# A SURVEY OF LAKES IN THE MACMILLAN PASS AREA

## WITH

## ESTIMATES OF POTENTIAL FISH PRODUCTION

THIS REPORT IS PRODUCED AS PART OF THE AQUATICS COMPONENT OF AN ECOLOGICAL LAND SURVEY (ELS) OF THE MACMILLAN PASS PROJECT AREA. THE ECOLOGICAL LAND SURVEY IS JOINTLY FINANCED BETWEEN THE DEPARTMENT OF INDIAN AND NORTHERN AFFAIRS, THE DEPARTMENT OF REGIONAL ECONOMIC EXPANSION AND THE GOVERNMENT OF YUKON, UNDER THE CANADA YUKON SUBSIDIARY AGREEMENT ON RENEWABLE RESOURCE DEVELOPMENT.

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## INTRODUCTION

Seventeen lakes in the MacMillan Pass - Ross River area were surveyed in the summer of 1981. The major emphasis of the study was to determine fish species composition and potential fish production. Appropriate data was collected for calculation of the morphoedaphic index (MEI): an empirically derived formula that can be used to predict potential fish yields in lakes (Ryder 1964; 1965). All lakes were sampled for fish by gill net to determine species composition and relative abundance. In addition measurements of a number of physical parameters were recorded including dissolved oxygen concentration, temperature and water clarity.

This report was prepared as an adjunct to an Ecological Land Survey covering the north half of map sheet 105J and the south half of map sheet 105O. The Ecological Land Survey is a jointly funded program between the Department of Indian and Northern Affairs, the Department of Regional Economic Expansion and the Government of Yukon.

## METHODS

Seventeen lakes representing a range of morphological types were selected for study. Eight of the lakes were accessible by road or water while the other nine were reached by helicopter.

A series of transects, prorated per unit area of each lake, were depth-sounded using a Furuno FG-11-A Mark - 3 echo-sounder. An approximation of mean depth was calculated by averaging equidistant depth readings across all transects (Henderson et. al., 1973). Water samples were taken from each of the lakes to be analyzed for total dissolved solids (TDS) and specific conductance. (The analyses were performed by Can Test Ltd., Vancouver, B.C.). The morphoedaphic index (MEI) was calculated using the equation.

$$MEI = TDS/\bar{Z}$$

where $\bar{Z}$ represents mean depth in meters. Unfortunately TDS readings were not available for 11 of the 17 lakes examined due to handling errors in the laboratory. In these cases the product of 0.65 and specific conductance (a significant correlate of TDS) was substituted for TDS in the equation. Twenty-five meters was used as the upper bound to $\bar{Z}$ as depths greater than 25 m appear to have little effect on fish production (Oglesby, 1977; Schlesinger and Regier, 1981).

Potential fish production was estimated using two models. The first was a regional model developed by Ryder (1965) for north-temperate lakes. With this method annual fish production can be estimated using the regression equation

$$Y = 1.384\ X^{.44610}$$

where X equals the morphoedaphic index and Y the fish yield in kilograms per hectare per year.

The second was a global model developed by Schlesinger and Regier (1981). With this method fish production can be predicted using the regression equation

$$\log Y = 0.053\ (TEMP) + 0.308\ (\log MEI) + 0.222$$

where TEMP represents mean annual air temperature (°C). As with the previous model, yield is expressed in kg/ha/yr.

All lakes surveyed were sampled for fish using a 90m variable mesh gill net, set overnight. Angling was also used when appropriate.

A number of physical parameters were measured at each lake. Dissolved oxygen concentration was measured at various depths using a Hach kit; temperature and conductivity were measured at various depths using a Yellow Springs Instrument Company model 33 salinity - conductivity temperature meter; and water clarity was estimated using a Sechi disc.

## RESULTS AND DISCUSSION

A number of sources of error were encountered in calculation of the morphoedaphic indices. It was necessary in some instances to use extrapolation to interpret portions of the depth - soundings due to the poor quality of the recordings. In addition, the method used to calculate the average depth (arithmetic averaging of depths along prorated transects) was not as accurate as the more standard procedure of dividing lake volume, as determined from mapped contours, by surface area. The former method was chosen because the poor quality of the soundings and the limited number of transects did not permit the preparation of accurate contour maps.

The substitution of converted conductivity readings for TDS measurements in the MEI equation introduced another element of error. In the six lakes where both conductivity and TDS data was available there was an average 24% (7-34%) discrepancy between the actual TDS measurement and the estimate from specific conductance.

Morphometric and edaphic data as well as potential fish production figures as predicted by the Ryder, and Schlesinger and Regier models are presented in Table 1.

Before using the Ryder regression - yield model to predict fish production it is necessary to assure that each lake falls within the terms of reference on which the regression is based. The lake must be large

Table 1 - Morphometric, Edaphic and Potential Fish Production Data.

| Lake[1] | Average Depth(m) | Surface Area(ha) | TDS(mg/l) | MEI | Potential fish production: Ryder Model (kg/ha/yr) | Potential fish production: Schlesinger Model (kg/ha/yr) | Total Production[5]: Ryder Model (kg) | Total Production[5]: Schlesinger Model (kg) |
|---|---|---|---|---|---|---|---|---|
| (Blue Birch) | 13.1 | 138 | 85[3] | 6.5 | 3.2 | 1.2 | 440 | 170 |
| (Bulgar) | 10.3 | 221 | 60[3] | 5.8 | 3.0 | 1.1 | 600 | 240 |
| Dragon | 22.9 | 587 | 135 | 5.9 | 3.1 | 1.1 | 1820 | 650 |
| (Echo) | 6.4 | 90 | 90 | 14.1 | 4.5 | 1.5 | 410 | 140 |
| Field | 3.1 | 304 | 66[3] | 21.4 | 5.4 | 1.7 | 1640 | 520 |
| Fuller | 29.0 | 348 | 36[3] | 1.4[4] | 1.6 | 0.7 | 560 | 240 |
| (Gulf) | 3.6 | 55 | 90 | 25.0 | 5.8 | 1.8 | 320 | 100 |
| Itsi | 17.0 | 209 | 58 | 3.4 | 2.4 | 0.9 | 500 | 190 |
| John | 2.0[2] | 114 | 58[3] | 29.0 | 6.2 | 1.8 | 710 | 205 |
| (Lagoon) | 6.0 | 99 | 29[3] | 4.9 | 2.8 | 1.1 | 280 | 110 |
| (Lap) | 31.6 | 197 | 103[3] | 4.1[4] | 2.6 | 1.0 | 510 | 197 |
| Lewis | 8.4 | 541 | 95 | 11.3 | 4.1 | 1.4 | 2220 | 760 |
| Niddery | 2.0[2] | 82 | 178[3] | 89.1 | 10.3 | 2.6 | 840 | 210 |
| (Oly) | 21.6 | 152 | 108[3] | 5.0 | 2.8 | 1.1 | 430 | 170 |
| Orchie | 13.9 | 235 | 144[3] | 16.3 | 3.9 | 1.3 | 920 | 310 |
| Otter | 13.4 | 415 | 66[3] | 4.9 | 2.8 | 1.1 | 1160 | 460 |
| Sheldon | 6.0 | 398 | 92 | 15.3 | 4.7 | 1.5 | 1870 | 600 |

1. Names in brackets are local or assigned (not listed in Gazetteer of Canada).

2. Estimated using metered rope.

3. Estimated from specific conductance.

4. 25 m used for $\bar{Z}$ in calculation ($MEI_{25}$)

5. Potential fish production of entire lake; rounded to nearest 10 kg.

(over 260 ha), north temperate in both latitude and altitude (under 600 m), have moderate to intensive unrestricted fishing on a spectrum of species, and not be subjected to anomalous environmental conditions of large magnitude (eg. winter kill, low dissolved oxygen, high turbidity or high flushing rate) (Ryder, 1965). Unfortunately none of the lakes examined met all of these criteria. Ten of the lakes were less than 260 ha in surface area (Blue Birch, Bulgar, Echo, Gulf, Itsi, John, Lagoon, Lap, Niddery and Oly); Fuller and Lagoon Lakes exhibited a high degree of inorganic turbidity; Niddery Lake was very shallow and thereby susceptible to winter kill and Echo Lake exhibited very low oxygen levels below the thermocline (see appendix 1). In addition, all of the lakes were over 600m in altitude and only Dragon and Orchie Lakes appeared to be subject to a significant degree of sport-fishing pressure.

The model should provide a fairly good estimate of fish production in Dragon and Orchie Lakes. Both lakes are higher in altitude than the 600 m limit but meet all other criteria. As the other lakes failed to meet two or more of the prerequisite terms of reference it is unlikely that the productivity estimates for these lakes are reliable.

The Schlesinger and Regier global model is considerably more flexible, although less accurate, than the Ryder regional model. It can be applied in any climatic area and to lakes which are subject to little or no fishing pressure.

The value for mean annual air temperature (-7.7°C) used in the model's potential fish production equation was derived from temperature records recorded at the Tsichu River weather station, North West Territories. Climatic conditions in the MacMillan Pass area are similar to those at this weather station (H. Wahl, pers. comm.).

The accuracy of the yield estimates calculated using this method is questionable. As previously mentioned the Ryder model yield predictions for Dragon and Orchie Lakes should be reasonably accurate. The production figures for these lakes calculated using the Schlesinger and Regier equation are substantially different (lower by 64 and 66% respectively). This raises doubts as to the reliability of any of the production estimates predicted by this method.

In summary, the potential fish production figures presented in this report should provide a crude estimate of the relative productivity of the systems, however, it is doubtful that they are sufficiently accurate to be used for management purposes (with the possible exception of the Ryder model yield predictions for Dragon and Orchie Lakes).

Fish sampling results are presented in figures 1-4. The relative abundance results provided by the histograms are rough approximations only. Gill netting is not a good method for describing this parameter as variations in set depth, set location, mesh sizes and other factors will bias the results.

Arctic grayling were probably more abundant in some of the lakes than is indicated by the histograms. This species is usually restricted to the upper levels of the water column while the gill net was usually set in deeper water. For example, in Oly Lake numerous grayling were observed in the surface waters, however, none were captured in an overnight gill net set.

In addition to the results presented in figure 1, least cisco and burbot have been reported from Dragon Lake and broad whitefish have been reported from the Itsi Lakes (Elson, 1974). Also, the presence of cysts of the parasite *Triaenophorus crassus* in the flesh of lake whitefish in Gulf Lake, and lake trout in Otter Lake, indicates the presence of northern pike in these lakes.

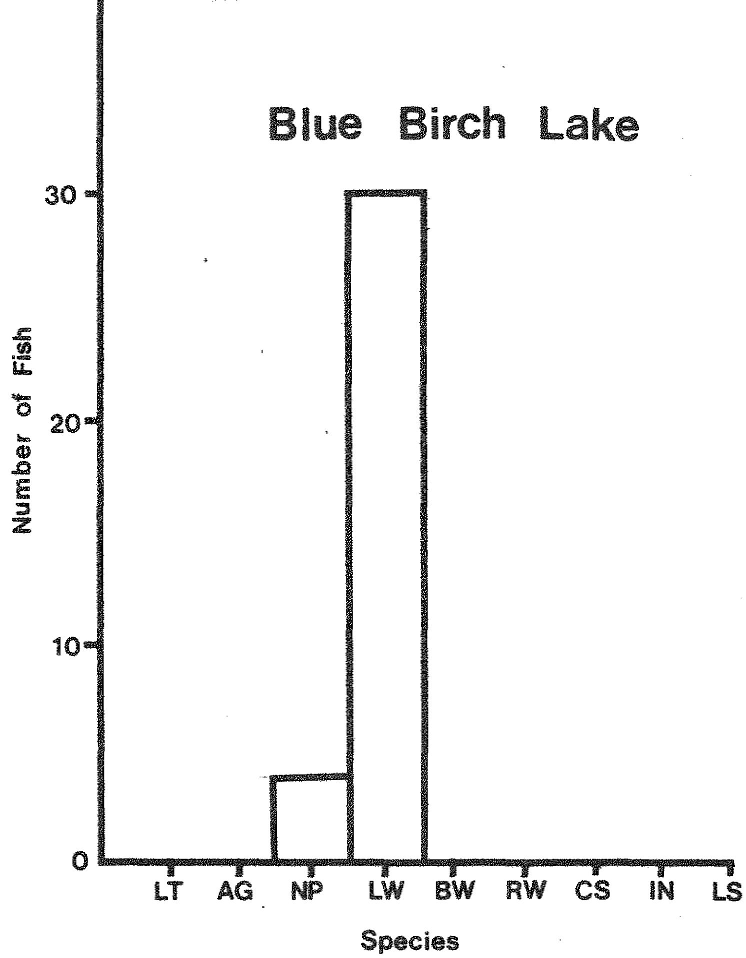
Lakes which supported a high percentage of gamefish (Dragon, Fuller, Oly, Otter, Lap and Itsi) were all characterized by relatively low MEI's. In contrast, productive lakes such as Sheldon, Lewis, John and Gulf supported large populations of whitefish but fewer gamefish. Echo and

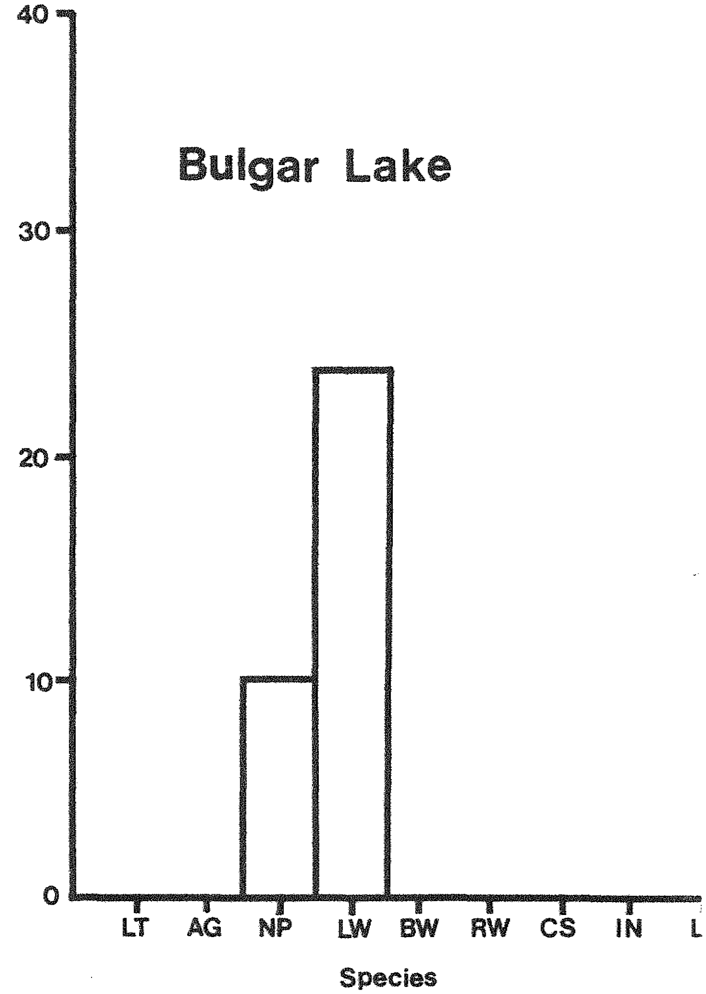
Niddery Lakes had very limited fish populations despite high MEI's. Anomalous environmental conditions account for the discrepancy. Echo Lake had a very low dissolved oxygen concentration below the thermocline while Niddery Lake was very shallow and undoubtedly subject to regular winter kills.

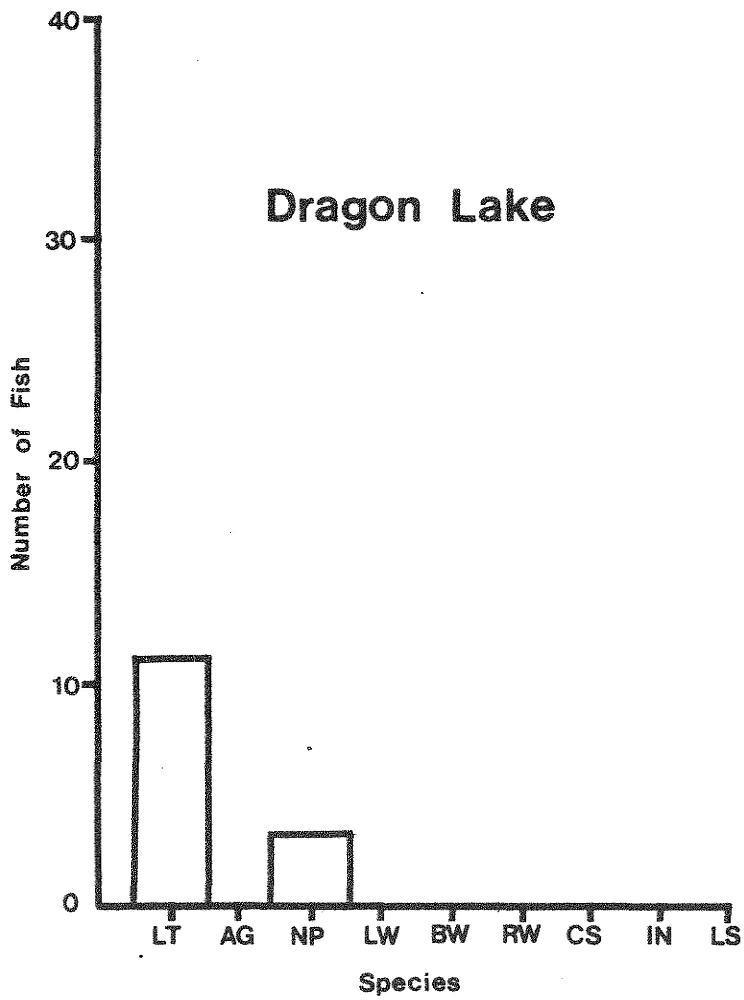
Of the seventeen lakes examined, only Dragon and Orchie are likely to be subjected to any degree of sportfishing pressure at present. Another lake in the area which was not examined during the present survey but was reportedly sport-fished regularly was Marjorie Lake. Other lakes which have good potential for sportfishing are Fuller, Itsi, Lagoon, Lap, Oly, and Otter.

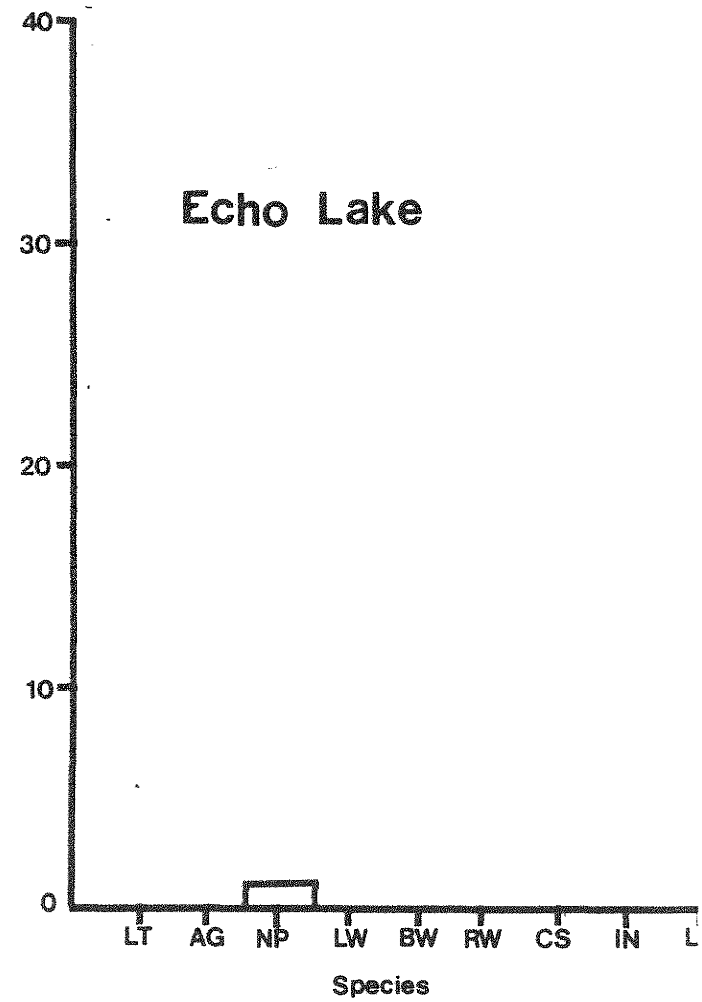
Figures 1-4 Fish sampling results.

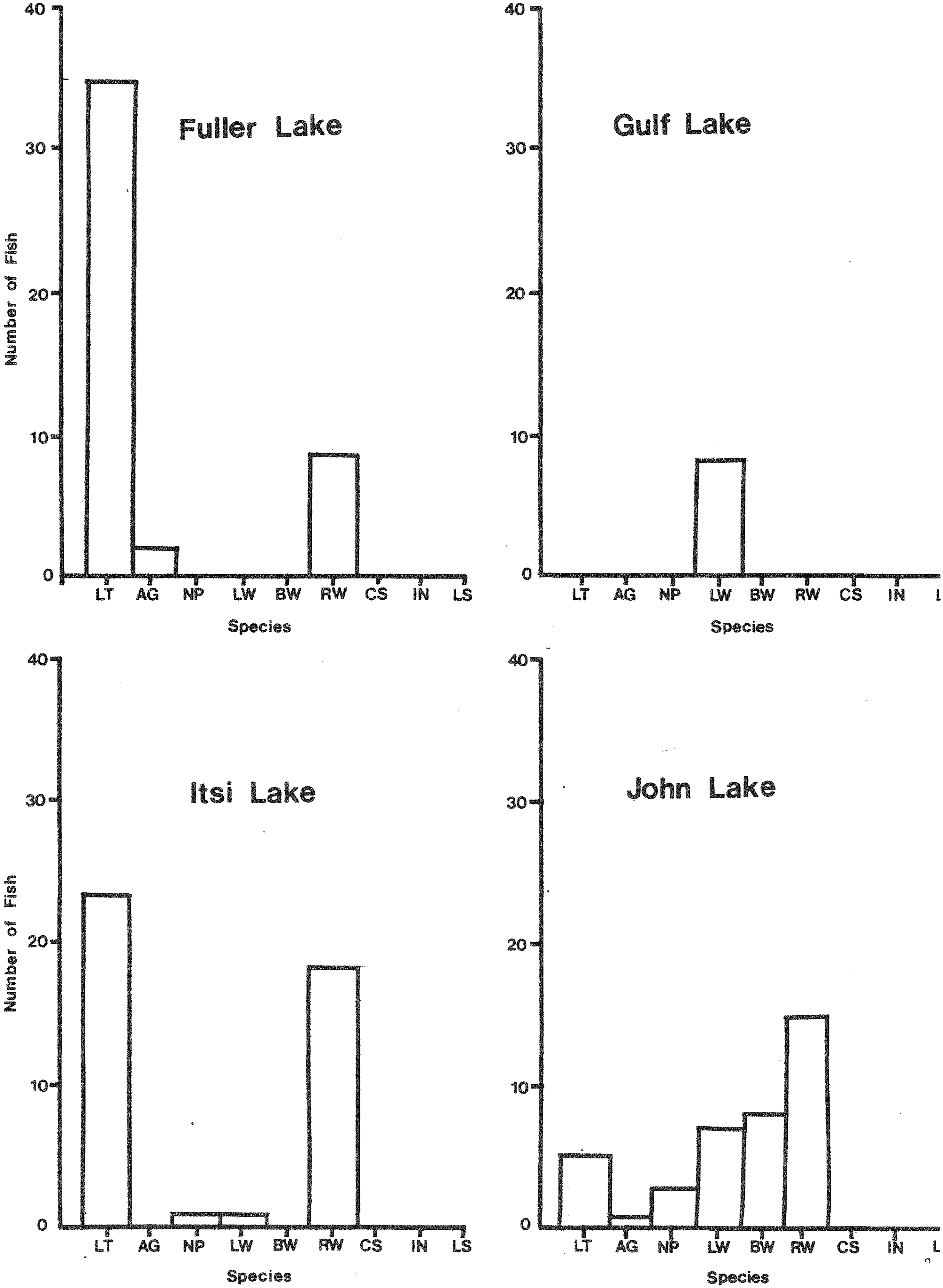
LT-lake trout
AG- arctic grayling
NP- northern pike
LW- lake whitefish
CS- least cisco
IN- inconnu
LS- longnose sucker


Blue Birch Lake
Number of Fish
0
10
20
30
40
LT AG NP LW BW RW CS IN LS
Species

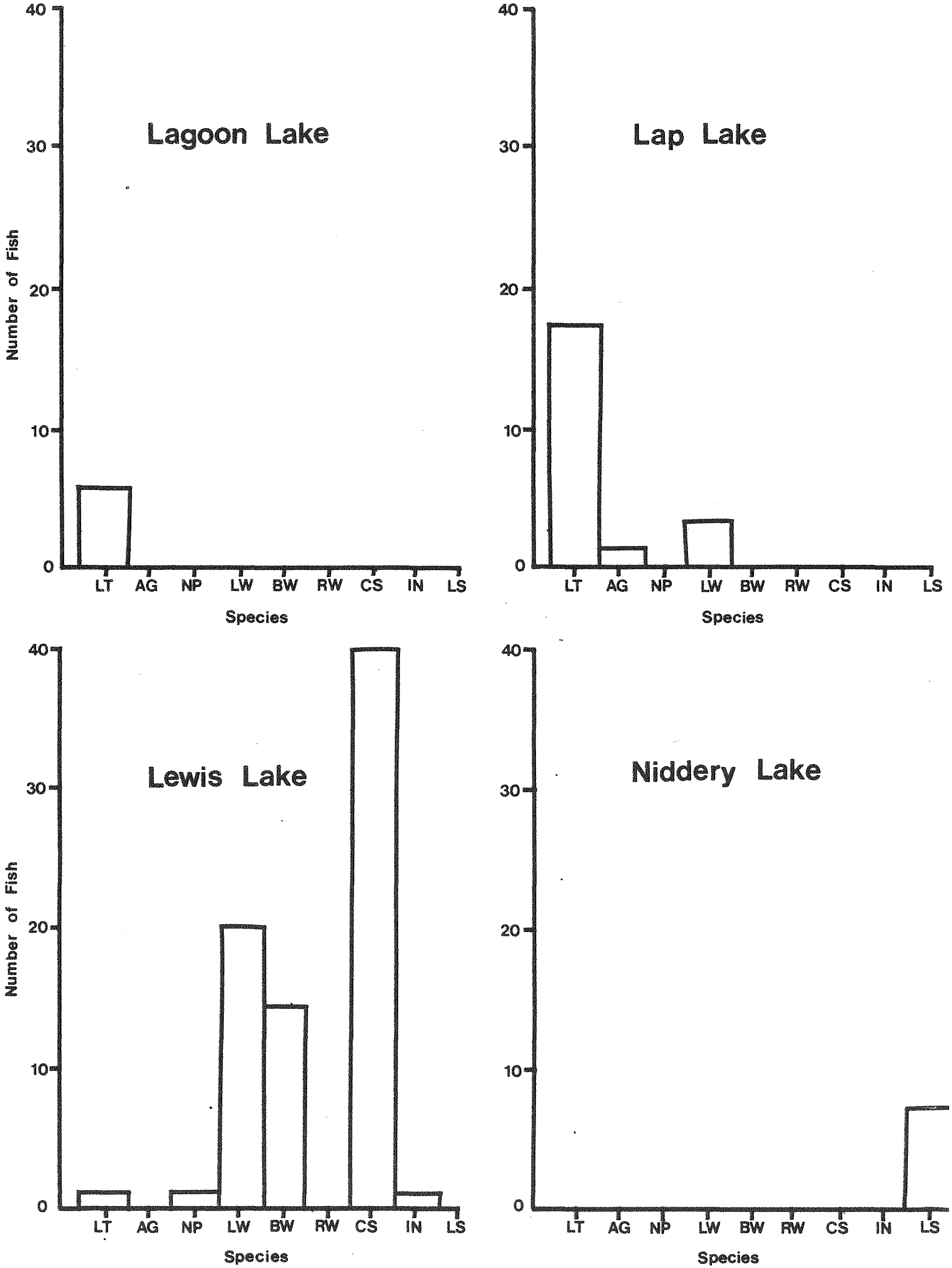

Bulgar Lake
0
10
20
30
40
LT AG NP LW BW RW CS IN L
Species

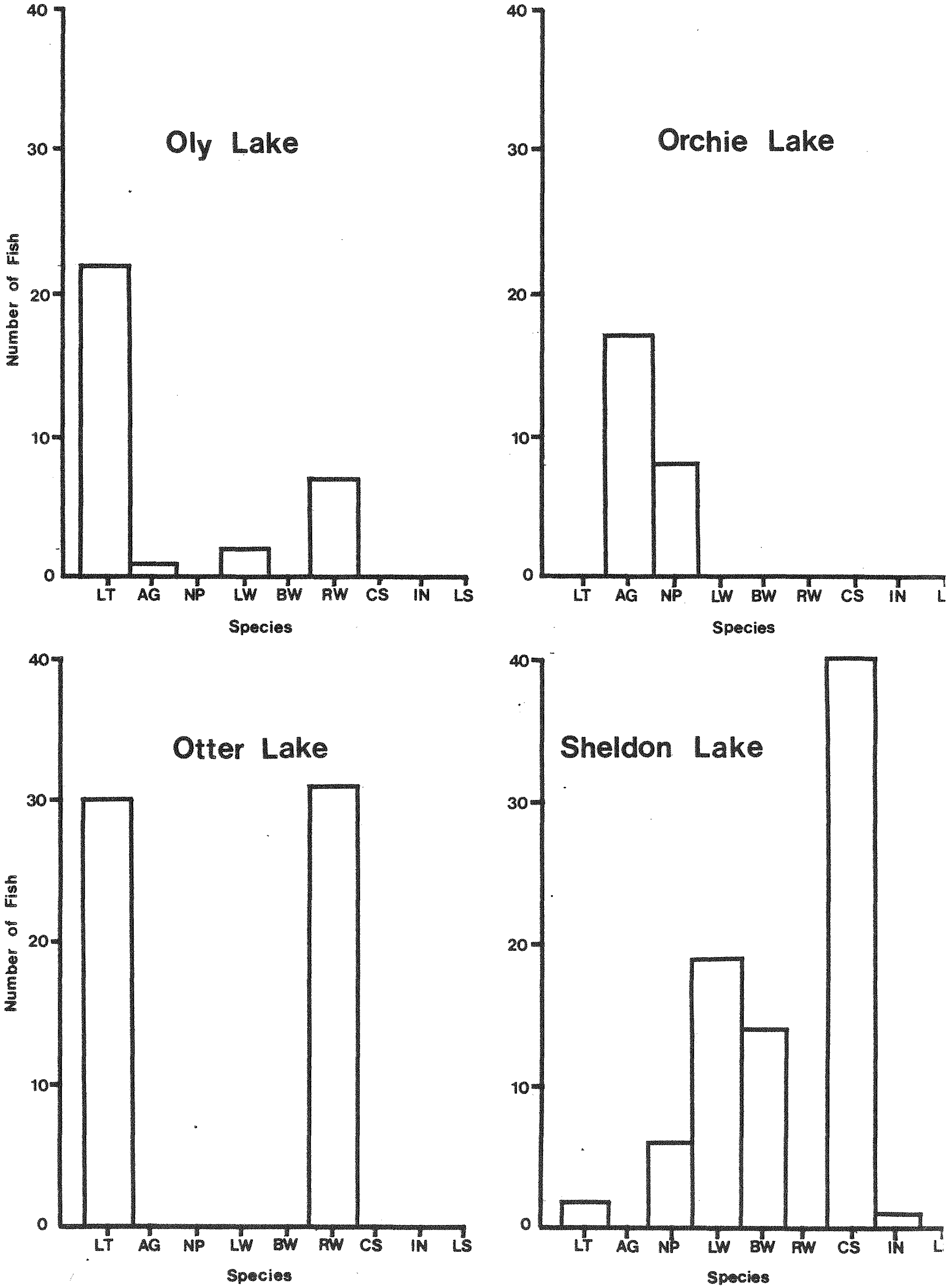

Dragon Lake
Number of Fish
0
10
20
30
40
LT AG NP LW BW RW CS IN LS
Species


Echo Lake
0
10
20
30
40
LT AG NP LW BW RW CS IN L
Species



Fuller Lake
Gulf Lake
Itsi Lake
John Lake
Number of Fish
0
10
20
30
40
LT
AG
NP
LW
BW
RW
CS
IN
LS
Species


Lagoon Lake
Lap Lake
Lewis Lake
Niddery Lake
Number of Fish
Number of Fish
0
10
20
30
40
LT
AG
NP
LW
BW
RW
CS
IN
LS
Species



Oly Lake
Orchie Lake
Otter Lake
Sheldon Lake
Number of Fish
Species
0
10
20
30
40
LT
AG
NP
LW
BW
RW
CS
IN
LS

## SUMMARY AND CONCLUSIONS

1. The Ryder model fish production estimates for Dragon and Orchie Lakes should be reasonably accurate. It is doubtful that the estimates for the other lakes are sufficiently accurate to be used for management purposes.

2. The Schlesinger and Regier model will probably not provide reliable estimates of fish production for any of the study lakes.

3. It will not be possible to determine reasonably accurate fish production estimates until more suitable models are developed.

4. Lakes with the highest proportion of gamefish tended to have the lowest MEI's indicating that the lakes most suitable for sport-fishing are the least productive.

5. Sport fishing pressure in the area appears to be light at present and concentrated on Dragon, Orchie, and Marjorie Lakes.

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# APPENDICES

Appendix 1 - Additional Physical Information.

| Lake | Date Surveyed | Maximum Depth(m) | Dissolved Oxygen(mg/l) | | | Temperature(°C) | | | Sechi Depth(m) |
|---|---|---|---|---|---|---|---|---|---|
| | | | 1m | 5m | 10m | 1m | 5m | 10m | |
| Blue Birch | Aug. 7 | 26 | 10 | 10 | 10 | 16 | 15 | 9 | 11 |
| Bulgar | July 30 | 20 | 9 | 9 | 9 | 17 | 16 | 8 | 6 |
| Dragon | July 10 | 80 | 9 | 9 | 8 | 15 | 13 | 6 | 11 |
| Echo | July 15 | 15 | 10 | | 1 | 18 | 13 | 7 | 4 |
| Field | July 6 | 7 | 10 | 10 | | 12 | 11 | | 3 |
| Fuller | Aug. 13 | 53 | 11 | 10 | 10 | 12 | 11 | 10 | 7 |
| Gulf | July 8 | 6 | 9 | 5 | | 14 | 10 | | 2 |
| Itsi | July 22 | 40 | 10 | 11 | 11 | 16 | 13 | 8 | 12 |
| John | July 23 | 7 | 10 | | | 13 | | | 4+ |
| Lagoon | Aug. 1 | 11 | 10 | 7 | | 13 | 12 | 10 | 6 |
| Lap | July 25 | 50 | 11 | 10 | 10 | 15 | 14 | 7 | 8 |
| Lewis | July 13 | 20 | 11 | 10 | 9 | 16 | 14 | 13 | 4 |
| Niddery | July 29 | 3 | 10 | | | 18 | | | 2+ |
| Oly | July 26 | 48 | 11 | 10 | 10 | 14 | 12 | 7 | 7 |
| Orchie | Aug. 5 | 40 | 9 | 9 | 9 | 15 | 15 | 10 | 10 |
| Otter | Aug. 9 | 27 | 10 | | 8 | 14 | 12 | 8 | 7 |
| Sheldon | July 5 | 13 | 11 | 11 | 11 | 11 | 11 | 10 | 7 |

Appendix 2

# MAP LEGEND

| Fish Species | Morphoedaphic Index |
|---|---|
| Average Depth | % Littorial |

## SPECIES SYMBOLS

**LT** - Lake Trout

**AG** - Arctic Grayling

**NP** - Northern Pike

**BB** - Burbot

**LW** - Lake Whitefish

**BW** - Broad Whitefish

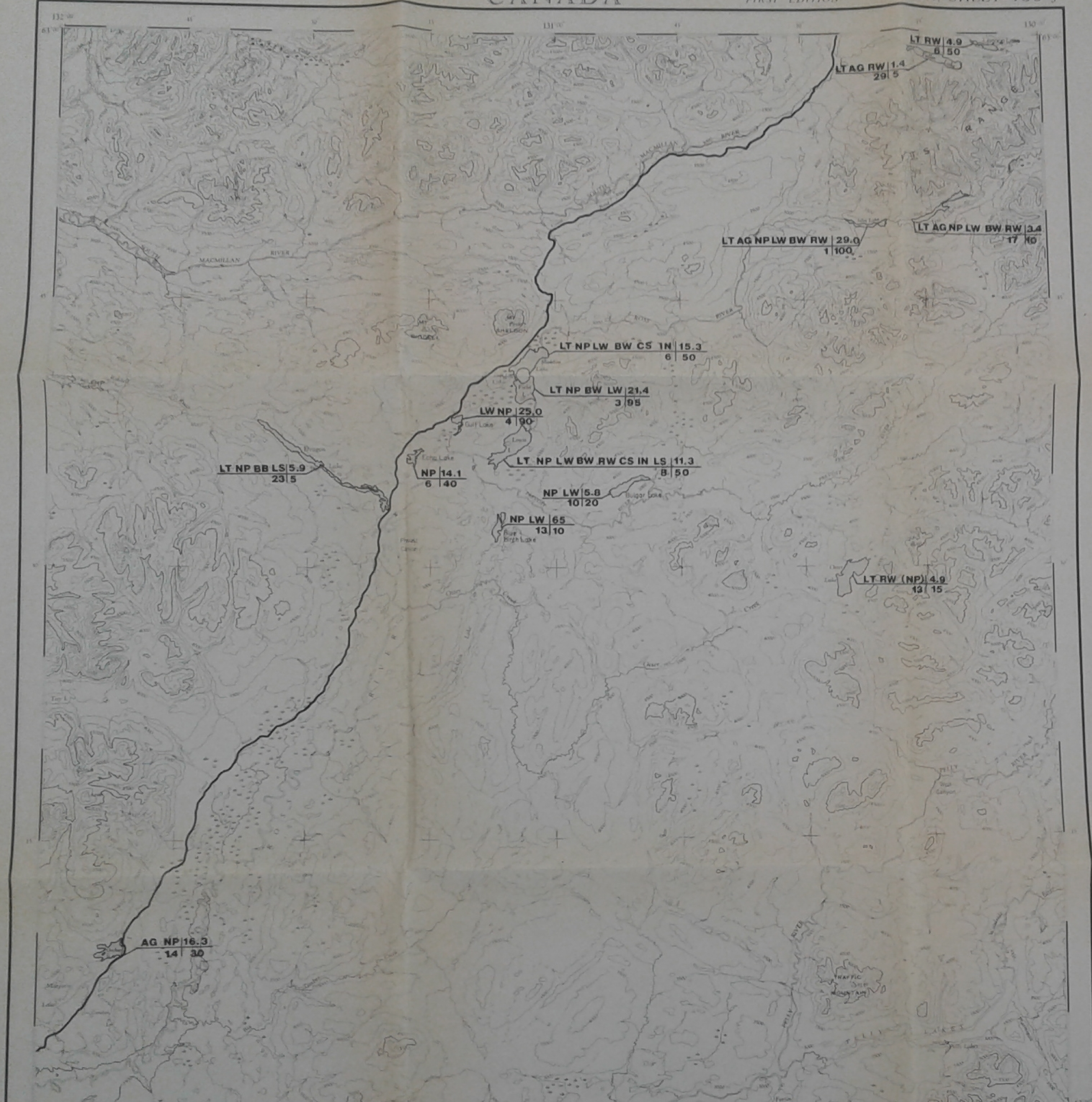
**RW** - Round Whitefish

**CS** - Least Cisco

**IN** - Inconnu

**LS** - Longnose Sucker

**(LT)** - indicates probable but unconfirmed presence




Scale 1 : 250,000

REFERENCE

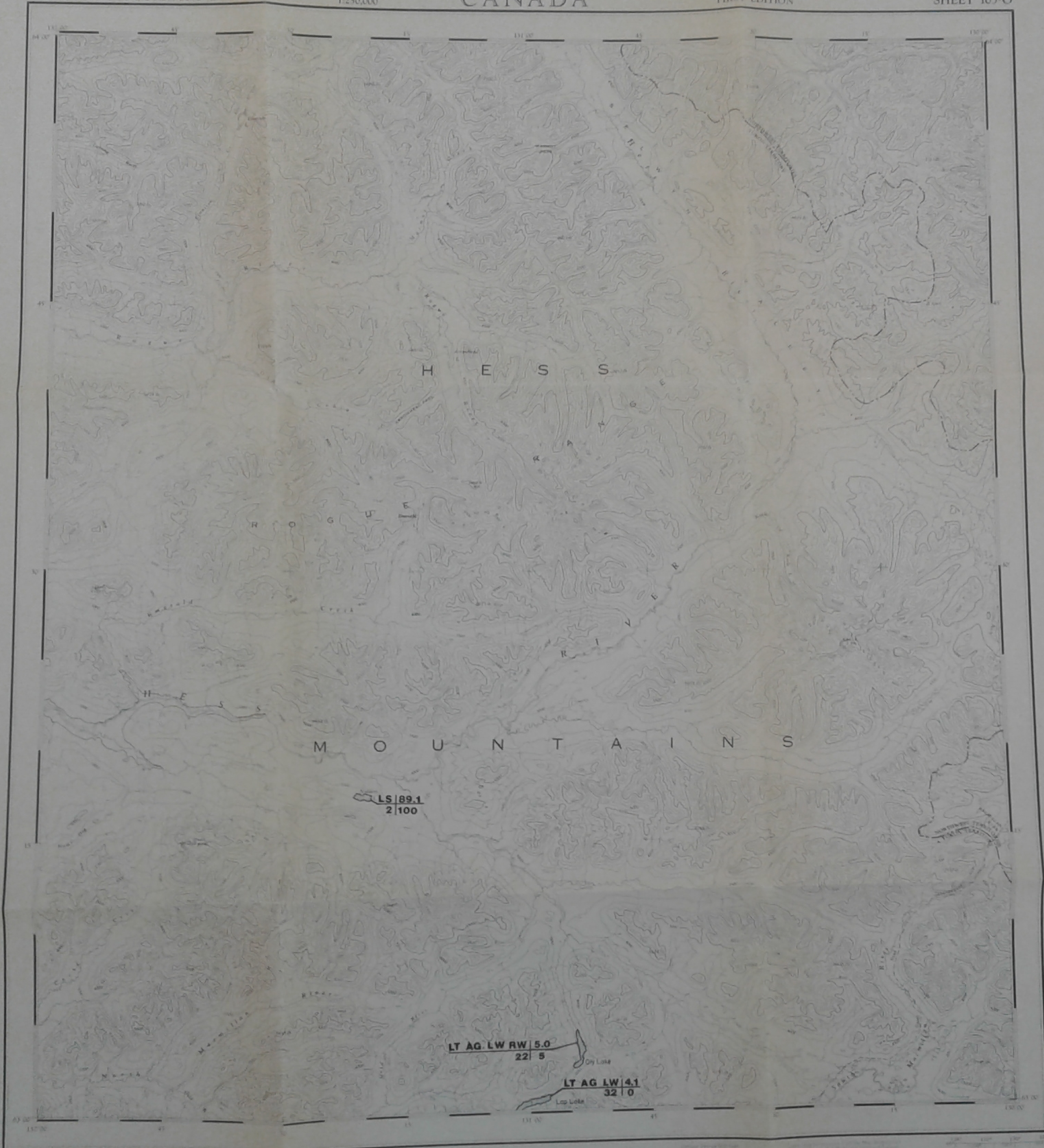
REFERENCE

# SHELDON LAKE

## YUKON TERRITORY

SHEET 105 J

NATIONAL TOPOGRAPHIC SYSTEM 1:250,000 **CANADA** FIRST EDITION SHEET 105-O




# NIDDERY LAKE

YUKON TERRITORY - NORTHWEST TERRITORIES

Scale 1:250,000