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# Heavy Metal Concentrations in Water and Biota of Langford Lake, B. C.

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File:

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## RESUME

Langford Lake was sampled in 1972, 1973, and 1974 for heavy metals. Samples of water, plants, plankton, crayfish, newts, and fish were taken.

Results obtained in 1973 to 1974 were different from those obtained and reported by Slaney in 1972. In 1972 results for heavy metal concentrations were unusually high while in 1973 and 1974 results were comparatively low.

Heavy metals, with the exception of lead, were present in increased concentrations in 1974 tissue samples compared to those collected in 1973. The reverse was true for concentrations in water samples.

Variation occurred in heavy metal concentrations throughout the lake. Concentrations in plants were generally higher in the southeast. For free swimming organisms no definite statement can be made as to which area contained the greatest concentration of heavy metals in the tissues. Concentrations in the sediments depended on whether it was the upper or lower layer being compared.

Because of low industrial development in the Langford Lake area, there are no large sources of metal pollutants. The water chemistry data suggest that there is no metal pollution in Langford Lake.

ACKNOWLEDGEMENTS

Several members of the Water Investigations Branch staff contributed to the sampling program of Langford Lake. Analyses were performed by the staff of the Water Resources Service Environmental Laboratory, Vancouver.

## Introduction

This study was undertaken to confirm results obtained by F. F. Slaney and Company Limited in a March 1972 study - "Limnology of Langford Lake, Victoria, B. C." (7). They found unusually high concentrations of lead in the livers of sunfish, Lepomis gibbosus, (Table I .) In an attempt to determine the source of pollution and the extent of the phenomenon, tissue samples from different areas of the lake have been collected and analysed for lead and other heavy metals.

## Methods

On May 17, 1973 and February 26 and 27, 1974 tissue and water samples were collected from Langford Lake to be analyzed for heavy metals. Sampled were 2 species of aquatic macrophytes - Elodea sp. and Ceratophyllum sp., zooplankton, crayfish - Pacifastacus trowbridgii, newts - Taricha granulosa, and sunfish - Lepomis gibbosus. Sampling and preservation procedures are outlined in Appendix I - "Proposed Heavy Metal sampling of Langford Lake, B. C." Water samples were collected and analyzed several times in 1974. All samples were submitted to the Water Resources Chemistry Laboratory in Vancouver for analysis.

## Results

A Comparison Between Water Investigations Branch Data (1973-4) and Slaney and Company Data (1972).

### 1. Tissue Samples

Results of tissue sample analysis for 1973 and 1974 are reported in Table I. Heavy metal concentrations, for comparison with other data, have been converted to µgrams/gram wet weight from µgrams/gram dry weight by the following formula:

$$\text{concentration in µg./g. wet weight} = \frac{100 - \%\ \text{water}}{100} \times \text{concentration in µg./g. dry weight}$$

Heavy metal concentrations were much lower in sunfish livers in

1973-4 than in 1972. Cadmium and lead, which were detected in large concentrations by Slaney and Company, were not detected in 1974. In 1974 copper concentrations in sunfish livers were 1/3 to 1/9 those of 1972 and zinc concentrations were 1/2 to 1/7 those of 1972.

2. Water Samples

Results of chemical analysis of water samples are reported in Tables II and III. Due to low precision results obtained by Slaney (1972), comparison of most results is not possible. A few parameters can be compared - alkalinity, generally the same in all years; ammonia nitrogen, higher by up to a factor of ten in 1974; pH, higher in 1974; copper, higher by about a factor of ten in 1972; and cadmium, below detection in most samples in all years.

B. Comparison of samples collected by Water Investigations Branch in 1973 and 1974

1. Tissue Samples

The concentrations of all 4 metals increased in macrophytes, and all metals except lead increased in animals in 1974 compared to 1973.

2. Water Samples.

Concentrations of almost all parameters - metals and nutrients, decreased in 1974 compared to 1973.

C. Comparison of Different Areas of the Lake.

1. Tissue Samples

a. Plants in the southeast end of the lake generally had higher concentrations of heavy metals than in the northwest end.

b. Newts of the northwest end had higher metal concentrations than of the southeast end except for lead.

c. Small fish of the northwest end were higher in copper and zinc and lower in cadmium than the southeast end in 1974.

d. Fish livers from large fish in the southeast end had higher concentrations of copper and zinc than the northeast end in 1974.

e. Sediments. The southeast end was higher in all metals than the northwest end for the upper sediments but the reverse was true for deeper sediments.

2. Water Samples.

With the exception of some metals, the water chemistry is uniform throughout the lake. Copper and zinc were found in higher concentrations in the northwest end than the southeast end of the lake.

Discussion

The results for heavy metals concentrations in sunfish livers obtained by the Water Investigations Branch do not substantiate those of Slaney (7). Sample contamination might have occurred at any step between sampling and analysis. Further discrepancies could arise because Slaney and Company sent their samples to Cantest Limited for analysis while ours were sent to the Water Resources Chemistry Laboratory.

A. Possible Sources of Metals.

The drainage area of Langford Lake includes gravel pits, a trailer court, a machine shop, various commercial premises, about 100 private residences with septic tanks, and mink, poultry, and cattle farms (7). Before the Fish and Wildlife Branch closed the lake to motor boats in 1973, there was considerable traffic on the lake. Because of lack of industry in the area, the only sources of metal pollutants would be burning of fuels, application of pesticides for agriculture, natural leaching, leaching from metallic refuse and paints, and treatment of the lake with an algacide.

The Langford Lake water chemistry data suggest that there is no metal pollution and one would not expect to find high concentrations of metals in living tissues unless the contamination is non-aquatic in

origin. Lead contamination of vegetation along highways and in urban areas has been studied (8) and lead could enter the aquatic food chain from this source; for example, through leaf fall into sediments or through non-aquatic organisms eaten by fish. Although we found concentrations of 19.3 to 51.5 ppm (dry weight) of lead in sediments in 1973 (higher than any concentrations of lead found in tissues for that year), if sediments were the source of lead, contamination would persist through all three years.

Another possible explanation of the high concentrations of lead in fish collected by Slaney and Company would be that contamination resulted during momentary pollution of the lake from an accidental spillage for example, of gasoline or paint. This might also explain the high levels of metals in the sediments. Metals would be retained by the sediments after the lake had flushed. However, it is doubtful that any of the individual establishments in the area are capable of altering the metal concentrations in Langford Lake significantly.

B. Comparisons with Other Studies

On a study by Peterson, Warren, Delavault, and Fletcher in 1970 (6), heavy metal contents of the livers of freshwater fishes from 68 lakes and 2 rivers in British Columbia were measured. They suggested that the following levels of metals in fish livers be considered anomalous:

Copper: greater than 80 ppm (wet weight)
Lead: greater than 1.2 ppm (wet weight)
Zinc: greater than 40 ppm (wet weight)

Results reported by Slaney (7) for lead and zinc are well above these anomalous levels whereas the results for Langford Lake in 1973 to 1974 are well below.

Lucas, Edgington, and Colby in 1970 (4) working with 10 different species of fish from the Great Lakes, found the average cadmium, copper,

and zinc concentrations in livers to be 0.4 ppm (wet weight), 9.0 ppm, and 30 ppm respectively. In 19 whole fish of 3 species they found averages of 0.094 ppm of cadmium and 1.3 ppm of copper. Again, Slaney (7) obtained results that are considerably higher than these averages while ours are well below in all cases except cadmium in whole fish.

In the eastern United States heavy metal concentrations in fish muscle tissues were measured for three states. The results are summarized below.

| | CONCENTRATION IN PPM (WET WEIGHT) | | |
|---|---|---|---|
| STATE | CADMIUM | LEAD | ZINC |
| Wisconsin (3) | None in 101 samples | up to 4.31 | up to 18.3 |
| Michigan (1) | up to 0.3 | 0.1 to 0.9 | 6 - 45 |
| New York (9) | 0.04 to 0.17 | | 1.2 - 38 |

Compared to these results the concentrations of cadmium and zinc in whole fish in 1973 to 1974 are high.

Although there is a lot of variation in heavy metal concentrations in fish tissues in the above literature, the data obtained by Slaney in 1972 are unusually high by comparison.

TABLE I HEAVY METAL CONCENTRATIONS OF VARIOUS TISSUES

| TISSUE | LOCATION | DATE | CADMIUM (µg/g) DRY WT | CADMIUM (µg/g) WET WT | COPPER (µg/g) DRY | COPPER (µg/g) WET | LEAD (µg/g) DRY | LEAD (µg/g) WET | ZINC (µg/g) DRY | ZINC (µg/g) WET | MOISTURE (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ELODEA | N-W END | 1973 | 0.57 | 0.034 | 4.53 | 0.267 | 17.0 | 1.003 | 73.7 | 4.35 | 94.1 |
| | S-E END | 1973 | 0.73 | 0.051 | 5.14 | 0.215 | 14.7 | 0.617 | 64.6 | 2.71 | 95.8 |
| | N-W | 1974 | 0.49 | 0.038 | 6.57 | 0.512 | 7.0 | 0.546 | 130. | 10.14 | 92.2 |
| | S-E | 1974 | 0.90 | 0.073 | 7.70 | 0.623 | 23.6 | 1.91 | 152. | 12.31 | 91.9 |
| CERATOPHYLLUM | N-W | 1973 | 0.44 | 0.036 | 3.05 | 0.271 | 4.4 | 0.356 | 75.4 | 6.11 | 91.9 |
| | S-E | 1973 | 0.63 | 0.045 | 3.14 | 0.223 | 6.3 | 0.447 | 69.8 | 4.96 | 92.9 |
| | N-W | 1974 | 0.67 | 0.048 | 6.89 | 0.489 | 6.7 | 0.475 | 164. | 11.64 | 92.9 |
| | S-E | 1974 | 0.69 | 0.052 | 8.07 | 0.605 | 32.7 | 2.45 | 208. | 15.60 | 92.5 |
| PLANKTON | ALL | 1973 | - | 0.01 | - | 0.47 | - | 0.22 | - | 0.72 | |
| ZOOPLANKTON | ALL | 1974 | 1.37 | 0.134 | 12.5 | 1.23 | NONE | | 107. | 10.49 | 90.2 |
| NEWT | S-E | 1973 | 1.00 | 0.237 | 3.51 | 0.832 | 7.5 | 1.778 | 87.8 | 20.81 | 76.3 |
| | N-W | 1974 | 1.36 | 0.276 | 7.48 | 1.52 | NONE | | 160. | 32.48 | 79.7 |
| CRAYFISH | | 1973 | 0.99 | 0.318 | 26.6 | 6.81 | 16.9 | 3.90 | 97.3 | 22.38 | 77.0 |
| | S-E | 1973 | 1.40 | 0.228 | 44.7 | 10.15 | 10.5 | 2.38 | 85.6 | 19.43 | 77.3 |
| | S-E | 1974 | 2.36 | 0.731 | 52.5 | 16.33 | NONE | | 123. | 38.25 | 68.9 |
| SMALL*. FISH | (1) N-W | 1973 | 0.55 | 0.124 | 2.31 | 0.522 | 7.7 | 1.74 | 104.7 | 23.66 | 77.4 |
| | (3) N-W | 1974 | 1.05 | 0.279 | 3.44 | 0.915 | NONE | | 166. | 44.16 | 73.4 |
| | (8) S-E | 1974 | 1.37 | 0.352 | 3.40 | 0.874 | NONE | | 138. | 35.47 | 74.3 |
| MEDIUM FISH | (5) N-W | 1974 | | | CONTAMINATED | | | | | | |
| MIXED-SIZES | S-E | 1973 | 0.68 | 0.149 | 1.85 | 0.405 | 7.8 | 1.71 | 89.2 | 19.54 | 78.1 |
| LARGE FISH | (5) N-W | 1974 | | | CONTAMINATED | | | | | | |
| FISH LIVERS SMALL | (5) N-W | 1972 | - | 23.0 | - | 21.0 | - | 114.0 | - | 55.0 | - |
| MEDIUM | (1) N-W | 1972 | - | 13.8 | - | 11.0 | - | 73.5 | - | 46.0 | - |
| MEDIUM | (1) N-W | 1972 | - | 28.0 | - | 18.0 | - | 180.0 | - | 61.0 | - |
| MEDIUM | (1) N-W | 1972 | - | 45.0 | - | 36.0 | - | 405.0 | - | 130.0 | - |
| MEDIUM | (5) N-W | 1974 | NONE | | 21.4 | 4.47 | NONE | | 91.5 | 19.12 | 79.1 |
| LARGE | (1) N-W | 1972 | - | 5.2 | - | 11.7 | - | 41.8 | - | 42.6 | - |
| LARGE | (5) N-W | 1974 | NONE | | 24.0 | 4.63 | NONE | | 111. | 21.42 | 80.7 |
| LARGE | (1) S-E | 1974 | NONE | | 35.0 | 6.69 | NONE | | 130. | 24.83 | 80.9 |
| UPPER SEDIMENTS | N-W | 1973 | 0.56 | - | 21.4 | - | 31.0 | - | 73.3 | - | - |
| | S-E | 1973 | 0.64 | - | 24.4 | - | 51.5 | - | 118.4 | - | - |
| LOWER SEDIMENTS | N-W | 1973 | 0.57 | - | 18.3 | - | 28.7 | - | 51.6 | - | - |
| | S-E | 1973 | 0.37 | - | 10.1 | - | 19.3 | - | 34.1 | - | - |

*FISH SIZES - SMALL: 8.8 - 3.5 cm, 12.4g - 0.7g
- MED. : 13.2 - 12.0 cm, 38.9 - 31.7g
- LARGE: 16.4 - 13.8 cm, 80.1 - 52.3g

NUMBER IN BRACKETS REFERS TO NUMBER OF FISH POLLED IN SAMPLE

TABLE II WATER CHEMISTRY-4 RESULTS - NORTHWEST END LANGFORD LAKE 1973-74

| | 11<br>FEB. 20/73<br>1.0m | 40<br>APR. 10/73<br>1.0m | 46<br>MAY 14/73<br>1.0m | 50<br>JUNE 20/73<br>1.0m | 50<br>JULY 24/73<br>1.0m | 50<br>OCT. 30/73<br>1.0m | 50<br>NOV. 27/73<br>1.0m | 50<br>FEB. 27/74<br>1.0m | 50<br>MAY 7/74<br>1.0m |
|---|---|---|---|---|---|---|---|---|---|
| ALKALINITY (mg/l) (PHENOLPTHALEIN) | - | - | 2.0 | 3.0 | 8.4 | 0.0 | 0.0 | 0.0 | 0.0 |
| ALKALINITY (mg/l) (TOTAL) | 47.0 | 48.0 | 51.1 | 50.6 | 49.1 | 61.2 | 53.1 | 44.8 | 46.0 |
| CALCIUM (U.F.)(mg/l) | - | - | - | - | - | 17.0 | 17.0 | - | 16.1 |
| CALCIUM (DISS.)(mg/l) | 16.0 | 16.5 | 16.0 | 16.0 | 16.0 | 17.0 | 17.0 | 15.1 | 15.8 |
| T.O.C. (mg/l) | 6. | 12. | 6. | 5. | 5. | 3. | 7. | 4. | 5. |
| T.I.C. (mg/l) | 10. | - | 11. | 11. | 9. | - | 12. | 10. | 9. |
| HARDNESS (mg/l) | - | - | - | 51.9 | 52.3 | 55.6 | 56.9 | 51.3 | 53.4 |
| MAGNESIUM (U.F.)(mg.l) | - | - | - | - | - | 3.2 | - | - | - |
| MAGNESIUM(DISS.)(mg/l) | - | - | - | 2.9 | 3.0 | 3.2 | 3.5 | 3.3 | 3.4 |
| $N\text{-}NH_3$ (mg/l) | .10 | .02 | .01 | - | <.01 | <.01 | - | .05 | - |
| $N\text{-}NO_2 + NO_3$ (mg/l) | .32 | .10 | .13 | <.02 | <.02 | <.02 | <.02 | .32 | .09 |
| N-ORGANIC (mg/l) | .46 | .38 | .40 | - | .38 | .59 | - | .37 | - |
| T.K.N. (mg/l) | .56 | .40 | .41 | .42 | - | - | 1.00 | .42 | .23 |
| N-TOTAL (mg/l) | .88 | .50 | .54 | - | - | - | - | .74 | .32 |
| pH (LAB) | 7.6 | 8.3 | 8.8 | 8.6 | 9.2 | 7.8 | 7.7 | 7.2 | 8.1 |
| pH (OURS-FIELD) | 7.6 | 8.1 | 7.6 | 8.5 | 9.3 | 8.4 | 8.7 | 7.0 | 7.8 |
| TOTAL SOL.P.(mg/l) | .038 | .012 | .014 | .010 | .010 | .008 | .014 | .031 | .010 |
| DISS. ORTHO-$PO_4$ (mg/l) | .026 | .003 | .003 | - | - | <.003 | .005 | - | <.003 |
| P. (TOTAL)(mg/l) | .046 | .032 | .020 | .025 | .015 | .035 | .106 | .042 | .013 |
| SPECIFIC COND.(µmhos/cm) | - | - | - | 132 | 133 | 138 | 141 | 124. | 132. |
| CONDUCTIVITY(OURS) (µmhos/cm) | - | - | 110 | - | 118 | - | 83 | - | - |
| TURBIDITY (J.T.V.) | .8 | .8 | .7 | .8 | .9 | 2.2 | 3.0 | .9 | 1. |
| CADMIUM(U.F.)(mg/l) | - | .0001 | - | - | - | - | - | <.0005 | <.0005 |
| COPPER (U.F.)(mg/l) | - | .002 | - | - | .004 | - | .001 | .001 | <.001 |
| IRON (U.F.)(mg/l) | - | - | - | - | - | - | 0.2 | - | 0.4 |
| LEAD (U.F.)(mg/l) | - | .003 | - | - | .015 | - | <.001 | <.001 | <.001 |
| MERCURY (U.F.)(µg/l) | - | - | - | - | - | - | <.05 | <.05 | <.05 |
| ZINC (U.F.)(mg/l) | - | .005 | - | - | - | - | <.005 | <.005 | <.005 |
| TEMPERATURE (°C) (AT SITE) | 5.0 | 11.0 | 16.5 | 17.0 | 20.2 | 11.0 | 6.1 | 4.7 | 14.0 |
| NICKEL(U.F.)(mg/l) | - | - | - | - | - | - | <.01 | - | <.01 |

TABLE II (cont'd) WATER CHEMISTRY - MIDDLE LANGFORD LAKE 1973

| | 10<br>FEB. 20/73<br>1.0m | 41<br>APR. 10/73<br>1.0m | 45<br>May 14/73<br>1.0m | 41<br>JULY 24/73<br>1.0m | 41<br>NOV. 27/73<br>1.0m |
|---|---|---|---|---|---|
| ALKALINITY (PHENOLPTHALEIN) | - | - | 5.1 | 0.0 | 2.0 |
| ALKALINITY (TOTAL) | 47.0 | 48.0 | 51.2 | 55.0 | 50.4 |
| CALCIUM (U.F.) | - | - | - | 18.0 | - |
| CALCIUM (DISS.) | 15.7 | 16.5 | 15.5 | 17.0 | 16.0 |
| T.O.C. | 6.5 | 9. | 6. | 8. | 6. |
| T.I.C. | 10. | - | 9. | 11. | 11. |
| HARDNESS | - | - | 51.1 | 56.9 | - |
| MAGNESIUM (U.F.) | - | - | - | - | - |
| MAGNESIUM (DISS.) | - | - | 3.0 | 3.5 | - |
| N - $NH_3$ | <.01 | .01 | <.01 | - | .01 |
| N - $NO_2$ + $NO_3$ | .31 | .10 | <.02 | <.02 | <.02 |
| N-ORGANIC | .37 | .41 | .34 | - | .37 |
| T.K.N. | - | .42 | - | .97 | .38 |
| N-TOTAL | - | .52 | - | - | - |
| pH (LAB) | 7.5 | 8.3 | 9.1 | 7.9 | 8.8 |
| pH (OURS-FIELD) | 7.5 | 8.0 | 9.1 | 8.1 | 7.5 |
| TOTAL SOL.P. | .033 | .013 | .007 | .031 | .015 |
| DISS. ORTHO - $PO_4$ | .027 | .003 | - | .026 | .003 |
| P. (TOTAL) | .045 | .026 | .019 | .106 | .019 |
| SPECIFIC COND. µmhos/cm | - | - | 134 | 142 | - |
| CONDUCTIVITY (OURS) µmhos/cm | - | - | 119 | - | - |
| TURBIDITY | .7 | .8 | .6 | 3.0 | .5 |
| CADMIUM (U.F.) | - | .0001 | - | - | - |
| COPPER (U.F.) | - | .001 | <.001 | - | - |
| IRON (U.F.) | - | - | - | - | - |
| LEAD (U.F.) | - | .001 | <.001 | - | - |
| MERCURY (U.F.) | - | - | - | - | - |
| ZINC (U.F.) | - | .005 | - | - | - |
| TEMPERATURE (°C) (AT SITE) | 4.5 | 11.0 | 20.5 | 6.4 | 16.9 |

All figures in mg/l unless otherwise indicated

TABLE II (cont'd) WATER CHEMISTRY RESULTS - SOUTHEAST END LAYCOCK LAKE 1973-4

| | 9 | | 42 | | 44 | | 52 | | 52 | | 52 | | 52 | | 52 | | 52 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | FEB. 20/73 | | APR. 10/73 | | MAY 14/73 | | JUNE 20/73 | | JULY 24/73 | | OCT. 30/73 | | NOV. 27/73 | | FEB. 27/74 | | MAY 52/74 | |
| | 1.0m | 10.m | 1.0m | 10.0m | 1.0m | 10.0m | 1.0m | 8.0m | 1.0m | 10.0m | 1.0m | 13.0m | 1.0m | 13.0m | 1.0m | 13.0m | 1.0m | 11.0m |
| ALKALINITY (PHENOLPTHALEIN) | - | - | - | - | - | - | 2.0 | - | 7.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| ALKALINITY (TOTAL) | 47.5 | 47.0 | 48.0 | 48.0 | 51.7 | 53.0 | 51.3 | 53.7 | 52.4 | 51.7 | 58.3 | 76.2 | 53.9 | 54.4 | 44.9 | 45.7 | 46.0 | 50.5 |
| CALCIUM (U.F.) | - | - | - | - | - | - | - | - | - | - | 17.0 | 20.5 | 17.0 | 17.5 | - | - | 16.0 | 17.5 |
| CALCIUM DISS. | 15.0 | 15.7 | 16.0 | 16.5 | 16.0 | 16.0 | 16.0 | 17.3 | 16.0 | 17.0 | 16.5 | 20.5 | 17.0 | 16.5 | 15.1 | 15.4 | 15.8 | 17.5 |
| T.O.C. | 6.5 | 6.5 | 8. | 8. | 6. | 6. | 7. | 5. | 6. | 5. | 3. | 5. | 8. | 8. | 4. | 4. | 4. | 4. |
| T.I.C. | 10. | 10. | - | - | 11. | 13. | 10. | 14. | 9. | 15. | - | - | 11. | 11. | 10. | 10. | 10. | 14. |
| HARDNESS | - | - | - | - | - | - | 51.9 | 56.0 | 52.3 | - | 54.4 | 66.4 | 56.9 | 55.6 | 50.5 | 51.2 | 53.4 | 58.9 |
| MAGNESIUM (U.F.) | - | - | - | - | - | - | - | - | - | - | 3.3 | 3.7 | - | - | - | - | - | - |
| MAGNESIUM (DISS.) | - | - | - | - | - | - | 2.9 | 3.1 | 3.0 | 3.3 | 3.2 | 3.7 | 3.5 | 3.5 | 3.1 | 3.1 | 3.4 | 3.7 |
| $N\text{-}NH_3$ | .02 | .06 | .01 | .06 | <.01 | <.01 | - | - | <.01 | <.01 | .02 | 1. | - | - | .12 | .10 | - | - |
| $N\text{-}NO_2+NO_3$ | .33 | .32 | .10 | .21 | <.02 | .20 | .02 | .05 | <.02 | .21 | <.02 | <.02 | <.02 | <.02 | .32 | .32 | .10 | .25 |
| N-ORGANIC | .46 | .48 | .42 | .31 | .40 | .29 | - | - | .37 | - | .64 | .32 | - | - | .39 | .33 | - | - |
| T.K.N. | .48 | .54 | .43 | .37 | - | - | .43 | .35 | - | .25 | .66 | 1.32 | 1.23 | 1.05 | .51 | .43 | .14 | .07 |
| N-TOTAL | .81 | .86 | .53 | .58 | - | - | - | - | - | - | - | - | - | - | .83 | .75 | .24 | .32 |
| pH (LAB) | 7.6 | 7.5 | 8.3 | 7.5 | - | 7.1 | 8.6 | 7.3 | 9.0 | 7.3 | 8.1 | 6.9 | 7.8 | 7.8 | 7.2 | 7.4 | 8.1 | 7.2 |
| pH (OURS-FIELD) | 7.5 | 7.4 | 8.0 | 7.7 | 7.4 | 7.2 | 8.7 | 7.5 | 9.1 | 7.2 | 8.2 | 7.6 | 7.8 | 7.8 | 7.0 | 7.0 | 7.6 | 7.0 |
| TOTAL SOL.P. | .037 | .032 | .013 | .017 | .017 | .025 | .011 | .027 | .006 | .036 | .007 | .735 | .016 | .012 | .035 | .033 | .010 | .016 |
| DISS.ORTHO-$PO_4$ | .031 | .031 | .004 | .011 | .003 | .015 | - | - | - | - | <.003 | .725 | .008 | .008 | - | - | <.003 | .010 |
| P. (TOTAL) | .051 | .070 | .029 | .029 | .029 | .027 | .023 | .044 | .013 | .046 | .037 | .795 | .115 | .109 | .05 | .045 | .012 | .018 |
| SPECIFIC COND. umhos/cm | - | - | - | - | - | - | 132 | 137 | 152 | 143 | 136 | 168 | 143 | 143 | 126. | 127. | 133. | 142. |
| CONDUCTIVITY (OURS) umhos/cm | - | - | - | - | 110 | 98 | - | - | 119 | 98 | 100 | 120 | 90 | 90 | - | - | - | - |
| TURBIDITY | .8 | .8 | .8 | .8 | .5 | .4 | .8 | 1.2 | .6 | .6 | 4.1 | 3.3 | 4.0 | 3.0 | .9 | .9 | 1.2 | .7 |
| CADMIUM(U.F.) | - | - | <.0001 | .0001 | - | - | - | - | - | - | - | <.0005 | - | - | <.0005 | <.0005 | - | <.0005 |
| COPPER (U.F.) | - | - | .001 | .001 | - | - | - | - | - | <.001 | - | <.001 | - | <.001 | <.001 | <.001 | - | <.001 |
| IRON (U.F.) | - | - | - | - | - | - | - | - | - | - | - | 1.38 | - | 0.1 | - | - | - | 0.1 |
| LEAD (U.F.) | - | - | .001 | .001 | - | - | - | - | - | <.001 | - | <.001 | - | <.001 | <.001 | <.001 | - | <.001 |
| MERCURY(U.F.)ug/l | - | - | - | - | - | - | - | - | <.05 | - | - | <.05 | - | <.05 | - | <.05 | - | <.05 |
| ZINC (U.F.) | - | - | .005 | .005 | - | - | - | - | - | - | - | <.005 | - | <.005 | .008 | <.005 | - | <.005 |
| TEMPERATURE (°C) (AT SITE) | 4.0 | 3.8 | 10.7 | 6.8 | 17.0 | 7.5 | 18.9 | 11.2 | 20.1 | 8.5 | 12.7 | 7.0 | 6.2 | 6.1 | 4.7 | 4.9 | 14.0 | 7.0 |
| NICKEL (U.F.) | - | - | - | - | - | - | - | - | - | - | - | - | - | <.01 | - | - | - | <.01 |

All figures in mg/l unless otherwise indicated

TABLE III WATER CHEMISTRY - 1972

| TEST | | A* | B | C | D | E | F |
|---|---|---|---|---|---|---|---|
| pH (electrometric) | | 6.85 | 6.95 | 6.75 | 6.35 | 6.90 | 6.90 |
| Suspended Matter | | 6.0 | 3.2 | 8.8 | 8.8 | 6.0 | 2.4 |
| Fixed | | 1.3 | 1.0 | 2.4 | 4.4 | 3.6 | 1.0 |
| Volatile | | 4.7 | 2.2 | 6.4 | 4.4 | 2.4 | 1.4 |
| Dissolved Anions | | | | | | | |
| Alkalinity , | | | | | | | |
| Bicarbonates | $HCO_3$ | 49. | 50. | 38. | 22. | 53. | 49. |
| Carbonates | $CO_3$ | nil | nil | nil | nil | nil | nil |
| Hydroxyl Ion | OH | nil | nil | nil | nil | nil | nil |
| Total Nitrogen | N | 1.3 | 1.3 | 1.3 | 12.5 | 0.5 | 6.3 |
| Total Nitrates | N | 0.14 | 0.19 | 0.11 | <0.1 | 0.15 | 0.14 |
| Total Ammonia | N | 0.01 | 0.01 | 0.01 | 0.02 | <0.01 | <0.01 |
| Total Phosphates | $PO_4$ | <0.1 | 0.10 | 0.29 | 0.45 | <0.1 | <0.1 |
| Ortho Phosphates | $PO_4$ | <0.1 | 0.10 | 0.29 | 0.45 | <0.1 | <0.1 |
| Total Copper | Cu | 0.02 | 0.02 | 0.03 | 0.03 | 0.03 | 0.03 |
| Total Lead | Pb | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Total Zinc | Zn | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Total Mercury | Hg | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 |
| Total Cadmium | Cd | <5. | <5. | <5. | <5. | <5. | <5. |
| Total Dissolved Solids | | 66. | 78. | 48. | 110. | 40. | 64. |
| Fixed | | 18. | 21. | 20. | 18. | 26. | 22. |
| Volatile | | 48. | 57. | 28. | 92. | 14. | 42. |

< = less than

Total = analysis performed on unfiltered sample

Total Dissolved Solids = Evaporated Residue

All figures in ppm., except Mercury and Cadmium in ppb., and pH.

Location 'B' is in the NW end

Location 'E' is in the SE end

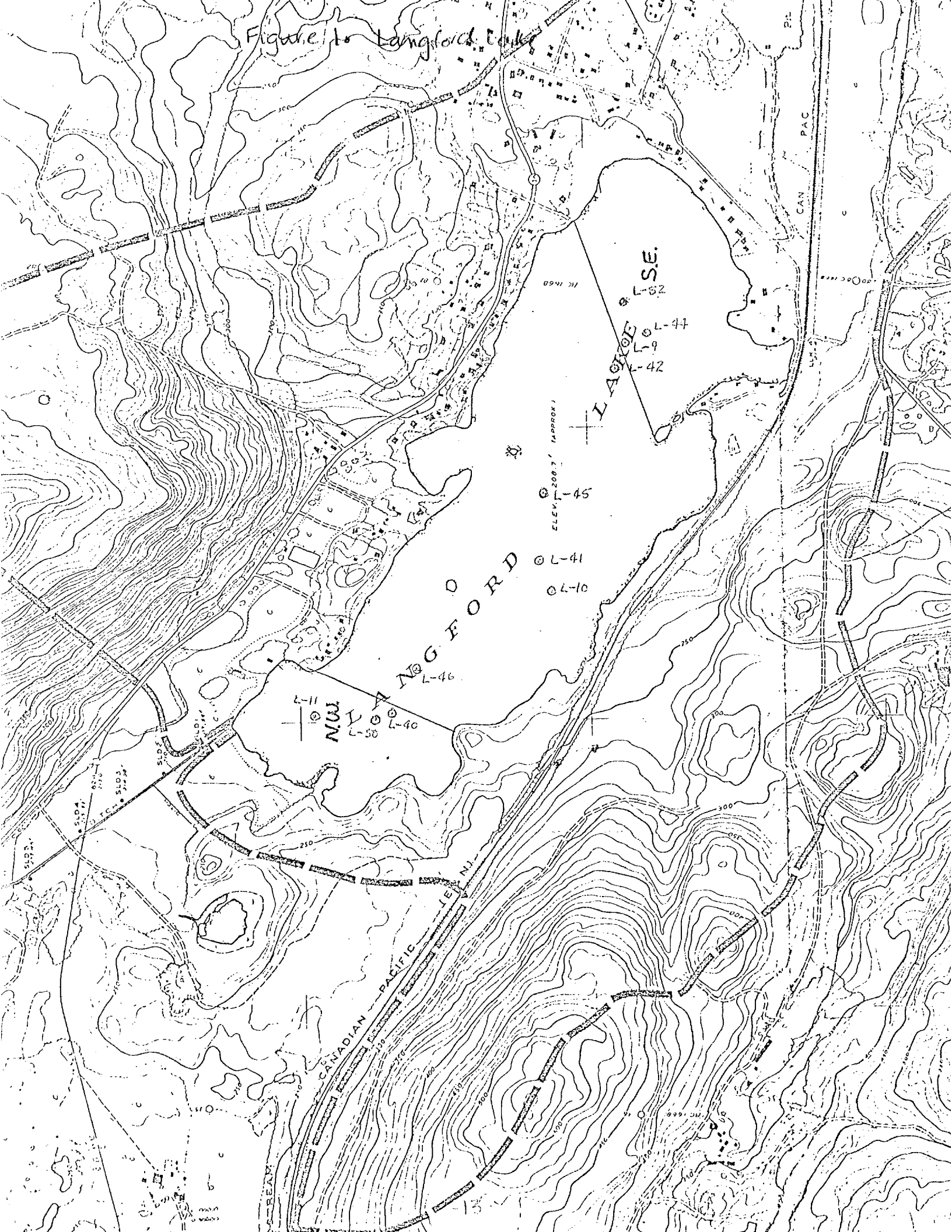


Figure 1 - Langford Lake
LAKE S.E.
L-52
L-44
L-9
L-42
L-45
ELEV. 208.7' (APPROX.)
L-41
L-10
NO. 2
L-46
L-11
N.W.
L-50
L-40
CANADIAN PACIFIC
E.J. N.J.
CAN PAC

# PROPOSED HEAVY METAL SAMPLING OF LANGFORD LAKE

## Locations

Two areas have been chosen (see map at end of proposal) as results obtained from analyses of water sampling in 1973 showed water in the northwest end of the lake to contain higher concentrations of copper, lead and zinc than anywhere else in the lake.

The areas chosen also had to be large enough to encompass a water sampling location and enough shoreline to set out several crayfish traps where suitable habitat was to be found.

## Collections

(a) Fish - it is hoped to collect two or three species of fish and to have at least three size categories of each species. A minimum of five specimens of each size category will be required. A random mesh net will be used consisting of five - 50 foot sections of net joined together into a 250 foot long net. Each 50 foot section is of different mesh size and thus will catch different sized fish.

(b) Crayfish - several minnow-traps (which have proven successful elsewhere in catching crayfish) will be placed out along the shoreline in each section in an attempt to catch as many crayfish as possible in each of three size ranges. A range of depths and

habitats will be sampled and the traps baited with bologna and cat food.

(c) Zooplankton - in order to obtain enough of a sample for analyses to be made several tows or hauls with our present plankton net will have to be made as the phytoplankton clog the mesh after only a few seconds in the water preventing any further filtration. Another possibility could be that we might borrow a plankton net with a larger mesh size.

(d) Macrophytes - at least two plant species will be collected and at least 15 specimens of each species will be needed.

(e) Sediments - these will be sampled at a later date if it is considered desirable at that time.

Field Preparations

(a) Fish - (1) remove from net, identify, sort into species.

(2) for each species in turn measure fork length and weigh each fish and place in one of three size categories.

(3) for each fish, remove the liver and place in a bag separate from the remainder of the fishes body.

(4) place the two bags related to each fish inside a third bag with a label giving:

- weight
- species
- fork length

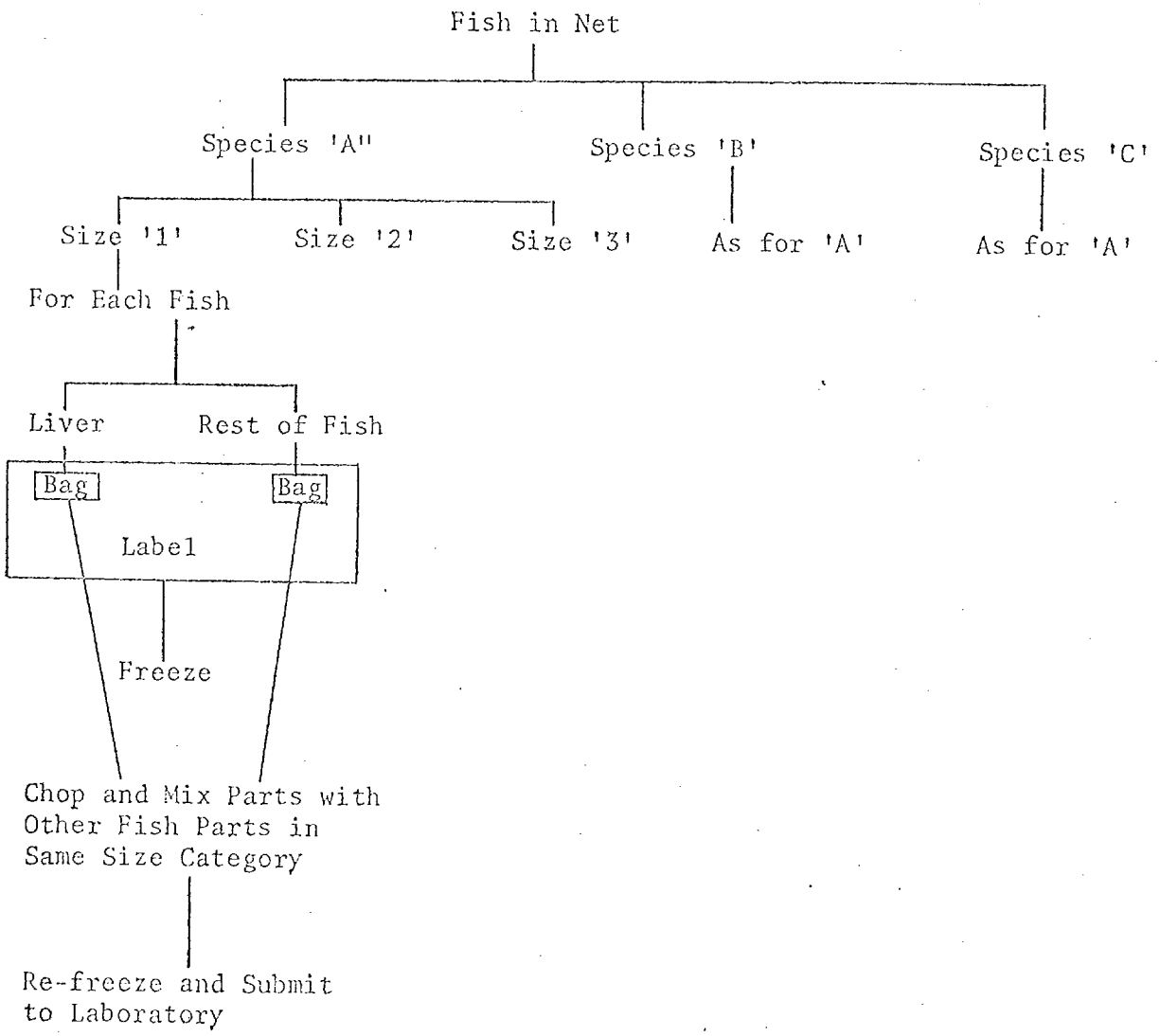
- size category
- collection location (NW or SE)
- date

(5) place bag in freezer

(6) after frozen, chop and mix with parts of other fish in same size category.

(7) re-freeze and submit to laboratory.

See following flow chart.



(b) Crayfish - (1) remove from traps, measure length and weigh each specimen, and label.

(2) sort into size categories and bag (should be at least five specimens in each of three size categories).

(3) freeze.

(4) chop and mix specimens of same size.

(5) re-freeze and submit to laboratory.

(c) Zooplankton - (1) many plankton net hauls to be taken until enough sample is obtained (should be at least 20 c.c. of homogenate), label.

(2) kill with formaldehyde.

(3) decant surplus water.

(4) weigh dry filter paper.

(5) pump water containing sample through filter paper.

(6) dry filter paper and zooplankton sample by vacuum dessicator.

(7) re-weigh filter paper and sample to determine weight of zooplankton.

(8) submit sample to laboratory.

(d) Macrophytes - (1) collections to be bagged and labelled.

(2) chop and mix together at least five specimens of one species, repeat for other species.

(3) freeze.

(4) submit to laboratory.

Lab Preparation (For Each Part of the Lake)

(a) Fish - (1) chemical analysis - on six samples from each species (three size ranges each with livers and rest of bodies).

(2) fresh weight per dry weight ratio - breakdown as in (1) but a sub-sample of each of the samples in (1) will be used.

(b) Crayfish - (1) chemical analysis - on three samples.

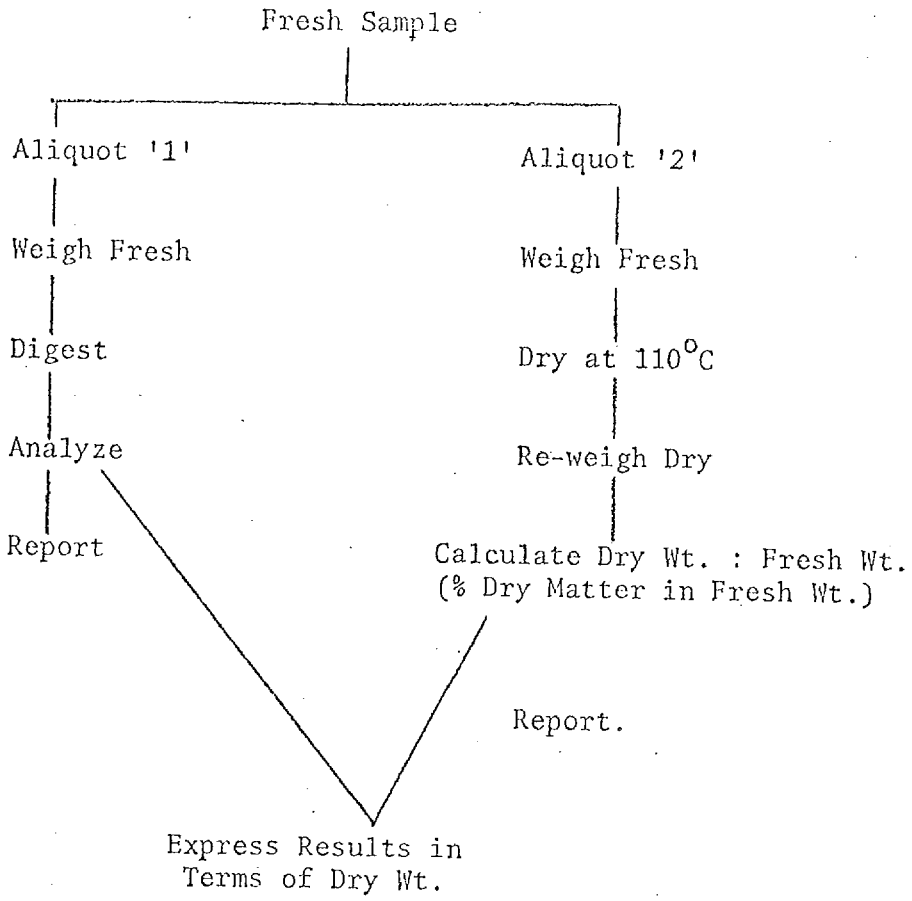
(2) fresh weight per dry weight ratio - breakdown as in (1) but use sub-samples of samples sent for (1).

(c) Zooplankton - (1) chemical analysis - on one sample.

(d) Macrophytes - (1) chemical analysis - on one sample for each species collected.

(2) fresh weight per dry weight ratio - breakdown as in (1) but sub-samples of samples in (1) will be used.

Laboratory Analyses




- metals to be tested for are: cadmium
  copper
  lead
  zinc