T E C H N I C A L R E P O R T

A LIMNOLOGICAL INVESTIGATION OF ORION LAKE

Prepared As A Course Requirement For:

Wildland Recreation Technology II

Selkirk College

Castlegar, B. C.

Prepared By:

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A C K N O W L E D G E M E N T

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Susan G. Ross

Albert Kenneth Ross

John MacDonald

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A P P E N D I X

INTRODUCTION

The objective of this study is to assess Orion Lake for its sport fishing suitability. This has been accomplished by investigating its biological and physical status through a limnological survey.

FISHING OPPORTUNITIES IN THE BLUEBERRY-PAULSON CORRIDOR

Nancy Greene Lake, Little Sheep Lake, Christina Lake, McRae Creek, and Blueberry Creek are the main bodies of water in the Blueberry-Paulson Corridor.

After interviewing fishermen who have fished these areas, it was found that none of the above offer a great fishery.

This has led to the conclusion that there is a clear need for improved fishing opportunities in the Blueberry-Paulson Corridor.

ORION LAKE (Southern Lake)

Location:

Department of Lands, Forests, and Water Resources maps:

Grand Forks 82 E/SE

1:125,000 series

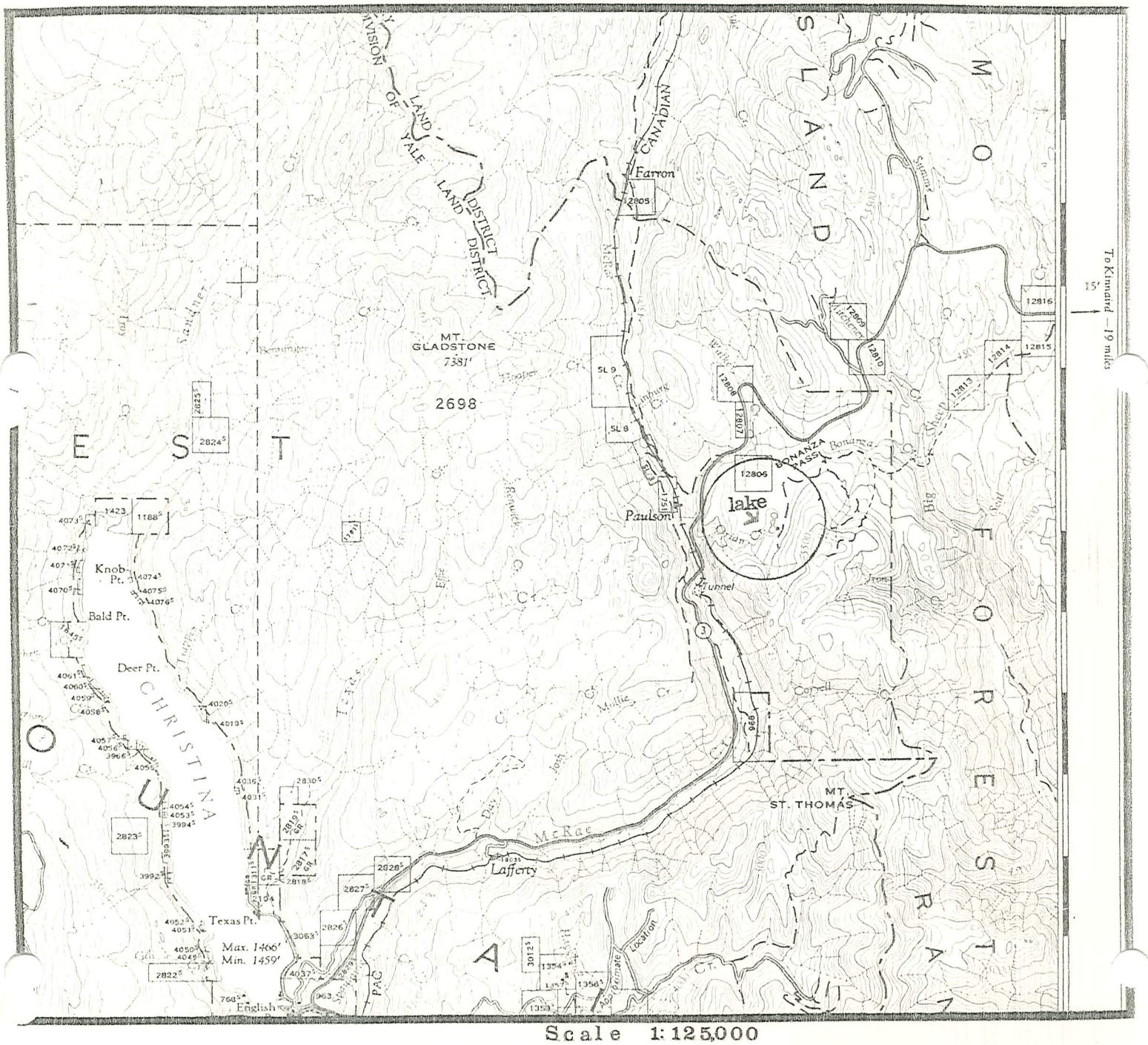
Military Grid Reference: 49 degrees, 12 minutes north and 118 degrees, 4 minutes east.

Access: (refer to location map)

Via vehicle from Highway #3 between Castlegar and Christina Lake.

Figure 1. Location Map

Map: 82E/SE Grand Forks



Scale 1:125,000

Turn onto a well maintained logging road at Bonanza Pass. Travel approximately 3 kilometers. Orion Lake is on the right-hand side of the road.

Description Of Lake:

Orion Lake is classified as an old beaver pond. It is classified as such due to the beaver dam at the south end which resulted in the formation of a small lake.

For reasons unknown, beavers have long since left the lake. Surrounding the deepest parts of the lake are floating sphagnum islands. Beyond these islands are numerous stands of drowned timber partially submerged in about 1 meter of water.

The surrounding shore cover is mainly forest, composed largely of trees averaging 20 feet or more in height. A highly productive littoral zone exists along the lake shore.

The lake has a surface elevation of approximately 1,463 meters. It is fed by seepage water and underground springs causing the water to be fairly cold. The water appears to be turbid, largely due to a large biomass of aquatic life.

Lake bottom material is mainly composed of muck and decaying vegetation. High concentrations of methane gas are present around the 1 meter depth range amongst the stands of drowned timber.

An old mill site is located at the north-eastern end of the lake, on the lake side of the road. On the eastern side of the lake, an old cart trail, overgrown with trees and shrubs is located about 50 meters from the lake shore.

The overall aspect of the lake appeared to be suitable for supporting a fishery of Brook Trout.

Final Statement:

It seemed appropriate to conduct an in-depth study of Orion Lake for the purpose of determining its potential for supporting a sport fishery of Brook Trout.

HABITAT REQUIREMENTS FOR BROOK TROUT (Salvelinus fontinalis) (Needham)

Type Of Lake:

Brook Trout do particularly well in spring-fed, muck-bottomed ponds with abundant growths of lily pads or pond weeds.

Temperature:

Maximum temperature tolerance is 75 degrees F. (24 degrees C.) and ideal temperature is 66 degrees F. (18 degrees C.)

Oxygen:

Oxygen levels should be over 4.29 ppm although 4 ppm is considered a minimum safe limit for clean natural trout waters.

Carbon Dioxide:

Carbon dioxide levels should be maximum or 10 ppm except where oxygen is overly abundant.

pH:

pH range is of little importance in natural unpolluted waters.

Acid or alkaline variations are not favoured or generally preferred by Brook Trout. However, according to the Forestry Handbook pH ranges should never exceed 8.5 or drop below 6.5 in any waters inhabited by Trout.

ORION LAKE LIMNOLOGICAL SURVEY PROCEDURES

Vegetation:

Species lists of emergent, submergent, and terrestrial plants were made by walking around the whole perimeter of the lake, and recording vegetation observed.

Physical Features:

Physical features were noted by walking the lake perimeter.

A working map was drawn to scale by plane table surveying and air-photo-interpretation.

A base line was laid out a specific distance in length, and a number of points were marked around the perimeter of the lake. Each point was pinpointed on the map by triangulation, thus forming a workable drawing of the lake.

Depth sounding was accomplished with a battery powered depth sounding probe. This machine continually recorded the depth as the canoe was paddled from one known point to another known point at a constant speed. The sounding machine automatically graphed the contour of the lake bottom on heat sensitive graph paper.

Chemical Analysis:

Chemical tests were taken about the midportion of the lake. A water sample was taken at the bottom with the aid of a Van Dorne bottle. Another sample was taken at the surface. These samples were then taken back to shore and analyzed with Selkirk College Hach Kits for CO_2, PO_4, O_2, and pH levels.

With the use of a battery powered oxygen temperature probe, an oxygen and temperature profile was recorded in a deep portion of the

lake.

pH was determined with a digital pH meter on shore.

Total dissolved solids were measured from a surface sample taken back to the College and weighed on the scales in the chemistry lab.

RELEVANCE OF DATA (Forestry Handbook)

Vegetation:

Vegetation cover along streams provide shade for water temperature control, hiding cover for fish, bank stability through root systems, and a place for insects to live and breed which indirectly provides a source of fish food as these insects fall into the water. For these reasons, the taller vegetation, the greater its value.

Aquatic plants are beneficial to fisheries habitat in many ways. These include production of oxygen, living, and hiding places for aquatic insects and fish; also a food source for herbivorous fish and insects.

Measurement Of Temperature:

Temperature is a vital and important component of habitat. Although temperature has a pronounced effect on the carrying capacity of dissolved oxygen in water, its relationship to production of flora and fauna is more important. During any month of the year, heat should not be added in excess of the amount that will raise the temperature of the water more that 5 degrees F.

Measurement Of Oxygen:

For cold water biota, it is desirable that dissolved oxygen concentrates be at or near saturation. This is especially important in spawning areas where dissolved oxygen levels must not be below 7 mg/L at any time.

For good growth and general well-being of trout, salmon, and their associated biota, dissolved oxygen concentrations should not be below 6 mg/L.

Measurement Of Carbon Dioxide:

The presence of CO_2 in the fishes' blood stream triggers the impulse to breathe in O_2. Without this CO_2, the fish would not begin to breathe. It is recommended that the "free" CO_2 concentration should not exceed 25 mg/L. CO_2 is also an essential element in the process of photosynthesis for plant growth.

Measurement Of Phosphates:

Phosphorus is one of the nutrients of major importance to biological systems. It is most likely the main limiting or regulating element in productivity.

For their nutrition plants require inorganic phosphate, typically as orthophosphate ions. The total phosphorus concentrations of most uncontaminated surface waters are between 10 to 50 ppb.

Measurement Of pH:

For good fish habitat, pH or hydrogen-ion concentration should fall within the range of 6.5 to 8.5 No highly dissociated materials should be added in quantities sufficient to lower the pH below 6.0 or to raise the pH above 9.0.

Measurement Of TDS (Total Dissolved Solids):

Dissolved materials that are relatively innocuous: (i.e. their harmful effect is due to osmotic effects at high concentrations) should not be increased by more that 1/3 of the concentration that is characteristic of the natural condition of the subject water. In no instance should the concentration of dissolved materials exceed 50

milliosmoles (equivalent of 1500 mg/L NaCl).

Measurement of Turbidity:

Turbidity affects light penetration in water, which in turn has a pronounced effect on the growth of aquatic plants. Turbidity also affects many species of fish classed as sight feeders. In addition, suspended materials absorb solar heat, causing water temperatures to increase.

Spring Sources :

As a general rule, springs producing more that 100 gallons per minute should be noted and the water temperature measured. This information is relevant for potential water sources for hatchery sites and rearing ponds.

Shore Developement Ratio:

Where "s" is the length of the shoreline, and "A" is the area or acreage of the lake. The term "shoreline developement" refers to the ratio of the actual length of shoreline of a lake to the length of the circumference of a circle the area of which is equal to that of the lake. This figure is expressible as an index figure to denote degree of regularity or irregularity. In general, the higher this index figure is for shore developement the greater the biological productivity of the body of water.

Lake Surface Elevation:

Elevation is critical in estimating the approximate number of snow-and-ice-free days that may be expected during the year. The duration of the ice-free period also influences the amount of biological activity (such as fish growth) in the lake.

LIMNOLOGICAL SURVEY RESULTS

For comparison purposes, three sets of information gathered on three different occasions are presented in chart form.

Beside Orion Lake survey data are Brook Trout habitat requirement data, also for comparison purposes. (following page)

Figure 2. DATA CHART FOR ORION LAKE 1978

		Oct. 14	Oct. 15	June 20	June 21	Brook Trout Requirements
O_2	Surface	5 ppm	8 ppm	10 ppm	11 ppm	4 ppm min.
	Bottom	3.6 ppm	6.1 ppm	N/A	N/A	4 ppm min.
CO_2	Surface	10 ppm	12 ppm	25 ppm	10 ppm	10 ppm max.
	Bottom	40 ppm	25 ppm	N/A	N/A	10 ppm max.
Temperature	Surface	5.8 C.	7.4 C.	17.9 C.	N/A	23 C. max.
	Bottom	5.8 C.	5.6 C.	N/A	N/A	23 C. max.
Turbidity		3.5 M.	3.5 M.	N/A	3.5 M.	No Set Figure
Colour		Brownish	Brownish	N/A	N/A	No Set Colour

Figure 3. 1978 DATA CHART FOR ORION LAKE

		Oct. 14	Oct. 15	June 20	June 21	Normal Acceptable Trout Levels
PO_4	Surface	2 ppm	1 ppm	N/A	N/A	.03-.15 ppm
	Bottom	13 ppm	2 ppm	N/A	N/A	.03-.15 ppm
pH	Surface	4.06	4.50	4.75	4.55	6.5 min.
	Bottom	5.08	5.04	N/A	N/A	8.5 min.
TDS		85.5 ppm	85.5 ppm	N/A	N/A	1500 ppm max.

Figure 4. 1978 TEMPERATURE AND OXYGEN GRADIENT RESULTS FOR ORION LAKE

Depth/m	Temperature/C	Oxygen/ppm
2	7	5.1-5.0
4	6.8	5.6-5.8
6	6.3	5.6-5.8
8	6.0	6.1-5.7
9.6	5.8	6.1-2.5

Shore Developement Ratio = 163

This represents a highly productive littoral zone.

Figure 5. TEMPERATURE - OXYGEN GRADIENT ABOVE A DEPRESSION OF DEPTH 9.6M IN OCTOBER 1978

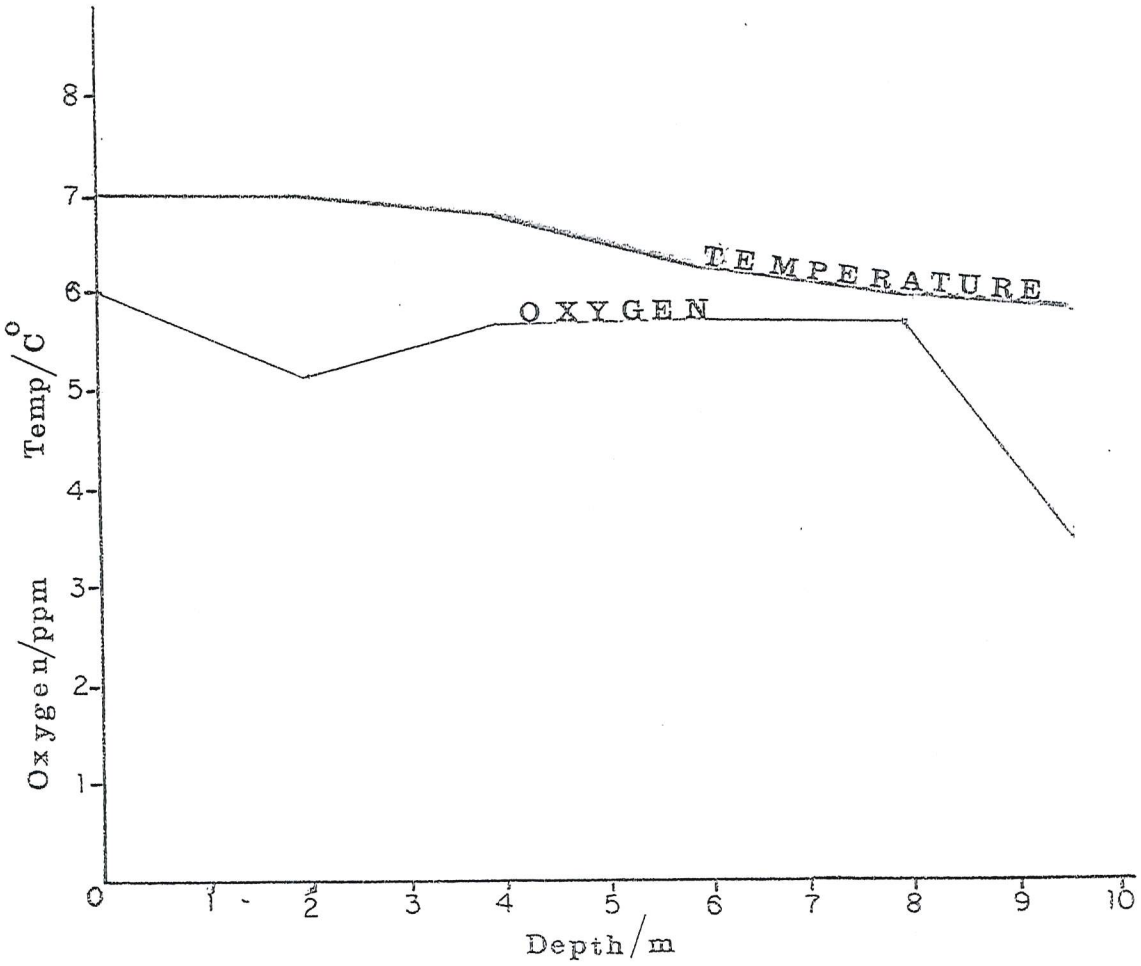
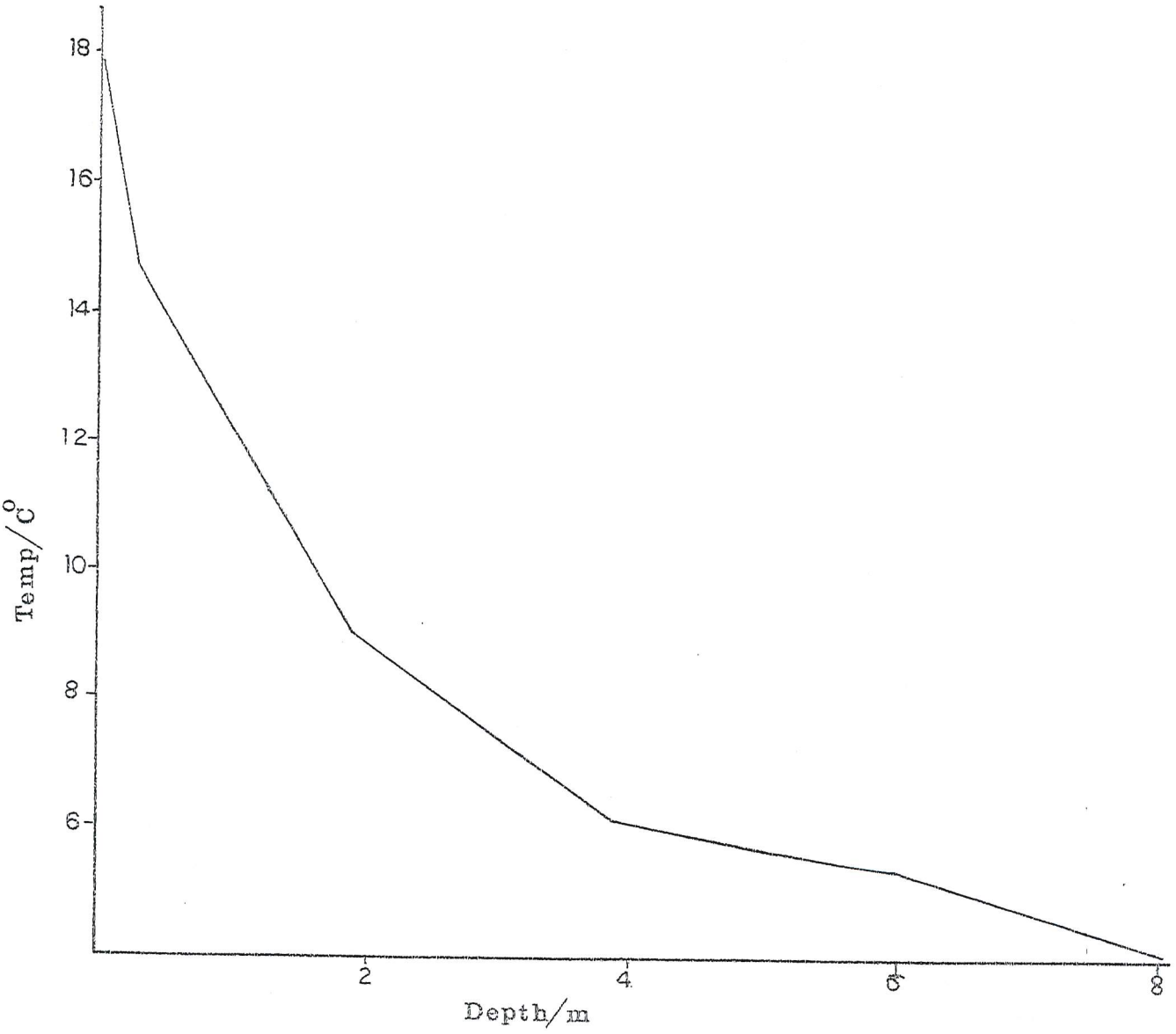


Figure 6. TEMPERATURE GRADIENT ABOVE A DEPRESSION OF DEPTH 8.5M IN June 1978



Vegetation:

Orion Lake contains an extensive population of aquatic plants, particularly submergent vegetation. Emergent vegetation appeared to be less extensive. Pondweed, slender spikerush, and milfoil were dominant aquatic species.

The terrestrial vegetation immediately around the lake was mainly forest. The biogeoclimatic zone was a transition between Interior Western Hemlock and Englemann Spruce Sub-Alpine Fir. This was evident because the two most dominant species were Abies lasiocarpa and Tsuga heterophylla. The ground vegetation present was characteristic of both biogeoclimatic zones.

Co-dominant species were Picea englemanni and Thuja plicata.

Vegetation Species Lists:

Submergent:

Pondweed

Arrowhead

Slender Spikerush

Elodea

Milfoil

Emergent:

Horsetail

Sedges

Reed Canary Grass

Terrestrial:

Common Name	Latin Name
Sub-Alpine Fir	Abies lasiocarpa
Western Hemlock	Tsuga heterophylla

Common Name	Latin Name
Englemann Spruce	Picea englemanni
Western Red Cedar	Thuja plicata
Princess Pine	Chimaphila umbellata
Trailing Rubus	Rubus pedatus
Pyrola spp	
False Box	Pachistima myrsinites
Rattlesnake Plantain	Goodyera oblongifolia
Queen's Cup	Clintonia uniflora
Bunch Berry	Cornus canadensis
Twin Flower	Linnaea boreàlis
Bracken Fern	Pteridium aquifolium pubescens
Cow Parsnip	Heracleum lanatum
Pearly Everlasting	Anaphalis margaritacea
Water Hemlock	Cicuta douglasii

Wildlife Species List :

Spruce Grouse

Barrows Goldeneye

Western Red Squirrel

Spider

Caddis Fly Nymph

Caddis Fly Larvae

Caddis Fly

Dragon Fly Nymph

Dragon Fly

Mosquito Larvae

Mosquito

Bugs

EQUIPMENT USED

Field Notebook

Plane Table

Ruler

Silva Compass

Pencil

Survey Tape

Sounding Line

Hach Kits

PO_4 - Model po-20 po-20A Ortho & meta (Poly) phosph

NO_3 - Model NI-10 Nitrate - Nitrite

O_2 - Model Ox-2-p Dissolved Oxygen

Van Dorne Bottle

Depth Sounder - Model 1600 Sea Deep International

Oxygen Temperature Probe - Model 54

Digital pH Meter - Model 107

Selkirk College Canoe

Aerial Photographs

Mirror Stereoscope

Kail Plotter

Binoculars

Camera

ANALYSIS OF DATA (refer to Charts 1 & 2)

Oxygen:

During October, tests revealed that dissolved oxygen levels were dangerously low and fast approaching or dropping below the minimum tolerance levels for Brook Trout. Lower levels of oxygen at this time of year can be expected, due to the fact that plant

decomposers use up more oxygen than is being produced by living plants. The lake contains a great amount of dead vegetative matter. In order to decompose this vegetation, bacteria consumes substantial quantities of oxygen.

For Brook Trout, oxygen levels should not drop below 4 ppm. A sample in October held only 3.6 ppm. It is inevitable that the level of oxygen will drop even lower during the winter months.

An oxygen test done in June revealed higher levels than in October. This is due to the fact that during the summer green plants are producing more oxygen through the process of photosynthesis.

Carbon Dioxide:

CO_2 levels in October and June exceeded the maximum tolerance level for Brook Trout. However, during the summer months when dissolved oxygen levels are higher, the high concentrations of CO_2 are of no consequence. In October when dissolved oxygen levels are extremely low and CO_2 concentrations are overly abundant, serious problems for fish survival will occur.

Ortho Phosphate:

Normal acceptable concentrations of PO_4 in trout streams, according to Fish and Wildlife Branch standards are .03 - .15 ppm. At present, there have been no toxic levels established for trout. Extremely high concentrations of Ortho Phosphate occurred in October. (No data was available for June for comparison purposes.) These high levels of phosphate could very well be a dilemma for Brook Trout survival, even though it represents an extremely productive ecosystem.

pH:

Tests run in October and June revealed a relatively acidic body of water. pH levels dropped below the minimum tolerance level for Brook Trout. The acidity is due to the high degree of decaying vegetation at the bottom of the lake and around its edges. Fish cannot tolerate a too acid or alkaline habitat. The closer it is to 7 pH (neutral) the better the habitat is.

Temperature:

Acceptable temperatures were recorded in October and June for they did not exceed the maximum tolerance level for Brook Trout. Temperatures during the winter may drop to as low as 4 degrees C. without harmful effect to fish. Winter is a period of slow growth when fish metabolism becomes very slow and oxygen requirements are less.

Total Dissolved Solids (TDS):

TDS concentrations did not exceed the maximum level for trout. TDS is regarded by the Fish and Wildlife Branch as a measure of productivity. If the concentrations exceed the recommended amounts, harmful effects might occur. ie.; osmosis in the fish's body.

Turbidity:

Turbidity appeared to remain constant in June and October. The secchi disc disappeared at 3.5 m. on all three accasions. This constant measurement of turbidity indicates that TDS probably remains constant as well. The high degree of turbidity also indicates that a large biomass of phyto plankton and zooplankton exist, which is beneficial for fish productivity.

Colour:

The brownish colour of the water is due to the fact that the lake contains high concentrations of suspended materials. This brownish tinge is characteristic of bog-type, muck-bottomed ponds.

CONCLUSIONS

Extremely low levels of O_2, high levels of CO_2 and PO_4, relatively acidic water, and high concentrations of methane gas indicate that Orion Lake is dying from natural ecological succession.

An additional large volume of well-oxygenated water channelled into Orion Lake would probably be sufficient for its restoration. However it is unfortunate that no such facility of water is available nearby.

RECOMMENDATION

It is recommended that Orion Lake not be considered for supporting a fishery of Brook Trout.

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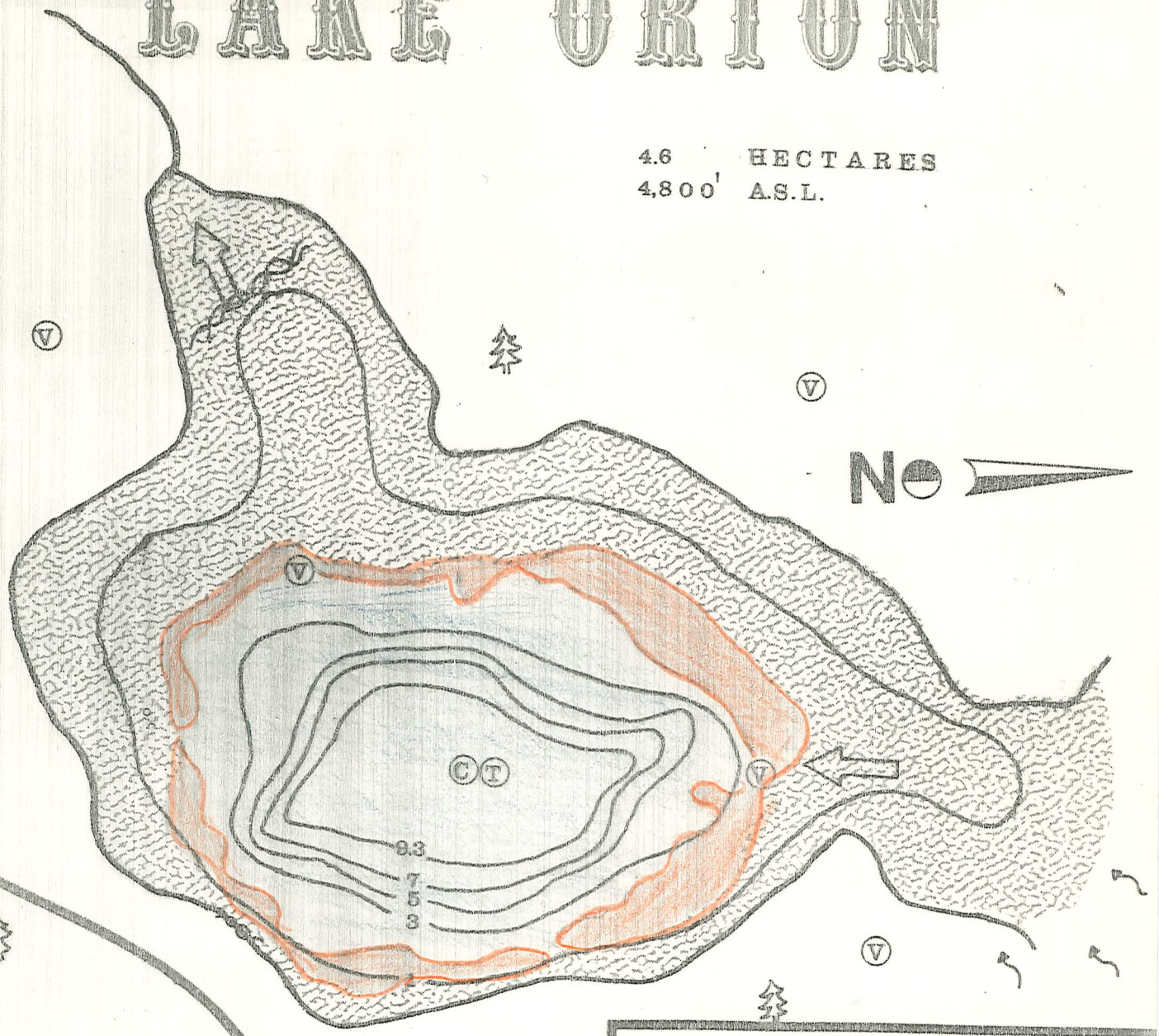
LAKE ORION

4.6 HECTARES
4,800' A.S.L.



LEGEND

- Sphagnum Island
- Open Water
- Drowned Timber
- Inlet
- Outlet
- Emergent Vegetation
- IWH ESSF Transition
- Beaver Activity
- Seepage Water
- Vegetation Samples (V)
- Chemical Samples (C)
- Contour Line
- Cart Trail
- Logging Road
- Mill Site
- Temperature Record (T)

SCALE
1cm=15m or 1:1500