CHAPTER 5

Physical Characteristics of the Main Valley Lakes.

5.1 PREVIOUS WORK

Clemens *et al* (1939) collected some basic physical data pertaining to morphometry, temperature and Secchi disc transparency as parts of the survey work they carried out. Stein and Coulthard (1971) also made some limited physical measurements as a part of their more encompassing study. Aside from the above general work, little was known of the physical limnology of the Okanagan main valley lakes prior to the inception of the Okanagan Basin Study.

5.2 RESULTS

Morphometric parameters for the six main valley lakes are summarised in Table 5.1. The main valley lakes present a wide variety of basins, with Okanagan Lake the largest in both volume and surface area and Vaseux Lake the smallest. Kalamalka Lake is the second largest lake, while Wood, Skaha and Osoyoos Lakes are of more similar size and volume. The greatest maximum depth occurs in Okanagan and Kalamalka Lakes, 794 and 466 feet (242 and 142 meters) respectively, while the remainder of the lakes have maximum depths of about 169 feet (50 meters). The mean depth of the lakes range from 250 feet (76 meters) for Okanagan Lake, to 21 feet (6.5 meters) for Vaseux Lake (Table 5.1). The theoretical water replacement time (residence time) of the lakes varies from 65 years for Kalamalka Lake to 1.5 weeks for Vaseux Lake (Table 5.2).

The temporal changes in selected thermal layers (epilimnion, mesolimnion and hypolimnion), have been calculated for the main valley Okanagan lakes (Figures 5.1 and 5.2). From these observations, the lakes of the mainstem were classified as dimictic; that is, two circulation periods per year. Temperature data from moored thermographs in each lake indicated that the lakes reached their maximum temperature in 1971 between the end of July and the middle of August (Table 5.3). The time of maximum lake temperature occurred at the approximate time of the highest air temperatures recorded at Penticton. The rate of warming of the hypolimnions of the five main lakes were as follows:

Osoyoos	0.54	°C/month
Skaha	0.37	
Wood	0.26	
Kalamalka	0.18	
Okanagan	0.06	

Wood Lake, for its size and mean depth should have had the highest rate of hypolimnetic warming. These data strongly support the theory that cold groundwater

TABLE 5.1

MORPHOMETRY OF THE SIX MAIN VALLEY LAKES IN THE OKANAGAN BASIN

(Blanton and Ng, 1972)

LAKE	VOLUME $(10^6 m^3)$	SURFACE AREA $(10^6 m^2)$	DEPTHS (m)		MAXIMUM Length (km)	MAXIMUM Length (km)	PERIMETER[4] (km)
			Mean	Maximum			
WOOD[2]	200	9.3	22	34	6.60	1.70	16.7
KALAMALKA[2]	1520	25.9	59	142	16.0	2.30	42.4
OKANAGAN[2]	26200	348.0	76	242	112.8	5.22	270.0
SKAHA[3]	558	20.1	26	57	11.90	2.40	29.5
VASEUX[2]	17.7	2.75	6.5	27	4.08	0.85	8.1
OSOYOOS (N)[1,2]	204	9.91	21	63	7.55	1.75	20.4
OSOYOOS (S)[1,2]	51.5	5.14	10	29	3.00	1.90	12.8

1. Osoyoos (N) is the basin north of the highway bridge. Osoyoos (S) is the basin between the highway bridge and the U.S. border
2. Data compiled from charts of the Fish and Wildlife Branch, Department of Recreation and Conservation, B.C.
3. Data compiled from a chart by A.M. Thomson, Study Director
4. These data were obtained from maps of the Canadian National Topographic System, 1960. Scale 1:126,720.

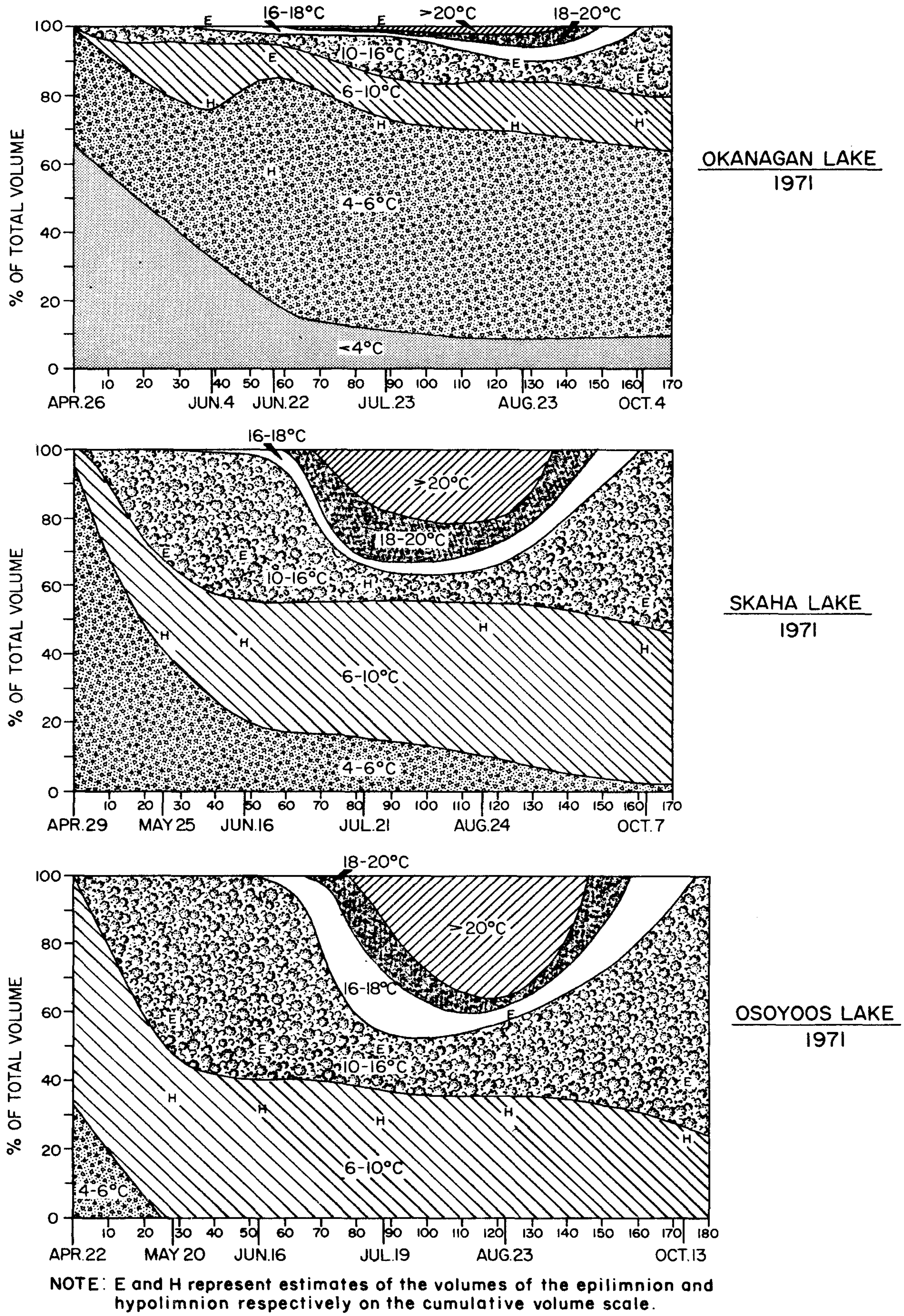
TABLE 5.2

MEAN ANNUAL OUTFLOW AND THEORETICAL WATER REPLACEMENT TIME (RESIDENCE TIME), OKANAGAN MAIN VALLEY LAKES

LAKE	MEAN ANNUAL OUTFLOW		RESIDENCE TIME
	$(x10^6 m^3)$	$(x10^3$ Acre ft)	YEARS
OKANAGAN	465.0	356.0	60.0
SKAHA		385.0	1.2
VASEUX	528.8	428.9	0.03
OSOYOOS*2	590.3	478.6	0.7
WOOD	11.1 *1 (18.2)	8.5 *1 (14.0)	30.0 *1 (14.0)
KALAMALKA	29.8 *1 (43.0)	22.8 *1 (33.0)	65.0 *1 (45.0)

*1 Prior to 1971, and discharge of cooling water pumped from Okanagan Lake to Hiram Walker plant, and discharged to Vernon Creek; figures in brackets indicate outflow and residence time after 1971: source- B.C. Water Resources Service.

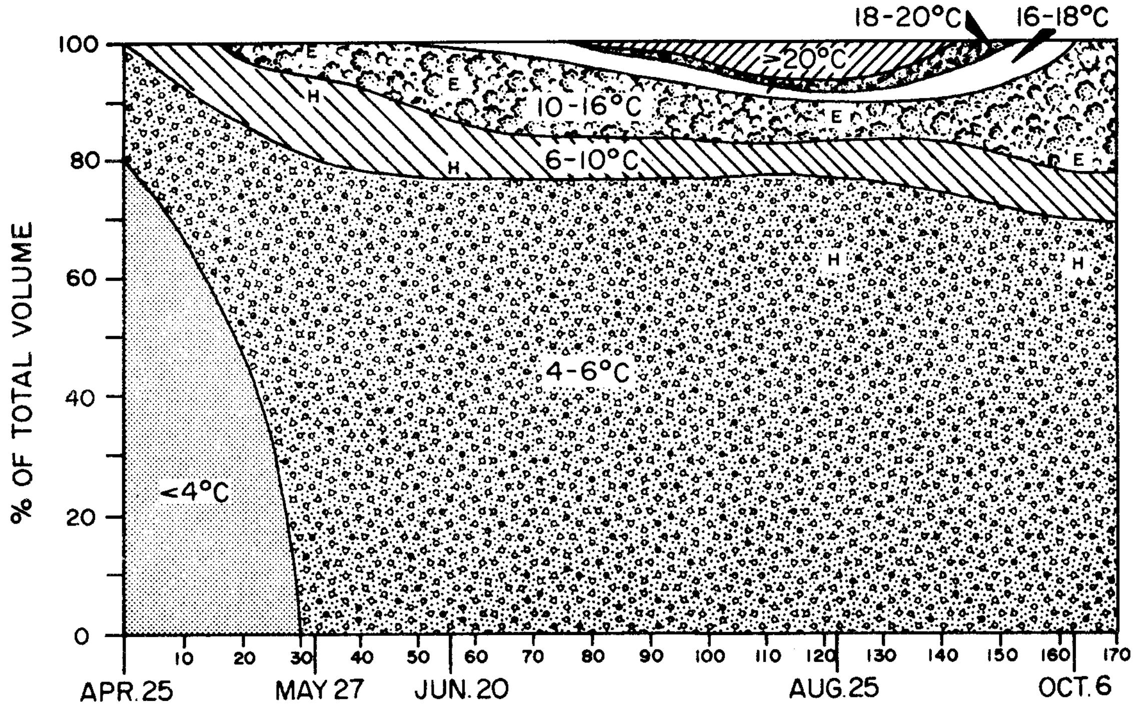
*2 Total Lake - Canadian and U.S. portions.



VOLUMES ASSOCIATED WITH GIVEN TEMPERATURE RANGES OBSERVED DURING THE 1971 MONITOR CRUISES IN OSOYOOS, SKAHA AND OKANAGAN LAKES. Figure 5.1

KALAMALKA LAKE

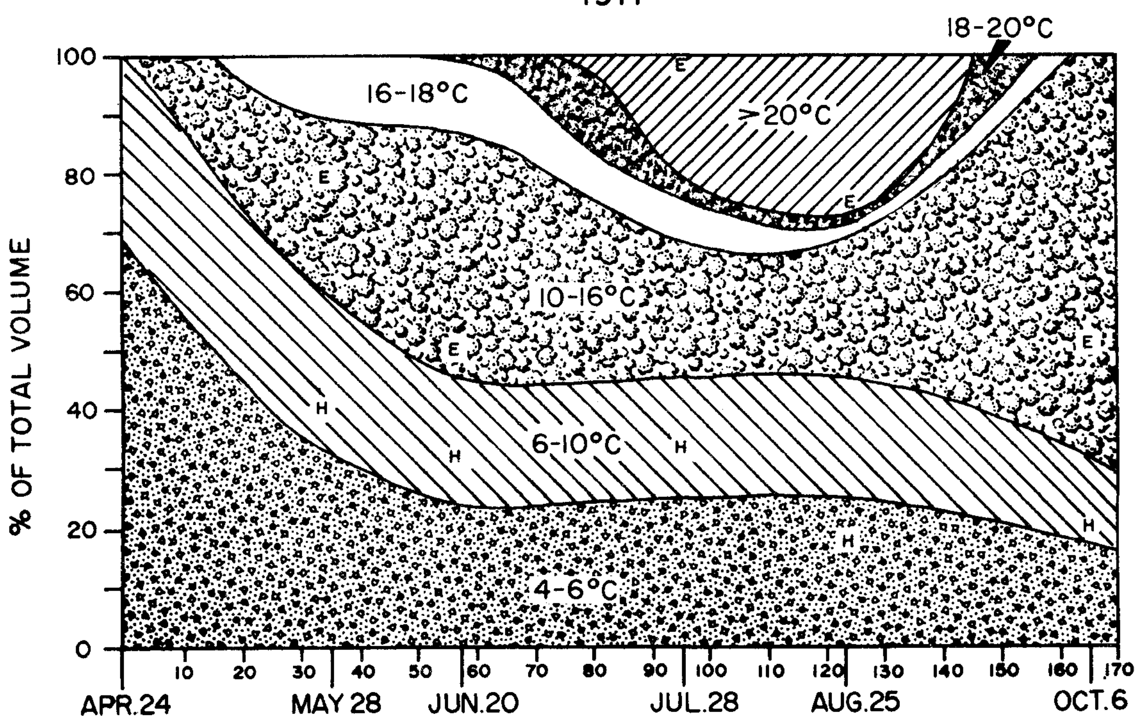
1971



NOTE: E and H represent estimates of the volumes of the epilimnion and hypolimnion respectively on the cumulative volume scale.

WOOD LAKE

1971



VOLUMES ASSOCIATED WITH GIVEN TEMPERATURE RANGES OBSERVED DURING THE 1971 MONITOR CRUISES IN WOOD AND KALAMALKA LAKES. Figure 5.2

TABLE 5.3

PERIOD OF MAXIMUM SURFACE TEMPERATURES FOR EACH LAKE WHERE MOORED THERMOGRAPHS MERE LOCATED

LAKE	INSTRUMENT DEPTH (m)	DATES OF MAXIMUM TEMPERATURES	MAXIMUM TEMPERATURE (OBSERVED)
WOOD	1.5	29 July to 2 August	27.5°C
KALAMALKA	1.5	30 July to 1 August	28.0°C
OKANAGAN (Vernon Arm)	1.5	4 to 8 August	26.5°C
OKANAGAN (Kelowna)	1.5	8 to 13 August	24.5°C
OKANAGAN (Penticton)	2.0	6 to 10 August	25.0°C (30 July)
SKAHA (Okanagan Falls)	2.0	9 to 13 August	25.0°C
VASEUX (outlet)	2.0	31 July to 5 August	27.5°C

TABLE 5.4

SUMMER HEAT INCOMES FOR THE MAIN VALLEY LAKES IN 1971

LAKE	CRUISE NUMBER	DATE OF OBSERVATION	HEAT CONTENT (g cal/cm^2)
OKANAGAN	5	30 August	33,300
KALAMALKA	5	25 August	25,100
SKAHA	5	24 August	22,200
OSOYOOS (N)	5	23 August	21,900
WOOD	5	25 August	18,100

inflow plays an important role in the limnology and hydrologic cycle of this lake.

The heat content in g cal/cm^2 was computed for each lake from 1971 cruise temperature data. These data were used to compute the summer heat income. Okanagan Lake had the highest heat income of the five main valley lakes (excluding Vaseux) and Wood Lake had the lowest (Table 5.4). Two values for heat content were computed for Vaseux Lake from limited data, since it was not sampled as intensively as the other lakes. It appears that it has the lowest heat content of the main valley lakes because it is the smallest.

Secchi disc and light transmittance data were gathered during the monitor cruise program in 1971. The lakes are listed in Table 5.5, in order of increasing transparency. The tendency of increased transmission in the blue light range is characteristic of dear and unproductive water masses (Sverdup, Johnson and Fleming, 1942). If one compares the ratio of blue to green transmission value, the ratio is lowest for Mood Lake and highest for Kalamalka Lake.

water transparency as determined by measurements of the Secchi disc produced results similar to the transmission data with Okanagan and Kalamalka Lakes being the clearest (highest mean Secchi reading) while Wood and Osoyoos Lakes were the least transparent (Table 5.5). These data, when compared with past records, indicate no significant decrease in transparency from measurements taken over the past five years (South Okanagan Health Unit, unpublished data and B.C. Fish and Wildlife Branch, unpublished data) in Okanagan, Wood and Kalamalka Lakes. However, Skaha and Osoyoos Lakes have shown some diminishment of water transparency during this period.

The study tracking Okanagan River water as it entered Skaha Lake consisted of four experiments; two in the spring of 1971 during homogeneous lake conditions and two in the fall when Skaha Lake was highly stratified with a strong thermo-cline at about 10 meters. General details of the experimental series are provided in Table 5.6.

During the spring experiments, it was noted that dye generally mixed homogeneously throughout the water mass, although detailed vertical sampling series were not taken. A synoptic series for dye distribution during the spring experiments is presented in Figure 5.3. It is noted that the dye (and presumably the Okanagan River outfall) moves quickly to the northwest corner of the lake and from there tends to diffuse in a generally south direction, over time. Tracking drogues set at 1, 2 and 3 meters during the spring experiments moved southwest, generally consistent with the dye movements.

During the fall experiments, modifications were made to allow vertical sampling to 20 meters. Sampling showed no dye below the thermocline, indicating no

TABLE 5.5

TRANSMISSION METER VALUES FOR FIVE MAIN VALLEY LAKES*

LAKE	x Secchi[a]	T^b	FILTERS BLUE T_{450}	GREEN T_{530}	RED T_{630}
WOOD	2.5	49.7	46.2	58.6	45.3
OSOYOOS	3.3	59.6	56.4	67.0	56.0
SKAHA	4.5	69.3	65.4	74.5	64.3
OKANAGAN	8.0	74.7	76.4	80.1	68.0
KALAMALKA	9.0	81.8	85.6	86.0	74.5

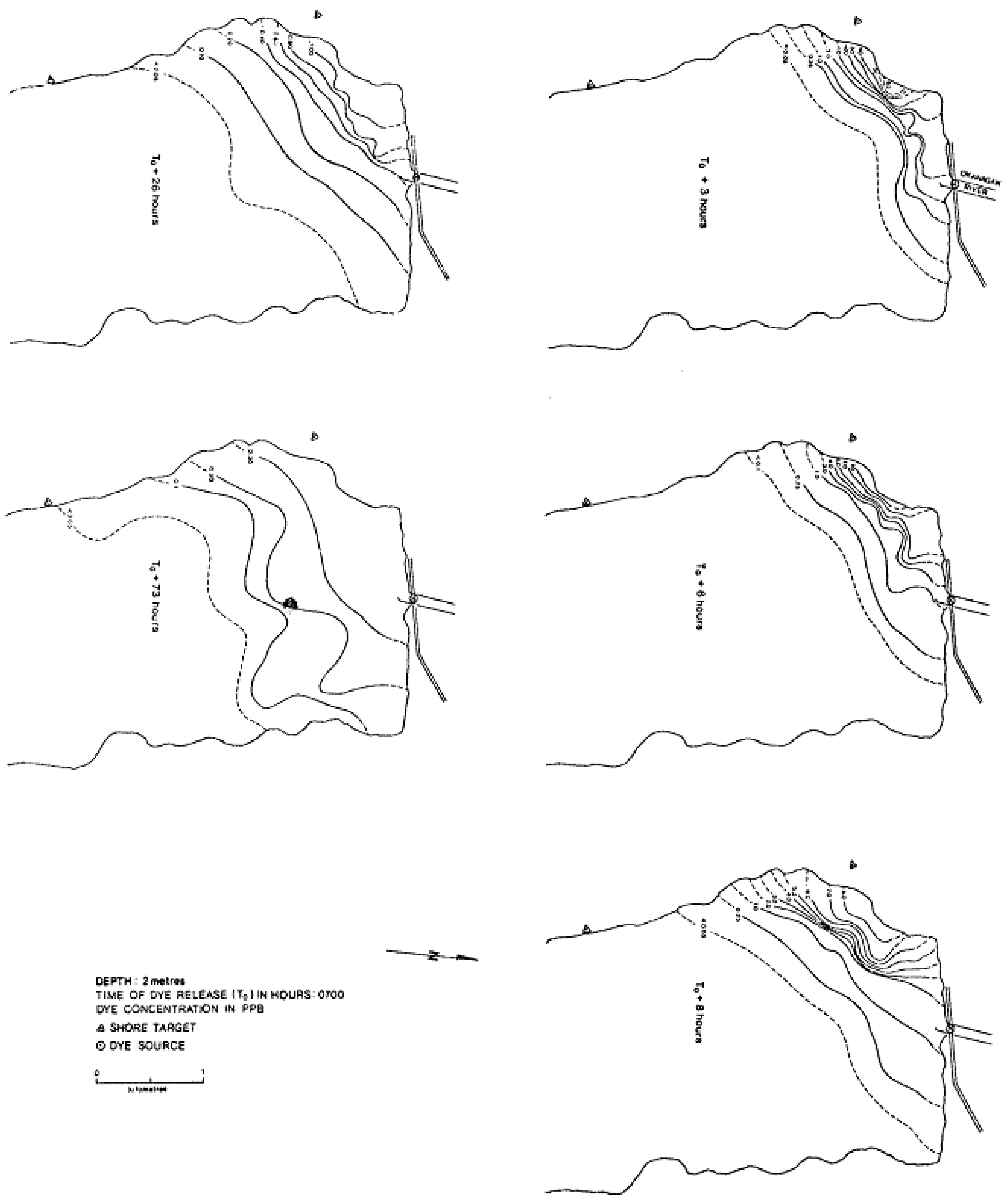
[a] n = 6

[b] $T = 1/3 \ (T_{450} + T_{530} + T_{630})$.

TABLE 5.6 GENERAL DETAILS OF THE SKAHA LAKE DIFFUSION EXPERIMENTS

EXPERIMENT	I	II	III	IV
Date	3/4/71	4/5/71	18/9/71	23/9/71
Type of dye source	Instantaneous	Continuous	Continuous	Continuous
Amount of dye released	67.5 gk	9.0 kg	34.0 kg	169.0 kg
Dimensions of plume measured	horizontal	horizontal	horizontal vertical	horizontal vertical
No. of realizations	3	1	2	2
Dates of realizations	3,4,6 April	4 May	18,19 Sept.	23,24,25 Sept.
Average time interval after dye released (hours)	6, 28, 72	2.5	3, 24	4, 36
Average sampling duration (hours)	6	3	4.5	4
Sampling Depth (meters)	1, 2, 3	1, 2, 3		
Okanagan River discharge (m^3/sec)*	28	20	6	6
Okanagan Falls discharge (m^3/sec)*	28	22	11	11
Wind during measurements (knots)	S 4.3	N 7.0	N 3.9	NE 4.2
Lake conditions	homogeneous	homogeneous	Thermocline at 10 m depth	Thermocline at 10 m depth

* 1 m^3/sec = 35.3 cfs



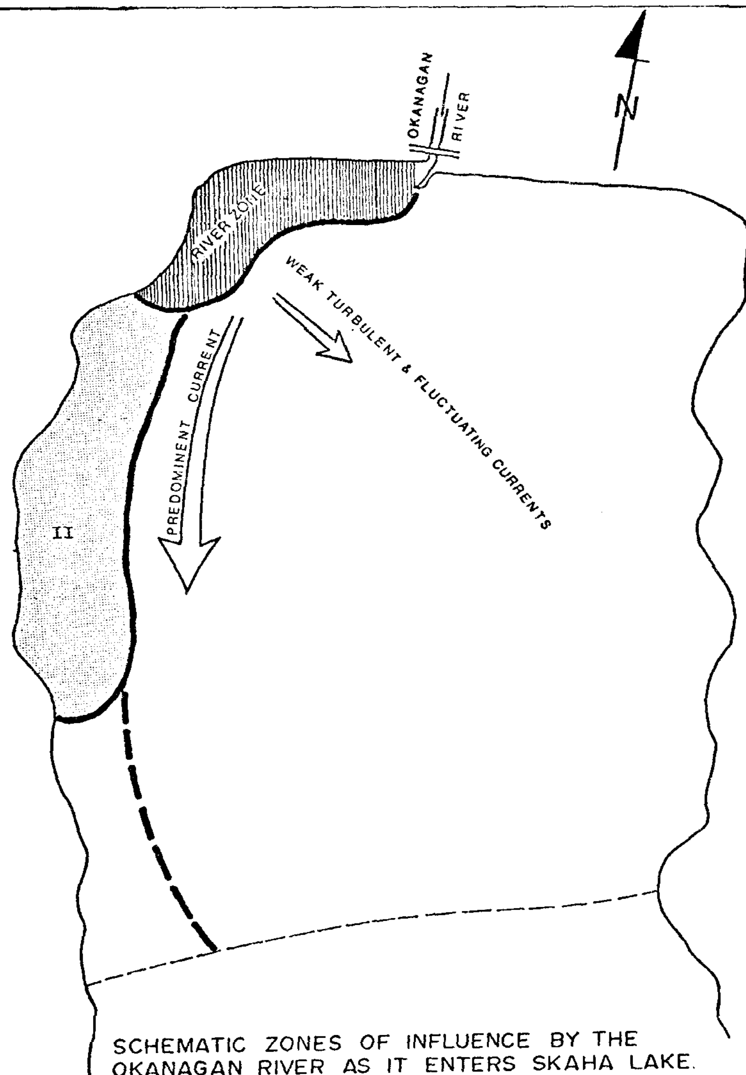
SYNOPTIC MAPS OF DYE DISTRIBUTION FOR SKAHA LAKE

3-6 APRIL, 1971. Figure 5.3

mixing of river and hypolimnetic waters. Horizontal dye movements in the fall were essentially identical for those during the spring (Figure 5.3). Southerly winds tended to slow the spreading of the dye, while northerly winds tended to hasten it.

The general horizontal fate of the Okanagan River plume is schematically presented in Figure 5.4. This basic movement consists of a main flow directed to the northwest corner of the lake by the small dyke at the river mouth. This is followed by a well-defined southerly current along the west shore. Complete mixing is assumed during homothermic conditions. During summer stratification, the river plume mixes only with the epilimnion.

More detailed results of the physical limnology studies on the main valley lakes are included in Appendix D.



SCHEMATIC ZONES OF INFLUENCE BY THE OKANAGAN RIVER AS IT ENTERS SKAHA LAKE.

Figure 5.4