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IMPLEMENTATION AGREEMENT

RESULTS OF THE CONTINUING WATER QUALITY MONITORING PROGRAM ON OKANAGAN LAKES FOR YEARS 1979 TO 1980

Prepared by

E.V. Jensen,
Waste Management Branch,
Ministry of Environment.

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NOTICE

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Office of the Program Coordinator,
P. O. Box 458,
Penticton, British Columbia. V2A 6K6

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ABSTRACT

A water quality monitoring program in spring and fall 1979-80 was continued from Environmental Protection Services studies in 1976-1978 to evaluate long term trophic changes in the main body of Lakes Okanagan, Skaha, Osoyoos, Wood and Kalamalka. Bi-weekly sampling in April to October, 1979, at a shallow station in Vernon Arm served to document the water quality response to complete sewage removal in August, 1977. Although no large water quality changes have occurred in Okanagan Lake since 1971, slight increases in total dissolved phosphorus and total nitrogen have been noticed in 1979 and 1980. Continued reduction in nutrient levels and algal biomass in Vernon Arm of Okanagan Lake attests to the improved water quality following sewage diversion. Skaha Lake has shown signs of a reversal in the improved water quality noted in 1976-78. Increased spring phosphorus and phytoplankton chlorophyll-a levels in 1979 have approached values reported in 1969-71 prior to phosophorus reduction in Penticton sewage. Osoyoos and Wood Lakes remain in an eutrophic state. Kalamalka Lake possesses spring nutrient and phytoplankton chlorophyll-a levels similar to Okanagan Lake. Small increases in spring nutrient levels and biological production have been noted in Kalamalka Lake in recent years.

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SUMMARY AND CONCLUSIONS

A water quality monitoring program for the mainstem Okanagan Lakes was carried out by Environmental Protection Service (EPS), Environment Canada, under the Okanagan Basin Implementation Agreement in 1976-1978. The study was continued in 1979 by the Waste Management Branch of the B. C. Ministry of Environment to further measure the water quality response to implemented waste management measures and to identify possible long term changes in lake water quality. Limnological data was collected in the spring and fall of 1979 and 1980 in Lakes Okanagan, Skaha, Osoyoos, Wood and Kalamalka using the same methods as the EPS in 1976 through 1978.

Okanagan Lake (Deep Stations)

Notable increases in organic nitrogen at OK-2 and OK-3 and slight increases in total dissolved phosphorus at all three stations were noted in 1980. The 1979 phytoplankton standing crop was greater than previous years with volumes dominated by blue-green algae and all densities dominated by diatoms. Slight increases in spring phytoplankton chlorophyll-a noted in 1979 were still below season means recorded in 1971. Hypolimnetic dissolved oxygen levels have remained much the same as in 1971 with better than 95% saturation in the fall months at all three sites.

In summation, the main body of Okanagan Lake is between oligotrophy and mesotrophy. Influences of cultural eutrophication (sewage discharge, septic tanks, fertilizers, increased soil erosion, etc.) are inevitably increasing the fertility of Okanagan Lake. Due to the long residence time of water in Okanagan Lake, changes will occur slowly over a long time frame and, at present, are overshadowed by small year to year fluctuations.

Okanagan Lake (Shallow Stations)

Complete sewage removal from Vernon Arm (OK-S2) in 1977 has resulted in notable decreases in nutrient levels and algal standing crop at OK-S2. Total and total dissolved phosphorus, nitrate and ammonia nitrogen all decreased markedly in 1978 and continued to decline in 1979. Algal standing crop at OK-S2 also dropped following sewage removal. Seasonal mean phytoplankton chlorophyll-a values at OK-S2 decreased from 4.16 μg/l in 1977 to 2.50 μg/l in 1978 and dropped again in 1979 to 1.59 μg/l. Seasonal periphyton chlorophyll-a values also dropped from 2.28 μg/l in 1977 to 0.58 and 0.15 μg/l in 1979 and 1980, respectively.

Skaha Lake

Spring phosphorus and chlorophyll-a levels in spring 1979 and 1980 have increased above the 1976-1978 values and have approached levels recorded prior to tertiary treatment of Penticton sewage in 1972. Greater demand on the Penticton Sewage Treatment Plant and reduced outflow from Skaha Lake in 1979 and 1980 are contributing factors in increased phosphorus loading to Skaha Lake. While no trend has developed in nitrate and ammonia nitrogen levels, spring total nitrogen levels in Skaha Lake have continued to increase since 1971 in response to wastewater discharge from the City of Penticton. Minimum hypolimnetic dissolved oxygen levels noted in fall 1979 and 1980 were greater than those recorded in 1977 and 1978. Nutrient levels and phytoplankton characteristics recorded in 1979-1980 have approached eutrophic levels.

Osoyoos Lake

While spring total phosphorus values have not changed appreciably, nitrate nitrogen and total nitrogen values have increased since the Okanagan Basin Limnology Study in 1971. Nitrogen phosphorus ratios have ranged from 13:1 in 1978 to 20:1 in 1980. Similar to Skaha Lake, minimum hypolimnion dissolved oxygen levels were slightly higher in 1979 and 1980 than previous years.

Hypolimnetic depletion rates in 1979 and 1980 are similar to critical values reported by Truscott and Kelso for years 1977 and 1978. High nutrient levels and critically low oxygen levels in the hypolimnion are indicative of the poor water quality and eutrophic status of Osoyoos Lake.

Wood Lake

Wood Lake waters contain the highest phosphorus and nitrogen levels of all Okanagan lakes. Total dissolved phosphorus levels have increased from a spring mean of 19.5 µg/l in 1976 to 79.3 µg/l in 1980. Critically low hypolimnetic DO levels of less than 1 mg/l measured in the hypolimnion of Wood Lake in 1977 through 1980 may allow phosphorus release from the sediments.

Wood Lake is the most eutrophic of the five mainstem Okanagan Lakes.

Kalamalka Lake

Spring total and total dissolved phosphorus levels in Kalamalka Lake are similar to those of Okanagan Lake, showing only small increases since 1976. No appreciable change has occurred in spring nitrogen levels over the past five years. Although chlorophyll-a levels have remained in the oligo-mesotrophic range, increases have been noted since 1978. The relatively low nutrient concentrations and well oxygenated hypolimnion are indicative of a meso-oligotrophic state.

1. INTRODUCTION

In 1976 the Okanagan Basin Implementation Board (OBIB) in conjunction with the Environmental Protection Service, Environment Canada, undertook a three-year (1976-1978, spring through fall) limnological study of Lakes Okanagan, Osoyoos and Skaha. The objectives of the Study were to monitor the water quality changes in each lake following implementation of waste treatment measures in 1972 and subsequent years. Particular attention was given to Vernon Arm of Okanagan Lake where complete diversion of Vernon sewage to land disposal had occurred in August, 1977. Skaha and Osoyoos Lakes were of major interest as they are downstream of the sewage treatment plant at Penticton where 70% phosphorus removal from sewage was effected in 1972. Phosphorus removal has increased to 85% in subsequent years. Results of this comprehensive study have been reported by Truscott and Kelso (1979) for OBIB under the terms of the Canada-British Columbia Okanagan Basin Implementation Agreement (OBIA).

Following the 1976-1978 study, the OBIB recognized that a continued lake response monitoring program on a reduced scale was an essential component of any water management plan for the Okanagan Basin. Such a program would identify long term changes in water quality of the main valley lakes and response to implementation of additional waste management procedures to maintain this quality. In addition, further monitoring on fixed term (April to October, 1979) was deemed necessary to more fully document the response to Vernon Arm to reduced nutrient loading.

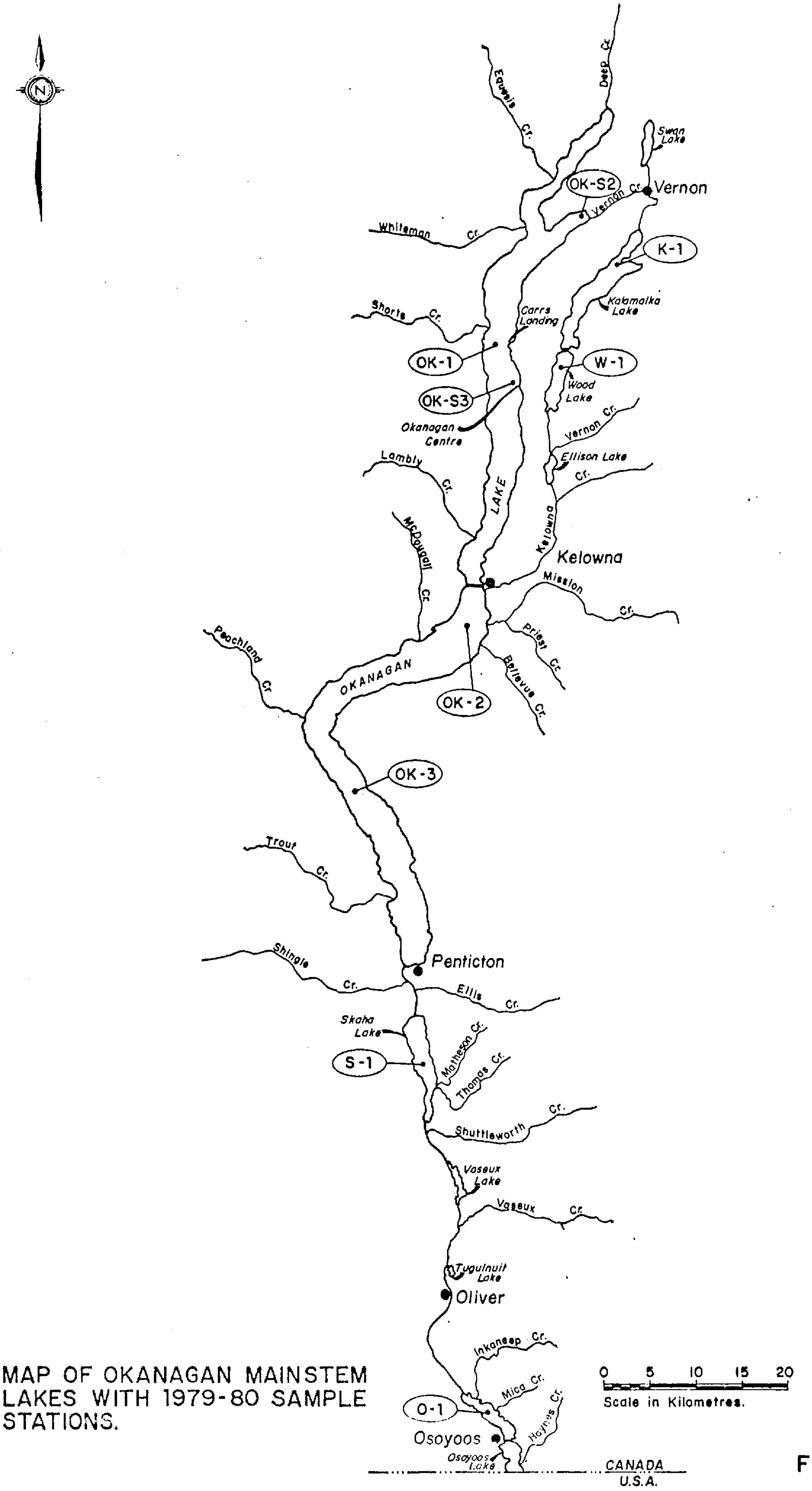
To meet these objectives a semi-annual (spring and fall only) sampling program of the Okanagan lakes in 1979 and 1980 was funded by the OBIA and sampling duties were shifted from the Environmental Protection Service to the Waste Management Branch of the Ministry of Environment. This report presents the 1979 monitoring results noting water quality response at the shallow station in Vernon Arm of Okanagan Lake and trends in lake quality at deep stations in Okanagan, Skaha, Osoyoos, Wood and Kalamalka Lakes during 1979 and 1980. This report serves to present and discuss the results of the 1979 and 1980 sampling program relative to the 1971 Okanagan Basin Limnological Study and the 1976-1978 Lake Monitoring Program but not to critically review and evaluate the validity of data generated during earlier studies. Several limitations of the 1971 limnology data, particularly chemical parameters, have been identified by Truscott and Kelso (1979). Questions have also been raised regarding the chlorophyll-a analysis and algal biovolume calculations presented by Truscott and Kelso. In comparing data for periods 1976-1978 to 1979-1980 emphasis has been placed in similar spring and fall sampling data.

2. METHODS

Sampling methods in 1979 and 1980 remained largely unchanged from the Truscott and Kelso study of 1976 to 1978. A brief outline of the sampling program is given below noting details of sampling techniques which deviate from the 1976-1978 study. A more complete treatment of sampling methods may be found in Truscott and Kelso (1979).

All deep stations (located over deep basin(s) of each major lake) were retained to ensure comparability of results. In addition, two stations were reactivated which had been sampled in 1971 during the Okanagan Basin Study. One is near the center of Wood Lake (W-1) and the other is south of Rattlesnake Point in Kalamalka Lake (K-1). These stations rounded out the water quality data base providing information for all five of the main valley lakes. Location of the seven deep stations sampled in 1979 and 1980 are shown in Figure 1.

Sampling at deep stations was reduced to once in the spring (March to April) and once in the fall (September to October). Spring sampling provided knowledge of nutrient concentrations, phytoplankton abundance and saturation levels for dissolved oxygen prior to thermal stratification. Autumn sampling prior to turnover focused on nutrient depletion and recycling, relative biomass and character of



MAP OF OKANAGAN MAINSTEM LAKES WITH 1979-80 SAMPLE STATIONS.

Figure 1

TABLE 1: SAMPLING DATES FOR SHALLOW STATIONS (1979) AND DEEP STATIONS (1979-1980) AT OKANAGAN LAKES

SHALLOW STATION SAMPLING DATES AT BEGINNING OF EACH TWO-WEEK PERIOD IN 1979:

	Apr. 9	Apr. 23	May 9	May 22	Jun. 5	Jun. 19	Jul. 3	Jul. 17	Aug. 1	Aug. 14	Sep. 11	Sep. 25	Oct. 9
OK-S2	x	x	x	x	x	x	x	x	x	x	x	x	x
OK-S3	x	x	x	x	x	x	x	x	x	x	x	x	x

DEEP STATIONS SAMPLING DATES FOR 1979 AND 1980:

	SPRING 1979	FALL 1979	SPRING 1980	FALL 1980
OK-1	Apr. 10	Oct. 9	Apr. 24	Sep. 16
OK-2	Apr. 18	Oct. 11	Apr. 14	Sep. 15
OK-3	Apr. 19	Sep. 26	Apr. 15	Sep. 10
S-1	Apr. 12	Oct. 2	Apr. 9	Sep. 8
O-1	Apr. 11	Oct. 1	Apr. 10	Sep. 9
W-1	Apr. 18	Oct. 3	Mar. 27	Sep. 17
K-1	Apr. 17	Oct. 10	Apr. 23	Sep. 17

TABLE 2: SUMMARY OF WATER CHEMISTRY SAMPLING METHODS

PARAMETER	FIELD PREPARATION*	TESTING AGENCY				SAMPLING DEPTHS
		1979		1980		
		SPRING	FALL	SPRING	FALL	
Total Phosphorus		I.W.D.[1]	Env.[2]	Env.	Env.	Spring 1979 & Fall 1980
Total Dissolved P	Filter through 0.45 micron Sartorius membrane filters.	I.W.D.	Env.	Env.	Env.	1 m. 12 m. 20 m. Bottom: 1-2 m. above bottom.
Nitrate-Nitrite		I.W.D	Env.	Env.	Env.	
Ammonia		I.W.D.	Env.	Env.	Env.	
Organic Nitrogen		N/A	Env.	Env.	Env.	Fall 1979 & Spring 1980
Total Dissolved N		I.W.D.	Env.	Env.	Env.	1 m. 12 m. 20 m. 44 m. or 1-2 m. above bottom if less than 44 m.
Total Nitrogen		I.W.D.	Env.	Env.	Env.	
Particulate Nitrogen	Filter through roasted GF-F Whatman glass fiber filters.	I.W.D.	I.W.D.	I.W.D.	I.W.D.	
Particulate Carbon		I.W.D.	I.W.D.	I.W.D.	I.W.D.	
Inorganic Carbon		N/A[3]	Env.	Env.	Env.	All water chemistry samples collected with 6-litre Van Dorn.
Organic Carbon		N/A	N/A	Env.	Env.	
Silica-Reactive		I.W.D.	Env.	Env.	Env.	
Specific Conductivity		N/A	Env.	Env.	Env.	
Turbidity		I.W.D.	N/A	N/A	Env.	
Temperature Profile**	Bathythermograph to maximum depth (B.T.) YSI probe to maximum of 44 meters.	B.T.	YSI	YSI	B.T.	
Dissolved Oxygen Profile**		Winkler	YSI	YSI	YSI	

[1] I.W.D. - Water Quality Branch of the Inland Waters Directorate in North Vancouver (see Inland Waters Directorate, 1974, for methods of determination).

[2] Env. - B. C. Environmental Laboratory, Vancouver (see "A Laboratory Manual for the Chemical Analysis of Waters, Wastewaters, Sediments, and Biological Material" - Ministry of Environment Lab. 1976, 2nd Ed.)

[3] N/A - Not analyzed.

** - Temperature and dissolved oxygen profile measurements for deep stations made at 2 m. intervals to 20 m. depth; 4 m. intervals below 20 m. depth in Fall 1979, Spring 1980 and Fall 1980. HACH chemical D.O. check used at surface and bottom depths. YSI refers to Yellow Springs Instrument dissolved oxygen meter.

* - Field preparation - All samples cooled on ice and transported to testing agency within 24 hours of collection.

TABLE 3: SUMMARY OF BIOLOGICAL SAMPLING METHODS AT OKANAGAN LAKES IN 1979 AND 1980.

PARAMETER	SHALLOW STATION OR DEEP STATION	SAMPLING DEPTH	COLLECTION METHOD	FIELD PREPARATION	TESTING AGENCY			
					1979		1980	
					SPRING	FALL	SPRING	FALL
Phytoplankton								
Chlorophyll-A*	Shallow	1 m.	6 litre van Dorn	Filtered through Whatman GFC filter paper; filters frozen with silica gel dessicant.	I.W.D.[1]	I.W.D.	-	-
Pheopigments	Deep	2, 4, 10 and 2.5x Secchi Disc depth			I.W.D.	Env.[2]	Env.	Env.
Periphyton								
Chlorophyll-A* Pheopigments	Shallow	1 m.	Plexi-glass surface	Filtered through Whatman GFC filter paper and frozen with silica gel dessicant.	I.W.D.	I.W.D.	-	-
Phytoplankton and Periphyton Identification				Preserved with Lugols solution.	I.W.D. sub-contract to D. Deimert		N/A	N/A
Periphyton Dry and Ash Free Weights	Shallow	1 m.	Plexi-glass surface	Preserved with Lugols solution.	I.W.D.	I.W.D.	-	-
Zooplankton								
Settled Volume Identification and Enumeration	Deep	40-50 m. or just above bottom of shallower stations	4 vertical hauls with #20 Wisconsin plankton net	Preserved with 5% Formalin.	Settled volumes determined in field laboratory in 1979 and 1980; enumeration and identification contracted I.W.D. to Dr. C. Low in 1979; samples collected but not analyzed in 1980.			

* - Chlorophyll-A calculated according to Lorenzen (1976).

[1] IWD - Water Quality Laboratory of the Inland Waters Directorate.

[2] Env. - B. C. Environmental Laboratory.

phytoplankton and zooplankton communities, thermal stratification and hypolimnetic oxygen depletion. Sampling dates for deep stations in 1979 and 1980 are provided in Table 1.

The number of shallow stations was reduced in 1979 to OK-S2 in Vernon Arm, and control station OK-S3 near Okanagan Centre on Okanagan Lake (Figure 1). Sampling at two-week intervals, April through October, was continued from previous years to measure in greater detail water quality and algae response to sewage diversion from Vernon Arm in August, 1977. Sampling dates for shallow stations OK-S2 and OK-S3 are given in Table 1.

A minimum number of parameters was selected from previous and existing monitoring programs to demonstrate important chemical, physical and biological aspects of the lakes. Chemical analyses were limited to major nutrients phosphorus, nitrogen and carbon. Select physical parameters and indicators of biomass were also analyzed. Summaries of the chemical, physical and biological sampling program for the deep and shallow stations are provided in Tables 2 and 3.

3. RESULTS AND DISCUSSION

Summaries of sampling results are presented throughout this text. Complete records of 1979-1980 data are provided in the appendices of this report. A more complete record of 1976-1978 data may be found in Truscott and Kelso (1979). Important water chemistry data from 1976 to 1980 and biological information for 1979 is stored in EQUIS* under Sampling Agency 53 and the following site identification numbers:

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* EQUIS - Environmental Quality Use Information System; B. C. Ministry system.

Abbreviation	Description	Site Identification Number
OK-1	Okanagan Lake N. Okanagan Centre	0500730
OK-2	Okanagan Lake S. Kelowna Bridge	0500236
OK-3	Okanagan Lake S. Squally Point	0500729
S-1	Skaha Lake opposite Gillies Creek	0500615
O-1	Osoyoos Lake opposite Monashee Cooperative	0500728
W-1	Wood Lake at Center	0500245
K-1	Kalamalka Lake at Rattlesnake Point	0500247

3.1 Physical Limnology at Deep Stations

3.1.1 Temperature

All of the main Okanagan Lakes have been previously described as dimictic (Blanton, 1973; Stockner et al, 1974). During the initial three years (1976-1978) monthly temperature profiles (April through October) were recorded for Lakes Okanagan, Osoyoos and Skaha. These observations confirmed those of Blanton. Temperature profiles for all seven lakes in the spring and fall of 1979 and 1980 are presented in Appendix II. Although spring 1979 sampling depicted isothermal temperature profiles of 3.0 to 4.0^{0} C, spring sampling in 1980 at approximately the same calendar dates revealed warmer surface temperatures ranging from 4.0 to 8.0^{0}C. Truscott and Kelso (1979) identified August as the month of maximum thermal stratification. Temperature profiles for the fall (September-October) of 1979 and 1980 showed relatively strong thermal stability in most lakes although cooling of surface waters (based on surface maxima in previous years) and transmission of heat to the hypolimnion was apparent.

TABLE 4: SECCHI READINGS (m) FOR DEEP STATIONS ON LAKES OKANAGAN (OK-1, OK-2, OK-3), SKAHA (S-1), OSOYOOS (O-1), WOOD (W-1), AND KALAMALKA (K-1) FOR 1971 and 1976-1980

STATION	MONTH	1971	1976	1977	1978	1979	1980	1976-1980 AVERAGE
OK-1	Spring[1]	10.0	-	6.3	6.5	12.0	6.5	7.8
	Fall[2]	9.0	8.5	7.3	7.5	11.0	9.0	8.6
Ok-2	Spring	9.5	-	8.0	5.5	9.5	7.5	7.6
	Fall	-	8.2	7.8	7.5	10.6	9.5	8.7
OK-3	Spring	-	-	8.0	8.0	12.0	11.5	9.9
	Fall	9.0	7.8	8.5	8.5	10.4	10.5	8.7
S-1	Spring	6.0	-	4.7	4.5	4.7	4.2	4.5
	Fall	-	4.3	3.9	4.2	3.8	2.8	3.8
O-1	Spring	3.5	-	4.1	3.4	4.5	3.5	3.9
	Fall	-	3.9	3.2	4.5	2.8	2.8	3.4
W-1	Spring	2.5[3]	2.0*	2.0*	3.3*	3.4	8.1	4.6
	Fall	-	1.5*	3.2*	4.1*	5.1	3.3	3.4
K-1	Spring	9.0[3]	8.7*	12.4*	11.6*	9.7	7.5	10.0
	Fall	-	5.9*	4.2*	6.7*	10.2	5.5	6.5

[1] Spring: April to May.

[2] Fall: September to October.

[3] Seasonal means (April-October), Stockner and Northcote (1971).

* Data collected by Waste Management Branch.

TABLE 5: SPRING[1] PHOSPHORUS VALUES (μg/1) AVERAGED OVER FOUR DEPTHS FOR LAKES OKANAGAN (OK-1 to OK-3, OK-S2, OK-S3), SKAHA (S-1), OSOYOOS (O-1), WOOD (W-1) and KALAMALKA (K-1) FOR YEARS 1971 and 1976 to 1980.

STATION	TOTAL PHOSPHORUS (μg/1)						TOTAL DISSOLVED PHOSPHORUS (μg/1)					
	1971	1976	1977	1978	1979	1980	1971 (Ortho)	1976	1977	1978	1979	1980
OK-1	8.7	-	9.5	8.5	9.0	10.8	3.3	-	3.0	2.5	4.5	5.5
OK-2	10.8	-	8.5	4.5	9.5	7.0	3.3	-	3.0	2.5	4.0	4.5
OK-3	9.8	-	7.5	6.0	5.8	7.8	3.3	-	3.0	3.0	2.0	7.0
OK-S2	- -	- (42.0)[2]	45.5 (50.3)	18.0 (13.6)	12.5 (14.5)	- -		- (29.0)	20.0 (26.0)	7.0 (5.2)	5.3 (9.2)	- -
OK-S3	- -	- (7.0)	10.5 (9.0)	11.0 (8.0)	10.0 (9.6)	- -		- (4.0)	6.3 (4.0)	6.5 (4.5)	3.8 (5.1)	- -
S-1	20.7	-	11.0	18.0	22.8	24.5	4.3	-	5.5	2.0	5.0	9.5
O-1	22.8	-	21.0	23.5	17.3	21.3	4.3	-	8.0	4.5	5.5	9.0
W-1	-	70.0*	68.5*	91.0*	54.7	84.0	-	19.5*	40.5*	74.0*	32.0	79.3
K-1	-	6.0*	5.0*	6.5*	7.0	9.8		<3.0*	<3.0*	4.0	4.3	5.8

[1] Spring months April - May.

[2] ( ) Values in brackets are seasonal mean values.

* Waste Management Branch data.

3.1.2 Secchi Disc

Spring and fall Secchi readings for 1979 and 1980 are shown in Table 4 along with similar sampling dates for 1971 and 1976 through 1978. The absence of seasonal information for 1979 and 1980 precludes identifying trends over the full four-year period. Comparison of spring and fall Secchi readings for 1976 through 1980 show a perceptable change only in Wood Lake (Table 4). Wood Lake water transparency in the spring increased from 2.0 to 8.1 m and in fall from 1.0 to 3.3 m.

Based on the 1979 and 1980 sampling results, stations order in decreasing transparency as follows:

1. Okanagan Lake south of Squally Point;
2. Okanagan Lake north of Okanagan Centre;
3. Okanagan Lake south of Kelowna Bridge;
4. Kalamalka Lake at Rattlesnake Point;
5. Wood Lake at Center;
6. Skaha Lake opposite Gillies Creek;
7. Osoyoos Lake opposite Monashee Co-Op (N. Basin).

3.2 Chemical Limnology at Deep Stations

3.2.1 Phosphorus (Total and Total Dissolved)

Okanagan Lake deep stations have shown no real changes in spring turnover total phosphorus (TP) values since the 1971 Basin Study (Table 5). A possible exception was a high value of 10.8 µg/l at OK-1 in spring, 1980. The range of 10-20 µg PO_4 (P) l^{-1} has been suggested as a critical threshold allowing excessive algal blooms and aquatic plant growth (Sawyer, 1947; Vollenweider, 1968). Thus, phosphorus in the main body of Okanagan Lake is less than this threshold. Spring turnover total dissolved P levels increased by 1.0 to 2.5 µg/l at all three Okanagan Lake deep stations in 1979 and 1980.

Skaha Lake spring turnover total phosphorus levels varied widely with mean values ranging between 11.0 (1977) and 24.5 µg/l (1980, Table 5). Waste Management Branch sampling in March found considerably higher levels of 22.5 µg/l in 1978, 35.0 in 1979 and 31.0 µg/l in 1980. Total dissolved phosphorus (TDP) levels doubled from 5.0 µg/l in April, 1979 to 10.0 µg/l in April, 1980. Waste Management Branch sampling in March produced conflicting results of 14.0 and 7.0 µg/l TDP in 1979 and 1980, respectively. Truscott and Kelso (1979) reported a reduction in average total P levels of 15.3 µg/l (4-65%) had occurred in Skaha Lake between 1969-1971 and 1976-1978. Since 1977, phosphorus levels have been increasing and approaching levels of 31.7 g/l (1969) and 41.3 g/l (1970). As noted by Fleming and Stockner (1975) and Nordin (1981), hydrologic fluctuations and concurrent changes in water residence time can have significant effects on nutrient concentration and biological activities within short periods of time.

Osoyoos Lake spring total phosphorus (TP) levels have not changed greatly since 1971 (Table 5). Mean spring TP levels of 17.3 µg/l in 1979 and 21.8 µg/l in 1980 are typical of present year to year variability in Osoyoos Lake. Spring mean total dissolved P levels ranged from 4.5 µg/l in 1978 to 9.0 µg/l in 1980 again providing no clear trend (Table 5).

Wood Lake water is exceedingly high in total and total dissolved phosphorus (Table 5). Based on earlier Waste Management Branch data, spring mean total P levels have not changed appreciably, ranging from 55.8 µg/l in 1979 to 91.0 µg/l in 1978. In contrast, spring total dissolved phosphorus levels have increased markedly from 4.5 µg/l in 1975 and 19.5 in 1976 to 74.0 µg/l and 79.3 µg/l in 1978 and 1980, respectively. Mass balance estimates for Wood Lake indicate that phosphorus is released from sediments in anoxic portions of the hypolimnion (Stockner and Northcote, 1974).

Although in Kalamalka Lake, spring turnover total phosphorus levels have remained less than 7.5 µg/l for years 1974 through 1979, a gradual increase has occurred since 1978 reaching 10.0 µg/l in 1980. Spring total dissolved phosphorus levels have also increased slowly from L3.0 µg/l in 1975-1977 to 4.0 µg/l in 1978-1979 and 5.8 µg/l in 1980.

TABLE 6: SPRING[1] NITROGEN VALUES (µg/1) AVERAGED OVER FOUR DEPTHS FOR LAKES OKANAGAN (OK-1 to OK-3; OK-S2, OK-S3), SKAHA (S-1), OSOYOOS (O-1), WOOD (W-1) AND KALAMALKA (K-1) FOR YEARS 1971 and 1976 to 1980.

STATION	NO_2/NO_3						NH_3				
	1971*	1976	1977	1978	1979	1980	1976	1977	1978	1979	1980
OK-1	<10.0	-	14.5	23.0	42.3	27.5	-	11.5	2.0	19.0	10.5
OK-2	<10.0	-	63.5	24.0	29.5	35.0	-	27.5	2.5	3.3	15.0
OK-3	<10.0	-	51.0	36.0	27.8	37.5		10.5	1.0	2.0	12.3
OK-S2	-	(41.5)	(30.9)	(13.4)	(6.4)	-	(26.3)	(26.0)	(5.2)	(6.4)	-
OK-S3	-	(2.6)	(1.2)	(1.3)	(7.5)	-	(7.4)	(7.1)	(2.7)	(5.1)	-
S-1	<10.0	-	2.0	1.0	19.0	<20.0	-	11.5	2.0	12.8	11.3
O-1	<10.0	-	16.0	19.5	36.5	142.5	-	7.5	12.0	27.3	17.5
W-1		215.0	155.0	355.0	53.7	225.0	35.5	24.0	21.5	43.0	31.8
K-1		35.0	50.0	50.0	40.8	40.0	16.0	14.5	10.5	7.5	18.0

[1] Spring - April and May

* Mean based on samples from April, June, August and October, 1971.

( ) Values in brackets are seasonal means, April to October.

3.2.2 Nitrogen (Total, Nitrite/Nitrate, Ammonia)

As nitrite-N is usually found in only minute quantities (0.001 mg/l) in oxygenated waters the nitrite/nitrate results will be reported as nitrate nitrogen.

Okanagan Lake deep stations exhibited little change in spring nitrogen levels for 1977 through 1980 (Table 6). Spring mean nitrate levels fluctuated widely from 14.5 to 63.5 µg/l over the four-year period. Ammonia levels ranged from 10.5 to 15.5 µg/l in 1980 with no trend demonstrated in years 1977 to 1980. OK-2 showed the highest spring mean total N concentration over 1977-1980 of 363.8 µg/l. Lower spring mean levels of 194.1 and 245.8 µg/l at OK-1 and OK-3, respectively, were found over the four-year period.

Skaha Lake spring nitrate nitrogen levels are very low, less than 20 µg/l in 1976-1980 (Table 6). Spring ammonia levels were consistently less than 15 µg/l with little or no hypolimnetic accumulation in the fall sampling periods. Truscott and Kelso (1979) noted a trend of increasing total nitrogen levels since 1971. This trend has continued in 1979 and 1980 data reaching a mean of 320 µg/l in spring 1980 (Table 7).

Osoyoos Lake nitrate nitrogen levels increased from 36.9 µg/l in April, 1979, to 142.5 µg/l in April 1980 (Table 6). Average spring ammonia levels ranged from 7.5 to 27.3 µg/l with a mean of 16.1 µg/l over the four-year period 1977-1980. Denitrification in the hypolimnion does not appear to be occurring despite dissolved oxygen concentrations reaching critically low levels. Nitrification processes may continue to 0.3 mg O_2/l at which time diffusion rates of oxygen to bacteria become critical (Wetzel, 1975). Spring total nitrogen values ranged from 285 to 440 µg/l over the four years with mean of 333.5 µg/l.

Wood Lake nitrogen levels are higher than any other major lake in the Okanagan system. Spring mean nitrate nitrogen levels fluctuated widely from 53.7 µg/l (1979) to 335 µg/l (1978) with a mean of 177.3 µg/l over the five-year period (1975-1980). Waste Management Branch

TABLE 7: EPILIMNETIC* APRIL N, P AND N:P VALUES FOR LAKES OKANAGAN (OK-1, OK-2, OK-3), SKAHA (S-1), OSOYOOS (O-1), WOOD (W-1) AND KALAMALKA (K-1) FOR 1971 and 1976 to 1980

STATION	TN						TP						N:P					
	1971	1976	1977	1978	1979	1980	1971	1976	1977	1978	1979	1980	1971	1976	1977	1978	1979	1980
OK-1	160.0	-	190.0	201.5	140.0	145.0	8.7	-	9.5	8.5	9.5	11.0	18:1	-	20:1	24:1	25:1	13:1
OK-2	196.6	-	383.5	201.5	190.0	680.0	10.8	-	8.5	4.5	10.0	7.5	18:1	-	45:1	44:1	19:1	91:1
OK-3	196.0	-	294.5	199.0	170.0	320.0	9.8	-	7.5	6.0	5.5	7.5	19:1	-	39:1	33:1	31:1	43:1
S-1	196.0	-	217.0	243.0	310.0	305.0	20.7	-	11.0	18.0	22.5	25.5	9:1	-	20:1	14:1	14:1	12:1
O-1	226.6	-	300.0	309.0	285.0	440.0	22.8	-	21.0	23.5	16.5	21.5	9:1	-	14:1	13:1	17:1	20:1
W-1	-	770.0	1080.0	800.0	560.0	590.0	-	70.0	68.5	91.0	54.0	86.5	-	11:1	16:1	9:1	10:1	7:1
K-1	-	-	220.0	230.0	205.0	250.0	-	-	5.0	6.5	7.5	10.0	-	-	44:1	35:1	27:1	26:1

* Epilimnetic values are an average of 1m and 12m sampling depths.

data for Wood Lake has shown epilimnion nitrate depletion by August and an associated accumulation in the hypolimnion. Ammonification in the anaerobic hypolimnion during the fall months have generated levels of 530 μg/l (1979 and 258 μg/l (1980) well in excess of 20 μg/l guideline set by the Environmental Studies Board (1973) to protect aquatic life.

Nitrogen levels in Kalamalka Lake have not altered significantly over the past five years. Spring mean nitrate nitrogen values ranged between 34.0 and 50.0 μg/l in 1975 to 1980. Ammonia levels ranged from 7.5 to 18.0 μg/l for the same time period.

Measurements of particulate nitrogen were also made in 1979 and 1980. Particulate nitrogen results are provided in Appendix III.

3.2.3 Nitrogen to Phosphorus Ratios

Nitrogen to phosphorus ratios of 10:1 (Golterman, 1975) to 12:1 (Dillon and Rigler, 1974) have been suggested as optimal for algal growth. Ratios greater than 12:1 (P limited) were found at most deep stations except Wood Lake for years 1977 through 1980 (Table 7). Skaha Lake N:P ratios have been decreasing since 1977 due to increasing TP levels. N:P ratios less than 10:1 (N limited) were found in Wood Lake in 1978 and 1980. Decreasing N:P ratios since 1977 in Kalamalka Lake are attributed to the doubling in spring TP levels.

3.2.4 Carbon (Particulate, Inorganic, Organic)

Irregular collection of inorganic and organic carbon samples prior to 1980 and lack of seasonal sampling of all three forms of carbon in 1979 and 1980 precludes determination of year to year trends. Individual sampling results are provided in Appendix III.

Lowest particulate and organic carbon were noted in Okanagan Lake with increasing levels in the other, more productive lakes. Close correspondence between seasonal fluctuations of particulate carbon and chlorophyll-a were noted by Truscott and Kelso (1979). Inorganic carbon levels were largest in hard water lakes Kalamalka and Wood.

3.2.5 Dissolved Oxygen

With few exceptions, uniform dissolved oxygen concentrations of more than 12 mg/l and over 100% saturation were found throughout the lakes in spring 1979 and 1980. Dissolved oxygen and temperature profiles are illustrated for all sites in Appendix II. As each lake was sampled only each spring and fall, hypolimnetic oxygen depletion cannot be determined accurately.

Autumn dissolved oxygen profiles for all three Okanagan Lake sites portray orthograde curves in 1979 and 1980 (Appendix II). Hypolimnetic dissolved oxygen (DO) concentrations decreased slightly in September, 1980 to approximately 95% saturation at OK-1, 96% at OK-2 and 99% at OK-3. These results compare similarily with October 1976, 1977 and 1978 hypolimnetic DO concentrations of approximately 92% at OK-2 and OK-3, and 97% saturation at OK-1. Little change in hypolimnetic oxygen depletion has been documented since 1971 at the Okanagan Lake stations.

As in previous years Skaha Lake showed a much greater hypolimnetic depletion in 1979 and 1980 than Okanagan Lake. Fall DO profiles for Skaha Lake in 1979 and 1980 depict negative heterograde curves showing sharp reduction of DO concentrations in the metalimnion. Hypolimnetic DO measurements to 44 m depth recorded a mean saturation level of 43.9% in October, 1979, and 52.0% in September, 1980, with hypolimnetic minima of 4.0 and 5.2 mg/l in the respective years. Although these values appear higher than previous years (33% in October, 1977, 13% in October, 1978) areal hypolimnetic oxygen depletion rates of 0.092 mg O_2/cm^2/day in 1979 and particularly 0.122 mgO_2/cm^2/day in 1980 were similar to 0.125 and 0.139 mgO_2/cm^2 / day in 1977 and 1978, respectively. Hutchinson (1957) suggested a boundary between an oligotrophic and eutrophic lakes as 0.025 to 0.055 $mgO_2/cm^2/day$. As oxygen levels are not known at intervals between spring and fall dates the calculated hypolimnetic oxygen depletion rates serve only as approximations for comparison with prior years. Hypolimnetic areal deficits in Skaha, Osoyoos and Wood during the period 1969 to 1971 were approximately 0.077, 0.082 and 0.080 $mg/cm^2/day$, respectively (Patalis and Salki, 1973).

Dissolved oxygen profiles for Osoyoos Lake in fall 1979 and 1980 represent clinograde curves, typical of eutrophic conditions (Appendix II). Minimum recorded hypolimnetic DO levels of 2.6 mg/l at 44 meters in 1979 and 3.8 mg/l at 60 meters in 1980 were well below the NRC recommended level of 6.0 mg/l needed for good growth and well being of trout, salmon and other fish species. Minimum average hypolimnetic DO saturation levels of 27.0% in 1979 and 35.0% in 1980 were above 15.1% in 1977 and 7.0% saturation in 1978. A hypolimnetic DO depletion rate of 0.095 $mgO_2\ /cm^2/day$ from April to September, 1980, correspond well with 0.098 $mgO_2/cm^2/day$ in 1977 and 0.091 $mgO_2/cm^2/day$ in 1978.

Wood Lake also demonstrated a clinograde dissolved oxygen profile with minimum hypolimnetic levels of 0.2 mg/l (mean 17% saturation) in 1979 and 0.4 mg/l (mean 8.7% saturation) in 1980. Waste Management Branch sampling found minimum DO levels of 0.2 mg/l in 1977 and 0.1 mg/l in 1978. Williams (1973) recorded a mean hypolimnetic saturation level of 6% in 1971. These levels are sufficiently low to allow reversal of the oxidation-reduction process and feedback of nutrients from the sediments to the overlying waters (Wetzel, 1975).

Dissolved oxygen profiles for Kalamalka Lake show a well oxygenated hypolimnion with a slight decrease to approximately 83.8% saturation at 44 meters in October, 1979, and 93.8% saturation at 96 meters in September, 1980. Metalimnion DO levels in excess of 100% saturation in the autumn of 1979 and 1980 are probably attributed to phytoplankton photosynthetic activities near the thermocline where sufficient light and nutrients are available (Appendix II).

3.2.6 Conductivity

Conductivities of epilimnetic and hypolimnetic waters for deep stations in 1979 and 1980 correspond well with seasonal values reported by Truscott and Kelso (1979) for 1976 through 1978 (Table 8). Okanagan, Skaha and Osoyoos Lakes have similar conductivities (1976 to 1980) ranging from 263 to 277 μmhos/cm. Wood and Kalamalka Lakes have higher conductivity ranges of 320 to 362 and 385 to 403 μmhos/cm, respectively. Truscott and Kelso (1979) reported conductivities of lakes in the Okanagan watershed as noticably higher than other British Columbian lakes due to aspects of easily eroded geological materials (limestones, glacial draft, clay-silt terraces, conglomerate rock and bassalts) and high residence times for the lake water.

Reduced epilimnetic conductivities in fall, 1980, with a concomitant increase in hypolimnetic conductivities, relative to spring values, represent epilimnetic decalcification through photosynthesis causing precipitation and partial resolubilization of $CaCO_3$ in the hyplimnion (Wetzel, 1975).

3.2.7 Silicon Dioxide

Mean epilimnetic silicon dioxide values for the spring and fall of 1979-1980 are presented in Table 9. All silicon test results are provided for each station in Appendix III.

All three Okanagan Lake stations recorded SiO_2 values greater than 4.0 mg/l in both spring and fall of 1979 and 1980. Skaha, Wood and Osoyoos Lakes all exhibited silicon depletion with values less than 3.5 mg/l and particularly low values in Skaha Lake (L 0.5 mg/l) in spring 1980 and Wood Lake (0.4 mg/l) in spring 1979. Silicon levels in Kalamalka Lakes were well above those of other mainstem lakes with values ranging from 7.6 to 9.5 mg/l.

TABLE 8 RANGE OF CONDUCTIVITIES FOR LAKES OKANAGAN (OK-1, OK-2, OK-3), SKAHA (S-1), OSOYOOS (O-1), WOOD (W-1) and KALAMALKA (K-1) in 1979 and 1980.

	CONDUCTIVITY* (μmhos/cm)			
	1979		1980	
Station	Spring	Fall	Spring	Fall
OK-1 EP		263	264-265	263-264
HYP		263	264-265	266-270
OK-2 EP		264-266	264	262
HYP		264-266	264-265	265-268
OK-3 EP		264-265	264	263
HYP		265-266	264	266-268
S-1 EP		262-263	268	272-277
O-1 EP		272-273	310	295-297
W-1 EP	328	320-325	346-347	326-329
HYP	328	335-338	348-349	360-362
K-1 EP	387	384-385	391-392	391
HYP	387	390-392	392	400-403

* Measured by Environmental Laboratory.

TABLE 9 MEAN EPILIMNETIC SiO_2 CONCENTRATIONS (mg/1) at OKANAGAN LAKES FOR SPRING AND FALL 1979 AND 1980.

	1979		1980	
Station	Spring	Fall	Spring	Fall
OK-1	4.8	-	4.5	4.3
OK-2	4.7	-	4.5	4.2
OK-3	4.8	-	4.5	4.2
S-1	2.0	-	<0.5	2.6
O-1	2.3	-	3.2	3.0
W-1	0.4	-	2.8	1.1
K-1	9.4	-	8.9	7.7

3.3 Biological Limnology at Deep Stations

3.3.1 Phytoplankton Chlorophyll-a

Chlorophyll-a provides a measure of phytoplankton biomass. Comparison of similar months from year to year is not as meaningful a comparison as seasonal means. As seasonal values were not measured in 1979 and 1980, spring mean chlorophyll-a values will be considered for comparison purposes. Mean weighted chlorophyll-a values are presented for a vertical water column from surface to bottom of the photic zone. All chlorophyll-a data for spring and fall 1979 and 1980 are presented in Appendix III.

Okanagan Lake spring chlorophyll-a levels were characteristic of oligotrophic conditions for the period 1976 to 1980. However, in spring, 1980, mean chlorophyll-a values at OK-1 and OK-2 approached mesotrophic levels of 5.1 and 5.0 ug/l, respectively (Table 10).

Skaha Lake monitoring demonstrated a shift from mesotrophic chlorophyll-a concentrations in 1976-1978 (2.0 to 4.0 ug/l) to eutrophic levels in 1979 (11.0 ug/l) and 1980 (19.6 ug/l, Table 10). This trend follows the increased spring total P and decreasing N:P ratios present in Skaha Lake.

Spring mean chlorophyll-a values for Osoyoos Lake show considerable variability in the meso-eutrophic range (3.37 to 10.40 ug/l) remaining below the seasonal mean of 19.59 μg/l for 1971 (Table 10).

Chlorophyll-a values for Wood and Kalamalka Lakes are reported in Table 10 for 1979 and 1980 only. Comparison of Waste Management Branch chlorophyll-a data and data collected on the Okanagan Basin Implementation Study is not possible due to differences in analytical methods.

Average spring phytoplankton chlorophyll-a values at K-1 in Kalamalka Lake of 2.88 μg/l in 1979 and 5.50 μg/l in 1980 are similar to those for Okanagan Lake in 1979 and 1980.

TABLE 10 SPRING MEAN[1] PHYTOPLANKTON CHLOROPHYLL-A (µg/l) AND PHEOPIGMENT (µg/l) LEVELS AT LAKES OKANAGAN (OK-1 to OK-3), SKAHA (S-1), OSOYOOS (O-1), WOOD (W-1) AND KALAMALKA (K-1) FOR YEARS 1971, 1977 to 1980.

	CHLOROPHYLL-A					CHLOROPHYLL-A + PHEOPIGMENTS				
STATION	1971	1977	1978	1979	1980	1976	1977	1978	1979	1980
OK-1	5.63*	2.56	2.51	2.43	4.95	2.15	2.13	3.05	3.08	5.60
OK-2	3.78*	1.70	2.60	3.75	5.0	1.67	1.62	3.25	4.30	5.90
OK-3	4.01*	0.60	1.90	2.20	1.93	2.38	1.25	2.22	3.38	2.43
S-1	13.19*	2.0	4.0	10.75	17.55	3.46	3.76	5.80	12.73	19.75
O-1	19.59*	7.80	7.80	3.37	10.40	4.64	6.3	6.95	4.53	12.28
W-1	-	-	-	7.30	8.78	-	-	-	12.93	9.28
K-1	-	-	-	2.88	5.5	-	-	-	3.48	6.0

[1] Mean of four epilimnetic sampling depths.

* 1971 seasonal mean values recalculated by Truscott and Kelso (1979) to show chl-a only.

Spring mean chlorophyll-a levels in Wood Lake of 7.30 μg/l (1979) and 8.78 μg/l (1980) were lower than anticipated given the available nutrients. Periodic blooms known to occur throughout the season may not be fairly represented by the values obtained with only spring and fall sampling dates.

3.3.2 Phytoplankton Identification, Volume and Density

Phytoplankton samples were collected in 1979 and 1980 but only 1979 samples were analyzed due to budgetary restraints. The 1980 samples are stored for possible analysis at some later date. Summaries of the results are provided in Tables 11 and 12 and Appendices IV and V of this report. Complete results may be obtained from the Waste Management Branch, Penticton, British Columbia.

Analysis of spring algal samples collected from Okanagan Lake in April, 1979 (Diemert and Kelso, 1980) show a greater standing crop relative to previous years (Appendix IV). An average volume of 3.10 cm^3/m^3 at OK-1 was largely *Lyngbya sp.* followed by diatoms *Synedra delicatissima*, *Asterionella formosa*, *Stephanodiscus niagare*. *Lyngbya sp.* was also dominate at OK-2 (4.57 cm^3/m^3) with lesser contributions by diatoms *S. niagare*, *S. delicatissima* and *Melosira italia*. Blue-green filaments also dominated OK-3 volumes with *Lyngbya sp.* and *Oscillatoria sp.* comprising approximately 80% of the average volume (5.78 cm^3/m^3). Diatoms noted above at OK-2 were also present at OK-3 providing approximately 20% of the total volume. Spring and fall density counts (cells/ml) showed diatoms first in abundance followed closely by blue-greens at all three Okanagan Lake stations. Summaries of phytoplankton densities are provided in Tables 11 and 12 and Appendix V.

Autumn phytoplankton volumes at Okanagan Lake stations in 1979 were similar to those of 1978. In October, 1978, the average volume at OK-1 was 1.28 cm^3/m^3. *Anabaena sp.* was dominant in both years. OK-2 was very similar to OK-1 in respect to both volume and dominant species. As in 1978 the filamentous blue-green *Lyngbya sp.* was dominant at OK-3 in fall, 1979. The 1979 fall data phytoplankton

TABLE 11 AVERAGE DENSITIES* (CELLS/ML) OF MAJOR PHYTOPLANKTON TAXONOMIC GROUPS FOR OKANAGAN LAKES IN SPRING 1979.(DEIMERT AND KELSO, 1979).

TAXONOMIC GROUP	OK-1	OK-2	OK-3	S-1	O-1	W-1	K-1
Total Phytoplankton	1041	1934	2076	2614	1163	6492	1536
Bacillariophyceae	394	833	1020	1233	711	4728	345
Chlorophyta	172	351	336	287	92	271	156
Cyanophyta	349	498	565	696	64	45	481
Chrysophyta	0	0	11	8	6	0	166
Crypotophyta	126	253	150	539	290	1470	388

*Cell densities based on 2.0 and 4.0 meter sampling depths.

TABLE 12 AVERAGE DENSITIES* (CELLS/ML) OF MAJOR PHYTOPLANKTON TAXONOMIC GROUPS FOR OKANAGAN LAKES IN FALL 1979 (DEIMERT AND KELSO, 1979).

TAXONOMIC GROUP	OK-1	OK-2	OK-3	S-1	O-1	W-1	K-1
Total Phytoplankton	754	724	458	7400	5237	1805	989
Bacillariophyceae	309	321	224	4731	1523	235	274
Chlorophyta	180	159	34	279	754	208	61
Cyanophyta	114	98	118	2062	2760	974	341
Chrysophyta	0	6	4	53	15	0	54
Cryptophyta	153	144	79	275	185	388	272

*Cell densities are an average of sampling depths 2.0, 4.0, 10 m and 2.5 times secchi disc depth.

volumes and densities indicate that all three sites on Okanagan Lake are maintaining their oligotrophic state.

Phytoplankton samples collected from Skaha Lake in spring and fall 1979 produced much greater volume and higher densities from samples collected for 1976 through 1978 (Appendix IV, Deimert and Kelso, 1979, and Appendix V). Complete dominance by blue greens, *Oscillotoria sp.* and *Lyngbya sp.*, in addition to *Anabaena sp.* in the fall was reminiscent of blue-green peaks of 91% in September, 1969. Algal densities in spring, 1979, showed *Cyclotella glomerata* as dominant with lesser percentages of *Oscillatoria sp.* and cryptomonad *Chroomonas acuta* Tables 11 and 12). Although diatom dominance and a uniform mixture of minor species in the spring would suggest a mesotrophic state, the high volume of blue-green algal, both spring and fall, indicate an eutrophic condition. Firm conclusions cannot be drawn without data for the summer months.

The Osoyoos Lake 1979 spring phytoplankton data are similar to previous years with blue-green *Oscillatoria sp.* and *Lyngbya sp.* comprising approximately 50% of the dominants by volume (Appendix IV, Deimert and Kelso, 1979). Dominants by density on the other hand, showed a good mixture of 55% diatoms (*Cyclotella sp., Asterionella formosa*) and *Selenastrum sp.*, 30% cryptomonads (*Chroomonas acuta* and *Cryptomonas borealis*), 10% greens (*Chlamydomona sp.*) and only 5% blue-green (Appendix V). Although the fall density counts continued to show a good species mixing of *Lyngbya sp.* followed by the diatom *Cyclotella Kutzingiana*, the phytoplankton volume was dominated up to 90% by blue-green species with the total volume doubling in fall, 1979, to 33.23 cm^3/m^3 (Appendix IV, Deimert and Kelso, 1979).

The 1979 fall volume indicates that Osoyoos Lake has the greatest productivity as it falls into the eutrophic range. Skaha Lake is slightly less productive and meso-eutrophic, and Okanagan Lake is much less productive in the oligotrophic range.

Wood Lake phytoplankton volumes and cell densities are well below those of Skaha and Osoyoos Lakes (Appendix IV, Deimert and Kelso, 1979). The 1979 seasonal mean volume of 4.91 cm^3/m^3 was greatly reduced from the 1976 value of 41.80 $cm^3/^3$. *Cyclotella glomerata* and *Chroomones acuta* were species count dominants in spring, 1979 (Appendix V) and in contrast with other lakes, diatoms *Cyclotella sp.* and *Stephenadiscus tenuis* were also volume dominants. Fall samples showed a mesotrophic mix of blue-greens *Lyngbya sp.*, *Anabaena sp.* and *Microcystis sp.* dominating over lesser dominant spcies of green, cryptomonad and diatom algae (Appendix V).

Kalamalka Lake showed phytoplankton cell densities and volumes only marginally higher than those found in Okanagan Lake (Appendix IV, Deimert and Kelso, 1979, and Appendix V). A varied assemblage of phyla were represented in the list of volume dominants in spring and fall samples with *Lyngbya sp.* occupying the major portion. *Chroomonas sp.* and *Lyngbya sp.* recorded the highest cell densities. Kalamalka Lake would appear to fall between Okanagan and Wood Lakes as being in a meso-oligotrophic condition.

3.3.3 Zooplankton Settled Volume

Zooplankton settled volumes provide an estimate of the zooplankton standing crop or net secondary production. Settled volume determinations carried out by Patalas and Salki (1973) and Truscott and Kelso (1979) illustrate considerable variability in the timing of peak secondary production and a general increase in secondary production downstream through the Okanagan Lake system. Over 1971 to 1978 zooplankton settled volumes decreased in Skaha Lake, increased in Okanagan Lake and remained relatively unchanged for Osoyoos Lake.

All tows in 1979 and 1980 produced lower zooplankton settled volumes than 1976 to 1978. Without additional seasonal information the results are inconclusive (Table 13). All settled volume data, including sampling dates are provided in Appendix III.

TABLE 13 ZOOPLANKTON SETTLED VOLUMES (mm^3/cm^2) FOR AUGUST, SEPTEMBER AND OCTOBER, 1969, 1971, 1976-1980.

STATION		1969	1971	1976	1977	1978	1979	1980
OK-1	August	-	11.5	19.6	-	23.83	-	-
	September	21.0	-	18.3	-	-	-	11.20
	October	-	-	-	-	-	8.41	-
OK-2	August	-	11.5	21.1	-	33.20	-	-
	September	8.9	-	20.5	-	-	-	-
	October	-	-	-	-	-	7.97	-
OK-3	August	-	-	13.4	-	21.28	-	-
	September	17.0	-	13.9	-	-	18.9	9.65
	October	-	-	-	-	-	-	-
S-1	August	-	24.1	13.7	16.9	16.7	-	-
	September	23.2	-	9.7	16.1	25.46	-	12.22
	October	-	-	-	-	-	-	-
O-1	August	-	10.9	18.6	16.8	27.01	-	-
	September	25.9	-	6.1	15.5	20.98	-	17.72
	October	-	-	-	-	-	10.64	-
W-1	August	-	-	-	-	-	-	-
	September	-	-	-	-	-	-	-
	October	-	-	-	-	-	3.82	18.59
K-1	August	-	-	-	-	-	-	-
	September	-	-	-	-	-	-	-
	October	-	-	-	-	-	5.81	7.94

3.3.4 Zooplankton Identification

Detailed seasonal investigations were made of zooplankton populations in Okanagan Lakes by Patalas and Salki (1973) and Truscott and Kelso (1979). Spring and fall sampling results for 1979 provide information on general species composition but a rather incomplete picture of seasonal standing crop fluctuations in the primary consumer groups. A summary of the taxonomic identification is given in Table 14. Complete sampling results are provided in Appendix VI. Taxonomic samples collected in 1980 were not analyzed and are being stored by the Waste Management Branch in Penticton.

Only three spring samples and one fall sample were available for Okanagan Lake in 1979 (Table 14). Although data are limited the percent composition was the same as in 1976-1978. The dominant species remained as *Cyclops bicuspidatus* and *Diaptomus ashlandi* for Copepoda (85%-97%), *Daphnia longiremus* and *Bosmina coregoni* for Cladocera (<1%), and *Notholca accuminata* and *Kellicotia longispina* as dominant Rotifers (<1% - 4%).

Identification of spring and fall zooplankton samples for Skaha Lake in 1979 demonstrated a composition similar to Okanagan Lake samples (Table 14). *Mysis relicta* through its diurnal vertical migration and evasive capabilities was collected in only one vertical haul in spring, 1979. Fish and Wildlife sampling (unpublished) using bottom trauls has shown *Mysis relicta* to be extremely abundant in Skaha Lake and may represent the bulk of the zooplankton standing crop.

A decrease in total crustacean zooplankton in Skaha Lake, as suggested by Truscott and Kelso (1979), cannot be substantiated without seasonal data for 1979.

Composition of Osoyooos Lake zooplankton in spring and fall, 1979, consisted of 90% - 92% Copepoda (*D. ashlandi, C. bicuspidatus*), less than one percent Cladocera (*Camptocercus sp., D. longiremus*) and less than one to four percent Rotifera (*F. longiseta, K. longispina)*.

TABLE 14 ZOOPLANKTON PERCENT COMPOSITION, AVERAGE ABUNDANCE (Indiv./cm^2) AND DOMINANT GENERA AT OKANAGAN LAKES IN 1979.

STATION		MAJOR TAXA	PERCENT COMPOSITION	ABUNDANCE (Indiv./cm^2)	DOMINANT SPECIES
OK-1	Apr.	Cladocera	0.20	0.07	*Daphnia longiremus*
		Copepoda	97.77	32.30	; *Cyclops bicuspidatus*
		Rotifera	2.03	0.67	*Notholca accuminata*
OK-2	Apr.	Cladocera	0.23	0.13	*Bosmina coregoni*
		Copepoda	90.23	51.25	; *C. bicuspidatus*
		Rotifera	9.54	5.42	*N. accuminata*
	Oct.	Cladocera	5.47	0.65	*D. longiremus; Sida crystalina*
		Copepoda	93.16	11.12	; *C. bicuspidatus; Diaptomus ashlandi*
		Rotifera	1.37	0.16	*Kellicotia longispina*
OK-3	Apr.	Cladocera	0.18	0.07	*B. coregoni*
		Copepoda	87.55	31.29	; *C. bicuspidatus*
		Rotifera	12.27	4.39	*N. accuminata; K. longispina*
S-1	Apr.	Cladocera	0.79	0.16	*D. longiremus*
		Copepoda	92.97	19.33	*D. ashlandi; C. bicuspidatus*
		Rotifera	5.93	1.23	*K. hiemalis; N. accuminata*
		Mysid	0.31	0.07	*Mysis relicta*
	Oct. 2	Cladocera	4.00	0.43	*B. coregoni*
		Copepoda	94.16	10.05	*D. ashlandi; C. bicuspidatus*
		Rotifera	1.84	0.20	*K. longispina*
O-1	Apr.	Cladocera	1.51	0.78	*Camptocercus sp.*
		Copepoda	91.40	47.48	*D. ashlandi; C. bicuspidatus*
		Rotifera	7.09	3.68	*F. longiseta*
	Oct. 1	Cladocera	4.38	0.52	*D. longiremus*
		Copepoda	91.73	10.80	*D. ashlandi*
		Rotifera	3.89	0.01	*Kellicotia longispina; K. quadrata*
W-1	Apr.	Cladocera	1.85	1.18	*D. longiremus; Sida crystalina*
		Copepoda	96.51	61.32	*D. ashlandi*
		Rotifera	1.64	1.05	*K. longispina*
	Oct.	Cladocera	12.48	0.73	*D. longiremus; S. crystalina*
		Copepoda	85.84	5.01	*D. ashlandi*
		Rotifera	1.68	0.10	*Trichocerca similis*
K-1	Apr.	Cladocera	0	0	
		Copepoda	89.13	29.28	*D. ashlandi; C. bicuspidatus*
		Rotifera	10.87	3.57	*Keratella cochlearis; K. longispina*

Peak numbers of zooplankton were noted in fall, 1979, for Wood Lake with Copepoda comprising 86%, Cladocera 12% and Rotifera approximately 2%. Spring and fall dominants were copepod *Diaptomus ashlandi*, cladocera *Daphnia longiremus* and *Sida crystalina*. Rotifers *Kellicotia longispina* and *Trichocerca similis* were spring and fall dominants respectively.

Cladocerans were absent in the Kalamalka Lake spring sample, possibly due to their preference of warmer waters (Wetzel, 1975). Copepoda comprising approximately 90% of the spring zooplankton population were represented by adults of species *Diaptomus ashlandi* and *Cyclops bicuspidatus*. Approximately 10% of the population was comprised of a varied assemblage of rotifers with *Keratela cochlearis* and *Kellicotia longispina* as the dominant species.

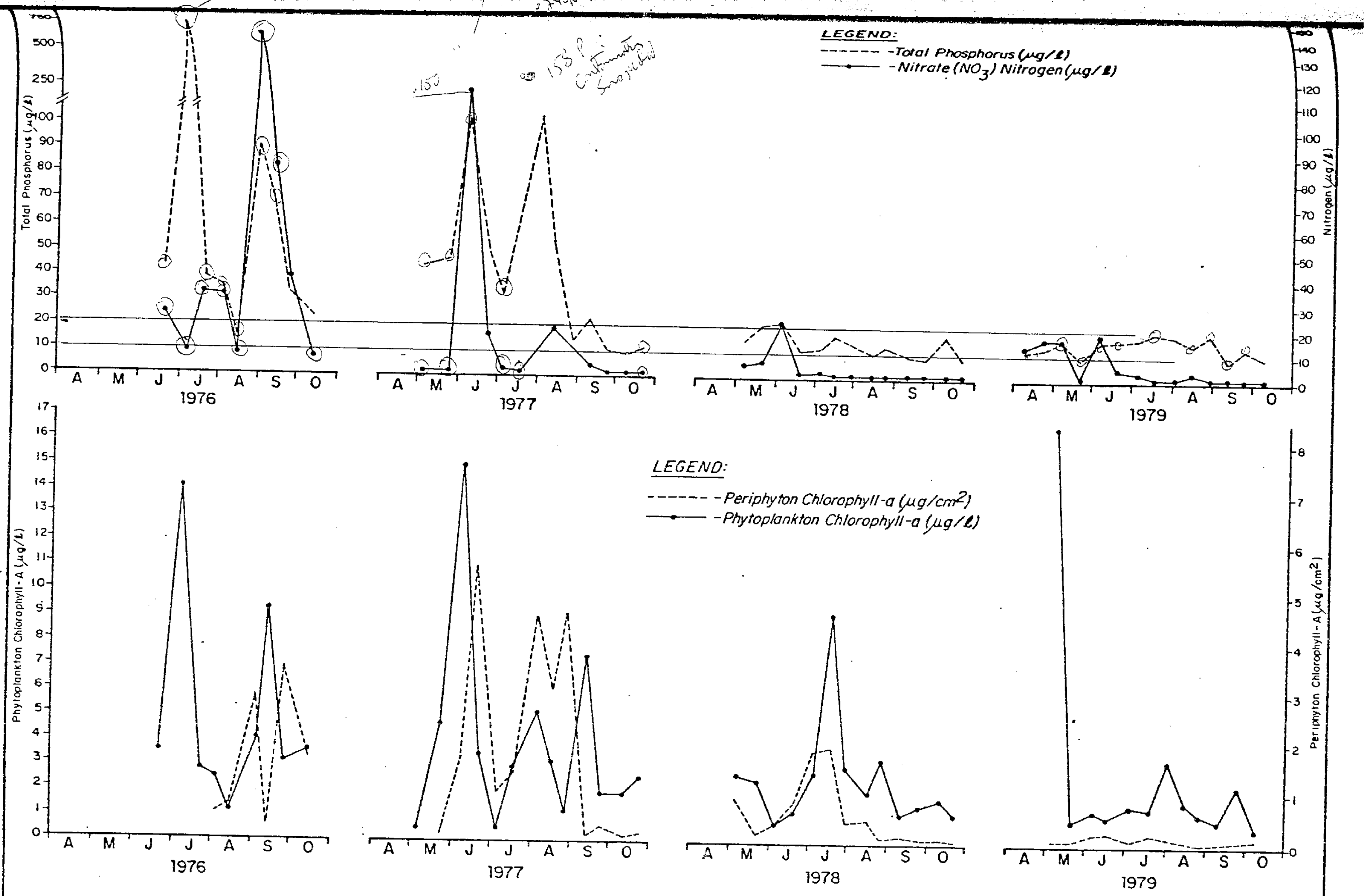
4. RESULTS AND DISCUSSION FOR SHALLOW STATIONS

4.1 Chemical Limnology for Shallow Stations

4.1.1 Phosphorus

Total phosphorus levels in Vernon Arm (OK-S2) decreased dramatically in August, 1977, when all wastewater was diverted from Vernon Creek (Figure 2). Total P seasonal means were 42.0 and 50.0 µg/l in 1976 and 1977, respectively (Truscott and Kelso 1979). Seasonal means of 13.6 and 14.5 µg/l total P for 1978 and 1979 demonstrate reduction in phosphorus loading to Vernon Arm of Okanagan Lake (Table 5). Seasonal means for total dissolved phosphorus were reduced from 29.0 µg/l (1976) and 26.0 µg/l (1977) to 5.2 µg/l in 1978 and 9.2 µg/l in 1979.
Data for 2 Aug 77 omitted because contamination suspected (P was 138 µg/l & N+N 240 µg/l)

Seasonal phosphorus values at the shallow control station OK-S3, located at Okanagan Centre, remained similar to those of deep Okanagan Lake stations with total P values ranging from 7.0 to 9.0 µg/l and total dissolved P ranging from 4.0 to 5.0 µg/l over the four-year sampling period. Individual sampling dates and results are provided in Appendix III.



Max P 90 in T+K
in winter

240 Max N+N
Min OK

Max P
158
Min OK

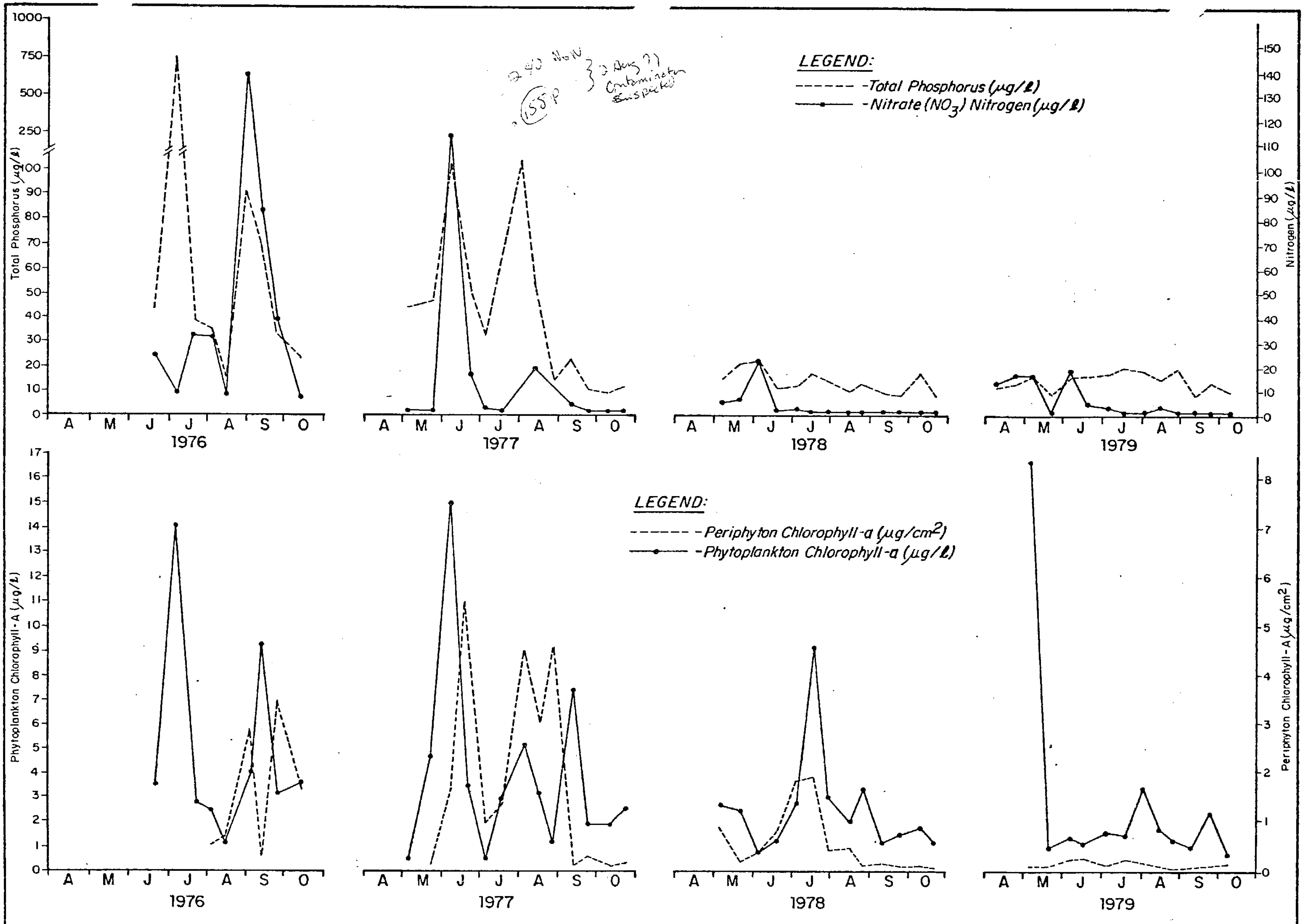
.150

158 P: Contamination Suspected

TOTAL PHOSPHORUS (µg/ℓ), PHYTOPLANKTON CHLOROPHYLL-A (µg/ℓ) and PERIPHYTON CHLOROPHYLL-A (µg/cm²) and NITROGEN (µg/ℓ) at VERNON ARM, OK^NAGAN LAKE (OK-S2), 1976 to 1979.

Figu 2

? August 77 Contamination Suspected ∴ data eliminated from plot for N+P



240 NoN
.155 P
} 3 Aug 77 Contamination suspected

TOTAL PHOSPHORUS (µg/ℓ), PHYTOPLANKTON CHLOROPHYLL-A (µg/ℓ) and PERIPHYTON CHLOROPHYLL-A (µg/cm²) and NITROGEN (µg/ℓ) at VERNON ARM, OKANAGAN LAKE (OK-S2), 1976 to 1979.

Figure: 2

4.1.2 Ammonia Nitrogen

Ammonia levels at OK-S2 in Vernon Arm exhibited a four-year trend 1976-1979) similar to the phosphorus data with noticably lower values in 1978 and 1979 (Figure 2). The seasonal mean ammonia level at OK-S2 in 1979 (6.4 µg/l) was slightly above that of 1978 (5.2 µg/l) but well below 1976 and 1977 levels of 26.3 and 26.0 µg/l prior to complete sewage diversion (Table 5). Ammonia levels at control station OK-S3 located near Okanagan Centre were similar to levels found at Okanagan Lake deep stations with seasonal means ranging from 2.7 to 7.4 µg/l for 1976 through 1979.

4.1.3 Nitrate Nitrogen

Following complete sewage diversion from Vernon Arm (OK-S2) in August, 1977, nitrate nitrogen concentrations dropped to levels well below those of the deep stations. Seasonal values for OK-S2 of 6.4 µg/l in 1979 and 13.4 µg/l in 1978 contrast sharply with 41.5 and 30.9 µg/l in 1976 and 1977, respectively (Table 7). An increase in the seasonal mean nitrate level at control station OK-S3 to 7.5 µg/l was well above the range of 1.2 to 2.6 µg/l for the previous three years and may indicate localized nutrient loading. A similar increase in nitrate nitrogen occurred at adjacent deep station OK-1 in 1977 through 1979 Table 6).

4.2 Biological Limnology for Shallow Stations

4.2.1 Phytoplankton Chlorophyll-a

Seasonal phytoplankton chlorophyll-a values at OK-S2 in Vernon Arm decreased progressively from 4.97 µg/l in 1976 and 4.16 µg/l in 1977 to 2.50 µg/l in 1978 and 1.59 µg/l in 1979 (Table 15). Reduced

TABLE 15 SEASONAL MEANS FOR PHYTOPLANKTON AND PERIPHYTON[1] CHLOROPHYLL-A AT SHALLOW STATIONS FROM 1976 THROUGH 1979

STATION		Chlorophyll-a			
		1976	1977	1978	1979
OK-S2	Phytoplankton (ug/l)	4.97	4.16	2.05	1.59
	Periphyton (ug/cm^2)	-	1.87	0.58	0.15
OK-S3	Phytoplankton (ug/l)	1.38	1.03	2.30	0.98
	Periphyton (ug/cm^2)	-	0.05	0.07	0.02

[1] Fourteen-day sampling periods

phytoplankton closely matches the observed reduction in nutrient levels following complete sewage diversion from Vernon Creek in August, 1977 (Figure 2). Similar trends in phytoplankton reduction, although less dramatic, have been observed by the Waste Management Branch in the main body of Vernon Arm for 1975 through 1980. Seasonal mean phytoplankton chlorophyll-a levels at control station OK-S3 varied little (0.98 to 2.30 μg/l) over the four-year period (1976 to 1979). All sampling results for 1979 at OK-S2 and OK-S3 are shown in Appendix III.

Dense stands of *Myriophyllum spicatum* in Vernon Arm surround station OK-S2. The *Myriophyllum spicatum* undoubtedly competes with phytoplankton for nutrients and sunlight. Wetzel (1975) reports that dense stands of macrophytes reduce the value of phytoplankton chlorophyll-a as a biological production indicator. Comparison of phytoplankton chlorophyll-a levels at OK-S2 and the center of Vernon Arm show relatively similar levels despite much higher nitrogen and phosphorus levels at OK-S2. Depsite this limitation phytoplankton chlorophyll-a may still serve as a general indicator of biological production between shallow stations of similar character or, as in this case, at one shallow station over a number of successive years.

4.2.2 Phytoplankton Identification and Volume

The seasonal mean phytoplankton volume decreased at OK-S2 in Vernon Arm of Okanagan Lake from 5.23 cm^3/m^3 in 1978 to 3.41 cm^3/m^3 in 1979 (Table 16). Comparison of 1978 data with the limited data available for 1977 also demonstrated a decrease in phytoplankton volume. In addition to decreasing phytoplankton volume for years 1977 through 1979 a diverse species composition was apparent at OK-S2 in 1979. Blue-green algae *Lyngbya sp.* and *Anabaena sp.* were dominants in May and June, succeeded by Dinophyceae *Gymnodinium sp.* in early September, chrysophyte *Cryptomonas borealis* in late September, and finally shifting back to *Anabaena sp.* in October. Shifts towards increased species diversity and lower total volumes are signs of reduced primary productivity probably in response to decreased nutrient levels following complete sewage diversion in August, 1977.

TABLE 16 TOTAL PHYTOPLANKTON VOLUME (cm^3/m^3) AND DOMINANT GENERA AT PEAK PRODUCTION AT SHALLOW STATIONS - 1977, 1978 AND 1979 (DEIMERT AND KELSO, 1979).

STATION	MEAN 1977 VALUES	1978 MEAN VALUES COMPARABLE TO 1977	1978 SEASONAL MEAN (MISSING 2 SEPT. VALUES AND 1 VALUE FROM MAY & OCT.)	1979 SEASONAL MEAN
OK-S2	9.55	2.97	5.23 (15.52)*	3.41 (9.07)*
	(Jul. 2/Aug. 2/Oct. 2)		*Gymnodinium sp.* July 3	*Lyngbya sp.* May 8
OK-S3	-	-	1.91 (3.03)*	5.69 (20.47)*
			Aphanizomenon sp. Jun. 13	*Lyngbya sp.* July 3

* Peak value for season.

The Okanagan Centre station (OK-S3) produced a phytoplankton volume peak of 20.47 cm^3/m^3 in July of 1979 (*Lyngbya sp.*) well above the 1978 volume peak in June at 3.03 cm^3/m^3 (*Aphanizomenon sp.*). Phytoplankton volume increases in 1979 may in part be in response to slight increases observed in spring total phosphorus and nitrate nitrogen.

4.2.3 Periphyton Chlorophyll-a

Because of their sessile nature, periphyton communities provide excellent biological indicators of water quality. Ash-free dry weights in conjunction with chlorophyll-a values were evaluated as an indicator of primary biological production in littoral areas (OK-S2) experiencing cultural eutrophication. Individual sampling results for each two-week period are provided in Appendix III.

Truscott and Kelso (1979) reported a reduction in periphyton chlorophyll-a from 1971 (8.5 $\mu g/cm^2$) to 1977 (2.28 $\mu g/cm^2$) despite differences in experimental variation. Further decreases in mean seasonal periphyton chlorophyll-a occurred in 1978 (0.58 $\mu g/cm^2$) and 1979 (0.15 $\mu g/cm^2$) probably in response to the reduced nutrient loading to Vernon Arm (Table 15). Seasonal mean periphyton chlorophyll-a levels at OK-S3 were also lower in 1979 than the two previous years (see Table 15) illustrating year to year variation.

4.2.4 Periphyton Identification and Volume

Vernon Arm shallow station (OK-S2) periphyton populations were dominated by diatoms in 1977 and 1978 but by green algae in 1976 and 1979 (Table 17). Diatoms became prominent (90%) only once in 1979 on September 25th. Major portions of the 1979 total volume consisted of filamentous greens *Oedogonium sp.*, *Cladophora sp.* and *Spirogyra sp.* (Deimert and Kelso, 1979).

Okanagan Centre periphyton volumes peaked in May, 1979, with smaller peaks in early July and late August. Diatoms (*Cymbella sp.*) composed over 90% of the population until mid-June, 75% to 85% June through August, and greater than 90% in the fall of 1979. As diatom domination lessened in mid-June, 5% to 16% of the population shifted to blue-greens, *Lyngbya* and *Anabaena sp.* Blue-green algae contributed 26% in 1977 and only 4% in 1978 (Table 17).

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TABLE 17 MEAN SEASONAL VOLUMES (mm^3/cm^3) AND MEAN PERCENT COMPOSITION BY VOLUME OF MAJOR PERIPHYTON PHYLA - 1977, 1978 AND 1979 (DEIMERT AND KELSO, 1979).

STATION	RANK IN PRODUCTION	MAJOR TAXA	MEAN SEASONAL VOLUMES WITH DATES OF MINIMA AND MAXIMA (mm^3/cm^3)						MEAN SEASONAL PERCENT BY VOLUME		
			1977		1978		1979		1977	1978	1979
OK-S2	2			(Oct. 10 - Jul. 18)		(Aug. 28 - Jul. 31)		(May 22 - Jun. 19)			
		Total	1.72	(0.18 - 7.07)	0.26	(0.05 - 1.04)	0.42	(0.06 - 1.00)			
		Diatoms	1.25		0.24		0.16		73	92	95*
		Greens	0.46		0.01		0.29		26	4	4
		Blue Greens	0.01		0.01		0.01		< 1	4	1
OK-S3				(Oct. 24 - Jul. 4)		(Oct. 23 - Jul. 31)		(Oct. 9 - May 8)			
		Total	0.16	(0.01 - 0.57)	0.05	(0.01 - 0.16)	0.04	(<0.01 - 0.11)	88	100	85
		Diatoms	0.14		0.05		0.03		12	-	6
		Greens	0.02		<0.01		<0.01		-	-	8
		Blue Greens	-		<0.01		0.01		-	-	1**

* Note: August 1 and August 14, 1979, samples lost.

** Chrysophyta

APPENDIX I

Precipitation Record (mm) for the Okanagan Valley

1976, 1977, 1978, 1979

(Provided by Atmospheric Environment Service,
Penticton, B. C.)

APPENDIX I PRECIPITATION (mm) FOR THE OKANAGAN VALLEY 1976, 1977, 1978, 1979 (PROVIDED BY ATMOSPHERIC ENVIRONMENT SERVICE, PENTICTON, B.C.)

	YEAR	AVERAGE	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.
VERNON (COLDSTREAM RANCH)	1976	51.8	25.1	55.9	76.2	45.0	121.7	11.2	27.9
	1977	27.4	5.6	39.9	19.1	34.0	41.1	32.5	19.8
	1978	37.9	38.1	62.7	34.0	31.2	24.5	62.7	25.7
	1979	28.6	17.8	31.2	24.2	36.4	33.6	45.2	24.2
OYAMA	1976	45.7	20.1	55.9	40.6	30.5	136.1	10.7	26.2
	1977	24.6	13.7	44.7	9.7	24.4	33.0	29.7	17.3
	1978	38.0	35.6	47.4	43.2	19.6	42.2	91.4	25.6
	1979	29.2	18.0	38.0	10.7	35.6	36.2	41.2	33.2
OKANAGAN CENTRE	1976	34.0	19.1	24.4	24.9	32.3	110.7	7.6	20.1
	1977	20.3	11.4	25.7	14.2	28.2	31.0	23.6	8.6
	1978	39.3	38.8	39.4	29.0	33.2	48.0	92.3	21.0
	1979	25.3	19.0	28.8	9.0	32.3	44.9	35.0	27.8
WINFIELD	1976	37.8	19.6	32.5	32.3	28.2	125.2	5.6	22.1
	1977	22.9	9.1	40.9	11.2	24.1	32.3	31.0	12.7
	1978	27.8	38.1	37.2	24.1	26.8	24.5	-	12.9
	1979	21.1	-	30.2	2.6	26.2	30.8	34.0	26.0
KELOWNA (AIRPORT)	1976	37.6	15.0	36.1	31.5	29.2	123.4	7.6	20.3
	1977	19.6	12.5	45.5	13.0	22.6	17.5	19.8	6.1
	1978	32.6	39.2	38.3	22.1	25.0	32.8	89.5	16.4
	1979	19.8	8.0	27.1	6.7	25.6	40.8	26.9	21.6
PEACHLAND	1976	32.0	12.7	27.7	36.8	21.3	100.1	1.3	24.1
	1977	17.0	8.9	32.5	17.5	15.8	9.4	30.7	5.3
	1978	29.3	46.7	24.6	10.9	24.6	41.7	44.2	6.4
	1979	25.2	11.0	21.4	10.1	29.2	47.3	30.6	37.4
SUMMERLAND	1976	34.8	15.5	25.4	40.4	48.8	80.0	18.0	15.5
	1977	19.3	14.0	46.2	10.2	20.1	13.5	23.4	8.1
	1978	30.2	57.7	34.8	20.6	20.3	40.6	36.7	6.4
	1979	21.1	13.4	16.7	21.3	19.7	53.3	33.7	28.3
PENTICTON (AIRPORT)	1976	26.4	16.5	29.5	15.7	22.6	86.1	3.0	11.7
	1977	24.6	15.2	61.0	9.4	19.8	30.5	34.0	2.8
	1978	27.2	60.4	21.2	18.5	26.0	44.9	36.8	2.3
	1979	23.2	10.5	29.2	14.6	28.0	49.2	37.7	27.1
OKANAGAN FALLS	1976	24.1	26.9	33.3	18.8	4.8	72.4	1.3	12.2
	1977	72.4	11.7	74.0	5.6	12.2	22.4	14.2	5.1
OLIVER	1978	20.5	44.2	19.1	8.4	7.4	44.2	25.1	2.4
	1979	19.0	17.0	15.4	12.8	28.6	37.6	27.9	33.5
OSOYOOS	1976	22.9	5.6	34.3	27.9	5.1	74.7	3.3	9.7
	1977	17.0	8.9	32.5	17.5	15.7	9.4	30.7	5.3
	1978	24.7	44.2	15.5	19.6	17.0	45.0	30.3	Trace
	1979	18.7	27.2	7.0	24.6	11.0	27.5	11.8	27.8
AREA SEASONAL MEAN	1976	34.7							
	1977	26.5							
	1978	29.8							
	1979	23.1							
	1980	Data not available.							

APPENDIX II

A. Vertical Temperature (^{o}C) and Dissolved Oxygen (mg/l) Profiles for Okanagan Lake (OK-1) north of Okanagan Centre and Okanagan Lake (OK-2) south of Kelowna, 1979-1980

B. Vertical Temperature (^{o}C) and Dissolved Oxygen (mg/l) Profiles for Okanagan Lake (OK-3) south of Squally Point, 1979-1980

C. Vertical Temperature (^{o}C) and Dissolved Oxygen (mg/l) Profiles for Osoyoos Lake (O-1) and Skaha Lake (S-1), 1979-1980

D. Vertical Temperature (^{o}C) and Dissolved Oxygen (mg/l) Profiles for Kalamalka Lake (K-1) and Wood Lake (W-1), 1979-1980

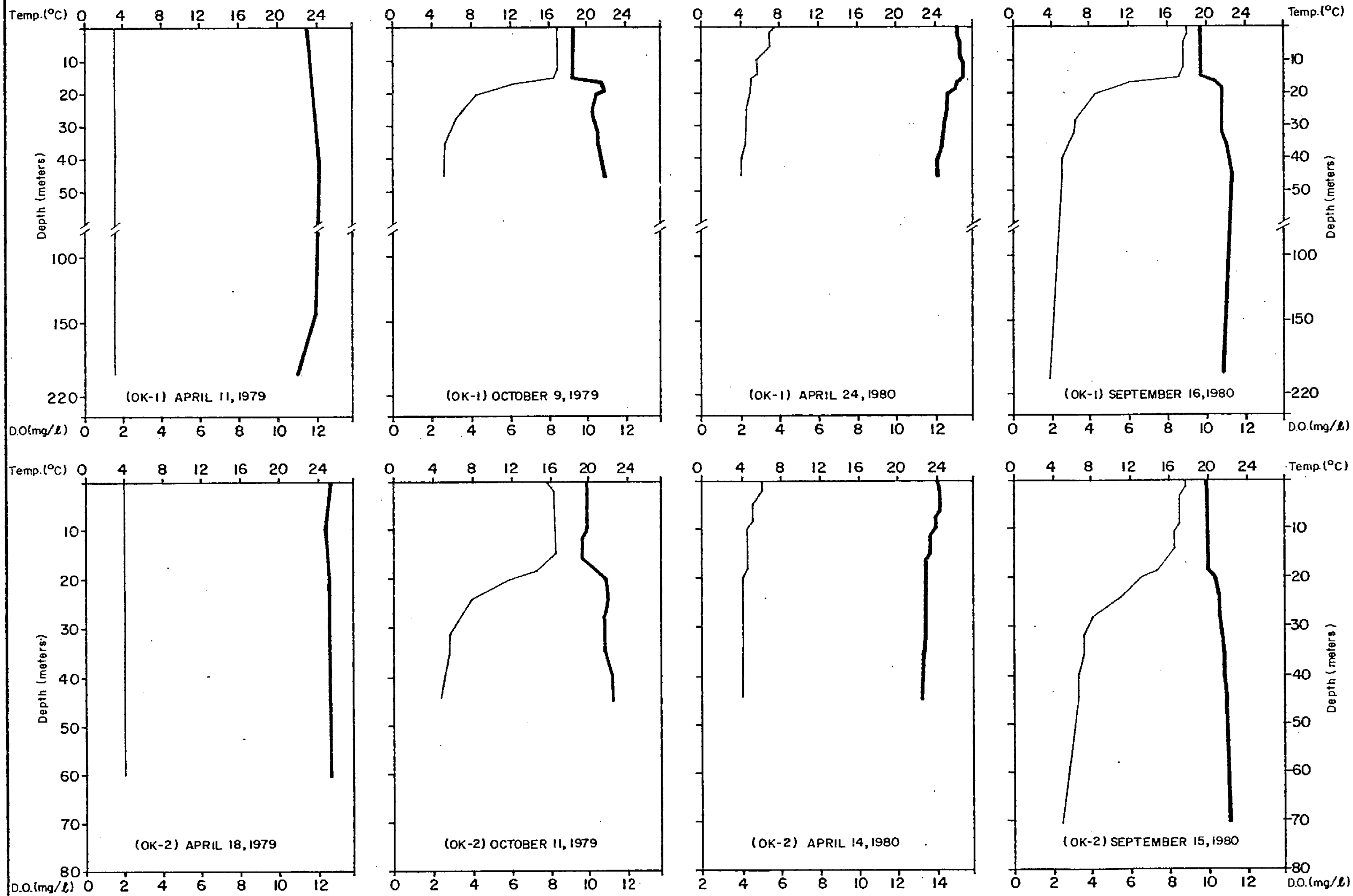

Figure: A Vertical Temperature (°C) and Dissolved Oxygen (mg/ℓ) Profiles for Okanagan Lake (OK-1) north of Okanagan Centre and Okanagan Lake (OK-2) south of Kelowna, 1979-80.

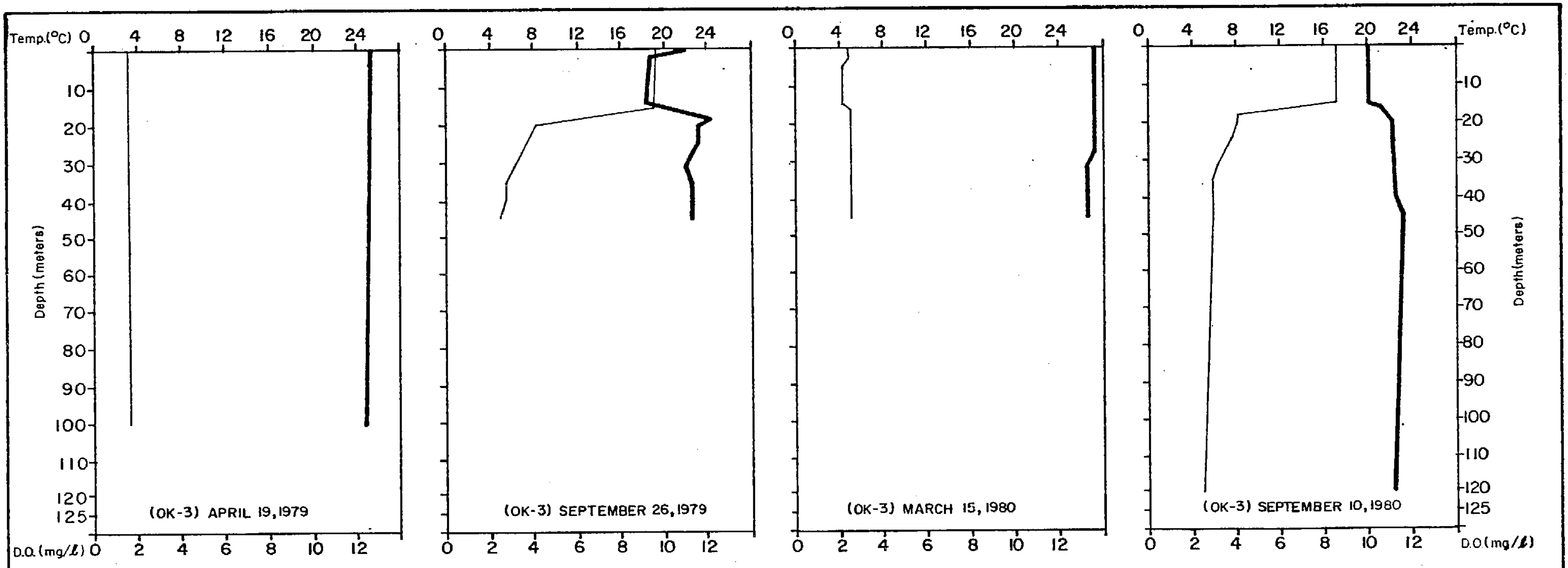

Figure: B Vertical Temperature (°C) and Dissolved Oxygen (mg/ℓ) Profiles for Okanagan Lake (OK-3) south of Squally Point, 1979-80.

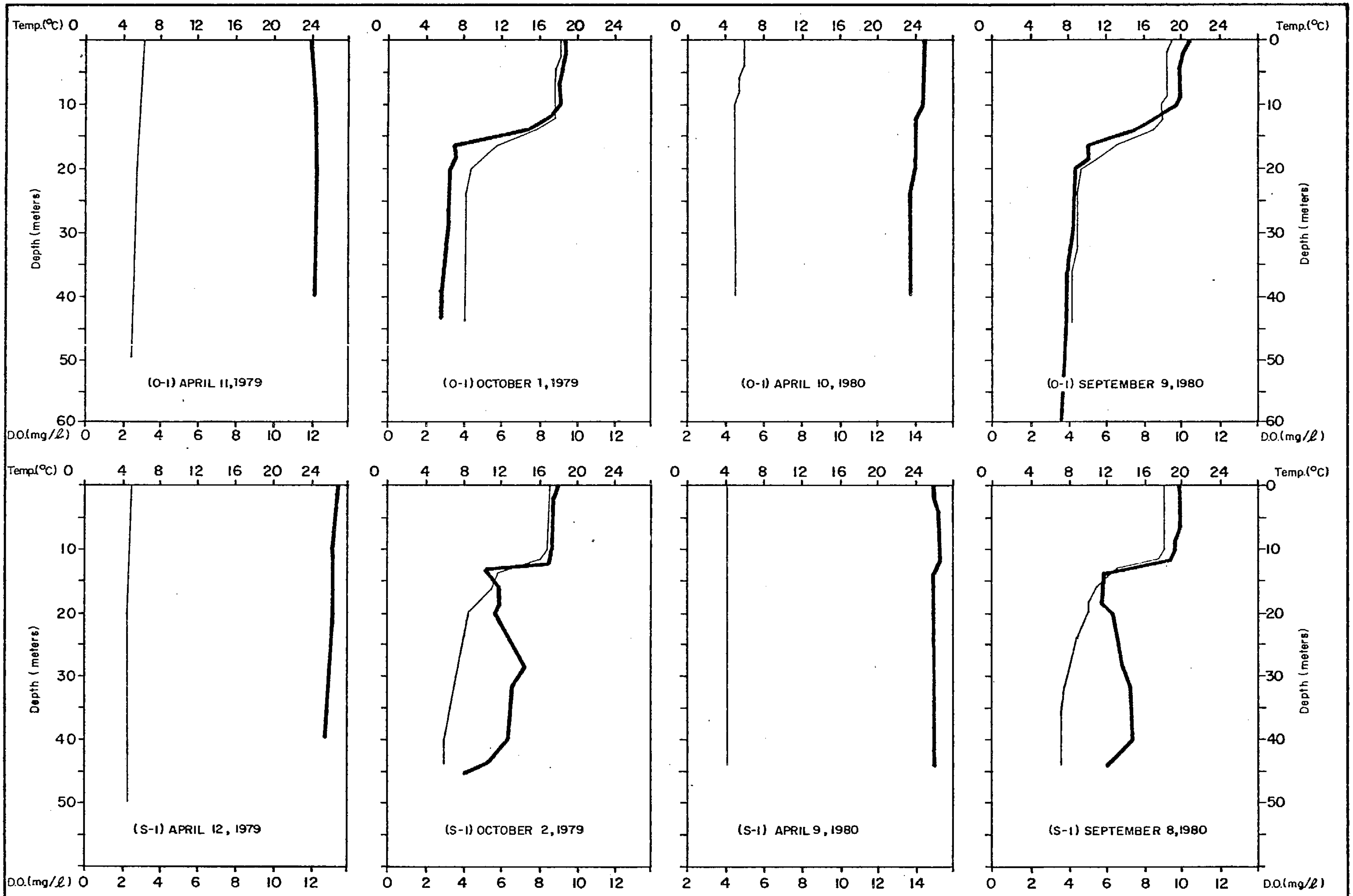

Figure: C Vertical Temperature (°C) and Dissolved Oxygen (mg/ℓ) Profiles for Osoyoos Lake (O·1) and Skaha Lake (S·1), 1979-80.

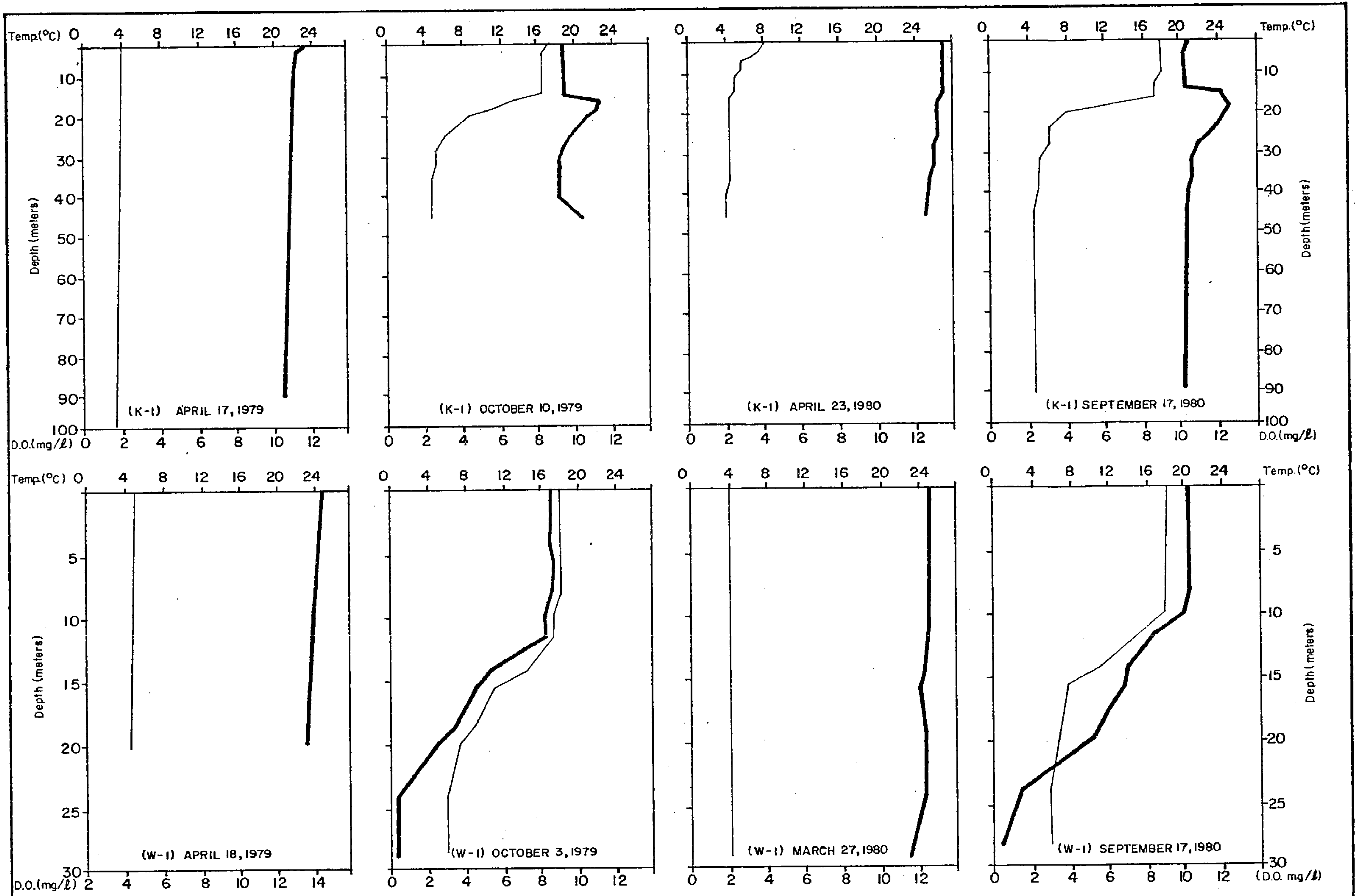

Figure: D Vertical Temperature (°C) and Dissolved Oxygen (mg/ℓ) Profiles for Kalamalka Lake (K-1) and Wood Lake (W-1), 1979-80.

APPENDIX III

A. WATER QUALITY DATA SUMMARY - OKANAGAN LAKE, OKANAGAN CENTRE (OK-1) - 1979 and 1980

	CHEMICAL PARAMETERS (mg/l)													BIOLOGICAL PARAMETERS				
Date	Depth (m)	TP	TDP	N/N	NH_3	TDN	TN	Org.	SiO_2	Carbon		Part. C	Part. N	Phytoplankton (µg/l)			Zooplankton Settled Volume	
										Inorg.	Org.			Depth (m)	Chl-A	Pheo.	Rep. No.	mm^3/cm^2
79.04.10	1	0.010	0.005	0.034	0.029	0.27	0.28	-	4.8	-	-	0.150	0.013	2	1.8	1.0	1	5.09
	20	0.009	0.003	0.035	0.012	0.18	0.20	-	4.8	-	-	0.291	0.022	4	2.2	0.78	2	3.67
	140	0.008	0.003	0.035	0.016	0.19	-	-	4.8	-	-	-	-	10	3.5	<0.48	3	2.04
	160	0.009	0.007	0.065	<0.02	0.19	0.19	-	5.2	-	-	0.134	<0.005	30	2.2	<0.36	4	3.46
79.10.09	1	0.007	0.004	<0.02	0.009	0.170	0.20	0.19	-	-	5.0	0.324	<0.005	2	0.56	<0.32	1	7.65
	12	0.006	0.003	<0.02	0.013	0.165	0.25	0.24	-	-	4.0	0.348	<0.005	4	0.56	<0.32	2	9.69
	20	0.009	0.007	<0.02	0.011	0.150	0.31	0.30	-	-	4.0	0.330	0.025	10	0.64	<0.32	3	9.16
	44	0.007	0.006	0.05	0.009	0.160	0.20	0.14	-	-	3.0	0.085	<0.005	30	0.56	0.45	4	7.13
80.04.24	1	0.010	0.005	<0.02	0.009	0.135	0.14	0.13	4.4	27.0	4.0	0.365	0.031	2	4.4	<0.5	1	9.16
	12	0.012	0.005	<0.02	0.012	0.135	0.15	0.14	4.5	26.0	5.0	0.428	0.046	4	4.9	<0.5	2	7.13
	20	0.011	0.005	0.03	0.010	0.150	0.17	0.13	4.6	27.0	5.0	0.273	0.021	10	6.5	<0.5	3	8.15
	44	0.010	0.007	0.04	0.011	0.160	0.18	0.13	4.7	27.0	4.0	0.164	0.013	17	6.6	<0.5	4	6.62
80.09.16	1	0.006	0.005	<0.02	0.019	0.165	0.24	0.22	4.3	28.0	3.0	0.398	<0.02	2	0.5	<0.5	1	10.18
	12	0.008	0.005	<0.02	0.013	0.150	0.28	0.27	4.3	27.0	3.0	0.417	<0.02	4	0.5	<0.5	2	12.22
	20	0.011	0.005	<0.02	0.016	0.140	0.18	0.16	4.4	28.0	3.0	0.475	0.037	10	0.5	<0.5	3	-
	208	0.017	0.015	0.10	0.047	0.255	0.36	0.21	5.6	29.0	3.0	0.196	<0.012	22.5	1.0	<0.5	4	-

B. WATER QUALITY DATA SUMMARY - OKANAGAN LAKE SOUTH OF KELOWNA BRIDGE (OK-2) - 1979 and 1980

Date	CHEMICAL PARAMETERS (mg/l)													BIOLOGICAL PARAMETERS				
	Depth (m)	TP	TDP	N/N	NH_3	TDN	TN	Org. N	SiO_2	Carbon		Part. C	Part. N	Phytoplankton (µg/l)			Zooplankton Settled Volume	
										Inorg.	Org.			Depth (m)	Chl-A	Pheo.	Rep. No.	mm^3/cm^2
79.04.18	1	0.011	0.005	0.030	0.002	0.16	0.20	-	4.5	-	-	0.391	0.041	2	4.0	0.59	1	8.35
	10	0.009	0.004	0.030	0.006	0.16	0.18	-	4.8	-	-	0.271	0.023	4	3.8	0.55	2	8.55
	20	0.007	0.004	0.029	0.003	0.16	0.20	-	4.8	-	-	0.362	0.028	10	4.0	0.57	3	9.16
	60	0.011	0.003	0.029	0.002	0.16	0.19	-	4.8	-	-	0.336	0.031	23	3.2	0.49	4	9.16
79.10.11	1	0.010	0.006	<0.02	0.011	0.155	0.17	0.16	-	-	3.0	0.570	0.023	2	0.80	<0.32	1	6.52
	12	0.010	0.007	<0.02	0.010	0.170	0.17	0.16	-	-	4.0	0.531	0.018	4	0.80	<0.32	2	6.92
	20	0.008	0.007	<0.02	0.009	0.145	0.21	0.20	-	-	3.0	0.349	0.016	10	0.80	<0.32	3	-
	44	0.009	0.009	0.050	0.008	0.175	0.21	0.15	-	-	3.0	0.128	<0.005	26	0.64	<0.32	4	7.13
80.04.14	1	0.008	0.005	<0.02	0.012	0.150	0.79	0.78	4.4	29.0	3.0	0.302	0.024	2	7.7	2.0	1	9.16
	12	0.007	0.004	0.03	0.013	0.195	0.57	0.53	4.5	29.0	3.0	0.282	0.023	4	4.8	0.8	2	5.09
	20	0.007	0.004	0.04	0.014	0.160	0.23	0.18	4.5	29.0	3.0	0.212	<0.005	10	4.0	<0.5	3	4.07
	44	0.007	0.004	0.05	0.023	0.195	0.35	0.28	4.5	29.0	3.0	0.264	0.017	19	3.5	<0.5	4	3.67
80.09.15	1	0.009	0.005	<0.02	0.016	0.170	0.42	0.40	4.2	28.0	3.0	0.512	<0.025	2	0.6	<0.5	1	10.18
	12	0.007	0.006	<0.02	0.012	0.160	0.32	0.31	4.2	28.0	3.0	0.438	0.021	4	0.6	<0.5	2	7.13
	20	0.010	0.004	<0.02	0.014	0.145	0.27	0.26	4.3	29.0	3.0	0.373	<0.02	10	0.8	<0.5	3	10.18
	76	0.009	0.007	0.06	0.017	0.180	0.26	0.18	4.8	29.0	3.0	0.161	0.009	24	0.9	0.5	4	11.20

C. WATER QUALITY DATA SUMMARY - OKANAGAN LAKE SOUTH OF SQUALLY POINT (OK-3), 1979 and 1980.

Date	CHEMICAL PARAMETERS (mg/l)													BIOLOGICAL PARAMETERS				
										Carbon				Phytoplankton (µg/l)			Zooplankton Settled Volume	
	Depth (m)	TP	TDP	N/N	NH_3	TDN	TN	Org. N	SiO_2	Inorg.	Org.	Part. C	Part. N	Depth (m)	Chl-A	Pheo.	Rep. No.	mm^3/cm^2
79.04.19	1	0.005	0.002	0.028	0.002	0.15	0.17	-	4.8	-	-	0.281	0.017	2	2.1	1.2	1	3.05
	20	0.006	0.003	0.027	<0.002	0.15	0.17	-	4.8	-	-	0.250	0.019	4	2.1	1.4	2	3.05
	50	0.006	0.002	0.027	0.003	0.15	0.15	-	4.7	-	-	0.228	<0.005	10	2.6	0.80	3	3.05
	100	0.006	<0.002	0.029	0.002	0.15	0.15	-	4.7	-	-	0.251	<0.005	30	2.1	1.2	4	3.20
79.09.26	1	0.006	0.004	<0.02	0.009	-	0.20	0.19	-	-	3.0	-	-	2	0.64	0.42	1	15.88
	12	0.006	-	<0.02	0.012	-	0.28	0.27	-	-	4.0	-	-	4	0.32	0.74	2	23.42
	20	0.009	0.006	<0.02	0.009	-	0.20	0.19	-	-	5.0	-	-	10	0.40	0.61	3	16.29
	44	0.007	0.006	0.02	0.009	-	0.15	0.12	-	-	3.0	-	-	30	0.24	0.43	4	20.36
80.04.15	1	0.008	0.004	0.040	0.013	0.155	0.33	0.28	4.5	27.0	3.0	0.227	0.024	2	1.8	<0.5	1	2.85
	12	0.007	0.005	0.040	0.012	0.150	0.31	0.26	4.5	27.0	3.0	0.198	0.025	4	2.1	<0.5	2	2.44
	20	0.006	0.005	0.030	0.011	0.150	0.21	0.17	4.5	27.0	3.0	0.205	0.023	10	1.7	<0.5	3	2.44
	44	0.010	0.009	0.040	0.013	0.150	0.31	0.26	4.5	27.0	3.0	0.223	<0.005	30	2.1	<0.5	4	1.83
80.09.10	1	0.009	0.005	<0.02	0.017	0.160	0.20	0.18	4.2	26.0	5.0	0.271	0.012	2	0.6	<0.5	1	10.18
	12	0.008	0.005	<0.02	0.013	0.160	0.15	0.14	4.2	26.0	5.0	0.246	0.015	4	0.6	<0.5	2	7.13
	20	0.012	0.005	<0.02	0.013	0.140	0.24	0.23	4.3	27.0	5.0	0.378	0.037	10	0.7	<0.5	3	10.18
	120	0.009	0.008	0.06	0.023	0.195	0.23	0.15	4.7	27.0	5.0	0.214	<0.012	21	1.1	<0.5	4	11.12

D. WATER QUALITY DATA SUMMARY - SKAHA LAKE, OPPOSITE GILLIES CREEK (S-1) - 1979 and 1980

Date	CHEMICAL PARAMETERS (mg/l)													BIOLOGICAL PARAMETERS				
	Depth (m)	TP	TDP	N/N	NH_3	TDN	TN	Org. N	SiO_2	Carbon		Part. C	Part. N	Phytoplankton (µg/l)			Zooplankton Settled Volume	
										Inorg.	Org.			Depth (m)	Chl-A	Pheo.	Rep. No.	mm³/cm²
79.04.12	1	0.021	0.005	0.011	0.011	0.19	0.29	-	1.9	-	-	0.747	0.102	2	10.0	<1.4	1	5.09
	10	0.024	0.005	0.016	0.016	0.22	0.33	-	2.0	-	-	0.655	0.105	4	11.0	<1.6	2	3.06
	20	0.023	0.005	0.021	0.013	0.20	0.30	-	1.9	-	-	0.647	0.103	10	11.0	2.5	3	3.06
	40	0.023	0.005	0.028	0.011	0.19	0.28	-	1.9	-	-	0.569	0.088	12	11.0	2.4	4	2.04
79.10.02	1	0.012	0.006	<0.02	0.012	0.31	0.37	0.36	-	-	4.0	0.536	0.064	2	3.04	0.88	1	-
	12	0.011	0.005	<0.02	0.011	0.37	0.44	0.43	-	-	5.0	0.551	0.066	4	2.88	0.87	2	-
	20	0.008	0.005	0.06	0.012	0.27	0.27	0.20	-	-	4.0	0.247	<0.005	9.9	2.88	0.87	3	-
	40	0.089*	0.084*	0.26*	0.014	0.82	0.82*	0.55*	-	-	4.0	0.265	<0.005	10.0	3.04	0.88	4	-
80.04.09	1	0.026	0.009	<0.02	<0.005	0.24	0.35	0.35	<0.5	27.0	6.0	0.856	0.107	2	17.0	1.8	1	10.18
	12	0.025	0.010	<0.02	0.016	0.16	0.26	0.24	<0.5	27.0	5.0	0.815	0.099	4	18.6	2.3	2	7.64
	20	0.024	0.009	<0.02	0.019	0.26	0.38	0.36	<0.5	27.0	5.0	0.949	0.120	10	17.0	2.4	3	6.11
	44	0.023	0.010	<0.02	<0.005	0.19	0.29	0.29	<0.5	27.0	6.0	0.843	0.100	12	17.6	2.3	4	7.13
80.09.08	1	0.011	0.005	<0.02	0.015	0.195	0.43	0.42	2.6	27.0	4.0	0.882	0.093	2	3.2	<0.5	1	12.22
	12	0.010	0.004	<0.02	0.012	0.200	0.30	0.29	2.6	27.0	4.0	0.897	0.084	4	2.9	<0.5	2	15.27
	20	0.009	0.005	0.10	0.021	0.240	0.42	0.30	1.6	29.0	4.0	0.361	<0.033	7	3.2	<0.5	3	12.22
	44	0.049	0.038	0.22*	0.016	0.370	0.59*	0.35	2.4	29.0	5.0	0.402	<0.033	10	5.2	<0.5	4	9.16

E. WATER QUALITY DATA SUMMARY - OSOYOOS LAKE, OPPOSITE MONASHEE CO-OP (O-1) - 1979 and 1980

Date	CHEMICAL PARAMETERS (mg/l)													BIOLOGICAL PARAMETERS				
	Depth (m)	TP	TDP	N/N	NH_3	TDN	TN	Org. N	SiO_2	Carbon		Part. C	Part. N	Phytoplankton (μg/l)			Zooplankton Settled Volume	
										Inorg.	Org.			Depth (m)	Chl-A	Pheo.	Rep. No.	mm^3/cm^2
79.04.11	1	0.017	0.005	0.032	0.028	0.23	0.29	-	2.2	-	-	0.451	0.062	2	3.6	0.71	1	3.05
	10	0.016	0.005	0.034	0.029	0.22	0.28	-	2.3	-	-	0.381	0.055	4	4.9	<0.69	2	4.07
	20	0.018	0.006	0.038	0.028	0.22	0.27	-	2.2	-	-	0.381	0.046	10	1.6	2.1	3	-
	40	0.018	0.006	0.042	0.024	0.22	0.26	-	2.6	-	-	0.342	0.043					-
79.10.01	1	0.014	0.009	<0.02	0.014	0.15	0.28	0.27	-	-	6.0	0.899	0.127	2	7.37	1.10	1	10.18
	12	0.015	0.009	<0.02	0.016	0.28	0.38	0.36	-	-	7.0	0.690	0.100	4	7.77	1.16	2	11.40
	20	0.023	0.014	0.25	0.012	0.41	0.43	0.17	-	-	4.0	0.285	0.016	10	7.13	1.06	3	10.59
	40	0.054	0.046	0.33	0.015	0.52	0.54	0.20	-	-	2.0	0.254	0.016	11	8.33	1.23	4	10.39
80.04.10	1	0.023	0.007	0.10	0.013	0.235	0.40	0.29	3.0	31.0	4.0	0.835	0.141	2	9.8	1.3	1	16.29
	12	0.020	0.008	0.14	0.016	0.255	0.48	0.32	3.4	31.0	2.0	0.613	0.100	4	11.0	3.2	2	36.65
	20	0.022	0.010	0.16	0.019	0.450	0.47	0.29	3.6	31.0	2.0	0.447	0.064	8.5	10.4	1.3	3	22.40
	44	0.020	0.011	0.17	0.022	0.520	0.46	0.27	3.6	31.0	2.0	0.436	0.059	10	10.4	1.7	4	18.33
80.09.09	1	0.011	0.008	<0.02	0.018	0.27	0.39	0.37	2.9	26.0	5.0	1.03	0.120	2	5.1	<0.5	1	11.81
	12	0.014	0.005	<0.02	0.027	0.24	0.34	0.31	3.0	26.0	6.0	0.860	0.098	4	5.0	<0.5	2	20.36
	20	0.026	0.016	0.29	0.019	0.46	0.49	0.18	5.5	32.0	5.0	0.334	<0.033	7	5.4	<0.5	3	20.57
	44	0.050	0.041	0.38	0.028	0.60	0.63	0.22	6.2	32.0	5.0	0.257	<0.033	10	4.5	0.7	4	18.33

F. WATER QUALITY DATA SUMMARY - KALAMALKA LAKE, SOUTH RATTLESNAKE POINT (K-1) - 1979 and 1980

Date	CHEMICAL PARAMETERS (mg/l)													BIOLOGICAL PARAMETERS				
	Depth (m)	TP	TDP	N/N	NH_3	TDN	TN	Org. N	SiO_2	Carbon Inorg.	Carbon Org.	Part. C	Part. N	Phytoplankton (µg/l) Depth (m)	Chl-A	Pheo.	Zooplankton Settled Volume Rep. No.	mm^3/cm^2
79.04.17	1	0.007	0.007	0.034	0.006	0.21	0.24	-	9.2	-	-	0.339	0.031	2	2.4	0.73	1	3.46
	5	0.008	0.004	0.034	0.007	0.20	0.23	-	9.5	-	-	0.316	0.034	4	3.5	<0.53	2	3.87
	50	0.006	0.003	0.045	0.004	0.20	0.22	-	9.3	-	-	0.229	0.017	10	3.0	0.71	3	3.46
	90	0.007	0.003	0.050	0.013	0.20	0.23	-	9.4	-	-	0.166	0.019	24	2.6	0.46	4	3.05
79.10.10	1	0.006	0.003	<0.02	0.012	0.190	0.20	0.19	-	-	2.0	0.274	<0.005	2	0.80	<0.32	1	6.11
	12	0.006	0.005	<0.02	0.013	0.185	0.16	0.15	-	-	2.0	0.274	<0.005	4	0.72	<0.32	2	6.52
	20	0.011	0.008	<0.02	0.010	0.170	0.19	0.18	-	-	1.0	0.229	<0.005	10	0.72	<0.32	3	5.70
	44	0.007	0.007	0.06	0.010	0.210	0.33	0.26	-	-	1.0	0.125	<0.005	25	0.80	<0.32	4	4.89
80.04.23	1	0.010	0.007	0.04	0.026	0.225	0.27	0.20	8.9	39.0	<1.0	NS	NS	2	4.5	<0.5	1	4.58
	12	0.010	0.006	0.03	0.013	0.190	0.25	0.21	8.9	38.0	<1.0	NS	NS	4	6.4	<0.5	2	5.09
	20	0.009	0.005	0.04	0.013	0.195	0.27	0.22	8.9	39.0	<1.0	NS	NS	10	4.7	<0.5	3	5.09
	44	0.010	0.005	0.05	0.020	0.205	0.26	0.10	9.0	38.0	<1.0	NS	NS	19	6.2	<0.5	4	3.67
80.09.17	1	0.006	0.005	<0.02	0.018	0.180	0.29	0.27	7.6	35.0	6.0	0.562	0.032	2	0.5	<0.5	1	8.65
	12	0.006	0.004	<0.02	0.026	0.190	0.35	0.32	7.7	36.0	4.0	0.467	0.033	4	0.5	<0.5	2	7.13
	20	0.009	0.005	<0.02	0.016	0.200	0.24	0.22	7.8	37.0	5.0	0.511	0.049	10	0.6	<0.5	3	8.35
	96	0.008	0.007	0.10	0.022	0.225	0.33	0.21	9.5	38.0	5.0	0.164	0.009	13	<0.5	<0.5	4	7.64

G. WATER QUALITY DATA SUMMARY - WOOD LAKE AT CENTRE (W-1) - 1979 and 1980

Date	CHEMICAL PARAMETERS (mg/l)													BIOLOGICAL PARAMETERS				
										Carbon				Phytoplankton (μg/l)			Zooplankton Settled Volume	
	Depth (m)	TP	TDP	N/N	NH_3	TDN	TN	Org. N	SiO_2	Inorg.	Org.	Part. C	Part. N	Depth (m)	Chl-A	Pheo.	Rep. No.	mm^3/cm^2
79.04.18	1	0.054	0.031	0.052	0.041	0.44	0.57	-	0.4	-	-	0.789	0.131	2	7.0	5.7	1	8.16
	5	0.054	0.032	0.054	0.046	0.44	0.55	-	0.4	-	-	0.685	0.113	4	7.3	5.4	2	7.74
	10	0.056	0.033	0.055	0.042	0.44	0.56	-	0.3	-	-	0.705	0.121	8	7.6	5.8	3	8.35
																	4	9.16
79.10.03	1	0.014	0.012	<0.02	0.018	-	0.51	0.49	-	-	6.0	0.493	0.052	2	1.60	0.47	1	1.63
	12	0.014	0.008	<0.02	0.022	-	0.43	0.41	-	-	6.0	0.519	0.047	4	1.76	0.76	2	5.49
	20	0.174	-	0.46	0.020	-	0.82	0.34	-	-	5.0	0.237	<0.005	10	1.60	0.64	3	3.05
	28	0.270	0.263	0.14	0.530	-	1.42	0.75	-	-	6.0	0.528	0.061	13	1.04	0.64	4	5.09
80.03.27	1	0.092	0.080	0.22	0.029	0.525	0.59	0.34	2.8	40.0	4.0	0.474	0.049	2	8.2	<0.5	1	-
	12	0.081	0.080	0.22	0.033	0.525	0.59	0.34	2.8	40.0	<1.0	0.451	0.045	4	8.9	<0.5	2	-
	20	0.082	0.078	0.23	0.027	0.525	0.57	0.31	2.8	40.0	<1.0	0.525	0.051	10	8.5	<0.5	3	-
	28	0.081	0.079	0.23	0.038	0.535	0.55	0.28	2.8	40.0	4.0	0.517	0.057	20	9.5	<0.5	4	-
80.09.17	1	0.016	0.009	<0.02	0.030	0.340	0.41	0.38	1.1	32.0	7.0	0.802	0.093	2	2.8	0.7	1	24.44
	12	0.018	0.008	<0.02	0.032	0.320	0.48	0.45	1.0	33.0	7.0	0.677	0.067	4	2.4	1.1	2	18.33
	20	0.171	0.156	0.37	0.038	0.615	0.88	0.47	3.6	40.0	8.0	0.309	<0.02	8	2.1	0.5	3	19.35
	28	0.251	0.240	0.23	0.258	0.625	0.87	0.38	4.7	41.0	9.0	0.344	0.034	10	1.6	0.5	4	12.22

H. WATER QUALITY DATA SUMMARY - OKANAGAN LAKE SHALLOW STATION AT VERNON ARM (OK-S2) - 1979

Date	CHEMICAL PARAMETERS (mg/l)						BIOLOGICAL PARAMETERS						
							Phytoplankton (µg/l)		Attached (ug/cm^2)		Periphyton (mg/cm^2)		
	TP	TDP	N/N	NH_3	TDN	SiO_2	Chl-A	Pheo.	Chl-A	Pheo.	Dry Wt.	Ash Wt.	Volat. Wt.
79.04.09	0.012	0.004	0.013	0.008	0.21	4.8					0.7000	0.5976	0.1023
79.04.23	0.013	0.005	0.017	0.008	0.17	5.3							
79.05.09	0.016	0.007	0.016	0.002	0.21	5.3	1.68	1.29	0.99	0.43			
79.05.22	0.009	0.005	< .002	0.004	0.155	4.8	1.04	0.47	1.51	1.66	1.3717	0.1582	1.2135
79.06.05	0.015	0.015	0.018	0.006	0.186	5.5	1.36	1.27	2.40	1.42	3.7476	0.4329	3.3147
79.06.19	0.016	0.009	0.005	0.012	0.196	4.7	1.20	1.55	2.64	0.92	0.1247	0.0924	0.0323
79.07.03	0.017	0.005	0.003	0.010	0.211	4.5	1.68	0.73	1.32	0.59	0.0382	0.0253	0.0129
79.07.17	0.020	0.009	<0.002	0.018	0.215	4.3	1.52	0.44	2.31	0.36	0.5411	0.4153	0.1258
79.08.01	0.018	0.021	<0.002	0.002	0.220	3.9	3.52	0.85	NS	NS	NS	NS	NS
79.08.14	0.015	0.008	0.003	0.009	0.225	3.7	1.76	0.37	NS	NS	NS	NS	NS
79.08.28	0.019	0.016	<0.002	0.007	0.246	4.1	1.28	0.59	0.78	0.12	0.0923	0.0588	0.0335
79.09.11	0.008	0.006	<0.002	0.002	0.195	4.5	1.04	0.36	0.73	0.13	0.0629	0.0305	0.0323
79.09.25	0.014	0.011	<0.002	0.005	0.200	4.2	2.32	0.37	1.12	0.30	0.235	0.182	0.053
79.10.09	0.010	0.008	<0.002	0.008	0.181	4.6	0.72	<0.32	1.34	0.27	0.269	0.211	0.058

I. WATER QUALITY DATA SUMMARY - OKANAGAN LAKE SHALLOW STATION AT OKANAGAN CENTRE (OK-S3) - 1979

Date	CHEMICAL PARAMETERS (mg/l)						BIOLOGICAL PARAMETERS						
							Phytoplankton (µg/l)		Attached (ug/cm^2)		Periphyton (mg/cm^2)		
	TP	TDP	N/N	NH_3	TDN	SiO_2	Chl-A	Pheo.	Chl-A	Pheo.	Dry Wt.	Ash Wt.	Volat. Wt.
79.04.10	0.006	0.002	0.033	<0.002	0.17	4.8	-	-					
79.04.23	0.012	0.002	0.032	0.002	0.17	4.6					0.1676	0.1305	0.037
79.05.09	0.012	0.006	0.016	0.003	0.17	4.7	1.84	1.47	0.57	1.41	0.2129	0.0576	0.1552
79.05.22	0.010	0.005	<0.002	0.007	0.155	4.6	1.50	0.53	0.23	0.31	0.1229	0.0252	0.0976
79.06.05	0.012	0.008	0.002	0.005	0.165	4.4	2.08	0.55	0.10	0.26	0.1711	0.0323	0.1388
79.06.19	0.008	0.006	<0.002	0.004	0.160	4.3	1.52	0.50	0.13	0.11	0.5423	0.4218	0.1205
79.07.03	0.007	0.003	0.002	0.005	0.165	4.2	0.80	0.71	0.08	0.16	0.377	0.3218	0.0552
79.07.17	0.027	0.007	<0.002	0.019	0.170	4.3	0.40	0.44	0.08	0.19	0.088	0.057	0.031
79.08.01	0.006	0.004	<0.002	0.004	0.195	4.3	0.40	0.38	0.26	0.13	0.1488	0.1000	0.0488
79.08.14	0.009	0.004	0.004	0.008	0.195	4.4	0.40	<0.32	0.11	0.09	0.0941	0.057	0.037
79.08.28	0.37*	0.008	<0.002	0.004	0.190	4.4	0.80	<0.64	0.46	0.09	0.2376	0.1594	0.0782
79.09.11	0.006	0.005	<0.002	0.003	0.190	4.5	0.72	<0.32	0.40	0.07	0.1888	0.1335	0.0552
79.09.25	0.005	0.006	<0.002	<0.002	0.125	4.4	0.40	0.33	0.17	0.08			
79.10.09	0.005	0.005	<0.002	0.004	0.175	4.6	0.88	0.46	0.10	0.07	0.041	0.623	0.018

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*Contamination suspected.

J. FIELD OBSERVATIONS AT OKANAGAN LAKE SHALLOW STATIONS - 1979

VERNON ARM

Date	SFC Temp. °C	pH	Secchi Depth (m)	Water Surface	Wind	Cloud Cover	Comments
79.04.10	4	NS	Bottom	Choppy	North	5/10	
79.04.23	6	NS	Bottom	Rippled	West	0	Barrel vandalized and relocated back to original position.
79.05.08	12.0	7.7	2.0	Choppy	S. Mod.	5/10	Periphyton plates not located.
79.05.22	12.5	7.8	2.8	Rippled	Light	Sunny	
79.06.05	18.0	7.9	2.0	Calm	Calm	5/10	Light rain.
79.06.19	17.0	8.3	2.0	Rough		8/10	
79.07.03	19.0	8.6	4.7		Light	Clear	
79.07.17	21.0	8.9	2.5	Calm	Calm	Clear	Sampler not located due to aquatic macrophyte.
79.08.01	23.0	9.0	2.0	Wavy	Mod.	Clear	Aquatic macrophyte dense; sampler not located.
79.08.14	23.5	8.8	4.0	Light Chop	Light	100%	Sampler not located.
79.08.28	23.0	8.4	4.5	Calm	Calm	0	
79.09.11	20.0	8.8	7.9		S. & Light	3/10	
79.09.25	18.5	8.6	8.2		S. & Light	Clear	
79.10.09	16.0	8.7	8.9	Calm	0	Clear	

OKANAGAN CENTRE

Date	SFC Temp. °C	pH	Secchi Depth (m)	Water Surface	Wind	Cloud Cover	Comments
79.04.10	4	NS	Bottom	Rippled	South	9/10	
79.04.23	4	NS	Bottom	Wavy	NW	0/10	
79.05.08	9.0	7.65	6.3		Calm	Sunny	
79.05.22	13.0	7.7	5.0	Calm	Calm	Sunny	
79.06.05	13.0	8.1	5.3	Choppy	S. Strong	5/10	
79.06.19	15.0	8.2	5.5	Calm	Calm	5/10	
79.07.03	17.0	8.5	8.0	Calm	Light	9/10	
79.07.17	21.5	8.7	7.0	Calm		0/10	
79/08.01	23.5	8.8	8.0	Calm		0/10	
79.08.14	21.5	8.4	10.0	Calm	Calm	10/10	
79.08.28	23.0	8.3	10.5	Calm	Calm	0/10	
79.09.11	20.0	8.9	10.5	Rippled	S. Wind	5/10	
79.09.25	19.5	8.8	12.0	Rippled	N. Wind	2/10	
79.10.09	16.0	8.8	13.0	Rippled	N. Wind	3/10	

APPENDIX IV

A. Standing Crop of Phytoplankton at Okanagan Lake Deep Stations 1969, 1976 to 1979 (Counts = No. cells/ml; Volumes = cm^3/m^3), Deimert and Kelso, 1979.

B. Standing Crop of Phytoplankton at Lakes Skaha and Osoyoos Deep Stations 1969, 1971, 1976 to 1979 (Counts = No. cells/ml; Volumes = cm^3/m^3), Deimert and Kelso, 1979.

C. Standing Crop of Phytoplankton at Lakes Wood and Kalamalka Deep Stations 1976 and 1979 (Number = No./cells/ml; Volume = cm^3/m^3), Deimert and Kelso, 1979.

A. STANDING CROP OF PHYTOPLANKTON AT OKANAGAN LAKE DEEP STATIONS 1969, 1976 TO 1979 (Counts = No. cells/ml; Volumes = cm^3/m^3) (Deimert and Kelso, 1979).

		1969	1976		1977		1978		1979	
STATION		JUN.-OCT.	NUMBER	VOLUME	NUMBER	VOLUME	NUMBER	VOLUME	NUMBER	VOLUME
OK-1	Apr.	-	-	-	1134	2.82	1350	0.83	1041	3.10
	Jun.	-	549	0.88	-	-	-	-	-	-
	Jul.	-	311	1.85	193	0.64	345	0.83	-	-
	Aug.	-	428	0.67	-	-	658	1.27	-	-
	Sep.	-	425	1.01	-	-	-	-	759	1.13
	Oct.	-	678	3.24	68	0.44	294	1.28	-	-
	Mean		478	1.53	465	0.42	661	1.04	900	2.12
OK-2	Apr.	-	-	-	1092	3.09	1551	0.95	1927	4.57
	Jun.	-	-	-	-	-	-	-	-	-
	Jul.	-	211	0.27	100	0.65	575	1.05	-	-
	Aug.	-	301	0.82	-	-	315	0.39	-	-
	Sep.	-	662	2.65	-	-	-	-	724	0.83
	Oct.	-	805	1.27	142	0.48	211	0.74	-	-
	Mean	342	495	1.25	445	0.45	663	0.78	1326	2.70
OK-3	Apr.	-	-	-	524	0.39	287	0.29	2076	5.78
	Jun.	-	901	1.06	-	-	-	-	-	-
	Jul.	-	300	0.58	337	0.31	1025	0.94	-	-
	Aug.	-	485	1.10	-	-	342	0.18	-	-
	Sep.	-	-	-	-	-	-	-	458	0.73
	Oct.	-	1025	2.54	139	0.16	180	0.93	-	-
	Mean		677	1.32	333	0.29	459	0.58	1267	3.26

B. STANDING CROP OF PHYTOPLANKTON AT LAKES SKAHA AND OSOYOOS DEEP STATIONS 1969, 1971, 1976 TO 1979 (Counts = No. cells/ml; Volumes = cm^3/m^3), DEIMERT AND KELSO, 1979.

		1969	1971	1976		1977		1978		1979	
STATION		JUN.-OCT.		NUMBER	VOLUME	NUMBER	VOLUME	NUMBER	VOLUME	NUMBER	VOLUME
S-1	Apr.	-	-	-	-	603	0.93	1827	1.94	2578	7.23
	May	-	-	-	-	639	0.89	1086	0.80	-	-
	Jun.	-	-	2253	1.93	432	0.65	2956	1.61	-	-
	Jul.	-	-	874	7.83	221	0.43	1419	2.34	-	-
	Aug.	-	-	1345	3.28	284	0.51	1749	3.10	-	-
	Sep.	-	-	1555	5.28	401	1.16	1033	4.35	-	-
	Oct.	-	-	861	3.90	734	1.30	2074	3.66	7400	27.49
	Mean	774	3700	1377	4.44	473	0.84	1735	2.55	4989	17.36
0-1	Apr.	-	-	-	-	865	0.92	1335	2.94	1163	1.09
	May	-	-	-	-	354	0.28	759	0.43	-	-
	Jun.	-	-	4539	5.74	3345	2.30	1112	1.02	-	-
	Jul.	-	-	4682	7.82	435	2.74	561	3.60	-	-
	Aug.	-	-	4452	7.45	448	2.31	1333	3.40	-	-
	Sep.	-	-	-	-	398	6.54	1663	15.54	-	-
	Oct.	-	-	-	-	735	2.55	2989	4.59	5237	33.23
	Mean	953	5470	4558	7.01	954	2.52	1393	4.50	3200	17.16

C. STANDING CROP OF PHYTOPLANKTON AT LAKES WOOD AND KALAMALKA DEEP STATIONS 1976 AND 1979 (Number = No. cells/ml; Volume = cm^3/m^3), DEIMERT AND KELSO, 1979.

		1976		1979	
STATION		NUMBER	VOLUME	NUMBER	VOLUME
W-1	Apr.	-	-	6492	2.09
	Jun.	2544	49.08	-	-
	Jul.	2981	74.92	-	-
	Aug.	2458	45.35	-	-
	Sep.	1538	28.71	-	-
	Oct.	572	10.96	1805	7.72
	Mean	2019	41.80	4149	4.91
K-1	Apr.	-	-	1536	5.03
	Jun.	4539	5.52	-	-
	Jul.	671	2.43	-	-
	Aug.	301	0.57	-	-
	Sep.	223	0.40	-	-
	Oct.	119	0.18	989	3.08
	Mean	1171	1.82	1263	4.06

APPENDIX V

A. Phytoplankton Dominants Ranked by Average Density (Cells/ml) for all Depths Sampled in Okanagan Lake in 1979

B. Phytoplankton Dominants Ranked by Average Density for all Depths Sampled in Skaha Lake (S-1) and Osoyoos Lake (O-1) in 1979

C. Phytoplankton Dominants Ranked by Average Density (Cells/ml) for all Depths Sampled in Wood Lake (W-1) and Kalamalka Lake (K-1)

A. PHYTOPLANKTON DOMINANTS RANKED BY AVERAGE DENSITY (CELLS/ML)
FOR ALL DEPTHS SAMPLED IN OKANAGAN LAKE IN 1979.

STATION	DATE	RANK	AVERAGE	SPECIES NAME	DATE	RANK	AVERAGE	SPECIES NAME
OK-1	Apr. 10	1	349	*Lyngbya sp.*	Oct. 9	1	152	*Chlamydomonas sp.*
		2	243	*Asterionella formosa*		2	135	*Chroomonas acuta*
		3	132	*Selenastrum sp.*		3	123	*Cyclotella glomerata*
		4	111	*Chroomonas acuta*		4	109	*Cyclotella kutzingiana*
		5	55	*Cyclotella glomerata*		5	64	*Lyngbya sp.*
		6	28	*Chlamydomonas sp.*		6	23	*Chroococcus merismopedia*
		7	23	*Synedra delicatissima*		7	23	*Microcystis sp.*
		8	19	*Melosira italica*		8	23	*Fragilaria crotonensis*
OK-2	Apr. 18	1	535	*Cyclotella glomerata*	Oct. 11	1	134	*Chroomonas acuta*
		2	490	*Lyngbya sp.*		2	121	*Chlamydomonas sp.*
		3	230	*Chroomonas acuta*		3	89	*Fragilaria crotonensis*
		4	211	*Selenastrum sp.*		4	86	*Cyclotella glomerata*
		5	136	*Chlamydomonas sp.*		5	70	*Cyclotella kutzingiana*
		6	64	*Melosira italica*		6	56	*Cyclotella ocellata*
		7	60	*Rhizosolenia eriensis*		7	52	*Lyngbya sp.*
		8	49	*Synedra delicatissima*		8	20	*Chroococcus merismopedia*
OK-3	Apr. 19	1	511	*Cyclotella glomerata*	Sep. 26	1	81	*Cyclotella glomerata*
		2	477	*Lyngbya sp.*		2	72	*Chroomonas acuta*
		3	209	*Selenastrum sp.*		3	71	*Cyclotella ocellata*
		4	164	*Oscillatoria sp.*		4	70	*Lyngbya sp.*
		5	161	*Melosira italica*		5	39	*Aphanothece sp.*
		6	136	*Fragilaria crotonensis*		6	30	*Fragilaria crotonensis*
		7	136	*Chroomonas acuta*		7	28	*Closterium sp.*
		8	121	*Chlamydomonas sp.*		8	19	*Chroococcus merismopedia*

B. PHYTOPLANKTON DOMINANTS RANKED BY AVERAGE DENSITY FOR ALL DEPTHS SAMPLED IN SKAHA LAKE (S-1) AND OSOYOOS LAKE (O-1) IN 1979.

STATION	DATE	RANK	AVERAGE	SPECIES NAME	DATE	RANK	AVERAGE	SPECIES NAME
S-1	Apr. 11	1	549	*Cyclotella glomerata*	Oct. 2	1	3249	*Cyclotella kutzingiana*
		2	513	*Oscillatoria sp.*		2	1489	*Lyngbya sp.*
		3	511	*Chroomonas acuta*		3	908	*Cyclotella glomerata*
		4	326	*Asterionella formosa*		4	904	*Oscillatoria sp.*
		5	317	*Lyngbya sp.*		5	332	*Anabaena sp.*
		6	192	*Melosira italica*		6	269	*Cyclotella bodanica*
		7	109	*Cyclotella bodanica*		7	222	*Chroomonas acuta*
		8	74	*Chlamydomonas sp.*		8	192	*Chlamydomonas sp.*
0-1	Apr. 11	1	332	*Cyclotella glomerata*	Oct. 1	1	1546	*Lyngbya sp.*
		2	251	*Chroomonas acuta*		2	792	*Cyclotella kutzingiana*
		3	181	*Asterionella formosa*		3	653	*Oscillatoria sp.*
		4	43	*Cyclotella ocellata*		4	528	*Mougeotia sp.*
		5	41	*Chlamydomonas sp.*		5	464	*Anabaena sp.*
		6	40	*Selenastrum sp.*		6	298	*Cyclotella glomerata*
		7	40	*Cryptomonas borealis*		7	245	*Cyclotella ocellata*
		8	32	*Lyngbya sp.*		8	173	*Chroomonas acuta*

C. PHYTOPLANKTON DOMINANTS RANKED BY AVERAGE DENSITY (CELLS/ML) FOR ALL DEPTHS SAMPLED IN WOOD LAKE (W-1) AND KALAMALKA LAKE (K-1).

STATION	DATE	RANK	AVERAGE	SPECIES NAME	DATE	RANK	AVERAGE	SPECIES NAME
W-1	Apr. 18	1	2315	*Cyclotella glomerata*	Oct. 3	1	889	*Lyngbya sp.*
		2	1440	*Chroomonas acuta*		2	356	*Chroomonas acuta*
		3	1123	*Cyclotella ocellata*		3	134	*Cyclotella glomerata*
		4	973	*Stephanodiscus tenuis*		4	96	*Microcystis sp.*
		5	279	*Cyclotella bodanica*		5	88	*Chlamydomonas sp.*
		6	271	*Chlamydomonas sp.*		6	72	*Cyclotella kutzingiana*
		7	60	*Synedra delicatissima*		7	69	*Elakatothrix sp.*
		8	30	*Oscillatoria sp.*		8	35	*Ankistrodesmus sp.*
K-1	Apr. 17	1	360	*Chroomonas acuta*	Oct. 10	1	330	*Lyngbya sp.*
		2	283	*Lyngbya sp.*		2	258	*Chroomonas acuta*
		3	198	*Oscillatoria sp.*		3	165	*Cyclotella glomerata*
		4	160	*Dinobryan sertularia*		4	128	*Cyclotella ocellata*
		5	132	*Chlamydomonas sp.*		5	53	*Dinobryon sertularia*
		6	92	*Synedra delicatissima*		6	45	*Anabaena sp.*
		7	81	*Asterionella formosa*		7	42	*Chlamydomonas sp.*
		8	79	*Cyclotella glomerata*		8	28	*Cyclotella kutzingiana*

APPENDIX VI

Zooplankton Taxonomic Identification and Counts per Haul at Lakes Okanagan, Skaha, Osoyoos, Wood and Kalamalka in 1979

APPENDIX VI ZOOPLANKTON TAXONOMIC IDENTIFICATION AND COUNTS PER HAUL AT LAKES OKANAGAN, SKAHA, OSOYOOS, WOOD AND KALAMALKA IN 1979.

STATION		SPECIES NAME	COUNTS PER SPLIT				
OK-1	Apr. 44 M Haul		Haul: Split:	1 1/128	2 1/128	3 1/64	4 1/64
		Daphnia longiremus			1		
		Nauplii		590	471	475	498
		Copepodids		51	45	51	42
		Diaptomus ashlandi		57	59	50	56
		Eucyclops agilis				1	
		Cyclops bicuspidatus		53	57	70	76
		Kellicotia longispina		3		1	5
		Keratella cochlearis		2		1	
		K. quadrata				1	
		K. hiemalis		1		1	
		Filina longiseta					
		Notholca accuminata		3	2	11	16
		Male rotifers		2	1	1	
OK-2	Apr. 44 M Haul		Haul: Split:	1 1/128	2 1/128	3 1/128	4 1/128
		Bosmina coregoni			1		1
		Nauplii		395	629	595	482
		Copepodids		92	80	97	73
		Diaptomus ashlandi		57	60	51	55
		Eucyclops agilis					
		Cyclops bicuspidatus		102	148	96	127
		Kellicotia longispina		8	11	11	13
		Keratella hiemalis		1	1		1
		Notholca accuminata		56	55	54	37
		Male rotifers				1	
OK-2	Oct. 11 44 M Haul		Haul: Split:	1 1/64	2 1/32		4 1/32
		Daphnia longiremus		11	19		21
		Sida crystalina		5	2		4
		Bosmina coregoni		3	2		4
		Nauplii		164	322		425
		Copepodids					
		Diaptomus ashlandi		111	218		239
		Epischura nevadensis		2	7		4
		Eucyclops agilis		4	7		4
		Cyclops bicuspidatus		123	236		285
		Kellicotia longispina		4	15		1
		Keratella quadrata					
		Filina longiseta					
		Trichocerca similis					
		Male rotifers			3		2

APPENDIX VI - Continued:

STATION		SPECIES NAME		COUNTS PER SPLIT			
OK-3	Apr. 44 M Haul		Haul: Split:	1 1/64	2 1/64	3 1/64	4 1/64
		Bosmina coregoni		1		1	
		Nauplii		463	679	796	740
		Copepodids		116	156	194	254
		Diaptomus ashlandi		50	58	60	78
		Eucyclops agilis			2	1	
		Cyclops bicuspidatus		113	171	157	202
		Kellicotia longispina		4	11	9	11
		Keratella hiemalis		5	8	4	2
		Notholca accuminata		51	98	110	100
		Male rotifers					
S-1	Apr. 44 M Haul		Haul: Split:	1 1/128	2 1/64	3 1/64	4 1/64
		Daphnia longiremus		2			1
		Sida crystalina					
		Nauplii		290	269	401	283
		Copepodids		140	86	88	69
		Diaptomus ashlandi		132	47	43	18
		Eucyclops agilis		2	1		
		Cyclops bicuspidatus		81	59	40	24
		Kellicotia longispina		7	5	6	9
		Keratella cochlearis		7	12	9	13
		K. hiemalis		12	9	12	16
		Filina longiseta		1	1	4	2
		Notholca accuminata		12	6	14	8
		Male rotifers		1	2		
		Mysis relicta (from whole sample)					2
S-1	Oct. 44 M Haul		Haul: Split:	1 1/32	2 1/32	3 1/16	4 1/64
		Daphnia longiremus		1		1	
		Sida crystalina		3	6	11	9
		Bosmina coregoni		2	5	4	7
		Leptodora kindtii					
		Alona affinis					
		Nauplii		395	667	774	326
		Copepodids		28	45	46	35
		Diaptomus ashlandi		137	234	261	162
		Epischura nevadensis		2	2	6	5
		Eucyclops agilis		1	2		
		Cyclops bicuspidatus		52	94	98	23
		Kellicotia longispina		1	6	3	
		Keratella cochlearis				1	1
		K. quadrata		1			
		Filina longiseta					
		Trichocerca similis			1		
		Polyarthra sp.					
		Male rotifers		1	15	1	1

APPENDIX VI - Continued:

STATION		SPECIES NAME	COUNTS PER SPLIT				
O-1	Apr. 44 M Haul		Haul: Split:	1 1/128	2 1/128		
		Camptocercus sp.		3	3		
		Nauplii		341	215		
		Copepodids		239	156		
		Diaptomus ashlandi		180	110		
		Cyclops bicuspidatus		140	73		
		Kellicotia longispina		1	10		
		Keratella cochlearis		3	3		
		Keratella quadrata		4	4		
		Filina longiseta		40	66		
		Notholca accuminata		6	4		
O-1	Oct. 44 M Haul		Haul: Split:	1 1/64	2 1/64	3 1/64	4 1/64
		Daphnia longiremus		9	12	7	4
		Sida crystalina		2	1	3	2
		Bosmina coregoni			2	3	
		Leptodora kindtii			1		
		Alona affinis		2			
		Nauplii		141	159	180	114
		Copepodids		38	42	47	36
		Diaptomus ashlandi		201	230	215	195
		Epischura nevadensis		2	1		1
		Eucyclops agilis		13	20	9	10
		Cyclops bicuspidatus		70	47	62	48
		Kellicotia longispina			6	4	12
		Keratella cochlearis		2	2	3	3
		K. quadrata		3	6	11	3
		Filina longiseta		1	5	3	4
		Trichocerca similis		1	1		1
		Polyarthra sp.			2		
		Male rotifers		1	2	4	1
W-1	Apr. 20 M Haul		Haul: Split:	1 1/128	2 1/128	3 1/128	
		Daphnia longiremus		3	6	2	
		Sida crystalina		2	4	2	
		Nauplii		567	716	447	
		Copepodids		84	124	67	
		Diaptomus ashlandi		75	92	66	
		Eucyclops agilis					
		Cyclops bicuspidatus		38	27	18	
		Kellicotia longispina		8	2	8	
		Keratella cochlearis		4		2	
		K. hiemalis		1			
		Filina longiseta		1			

APPENDIX VI - Continued:

STATION		SPECIES NAME		COUNTS PER SPLIT			
W-1	Oct.		Haul:	1	2	3	3
	20 M Haul		Split:	1/16	1/32	1/32	1/32
		Daphnia longiremus		20	12	17	18
		Sida crystalina		10	7	9	17
		Bosmina coregoni					
		Nauplii		164	215	271	232
		Copepodids		25	23	20	50
		Diaptomus ashlandi		179	164	153	368
		Epischura nevadensis			1	1	1
		Eucyclops agilis		1	1	1	1
		Cyclops bicuspidatus		42	19	31	42
		Kellicotia longispina		1			
		Keratella quadrata		2			
		Filina longiseta		1			
		Trichocerca similis			1		1
		Male rotifers		1			
K-1	Apr.		Haul:	1	2	3	4
	44 M Haul		Split:	1/128	1/128	1/128	1/128
		Nauplii		222	287	203	230
		Copepodids		152	248	189	135
		Diaptomus ashlandi		53	70	24	32
		Eucyclops agilis			1		
		Cyclops bicuspidatus		9	41	22	5
		Kellicotia longispina		2	18	11	17
		Keratella cochlearis		25	55	20	41
		K. quadrata			1	3	
		K. hiemalis		10	13	13	14
		Filina longiseta				1	2
		Notholca accuminata		2			
		Male rotifers		5	2		