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THE MORPHOMETRY OF NILKITKWA LAKE

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A detailed sounding program of Nilkitkwa Lake was carried out in June 1963 in order to prepare a contour map and to describe the morphometry of the lake. These data are of fundamental importance for the projected study of the migration behaviour of sockeye smolts from the Babine system and for any associated limnological study. The contour map, which was plotted from the soundings, is attached to this report. Also reported herein are the morphometric characteristics of the lake.

Nilkitkwa Lake is situated on the great central plateau in the central interior of British Columbia, in latitude $55^{\circ} 12'$ north, longitude $126^{\circ} 33'$ west. It lies at an elevation of about 2,330 feet above sea level in a broad undulating valley between the Babine Range to the southwest and the Bait Range and the Frypan Mountains to the northeast. The main axis of the lake lies in a north northwesterly and south southeasterly direction as does the northwest arm of Babine Lake from which Nilkitkwa Lake is separated by a two-mile interval of low lying land. Several streams empty into Nilkitkwa Lake, but by far the greatest volume of water comes from Babine Lake through the Upper Babine River. The outlet is to the north through the Lower Babine River which after leaving Nilkitkwa Lake flows in a northwesterly direction for 50 miles to join the Skeena River 40 miles north of Hazelton.

Geologically the lake lies in a belt of jurassic, extrusive volcanic and sedimentary rocks that borders the Coast Range on the east. The belt is interrupted in several places by relatively small intrusions of granitic rocks, by isolated basins of cretaceous sedimentary rocks, and by areas of sedimentary and volcanic rocks of tertiary age. The absence of bed-rock and presence of silt, gravel, and small boulders along the shore line of Milkitwa Lake suggest glacial or alluvial origin.

The methods used in obtaining the data follow. A map with a scale of one inch to 475 feet which had been drawn from aerial photographs by personnel of the Fish Culture Development Branch of the Department of Fisheries was obtained. Depths were measured with a sounding line of cotton graduated in metres and calibrated at intervals to eliminate error due to stretching or shrinking. The location of soundings was accomplished by means of sighting between prominent places on the shore and by timing distances run by an outboard motor. A total of 548 soundings was made. All soundings were made between June 4 and 23, 1963, a time of year when the lake level is highest. A reference stake was driven by the lake shore midway along the lake to mark the water level at the time of sounding. This level was used as the datum line upon which all calculations are based.

Contour lines were drawn at three-metre intervals from a plot of the depth measurements. Areas of the lake surface and of each three-metre contour were determined by means of a planimeter. Volumes were calculated from the areas of adjacent contours for each horizontal stratum using the formula, volume = $\frac{h}{3} (a_1 + a_2 + \sqrt{a_1 a_2})$, in which h is vertical depth of each stratum. a_1 is the area of the upper surface and a_2 is the area of the lower surface of the stratum. The volumes of the several strata were summed

to obtain the total volume. Mean depth was calculated by dividing the volume by the surface area. Length of shore-line was measured from the map using the scale of one inch to 475 feet. Shore development is the ratio of actual shore length to the perimeter of a circle of area equal to that of the lake. Volume development represents the ratio of the total volume to the volume of a cone whose area of base is equal to the surface area of the lake and whose height is equal to the maximum depth of the lake.

The areas and volumes for each three-metre interval and other morphometric characteristics of Milkitka Lake are shown in Table I.

Milkitka Lake is a long narrow lake, 8.79 km. long and 0.67 km. wide (5.46 miles by 0.54 mile) covering an area of 4.37 sq. km. (1.88 sq. mile). The bottom configuration is very irregular, particularly that of the northern end, containing several depressions and a number of banks some of which rise above the surface to form small islands. Considerable areas of shallow water exist. Over 60% of the lake's surface lies over water 9 metres deep and less. The mean depth is 7.65 metres (25.10 feet). The deepest water is found in a depression with a maximum depth of 21.75 metres (71.36 feet) near the southern end of the lake. Between this depression and Smokehouse Island is another depression with a depth of 18 metres. The northern end of the lake has eight depressions with depths of 20, 19 $\frac{1}{2}$, 19 $\frac{1}{2}$, 15 $\frac{1}{2}$, 15, 14, and 12 metres.

The shore development of the lake is fairly extensive (2.90) due not so much to irregularity of the shore-line or to islands as to the elongated form of the lake. The fact that the volume development is slightly over unity (1.06) indicates that the basin walls are slightly concave to the water surface.

From an examination of the attached contour map it is apparent that Nilkitwa Lake is almost divided midway by a neck of water about 190 metres (208 yards) in width. The maximum depth across the lake immediately south of this neck of water is 6.75 metres. These data suggest that the two parts might be considered as individual lakes, Upper Nilkitwa (the southern portion) and Lower Nilkitwa (the northern portion). In this respect Upper and Lower Nilkitwa are compared in Table II. The comparison shows that Lower Nilkitwa is longer, narrower, and shallower and has a smaller area and volume, than Upper Nilkitwa. Because of its more elongated shape, islands, and more irregular shore-line, Lower Nilkitwa has a longer shore-line and consequently a higher shore development than Upper Nilkitwa.

No records are available on the variation in the water level of Nilkitwa Lake from year to year and at different seasons of the same year. However, water level and discharge figures are available for the Upper Babine River, the main source of incoming water. Though these water levels cannot be applied directly they do reflect general changes in lake level. The maximum variation between low and high water is probably in the order of a metre and a half. The lowest water usually occurs in April, the highest in June. The water discharge of the Upper Babine River during June, 1953, as reported by the Water Resources Division of the Department of Resources and Development, averaged 4,500 c.f.s. At this rate of flow the water in Nilkitwa Lake could be completely replaced by water from the Upper Babine River in 3 days 9 hours. During June, 1952 when the mean discharge was 6,060 c.f.s., the highest on record, the lake water could have flushed out in 2 days 18½ hours. The lowest discharge recorded was that of 175 c.f.s. in April 1951. Allowing for a reduction in the volume of the

lake the water transfer would be effected in 71 days 7 hours. These calculations are made with the assumption that all the outgoing water in Milkikwa Lake is uniformly replaced by incoming water.

The findings of this study may be summarized briefly as follows:

- (1) Milkikwa Lake is a small shallow lake situated on the Babine River two miles below the outlet of Babine Lake.
- (2) The lake has a fairly extensive shore development due to its elongated shape.
- (3) The lake might be considered as two lakes separated midway by a narrow neck of water.
- (4) A complete transfer of water in the lake could occur between 2 days 12 $\frac{1}{2}$ hours at times of high water and 71 days 7 hours at times of low water.

This study has been carried out in conjunction with the smolt estimation project of the sockeye salmon investigation on Babine Lake. Mr. F. C. Withler assisted in the sounding of the lake and Mr. D. Denbigh in the drawing of the map.

General References

- Hanson, G. Driftwood Creek map-area, Babine mountains, B. C. Geol. Surv. Sum. Rep., Part A:19-37, 1924.
- Walch, P. S. Limnological methods. 1-361. Blakiston Co., Philadelphia. Toronto. 1948.

Table I. The morphometry of Milkikwa Lake

Area	4.57 sq. km. (1.88 sq. mi.)
Maximum length	8.79 km. (5.46 mi.)
Maximum width	0.87 km. (0.54 mi.)
Maximum depth	21.75 m. (71.36 ft.)
Mean depth	7.55 m. (25.10 ft.)
Volume	37.3 x 10 ⁶ cu. m. (48.8 x 10 ⁶ cu. yd.)
Shore-line	22.70 km. (14.10 mi.)
Shore development	2.90
Volume development	1.06

Depth	Area (hectares)	Stratum (m.)	Volume (cu. m. x 10 ⁶)	% total volume
0	437	0-3	12.5	33.4
3	348	3-6	9.3	24.9
6	273	6-9	6.7	18.0
9	179	9-12	4.4	11.9
12	119	12-15	2.8	7.4
15	68	15-18	1.3	3.6
18	25	18-21	0.3	0.8
21	1	21-21.75	-	-
			Total	37.3

Table II. The morphometry of Upper and Lower Milkitkwa

	Upper Milkitkwa	Lower Milkitkwa
Area	2.45 sq. km. (0.95 sq. mi.)	2.42 sq. km. (0.94 sq. mi.)
Maximum length	3.69 km. (2.29 mi.)	5.10 km. (3.17 mi.)
Maximum width	0.87 km. (0.54 mi.)	0.74 km. (0.46 mi.)
Maximum depth	21.75 m. (71.36 ft.)	20.0 m. (65.62 ft.)
Mean depth	8.57 m. (28.12 ft.)	6.70 m. (21.98 ft.)
Volume	21.0 x 10 ⁶ cu. m. (27.5 x 10 ⁶ cu. yd.)	16.3 x 10 ⁶ cu. m. (21.3 x 10 ⁶ cu. yd.)
Shore-line	9.10 km. (5.65 mi.)	13.60 km. (8.45 mi.)
Shore development	1.64	2.46
Volume development	1.18	1.01

