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LAC LAFLAMME  
CALIBRATED WATERSHED  
AN OVERVIEW  
MAY, 1981

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1981

Inland Waters Directorate  
Quebec Region

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## 1- INTRODUCTION

The Long Range Transport of Air Pollutants (LRTAP) study plan included the study of three lake basins with the aim of better understanding the impact of atmospheric pollutants on sensitive aquatic ecosystems in Eastern Canada. In the Algoma Region of Ontario the effects on a deciduous forest in the Great Lake Region are being evaluated. In Kejimikujik Park, Nova Scotia, ecosystems influenced by the marine environment are being studied.

Not part of the LRTAP study plan, but contributing nonetheless are the studies at the Experimental Lakes Area near Kenora, Ontario, where the processes within lakes undergoing artificial acidification are being studied.

To determine the effect of atmospheric pollution on the aquatic ecosystems of boreal forests, three areas were proposed; La Mauricie National Park, the St. Maurice forestry reserve, and the Montmorency Forest in Laurentides Park, all in Quebec. Because of its characteristics and logistical advantages the ultimate choice was Lac Laflamme in the Montmorency Forest. One of the principal characteristics of this lake is its apparent resistance to acidification even in view of its sensitivity. Despite the high acidity of the rain in the area the lake appears to have resisted acidification. The study of this lake should allow us to determine the mechanisms whereby the lake is buffered and to follow geological and biological processes involved.

Lac Laflamme is a headwater lake in a simple hydrological system. The vegetation cover in the basin is homogeneous and stable, typical of the vast boreal forests. It is far removed from local sources of air pollution, but

is affected by pollutants transported over a long distance. In addition to these characteristics Lac Laflamme offers several advantages in terms of accessibility of the site and the facilities and instrumentation at the University of Laval Forestry School Experimental Station located nearby.

The main goals of the studies at this site are the determination of an ion budget and the biological and chemical conditions of the basin. Work has been underway since January 1980 with the aim of meeting these objectives in terms of obtaining information on the chemical, biological, and hydrogeological components of the system. The activities include the analysis of the precipitation and studies of the changes of chemical and hydrological parameters at various levels of the ecosystem (forest, surficial deposits, organic layer, lake basin etc). Studies of the plankton and fish communities are also underway.

We foresee carrying out a study on the contribution of the aquatic macrophytes and sediments in Lac Laflamme to the movement of the chemical components through the system.

According to their goal the studies in progress could be divided in two groups: studies into the biological and chemical characteristics of Lac Laflamme, and the studies directed toward the determination of the ion balance. Studies on biological communities include the phytoplankton community and fish population studies. Evaluation of the Lac Laflamme water quality and the mass balance include: snow and water quality determination in the lake basin, evaluation of the water interception, evaporation runoff and percolation (hydrological studies), qualitative and quantitative studies of

underground water (hydrogeological studies), lake bottom sediments and lakewater quality analysis on a regular basis (IWD program).

## 2- MASS BALANCE AND WATER QUALITY

### 2.1 Snow and water quality of the lake Laflamme (Jones & Bisson 1980 - completed)

Jones and Bisson studied the importance of atmospheric pollutants accumulation in snow and their rate of release in the spring. The authors also investigated the variation in concentration of parameters related to snow melt period from January 30th to May 6th 1980. Water samples were collected at the geometric center of the lake and at each of the four intermittent tributaries. For snow studies a sampling area was selected in each of the sub-watersheds of the four tributaries. Sampling was done once a week. Evaluation of the contribution of acid precipitation was measured through sulfate, nitrate, chloride and hydrogen ion concentrations. Contribution of the weathering process and atmospheric deposition was estimated by measuring the ammonium, calcium, magnesium, sodium and potassium concentrations. Other parameters considered include pH, conductivity, inorganic carbon, major and minor ions. According to this study, the Lac Laflamme watershed seems to be able to buffer acid precipitation except during the extreme and brief meteorological events. However, the lake alkalinity shows that the buffering chemical reserve of the lake could be quickly exhausted by the cumulative effect of acid precipitation.

## 2.2 Hydrological studies (Plamondon 1981 - in progress)

Plamondon's research is concerned with the quantification of the major parameters of the hydrological cycle including interception in the forest cover, evaporation, surface runoff, percolation and water runoff in the main soil layer. The first part of the study was directed towards the physical description of the watershed and the installation of instruments. The analysis of the first results is in progress and the physical description of the lake watershed is completed.

## 2.3 Hydrogeological studies (Azzaria & Gelinas 1981 - in progress)

Azzaria and Gelinas are studying the hydrogeological aspects of groundwater. The nature, distribution and hydrogeological properties of the underground reservoir and the development of a runoff model to predict the speed, direction and flow of groundwater are included. The second part of their work deals with water quality changes in the seepage, the study of the mineralogical nature of the soil and geochemical processes involved in the reactions between water and the soils. These investigations should allow us to determine to what extent the geological materials in the watershed can neutralize the acidic precipitation. Preliminary results show that groundwater could be the major water input to the lake. The hydraulic conductivity tests and the runoff model suggest that even without surface runoff a significant amount of water reaches the lake. Preliminary soil analysis also indicate that sodium and calcium plagioclases may contribute to reduce the acidity of water percolating through it if the contact time is sufficiently long.

#### 2.4 Lake sediment study (Ouellet 1980 - completed)

Stratigraphic analysis of Lac Laflamme sediments has been carried out by Ouellet. Paleolimnological and geochemical analyses were performed to determine the possible effects that could be attributed to the long range transport of atmospheric pollutants. Stratigraphic analysis shows no obvious indication of major change in the lake system during the last hundred years. Paleolimnological analysis does not show any change which could be related to acidification.

#### 2.5 Water quality study (IWD - in progress)

To assess the water quality changes related to acid precipitation and to collect the data needed for the mass balance determination, mid-lake and outlet water has been sampled weekly. The parameters analysed include major ions, heavy metals, trace metals, inorganic phosphorus, total phosphorus, pH, color, conductance and alkalinity. Preliminary analysis of the results is in progress.

### 3. BIOLOGY OF LAC LAFLAMME

#### 3.1 Phytoplankton community study (Auclair, 1981 - in progress)

Auclair's work allowed us to determine the composition of the phytoplanktonic species in the lake and to study the possible relations between population dynamics and some water quality parameters. Preliminary analysis indicates an important temporal variability of nitrogen and a low phosphorus mineralization between mid-december and mid-january. Analysis of the data is now underway.

### 3.2 Fish population study (Lafontaine et al. 1981 - to be completed)

To assess the fish population in the lake Laflamme, Lafontaine et al. studied the embryonic development, growth and reproduction of brook trout (Salvelinus fontinalis). From this study it appears that the fish population of the lake is in good condition. More research is required however to complete the fish population analysis. The Inland Waters Directorate, Quebec Region, intends to complete the fish population study in 1981.



#### 4. BIBLIOGRAPHY

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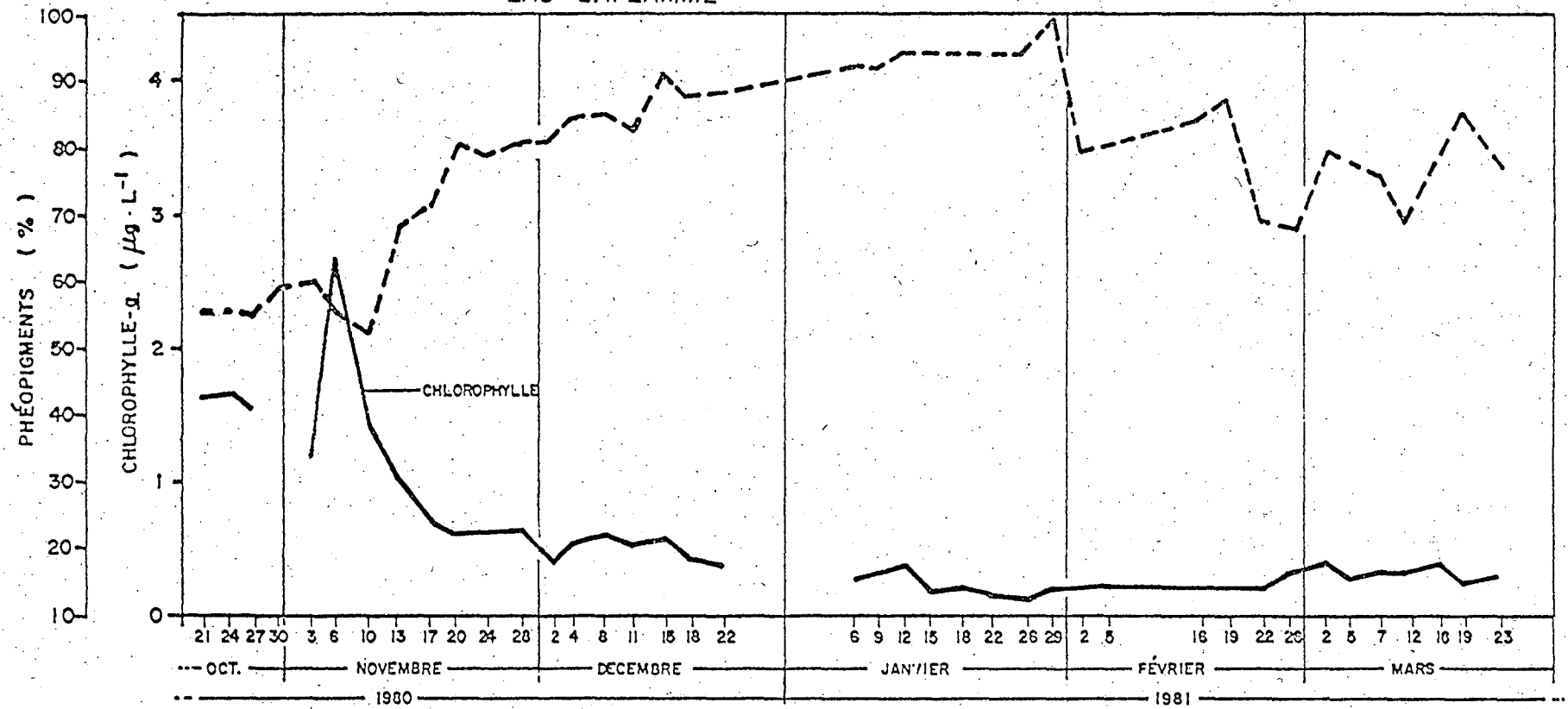
APPENDIX

LAC LAFLAMME - BUDGET

ACTIVITIES	COSTS		
	1979/80	1980/81	1981/82
Mass balance and water quality			
- Snow and water quality of the lake Laflamme	13 K		
- Hydrological studies		15 K	28 K
- Hydrogeological studies		28 K	50 K*
- Lake sediment study	6 K		
- Water quality study			10 K*
Biology of Lac Laflamme			
- Phytoplankton community study		12 K	
- Fish population study		13 K	
	19 K	68 K	88 K

\* Estimated costs

# LAC LAFLAMME



\*(Auclair 1981)

# LAC LAFLAMME

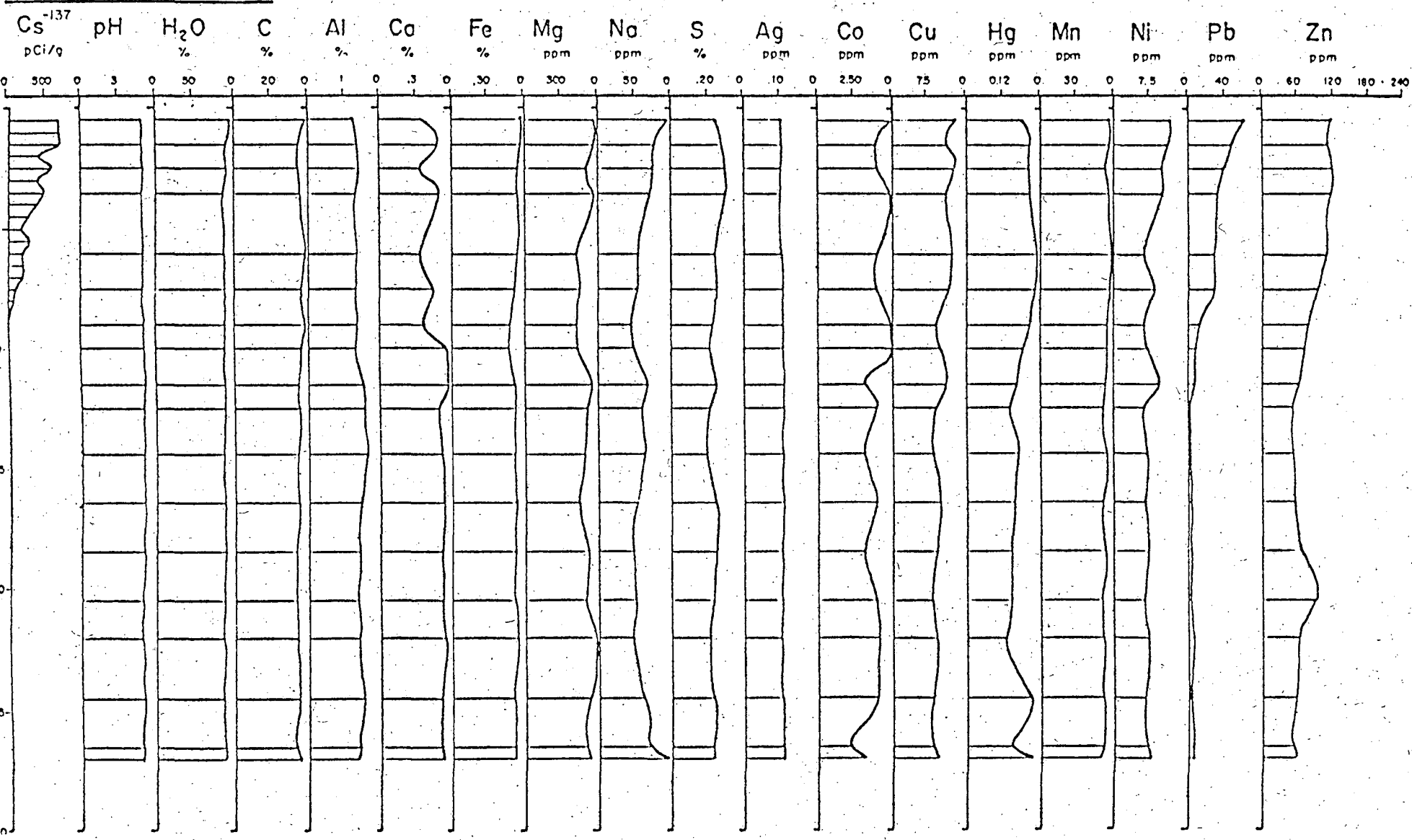
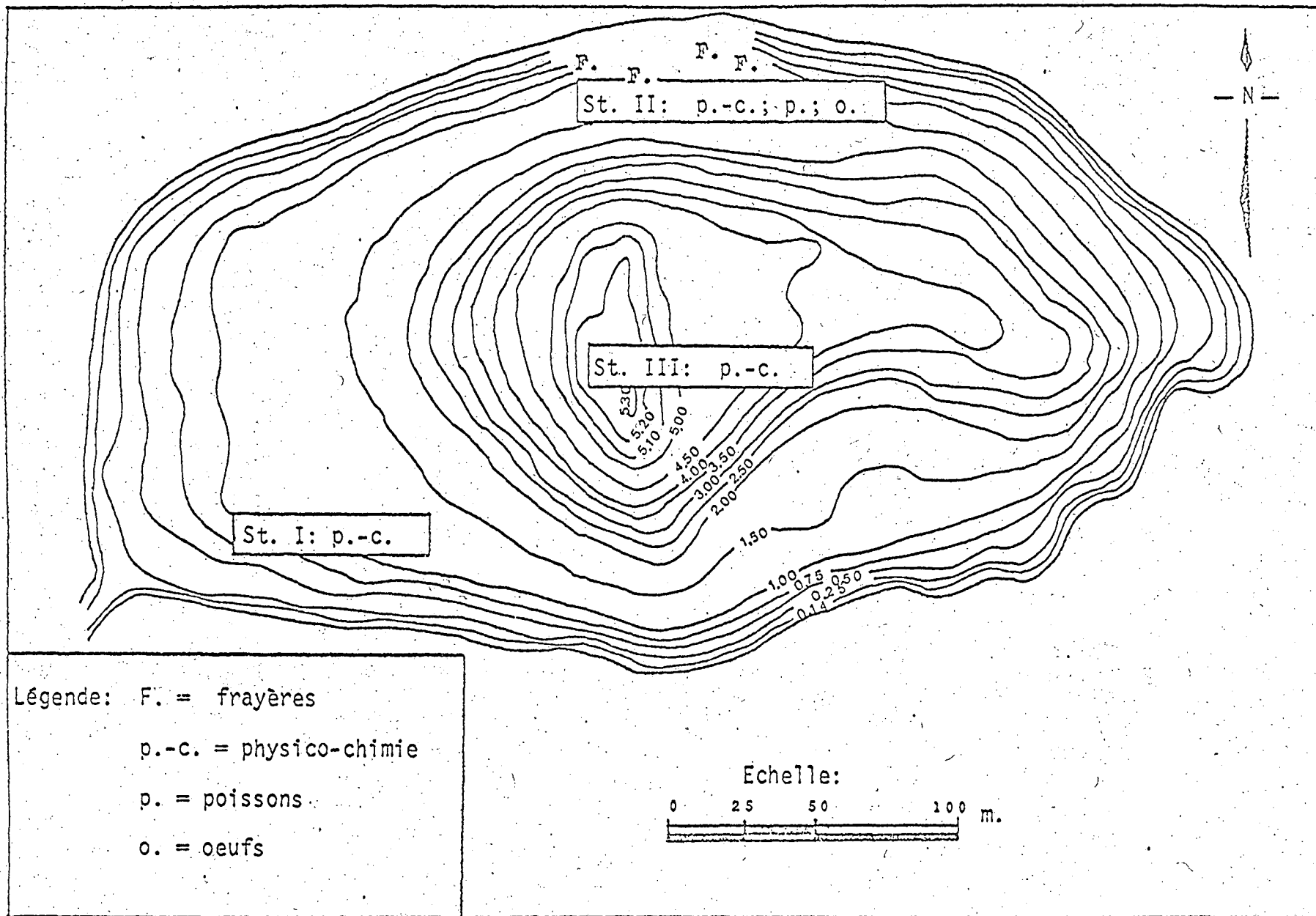


Diagramme géochimique des sédiments les plus récents du lac Laflamme (Ouellet 1980)

Carte des stations d'échantillonnage au Lac Laflamme (46°11'N - 74°57'O), Parc des  
Laurentides. (Lafontaine et al. 1981)



START OF TAPE  
OPTIONS?3

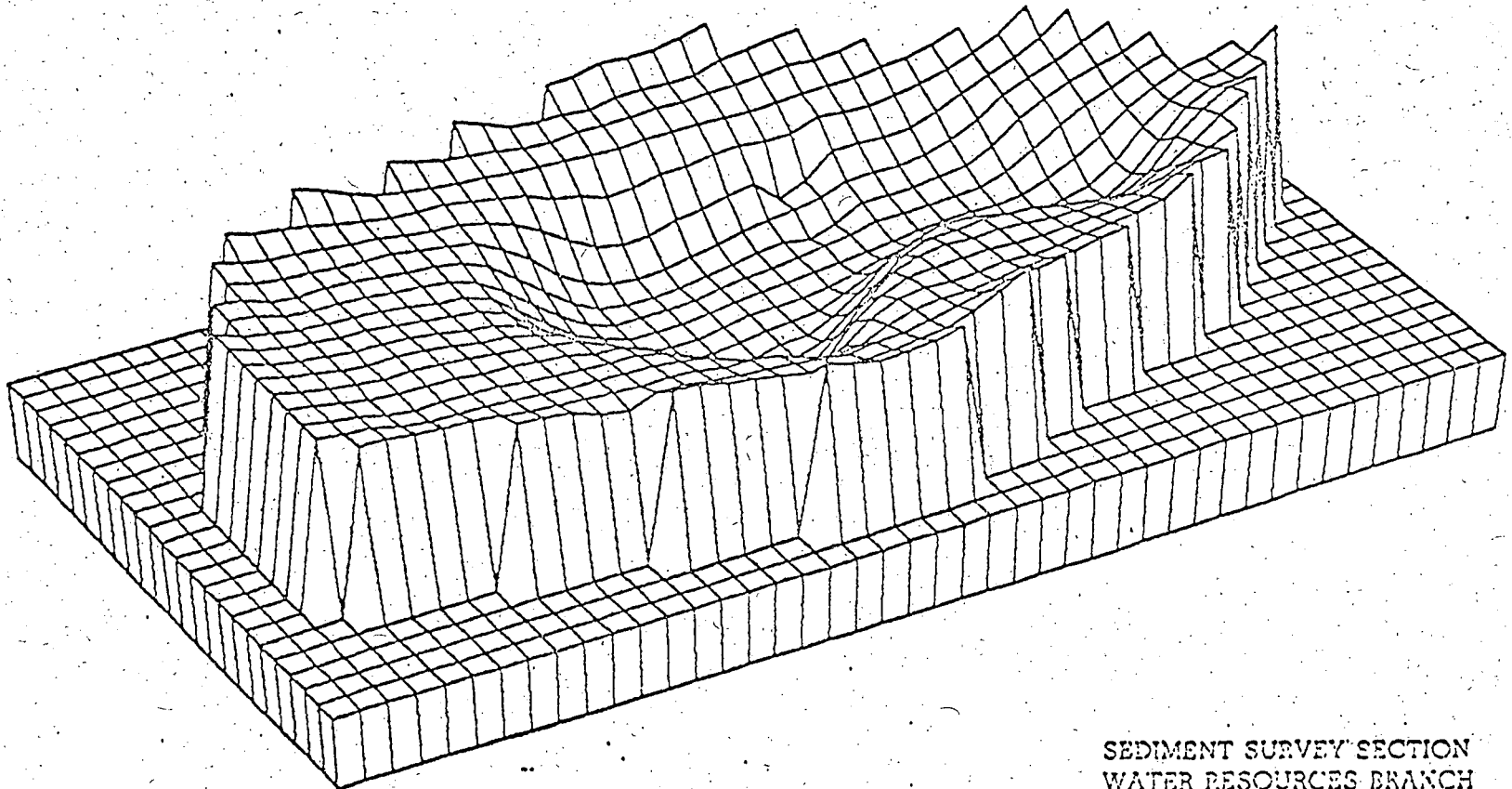
WHERE WOULD YOU LIKE ORIGIN?(X,Y)

?-1,-1

-1,-1 CENTER SIZE (WIDTH,HEIGHT)

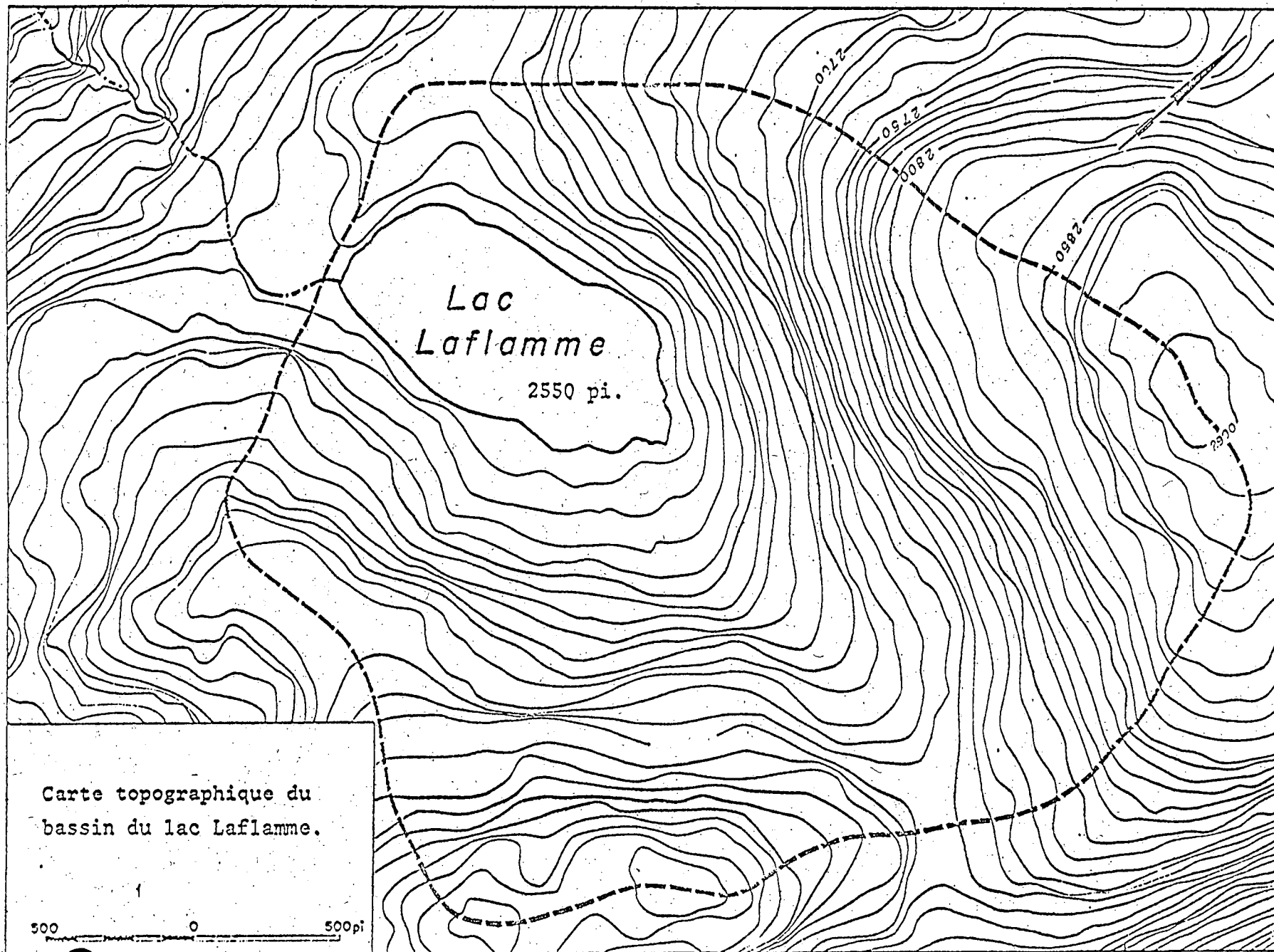
?-3,40

40,40,CC



LLP# 1807 2000 = 10. NORTH = 85. PLOT = 40. PLOT = 8.

SEDIMENT SURVEY SECTION  
WATER RESOURCES BRANCH  
INLAND WATERS DIRECTORATE  
DEPARTMENT OF THE ENVIRONMENT  
OTTAWA, ONTARIO  
K1A 0E7  
PHONE. 997-1185



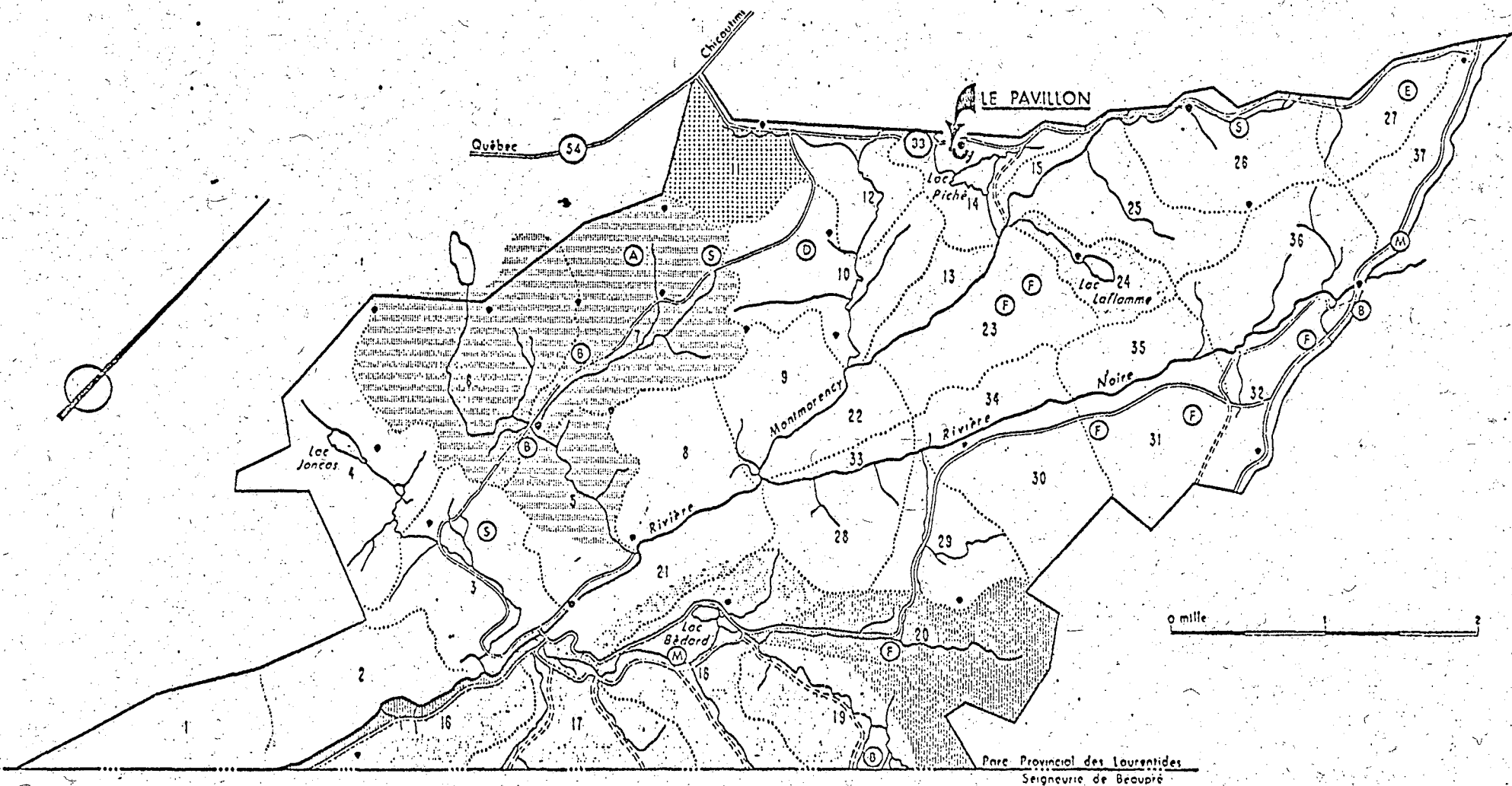
Carte topographique du  
bassin du lac Laflamme.

500 0 500 pi.



# LA FORÊT MONTMORENCY

(Plamondon 1981)



Limite de la Forêt Montmorency ————  
 Chemin principal ————  
 Chemin secondaire ————  
 Limite de compartiment ————  
 Station de météo ————

Réserve écologique ————  
 Réserve d'eau potable ————  
 Opérations forestières, 1966-1973 ————  
 Opérations forestières, 1974 ————  
 Bassin expérimental des eaux volées ————

Fertilisation aérienne ———— (A)  
 Étude de biomasse ———— (B)  
 Fertilisation expérimentale ———— (F)  
 Écologie des petits rongeurs ———— (M)  
 Étude des caries V densité ———— (D)  
 Éclaircies précommerciales expérimentales ———— (S)  
 Sylviculture de l'épinette blanche ———— (E)