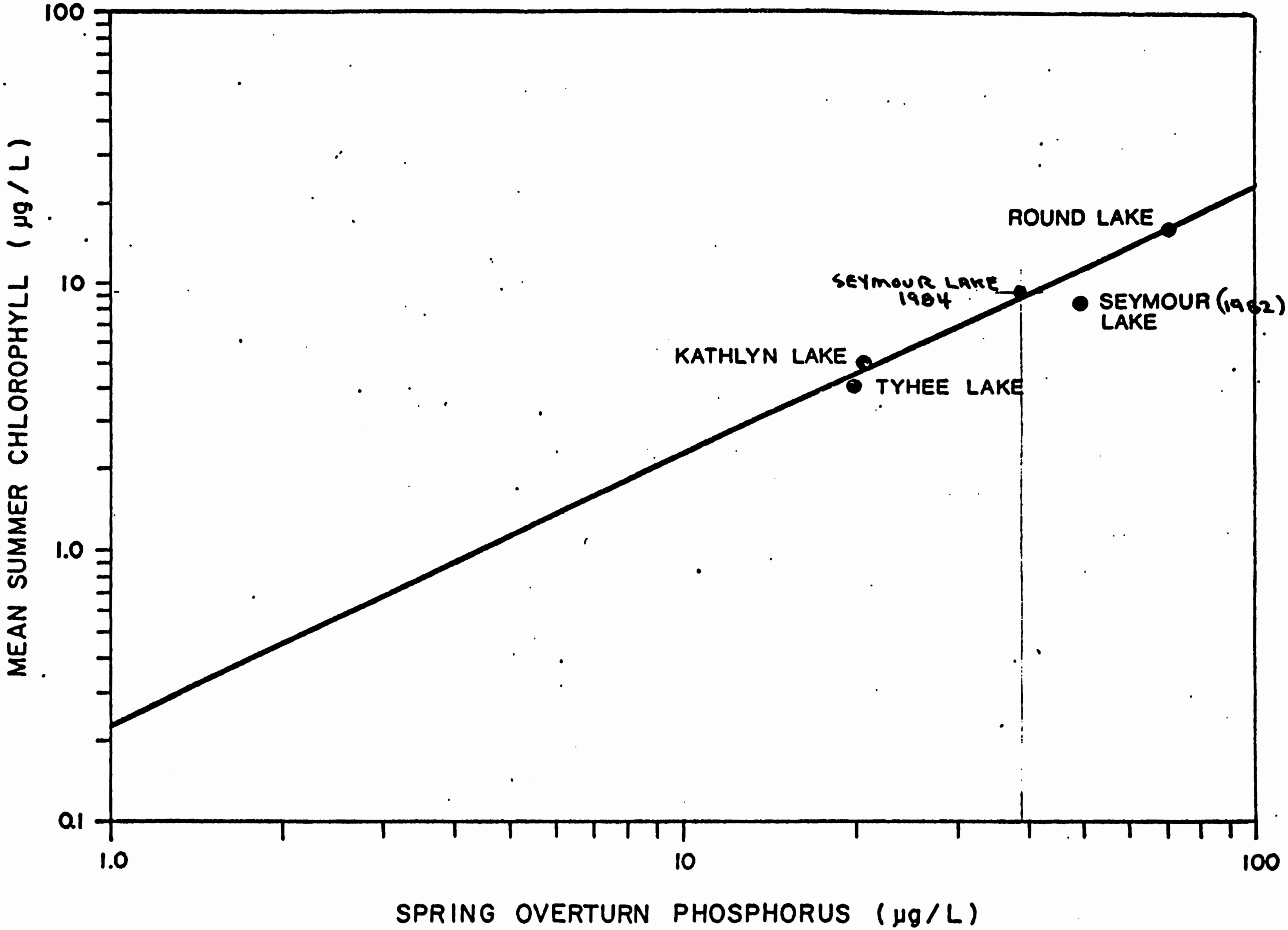


FIGURE 2 : PHOSPHORUS-CHLOROPHYLL a RELATIONSHIP FOR BRITISH COLUMBIA LAKES, IN RELATION TO THE STUDY LAKES

TABLE 1

Seymour Lake 1131010

Date	Depth	pH (units)	SP COND umho/cm	Temp (°C)	D.O.	True Color rel. units	Turbidity N.T.U.	NH_4 mg/L	NO_2/NO_3 mg/L	TKN mg/L	Total N mg/L	Total P mg/L	Ortho P mg/L	tot diss P mg/L	TOC mg/L	Chlor a ug/L	Si mg/L	oxidation reduction potential mv	hardness mg/L	alkalinity mg/L
84/02/27	1 m	7.0	91	2.2	7.5	40	0.8	.01	.31	.47	.78	.027	.007	.02		2.9				
84/02/27	7 m	6.9	92	4.1	0.4	40	1.4	.007	.35	.45	.80	.031	.012	.021						
84/04/17	3 m	7.1	86	5.8	8.8	30	2	.007	.11	.57	.68	.039	.005	.015	11	9.1*	5		37.2	40.2
84/07/18	1 m	7.8	84	8.5	9.5	30	.7	.014	L.02	.49	.49	.016	L.003	.011	13	5.4**	2.6	+75		
84/07/18	6 m	7.1	88	10.3	.04	40	4.5	.142	L.02	.79	.79	.103	.043	.07	13			-83		
84/09/04	1 m	7.7	85	14.8	9.8	30	2.4	.017	L.02	.70	.70	.023	L.003	.012	—	13.4		102		
84/09/04	6 m	7.1	106	12.1	.07	50	10	.46	L.02	.46	1.21	.174	.14	.166				-104		

* 0-1-3 m

** vert-tygon

TABLE 2
PHYTOPLANKTON ANALYSIS
SEYMOUR LAKE 1131010
APRIL 17/84

algal genus	#organisms cells/ml	taste and odor significance when algae are moderate concentration	algal group
mallomonas	8.8	violet odor	flagellate
achnanthes	15.8	--	diatom
cocconis	3.1	--	diatom
symbella	present	--	diatom
fragilaria	22		diatom
fragilaria construens	40.8	geranium odor	diatom
gomphonema	9.4	--	diatom
navicula	3.1	--	diatom
nitzschia	3.1	--	diatom
synedra	12.6	grassy odor	diatom
tabellaria	34.5	geranium odor	diatom
cyclotella	1.5	geranium odor	diatom
melosias			diatom
italica	114	geranium odor	diatom
stephanodiscus	3.1	geranium odor	diatom
chroomonas acuta	56.1	clean water	flagellate
cryptomonas marsonii	38	violet odor	flagellate
cryptomonas ovata	35	violet odor	flagellate
ankistrodesmus	5.8		green
TOTAL	406.7		

TABLE 3
PHYTOPLANKTON ANALYSIS
SEYMOUR LAKE CENTER
JULY 18/84

algal genus	#organisms cells/ml	taste and odor significance when algae are moderate concentration	algal group
anabena	present	musty/grassy odor, toxic in high concentrations	blue green
aphanizomenon flos-aquae	4891	grassy/nasturtium/musty	blue green
asterionella	12	geranium odor	diatom
tabellaria	present	geranium odor	diatom
melosira	21.2	geranium odor	diatom
ceratium	present	fishy	flagellate
cryptomonas	present	violet odor	flagellate
asterococcus	36.8		
TOTAL	4961		

TABLE 4
PHYTOPLANKTON ANALYSIS
SEYMOUR LAKE 1131010
SEPT. 4/84

algal genus	#organisms cells/ml	taste and odor significance when algae are moderate concentration	algal group
gomphosphaeria	120	grassy odor	blue green
anabena spiroides	1601	musty/grassy, nasturtium odor	blue greeen
aphanizomenon flos-aquae	72,220	musty/grassy, nasturtium odor	blue green
dinobryon	146	violet odor	flagellate
mallomonas	21.9	violet odor	flagellate
asterionella	64.4	geranium odor	diatom
diploneis	present	--	diatom
navicula	present	--	diatom
tabellaria	189	geranium odor	diatom
cyclotella	2.2	geranium odor	diatom
melosira	2	geranium odor	diatom
chroomonas	277	clean water	flagellate
cryptomonas	182	violet odor	flagellate
trachelmonal	41.4	--	flagellate
elaktothrix	present	--	green
asterococcus	2.4		green
botryococcus	365	--	green
quadrigula	1.6	--	green
scenedesmus	58.4	--	green
TOTAL	75,300.3		

TABLE 5
SEYMOUR 85/04/17
SAMPLE TYPE: BOTTOM SEDIMENTS

SITE DESCRIPTION	residue total volatile %	TKN mg/g	PO^{-}_4	P ug/g	As ug/g	Zn ug/g	Pb ug/g	Mn ug/g	Fe ug/g	Mg ug/g	Cu ug/g	Al ug/g	Cu ug/g
Seymour Lake north end	29.9	13.2	L0.1	1,225	40	124	29	692	28,830	6,366	48	21,086	5,511
Seymour Lake center 1131010	29.6	13.1	L0.1	1,160	42	127	50	727	29,600	6,140	52	23,100	6,330
B.C. Means	28.7	10.1	--	1,136	40.4	90.8	42.2	866	28,209	9,261	42	19,032	34,796

TABLE 6

SEYMOUR CREEK

Date	pH (units)	SP. COND. umho/cm	Temp (°C)	D.O.	True Color rel. units	Turbidity N.T.U.	NH_4 mg/L	NO_2/NO_3 mg/L	TKN mg/L	Total N mg/L	Total P mg/L	Ortho P mg/L	tot diss P mg/L	TOC mg/L	SULPHATE mg/L	total residue mg/L	alkalinity mg/L
84/02/27	6.8	97	0	—	40	1.	.02	.19	.56	.75	.026	.008	.017	.008	.017		
84/04/17			-	—			L.005	.09	.58	.67	.031	.005	.015	.005	.015		40.2
84/07/18	7.5	90	-	—	40	2.2	.022	.03	.53	.56	.035	.014	.027	.014	.027	-83	
84/09/04	7.5	93	13.2	—	20	1.7	.007	.02	.41	.43	.028	.011	.02	.011	.020	-104	