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Douglas Ecological Consultants Ltd.

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FOREWORD

Following a feasibility study in 1975, Syncrude Canada Ltd. commissioned Douglas Ecological Consultants Ltd. to establish a network of lichen plots. After the Syncrude plant begins operations, the plots will be monitored regularly to detect incipient vegetation damage caused by industrial emissions. This monograph consists of the baseline information and species accounts compiled by Dr. Douglas during 1976.

It is Syncrude's policy to publish its environmental consultants' final reports as they are received, withholding only proprietary technical information or that of a financial nature. Because we do not necessarily base our decisions on just one consultant's opinion, recommendations found in the text should not be construed as commitments to action by Syncrude.

Syncrude Canada Ltd. welcomes public and scientific interest in its environmental activities. Please address any questions or comments to Syncrude Environmental Affairs, 10030 - 107 Street, Edmonton, Alberta T5J 3E5.

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ABSTRACT

A network of 56 permanent plots, radiating from the periphery of the Syncrude Lease, was established during the summer of 1976. This network will allow continuous quantitative monitoring of the lichen flora using photographic techniques. Since lichens are highly sensitive to air pollutants such as SO_2, they are capable of showing damage or reduced growth long before it is detectable in other vegetation. This "early warning system" may indicate that unnatural biological changes are beginning to take place in the ecosystem and appropriate action, if necessary, may then be taken to minimize further biological changes.

It is recommended that partial resurveys of the grid network should be conducted annually during the first years of the Syncrude plant's operation. These partial resurveys will be relatively economical since only 21 plots, all accessible by road, need be examined. If no adverse changes in the lichen flora are detected during partial resurveys, several years may then elapse before a subsequent partial resurvey is necessary. Complete resurveys will only be required if a partial resurvey indicates adverse changes are occurring.

Collections of lichens and mosses during 1975 and 1976 have resulted in a known flora of 121 species of lichens and 136 species of mosses for the Fort McMurray region. Seventeen species of lichens and three species of mosses apparently are new to the flora of Alberta.

INTRODUCTION

The sensitivity of plants to air pollution was first noted by Nylander (1866) more than a century ago when he observed the scarcity of lichens within the city of Paris. Similar observations were also made on mosses in Munich twenty-six years later (Arnold, 1892). During recent years, botanists have analyzed lichen populations around major sources of pollution (i.e., mines, power plants and pulp mills) to determine how the lichens have been affected (Nash, 1972; LeBlanc et al., 1970, 1974; Showman, 1975; and Sheridan et al., 1976). They have been interested in finding species that are most sensitive to air pollution and that might be used as biological indicators of air pollution. Some of these studies have been conducted in North America (Brodo, 1966; Rao & LeBlanc, 1967; LeBlanc, et al., 1972; Mathis & Tomlinson, 1972). Studies in Europe include Skye (1958), Fenton (1960, 1964), Gilbert (1965, 1970), Skye & Hallberg (1969), Hawksworth & Rose (1970), and Johnson and Søcting (1976). Ferry, et al., (1973) have summarized the literature.

Past studies of lichens in relation to air pollution have always been conducted around long established sources of pollution. Many of these pollution sources have created "lichen deserts" in immediately adjacent areas, lending themselves nicely to the construction of lichen distribution maps, or to the formulation of zones of pollution based on the gradual appearance of certain species and on changes in the number of species in lichen communities at varying distances from the pollution source (Hawksworth & Rose, 1970; Nash, 1975). DeSloover & LeBlanc (1968) have developed a statistic called the Index of Atmospheric Purity, in which pollution zones are mapped and characterized by certain species which were found to be sensitive or, in some cases, resistant to air pollution.

Recent studies indicate that this destruction by SO_2 emissions (usually the major component of air pollution in these studies) is dependent upon moisture. The reaction of SO_2 with water yields H_2SO_3 and other ions that are highly acidic and damage the photosynthetic capabilities of the plants. Turk and Wirth (1975) have demonstrated this with lichens, including the species Hypogymnia physodes (an important species in the Fort McMurray region), showing that they are extremely sensitive to the low pH created by the SO_2 emissions. Since the photosynthetic tissue of lichens is minimal, it is valid to assume these plants should be the first to show signs of air pollution damage. Mosses are also very sensitive since they only photosynthesize under moist conditions (Peterson & Mayo, 1975) and seem to have their juvenile stage (protonema) affected by SO_2 emissions (Nash & Nash, 1974).

Lichens are prominent in the floras of most areas of the earth. Due to their sensitivity to air pollution, researchers are often able to determine the relative purity of the air by noting the composition and luxuriance of a lichen flora within a given region. Lichens may provide an "early warning system" indicating that air pollution is promoting biological changes in the ecosystem. This prompted Gilbert (1970), working in England, to suggest that people with respiratory disorders should try to live in areas having a rich lichen flora. He also suggested that farmers and city planners should select pollution resistant strains of rye and shade trees if their areas are devoid of lichens. Other advantages in studying lichens in relation to air pollution include: 1) a given lichen flora reflects the average, cumulative effects of air pollution over a long period of time; 2) data from lichen studies supplement data gathered by SO_2 monitoring devices; and 3) lichens are excellent for comparative photographic records of growth and vitality over long periods of time.

OBJECTIVES

During the summer of 1975, a study of the scientific, technical and economic feasibility of establishing a biological monitoring network using lichens was undertaken in the Ft. McMurray region (Douglas and Skorepa, 1976). Objectives of the 1975 study were:

1. To determine the scientific, technical and economic feasibility of air pollution effect monitoring using lichens in association with air monitoring sites.

2. To determine the scientific, technical and economic feasibility of establishing air pollution effect gradients using lichenological methods on a radially arranged pattern of observation sites.

3. To add to Syncrude's general inventory of environmental information by the collection of lichen floristic data.

Results of the 1975 study indicated that, with certain modifications, the establishment of a biological monitoring network using lichens was feasible. Establishment of the network took place during the summer of 1976 with the following objectives:

1. To establish a radially arranged pattern of observation sites using lichenological methods for determining the effects of air pollution upon the environment.

2. To establish an air pollution monitoring system, based on photography of two-dimensional foliose lichens and on laboratory analysis, using methods capable of detecting minute changes in the percent cover or growth of selected lichen species.

3. To collect and preserve critical lichen and moss samples for future comparative analysis of SO_2, and possibly heavy metal content.

4. To add to Syncrude's general inventory of environmental information by collection of lichen and moss floristic data.

METHODS

Plot Locations

Fifty-six sampling sites were established along eight transects radiating from the periphery of the Syncrude lease. Seven sites, at distances of approximately 1, 2, 6, 12, 20, 30, and 40 km, were located on each transect. Each site has been precisely located on Alberta government air photos.

Data Analysis

Stands dominated by white spruce (Picea glauca) and black spruce (Picea mariana) are the most abundant in the Ft. McMurray area, and were used most frequently for sample sites; however, occasional balsam fir (Abies balsamea) and larch (Larix laricina) stands were used in areas where they are common, since they were found to support a lichen flora similar to the two spruce species. The remaining common tree species in the area, quaking aspen (Populus tremuloides) and jack pine (Pinus banksiana) are not usually conducive to lichen growth in this region and were only used in isolated instances.

Sampling was done at each plot by establishing twenty 10 by 20 cm quadrats within the selected tree stand. Ten to twenty trees were used for quadrat placement with no more than 2 quadrats per tree. This lessens the chance of losing too many quadrats due to the destruction of a few trees at the site. Each quadrat placement was marked with a heavy 6 cm circular aluminum tag stamped with the plot number and the individual quadrat number (Fig. 1). In order to facilitate finding each sample tree during future studies, each tree was marked on a map relating distance and compass direction to the next tree in the sequence.

Figure 1. This sheet-metal shadow box provided uniform lighting (by flash) for lichen photographs. Circular metal tag used for all sites and quadrats is visible at top of open shadow box.

Each sample was taken by attaching an aluminum wire quadrat to the tree with 4 aluminum nails and then nailing a sheet-metal shadow box over it (Fig. 1). The quadrat was then photographed (in duplicate, but not simultaneously) through a small opening in the end of the shadow box using two Canon FTb single lens reflex cameras with 55 mm Macro lenses and two Honeywell 480 electronic flash units (each set on manual) for a light source. Kodachrome film ASA 25 was used with exposure settings of f 16 at 1/60 second. Tests conducted prior to field sampling indicated this was the optimum camera setting. Each quadrat sampled contained at least one lichen thallus, usually of Parmelia sulcata (Fig. 2) or Hypogymnia physodes (Fig. 3); however, on rare occasions Parmelia flaventior (Fig. 4) (a lichen closely related to P. caperata, on which studies by Showman (1975) have shown growth rates to be approximately 3 mm per year) or one of several species of Physcia was used when neither of the two common lichens were available. The 4 aluminum nails were left in the tree to aid exact placement of quadrats when the plots are resampled at a future date. To determine the percent cover of each lichen species in each quadrat, the Kodachrome slides were projected with an Argus Roundabout 908 projector against a screen composed of a grid network made from Letratone (Lt 113) dot patterns (Fig. 5). The quadrat image was enlarged 3 times with a 30 by 60 cm area covering 23,220 dots on the screen. The number of dots that each lichen species covered was counted and divided by the total (23,220) to give percent coverage. The dots on the grid network measure 1.5 mm in diameter and are spaced 1 mm apart horizontally and vertically and 2 mm apart diagonally, thus enabling any radial change of 0.3 mm or more to be accurately detected.

Figure 2. Aluminum quadrat frame (at Plot 1) encloses an example of *Parmelia sulcata*, the most commonly used lichen in the study.

Figure 3. *Hypogymnia physodes*, enclosed in Quadrat 17 at Plot 1, was the second most important lichen in the study.

Figure 4. *Parmelia flaventior*, one of the more conspicuous lichens in the region, was used on rare occasions.

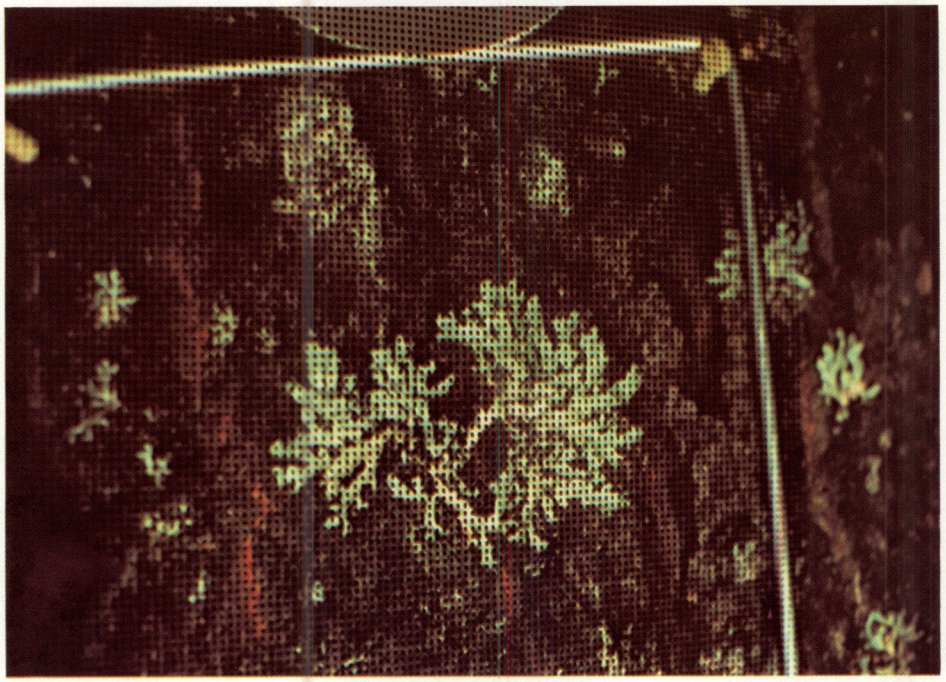

Figure 5. This section of a quadrat illustrates the dot patterns (over *Parmelia sulcata*) on the projection screen grid network.

Plant Identification and Collections

There are few taxonomic problems involving the lichen flora of the Fort McMurray area, but some difficulty is encountered in the field identification of several groups. Alectoria, Ramalina, and Usnea are not well known in North America and even if they were better known, intermediate specimens or chemical characters used for identification make some of them difficult or impractical to identify in the field. All but two specimens of Alectoria examined and collected were A. glabra, but other species (A. fuscescens, A. fremontii, A. nadvornikiana) could occur and should be looked for during future work. The major problem with Ramalina in the field is that a small R. fastigiata could be mistaken for R. minuscula. Usnea is the most difficult genus. The species may be divided into two groups. The most common are the "tufted" Usneas, which are not much longer than broad (rarely over 10 cm long). This group of poorly defined species may someday be lumped into one or two species. It is impractical to try to differentiate these forms in the field, since the number of individuals is great and since they must be partly destroyed for chemical identification. It is best to refer to the group as "tufted" Usneas. The second, less common, group may be differentiated as "pendulous" Usneas (much longer than broad). These grow mostly on larch trees and consist mainly of Usnea alpina. Squamules of Cladonia sometimes occur in trunk quadrats near the ground. These fragments are not identifiable.

Moss identifications are those of W.L. Peterson except for the genus Encalypta done by D.G. Horton, and Seligeria and Sphagnum by D.H. Vitt. The lichen identifications are mainly those of A.C. Skorepa. The nomenclature follows that of Moss (1959) for vascular plants, Hale &

Culberson (1970) for lichens, and Crum *et al.* (1973) for mosses (in most cases). All original voucher specimens are deposited in the G.W. Douglas private herbarium with partial duplicate sets in Ottawa (CAN) and the University of Alberta (ALTA). Collection numbers preceded by "D" represent collections by G.W. Douglas, those preceded by "PD" are collections of W.L. Peterson and R.I. Douglas and those preceded by "S" are those of A.C. Skorepa.

In addition to representative collections of lichens and mosses of the area, large quantities of two lichens (*Parmelia sulcata* (Fig. 6) and *Peltigera apthosa* (Fig. 7)) and two mosses (*Hylocomnium splendens* and *Pleurozium schreberi* (Fig. 8)) were collected at each site when possible, air dried and preserved in air tight 8 oz. plastic jars (Can Lab B7531-101) for future biochemical analysis. These widespread species were chosen because of their relative abundance and large size.

Figure 6. Material of *Parmelia sulcata*, an abundant lichen in the Fort McMurray region, was collected for future biochemical analysis.

Figure 7. *Peltigera apthosa* occurs frequently on the forest floor in the Fort McMurray region and was collected for future biochemical analysis.

Figure 8. *Pleurozium schreberi* is one of the most widespread mosses in the region and was collected for future biochemical analysis.

RESULTS

Quadrat Data

Table 1. Percent cover of Parmelia sulcata and Hypogymnia physodes in Plot 1.

Quadrat #	Lichen Species	Tree Species	Percent Cover
1	Parmelia sulcata	Black Spruce	3.09%
2	Parmelia sulcata	Black Spruce	8.34%
3	Hypogymnia physodes	Black Spruce	1.85%
4	Parmelia sulcata	Black Spruce	2.50%
5	Parmelia sulcata	Black Spruce	4.60%
6	Parmelia sulcata	Black Spruce	8.80%
7	Parmelia sulcata	Black Spruce	3.68%
8	Parmelia sulcata	Black Spruce	1.85%
9	Parmelia sulcata	Black Spruce	1.15%
10	Parmelia sulcata	Black Spruce	2.31%
11	Parmelia sulcata	Black Spruce	7.76%
12	Parmelia sulcata	Black Spruce	2.73%
13	Parmelia sulcata	Larch	11.15%
14	Parmelia sulcata	Larch	8.05%
15	Parmelia sulcata	Black Spruce	9.33%
16	Parmelia sulcata	Black Spruce	7.45%
17	Hypogymnia physodes	Black Spruce	9.18%
18	Parmelia sulcata	Larch	6.92%
19	Parmelia sulcata	Aspen	7.33%
20	Parmelia sulcata	Black Spruce	12.79%

Table 2. Percent cover of Parmelia sulcata and Hypogymnia physodes in Plot 2.

Quadrat #	Lichen Species	Tree Species	Percent Cover
1	Parmelia sulcata	Balsam Poplar	2.72%
2	Parmelia sulcata	Black Spruce	1.80%
3	Parmelia sulcata	Black Spruce	3.75%
4	Parmelia sulcata	Black Spruce	2.12%
5	Parmelia sulcata	Black Spruce	0.89%
6	Parmelia sulcata	Black Spruce	1.00%
7	Hypogymnia physodes	Black Spruce	2.93%
8	Parmelia sulcata	Black Spruce	1.53%
9	Parmelia sulcata	Black Spruce	0.91%
10	Parmelia sulcata	Black Spruce	0.89%
11	Parmelia sulcata	Black Spruce	11.03%
12	Parmelia sulcata	Black Spruce	2.99%
13	Parmelia sulcata	Black Spruce	12.52%
14	Parmelia sulcata	Black Spruce	4.86%
15	Parmelia sulcata	Black Spruce	4.49%
16	Parmelia sulcata	Black Spruce	4.21%
17	Parmelia sulcata	Balsam Poplar	2.85%
18	Parmelia sulcata	Black Spruce	4.37%
19	Parmelia sulcata	Black Spruce	5.76%
20	Hypogymnia physodes	Black Spruce	3.54%

Table 3. Percent cover of Parmelia sulcata in Plot 3.

Quadrat #	Lichen Species	Tree Species	Percent Cover
1	Parmelia sulcata	Black Spruce	4.50%
2	Parmelia sulcata	Black Spruce	0.21%
3	Parmelia sulcata	Black Spruce	3.09%
4	Parmelia sulcata	Black Spruce	1.79%
5	Parmelia sulcata	Black Spruce	2.34%
6	Parmelia sulcata	Black Spruce	1.13%
7	Parmelia sulcata	Black Spruce	1.67%
8	Parmelia sulcata	Black Spruce	1.3 %
9	Parmelia sulcata	Black Spruce	1.2 %
10	Parmelia sulcata	Black Spruce	4.7 %
11	Parmelia sulcata	Aspen	3.0 %
12	Parmelia sulcata	Black Spruce	3.0 %
13	Parmelia sulcata	Black Spruce	1.9 %
14	Parmelia sulcata	Black Spruce	2.0 %
15	Parmelia sulcata	Black Spruce	3.6 %
16	Parmelia sulcata	Black Spruce	5.3 %
17	Parmelia sulcata	Black Spruce	4.04%
18	Parmelia sulcata	Black Spruce	8.7 %
19	Parmelia sulcata	Black Spruce	3.89%
20	Parmelia sulcata	Black Spruce	1.56%

Table 4. Percent cover of Parmelia sulcata and Hypogymnia physodes in Plot 4.

Quadrat #	Lichen Species	Tree Species	Percent Cover
1	Parmelia sulcata	White Spruce	6.07%
2	Parmelia sulcata	White Spruce	2.94%
3	Parmelia sulcata	White Spruce	3.90%
4	Parmelia sulcata	White Spruce	2.28%
5	Hypogymnia physodes	Jack Pine	0.55%
6	Hypogymnia physodes	White Spruce	6.35%
7	Hypogymnia physodes	White Spruce	9.85%
8	Hypogymnia physodes	White Spruce	6.44%
9	Hypogymnia physodes	White Spruce	3.55%
10	Hypogymnia physodes	White Spruce	3.92%
11	Hypogymnia physodes	White Spruce	8.95%
12	Hypogymnia physodes	White Spruce	3.10%
13	Hypogymnia physodes	White Spruce	10.73%
14	Hypogymnia physodes	White Spruce	15.01%
15	Hypogymnia physodes	White Spruce	0.88%
16	Hypogymnia physodes	White Spruce	4.87%
17	Hypogymnia physodes	White Spruce	1.90%
18	Hypogymnia physodes	White Spruce	3.56%
19	Hypogymnia physodes	White Spruce	2.50%
20	Hypogymnia physodes	White Spruce	2.55%

Table 5. Percent cover of Parmelia sulcata in Plot 5.

Quadrat #	Lichen Species	Tree Species	Percent Cover
1	Parmelia sulcata	White Spruce	1.64%
2	Parmelia sulcata	White Spruce	8.99%
3	Parmelia sulcata	White Spruce	4.97%
4	Parmelia sulcata	White Spruce	4.03%
5	Parmelia sulcata	White Spruce	5.33%
6	Parmelia sulcata	White Spruce	1.03%
7	Parmelia sulcata	White Spruce	8.99%
8	Parmelia sulcata	White Spruce	1.58%
9	Parmelia sulcata	White Spruce	3.98%
10	Parmelia sulcata	White Spruce	2.93%
11	Parmelia sulcata	White Spruce	2.80%
12	Parmelia sulcata	White Spruce	2.47%
13	Parmelia sulcata	White Spruce	6.56%
14	Parmelia sulcata	White Spruce	2.72%
15	Parmelia sulcata	White Spruce	2.51%
16	Parmelia sulcata	White Spruce	2.20%
17	Parmelia sulcata	White Spruce	7.88%
18	Parmelia sulcata	White Spruce	2.60%
19	Parmelia sulcata	White Spruce	4.35%
20	Parmelia sulcata	White Spruce	3.02%

Table 6. Percent cover of Parmelia sulcata and Physica adscendes in Plot 6.

Quadrat #	Lichen Species	Tree Species	Percent Cover
1	Parmelia sulcata	White Spruce	2.73%
2	Parmelia sulcata	Balsam Fir	4.05%
3	Parmelia sulcata	White Spruce	2.69%
4	Parmelia sulcata	Aspen	2.75%
5	Parmelia sulcata	White Spruce	4.93%
6	Parmelia sulcata	Aspen	2.14%
7	Parmelia sulcata	White Spruce	1.23%
8	Parmelia sulcata	White Spruce	5.22%
9	Parmelia sulcata	White Spruce	4.64%
10	Parmelia sulcata	Balsam Fir	7.16%
11	Parmelia sulcata	White Spruce	0.59%
12	Parmelia sulcata	White Spruce	5.32%
13	Parmelia sulcata	White Spruce	3.05%
14	Parmelia sulcata	White Spruce	0.91%
15	Parmelia sulcata	White Spruce	2.73%
16	Physica adscendes	Aspen	2.82%
17	Parmelia sulcata	White Spruce	1.23%
18	Parmelia sulcata	White Spruce	3.21%
19	Parmelia sulcata	White Spruce	1.68%
20	Parmelia sulcata	White Spruce	2.72%

Table 7. Percent cover of Parmelia sulcata in Plot 7.

Quadrat #	Lichen Species	Tree Species	Percent Cover
1	Parmelia sulcata	White Spruce	4.97%
2	Parmelia sulcata	White Spruce	4.50%
3	Parmelia sulcata	White Spruce	2.41%
4	Parmelia sulcata	White Spruce	4.39%
5	Parmelia sulcata	White Spruce	3.08%
6	Parmelia sulcata	White Spruce	2.51%
7	Parmelia sulcata	White Spruce	3.87%
8	Parmelia sulcata	White Spruce	7.02%
9	Parmelia sulcata	White Spruce	3.51%
10	Parmelia sulcata	White Spruce	8.39%
11	Parmelia sulcata	White Spruce	4.18%
12	Parmelia sulcata	White Spruce	4.01%
13	Parmelia sulcata	White Spruce	5.25%
14	Parmelia sulcata	White Spruce	1.11%
15	Parmelia sulcata	White Spruce	2.28%
16	Parmelia sulcata	White Spruce	3.70%
17	Parmelia sulcata	White Spruce	2.77%
18	Parmelia sulcata	White Spruce	2.76%
19	Parmelia sulcata	White Spruce	4.18%
20	Parmelia sulcata	White Spruce	4.32%

Table 8. Percent cover of Parmelia sulcata in Plot 8.

Quadrat #	Lichen Species	Tree Species	Percent Cover
1	Parmelia sulcata	Black Spruce	4.46%
2	Parmelia sulcata	Black Spruce	3.13%
3	Parmelia sulcata	Black Spruce	6.96%
4	Parmelia sulcata	Black Spruce	5.95%
5	Parmelia sulcata	Larch	2.00%
6	Parmelia sulcata	Black Spruce	7.74%
7	Parmelia sulcata	Larch	4.04%
8	Parmelia sulcata	Larch	2.89%
9	Parmelia sulcata	Black Spruce	3.41%
10	Parmelia sulcata	Black Spruce	6.58%
11	Parmelia sulcata	Black Spruce	3.00%
12	Parmelia sulcata	Black Spruce	2.24%
13	Parmelia sulcata	Black Spruce	2.16%
14	Parmelia sulcata	Black Spruce	3.17%
15	Parmelia sulcata	Larch	7.77%
16	Parmelia sulcata	Black Spruce	8.06%
17	Parmelia sulcata	Black Spruce	4.86%
18	Parmelia sulcata	Black Spruce	1.79%
19	Parmelia sulcata	Black Spruce	8.47%
20	Parmelia sulcata	Black Spruce	4.00%

Table 9. Percent cover of Parmelia sulcata in Plot 9.

Quadrat #	Lichen Species	Tree Species	Percent Cover
1	Parmelia sulcata	Black Spruce	4.94%
2	Parmelia sulcata	Black Spruce	7.41%
3	Parmelia sulcata	Black Spruce	4.44%
4	Parmelia sulcata	Black Spruce	3.57%
5	Parmelia sulcata	Black Spruce	4.31%
6	Parmelia sulcata	Black Spruce	6.30%
7	Parmelia sulcata	Black Spruce	3.42%
8	Parmelia sulcata	Black Spruce	5.38%
9	Parmelia sulcata	Black Spruce	1.51%
10	Parmelia sulcata	Black Spruce	3.99%
11	Parmelia sulcata	Black Spruce	3.09%
12	Parmelia sulcata	Black Spruce	0.76%
13	Parmelia sulcata	Black Spruce	6.05%
14	Parmelia sulcata	Black Spruce	4.09%
15	Parmelia sulcata	Black Spruce	2.67%
16	Parmelia sulcata	Black Spruce	1.56%
17	Parmelia sulcata	Black Spruce	5.27%
18	Parmelia sulcata	Black Spruce	3.97%
19	Parmelia sulcata	Black Spruce	3.08%
20	Parmelia sulcata	Black Spruce	3.23%

Table 10. Percent cover of Parmelia sulcata in Plot 10.

Quadrat #	Lichen Species	Tree Species	Percent Cover
1	Parmelia sulcata	White Spruce	6.98%
2	Parmelia sulcata	White Spruce	4.64%
3	Parmelia sulcata	White Spruce	4.41%
4	Parmelia sulcata	White Spruce	5.55%
5	Parmelia sulcata	White Spruce	5.88%
6	Parmelia sulcata	White Spruce	3.85%
7	Parmelia sulcata	White Spruce	4.69%
8	Parmelia sulcata	White Spruce	1.83%
9	Parmelia sulcata	White Spruce	3.08%
10	Parmelia sulcata	White Spruce	4.97%
11	Parmelia sulcata	White Spruce	10.14%
12	Parmelia sulcata	White Spruce	2.56%
13	Parmelia sulcata	White Spruce	2.94%
14	Parmelia sulcata	White Spruce	5.63%
15	Parmelia sulcata	White Spruce	2.05%
16	Parmelia sulcata	White Spruce	6.98%
17	Parmelia sulcata	White Spruce	7.19%
18	Parmelia sulcata	White Spruce	4.66%
19	Parmelia sulcata	White Spruce	8.29%
20	Parmelia sulcata	White Spruce	2.64%

Table 11. Percent cover of Parmelia sulcata in Plot 11.

Quadrat #	Lichen Species	Tree Species	Percent Cover
1	Parmelia sulcata	White Spruce	6.83%
2	Parmelia sulcata	White Spruce	3.29%
3	Parmelia sulcata	White Spruce	2.08%
4	Parmelia sulcata	White Spruce	6.30%
5	Parmelia sulcata	White Spruce	5.15%
6	Parmelia sulcata	White Spruce	2.56%
7	Parmelia sulcata	White Spruce	6.58%
8.	Parmelia sulcata	White Spruce	----
9	Parmelia sulcata	White Spruce	3.68%
10	Parmelia sulcata	White Spruce	2.27%
11	Parmelia sulcata	White Spruce	5.19%
12	Parmelia sulcata	White Spruce	5.49%
13	Parmelia sulcata	White Spruce	3.54%
14	Parmelia sulcata	White Spruce	6.71%
15	Parmelia sulcata	White Spruce	5.64%
16	Parmelia sulcata	White Spruce	4.44%
17	Parmelia sulcata	White Spruce	2.47%
18	Parmelia sulcata	White Spruce	9.82%
19	Parmelia sulcata	White Spruce	4.95%
20	Parmelia sulcata	White Spruce	5.94%

Table 12. Percent cover of Parmelia sulcata in Plot 12.

Quadrat #	Lichen Species	Tree Species	Percent Cover
1	Parmelia sulcata	White Spruce	4.94%
2	Parmelia sulcata	White Spruce	2.83%
3	Parmelia sulcata	White Spruce	3.39%
4	Parmelia sulcata	White Spruce	4.45%
5	Parmelia sulcata	White Spruce	3.91%
6	Parmelia sulcata	White Spruce	2.94%
7	Parmelia sulcata	White Spruce	3.13%
8	Parmelia sulcata	White Spruce	8.11%
9	Parmelia sulcata	White Spruce	5.28%
10	Parmelia sulcata	White Spruce	4.58%
11	Parmelia sulcata	White Spruce	3.79%
12	Parmelia sulcata	White Spruce	3.74%
13	Parmelia sulcata	White Spruce	3.17%
14	Parmelia sulcata	White Spruce	7.29%
15	Parmelia sulcata	White Spruce	4.72%
16	Parmelia sulcata	White Spruce	9.51%
17	Parmelia sulcata	White Spruce	3.58%
18	Parmelia sulcata	White Spruce	3.90%
19	Parmelia sulcata	White Spruce	1.40%
20	Parmelia sulcata	White Spruce	1.18%

Table 13. Percent cover of Parmelia sulcata in Plot 13.

Quadrat #	Lichen Species	Tree Species	Percent Cover
1	Parmelia sulcata	Balsam Fir	5.75%
2	Parmelia sulcata	Balsam Fir	3.54%
3	Parmelia sulcata	Balsam Fir	4.38%
4	Parmelia sulcata	Balsam Fir	4.28%
5	Parmelia sulcata	Balsam Fir	3.24%
6	Parmelia sulcata	Balsam Fir	7.91%
7	Parmelia sulcata	Balsam Fir	2.41%
8	Parmelia sulcata	Balsam Fir	8.70%
9	Parmelia sulcata	Balsam Fir	4.84%
10	Parmelia sulcata	White Spruce	4.01%
11	Parmelia sulcata	Balsam Fir	3.67%
12	Parmelia sulcata	Balsam Fir	5.80%
13	Parmelia sulcata	Balsam Fir	1.12%
14	Parmelia sulcata	Balsam Fir	3.05%
15	Parmelia sulcata	Balsam Fir	5.37%
16	Parmelia sulcata	Balsam Fir	7.93%
17	Parmelia sulcata	Balsam Fir	2.50%
18	Parmelia sulcata	Balsam Fir	4.60%
19	Parmelia sulcata	Balsam Fir	2.47%
20	Parmelia sulcata	Balsam Fir	6.99%

Table 14. Percent cover of Parmelia sulcata in Plot 14.

Quadrat #	Lichen Species	Tree Species	Percent Cover
1	Parmelia sulcata	Black Spruce	7.65%
2	Parmelia sulcata	Black Spruce	3.41%
3	Parmelia sulcata	Black Spruce	4.19%
4	Parmelia sulcata	Black Spruce	8.14%
5	Parmelia sulcata	Black Spruce	6.22%
6	Parmelia sulcata	Black Spruce	13.82%
7	Parmelia sulcata	Birch	15.00%
8	Parmelia sulcata	Black Spruce	7.56%
9	Parmelia sulcata	Black Spruce	12.65%
10	Parmelia sulcata	Black Spruce	16.75%
11	Parmelia sulcata	Birch	11.11%
12	Parmelia sulcata	Black Spruce	5.25%
13	Parmelia sulcata	Black Spruce	6.31%
14	Parmelia sulcata	Black Spruce	5.07%
15	Parmelia sulcata	Black Spruce	6.00%
16	Parmelia sulcata	Black Spruce	8.54%
17	Parmelia sulcata	Black Spruce	3.26%
18	Parmelia sulcata	Black Spruce	5.87%
19	Parmelia sulcata	Black Spruce	5.32%
20	Parmelia sulcata	Birch	9.56%

Table 15. Percent cover of Parmelia sulcata and Hypogymnia physodes in Plot 15.

Quadrat #	Lichen Species	Tree Species	Percent Cover
1	Parmelia sulcata	Black Spruce	1.39%
2	Hypogymnia physodes	Black Spruce	1.07%
3	Parmelia sulcata	Black Spruce	2.25%
4	Parmelia sulcata	Black Spruce	2.20%
5	Parmelia sulcata	Black Spruce	1.34%
6	Parmelia sulcata	Black Spruce	2.99%
7	Hypogymnia physodes	Black Spruce	2.71%
8	Parmelia sulcata	Black Spruce	0.92%
9	Hypogymnia physodes	Black Spruce	3.07%
10	Parmelia sulcata	Black Spruce	1.82%
11	Parmelia sulcata	Black Spruce	12.80%
12	Parmelia sulcata	Black Spruce	1.58%
13	Parmelia sulcata	Black Spruce	0.75%
14	Parmelia sulcata	Black Spruce	0.96%
15	Parmelia sulcata	Black Spruce	3.28%
16	Parmelia sulcata	Black Spruce	1.50%
17	Parmelia sulcata	Black Spruce	3.72%
18	Parmelia sulcata	Black Spruce	1.68%
19	Parmelia sulcata	Larch	3.32%
20	Parmelia sulcata	Black Spruce	5.83%

Table 16. Percent cover of Parmelia sulcata and Hypogymnia physodes in Plot 16.

Quadrat #	Lichen Species	Tree Species	Percent Cover
1	Parmelia sulcata	Larch	3.85%
2	Parmelia sulcata	Black Spruce	0.97%
3	Parmelia sulcata	Black Spruce	0.48%
4	Parmelia sulcata	Black Spruce	3.23%
5	Parmelia sulcata	Black Spruce	2.99%
6	Hypogymnia physodes	Black Spruce	2.02%
7	Parmelia sulcata	Black Spruce	4.10%
8	Parmelia sulcata	Black Spruce	3.69%
9	Hypogymnia physodes	Black Spruce	0.96%
10	Hypogymnia physodes	Larch	3.31%
11	Parmelia sulcata	Larch	5.53%
12	Parmelia sulcata	Black Spruce	4.30%
13	Hypogymnia physodes	Black Spruce	1.91%
14	Parmelia sulcata	Larch	4.53%
15	Parmelia sulcata	Black Spruce	2.85%
16	Parmelia sulcata	Black Spruce	2.90%
17	Parmelia sulcata	Black Spruce	3.97%
18	Parmelia sulcata	Black Spruce	5.84%
19	Hypogymnia physodes	Black Spruce	2.19%
20	Parmelia sulcata	Black Spruce	4.50%

Table 17. Percent cover of Parmelia sulcata in Plot 17.

Quadrat #	Lichen Species	Tree Species	Percent Cover
1	Parmelia sulcata	White Spruce	4.13%
2	Parmelia sulcata	White Spruce	4.67%
3	Parmelia sulcata	White Spruce	3.48%
4	Parmelia sulcata	White Spruce	5.03%
5	Parmelia sulcata	White Spruce	4.77%
6	Parmelia sulcata	White Spruce	3.97%
7	Parmelia sulcata	White Spruce	4.57%
8	Parmelia sulcata	White Spruce	4.01%
9	Parmelia sulcata	White Spruce	2.13%
10	Parmelia sulcata	White Spruce	6.18%
11	Parmelia sulcata	Larch	9.40%
12	Parmelia sulcata	White Spruce	1.76%
13	Parmelia sulcata	White Spruce	4.17%
14	Parmelia sulcata	White Spruce	1.48%
15	Parmelia sulcata	White Spruce	4.81%
16	Parmelia sulcata	White Spruce	2.42%
17	Parmelia sulcata	White Spruce	2.48%
18	Parmelia sulcata	White Spruce	3.19%
19	Parmelia sulcata	White Spruce	3.03%
20	Parmelia sulcata	White Spruce	1.73%

Table 18. Percent cover of Parmelia sulcata in Plot 18.

Quadrat #	Lichen Species	Tree Species	Percent Cover
1	Parmelia sulcata	Black Spruce	3.89%
2	Parmelia sulcata	Black Spruce	6.04%
3	Parmelia sulcata	Black Spruce	3.23%
4	Parmelia sulcata	Black Spruce	7.47%
5	Parmelia sulcata	Black Spruce	3.02%
6	Parmelia sulcata	Larch	4.13%
7	Parmelia sulcata	Larch	3.14%
8	Parmelia sulcata	Black Spruce	6.38%
9	Parmelia sulcata	Black Spruce	3.94%
10	Parmelia sulcata	Larch	4.50%
11	Parmelia sulcata	Black Spruce	5.81%
12	Parmelia sulcata	Black Spruce	1.55%
13	Parmelia sulcata	Black Spruce	8.92%
14	Parmelia sulcata	Black Spruce	6.61%
15	Parmelia sulcata	Black Spruce	6.11%
16	Parmelia sulcata	Black Spruce	3.70%
17	Parmelia sulcata	Larch	4.97%
18	Parmelia sulcata	Black Spruce	1.33%
19	Parmelia sulcata	Black Spruce	5.02%
20	Parmelia sulcata	Black Spruce	3.84%

Table 19. Percent cover of Parmelia sulcata and Hypogymnia physodes in Plot 19.

Quadrat #	Lichen Species	Tree Species	Percent Cover
1	Parmelia sulcata	Black Spruce	8.12%
2	Parmelia sulcata	Black Spruce	8.12%
3	Parmelia sulcata	Black Spruce	1.15%
4	Parmelia sulcata	Black Spruce	8.42%
5	Parmelia sulcata	Black Spruce	2.68%
6	Parmelia sulcata	Black Spruce	1.80%
7	Parmelia sulcata	Black Spruce	7.71%
8	Parmelia sulcata	Black Spruce	1.69%
9	Parmelia sulcata	Black Spruce	1.40%
10	Parmelia sulcata	Black Spruce	5.83%
11	Parmelia sulcata	Black Spruce	1.07%
12	Parmelia sulcata	Black Spruce	1.75%
13	Parmelia sulcata	Black Spruce	2.65%
14	Parmelia sulcata	Black Spruce	9.61%
15	Parmelia sulcata	Black Spruce	2.14%
16	Hypogymnia physodes	Black Spruce	2.12%
17	Parmelia sulcata	Black Spruce	8.45%
18	Parmelia sulcata	Black Spruce	4.04%
19	Parmelia sulcata	Black Spruce	2.45%
20	Parmelia sulcata	Black Spruce	6.42%

Table 20. Percent cover of Parmelia sulcata in Plot 20.

Quadrat #	Lichen Species	Tree Species	Percent Cover
1	Parmelia sulcata	White Spruce	9.80%
2	Parmelia sulcata	White Spruce	4.84%
3	Parmelia sulcata	White Spruce	1.24%
4	Parmelia sulcata	White Spruce	8.76%
5	Parmelia sulcata	White Spruce	2.89%
6	Parmelia sulcata	White Spruce	3.73%
7	Parmelia sulcata	White Spruce	1.09%
8	Parmelia sulcata	White Spruce	3.53%
9	Parmelia sulcata	White Spruce	5.54%
10	Parmelia sulcata	White Spruce	2.06%
11	Parmelia sulcata	White Spruce	5.68%
12	Parmelia sulcata	White Spruce	1.51%
13	Parmelia sulcata	Balsam Poplar	5.77%
14	Parmelia sulcata	Balsam Poplar	7.46%
15	Parmelia sulcata	White Spruce	6.11%
16	Parmelia sulcata	White Spruce	5.79%
17	Parmelia sulcata	White Spruce	2.99%
18	Parmelia sulcata	White Spruce	4.16%
19	Parmelia sulcata	White Spruce	6.51%
20	Parmelia sulcata	White Spruce	5.75%

Table 21. Percent cover of Parmelia sulcata and Hypogymnia physodes in Plot 21.

Quadrat #	Lichen Species	Tree Species	Percent Cover
1	Parmelia sulcata	White Spruce	5.67%
2	Parmelia sulcata	White Spruce	1.78%
3	Parmelia sulcata	White Spruce	3.35%
4	Parmelia sulcata	White Spruce	3.90%
5	Parmelia sulcata	White Spruce	1.00%
6	Parmelia sulcata	White Spruce	2.63%
7	Parmelia sulcata	White Spruce	5.10%
8	Parmelia sulcata	White Spruce	5.54%
9	Parmelia sulcata	White Spruce	1.99%
10	Parmelia sulcata	White Spruce	1.95%
11	Parmelia sulcata	White Spruce	12.89%
12	Hypogymnia physodes	White Spruce	3.01%
13	Parmelia sulcata	White Spruce	4.01%
14	Parmelia sulcata	White Spruce	2.32%
15	Parmelia sulcata	White Spruce	2.50%
16	Parmelia sulcata	White Spruce	3.70%
17	Parmelia sulcata	White Spruce	2.62%
18	Hypogymnia physodes	White Spruce	5.22%
19	Parmelia sulcata	White Spruce	1.99%
20	Parmelia sulcata	White Spruce	3.70%

Table 22. Percent cover of Parmelia sulcata in Plot 22.

Quadrat #	Lichen Species	Tree Species	Percent Cover
1	Parmelia sulcata	Black Spruce	6.48%
2	Parmelia sulcata	Black Spruce	0.66%
3	Parmelia sulcata	Black Spruce	8.16%
4	Parmelia sulcata	Black Spruce	1.18%
5	Parmelia sulcata	Black Spruce	5.99%
6	Parmelia sulcata	Black Spruce	1.52%
7	Parmelia sulcata	Black Spruce	1.64%
8	Parmelia sulcata	Black Spruce	12.12%
9	Parmelia sulcata	Black Spruce	1.12%
10	Parmelia sulcata	Black Spruce	2.18%
11	Parmelia sulcata	Black Spruce	2.41%
12	Parmelia sulcata	Black Spruce	1.02%
13	Parmelia sulcata	Black Spruce	3.27%
14	Parmelia sulcata	Black Spruce	4.75%
15	Parmelia sulcata	Black Spruce	2.91%
16	Parmelia sulcata	Black Spruce	2.75%
17	Parmelia sulcata	Black Spruce	5.94%
18	Parmelia sulcata	Black Spruce	5.40%
19	Parmelia sulcata	Black Spruce	1.56%
20	Parmelia sulcata	Black Spruce	1.79%

Table 23. Percent cover of Parmelia sulcata in Plot 23.

Quadrat #	Lichen Species	Tree Species	Percent Cover
1	Parmelia sulcata	White Spruce	7.26%
2	Parmelia sulcata	White Spruce	4.03%
3	Parmelia sulcata	White Spruce	3.18%
4	Parmelia sulcata	White Spruce	1.42%
5	Parmelia sulcata	White Spruce	2.75%
6	Parmelia sulcata	White Spruce	5.69%
7	Parmelia sulcata	White Spruce	8.24%
8	Parmelia sulcata	White Spruce	0.75%
9	Parmelia sulcata	White Spruce	1.06%
10	Parmelia sulcata	White Spruce	1.85%
11	Parmelia sulcata	White Spruce	1.83%
12	Parmelia sulcata	White Spruce	3.70%
13	Parmelia sulcata	White Spruce	4.97%
14	Parmelia sulcata	White Spruce	8.46%
15	Parmelia sulcata	White Spruce	4.62%
16	Parmelia sulcata	White Spruce	6.61%
17	Parmelia sulcata	White Spruce	8.58%
18	Parmelia sulcata	White Spruce	6.73%
19	Parmelia sulcata	White Spruce	1.91%
20	Parmelia sulcata	White Spruce	3.32%

Table 24. Percent cover of Parmelia sulcata and Hypogymnia physodes in Plot 24.

Quadrat #	Lichen Species	Tree Species	Percent Cover
1	Parmelia sulcata	Larch	1.52%
2	Parmelia sulcata	Larch	4.17%
3	Parmelia sulcata	Larch	3.21%
4	Parmelia sulcata	Black Spruce	2.08%
5	Parmelia sulcata	Black Spruce	6.77%
6	Parmelia sulcata	Larch	4.41%
7	Parmelia sulcata	Black Spruce	4.66%
8	Parmelia sulcata	Larch	6.76%
9	Parmelia sulcata	Larch	5.84%
10	Parmelia sulcata	Black Spruce	6.20%
11	Parmelia sulcata	Black Spruce	3.05%
12	Parmelia sulcata	Black Spruce	11.42%
13	Parmelia sulcata	Black Spruce	2.49%
14	Hypogymnia physodes	Black Spruce	2.07%
15	Parmelia sulcata	Black Spruce	1.58%
16	Parmelia sulcata	Larch	3.19%
17	Parmelia sulcata	Larch	8.84%
18	Parmelia sulcata	Black Spruce	7.83%
19	Hypogymnia physodes	Black Spruce	1.07%
20	Hypogynmia physodes	Black Spruce	3.07%

Table 25. Percent cover of Parmelia sulcata and Hypogymnia physodes in Plot 25.

Quadrat #	Lichen Species	Tree Species	Percent Cover
1	Parmelia sulcata	White Spruce	3.63%
2	Parmelia sulcata	White Spruce	8.76%
3	Parmelia sulcata	White Spruce	3.75%
4	Parmelia sulcata	White Spruce	6.01%
5	Hypogymnia physodes	White Spruce	5.96%
6	Parmelia sulcata	White Spruce	1.86%
7	Parmelia sulcata	White Spruce	6.46%
8	Parmelia sulcata	White Spruce	8.72%
9	Parmelia sulcata	White Spruce	12.11%
10	Parmelia sulcata	White Spruce	4.32%
11	Parmelia sulcata	White Spruce	10.19%
12	Parmelia sulcata	White Spruce	4.07%
13	Parmelia sulcata	White Spruce	9.43%
14	Parmelia sulcata	White Spruce	3.27%
15	Parmelia sulcata	White Spruce	11.50%
16	Parmelia sulcata	White Spruce	4.05%
17	Parmelia sulcata	White Spruce	5.83%
18	Parmelia sulcata	White Spruce	2.05%
19	Parmelia sulcata	White Spruce	2.50%
20	Parmelia sulcata	White Spruce	7.99%

Table 26. Percent cover of Parmelia sulcata in Plot 26.

Quadrat #	Lichen Species	Tree Species	Percent Cover
1	Parmelia sulcata	White Spruce	2.42%
2	Parmelia sulcata	White Spruce	5.15%
3	Parmelia sulcata	White Spruce	6.13%
4	Parmelia sulcata	White Spruce	4.79%
5	Parmelia sulcata	White Spruce	2.69%
6	Parmelia sulcata	White Spruce	5.12%
7	Parmelia sulcata	White Spruce	13.98%
8	Parmelia sulcata	White Spruce	10.61%
9	Parmelia sulcata	White Spruce	4.79%
10	Parmelia sulcata	White Spruce	2.50%
11	Parmelia sulcata	White Spruce	2.52%
12	Parmelia sulcata	White Spruce	1.54%
13	Parmelia sulcata	White Spruce	2.51%
14	Parmelia sulcata	White Spruce	3.13%
15	Parmelia sulcata	White Spruce	2.36%
16	Parmelia sulcata	White Spruce	4.67%
17	Parmelia sulcata	White Spruce	2.02%
18	Parmelia sulcata	White Spruce	5.40%
19	Parmelia sulcata	White Spruce	5.68%
20	Parmelia sulcata	White Spruce	2.67%

Table 27. Percent cover of Parmelia sulcata in Plot 27.

Quadrat #	Lichen Species	Tree Species	Percent Cover
1	Parmelia sulcata	White Spruce	4.45%
2	Parmelia sulcata	White Spruce	1.56%
3	Parmelia sulcata	White Spruce	4.69%
4	Parmelia sulcata	White Spruce	1.52%
5	Parmelia sulcata	White Spruce	4.33%
6	Parmelia sulcata	White Spruce	2.54%
7	Parmelia sulcata	White Spruce	1.33%
8	Parmelia sulcata	White Spruce	6.01%
9	Parmelia sulcata	White Spruce	5.00%
10	Parmelia sulcata	White Spruce	0.8 %
11	Parmelia sulcata	White Spruce	1.42%
12	Parmelia sulcata	White Spruce	3.65%
13	Parmelia sulcata	White Spruce	3.90%
14	Parmelia sulcata	White Spruce	10.72%
15	Parmelia sulcata	White Spruce	3.11%
16	Parmelia sulcata	White Spruce	2.01%
17	Parmelia sulcata	White Spruce	1.62%
18	Parmelia sulcata	White Spruce	4.08%
19	Parmelia sulcata	White Spruce	5.43%
20	Parmelia sulcata	White Spruce	4.66%

Table 28. Percent cover of Parmelia sulcata in Plot 28.

Quadrat #	Lichen Species	Tree Species	Percent Cover
1	Parmelia sulcata	White Spruce	4.32%
2	Parmelia sulcata	White Spruce	3.32%
3	Parmelia sulcata	White Spruce	6.55%
4	Parmelia sulcata	White Spruce	4.87%
5	Parmelia sulcata	White Spruce	4.20%
6	Parmelia sulcata	White Spruce	3.51%
7	Parmelia sulcata	White Spruce	4.24%
8	Parmelia sulcata	White Spruce	2.33%
9	Parmelia sulcata	White Spruce	2.22%
10	Parmelia sulcata	White Spruce	9.14%
11	Parmelia sulcata	White Spruce	2.45%
12	Parmelia sulcata	White Spruce	8.69%
13	Parmelia sulcata	White Spruce	3.98%
14	Parmelia sulcata	White Spruce	6.20%
15	Parmelia sulcata	White Spruce	4.01%
16	Parmelia sulcata	White Spruce	5.52%
17	Parmelia sulcata	White Spruce	1.23%
18	Parmelia sulcata	White Spruce	4.75%
19	Parmelia sulcata	White Spruce	1.61%
20	Parmelia sulcata	White Spruce	5.25%

Table 29. Percent cover of Parmelia sulcata in Plot 29.

Quadrat #	Lichen Species	Tree Species	Percent Cover
1	Parmelia sulcata	White Spruce	1.15%
2	Parmelia sulcata	White Spruce	1.94%
3	Parmelia sulcata	White Spruce	2.50%
4	Parmelia sulcata	White Spruce	6.83%
5	Parmelia sulcata	White Spruce	3.39%
6	Parmelia sulcata	White Spruce	1.01%
7	Parmelia sulcata	White Spruce	2.11%
8	Parmelia sulcata	White Spruce	4.66%
9	Parmelia sulcata	White Spruce	2.33%
10	Parmelia sulcata	White Spruce	3.60%
11	Parmelia sulcata	White Spruce	2.63%
12	Parmelia sulcata	White Spruce	1.34%
13	Parmelia sulcata	White Spruce	2.14%
14	Parmelia sulcata	White Spruce	1.30%
15	Parmelia sulcata	White Spruce	5.43%
16	Parmelia sulcata	White Spruce	3.78%
17	Parmelia sulcata	White Spruce	1.24%
18	Parmelia sulcata	White Spruce	3.91%
19	Parmelia sulcata	White Spruce	4.06%
20	Parmelia sulcata	White Spruce	7.96%

Table 30. Percent cover of Parmelia sulcata in Plot 30.

Quadrat #	Lichen Species	Tree Species	Percent Cover
1	Parmelia sulcata	White Spruce	7.89%
2	Parmelia sulcata	White Spruce	4.15%
3	Parmelia sulcata	White Spruce	10.09%
4	Parmelia sulcata	White Spruce	8.33%
5	Parmelia sulcata	White Spruce	6.38%
6	Parmelia sulcata	White Spruce	5.78%
7	Parmelia sulcata	White Spruce	5.41%
8	Parmelia sulcata	White Spruce	12.08%
9	Parmelia sulcata	White Spruce	5.67%
10	Parmelia sulcata	White Spruce	2.83%
11	Parmelia sulcata	White Spruce	2.78%
12	Parmelia sulcata	White Spruce	5.90%
13	Parmelia sulcata	White Spruce	27.12%
14	Parmelia sulcata	White Spruce	6.40%
15	Parmelia sulcata	White Spruce	4.27%
16	Parmelia sulcata	White Spruce	6.09%
17	Parmelia sulcata	White Spruce	16.62%
18	Parmelia sulcata	White Spruce	5.76%
19	Parmelia sulcata	White Spruce	12.76%
20	Parmelia sulcata	White Spruce	6.87%

Table 31. Percent cover of Parmelia sulcata in Plot 31.

Quadrat #	Lichen Species	Tree Species	Percent Cover
1	Parmelia sulcata	White Spruce	3.19%
2	Parmelia sulcata	White Spruce	1.79%
3	Parmelia sulcata	White Spruce	2.38%
4	Parmelia sulcata	White Spruce	8.89%
5	Parmelia sulcata	White Spruce	2.52%
6	Parmelia sulcata	White Spruce	1.11%
7	Parmelia sulcata	White Spruce	1.74%
8	Parmelia sulcata	White Spruce	0.72%
9	Parmelia sulcata	White Spruce	3.25%
10	Parmelia sulcata	Balsam Fir	10.55%
11	Parmelia sulcata	Balsam Fir	11.25%
12	Parmelia sulcata	White Spruce	0.87%
13	Parmelia sulcata	Balsam Fir	1.43%
14	Parmelia sulcata	White Spruce	1.64%
15	Parmelia sulcata	Balsam Fir	5.54%
16	Parmelia sulcata	Balsam Fir	3.16%
17	Parmelia sulcata	Balsam Fir	10.29%
18	Parmelia sulcata	White Spruce	2.51%
19	Parmelia sulcata	Balsam Fir	5.23%
20	Parmelia sulcata	Balsam Fir	5.29%

Table 32. Percent cover of Parmelia sulcata in Plot 32.

Quadrat #	Lichen Species	Tree Species	Percent Cover
1	Parmelia sulcata	White Spruce	16.73%
2	Parmelia sulcata	White Spruce	4.44%
3	Parmelia sulcata	White Spruce	3.71%
4	Parmelia sulcata	White Spruce	7.11%
5	Parmelia sulcata	White Spruce	3.51%
6	Parmelia sulcata	White Spruce	6.14%
7	Parmelia sulcata	Birch	13.23%
8	Parmelia sulcata	White Spruce	5.74%
9	Parmelia sulcata	White Spruce	19.86%
10	Parmelia sulcata	White Spruce	4.48%
11	Parmelia sulcata	White Spruce	4.41%
12	Parmelia sulcata	White Spruce	1.91%
13	Parmelia sulcata	White Spruce	3.74%
14	Parmelia sulcata	White Spruce	5.09%
15	Parmelia sulcata	White Spruce	3.49%
16	Parmelia sulcata	White Spruce	6.41%
17	Parmelia sulcata	White Spruce	3.18%
18	Parmelia sulcata	White Spruce	3.65%
19	Parmelia sulcata	White Spruce	1.30%
20	Parmelia sulcata	Balsam Poplar	0.29%

Table 33. Percent cover of Parmelia sulcata in Plot 33.

Quadrat #	Lichen Species	Tree Species	Percent Cover
1	Parmelia sulcata	White Spruce	10.31%
2	Parmelia sulcata	White Spruce	4.63%
3	Parmelia sulcata	White Spruce	6.21%
4	Parmelia sulcata	White Spruce	5.79%
5	Parmelia sulcata	White Spruce	5.11%
6	Parmelia sulcata	White Spruce	4.45%
7	Parmelia sulcata	White Spruce	9.89%
8	Parmelia sulcata	White Spruce	15.83%
9	Parmelia sulcata	White Spruce	4.35%
10	Parmelia sulcata	White Spruce	8.43%
11	Parmelia sulcata	White Spruce	2.16%
12	Parmelia sulcata	White Spruce	6.43%
13	Parmelia sulcata	White Spruce	2.49%
14	Parmelia sulcata	White Spruce	2.92%
15	Parmelia sulcata	White Spruce	1.85%
16	Parmelia sulcata	White Spruce	6.34%
17	Parmelia sulcata	White Spruce	15.58%
18	Parmelia sulcata	White Spruce	6.82%
19	Parmelia sulcata	White Spruce	3.85%
20	Parmelia sulcata	White Spruce	5.00%

Table 34. Percent cover of Parmelia sulcata, Parmelia flaventior and Physica sp. in Plot 34.

Quadrat #	Lichen Species	Tree Species	Percent Cover
1	Parmelia sulcata	White Spruce	0.62%
2	Parmelia sulcata	White Spruce	1.25%
3	Parmelia sulcata	White Spruce	3.23%
4	Parmelia sulcata	White Spruce	3.32%
5	Parmelia sulcata	White Spruce	1.33%
6	Parmelia sulcata	White Spruce	5.99%
7	Parmelia sulcata	Balsam Fir	1.14%
8	Parmelia sulcata	Balsam Fir	4.57%
9	Parmelia sulcata	Balsam Fir	5.34%
10	Parmelia sulcata	Balsam Fir	1.75%
11	Parmelia sulcata	Balsam Fir	1.94%
12	Parmelia sulcata	Balsam Fir	1.28%
13	Parmelia sulcata	Balsam Fir	3.78%
14	Parmelia sulcata	Balsam Fir	2.73%
15	Parmelia sulcata	Balsam Fir	5.45%
16	Parmelia sulcata	Balsam Fir	7.86%
17	Parmelia sulcata	White Spruce	2.06%
18	Parmelia flaventior	White Spruce	8.69%
19	Parmelia flaventior	White Spruce	5.58%
20	Physica sp.	White Spruce	2.50%

Table 35. Percent cover of Parmelia sulcata in Plot 35.

Quadrat #	Lichen Species	Tree Species	Percent Cover
1	Parmelia sulcata	White Spruce	3.42%
2	Parmelia sulcata	White Spruce	2.42%
3	Parmelia sulcata	White Spruce	3.17%
4	Parmelia sulcata	White Spruce	1.60%
5	Parmelia sulcata	White Spruce	1.26%
6	Parmelia sulcata	White Spruce	4.92%
7	Parmelia sulcata	White Spruce	1.43%
8	Parmelia sulcata	White Spruce	2.05%
9	Parmelia sulcata	White Spruce	2.20%
10	Parmelia sulcata	White Spruce	2.43%
11	Parmelia sulcata	White Spruce	4.11%
12	Parmelia sulcata	White Spruce	3.00%
13	Parmelia sulcata	White Spruce	6.69%
14	Parmelia sulcata	White Spruce	5.79%
15	Parmelia sulcata	White Spruce	3.93%
16	Parmelia sulcata	White Spruce	4.60%
17	Parmelia sulcata	White Spruce	7.45%
18	Parmelia sulcata	White Spruce	4.47%
19	Parmelia sulcata	White Spruce	2.75%
20	Parmelia sulcata	White Spruce	3.79%

Table 36. Percent cover of Parmelia sulcata in Plot 36.

Quadrat #	Lichen Species	Tree Species	Percent Cover
1	Parmelia sulcata	White Spruce	6.71%
2	Parmelia sulcata	Balsam Fir	7.20%
3	Parmelia sulcata	White Spruce	12.28%
4	Parmelia sulcata	White Spruce	8.33%
5	Parmelia sulcata	Balsam Fir	4.48%
6	Parmelia sulcata	Aspen	7.61%
7	Parmelia sulcata	Balsam Fir	10.49%
8	Parmelia sulcata	Balsam Fir	4.81%
9	Parmelia sulcata	Balsam Fir	10.77%
10	Parmelia sulcata	Balsam Fir	6.65%
11	Parmelia sulcata	White Spruce	8.56%
12	Parmelia sulcata	Balsam Fir	3.18%
13	Parmelia sulcata	Balsam Fir	4.01%
14	Parmelia sulcata	Balsam Fir	5.80%
15	Parmelia sulcata	Balsam Fir	7.18%
16	Parmelia sulcata	White Spruce	5.28%
17	Parmelia sulcata	White Spruce	1.05%
18	Parmelia sulcata	White Spruce	6.83%
19	Parmelia sulcata	White Spruce	4.79%
20	Parmelia sulcata	White Spruce	4.47%

Table 37. Percent cover of Parmelia sulcata and Hypogymnia physodes in Plot 37.

Quadrat #	Lichen Species	Tree Species	Percent Cover
1	Parmelia sulcata	Black Spruce	2.47%
2	Parmelia sulcata	Black Spruce	3.67%
3	Hypogymnia physodes	Black Spruce	4.22%
4	Parmelia sulcata	Black Spruce	3.28%
5	Parmelia sulcata	Black Spruce	0.71%
6	Parmelia sulcata	Black Spruce	1.01%
7	Parmelia sulcata	Black Spruce	1.09%
8	Parmelia sulcata	Larch	1.28%
9	Parmelia sulcata	Black Spruce	3.65%
10	Parmelia sulcata	Larch	1.90%
11	Parmelia sulcata	Larch	1.80%
12	Parmelia sulcata	Larch	4.65%
13	Parmelia sulcata	Black Spruce	2.21%
14	Parmelia sulcata	Larch	2.62%
15	Parmelia sulcata	Larch	5.96%
16	Parmelia sulcata	Larch	3.37%
17	Parmelia sulcata	Black Spruce	1.28%
18	Parmelia sulcata	Larch	3.37%
19	Parmelia sulcata	Black Spruce	2.82%
20	Parmelia sulcata	Larch	2.60%

Table 38. Percent cover of Parmelia sulcata, Hypogymnia physodes and Parmeliopsis sp. in Plot 38.

Quadrat #	Lichen Species	Tree Species	Percent Cover
1	Hypogymnia physodes	Jack Pine	1.66%
2	Parmelia sulcata	Jack Pine	1.61%
3	Parmelia sulcata	Jack Pine	2.93%
4	Parmelia sulcata	Jack Pine	1.34%
5	Hypogymnia physodes	Jack Pine	1.33%
6	Hypogymnia physodes	Jack Pine	1.87%
7	Parmelia sulcata	Jack Pine	2.20%
8	Hypogymnia physodes	Jack Pine	5.22%
9	Hypogymnia physodes	Black Spruce	1.68%
10	Parmelia sulcata	Jack Pine	4.87%
11	Hypogymnia physodes	Black Spruce	2.16%
12	Hypogymnia physodes	Black Spruce	3.23%
13	Hypogymnia physodes	Jack Pine	4.12%
14	Parmeliopsis sp.	Jack Pine	0.96%
15	Parmeliopsis sp.	Jack Pine	4.54%
16	Hypogymnia physodes	Jack Pine	2.32%
17	Hypogymnia physodes	Jack Pine	3.07%
18	Hypogymnia physodes	Jack Pine	1.13%
19	Parmelia sulcata	Jack Pine	2.61%
20	Hypogymnia physodes	Jack Pine	2.10%

Table 39. Percent cover of Parmelia sulcata in Plot 39.

Quadrat #	Lichen Species	Tree Species	Percent Cover
1	Parmelia sulcata	White Spruce	4.43%
2	Parmelia sulcata	White Spruce	2.97%
3	Parmelia sulcata	White Spruce	4.01%
4	Parmelia sulcata	White Spruce	1.85%
5	Parmelia sulcata	White Spruce	2.05%
6	Parmelia sulcata	White Spruce	3.98%
7	Parmelia sulcata	White Spruce	2.08%
8	Parmelia sulcata	White Spruce	0.81%
9	Parmelia sulcata	White Spruce	----
10	Parmelia sulcata	White Spruce	2.87%
11	Parmelia sulcata	White Spruce	2.93%
12	Parmelia sulcata	White Spruce	3.79%
13	Parmelia sulcata	White Spruce	3.02%
14	Parmelia sulcata	White Spruce	2.46%
15	Parmelia sulcata	White Spruce	3.32%
16	Parmelia sulcata	White Spruce	9.90%
17	Parmelia sulcata	Jack Pine	1.43%
18	Parmelia sulcata	White Spruce	5.07%
19	Parmelia sulcata	White Spruce	0.80%
20	Parmelia sulcata	White Spruce	3.16%

Table 40. Percent cover of Parmelia sulcata and Hypogymnia physodes in Plot 40.

Quadrat #	Lichen Species	Tree Species	Percent Cover
1	Parmelia sulcata	Larch	6.32%
2	Hypogymnia physodes	Black Spruce	1.41%
3	Hypogymnia physodes	Black Spruce	2.57%
4	Parmelia sulcata	Black Spruce	1.68%
5	Hypogymnia physodes	Black Spruce	1.99%
6	Hypogymnia physodes	Black Spruce	1.14%
7	Hypogymnia physodes	Black Spruce	1.01%
8	Hypogymnia physodes	Black Spruce	0.99%
9	Parmelia sulcata	Black Spruce	5.36%
10	Parmelia sulcata	Black Spruce	2.69%
11	Hypogymnia physodes	Black Spruce	1.12%
12	Parmelia sulcata	Black Spruce	2.15%
13	Parmelia sulcata	Black Spruce	7.71%
14	Hypogymnia physodes	Black Spruce	1.37%
15	Hypogymnia physodes	Black Spruce	3.04%
16	Parmelia sulcata	Black Spruce	4.37%
17	Parmelia sulcata	Black Spruce	0.88%
18	Parmelia sulcata	Black Spruce	2.67%
19	Parmelia sulcata	Black Spruce	2.07%
20	Hypogymnia physodes	Black Spruce	1.29%

Table 41. Percent cover of Parmelia sulcata in Plot 41.

Quadrat #	Lichen Species	Tree Species	Percent Cover
1	Parmelia sulcata	Black Spruce	2.24%
2	Parmelia sulcata	Black Spruce	4.63%
3	Parmelia sulcata	Black Spruce	5.32%
4	Parmelia sulcata	Black Spruce	2.20%
5	Parmelia sulcata	Black Spruce	4.67%
6	Parmelia sulcata	Black Spruce	8.48%
7	Parmelia sulcata	Black Spruce	5.25%
8	Parmelia sulcata	Black Spruce	3.42%
9	Parmelia sulcata	Black Spruce	5.38%
10	Parmelia sulcata	Black Spruce	6.45%
11	Parmelia sulcata	Black Spruce	3.25%
12	Parmelia sulcata	Black Spruce	3.75%
13	Parmelia sulcata	Black Spruce	3.32%
14	Parmelia sulcata	Black Spruce	1.99%
15	Parmelia sulcata	Black Spruce	1.80%
16	Parmelia sulcata	Black Spruce	1.87%
17	Parmelia sulcata	Black Spruce	2.62%
18	Parmelia sulcata	Black Spruce	1.57%
19	Parmelia sulcata	Black Spruce	2.55%
20	Parmelia sulcata	Black Spruce	2.99%

Table 42. Percent cover of Parmelia sulcata in Plot 42.

Quadrat #	Lichen Species	Tree Species	Percent Cover
1	Parmelia sulcata	White Spruce	2.64%
2	Parmelia sulcata	White Spruce	12.38%
3	Parmelia sulcata	White Spruce	5.58%
4	Parmelia sulcata	White Spruce	4.32%
5	Parmelia sulcata	White Spruce	4.44%
6	Parmelia sulcata	White Spruce	9.71%
7	Parmelia sulcata	White Spruce	4.78%
8	Parmelia sulcata	White Spruce	4.27%
9	Parmelia sulcata	White Spruce	11.09%
10	Parmelia sulcata	White Spruce	7.06%
11	Parmelia sulcata	White Spruce	9.29%
12	Parmelia sulcata	White Spruce	7.99%
13	Parmelia sulcata	White Spruce	3.99%
14	Parmelia sulcata	White Spruce	3.37%
15	Parmelia sulcata	White Spruce	2.27%
16	Parmelia sulcata	White Spruce	14.13%
17	Parmelia sulcata	White Spruce	2.89%
18	Parmelia sulcata	White Spruce	12.76%
19	Parmelia sulcata	White Spruce	3.60%
20	Parmelia sulcata	White Spruce	6.41%

Table 43. Percent cover of Parmelia sulcata in Plot 43.

Quadrat #	Lichen Species	Tree Species	Percent Cover
1	Parmelia sulcata	White Spruce	7.84%
2	Parmelia sulcata	White Spruce	3.28%
3	Parmelia sulcata	White Spruce	4.34%
4	Parmelia sulcata	White Spruce	2.20%
5	Parmelia sulcata	White Spruce	2.03%
6	Parmelia sulcata	White Spruce	2.94%
7	Parmelia sulcata	White Spruce	4.69%
8	Parmelia sulcata	White Spruce	1.97%
9	Parmelia sulcata	White Spruce	5.92%
10	Parmelia sulcata	White Spruce	2.84%
11	Parmelia sulcata	White Spruce	3.41%
12	Parmelia sulcata	White Spruce	4.93%
13	Parmelia sulcata	White Spruce	7.91%
14	Parmelia sulcata	White Spruce	1.44%
15	Parmelia sulcata	White Spruce	2.26%
16	Parmelia sulcata	White Spruce	3.05%
17	Parmelia sulcata	White Spruce	4.98%
18	Parmelia sulcata	White Spruce	3.23%
19	Parmelia sulcata	White Spruce	4.18%
20	Parmelia sulcata	White Spruce	4.39%

Table 44. Percent cover of Parmelia sulcata and Hypogymnia physodes in Plot 44.

Quadrat #	Lichen Species	Tree Species	Percent Cover
1	Parmelia sulcata	Black Spruce	0.83%
2	Parmelia sulcata	Black Spruce	2.59%
3	Parmelia sulcata	Black Spruce	0.87%
4	Parmelia sulcata	Black Spruce	0.43%
5	Parmelia sulcata	Black Spruce	1.27%
6	Parmelia sulcata	Black Spruce	1.77%
7	Hypogymnia physodes	Black Spruce	2.83%
8	Hypogymnia physodes	Black Spruce	0.97%
9	Parmelia sulcata	Larch	1.85%
10	Hypogymnia physodes	Black Spruce	2.13%
11	Hypogymnia physodes	Black Spruce	2.67%
12	Hypogymnia physodes	Black Spruce	2.13%
13	Hypogymnia physodes	Black Spruce	2.00%
14	Hypogymnia physodes	Black Spruce	0.73%
15	Parmelia sulcata	Black Spruce	3.72%
16	Parmelia sulcata	Black Spruce	0.84%
17	Parmelia sulcata	Black Spruce	3.55%
18	Parmelia sulcata	Black Spruce	2.50%
19	Parmelia sulcata	Black Spruce	2.76%
20	Parmelia sulcata	Black Spruce	1.20%

Table 45. Percent cover of Parmelia sulcata and Hypogymnia physodes in Plot 45.

Quadrat #	Lichen Species	Tree Species	Percent Cover
1	Parmelia sulcata	Black Spruce	2.98%
2	Parmelia sulcata	Black Spruce	3.40%
3	Hypogymnia physodes	Black Spruce	1.23%
4	Hypogymnia physodes	Black Spruce	0.49%
5	Hypogymnia physodes	Black Spruce	1.21%
6	Parmelia sulcata	Black Spruce	1.61%
7	Hypogymnia physodes	Black Spruce	1.11%
8	Hypogymnia physodes	Black Spruce	1.17%
9	Hypogymnia physodes	Black Spruce	2.11%
10	Parmelia sulcata	Black Spruce	1.30%
11	Parmelia sulcata	Black Spruce	1.04%
12	Parmelia sulcata	Black Spruce	1.34%
13	Hypogymnia physodes	Black Spruce	0.64%
14	Hypogymnia physodes	Black Spruce	6.16%
15	Parmelia sulcata	Black Spruce	2.28%
16	Parmelia sulcata	Black Spruce	1.77%
17	Hypogymnia physodes	Black Spruce	2.42%
18	Hypogymnia physodes	Black Spruce	1.19%
19	Parmelia sulcata	Black Spruce	1.70%
20	Parmelia sulcata	Black Spruce	2.02%

Table 46. Percent cover of Parmelia sulcata in Plot 46.

Quadrat #	Lichen Species	Tree Species	Percent Cover
1	Parmelia sulcata	White Spruce	6.42%
2	Parmelia sulcata	White Spruce	12.87%
3	Parmelia sulcata	White Spruce	3.32%
4	Parmelia sulcata	White Spruce	6.68%
5	Parmelia sulcata	White Spruce	8.48%
6	Parmelia sulcata	White Spruce	2.89%
7	Parmelia sulcata	White Spruce	3.75%
8	Parmelia sulcata	White Spruce	2.20%
9	Parmelia sulcata	White Spruce	3.40%
10	Parmelia sulcata	White Spruce	6.82%
11	Parmelia sulcata	White Spruce	3.17%
12	Parmelia sulcata	White Spruce	1.93%
13	Parmelia sulcata	White Spruce	4.86%
14	Parmelia sulcata	White Spruce	4.03%
15	Parmelia sulcata	White Spruce	5.92%
16	Parmelia sulcata	White Spruce	6.58%
17	Parmelia sulcata	White Spruce	3.07%
18	Parmelia sulcata	White Spruce	6.43%
19	Parmelia sulcata	White Spruce	4.52%
20	Parmelia sulcata	White Spruce	5.49%

Table 47. Percent cover of Parmelia sulcata in Plot 47.

Quadrat #	Lichen Species	Tree Species	Percent Cover
1	Parmelia sulcata	Black Spruce	2.54%
2	Parmelia sulcata	Black Spruce	3.70%
3	Parmelia sulcata	Black Spruce	3.80%
4	Parmelia sulcata	Black Spruce	4.85%
5	Parmelia sulcata	Black Spruce	10.86%
6	Parmelia sulcata	Black Spruce	6.52%
7	Parmelia sulcata	Black Spruce	4.81%
8	Parmelia sulcata	Black Spruce	9.31%
9	Parmelia sulcata	Black Spruce	7.27%
10	Parmelia sulcata	Black Spruce	7.15%
11	Parmelia sulcata	Black Spruce	8.50%
12	Parmelia sulcata	Black Spruce	9.91%
13	Parmelia sulcata	Black Spruce	12.84%
14	Parmelia sulcata	Black Spruce	5.43%
15	Parmelia sulcata	Black Spruce	10.83%
16	Parmelia sulcata	Black Spruce	10.28%
17	Parmelia sulcata	Black Spruce	14.74%
18	Parmelia sulcata	Black Spruce	10.00%
19	Parmelia sulcata	Black Spruce	10.83%
20	Parmelia sulcata	Black Spruce	4.20%

Table 48. Percent cover of Parmelia sulcata in Plot 48.

Quadrat #	Lichen Species	Tree Species	Percent Cover
1	Parmelia sulcata	Black Spruce	4.51%
2	Parmelia sulcata	Black Spruce	3.55%
3	Parmelia sulcata	Black Spruce	6.29%
4	Parmelia sulcata	Black Spruce	1.57%
5	Parmelia sulcata	Black Spruce	1.67%
6	Parmelia sulcata	Black Spruce	2.80%
7	Parmelia sulcata	Black Spruce	0.87%
8	Parmelia sulcata	Black Spruce	1.58%
9	Parmelia sulcata	Black Spruce	4.60%
10	Parmelia sulcata	Black Spruce	3.76%
11	Parmelia sulcata	Black Spruce	3.93%
12	Parmelia sulcata	Black Spruce	1.69%
13	Parmelia sulcata	Black Spruce	2.07%
14	Parmelia sulcata	Black Spruce	5.59%
15	Parmelia sulcata	Black Spruce	3.64%
16	Parmelia sulcata	Black Spruce	3.88%
17	Parmelia sulcata	Black Spruce	2.20%
18	Parmelia sulcata	Black Spruce	1.14%
19	Parmelia sulcata	Black Spruce	1.86%
20	Parmelia sulcata	Black Spruce	7.81%

Table 49. Percent cover of Parmelia sulcata in Plot 49.

Quadrat #	Lichen Species	Tree Species	Percent Cover
1	Parmelia sulcata	Black Spruce	4.27%
2	Parmelia sulcata	Black Spruce	16.77%
3	Parmelia sulcata	Black Spruce	2.04%
4	Parmelia sulcata	Black Spruce	5.37%
5	Parmelia sulcata	Black Spruce	1.21%
6	Parmelia sulcata	Black Spruce	4.65%
7	Parmelia sulcata	Black Spruce	5.81%
8	Parmelia sulcata	Black Spruce	6.68%
9	Parmelia sulcata	Black Spruce	3.51%
10	Parmelia sulcata	Black Spruce	8.60%
11	Parmelia sulcata	Black Spruce	2.61%
12	Parmelia sulcata	Black Spruce	5.20%
13	Parmelia sulcata	Black Spruce	2.72%
14	Parmelia sulcata	Black Spruce	4.54%
15	Parmelia sulcata	Black Spruce	3.08%
16	Parmelia sulcata	Black Spruce	0.94%
17	Parmelia sulcata	Black Spruce	2.41%
18	Parmelia sulcata	Black Spruce	1.61%
19	Parmelia sulcata	Black Spruce	1.99%
20	Parmelia sulcata	Black Spruce	2.27%

Table 50. Percent cover of Parmelia sulcata and Physica adscendens in Plot 50.

Quadrat #	Lichen Species	Tree Species	Percent Cover
1	Parmelia sulcata	Black Spruce	1.90%
2	Parmelia sulcata	Black Spruce	1.57%
3	Parmelia sulcata	Black Spruce	0.90%
4	Parmelia sulcata	Black Spruce	1.38%
5	Parmelia sulcata	Black Spruce	1.98%
6	Parmelia sulcata	Black Spruce	3.94%
7	Parmelia sulcata	Black Spruce	2.04%
8	Parmelia sulcata	Black Spruce	2.17%
9	Parmelia sulcata	Black Spruce	15.52%
10	Physica adscendens	Black Spruce	10.59%
11	Parmelia sulcata	Black Spruce	1.23%
12	Parmelia sulcata	Black Spruce	4.88%
13	Parmelia sulcata	Black Spruce	7.53%
14	Parmelia sulcata	Black Spruce	1.90%
15	Parmelia sulcata	Black Spruce	3.32%
16	Parmelia sulcata	Black Spruce	1.92%
17	Parmelia sulcata	Black Spruce	0.66%
18	Parmelia sulcata	Black Spruce	4.41%
19	Parmelia sulcata	Black Spruce	0.76%
20	Parmelia sulcata	Black Spruce	2.42%

Table 51. Percent cover of Parmelia sulcata and Hypogymnia physodes in Plot 51.

Quadrat #	Lichen Species	Tree Species	Percent Cover
1	Parmelia sulcata	White Spruce	7.12%
2	Parmelia sulcata	White Spruce	6.17%
3	Parmelia sulcata	White Spruce	12.71%
4	Parmelia sulcata	Balsam Fir	3.34%
5	Parmelia sulcata	Balsam Fir	11.91%
6	Parmelia sulcata	White Spruce	7.68%
7	Parmelia sulcata	White Spruce	4.00%
8	Hypogymnia physodes	White Spruce	2.80%
9	Parmelia sulcata	White Spruce	4.07%
10	Parmelia sulcata	White Spruce	7.12%
11	Parmelia sulcata	White Spruce	2.99%
12	Parmelia sulcata	Balsam Fir	8.27%
13	Parmelia sulcata	White Spruce	9.29%
14	Parmelia sulcata	Balsam Fir	15.96%
15	Parmelia sulcata	White Spruce	5.59%
16	Parmelia sulcata	Balsam Fir	10.47%
17	Parmelia sulcata	White Spruce	2.52%
18	Parmelia sulcata	White Spruce	6.95%
19	Parmelia sulcata	White Spruce	3.87%
20	Parmelia sulcata	Balsam Fir	13.31%

Table 52. Percent cover of Parmelia sulcata in Plot 52.

Quadrat #	Lichen Species	Tree Species	Percent Cover
1	Parmelia sulcata	White Spruce	9.06%
2	Parmelia sulcata	White Spruce	2.32%
3	Parmelia sulcata	White Spruce	7.21%
4	Parmelia sulcata	White Spruce	8.01%
5	Parmelia sulcata	White Spruce	3.55%
6	Parmelia sulcata	White Spruce	4.97%
7	Parmelia sulcata	White Spruce	7.34%
8	Parmelia sulcata	White Spruce	3.74%
9	Parmelia sulcata	White Spruce	7.06%
10	Parmelia sulcata	White Spruce	11.90%
11	Parmelia sulcata	White Spruce	6.44%
12	Parmelia sulcata	White Spruce	8.16%
13	Parmelia sulcata	White Spruce	2.27%
14	Parmelia sulcata	White Spruce	7.45%
15	Parmelia sulcata	White Spruce	5.33%
16	Parmelia sulcata	White Spruce	10.39%
17	Parmelia sulcata	White Spruce	3.22%
18	Parmelia sulcata	White Spruce	5.78%
19	Parmelia sulcata	White Spruce	1.95%
20	Parmelia sulcata	White Spruce	2.90%

Table 53. Percent cover of Parmelia sulcata and Physcia sp. in Plot 53.

Quadrat #	Lichen Species	Tree Species	Percent Cover
1	Parmelia sulcata	White Spruce	2.01%
2	Parmelia sulcata	White Spruce	6.48%
3	Parmelia sulcata	White Spruce	1.43%
4	Parmelia sulcata	White Spruce	2.45%
5	Parmelia sulcata	White Spruce	2.69%
6	Parmelia sulcata	White Spruce	0.68%
7	Parmelia sulcata	White Spruce	4.04%
8	Parmelia sulcata	White Spruce	5.11%
9	Parmelia sulcata	White Spruce	3.61%
10	Parmelia sulcata	White Spruce	7.04%
11	Parmelia sulcata	White Spruce	6.52%
12	Parmelia sulcata	White Spruce	5.68%
13	Physcia sp.	Balsam Poplar	10.53%
14	Parmelia sulcata	White Spruce	4.06%
15	Parmelia sulcata	White Spruce	2.95%
16	Parmelia sulcata	White Spruce	2.82%
17	Parmelia sulcata	White Spruce	5.59%
18	Parmelia sulcata	White Spruce	6.36%
19	Parmelia sulcata	White Spruce	3.02%
20	Parmelia sulcata	White Spruce	6.42%

Table 54. Percent cover of Parmelia sulcata in Plot 54.

Quadrat #	Lichen Species	Tree Species	Percent Cover
1	Parmelia sulcata	White Spruce	6.51%
2	Parmelia sulcata	White Spruce	2.40%
3	Parmelia sulcata	White Spruce	2.34%
4	Parmelia sulcata	White Spruce	4.66%
5	Parmelia sulcata	White Spruce	5.78%
6	Parmelia sulcata	White Spruce	2.94%
7	Parmelia sulcata	White Spruce	5.64%
8	Parmelia sulcata	White Spruce	1.19%
9	Parmelia sulcata	White Spruce	2.44%
10	Parmelia sulcata	White Spruce	3.55%
11	Parmelia sulcata	White Spruce	3.09%
12	Parmelia sulcata	White Spruce	6.71%
13	Parmelia sulcata	White Spruce	2.29%
14	Parmelia sulcata	White Spruce	2.32%
15	Parmelia sulcata	White Spruce	1.03%
16	Parmelia sulcata	White Spruce	5.11%
17	Parmelia sulcata	White Spruce	2.04%
18	Parmelia sulcata	White Spruce	3.65%
19	Parmelia sulcata	White Spruce	3.06%
20	Parmelia sulcata	White Spruce	2.69%

Table 55. Percent cover of Parmelia sulcata in Plot 55.

Quadrat #	Lichen Species	Tree Species	Percent Cover
1	Parmelia sulcata	White Spruce	4.69%
2	Parmelia sulcata	White Spruce	4.79%
3	Parmelia sulcata	White Spruce	3.71%
4	Parmelia sulcata	White Spruce	1.18%
5	Parmelia sulcata	White Spruce	6.07%
6	Parmelia sulcata	White Spruce	2.16%
7	Parmelia sulcata	White Spruce	0.75%
8	Parmelia sulcata	White Spruce	6.46%
9	Parmelia sulcata	White Spruce	2.18%
10	Parmelia sulcata	White Spruce	6.17%
11	Parmelia sulcata	White Spruce	3.34%
12	Parmelia sulcata	White Spruce	3.14%
13	Parmelia sulcata	White Spruce	3.07%
14	Parmelia sulcata	White Spruce	2.53%
15	Parmelia sulcata	White Spruce	2.16%
16	Parmelia sulcata	White Spruce	1.00%
17	Parmelia sulcata	White Spruce	1.23%
18	Parmelia sulcata	White Spruce	0.80%
19	Parmelia sulcata	White Spruce	1.86%
20	Parmelia sulcata	White Spruce	2.60%

Table 56. Percent cover of Parmelia sulcata and Hypogymnia physodes in Plot 56.

Quadrat #	Lichen Species	Tree Species	Percent Cover
1	Parmelia sulcata	Black Spruce	0.74%
2	Parmelia sulcata	Black Spruce	8.84%
3	Parmelia sulcata	Black Spruce	2.76%
4	Hypogymnia physodes	Black Spruce	1.34%
5	Parmelia sulcata	Black Spruce	5.76%
6	Parmelia sulcata	Black Spruce	5.34%
7	Parmelia sulcata	Black Spruce	3.12%
8	Parmelia sulcata	Black Spruce	3.40%
9	Parmelia sulcata	Black Spruce	3.98%
10	Hypogymnia physodes	Black Spruce	1.15%
11	Parmelia sulcata	Black Spruce	3.32%
12	Parmelia sulcata	Black Spruce	1.28%
13	Hypogymnia physodes	Black Spruce	0.62%
14	Parmelia sulcata	Black Spruce	7.74%
15	Parmelia sulcata	Black Spruce	0.52%
16	Parmelia sulcata	Black Spruce	3.07%
17	Parmelia sulcata	Black Spruce	1.70%
18	Parmelia sulcata	Black Spruce	2.84%
19	Parmelia sulcata	Black Spruce	5.45%
20	Hypogymnia physodes	Black Spruce	2.52%

Future Statistical Analysis

When the monitoring plots are re-examined during the first few years of the Syncrude plant's operation, it will be necessary to determine the change in growth of lichens. In order to accomplish this, at least 20 plots should be resampled, ideally at random, but only a small amount of bias would be introduced by choosing plots accessible by road as long as some of the plots are located in both the inner and outer perimeter. After the plots are resampled, the mean ($\bar{x}$) percent cover values can be compared within plots (i.e., $\bar{x}$ plot 1 in 1976 vs $\bar{x}$ plot 1 in 1978) by means of a T test to determine if any significant change has occurred. Some plots may show a significant increase in $\bar{x}$ cover (indicating lichen growth) while others may show no change (growth = deback), and some may show a significant decrease (possible inhibition of growth). The growth rates of lichens in the outer perimeter should establish a norm for lichens in the Fort McMurray area. This test only allows a comparison of $\bar{x}$ cover within plots (i.e., between different sampling dates on the same plot). An analysis of variance such as Duncans New Multiple Range Test could be used to compare the change within and between plots. This test would be conducted on the percent change in lichen cover within each plot, not the absolute lichen cover. Plots that were not significantly different from each other could be grouped on a map to visually display areas of change. This would allow comparison of areas of reduced growth with additional external data such as distance from the Syncrude plant and prevailing winds.

Lichen-moss Flora

Considering there are few dry, open hillsides or rock outcrops in the Fort McMurray area, the 121 species of lichens found represent a relatively large flora. The flora is composed mostly of common montane and boreal forest species which have a western or northern distribution pattern in North America; however, there are a few interesting species that are typically eastern in distribution. Genera such as Alectoria, Evernia, and Hypogymnia have strictly northern affinities. Cetraria pinastri, Parmelia sulcata, P. subaurifera, Parmeliopsis ambigua, Ramalina crinalis, R. minuscula and many Usneas are most characteristic of northern coniferous forests. Some species, especially those found on aspen, are widespread in North America. These include Physcia aipola, P. orbicularis, Caloplaca cerina, C. holocarpa, and Xanthoria polycarpa. Most of the species are common in North America, but some of the collections represent range extensions or unusual discoveries. Seventeen of the species collected are apparently new to the flora of Alberta (Bird, 1972, 1973). At least seven of these new species have been reported from nearby northern Saskatchewan (Argus, 1964; Looman, 1962; Thompson & Scotter, 1961) or Manitoba (Wright, 1929). Lobaria pulmonaria, a large foliose lichen was found about 640 km northeast of its known range. The specimen of Biatorella is unusual and could represent an undescribed species, although more material is required for verification.

The presently known flora is composed of 46 fruticose species, 43 foliose species, 30 crustose species and 2 umbilicate species. Cladonia is the largest genus with 25 species; these are conspicuous lichens of logs and the forest floor. Parmelia is represented by 10 species, Physcia by 7 species, and Lecanora, Lecidea and Peltigera by 6 each. Parmelia

sulcata is the dominant foliose lichen on conifers, and Peltigera apthosa is the most common foliose lichen found on the ground. Further collecting in the Fort McMurray area should reveal additional species and provide additional information on the abundance of species already recorded.

As in lichens, the 136 moss species collected represent a sizable flora. Most species are typical of the boreal forest with Hylocomnium splendens, Pleurozium schreberi, Aulacomnium palustre, Tomenthypnum nitens, and a number of Sphagnum spp. being very common. Others such as Orthodicranum flagellare, Calliergon spp., Dicranella spp., and Drepanocladus spp. are also fairly common, but require a more specialized habitat, and therefore are not as readily collected. The relative absence of rock outcrops in the Fort McMurray area eliminates a number of species that are restricted to this habitat; however, Hedwigia ciliata, Dicranoweisia crispula, Orthotrichum anomalum and several Grimmia spp. were located on glacial till and rocks along rivers and streams. Several species that are extremely rare in Alberta were found. Dicranum muehlenbeckii and Encalypta mutica (Horton & Murray, 1976) were previously known only from the Rocky Mountains. Splachnum ampullaceum, Sphagnum fimbriatum and S. platyphyllum have previously been collected only at three or four localities in Alberta and their distribution is poorly known. Entodon cladorrhizans was collected at two localities along the Athabasca River and probably occurs sporadically along the major rivers in the province; previously, it has been collected only around Edmonton and Fort Saskatchewan along the North Saskatchewan River.

Three species collected are new to the flora of Alberta. Calliergidium pseudostramincum and Seligeria calcarea are members of the eastern North American flora and now represent the most western points in their distribution. S. calcarea was previously known only from east of the Mississippi River

(Vitt, 1976). Hygroamblystegium noterophilum is also predominantly eastern in its distribution although it has been reported from the west coast (Lawton, 1971). Additional collecting in the area, especially around rock outcrops, should reveal additional species.

Annotated Lichen Checklist

Actinogyra muehlenbergii (Ach.) Schol. Rare. Found on small exposed granite rocks. PD4603.

Alectoria americana Mot. Rare. Found once on black spruce and once on white spruce. This species has not previously been reported from Alberta. PD5040, PD5142.

A. glabra Mot. Common. A black fruticose lichen usually found on conifers. S9876, S9875, S9865, S9847, S9780, S9769, S9766, S9767, S9910.

A. nidulifera Norrl. Rare. Found on both black spruce and white spruce. This distinctive species is new to Alberta. PD5155, S9661, S9873.

Anaptychia speciosa (Wulf.) Mass. Rare. A small foliose lichen found on aspen and white spruce. S9627, S9721.

Bacidia obscurata (Somm.) Zahlbr. Rare. Found once on balsam poplar. S9752.

B. sphaeroides (Dicks.) Zahlbr. Rare. Found on balsam poplar and decaying wood. PD5016, S9761.

Biatorella sp. Rare. Found once on a larch tree. S9826.

Buellia triphragmioides Anzi. Rare. Found once on white spruce. S9719.

B. zahlbruckneri J. Stein. Rare. Found once on white spruce. S9856.

Calicium salicinum Pers. Rare. Found once on white spruce. S9711.

Caloplaca cerina (Ehrh.) Th.Fr. Rare. Found on aspen. D8658c, S9634, S9785.

C. fraudans (Th.Fr.) Oliv. Rare. Found once on rock near Beaver Creek. PD5189.

C. holocarpa (Hoffm.) Wade. Common. Usually with C. cerina on aspen. D8659, D9858b, D9664, S9642, S9639, S9909, S9630.

Candelaria concolor (Dicks.) B. Stein. Rare. A yellow foliose species found on aspens. It was not collected.

Candelariella vitellina (Ehrh.) Mull. Arg. Common. A yellow crustose species common on aspen and occasionally on spruce. D9658a, S9631.

Cetraria chlorophylla (Willd.) Vain. Rare. Found once on black spruce. S9647.

C. ericetorum Opiz. Rare. Found once on a log in a pine stand and once with Cladina mitis. PD4948b, S9925.

C. halei W. Culb. & C. Culb. Common. Widespread in coniferous forests. It is most often found on branches of spruce and pine. D8655b, PD5113, S9709, S9811, S9812.

C. nivalis (L.) Ach. Rare. Usually on sandy soil. PD4555, S9922.

C. pinastri (Scop.) S. Gray. Common. Found on the lower trunks of conifers. D8652, PD4907, PD4953, S9708, S9736.

Chaenotheca chrysocephala (Ach.) Th.Fr. Rare. Found once on black spruce. This species has not previously been reported from Alberta. S9655.

Cladina arbuscula (Wallr.) Rabenh. Not common. Found on the ground in white spruce stands. PD4982, S9786.

C. mitis (Sandst.) Hale & W. Culb. Common. On the ground in most spruce stands. D8686, Lulman s.n., PD4909, PD4948a, PD4981, PD4415, PD5194, S9745, S9759, S9825, S9669 (Fig. 9).

C. rangiferina (L.) Wigg. Occasional. On the ground, usually in spruce forests. PD4418, PD4876, S9713, S9781.

C. stellaris (Opiz.) Brodo. Not common. This distinctive lichen was formerly known as C. alpestris (Brodo, 1976). It occurs on the ground most commonly in pine and black spruce stands. D8684, PD4420, PD4875, PD4957, S9923.

Cladonia belidiflora (Ach.) Schaer. Rare. This speices was collected once on soil near a sulfur spring. PD5045.

Figure 9. *Cladina mitis* is one of the most common dry site lichens in the Fort McMurray region.

Cladonia botrytes (Hag.) Willd. Not common. Usually on decaying logs. PD5055, S9676.

C. cariosa (Ach.) Spreng. Not common. Found on soil in spruce stands. D8715, PD5044, PD5150.

C. cenotea (Ach.) Schaer. Not common. On the ground in black spruce stands. PD4964, S9667.

C. chlorophaea (Flörke) Spreng. Not common. Usually found on decaying logs or soil in white spruce stands. PD4918, PD5047, PD5062.

C. coccifera (L.) Willd. Occasional. This red tipped species is usually found in muskeg areas growing on soil. PD4834, PD4956, PD4974, PD5136.

C. coniocraea (Flörke) Spreng. Common. Usually growing on decaying logs. D8647, D8722b, D8689, PD4926, PD4981, PD5065, S9806, S9794.

C. cornuta (L.) Hoffm. Common. Found on the ground in black spruce stands. S9657, S9668, S9897.

C. crispata (Ach.) Flot. Not common. Found on the ground, on logs, and the base of a spruce tree. D8721, D8722a, PD4976, S9646, S9760.

C. cristatella Tuck. Rare. Found on decaying logs in spruce stands. PD4733, PD4915.

C. deformis (L.) Hoffm. Occasional. On the ground or on decaying logs, usually in white spruce stands. PD5179, S9645, S9793, S9670.

C. fimbriata (L.) Fr. Common. Usually on rotten logs, or on the bases of spruce trees. D8646, S9673, S9762, S9798.

C. furcata (Huds.) Schrad. Rare. Found once growing with "feather mosses". PD5181.

C. gracilis (L.) Willd. Common. On logs and the bases of trees. D8723, D8720a, D8719, PD4900, PD4978, PD5005, S9693, S9788, S9896.

Cladonia gonecha (Ach.) Asah. Rare. Found once in a white spruce stand growing on a decaying log. PD4901.

C. hookeri Tuck. Found once on the ground in a black spruce stand. This species has not previously been reported from Alberta. D8682.

C. macrophylla (Schaer.) Stenham. Rare. Found once on sandy soil in a white spruce stand. PD4955.

C. multiformis Merr. Common. Easily found on most rotten logs and often on soil. D8645, D9713, D9712, D8688, D8685, D8656, D8681, D8717, PD4845, PD4911, PD4913, PD4910, PD4979, PD5006, PD5063, PD5064, PD5149, S9792, S9656, S9694, S9695.

C. phyllophora Hoffm. Rare. Found once on sandy soil in a jack pine stand. PD5156.

C. pityrea (Flörke) Th.Fr. Rare. Found once on soil in a white spruce stand. PD5151.

C. pyxidata (L.) Hoffm. Occasional. Usually on the ground near the base of trees. D8714, D8716, PD4944, PD4946, PD5046.

C. subulata (L.) Wigg. Rare. Found twice on decaying logs. PD4733, PD4954.

C. subfurcata (Nyl.) Arn. Rare. Found once growing on a Sphagnum hummock. This species is new to Alberta. PD4984.

C. uncialis (L.) Wigg. Not common. Found several times on sandy soil. PD4880, PD5048, PD5094, S9921.

C. verticillata (Hoffm.) Schaer. Rare. Found on soil in a larch stand. PD4988.

Coniocybe furfuracea (L.) Ach. Rare. Found once on soil under a fallen tree. PD4481.

Dermatocarpon moulinsii (Mont.) Zahlbr. Rare. This distinctive umbilicate lichen was found once on a rock outcrop just above the Athabasca River. It is new to Alberta. PD5067.

Evernia mesomorpha Nyl. Common. This fruticose lichen is usually abundant on the branches of conifers. D8642a, D8653, PD4858, PD5987, PD5036, PD5039, PD5120, PD5155, S9660, S9685, S9725, S9758, S9814, S9816, S9818, S9819, S9851, S9871, S9878, S9885, S9893, S9894.

Hypogymnia austerodes (Nyl.) Ras. Occasional. Found mostly on the wood of dead branches and logs. S9927.

H. physodes (L.) W. Wats. Common. This foliose lichen is the second most common species on the trunks of trees. D8654a, PD4914, PD5003, S9654, S9664, S9672, S9678, S9716, S9722, S9731, S9879, S9886, S9924.

Icmadophila ericetorum (L.) Zahlbr. Not common. Usually found growing over Sphagnum. D8637, PD4538, PD4624, PD4731, PD4925, PD4983, S9662.

Lecanora allophana (Ach.) Nyl. Common. Found on small branches of spruce trees. PD5168, S9650, S9727, S9790, S9823.

L. chrysoleuca (Sm.) Ach. Rare. Found once on rock along the Steepbank River. PD4958.

L. coilocarpa (Ach.) Nyl. Rare. Found once on black spruce. S9651.

L. epibryon (Ach.) Ach. Rare. Found once growing over decaying moss. PD5190.

L. polytropa (Ehrh.) Rabenh. Rare. Found once on a dead willow. This species is new to Alberta. PD5152a.

L. subfusca (L.) Ach. Rare. Found once on a dead willow. This species is new to Alberta. PD5152b.

Lecidea elabens Fr. Rare. Found once on white spruce. This species has not previously been reported from Alberta. S9831.

L. glomerulosa (DC.) Steud. Occasional. On the bark of balsam poplar. D8661, S9633, S9898, S9907, S9911.

L. granulosa (Hoffm.) Ach. Not common. Found on sandy soil and on the floor of a black spruce stand. D8683, S9919.

Lecidea rubiformis (Wahlenb. ex Ach.) Wahlenb. Rare. Found once on an exposed calcareous rock outcrop. PD5073.

L. scalaria (Ach.) Ach. Not common. Found on black spruce. S9688.

L. vernalis (L.) Ach. Occasional. Found on mosses at the base of spruce and on the bark of larch and spruce. S9754, S9763, S9789, S9774, S9712, S9822.

Leptogium saturninum (Dicks.) Nyl. Rare. Found on calcareous rocks and once on balsam poplar. PD4715, PD5176, S9744.

Lobaria pulmonaria (L.) Hoffm. This large foliose lichen is usually found on deciduous trees in mesic forests in North America, the Rocky Mountains of southern Alberta, and along the west coast (Jordan, 1973). At Fort McMurray, it was found once at the base of a white spruce. S9801.

Parmelia albertana Ahti. Rare. Found once on the bark of a balsam fir tree. PD5110.

P. flaventior Stirt. Occasional. Found on spruce trees. PD4407, PD4793, PD5066, S9675, S9782.

P. galbina (Ach.) Rare. Found once on the branch of a jack pine tree. This species is new to Alberta. PD5154.

P. glabratula. Rare. Found once on the bark of a small birch tree. This species is new to Alberta. PD5158a.

P. lineola Berry. Rare. Collected once on rock near the Steepbank River. This species is new to Alberta. PD4952.

P. multispora Schneid. Rare. Found on white spruce. This species is new to Alberta. S9715.

P. perlata (Huds.) Ach. Rare. Found on black spruce. This species is new to Alberta. S9671.

Parmelia septentrionalis (Lynge) Ahti. Rare. Found once on the bark of a small birch tree. PD5158b.

P. subaurifera Nyl. Common. Usually found on spruce trees and fir trees. PD5002, PD5109, S9684, S9686, S9700, S9707, S9714, S9729, S9784, S9899, S9902.

P. sulcata Tayl. Common. This foliose lichen is the most abundant species on tree trunks and branches. D8643, D8646, D8655a, PD4917, PD5042, PD5061, S9677, S9728, S9765, S9901.

Parmeliopsis aleurites (Ach.) Nyl. Common. Found mostly on logs and on the branches of conifers. PD4986, PD5136, S9777, S9783.

P. ambigua (Wulf.) Nyl. Common. Usually found with Cetraria pinastri at the base of spruce trees. PD4985, PD5041, S9665.

P. hyperoptera (Ach.) Arn. Not common. Found on the bark of a jackpine. PD4873.

Peltigera apthosa (L.) Willd. Common. Usually found among mosses on the ground. D8711, PD4516, PD4892, PD4929, PD5105, S9689, S9692.

P. canina (L.) Willd. Occasional. On logs and on the ground. D8644, D8648b, PD4908, PD5122, PD5148, S9679, S9690, S9799.

P. malacea (Ach.) Funck. Not common. Found on the forest floor in a white spruce-balsam fir stand. PD5106.

P. polydactyla (Neck.) Hoffm. Occasional. Found growing over decaying logs. D8648a, PD4951, PD5113.

P. rufescens (Weiss) Humb. Occasional. Usually growing on soil or over moss. PD4950, PD5056, PD5193.

P. cf. scabrosa Th.Fr. Rare. Found once on a rotten log. D8718.

P. spuria (Ach.) DC. Rare. Found once at the base of a small willow. PD4658.

Pertusaria amara (Ach.) Nyl. Not common. On white spruce. This species has not previously been reported from Alberta. S9674, S9776.

Pertusaria multipuncta (Turn.) Nyl. Common. This crustose species is usually found on aspen and balsam poplar. D8665, S9723, S9732, S9743.

Physcia adscendens (Th.Fr.) Oliv. Common. This species is typically found on deciduous trees. D8662, PD5043, S9635, S9638.

P. aipola (Ehrh.) Hampe. Common. Usually on aspen or balsam poplar; sometimes on white spruce. D8663, PD5018, PD5019, PD5111, PD5135, PD5160, S9629, S9637, S9848.

P. ciliata (Hoffm.) Du Reitz. Not common. Found twice on balsam poplar. S9741, S9749.

P. constipata (Nyl.) Norrl. & Nyl. Rare. Found once on soil over rock near the Athabasca River. PD5053.

P. millegrana Degel. Rare. Found once on the bark of an aspen tree. This species is rare in Alberta. PD5127.

P. orbicularis (Neck.) Poetsch. Not common. Found on aspen and spruce. D8660, S9628, S9710.

P. setosa (Ach.) Nyl. Rare. Found growing on calcareous rock along Beaver Creek. PD5183.

Physconia detersa (Nyl.) Poelt. Not common. On aspen and balsam poplar. This species has not previously been reported from Alberta. PD4521, PD5161, S9637, S9739, S9740.

P. grisea (Lam.) Poelt. Rare. Found growing over exposed rock along the Athabasca River. PD5050.

P. pulverulenta (Schreb.) Poelt. Rare. On the bark of an aspen tree. PD5117.

Ramalina crinalis (Ach.) Gyeln. Not common. A boreal forest species that is usually found on white spruce in the Fort McMurray area. S9747, S9795, S9796.

Ramalina farinacea (L.) Ach. Common. Usually on balsam poplar and spruce trees. PD5039, PD5128, S9687, S9697, S9701, S9724, S9737, S9779, S9800, S9803, S9804.

R. fastigiata (Pers) Ach. Occasional. Usually on the branches of white and black spruce. S9911.

R. minuscula (Nyl.) Nyl. Common. Usually found on black spruce branches. PD5147, S9643, S9644, S9680, S9683, S9815, S9828.

R. pollinaria (Westr.) Ach. Rare. Found on the trunk and branches of black spruce. This species has infrequently been reported from Alberta.

Rhizocarpon disporum (Naeg.) Müll. Arg. Rare. Collected twice on rock. PD4959, PD5157.

Rhinodina archaea (Ach.) Arn. Rare. Found once on white spruce. S9691.

R. exigua (Ach.) S. Gray. Common. Usually found on white spruce and larch. S9820, S9821, S9827, S9824, S9829.

Solorina saccata (L.) Ach. Not common. Found several times on calcareous soil around rock outcrops. PD4546, PD4723, PD5057, PD5191.

Stereocaulon alpinum Laur. Not common. On sandy soil in a jackpine stand and on rocky soil near a stream. PD4945, PD4949, S9918.

S. paschale (L.) Hoffm. Rare. On small exposed granite rocks. PD4602.

Usnea alpina Mot. Not common. Sometimes locally abundant, this species is usually found on spruce and larch. Apparently, this species hasn't previously been reported from Alberta. PD5143, S9652, S9698, S9702, S9804, S9787, S9834, S9835, S9892, S9841, S9842, S9843, S9849, S9850, S9853, S9854, S9857, S9861, S9883.

U. cavernosa Tuck. Not common. A pendulous species found on white and black spruce. PD4859, PD5037, PD5192, S9658, S9703, S9705.

Usnea glabrata (Ach.) Vin. Rare. Found once on a branch of a spruce tree. PD4916c.

U. sorediifera (Arn.) Lynge. Common. Abundant on most spruce and larch trees in the area. D8642, PD5119, S9653, S9659, S9730, S9748, S9755, S9756, S9764, S9772, S9805, S9817, S9860, S9862, S9863, S9870, S9877, S9881, S9882, S9887, S9891.

U. subfloridana Stirt. Common. Usually found on conifers with U. sorediifera. PD4916, PD5004, PD5038, PD5118, S9666, S9682, S9771, S9802, S9832, S9833, S9838, S9839, S9855, S9866, S9868, S9872, S9880, S9888, S9889, S9895, S9813.

Xanthoria polycarpa (Ehrh.) Oliv. Not common. Found on aspen. D8666, S9641.

X. elegans (Link.) Th.Fr. Rare. Found once on a rock outcrop along the Athabasca River. PD5049.

Annotated Moss Checklist

Aloina brevirostris (Hook. & Grev.) Kindb. Rare. This species is never very common, and usually occurs on calcareous soil. It is distinguished by cucculate leaves and photosynthetic filaments projecting from the ventral surface. It was found at one locality on Beaver Creek. PD4772.

Amblystegium serpens (Hedw.) B.S.G. Not common. Usually growing on rotten wood in the Ft. McMurray area. This small moss is distinguished by short rectangular cells and a costa that does not extend past the middle of the leaf. PD4831, PD4520.

A. varium (Hedw.) Lindb. Rare. Collected once near the base of a black spruce tree. It is distinguished from A. serpens by its costa that extends into the leaf apex. PD4860.

Aulacomnium palustre (Hedw.) Schwaegr. Very common. This species is probably found in more localities than any other moss in the Ft. McMurray area. It grows in most damp sites, and is very abundant around and in calcareous fens. The species is distinguished by habitat and its light green color. It occasionally produces gemmae. PD4832, PD4802, PD4453, PD4506.

Barbula icmadophila Schimp. ex C. Muell. Not common. Distinguished by a twisted peristome, lanceolate leaves, and an excurrent costa. It occurs mixed with other mosses on calcareous soil. PD4712.

Brachythecium curtum (Lindb.) Limpr. Not common. A fairly large species that is somewhat complanate. The leaves are strongly serrate and have twisted tips. Collected on a damp decaying log. PD4931.

B. erythrorrhizon B.S.G. Rare. This species is distinguished from B. salebrosum by falcate-secund leaves.

Brachythecium rutabulum (Hedw.) B.S.G. Not common. Similar in appearance to B. salebrosum but differs in rough retae and leaves scarcely plicate. It usually occurs on decaying logs. PD4575, PD4668.

B. salebrosum (Web. & Mohr) B.S.G. Common. Usually growing over soil and litter in moist aspen stands. Members of this genus are difficult to identify without sporophytes, but this species has deeply plicate leaves and numerous quadrate alar cells. PD4526, PD4941, PD4522.

B. velutinum (Hedw.) B.S.G. Occasional. A small species that is often overlooked. The leaves are falcate-secund and the seta is rough. PD5023, PD4528.

Bryoerythrophyllum recurvirostrum (Hedw.) Chen. Common. Usually found in calcareous or weedy habitats such as roadsides or riverbanks. In the field, it is distinguished from Barbula by its brick-red coloration. PD4704, PD4600, PD4765, PD4759, PD4543.

Bryum argenteum Hedw. Not common. This small silver moss was found several times along river and stream banks in a weedy habitat. The species is cosmopolitan in distribution and usually follows man into remote areas. PD5177, PD4549, PD4767, PD4905.

B. creberrimum Tayl. Occasional. Usually on soil in calcareous regions. PD4599, PD4691, PD5088.

B. pallens (Brid.) Sw. ex Roehl. Rare. Usually on calcareous soils. It was collected once near a sulfur spring. PD5033.

B. pseudotriquetrum (Hedw.) Gartn., Meyer & Scherb. Common. Most often in wet habitats such as bogs and stream edges; but sometimes in dryer places such as the forest floor and on decaying logs. It is distinguished by strongly decurrent leaves and red stems. PD4514, PD4607.

Bryum tortifolium Funck ex Brid. Rare. Usually on calcareous soil. A very distinctive species with rather ovate leaves and gemmae on the stems. PD4650.

Calliergidium pseudostramineum (C.M.) Grout. Rare. This species is poorly represented in most herbaria and its distribution is not completely known. These collections are the first from Alberta. The species is distinguished by a rounded tip, abrupt alar cells, entire margins, and striolate leaves. PD4473, PD4564, PD4857, PD5086.

Calliergon cordifolium (Hedw.) Kindb. Occasional. All Calliergon species can be distinguished by the single costa, blunt leaves, and a semi-aquatic habitat. C. cordifolium has alar cells that are gradually differentiated. It is often found in damp depressions along streams and fens. PD4431, PD4503, PD4530, PD4651, PD4824, PD5051.

C. giganteum (Schimp.) Kindb. Occasional. The largest number of the genus, identified by pinnate branching, abruptly inflated alar cells and a dioicous sexual state. Found growing submerged along a lake margin. PD4672.

C. richardsonii (Mitt.) Kindb. ex Warnst. Common. This species is distinguished from C. giganteum and C. cordifolium by a shorter costa and an autoicous sexual state. It is probably the most common Calliergon sp. in the Ft. McMurray area and is found in wet depressions along fens and streams. PD4617, PD4883.

C. stramineum (Brid.) Kindb. Occasional. A slender species that is sparsley branched. It often has radicles that can be seen with a hand lens, growing from leaf tips. It is found in damp depressions in fens and damp woods. PD4563, PD4652.

Campylium chrysophyllum (Brid.) S. Lange. Rare. A small species that has a strong costa extending to the middle of the leaf or more. It was found on damp soils. PD4606.

Campylium hispidulum (Brid.) Mitt. Occasional. A very small species that usually grows on wood. It does not have a costa and can be distinguished from C. stellatum by size and habitat. PD4688, PD4788.

C. stellatum (Hedw.) C. Jens. Occasional. This species is fairly easy to identify by its golden color and squarrose leaves. It is characteristic of calcareous fens. PD4622, PD4795, PD4861, PD4971, PD5017, PD5035, PD5080.

Catoscopium nigritum (Hedw.) Brid. Common. Usually found just above water line around calcareous fens. It is unmistakable when fertile since it has capsules that resemble tiny golf clubs (woods). Sterile plants can be determined by a slightly tristichous arrangement of the leaves. PD4965, PD5084, PD5085, PD5091, PD5093.

Ceratodon purpureus (Hedw.) Brid. Common. Usually found in disturbed areas such as seismic lines, roadsides, and riverbanks. It occurs on fairly dry soil and is almost always fertile. Its capsule is distinctively ribbed and purple-red in coloration. PD4594, PD4764, PD4779, PD4905, PD5070

Cinclidium stygium Sw. Occasional. Usually found in wet depressions between Sphagnum hummocks. It superficially resembles the genus Mnium, but can be distinguished by its large endostome and habitat. PD4616, PD4654, PD4884, PD4967, PD5087.

Climacium dendroides Hedw. Web. & Mohr. Not common. This species is the only moss in the Ft. McMurray area with a dendroid growth habit. It grows in damp places, usually along stream banks that are occasionally flooded. PD4429, PD4519, PD4825, PD5012.

Cratoneuron filicinum (Hedw.) Spruce. Not common. A species that usually occurs in aquatic or very damp calcareous habitats. PD5022.

Desmatodon obtusifolius (Schwaegr.) Schimp. Occasional. Small, contorted plants usually growing on exposed soil around streams. PD4491, PD4593, PD4703, PD4766.

Dicranella grevilleana (Brid.) Schimp. Occasional. Usually found along seismic lines or other disturbed habitats. When found, this tiny moss is usually fertile and growing in large loose patches. The species of this genus are virtually impossible to identify in the sterile state. PD4689, PD4690, PD5028, PD5146.

D. schreberiana (Hedw.) Schimp. var. robusta Schimp. ex Braithw. Not common. A large species of the genus that occurs in wet or moist habitats. It is closely related to D. palustris, but has a blunt leaf apex. PD5029, PD5090.

D. varia (Hedw.) Schimp. Occasional. Usually growing with D. grevilleana, and may be distinguished from it by setacceous leaves that do not form a clasping leaf base. PD4690, PD4697, PD4747, PD5184.

Dicranoweisia crispula (Hedw.) Lindb. ex Milde. Rare. This species grows on acidic rock, and was found once near the Athabasca river on a large rock probably deposited by glaciation. It is distinguished by highly crisped leaves and microscopic cuticular ridges on the leaves. PD4604.

Dicranum acutifolium (Lindb. & Arn.) C. Jens. Not common. A species similar to D. fuscescens in appearance, but differs in irregular cell patterns and ecology. It is more common in the Rocky Mts. and usually grows in alpine areas or mixed with other mosses in carpets. PD4614, PD4741, PD5174.

D. fragilifolium Lindb. Common. A species with broken leaf tips and curved capsules. Two other similar appearing species, Orthodicranum strictum and O. viride, might be confused with it; however, they do not occur in the Ft. McMurray area. It is found on decaying logs and stumps. PD4440, PD4448, PD4478, PD4732, PD4897, PD4899.

Dicranum fuscescens Turn. Occasional. It is identified by its falcate-secund to crisped leaves and its short slightly strumose capsules. It occurs on decaying logs. PD4468, PD4694, (PD4897 in pt.)

D. muehlenbeckii B.S.G. Rare. This moss is more common at higher elevations especially in the Rocky Mts. It is related to D. fuscescens, but differs in capsule shape and internal leaf anatomy. PD4680, PD5182.

D. polysetum Sw. Common. It is easily identified by its multiple setae and showy, light green, undulate leaves. A moss of well drained areas such as ridges in white spruce or aspen stands. PD4419, PD4421, PD4426, PD4459, PD4477, PD4497, PD4535, PD4637, PD4663, PD4804, PD4895, PD4930, PD4999, PD5107.

D. scoparium Hedw. Not common. This normally abundant species is distinguished by its long cells in the upper portion of the leaf and lamellae on the adaxial costal surface. Found once at Stand #41. PD4590, PD4836, PD4837, PD4838.

D. undulatum Brid. Very common. Typically found in calcareous fens growing in dense clumps. It is easily identified by its undulate leaves that are appresed to the stem, unlike the spreading ones of D. polysetum. PD4472, PD4578, PD4656, PD4761, PD4811, PD5000 (Fig. 10).

Distichium capillaceum (Hedw.) B.S.G. Occasional. Usually found in rock crevices or under sheltered ledges along streams. The disticous arrange of the setaceous leaves and the elongate erect capsule distinguish this species. PD4545.

D. inclinatum (Hedw.) B.C.G. Rare. This species, like D. capillaceum has leaves that are disticously arranged; however, instead of a long erect capsule, it has a shorter inclined one. It was collected twice, growing on tar sand outcroppings. PD4847, PD5092.

Ditrichum flexicaule (Schwaegr.) Hampe. Common. Found on calcareous soil, or well drained soil near streams. This species is distinguishable from Distichium by its spirally arranged leaves, and from Dicranum by its lack of differentiated alar cells. It was collected several times with young shoots that resemble flagellated branches. PD4573, PD4598, PD4605, PD4610, PD4717, PD4937, PD4939.

Drepanocladus aduncus (Hedw.) Warnst. Occasional. The genus is typically found in wet habitats. The species are mostly determined on the basis of stem anatomy and alar cell differentiation. D. aduncus has numerous inflated alar cells. PD4648, PD4863, PD4942, PD5081.

D. exannulatus (B.S.G.) Warnst. Occasional. Distinguished by serrulate flat leaves with a strong costa. PD4454, PD4529, PD4550, PD4686.

D. fluitans (Hedw.) Warnst. Not common. Usually found in semi-aquatic to aquatic habitat. It differs from D. exannulatus by a slender costa and fewer, smaller alar cells. PD4657.

D. revolvens (Sw.) Warnst. Common. This species has leaves that are often a reddish color, with few differentiated alar cells and circinate leaf tips. PD4565, PD4886, PD5014, PD5079.

D. uncinatus (Hedw.) Warnst. Common. This species is easily recognized by strongly plicate leaves. It occurs in dry to moist habitats such as logs, trees, and damp soil. PD4571, PD4671, PD4938, PD5025, PD5103.

Encalypta mutica Hagen. Rare. This species is usually associated with streams and highly calcareous soil. This locality represents a considerable range extension. Previously, its Alberta distribution was restricted to the Rocky Mts. PD4773, PD4774.

E. procera Bruch. Not common. Found on damp calcareous soil above a small stream. It is easily recognized by broad leaves and filiform broad bodies. PD4712, PD4778.

Figure 10. *Dicranum undulatum* is a conspicuous and common moss in the region.

Figure 11. This moss, *Funaria hygrometrica*, is common in the Fort McMurray area and has one of the largest distributions.

Encalypta rhabdocarpa Schwaegr. Not common. A small piliferous species usually occurring on dry calcareous soils, or sheltered areas such as rock crevices, or under the overhanging edge of soil banks. PD4414, PD4710, PD4711, PD4716, PD4770.

E. vulgaris Hedw. Rare. Similar in appearance to E. rhaptocarpa, but differs essentially on the absence of a peristome. PD5071.

Entodon cladorrhizans (Hedw.) C.M. Rare. Similar in appearance to the ubiquitous Pleurozium schreberi, but differs in having a flatter arrangement of leaves, and an erect capsule. It was found in two locations along the Athabasca River and these collections represent an important extension of its range in Alberta. It was formerly known only from the Edmonton area. PD4745, PD5100, PD5108.

Eurhynchium pulchellum (Hedw.) Jenn. Common. A slender, trailing species that is characterized by small, concave leaves that often give the moss a "clipped" appearance. It is commonly found on decaying logs and the forest floor. PD4460, PD4572, PD4829.

Fissidens bryoides Hedw. Rare. Found several times growing on soil in protected pockets. This tiny moss, when found, is identifiable by its small size and distinctive leaves that are arranged like those of an Iris. PD4501, PD4510, PD4920, PD5180.

Fontinalis hypnoides C.J. Hartm. Rare. Found twice in small streams attached to rocks. This aquatic genus is extremely difficult to work with owing to ecological variability. F. hypnoides is distinguished by very flat leaves while other species have either concave or keeled leaves. PD4768, PD4786.

Funaria hygrometrica Hedw. Common. Often abundant on burned over soil. This "cord moss" is distinguished by twisted setae (resembling cord) that often intertwine with each other, and an oblique capsule mouth. It is cosmopolitan in distribution. PD4494, PD4852, PD4904 (**Fig.** 11).

Grimmia agassizii (Sull. & Lesq. ex Sull.) Jaeg. & Sauerb. Rare. This species was found once on a partially inundiated rock. It can be distinguished from other members of the genus by almost parallel leaf sides and muticose leaf tips. PD4755.

G. alpicola Hedw. Rare. Growing on rocks near streams. This species is distinguished by spore size, (9-17 um as compared to 7-12 um for others). Most Grimmia species are unidentifiable in the sterile state. PD4756.

G. apocarpa Hedw. Uncommon. This species grows on dry rocks and is the most common member of the genus in the Ft. McMurray area. It differs from G. alpicola on spore size and from G. agassizii on leaf shape. PD4700, PD4703, PD4706, PD4714, PD4783, PD4785, PD4940, PD5074, PD5078.

G. flaccida. Rare. Differs from G. apocarpa in the eperistomate capsule. It was found once growing on a dry rock. PD5069.

Haplocladium microphyllum (Hedw.) Broth. Not common. A slender moss resembling Thuidium abietinum, but differing in single papillae per apical cell. It is usually found in moist logs in shaded areas. PD4511.

Hedwigia ciliata (Hedw.) P. Beauv. Rare. This rock species was found once on a large roadside boulder. It is distinguished by its ecostate leaves, hyaline leaf tips and ciliate perichaetial leaves. When dry it usually has a strong whitish appearance. PD5130.

Helodium blandowii (Web. & Mohr.) Warnst. Common. Usually found in brushy areas around calcareous fens. This species looks superficially like a member of the genus Thuidium, but unlike Thuidium, it has dense filamentous paraphyllia along the stem. PD4474, PD4490, PD4744, PD4800, PD4826.

Hygroamblystegium noterophilum (Sull. & Lesq. ex Sull.) Warnst. Rare. An aquatic species that is very coarse and rigid. It was found growing attached to a rock in a small stream. The species is new to Alberta, formerly known only from eastern North America. PD4595.

H. tenax (Hedw.) Jenn. Rare. An aquatic moss usually found in still water. It differs from H. noterophilum by a narrower, thinner costa. PD4647.

Hygrohypnum luridum (Hedw.) Jenn. Rare. An aquatic moss that was found on a partially submerged rock in a stream. It has deeply concave leaves and a moderately developed costa. PD4757, PD4758.

Hylocomnium splendens (Hedw.) B.S.G. Very common. Often called the "stair step moss" this species is large, feathery and easily identified. It and Pleurozium schreberi, are the most common species in the boreal forest, often forming extensive carpets hundreds of meters across. PD4580, PD4726, PD5139, PD5163, PD5169.

Hypnum cupressiforme Hedw. Not common. A species of rather dry habitats such as exposed banks and rocks. Its small size and numerous quadrate alar cells distinguish the species. PD5175.

H. lindbergii Mitt. Common. A fairly large species occurring in bogs or on wet soil. It has ribbed capsules and large, inflated alar cells. PD4432, PD4485, PD4507, PD4536, PD4566, PD4701, PD4760.

H. pratense Koch ex Brid. Rare. Similar in appearance to H. lindbergii, but differs mainly on a smooth capsule, and slightly inflated alar cells. It is usually found in and around fens and bogs. PD4862.

H. vaucheri Lesq. Rare. Found in dense clumps below a rock outcrop. The dense, erect growth habit helps distinguish this species in the field. PD4718, PD4782, PD5186.

Isopterygium pulchellum (Hedw.) Jaeg. & Sauerb. Occasional. Usually found on logs or tree bases in forested areas. This slender ecostate moss is quite shiny and has fairly complanate leaves. PD4777, PD4932.

Leptobryum pyriforme (Hedw.) Wils. Common. Usually on soil or humus in shaded areas. The setaceous leaves that somewhat resemble Ditrichum are slightly confusing; however, the distinctive pear-shaped capsules on long setae make identification rather easy. PD4439, PD4495, PD4515, PD4540, PD4548, PD4903.

Leptodictyum riparium (Hedw.) Warnst. Occasional. One of the most common aquatic species in the Ft. McMurray area. The lax, widely spaced leaves, long rhomboidal cells and the absence of differentiated alar cells distinguish this species. PD4435, PD4437, PD4512, PD4513, PD4596, PD4696, PD4695, PD4769, PD4864.

Meesia triquetra (L. ex Richt.) Ångstr. Not common. Usually found in calcareous areas such as fens. It is distinguished by its slightly recurved leaves and their tristichous arrangement. PD4885, PD4891, PD4966, PD5027, PD5089.

M. uliginosa Hedw. Common. Usually in wet humus or soil around bogs or fens. The extremely long seta and bent capsule are important characters in distinguishing the genus Meesia, and the ligulate, blunt leaves distinguish this species. PD4537, PD4621, PD4623, PD4881, PD4973.

Mnium marginatum (With.) Brid. ex P. Beauv. Common. A slender species usually growing with other mosses on decaying logs. The double teeth distinguish this species in the Ft. McMurray area. PD4436, PD4722, PD4724, PD5083.

Myurella julacea (Schwaegr.) B.S.G. Common. A very small moss that can be easily overlooked. As the name implies, it is very julaceous. It is distinguished from M. tenerrima by its rounded, usually obtuse leaves. It is found in protected areas on calcareous soils. PD4615, PD4719, PD4721, PD5057.

M. tenerrima (Brid.) Lindb. Not common. Similar to M. julacea, except for a slender, often reflexed leaf apex. PD4500, PD5077.

Neckera pennata Hedw. Rare. Found at one location on the base of an Aspen tree. It is distinguished by its ecostate, and transversely undulate leaves. PD5099.

Oncophorus wahlenbergii Brid. Common. This species is found on decaying logs along with Dicranum fuscescens and Orthodicranum flagellare. It has a sheathing leaf base and a strongly strumose capsule. PD4449, PD4524, PD4531, PD4685, PD4896, PD5128.

Orthodicranum flagellare (Hedw.) Very common. Usually on decaying logs growing with Dicranum fragilifolium and occasionally D. fuscescens. The straight capsule and flagellated branches readily distinguish this species. PD4462, PD4464, PD4469, PD4533, PD4592, PD4627, PD4684, PD4898, PD4933, PD5097.

Orthotrichum anomalum Hedw. Rare. On rocks in calcareous regions. It is one of the few members of this difficult genus that grow on rock. PD5015, PD5187.

O. cf. laevigatum Zett. forma macounii (Aust.) Lawt. & Vitt. Rare. This collection is sterile and cannot be positively identified; however, it was growing in the proper habitat (on rock) and compares favourably in gametophytic characters. PD4720.

Orthotrichum obtusifolium Brid. Common. Found on trunks of Aspen trees. It can be distinguished from O. speciosum var. elegans by leaves that are rounded and obtuse at the tips and plane margins. PD4442, PD4790, PD4923.

O. speciosum Nees **ex** Sturm var. elegans (Schwaegr. ex Hook. & Grev.) Warnst. Common. Like O. obtusifolium, this species occurs on the trunks of trees, usually Aspen. It differs in having acute tips and recurved margins. PD4443, PD4527, PD4791, PD4924.

Paludella squarrosa (Hedw.) Brid. Rare. Found once growing among Sphagnum in a black spruce bog. This small, striking moss should not be confused with any other species as it has strongly squarrose leaves that are extremely diagnostic. Due to its small size and habitat, it is often overlooked by an untrained eye. PD4887.

Plagiomnium ciliare (C.M.) Koponen. Common. The genus is distinguished from other members of the Mniaceae by single teeth along the margin. This species is dioicous and has sharp teeth to the base of the leaf. All species in the Ft. McMurray area occur in moist forest habitats such as on logs and humus. PD4430, PD4434, PD4438, PD4466, PD4480, PD4801.

P. cuspidatum (Hedw.) Koponen. Common. This species has sharp teeth extending only half way down the leaf margin. Its habitat is similar to P. ciliare. PD4523, PD4525, PD4681, PD4820, PD4828, PD4830.

P. elipticum (Brid.) Koponen. Common. Easily recognized by blunt teeth that are usually restricted to the upper half of the leaf. PD4567, PD4902, PD5030.

P. medium (B.S.G.) Koponen. Occasional. This species has sharp teeth to the leaf base as does P. ciliare, but differs in its synoicous sexual state. PD4687, PD4827.

Plagiothecium laetum B.S.G. Not common. A flat, glossy moss with symetric, complanate, slightly undulate leaves. It occurs in moist areas near tree bases or on damp humus in shaded areas. PD4482, PD4532, PD4565.

Platydictya jungermannioides (Brid.) Crum. Not common. This species grows in damp, shady places such as under rock ledges, in holes in logs, and on stumps and soil banks. It is very small, thread-like and easily overlooked. It lacks a costa and can therefore be distinguished from the genus Amblystegium. PD4502, PD4534, PD4775, PD4784.

Pleurozium schreberi (Brid.) Mitt. Very common. This large member of the boreal feather moss community is easily distinguished by its red stem and pale leaves. It is the most common species in the Ft. McMurray area and is found in almost all wooded areas. PD5137, PD5162, PD5170.

Pohlia cruda (Hedw.) Lindb. Not common. This species grows in shaded and sheltered places such as moist banks and crevices. It is distinguished by its pale green coloration and long upper leaf cells. PD4547, PD4643, PD4646, PD4780.

P. nutans (Hedw.) Lindb. Common. This species is usually found on decaying logs and on soil in forests. It is sometimes referred to as the "copper wire moss", since its setae are distinctively this color when mature. This characteristic is good for field identification. PD4441, PD4463, PD4890, PD4997, PD5082.

P. proligera (Kindb. ex Limpr.) Lindb. ex Arn. Not common. This species is identifiable by numerous long spiraled gemmae in the upper leaf axils. It was found in only one area, growing on a disturbed soil bank near the Athabasca River. It was abundant at this location. PD5145.

Pohlia wahlenbergii (Web. & Mohr.) Andr. Not common. Usually growing in wet habitats and can be distinguished by its pale-green coloration, red stems, and short upper leaf cells. PD4754, PD5098.

Polytrichum commune Hedw. Occasional. This species differs from other members of the genus by lacking hyaline margins that fold over the leaf surface. It is often found in wet areas surrounding mires and fens. PD4692, PD4746, PD4803.

P. juniperinum Hedw. Common. The "Juniper Moss" as it is commonly known is characterized by its scale-like leaves with a red awn. It is commonly found on disturbed soil and burned areas. PD4450, PD4539, PD4839, PD4889.

P. piliferum Hedw. Occasional. Similar to P. juniperinum except for a hyaline, instead of red, awn. It occurs on sandy soil, usually in Pine associations. PD4730, PD4737, PD4872, PD5096.

P. strictum Brid. Common. A slender species sometimes considered a variety of P. juniperinum. It is distinguished from the latter by its size, extensive tomentum at the leaf bases, and its habitat. Most commonly found in mixed Sphagnum hummocks. PD4465, PD4666, PD4814.

Pseudoleskeella tectorum (Funck. ex Brid.) Kindb. ex Broth. Rare. Usually occurring in thin mats over dry, exposed rocks. It is distinguished from other members of the Leskeaceae by the absence of a costa and no or small papillae. PD5054, PD5072.

Ptilium crista-castrensis (Hedw.) De Not. Common. Commonly called "Knights Plume", this moss is distinguished by its regular branching pattern, and leaves that turn toward the base. It is a common member of the boreal feather moss community. PD4445, PD4682, PD4808.

Pylaisiella polyantha (Hedw.) Grout. Common. This moss forms stockings on many Aspen trees in the Ft. McMurray area, and is usually found with abundant cylindrical capsules on long setae. PD4444, PD4544, PD4708.

Rhizomnium gracile Koponen. Occasional. The genus lacks teeth along the margin and this small species is distinguished by round leaves, a short costa and a habitat of fens and bogs. PD4626, PD4882, PD4998, PD5165.

Rhytidiadelphus triquetrus (Lindb. ex Limpr.) Warnst. Occasional. A large moss that occurs in loose mats. The leaves are strongly undulate and have a double costa. It grows in shaded coniferous woods, usually along stream and river drainages. PD4630, PD4698, PD4743, PD4751.

Rhytidium rugosum (Sull.) Kindb. Rare. A robust species distinguished from Rhytidiadelphus triquetrus by its strong single costa and lack of paraphyllia. Found on dry soil near exposed calcareous outcrops. PD4498, PD4699, PD4709, PD4844, PD5034.

Seligeria calcarea (Hedw.) B.S.G. Rare. This collection is a major range extension for this species, as it was previously known only from east of the Mississippi River. This minute moss, usually less than 2 mm high occurs on moist, sheltered calcareous rock. It was collected several times along Beaver Creek. PD4413, PD4771, PD5188.

Sphagnum angustifolium (Russow) C. Jens. Common. A small species that can be distinguished in Alberta by its two hanging branches per fascicle. It is found in large mats in weak or slightly minerotrophic habitats. PD4554, PD4557, PD4588, PD4841, PD4868, PD4888, PD4995.

S. centrale C. Jens. Rare. A robust species similar to S. magellanicum in external morphology. It differs in internal structure and lacks the reddish coloration usually found in the latter. S. centrale usually grows in shaded forest areas. It was collected once. PD4483.

Sphagnum fimbriatum Wils. Rare. This species is best distinguished by its stem leaves that are lacerate on the tip and sides. This collection, from a lake margin, represents the 4th locality for the species in Alberta. PD4587.

S. fuscum (Schimp.) Klinggr. Very common. A small brown species that usually occurs in compact hummocks associated with black spruce communities. PD4471, PD4553, PD4620, PD4667, PD4812, PD4856, PD4962, PD4994, PD5172.

S. magellanicum Brid. Occasional. A robust species identified by its turgid branches and reddish color. In the Ft. McMurray area it is usually found growing in small hummocks in calcareous areas. PD4452, PD4556, PD4868, PD4869.

S. nemoreum Scop. Common. As with many Sphagna, S. nemoreum is not easy for the non-specialist to distinguish in the field. It differs from other species mainly in microscopic characters, but may be tentatively identified by its round top, and delicate pink color. Usually in large mats or hummocks at edges of fens. PD4752, PD4809, PD4813, PD4840, PD4871.

S. obtusum Warnst. Rare. This species is moderately robust with obtuse leaves, and differs from S. angustifolium by its larger size and "greasy" sheen when wet. It was found along the edge of a lake growing with Carex spp. and S. magellanicum. PD4562.

S. platyphyllum (Braithw.) Warnst. Rare. A close relative of S. subsecundum, usually found in fens and at lake margins. These collections represent the 4th and 5th localities for the species in Alberta. PD4484, PD4589.

Sphagnum riparium Aongstr. Occasional. A moderately robust species, distinguished from similar Sphagna by the prominent rent in the stem leaves. It was found submerged near the edge of two lakes. PD4560, PD4669, PD4673.

S. russowii Warnst. Common. A flat topped species with pink coloration and notched leaves, usually occurring in wet woods or along fen margins in the Ft. McMurray area. PD4446, PD4451, PD4815, PD4870, PD5173.

S. squarrosum Crome. Common. A robust species with strongly squarrose leaves. It occurs in wet shaded areas, usually at fen margins or in spruce forests. PD4479, PD4486, PD4561, PD4586, PD4670, PD4816, PD4996, PD5013.

S. subsecundum Nees in Sturm. Not common. This small species is usually fairly common in Alberta, often found in minerotrophic mires. It was collected only once in the Ft. McMurray area. PD4484.

S. teres (Schimp.) Aongstr. Not common. A slender species with a prominent apical bud and slightly squarrose leaves. Usually found in minerotrophic mires and medium fens or lake shores and stream sides. PD4582, PD4585, PD4655, PD4993.

S. warnstorfii Russow. Very common. Similar to S. fuscum in appearance, but differs chiefly in its purplish coloration, and 5 ranked pattern of leaf arrangements. In the Ft. McMurray area, it occurs in extensive loose mats, usually associated with open black spruce fens. PD4470, PD4581, PD4583, PD4584, PD4591, PD4625, PD4649, PD4653, PD4655, PD4992, PD5009, PD5140, PD5141, PD5166.

Splachnum ampullaceum Hedw. Rare. This "dung moss" was found once growing on moose dung. It has only been collected in Alberta a few times, and is apparently specific to herbivore droppings. The large yellow to pink vial shaped capsules are diagnostic. PD5126.

Tetraphis pellucida Hedw. Occasional. A small moss characterized by its peristome of 4 large teeth and asexual reproduction by gemmae cups. It is found on shaded sides of decaying logs and stumps and is often overlooked. PD4447, PD4753, PD4762.

Tetraplodon angustatus (Hedw.) B.S.G. Occasional. The genus Tetraplodon is another group of "dung mosses"; however, they are usually found on carnivore dung. T. angustatus has short setae and serrate leaf margins. PD4558, PD4559, PD4608, PD4644, PD4874.

T. mnioides (Hedw.) B.S.G. Occasional. Similar to T. angustatus, but has long setae and entire leaf margins. This is usually the more common of the two species in Alberta; however, in the Ft. McMurray area, it was collected only twice. PD4551, PD4906.

Thuidium abietinum (Hedw.) B.S.G. Occasional. An easily recognized species. It differs from other members of the genus by branching patterns of only 1° pinnate. It is usually found in dry sites on calcareous soil. PD4705, PD4748, PD4849, PD4850, PD4851, PD4936.

T. recognitum (Hedw.) Lindb. Occasional. Usually on humus or soil in calcareous areas. The bipinnate stems separate it from T. abietinum. PD4467, PD4504, PD4638, PD5011, PD5104.

Timmia megapolitana Hedw. Common. Growing on moist soil in shaded areas, usually along streams. It resembles a small Polytrichum, but is quickly separated because it lacks lamellae. PD4433, PD4570, PD4645, PD4702.

Tomenthypnum nitens (Hedw.) Loeske. Common. A moderately robust species distinguished by its plicate leaves and dense, reddish tomentum that covers most of the stem. It is common in calcareous fens. PD4455, PD4499, PD4611, PD4512, PD4835, PD4968, PD4969.

Tortella fragilis (Hook. ex Drumm.) Limpr. Uncommon. Usually found on dry calcareous soil, or in rock crevices. The fragile, rigid leaves with shiny costae make this species easy to distinguish. PD4542, PD4597, PD4636, PD4776, PD5032.

Tortula mucronifolia Schwaegr. Uncommon. On calcareous soil, usually in shaded areas or rock crevices. This species is distinguished from other Tortula species by the lack of papillae. PD4499, PD4574, PD4763, PD5024.

T. ruralis (Hedw.) Gar. Uncommon. On dry soil or rocks in calcareous areas. It is distinguished by long hyaline awns, "C" shaped papillae, and twisted peristomes. PD4713, PD5031, PD5077.

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APPENDIX

The following paper has also been published in the Proceedings, Alberta Sulphur Gas Workshop III, edited by Dr. H.S. Sandhu, Alberta Research Secretariat.

A LICHEN NETWORK AS AN EARLY WARNING MONITOR OF INDUSTRY AIR EMISSIONS

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ABSTRACT

As the Syncrude development has been constructed, a number of air, vegetation and water quality monitoring devices have been investigated. One such device, a system of 56 permanent plots laid out in a symmetrical radiating pattern from the Syncrude plant site, utilizes two lichen species, *Parmelia sulcata* and *Hypogymnia physodes* as indicators of air quality. The initial plot establishment in 1976 may be followed by repeated full or partial resurveys. Measurements of growth, sulphate, sulphur and heavy metals can be made during each survey.

INTRODUCTION

During the period 1965 to the present a very extensive literature has developed with respect to air quality and lichens. The most comprehensive compendium of references covering all aspects of air pollution and lichens has been compiled by Ferry *et al.* (1973) and Hawksworth (1974, 1975, 1976). Three major categories of investigation have been identified by Nieboer *et al.* (1975). They consider that the broad subject areas are lichen distribution and abundance mapping, in vivo lichen transplant studies and in vitro lichen, alga and fungal SO_2 sensitivity experimentation. The work described here encompasses the first of these three categories.

Observations by Nylander (1866) demonstrated a zonation of lichens (according to air pollution levels) in an urban setting. Experimental work has now shown that a varied number of factors including sulphur dioxide concentration, humidity and light affect lichen sensitivity to air pollution.

Local or regional surveys of lichens have historically been completed after the pollution source is established and has created a measurable change in lichen flora. The formulation of a numerical scale of change has been developed by De Sloover and LeBlanc (1968) and can be utilized effectively as a means of impact assessment. It is a unique feature of the Syncrude lichen network that it has been established at a time when there is no quantitative evidence of lichens being affected by air quality in Fort McMurray, and the only significant emission source is that of Great Canadian Oil Sands. Stated otherwise, the lichen network is in place at time zero with respect to the Syncrude development.

OBJECTIVES

In setting up the lichen network Syncrude had four basic objectives including:

1) Sampling a representative lichen flora at each sample site.
2) Creating a permanent plot system.
3) Developing a statistically sound method of sampling and measuring lichen response to air quality.
4) Collecting and preserving representative lichen material from the McMurray area for taxonomic and analytic purposes.

METHODS

The region surrounding the Syncrude plant site was delineated by a circle of 50 km radius, within which plot sites were sought. During the first year's work (1975) air photos at a scale of 1:60,000 were scanned for possible plot locations within easy access of cutlines, roads or airstrips.

The predominant forest cover at each prospective plot was noted. Of the four forest communities in the McMurray area, white spruce *(Picea glauca)* and black spruce *(Picea mariana)* predominate. These species provide the most diverse corticolous habitat for lichens.

At each plot 40 quadrats, with dimensions 10 cm × 20 cm were set in equal numbers on trunks and branches. Each quadrat was subdivided into eight equal sections for estimates of cover and frequency. Quadrats were set on at least 10 trees to minimize future loss of data due to destruction of any tree. The cover and abundance data were transformed to prominence values (cover × frequency) for more valid interplot comparison (Table 1).

In the subsequent year (1976) the number of plots was increased to 56, with 7 plots on each of 8 radii from the Syncrude plant up to a maximum distance of 50 km. With increasing distance from the plant, plots were more widely spaced. Each quadrat location was marked with an aluminum tag stamped with quadrat and plot number. The plot location was marked on air photos for relocation, and each sampled tree mapped by compass direction and distance from all other sample trees (Figure 1) (Table 2).

Each quadrat was located on the tree trunk with nails. Unlike the 1975 survey, each quadrat was photographed using a shadow box covering the entire sample area. Colour slide film (ASA 25) was exposed at 1/60 second for all photographs, using a ring light source.

The exposed slides were projected on a screen with a uniform dot pattern superimposed. Counting the lichen thallus under the dots and dividing by the total number of dots gave percentage coverage of the thallus.

RESULTS OF THE PARTIAL AND FULL SURVEYS

At the conclusion of the 1975 season, twelve plots had been established in the four forest cover types common to the area.

SPECIES	Plot 1 - Aspen			Plot 2 - Black Spruce		
	C*	F**	PV***	C*	F**	PV***
Alectoria glabra				0.9±1.3	31.3±39.6	7.3±11.7
Caloplaca cerina	0.1±0.5	5.0±22.4	1.0±4.5			
Caloplaca holocarpa	1.3±1.2	81.9±29.4	12.2±12.5			
Candelaria concolor	0.01±0.02	0.6±2.8	0.02±0.09			
Candelariella vitellina	0.13±0.14	31.9±29.1	0.9±1.2			
Cetraria halei				0.3±0.5	15.0±20.1	1.7±3.1
Cetraria pinastri				0.3±0.3	45.6±33.5	2.3±3.3
Cladonia spp.				0.05±0.2	1.3±5.6	0.3±1.1
Evernia mesomorpha				3.7±7.9	53.1±41.3	35.0±79.4
Hypogymnia physodes				0.5±0.8	26.3±30.9	3.8±6.6
Lecanora allophana				0.01±0.02	1.3±5.6	0.03±0.1
Lecidea glomerulosa	0.09±0.2	4.7±8.3	1.6±1.0			
Parmelia subaurifera	0.07±0.2	1.3±3.9	0.3±0.8			
Parmelia sulcata	0.2±0.6	3.8±10.0	0.9±3.8	1.8±3.4	41.9±36.8	16.3±34.1
Parmeliopsis ambigua				2.1±7.3	16.3±26.3	17.7±63.6
Pertusaria multipuncta	0.06±0.3	1.3±5.6	0.3±1.4	1.0±4.0	7.5±24.5	9.4±40.2
Physcia adscendens	2.5±1.9	88.8±25.6	24.7±18.2			
Physcia aipolia	2.5±2.4	45.6±28.5	19.0±21.2			
Physcia orbicularis	0.07±0.2	2.5±6.5	0.3±0.8			
Usnea spp. (tufted)				32.4±16.0	98.1±8.4	323.8±160.0
Xanthoria polycarpa	0.4±0.1	1.9±4.6	0.2±0.4			

Table 1. Cover*, Cover Frequency** and Prominence Values*** in Plots 1 and 2.

PLOT 1				PLOT 2			
Tree No.	Tree Type	Distance to Next Tree (meters)	Azimuth to Next Tree	Tree No.	Tree Type	Distance to Next Tree (meters)	Azimuth to Next Tree
1	Black spruce	5.8	144°	1	Balsam poplar	4.1	298°
2	Black spruce	0.6	246°	2	Black spruce	6.4	170°
3	Black spruce	1.8	82°	3	Black spruce	same tree as 2	
4	Black spruce	3.8	0°	4	Black spruce	2.8	62°
5	Black spruce	2.6	81°	5	Black spruce	7.4	156°
6	Black spruce	0.4	175°	6	Black spruce	4.9	244°
7	Black spruce	3.0	92°	7	Black spruce	7.8	246°
8	Black spruce	same tree as 7		8	Black spruce	2.5	276°
9	Black spruce	4.5	170°	9	Black spruce	same tree as 8	
10	Black spruce	same tree as 9		10	Black spruce	0.7	298°
11	Black spruce	2.1	52°	11	Black spruce	same tree as 10	
12	Black spruce	9.7	80°	12	Black spruce	2.6	210°
13	Larch	same tree as 12		13	Black spruce	1.5	0°
14	Larch	2.2	60°	14	Black spruce	same tree as 13	
15	Black spruce	4.2	336°	15	Black spruce	0.5	20°
16	Black spruce	7.1	38°	16	Black spruce	same tree as 15	
17	Black spruce	5.5	142°	17	Balsam poplar	1.8	320°
18	Larch	4.4	95°	18	Balsam poplar	1.5	252°
19	Aspen	1.9	12°	19	Balsam poplar	3.0	236°
20	Black spruce			20	Balsam poplar		

Table 2. Descriptive Location of Sample Trees Within Plots 1 and 2.

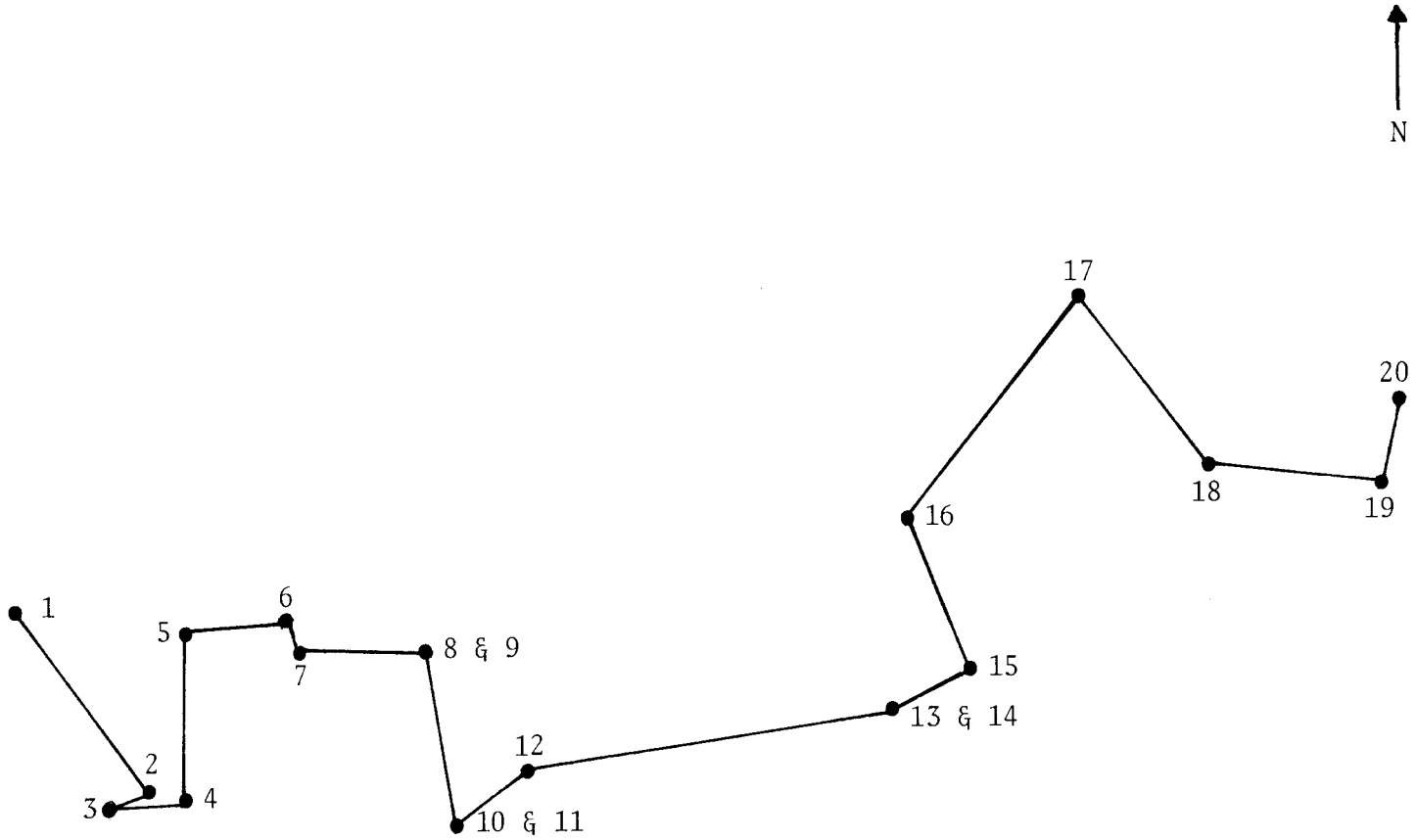

Figure 1. Configuration of sampled trees within plot #1.

● = Tree with numbered quadrat

2M

Lichens common to the white spruce communities include *Parmelia sulcata* and *Usnea sorediifera* on branches and trunks, while *Hypogymnia physodes* is common on trunks. Ground cover includes a consistently high measure of *Peltigera aphthosa*.

The black spruce forest, often with a larch (*Larix laricina*) component is commonly associated with a high lichen flora. *Parmelia sulcata* and *Usnea sorediifera* are important on branches and trunks creating a pendulous mass of wefts throughout the canopy. *Evernia mesomorpha* is common to branches and *Hypogymnia physodes* to trunks. *Cladonia spp.* are prominent ground cover.

Aspen is not a good hunting ground for lichens, and the smooth bark is particularly unsuitable to most lichens. *Physcia aipolia* is most common on aspen tree trunks.

Jack pine (*Pinus banksiana*) stands are associated with relict sand dunes in the area and have poor lichen flora on the tree trunks and branches.

The initial survey demonstrated a very high degree of error in field cover determinations. Since much of the value of the monitoring plots depends upon detection of small cover changes, the shadow box photography method was chosen in preference to visual field evaluation.

Lichen species richness within certain forest stands was high but few lichen species were common to all chosen plot areas. In addition, certain lichen species are poorly documented for taxonomic purposes, and could provide problems at a later date when resurveys are conducted. *Alectorsia*, *Ramalina* and *Usneas* are particularly troublesome. Many lichens are very small and would present growth analysis problems.

For these reasons, plots were located in black and white spruce stands. Lichens chosen for quadrat analysis were *Parmelia sulcata*, *Hypogymnia physodes* and occasionally *Physcia adscendens* or *Parmeliopsis spp.* Cover values for *Parmelia sulcata* never exceeded 24% (Plot 30) and were as low as 0.48% (Plot 16).

Hypogymnia physodes reached a cover value of 15.01% and was as low as 0.55% (Plot 5).

DISCUSSION AND FUTURE WORK

Few opportunities are presented for the evaluation in one area of lichen species composition and 'state of health', prior to startup of a major facility emitting substantial quantities of air pollutants. The only instance we are aware of in the literature is that of a lichen survey conducted in Tennessee prior to operation of a coal fired power plant. However, in this case lichen cover and abundance were visually estimated and no accurate assessment of growth could be made from the sample thalli.

Evidently we are in a position to document lichen species change as well as individual growth patterns, over time. Numerous studies have been carried out to elucidate the factors and mechanisms affecting lichen growth or decline. Fortunately much of this work has been carried out using *Parmelia spp.* and *Hypogymnia* spp. as two major lichen monitors. There should, therefore, be possibilities to discriminate between the effects of sulphur dioxide, nitrous oxides or general senescence when resurveys are conducted in the Mildred Lake area. We feel that further studies should be conducted on material collected in and around Fort McMurray particularly as these thalli may be responsive to environmental factors in a number of ways peculiar to the area. As an initial step, collections were made of *Parmelia sulcata, Peltigera aphthosa, Hylocommium splendens* and *Pleurozium schreberi*. These materials are sealed in airtight containers and may be used at a later date for biochemical analyses as well as physiological testing.

Conditions of Use

Peterson, W.L. and G.W. Douglas, 1977. Air quality monitoring with a lichen network: Baseline data. Syncrude Canada Ltd., Edmonton, Alberta. Environmental Research Monograph 1977-5. 79 pp.