ESTABLISHMENT AND VEGETATION SURVEY OF 16 *PINUS BANKSIANA* - DOMINATED PERMANENT PLOTS FOR THE ATHABASCA OIL SANDS ECOLOGICAL MONITORING PROJECT IN 1981

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by

GEORGE H. LA ROI
MIKE OSTAFICHUK

for

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ABSTRACT

Sixteen, undisturbed, 5-hectare, permanent plots dominated by *Pinus banksiana* (jack pine) were established along an impingement gradient of atmospheric emissions from oil sands processing plants north of Fort McMurray in northern Alberta in August of 1981. Four plots were burned over by wildfire shortly afterwards and will belong to the very young age-class (1-10 yrs) until 1991. Seven plots are young age-class (11-50 yrs) and four are middle age-class (51-110 yrs). Fourteen plots are located on Eluviated Dystric Brunisols derived from sand; two plots are on Gray Luvisols derived from clay-rich, stoney till.

One 50 x 50 m reference stand was grid-staked into 100 5 x 5 m sampling units in each permanent plot for long-term, ecological monitoring purposes. The vascular plant and bryophyte--lichen community components of each reference stand were quantitatively surveyed for species composition, species richness, species structure, and species dominance hierarchy. Stand ages were determined from tree increment cores.

All reference stands have low % covers of trees, forbs, graminoids, and pteridophytes; most have a moderate cover of dwarf shrubs and a relatively high cover of terrestrial lichens; some have moderate covers of tall shrubs and feather mosses. Vascular species richness and equitability seem to increase with increasing soil moisture but are not correlated with either stand age or tree cover. Terrestrial lichen cover decreases and feather moss cover increases with increasing vascular species richness.

In terms of % cover, the dominant plant species of the permanent plot system in 1981 were: *Pinus banksiana*, *Arctostaphylos uva-ursi* (bearberry), *Vaccinium vitis-idaea* (lingon-berry), *Vaccinium myrtilloides* (blueberry), *Linnaea borealis* (twin flower), *Maianthemum canadense* (wild lily of the valley) in the vascular component; and *Cladina mitis* (Reindeer lichen), *Cladonia gracilis*, *Cladonia cornuta*, *Peltigera malacea*, *Polytrichum piliferum* (hair-cap moss), *Pleurozium schreberi* (red-stem feather moss) in the bryophyte-lichen component.

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This study was conducted under the scientific supervision of Dr. Percy Sims of the Research Management Division, whose help we greatly appreciated, and was made possible by a research contract from the Research Management Division of the Alberta Department of the Environment (RMD-80/35A), which is gratefully acknowledged. Evelyn Jamha typed the final manuscript.

1. INTRODUCTION

The two principal objectives of this study were: (1) to establish a set of *Pinus banksiana* (jack pine) dominated permanent plots, including young and middle age-classes, along a gradient of aerial emissions from existing oil sands plants in the Athabasca Oil Sands region of northern Alberta; and (2) to conduct an intensive survey of the plant community components of the terrestrial ecosystems found in these plots.

These objectives were accomplished in August of 1981 by a team of six vegetation scientists working from the Mildred Lake field station *via* helicopter, after preliminary site selection from existing maps and airphotos of the region.

One of the purposes of the ecological monitoring research program is to develop economically reasonable methods for the detection and assessment of the effects of aerial emissions (e.g., SO_2, NO_x, heavy metals) from oil sands processing plants on the surrounding terrestrial ecosystems, both natural and cultural. Realizing that these effects may be both subtle and cumulative, and possibly deleterious, the Research Management Division decided to establish a set of permanent plots representative of the major terrestrial ecosystem types in the region and to conduct appropriate research in these plots which would lead to the desired monitoring capability.

Since *Pinus banksiana* vegetation covers an important fraction of the upland physical landscape of the region, especially on Brunisolic soils derived from sandy, aeolian, parent materials (Stringer 1976), and because *P. banksiana* - dominated ecosystems are potentially more susceptible to emissions impact than those on more fertile soils, it was decided to initiate the research program in the *Pinus banksiana*/Brunisol habitat type.

As vegetation scientists we are certain that the plant community component of a terrestrial ecosystem can become a very sensitive tool for the detection and assessment of environmental changes, both natural and man-caused, given an adequate knowledge of its structure, function, and response behavior. One of the chief motivations for our continuing basic research program on the

structural dynamics of boreal ecosystems at Hondo, Alberta, is to acquire the necessary information on plant community behavior in relatively clean airsheds that will enable us to develop this tool for use in contaminated airsheds. In this context, it is important to emphasize that the boreal vegetation of the Athabasca Oil Sands region is very similar to that of the Hondo - Lesser Slave Lake region; both fall within the Moist Subregion of the Boreal Mixedwood Ecoregion 8 of Strong and Leggatt (1981) and the Mixedwood Section 18a of the Boreal Forest Region of Rowe (1972); and both contain extensive areas of aeolian sand parent material of the Heart Complex occupied by *Pinus banksiana* forests.

2. STUDY AREA

All permanent plots are located within the area known as the Alberta Oil Sands Environmental Research Program (AOSERP) area (Figure 1), in which numerous environmental research studies have been conducted (Smith 1981). The precise locations of each permanent plot are detailed in Table 1. This area has a dry, continental, middle boreal macroclimate; pertinent climatological normals may be found in Environment Canada (1975); a comprehensive soil survey has recently been completed for the AOSERP area by Turchenek (1981).

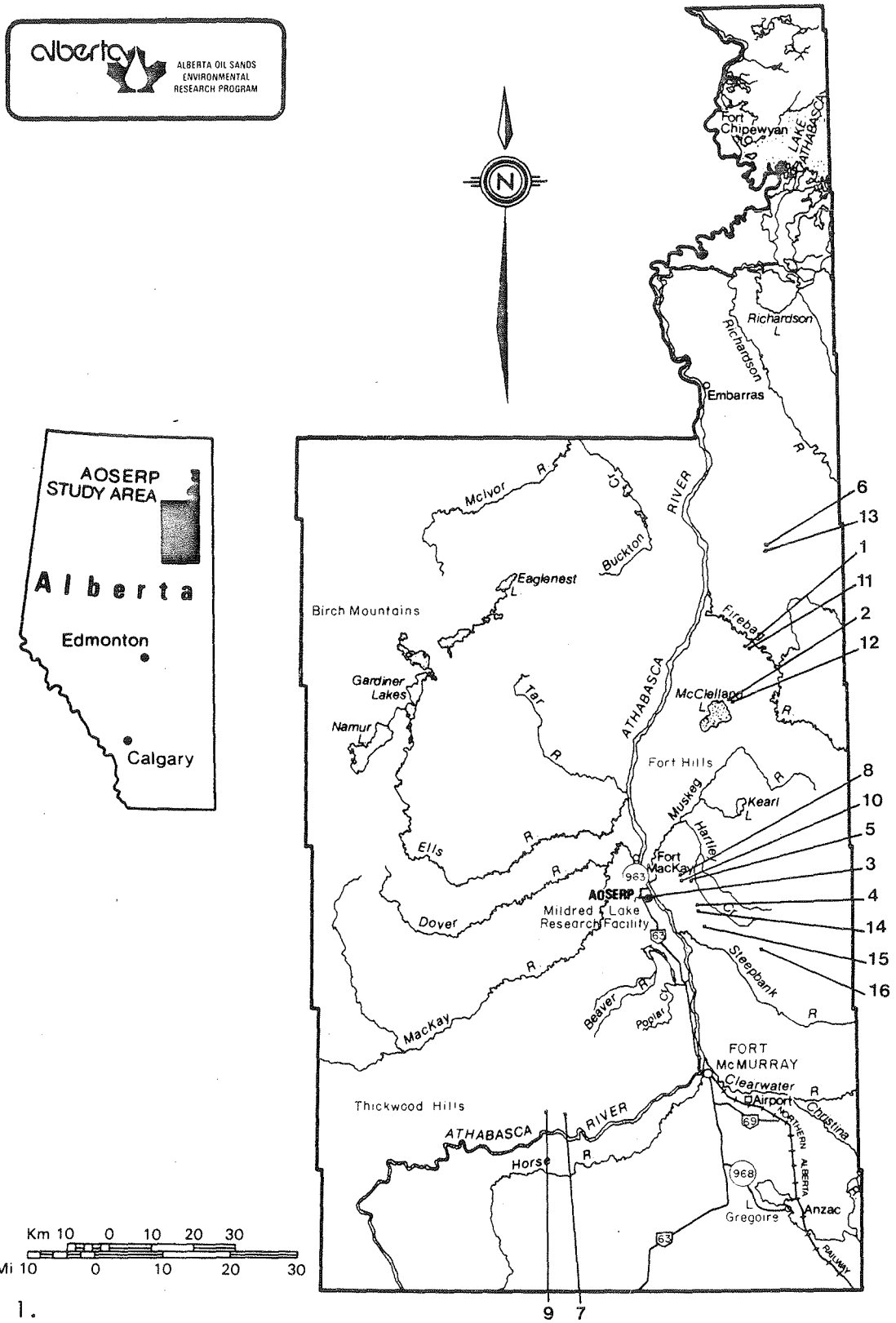


Figure 1.

Approximate locations of the 16 *Pinus banksiana* - dominated permanent plots in the Athabasca Oil Sands area of northern Alberta.

3. METHODS

3.1 CRITERIA FOR SELECTION OF PERMANENT PLOTS

Permanent plots were selected according to the following criteria: (1) total dominance of the tree stratum by *Pinus banksiana*; (2) area not less than 5 ha, preferably surrounded by similar vegetation to minimize edge and island effects; (3) area undisturbed by human activities on the ground; (4) tree populations of *P. banksiana* to fall within either a young age-class (11-50 yrs) or a middle age-class (51-110 yrs); (5) good representation along the present gradient of aerial emissions from oil sands processing plants (i.e., Suncor and Syncrude), as defined by the impingement map of Thomson (1981, Figure 1, Present Scenario), including one plot per age-class in emission-free (control) areas.

The strategy of permanent plot deployment was to ensure that young and middle-aged *P. banksiana* stands were located in areas of high, medium, low and no impingement so that the responses of these ecosystems to varying concentrations of emissions can be observed. We recognize that the impingement map may not be very accurate and that new oil sands plants will significantly alter the present gradient.

3.2 PROCEDURE FOR ESTABLISHMENT OF PERMANENT PLOTS

The first quantitative survey of vegetation in the AOSERP area was completed by Stringer (1976). Forest cover maps of various scales have been prepared by the Alberta Forest Service for parts of the AOSERP area since the early 1960's. A vegetation map of the area was completed in 1978 (Thompson et al. 1978). Airphotos of several scales and film types provide reasonably complete coverage of the AOSERP area.

A preliminary reconnaissance for potential permanent plots representative of all major habitat types in the AOSERP area was completed *via* helicopter by R.A. Ellis (vegetation) and L. Turchenek (soils and parent materials) in October 1980. A total of 26 possible plots was found, including 11 dominated by *Pinus banksiana* with

Eluviated Dystric Brunisolic soils (Ellis and Turchenek 1980). More recently Turchenek (1981) completed a soil map (scale 1:126,270) of the AOSERP area.

Using the above information in conjunction with the plot selection criteria (3.1) and additional helicopter reconnaissance work, 16 suitable plots were located, 14 of which are on Eluviated Dystric Brunisols (tentative identification), in August 1981. All of these plots are situated near good helicopter landing sites or access roads.

After determining compliance with selection criteria on the ground, the 5 ha permanent plot was delineated in a NS x EW rectilinear configuration (square 224 x 224 m wherever possible) using compass, string, and blue tree marking paint. Time permitting, an inner 2 ha intensive study plot was delineated in the same manner. Two weeks later an Alberta Forest Service mensuration team marked additional trees around the boundaries of the 5 ha plots, to make certain that accidental disturbance by man would not occur.

3.3. PROCEDURE FOR ESTABLISHMENT OF REFERENCE STANDS WITHIN PERMANENT PLOTS

One 50 x 50 m (1/4 ha) reference stand was established inside the boundaries of each permanent plot, usually near one of its corners, within the 2 ha intensive study plot. Using declination--corrected compasses, cloth metric tapes, 121 one-meter lengths of 2.5 cm diameter white PVC pipe, and a Dymo tape labelling tool, the reference stand was gridded and staked into 100 5 x 5 m square sampling units, each identified on its SW corner post, by inserting stakes at 5 m intervals parallel to and 5 m from the initial 50 m baseline along the S boundary of the reference stand, then repeating this process, always starting from the 50 m baseline along the W boundary, until the grid was complete.

Figure 2 shows the configuration, compass orientation, and sampling unit numbering system employed in all 16 reference stands. The same dimensions and procedures were used in establishing eight reference stands in the Hondo - Lesser Slave Lake region in 1980. One

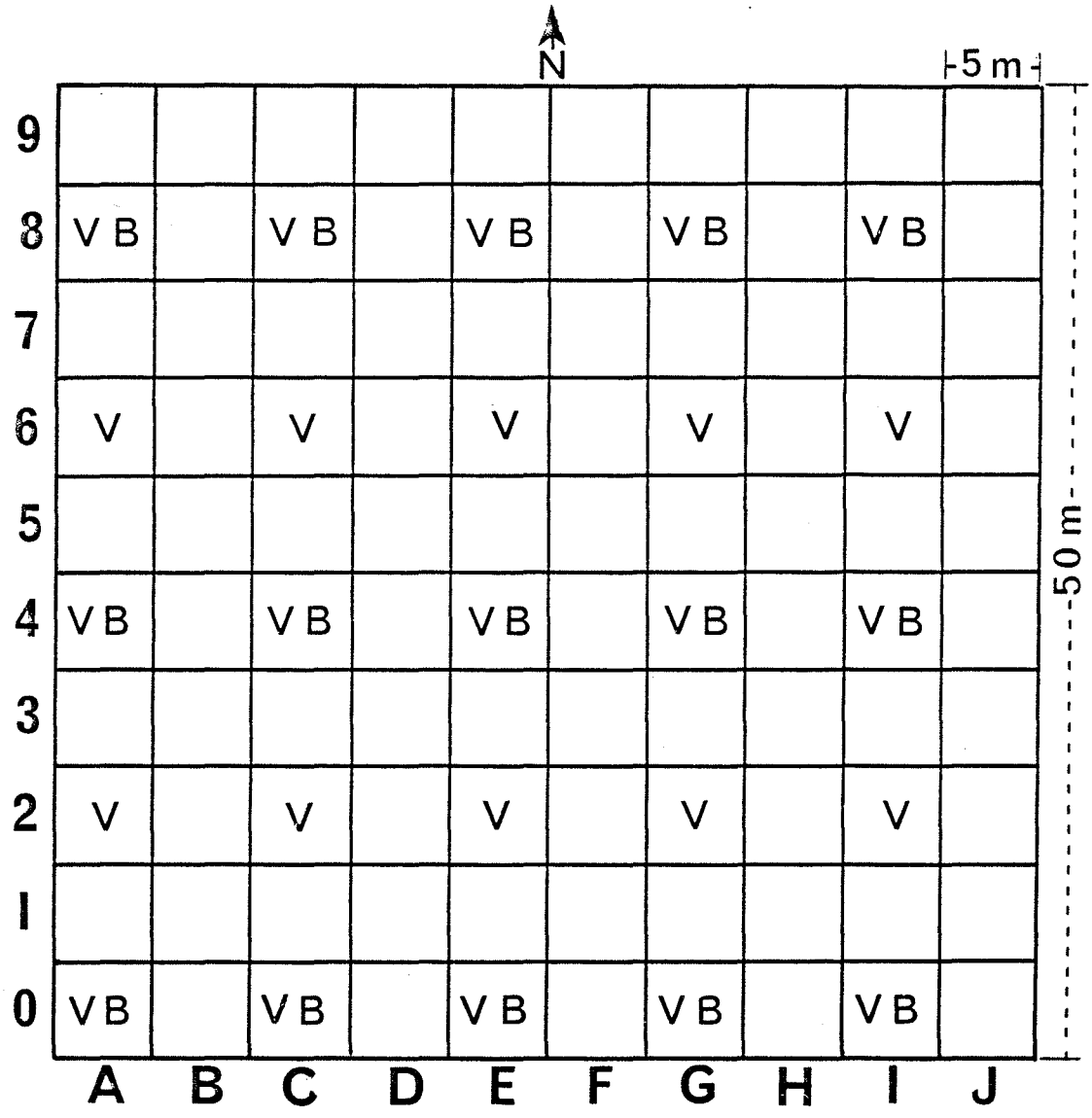


Figure 2.

Dimensions and orientation of standard reference stand established in each of the 16 *Pinus banksiana* - dominated permanent plots of the Athabasca Oil Sands area in northern Alberta. 'V' and 'B' in the 5 x 5 m squares denote the sampling units for surveys of the vascular and bryoid (bryophyte + lichen) community components.

reference stand can be established by an experienced team of three persons in 3 to 5 hours, depending upon the nature and extent of understory vegetation and deadfall, topography, weather, etc.

Reference stands are numbered in order of increasing age (see 3.5); nos. 1 to 14 occurred on Eluviated Dystric Brunisols, and nos. 15 and 16 occurred on Gray Luvisols.

3.4 PROCEDURE FOR SURVEY OF PLANT COMMUNITIES IN REFERENCE STANDS

3.4.1 Vascular Plant Community

Ocular estimates of the above-ground live shoot cover (i.e., area of vertical projection of leaves, stems, flowers, fruits, etc. expressed as a fraction of plot area) of each vascular plant species population were made to the nearest 1% ('+' for *ca.* 0.5%, 'R' for *ca.* 0.1%, '•' for *ca.* 0.01%) in each of 25 of the 100 5 x 5 m sampling units in the reference stand. Sampling intensity was therefore 25% for vascular species; sample size (n) was 25; means and standard deviations of plant cover were computed for each species based on this sample. Placement of the sampling units was the same in all reference stands, i.e., a systematic arrangement of alternate squares (columns A, C, E, G, I) in alternate 'survey rows' (0, 2, 4, 6, 8) such that 'control rows' 1, 3, 5, 7, and 9 were not disturbed by the survey process. Figure 2 gives the locations of surveyed sampling units ('V' = vascular). Plot frequency was determined for each vascular plant species based on its % occurrence in the 25 sampling units.

Plants need not be rooted in the 5 x 5 m sampling units to be included in the cover and plot frequency estimations of the species population to which they belong; hence portions of tree crowns overhanging the sampling unit were included in the cover estimate for that sampling unit.

Vascular plant species are tabulated by major growth-form groups in the individual reference stand tables and synthesis table of Results; these groups are tree, shrub, forb, graminoid, and pteridophyte; estimated cover of growth-forms was computed as the summation

of their component species' cover estimates. Vascular plant species nomenclature follows Moss (1959).

3.4.2 Terrestrial Bryophyte and Lichen Community

Bryophyte and lichen species growing on or near the forest floor were surveyed in the same manner as vascular plant species except that the sample consisted of 15 5 x 5 m units rather than 25. Since these plants are far smaller than vasculars, the usual practice in forest community analysis is to use smaller plots rather than fewer plots. The decision to use sampling units of equal size for all plant species in the reference stands permits comparison of both the means and standard deviations of cover estimates of all species, which should offer opportunities for comparison of species performance between as well as within growth-form groups. Figure 2 give the locations of sampling units surveyed for bryophytes and lichens ('B' = 'bryoid', the collective term).

Bryoid species are tabulated by major growth-form groups in the individual reference stand tables and synthesis table of Results; these groups are bryophytes, terrestrial lichens, and 'epiphytic lichens' (i.e., lichens growing on tree bases, logs, etc. within 30 cm of the ground surface). Moss species nomenclature follows Crum et al. (1973); liverworts follow Bird and Hong (1975); lichens follow Hale and Culberson (1970) and Brodo and Hawksworth (1977).

3.4.3 Photographic Documentation

Several color slide photos of representative parts of the plant community were taken in and around the reference stands and from the helicopter. The best of these are given in section 4.2.

3.5 STAND AGE AND ORIGIN

The ages, diameters, and heights of three to five dominant and subdominant *Pinus banksiana* trees in or near the reference stands were determined from ring counts of increment cores taken *ca.* 35 cm above ground. The cores are mounted in standard core-holders and deposited in the dendrochronology collection of the Plant Ecology

Section, Department of Botany, University of Alberta. Stand ages were based on a ring count from the oldest cored tree + 5 years, except in one stand (no. 8) where the oldest trees bore fire scars and were greatly outnumbered by a more recent, post-fire cohort; the oldest tree of the latter cohort defined stand age. Five years is the estimated time for a seedling to reach 35 cm height.

In very young and stagnated *Pinus banksiana* stands three to five trees were felled at *ca.* 5 cm above ground and discs cut from the stem bases for age determinations. These discs are deposited as per increment cores.

Six stands had one to several fire-scarred trees. Wedges were sawn from some of these trees in an attempt to determine the precise dates of previous fires, i.e., 'stand origin dates' (Tande 1979). These wedges are deposited as per increment cores.

No attempt was made to determine the age-structure or fire history of reference stands or permanent plots. Such work will require much larger and geographically more extensive dendrochronological samples.

4. RESULTS

Most of the results of this study are most efficiently presented in quantitative, tabular form. Hence the brief texts of the following sections are chiefly intended to facilitate interpretation and use of tabulated statistics from the permanent plots and reference stands.

4.1 LOCATIONS OF THE PERMANENT PLOTS

4.1.1 Geographic Position

Table 1 gives the geographic coordinates, legal subdivisions, and airphoto coordinates of the 16 *Pinus banksiana* - dominated permanent plots. Figure 1 shows the approximate positions of the permanent plots on the AOSERP area map. (Note: hereafter in the text of this report the permanent plots are numbered according to the simpler 1 to 16 series of reference stands rather than by their original and more awkward reconnaissance numbers (see Table 1)).

The permanent plots may be assigned to three geographic groups: (1) Central, consisting of nos. 3, 4, 5, 8, 10, 14, 15, 16, of which all save no. 3 (Mildred Lake) are located East of the Athabasca River opposite the present oil sands processing plants; (2) Southwest, consisting of nos. 7 and 9, both located North of the Athabasca River and *ca.* 40 km West of Fort McMurray; (3) Northeast, consisting of nos. 1, 2, 6, 11, 12, 13, all of which are located East of the Athabasca River between McClelland Lake and the Richardson fire lookout tower.

4.1.2. Impingement Zones and Age-Classes

Based on their positions on the atmospheric emissions impingement map of Thomson (1981; Figure 1, Present Scenario) and the ages of their component reference stands, the 16 permanent plots are assigned to 9 out of a possible 12 combinations of six impingement zones and two age-classes (Table 2).

Table 1. Locations of the 16 *Pinus banksiana* - dominated permanent plots in the Athabasca Oil Sands area of northern Alberta. Airphoto coordinates originate from the SW corner of the photo image.

Reference Stand Number	Permanent Plot Number[a]	Geographic Coordinates		Legal Subdivisions	Airphoto Coordinates		
		Latitude (N)	Longitude (W)	Sect-Twnp-Range (All W of 4th Mer)	Photo Number	X (mm)	Y (mm)
1	25	57°37'30"	111°12'30"	NE26-99-8	A23888-119	58	152
2	55	57°31'	111°15'20"	SE20-98-8	A23888-135	46	85
3	6	57°4'30"	111°35'30"	NE18-93-10	A23869-177	158	68
4	21	57°3'55"	111°24'45"	SE17-93-9	A23886-88	56	188
5	57	57°7'15"	111°25'30"	SE6/SW5-94-9	A23869-179	165	163
6	58	57°50'10"	111°7'30"	SE7/SW8-102-7	A37474*IR*-58	59	81
7	9	56°37'30"	111°55'45"	NE12-88-13	A23884-150	53	174
8	18B	57°7'40"	111°28'	NE1-94-10	A23869-179	119	178
9	52	56°37'50"	111°59'50"	NW15-88-13	A23884-149	37	177
10	18A	57°7'15"	111°27'30"	SE1-94-10	A23869-179	130	164
11	24	57°37'30"	111°11'30"	NE26-99-8	A23888-119	71	152
12	54	57°30'40"	111°15'20"	NE17-98-8	A23888-135	46	71
13	59	57°50'	111°7'40"	SE7/NE6-102-7	A37474*IR*-58	58	77
14	20	57°3'40"	111°24'40"	SE17-93-9	A23886-88	57	183
15	51	57°1'45"	111°22'50"	NE33-92-9	A23886-88	94	111
16	56	56°59'30"	111°10'30"	NW23-92-8	A23886-86	143	40

[a] Hereafter in this report the permanent plots are numbered 1-16 as per reference stands.

Table 2. Combined atmospheric emission impingement - stand age classification of the 16 *Pinus banksiana* - dominated permanent plots[a] in the Athabasca Oil Sands area of northern Alberta as they existed when surveyed in August, 1981[b]. The impingement zones are based on Thomson (1981).

Impingement Zone (ppb)	Stand Age-Class: Young (11 to 50 yrs)	Stand Age-Class: Middle (51 to 110 yrs)	Total Plots
0. Control (*ca.* 0)	6[b]	13[b]	2
1. Very Low (0 to 2.5)	1[b], 7	9, 11[b]	4
2. Low (2.6 to 5.0)	2, 3, 8	10, 12	5
3. Medium (5.1 to 7.5)	5, 16[c]	-	2
4. High (7.6 to 10.0)	4, 14[d]	-	2
5. Very High (>10.0)	15[c]	-	1
Total Plots	11	5	16

[a] Permanent plots are numbered according to the simpler 1 to 16 system of their component reference stands (see Table 1).

[b] Nos. 1, 6, 11, and 13 were burned over by a wildfire *ca.* two weeks after establishment and survey; from 1981 through 1991 they will belong to the very young stand age-class (1 to 10 yrs).

[c] Nos. 15 and 16 are located on clay-rich, stoney till parent material; the other 11 permanent plots are on sands.

[d] No. 14 is dominated by *P. banksiana* trees in the 111 to 133 yr age range, but its understory community originated after an intense ground fire in 1943-44 and is therefore *ca.* 38 yrs old (see also Table 3).

Nine permanent plots belonged to the young age-class (11 to 50 yrs) on the survey date; two of these (nos. 1 and 6) were burned over by a wildfire *ca.* two weeks after being surveyed and now belong to the very young age-class (1 to 10 yrs). Five permanent plots belonged to the middle age-class (51 to 110 yrs) on the survey date; two of these (nos. 11 and 13) were also burned over in late August of 1981 and now belong to the very young age-class. As of the date of this report four permanent plots fall into the very young, nine into the young, and three into the middle age-class.

Each of the one control and five impingement zones contains at least one permanent plot and five zones contain two or more plots (Table 2). Owing to the small areas presently occupied by the High and Very High impingement zones (Thomson 1981) and to the fact that these areas are mostly covered by poorly drained peatland vegetation, only two permanent plots with Dystric Brunisolic sand soils were established in them. However, two *Pinus banksiana* - dominated permanent plots on relatively fertile, clay-rich, stoney Gray Luvisolic soils were also established in the Medium and Very High impingement zones.

The present status of the permanent plot system in relation to the first principal objective of this study (see section 1.) may be summarized as follows:

(1) Four very young age-class (1981 fire origin date) permanent plots on Dystric Brunisols are located in the Control and Very Low impingement zones;

(2) Seven young age-class permanent plots on Dystric Brunisols are located along an impingement gradient from Very Low to High;

(3) Two young age-class permanent plots on Gray Luvisols are located in the Medium and Very High impingement zones;

(4) Three middle age-class permanent plots on Dystric Brunisols are located in the Very Low and Low impingement zones.

4.2 AGES AND ORIGINS OF REFERENCE STANDS

The ages of reference stands when surveyed in August of 1981 varied from 13 yrs in no. 1 to 133 yrs in no. 14 (Table 3). Eight stands fell within the 38 to 45 yr age range, including nos. 15 and 16 on Gray Luvisols. Three stands have experienced ground fires at least once since establishment of their dominant trees (nos. 8, 12, 14). Although the trees in no. 14 recruited in 1848, their numerous fire scars indicate that the stand's understory originated after the ground fire of 1943-44; hence this stand is placed in the young age-class in Table 2.

Live tree densities varied greatly among reference stands, from *ca.* 34,000 stems ha^{-1} in no. 2 to *ca.* 800 ha^{-1} in no. 14, probably because of wide differences in wildfire frequency and intensity in the AOSERP area, as well as natural thinning processes during stand maturation. Stand no. 2 (34 yrs) was the only 'dog hair' permanent plot established; its stunted dwarf trees were much smaller than those in no. 1 (13 yrs).

Only six reference stands had living fire-scarred trees from which precise origin dates could be inferred (Table 3). These dates are 1907, 1921, 1926, 1943, 1944. The AOSERP area has a complex fire history, judging from the mosaic of different age-classes visible from the helicopter and on airphotos. Several dry lightning fires were started during the survey period. This fact, coupled with the dangers of disturbance to permanent plots from other causes, requires that an adequately replicated system of ecological monitoring stations should be created in the study area.

4.3 PHOTOGRAPHS OF VEGETATION IN PERMANENT PLOTS

An annotated set of 61 color slides is included in the Appendix (section 7.) of this report. These photos document the August 1981 vegetation of the 16 permanent plots from four perspectives, wherever possible: (1) aerial oblique from the helicopter, often with a red marker placed in the NE corner of the reference stand, to show the physiognomic features and landscape position; (2) ground lateral in the reference stand, to show the typical

Table 3. Ages and origin dates of reference stands in the 16 *Pinus banksiana* - dominated permanent plots of the Athabasca Oil Sands area in northern Alberta. Tree ages are from ring counts of increment cores taken 35 cm above ground and from discs sawed 5 cm above ground in the case of very small trees. Stand origin dates are obtained from wedges sawn from fire-scarred trees, following Tande (1979).

Reference Stand Number	Permanent Plot Number	Ages of Trees (years)	Stand Origin Date
1	25	11,12,12,<u>13</u>[a]	...
2	55	26,28,33,<u>34</u>	...
3	6	34,37,<u>38</u>	...
4	21	34,37,<u>38</u>	1943, 1944
5	57	40,40,<u>42</u>	...
6	58	38,40,<u>43</u>	...
7	9	41,42,<u>43</u>	1944
8[b]	18B	36,39,42,44,<u>45</u>,74	1921-1926
9	52	54,57,<u>59</u>	1907, 1926
10	18A	59,66,77,<u>85</u>	...
11	24	78,87,<u>89</u>	...
12[b]	54	68,69,<u>91</u>	...
13	59	99,107,<u>109</u>	1915
14[b]	20	111,129,<u>133</u>	1943, 1944
15	51	36,38,<u>39</u>	...
16	56	37,41,<u>41</u>	...

[a] Stand ages determined from oldest trees of dominant age-class (cohort), underlined.

[b] These three stands experienced one or more ground fires since establishment of their dominant cohort; in no. 8 most trees were recruited after the most recent fire; in no. 12 two cohorts were well represented; in no. 14 almost all trees had fire scars dating to 1943-44, no post-fire cohort was present, and its understory originated in 1943-44, not in 1848.

internal structure of the community; (3) detail of the understory vascular plant component, to show the major species in their typical late summer phenological state; (4) detail of the terrestrial bryophytes and lichens, to show the major species and the substrates upon which they typically grow.

The slide annotations are very brief, plant ecologically oriented, and intended to complement the next section (4.4). Much more can be learned from these pictures, to meet a variety of purposes, than can be covered or anticipated in this report.

4.4. DESCRIPTIONS OF THE PLANT COMMUNITY COMPONENTS OF REFERENCE STANDS

4.4.1 Quantitative Data for Individual Reference Stands

Table 4 gives the results of the August 1981 survey of the plant community components of the 16 reference stands, in order of increasing stand age, beginning with the 14 stands on Dystric Brunisols and ending with the two stands on Gray Luvisols (see survey methods in 3.4). Statistics contained in this table are: (1) species richness (number of species) and % cover of vascular plants, bryophytes, terrestrial lichens, and the total plant community (including epiphytic lichens); (2) plot frequency of each species (% occurrence in 5 x 5 m sampling units); (3) mean % cover and standard deviation of mean cover of each species; (4) cover rank of each species (species numbered in order of decreasing mean cover; vascular plants and bryoids treated separately (see 4.4.3)).

Using these data, tests of significance can be performed for the various community attributes as they existed in August 1981. In all cases the vascular plant sample consists of 25 sampling units (n_V = 25) and the bryoid sample consists of 15 sampling units (n_B = 15) out of a possible total (frame) of 100 5 x 5 m sampling units in each 50 x 50 m reference stand. Since there was no evidence of regular dispersion in any of the plant populations surveyed, the samples may be treated as a set of randomly placed sampling units for testing purposes, i.e., there are 24 degrees of freedom for vascular data and

Table 4. Quantitative plant community data for individual reference stands located in 16 *Pinus banksiana* - dominated permanent plots of the Athabasca Oil Sands area in northern Alberta, as they existed in August, 1981. Each reference stand is treated as five-page data-set, with stands numbered in order of increasing age (see Table 3). For details of survey methods see section 3.4; for details on statistical aspects see section 4.4.1.

ATHABASCA OIL SANDS ECOLOGICAL MONITORING PROJECT

Reference Stand No. 1 Permanent Plot No. 25

Survey Date 7 Aug 1981 Stand Age 13 yrs

Vascular Plants	Species Richness = 32	Cover = 11.7%
Bryophytes	Species Richness = 2	Cover = 2.7%
Terrestrial Lichens	Species Richness = 10	Cover = 12.0%
Plant Community	Species Richness = 45	Cover = 26.4%

CODE	Species	Frequency % 5x5 m Plots	Plant Cover % Mean	S.D.	Rank
Trees					
PIBA	*Pinus banksiana*	100	4.04	3.67	1
PIGL	*Picea glauca*	.	.	.	.
PIMA	*Picea mariana*	.	.	.	.
POTR	*Populus tremuloides*	4	0.0040	0.020	26
POBA	*Populus balsamifera*	.	.	.	.
LALA	*Larix laricina*	.	.	.	.
	Total Tree Cover = 4.04%				
Shrubs					
VAMY	*Vaccinium myrtilloides*	68	0.584	0.586	4
VAVI	*Vaccinium vitis-idaea*	44	0.344	0.532	7
ARUV	*Arctostaphylos uva-ursi*	100	3.24	0.970	2
ROAC	*Rosa acicularis*	8	0.0240	0.101	20
PRPE	*Prunus pensylvanica*	4	0.0040	0.020	27
AMAL	*Amelanchier alnifolia*	8	0.0080	0.028	24
RUST	*Rubus strigosus*	.	.	.	.
LODI	*Lonicera dioica*	.	.	.	.
VIED	*Viburnum edule*	.	.	.	.
HUTO	*Hudsonia tomentosa*	24	0.180	0.350	9
SABE	*Salix bebbiana*	4	0.0400	0.200	17
ALCR	*Alnus crispa*	.	.	.	.
LEGR	*Ledum groenlandicum*	.	.	.	.
RIGL	*Ribes glandulosum*	.	.	.	.
SHCA	*Shepherdia canadensis*	.	.	.	.
SAPS	*Salix pseudomonticola*	.	.	.	.
SYAL	*Symphoricarpos albus*	.	.	.	.
VACA	*Vaccinium caespitosum*	.	.	.	.
BEPU	*Betula pumila*	.	.	.	.
SAMY	*Salix myrtillifolia*	.	.	.	.
	Total Shrub Cover = 4.32%				

continued ...

Reference Stand No. 1 Continued.

CODE	Species	Frequency % 5x5 m Plots	Plant Cover % Mean	S.D.	Rank
Forbs					
MACA	*Maianthemum canadense*	52	0.0660	0.137	14
ASLA	*Aster laevis*	100	0.385	0.238	6
ANMU	*Anemone multifida*	36	0.0216	0.040	21
GABO	*Galium boreale*	48	0.0352	0.102	18
MELI	*Melampyrum lineare*	.	.	.	.
LIBO	*Linnaea borealis*	64	0.150	0.251	11
CARO	*Campanula rotundifolia*	84	0.0156	0.026	23
SODE	*Solidago decumbens*	76	0.0472	0.048	15
VIAD	*Viola adunca*	16	0.0284	0.102	19
APAN	*Apocynum androsaemifolium*	60	0.0776	0.135	12
COPA	*Comandra pallida*	.	.	.	.
FRVI	*Fragaria virginiana*	84	0.516	0.484	5
POTRI	*Potentilla tridentata*	4	0.0004	0.002	30
GELI	*Geocaulon lividum*	.	.	.	.
PYVI	*Pyrola virens*	4	0.0004	0.002	31
HICA	*Hieracium canadense*	4	0.0004	0.002	32
PYSE	*Pyrola secunda*	.	.	.	.
EPAN	*Epilobium angustifolium*	8	0.0008	0.003	29
ARCA	*Artemisia campestris*	44	0.0776	0.163	13
ARNU	*Aralia nudicaulis*	.	.	.	.
COCA	*Cornus canadensis*	.	.	.	.
LIPH	*Lilium philadelphicum*	.	.	.	.
ANPA	*Anemone patens*	.	.	.	.
TRBO	*Trientalis borealis*	.	.	.	.
VIRE	*Viola renifolia*	.	.	.	.
GORE	*Goodyera repens*	.	.	.	.
LAOC	*Lathyrus ochroleucus*	.	.	.	.
VIAM	*Vicia americana*	.	.	.	.
PEPA	*Petasites palmatus*	.	.	.	.
ASCI	*Aster ciliolatus*	.	.	.	.
CYAC	*Cypripedium acaule*	.	.	.	.
ACMI	*Achillea millefolium*	56	0.0468	0.103	16
ANRA	*Antennaria racemosa*	.	.	.	.
GEAM	*Gentianella amarella*	.	.	.	.
RUAC	*Rubus acaulis*	.	.	.	.
PYAS	*Pyrola asarifolia*	.	.	.	.
MINU	*Mitella nuda*	.	.	.	.
DRSP	*Draba* sp.	12	0.0012	0.003	28
SESP	*Senecio* sp.	.	.	.	.

Total Forb Cover = 1.47%

continued ...

Reference Stand No. 1 Continued

CODE	Species	Frequency % 5x5 m Plots	Plant Cover % Mean	S.D.	Rank
Graminoids					
ORPU	*Oryzopsis pungens*	100	1.41	0.882	3
ELIN	*Elymus innovatus*	.	.	.	.
CXUM	*Carex umbellata*	80	0.260	0.263	8
CXFO	*Carex foenea*	68	0.153	0.203	10
ORAS	*Oryzopsis asperifolia*	20	0.0164	0.037	22
AGSC	*Agrostis scabra*	.	.	.	.
BRCI	*Bromus ciliatus*	.	.	.	.
SCPU	*Schizachne purpurascens*	.	.	.	.
JUBA	*Juncus balticus*	.	.	.	.
ELGL	*Elymus glaucus*	.	.	.	.
CACA	*Calamagrostis canadensis*	.	.	.	.
CAIN	*Calamagrostis inexpansa*	.	.	.	.
CXSP	*Carex* sp.	.	.	.	.
	Total Graminoid Cover = 1.84%				
Pteridophytes					
EQVA	*Equisetum variegatum*	.	.	.	.
LYTR	*Lycopodium tristachyum*	.	.	.	.
LYAN	*Lycopodium annotinum*	.	.	.	.
EQSY	*Equisetum sylvaticum*	.	.	.	.
EQSC	*Equisetum scirpoides*	.	.	.	.
EQPR	*Equisetum pratense*	.	.	.	.
LYCL	*Lycopodium clavatum*	.	.	.	.
EQAR	*Equisetum arvense*	.	.	.	.
SEDE	*Selaginella densa*	4	0.0040	0.020	25
	Total Pteridophyte Cover = 0.004%				

continued ...

Reference Stand No. 1 Continued

CODE	Species	Frequency % 5x5 m Plots	Plant Cover % Mean	S.D.	Rank
Bryophytes					
AUL PAL	*Aulacomnium palustre*	.	.	.	.
BRA SAL	*Brachythecium salebrosum*	.	.	.	.
CER PUR	*Ceratodon purpureus*	27	0.027	0.046	10
DIC POL	*Dicranum polysetum*	.	.	.	.
DIC SCO	*Dicranum scoparium*	.	.	.	.
DIT FLE	*Ditrichum flexicaule*	.	.	.	.
DRE UNC	*Drepanocladus uncinatus*	.	.	.	.
HYL SPL	*Hylocomium splendens*	.	.	.	.
ORT FLA	*Orthodicranum flagellare*	.	.	.	.
PLE SCH	*Pleurozium schreberi*	.	.	.	.
POH NUT	*Pohlia nutans*	.	.	.	.
POL JUN	*Polytrichum juniperinum*	.	.	.	.
POL PIL	*Polytrichum piliferum*	87	2.63	3.81	3
PTI CIL	*Ptilidium ciliare*	.	.	.	.
PTI PUL	*Ptilidium pulcherrimum*	.	.	.	.
PTI C-C	*Ptilium crista-castrensis*	.	.	.	.
TET ANG	*Tetraplodon angustatus*	.	.	.	.
TOM NIT	*Tomenthypnum nitens*	.	.	.	.
	Total Bryophyte Cover = 2.657%				
Terrestrial Lichens					
CET ERI	*Cetraria ericetorum*	.	.	.	.
CET CUC	*Cetraria cucullata*	.	.	.	.
CET NIV	*Cetraria nivalis*	.	.	.	.
CLA MIT	*Cladina mitis*	27	0.009	0.026	11
CLA RAN	*Cladina rangiferina*	.	.	.	.
CLA STE	*Cladina stellaris*	.	.	.	.
CLA AMA	*Cladonia amaurocraea*	.	.	.	.
CLA CAP	*Cladonia capitata*	.	.	.	.
CLA CEN	*Cladonia cenotea*	.	.	.	.
CLA CHL	*Cladonia chlorophaea*	7	0.0007	0.0026	14
CLA COC	*Cladonia coccifera*	100	1.12	*	5
CLA CON	*Cladonia coniocraea*	.	.	.	.
CLA COR	*Cladonia cornuta*	80	0.134	0.244	8
CLA CRP	*Cladonia crispata*	.	.	.	.
CLA CRT	*Cladonia cristatella*	100	2.61	*	4
CLA GON	*Cladonia gonecha*	.	.	.	.
CLA GRA	*Cladonia gracilis*	100	3.21	3.50	2

continued ...

Reference Stand No. Concluded.

CODE	Species	Frequency % 5x5 m Plots	Plant Cover Mean	S.D.	Rank
CLA MUL	*Cladonia multiformis*	.	.	.	.
CLA PHY	*Cladonia phyllophora*	.	.	.	.
CLA PYX	*Cladonia pyxidata*	.	.	.	.
CLA SUB	*Cladonia subulata*	93	0.453	0.463	7
CLA UNC	*Cladonia uncialis*	100	3.81	3.23	1
CLA VER	*Cladonia verticillata*	80	0.074	0.045	9
PEL APH	*Peltigera aphthosa*	.	.	.	.
PEL MAL	*Peltigera malacea*	13	0.007	0.026	12
PEL RUF	*Peltigera rufescens*	53	0.614	1.29	6
STE ALP	*Stereocaulon alpinum*	.	.	.	.

Total Terrestrial Lichen Cover = 12.04%

Epiphytic Lichens

BRY SPP	*Bryoria species*	.	.	.	.
CET HAL	*Cetraria halei*	.	.	.	.
CET PIN	*Cetraria pinastri*	20	0.002	0.004	13
EVE MES	*Evernia mesomorpha*	.	.	.	.
HYP PHY	*Hypogymnia physodes*	.	.	.	.
PAR ELE	*Parmelia elegantula*	.	.	.	.
PAR SUL	*Parmelia sulcata*	.	.	.	.
PAR AMB	*Parmeliopsis ambigua*	.	.	.	.
PAR HYP	*Parmeliopsis hyperopta*	.	.	.	.
PLA GLA	*Platismatia glauca*	.	.	.	.
USN SPP	*Usnea species*	.	.	.	.

Total Epiphytic Lichen Cover = 0.002%

ATHABASCA OIL SANDS ECOLOGICAL MONITORING PROJECT

Reference Stand No. 2 Permanent Plot No. 55

Survey Date 12 Aug 1981 Stand Age 34 yrs

Vascular Plants	Species Richness = 10	Cover = 28.3%
Bryophytes	Species Richness = 2	Cover = 1.2%
Terrestrial Lichens	Species Richness = 13	Cover = 27.4%
Plant Community	Species Richness = 34	Cover = 57.1%

CODE	Species	Frequency %	Plant Cover %		
		5x5 m Plots	Mean	S.D.	Rank
Trees					
PIBA	*Pinus banksiana*	100	27.60	7.23	1
PIGL	*Picea glauca*	.	.	.	.
PIMA	*Picea mariana*	.	.	.	.
POTR	*Populus tremuloides*	.	.	.	.
POBA	*Populus balsamifera*	.	.	.	.
LALA	*Larix laricina*	.	.	.	.
	Total Tree Cover = 27.60%				
Shrubs					
VAMY	*Vaccinium myrtilloides*	.	.	.	.
VAVI	*Vaccinium vitis-idaea*	.	.	.	.
ARUV	*Arctostaphylos uva-ursi*	84	0.708	0.669	2
ROAC	*Rosa acicularis*	.	.	.	.
PRPE	*Prunus pensylvanica*	.	.	.	.
AMAL	*Amelanchier alnifolia*	.	.	.	.
RUST	*Rubus strigosus*	.	.	.	.
LODI	*Lonicera dioica*	.	.	.	.
VIED	*Viburnum edule*	.	.	.	.
HUTO	*Hudsonia tomentosa*	.	.	.	.
SABE	*Salix bebbiana*	.	.	.	.
ALCR	*Alnus crispa*	.	.	.	.
LEGR	*Ledum groenlandicum*	.	.	.	.
RIGL	*Ribes glandulosum*	.	.	.	.
SHCA	*Shepherdia canadensis*	.	.	.	.
SAPS	*Salix pseudomonticola*	.	.	.	.
SYAL	*Symphoricarpos albus*	.	.	.	.
VACA	*Vaccinium caespitosum*	.	.	.	.
BEPU	*Betula pumila*	.	.	.	.
SAMY	*Salix myrtillifolia*	.	.	.	.
	Total Shrub Cover = 0.708%				

continued ...

Reference Stand No. 2 Continued.

CODE	Species	Frequency % 5x5 m Plots	Plant Cover % Mean	S.D.	Rank
Forbs					
MACA	*Maianthemum canadense*	8	0.0008	0.003	6
ASLA	*Aster laevis*	.	.	.	.
ANMU	*Anemone multifida*	4	0.0004	0.002	8
GABO	*Galium boreale*	.	.	.	.
MELI	*Melampyrum lineare*	.	.	.	.
LIBO	*Linnaea borealis*	4	0.0004	0.002	9
CARO	*Campanula rotundifolia*	4	0.0004	0.002	10
SODE	*Solidago decumbens*	12	0.0012	0.003	5
VIAD	*Viola adunca*	.	.	.	.
APAN	*Apocynum androsaemifolium*	P	.	.	.
COPA	*Comandra pallida*	.	.	.	.
FRVI	*Fragaria virginiana*	.	.	.	.
POTRI	*Potentilla tridentata*	.	.	.	.
GELI	*Geocaulon lividum*	.	.	.	.
PYVI	*Pyrola virens*	4	0.0040	0.020	3
HICA	*Hieracium canadense*	.	.	.	.
PYSE	*Pyrola secunda*	.	.	.	.
EPAN	*Epilobium angustifolium*	.	.	.	.
ARCA	*Artemisia campestris*	.	.	.	.
ARNU	*Aralia nudicaulis*	.	.	.	.
COCA	*Cornus canadensis*	.	.	.	.
LIPH	*Lilium philadelphicum*	.	.	.	.
ANPA	*Anemone patens*	.	.	.	.
TRBO	*Trientalis borealis*	.	.	.	.
VIRE	*Viola renifolia*	.	.	.	.
GORE	*Goodyera repens*	.	.	.	.
LAOC	*Lathyrus ochroleucus*	.	.	.	.
VIAM	*Vicia americana*	.	.	.	.
PEPA	*Petasites palmatus*	.	.	.	.
ASCI	*Aster ciliolatus*	.	.	.	.
CYAC	*Cypripedium acaule*	.	.	.	.
ACMI	*Achillea millefolium*	.	.	.	.
ANRA	*Antennaria racemosa*	.	.	.	.
GEAM	*Gentianella amarella*	.	.	.	.
RUAC	*Rubus acaulis*	.	.	.	.
PYAS	*Pyrola asarifolia*	.	.	.	.
MINU	*Mitella nuda*	.	.	.	.
DRSP	*Draba* sp.	.	.	.	.
SESP	*Senecio* sp.	.	.	.	.

Total Forb Cover = 0.0072%

continued ...

Reference Stand No. 2 Continued

CODE	Species	Frequency % 5x5 m Plots	Plant Cover % Mean	S.D.	Rank
Graminoids					
ORPU	*Oryzopsis pungens*	36	0.0036	0.005	4
ELIN	*Elymus innovatus*	.	.	.	.
CXUM	*Carex umbellata*	.	.	.	.
CXFO	*Carex foenea*	8	0.0008	0.003	7
ORAS	*Oryzopsis asperifolia*	.	.	.	.
AGSC	*Agrostis scabra*	.	.	.	.
BRCI	*Bromus ciliatus*	.	.	.	.
SCPU	*Schizachne purpurascens*	.	.	.	.
JUBA	*Juncus balticus*	.	.	.	.
ELGL	*Elymus glaucus*	.	.	.	.
CACA	*Calamagrostis canadensis*	.	.	.	.
CAIN	*Calamagrostis inexpansa*	.	.	.	.
CXSP	*Carex* sp.	.	.	.	.
	Total Graminoid Cover = 0.0044%				
Pteridophytes					
EQVA	*Equisetum variegatum*	.	.	.	.
LYTR	*Lycopodium tristachyum*	.	.	.	.
LYAN	*Lycopodium annotinum*	.	.	.	.
EQSY	*Equisetum sylvaticum*	.	.	.	.
EQSC	*Equisetum scirpoides*	.	.	.	.
EQPR	*Equisetum pratense*	.	.	.	.
LYCL	*Lycopodium clavatum*	.	.	.	.
EQAR	*Equisetum arvense*	.	.	.	.
SEDE	*Selaginella densa*	.	.	.	.
	Total Pteridophyte Cover = 0.0%				

continued ...

Reference Stand No. 2 Continued

CODE	Species	Frequency % 5x5 m Plots	Plant Cover % Mean	S.D.	Rank
Bryophytes					
AUL PAL	*Aulacomnium palustre*	.	.	.	.
BRA SAL	*Brachythecium salebrosum*	.	.	.	.
CER PUR	*Ceratodon purpureus*	.	.	.	.
DIC POL	*Dicranum polysetum*	.	.	.	.
DIC SCO	*Dicranum scoparium*	.	.	.	.
DIT FLE	*Ditrichum flexicaule*	.	.	.	.
DRE UNC	*Drepanocladus uncinatus*	.	.	.	.
HYL SPL	*Hylocomium splendens*	.	.	.	.
ORT FLA	*Orthodicranum flagellare*	.	.	.	.
PLE SCH	*Pleurozium schreberi*	.	.	.	.
POH NUT	*Pohlia nutans*	.	.	.	.
POL JUN	*Polytrichum juniperinum*	13	0.001	0.004	23
POL PIL	*Polytrichum piliferum*	100	1.23	1.17	4
PTI CIL	*Ptilidium ciliare*	.	.	.	.
PTI PUL	*Ptilidium pulcherrimum*	.	.	.	.
PTI C-C	*Ptilium crista-castrensis*	.	.	.	.
TET ANG	*Tetraplodon angustatus*	.	.	.	.
TOM NIT	*Tomenthypnum nitens*	.	.	.	.
	Total Bryophyte Cover = 1.231%				
Terrestrial Lichens					
CET ERI	*Cetraria ericetorum*	93	0.027	0.038	12
CET CUC	*Cetraria cucullata*	.	.	.	.
CET NIV	*Cetraria nivalis*	.	.	.	.
CLA MIT	*Cladina mitis*	100	9.74	9.38	2
CLA RAN	*Cladina rangiferina*	.	.	.	.
CLA STE	*Cladina stellaris*	.	.	.	.
CLA AMA	*Cladonia amaurocraea*	.	.	.	.
CLA CAP	*Cladonia capitata*	.	.	.	.
CLA CEN	*Cladonia cenotea*	.	.	.	.
CLA CHL	*Cladonia chlorophaea*	80	0.050	0.049	10
CLA COC	*Cladonia coccifera*	100	0.250	0.390	6
CLA CON	*Cladonia coniocraea*	.	.	.	.
CLA COR	*Cladonia cornuta*	93	0.207	0.324	7
CLA CRP	*Cladonia crispata*	40	0.010	0.025	16
CLA CRT	*Cladonia cristatella*	13	0.001	0.004	22
CLA GON	*Cladonia gonecha*	.	.	.	.
CLA GRA	*Cladonia gracilis*	100	4.60	2.29	3

continued ...

Reference Stand. No. 2 Concluded.

CODE	Species	Frequency % 5x5 m Plots	Plant Cover Mean	S.D.	Rank
CLA MUL	*Cladonia multiformis*	.	.	.	.
CLA PHY	*Cladonia phyllophora*	100	0.508	0.608	5
CLA PYX	*Cladonia pyxidata*	7	0.0007	0.0026	24
CLA SUB	*Cladonia subulata*	.	.	.	.
CLA UNC	*Cladonia uncialis*	100	11.9	10.6	1
CLA VER	*Cladonia verticillata*	.	.	.	.
PEL APH	*Peltigera aphthosa*	.	.	.	.
PEL MAL	*Peltigera malacea*	47	0.107	0.252	8
PEL RUF	*Peltigera rufescens*	27	0.009	0.026	18
STE ALP	*Stereocaulon alpinum*	.	.	.	.

Total Terrestrial Lichen Cover = 27.41%

Epiphytic Lichens

BRY SPP	*Bryoria species*	100	0.010	0	15
CET HAL	*Cetraria halei*	80	0.014	0.024	14
CET PIN	*Cetraria pinastri*	100	0.082	0.037	9
EVE MES	*Evernia mesomorpha*	33	0.003	0.005	20
HYP PHY	*Hypogymnia physodes*	100	0.016	0.023	13
PAR ELE	*Parmelia elegantula*	.	.	.	.
PAR SUL	*Parmelia sulcata*	20	0.002	0.004	21
PAR AMB	*Parmeliopsis ambigua*	100	0.028	0.037	11
PAR HYP	*Parmeliopsis hyperopta*	47	0.005	0.005	19
PLA GLA	*Platismatia glauca*	100	0.010	0	17
USN SPP	*Usnea species*	.	.	.	.

Total Epiphytic Lichen Cover = 0.1700%

ATHABASCA OIL SANDS ECOLOGICAL MONITORING PROJECT

Reference Stand No. 3 Permanent Plot No. 6

Survey Date 5 Aug 1981 Stand Age 38 yrs

Vascular Plants	Species Richness = 35	Cover = 42.0%
Bryophytes	Species Richness = 11	Cover = 3.8%
Terrestrial Lichens	Species Richness = 19	Cover = 46.0%
Plant Community	Species Richness = 69	Cover = 91.9%

CODE	Species	Frequency % 5x5 m Plots	Plant Cover % Mean	S.D.	Rank
Trees					
PIBA	*Pinus banksiana*	100	7.56	5.00	3
PIGL	*Picea glauca*	8	0.0400	0.138	27
PIMA	*Picea mariana*	.	.	.	.
POTR	*Populus tremuloides*	28	0.144	0.269	17
POBA	*Populus balsamifera*	.	.	.	.
LALA	*Larix laricina*	.	.	.	.
	Total Tree Cover = 7.744%				
Shrubs					
VAMY	*Vaccinium myrtilloides*	100	3.38	1.88	4
VAVI	*Vaccinium vitis-idaea*	100	8.14	5.46	2
ARUV	*Arctostaphylos uva-ursi*	100	14.4	7.05	1
ROAC	*Rosa acicularis*	44	0.524	0.754	11
PRPE	*Prunus pensylvanica*	52	0.184	0.303	15
AMAL	*Amelanchier alnifolia*	84	0.580	0.564	10
RUST	*Rubus strigosus*	.	.	.	.
LODI	*Lonicera dioica*	20	0.0680	0.165	23
VIED	*Viburnum edule*	.	.	.	.
HUTO	*Hudsonia tomentosa*	.	.	.	.
SABE	*Salix bebbiana*	.	.	.	.
ALCR	*Alnus crispa*	60	1.88	2.08	5
LEGR	*Ledum groenlandicum*	.	.	.	.
RIGL	*Ribes glandulosum*	.	.	.	.
SHCA	*Shepherdia canadensis*	P	.	.	.
SAPS	*Salix pseudomonticola*	.	.	.	.
SYAL	*Symphoricarpos albus*	.	.	.	.
VACA	*Vaccinium caespitosum*	.	.	.	.
BEPU	*Betula pumila*	.	.	.	.
SAMY	*Salix myrtillifolia*	.	.	.	.
	Total Shrub Cover = 29.196%				

continued ...

Reference Stand No. 3 Continued.

CODE	Species	Frequency % 5x5 m Plots	Plant Cover % Mean	S.D.	Rank
Forbs					
MACA	*Maianthemum canadense*	100	1.27	0.779	6
ASLA	*Aster laevis*	4	0.004	0.020	34
ANMU	*Anemone multifida*	60	0.117	0.177	20
GABO	*Galium boreale*	44	0.0850	0.162	22
MELI	*Melampyrum lineare*	96	0.592	0.560	9
LIBO	*Linnaea borealis*	72	0.612	0.923	7
CARO	*Campanula rotundifolia*	52	0.0460	0.103	26
SODE	*Solidago decumbens*	48	0.0570	0.104	24
VIAD	*Viola adunca*	12	0.0084	0.027	32
APAN	*Apocynum androsaemifolium*	.	.	.	.
COPA	*Comandra pallida*	96	0.512	0.268	12
FRVI	*Fragaria virginiana*	12	0.0280	0.102	30
POTRI	*Potentilla tridentata*	68	0.0890	0.133	21
GELI	*Geocaulon lividum*	8	0.160	0.624	16
PYVI	*Pyrola virens*	36	0.0380	0.103	28
HICA	*Hieracium canadense*	48	0.0500	0.104	25
PYSE	*Pyrola secunda*	.	.	.	.
EPAN	*Epilobium angustifolium*	20	0.124	0.298	18
ARCA	*Artemisia campestris*	.	.	.	.
ARNU	*Aralia nudicaulis*	56	0.604	0.788	8
COCA	*Cornus canadensis*	8	0.0240	0.101	31
LIPH	*Lilium philadelphicum*	28	0.0330	0.103	29
ANPA	*Anemone patens*	8	0.0080	0.028	33
TRBO	*Trientalis borealis*	.	.	.	.
VIRE	*Viola renifolia*	.	.	.	.
GORE	*Goodyera repens*	.	.	.	.
LAOC	*Lathyrus ochroleucus*	.	.	.	.
VIAM	*Vicia americana*	.	.	.	.
PEPA	*Petasites palmatus*	.	.	.	.
ASCI	*Aster ciliolatus*	.	.	.	.
CYAC	*Cypripedium acaule*	.	.	.	.
ACMI	*Achillea millefolium*	.	.	.	.
ANRA	*Antennaria racemosa*	.	.	.	.
GEAM	*Gentianella amarella*	.	.	.	.
RUAC	*Rubus acaulis*	.	.	.	.
PYAS	*Pyrola asarifolia*	.	.	.	.
MINU	*Mitella nuda*	.	.	.	.
DRSP	*Draba* sp.	.	.	.	.
SESP	*Senecio* sp.	.	.	.	.

Total Forb Cover = 4.461%

continued ...

Reference Stand No. 3 Continued

CODE	Species	Frequency % 5x5 m Plots	Plant Cover % Mean	S.D.	Rank
Graminoids					
ORPU	*Oryzopsis pungens*	100	0.189	0.180	14
ELIN	*Elymus innovatus*	72	0.276	0.335	13
CXUM	*Carex umbellata*	.	.	.	.
CXFO	*Carex foenea*	.	.	.	.
ORAS	*Oryzopsis asperifolia*	.	.	.	.
AGSC	*Agrostis scabra*	.	.	.	.
BRCI	*Bromus ciliatus*	.	.	.	.
SCPU	*Schizachne purpurascens*	4	0.0040	0.020	35
JUBA	*Juncus balticus*	.	.	.	.
ELGL	*Elymus glaucus*	.	.	.	.
CACA	*Calamagrostis canadensis*	.	.	.	.
CAIN	*Calamagrostis inexpansa*	.	.	.	.
CXSP	*Carex* sp.	.	.	.	.
	Total Graminoid Cover = 0.469%				
Pteridophytes					
EQVA	*Equisetum variegatum*	.	.	.	.
LYTR	*Lycopodium tristachyum*	8	0.120	0.440	19
LYAN	*Lycopodium annotinum*	.	.	.	.
EQSY	*Equisetum sylvaticum*	.	.	.	.
EQSC	*Equisetum scirpoides*	.	.	.	.
EQPR	*Equisetum pratense*	.	.	.	.
LYCL	*Lycopodium clavatum*	.	.	.	.
EQAR	*Equisetum arvense*	.	.	.	.
SEDE	*Selaginella densa*	.	.	.	.
	Total Pteridophyte Cover = 0.120%				

continued ...

Reference Stand No. 3 Continued

CODE	Species	Frequency % 5x5 m Plots	Plant Cover % Mean	S.D.	Rank
Bryophytes					
AUL PAL	*Aulacomnium palustre*	.	.	.	.
BRA SAL	*Brachythecium salebrosum*	27	0.009	0.026	23
CER PUR	*Ceratodon purpureus*	13	0.013	0.035	19
DIC POL	*Dicranum polysetum*	67	0.415	0.496	3
DIC SCO	*Dicranum scoparium*	40	0.016	0.034	16
DIT FLE	*Ditrichum flexicaule*	.	.	.	.
DRE UNC	*Drepanocladus uncinatus*	.	.	.	.
HYL SPL	*Hylocomium splendens*	53	0.282	0.587	5
ORT FLA	*Orthodicranum flagellare*	.	.	.	.
PLE SCH	*Pleurozium schreberi*	73	3.01	5.23	2
POH NUT	*Pohlia nutans*	.	.	.	.
POL JUN	*Polytrichum juniperinum*	20	0.002	0.004	29
POL PIL	*Polytrichum piliferum*	13	0.007	0.026	26
PTI CIL	*Ptilidium ciliare*	7	0.0007	0.0026	33
PTI PUL	*Ptilidium pulcherrimum*	.	.	.	.
PTI C-C	*Ptilium crista-castrensis*	33	0.003	0.005	27
TET ANG	*Tetraplodon angustatus*	.	.	.	.
TOM NIT	*Tomenthypnum nitens*	7	0.0007	0.0026	34
	Total Bryophyte Cover = 3.758%				
Terrestrial Lichens					
CET ERI	*Cetraria ericetorum*	20	0.008	0.026	25
CET CUC	*Cetraria cucullata*	.	.	.	.
CET NIV	*Cetraria nivalis*	20	0.002	0.004	28
CLA MIT	*Cladina mitis*	100	45.3	27.2	1
CLA RAN	*Cladina rangiferina*	.	.	.	.
CLA STE	*Cladina stellaris*	60	0.030	0.044	13
CLA AMA	*Cladonia amaurocraea*	.	.	.	.
CLA CAP	*Cladonia capitata*	7	0.0007	0.0026	31
CLA CEN	*Cladonia cenotea*	33	0.009	0.025	22
CLA CHL	*Cladonia chlorophaea*	87	0.021	0.032	14
CLA COC	*Cladonia coccifera*	.	.	.	.
CLA CON	*Cladonia coniocraea*	67	0.011	0.025	20
CLA COR	*Cladonia cornuta*	73	0.031	0.043	11
CLA CRP	*Cladonia crispata*	27	0.021	0.041	15
CLA CRT	*Cladonia cristatella*	53	0.011	0.025	21
CLA GON	*Cladonia gonecha*	13	0.001	0.004	30
CLA GRA	*Cladonia gracilis*	27	0.009	0.026	24

continued ...

Reference Stand No. 3 Concluded.

CODE	Species	Frequency % 5x5 m Plots	Plant Cover Mean	S.D.	Rank
CLA MUL	*Cladonia multiformis*	67	0.049	0.050	8
CLA PHY	*Cladonia phyllophora*	40	0.016	0.034	17
CLA PYX	*Cladonia pyxidata*	7	0.0007	0.0026	32
CLA SUB	*Cladonia subulata*	.	.	.	.
CLA UNC	*Cladonia uncialis*	.	.	.	.
CLA VER	*Cladonia verticillata*	.	.	.	.
PEL APH	*Peltigera aphthosa*	20	0.080	0.257	6
PEL MAL	*Peltigera malacea*	53	0.293	0.443	4
PEL RUF	*Peltigera rufescens*	13	0.067	0.258	7
STE ALP	*Stereocaulon alpinum*	.	.	.	.

Total Terrestrial Lichen Cover = 45.96%

Epiphytic Lichens

BRY SPP	*Bryoria species*	.	.	.	.
CET HAL	*Cetraria halei*	.	.	.	.
CET PIN	*Cetraria pinastri*	100	0.046	0.046	9
EVE MES	*Evernia mesomorpha*	.	.	.	.
HYP PHY	*Hypogymnia physodes*	67	0.031	0.044	12
PAR ELE	*Parmelia elegantula*	.	.	.	.
PAR SUL	*Parmelia sulcata*	33	0.015	0.035	18
PAR AMB	*Parmeliopsis ambigua*	100	0.040	0.044	10
PAR HYP	*Parmeliopsis hyperopta*	.	.	.	.
PLA GLA	*Platismatia glauca*	.	.	.	.
USN SPP	*Usnea species*	.	.	.	.

Total Epiphytic Lichen Cover = 0.1320%

ATHABASCA OIL SANDS ECOLOGICAL MONITORING PROJECT

Reference Stand No. 4 — Permanent Plot No. 21

Survey Date 9 Aug 1981 — Stand Age 38 yrs

Vascular Plants	Species Richness = 26	Cover = 20.7%
Bryophytes	Species Richness = 7	Cover = 1.6%
Terrestrial Lichens	Species Richness = 20	Cover = 21.9%
Plant Community	Species Richness = 63	Cover = 44.3%

CODE	Species	Frequency %	Plant Cover %		
		5x5 m Plots	Mean	S.D.	Rank
Trees					
PIBA	*Pinus banksiana*	100	7.40	4.97	1
PIGL	*Picea glauca*	.	.	.	.
PIMA	*Picea mariana*	P	.	.	.
POTR	*Populus tremuloides*	.	.	.	.
POBA	*Populus balsamifera*	.	.	.	.
LALA	*Larix laricina*	.	.	.	.
	Total Tree Cover = 7.40%				
Shrubs					
VAMY	*Vaccinium myrtilloides*	100	3.02	1.311	3
VAVI	*Vaccinium vitis-idaea*	96	3.64	3.134	2
ARUV	*Arctostaphylos uva-ursi*	96	1.70	1.431	5
ROAC	*Rosa acicularis*	16	0.0480	0.139	15
PRPE	*Prunus pensylvanica*	.	.	.	.
AMAL	*Amelanchier alnifolia*	28	0.0890	0.235	11
RUST	*Rubus strigosus*	.	.	.	.
LODI	*Lonicera dioica*	4	0.0004	0.002	26
VIED	*Viburnum edule*	.	.	.	.
HUTO	*Hudsonia tomentosa*	.	.	.	.
SABE	*Salix bebbiana*	8	0.0240	0.101	19
ALCR	*Alnus crispa*	.	.	.	.
LEGR	*Ledum groenlandicum*	12	0.0800	0.236	12
RIGL	*Ribes glandulosum*	P	.	.	.
SHCA	*Shepherdia canadensis*	.	.	.	.
SAPS	*Salix pseudomonticola*	.	.	.	.
SYAL	*Symphoricarpos albus*	.	.	.	.
VACA	*Vaccinium caespitosum*	.	.	.	.
BEPU	*Betula pumila*	.	.	.	.
SAMY	*Salix myrtillifolia*	.	.	.	.
	Total Shrub Cover = 8.601%				

continued ...

Reference Stand No. 4 Continued.

CODE	Species	Frequency % 5x5 m Plots	Plant Cover % Mean	S.D.	Rank
Forbs					
MACA	*Maianthemum canadense*	100	0.0600	0.570	7
ASLA	*Aster laevis*	4	0.0040	0.020	25
ANMU	*Anemone multifida*	.	.	.	.
GABO	*Galium boreale*	.	.	.	.
MELI	*Melampyrum lineare*	44	0.0380	0.103	18
LIBO	*Linnaea borealis*	96	0.960	0.558	6
CARO	*Campanula rotundifolia*	40	0.0076	0.020	23
SODE	*Solidago decumbens*	P	.	.	.
VIAD	*Viola adunca*	.	.	.	.
APAN	*Apocynum androsaemifolium*	.	.	.	.
COPA	*Comandra pallida*	56	0.244	0.372	9
FRVI	*Fragaria virginiana*	.	.	.	.
POTRI	*Potentilla tridentata*	32	0.0140	0.033	21
GELI	*Geocaulon lividum*	12	0.100	0.289	10
PYVI	*Pyrola virens*	48	0.0690	0.137	13
HICA	*Hieracium canadense*	8	0.0044	0.020	24
PYSE	*Pyrola secunda*	.	.	.	.
EPAN	*Epilobium angustifolium*	12	0.0084	0.028	22
ARCA	*Artemisia campestris*	.	.	.	.
ARNU	*Aralia nudicaulis*	.	.	.	.
COCA	*Cornus canadensis*	92	2.20	5.95	4
LIPH	*Lilium philadelphicum*	.	.	.	.
ANPA	*Anemone patens*	.	.	.	.
TRBO	*Trientalis borealis*	.	.	.	.
VIRE	*Viola renifolia*	.	.	.	.
GORE	*Goodyera repens*	.	.	.	.
LAOC	*Lathyrus ochroleucus*	.	.	.	.
VIAM	*Vicia americana*	.	.	.	.
PEPA	*Petasites palmatus*	.	.	.	.
ASCI	*Aster ciliolatus*	.	.	.	.
CYAC	*Cypripedium acaule*	.	.	.	.
ACMI	*Achillea millefolium*	.	.	.	.
ANRA	*Antennaria racemosa*	.	.	.	.
GEAM	*Gentianella amarella*	.	.	.	.
RUAC	*Rubus acaulis*	.	.	.	.
PYAS	*Pyrola asarifolia*	.	.	.	.
MINU	*Mitella nuda*	.	.	.	.
DRSP	*Draba* sp.	.	.	.	.
SESP	*Senecio* sp.	.	.	.	.

Total Forb Cover = 4.25%

continued ...

Reference Stand No. 4 Continued

CODE	Species	Frequency % 5x5 m Plots	Plant Cover % Mean	S.D.	Rank
Graminoids					
ORPU	*Oryzopsis pungens*	100	0.276	0.248	8
ELIN	*Elymus innovatus*	32	0.0640	0.200	14
CXUM	*Carex umbellata*	.	.	.	.
CXFO	*Carex foenea*	92	0.0450	0.046	16
ORAS	*Oryzopsis asperifolia*	32	0.0210	0.040	20
AGSC	*Agrostis scabra*	.	.	.	.
BRCI	*Bromus ciliatus*	.	.	.	.
SCPU	*Schizachne purpurascens*	.	.	.	.
JUBA	*Juncus balticus*	.	.	.	.
ELGL	*Elymus glaucus*	.	.	.	.
CACA	*Calamagrostis canadensis*	.	.	.	.
CAIN	*Calamagrostis inexpansa*	.	.	.	.
CXSP	*Carex* sp.	.	.	.	.

Total Graminoid Cover = 0.41%

Pteridophytes					
EQVA	*Equisetum variegatum*	8	0.0400	0.200	17
LYTR	*Lycopodium tristachyum*	P	.	.	.
LYAN	*Lycopodium annotinum*	.	.	.	.
EQSY	*Equisetum sylvaticum*	.	.	.	.
EQSC	*Equisetum scirpoides*	.	.	.	.
EQPR	*Equisetum pratense*	.	.	.	.
LYCL	*Lycopodium clavatum*	.	.	.	.
EQAR	*Equisetum arvense*	.	.	.	.
SEDE	*Selaginella densa*	.	.	.	.

Total Pteridophyte Cover = 0.040%

continued ...

Reference Stand No. 4 Continued

CODE	Species	Frequency % 5x5 m Plots	Plant Cover % Mean	S.D.	Rank
Bryophytes					
AUL PAL	*Aulacommium palustre*	.	.	.	.
BRA SAL	*Brachythecium salebrosum*	.	.	.	.
CER PUR	*Ceratodon purpureus*	27	0.075	0.257	7
DIC POL	*Dicranum polysetum*	20	0.002	0.004	20
DIC SCO	*Dicranum scoparium*	7	0.0007	0.0026	34
DIT FLE	*Ditrichum flexicaule*	.	.	.	.
DRE UNC	*Drepanocladus uncinatus*	.	.	.	.
HYL SPL	*Hylocomium splendens*	13	0.001	0.004	32
ORT FLA	*Orthodicranum flagellare*	.	.	.	.
PLE SCH	*Pleurozium schreberi*	20	0.14	0.35	16
POH NUT	*Pohlia nutans*	.	.	.	.
POL JUN	*Polytrichum juniperinum*	27	0.003	0.005	27
POL PIL	*Polytrichum piliferum*	87	1.49	2.57	2
PTI CIL	*Ptilidium ciliare*	.	.	.	.
PTI PUL	*Ptilidium pulcherrimum*	.	.	.	.
PTI C-C	*Ptilium crista-castrensis*	.	.	.	.
TET ANG	*Tetraplodon angustatus*	.	.	.	.
TOM NIT	*Tomenthypnum nitens*	.	.	.	.
	Total Bryophyte Cover = 1.586%				
Terrestrial Lichens					
CET ERI	*Cetraria ericetorum*	93	0.027	0.038	10
CET CUC	*Cetraria cucullata*	.	.	.	.
CET NIV	*Cetraria nivalis*	.	.	.	.
CLA MIT	*Cladina mitis*	100	19.1	15.1	1
CLA RAN	*Cladina rangiferina*	.	.	.	.
CLA STE	*Cladina stellaris*	13	0.001	0.004	31
CLA AMA	*Cladonia amaurocraea*	.	.	.	.
CLA CAP	*Cladonia capitata*	33	0.003	0.005	26
CLA CEN	*Cladonia cenotea*	7	0.0007	0.0026	33
CLA CHL	*Cladonia chlorophaea*	40	0.004	0.005	24
CLA COC	*Cladonia coccifera*	87	0.033	0.042	9
CLA CON	*Cladonia coniocraea*	27	0.009	0.026	21
CLA COR	*Cladonia cornuta*	100	0.654	0.951	4
CLA CRP	*Cladonia crispata*	.	.	.	.
CLA CRT	*Cladonia cristatella*	40	0.004	0.005	25
CLA GON	*Cladonia gonecha*	47	0.017	0.034	14
CLA GRA	*Cladonia gracilis*	93	0.567	0.480	5

continued ...

Reference Stand No. 4 Concluded.

CODE	Species	Frequency % 5x5 m Plots	Plant Cover Mean	S.D.	Rank
CLA MUL	*Cladonia multiformis*	27	0.021	0.041	11
CLA PHY	*Cladonia phyllophora*	87	0.820	0.652	3
CLA PYX	*Cladonia pyxidata*	20	0.002	0.004	28
CLA SUB	*Cladonia subulata*	20	0.002	0.004	29
CLA UNC	*Cladonia uncialis*	60	0.018	0.034	13
CLA VER	*Cladonia verticillata*	20	0.002	0.004	30
PEL APH	*Peltigera aphthosa*	.	.	.	.
PEL MAL	*Peltigera malacea*	60	0.560	0.817	6
PEL RUF	*Peltigera rufescens*	27	0.009	0.026	22
STE ALP	*Stereocaulon alpinum*	.	.	.	.

Total Terrestrial Lichen Cover = 21.85%

Epiphytic Lichens

BRY SPP	*Bryoria species*	93	0.009	0.003	19
CET HAL	*Cetraria halei*	87	0.009	0.004	20
CET PIN	*Cetraria pinastri*	100	0.034	0.041	8
EVE MES	*Evernia mesomorpha*	80	0.008	0.004	23
HYP PHY	*Hypogymnia physodes*	40	0.010	0.025	18
PAR ELE	*Parmelia elegantula*	.	.	.	.
PAR SUL	*Parmelia sulcata*	13	0.013	0.035	17
PAR AMB	*Parmeliopsis ambigua*	73	0.019	0.033	12
PAR HYP	*Parmeliopsis hyperopta*	7	0.0007	0.0026	35
PLA GLA	*Platismatia glauca*	7	0.0007	0.0026	36
USN SPP	*Usnea species*	93	0.15	0.024	15

Total Epiphytic Lichen Cover = 0.1184%

ATHABASCA OIL SANDS ECOLOGICAL MONITORING PROJECT

Reference Stand No. 5 — Permanent Plot No. 57

Survey Date 13 Aug 1981 — Stand Age 42 yrs

Vascular Plants	Species Richness = 22	Cover = 26.0%
Bryophytes	Species Richness = 7	Cover = 0.02%
Terrestrial Lichens	Species Richness = 16	Cover = 66.5%
Plant Community	Species Richness = 54	Cover = 92.7%

CODE	Species	Frequency % 5x5 m Plots	Plant Cover % Mean	S.D.	Rank
Trees					
PIBA	*Pinus banksiana*	100	15.8	7.53	1
PIGL	*Picea glauca*	.	.	.	.
PIMA	*Picea mariana*	.	.	.	.
POTR	*Populus tremuloides*	.	.	.	.
POBA	*Populus balsamifera*	.	.	.	.
LALA	*Larix laricina*	.	.	.	.
	Total Tree Cover = 15.76%				
Shrubs					
VAMY	*Vaccinium myrtilloides*	100	1.98	1.20	4
VAVI	*Vaccinium vitis-idaea*	100	5.00	5.10	2
ARUV	*Arctostaphylos uva-ursi*	96	2.02	1.39	3
ROAC	*Rosa acicularis*	16	0.0480	0.139	11
PRPE	*Prunus pensylvanica*	48	0.128	0.195	8
AMAL	*Amelanchier alnifolia*	36	0.0770	0.164	10
RUST	*Rubus strigosus*	.	.	.	.
LODI	*Lonicera dioica*	.	.	.	.
VIED	*Viburnum edule*	.	.	.	.
HUTO	*Hudsonia tomentosa*	.	.	.	.
SABE	*Salix bebbiana*	40	0.248	0.381	6
ALCR	*Alnus crispa*	.	.	.	.
LEGR	*Ledum groenlandicum*	.	.	.	.
RIGL	*Ribes glandulosum*	.	.	.	.
SHCA	*Shepherdia canadensis*	.	.	.	.
SAPS	*Salix pseudomonticola*	.	.	.	.
SYAL	*Symphoricarpos albus*	.	.	.	.
VACA	*Vaccinium caespitosum*	.	.	.	.
BEPU	*Betula pumila*	.	.	.	.
SAMY	*Salix myrtillifolia*	.	.	.	.
	Total Shrub Cover = 9.501%				

continued ...

Reference Stand No. 5 Continued.

CODE	Species	Frequency % 5x5 m Plots	Plant Cover % Mean	S.D.	Rank
Forbs					
MACA	*Maianthemum canadense*	100	0.312	0.284	5
ASLA	*Aster laevis*	72	0.167	0.297	7
ANMU	*Anemone multifida*	12	0.0210	0.100	15
GABO	*Galium boreale*	.	.	.	.
MELI	*Melampyrum lineare*	4	0.0200	0.200	16
LIBO	*Linnaea borealis*	4	0.0400	0.200	12
CARO	*Campanula rotundifolia*	32	0.0032	0.005	20
SODE	*Solidago decumbens*	28	0.0100	0.027	17
VIAD	*Viola adunca*	.	.	.	.
APAN	*Apocynum androsaemifolium*	72	0.106	0.156	9
COPA	*Comandra pallida*	.	.	.	.
FRVI	*Fragaria virginiana*	4	0.0004	0.002	21
POTRI	*Potentilla tridentata*	.	.	.	.
GELI	*Geocaulon lividum*	.	.	.	.
PYVI	*Pyrola virens*	8	0.0080	0.028	18
HICA	*Hieracium canadense*	4	0.0004	0.002	22
PYSE	*Pyrola secunda*	.	.	.	.
EPAN	*Epilobium angustifolium*	.	.	.	.
ARCA	*Artemisia campestris*	.	.	.	.
ARNU	*Aralia nudicaulis*	.	.	.	.
COCA	*Cornus canadensis*	.	.	.	.
LIPH	*Lilium philadelphicum*	.	.	.	.
ANPA	*Anemone patens*	.	.	.	.
TRBO	*Trientalis borealis*	.	.	.	.
VIRE	*Viola renifolia*	.	.	.	.
GORE	*Goodyera repens*	.	.	.	.
LAOC	*Lathyrus ochroleucus*	.	.	.	.
VIAM	*Vicia americana*	.	.	.	.
PEPA	*Petasites palmatus*	.	.	.	.
ASCI	*Aster ciliolatus*	.	.	.	.
CYAC	*Cypripedium acaule*	.	.	.	.
ACMI	*Achillea millefolium*	.	.	.	.
ANRA	*Antennaria racemosa*	.	.	.	.
GEAM	*Gentianella amarella*	.	.	.	.
RUAC	*Rubus acaulis*	.	.	.	.
PYAS	*Pyrola asarifolia*	.	.	.	.
MINU	*Mitella nuda*	.	.	.	.
DRSP	*Draba* sp.	.	.	.	.
SESP	*Senecio* sp.	.	.	.	.

Total Forb Cover = 0.688%

continued ...

Reference Stand No. 5 Continued

CODE	Species	Frequency % 5x5 m Plots	Plant Cover % Mean	S.D.	Rank
Graminoids					
ORPU	*Oryzopsis pungens*	96	0.0280	0.037	14
ELIN	*Elymus innovatus*	.	.	.	.
CXUM	*Carex umbellata*	.	.	.	.
CXFO	*Carex foenea*	96	0.0310	0.040	13
ORAS	*Oryzopsis asperifolia*	.	.	.	.
AGSC	*Agrostis scabra*	.	.	.	.
BRCI	*Bromus ciliatus*	.	.	.	.
SCPU	*Schizachne purpurascens*	.	.	.	.
JUBA	*Juncus balticus*	.	.	.	.
ELGL	*Elymus glaucus*	.	.	.	.
CACA	*Calamagrostis canadensis*	.	.	.	.
CAIN	*Calamagrostis inexpansa*	.	.	.	.
CXSP	*Carex* sp.	.	.	.	.

Total Graminoid Cover = 0.059%

CODE	Species	Frequency % 5x5 m Plots	Plant Cover % Mean	S.D.	Rank
Pteridophytes					
EQVA	*Equisetum variegatum*	4	0.0040	0.020	19
LYTR	*Lycopodium tristachyum*	.	.	.	.
LYAN	*Lycopodium annotinum*	.	.	.	.
EQSY	*Equisetum sylvaticum*	.	.	.	.
EQSC	*Equisetum scirpoides*	.	.	.	.
EQPR	*Equisetum pratense*	.	.	.	.
LYCL	*Lycopodium clavatum*	.	.	.	.
EQAR	*Equisetum arvense*	.	.	.	.
SEDE	*Selaginella densa*	.	.	.	.

Total Pteridophyte Cover = 0.004%

continued ...

Reference Stand No. 5 Continued

CODE	Species	Frequency % 5x5 m Plots	Plant Cover % Mean	S.D.	Rank
Bryophytes					
AUL PAL	*Aulacomnium palustre*	.	.	.	.
BRA SAL	*Brachythecium salebrosum*	.	.	.	.
CER PUR	*Ceratodon purpureus*	.	.	.	.
DIC POL	*Dicranum polysetum*	47	0.005	0.005	21
DIC SCO	*Dicranum scoparium*	13	0.001	0.004	27
DIT FLE	*Ditrichum flexicaule*	.	.	.	.
DRE UNC	*Drepanocladus uncinatus*	.	.	.	.
HYL SPL	*Hylocomium splendens*	.	.	.	.
ORT FLA	*Orthodicranum flagellare*	.	.	.	.
PLE SCH	*Pleurozium schreberi*	13	0.001	0.004	28
POH NUT	*Pohlia nutans*	7	0.0007	0.0026	32
POL JUN	*Polytrichum juniperinum*	7	0.0007	0.0026	31
POL PIL	*Polytrichum piliferum*	27	0.009	0.026	19
PTI CIL	*Ptilidium ciliare*	.	.	.	.
PTI PUL	*Ptilidium pulcherrimum*	.	.	.	.
PTI C-C	*Ptilium crista-castrensis*	13	0.007	0.026	20
TET ANG	*Tetraplodon angustatus*	.	.	.	.
TOM NIT	*Tomenthypnum nitens*	.	.	.	.
	Total Bryophyte Cover = 0.0244%				
Terrestrial Lichens					
CET ERI	*Cetraria ericetorum*	87	0.020	0.032	10
CET CUC	*Cetraria cucullata*	.	.	.	.
CET NIV	*Cetraria nivalis*	7	0.0007	0.0026	29
CLA MIT	*Cladina mitis*	100	65.3	14.8	1
CLA RAN	*Cladina rangiferina*	20	0.002	0.004	25
CLA STE	*Cladina stellaris*	93	0.039	0.044	8
CLA AMA	*Cladonia amaurocraea*	.	.	.	.
CLA CAP	*Cladonia capitata*	.	.	.	.
CLA CEN	*Cladonia cenotea*	.	.	.	.
CLA CHL	*Cladonia chlorophaea*	87	0.015	0.024	12
CLA COC	*Cladonia coccifera*	53	0.011	0.025	13
CLA CON	*Cladonia coniocraea*	.	.	.	.
CLA COR	*Cladonia cornuta*	53	0.107	0.252	5
CLA CRP	*Cladonia crispata*	.	.	.	.
CLA CRT	*Cladonia cristatella*	27	0.009	0.026	18
CLA GON	*Cladonia gonecha*	40	0.004	0.005	23
CLA GRA	*Cladonia gracilis*	93	0.256	0.541	3

continued ...

Reference Stand No. 5 Concluded.

CODE	Species	Frequency % 5x5 m Plots	Plant Cover Mean	S.D.	Rank
CLA MUL	*Cladonia multiformis*	47	0.011	0.025	14
CLA PHY	*Cladonia phyllophora*	33	0.003	0.004	24
CLA PYX	*Cladonia pyxidata*	.	.	.	.
CLA SUB	*Cladonia subulata*	.	.	.	.
CLA UNC	*Cladonia uncialis*	93	0.111	0.250	4
CLA VER	*Cladonia verticillata*	.	.	.	.
PEL APH	*Peltigera aphthosa*	.	.	.	.
PEL MAL	*Peltigera malacea*	73	0.573	0.892	2
PEL RUF	*Peltigera rufescens*	20	0.080	0.257	7
STE ALP	*Stereocaulon alpinum*	.	.	.	.

Total Terrestrial Lichen Cover = 66.54%

Epiphytic Lichens

BRY SPP	*Bryoria species*	100	0.010	0	15
CET HAL	*Cetraria halei*	93	0.009	0.003	17
CET PIN	*Cetraria pinastri*	100	0.034	0.041	9
EVE MES	*Evernia mesomorpha*	47	0.005	0.005	22
HYP PHY	*Hypogymnia physodes*	100	0.016	0.023	11
PAR ELE	*Parmelia elegantula*	.	.	.	.
PAR SUL	*Parmelia sulcata*	7	0.0007	0.0026	30
PAR AMB	*Parmeliopsis ambigua*	100	0.088	0.254	6
PAR HYP	*Parmeliopsis hyperopta*	20	0.002	0.004	26
PLA GLA	*Platismatia glauca*	.	.	.	.
USN SPP	*Usnea species*	100	0.010	0	16

Total Epiphytic Lichen Cover = 0.1747%

ATHABASCA OIL SANDS ECOLOGICAL MONITORING PROJECT

Reference Stand No. 6 — Permanent Plot No. 58

Survey Date 15 Aug 1981 — Stand Age 43 yrs

Vascular Plants	Species Richness = 16	Cover = 10.8%
Bryophytes	Species Richness = 1	Cover = 0.4%
Terrestrial Lichens	Species Richness = 17	Cover = 66.4%
Plant Community	Species Richness = 42	Cover = 77.7%

CODE	Species	Frequency %	Plant Cover %		
		5x5 m Plots	Mean	S.D.	Rank
Trees					
PIBA	*Pinus banksiana*	100	8.66	8.21	1
PIGL	*Picea glauca*	.	.	.	.
PIMA	*Picea mariana*	.	.	.	.
POTR	*Populus tremuloides*	.	.	.	.
POBA	*Populus balsamifera*	.	.	.	.
LALA	*Larix laricina*	.	.	.	.
	Total Tree Cover = 8.66%				
Shrubs					
VAMY	*Vaccinium myrtilloides*	24	0.324	0.788	3
VAVI	*Vaccinium vitis-idaea*	.	.	.	.
ARUV	*Arctostaphylos uva-ursi*	96	1.56	1.13	2
ROAC	*Rosa acicularis*	.	.	.	.
PRPE	*Prunus pensylvanica*	24	0.0560	0.139	6
AMAL	*Amelanchier alnifolia*	.	.	.	.
RUST	*Rubus strigosus*	.	.	.	.
LODI	*Lonicera dioica*	.	.	.	.
VIED	*Viburnum edule*	.	.	.	.
HUTO	*Hudsonia tomentosa*	16	0.0016	0.004	12
SABE	*Salix bebbiana*	.	.	.	.
ALCR	*Alnus crispa*	.	.	.	.
LEGR	*Ledum groenlandicum*	.	.	.	.
RIGL	*Ribes glandulosum*	.	.	.	.
SHCA	*Shepherdia canadensis*	.	.	.	.
SAPS	*Salix pseudomonticola*	.	.	.	.
SYAL	*Symphoricarpos albus*	.	.	.	.
VACA	*Vaccinium caespitosum*	.	.	.	.
BEPU	*Betula pumila*	.	.	.	.
SAMY	*Salix myrtillifolia*	.	.	.	.
	Total Shrub Cover = 1.94%				

continued ...

Reference Stand No. 6 Continued.

CODE	Species	Frequency % 5x5 m Plots	Plant Cover % Mean	S.D.	Rank
Forbs					
MACA	*Maianthemum canadense*	60	0.0792	0.163	4
ASLA	*Aster laevis*	12	0.0012	0.003	14
ANMU	*Anemone multifida*	.	.	.	.
GABO	*Galium boreale*	.	.	.	.
MELI	*Melampyrum lineare*	.	.	.	.
LIBO	*Linnaea borealis*	.	.	.	.
CARO	*Campanula rotundifolia*	24	0.0024	0.004	11
SODE	*Solidago decumbens*	44	0.0332	0.047	8
VIAD	*Viola adunca*	.	.	.	.
APAN	*Apocynum androsaemifolium*	80	0.0600	0.102	5
COPA	*Comandra pallida*	.	.	.	.
FRVI	*Fragaria virginiana*	.	.	.	.
POTRI	*Potentilla tridentata*	.	.	.	.
GELI	*Geocaulon lividum*	.	.	.	.
PYVI	*Pyrola virens*	16	0.0016	0.004	13
HICA	*Hieracium canadense*	4	0.0040	0.020	10
PYSE	*Pyrola secunda*	.	.	.	.
EPAN	*Epilobium angustifolium*	.	.	.	.
ARCA	*Artemisia campestris*	.	.	.	.
ARNU	*Aralia nudicaulis*	.	.	.	.
COCA	*Cornus canadensis*	.	.	.	.
LIPH	*Lilium philadelphicum*	.	.	.	.
ANPA	*Anemone patens*	.	.	.	.
TRBO	*Trientalis borealis*	.	.	.	.
VIRE	*Viola renifolia*	.	.	.	.
GORE	*Goodyera repens*	.	.	.	.
LAOC	*Lathyrus ochroleucus*	.	.	.	.
VIAM	*Vicia americana*	.	.	.	.
PEPA	*Petasites palmatus*	.	.	.	.
ASCI	*Aster ciliolatus*	.	.	.	.
CYAC	*Cypripedium acaule*	.	.	.	.
ACMI	*Achillea millefolium*	.	.	.	.
ANRA	*Antennaria racemosa*	.	.	.	.
GEAM	*Gentianella amarella*	.	.	.	.
RUAC	*Rubus acaulis*	.	.	.	.
PYAS	*Pyrola asarifolia*	.	.	.	.
MINU	*Mitella nuda*	.	.	.	.
DRSP	*Draba* sp.	.	.	.	.
SESP	*Senecio* sp.	.	.	.	.

Total Forb Cover = 0.182%

continued ...

Reference Stand No. 6 Continued

CODE	Species	Frequency % 5x5 m Plots	Plant Cover % Mean	S.D.	Rank
Graminoids					
ORPU	*Oryzopsis pungens*	56	0.0432	0.103	7
ELIN	*Elymus innovatus*	.	.	.	.
CXUM	*Carex umbellata*	4	0.0004	0.002	16
CXFO	*Carex foenea*	88	0.0088	0.003	9
ORAS	*Oryzopsis asperifolia*	.	.	.	.
AGSC	*Agrostis scabra*	4	0.0004	0.002	15
BRCI	*Bromus ciliatus*	.	.	.	.
SCPU	*Schizachne purpurascens*	.	.	.	.
JUBA	*Juncus balticus*	.	.	.	.
ELGL	*Elymus glaucus*	.	.	.	.
CACA	*Calamagrostis canadensis*	.	.	.	.
CAIN	*Calamagrostis inexpansa*	.	.	.	.
CXSP	*Carex* sp.	.	.	.	.
	Total Graminoid Cover = 0.053%				
Pteridophytes					
EQVA	*Equisetum variegatum*	.	.	.	.
LYTR	*Lycopodium tristachyum*	.	.	.	.
LYAN	*Lycopodium annotinum*	.	.	.	.
EQSY	*Equisetum sylvaticum*	.	.	.	.
EQSC	*Equisetum scirpoides*	.	.	.	.
EQPR	*Equisetum pratense*	.	.	.	.
LYCL	*Lycopodium clavatum*	.	.	.	.
EQAR	*Equisetum arvense*	.	.	.	.
SEDE	*Selaginella densa*	.	.	.	.
	Total Pteridophyte Cover = 0.0%				

continued ...

Reference Stand No. 6 Continued

CODE	Species	Frequency % 5x5 m Plots	Plant Cover % Mean	S.D.	Rank
Bryophytes					
AUL PAL	*Aulacomnium palustre*	.	.	.	.
BRA SAL	*Brachythecium salebrosum*	.	.	.	.
CER PUR	*Ceratodon purpureus*	.	.	.	.
DIC POL	*Dicranum polysetum*	.	.	.	.
DIC SCO	*Dicranum scoparium*	.	.	.	.
DIT FLE	*Ditrichum flexicaule*	.	.	.	.
DRE UNC	*Drepanocladus uncinatus*	.	.	.	.
HYL SPL	*Hylocomium splendens*	.	.	.	.
ORT FLA	*Orthodicranum flagellare*	.	.	.	.
PLE SCH	*Pleurozium schreberi*	.	.	.	.
POH NUT	*Pohlia nutans*	.	.	.	.
POL JUN	*Polytrichum juniperinum*	.	.	.	.
POL PIL	*Polytrichum piliferum*	87	0.360	0.600	5
PTI CIL	*Ptilidium ciliare*	.	.	.	.
PTI PUL	*Ptilidium pulcherrimum*	.	.	.	.
PTI C-C	*Ptilium crista-castrensis*	.	.	.	.
TET ANG	*Tetraplodon angustatus*	.	.	.	.
TOM NIT	*Tomenthypnum nitens*	.	.	.	.
	Total Bryophyte Cover = 0.360%				
Terrestrial Lichens					
CET ERI	*Cetraria ericetorum*	93	0.027	0.038	9
CET CUC	*Cetraria cucullata*	.	.	.	.
CET NIV	*Cetraria nivalis*	7	0.0007	0.0026	24
CLA MIT	*Cladina mitis*	100	58.7	16.8	1
CLA RAN	*Cladina rangiferina*	.	.	.	.
CLA STE	*Cladina stellaris*	13	0.001	0.003	22
CLA AMA	*Cladonia amaurocraea*	33	0.013	0.025	13
CLA CAP	*Cladonia capitata*	.	.	.	.
CLA CEN	*Cladonia cenotea*	.	.	.	.
CLA CHL	*Cladonia chlorophaea*	.	.	.	.
CLA COC	*Cladonia coccifera*	100	0.052	0.046	8
CLA CON	*Cladonia coniocraea*	.	.	.	.
CLA COR	*Cladonia cornuta*	100	1.74	1.15	3
CLA CRP	*Cladonia crispata*	.	.	.	.
CLA CRT	*Cladonia cristatella*	27	0.003	0.005	18
CLA GON	*Cladonia gonecha*	27	0.003	0.005	19
CLA GRA	*Cladonia gracilis*	100	1.61	0.815	4

continued ...

Reference Stand No. 6 Concluded.

CODE	Species	Frequency % 5x5 m Plots	Plant Cover Mean	S.D.	Rank
CLA MUL	*Cladonia multiformis*	.	.	.	.
CLA PHY	*Cladonia phyllophora*	100	0.118	0.248	7
CLA PYX	*Cladonia pyxidata*	20	0.002	0.004	21
CLA SUB	*Cladonia subulata*	7	0.0007	0.0026	25
CLA UNC	*Cladonia uncialis*	100	3.81	2.23	2
CLA VER	*Cladonia verticillata*	13	0.001	0.003	23
PEL APH	*Peltigera aphthosa*	.	.	.	.
PEL MAL	*Peltigera malacea*	67	0.295	0.581	6
PEL RUF	*Peltigera rufescens*	7	0.0007	0.0026	26
STE ALP	*Stereocaulon alpinum*	.	.	.	.

Total Terrestrial Lichen Cover = 66.38%

Epiphytic Lichens

BRY SPP	*Bryoria species*	80	0.008	0.004	15
CET HAL	*Cetraria halei*	80	0.014	0.024	12
CET PIN	*Cetraria pinastri*	100	0.010	0	14
EVE MES	*Evernia mesomorpha*	67	0.007	0.005	16
HYP PHY	*Hypogymnia physodes*	27	0.003	0.005	20
PAR ELE	*Parmelia elegantula*	.	.	.	.
PAR SUL	*Parmelia sulcata*	.	.	.	.
PAR AMB	*Parmeliopsis ambigua*	80	0.020	0.033	10
PAR HYP	*Parmeliopsis hyperopta*	33	0.003	0.005	17
PLA GLA	*Platismatia glauca*	.	.	.	.
USN SPP	*Usnea species*	87	0.015	0.024	11

Total Epiphytic Lichen Cover = 0.080%

ATHABASCA OIL SANDS ECOLOGICAL MONITORING PROJECT

Reference Stand No. 7 — Permanent Plot No. 9(53)

Survey Date 11 Aug 1981 — Stand Age 43 yrs

Vascular Plants	Species Richness = 32	Cover = 21.2%
Bryophytes	Species Richness = 10	Cover = 0.4%
Terrestrial Lichens	Species Richness = 20	Cover = 46.8%
Plant Community	Species Richness = 71	Cover = 68.7%

CODE	Species	Frequency % 5x5 m Plots	Plant Cover % Mean	S.D.	Rank
Trees					
PIBA	*Pinus banksiana*	100	13.8	7.90	1
PIGL	*Picea glauca*	4	0.0004	0.002	27
PIMA	*Picea mariana*	.	.	.	.
POTR	*Populus tremuloides*	.	.	.	.
POBA	*Populus balsamifera*	.	.	.	.
LALA	*Larix laricina*	.	.	.	.
	Total Tree Cover = 13.76%				
Shrubs					
VAMY	*Vaccinium myrtilloides*	100	1.39	1.45	3
VAVI	*Vaccinium vitis-idaea*	100	2.14	1.37	2
ARUV	*Arctostaphylos uva-ursi*	92	1.30	1.30	4
ROAC	*Rosa acicularis*	88	0.612	0.527	6
PRPE	*Prunus pensylvanica*	60	0.0740	0.136	11
AMAL	*Amelanchier alnifolia*	56	0.113	0.178	9
RUST	*Rubus strigosus*	4	0.0004	0.002	28
LODI	*Lonicera dioica*	4	0.0004	0.002	29
VIED	*Viburnum edule*	4	0.0004	0.002	30
HUTO	*Hudsonia tomentosa*	.	.	.	.
SABE	*Salix bebbiana*	.	.	.	.
ALCR	*Alnus crispa*	.	.	.	.
LEGR	*Ledum groenlandicum*	.	.	.	.
RIGL	*Ribes glandulosum*	.	.	.	.
SHCA	*Shepherdia canadensis*	.	.	.	.
SAPS	*Salix pseudomonticola*	.	.	.	.
SYAL	*Symphoricarpos albus*	.	.	.	.
VACA	*Vaccinium caespitosum*	.	.	.	.
BEPU	*Betula pumila*	.	.	.	.
SAMY	*Salix myrtillifolia*	.	.	.	.
	Total Shrub Cover = 5.63%				

continued ...

Reference Stand No. 7 Continued.

CODE	Species	Frequency % 5x5 m Plots	Plant Cover % Mean	S.D.	Rank
Forbs					
MACA	*Maianthemum canadense*	100	0.628	0.282	5
ASLA	*Aster laevis*	84	0.154	0.273	8
ANMU	*Anemone multifida*	64	0.0656	0.103	12
GABO	*Galium boreale*	32	0.0068	0.020	24
MELI	*Melampyrum lineare*	40	0.0344	0.102	17
LIBO	*Linnaea borealis*	68	0.553	0.781	7
CARO	*Campanula rotundifolia*	80	0.0116	0.019	22
SODE	*Solidago decumbens*	56	0.0540	0.104	14
VIAD	*Viola adunca*	56	0.0236	0.039	20
APAN	*Apocynum androsaemifolium*	48	0.0424	0.103	16
COPA	*Comandra pallida*	.	.	.	.
FRVI	*Fragaria virginiana*	16	0.0248	0.101	19
POTRI	*Potentilla tridentata*	8	0.0044	0.020	25
GELI	*Geocaulon lividum*	4	0.0200	0.100	21
PYVI	*Pyrola virens*	12	0.0084	0.028	23
HICA	*Hieracium canadense*	4	0.0004	0.002	32
PYSE	*Pyrola secunda*	.	.	.	.
EPAN	*Epilobium angustifolium*	.	.	.	.
ARCA	*Artemisia campestris*	.	.	.	.
ARNU	*Aralia nudicaulis*	.	.	.	.
COCA	*Cornus canadensis*	.	.	.	.
LIPH	*Lilium philadelphicum*	.	.	.	.
ANPA	*Anemone patens*	.	.	.	.
TRBO	*Trientalis borealis*	.	.	.	.
VIRE	*Viola renifolia*	.	.	.	.
GORE	*Goodyera repens*	.	.	.	.
LAOC	*Lathyrus ochroleucus*	.	.	.	.
VIAM	*Vicia americana*	.	.	.	.
PEPA	*Petasites palmatus*	.	.	.	.
ASCI	*Aster ciliolatus*	.	.	.	.
CYAC	*Cypripedium acaule*	.	.	.	.
ACMI	*Achillea millefolium*	.	.	.	.
ANRA	*Antennaria racemosa*	.	.	.	.
GEAM	*Gentianella amarella*	.	.	.	.
RUAC	*Rubus acaulis*	.	.	.	.
PYAS	*Pyrola asarifolia*	.	.	.	.
MINU	*Mitella nuda*	.	.	.	.
DRSP	*Draba* sp.	.	.	.	.
SESP	*Senecio* sp.	.	.	.	.

Total Forb Cover = 1.63%

continued ...

Reference Stand No. 7 Continued

CODE	Species	Frequency % 5x5 m Plots	Plant Cover % Mean	S.D.	Rank
Graminoids					
ORPU	*Oryzopsis pungens*	92	0.0432	0.101	15
ELIN	*Elymus innovatus*	64	0.0548	0.103	13
CXUM	*Carex umbellata*	32	0.0336	0.103	18
CXFO	*Carex foenea*	36	0.0036	0.005	26
ORAS	*Oryzopsis asperifolia*	.	.	.	.
AGSC	*Agrostis scabra*	.	.	.	.
BRCI	*Bromus ciliatus*	.	.	.	.
SCPU	*Schizachne purpurascens*	.	.	.	.
JUBA	*Juncus balticus*	.	.	.	.
ELGL	*Elymus glaucus*	.	.	.	.
CACA	*Calamagrostis canadensis*	.	.	.	.
CAIN	*Calamagrostis inexpansa*	.	.	.	.
CXSP	*Carex* sp.	.	.	.	.
	Total Graminoid Cover = 0.14%				
Pteridophytes					
EQVA	*Equisetum variegatum*	4	0.0004	0.002	31
LYTR	*Lycopodium tristachyum*	20	0.0840	0.186	10
LYAN	*Lycopodium annotinum*	.	.	.	.
EQSY	*Equisetum sylvaticum*	.	.	.	.
EQSC	*Equisetum scirpoides*	.	.	.	.
EQPR	*Equisetum pratense*	.	.	.	.
LYCL	*Lycopodium clavatum*	.	.	.	.
EQAR	*Equisetum arvense*	.	.	.	.
SEDE	*Selaginella densa*	.	.	.	.
	Total Pteridophyte Cover = 0.08%				

continued ...

Reference Stand No. 7 Continued

CODE	Species	Frequency % 5x5 m Plots	Plant Cover % Mean	S.D.	Rank
Bryophytes					
AUL PAL	*Aulacomnium palustre*	.	.	.	.
BRA SAL	*Brachythecium salebrosum*	.	.	.	.
CER PUR	*Ceratodon purpureus*	27	0.021	0.041	16
DIC POL	*Dicranum polysetum*	53	0.083	0.256	9
DIC SCO	*Dicranum scoparium*	.	.	.	.
DIT FLE	*Ditrichum flexicaule*	.	.	.	.
DRE UNC	*Drepanocladus uncinatus*	.	.	.	.
HYL SPL	*Hylocomium splendens*	13	0.001	0.004	29
ORT FLA	*Orthodicranum flagellare*	7	0.0007	0.0026	35
PLE SCH	*Pleurozium schreberi*	47	0.029	0.045	13
POH NUT	*Pohlia nutans*	.	.	.	.
POL JUN	*Polytrichum juniperinum*	47	0.149	0.347	6
POL PIL	*Polytrichum piliferum*	40	0.082	0.256	10
PTI CIL	*Ptilidium ciliare*	7	0.0007	0.0026	37
PTI PUL	*Ptilidium pulcherrimum*	.	.	.	.
PTI C-C	*Ptilium crista-castrensis*	20	0.008	0.026	22
TET ANG	*Tetraplodon angustatus*	7	0.0007	0.0026	38
TOM NIT	*Tomenthypnum nitens*	.	.	.	.
	Total Bryophyte Cover = 0.3751%				
Terrestrial Lichens					
CET ERI	*Cetraria ericetorum*	40	0.004	0.005	24
CET CUC	*Cetraria cucullata*	.	.	.	.
CET NIV	*Cetraria nivalis*	27	0.003	0.005	27
CLA MIT	*Cladina mitis*	100	43.7	22.9	1
CLA RAN	*Cladina rangiferina*	7	0.0007	0.0026	31
CLA STE	*Cladina stellaris*	.	.	.	.
CLA AMA	*Cladonia amaurocraea*	.	.	.	.
CLA CAP	*Cladonia capitata*	7	0.0007	0.0026	32
CLA CEN	*Cladonia cenotea*	7	0.0007	0.0026	33
CLA CHL	*Cladonia chlorophaea*	67	0.031	0.044	12
CLA COC	*Cladonia coccifera*	33.3	0.003	0.005	27
CLA CON	*Cladonia coniocraea*	.	.	.	.
CLA COR	*Cladonia cornuta*	100	0.527	0.593	3
CLA CRP	*Cladonia crispata*	7	0.0007	0.0026	34
CLA CRT	*Cladonia cristatella*	73	0.007	0.005	22
CLA GON	*Cladonia gonecha*	53	0.005	0.005	23
CLA GRA	*Cladonia gracilis*	100	0.214	0.320	5

continued ...

Reference Stand No. 7 Concluded.

CODE	Species	Frequency % 5x5 m Plots	Plant Cover Mean	S.D.	Rank
CLA MUL	*Cladonia multiformis*	100	0.394	0.444	4
CLA PHY	*Cladonia phyllophora*	33	0.021	0.041	15
CLA PYX	*Cladonia pyxidata*	.	.	.	.
CLA SUB	*Cladonia subulata*	.	.	.	.
CLA UNC	*Cladonia uncialis*	20	0.002	0.004	28
CLA VER	*Cladonia verticillata*	.	.	.	.
PEL APH	*Peltigera aphthosa*	20	0.008	0.026	21
PEL MAL	*Peltigera malacea*	73	1.87	1.63	2
PEL RUF	*Peltigera rufescens*	7	0.0007	0.0026	36
STE ALP	*Stereocaulon alpinum*	13	0.001	0.003	30

Total Terrestrial Lichen Cover = 46.79%

Epiphytic Lichens

BRY SPP	*Bryoria species*	100	0.010	0	19
CET HAL	*Cetraria halei*	100	0.016	0.023	17
CET PIN	*Cetraria pinastri*	100	0.022	0.032	14
EVE MES	*Evernia mesomorpha*	87	0.009	0.004	20
HYP PHY	*Hypogymnia physodes*	100	0.100	0.252	8
PAR ELE	*Parmelia elegantula*	.	.	.	.
PAR SUL	*Parmelia sulcata*	40	0.004	0.005	25
PAR AMB	*Parmeliopsis ambigua*	100	0.112	0.250	7
PAR HYP	*Parmeliopsis hyperopta*	80	0.014	0.024	18
PLA GLA	*Platismatia glauca*	.	.	.	.
USN SPP	*Usnea species*	100	0.034	0.041	11

Total Epiphytic Lichen Cover = 0.3210%

ATHABASCA OIL SANDS ECOLOGICAL MONITORING PROJECT

Reference Stand No. 8 — Permanent Plot No. 18B

Survey Date 6 Aug 81 — Stand Age 45 yrs

Vascular Plants	Species Richness = 20	Cover = 11.2%
Bryophytes	Species Richness = 1	Cover = 0.1%
Terrestrial Lichens	Species Richness = 15	Cover = 76.3%
Plant Community	Species Richness = 44	Cover = 87.9%

CODE	Species	Frequency % 5x5 m Plots	Plant Cover % Mean	S.D.	Rank
Trees					
PIBA	*Pinus banksiana*	100	5.00	3.20	1
PIGL	*Picea glauca*	.	.	.	.
PIMA	*Picea mariana*	.	.	.	.
POTR	*Populus tremuloides*	.	.	.	.
POBA	*Populus balsamifera*	.	.	.	.
LALA	*Larix laricina*	.	.	.	.
	Total Tree Cover = 5.00%				
Shrubs					
VAMY	*Vaccinium myrtilloides*	96	0.816	0.626	4
VAVI	*Vaccinium vitis-idaea*	88	1.15	0.886	3
ARUV	*Arctostaphylos uva-ursi*	100	2.10	1.04	2
ROAC	*Rosa acicularis*	44	0.504	0.899	5
PRPE	*Prunus pensylvanica*	32	0.0764	0.164	10
AMAL	*Amelanchier alnifolia*	.	.	.	.
RUST	*Rubus strigosus*	.	.	.	.
LODI	*Lonicera dioica*	.	.	.	.
VIED	*Viburnum edule*	.	.	.	.
HUTO	*Hudsonia tomentosa*	.	.	.	.
SABE	*Salix bebbiana*	.	.	.	.
ALCR	*Alnus crispa*	.	.	.	.
LEGR	*Ledum groenlandicum*	.	.	.	.
RIGL	*Ribes glandulosum*	.	.	.	.
SHCA	*Shepherdia canadensis*	.	.	.	.
SAPS	*Salix pseudomonticola*	.	.	.	.
SYAL	*Symphoricarpos albus*	.	.	.	.
VACA	*Vaccinium caespitosum*	.	.	.	.
BEPU	*Betula pumila*	.	.	.	.
SAMY	*Salix myrtillifolia*	.	.	.	.
	Total Shrub Cover = 4.6464%				

continued ...

Reference Stand No. 8 Continued.

CODE	Species	Frequency % 5x5 m Plots	Plant Cover % Mean	S.D.	Rank
Forbs					
MACA	*Maianthemum canadense*	96	0.473	0.302	6
ASLA	*Aster laevis*	92	0.408	0.300	7
ANMU	*Anemone multifida*	12	0.0084	0.028	15
GABO	*Galium boreale*	.	.	.	.
MELI	*Melampyrum lineare*	12	0.0120	0.033	13
LIBO	*Linnaea borealis*	.	.	.	.
CARO	*Campanula rotundifolia*	56	0.0164	0.032	12
SODE	*Solidago decumbens*	88	0.205	0.210	9
VIAD	*Viola adunca*	.	.	.	.
APAN	*Apocynum androsaemifolium*	88	0.404	0.305	8
COPA	*Comandra pallida*	.	.	.	.
FRVI	*Fragaria virginiana*	.	.	.	.
POTRI	*Potentilla tridentata*	20	0.0056	0.020	17
GELI	*Geocaulon lividum*	.	.	.	.
PYVI	*Pyrola virens*	8	0.0008	0.003	19
HICA	*Hieracium canadense*	36	0.0108	0.027	14
PYSE	*Pyrola secunda*	.	.	.	.
EPAN	*Epilobium angustifolium*	.	.	.	.
ARCA	*Artemisia campestris*	.	.	.	.
ARNU	*Aralia nudicaulis*	.	.	.	.
COCA	*Cornus canadensis*	.	.	.	.
LIPH	*Lilium philadelphicum*	.	.	.	.
ANPA	*Anemone patens*	4	0.0004	0.002	20
TRBO	*Trientalis borealis*	.	.	.	.
VIRE	*Viola renifolia*	.	.	.	.
GORE	*Goodyera repens*	.	.	.	.
LAOC	*Lathyrus ochroleucus*	.	.	.	.
VIAM	*Vicia americana*	.	.	.	.
PEPA	*Petasites palmatus*	.	.	.	.
ASCI	*Aster ciliolatus*	.	.	.	.
CYAC	*Cypripedium acaule*	.	.	.	.
ACMI	*Achillea millefolium*	.	.	.	.
ANRA	*Antennaria racemosa*	.	.	.	.
GEAM	*Gentianella amarella*	.	.	.	.
RUAC	*Rubus acaulis*	.	.	.	.
PYAS	*Pyrola asarifolia*	.	.	.	.
MINU	*Mitella nuda*	.	.	.	.
DRSP	*Draba* sp.	.	.	.	.
SESP	*Senecio* sp.	.	.	.	.

Total Forb Cover = 1.5444%

continued ...

Reference Stand No. 8 Continued

CODE	Species	Frequency % 5x5 m Plots	Plant Cover % Mean	S.D.	Rank
Graminoids					
ORPU	*Oryzopsis pungens*	88	0.0340	0.042	11
ELIN	*Elymus innovatus*	.	.	.	.
CXUM	*Carex umbellata*	16	0.0052	0.020	18
CXFO	*Carex foenea*	28	0.0064	0.020	16
ORAS	*Oryzopsis asperifolia*	.	.	.	.
AGSC	*Agrostis scabra*	.	.	.	.
BRCI	*Bromus ciliatus*	.	.	.	.
SCPU	*Schizachne purpurascens*	.	.	.	.
JUBA	*Juncus balticus*	.	.	.	.
ELGL	*Elymus glaucus*	.	.	.	.
CACA	*Calamagrostis canadensis*	.	.	.	.
CAIN	*Calamagrostis inexpansa*	.	.	.	.
CXSP	*Carex* sp.	.	.	.	.

Total Graminoid Cover = 0.0456%

CODE	Species				
Pteridophytes					
EQVA	*Equisetum variegatum*	.	.	.	.
LYTR	*Lycopodium tristachyum*	.	.	.	.
LYAN	*Lycopodium annotinum*	.	.	.	.
EQSY	*Equisetum sylvaticum*	.	.	.	.
EQSC	*Equisetum scirpoides*	.	.	.	.
EQPR	*Equisetum pratense*	.	.	.	.
LYCL	*Lycopodium clavatum*	.	.	.	.
EQAR	*Equisetum arvense*	.	.	.	.
SEDE	*Selaginella densa*	.	.	.	.

Total Pteridophyte Cover = 0.000%

continued ...

Reference Stand No. 8 Continued

CODE	Species	Frequency % 5x5 m Plots	Plant Cover % Mean	S.D.	Rank
Bryophytes					
AUL PAL	*Aulacomnium palustre*	.	.	.	.
BRA SAL	*Brachythecium salebrosum*	.	.	.	.
CER PUR	*Ceratodon purpureus*	.	.	.	.
DIC POL	*Dicranum polysetum*	.	.	.	.
DIC SCO	*Dicranum scoparium*	.	.	.	.
DIT FLE	*Ditrichum flexicaule*	.	.	.	.
DRE UNC	*Drepanocladus uncinatus*	.	.	.	.
HYL SPL	*Hylocomium splendens*	.	.	.	.
ORT FLA	*Orthodicranum flagellare*	.	.	.	.
PLE SCH	*Pleurozium schreberi*	.	.	.	.
POH NUT	*Pohlia nutans*	.	.	.	.
POL JUN	*Polytrichum juniperinum*	.	.	.	.
POL PIL	*Polytrichum piliferum*	40	0.088	0.256	10
PTI CIL	*Ptilidium ciliare*	.	.	.	.
PTI PUL	*Ptilidium pulcherrimum*	.	.	.	.
PTI C-C	*Ptilium crista-castrensis*	.	.	.	.
TET ANG	*Tetraplodon angustatus*	.	.	.	.
TOM NIT	*Tomenthypnum nitens*	.	.	.	.
	Total Bryophyte Cover = 0.0880%				
Terrestrial Lichens					
CET ERI	*Cetraria ericetorum*	100	0.214	0.320	2
CET CUC	*Cetraria cucullata*	.	.	.	.
CET NIV	*Cetraria nivalis*	40	0.004	0.005	22
CLA MIT	*Cladina mitis*	100	75.3	10.6	1
CLA RAN	*Cladina rangiferina*	33	0.003	0.005	23
CLA STE	*Cladina stellaris*	100	0.130	0.245	4
CLA AMA	*Cladonia amaurocraea*	.	.	.	.
CLA CAP	*Cladonia capitata*	7	0.0007	0.0026	24
CLA CEN	*Cladonia cenotea*	.	.	.	.
CLA CHL	*Cladonia chlorophaea*	73	0.31	0.043	14
CLA COC	*Cladonia coccifera*	.	.	.	.
CLA CON	*Cladonia coniocraea*	.	.	.	.
CLA COR	*Cladonia cornuta*	100	0.124	0.246	6
CLA CRP	*Cladonia crispata*	.	.	.	.
CLA CRT	*Cladonia cristatella*	93	0.069	0.045	12
CLA GON	*Cladonia gonecha*	7	0.151	0.346	3
CLA GRA	*Cladonia gracilis*	100	0.070	0.044	11

continued ...

Reference Stand No. 8 Concluded.

CODE	Species	Frequency % 5x5 m Plots	Plant Cover Mean	S.D.	Rank
CLA MUL	*Cladonia multiformis*	40	0.016	0.034	16
CLA PHY	*Cladonia phyllophora*	87	0.039	0.045	13
CLA PYX	*Cladonia pyxidata*	.	.	.	.
CLA SUB	*Cladonia subulata*	.	.	.	.
CLA UNC	*Cladonia uncialis*	67	0.121	0.248	7
CLA VER	*Cladonia verticillata*	.	.	.	.
PEL APH	*Peltigera aphthosa*	.	.	.	.
PEL MAL	*Peltigera malacea*	40	0.100	0.254	8
PEL RUF	*Peltigera rufescens*	.	.	.	.
STE ALP	*Stereocaulon alpinum*	.	.	.	.
	Total Terrestrial Lichen Cover = 76.34%				
	Epiphytic Lichens				
BRY SPP	*Bryoria species*	40	0.004	0.005	21
CET HAL	*Cetraria halei*	47	0.011	0.025	18
CET PIN	*Cetraria pinastri*	100	0.094	0.023	9
EVE MES	*Evernia mesomorpha*	47	0.011	0.025	19
HYP PHY	*Hypogymnia physodes*	27	0.021	0.041	15
PAR ELE	*Parmelia elegantula*	.	.	.	.
PAR SUL	*Parmelia sulcata*	.	.	.	.
PAR AMB	*Parmeliopsis ambigua*	93	0.129	0.245	5
PAR HYP	*Parmeliopsis hyperopta*	47	0.011	0.025	20
PLA GLA	*Platismatia glauca*	.	.	.	.
USN SPP	*Usnea species*	60	0.012	0.025	17
	Total Epiphytic Lichen Cover = 0.2930%				

ATHABASCA OIL SANDS ECOLOGICAL MONITORING PROJECT

Reference Stand No. 9 Permanent Plot No. 52

Survey Date 11 Aug 1981 Stand Age 59 yrs

Vascular Plants	Species Richness = 42	Cover = 25.3%
Bryophytes	Species Richness = 10	Cover = 16.0%
Terrestrial Lichens	Species Richness = 15	Cover = 43.6%
Plant Community	Species Richness = 76	Cover = 85.1%

CODE	Species	Frequency % 5x5 m Plots	Plant Cover % Mean	S.D.	Rank
Trees					
PIBA	*Pinus banksiana*	100	10.1	7.50	1
PIGL	*Picea glauca*	4	0.0200	0.10	24
PIMA	*Picea mariana*	8	0.0204	0.10	23
POTR	*Populus tremuloides*	20	0.0056	0.02	33
POBA	*Populus balsamifera*	.	.	.	.
LALA	*Larix laricina*	.	.	.	.
	Total Tree Cover = 10.166%				
Shrubs					
VAMY	*Vaccinium myrtilloides*	92	0.956	0.934	6
VAVI	*Vaccinium vitis-idaea*	100	4.32	4.88	2
ARUV	*Arctostaphylos uva-ursi*	96	1.94	1.48	4
ROAC	*Rosa acicularis*	100	1.44	0.808	5
PRPE	*Prunus pensylvanica*	.	.	.	.
AMAL	*Amelanchier alnifolia*	.	.	.	.
RUST	*Rubus strigosus*	.	.	.	.
LODI	*Lonicera dioica*	4	0.0004	0.002	41
VIED	*Viburnum edule*	.	.	.	.
HUTO	*Hudsonia tomentosa*	.	.	.	.
SABE	*Salix bebbiana*	P	.	.	.
ALCR	*Alnus crispa*	32	3.56	8.31	3
LEGR	*Ledum groenlandicum*	8	0.0400	0.138	20
RIGL	*Ribes glandulosum*	.	.	.	.
SHCA	*Shepherdia canadensis*	P	.	.	.
SAPS	*Salix pseudomonticola*	4	0.0200	0.100	25
SYAL	*Symphoricarpos albus*	4	0.0200	0.100	26
VACA	*Vaccinium caespitosum*	.	.	.	.
BEPU	*Betula pumila*	.	.	.	.
SAMY	*Salix myrtillifolia*	.	.	.	.
	Total Shrub Cover = 12.3004%				

continued ...

Reference Stand No. 9 Continued.

CODE	Species	Frequency % 5x5 m Plots	Plant Cover % Mean	S.D.	Rank
Forbs					
MACA	*Maianthemum canadense*	100	0.396	0.264	9
ASLA	*Aster laevis*	52	0.0732	0.136	15
ANMU	*Anemone multifida*	80	0.0868	0.133	13
GABO	*Galium boreale*	68	0.0856	0.133	14
MELI	*Melampyrum lineare*	16	0.0052	0.020	34
LIBO	*Linnaea borealis*	76	0.824	0.715	7
CARO	*Campanula rotundifolia*	56	0.0128	0.027	29
SODE	*Solidago decumbens*	32	0.0336	0.103	22
VIAD	*Viola adunca*	40	0.0112	0.027	30
APAN	*Apocynum androsaemifolium*	.	.	.	.
COPA	*Comandra pallida*	.	.	.	.
FRVI	*Fragaria virginiana*	76	0.222	0.311	10
POTRI	*Potentilla tridentata*	44	0.0420	0.103	19
GELI	*Geocaulon lividum*	28	0.108	0.202	12
PYVI	*Pyrola virens*	12	0.0048	0.020	35
HICA	*Hieracium canadense*	40	0.0184	0.037	27
PYSE	*Pyrola secunda*	4	0.0040	0.020	38
EPAN	*Epilobium angustifolium*	8	0.0080	0.028	32
ARCA	*Artemisia campestris*	.	.	.	.
ARNU	*Aralia nudicaulis*	.	.	.	.
COCA	*Cornus canadensis*	20	0.0520	0.139	18
LIPH	*Lilium philadelphicum*	16	0.0016	0.004	40
ANPA	*Anemone patens*	.	.	.	.
TRBO	*Trientalis borealis*	.	.	.	.
VIRE	*Viola renifolia*	8	0.0044	0.020	36
GORE	*Goodyera repens*	8	0.0044	0.020	37
LAOC	*Lathyrus ochroleucus*	.	.	.	.
VIAM	*Vicia americana*	.	.	.	.
PEPA	*Petasites palmatus*	.	.	.	.
ASCI	*Aster ciliolatus*	.	.	.	.
CYAC	*Cypripedium acaule*	.	.	.	.
ACMI	*Achillea millefolium*	.	.	.	.
ANRA	*Antennaria racemosa*	.	.	.	.
GEAM	*Gentianella amarella*	.	.	.	.
RUAC	*Rubus acaulis*	.	.	.	.
PYAS	*Pyrola asarifolia*	.	.	.	.
MINU	*Mitella nuda*	.	.	.	.
DRSP	*Draba* sp.	.	.	.	.
SESP	*Senecio* sp.	4	0.0040	0.020	39

Total Forb Cover = 2.0024%

continued ...

Reference Stand No. 9 Continued

CODE	Species	Frequency % 5x5 m Plots	Plant Cover % Mean	S.D.	Rank
Graminoids					
ORPU	*Oryzopsis pungens*	92	0.0576	0.102	17
ELIN	*Elymus innovatus*	88	0.504	0.316	8
CXUM	*Carex umbellata*	88	0.163	0.245	11
CXFO	*Carex foenea*	40	0.0148	0.032	28
ORAS	*Oryzopsis asperifolia*	.	.	.	.
AGSC	*Agrostis scabra*	.	.	.	.
BRCI	*Bromus ciliatus*	.	.	.	.
SCPU	*Schizachne purpurascens*	.	.	.	.
JUBA	*Juncus balticus*	84	0.0366	0.042	21
ELGL	*Elymus glaucus*	56	0.0664	0.137	16
CACA	*Calamagrostis canadensis*	.	.	.	.
CAIN	*Calamagrostis inexpansa*	.	.	.	.
CXSP	*Carex* sp.	.	.	.	.

Total Graminoid Cover = 0.8424%

CODE	Species	Frequency % 5x5 m Plots	Plant Cover % Mean	S.D.	Rank
Pteridophytes					
EQVA	*Equisetum variegatum*	68	0.0104	0.019	31
LYTR	*Lycopodium tristachyum*	.	.	.	.
LYAN	*Lycopodium annotinum*	.	.	.	.
EQSY	*Equisetum sylvaticum*	4	0.0004	0.002	42
EQSC	*Equisetum scirpoides*	.	.	.	.
EQPR	*Equisetum pratense*	.	.	.	.
LYCL	*Lycopodium clavatum*	.	.	.	.
EQAR	*Equisetum arvense*	.	.	.	.
SEDE	*Selaginella densa*	.	.	.	.

Total Pteridophyte Cover = 0.0108%

continued ...

Reference Stand No. 9 Continued

CODE	Species	Frequency % 5x5 m Plots	Plant Cover % Mean	S.D.	Rank
Bryophytes					
AUL PAL	*Aulacomnium palustre*	.	.	.	.
BRA SAL	*Brachythecium salebrosum*	7	0.0007	0.0026	33
CER PUR	*Ceratodon purpureus*	.	.	.	.
DIC POL	*Dicranum polysetum*	93	0.189	0.332	8
DIC SCO	*Dicranum scoparium*	.	.	.	.
DIT FLE	*Ditrichum flexicaule*	.	.	.	.
DRE UNC	*Drepanocladus uncinatus*	.	.	.	.
HYL SPL	*Hylocomium splendens*	87	0.267	0.381	6
ORT FLA	*Orthodicranum flagellare*	20	0.002	0.004	28
PLE SCH	*Pleurozium schreberi*	100	15.1	20.8	2
POH NUT	*Pohlia nutans*	.	.	.	.
POL JUN	*Polytrichum juniperinum*	20	0.068	0.258	11
POL PIL	*Polytrichum piliferum*	.	.	.	.
PTI CIL	*Ptilidium ciliare*	47	0.029	0.045	15
PTI PUL	*Ptilidium pulcherrimum*	20	0.002	0.004	29
PTI C-C	*Ptilium crista-castrensis*	73	0.374	0.595	4
TET ANG	*Tetraplodon angustatus*	7	0.0007	0.0026	34
TOM NIT	*Tomenthypnum nitens*	.	.	.	.
	Total Bryophyte Cover = 16.03%				
Terrestrial Lichens					
CET ERI	*Cetraria ericetorum*	.	.	.	.
CET CUC	*Cetraria cucullata*	.	.	.	.
CET NIV	*Cetraria nivalis*	.	.	.	.
CLA MIT	*Cladina mitis*	100	41.6	24.3	1
CLA RAN	*Cladina rangiferina*	27	0.015	0.035	20
CLA STE	*Cladina stellaris*	47	0.083	0.256	10
CLA AMA	*Cladonia amaurocraea*	13	0.001	0.004	30
CLA CAP	*Cladonia capitata*	.	.	.	.
CLA CEN	*Cladonia cenotea*	.	.	.	.
CLA CHL	*Cladonia chlorophaea*	73	0.019	0.033	17
CLA COC	*Cladonia coccifera*	.	.	.	.
CLA CON	*Cladonia coniocraea*	.	.	.	.
CLA COR	*Cladonia cornuta*	87	0.045	0.047	12
CLA CRP	*Cladonia crispata*	.	.	.	.
CLA CRT	*Cladonia cristatella*	13	0.001	0.004	31
CLA GON	*Cladonia gonecha*	27	0.003	0.005	26
CLA GRA	*Cladonia gracilis*	100	0.028	0.037	16

continued ...

Reference Stand No. 9 Concluded.

CODE	Species	Frequency % 5x5 m Plots	Plant Cover Mean	S.D.	Rank
CLA MUL	*Cladonia multiformis*	80	0.032	0.043	14
CLA PHY	*Cladonia phyllophora*	13	0.001	0.004	32
CLA PYX	*Cladonia pyxidata*	.	.	.	.
CLA SUB	*Cladonia subulata*	.	.	.	.
CLA UNC	*Cladonia uncialis*	33	0.009	0.025	24
CLA VER	*Cladonia verticillata*	.	.	.	.
PEL APH	*Peltigera aphthosa*	47	0.341	0.483	5
PEL MAL	*Peltigera malacea*	87	1.15	0.966	3
PEL RUF	*Peltigera rufescens*	20	0.267	0.584	7
STE ALP	*Stereocaulon alpinum*	.	.	.	.

Total Terrestrial Lichen Cover = 43.60%

Epiphytic Lichens

BRY SPP	*Bryoria species*	93	0.009	0.003	22
CET HAL	*Cetraria halei*	93	0.015	0.024	19
CET PIN	*Cetraria pinastri*	100	0.010	0	21
EVE MES	*Evernia mesomorpha*	93	0.009	0.003	23
HYP PHY	*Hypogymnia physodes*	87	0.093	0.254	9
PAR ELE	*Parmelia elegantula*	.	.	.	.
PAR SUL	*Parmelia sulcata*	33	0.003	0.005	25
PAR AMB	*Parmeliopsis ambigua*	100	0.016	0.023	18
PAR HYP	*Parmeliopsis hyperopta*	27	0.003	0.005	27
PLA GLA	*Platismatia glauca*	.	.	.	.
USN SPP	*Usnea species*	100	0.034	0.041	13

Total Epiphytic Lichen Cover = 0.1920%

ATHABASCA OIL SANDS ECOLOGICAL MONITORING PROJECT

Reference Stand No. 10 Permanent Plot No. 18A

Survey Date 8 Aug 1981 Stand Age 85 yrs

Vascular Plants	Species Richness = 18	Cover = 20.7%
Bryophytes	Species Richness = 9	Cover = 2.8%
Terrestrial Lichens	Species Richness = 17	Cover = 66.6%
Plant Community	Species Richness = 52	Cover = 90.4%

CODE	Species	Frequency % 5x5 m Plots	Plant Cover % Mean	S.D.	Rank
Trees					
PIBA	*Pinus banksiana*	100	8.52	5.64	1
PIGL	*Picea glauca*	P	.	.	.
PIMA	*Picea mariana*	.	.	.	.
POTR	*Populus tremuloides*	.	.	.	.
POBA	*Populus balsamifera*	4	0.0040	0.020	14
LALA	*Larix laricina*	.	.	.	.
	Total Tree Cover = 8.53%				
Shrubs					
VAMY	*Vaccinium myrtilloides*	96	3.50	3.92	3
VAVI	*Vaccinium vitis-idaea*	100	5.56	4.39	2
ARUV	*Arctostaphylos uva-ursi*	96	2.56	1.47	4
ROAC	*Rosa acicularis*	.	.	.	.
PRPE	*Prunus pensylvanica*	20	0.0128	0.0033	12
AMAL	*Amelanchier alnifolia*	.	.	.	.
RUST	*Rubus strigosus*	.	.	.	.
LODI	*Lonicera dioica*	.	.	.	.
VIED	*Viburnum edule*	.	.	.	.
HUTO	*Hudsonia tomentosa*	.	.	.	.
SABE	*Salix bebbiana*	.	.	.	.
ALCR	*Alnus crispa*	.	.	.	.
LEGR	*Ledum groenlandicum*	.	.	.	.
RIGL	*Ribes glandulosum*	.	.	.	.
SHCA	*Shepherdia canadensis*	.	.	.	.
SAPS	*Salix pseudomonticola*	.	.	.	.
SYAL	*Symphoricarpos albus*	.	.	.	.
VACA	*Vaccinium caespitosum*	.	.	.	.
BEPU	*Betula pumila*	.	.	.	.
SAMY	*Salix myrtillifolia*	.	.	.	.
	Total Shrub Cover = 11.64%				

continued ...

Reference Stand No. 10 Continued.

CODE	Species	Frequency % 5x5 m Plots	Plant Cover % Mean	S.D.	Rank
Forbs					
MACA	*Maianthemum canadense*	36	0.0804	0.163	8
ASLA	*Aster laevis*	4	0.0004	0.002	18
ANMU	*Anemone multifida*	.	.	.	.
GABO	*Galium boreale*	.	.	.	.
MELI	*Melampyrum lineare*	40	0.0968	0.183	7
LIBO	*Linnaea borealis*	.	.	.	.
CARO	*Campanula rotundifolia*	28	0.0028	0.005	15
SODE	*Solidago decumbens*	8	0.0008	0.003	17
VIAD	*Viola adunca*	.	.	.	.
APAN	*Apocynum androsaemifolium*	28	0.0332	0.103	9
COPA	*Comandra pallida*	.	.	.	.
FRVI	*Fragaria virginiana*	.	.	.	.
POTRI	*Potentilla tridentata*	4	0.0200	0.100	11
GELI	*Geocaulon lividum*	20	0.224	0.578	5
PYVI	*Pyrola virens*	36	0.138	0.597	6
HICA	*Hieracium canadense*	12	0.0084	0.028	13
PYSE	*Pyrola secunda*	.	.	.	.
EPAN	*Epilobium angustifolium*	.	.	.	.
ARCA	*Artemisia campestris*	.	.	.	.
ARNU	*Aralia nudicaulis*	.	.	.	.
COCA	*Cornus canadensis*	.	.	.	.
LIPH	*Lilium philadelphicum*	.	.	.	.
ANPA	*Anemone patens*	.	.	.	.
TRBO	*Trientalis borealis*	.	.	.	.
VIRE	*Viola renifolia*	.	.	.	.
GORE	*Goodyera repens*	.	.	.	.
LAOC	*Lathyrus ochroleucus*	.	.	.	.
VIAM	*Vicia americana*	.	.	.	.
PEPA	*Petasites palmatus*	.	.	.	.
ASCI	*Aster ciliolatus*	.	.	.	.
CYAC	*Cypripedium acaule*	.	.	.	.
ACMI	*Achillea millefolium*	.	.	.	.
ANRA	*Antennaria racemosa*	.	.	.	.
GEAM	*Gentianella amarella*	.	.	.	.
RUAC	*Rubus acaulis*	.	.	.	.
PYAS	*Pyrola asarifolia*	.	.	.	.
MINU	*Mitella nuda*	.	.	.	.
DRSP	*Draba* sp.	.	.	.	.
SESP	*Senecio* sp.	.	.	.	.

Total Forb Cover = 0.50%

continued ...

Reference Stand No. 10 Continued

CODE	Species	Frequency % 5x5 m Plots	Plant Cover % Mean	S.D.	Rank
Graminoids					
ORPU	*Oryzopsis pungens*	48	0.0228	0.040	10
ELIN	*Elymus innovatus*	.	.	.	.
CXUM	*Carex umbellata*	.	.	.	.
CXFO	*Carex foenea*	16	0.0016	0.004	16
ORAS	*Oryzopsis asperifolia*	.	.	.	.
AGSC	*Agrostis scabra*	.	.	.	.
BRCI	*Bromus ciliatus*	.	.	.	.
SCPU	*Schizachne purpurascens*	.	.	.	.
JUBA	*Juncus balticus*	.	.	.	.
ELGL	*Elymus glaucus*	.	.	.	.
CACA	*Calamagrostis canadensis*	.	.	.	.
CAIN	*Calamagrostis inexpansa*	.	.	.	.
CXSP	*Carex* sp.	.	.	.	.
	Total Graminoid Cover = 0.02%				
Pteridophytes					
EQVA	*Equisetum variegatum*	.	.	.	.
LYTR	*Lycopodium tristachyum*	.	.	.	.
LYAN	*Lycopodium annotinum*	.	.	.	.
EQSY	*Equisetum sylvaticum*	.	.	.	.
EQSC	*Equisetum scirpoides*	.	.	.	.
EQPR	*Equisetum pratense*	.	.	.	.
LYCL	*Lycopodium clavatum*	.	.	.	.
EQAR	*Equisetum arvense*	.	.	.	.
SEDE	*Selaginella densa*	.	.	.	.
	Total Pteridophyte Cover = 0.0%				

continued ...

Reference Stand No. 10 Continued

CODE	Species	Frequency % 5x5 m Plots	Plant Cover % Mean	S.D.	Rank
Bryophytes					
AUL PAL	*Aulacomnium palustre*	.	.	.	.
BRA SAL	*Brachythecium salebrosum*	.	.	.	.
CER PUR	*Ceratodon purpureus*	7	0.0007	0.0026	31
DIC POL	*Dicranum polysetum*	100	0.827	0.642	4
DIC SCO	*Dicranum scoparium*	40	0.016	0.034	18
DIT FLE	*Ditrichum flexicaule*	.	.	.	.
DRE UNC	*Drepanocladus uncinatus*	.	.	.	.
HYL SPL	*Hylocomium splendens*	40	0.010	0.025	22
ORT FLA	*Orthodicranum flagellare*	.	.	.	.
PLE SCH	*Pleurozium schreberi*	100	1.83	3.47	2
POH NUT	*Pohlia nutans*	.	.	.	.
POL JUN	*Polytrichum juniperinum*	.	.	.	.
POL PIL	*Polytrichum piliferum*	13	0.001	0.004	30
PTI CIL	*Ptilidium ciliare*	40	0.022	0.041	17
PTI PUL	*Ptilidium pulcherrimum*	13	0.007	0.004	25
PTI C-C	*Ptilium crista-castrensis*	60	0.036	0.047	14
TET ANG	*Tetraplodon angustatus*	.	.	.	.
TOM NIT	*Tomenthypnum nitens*	.	.	.	.
	Total Bryophyte Cover = 2.750%				
Terrestrial Lichens					
CET ERI	*Cetraria ericetorum*	73	0.049	0.049	10
CET CUC	*Cetraria cucullata*	.	.	.	.
CET NIV	*Cetraria nivalis*	33	0.003	0.005	27
CLA MIT	*Cladina mitis*	100	63.3	9.76	1
CLA RAN	*Cladina rangiferina*	27	0.003	0.005	28
CLA STE	*Cladina stellaris*	100	0.710	0.570	5
CLA AMA	*Cladonia amaurocraea*	13	0.007	0.004	24
CLA CAP	*Cladonia capitata*	.	.	.	.
CLA CEN	*Cladonia cenotea*	7	0.007	0.0026	32
CLA CHL	*Cladonia chlorophaea*	53	0.005	0.005	26
CLA COC	*Cladonia coccifera*	.	.	.	.
CLA CON	*Cladonia coniocraea*	7	0.0007	0.0026	33
CLA COR	*Cladonia cornuta*	100	1.62	1.15	3
CLA CRP	*Cladonia crispata*	.	.	.	.
CLA CRT	*Cladonia cristatella*	33	0.009	0.025	23
CLA GON	*Cladonia gonecha*	7	0.0007	0.0025	34
CLA GRA	*Cladonia gracilis*	87	0.195	0.330	7

continued ...

Reference Stand No, 10 Concluded.

CODE	Species	Frequency % 5x5 m Plots	Plant Cover Mean	S.D.	Rank
CLA MUL	*Cladonia multiformis*	53	0.035	0.047	15
CLA PHY	*Cladonia phyllophora*	47	0.041	0.050	13
CLA PYX	*Cladonia pyxidata*	.	.	.	.
CLA SUB	*Cladonia subulata*	.	.	.	.
CLA UNC	*Cladonia uncialis*	87	0.069	0.046	9
CLA VER	*Cladonia verticillata*	.	.	.	.
PEL APH	*Peltigera aphthosa*	.	.	.	.
PEL MAL	*Peltigera malacea*	93	0.573	0.473	6
PEL RUF	*Peltigera rufescens*	.	.	.	.
STE ALP	*Stereocaulon alpinum*	.	.	.	.

Total Terrestrial Lichen Cover = 66.62%

Epiphytic Lichens

BRY SPP	*Bryoria species*	100	0.010	0	20
CET HAL	*Cetraria halei*	47	0.011	0.025	19
CET PIN	*Cetraria pinastri*	100	0.046	0.046	11
EVE MES	*Evernia mesomorpha*	100	0.010	0	21
HYP PHY	*Hypogymnia physodes*	100	0.046	0.046	12
PAR ELE	*Parmelia elegantula*	.	.	.	.
PAR SUL	*Parmelia sulcata*	.	.	.	.
PAR AMB	*Parmeliopsis ambigua*	100	0.130	0.240	8
PAR HYP	*Parmeliopsis hyperopta*	27	0.003	0.005	29
PLA GLA	*Platismatia glauca*	.	.	.	.
USN SPP	*Usnea species*	100	0.022	0.032	16

Total Epiphytic Lichen Cover = 0.2780%

ATHABASCA OIL SANDS ECOLOGICAL MONITORING PROJECT

Reference Stand No. 11 — Permanent Plot No. 24

Survey Date 7 Aug 1981 — Stand Age 89 yrs

Vascular Plants	Species Richness = 37	Cover = 34.1%
Bryophytes	Species Richness = 6	Cover = 68.7%
Terrestrial Lichens	Species Richness = 14	Cover = 0.7%
Plant Community	Species Richness = 65	Cover = 104.2%

CODE	Species	Frequency % 5x5 m Plots	Plant Cover % Mean	S.D.	Rank
Trees					
PIBA	*Pinus banksiana*	100	12.1	4.17	1
PIGL	*Picea glauca*	.	.	.	.
PIMA	*Picea mariana*	.	.	.	.
POTR	*Populus tremuloides*	.	.	.	.
POBA	*Populus balsamifera*	.	.	.	.
LALA	*Larix laricina*	.	.	.	.
	Total Tree Cover = 12.12%				
Shrubs					
VAMY	*Vaccinium myrtilloides*	100	2.22	1.23	4
VAVI	*Vaccinium vitis-idaea*	100	2.08	1.40	6
ARUV	*Arctostaphylos uva-ursi*	44	0.348	0.653	11
ROAC	*Rosa acicularis*	76	1.14	1.02	8
PRPE	*Prunus pensylvanica*	40	0.224	0.323	13
AMAL	*Amelanchier alnifolia*	36	0.1004	0.233	16
RUST	*Rubus strigosus*	16	0.0444	0.139	22
LODI	*Lonicera dioica*	.	.	.	.
VIED	*Viburnum edule*	.	.	.	.
HUTO	*Hudsonia tomentosa*	.	.	.	.
SABE	*Salix bebbiana*	.	.	.	.
ALCR	*Alnus crispa*	84	7.35	7.42	2
LEGR	*Ledum groenlandicum*	.	.	.	.
RIGL	*Ribes glandulosum*	.	.	.	.
SHCA	*Shepherdia canadensis*	.	.	.	.
SAPS	*Salix pseudomonticola*	.	.	.	.
SYAL	*Symphoricarpos albus*	.	.	.	.
VACA	*Vaccinium caespitosum*	.	.	.	.
BEPU	*Betula pumila*	.	.	.	.
SAMY	*Salix myrtillifolia*	.	.	.	.
	Total Shrub Cover = 13.509%				

continued ...

Reference Stand No. 11 Continued.

CODE	Species	Frequency % 5x5 m Plots	Plant Cover % Mean	S.D.	Rank
Forbs					
MACA	*Maianthemum canadense*	80	0.166	0.244	14
ASLA	*Aster laevis*	.	.	.	.
ANMU	*Anemone multifida*	28	0.0224	0.100	25
GABO	*Galium boreale*	64	0.0388	0.047	24
MELI	*Melampyrum lineare*	88	0.420	0.331	10
LIBO	*Linnaea borealis*	100	1.16	0.590	7
CARO	*Campanula rotundifolia*	16	0.0052	0.020	29
SODE	*Solidago decumbens*	4	0.0004	0.002	36
VIAD	*Viola adunca*	4	0.0004	0.002	37
APAN	*Apocynum androsaemifolium*	.	.	.	.
COPA	*Comandra pallida*	8	0.0044	0.020	30
FRVI	*Fragaria virginiana*	32	0.0604	0.138	20
POTRI	*Potentilla tridentata*	64	0.073	0.102	18
GELI	*Geocaulon lividum*	40	0.284	0.408	12
PYVI	*Pyrola virens*	72	0.066	0.102	19
HICA	*Hieracium canadense*	16	0.0124	0.033	28
PYSE	*Pyrola secunda*	12	0.0440	0.139	23
EPAN	*Epilobium angustifolium*	4	0.0200	0.100	26
ARCA	*Artemisia campestris*	.	.	.	.
ARNU	*Aralia nudicaulis*	92	2.18	1.51	5
COCA	*Cornus canadensis*	8	0.0600	0.220	21
LIPH	*Lilium philadelphicum*	.	.	.	.
ANPA	*Anemone patens*	.	.	.	.
TRBO	*Trientalis borealis*	4	0.0200	0.100	27
VIRE	*Viola renifolia*	.	.	.	.
GORE	*Goodyera repens*	.	.	.	.
LAOC	*Lathyrus ochroleucus*	.	.	.	.
VIAM	*Vicia americana*	.	.	.	.
PEPA	*Petasites palmatus*	.	.	.	.
ASCI	*Aster ciliolatus*	.	.	.	.
CYAC	*Cypripedium acaule*	.	.	.	.
ACMI	*Achillea millefolium*	.	.	.	.
ANRA	*Antennaria racemosa*	.	.	.	.
GEAM	*Gentianella amarella*	.	.	.	.
RUAC	*Rubus acaulis*	.	.	.	.
PYAS	*Pyrola asarifolia*	.	.	.	.
MINU	*Mitella nuda*	.	.	.	.
DRSP	*Draba* sp.	.	.	.	.
SESP	*Senecio* sp.	.	.	.	.

Total Forb Cover = 4.6374%

continued ...

Reference Stand No. 11 Continued

CODE	Species	Frequency % 5x5 m Plots	Plant Cover % Mean	S.D.	Rank
Graminoids					
ORPU	*Oryzopsis pungens*	88	0.0752	0.100	17
ELIN	*Elymus innovatus*	96	0.492	0.248	9
CXUM	*Carex umbellata*	8	0.0008	0.003	34
CXFO	*Carex foenea*	4	0.0040	0.020	32
ORAS	*Oryzopsis asperifolia*	44	0.117	0.199	15
AGSC	*Agrostis scabra*	.	.	.	.
BRCI	*Bromus ciliatus*	4	0.0040	0.020	33
SCPU	*Schizachne purpurascens*	8	0.0044	0.020	31
JUBA	*Juncus balticus*	.	.	.	.
ELGL	*Elymus glaucus*	.	.	.	.
CACA	*Calamagrostis canadensis*	.	.	.	.
CAIN	*Calamagrostis inexpansa*	.	.	.	.
CXSP	*Carex* sp.	.	.	.	.

Total Graminoid Cover = 0.6974%

CODE	Species	Frequency % 5x5 m Plots	Plant Cover % Mean	S.D.	Rank
Pteridophytes					
EQVA	*Equisetum variegatum*	.	.	.	.
LYTR	*Lycopodium tristachyum*	68	3.14	4.58	3
LYAN	*Lycopodium annotinum*	4	0.0004	0.002	35
EQSY	*Equisetum sylvaticum*	.	.	.	.
EQSC	*Equisetum scirpoides*	.	.	.	.
EQPR	*Equisetum pratense*	.	.	.	.
LYCL	*Lycopodium clavatum*	.	.	.	.
EQAR	*Equisetum arvense*	.	.	.	.
SEDE	*Selaginella densa*	.	.	.	.

Total Pteridophyte Cover = 3.1404%

continued ...

Reference Stand No. 11 Continued

CODE	Species	Frequency % 5x5 m Plots	Plant Cover % Mean	S.D.	Rank
Bryophytes					
AUL PAL	*Aulacomnium palustre*	.	.	.	.
BRA SAL	*Brachythecium salebrosum*	.	.	.	.
CER PUR	*Ceratodon purpureus*	.	.	.	.
DIC POL	*Dicranum polysetum*	100	3.60	4.84	2
DIC SCO	*Dicranum scoparium*	33	0.003	0.005	22
DIT FLE	*Ditrichum flexicaule*	.	.	.	.
DRE UNC	*Drepanocladus uncinatus*	.	.	.	.
HYL SPL	*Hylocomium splendens*	100	1.23	1.45	3
ORT FLA	*Orthodicranum flagellare*	.	.	.	.
PLE SCH	*Pleurozium schreberi*	100	63.7	26.0	1
POH NUT	*Pohlia nutans*	.	.	.	.
POL JUN	*Polytrichum juniperinum*	20	0.074	0.257	9
POL PIL	*Polytrichum piliferum*	.	.	.	.
PTI CIL	*Ptilidium ciliare*	.	.	.	.
PTI PUL	*Ptilidium pulcherrimum*	80	0.056	0.049	13
PTI C-C	*Ptilium crista-castrensis*	.	.	.	.
TET ANG	*Tetraplodon angustatus*	.	.	.	.
TOM NIT	*Tomenthypnum nitens*	.	.	.	.
	Total Bryophyte Cover = 68.66%				
Terrestrial Lichens					
CET ERI	*Cetraria ericetorum*	.	.	.	.
CET CUC	*Cetraria cucullata*	.	.	.	.
CET NIV	*Cetraria nivalis*	.	.	.	.
CLA MIT	*Cladina mitis*	27	0.281	1.03	5
CLA RAN	*Cladina rangiferina*	.	.	.	.
CLA STE	*Cladina stellaris*	7	0.0007	0.0026	28
CLA AMA	*Cladonia amaurocraea*	.	.	.	.
CLA CAP	*Cladonia capitata*	7	0.0007	0.0026	24
CLA CEN	*Cladonia cenotea*	.	.	.	.
CLA CHL	*Cladonia chlorophaea*	60	0.024	0.040	17
CLA COC	*Cladonia coccifera*	7	0.0007	0.0026	25
CLA CON	*Cladonia coniocraea*	7	0.0007	0.0026	26
CLA COR	*Cladonia cornuta*	67	0.031	0.044	14
CLA CRP	*Cladonia crispata*	.	.	.	.
CLA CRT	*Cladonia cristatella*	53	0.017	0.034	18
CLA GON	*Cladonia gonecha*	20	0.002	0.004	23
CLA GRA	*Cladonia gracilis*	80	0.056	0.049	12

continued ...

Reference Stand No. 11 Concluded.

CODE	Species	Frequency % 5x5 m Plots	Plant Cover Mean	S.D.	Rank
CLA MUL	*Cladonia multiformis*	7	0.0007	0.0026	27
CLA PHY	*Cladonia phyllophora*	.	.	.	.
CLA PYX	*Cladonia pyxidata*	.	.	.	.
CLA SUB	*Cladonia subulata*	.	.	.	.
CLA UNC	*Cladonia uncialis*	7	0.007	0.025	21
CLA VER	*Cladonia verticillata*	.	.	.	.
PEL APH	*Peltigera aphthosa*	7	0.067	0.258	11
PEL MAL	*Peltigera malacea*	13	0.273	1.03	6
PEL RUF	*Peltigera rufescens*	.	.	.	.
STE ALP	*Stereocaulon alpinum*	.	.	.	.

Total Terrestrial Lichen Cover = 0.6974%

Epiphytic Lichens

BRY SPP	*Bryoria species*	67	0.025	0.039	15
CET HAL	*Cetraria halei*	60	0.012	0.025	19
CET PIN	*Cetraria pinastri*	100	0.094	0.023	8
EVE MES	*Evernia mesomorpha*	.	.	.	.
HYP PHY	*Hypogymnia physodes*	87	0.189	0.332	7
PAR ELE	*Parmelia elegantula*	.	.	.	.
PAR SUL	*Parmelia sulcata*	67	0.007	0.005	20
PAR AMB	*Parmeliopsis ambigua*	100	0.070	0.044	10
PAR HYP	*Parmeliopsis hyperopta*	67	0.025	0.039	16
PLA GLA	*Platismatia glauca*	.	.	.	.
USN SPP	*Usnea species*	100	0.281	0.530	4

Total Epiphytic Lichen Cover = 0.7030%

ATHABASCA OIL SANDS ECOLOGICAL MONITORING PROJECT

Reference Stand No. 12 Permanent Plot No. 54

Survey Date 12 Aug 1981 Stand Age 91 yrs

Vascular Plants	Species Richness = 17	Cover = 15.9%
Bryophytes	Species Richness = 8	Cover = 5.4%
Terrestrial Lichens	Species Richness = 20	Cover = 30.3%
Plant Community	Species Richness = 54	Cover = 51.7%

CODE	Species	Frequency % 5x5 m Plots	Plant Cover % Mean	S.D.	Rank
Trees					
PIBA	*Pinus banksiana*	100	8.80	3.81	1
PIGL	*Picea glauca*	.	.	.	.
PIMA	*Picea mariana*	.	.	.	.
POTR	*Populus tremuloides*	.	.	.	.
POBA	*Populus balsamifera*	.	.	.	.
LALA	*Larix laricina*	.	.	.	.
	Total Tree Cover = 8.80%				
Shrubs					
VAMY	*Vaccinium myrtilloides*	96	2.43	1.81	3
VAVI	*Vaccinium vitis-idaea*	96	3.24	2.19	2
ARUV	*Arctostaphylos uva-ursi*	52	0.328	0.471	6
ROAC	*Rosa acicularis*	.	.	.	.
PRPE	*Prunus pensylvanica*	.	.	.	.
AMAL	*Amelanchier alnifolia*	4	0.0004	0.002	15
RUST	*Rubus strigosus*	.	.	.	.
LODI	*Lonicera dioica*	.	.	.	.
VIED	*Viburnum edule*	.	.	.	.
HUTO	*Hudsonia tomentosa*	.	.	.	.
SABE	*Salix bebbiana*	.	.	.	.
ALCR	*Alnus crispa*	.	.	.	.
LEGR	*Ledum groenlandicum*	.	.	.	.
RIGL	*Ribes glandulosum*	.	.	.	.
SHCA	*Shepherdia canadensis*	.	.	.	.
SAPS	*Salix pseudomonticola*	.	.	.	.
SYAL	*Symphoricarpos albus*	.	.	.	.
VACA	*Vaccinium caespitosum*	.	.	.	.
BEPU	*Betula pumila*	.	.	.	.
SAMY	*Salix myrtillifolia*	.	.	.	.
	Total Shrub Cover = 5.9964%				

continued ...

Reference Stand No. 12 Continued.

CODE	Species	Frequency % 5x5 m Plots	Plant Cover % Mean	S.D.	Rank
Forbs					
MACA	*Maianthemum canadense*	84	0.0748	0.100	7
ASLA	*Aster laevis*	.	.	.	.
ANMU	*Anemone multifida*	16	0.0016	0.004	11
GABO	*Galium boreale*	4	0.0004	0.020	16
MELI	*Melampyrum lineare*	96	0.488	0.450	4
LIBO	*Linnaea borealis*	72	0.436	0.501	5
CARO	*Campanula rotundifolia*	8	0.0008	0.003	13
SODE	*Solidago decumbens*	12	0.0012	0.003	12
VIAD	*Viola adunca*	.	.	.	.
APAN	*Apocynum androsaemifolium*	.	.	.	.
COPA	*Comandra pallida*	.	.	.	.
FRVI	*Fragaria virginiana*	.	.	.	.
POTRI	*Potentilla tridentata*	4	0.0004	0.002	17
GELI	*Geocaulon lividum*	12	0.0480	0.200	9
PYVI	*Pyrola virens*	48	0.0372	0.048	10
HICA	*Hieracium canadense*	.	.	.	.
PYSE	*Pyrola secunda*	.	.	.	.
EPAN	*Epilobium angustifolium*	.	.	.	.
ARCA	*Artemisia campestris*	.	.	.	.
ARNU	*Aralia nudicaulis*	.	.	.	.
COCA	*Cornus canadensis*	.	.	.	.
LIPH	*Lilium philadelphicum*	.	.	.	.
ANPA	*Anemone patens*	.	.	.	.
TRBO	*Trientalis borealis*	.	.	.	.
VIRE	*Viola renifolia*	.	.	.	.
GORE	*Goodyera repens*	.	.	.	.
LAOC	*Lathyrus ochroleucus*	.	.	.	.
VIAM	*Vicia americana*	.	.	.	.
PEPA	*Petasites palmatus*	.	.	.	.
ASCI	*Aster ciliolatus*	.	.	.	.
CYAC	*Cypripedium acaule*	.	.	.	.
ACMI	*Achillea millefolium*	.	.	.	.
ANRA	*Antennaria racemosa*	.	.	.	.
GEAM	*Gentianella amarella*	.	.	.	.
RUAC	*Rubus acaulis*	.	.	.	.
PYAS	*Pyrola asarifolia*	.	.	.	.
MINU	*Mitella nuda*	.	.	.	.
DRSP	*Draba* sp.	.	.	.	.
SESP	*Senecio* sp.	.	.	.	.

Total Forb Cover = 1.0892%

continued ...

Reference Stand No. 12 Continued

CODE	Species	Frequency % 5x5 m Plots	Plant Cover % Mean	S.D.	Rank
Graminoids					
ORPU	*Oryzopsis pungens*	84	0.0496	0.102	8
ELIN	*Elymus innovatus*	.	.	.	.
CXUM	*Carex umbellata*	.	.	.	.
CXFO	*Carex foenea*	.	.	.	.
ORAS	*Oryzopsis asperifolia*	8	0.0008	0.003	14
AGSC	*Agrostis scabra*	.	.	.	.
BRCI	*Bromus ciliatus*	.	.	.	.
SCPU	*Schizachne purpurascens*	.	.	.	.
JUBA	*Juncus balticus*	.	.	.	.
ELGL	*Elymus glaucus*	.	.	.	.
CACA	*Calamagrostis canadensis*	.	.	.	.
CAIN	*Calamagrostis inexpansa*	.	.	.	.
CXSP	*Carex* sp.	.	.	.	.

Total Graminoid Cover = 0.0504%

CODE	Species				
Pteridophytes					
EQVA	*Equisetum variegatum*	.	.	.	.
LYTR	*Lycopodium tristachyum*	.	.	.	.
LYAN	*Lycopodium annotinum*	.	.	.	.
EQSY	*Equisetum sylvaticum*	.	.	.	.
EQSC	*Equisetum scirpoides*	.	.	.	.
EQPR	*Equisetum pratense*	.	.	.	.
LYCL	*Lycopodium clavatum*	.	.	.	.
EQAR	*Equisetum arvense*	.	.	.	.
SEDE	*Selaginella densa*	.	.	.	.

Total Pteridophyte Cover = 0.0%

continued ...

Reference Stand No. 12 Continued

CODE	Species	Frequency % 5x5 m Plots	Plant Cover % Mean	S.D.	Rank
Bryophytes					
AUL PAL	*Aulacomnium palustre*	.	.	.	.
BRA SAL	*Brachythecium salebrosum*	.	.	.	.
CER PUR	*Ceratodon purpureus*	13	0.001	0.004	32
DIC POL	*Dicranum polysetum*	100	0.257	0.541	10
DIC SCO	*Dicranum scoparium*	100	0.841	1.05	6
DIT FLE	*Ditrichum flexicaule*	.	.	.	.
DRE UNC	*Drepanocladus uncinatus*	.	.	.	.
HYL SPL	*Hylocomium splendens*	33	0.534	1.13	7
ORT FLA	*Orthodicranum flagellare*	.	.	.	.
PLE SCH	*Pleurozium schreberi*	67	2.63	6.54	2
POH NUT	*Pohlia nutans*	.	.	.	.
POL JUN	*Polytrichum juniperinum*	100	0.974	1.13	5
POL PIL	*Polytrichum piliferum*	40	0.004	0.005	26
PTI CIL	*Ptilidium ciliare*	.	.	.	.
PTI PUL	*Ptilidium pulcherrimum*	80	0.104	0.252	11
PTI C-C	*Ptilium crista-castrensis*	.	.	.	.
TET ANG	*Tetraplodon angustatus*	.	.	.	.
TOM NIT	*Tomenthypnum nitens*	.	.	.	.
	Total Bryophyte Cover = 5.345%				
Terrestrial Lichens					
CET ERI	*Cetraria ericetorum*	73	0.037	0.046	14
CET CUC	*Cetraria cucullata*	7	0.007	0.026	24
CET NIV	*Cetraria nivalis*	20	0.002	0.004	31
CLA MIT	*Cladina mitis*	100	24.6	19.7	1
CLA RAN	*Cladina rangiferina*	27	0.003	0.005	30
CLA STE	*Cladina stellaris*	67	0.031	0.044	15
CLA AMA	*Cladonia amaurocraea*	33	0.003	0.005	27
CLA CAP	*Cladonia capitata*	.	.	.	.
CLA CEN	*Cladonia cenotea*	7	0.0007	0.0026	34
CLA CHL	*Cladonia chlorophaea*	93	0.057	0.047	12
CLA COC	*Cladonia coccifera*	100	0.046	0.046	13
CLA CON	*Cladonia coniocraea*	.	.	.	.
CLA COR	*Cladonia cornuta*	100	0.395	0.583	8
CLA CRP	*Cladonia crispata*	.	.	.	.
CLA CRT	*Cladonia cristatella*	7	0.0007	0.0026	35
CLA GON	*Cladonia gonecha*	33	0.003	0.005	28
CLA GRA	*Cladonia gracilis*	100	1.77	1.76	4

continued ...

Reference Stand No. 12 Concluded.

CODE	Species	Frequency % 5x5 m Plots	Plant Cover Mean	S.D.	Rank
CLA MUL	*Cladonia multiformis*	33	0.003	0.005	29
CLA PHY	*Cladonia phyllophora*	.	.	.	.
CLA PYX	*Cladonia pyxidata*	100	0.702	0.786	7
CLA SUB	*Cladonia subulata*	.	.	.	.
CLA UNC	*Cladonia uncialis*	100	0.316	0.429	9
CLA VER	*Cladonia verticillata*	.	.	.	.
PEL APH	*Peltigera aphthosa*	33	0.021	0.041	17
PEL MAL	*Peltigera malacea*	100	2.28	1.59	3
PEL RUF	*Peltigera rufescens*	.	.	.	.
STE ALP	*Stereocaulon alpinum*	7	0.0007	0.0026	36

Total Terrestrial Lichen Cover = 30.28%

Epiphytic Lichens

BRY SPP	*Bryoria species*	100	0.010	0	19
CET HAL	*Cetraria halei*	100	0.010	0	20
CET PIN	*Cetraria pinastri*	100	0.010	0	21
EVE MES	*Evernia mesomorpha*	67	0.007	0.005	23
HYP PHY	*Hypogymnia physodes*	100	0.028	0.037	16
PAR ELE	*Parmelia elegantula*	.	.	.	.
PAR SUL	*Parmelia sulcata*	47	0.005	0.005	25
PAR AMB	*Parmeliopsis ambigua*	100	0.010	0	22
PAR HYP	*Parmeliopsis hyperopta*	13	0.001	0.004	33
PLA GLA	*Platismatia glauca*	.	.	.	.
USN SPP	*Usnea species*	100	0.016	0.023	18

Total Epiphytic Lichen Cover = 0.0970%

ATHABASCA OIL SANDS ECOLOGICAL MONITORING PROJECT

Reference Stand No. 13 Permanent Plot No. 59

Survey Date 15 Aug 1981 Stand Age 109 yrs

Vascular Plants	Species Richness = 12	Cover = 12.8%
Bryophytes	Species Richness = 2	Cover = 0.03%
Terrestrial Lichens	Species Richness = 14	Cover = 69.2%
Plant Community	Species Richness = 37	Cover = 82.2%

CODE	Species	Frequency % 5x5 m Plots	Plant Cover % Mean	S.D.	Rank
Trees					
PIBA	*Pinus banksiana*	100	12.2	8.24	1
PIGL	*Picea glauca*	.	.	.	.
PIMA	*Picea mariana*	.	.	.	.
POTR	*Populus tremuloides*	.	.	.	.
POBA	*Populus balsamifera*	.	.	.	.
LALA	*Larix laricina*	.	.	.	.
	Total Tree Cover = 12.20%				
Shrubs					
VAMY	*Vaccinium myrtilloides*	20	0.0840	0.186	3
VAVI	*Vaccinium vitis-idaea*	.	.	.	.
ARUV	*Arctostaphylos uva-ursi*	64	0.441	0.789	2
ROAC	*Rosa acicularis*	.	.	.	.
PRPE	*Prunus pensylvanica*	.	.	.	.
AMAL	*Amelanchier alnifolia*	.	.	.	.
RUST	*Rubus strigosus*	.	.	.	.
LODI	*Lonicera dioica*	.	.	.	.
VIED	*Viburnum edule*	.	.	.	.
HUTO	*Hudsonia tomentosa*	.	.	.	.
SABE	*Salix bebbiana*	.	.	.	.
ALCR	*Alnus crispa*	.	.	.	.
LEGR	*Ledum groenlandicum*	.	.	.	.
RIGL	*Ribes glandulosum*	.	.	.	.
SHCA	*Shepherdia canadensis*	.	.	.	.
SAPS	*Salix pseudomonticola*	.	.	.	.
SYAL	*Symphoricarpos albus*	.	.	.	.
VACA	*Vaccinium caespitosum*	.	.	.	.
BEPU	*Betula pumila*	.	.	.	.
SAMY	*Salix myrtillifolia*	.	.	.	.
	Total Shrub Cover = 0.525%				

continued ...

Reference Stand No. 13 Continued.

CODE	Species	Frequency % 5x5 m Plots	Plant Cover % Mean	S.D.	Rank
Forbs					
MACA	*Maianthemum canadense*	8	0.0080	0.028	4
ASLA	*Aster laevis*	.	.	.	.
ANMU	*Anemone multifida*	.	.	.	.
GABO	*Galium boreale*	4	0.0004	0.002	12
MELI	*Melampyrum lineare*	.	.	.	.
LIBO	*Linnaea borealis*	.	.	.	.
CARO	*Campanula rotundifolia*	.	.	.	.
SODE	*Solidago decumbens*	4	0.0040	0.020	7
VIAD	*Viola adunca*	.	.	.	.
APAN	*Apocynum androsaemifolium*	4	0.0040	0.020	8
COPA	*Comandra pallida*	.	.	.	.
FRVI	*Fragaria virginiana*	.	.	.	.
POTRI	*Potentilla tridentata*	.	.	.	.
GELI	*Geocaulon lividum*	.	.	.	.
PYVI	*Pyrola virens*	8	0.0008	0.003	10
HICA	*Hieracium canadense*	.	.	.	.
PYSE	*Pyrola secunda*	.	.	.	.
EPAN	*Epilobium angustifolium*	.	.	.	.
ARCA	*Artemisia campestris*	.	.	.	.
ARNU	*Aralia nudicaulis*	.	.	.	.
COCA	*Cornus canadensis*	.	.	.	.
LIPH	*Lilium philadelphicum*	.	.	.	.
ANPA	*Anemone patens*	.	.	.	.
TRBO	*Trientalis borealis*	.	.	.	.
VIRE	*Viola renifolia*	.	.	.	.
GORE	*Goodyera repens*	.	.	.	.
LAOC	*Lathyrus ochroleucus*	.	.	.	.
VIAM	*Vicia americana*	.	.	.	.
PEPA	*Petasites palmatus*	.	.	.	.
ASCI	*Aster ciliolatus*	.	.	.	.
CYAC	*Cypripedium acaule*	.	.	.	.
ACMI	*Achillea millefolium*	.	.	.	.
ANRA	*Antennaria racemosa*	.	.	.	.
GEAM	*Gentianella amarella*	.	.	.	.
RUAC	*Rubus acaulis*	.	.	.	.
PYAS	*Pyrola asarifolia*	.	.	.	.
MINU	*Mitella nuda*	.	.	.	.
DRSP	*Draba* sp.	.	.	.	.
SESP	*Senecio* sp.	.	.	.	.

Total Forb Cover = 0.0172%

continued ...

Reference Stand No. 13 Continued

CODE	Species	Frequency % 5x5 m Plots	Plant Cover % Mean	S.D.	Rank
Graminoids					
ORPU	*Oryzopsis pungens*	8	0.0044	0.020	6
ELIN	*Elymus innovatus*	.	.	.	.
CXUM	*Carex umbellata*	4	0.0040	0.020	9
CXFO	*Carex foenea*	16	0.0052	0.020	5
ORAS	*Oryzopsis asperifolia*	.	.	.	.
AGSC	*Agrostis scabra*	8	0.0008	0.003	11
BRCI	*Bromus ciliatus*	.	.	.	.
SCPU	*Schizachne purpurascens*	.	.	.	.
JUBA	*Juncus balticus*	.	.	.	.
ELGL	*Elymus glaucus*	.	.	.	.
CACA	*Calamagrostis canadensis*	.	.	.	.
CAIN	*Calamagrostis inexpansa*	.	.	.	.
CXSP	*Carex* sp.	.	.	.	.

Total Graminoid Cover = 0.0144%

Pteridophytes					
EQVA	*Equisetum variegatum*	.	.	.	.
LYTR	*Lycopodium tristachyum*	.	.	.	.
LYAN	*Lycopodium annotinum*	.	.	.	.
EQSY	*Equisetum sylvaticum*	.	.	.	.
EQSC	*Equisetum scirpoides*	.	.	.	.
EQPR	*Equisetum pratense*	.	.	.	.
LYCL	*Lycopodium clavatum*	.	.	.	.
EQAR	*Equisetum arvense*	.	.	.	.
SEDE	*Selaginella densa*	.	.	.	.

Total Pteridophyte Cover = 0.0%

continued ...

Reference Stand No. 13 Continued

CODE	Species	Frequency % 5x5 m Plots	Plant Cover % Mean	S.D.	Rank
Bryophytes					
AUL PAL	*Aulacommium palustre*	.	.	.	.
BRA SAL	*Brachythecium salebrosum*	.	.	.	.
CER PUR	*Ceratodon purpureus*	.	.	.	.
DIC POL	*Dicranum polysetum*	.	.	.	.
DIC SCO	*Dicranum scoparium*	33	0.021	0.041	12
DIT FLE	*Ditrichum flexicaule*	.	.	.	.
DRE UNC	*Drepanocladus uncinatus*	.	.	.	.
HYL SPL	*Hylocomium splendens*	.	.	.	.
ORT FLA	*Orthodicranum flagellare*	.	.	.	.
PLE SCH	*Pleurozium schreberi*	.	.	.	.
POH NUT	*Pohlia nutans*	.	.	.	.
POL JUN	*Polytrichum juniperinum*	.	.	.	.
POL PIL	*Polytrichum piliferum*	.	.	.	.
PTI CIL	*Ptilidium ciliare*	7	0.007	0.026	17
PTI PUL	*Ptilidium pulcherrimum*	.	.	.	.
PTI C-C	*Ptilium crista-castrensis*	.	.	.	.
TET ANG	*Tetraplodon angustatus*	.	.	.	.
TOM NIT	*Tomenthypnum nitens*	.	.	.	.
	Total Bryophyte Cover = 0.0280%				
Terrestrial Lichens					
CET ERI	*Cetraria ericetorum*	60	0.006	0.005	18
CET CUC	*Cetraria cucullata*	.	.	.	.
CET NIV	*Cetraria nivalis*	7	0.0007	0.0026	25
CLA MIT	*Cladina mitis*	100	25.5	10.6	2
CLA RAN	*Cladina rangiferina*	.	.	.	.
CLA STE	*Cladina stellaris*	20	0.002	0.004	22
CLA AMA	*Cladonia amaurocraea*	20	0.002	0.004	23
CLA CAP	*Cladonia capitata*	.	.	.	.
CLA CEN	*Cladonia cenotea*	.	.	.	.
CLA CHL	*Cladonia chlorophaea*	87	0.045	0.047	8
CLA COC	*Cladonia coccifera*	93	0.100	0.250	7
CLA CON	*Cladonia coniocraea*	.	.	.	.
CLA COR	*Cladonia cornuta*	100	6.73	4.01	3
CLA CRP	*Cladonia crispata*	.	.	.	.
CLA CRT	*Cladonia cristatella*	60	0.006	0.005	19
CLA GON	*Cladonia gonecha*	33	0.003	0.005	21
CLA GRA	*Cladonia gracilis*	100	34.7	10.1	1

continued ...

Reference Stand No. 13 Concluded.

CODE	Species	Frequency % 5x5 m Plots	Plant Cover Mean	S.D.	Rank
CLA MUL	*Cladonia multiformis*	.	.	.	.
CLA PHY	*Cladonia phyllophora*	33	0.033	0.048	9
CLA PYX	*Cladonia pyxidata*	.	.	.	.
CLA SUB	*Cladonia subulata*	.	.	.	.
CLA UNC	*Cladonia uncialis*	100	1.67	1.04	4
CLA VER	*Cladonia verticillata*	.	.	.	.
PEL APH	*Peltigera aphthosa*	.	.	.	.
PEL MAL	*Peltigera malacea*	53	0.360	0.600	5
PEL RUF	*Peltigera rufescens*	.	.	.	.
STE ALP	*Stereocaulon alpinum*	.	.	.	.

Total Terrestrial Lichen Cover = 69.16%

Epiphytic Lichens

BRY SPP	*Bryoria species*	87	0.009	0.004	16
CET HAL	*Cetraria halei*	93	0.009	0.004	13
CET PIN	*Cetraria pinastri*	93	0.009	0.003	14
EVE MES	*Evernia mesomorpha*	73	0.139	0.349	6
HYP PHY	*Hypogymnia physodes*	80	0.026	0.039	11
PAR ELE	*Parmelia elegantula*	.	.	.	.
PAR SUL	*Parmelia sulcata*	13	0.001	0.004	24
PAR AMB	*Parmeliopsis ambigua*	93	0.009	0.004	15
PAR HYP	*Parmeliopsis hyperopta*	40	0.004	0.005	20
PLA GLA	*Platismatia glauca*	.	.	.	.
USN SPP	*Usnea species*	87	0.027	0.038	10

Total Epiphytic Lichen Cover = 0.2330%

ATHABASCA OIL SANDS ECOLOGICAL MONITORING PROJECT

Reference Stand No. 14 — Permanent Plot No. 20

Survey Date 9 Aug 1981 — Stand Age 133 yrs

Vascular Plants	Species Richness = 23	Cover = 23.5%
Bryophytes	Species Richness = 8	Cover = 0.6%
Terrestrial Lichens	Species Richness = 16	Cover = 2.9%
Plant Community	Species Richness = 56	Cover = 27.3%

CODE	Species	Frequency % 5x5 m Plots	Plant Cover % Mean	S.D.	Rank
Trees					
PIBA	*Pinus banksiana*	96	4.78	3.32	2
PIGL	*Picea glauca*	.	.	.	.
PIMA	*Picea mariana*	.	.	.	.
POTR	*Populus tremuloides*	.	.	.	.
POBA	*Populus balsamifera*	.	.	.	.
LALA	*Larix laricina*	.	.	.	.
	Total Tree Cover = 4.784%				
Shrubs					
VAMY	*Vaccinium myrtilloides*	100	2.96	1.34	4
VAVI	*Vaccinium vitis-idaea*	100	3.64	2.84	3
ARUV	*Arctostaphylos uva-ursi*	100	7.04	3.90	1
ROAC	*Rosa acicularis*	8	0.0240	0.101	14
PRPE	*Prunus pensylvanica*	.	.	.	.
AMAL	*Amelanchier alnifolia*	76	0.185	0.289	10
RUST	*Rubus strigosus*	.	.	.	.
LODI	*Lonicera dioica*	.	.	.	.
VIED	*Viburnum edule*	.	.	.	.
HUTO	*Hudsonia tomentosa*	.	.	.	.
SABE	*Salix bebbiana*	.	.	.	.
ALCR	*Alnus crispa*	.	.	.	.
LEGR	*Ledum groenlandicum*	4	0.0200	0.100	15
RIGL	*Ribes glandulosum*	.	.	.	.
SHCA	*Shepherdia canadensis*	P	.	.	.
SAPS	*Salix pseudomonticola*	.	.	.	.
SYAL	*Symphoricarpos albus*	.	.	.	.
VACA	*Vaccinium caespitosum*	.	.	.	.
BEPU	*Betula pumila*	.	.	.	.
SAMY	*Salix myrtillifolia*	.	.	.	.
	Total Shrub Cover = 13.8732%				

continued ...

Reference Stand No. 14 Continued.

CODE	Species	Frequency % 5x5 m Plots	Plant Cover % Mean	S.D.	Rank
Forbs					
MACA	*Maianthemum canadense*	100	0.872	0.700	7
ASLA	*Aster laevis*	.	.	.	.
ANMU	*Anemone multifida*	.	.	.	.
GABO	*Galium boreale*	.	.	.	.
MELI	*Melampyrum lineare*	52	0.0748	0.163	13
LIBO	*Linnaea borealis*	100	1.22	0.639	5
CARO	*Campanula rotundifolia*	40	0.0112	0.027	17
SODE	*Solidago decumbens*	.	.	.	.
VIAD	*Viola adunca*	.	.	.	.
APAN	*Apocynum androsaemifolium*	.	.	.	.
COPA	*Comandra pallida*	84	0.744	0.609	8
FRVI	*Fragaria virginiana*	.	.	.	.
POTRI	*Potentilla tridentata*	32	0.0140	0.033	16
GELI	*Geocaulon lividum*	92	0.916	0.824	6
PYVI	*Pyrola virens*	24	0.0024	0.004	20
HICA	*Hieracium canadense*	8	0.0008	0.003	23
PYSE	*Pyrola secunda*	.	.	.	.
EPAN	*Epilobium angustifolium*	4	0.0040	0.020	19
ARCA	*Artemisia campestris*	.	.	.	.
ARNU	*Aralia nudicaulis*	.	.	.	.
COCA	*Cornus canadensis*	100	0.696	0.517	9
LIPH	*Lilium philadelphicum*	.	.	.	.
ANPA	*Anemone patens*	.	.	.	.
TRBO	*Trientalis borealis*	.	.	.	.
VIRE	*Viola renifolia*	.	.	.	.
GORE	*Goodyera repens*	.	.	.	.
LAOC	*Lathyrus ochroleucus*	.	.	.	.
VIAM	*Vicia americana*	.	.	.	.
PEPA	*Petasites palmatus*	.	.	.	.
ASCI	*Aster ciliolatus*	.	.	.	.
CYAC	*Cypripedium acaule*	.	.	.	.
ACMI	*Achillea millefolium*	.	.	.	.
ANRA	*Antennaria racemosa*	.	.	.	.
GEAM	*Gentianella amarella*	.	.	.	.
RUAC	*Rubus acaulis*	.	.	.	.
PYAS	*Pyrola asarifolia*	.	.	.	.
MINU	*Mitella nuda*	.	.	.	.
DRSP	*Draba* sp.	.	.	.	.
SESP	*Senecio* sp.	.	.	.	.

Total Forb Cover = 4.5604%

continued ...

Reference Stand No. 14 Continued

CODE	Species	Frequency % 5x5 m Plots	Plant Cover % Mean	S.D.	Rank
Graminoids					
ORPU	*Oryzopsis pungens*	100	0.150	0.259	12
ELIN	*Elymus innovatus*	72	0.163	0.261	11
CXUM	*Carex umbellata*	.	.	.	.
CXFO	*Carex foenea*	12	0.0012	0.003	22
ORAS	*Oryzopsis asperifolia*	12	0.0021	0.100	21
AGSC	*Agrostis scabra*	.	.	.	.
BRCI	*Bromus ciliatus*	.	.	.	.
SCPU	*Schizachne purpurascens*	.	.	.	.
JUBA	*Juncus balticus*	.	.	.	.
ELGL	*Elymus glaucus*	.	.	.	.
CACA	*Calamagrostis canadensis*	.	.	.	.
CAIN	*Calamagrostis inexpansa*	.	.	.	.
CXSP	*Carex* sp.	.	.	.	.

Total Graminoid Cover = 0.3165%

CODE	Species	Frequency % 5x5 m Plots	Plant Cover % Mean	S.D.	Rank
Pteridophytes					
EQVA	*Equisetum variegatum*	4	0.0040	0.020	18
LYTR	*Lycopodium tristachyum*	.	.	.	.
LYAN	*Lycopodium annotinum*	.	.	.	.
EQSY	*Equisetum sylvaticum*	.	.	.	.
EQSC	*Equisetum scirpoides*	.	.	.	.
EQPR	*Equisetum pratense*	.	.	.	.
LYCL	*Lycopodium clavatum*	.	.	.	.
EQAR	*Equisetum arvense*	.	.	.	.
SEDE	*Selaginella densa*	.	.	.	.

Total Pteridophyte Cover = 0.0040%

continued ...

Reference Stand No. 14 Continued

CODE	Species	Frequency % 5x5 m Plots	Plant Cover % Mean	S.D.	Rank
Bryophytes					
AUL PAL	*Aulacomnium palustre*	.	.	.	.
BRA SAL	*Brachythecium salebrosum*	.	.	.	.
CER PUR	*Ceratodon purpureus*	13	0.007	0.026	21
DIC POL	*Dicranum polysetum*	87	0.039	0.045	11
DIC SCO	*Dicranum scoparium*	73	0.175	0.338	7
DIT FLE	*Ditrichum flexicaule*	.	.	.	.
DRE UNC	*Drepanocladus uncinatus*	.	.	.	.
HYL SPL	*Hylocomium splendens*	13	0.001	0.004	28
ORT FLA	*Orthodicranum flagellare*	.	.	.	.
PLE SCH	*Pleurozium schreberi*	60	0.367	0.708	3
POH NUT	*Pohlia nutans*	.	.	.	.
POL JUN	*Polytrichum juniperinum*	27	0.009	0.026	18
POL PIL	*Polytrichum piliferum*	20	0.002	0.004	27
PTI CIL	*Ptilidium ciliare*	.	.	.	.
PTI PUL	*Ptilidium pulcherrimum*	7	0.0007	0.0026	33
PTI C-C	*Ptilium crista-castrensis*	.	.	.	.
TET ANG	*Tetraplodon angustatu*	.	.	.	.
TOM NIT	*Tomenthypnum nitens*	.	.	.	.
	Total Bryophyte Cover = 0.6007%				
Terrestrial Lichens					
CET ERI	*Cetraria ericetorum*	33	0.009	0.025	17
CET CUC	*Cetraria cucullata*	.	.	.	.
CET NIV	*Cetraria nivalis*	.	.	.	.
CLA MIT	*Cladina mitis*	100	0.299	0.692	4
CLA RAN	*Cladina rangiferina*	.	.	.	.
CLA STE	*Cladina stellaris*	.	.	.	.
CLA AMA	*Cladonia amaurocraea*	.	.	.	.
CLA CAP	*Cladonia capitata*	7	0.0007	0.0026	29
CLA CEN	*Cladonia cenotea*	7	0.0007	0.0026	30
CLA CHL	*Cladonia chlorophaea*	93	0.105	0.252	9
CLA COC	*Cladonia coccifera*	40	0.004	0.005	24
CLA CON	*Cladonia coniocraea*	27	0.003	0.005	25
CLA COR	*Cladonia cornuta*	87	0.195	0.330	6
CLA CRP	*Cladonia crispata*	7	0.0007	0.0026	31
CLA CRT	*Cladonia cristatella*	47	0.005	0.005	23
CLA GON	*Cladonia gonecha*	27	0.003	0.005	26
CLA GRA	*Cladonia gracilis*	100	0.370	0.463	2

continued ...

Reference Stand No. 14 Concluded.

CODE	Species	Frequency % 5x5 m Plots	Plant Cover Mean	S.D.	Rank
CLA MUL	*Cladonia multiformis*	.	.	.	.
CLA PHY	*Cladonia phyllophora*	.	.	.	.
CLA PYX	*Cladonia pyxidata*	.	.	.	.
CLA SUB	*Cladonia subulata*	.	.	.	.
CLA UNC	*Cladonia uncialis*	73	0.211	0.409	5
CLA VER	*Cladonia verticillata*	7	0.0007	0.0026	32
PEL APH	*Peltigera aphthosa*	7	0.007	0.026	22
PEL MAL	*Peltigera malacea*	100	1.73	1.33	1
PEL RUF	*Peltigera rufescens*	.	.	.	.
STE ALP	*Stereocaulon alpinum*	.	.	.	.

Total Terrestrial Lichen Cover = 2.944%

Epiphytic Lichens

BRY SPP	*Bryoria species*	100	0.010	0	15
CET HAL	*Cetraria halei*	67	0.007	0.005	20
CET PIN	*Cetraria pinastri*	100	0.010	0	16
EVE MES	*Evernia mesomorpha*	80	0.026	0.039	13
HYP PHY	*Hypogymnia physodes*	100	0.040	0.044	10
PAR ELE	*Parmelia elegantula*	.	.	.	.
PAR SUL	*Parmelia sulcata*	73	0.007	0.005	19
PAR AMB	*Parmeliopsis ambigua*	100	0.028	0.037	12
PAR HYP	*Parmeliopsis hyperopta*	53	0.011	0.025	14
PLA GLA	*Platismatia glauca*	.	.	.	.
USN SPP	*Usnea species*	100	0.142	0.240	8

Total Epiphytic Lichen Cover = 0.2810%

ATHABASCA OIL SANDS ECOLOGICAL MONITORING PROJECT

Reference Stand No. 15 Permanent Plot No. 51

Survey Date 10 Aug 1981 Stand Age 39 years

Vascular Plants	Species Richness = 43	Cover = 42.1%
Bryophytes	Species Richness = 13	Cover = 5.5%
Terrestrial Lichens	Species Richness = 17	Cover = 6.2%
Plant Community	Species Richness = 81	Cover = 54.0%

CODE	Species	Frequency % 5x5 m Plots	Plant Cover % Mean	S.D.	Rank
Trees					
PIBA	*Pinus banksiana*	100	11.8	6.90	2
PIGL	*Picea glauca*	32	0.145	0.305	15
PIMA	*Picea mariana*	64	0.868	1.04	8
POTR	*Populus tremuloides*	4	0.0040	0.020	34
POBA	*Populus balsamifera*	4	0.0040	0.020	35
LALA	*Larix laricina*	.	.	.	.
	Total Tree Cover = 12.781%				
Shrubs					
VAMY	*Vaccinium myrtilloides*	100	3.38	1.30	4
VAVI	*Vaccinium vitis-idaea*	64	1.32	2.07	7
ARUV	*Arctostaphylos uva-ursi*	56	0.560	0.666	10
ROAC	*Rosa acicularis*	100	1.94	0.768	5
PRPE	*Prunus pensylvanica*	.	.	.	.
AMAL	*Amelanchier alnifolia*	4	0.0004	0.002	42
RUST	*Rubus strigosus*	.	.	.	.
LODI	*Lonicera dioica*	.	.	.	.
VIED	*Viburnum edule*	.	.	.	.
HUTO	*Hudsonia tomentosa*	.	.	.	.
SABE	*Salix bebbiana*	80	0.556	0.561	11
ALCR	*Alnus crispa*	.	.	.	.
LEGR	*Ledum groenlandicum*	100	13.3	8.64	1
RIGL	*Ribes glandulosum*	.	.	.	.
SHCA	*Shepherdia canadensis*	56	0.644	0.916	9
SAPS	*Salix pseudomonticola*	.	.	.	.
SYAL	*Symphoricarpos albus*	.	.	.	.
VACA	*Vaccinium caespitosum*	.	.	.	.
BEPU	*Betula pumila*	.	.	.	.
SAMY	*Salix myrtillifolia*	16	0.0680	0.219	17
	Total Shrub Cover = 21.7884%				

continued ...

Reference Stand No. 15 Continued.

CODE	Species	Frequency % 5x5 m Plots	Plant Cover % Mean	S.D.	Rank
Forbs					
MACA	*Maianthemum canadense*	4	0.0040	0.020	36
ASLA	*Aster laevis*	.	.	.	.
ANMU	*Anemone multifida*	.	.	.	.
GABO	*Galium boreale*	.	.	.	.
MELI	*Melampyrum lineare*	96	0.472	0.382	12
LIBO	*Linnaea borealis*	100	1.81	1.42	6
CARO	*Campanula rotundifolia*	.	.	.	.
SODE	*Solidago decumbens*	.	.	.	.
VIAD	*Viola adunca*	.	.	.	.
APAN	*Apocynum androsaemifolium*	.	.	.	.
COPA	*Comandra pallida*	.	.	.	.
FRVI	*Fragaria virginiana*	28	0.0724	0.164	16
POTRI	*Potentilla tridentata*	56	0.0612	0.103	18
GELI	*Geocaulon lividum*	.	.	.	.
PYVI	*Pyrola virens*	4	0.0004	0.002	43
HICA	*Hieracium canadense*	.	.	.	.
PYSE	*Pyrola secunda*	4	0.0200	0.100	27
EPAN	*Epilobium angustifolium*	8	0.0008	0.003	39
ARCA	*Artemisia campestris*	.	.	.	.
ARNU	*Aralia nudicaulis*	.	.	.	.
COCA	*Cornus canadensis*	100	4.24	3.43	3
LIPH	*Lilium philadelphicum*	.	.	.	.
ANPA	*Anemone patens*	.	.	.	.
TRBO	*Trientalis borealis*	.	.	.	.
VIRE	*Viola renifolia*	8	0.0080	0.028	31
GORE	*Goodyera repens*	8	0.0008	0.003	40
LAOC	*Lathyrus ochroleucus*	12	0.0280	0.102	23
VIAM	*Vicia americana*	16	0.0320	0.103	22
PEPA	*Petasites palmatus*	8	0.0240	0.101	25
ASCI	*Aster ciliolatus*	32	0.0372	0.103	21
CYAC	*Cypripedium acaule*	.	.	.	.
ACMI	*Achillea millefolium*	4	0.0040	0.020	37
ANRA	*Antennaria racemosa*	8	0.0044	0.020	32
GEAM	*Gentianella amarella*	12	0.0084	0.028	30
RUAC	*Rubus acaulis*	4	0.0400	0.200	20
PYAS	*Pyrola asarifolia*	8	0.0044	0.020	33
MINU	*Mitella nuda*	4	0.0200	0.100	28
DRSP	*Draba* sp.	.	.	.	.
SESP	*Senecio* sp.	.	.	.	.

Total Forb Cover = 6.89%

continued ...

Reference Stand No. 15 Continued

CODE	Species	Frequency % 5x5 m Plots	Plant Cover % Mean	S.D.	Rank
Graminoids					
ORPU	*Oryzopsis pungens*	32	0.0264	0.101	24
ELIN	*Elymus innovatus*	84	0.368	0.567	13
CXUM	*Carex umbellata*	.	.	.	.
CXFO	*Carex foenea*	.	.	.	.
ORAS	*Oryzopsis asperifolia*	8	0.0008	0.003	41
AGSC	*Agrostis scabra*	.	.	.	.
BRCI	*Bromus ciliatus*	.	.	.	.
SCPU	*Schizachne purpurascens*	.	.	.	.
JUBA	*Juncus balticus*	.	.	.	.
ELGL	*Elymus glaucus*	.	.	.	.
CACA	*Calamagrostis canadensis*	36	0.0144	0.033	29
CAIN	*Calamagrostis inexpansa*	.	.	.	.
CXSP	*Carex* sp.	8	0.0040	0.020	38

Total Graminoid Cover = 0.41%

CODE	Species	Frequency % 5x5 m Plots	Plant Cover % Mean	S.D.	Rank
Pteridophytes					
EQVA	*Equisetum variegatum*	.	.	.	.
LYTR	*Lycopodium tristachyum*	.	.	.	.
LYAN	*Lycopodium annotinum*	.	.	.	.
EQSY	*Equisetum sylvaticum*	44	0.0528	0.104	19
EQSC	*Equisetum scirpoides*	12	0.0244	0.101	25
EQPR	*Equisetum pratense*	.	.	.	.
LYCL	*Lycopodium clavatum*	.	.	.	.
EQAR	*Equisetum arvense*	92	0.177	0.189	14
SEDE	*Selaginella densa*	.	.	.	.

Total Pteridophyte Cover = 0.2544%

continued ...

Reference Stand No. 15 Continued

CODE	Species	Frequency % 5x5 m Plots	Plant Cover % Mean	S.D.	Rank
Bryophytes					
AUL PAL	*Aulacomnium palustre*	.	.	.	.
BRA SAL	*Brachythecium salebrosum*	33	0.009	0.025	23
CER PUR	*Ceratodon purpureus*	20	0.008	0.026	24
DIC POL	*Dicranum polysetum*	47	0.011	0.025	20
DIC SCO	*Dicranum scoparium*	7	0.0007	0.0026	35
DIT FLE	*Ditrichum flexicaule*	7	0.0007	0.0026	36
DRE UNC	*Drepanocladus uncinatus*	60	0.024	0.040	12
HYL SPL	*Hylocomium splendens*	87	2.02	5.02	3
ORT FLA	*Orthodicranum flagellare*	7	0.0007	0.0026	37
PLE SCH	*Pleurozium schreberi*	100	2.62	3.44	2
POH NUT	*Pohlia nutans*	.	.	.	.
POL JUN	*Polytrichum juniperinum*	20	0.002	0.004	32
POL PIL	*Polytrichum piliferum*	.	.	.	.
PTI CIL	*Ptilidium ciliare*	.	.	.	.
PTI PUL	*Ptilidium pulcherrimum*	27	0.015	0.035	17
PTI C-C	*Ptilium crista-castrensis*	87	0.760	0.675	4
TET ANG	*Tetraplodon angustatus*	.	.	.	.
TOM NIT	*Tomenthypnum nitens*	7	0.0007	0.0026	38
	Total Bryophyte Cover = 5.472%				
Terrestrial Lichens					
CET ERI	*Cetraria ericetorum*	.	.	.	.
CET CUC	*Cetraria cucullata*	.	.	.	.
CET NIV	*Cetraria nivalis*	33	0.003	0.005	28
CLA MIT	*Cladina mitis*	100	4.94	6.73	1
CLA RAN	*Cladina rangiferina*	.	.	.	.
CLA STE	*Cladina stellaris*	7	0.0007	0.0026	33
CLA AMA	*Cladonia amaurocraea*	.	.	.	.
CLA CAP	*Cladonia capitata*	.	.	.	.
CLA CEN	*Cladonia cenotea*	47	0.011	0.025	19
CLA CHL	*Cladonia chlorophaea*	40	0.004	0.005	27
CLA COC	*Cladonia coccifera*	26.6	0.003	0.005	29
CLA CON	*Cladonia coniocraea*	.	.	.	.
CLA COR	*Cladonia cornuta*	100	0.203	0.499	8
CLA CRP	*Cladonia crispata*	.	.	.	.
CLA CRT	*Cladonia cristatella*	60	0.006	0.005	26
CLA GON	*Cladonia gonecha*	27	0.003	0.005	30
CLA GRA	*Cladonia gracilis*	93	0.051	0.047	10

continued ...

Reference Stand No. 15 Concluded.

CODE	Species	Frequency % 5x5 m Plots	Plant Cover Mean	S.D.	Rank
CLA MUL	*Cladonia multiformis*	100	0.256	0.387	7
CLA PHY	*Cladonia phyllophora*	47	0.017	0.034	15
CLA PYX	*Cladonia pyxidata*	.	.	.	.
CLA SUB	*Cladonia subulata*	.	.	.	.
CLA UNC	*Cladonia uncialis*	.	.	.	.
CLA VER	*Cladonia verticillata*	7	0.0007	0.0026	34
PEL APH	*Peltigera aphthosa*	53	0.354	0.607	5
PEL MAL	*Peltigera malacea*	27	0.267	0.458	6
PEL RUF	*Peltigera rufescens*	33	0.027	0.045	11
STE ALP	*Stereocaulon alpinum*	20	0.008	0.026	25

Total Terrestrial Lichen Cover = 6.154%

Epiphytic Lichens

BRY SPP	*Bryoria species*	100	0.010	0	21
CET HAL	*Cetraria halei*	100	0.022	0.032	13
CET PIN	*Cetraria pinastri*	100	0.016	0.023	16
EVE MES	*Evernia mesomorpha*	.	.	.	.
HYP PHY	*Hypogymnia physodes*	100	0.058	0.046	9
PAR ELE	*Parmelia elegantula*	.	.	.	.
PAR SUL	*Parmelia sulcata*	33	0.003	0.005	31
PAR AMB	*Parmeliopsis ambigua*	100	0.022	0.032	14
PAR HYP	*Parmeliopsis hyperopta*	67	0.013	0.025	18
PLA GLA	*Platismatia glauca*	.	.	.	.
USN SPP	*Usnea species*	100	0.010	0	22

Total Epiphytic Lichen Cover = 0.1540%

ATHABASCA OIL SANDS ECOLOGICAL MONITORING PROJECT

Reference Stand No. 16 — Permanent Plot No. 56

Survey Date 13 Aug 1981 — Stand Age 41 yrs

Vascular Plants	Species Richness = 46	Cover = 45.3%
Bryophytes	Species Richness = 12	Cover = 30.3%
Terrestrial Lichens	Species Richness = 15	Cover = 1.8%
Plant Community	Species Richness = 83	Cover = 77.5%

CODE	Species	Frequency % 5x5 m Plots	Plant Cover % Mean	S.D.	Rank
Trees					
PIBA	*Pinus banksiana*	100	13.8	7.21	1
PIGL	*Picea glauca*	24	0.1004	0.204	23
PIMA	*Picea mariana*	44	0.4640	0.851	13
POTR	*Populus tremuloides*	36	0.109	0.201	20
POBA	*Populus balsamifera*	4	0.0004	0.002	41
LALA	*Larix laricina*	8	0.0008	0.003	38
	Total Tree Cover = 14.4744%				
Shrubs					
VAMY	*Vaccinium myrtilloides*	100	3.90	2.47	4
VAVI	*Vaccinium vitis-idaea*	100	4.13	4.27	3
ARUV	*Arctostaphylos uva-ursi*	20	0.0844	0.236	26
ROAC	*Rosa acicularis*	92	1.36	1.05	8
PRPE	*Prunus pensylvanica*	.	.	.	.
AMAL	*Amelanchier alnifolia*	.	.	.	.
RUST	*Rubus strigosus*	.	.	.	.
LODI	*Lonicera dioica*	.	.	.	.
VIED	*Viburnum edule*	12	0.100	0.289	24
HUTO	*Hudsonia tomentosa*	.	.	.	.
SABE	*Salix bebbiana*	88	0.716	0.877	11
ALCR	*Alnus crispa*	.	.	.	.
LEGR	*Ledum groenlandicum*	76	1.59	2.94	7
RIGL	*Ribes glandulosum*	.	.	.	.
SHCA	*Shepherdia canadensis*	24	0.904	2.31	10
SAPS	*Salix pseudomonticola*	4	0.0200	0.100	31
SYAL	*Symphoricarpos albus*	.	.	.	.
VACA	*Vaccinium caespitosum*	96	0.956	0.748	9
BEPU	*Betula pumila*	4	0.0004	0.002	42
SAMY	*Salix myrtillifolia*	.	.	.	.
	Total Shrub Cover = 13.7652%				

continued ...

Reference Stand No. 16 Continued.

CODE	Species	Frequency % 5x5 m Plots	Plant Cover % Mean	S.D.	Rank
Forbs					
MACA	*Maianthemum canadense*	.	.	.	.
ASLA	*Aster laevis*	.	.	.	.
ANMU	*Anemone multifida*	.	.	.	.
GABO	*Galium boreale*	.	.	.	.
MELI	*Melampyrum lineare*	88	0.372	0.345	14
LIBO	*Linnaea borealis*	100	2.30	0.890	6
CARO	*Campanula rotundifolia*	4	0.0004	0.002	44
SODE	*Solidago decumbens*	8	0.0008	0.003	39
VIAD	*Viola adunca*	.	.	.	.
APAN	*Apocynum androsaemifolium*	.	.	.	.
COPA	*Comandra pallida*	.	.	.	.
FRVI	*Fragaria virginiana*	84	0.316	0.295	15
POTRI	*Potentilla tridentata*	76	0.158	0.201	18
GELI	*Geocaulon lividum*	.	.	.	.
PYVI	*Pyrola virens*	12	0.0048	0.020	34
HICA	*Hieracium canadense*	56	0.0664	0.137	27
PYSE	*Pyrola secunda*	8	0.0080	0.003	33
EPAN	*Epilobium angustifolium*	56	0.181	0.269	17
ARCA	*Artemisia campestris*	.	.	.	.
ARNU	*Aralia nudicaulis*	.	.	.	.
COCA	*Cornus canadensis*	100	9.88	7.02	2
LIPH	*Lilium philadelphicum*	.	.	.	.
ANPA	*Anemone patens*	.	.	.	.
TRBO	*Trientalis borealis*	48	0.0924	0.160	25
VIRE	*Viola renifolia*	.	.	.	.
GORE	*Goodyera repens*	.	.	.	.
LAOC	*Lathyrus ochroleucus*	84	0.504	0.548	12
VIAM	*Vicia americana*	8	0.0240	0.101	30
PEPA	*Petasites palmatus*	28	0.148	0.304	19
ASCI	*Aster ciliolatus*	40	0.108	0.231	21
CYAC	*Cypripedium acaule*	P	.	.	.
ACMI	*Achillea millefolium*	20	0.0092	0.028	32
ANRA	*Antennaria racemosa*	8	0.0400	0.138	28
GEAM	*Gentianella amarella*	.	.	.	.
RUAC	*Rubus acaulis*	.	.	.	.
PYAS	*Pyrola asarifolia*	.	.	.	.
MINU	*Mitella nuda*	.	.	.	.
DRSP	*Draba* sp.	.	.	.	.
SESP	*Senecio* sp.	.	.	.	.

Total Forb Cover = 14.2128%

continued ...

Reference Stand No. 16 Continued

CODE	Species	Frequency % 5x5 m Plots	Plant Cover % Mean	S.D.	Rank
Graminoids					
ORPU	*Oryzopsis pungens*	12	0.0012	0.003	37
ELIN	*Elymus innovatus*	100	2.48	1.22	5
CXUM	*Carex umbellata*	4	0.0004	0.002	45
CXFO	*Carex foenea*	.	.	.	.
ORAS	*Oryzopsis asperifolia*	.	.	.	.
AGSC	*Agrostis scabra*	8	0.0008	0.003	40
BRCI	*Bromus ciliatus*	.	.	.	.
SCPU	*Schizachne purpurascens*	.	.	.	.
JUBA	*Juncus balticus*	.	.	.	.
ELGL	*Elymus glaucus*	.	.	.	.
CACA	*Calamagrostis canadensis*	.	.	.	.
CAIN	*Calamagrostis inexpansa*	4	0.0004	0.002	46
CXSP	*Carex* sp.	.	.	.	.

Total Graminoid Cover = 2.4828%

Pteridophytes					
EQVA	*Equisetum variegatum*	.	.	.	.
LYTR	*Lycopodium tristachyum*	20	0.104	0.249	22
LYAN	*Lycopodium annotinum*	12	0.0280	0.102	29
EQSY	*Equisetum sylvaticum*	16	0.0016	0.004	35
EQSC	*Equisetum scirpoides*	12	0.0012	0.003	36
EQPR	*Equisetum pratense*	4	0.0004	0.002	43
LYCL	*Lycopodium clavatum*	16	0.1840	0.626	16
EQAR	*Equisetum arvense*	.	.	.	.
SEDE	*Selaginella densa*	.	.	.	.

Total Pteridophyte Cover = 0.3192%

continued ...

Reference Stand No. 16 Continued

CODE	Species	Frequency % 5x5 m Plots	Plant Cover % Mean	S.D.	Rank
Bryophytes					
AUL PAL	*Aulacomnium palustre*	7	0.0007	0.0026	31
BRA SAL	*Brachythecium salebrosum*	20	0.008	0.027	20
CER PUR	*Ceratodon purpureus*	20	0.014	0.035	15
DIC POL	*Dicranum polysetum*	60	0.012	0.025	16
DIC SCO	*Dicranum scoparium*	.	.	.	.
DIT FLE	*Ditrichum flexicaule*	.	.	.	.
DRE UNC	*Drepanocladus uncinatus*	.	.	.	.
HYL SPL	*Hylocomium splendens*	93	5.09	5.35	2
ORT FLA	*Orthodicranum flagellare*	.	.	.	.
PLE SCH	*Pleurozium schreberi*	100	22.9	15.4	1
POH NUT	*Pohlia nutans*	.	.	.	.
POL JUN	*Polytrichum juniperinum*	80	0.556	0.902	5
POL PIL	*Polytrichum piliferum*	7	0.0007	0.0026	33
PTI CIL	*Ptilidium ciliare*	7	0.0007	0.0026	35
PTI PUL	*Ptilidium pulcherrimum*	7	0.0007	0.0026	36
PTI C-C	*Ptilium crista-castrensis*	87	1.69	2.42	3
TET ANG	*Tetraplodon angustatus*	7	0.0007	0.0026	37
TOM NIT	*Tomenthypnum nitens*	.	.	.	.
	Total Bryophyte Cover = 30.27%				
Terrestrial Lichens					
CET ERI	*Cetraria ericetorum*	.	.	.	.
CET CUC	*Cetraria cucullata*	.	.	.	.
CET NIV	*Cetraria nivalis*	.	.	.	.
CLA MIT	*Cladina mitis*	93	0.195	0.329	8
CLA RAN	*Cladina rangiferina*	.	.	.	.
CLA STE	*Cladina stellaris*	20	0.002	0.004	27
CLA AMA	*Cladonia amaurocraea*	.	.	.	.
CLA CAP	*Cladonia capitata*	.	.	.	.
CLA CEN	*Cladonia cenotea*	20	0.002	0.004	26
CLA CHL	*Cladonia chlorophaea*	93	0.027	0.038	13
CLA COC	*Cladonia coccifera*	7	0.0007	0.0026	33
CLA CON	*Cladonia coniocraea*	13	0.001	0.004	28
CLA COR	*Cladonia cornuta*	93	0.582	0.963	4
CLA CRP	*Cladonia crispata*	.	.	.	.
CLA CRT	*Cladonia cristatella*	27	0.003	0.005	25
CLA GON	*Cladonia gonecha*	47	0.005	0.005	22
CLA GRA	*Cladonia gracilis*	100	0.196	0.329	7

continued ...

Reference Stand No. 16 Concluded.

CODE	Species	Frequency % 5x5 m Plots	Plant Cover Mean	S.D.	Rank
CLA MUL	*Cladonia multiformis*	93	0.129	0.245	9
CLA PHY	*Cladonia phyllophora*	.	.	.	.
CLA PYX	*Cladonia pyxidata*	.	.	.	.
CLA SUB	*Cladonia subulata*	.	.	.	.
CLA UNC	*Cladonia uncialis*	.	.	.	.
CLA VER	*Cladonia verticillata*	.	.	.	.
PEL APH	*Peltigera aphthosa*	60	0.415	0.623	6
PEL MAL	*Peltigera malacea*	7	0.007	0.026	21
PEL RUF	*Peltigera rufescens*	67	0.115	0.250	10
STE ALP	*Stereocaulon alpinum*	47	0.089	0.255	11

Total Terrestrial Lichen Cover = 1.769%

Epiphytic Lichens

BRY SPP	*Bryoria species*	100	0.010	0	17
CET HAL	*Cetraria halei*	100	0.010	0	18
CET PIN	*Cetraria pinastri*	100	0.016	0.023	14
EVE MES	*Evernia mesomorpha*	13	0.001	0.004	30
HYP PHY	*Hypogymnia physodes*	100	0.034	0.041	12
PAR ELE	*Parmelia elegantula*	13	0.001	0.004	31
PAR SUL	*Parmelia sulcata*	33	0.003	0.005	24
PAR AMB	*Parmeliopsis ambigua*	100	0.016	0.023	28
PAR HYP	*Parmeliopsis hyperopta*	40	0.004	0.005	23
PLA GLA	*Platismatia glauca*	.	.	.	.
USN SPP	*Usnea species*	100	0.010	0	19

Total Epiphytic Lichen Cover = 0.105%

14 for bryoid data. Strictly speaking, these statistics are estimates of the parameters of the reference stands, not of the larger permanent plots in which the reference stands are located. The finite population corrections (Snedecor 1956: 498) $f_V = 0.500$ and $f_B = 0.387$ (defined as the square root of the sampling intensity, i.e., 0.25 for vasculars and 0.15 for bryoids) may be used in calculating standard errors of the means of vascular and bryoid species, respectively, when the reference stands are used in hypothesis testing. For example, the standard error of mean *Linnaea borealis* cover % in stand no. 3 is

$$s_{\bar{x},\ Libo} = f_V(\text{S.D.}/\sqrt{n_V}),\ \text{i.e. } 0.5(0.923/\sqrt{25}),\ \text{or } \pm 0.0923\%.$$

4.4.2 Synthesis Table

Table 5 is a synthesis condensed from Table 4 to facilitate comparisons of communities, growth-forms, species, and reference stands. It gives: (1) the estimated total cover % (in italics) of the five major vascular and three major bryoid growth-form groups for each of the 16 reference stands; (2) the Constancy of occurrence of each species in the 14 reference stands found on Dystric Brunisols (i.e., % occurrence in reference stands based on presence in one or more of their sampling units); and (3) the logarithmic cover-classes of each species in each of the 16 reference stands, where the cover-classes are defined as follows:

Logarithmic Cover-Class	% Cover Range
1	0.0001 to 0.001
2	0.001 to 0.01
3	0.01 to 0.1
4	0.1 to 1.0
5	1.0 to 10.0
6	10.0 to 100.0

These cover-classes are identical to the six logarithmic cycles of % cover used in Figure 3 in the next section (4.4.3); they permit rapid assessment of the relative abundance of species within and between reference stands, without the cumbersome use of 9-digit numbers, floating decimal points, etc. It should not be inferred, however,

Table 5. Synthesis table showing the estimated % cover of major plant growth-forms[a]; the % Constancy of occurrence of species[b], and the cover-class[c] of species in reference stands located in 16 *Pinus banksiana* - dominated permanent plots of the Athabasca Oil Sands area in northern Alberta.

Growth-Form / Species	Constancy (%)	Reference Stand Number 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Tree		*4*	*28*	*8*	*7*	*16*	*9*	*14*	*5*	*10*	*9*	*12*	*9*	*12*	*5*	*13*	*14*
Pinus banksiana	100	5	6	5	5	6	5	6	5	6	5	6	5	6	5	6	6
Picea glauca	21	.	.	3	.	.	.	1	.	3	.	.	.	.	.	4	4
Picea mariana	7	.	.	.	.	.	.	.	.	3	.	.	.	.	.	4	4
Populus tremuloides	21	2	.	4	.	.	.	.	.	2	.	.	.	.	.	2	4
Populus balsamifera	7	.	.	.	.	.	.	.	.	.	2	.	.	.	.	2	1
Larix laricina	0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Shrub		*4*	*1*	*29*	*9*	*10*	*2*	*6*	*5*	*12*	*12*	*14*	*6*	*1*	*14*	*22*	*14*
Vaccinium myrtilloides	93	4	.	5	5	5	4	5	4	4	5	5	5	3	5	5	5
Vaccinium vitis-idaea	79	4	.	5	5	5	.	5	5	5	5	5	5	.	5	5	5
Arctostaphylos uva-ursi	100	5	4	6	5	5	5	5	5	5	5	4	4	4	5	4	3
Rosa acicularis	64	3	.	4	3	3	.	4	4	5	.	5	.	.	3	5	5
Prunus pensylvanica	57	2	.	4	.	4	3	3	3	.	3	4	.	.	.	.	.
Amelanchier alnifolia	50	2	.	4	3	.	.	4	.	.	.	4	1	.	4	1	.
Rubus strigosus	14	.	.	.	.	.	.	1	.	.	.	3	.	.	.	.	.
Lonicera dioica	29	.	.	3	1	.	.	1	.	1	.	.	.	.	.	.	.
Viburnum edule	7	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	3
Hudsonia tomentosa	14	4	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.
Salix bebbiana	21	3	.	.	3	4	.	.	.	.	.	.	.	.	.	4	4
Alnus crispa	21	.	.	5	.	.	.	.	.	5	.	5	.	.	.	.	.
Ledum groenlandicum	21	.	.	.	3	.	.	.	.	3	.	.	.	.	3	6	5
Shepherdia canadensis	0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	4

Table 5. Continued

Growth-Form / Species	Constancy (%)	Reference Stand Number 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Shrub Continued																	
Salix pseudomonticola	7	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.	3
Symphoricarpos albus	7	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.	.
Vaccinium caespitosum	0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4
Betula pumila	0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Salix myrtillifolia	0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	.
Forb		*1*	*t*	*4*	*4*	*1*	*t*	*2*	*2*	*2*	*1*	*5*	*1*	*t*	*5*	*7*	*14*
Maianthemum canadense	100	3	1	5	4	4	3	4	4	4	3	4	3	2	4	2	.
Aster laevis	64	4	.	2	2	4	2	4	4	3	1	.	.	.	.	.	.
Anemone multifida	64	3	1	4	.	3	.	3	2	3	.	3	2	.	.	.	.
Galium boreale	50	3	.	3	.	.	.	2	.	3	.	3	1	1	.	.	.
Melampyrum lineare	71	.	.	4	3	3	.	3	3	2	3	4	4	.	3	4	4
Linnaea borealis	71	4	1	4	4	3	.	4	.	4	.	5	4	.	5	5	5
Campanula rotundifolia	93	3	1	3	2	2	2	3	3	3	2	2	1	.	3	.	1
Solidago decumbens	86	3	2	3	.	2	3	3	4	3	1	1	2	2	.	.	1
Viola adunca	36	3	.	2	.	.	.	3	.	3	.	1	.	.	.	.	.
Apocynum androsaemifolium	50	3	.	.	.	4	3	3	4	.	3	.	.	2	.	.	.
Comandra pallida	21	.	.	4	.	.	.	.	.	.	.	2	.	.	4	.	.
Fragaria virginiana	43	4	.	3	.	1	.	3	.	4	.	3	.	.	.	3	4
Potentilla tridentata	71	1	.	3	3	.	.	2	2	3	3	3	1	.	3	3	4
Geocaulon lividum	57	.	.	4	3	.	.	3	.	4	4	4	3	.	4	.	.
Pyrola virens	100	1	2	3	3	2	2	2	1	2	4	3	3	1	2	1	2
Hieracium canadense	79	1	.	3	2	1	2	1	3	3	2	3	.	.	1	.	3
Pyrola secunda	14	.	.	.	.	.	.	.	.	2	.	3	.	.	.	3	2
Epilobium angustifolium	43	1	.	4	2	.	.	.	.	2	.	3	.	.	2	1	4

Table 5. Continued

Growth-Form / Species	Constancy (%)	Reference Stand Number 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Forb Continued																	
Artemisia campestris	7	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Aralia nudicaulis	14	.	.	4	.	.	.	.	.	.	.	5	.	.	.	.	.
Cornus canadensis	36	.	.	3	5	.	.	.	.	3	.	3	.	.	4	5	5
Lilium philadelphicum	14	.	.	3	.	.	.	.	.	2	.	.	.	.	.	.	.
Anemone patens	14	.	.	2	.	.	.	.	1	.	.	.	.	.	.	.	.
Trientalis borealis	7	.	.	.	.	.	.	.	.	.	.	3	.	.	.	.	3
Viola renifolia	7	.	.	.	.	.	.	.	.	2	.	.	.	.	.	2	.
Goodyera repens	7	.	.	.	.	.	.	.	.	2	.	.	.	.	.	1	.
Lathyrus ochroleucus	0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	4
Vicia americana	0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	3
Petasites palmatus	0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	4
Aster ciliolatus	0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	4
Achillea millefolium	7	3	.	.	.	.	.	.	.	.	.	.	.	.	.	2	2
Antennaria racemosa	0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	3
Gentianella amarella	0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.
Rubus acaulis	0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	.
Pyrola asarifolia	0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.
Mitella nuda	0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	.
Draba sp.	7	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Senecio sp.	7	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.
Graminoid		*2*	*t*	*t*	*t*	*t*	*t*	*t*	*t*	*1*	*t*	*1*	*t*	*t*	*t*	*t*	*2*
Oryzopsis pungens	100	5	2	4	4	3	3	3	3	3	3	3	3	2	4	3	2
Elymus innovatus	43	.	.	4	3	.	.	3	.	4	.	4	.	.	4	4	5
Carex umbellata	50	4	.	.	.	.	1	3	2	4	.	1	.	2	.	.	1

Table 5. Continued

Growth-Form / Species	Constancy (%)	Reference Stand Number 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Graminoid Continued																	
Carex foenea	86	4	1	.	3	3	2	2	2	3	2	2	.	2	2	.	.
Oryzopsis asperifolia	36	3	.	.	3	.	.	.	.	.	.	4	1	.	2	1	.
Agrostis scabra	14	.	.	.	.	.	1	.	.	.	.	.	.	1	.	.	1
Bromus ciliatus	7	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.
Schizachne purpurascens	14	.	.	2	.	.	.	.	.	.	.	2	.	.	.	.	.
Juncus balticus	7	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.	.
Elymus glaucus	7	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.	.
Calamagrostis canadensis	0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	.
Calamagrostis inexpansa	0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Carex sp.	0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.
Pteridophyte		*t*	.	*t*	*t*	*t*	.	*t*	.	*t*	.	*3*	.	.	*t*	*t*	*t*
Equisetum variegatum	36	.	.	.	3	2	.	1	.	3	.	.	.	.	1	.	.
Lycopodium tristachyum	21	.	.	4	.	.	.	3	.	.	.	5	.	.	.	.	4
Lycopodium annotinum	7	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	3
Equisetum sylvaticum	7	.	.	.	.	.	.	.	.	1	.	.	.	.	.	3	2
Equisetum scirpoides	0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	2
Equisetum pratense	0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Lycopodium clavatum	0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4
Equisetum arvense	0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	.
Selaginella densa	7	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Table 5. Continued

Growth-Form / Species	Constancy (%)	Reference Stand Number 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Bryophyte		*3*	*1*	*4*	*2*	*t*	*t*	*t*	*t*	*16*	*3*	*69*	*5*	*t*	*1*	*5*	*30*
Aulacomnium palustre	0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Brachythecium salebrosum	14	.	.	2	.	.	.	.	.	1	.	.	.	.	.	2	2
Ceratodon purpureus	50	3	.	3	3	.	.	3	.	.	1	.	2	.	2	2	3
Dicranum polysetum	64	.	.	4	2	2	.	3	.	4	4	5	4	.	3	3	3
Dicranum scoparium	57	.	.	3	1	2	.	.	.	.	3	2	4	3	4	1	.
Ditrichum flexicaule	0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.
Drepanocladus uncinatus	0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	.
Hylocomium splendens	57	.	.	4	2	.	.	2	.	4	3	5	4	.	2	5	5
Orthodicranum flagellare	14	.	.	.	.	.	.	1	.	2	.	.	.	.	.	1	.
Pleurozium schreberi	64	.	.	5	3	2	.	3	.	6	5	6	5	.	4	5	6
Pohlia nutans	7	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.
Polytrichum juniperinum	64	.	2	2	2	1	.	4	.	3	.	3	4	.	2	2	4
Polytrichum piliferum	79	5	5	2	5	2	4	3	3	.	2	.	2	.	2	.	1
Ptilidium ciliare	36	.	.	1	.	.	.	1	.	3	3	.	.	2	.	.	1
Ptilidium pulcherrimum	36	.	.	.	.	.	.	.	.	2	2	3	4	.	1	3	1
Ptilium crista-castrensis	36	.	.	2	.	2	.	2	.	4	3	.	.	.	.	4	5
Tetraplodon angustatus	14	.	.	.	.	.	.	1	.	1	.	.	.	.	.	.	1
Tomenthypnum nitens	7	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1	.
Terrestrial Lichen		*12*	*27*	*46*	*22*	*67*	*66*	*47*	*76*	*44*	*67*	*1*	*30*	*69*	*3*	*6*	*2*
Cetraria ericetorum	79	.	3	2	3	3	3	2	4	.	3	.	3	2	2	.	.
Cetraria cucullata	7	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.
Cetraria nivalis	57	.	.	2	.	1	1	2	2	.	2	.	2	1	.	2	.
Cladina mitis	100	2	5	6	6	6	6	6	6	6	6	4	6	6	4	5	4
Cladina rangiferina	43	.	.	.	.	2	.	1	2	3	2	.	2	.	.	.	.

Table 5. Continued

Growth-Form / Species	Constancy (%)	Reference Stand Number 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Terrestrial Lichen Continued																	
Cladina stellaris	71	.	.	3	2	3	2	.	4	3	4	1	3	2	.	1	2
Cladonia amaurocraea	36	.	.	.	.	.	3	.	.	2	2	.	2	2	.	.	.
Cladonia capitata	43	.	.	1	2	.	.	1	1	.	.	1	.	.	1	.	.
Cladonia cenotea	43	.	.	2	1	.	.	1	.	.	1	.	1	.	1	3	2
Cladonia chlorophaea	93	1	3	3	2	3	.	3	3	3	2	3	3	3	4	2	3
Cladonia coccifera	71	5	4	.	3	3	3	2	.	.	.	1	3	4	2	2	1
Cladonia coniocraea	36	.	.	3	2	.	.	.	.	.	1	1	.	.	2	.	2
Cladonia cornuta	100	4	4	3	4	4	5	4	4	3	5	3	4	5	4	4	4
Cladonia crispata	29	.	3	3	.	.	.	1	.	.	.	.	.	.	1	.	.
Cladonia cristatella	100	5	2	3	2	2	2	2	3	2	2	3	1	2	2	2	2
Cladonia gonecha	86	.	.	2	3	2	2	2	4	2	1	2	2	2	2	2	2
Cladonia gracilis	100	5	5	2	4	4	5	4	3	3	4	3	5	6	4	3	4
Cladonia multiformis	64	.	.	3	3	3	.	4	3	3	3	1	2	.	.	4	4
Cladonia phyllophora	71	.	4	3	4	2	4	3	3	2	3	.	.	3	.	3	.
Cladonia pyxidata	36	.	1	1	2	.	2	.	.	.	.	.	4	.	.	.	.
Cladonia subulata	21	4	.	.	2	.	1	.	.	.	.	.	.	.	.	.	.
Cladonia uncialis	93	5	6	.	3	4	5	2	4	2	3	2	4	5	4	.	.
Cladonia verticillata	29	3	.	.	2	.	2	.	.	.	.	.	.	.	1	1	.
Peltigera aphthosa	43	.	.	3	.	.	.	2	.	4	.	3	3	.	2	4	4
Peltigera malacea	100	2	4	4	4	4	4	5	4	5	4	4	5	4	5	4	2
Peltigera rufescens	57	4	2	3	2	3	1	1	.	4	.	.	.	.	.	3	4
Stereocaulon alpinum	14	.	.	.	.	.	.	2	.	.	.	.	1	.	.	2	3

Table 5. Concluded

Growth-Form / Species	Constancy (%)	Reference Stand Number 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Epiphytic Lichen		*t*	*t*	*t*	*t*	*t*	*t*	*t*	*t*	*t*	*t*	*1*	*t*	*t*	*t*	*t*	*t*
Bryoria spp.	86	.	3	.	2	3	2	3	2	2	3	3	3	2	3	3	3
Cetraria halei	86	.	3	.	2	2	3	3	3	3	3	3	3	2	2	3	3
Cetraria pinastri	100	2	3	3	3	3	3	3	3	3	3	3	3	2	3	3	3
Evernia mesomorpha	79	.	2	.	2	2	2	2	3	2	3	.	2	4	3	.	2
Hypogymnia physodes	93	.	3	3	3	3	2	4	3	3	3	4	3	3	3	3	3
Parmelia elegantula	0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
Parmelia sulcata	71	.	2	3	3	1	.	2	.	2	.	2	2	2	2	2	2
Parmeliopsis ambigua	93	.	3	3	3	3	3	4	4	3	4	3	3	2	3	3	3
Parmeliopsis hyperopta	86	.	2	.	1	2	2	3	3	2	2	3	2	2	3	3	2
Platismatia glauca	14	.	3	.	1	.	.	.	.	.	.	.	.	.	.	.	.
Usnea spp.	79	.	.	.	3	3	3	3	3	3	3	4	3	3	4	3	3

[a] % Cover of growth-forms was calculated as the sum of the mean % cover values of component species from Table 4, and printed in italicized numbers; *t* = less than 0.5% cover, i.e. 'trace'.

[b] Constancy values expressed as % occurrence of a species in reference stand nos. 1-14, all of which occur on Dystric Brunisolic sand soils; nos. 15 and 16 occur on Gray Luvisolic till soils.

[c] Cover-classes are logarithmic: 1 = 0.0001 to 0.001%; 2 = >0.001 to 0.01%; 3 = >0.01 to 0.1%; 4 = >0.1 to 1.0%; 5 = >1.0 to 10%; 6 = >10 to 100%. (see section 4.4.2).

that species with the same cover-class designation in Table 5 are insignificantly different in mean cover %, or that species with different cover-classes in Table 5 are significantly different in cover. Such inferences can only be made safely using appropriate tests of data provided in Table 4.

4.4.3 Species Structure and Dominance Hierarchy of Reference Stands

The preceding two sections have tabulated the quantitative results of the August 1981 survey of plant communities in the reference stands of 16 newly established *Pinus banksiana* - dominated permanent plots in the Athabasca Oil Sands area of northern Alberta. Having thus accomplished the second of the two principal objectives of this study (see 1.), we offer here a brief ecological assessment of the species structure and dominance hierarchy characteristics of these *Pinus banksiana* forests, using the data in Tables 4 and 5.

The 'species structure' of a community (Odum 1975) refers to the frequency distribution of abundance among the species which collectively constitute that community. Communities consisting of equally abundant species are said to have an 'even' or 'equitable' species structure; communities composed of species of widely varying abundance have an 'uneven' or 'inequitable' species structure. Although tabulated quantitative data on the mean abundance (e.g., % cover) of each species are the necessary basis for depicting species structure, they do not, in and of themselves, convey the essence of species structure.

Two graphic approaches to species structure have been widely used in plant ecology. Preston's (1948) curve shows the number of species per abundance-class, where each abundance-class or 'octave' has an abundance range equal to twice that of the one preceding it; with this curve Preston demonstrated that many biological communities have a log-normal species structure, with species of intermediate abundance being much more numerous than those of either very high or very low abundance. Whittaker's (1965) 'dominance-diversity' or 'importance-value' curve plots the abundance of each species on a

logarithmic scale and arranges the species in a sequence of decreasing abundance; with this curve Whittaker showed that communities of harsh environments often have very steeply sloping and near-linear species structures, while those of favorable environments more commonly have more gently sloping and sigmoid (S-shaped) species structures. Figure 3 shows the dominance-diversity curves for a representative set of seven reference stands (nos. 1, 2, 3, 8, 10, 11, 15).

The 'dominance hierarchy' of a community (Purchase and La Roi in prep.) describes the ranking of species, in order of their estimated mean abundances, from the quantitative dominant species at one extreme to the rarest species at the other extreme. This ranking of species is effectively accomplished on the species structure curve by identifying the data points with the four-letter (vascular) or six-letter (bryoid) code names of the species they represent (see Table 4 for code and full scientific names of all species). Thus one pair of curves (vascular and bryoid) can economically describe both the species structure and the dominance hierarchy of a plant community (Figure 3).

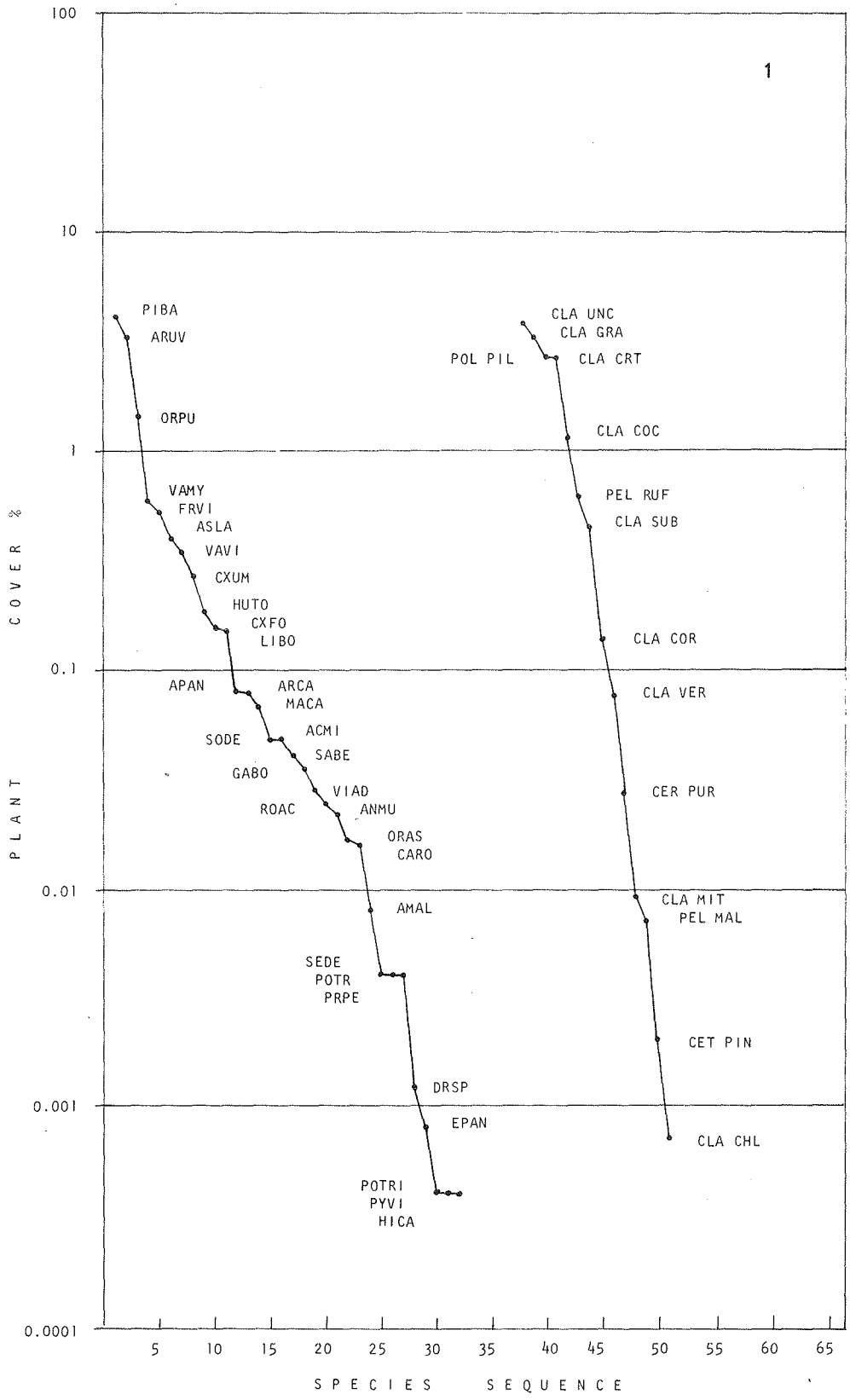
The following two sections describe some of the main plant ecological features of the *Pinus banksiana* forests found in the 16 reference stands, using Tables 4 and 5, and Figure 3.

4.4.3.1 Vascular Plant Community. The total number of vascular plant species recorded per stand varied widely among the 16 reference stands: from 10 to 42 species in the 14 stands on Dystric Brunisols, and from 43 to 46 species in the two stands on Gray Luvisols. Thus vascular species richness is by no means uniform and is notably higher in stands with clay-rich soils (nos. 15 and 16).

There appears to be no correlation between the age and vascular species richness of these *Pinus banksiana* forests. However, richness does seem to be positively correlated with increasing soil moisture availability, though the latter has not yet been objectively assessed. Stand nos. 1 (13 yrs) and 13 (89 yrs) are located very close to each other on opposite sides of a fire margin (Figure 1);

Figure 3.

Species structure curves and species dominance hierarchies for the vascular plant and terrestrial bryophyte-lichen community components of seven reference stands surveyed in the Athabasca Oil Sands area of northern Alberta in August, 1981. The left side of each page contains the vascular component with four-letter species code names placed opposite their estimated mean % cover values. The right side of each page contains the terrestrial bryophyte-lichen component with six-letter species code names. Full scientific names and code names of all species are given in Table 4. For details see section 4.4.3. Reference stand numbers appear at the upper right of pages.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VAVI
CXUM
HUTO
CXFO
LIBO
APAN
ARCA
MACA
ACMI
SODE
SABE
GABO
VIAD
ROAC
ANMU
ORAS
CARO
AMAL
SEDE
POTR
PRPE
DRSP
EPAN
POTRI
PYVI
HICA
CLA UNC
CLA GRA
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CLA CRT
CLA COC
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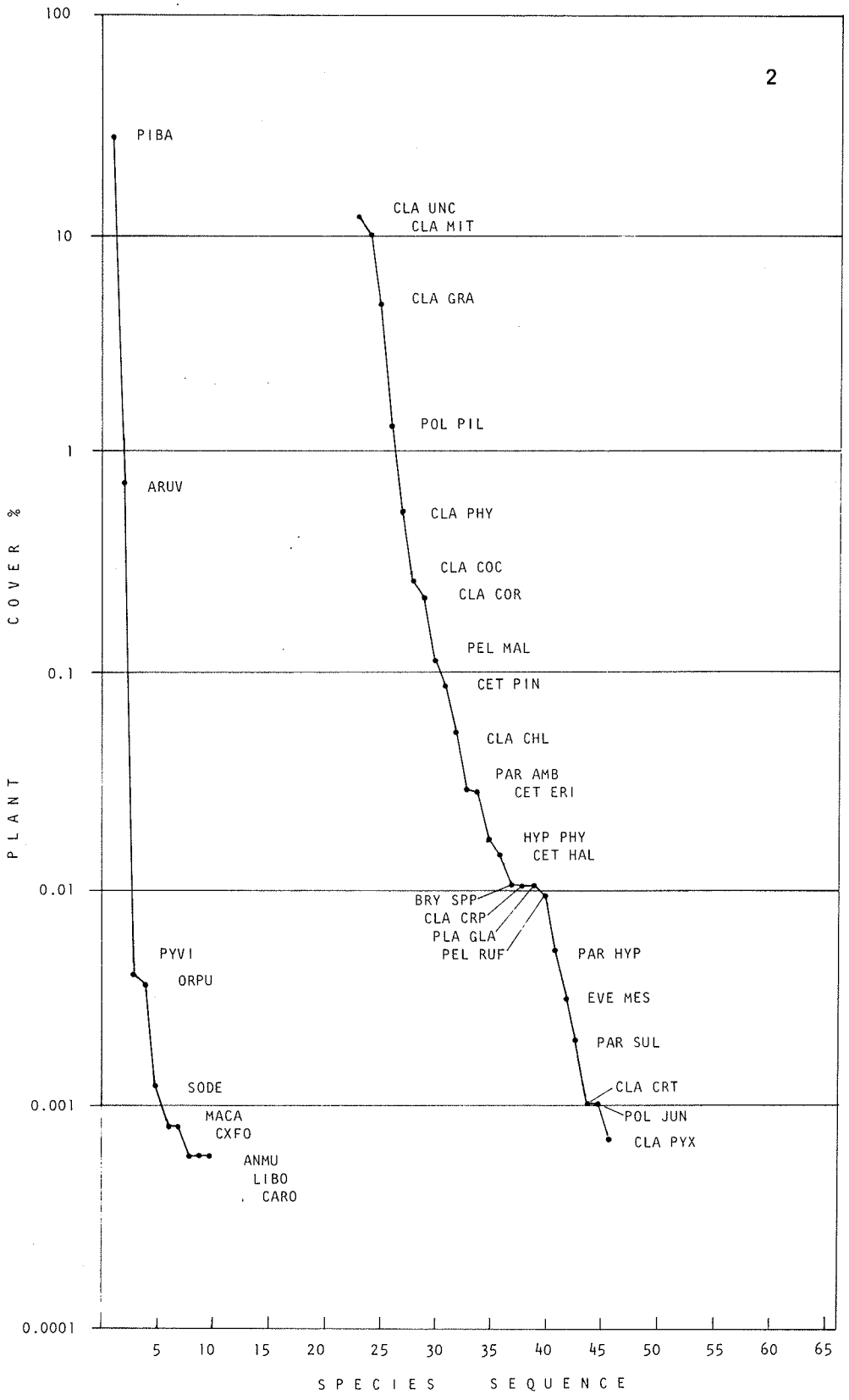
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ARUV
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CLA COR
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CLA CHL
PAR AMB
CET ERI
HYP PHY
CET HAL
BRY SPP
CLA CRP
PLA GLA
PEL RUF
PAR HYP
EVE MES
PAR SUL
CLA CRT
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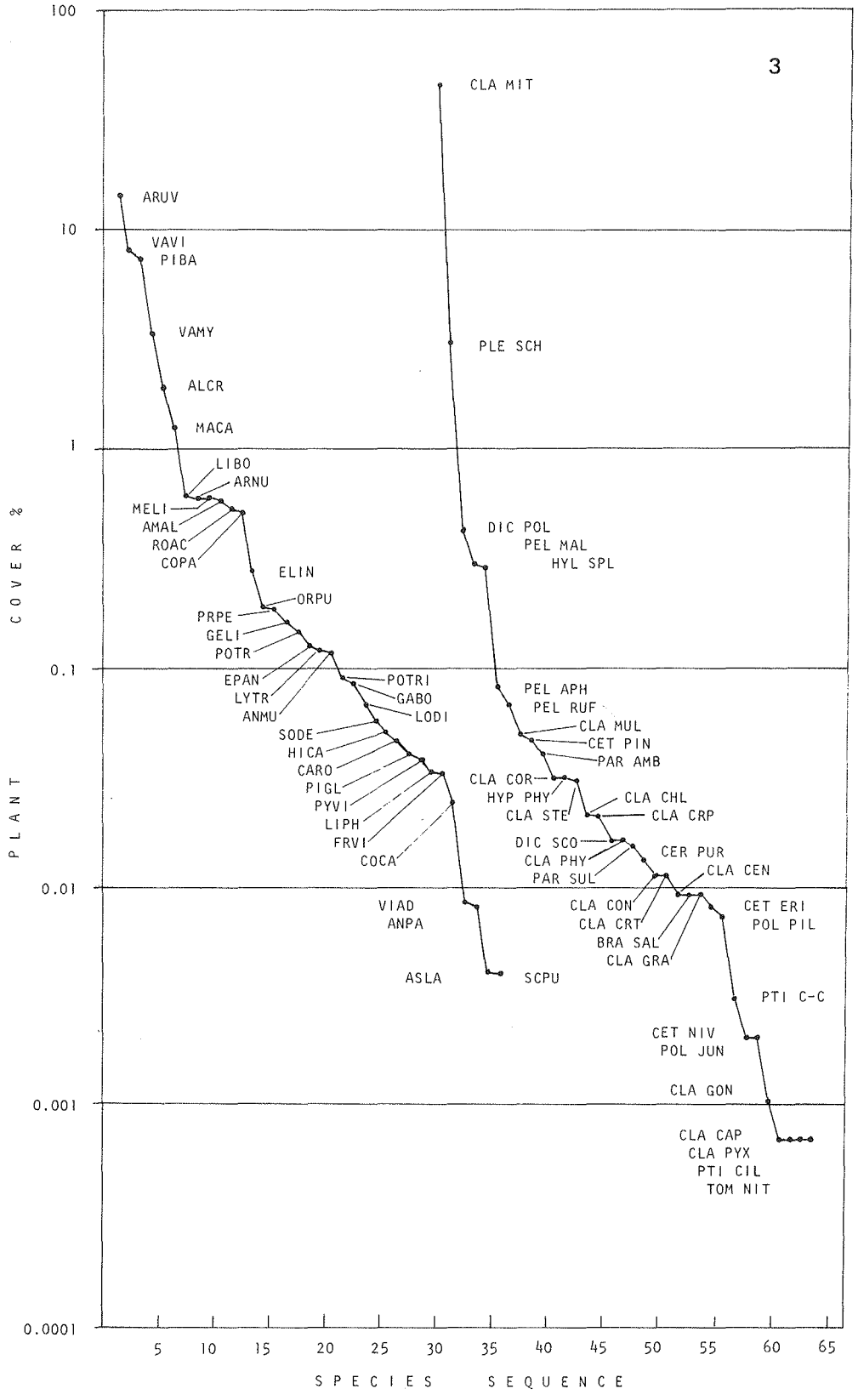
SPECIES SEQUENCE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ARUV
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PIBA
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MACA
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PEL RUF
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FRVI
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CLA CHL
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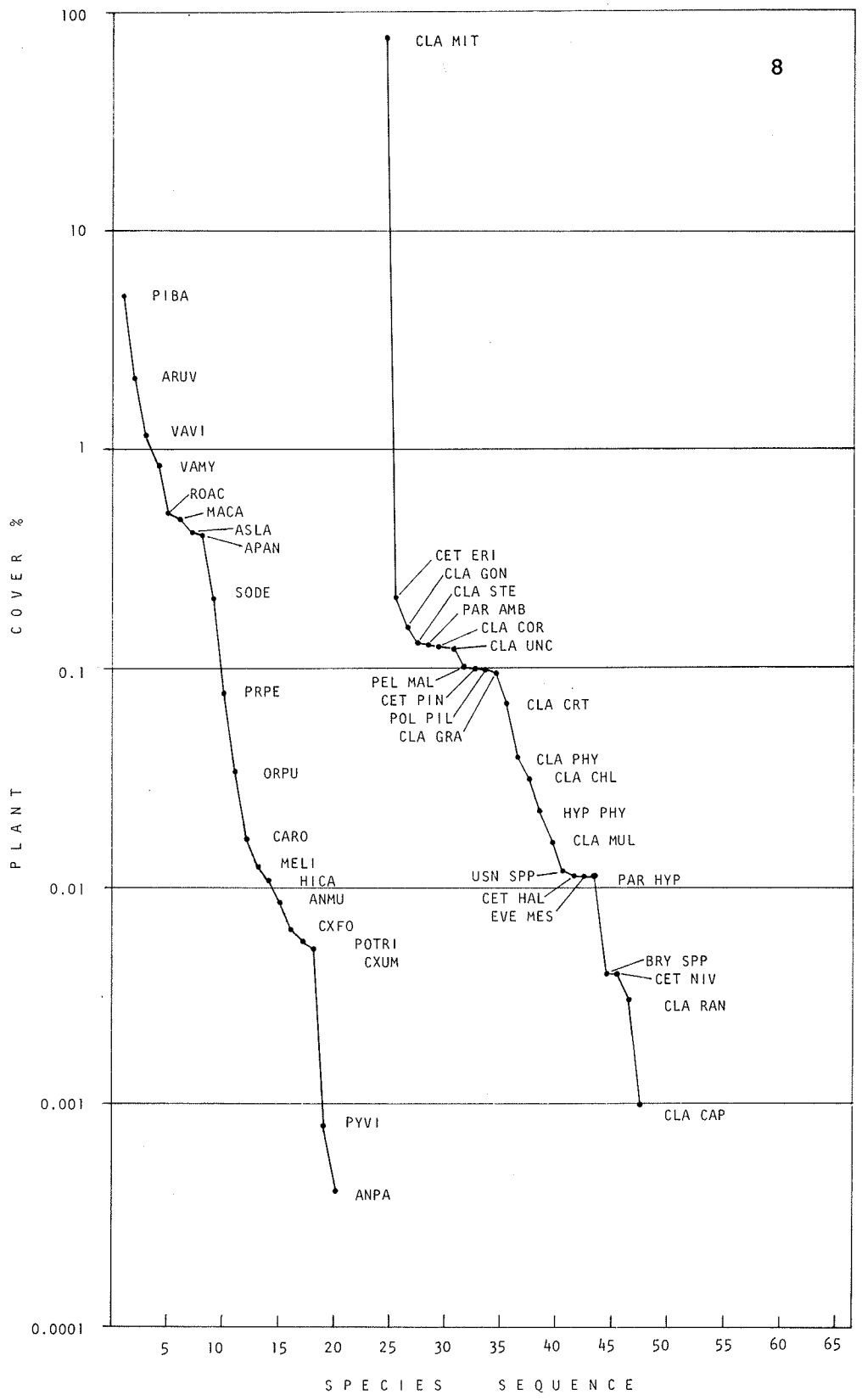
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MELI
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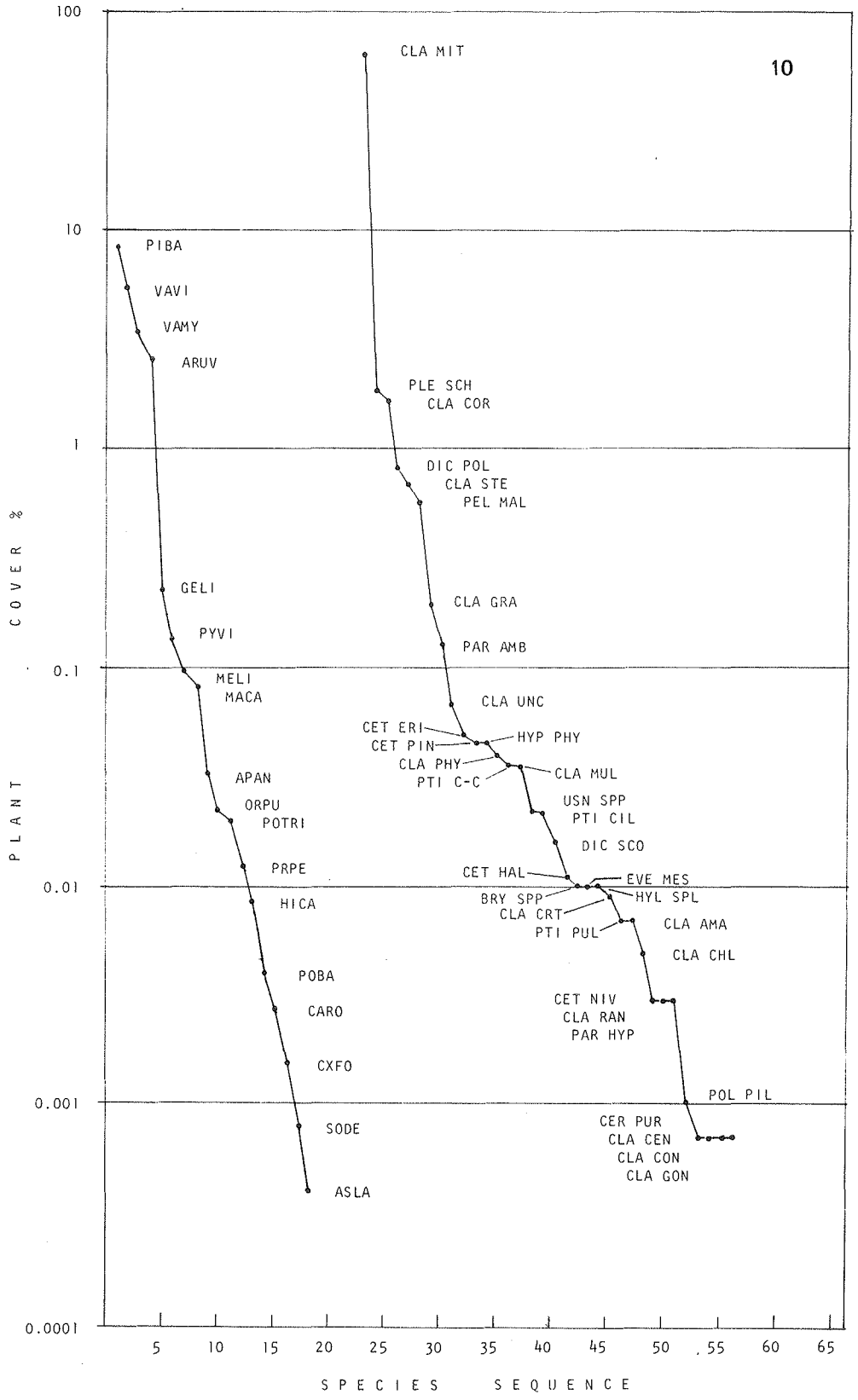
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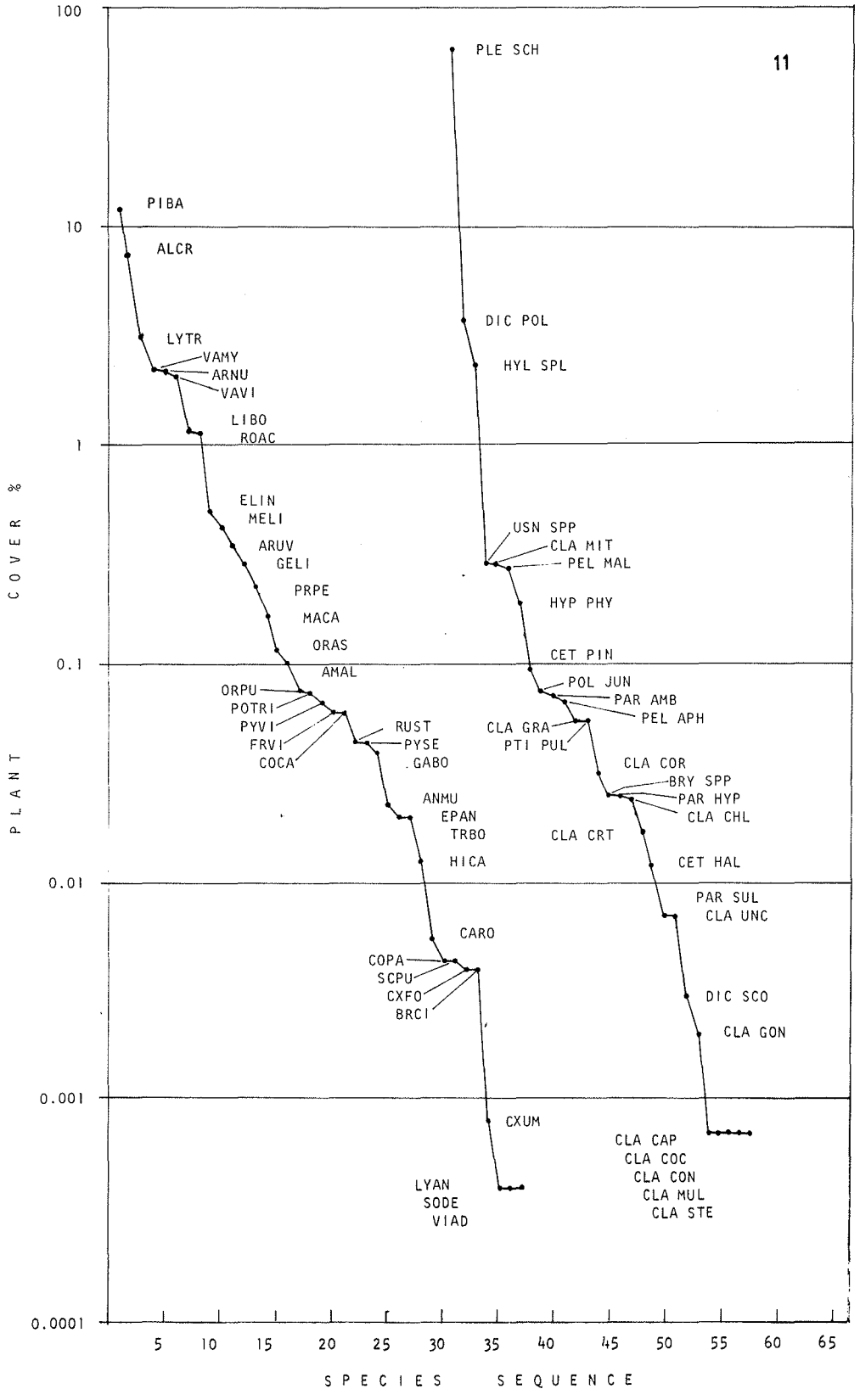
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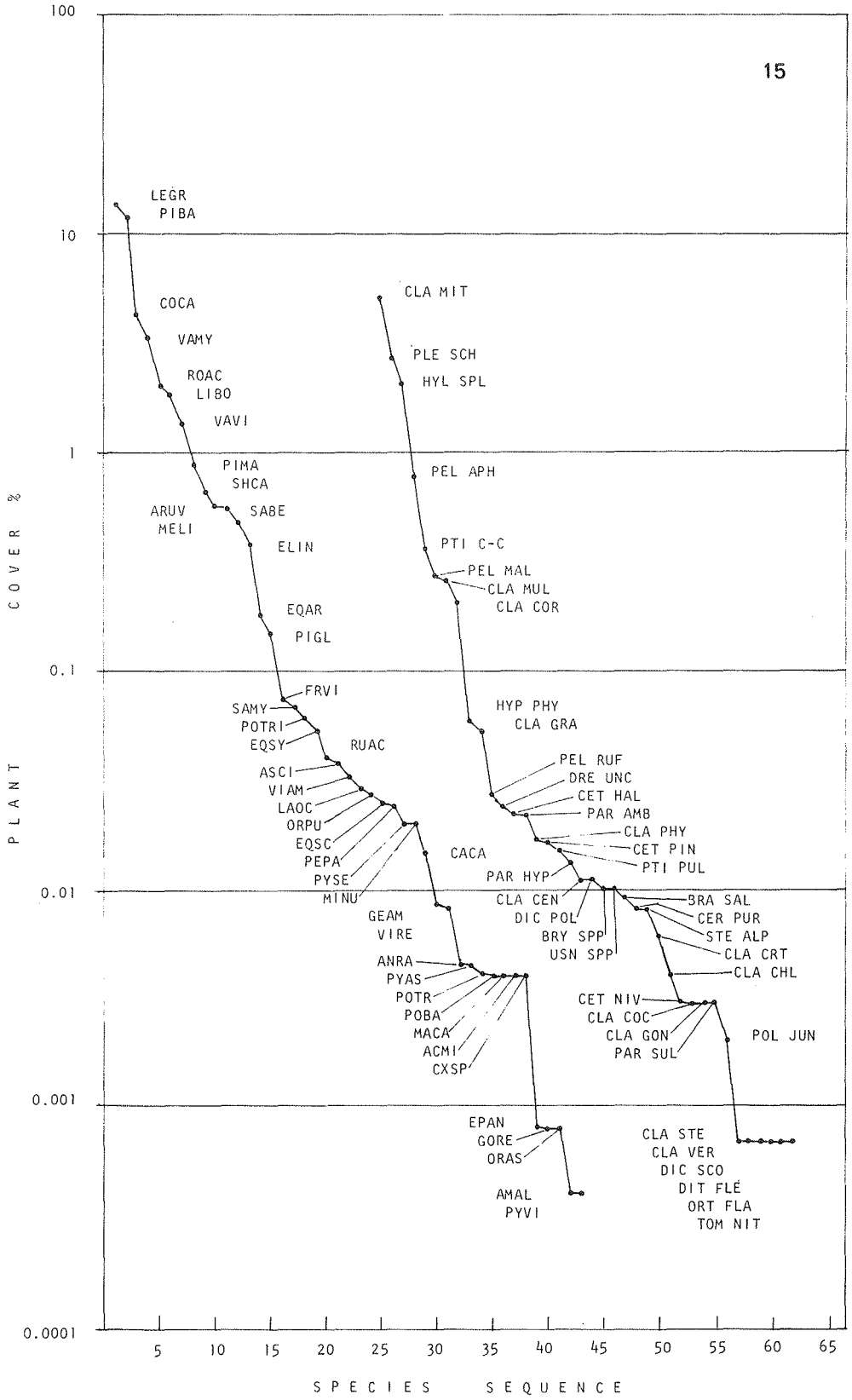
SPECIES SEQUENCE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FRVI
SAMY
POTRI
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VIAM
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ORPU
EQSC
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EPAN
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CET HAL
PAR AMB
CLA PHY
CET PIN
PTI PUL
CACA
PAR HYP
CLA CEN
DIC POL
BRY SPP
USN SPP
BRA SAL
CER PUR
STE ALP
CLA CRT
CLA CHL
CET NIV
CLA COC
CLA GON
PAR SUL
POL JUN
CLA STE
CLA VER
DIC SCO
DIT FLE
ORT FLA
TOM NIT
5
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SPECIES SEQUENCE

though very different in age, appearance, and species composition (Table 5), they are quite similar in richness (32 cf. 37 spp.) and have very similar species structure curves (Figure 3). Stand nos. 8 and 10 demonstrate the same important point (Figure 3), namely, that species richness and species structure remain reasonably stable over a wide range of stand age if physical site properties are closely similar.

There is a negative correlation between species richness and the steepness of the species structure curve, i.e., the greater the richness the more gentle the slope of the curve (Figure 3). Thus species-rich stands seem to be more equitable as well. It appears that equitability, like richness, increases with soil moisture, but since no moisture data are available as yet, this potentially important hypothesis cannot be tested.

Tree cover, consisting almost exclusively of *Pinus banksiana* (Table 3), was quite low in all 16 reference stands, ranging from 4% in the youngest stand (no. 1) to 28% in the second youngest stand (no. 2). Physiognomically speaking, such communities are 'woodlands' rather than 'forests'. There was virtually no correlation between tree cover and stand age or species richness; stands on drier sites were not necessarily more open either. *Picea glauca* regeneration was found only in five relatively species-rich stands; the species-poor stands show no sign of succession to *Picea glauca*.

Shrub cover, consisting principally of three dwarf ericads, *Arctostaphylos uva-ursi*, *Vaccinium vitis-idaea*, and *Vaccinium myrtilloides*, varied widely among stands, from a low of 1% in species-poor stand nos. 2 and 13, to a high of 29% in species-rich no. 3 (Table 3). In seven of the 16 stands shrub cover exceeded tree cover. *Arctostaphylos uva-ursi* was the dominant shrub in seven stands, and so was *Vaccinium vitis-idaea*. *Alnus crispa*, the only important tall shrub, was present, and moderately abundant, only in the three most species-rich stands on Dystric Brunisols (nos. 3, 9, 11).

Forb cover was less than 5% in 12 of the 16 stands, reaching maximum values of 7 and 14% in the two stands on Gray Luvisols (nos. 15 and 16). *Maianthemum canadense* was the dominant forb in six stands, *Cornus canadensis* in three, and *Linnaea borealis* in two stands. Though low in cover, this growth-form group was responsible for much of the total vascular species richness in many stands.

Graminoid cover was less than 1% in 12 stands, reaching a high of 2% in the youngest stand (no. 1) and the most species-rich stand (no. 16), suggesting that this growth-form is most abundant in stands where nutrients are more plentiful (Table 3), at least temporarily. *Oryzopsis pungens* was the dominant graminoid in seven, relatively species-poor stands, and *Elymus innovatus* was dominant in seven, relatively species-rich stands.

Pteridophyte cover was negligible or absent in 15 stands, reaching a high of 3% in no. 11, where *Lycopodium tristachyum* was surprisingly aggressive and species richness was high (Figure 3). *Equisetum variegatum* had the highest Constancy (36%) of the nine species belonging to this growth-form group (Table 3).

4.4.3.2 Terrestrial Bryophyte and Lichen Community. A feature of *Pinus banksiana* forests and woodlands on light textured soils is a well developed lichen community with mosses generally in second place. In the young stands xerophytic mosses, *Polytrichum piliferum* and *Ceratodon purpureus*, are prominent and probably important in stabilizing the soil after a burn (nos. 1, 2).

In older stands mesophytic feather mosses, *Hylocomium splendens, Pleurozium schreberi, Ptilium crista-castrensis*, are the leading species (nos. 9 to 12). Stands on heavier soils (nos. 15, 16) exhibit good feather moss development at a relatively early age.

The model for moss succession suggested above, *Polytrichum piliferum* and *Ceratodon purpureus* to feather mosses with increasing stand age, should be regarded as a strong tendency, but often obscured by factors other than stand age. Stand no. 13 is about 110 years old with evidence of a fire 66 years ago. Stand No. 14 is 133 years old with evidence of fire 38 years ago. Under circumstances where a

ground fire has destroyed the mosses and lichens but spared the trees, species composition and succession are undoubtedly influenced by the trees and the consequent environment on the forest floor.

Any interpretation of future changes in the species structure of the mosses in the reference stands must take into account successional history. *Aulacomnium palustre* and *Tomenthypnum nitens* (nos. 3, 15, 16) are common wetland mosses. They were found as depauperate specimens in atypical micro-habitats in this survey

The most prominent lichen in most of the reference stands is *Cladina mitis* (Reindeer lichen). In the two youngest stands (nos. 1, 2) the red fruited *Cladonia coccifera* and *Cladonia cristatella* together with *Cladonia uncialis* are especially prominent. The genus *Cladina* (formerly part of *Cladonia*) and *Cladonia* are represented by 20 species which is over 81% of the terrestrial lichen flora. Fallen trees and wood in various stages of decay are responsible for much of the species diversity observed. The decaying wood provides a variety of habitats with regard to both substrate and microtopography. For example, fallen decorticated (barkless) trees may have *Parmeliopsis ambigua* and *Parmeliopsis hyperopta* on the south-facing side and *Usnea* spp., *Hypogymnia physodes*, and *Cladonia capitata* on the north-facing side.

As treated here, Epiphytic Lichens include those species which normaly grow as epiphytes, but sampling of this component was restricted to 30 cm or less above ground, to include tree bases, low-hanging branches and fallen wood, i.e., epiphytes living in a more or less terrestrial environment. The restriction used in sampling this element of the lichen flora is not to belittle the possible importance of the epiphytes. Numerous studies have shown their importance in assessing air pollution.

Because of uncertainty in identifying juvenile material, species of *Bryoria* (formerly *Alectoria*) and species of *Usnea* were recorded at genus level. In Tables 4 and 5 BRY SPP contains *Bryoria fuscescens* and *B. fremontii* for the most part; USN SPP includes *Usnea alpina, U. sorediifera* and *U. subfloridana* as the main species.

Another instance where a grouping was necessary can be found in the data for stand no. 1 where *Cladonia coccifera* and *Cladonia cristatella* were evaluated for combined cover, and the total allocated according to an estimate of relative proportions of the two species. As a consequence, standard deviations cannot be determined (marked with an asterisk in Table 4). The comments regarding age and fire history made above with regard to interpreting performance of mosses should also apply when interpreting performance of lichens. Stand no. 13 (109 yrs old, fire 66 yrs ago), for example, has *Cladonia gracilis* as the leading lichen, which, together with other features, seems to set it apart from the other stands. A full knowledge of the past history of this stand would be helpful in future interpretation.

5. DISCUSSION

5.1 THE *PINUS BANKSIANA* - DOMINATED PERMANENT PLOT SYSTEM

As indicated in section 4.1.2 the Athabasca Oil Sands Ecological Monitoring Project now has an established system of 16 *Pinus banksiana* - dominated permanent plots which consists of four subsets based on combinations of impingement, stand age, and soil:

(1) Four very young (1981 fire origin) plots on Dystric Brunisols in the Control and Very Low impingement zones;

(2) Seven young plots on Dystric Brunisols along an impingement gradient from Very Low to High;

(3) Two young plots on Gray Luvisols in the Medium and Very High impingement zones;

(4) Three middle-age plots on Dystric Brunisols in the Low and Very Low impingement zones.

Although each of these subsets offers promising opportunities for ecological monitoring research the second would probably be the best one in which to initiate an intensive program, for two reasons: (1) young *Pinus banksiana* vegetation is more extensive in the AOSERP area than either very young or middle-age; (2) this subset covers a wider range of estimated impingement concentrations (Thomson 1981) than any of the other three subsets.

Gaps in the present system, aside from those occasioned by the wildfire of late August 1981, occur because the sought-for combinations of impingement, age, and soil do not exist in the area as of now.

5.2 THE FOUR PERMANENT PLOTS BURNED OVER IN 1981

As reported in section 4.1.2 permanent plot nos. 1, 6, 11, and 13 were burned over by a wild-fire *ca.* two weeks after their establishment and survey in mid-August of 1981 (see subset (1) in 5.1 above and Table 2). Although these plots were originally intended to fill young (11-50 yrs) and middle (51-110 yrs) age-classes of the system, they now form an excellent subset in which the pre-burn

vegetation has been intensively studied. With very little difficulty the four reference stands can be re-located and re-staked, so that a study of secondary, post-fire succession can begin in them in 1982. This is a unique opportunity that should not be lost. There is a distinct possibility that different stages in the ecological life histories of *Pinus banksiana* communities will vary in their sensitivity to atmospheric emissions; the very young subset of permanent plots will permit testing of this hypothesis.

5.3 COMPARISON OF THE ATHABASCA OIL SANDS PERMANENT PLOT SYSTEM WITH THE HONDO - LESSER SLAVE LAKE PERMANENT PLOT SYSTEM

The *Pinus banksiana* dominated reference stands of the Athabasca Oil Sands appear to be remarkably similar to those previously established in 1980 in the Hondo - Lesser Slave Lake area of north central Alberta located *ca.* 280 km WSW in the same Boreal Forest Mixedwood Ecoregion (Strong and Leggat 1981). The latter study area is not presently affected by atmospheric emissions from the Athabasca Oil Sands or other sources, and is hence located in a relatively clean or control airshed. A detailed comparison of the flora, species structure, dominance hierarchy, and soils of the reference stands of the two study areas will be undertaken in a future publication.

5.4 RECOMMENDATIONS

Based upon our knowledge of the overall objectives of the Athabasca Oil Sands Ecological Monitoring Project and the results of the present study, we make the following recommendations regarding the present system of permanent plots (no priority intended in the order of presentation):

(1) Intensive studies of the permanent plots must be undertaken with extreme care to ensure that the fragile terrestrial lichen component of the plant communities is not seriously damaged. Whenever feasible, the plots should be entered when the lichen carpets are in a moist, plastic rather than a dry, brittle state.

(2) The reference stands should not be used for disruptive or manipulative purposes; other parts of the permanent plots can be allocated to such activities.

(3) All 16 plots are extremely flammable during warm, dry summers; if they are used during such periods, no smoking or other uses of fire should be tolerated.

(4) The plots burned in 1981 should be documented as to flora, soils (especially nutrient availability) and other parameters starting in early summer of 1982, so the immediate post-fire condition is known.

(5) The gaps created in the permanent plot system of impingement zones and stand age (Table 2) by the wildfire of August 1981 should be filled, if possible, by new permanent plots established and surveyed in 1982, preferably as close as possible to the very young subset, to facilitate comparisons.

(6) To test the soil moisture-species richness and soil moisture-species structure hypotheses postulated in section 4.4.3.1, soil moisture sensors should be installed in and around the reference stands of all 16 permanent plots, preferably in 1982; equilibration with the root systems, etc. will take at least one growing season, so good data will not come from these sensors until one year after installation.

(7) The epiphytic lichen component of the plant community deserves careful attention in a separate study, not only because these plants are quantitatively important members of the system, but because of their acknowledged sensitivity to atmospheric pollutants.

(8) The Alberta Forest Service has established mensuration plots within the permanent plots, complete with tagged trees. The routine observations made by the AFS should be continued, but at more frequent intervals than the standard five years.

(9) The reference stand survey procedure described in section 3.4 should be repeated at annual inervals, preferably in late summer, so as to obtain reasonably comparable data during a plateau

period of the growing season when phenological changes are not taking place rapidly.

(10) The fire history and other aspects of the environmental history of the permanent plots deserve more careful study before inferences are attempted concerning effects of present environmental conditions, including emissions.

(11) Helicopter access to some of the permanent plots is now more risky than it should be; approved landing circles should be created and maintained for the safety of all concerned and to make it easier to find the permanent plots by persons who have not previously seen them.

(12) Permanent plot no. 3 at Mildred Lake belongs to the young subset of seven permanent plots which should be given first priority in initiating ecological monitoring research (see 5.1); since this plot is easily accessible and proximal to the field station, it should serve as the test site for many of the studies contemplated for inclusion in the research program.

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7. APPENDIX

7.1 ANNOTATED LIST OF COLOR SLIDES

The 62 slides listed below were taken of the plant communities in the 16 permanent plots as they existed in mid-August of 1981.

Slide Number	Permanent Plot Number	Annotation
1	1	Air oblique of permanent plot.
2	1	Ground lateral of reference stand with abundant deadfall and organic debris.
3	1	Detail of understory vascular plants *(Fragaria virginiana, Oryzopsis pungens, Arctostaphylos uva-ursi)*.
4	1	Detail of terrestrial lichens *(Cladonia coccifera, Cladonia uncialis, Cladonia gracilis)*.
5	2	Air oblique of permanent plot with fire margin in background.
6	2	Ground lateral of reference stand with very high tree density ('dog hair').
7	2	Detail of understory vascular plants *(Arctostaphylos uva-ursi)*.
8	2	Detail of bryophytes *(Polytrichum piliferum)* and terrestrial lichens *(Cladina mitis, Cladonia uncialis, Cladonia coccifera, Cetraria pinastri)*.
9	3	Staking of reference stand in progress; note *Alnus crispa* (tall shrub) behind team.
10	3	Ground lateral of reference stand.
11	3	Ground lateral of deadfall and terrestrial lichens *(Cladina mitis)* with scattered understory vasculars *(Arctostaphylos uva-ursi, Maianthemum canadense, Comandra pallida)*.
12	4	Air oblique of permanent plot with red marker in NE corner of reference stand (upper right).
13	4	Ground lateral of reference stand.
14	4	Juvenile *Pinus banksiana* heavily browsed by snowshoe hare.

Annotated List of Color Slides Continued

Slide Number	Permanent Plot Number	Annotation
15	4	Detail of understory vasculars *(Arctostaphylos uva-ursi, Oryzopsis pungens, Maianthemum canadense, Vaccinium myrtilloides)* and terrestrial lichens *(Cladina mitis, Cladonia uncialis, Cladonia coccifera, Cladonia gracilis)*.
16	5	Air oblique of permanent plot with red marker in NE corner of reference stand.
17	5	Ground lateral of reference stand with bare patches of needle litter.
18	5	Ground lateral of permanent plot S of reference stand where physiognomy is more open and lichen carpet is better developed.
19	5	Detail of understory vasculars *(Vaccinium vitis-idaea)* and terrestrial lichens *(Cladina mitis, Cladina stellaris)*.
20	6	Ground lateral of reference stand.
21	6	Ground lateral of reference stand showing exclusion of terrestrial lichens around bases of *Pinus banksiana* trees.
22	6	Detail of understory vasculars *(Arctostaphylos uva-ursi, Carex foenea)* and terrestrial lichens *(Cladina mitis, Cladonia uncialis, Peltigera malacea)*.
23	7	Air oblique of permanent plot with decadent *Pinus banksiana* behind it; red marker is in NE corner of reference stand (bottom).
24	7	Ground lateral of permanent plot showing areas of abundant deadfall.
25	7	Detail of understory vasculars (*Vaccinium myrtilloides, Vaccinium vitis-idaea)* and epiphytic lichens *(Usnea* spp., *Evernia mesomorpha)* on trunk base of *Pinus banksiana*.
26	7	Detail of understory vasculars *(Vaccinium vitis-idaea, Anemone multifida, Maianthemum canadense, Vaccinium myrtilloides, Apocynum androsaemifolium)* and terrestrial lichens *(Cladina mitis, Cetraria pinastri)*.

Annotated List of Color Slides Continued

Slide Number	Permanent Plot Number	Annotation
27	7	Detail of epiphytic lichens *(Cetraria pinastri, Usnea* spp., *Parmelia sulcata, Parmeliopsis ambigua, Parmeliopsis hyperopta, Hypogymnia physodes)* on burned *Pinus banksiana* log.
28	8	Air oblique of permanent plot with criss-crossed deadfall and red marker in NE corner of reference stand.
29	8	Ground lateral of reference stand with abundant deadfall and *Solidago decumbens* in flower (yellow).
30	8	Ground lateral of reference stand showing extensive lichen carpet *(Cladina mitis)* and *Maianthemum canadense* leaves (yellow-green).
31	8	Detail of terrestrial lichens *(Cladina mitis, Cladonia uncialis).*
32	9	Air oblique of permanent plot with red marker in NE corner of reference stand (center).
33	9	Ground lateral of mesophytic phase of reference stand with abundant *Alnus crispa, Rosa acicularis,* and feather mosses *(Pleurozium schreberi).*
34	9	Ground lateral of xerophytic phase of reference stand (R.A. Ellis); abundant epiphytic lichens on lower tree branches.
35	9	Detail of understory vasculars *(Rosa acicularis, Solidago decumbens, Vaccinium vitis-idaea, Arctostaphylos uva-ursi, Anemone multifida)* and patches of *Cladina mitis.*
36	9	Detail of lichens on trunk base of *Pinus banksiana (Usnea* spp., *Parmeliopsis ambigua, Cetraria pinastri, Evernia mesomorpha, Bryoria* spp., *Hypogymnia physodes).*

Annotated List of Color Slides Continued

Slide Number	Permanent Plot Number	Annotation
37	10	Air oblique of forest adjoining permanent plot (not shown).
38	10	Ground lateral of reference stand.
39	10	Detail of understory vasculars *(Arctostaphylos uva-ursi, Vaccinium vitis-idaea)* and terrestrial lichens *(Cladina stellaris, Cladina mitis)*.
40	11	Air oblique of permanent plot.
41	11	Ground lateral of reference stand with survey team and *Alnus crispa* in background.
42	11	Detail of understory vasculars *(Lycopodium tristachyum, Linnaea borealis, Vaccinium myrtilloides, Vaccinium vitis-idaea, Elymus innovatus)* and feather moss carpet *(Pleurozium schreberi)*.
43	12	Air oblique of permanent plot with red marker in NE corner of reference stand.
44	12	Survey team inserting stakes in reference stand.
45	12	Ground lateral of reference stand with abundant *Vaccinium myrtilloides* and Vaccinium *vitis-idaea*.
46	12	Detail of understory vasculars *(Vaccinium myrtilloides, Vaccinium vitis-idaea)*, bryophytes *(Pleurozium schreberi)*, and terrestrial lichens *(Cladina mitis)*.
47	12	Detail of terrestrial bryophytes *(Polytrichum juniperinum, Pleurozium schreberi)* and lichens *(Cladina mitis, Cetraria ericetorum, Cladonia gracilis)*.

Annotated List of Color Slides Continued

Slide Number	Permanent Plot Number	Annotation
48	13	Air oblique of permanent plot with red marker in NE corner of reference stand (left) and winter road in background.
49	13	Ground lateral of reference stand with survey team in background and extensive lichen carpet *(Cladonia gracilis, Cladina mitis).*
50	13	Detail of *Pinus banksiana* trunk base with epiphytic lichens *(Usnea* spp., *Hypogymnia physodes, Cetraria pinastri)* and terrestrial lichens *(Cladina mitis, Cladonia gracilis).*
51	14	Ground lateral of reference stand with M. Ostafichuk surveying bryophytes and lichens; note fire-scarred trees.
52	14	Double fire-scarred *Pinus banksiana* trunk; note paucity of epiphytic and terrestrial lichens.
53	14	Ground lateral of reference stand with wind-thrown *Pinus banksiana* and exposed sand.
54	14	Detail of understory vasculars *(Maianthemum canadense, Cornus canadensis, Geocaulon lividum, Comandra pallida, Arctostaphylos uva-ursi, Vaccinium vitis-idaea, Elymus innovatus, Linnaea borealis),* bryophytes *(Pleurozium schreberi, Dicanum scoparium),* and terrestrial lichens *(Cladina mitis).*
55	15	Air oblique of permanent plot, located in upper left quadrant of picture, adjoining beaver pond.
56	15	Ground lateral of reference stand with abundant *Ledum groenlandicum* and young *Picea mariana.*
57	15	Detail of understory vasculars *(Cornus canadensis, Linnaea borealis, Vaccinium myrtilloides, Ledum groenlandicum)* and

Annotated List of Color Slides Concluded

Slide Number	Permanent Plot Number	Annotation
		terrestrial lichens *(Cladina mitis, Cladonia cornuta)* in reference stand.
58	15	Detail of understory vasculars *(Rosa acicularis, Linnaea borealis)* and terrestrial lichens *(Cladina mitis, Cladonia cornuta, Cladonia gracilis, Cladonia coccifera)* on well-rotted wood substrate.
59	16	Air oblique of permanent plot, located to left of seismic line on higher ground.
60	16	Ground lateral of reference stand with abundant *Calamagrostis canadensis, Cornus canadensis, Vaccinium myrtilloides.*
61	16	Detail of understory vasculars *(Cornus canadensis, Linnaea borealis, Vaccinium myrtilloides, Calamagrostis canadensis, Rosa acicularis, Elymus innovatus)* and feather moss carpet *(Pleurozium schreberi, Hylocomium splendens).*
62		Permanent plot establishment and vegetation survey team (left to right): G. La Roi, L. Flanagan, P. Farrington, R. Ellis, T. Thomson (pilot), W. Lee, M. Ostafichuk.

7.2 COLOUR SLIDES

The 62 slides are available on loan from the Publications Office, Research Management Division, 15th Floor, Oxbridge Place, 9820 - 106 Street, Edmonton, Alberta, T5J 2K6, (403) 427-3943.