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Biophysical Surveys of Aquatic Habitats in Gwaii Haanas

**1993: Upper Victoria Lake, Lower Victoria Lake, Escarpment Lake
and 14 Selected Streams**

**T. E. Reimchen
Islands Ecological Research
Queen Charlotte City, B.C.
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2.2 RESULTS

2.2.1 UPPER VICTORIA LAKE

General description, morphometry and bathymetry

This lake, which is the largest in Gwaii Haanas, lies near the south end of the San Christoval Range and drains westerly into the open Pacific. The lake is surrounded by low mountains (<700 m) which are almost entirely forested (Figure 4). Underlying rocks are the syntectonic plutons (Figure 2). The lake has 19 inlet streams (on 1:20000 scale), of which two are dominant, one flowing in a southerly direction into the north shore and a second flowing from the southeast into the east corner of the lake (Figure 5). Some 22 ponds (<1 ha) are distributed in these inlet drainages. A single outlet stream connects the lake to the ocean. Total length of the stream is 1400 m but this is broken into two segments connected by a small lake. The stream gradient is gentle between the main lake basin and the small lake (1:100) but is much steeper between the small lake and the ocean (9:100) apparently excluding upstream fish movement.

Broad physical features of the lake are summarized in Table 1. The lake is 3 km in length and close to 1 km in width with a maximum depth of 47 m. Surface area of 239 ha comprises 7% of the total watershed area. There are no islands in the lake although several eroded rocks occur some 20 m from shore (near EK3, Figure 6).

Figure 4 (opposite). Upper Victoria Lake. Top - east shore viewed from north central shoreline. Middle - looking north from stream delta on north shore. Bottom -looking southeast from Nuphar beds near stream delta (sector 17, Figure 10).

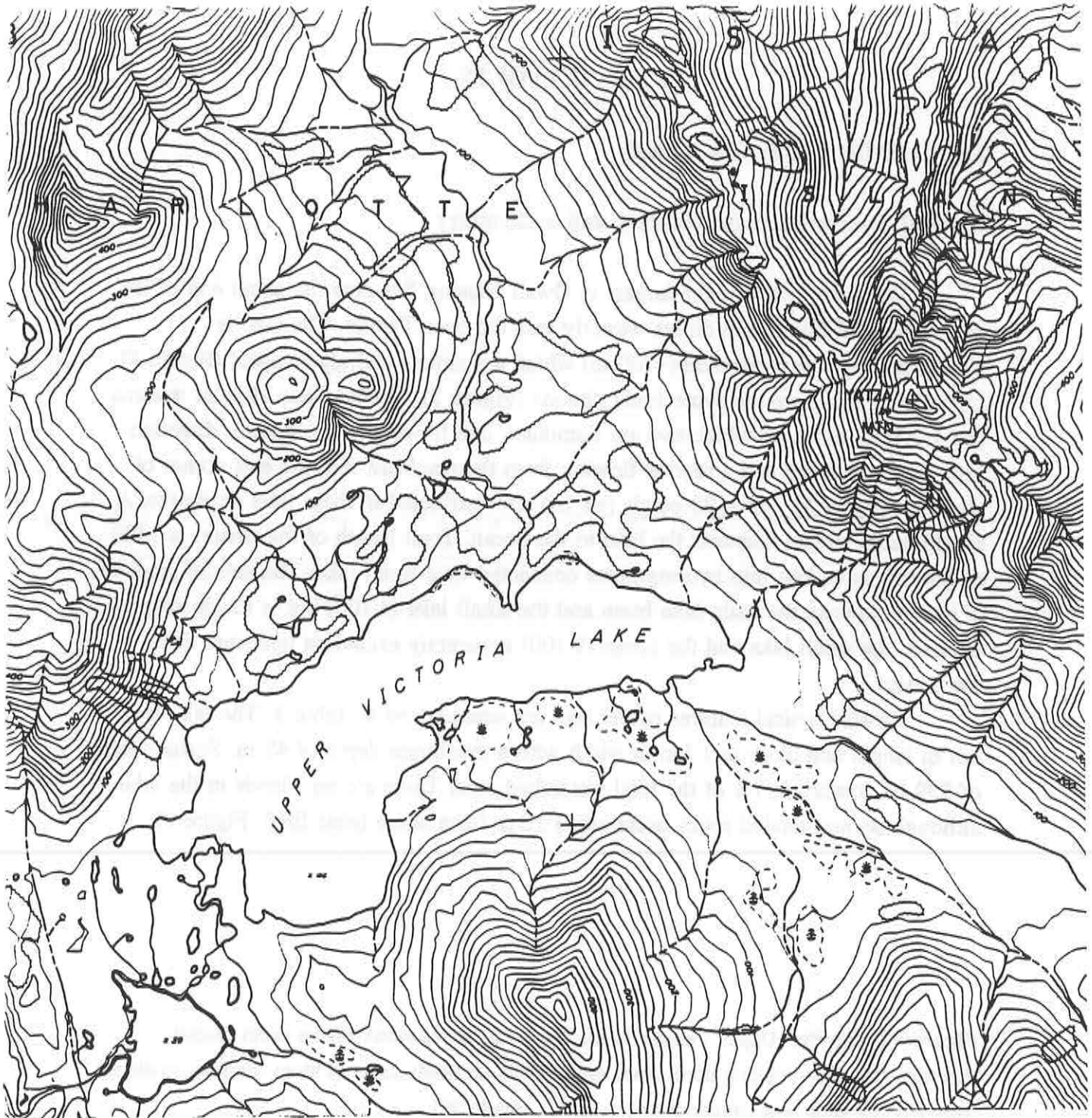


Figure 5. Topographic map of Upper Victoria Lake watershed. Scale: 1 cm = 300 m. Contours in 20 m intervals.

Table 1: General morphometric parameters for Upper Victoria Lake.

Elevation	44 m
Watershed area	3767 ha
Lake area	239 ha
Maximum length	3051 m
Maximum width	1272 m
Mean width	782 m
Maximum depth	47 m
Mean depth	22.1 m
Relative depth	2.7 %
Volume	52,678,705 m ³
Length of shoreline	9884 m
Shoreline development	1.8

Sampling localities for biophysical data are shown in Figure 6. Steep shore profile on the southwest shores made these regions unsuitable for Fyke nets.

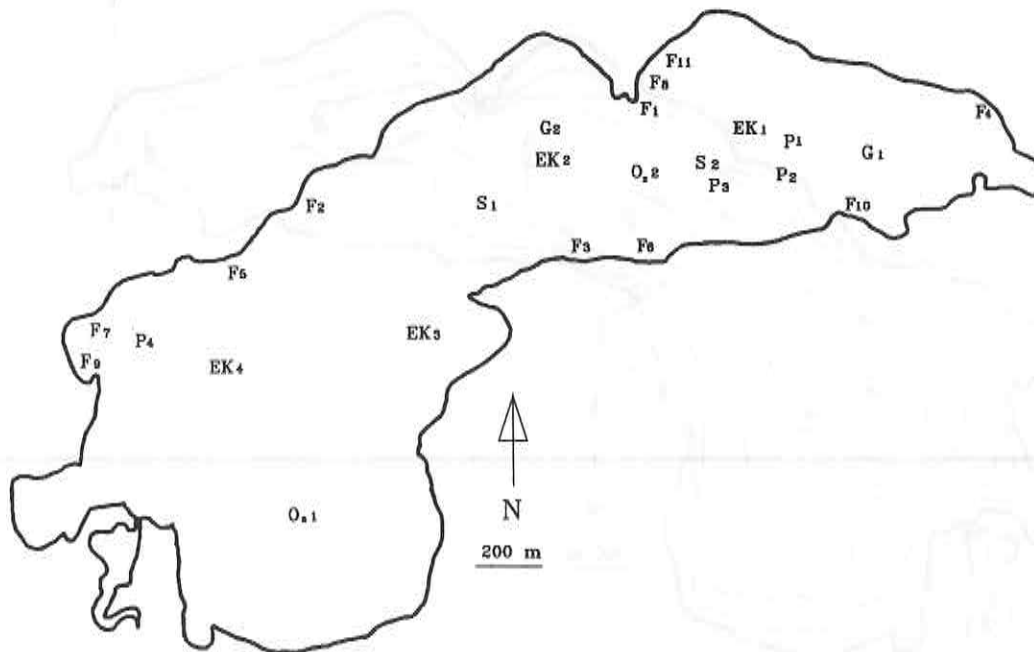


Figure 6. Site localities for biophysical surveys in Lower Victoria Lake. EK - Ekman dredge, F - Fyke net, G - gillnet, O₂ - oxygen and temperature, P - plankton, S - Secchi.

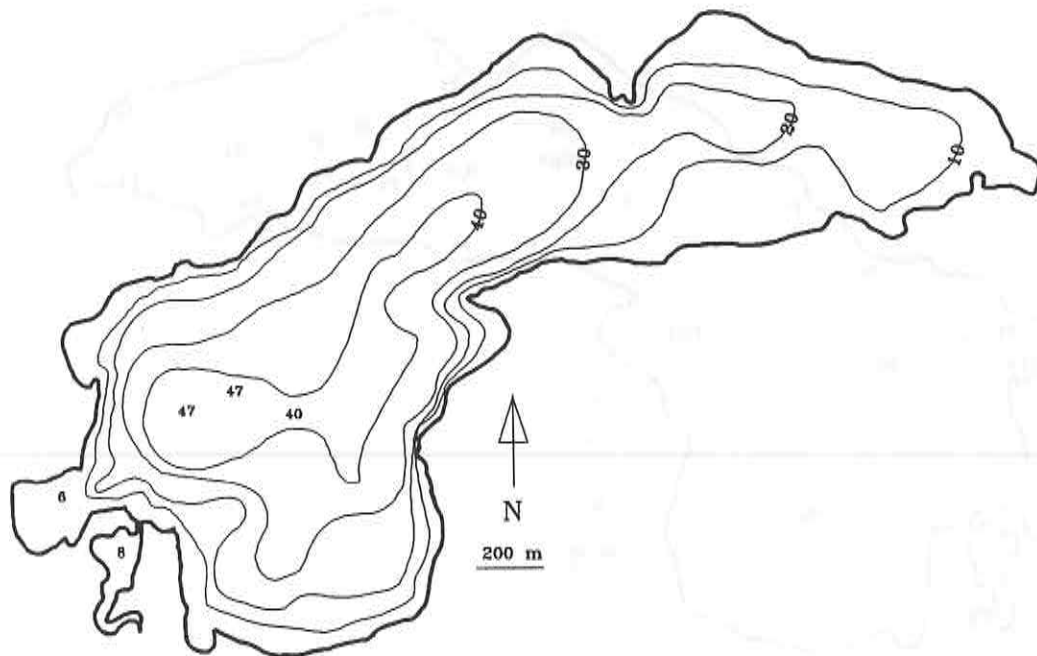
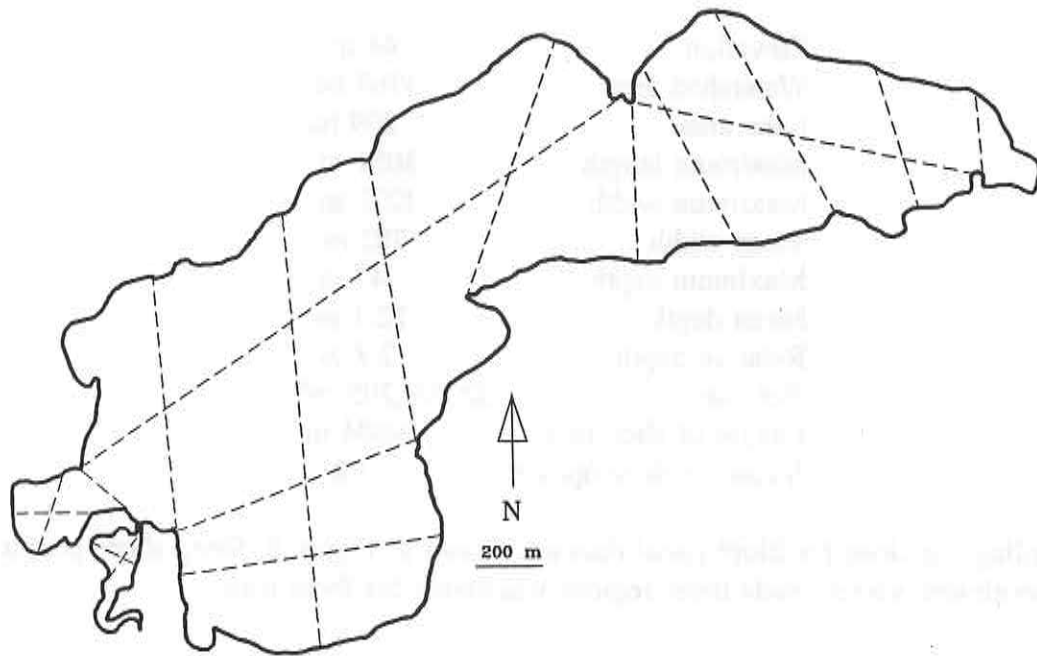


Figure 7. Bathymetry data for Upper Victoria Lake. Upper - boat transect positions, Lower - depth contours (m) and maximum depth records for selected areas.

Depth contours (Figure 7) demonstrate a relatively steep profile on the western region of the lake which was also the site of maximum depth. There are suggestions of several 40 m+ depressions in the western region. The eastern region of the lake tends to have a gentle slope on both the north and south shores. The only substantive exception occurs where the major inlet stream on the north-central shore has formed a delta which currently extends about one-third of the way across the lake. Much of delta is now covered in vegetation, primarily lodgepole pine (*Pinus contorta*). A hypsographic profile for the lake (Figure 8) shows a relatively simple association for proportional area of lake above successive bottom contours and that approximately 27% of the lake surface is less than 10 m in depth.

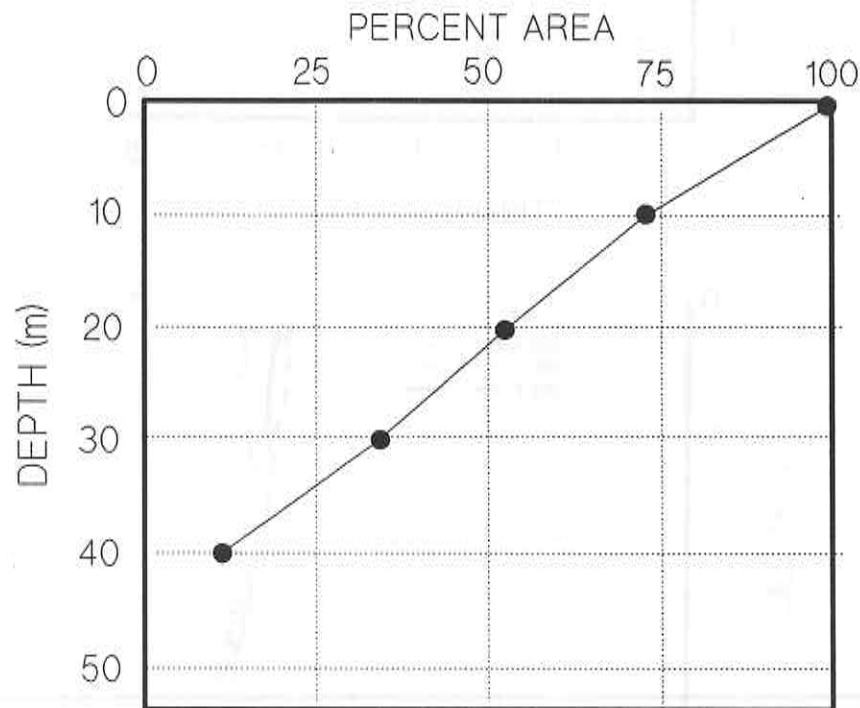


Figure 8. Hypsographic curve for Upper Victoria Lake.

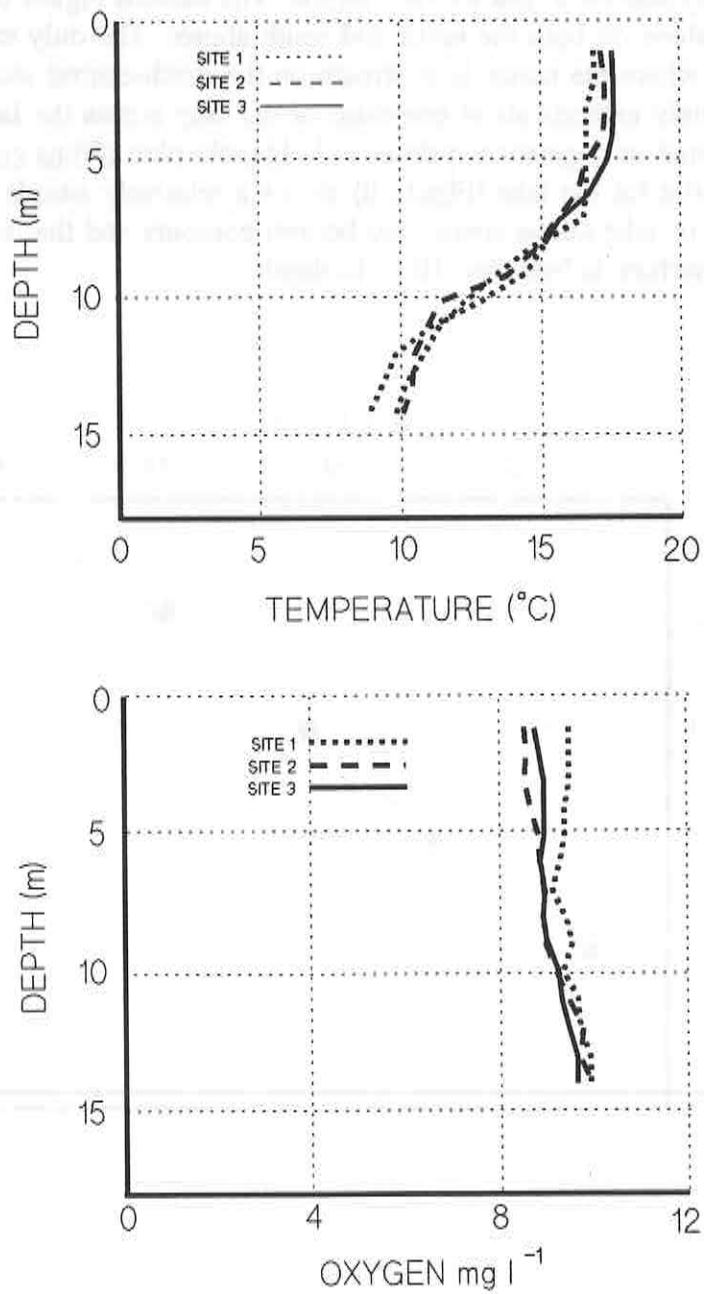


Figure 9. Temperature and oxygen profiles for Upper Victoria Lake.

Chemical and spectral analyses

Conductivity of the lake was 40 mhos cm^{-1} at three localities while pH ranged from 7.05-7.15. Chemical analyses, summarized in Table 2, show low levels of all elements of which sodium was the most common.

Water transparency was relatively high and similar in different parts of the lake. Maximum transparency using a Secchi disk was 6.48 and 6.53 m. Spectrophotometric measurement was 94.2% transmission at 400 nm.

Table 2. Water chemical analyses for Upper Victoria Lake. All results in ppm. Blank values (-) are below detectable limits.

P	S	Mg	As	Na	Al	Zn	Cu
0.204	0.412	0.375	0.124	4.910	0.080	0.030	0.017
Pb	Ti	Ni	K	Mn	Fe	Ca	
0.014	-	-	0.850	0.002	-	0.779	

Temperature and oxygen

Lake temperature was 17°C at the surface and 9°C at 15m depth. The temperature profile (Figure 9a) indicates relatively uniform temperatures in the upper 5-7 m (i.e. the epilimnion), a steady drop to a depth of 13 m depth (metalimnion), and then a gradual uniformity with further depth (hypolimnion). Site #O₂1, on the west basin of the lake, had the deepest epilimnion (7 m).

Oxygen levels (Figure 9b) are typical for an oligotrophic lake, ranging from 8.5 mg l⁻¹ to 10 mg l⁻¹ or approximately 82%-94% saturation. Lowest levels were near the surface and oxygen levels gradually increased with greater depths, concomitant with a reduction in water temperature and increased solubility. This orthograde oxygen profile is basically due to the absence of bio-oxidative depletion in deeper waters.

Littoral substrate

During summer low waters, the exposed shoreline is generally from 5 m to 30 m width (see Figure 4) and is composed of coarse sands and gravels around much of the perimeter, apart from the south-central and western shores which have exposed bedrock shelves (Figure 10). Detailed partitioning of the classification including shallow and deep littoral habitats, is shown in Table 3. The only area with abundant coarse sands (<2 mm) occurred in sector 9. There was relatively little submerged wood debris in littoral zones around the lake.

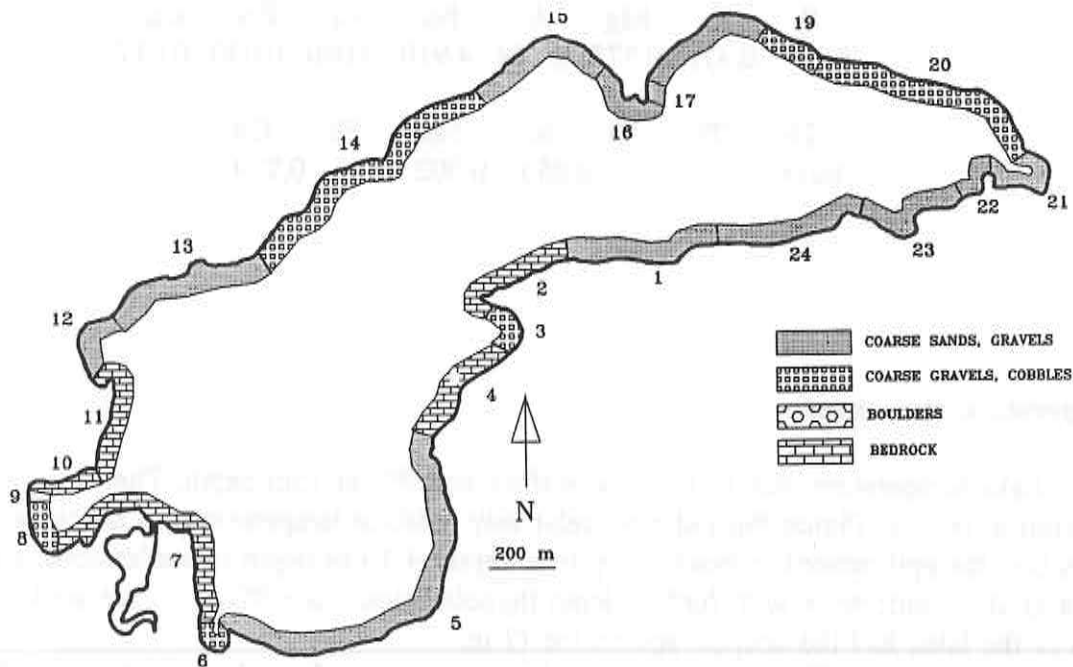


Figure 10. Dominant substrates in littoral zone for Upper Victoria Lake. Sectors show linear areas of similar substrate surveyed for macrophytes.

Vegetation

Aquatic

Aquatic plants were uncommon throughout most of the lake, particularly in sectors with bedrock or cobbles (Table 3). Nine species of vascular aquatic plants, as well as macroscopic algae, liverworts and a sponge were found in the littoral region (<2 m depth). The majority of species were submersed; conspicuous floating-leaved aquatics, such as Nuphar luteum, were common only in small local areas (Figure 3). When bedrock occurred, the only vegetation was attached algae.

Isoetes echinospora, Ranunculus flammula, Callitriche heterophylla and Chara were widely distributed, primarily on substrates of small to coarse gravel. Floating-leaved aquatics (Nuphar lutea, Sparganium hyperboreum and Potamogeton natans) had a patchy distribution, usually on silt and sand substrates. The most diverse sites, with up to seven species present, are in areas protected from dominant winds, bays (sectors 8, 9, Figure 10) and some sectors with coarse gravel substrate (sector 3).

Terrestrial

Most of the lake shoreline is bordered by sparse stands of lodgepole pine (Pinus contorta), yellow cedar (Chamaecyparis nootkatensis) and sitka alder (Alnus viridis). Red cedar (Thuja plicata) and hellebore (Veratrum eschscholtzii) were locally abundant (sector 5). Throughout much of the basin, including the broad valley to the northeast of the lake and the land adjacent to the outlet stream, there are open areas of Sphagnum bog. The north-western edge of the lake has a steeper profile and is more heavily forested than other regions.

Table 3. Dominant littoral substrates and macrophytes for Upper Victoria Lake. Values show percentage occurrence. Wood debris S - bark and twigs, L - large branches and trees. Macrophyte codes A - abundant, C - common, R - rare. See Figure 10 for lake sectors.

DEPTH SUBSTRATE	LAKE SECTOR														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
<1m Gravel (<2mm)	30		10					50	90	C		50	50	20	
Gr(2-16mm)	40		40		70	50		50	10			50	30	40	50
Gr(16-64mm)	20		50		20	50							20	40	50
Gr(64-128mm)	10				5										
Gr(128-256mm)					5										
Gr(>256mm)		50		C			50			C	50				
Bedrock		50		C			50			C	50				
Wood debris															
>1m Gravel (<2mm)													90	10	20
Gr(2-16mm)													10	30	
Gr(16-64mm)								40						30	20
Gr(64-128mm)								30				40		30	60
Gr(128-256mm)								30				60			
Gr(>256mm)															
Bedrock															
Wood debris														L	
Isoetes	R					C		R				C	C	C	C
Sparganium	C											C			C
Potamogeton															
Carex	R														
Juncus	R														
Eleocharis															
Nuphar						R			A			C			
Ranunculus	C					C						C		R	R
Callitriche	C					C		R				R	R	C	C
Lilaeopsis															
Utricularia															
Algae			A		A							C			
Chara	R	R				R							R	C	R
Liverwort															C
Sponge		R			R		R								

Table 3 cont.

		LAKE SECTOR								
DEPTH	SUBSTRATE	16	17	18	19	20	21	22	23	24
<1m	Gravel(<2mm)	10	50		10		90	20	80	20
	Gr(2-16mm)	80	50	80	70	20	10	80	20	70
	Gr(16-64mm)	10		20	10	80				10
	Gr(64-128mm)									
	Gr(128-256mm)									
	Gr(>256mm)									
	Bedrock									
	Wood debris		S	L						
>1m	Gravel(<2mm)			90		20				
	Gr(2-16mm)			10						
	Gr(16-64mm)				80					
	Gr(64-128mm)				20	80				
	Gr(128-256mm)									
	Gr(>256mm)									
	Bedrock									
	Wood debris			S						
	Isoetes	R	R	R	R		C	R		R
	Sparganium		C	R			C			
	Potamogeton	C					C		C	
	Carex		C	C						
	Juncus	C					C			C
	Eleocharis									
	Nuphar		C				A		C	
	Ranunculus	C	C			A				C
	Callitriche	R	C		C	A	C	R		R
	Lilaeopsis	R								
	Utricularia									
	Algae				C					
	Chara	R	R				R			
	Liverwort									
	Sponge			R	R	R				R

Zooplankton

There were an average of 1778 zooplankton per cubic meter (range 1097-3275, see Table 4). The two highest counts occurred in the collection from a shallow-water site (P3, Figure 6) with marginally higher counts present in the night sample. Based on a random sample of 70 individuals, 63% were cladocerans, the remainder being predominantly cyclopoid copepods.

Table 4. Zooplankton counts for Upper Victoria Lake. See Figure 6 for site position in lake. Plankton includes total counts for cladocerans and copepods.

SITE	TIME	DEPTH(m)	PLANKTON	NUMBER m ³
P1	NOON	18.3	227	1097
P1	MIDNIGHT	18.3	321	1552
P2	NOON	23.8	326	1212
P3	DAY	11.9	287	2134
P3	MIDNIGHT	13.4	496	3275
P4	NOON	44.5	702	1396
AVERAGE				1778

Fish

Over the 5 day survey, Fyke nets were set at 11 positions around the lake. Fish were present at all collecting sites and with highest abundance on the northwest region of the lake (Fyke 2, 5, 7, Figure 6, Table 5). In total, 844 fish were captured, all of which were Dolly Varden. Length frequency distribution (Figure 11) shows a mode near 9 cm (probably the 1+ yr class) with a range from 4.0 to 21.5. Proportion of size classes differed among sequential samples from the same region suggesting the presence of size-specific or age-specific schools.

Table 5. Summarized data on fish collections in Fyke nets from Upper Victoria Lake. See Figure 6 for positions in lake. SITE L (littoral), OWB (open water benthic), OWS (open water surface).

DATE	SITE	DOLLY VARDEN	RAINBOW TROUT	STICKLE BACK
07/07/93	Fyke1 L	2	0	0
	Fyke2 L	184	0	0
08/07/93	Fyke3 L	31	0	0
	Fyke4 L	2	0	0
	Fyke5 L	219	0	0
09/07/93	Fyke6 L	13	0	0
	Fyke7 L	188	0	0
	Fyke8 L	54	0	0
10/07/93	Fyke9 L	59	0	0
	Fyke10 L	61	0	0
	Fyke11 L	6	0	0
08/07/93	GN1 OWB	0	0	0
09/07/93	GN2 OWB	24	0	0
10/07/93	GN3 OWS	1	0	0
	Totals	844	0	0

The eastern basin of the lake contains a strong mode near 14 cm SL and relatively low numbers of smaller fish (<10 cm) (Figure 11). In contrast, the western basin has predominantly small size classes with a mode near 8 cm (Figure 12). This may be a sampling artifact but the replicated size trends on successive Fyke settings suggests a biological effect. These length differences are primarily age-related and represent at least two separate year classes, the smaller mode comprising young of the year fish. Possibly, the size differences are functionally associated with differences in prey availability. The eastern basin has broader shallow zones where some benthos can be expected to occur while the western basin is deeper and will have reduced benthic diversity. Larger fish are able to take a broader size range of prey than smaller fish and consequently can exploit both macrobenthos as well as zooplankton. As such, they may have a competitive advantage over smaller fish in the shallow zones.

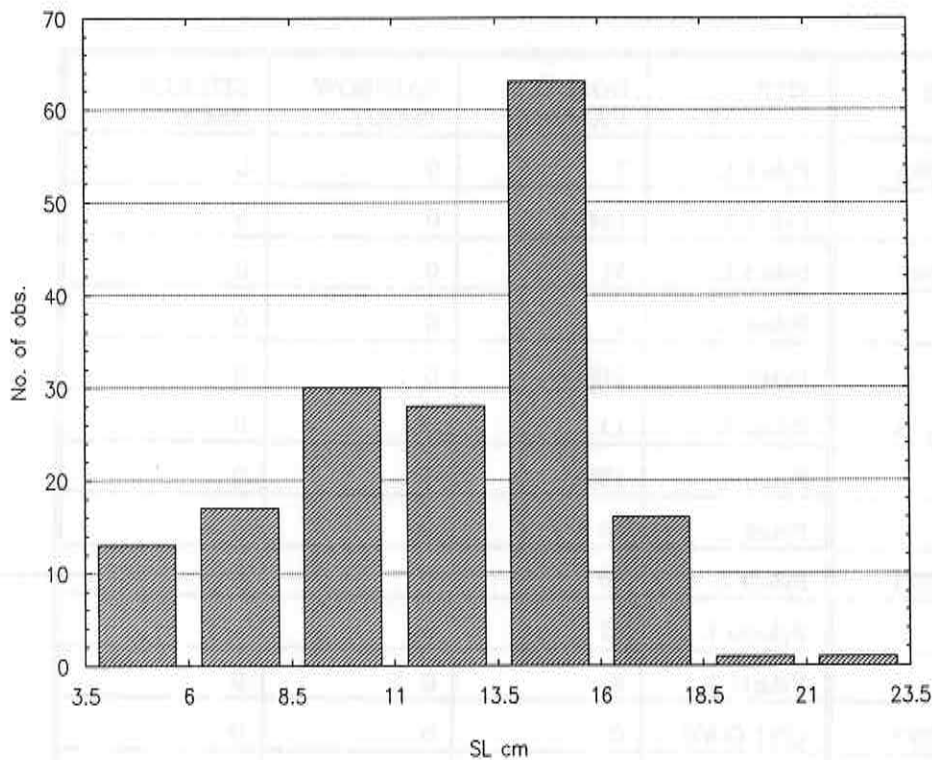


Figure 11. Frequency histogram of body length (SL) for Dolly Varden in eastern basin at Upper Victoria Lake.

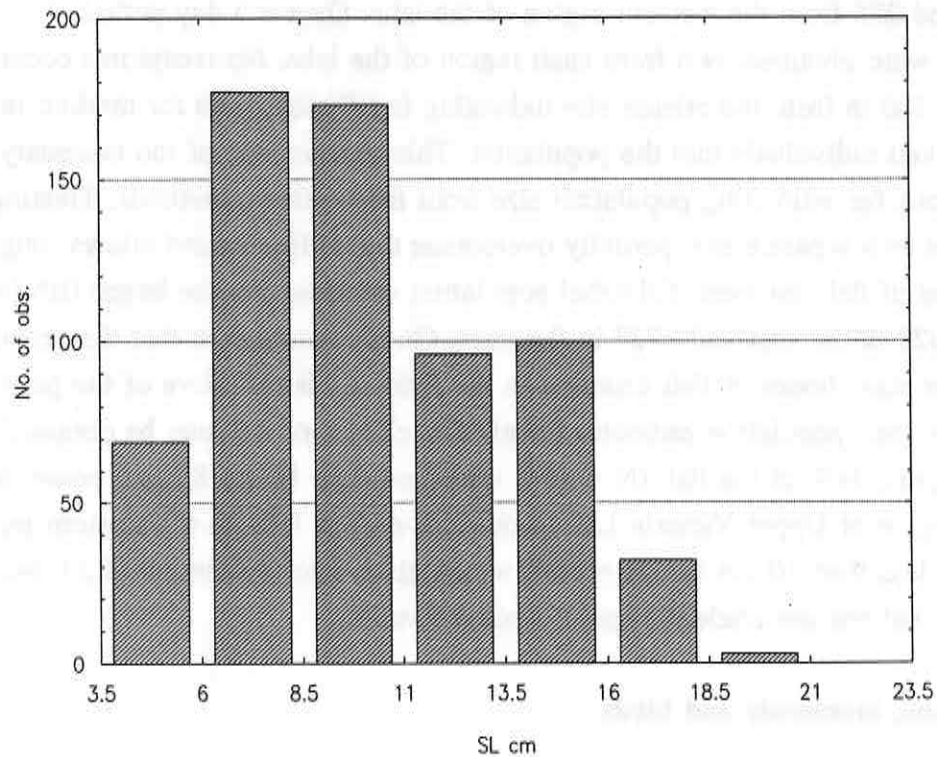


Figure 12. Frequency histogram of body length (SL) for Dolly Varden in western basin at Upper Victoria Lake.

Gillnets suspended in the upper part of the water column did not have any fish. Those set at the lake bottom (30-55 m depth) produced 24 fish all of which were Dolly Varden ranging from 8 to 12 cm SL.

Minnow traps, set in pools of the largest inlet stream (sector 16), had no fish although visual surveys in the stream showed occasional Dolly Varden (app 4. cm SL).

To estimate fish abundance in the lake, I marked and released 334 of the largest individuals (>10 cm) captured in the Fyke nets, 109 from the eastern region of the lake and 225 from the western region of the lake. Over a 5 day period, 4 recaptures were obtained, two from each region of the lake. No recaptures occurred more than 200 m from the release site indicating insufficient time for random mixing of the marked individuals into the population. This violates one of the necessary preconditions for estimating population size from mark-release methods. Treating each lake region as a separate unit partially overcomes this difficulty and allows rough calculations of fish numbers. Schnabel population estimates for the larger fish (>10 cm) are 1923 in the east and 8727 in the west. On the assumption that the proportions of different size classes of fish captured in the Fyke net is reflective of the proportion in the lake, then population estimates for all size classes of fish can be obtained. In the eastern region, 34% of the fish (N = 164) were less than 10 cm SL and consequently, the east region of Upper Victoria Lake would have 2914 fish. In the western region, 64% were less than 10 cm SL (N = 630) which gives a total estimate of 24 242 fish. These calculations are crude but are of heuristic value.

Amphibians, mammals and birds

Northwestern toad tadpoles occurred at the mouth of a small stream at sector 1 (Figure 6) while adult toads were seen on an open bog close to the outlet stream of the lake.

Over the 6 day observation period, the only mammals observed were four deer (3 adult, 1 fawn). Shoreline surveys also indicated three black bear scats and raccoon tracks.

Thirteen species of birds were associated either with the lake surface or the shoreline:

- Common Loon (4)
- Red-Throated Loon (1)
- Canada Goose (droppings common)
- Common Merganser (1)
- Blue Grouse (2 heard)

Sandhill Crane (2)
Marbled Murrelet (2 calls total)
Red-shafted Flicker
Tree Swallows (30+)
Chestnut-backed Chickadee (common)
Robin (common)
Hermit Thrush (common)
Western Flycatcher (common)

The small lake on the outlet stream had a pair of Red-Throated Loon during the day. This is probably a nesting pair as territorial vocalizations were heard. A pair of Sandhill Cranes occupied the open bogs on the northeastern slopes of the lake. Several Marbled Murrelets were heard each evening in high overhead flights; there was no circling or stationary calls from any region of the lake. Tree Swallows were common in flight in a number of bays taking insects over the Nuphar plants.