A REVIEW AND ASSESSMENT OF VEGETATION INFORMATION FOR THE AOSERP STUDY AREA

by

O.A. STEEN

Hardy Associates (1978) Ltd.

for

ALBERTA OIL SANDS

ENVIRONMENTAL RESEARCH PROGRAM

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ALBERTA OIL SANDS ENVIRONMENTAL RESEARCH PROGRAM

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Project LS 2.3.2

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The Hon. J.W. (Jack) Cookson
Minister of theEnvironment
222 Legislative Building
Edmonton, Alberta

Sir:

Enclosed is the report "A Review and Assessment of Vegetation Information for the AOSERP Study Area".

This report was prepared for the Alberta Oil Sands Environmental Research Program, through its Land System, under the Canada-Alberta Agreement of February 1975 (amended September 1977).

Respectfully,

W. Solodzuk, P.Eng.
Chairman, Steering Committee, AOSERP
Deputy Minister, Alberta Environment

A REVIEW AND ASSESSMENT OF VEGETATION IN FORMATION FOR THE AOSERP STUDY AREA

DESCRIPTIVE SUMMARY

The maps prepared by Intera Environmental Consultant Ltd. (Thompson et al. 1978; Thompson 1979) for the AOSERP study area outlined the distribution of major vegetation types described by Stringer (1976) and were intended for general use in planning and desig design of projects within the AOSERP study area. However, the level of details offered by the maps has not been sufficient for some projects. Hence this study was sponsored with the following three objectives:

1. Review and summarize available literature related to vegetation types and habitats of the AOSERP study area;
2. Describe the results of a small pilot study assessing the vegetation communities and adequacy of the vegetation map in the Muskeg River area; and
3. Summarize the results of a vegetation workshop designed to assess user need, the adequacy of the pilot study, and applicable methodology for future detailed vegetation studies.

A detailed vegetation classification based on total vegetation composition is not available for the whole of the AOSERP area. Stringer's (1976) classification is the most comprehensive of those available for the AOSERP study area although it is preliminary and the types are very broad. The study makes some recommendations based on the proceedings of the vegetation workshop.

The report has been reviewed and accepted by the Alberta Oil Sands Environmental Research Program.

Wm R MacDonald

W.R. MacDonald, Ph.D
Director (1980-81)
Alberta Oil Sands Environmental
Research Program

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ABSTRACT

Vegetation literature and maps pertinent to the AOSERP study area are reviewed and summarized. Studies from throughout northern Alberta and Saskatchewan are discussed although emphasis is given to the preliminary vegetation classification described by Stringer (1976) and the vegetation maps prepared by Intera Environmental Consultants Ltd. Stringer's classification describes principal physiognomic types, appropriate for overview mapping and description, but many of the types include large compositional variation. The vegetation types mapped by Intera are modified from Stringer's classification and, in forested areas at least, convey little information on vegetation composition other than for trees.

A ground survey of vegetation types in the lower Muskeg and MacKay rivers area revealed major variations in the lesser vegetation within most types shown on Intera's maps. In addition, major physiognomic vegetation types were encountered which are not described by Stringer (1976) or included on Intera's map legend. Twenty-one provisional community types are described based on observations and data collected from 39 plots. Three techniques for including minor vegetation information on Intera's maps are discussed.

A vegetation study workshop was held on 26 November 1979 to evaluate user needs for more detailed vegetation descriptions and maps and to review the results of the vegetation survey as a step towards meeting these needs. In general, the participants agreed that the maps are useful in their present form and that programs to add minor vegetation information cannot be justified at this time. Several recommendations for other vegetation studies emerged from the workshop.

ACKNOWLEDGEMENTS

This research project LS 2.3.2 was funded by the Alberta Oil Sands Environmental Research Program, a joint Alberta-Canada research program established to fund, direct, and co-ordinate environmental research in the Athabasca Oil Sands area of northeastern Alberta. Field and laboratory assistance provided by Mr. W.A. Hemstock and editorial review provided by Mr. D.E. Reid are gratefully acknowledged. The author expresses his thanks to Dr. D.H. Vitt, Botany Department, University of Alberta, for identification of moss species, and to all participants of the vegetation study workshop for their many valuable contributions.

1. INTRODUCTION

Vegetation maps have been prepared for the entire Alberta Oil Sands Environmental Research Program (AOSERP) study area at a scale of 1:50 000 by Intera Environmental Consultants Ltd., (Thompson et al. 1978; Thompson 1979). These maps outline the distribution of major vegetation types described by Stringer (1976) and are intended for general use in planning and design of projects within the AOSERP study area.

However, the level of detail offered by the maps has not been sufficient for some projects (see Appendix 8.2). Consequently, Hardy Associates (1978) Ltd. was contracted by AOSERP to prepare a proposal for more detailed vegetation studies. This proposal was to be based on an evaluation of available descriptions and maps, the results of a small pilot study, and a vegetation workshop attended by potential users of the maps. This report describes the results of these activities.

2. OBJECTIVES AND APPROACH

The principal objectives of this report are to:

1. Review and summarize available literature related to vegetation types and habitats of the AOSERP study area;
2. Describe the results of a small pilot study assessing the vegetation communities and adequacy of the vegetation map in the Muskeg River area; and
3. Summarize the results of a vegetation workshop designed to assess user needs, the adequacy of the pilot study, and applicable methodology for future detailed vegetation studies. Terms of reference for this project are included in Appendix 8.2.

This report is organized into three major sections in accordance with the three principal objectives. The first section reviews available background literature and maps including the maps prepared by Intera (Thompson et al. 1978) and the vegetation classification developed by Stringer (1976). The second section summarizes the results of the ground check of the maps in T94 R10 W4 and T94 R11 W4. It also describes vegetation communites encountered in these two townships. These two sections of the report were presented to workshop participates prior to the workshop as a basis for discussion. The third major section summarizes results and recommendations which emerged from the workshop.

3. PREVIOUS VEGETATION STUDIES

3.1 INTRODUCTION

The objective of this literature review is to briefly discuss and summarize the available vegetation literature pertinent to the AOSERP study area. It is intended that this review provide one basis for evaluating the current progress regarding vegetation descriptions in this area and for designing certain future vegetation studies.

This review considers only vegetation studies from northern Alberta or Saskatchewan as they are pertinent to the AOSERP study area. It is not a comprehensive review of boreal vegetation literature.

3.2 BACKGROUND STUDIES

Background studies of vegetation include those which were conducted prior to development of the oil sands industry in northeastern Alberta and those which have been conducted more recently in other similar boreal forest areas. These studies provide a background for interpretation and comparison with descriptions in the AOSERP area subsequent to 1973.

3.2.1 Regional Descriptions

Halliday's Forest Classification of Canada, published in 1937, divided the forested lands of Canada into eight major regions and several forest sections. This classification was updated and the descriptions expanded by Rowe in 1959 and again in 1972. However, the basic framework of Halliday's classification and map was maintained.

Each edition of this classification placed northeastern Alberta in the Boreal Forest Region. This region, which is characterized by coniferous forests of white and black spruce, stretches as a continuous belt from the Labrador coast westward to the Rocky Mountains and Northwestward to Alaska.

Based on Rowe's (1959, 1972) maps, four sections (subregions) of the Boreal Forest Region are present within the AOSERP study area

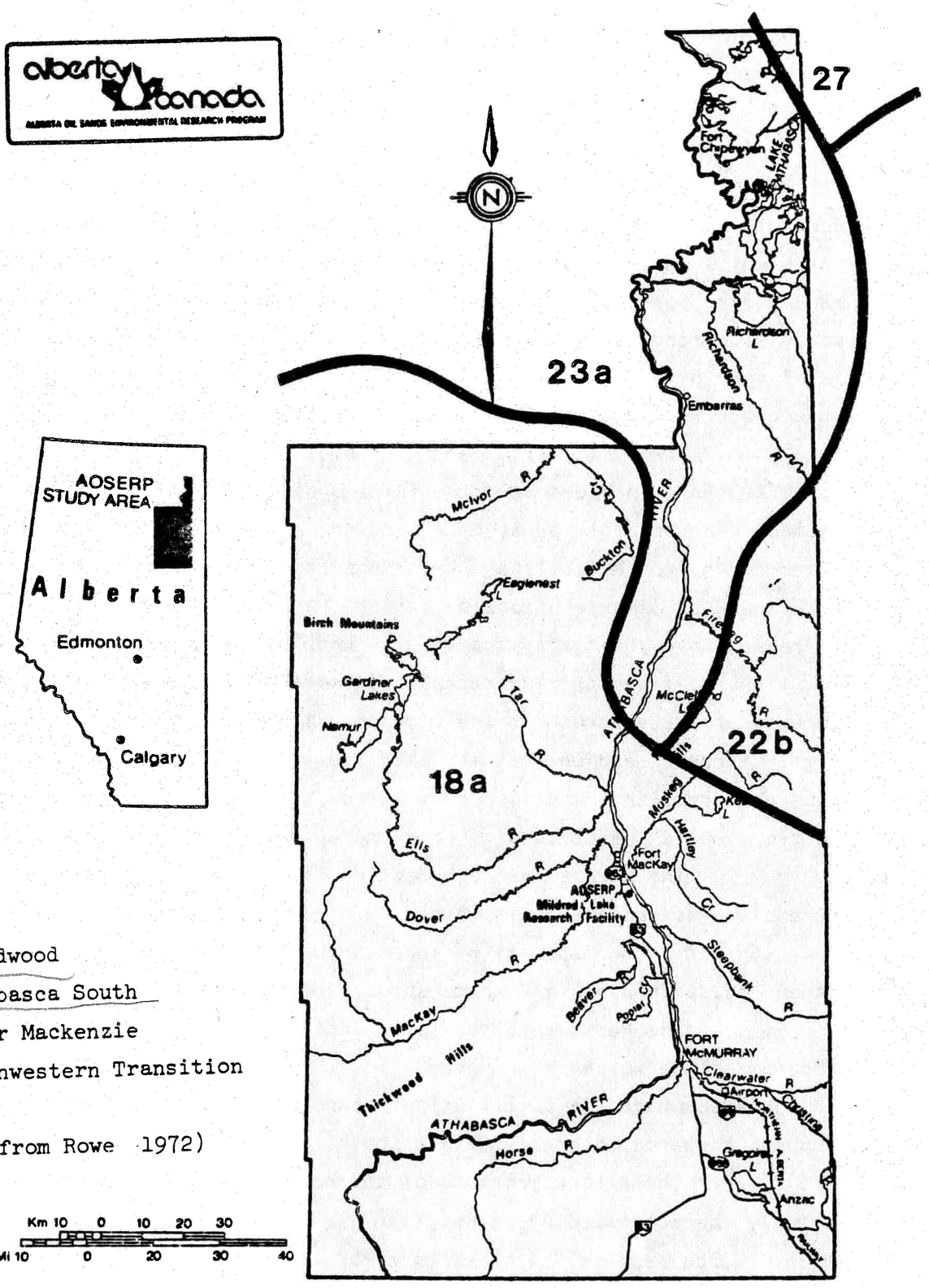
(Figure 1). The largest portion of the AOSERP study area is included in the Mixedwood Section which is characterized on upland sites by mixed forests with varying proportions of trembling aspen (*Populus tremuloides*), white spruce (*Picea glauca*), balsam poplar (*Populus balsamifera*), balsam fir (*Abies balsamea*), and white birch (*Betula papyrifera*). According to Rowe (1972), aspen typically dominates young forests on recently burned sites while white spruce dominates mature forests which have escaped recent disturbance. Jack pine (*Pinus banksiana*) occurs locally on dry sandy sites and forms a mixture with black spruce (*Picea mariana*) on level tops of some higher hills. Black spruce and larch (*Larix laricina*) muskeg occur in depressions and poorly drained flats.

Rowe's (1972) Upper Mackenzie Section (Mackenzie Section in Halliday 1937) includes riverine forests of the Mackenzie drainage system. In the study area, this section occurs along the Athabasca River north from McClelland Lake. Topographic conditions are typically a sequence of alluvial flats bordering the river, low benchlands and terraces above the flats, and finally undulating to rolling uplands. The alluvial flats and low terraces support excellent merchantable forests of white spruce in addition to balsam poplar forests. The higher terraces and uplands are characterized by large areas of jack pine and trembling aspen on sandy soils. In contrast to the Mixedwood Section, white spruce is a minor component of the upland forest.

The Athabasca South Section is a sand plain characterized by extensive jack pine forests which are often open grown or parklike. Characteristic tree species of the Mixedwood Section such as trembling aspen, balsam poplar, and white spruce are uncommon.

The Northwest Transition Section includes a very minor portion of the AOSERP study area (Figure 1). This is a northern forest fringe area where the distribution, abundance, and size of trees are reduced compared to areas further south.

These four sections of the boreal forest in Alberta are also briefly characterized by La Roi (1967a). In addition to a brief description of each section, he presents a more extensive, although popularized, description of forests in the Mixedwood Section (termed Boreal Mixedwood Section by La Roi), including a comparison of aspen- and spruce-dominated forests, their vegetation, environmental differences, and successional sequences.



18a - Mixedwood

22b - Athabasca South

23a - Upper Mackenzie

27 - Northwestern Transition

(adapted from Rowe 1972)

Figure 1. Boreal forest sections of the AOSERP study area.

3.2.2 Vegetation Type Descriptions

3.2.2.1 Background Studies Within AOSERP Study Area. The earliest written accounts of vegetation types in northeastern Alberta come from early exploration and survey expeditions beginning in the early 1800's. The Clearwater and Athabasca rivers were major transportation routes and as a result, several general descriptions and impressions of these valleys are given in the early literature. These early accounts are summarized by Raup (1933, 1934, 1935, 1946).

In 1946, Raup published the results of an extensive study of vegetation in the Athabasca-Great Slave Lake Region. This large region includes northeastern Alberta, northwestern Saskatchewan, and southern portions of the District of Mackenzie. Thus it encompasses essentially all of the AOSERP study area. Only forested vegetation, made up of seven principal forest types (parklike white spruce, flood plain white spruce, upland mesophytic white spruce, jack pine, balsam fir-white spruce, black spruce-lodgepole pine, and bog forest), was described by Raup.

A small scale (1:5 750 000, approximately) map is presented by Raup which outlines the areas dominated by each of these forest types. According to this map, the AOSERP study area lies primarily within areas dominated by upland mesophytic white spruce forests with smaller areas in floodplain white spruce, balsam fir-white spruce, and jack pine forests. For the AOSERP study area, this map corresponds closely to that prepared by Halliday (1937) and Rowe (1959, 1972) with the principal difference being that Raup shows a balsam fir-white spruce forest type along the Clearwater River and the Athabasca River to approximately 70 km north of Fort MacKay.

Characteristic species of trees, shrubs, herbs, mosses, and lichens were listed by Raup (1946) for various associations of each of the principal forest types. The most mesophytic forests of the region were concluded to be the balsam fir-white spruce forests, confined primarily to valleys and terraces of the Athabasca and Clearwater rivers. The flood plain white spruce forests [roughly comparable to Upper Mackenzie Section of Rowe (1972)] were divided into two associations. The first is dominated by balsam poplar and the second by white

spruce. Similarly, three types of upland mesophytic white spruce forests (similar to Mixedwood Section) were described: white spruce woods, white spruce-trembling aspen woods, and aspen woods. The bog forest type was not mapped but was described as being dominated by black spruce, tamarack, labrador tea, and sphagnum mosses.

The only other background descriptions of vegetation which included the AOSERP area were those contained in exploratory soil survey reports by Lindsay et al. (1957, 1961, 1962). These soil reports provide brief comments on the vegetation and the correlation of vegetation types to soil types. The authors noted that open sphagnum bogs with occassional stunted black spruce are characteristic of deep organic deposits but, as organic accumulations become thinner, growth of black spruce improves. Sedges, reedgrass, and horsetail characterize wet meadow soils with less than 30 cm of peat accumulation. Most inorganic soils of medium to fine texture are forested by a mixed cover of trembling aspen and white spruce. White spruce dominates the more poorly drained soils and aspen the better drained soils. Mixed stands of aspen and jack pine occupy sandy soils with high watertables while pure jack pine stands occur on well-drained, porous, sandy soils.

No other vegetation studies are known to have been conducted in the AOSERP study area prior to initiation of the oil sands development. However, the results of vegetation studies in other boreal forest areas of Alberta and Saskatchewan provide valuable background information for interpreting vegetation patterns within the AOSERP area.

3.2.2.2 Background Studies Outside the AOSERP Study Area. Studies by Raup (1930, 1933, 1935) provide some of the earliest descriptions of vegetation types in northeastern Alberta. In a comprehensive study of vegetation in Wood Buffalo National Park, Raup (1935) describes upland forest, muskeg, upland lake shore, and prairie vegetation types. Principal and secondary species are listed for white spruce forests, jack pine forests, aspen forests, sedge meadows, tall shrub community, bog shrub community, and treed muskeg. Maps outlining major physiognomic types were prepared for local areas of the park.

Lacate et al. (1965) report the results of a forest reconnaissance survey of the Peace River area, Wood Buffalo National Park. Three of the major forest types described by Raup (1946) were considered characteristic of the area: flood plain white spruce forest, upland mesophytic white spruce forest, and jack pine forest. Emphasis was given to the first since it includes the most productive and accessible timber. Successional trends culminating in a mature white spruce forest on the alluvial lowlands are briefly characterized and the composition and cover of the shrub, herb, and moss layers of seral and mature stands is briefly contrasted.

The uplands of the area were concluded to be much more diverse than the lowlands, including many poorly defined site and vegetation types with numerous transitional forms. Brief observations are made of jack pine forests on dry sandy soils, and aspen forests on more moist soils. The importance of fire in determining the characteristics of both upland and lowland forests is emphasized.

An extensive landscape classification and mapping study in the Peace-Athabasca delta of northeastern Alberta is reported by Dirschl et al. (1974). The area of this study overlaps a small portion of the AOSERP study area. For purposes of small scale mapping (1:37 000), seven terrestrial vegetation types (delta coniferous forest, delta deciduous forest, tall shrub, low shrub, fen, immature fen or marsh, forests on bedrock outcrops, and grasslands on outcrops) and seven aquatic types were recognized. For larger scale mapping (1:10 000), several vegetation dominance types on various land types were recognized; for example *Salix interior* type on point bars. Thus, these types are considerably more detailed than most other classifications of the region. Percent cover of major species are listed for 39 sample plots. In addition, vegetation successional trends within the delta are hypothesized, especially in relation to changing water levels.

An extensive survey and classification of boreal forest vegetation from Alaska to Labrador is reported by La Roi (1967b) and La Roi and Stringer (1976). La Roi (1967b) describes the vascular species composition and La Roi and Stringer (1976) the bryophyte species composition of six black spruce and six white spruce-fir stand groups.

Forest communities of northwestern Alberta in the Mixedwood and Hay River sections of Rowe (1972) are described by Moss (1953a). He classified the forest into a white spruce association, black spruce-feathermoss association, black spruce-peat moss association, tamarack association, balsam fir vegetation, pine association, and poplar association. Four variations of the white spruce association (needle cover, grass-shrub, shrub-herb, and feathermoss) were noted, based on composition of the undergrowth. These were related to the white spruce types described by Raup (1946) for northeastern Alberta. Two prevalent variations of the pine forests based on undergrowth composition were described as pine-feathermoss and pine-heath. The poplar association was divided into balsam poplar and aspen poplar variations but not further subdivided on the basis of undergrowth. This study presents one of the most detailed early classifications of boreal forests in Alberta.

A classification of forested land within the Mixedwood Section of Alberta, south of the AOSERP study area, is outlined by Duffy (1965). The classification ranks physiographic sites in order of white spruce timber productivity. Seven vegetation communities are recognized and related to soil characteristics and tree productivity. Characteristic species of each community are listed but no quantitative data on composition are presented.

In Saskatchewan, vegetation studies of forests in the Mixedwood Section of Rowe (1972) are reported by Kabzems et al. (1976), Swan and Dix (1966), and Dix and Swan (1971). Kabzems et al. (1976) describe 23 forest ecosystems based on canopy dominants, undergrowth composition, and soil drainage. Forest ecosystem types are arranged in six series according to soil drainage characteristics. Three pine, four white spruce, three aspen, four white spruce-aspen, five black spruce, two tamarack, one pine-black spruce, and one tamarack-black spruce ecosystem types are described. The *Picea glauca-Populus/Cornus* ecosystem on well-drained soils is concluded to be the characteristic forest of the section and includes most white spruce-aspen mixed forests. Succession and timber productivity are described for each ecosystem type. Swan and Dix (1966) describe gradients in the structure, composition, and environmental relations of the Mixedwood Section of boreal

forest in central Saskatchewan but do not classify types. Dix and Swan (1971) describe successional characteristics and the role of fire in the boreal forests of central Saskatchewan.

Three other vegetation studies of boreal forest vegetation in Alberta deserve mention, although they were conducted in the Lower Foothills Section of Rowe (1972), and thus, types may not be directly comparable to types found in the AOSERP study area.

Achuff and La Roi (1977) studied 30 stands of spruce-fir forests in highlands of northern Alberta. These highlands are flat topped plateaus rising 300 to 600 m above the more gently undulating lowlands and include, for example, the Christina Highlands south of Fort McMurray and the Pelican Mountains near Lesser Slave Lake. Although these highlands are not represented in the AOSERP study area, some of the higher elevations of the area such as the Birch Mountains may include vegetation types transitional to those described by Achuff and La Roi (1977).

Four community types were recognized by Achuff and La Roi (1977) on the basis of undergrowth composition. The most extensive and lowest elevation type (*Viburnum/Hylocomium*) is frequently reported from other boreal areas of Alberta. It corresponds generally to the white spruce woods described by Raup (1946) for northeastern Alberta and the white spruce-feathermoss type documented for northwestern Alberta by Moss (1932).

In another study in the Lower Foothills Section of Alberta (near Chip Lake), Lesko and Lindsay (1973) describe 15 forest community types based on composition of the tree and lesser vegetation. Nine white spruce, two lodgepole pine, three black spruce, and an alluvial forest complex type were described and related to soil survey mapping units and timber productivity. Variability in undergrowth composition was identified by the forest types but not strongly related to soil type. Soils with extreme drainage characteristics (very rapid or poor) were found to have very specific forest types while others have a large diversity of types with broad overlappings.

Forest vegetation of the Swan Hills of west-central Alberta is documented by Moss and Pegg (1963).

In the Aspen Grove Section of central Alberta, Moss (1932) described the species composition and tree growth of three forest types

(aspen, balsam poplar, and white spruce). Quantitative data on species composition are given for each vegetational stratum although variations within the types are not described.

Wetland vegetation types of the boreal forests of Alberta and Saskatchewan are described by Lewis and Dowding (1926), Lewis et al. (1928), Moss (1953b), and Jeglum (1973). Lewis and Dowding (1926) describe the muskeg vegetation in the vicinity of Edmonton and Lewis et al. (1928) describe vegetation associations of swamp, moor, and bog forests in central Alberta.

Moss (1953b) characterizes swamps, marshes, wet meadows, saline meadows, *Drepanocladus* bogs, and *Sphagnum* bogs in northwestern Alberta. Composition of these types is similar to types described by Raup (1935) in northeastern Alberta. Succession and retrogression caused by burning of wetlands are described. Jeglum (1973) describes the structure, composition, and environmental characteristics of fens, bogs, and moist forests in the Mixedwood Section of Saskatchewan. Wetland vegetation of the Peace Athabasca delta is discussed by Dirschl et al. (1974).

Forest cover type maps at a scale of 1:63 360 and 1:126 720 are available for the entire AOSERP study area. These maps were prepared by the Alberta Forest Service from interpretation of black and white aerial photographs flown between 1950 and 1954. Map units are annotated for forest cover type (pine, spruce, balsam fir, tamarack, deciduous, and combinations of these species), height class, and density class. Broad categories of non-forested types, including burned areas, marsh or bog, treed muskeg, scrub, grassland, and potentially productive areas, are also outlined. However, the utility of these maps for vegetation interpretation is severely limited by the fact that mapping categories combine several vegetation types.

A more detailed, larger scale (1:31 680) set of forest cover maps (Phase III maps) is available for approximately 60% of the study area. These maps are published by Alberta Energy and Natural Resources and present more detailed information on forest height and crown cover, commercialism class, disturbance, date of stand origin, area of map units, and site class. Although tree species composition of the forested units

is described, no information on undergrowth is presented. In areas of non-productive forest, mapping categories are treed muskeg, scrub coniferous, scrub deciduous, open muskeg, grassland, sand or unconsolidated deposits, clearing, rock barren, soil barren, and water. Prior to publication of Intera's maps (Thompson et al. 1978), these were the most detailed vegetation maps of the AOSERP study area. Stringer (1976) found that a close correlation exists between existing vegetation and these forest cover maps.

A comprehensive report dealing with timber volume summaries and timber management plans for the Alberta oil sands area has been prepared by the Alberta Timber Management Branch (Grey et al. 1973).

3.3 RECENT VEGETATION DESCRIPTIONS OF THE AOSERP STUDY AREA

Industrial development of oil sands in northeastern Alberta and a recognition by the governments of Alberta and Canada of the need for environmental research related to this development, resulted in the establishment of AOSERP in 1975 (Smith 1979). Under sponsorship of the program, inventory studies of vegetation within the AOSERP study area were initiated. In addition, other government agencies such as the Alberta Forest Service provided information relating to vegetation of the area. Descriptions of vegetation on individual oil sands leases by industry has provided a third significant contribution to the knowledge of vegetation in the area.

The most detailed and comprehensive description of vegetation types within the AOSERP study area is provided by Stringer (1976). This study was initiated by AOSERP soon after its formation in order to obtain baseline vegetation descriptions for use in designing a full-scale vegetation survey and mapping program. Eighty-four plots were selected as representative of all major vegetation types in the study area. The structure and species composition of each plot were described and data were classified by a quantitative clustering routine into 10 distinct vegetation types. These are fen, sandbar willow scrub, tall river alder-willow scrub, tall willow scrub, bottomland balsam poplar forest, upland white spruce-aspen forest, black spruce bog forest, semi-open black spruce-tamarack bog forest and muskeg, lightly forested

tamarack and open muskeg, and jack pine forests. In addition, two weakly defined types (Mixedwood and Deciduous Forest and Mixedwood and Coniferous Forest) are also described.

Although the characteristics used to recognize these types are largely physiognomic, the species composition and structural characteristics of the 12 types are described by Stringer (1976) in text and species composition tables. No subdivisions of these types on the basis of undergrowth composition are presented. The correlation of the 12 types with units on forest cover maps prepared by the Alberta Forest Service is discussed and the photointerpretive characteristics of the types are described as an aid to mapping. An extensive list of species, both vascular and nonvascular, and a discussion of taxonomic problems are included.

Due to the limited number of plots sampled by Stringer (1976), the entire range of vegetation types in the AOSERP study area could not be adequately covered. As Stringer points out, his vegetation classification is preliminary; it "describes the major vegetation types and indicates some of the minor ones". His vegetation types "should be looked upon as the first tentative steps toward a vegetation classification, and should be used only as a guide to more definitive studies" (Stringer 1976).

Stringer's (1976) classification emphasizes mature or maturing vegetation and gives relatively little attention to extensive areas that are in early stages of regeneration after fire. Fire is a dominant factor controlling vegetation patterns throughout the boreal forest (Rowe and Scotter 1973; Dix and Swan 1971), including the AOSERP area (Syncrude 1973; Stringer 1976; Peterson and Levinsohn 1977; Alsands 1978). Since the vegetation of these recently burned areas is diverse and the dynamics of the communities are not well understood, a major problem exists in attempting to classify these areas.

Since Stringers' classification was to be used as a basis for an extensive mapping program, the definitive characteristics of the types are largely physiognomic. That is, the types are defined by dominant species and their growth form. No subdivisions of these types into vegetation associations or community types on the basis of lesser

vegetation is provided. However, Stringer's type descriptions, as well as the background literature, suggest that considerable variation may exist within the types in terms of composition of the lesser vegetation. For example, Moss (1953a) indicates four and Kabzems et al. (1976) describe three undergrowth types in white spruce forests. Thus, Stringer's classification is appropriate for relatively small scale mapping and overviews of vegetation but may be much less appropriate for detailed, site specific evaluations.

Each of Stringer's (1976) types is listed in Tables 1, 2, and 3, together with the corresponding or included types of other classifications as a basis for comparison of level of classification detail.

Other principal vegetation types described in northern Alberta which do not appear to have a corresponding classification in Stringer (1976) include:

1. White Spruce Association of Floodplain White Spruce Forests (Raup 1946);
2. Black Spruce-Feathermoss Association (Moss 1953a);
3. Balsam Fir Vegetation (Moss 1953a);
4. Willow Muskeg (Syncrude 1973); and
5. Willow-Reed grass (Peterson and Levinsohn 1977)

Stringer's (1976) vegetation classification, with some modification, has been used in a comprehensive biophysical inventory and mapping program of the AOSERP study area (Thompson et al. 1978; Turchenek and Lindsay 1978). Intera Consultants Ltd. (Thompson et al. 1978) used Stringer's types as the basis for vegetation mapping at a scale of 1:50 000 from interpretation of false color infrared aerial photographs (1:60 000). The vegetation mapping units used by Intera and their correspondence to Stringer's (1976) classification are listed on Table 4. A close correspondence of types is evident. However, certain of Stringer's types are combined or subdivided for purposes of mapping at a scale of 1:50 000. For example, the sandbar willow scrub, tall river alder-willow scrub, and tall willow scrub are combined into the deciduous shrub mapping unit (Bottomland and Riparian Communities) since these types could not be distinguished at the scale of 1:60 000. In addition,

Table 1. Bottomland and riparian vegetation types described by Stringer (1976) and the corresponding or included vegetation types described by other authors.

Stinger 1976	Raup 1935	Dirschl et al. 1974	Jeglum 1973	Syncrude 1973	Peterson and Levinsohn 1977	Moss 1953a
Sandbar Willow Scrub	Sandbar Willow Type	Low Shrub Type (in part)				
Tall Willow Scrub	Tall Shrub Community	Tall Shrub Type	Tall Shrub Fen (5 Types)	Riverine Association (in part)		
Bottomland Balsam Poplar Forest	Poplar Association	Deciduous Forest	*Populus balsamifera* Forest	Riverine Association (in part)	Balsam Poplar-Alder Type	Balsam Poplar Variation (Poplar Assoc.)

Table 2. Upland forest types described by Stringer (1976) and the corresponding or included vegetation types described by other authors.

Stringer 1976	Peterson and Levinsohn 1977	Syncrude 1973	Turchenek and Lindsay 1978	Raup 1935	Raup 1946	Duffy 1956	Kabzems et al. 1976	Moss 1953a
Upland Mixedwood and Deciduous Forest	Aspen-Birch Type?		White Birch-Dwarf Birch Type?					
Upland White Spruce-Aspen Forests	White Spruce-Aspen Type; Aspen-White Spruce Type	Pure Aspen; Pure White Spruce; and Boreal Mixedwood Types		White Spruce Forest; Aspen Forest	White Spruce Woods; White Spruce-Trembling Aspen Woods; Aspen Woods	White Spruce Forest (7 Types)	*Picea glauca* Forest (4 ecosystems); *Populus tremuloides* Forests (3 ecosystems); *Picea glauca/Populus* Forests (4 ecosystems)	White Spruce Association (4 variations); Poplar Assoc.; Balsam Fir Vegetation
Upland Mixedwood and Coniferous Forest					Black Spruce-Lodgepole Pine Forest		*Pinus-Picea mariana* Forest	
Upland Jack Pine Forest		Jack Pine/ Lodgepole Pine Type; Pine-Aspen Type		Jack Pine Forest			*Pinus banksiana* Forest (3 ecosystems)	Pine Assoc. (2 communities)

Table 3. Wetland vegetation types described by Stringer (1976) and the corresponding or included vegetation types described by other authors.

Stringer 1976	Raup 1935	Jeglum 1973	Syncrude 1973	Dirschl et al. 1974	Peterson and Levinsohn 1977	Moss 1935b	Raup 1946	Moss 1953a	Kabzems et al. 1976
Fen	Sedge Meadow	Fen (22 Types)	Fen Muskeg, Marsh	Fen	Sedge-Reed Grass Type	Marsh			
Black Spruce Bog Forest and Muskeg	Bog Forest		Treed Muskeg (in part)		Black Spruce-Feathermoss Type?		Bog Forest	Black Spruce Peat Moss Association	*Picea mariana* Forests (3 ecosystems)
Semi-Open Black Spruce-Tamarack Bog Forest and Muskeg	Treed Muskeg	Black Spruce Swamp	Treed Muskeg (in part)		Black Spruce-Labrador Tea Type				*Larix laricina*/ *Picea* Forests
Lightly Forested Tamarack and Open Muskeg	Bog Shrub Communities	Open Bog, Muskeg	Willow Muskeg			Bogs (2 Types)		Tamarack Association	*Larix laricina* Forests (2 ecosystems)

Table 4. Comparison of the vegetation classification systems used by Intera (Thompson et.al. 1978) and Stringer (1976) in the AOSERP study area.

VEGETATION TYPES		
	INTERA	STRINGER
Class	Type	Type
BOTTOMLAND AND RIPARIAN COMMUNITIES	Bottomland and riparian forest	Bottomland balsam poplar forest
	Deciduous shrub	Sandbar willow scrub Tall river alder-willow scrub Tall willow scrub
UPLAND COMMUNITIES	Undifferentiated	———
	White spruce-aspen forest-deciduous	Upland white spruce and aspen forest Upland mixedwood and deciduous forest
	White spruce-aspen forest-mixed	
	White spruce-aspen forest-coniferous	
	Mixed coniferous	Mixedwood and coniferous forest
	Jack pine	Jack pine forest
	Upland open	———
WETLAND COMMUNITIES	Undifferentiated (usually complex)	———
	Fen communities	Fen
	Black spruce bog	Black spruce bog forest
	Semi-open black spruce bog	Semi-open black spruce-tamarack bog forest
	Lightly forested tamarack and open muskeg	Lightly forested tamarack and open muskeg
BURN	Burn	———
NONVEGETATED		———
AQUATIC VEGETATION		———

Stringer's upland white spruce and aspen forest type is subdivided into three mapping units based on whether the canopy is dominated by deciduous, coniferous, or a mixture of species. Finally, Stringer's weakly defined upland mixedwood and deciduous type is not distinguished from his upland white spruce and aspen forest type for mapping purposes.

Intera also included six mapping unit categories not described by Stringer. These include upland undifferentiated and wetland undifferentiated to include areas too complex to map at greater detail. They also include an upland open category for open areas within aspen forests; the composition is assumed to be grasses, low herbs, and shrubs. The three remaining new categories are burn, nonvegetated, and aquatic vegetation.

Since the vegetation maps present no detailed information on vegetation composition other than for trees in forested areas and physiognomy in nonforested areas, the maps rely heavily upon Stringer (1976) for descriptions of vegetation composition. However, Stringer's types are very broad, lumping for example, all pine forests into one type and including all upland white spruce, white spruce-aspen, and aspen forests as another type. Thus, the species composition of a given map unit cannot necessarily be inferred from Stringer's descriptions. The result is that, in forested areas at least, the maps do not display substantially more information than that which is present on forest cover maps prepared by the Alberta Forest Service.

The vegetation types included on Intera's maps but not described by Stringer (1975), have no supporting descriptions of vegetation composition.

Stringer's (1976) classification was also used with some modification by Turchenek and Lindsay (1978) for mapping of biophysical land systems in the AOSERP study area. Although vegetation is not mapped, it is one of the definitive characteristics of the land system. Similar to Intera, Turchenek and Lindsay combined the three shrub types and subdivided the upland white spruce-aspen forest type for mapping purposes.

In addition to these extensive studies sponsored by AOSERP, other vegetation descriptions and maps have been prepared for individual

lease areas, sponsored by the oil sands industry. These studies have, for the most part, been at a level of detail similar to the types of Stringer (1976).

As part of a wildlife habitat evaluation, Syncrude (1973) described and mapped 11 vegetation types on oil sands Lease 17. These types are: pure aspen, jack pine/lodgepole pine, pure white spruce, white spruce-aspen, pine-aspen, willow-birch muskeg, black spruce muskeg, willow muskeg, recent burn, old burn, riverine, and open marsh. Although little indication is given of non-woody species composition of the types, principal shrub species are identified, especially in relation to browse potential. Spruce-aspen mixedwood forests are contrasted to pine-aspen mixedwood forests and two types of pine forests are noted. The willow muskeg type which had not been described previously was noted to be extensive on recently burned muskeg areas.

In a later report dealing primarily with potential revegetation species, Syncrude (1974) briefly described eight main vegetation types on Lease 17: jack pine, jack pine-aspen, aspen, white spruce-aspen, white spruce, riverine, black spruce, and sedge fen. Similar to many previous descriptions, these types are broad physiognomic types with no emphasis in their definition on lesser vegetation.

On the western half of Syncrude's Lease 17, Peterson and Levinsohn (1977) described and mapped (1:24 000) eight vegetation types. Their willow-reedgrass type and aspen-birch type were concluded to be distinct from types described by Stringer (1976). In addition, their black spruce-feathermoss type may not be the ecological equivalent of the black spruce bog forest of Stringer (1976) as stated but may be more similar to the black spruce-feathermoss type described by Moss (1953a). The remaining five types correspond generally to Stringer's (1976) classification.

Vegetation of the Suncor (formerly Great Canadian Oil Sands) Lease 86 is described and mapped (1:24 000) by R.M. Hardy and Associates (1978). Principal species, site characteristics, and distribution of eight physiognomic types are described. These correspond generally to Stringer's (1976) classification. In addition, community types within the physiognomic types are indicated, but only very briefly described.

Two community types are distinguished within fen, aspen forest, and black spruce forests, and three within white spruce-aspen forest.

Shell (1975) and Alsands (1978) document physiognomic vegetation types on the Alsands project area (Leases 23 and 96). The structure, composition, and site characteristics of 10 types are described and mapped with correspondence generally to Stringer's (1976) types.

Major physiognomic vegetation types of the surface minable portion of the Athabasca Oil Sands region are briefly described and mapped by Hardy Associates and Monenco (1979). Lombard North (1974) provides brief descriptions of 11 principal vegetation types on the Amoco Lease near Gregoire Lake.

As part of an upland bird habitat evaluation conducted by the Canadian Wildlife Service, Francis and Lumbis (in prep.) described the vegetation of 20 census blocks in shrub and forest types. For the most part, blocks encompassed heterogeneous vegetation. Dominant species of the tree understory strata are documented and community structure and variability are briefly described.

As part of a study to assess the feasibility of lichen monitoring in the Fort McMurray region, Douglas and Skorepa (1976) briefly describe the vascular species composition of four principal forest types: white spruce, black spruce, aspen, and jack pine.

Addison and Baker (1979) have established 11 jack pine forest sites in the AOSERP study area to provide baseline data for long-term monitoring of vascular and lichen communities and soils. They noted that vegetation of the jack pine sites was variable and could be broken into four groups primarily on the basis of herbaceous composition. The distribution of these groups is apparently related to soil moisture regime.

3.4 LICHEN COMMUNITY DESCRIPTIONS

Lichen communities may be used as biological indicators of atmospheric pollution and as a result, are of considerable interest in the AOSERP area. However, descriptions of lichen communities and their relation to potential air pollution in northeastern Alberta are relatively few.

Douglas and Skorepa (1976) discuss the feasibility of establishing a lichen grid monitoring network north of Fort McMurray. Quantitative data from lichen communities on tree branches and trunks were obtained from 12 plots in pine, spruce, and aspen forests. Percent cover and frequency of lichen species are listed. A rich lichen flora occurs on white and black spruce in the region and could be used in a lichen monitoring study. Relatively few lichens occur on aspen.

Peterson and Douglas (1977) have established lichen monitoring plots radiating from the perpiphery of the Syncrude lease. Percent cover of selected species are tabulated. The presently known lichen and bryophyte flora is briefly described and an annotated checklist is included.

Addison and Baker (1979) list the percent cover and frequency of four lichen species groups on jack pine stems at increasing distances from the Suncor plant. They also describe changes in lichen cover in a transplant study conducted over a one year period.

In Alberta, but outside the AOSERP study area, lichen community descriptions are provided by Case (1976) for the Whitecourt area, Skorepa and Vitt (1976) for the Rocky Mountain House area, and Hardy Associates (1979) for the Cold Lake area.

3.5 RARE VASCULAR PLANT LISTS FOR ALBERTA

Under the Rare and Endangered Plants Project of the National Museum of Natural Sciences, Argus and White (1978) have prepared a provisional list of rare vascular plants of Alberta. This list is based on several herbarium collections and distribution maps. Notes on species include range, habitat, status, and references documenting the status.

Packer and Bradley (1978) list approximately 540 species of native vascular plants considered rare in Alberta. The degree of rarity, habitat, range, and protection status are described.

4. VEGETATION PILOT STUDY

4.1 INTRODUCTION AND OBJECTIVES

Vegetation maps at a scale of 1:50 000 have been prepared for the AOSERP study area by Intera Environmental Consultants Ltd. (Thompson et al. 1978). The purpose of these maps is to provide baseline vegetation information which can be used in the planning and design of other resource studies in the AOSERP area.

These maps display a considerable volume of useful information on the distribution of major vegetation types in the AOSERP area. However, the detail offered by the maps has often not been sufficient to meet the needs of other resource studies (B.A. Khan, pers. comm.). This stems from at least three aspects of the maps: first, the mapping scale (1:50 000) is relatively small and thus individual map units often include several vegetation types; secondly, the vegetation types outlined on the maps are largely physiognomic units and convey little information on vegetation composition. In forested areas, for example, the map units are defined only by the tree layer. Finally, the maps have not been intensively ground checked (a brief reconnaissance check was completed) and thus include errors of interpretation.

The vegetation units outlined on the maps are based in large part on the vegetation classification developed for the AOSERP area by Stringer (1976). Although Stringer's classification is the most comprehensive and detailed classification available for the AOSERP study area, it is preliminary and the types are very broad. A detailed vegetation classification based on total vegetation composition is not available for the whole of the AOSERP area.

Hardy Associates was contracted by AOSERP to conduct a pilot study in the lower Muskeg River area to document variability of lesser vegetation within map units and to examine possible means for enhancing vegetation detail on the maps, especially with regard to lesser vegetation. The purpose of this section is to describe the results of the brief pilot study and to develop some preliminary recommendations for enhancing vegetation detail on the maps. A preliminary vegetation classification, which is more detailed than that described by Stringer (1976),

is described as an example of how vegetation community information could be documented for inclusion on map units. Field studies were conducted from 30 August to 5 September 1979.

The specific objectives of this section are to:

1. Describe a preliminary vegetation community classification based on ground survey of vegetation map units in the Fort MacKay area; and
2. Provide recommendations based on the field survey for developing methodologies to enhance the vegetation detail on Intera's vegetation maps.

4.2 STUDY AREA LOCATION

Field studies were conducted in T94 R10 W4 and T94 R11 W4 (Figure 2). These two townships include the lower reaches of the Muskeg and MacKay rivers, on opposite sides of the Athabasca River. They are north of Syncrude's Lease 17 and south of the Alsands Project Group lease. They were selected for study since they contain a diversity of vegetation types, are near areas under development or slated for development, and are reasonably accessible. Several cutlines are present, facilitating ground surveys.

4.3 METHODS

4.3.1 Field Methods

4.3.1.1 Ground Checking of Maps. Ground surveys of vegetation map units was accomplished primarily on foot from cutlines. Cutlines chosen for travel were those which crossed a relatively large number of vegetation units as indicated on Intera's maps and on 1:60 000 FCIR air photos. Most of the larger map units within the study area were visited at least briefly. Each map unit was travelled for a sufficient distance from the cutline to indicate variability. Large, very heterogeneous map units were surveyed by low-level helicopter reconnaissance.

In each map unit visited, the vegetation was classified on the basis of dominant species and vegetation physiognomy according to Intera's

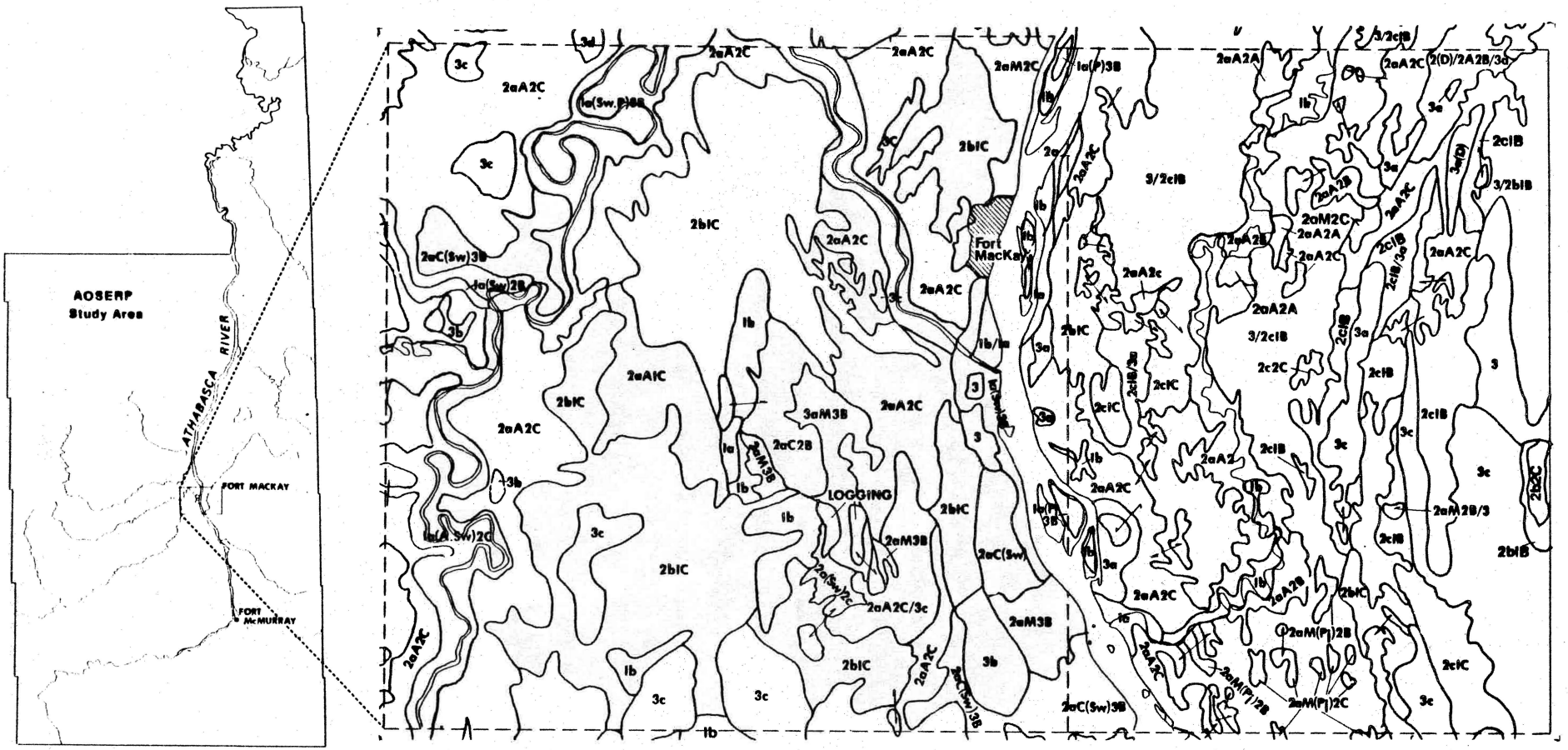


Figure 2. Location of detailed vegetation study area, showing vegetation units mapped by Intera Environmental Consultants Ltd.

mapping legend. In those map units where the vegetation physiogmomy did not correspond to any of Intera's or Stringer's units, the characteristics of the vegetation were noted and a sample plot was selected to describe the vegetation.

Special attention was given to the lesser vegetation to determine if it was visually homogeneous within each physiognomic type as outlined in Intera's classification or if classifiable variability existed with the physiognmic types. Where major differences in lesser vegetation were noted, study plots were selected to document this variability and to form a basis for more detailed vegetation classification. A preliminary community classification was developed in the field in order that lesser vegetation types could be noted on the maps.

4.3.1.2 Community Classification. Study plots were selected to document, to the extent which the short time allowed, each major vegetation community type encountered during ground checking of the maps. At least one study plot was located within each major physiognomic type described by Stringer (1976). In types where significant variability of lesser vegetation was noted, two or more plots were selected to document this variability. The principal exception is fens where time did not allow a sufficient number of study plots to document variability. Data were recorded from a total of 39 plots in six days of survey.

Each study plot was required to be representative of a principal vegetation community type in the area and to display visual homogeneity of vegetation, site characteristics, and soils. Study plots were 20 m X 20 m in most vegetation but reduced to 10 m X 10 m in dense shrub thickets and dense black spruce bog forests. All plots were free of human disturbance such as tree cutting or seismic activity.

In each study plot, the percent cover of all species noted within each vegetation stratum was visually estimated. For purposes of this study, vegetation strata were defined as

tree: >8m
tall shrub: 2 to 8m
low shrub: upright woody plants <2m

dwarf shrub/herbaceous: prostrate shrubs and all vascular herbaceous plants

moss: Mosses and lichens

No attempt was made to make a comprehensive and exhaustive list of species at each plot but rather to make a list which would adequately describe the vegetation and distinguish it from other vegetation types.

In addition, the percent cover of principal corticolous lichen species on tree boles between 1 and 2 m above ground were visually estimated. Although a more precise methodolgy would have been developed if time had allowed, this visual estimate was sufficient to indicate principal species and their relative abundance.

In forested plots, the heights, diameters (dbh), and ages of two or three trees of the predominant species in the upper canopy (dominant/codominant) were recorded.

A shallow (approximately 40 to 50 cm) soil pit was dug near the centre of each plot to note surface substrate characteristics and soil type. Texture and depth of principal surface horizons were described and the soil provisionally classified according to the Canada Soil Survey Committee (1978).

Soil parent material, stoniness, drainage, slope, solar aspect, and topography were recorded at each site. The approximate location of each plot was noted on the vegetation maps for future reference. A photograph was taken of each plot.

4.3.2 Data Analyses

Since this is a pilot study based on reconnaissance and a relatively small amount of data, no detailed or quantitative analyses of the data were carried out. The plot data were grouped according to Stringer's (1976) classification in order that the more detailed community classification would represent hierarchial subdivisions of Intera's units. Data which could not be fitted within any of Stringer's or Intera's types were compared with classifications presented by other authors in order to maintain some consistency of terminology.

Various techniques of presenting more detailed information on the vegetation maps have been explored. These include expanding the annotations within the map units and footnoting the map units, as described in Section 4.4.3.2.

4.4 RESULTS

4.4.1 Ground Survey of Vegetation Variability

The purpose of this section is to very briefly describe the results of the survey of lesser vegetation variability within the mapping types outlined by Intera. Ground surveys were conducted entirely within T94 R10 W14 and T94 R11 W4.

Some major physiognomic vegetation types which are not recognized by Stringer (1976) and not included on the map legend were encountered within the study area. For example, riparian white spruce forests which occur along the Athabasca and Muskeg rivers are not included in Stringer's classification and are indicated on the maps only as part of a much more generalized "Bottomland and Riparian Forest." Shrub fen, upland black spruce forest (black spruce--feathermoss forest), and shrub bog are other extensive physiognomic types which are not described by Stringer or Intera. The latter type may correspond, in part at least, to Intera's "Upland Undifferentiated" category.

Ground surveys in the Fort MacKay area indicated that major differences in the composition of lesser vegetation is present within most vegetation types included on the map legend. For the most part, this variability is present at a scale which can be outlined on 1:50 000 scale maps.

Two and occasionally three or more major vegetation community types can be described within all but two of the types mapped by Intera. In general, these community types reflect differences in surficial material type and texture, topography, soil drainage, and history of site disturbance. In two mapping types (White Spruce-Aspen Forest-Coniferous, and Mixed Coniferous), no variability meaningful to anticipated use of the maps was detected. The major vegetation community types encountered within each of the mapping types are briefly described below.

4.4.2 Preliminary Detailed Community Classification

This section briefly describes 24 provisional community types noted during vegetation surveys in the Fort MacKay area. These types are presented as an example of how vegetation community detail could be catalogued for presentation on the maps.

The community types are grouped according to Stringer's (1976) classification which corresponds closely to that used for mapping purposes by Intera (Thompson et al. 1978). Since these communities are based on very limited data, they are strictly provisional and described only for purposes of discussion relating to methodology for enhancing detail on the maps.

4.4.2.1 Fen. Fen vegetation occurs on very wet sites and is characterized by a dominant herb stratum comprised primarily of sedges and grasses. Semi-aquatic forbs are typically present but are a minor component. A mat of mosses typically covers the ground and in contrast to bogs, is dominated by *Drepanocladus* spp. *Sphagnum* mosses are rare. Shrub cover ranges from nearly absent to continuous and very scattered trees may be present. In comparison to bogs, the surface water in fens has a higher pH and cation content. Fens are richer in nutrients than are bogs.

Stringer (1976) lumps all fens into one type but other authors such as Jeglum (1973) describe several types. Due to the short time available in this study, data were collected from only two fen types with one plot in each type. These types are termed open fen and low shrub fen and correspond to Jeglum's (1973) categories of the same name. Tall shrub fen was also noted in the study area but due to lack of time was not sampled.

4.4.2.1.1 Open Fen. Open fen is characterized by a sparse or absent shrub layer (Figure 3). The vegetation is dominated primarily by sedges and mosses with principal species being *Carex diandra, C. lasiocarpa, C. aquatilis,* and *Drepanocladus* spp. Other species in the plot studied are listed on Table 2.

Soils of this type are organic and very poorly drained. This type is common around the perimeters of small lakes and ponds and in low areas where drainage waters collect and move slowly through the stand.

Considerable compositional variability is present within this type and it would probably be subdivided by additional survey.

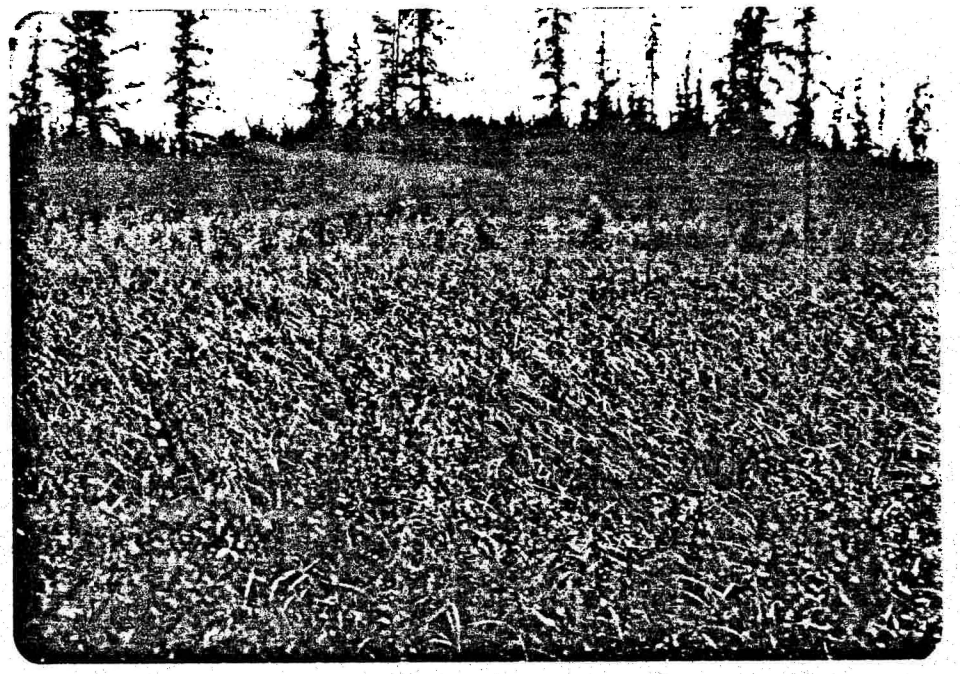


Figure 3. Open fen near Muskeg River.

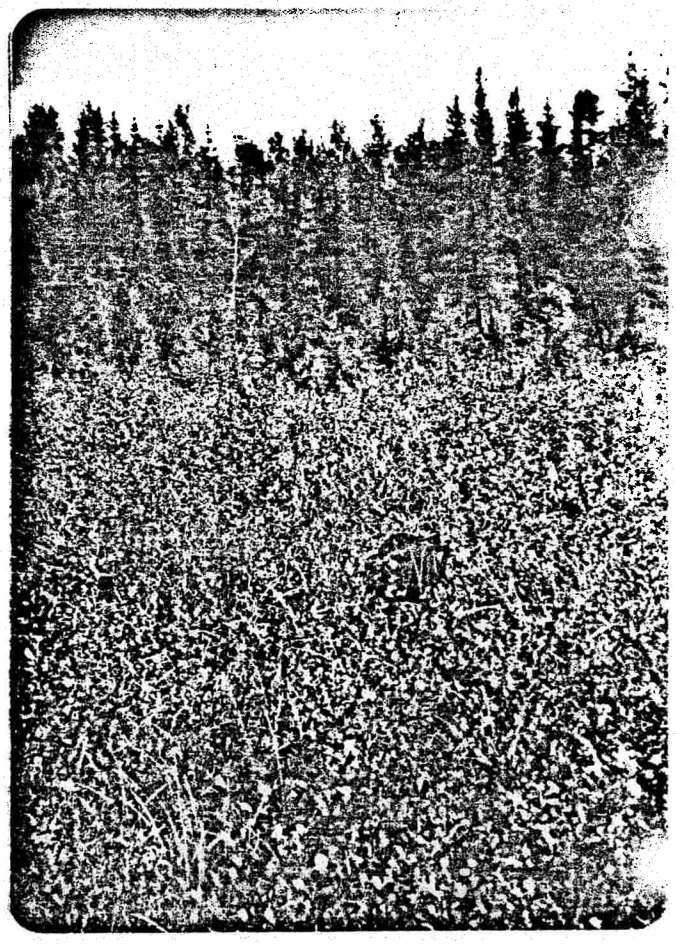


Figure 4. Low shrub fen near Muskeg River.

4.4.2.1.2 Low Shrub Fen. Low shrub fen is characterized by a prominent shrub stratum, 1 to 1.5 m tall (Figure 4). Dominant shrubs are primarily *Betula pumila* with lesser *Salix macalliana, S. pedicellaris, S. candida,* and *Larix laricina.* Beneath the shrubs is a herbaceous layer dominated by sedges and a moss carpet of various fen species (Table 2).

Shallow standing water is commonly present on the surface throughout the growing season.

4.4.2.1.3 Tall Shrub Fen. Tall shrub fen with a discontinuous tall shrub stratum dominated by *Salix bebbiana* was noted in the area but no data were collected. Sedges and grasses (primarily *Calamagrostis*) dominate the herbaceous layer but the vegetation is very heterogeneous and patchy. This type occurs in broad low areas traversed by minor drainage-ways. As the site becomes somewhat better drained, this type appears to grade into Tall Willow-River Alder Scrub.

4.4.2.2 Tall Willow-River Alder Scrub. According to Stringer (1976), the tall willow-river alder type includes vegetation dominated by a closed canopy of willows and river alder approximately 5 to 6 m tall. It occurs along rivers and watercourses and in wet, but freely drained, depressions throughout the AOSERP area. The lesser vegetation is sparse but variable.

Two principal communities of this physiognomic type were noted in the area surveyed. The first occurs in wet depressions on the uplands, often in association with fens while the second forms a band along principal water courses.

4.4.2.2.1 Tall Willow-Alder/Reed Grass Community. This community type is common on the uplands in the area surveyed where it occurs as small stands in close association with fens and occasionally as more extensive stands in areas of numerous, minor channels. The small stands associated with fens are generally too small to map at a scale of 1: 50 000.

The vegetation is dominated by a nearly closed canopy of willows (especially *Salix bebbiana*) and alder (*Alnus tenuifolia*) (Figure 5) although scattered white birch (*Betula papyrifera*), trembling aspen

Figure 5. Tall willow-alder/ reed grass community.

Figure 6. Tall willow-river alder/red osier dogwood community.

(*Populus tremuloides*), and white spruce (*Picea glauca*) are typically present. The low shrub layer is sparse and typically comprised of red osier dogwood (*Cornus stolonifera*), other willow species, low bush cranberry (*Viburnum edule*) and seedlings of the above tree species. The herbaceous layer is sparse to moderately dense but nearly always includes a moderate cover of reedgrass (*Calamagrostis canadensis*). Other herbaceous species and mosses in the one plot studied are listed in Table 3.

A few corticolous lichens occur on the stems of the alders but cover is small. Tufted *Usnea* spp., *Parmelia sulcata, Evernia mesomorpha, Cetraria pinastre,* and *Alectoria glabra* were noted.

This community apparently corresponds to the willow-reed grass type described by Peterson and Levinsohn (1977), except that they identify the principal alder as being *Alnus crispa*.

4.4.2.2.2 Tall Willow-River Alder/Red Osier Dogwood Community. This community occurs on alluvial plains and terraces along rivers and major streams. These sites are apparently flooded periodically.

Similar to the previous community, the vegetation is dominated by tall willows (especially *Salix bebbiana*) and river alder (Figure 6). Some principal differences compared to the previous community are that balsam poplar (*Populus balsamifera*) and red osier dogwood (*Cornus stolonifera*) are more abundant, the low shrub layer is generally better developed and includes a greater number of species, and reedgrass is less abundant. Table 3 indicates compositional differences between two plots representing these two types.

4.4.2.3 Bottomland Balsam Poplar Forest. Bottomland balsam poplar forests occupy alluvial flats and terraces along rivers and major streams. According to Stringer (1976), the forest canopy is dominated by tall (>29 m) balsam poplar with occasional white spruce and trembling aspen.

Two stands of this type along the Athabasca River were visited. The vegetation of these stands did not differ substantially from one another or from the descriptions provided for the type by Stringer (1976). Consequently, only one community type is identified.

4.4.2.3.1 Balsam Poplar-White Spruce/Red Osier Dogwood Community. Composition of this community is adequately described by Stringer's (1976) description of bottomland balsam poplar forests. Based on our data from two stands, characteristic features of this community include a tall (26 m in one stand, and 41 m in the other) tree layer dominated by balsam poplar with scattered white spruce and occasional balsam fir (*Abies balsamea*). Red osier dogwood (*Cornus stolonifera*) appears to be consistently present and dominates a characteristic tall shrub stratum often 3 to 4 m tall (Figure 7). River alder is also present but less dense in this stratum. A medium dense low shrub stratum includes low bush cranberry (*Viburnum edule*), rose (*Rosa acicularis*), chokecherry (*Prunus virginiana*), raspberry (*Rubus strigosus*), and gooseberry (*Ribes* spp.). The herbaceous layer typically covers 25 to 50% of the soil surface and the moss layer is sparse. Composition of the two stands studied is indicated on Table 4.

The largest trees of the AOSERP study area probably occur within this community. Balsam poplar trees 26 m tall and 98 cm in diameter (dbh) and white spruce trees 42 m tall and 88 cm in diameter (dbh) were recorded in stands adjacent to the Athabasca River.

4.4.2.4 Bottomland White Spruce Forest. This physiognomic type is not included in Stringer's (1976) classification scheme but is found locally on alluvial flats along the Athabasca, Muskeg, and MacKay rivers. Most sites which potentially support this type, are currently vegetated by an earlier successional stage represented by Bottomland Balsam Poplar forests.

Only one community type of this physiognomic type was noted in the Fort MacKay area.

4.4.2.4.1 White Spruce/River Alder-Horsetail Community. This community is characterized by an intermittent tall shrub layer dominated by alder (*Alnus tenuifolia*), a sparse or nonexistent low shrub layer, and a herb layer with prominent horsetail (*Equisetum pratense, E. palustre,* and *E. scirpoides*) (Figure 8). Other herbaceous species are less dense but

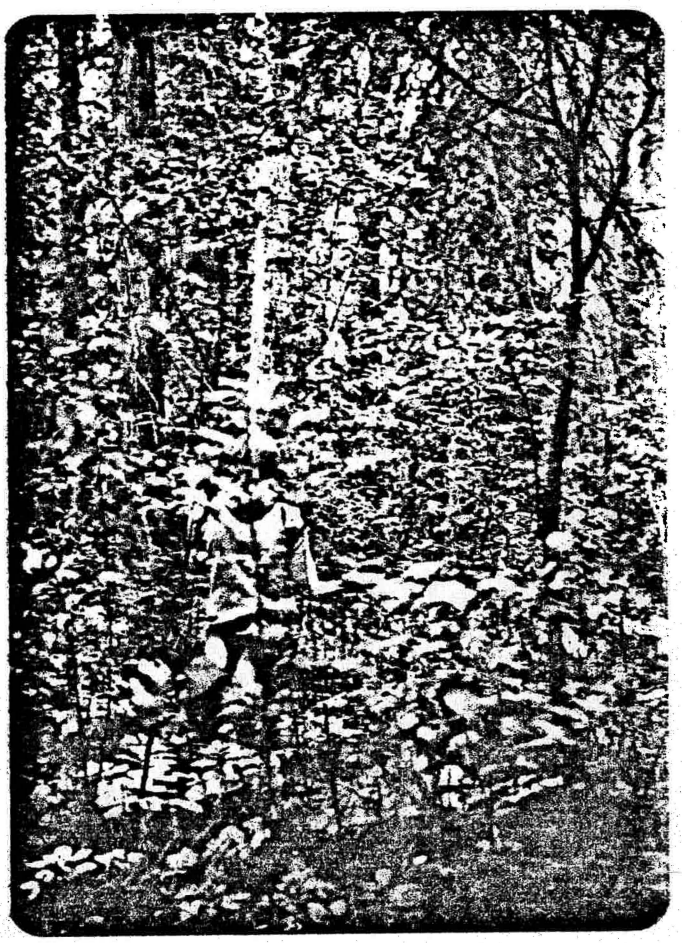


Figure 7. Bottomland balsam poplar forest (balsam poplar-white spruce/red osier dogwood community).

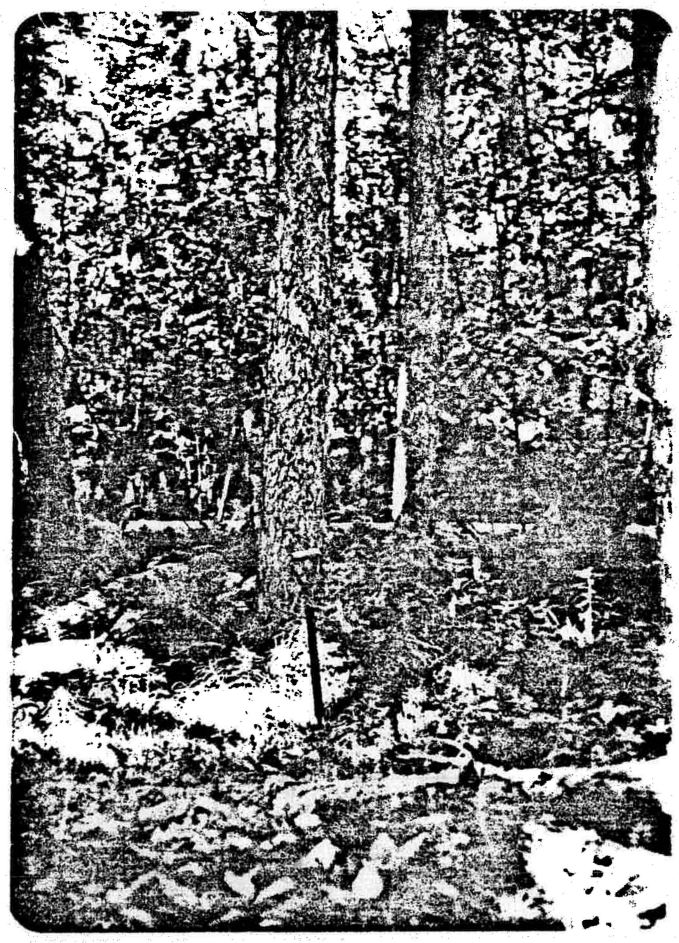


Figure 8. Bottomland white spruce forest (white spruce/river alder-horsetail community).

a discontinuous layer of feathermosses (especially *Hylocomium splendens*) covers much of the surface. The composition of the one stand studied is shown on Table 4.

This community appears to be rich in arboreal lichens with principal species being pendulose and tufted *Usnea* spp., *Evernia mesomorpha*, and *Parmelia sulcata*.

Soils of this community are moderately well to imperfectly drained and sandy.

A second community type of Bottomland White Spruce Forests is anticipated based on observations of earlier successional stages represented by Bottomland Balsam Poplar Forests. The undergrowth is probably characterized by a greater cover of shrubs, especially red osier dogwood, and herbs. It would be expected on well-drained sites, somewhat drier than those of the above community.

4.4.2.5 Upland White Spruce-Aspen Forest. Stringer (1976) includes all upland forests of trembling aspen, white spruce, or aspen-white spruce mixtures in this one type. For mapping purposes, Intera (Thompson et al. 1978) subdivides this type into deciduous, mixed, and coniferous but no undergrowth information is included. As well, some aspen-jack pine mixed forests are included in their map classification but are not described by Stringer (1976).

Based on our preliminary field survey, the Upland White Spruce-Aspen type is subdivided into seven community types. However, other vegetation literature from northern Alberta suggests that more extensive surveys would probably describe additional community types.

The seven communities are grouped into three physiognomic types:aspen dominated forests, white spruce-aspen mixed forests, and white spruce forests. These correspond to Intera's mapping units 2aA, 2aM, and 2aC.

4.4.2.5.1 Aspen Dominated Forests

4.4.2.5.1.1 Aspen-Jack Pine/Buffalo-Berry Community. This community type is common on well-drained sandy soils which are probably the driest

sites of Stringer's (1976) White Spruce-Aspen type. The tree layer is dominated by trembling aspen but nearly always includes scattered jack pine. Trees are generally 13 to 20 m tall and of relatively uniform size within a given stand. A tall shrub layer is absent but a low shrub layer dominated by buffalo-berry (*Shepherdia canadensis*) is prominent (Figure 9). This low shrub layer together with other dry site species characterizes the community. Other common low shrubs include rose (*Rosa acicularis*), Saskatoon berry (*Amelanchier alnifolia*) and blueberry (*Vaccinium myrtilloides*). The dwarf shrub/herbaceous layer is moderately dense and characterized by the dwarf shrubs, bearberry (*Arctostaphylos uva-ursi*) and bog cranberry (*Vaccinium vitis-idaea*), and by ryegrass (*Elymus innovatus*). In contrast to other communities of this type, ground dwelling lichens are common. The composition of two stands of this community is described in Appendix 8.1 (Table 5).

Although few arboreal lichens occur on aspen in this community, the scattered pine trees support several species, especially *Evernia mesmorpha, Hypogymnea physodes*, and *Cetraria* spp.

4.4.2.5.1.2 Aspen/Low Bush Cranberry Community. This is probably the most common community of aspen forests in the AOSERP study area. It forms extensive stands on well- to moderately well-drained glacial tills and aeolian sand deposits. The tree layer is often pure aspen but may include widely scattered white spruce indicating succession towards a white spruce dominated community. Scattered alder (*Alnus crispa*) and willow (*Salix* spp.) form only a very sparse tall shrub layer but low shrub species are moderately dense (20 to 50% cover) (Figure 10). Principal species of this layer are low bush cranberry (*Viburnum edule*) and rose (*Rosa acicularis*). A rich and relatively luxuriant assemblage of herbaceous species (Appendix 8.1, Table 5) forms a moderately dense layer. Dwarf shrubs, mosses, and lichens are poorly represented.

Arboreal lichens are poorly represented.

4.4.2.5.1.3 Aspen/Green Alder Community. Much less common than the previous aspen community, the aspen/green alder community occurs on more moist topographic positions such as lower slopes. It typically forms a

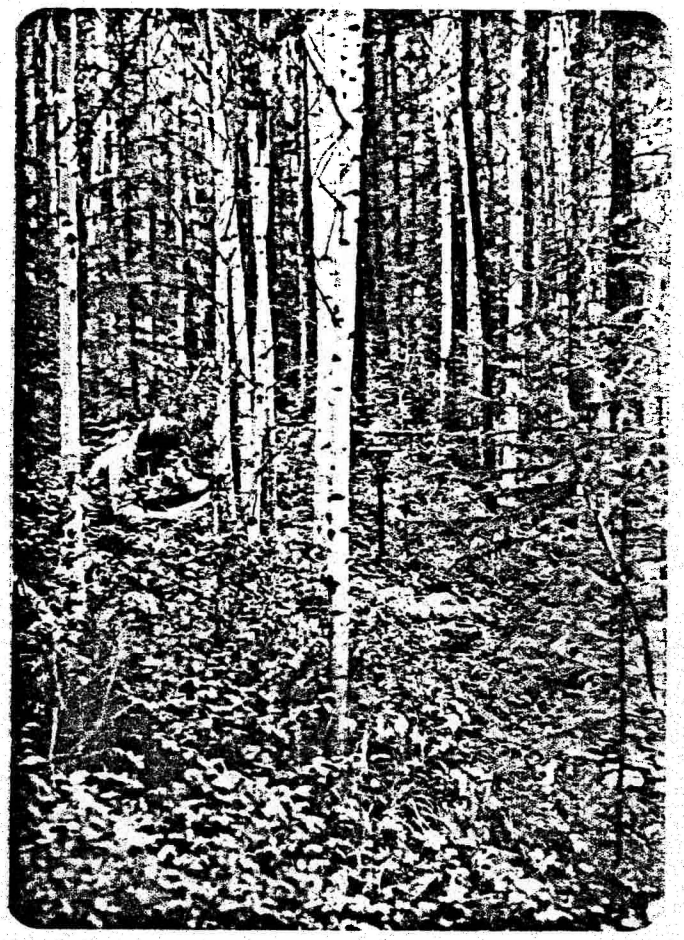


Figure 9. Aspen-jack pine/buffaloberry community.

Figure 10. Aspen/low bush cranberry community.

band between the previous community and either the Tall Willow-Alder type, fens, or bogs.

The distinguishing feature of this community is a moderately dense tall shrub layer dominated by green alder (*Alnus crispa*) (Figure 11) beneath the aspen canopy. In addition, low shrub cover and especially herbaceous plant cover is considerably reduced, probably due to decreased sunlight reaching the forest floor.

Arboreal lichens are poorly represented.

4.4.2.5.2 White Spruce-Aspen Mixed Forests

4.4.2.5.2.1 Aspen-White Spruce/Buffalo-Berry Community. This community occurs on relatively dry upper slopes with silty loam or loam soils. Due to the finer textured soils, these sites are somewhat more moist than those of the similar aspen-jack pine/buffalo berry community.

Aspen and white spruce in various proportions dominate the tree layer. Tall shrubs are virtually absent but a low shrub layer dominated by buffalo-berry is conspicuous (Figure 12). A variety of other shrub and herbaceous species are present (Appendix 8.1, Table 6) and mosses are more abundant than in the aspen-jack pine/buffalo-berry community. Arboreal lichens are well represented on the white spruce but not the aspen.

4.4.2.5.2.2 White Spruce-Aspen/Low Bush Cranberry Community. This community apparently represents a successional stage developed from the aspen/low bush cranberry community. The undergrowth is similar to that of the earlier stage but reflects the influence of increased white spruce in the canopy. In particular, the cover and luxuriance of the low shrub and herbaceous layers is reduced while the cover of feather-mosses is somewhat increased (Appendix 8.1, Table 6). However, low shrubs and herbaceous plants still dominate the undergrowth with a cover much greater than that of mosses (Figure 13).

4.4.2.5.2.3 White Spruce-Aspen/Low Bush Cranberry-Feathermoss. This community represents a still later successional stage developed from the aspen/low bush cranberry community. White spruce dominates the canopy although remnant aspen are also well represented. Low shrubs and

Figure 11. Aspen/green alder community.

Figure 12. Aspen-white spruce/buffalo-berry community.

Figure 13. White spruce-aspen/low bush cranberry community.

Figure 14. White spruce-aspen/ low bush cranberry-feathermoss community.

herbaceous species dominate the aspect of the undergrowth (Figure 14) but the cover of feathermosses (especially *Pleurozium schreberi* and *Hylocomium splendens*) is substantially increased compared to earlier stages (Appendix 8.1, Table 6).

4.4.2.5.3 Upland White Spruce Forests

4.4.2.5.3.1 White Spruce/Feathermoss Community. This community appears to be the climax forest on well- to moderately well-drained soils in the study area. Distinguishing features are the white spruce dominated tree layer with only scattered aspen, birch, or black spruce (*Picea mariana*) and the nearly continuous feathermoss layer (Figure 15) dominated by *Pleurozium schreberi* and *Hylocomium splendens*. Tall shrubs are virtually absent but a relatively sparse low shrub layer of Labrador tea (*Ledum groenlandicum*), low bush cranberry, red osier dogwood, and rose is characteristic. A variety of low herbaceous plants are rooted in the moss layer (Appendix 8.1, Table 7).

Arboreal corticolous lichens are well represented on spruce boles in this community.

4.4.2.6 Upland Jack Pine Forest. According to Stringer (1976), this physiognomic type includes jack pine forests on dry, well-drained aeolian sand deposits. He concludes that the undergrowth composition is very distinctive and uniform.

Based on our survey, we have identified two provisional community types within jack pine forests. The first corresponds closely to Stringer's description.

4.4.2.6.1 Jack Pine/Lichen Community. The jack pine/lichen community occurs on sites that are apparently the driest and most nutrient poor of the AOSERP area. It is typically found on upper slopes and knolls of aeolian sand deposits which are rapidly drained. The aeolian deposits are often thin and bedrock may be contacted within 60 cm.

The trees are relatively open grown and almost entirely jack pine although widely scattered white spruce may be present. No tall

Figure 15. White spruce/ feathermoss community.

Figure 16. Jack pine/lichen community.

shrubs are present. The prominent low shrub layer is predominantly blueberry (*Vaccinium myrtilloides*) less than 50 cm tall (Figure 16). The dwarf shrub/herbaceous layer beneath these shrubs is very sparse but terrestrial lichens (especially *Cladina mitis*) form a conspicuous and often nearly continuous ground cover.

4.4.2.6.2 Jack Pine/Buffalo Berry Community. Most jack pine forests on medium and fine textured soils are included within this community type. Surface soil textures in the two plots studied are silt loam and silty clay loam, although one plot has a thin (10 cm) aeolian sand veneer over the finer textured soils.

This community differs considerably from the previous (Table 8). The tree layer, which is predominantly jack pine but may include scattered aspen and white spruce, is typically closed. In addition, a prominent low shrub layer is dominated by buffalo-berry (*Shepherdia canadensis*) and a much richer and more dense dwarf shrub/herbaceous layer is present (Figure 17). Although terrestrial lichens are commonly present, they cover only a small percentage of the ground surface (Appendix 8.1, Table 8).

A rich arboreal lichen flora is present on the pine trees of the community .

4.4.2.7 Upland Mixedwood and Coniferous Forest. Stringer (1976) states that this type includes " a heterogeneous group of mixedwood and coniferous forest stands on upland, sandy sites". Jack pine, black spruce, and white birch are principal tree species.

In the Fort MacKay area, this physiognomic type is represented primarily by jack pine-black spruce forests. Only one community type was noted.

4.4.2.7.1 Jack Pine-Black Spruce/Labrador Tea Community. The composition of this community is adequately documented by Stringer's (1976) description of this physiognomic type. Characteristic features are a jack pine-black spruce dominated tree layer which frequently consists of widely spaced trees, a prominent low shrub layer consisting almost entirely of

Figure 17. Jack pine/buffalo-berry community.

Figure 18. Jack pine-black spruce/ labrador tea community.

Labrador tea (*Ledum groenlandicum*) and blueberry (*Vaccinium myrtilloides*), and an extensive cover of lichens (especially *Cladina mitis*) (Figure 18). Feathermosses are locally important. The composition of two plots is presented in Table 9, Appendix 8.1.

Soils of this community are moderately well to imperfectly drained sands and loamy sands which are more moist and probably colder than those of the somewhat similar pine/lichen community.

4.4.2.8 Upland Black Spruce Forest.

4.4.2.8.1 Black Spruce/Feathermoss Community. The placement of this community type within Stringer's (1976) classification is problematical since it does not appear to fit well within any of his physiognomic types. Based on his photograph of stand 18, Stringer (1976:103) apparently included this community within his upland white spruce and aspen forest type but based on our survey it is quite distinct from other communities of this type. On Intera's maps, areas of this community are classified as upland white spruce-aspen forest, conifer type (2aC). Peterson and Levinson (1977) also identify a black spruce/feathermoss type and conclude that it corresponds to Stringer's black spruce bog forest. However, since it does not seem to fit well here either, we have elected, for purposes of this provisional classification, to maintain it as a distinctive type.

The black spruce/feathermoss community is characterized by a dense tree layer dominated by black spruce (Typically 18 to 25 m tall and 10 to 30 cm dbh) and scattered white spruce with an undergrowth formed by a continuous cover of feathermosses (*Pleurozium schreberi* and *Hylocomium splendens*) (Figure 19). Relatively little other vegetation is present with the exception of scattered low shrubs, horsetails (*Equisetum* spp.), and graminoids (Appendix 8.1, Table 10).

The soil of the plot studied is a silty clay, peaty Rego Gleysol developed apparently in lacustrine deposits with a watertable 35 cm below the surface (in late August).

4.4.2.9 Black Spruce Bog Forest. Stringer's (1976) black spruce bog forest includes black spruce stands on organic soils composed of sphagnum

Figure 19. Black spruce/feathermoss community.

Figure 20. Black spruce/ labrador tea- sphagnum community.

peat usually in excess of 1 m deep. The tree layer which varies from "sparse to medium dense" is formed of trees which are of small diameter (seldom over 10 cm dbh) and short (mostly less than 10 m).

Two provisional community types were distinguished during our brief survey. The first corresponds most closely to Stringer's (1976) description.

4.4.2.9.1 Black Spruce/Labrador Tea-Sphagnum Community. This community is extensive on deep organic deposits in very poorly drained depressions and flats. It is characterized by a relatively open and often multi-storied tree layer composed mostly of stems less than 15 m tall and 20 cm dbh. A few scattered tamarack (*Larix Laricina*) and occasionally white birch (*Betula papyrifera)* trees may be scattered among the dominant black spruce. The tall shrub layer is composed of black spruce saplings. Other tall shrubs are absent or incidental. A moderately dense low shrub layer, dominated by Labrador tea (*Ledum groenlandicum*) is a distinguishing feature of the community (Figure 20). These shrubs cover 20 to 60 percent of the surface and are about 40 to 75 cm tall. They are rooted in a thick and nearly continuous mat of mosses and lichens. Principal mosses are *Sphagnum* spp. A sparse cover of dwarf shrubs and herbaceous plants include characteristic bog species (Appendix 8.1, Table 11).

Soils are organic, or less often peaty Gleysols. Frozen peat was encountered in one plot at 37 cm below the surface.

Arboreal lichens are abundant on black spruce branches in this community.

4.4.2.9.2 Black Spruce/Willow-Moss Community. This community differs from the previous primarily in the composition of the shrub and moss layers. The low shrub layer is generally more sparse than in the previous type and is dominated by willows (especially *Salix macalliana, S. pedicellaris* and *S. myrtillifolia*) and birches (*Betula pumila* and *B. glandulosa*). Labrador tea is consistently present but less dense. The moss layer is nearly continuous and dominated by *Tomethyprum nitens* with only scattered sphagnum mosses. In addition, herbaceous cover is

generally greater (Appendix 8.1, Table 11) and organic accumulations are thinner. The tree layer is similar. This community may represent a successional stage to the previous community following fire.

4.4.2.10 Semi-Open Black Spruce-Tamarack Bog Forest. Dense mature bog forest grades continuously into open bog vegetation as sites become wetter. Many intermediates between bog forest and open bog are present and included within this type. According to Stringer (1976), this type is very similar to black spruce bog forests but includes a higher proportion of open bog and more frequent tamarack.

Two provisional communities are included within this type and are similar to the two communities of the black spruce bog forest.

4.4.2.10.1 Black Spruce-Tamarack/Labrador Tea-Sphagnum Community. This muskeg community is similar to the black spruce/Labrador tea-sphagnum community with the exception of its less dense tree layer and greater proportion of tamarack.

4.4.2.10.2 Black Spruce-Tamarack/Willow-Moss Community. This community is similar to the black spruce/willow-moss community with the exception of a less dense tree layer and greater proportion of tamarack.

4.4.2.11 Shrub Bog. This type is not described by Stringer (1976) but includes relatively large bog areas which have been recently burned in the vicinity of the lower MacKay River. It is apparently a successional stage in the return of black spruce bog forest (black spruce/willow-moss community) following fire. Although it is dominated by a dense cover of shrubs, abundant black spruce reproduction indicates succession towards bog forest. It is superficially similar to low shrub fen but is distinguished from fen by the predominance of bog mosses (*Tomethypnum nitens* and *Sphagnum* spp.) rather than fen mosses (*Drepanocladus* spp.). However, due to the highly disturbed character of this type, some fen characteristics are expressed. For example, reed grass (*Calamagrostis canadensis*) and sedges (*Carex* spp.) and occassionally fen mosses (*Drepanocladus* spp.) are present. This has been termed a bog type based on

interpretations regarding successional trends but additional data on composition and successional trends are required to better define this type. It is proposed only as a very provisional type. One community is distinguished.

4.4.2.11.1 Willow-Dwarf Birch-Bog Moss Community. This community is dominated by a moderately dense low shrub stratum approximately 1 to 3 m tall (Figure 21). Principal shrubs are willows (especially *Salix maccalliana* and *S. pedicellaris*) although swamp birch (*Betula pumila*) and lesser dwarf birch (*B. glandulosa*) are commonly present. A variable and discontinuous herbaceous layer often includes reedgrass, sedges (*Carex aquatilis, C. lasiocarpa, C. diandra*), and coltsfoot (*Petasites palmatus*). Moss cover is relatively well-developed and dominated by *Tomenthypnum nitens* with scattered *Sphagnum* spp. and *Aulacomnium palustre* (Appendix 8.1, Table 12). Seedlings of black spruce, tamarack and occasional white spruce are numerous.

Soils are organic. However, peat depths appear to be thinner than in the bog forest, possibly due to the effects of recent fire. Additional data on soils of this community are needed.

4.4.2.12 Lightly Forested Tamarack and Open Muskeg. Stringer (1976) states that stands in this type are generally open muskeg (i.e., non-treed bog) but may have a few scattered tamarack trees present. A shrub stratum is prominent.

This type differs from the provisional shrub bog type described previously by its greater cover of sphagnum mosses and other characteristic bog species such as small bog cranberry (*Oxycoccus microcarpus*), leather leaf (*Chamaedaphne calyculata*), and *Carex chordorrhiza*. One community is tentatively described.

4.4.2.12.1 Sphagnum Moss-Bog Birch Community. Ground cover in this community is dominated by *Sphagnum* mosses (Appendix 8.1, Table 13). A prominent but open cover of low shrubs (Figure 22) includes dwarf birch (*Betula glandulosa*), willow (*Salix pedicellaris* and *S. maccalliana*),

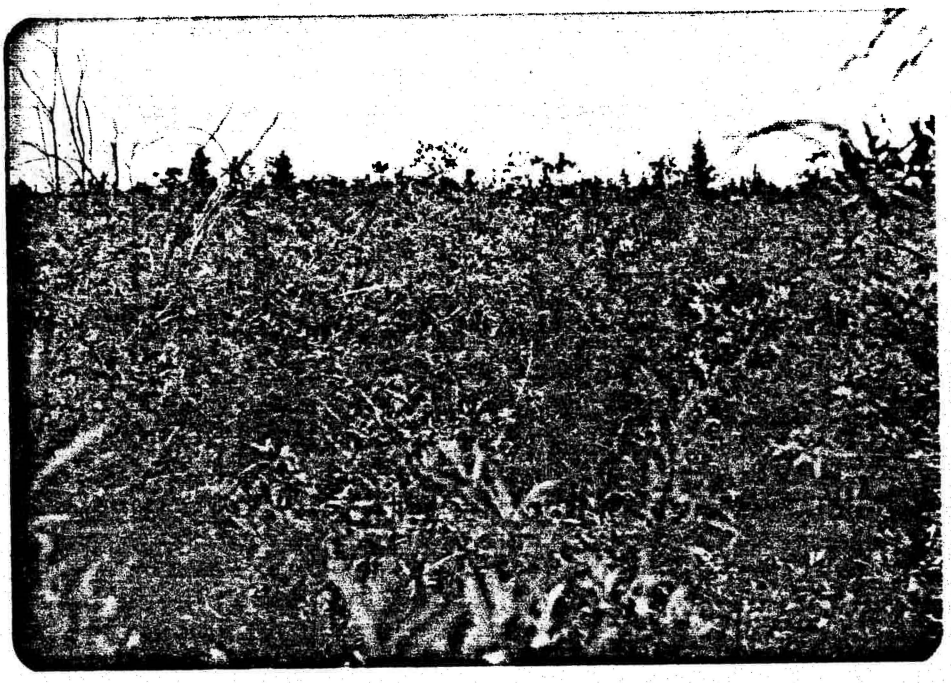


Figure 21. Willow-dwarf birch-bog moss community southwest of Fort MacKay.

Figure 22. Sphagnum moss-bog birch community near Muskeg River.

leather leaf, and Labrador tea. The dwarf shrub/herbaceous layer generally covers 10 to 50% of the surface and is predominantly sedges.

4.4.3 Preliminary Recommendations for Enhancing Vegetation Maps

The following recommendations were proposed for purposes of discussion at the AOSERP detailed vegetation workshop.

4.4.3.1 Completeness of the Mapping Classification. Examples of physiognomic types which occur within the Fort MacKay area but are not described by Stringer (1976) are presented in Section 4.4.2. Additional field survey may result in a modification of these types and the description of additional types. Consequently, a more extensively field survey program is recommended to more adequately document major physiognomic types of the AOSERP area. In general, new physiognomic types should be discernible on 1:60 000 false color infrared photography although some types such as shrub fen and shrub bog may require ground survey for final identification.

4.4.3.2 Vegetation Composition Detail. By coding the vegetation community classification outlined in Section 4.4.2, greater vegetation composition detail could be added to the maps. Each community type could be given a distinctive code as, for example:

Bottomland and Riparian Forest (1a)

Balsam Poplar-White Spruce/Red Osier Dogwood Community:	$\frac{1a}{1}$
White Spruce/River Alder-Horsetail Community:	$\frac{1a}{2}$

Deciduous Shrub (1b)

Tall Willow-Alder/Reed Grass Community:	$\frac{1b}{1}$
Tall Willow-River Alder/Red Osier Dogwood Community:	$\frac{1b}{2}$
Low Shrub Fen:	$\frac{1b}{3}$

Tall Shrub Fen: 1b/4

Willow Dwarf Birch-Bog Moss Community (Shrub Bog): 1b/5

Upland White Spruce-Aspen Forest (2a)

Aspen (2aA)

Aspen-Jack Pine/Buffalo Berry Community: 2aA/1

Aspen/Low Bush Cranberry Community: 2aA/2

Aspen/Green Alder Community: 2aA/3

Mixed (2aM)

Aspen-White Spruce/Buffalo Berry Community: 2aM/1

White Spruce-Aspen/Low Bush Cranberry Community: 2aM/2

White Spruce-Aspen/Low Bush Cranberry Feathermoss Community: 2aM/3

Coniferous (2aC)

White Spruce/Feathermoss Community: 2aC/1

Mixed Coniferous (2b)

Jack Pine-Black Spruce/Labrador Tea Community: 2b/1

Jack Pine (2c)

Jack Pine/Lichen Community: 2c/1

Jack Pine/Buffalo Berry Community: 2c/2

Upland Open (2d)

(A classification would be developed)

Fen Communities (3a)

Open Fen: 3a/1

(Low Shrub Fen and Tall Shrub Fen included in 1b)

Upland Black Spruce Forest (no current designation)

Black Spruce/Feathermoss Community: $\frac{?}{1}$

Black Spruce Bog Forest (3b)

Black Spruce/Labrador Tea-Sphagnum Community: $\frac{3b}{1}$

Black Spruce/Willow-Moss Community: $\frac{3b}{2}$

Semi-Open Black Spruce-Tamarack Bog Forest (3c)

Black Spruce-Tamarack/Labrador Tea-Sphagnum Community: $\frac{3c}{1}$

Black Spruce-Tamarack/Willow Moss Community: $\frac{3c}{2}$

Lightly Forested Tamarack and Open Muskeg (3d)

Sphagnum Moss-Bog Birch Community: $\frac{3d}{1}$

This code system could be expanded as additional types are documented or these types are altered. Minor variants of the community types could be indicated by subscripting the community type designation ($\frac{2aA}{1a}$, $\frac{2aA}{1b}$, etc.).

The detailed community type code could be added to the maps by modifying the existing annotations. An example is $\frac{2aA2b}{2}$ which can be interpreted to mean aspen forests of height class 2 and crown cover class b with lesser vegetation of the Low Bush Cranberry Community.

Many of the largest map areas include two or more lesser vegetation types within a single mapping type. These could be indicated by a complex code such as $\frac{2aA2b}{2.1(3)}$ which would be interpreted as aspen forest with lesser vegetation primarily of the Low Bush Cranberry Community, with a smaller area of the Buffalo Berry Community and minor inclusions of the Green Alder Community.

An alternative to modifying the annotations on the map is to develop a footnote system. Each area outlined on a map sheet would be given a number which would also appear in a tabular footnoting system at the bottom of the map sheet. The principal, secondary and minor types within the area could be listed together with any special notes on the vegetation. Mapped areas with the same vegetation would be given the same footnote number. The tabulated footnotes could be organized according to township in which the mapped areas occur and their predominant vegetation.

A possible example of a tabulated footnote system may read:

Number	Principal Type	Secondary Type	Minor Type	Notes
T94 R10				
1	2aA2b/1	2c2b/2	3a/1	
2	2aA2b/1	2b2b/1	3c1a/1	
3	2aA2b/1	2b2b/1	3b2b/2	

In map areas where two or more lesser vegetation community types are present, the extent of the types could be outlined by more detailed mapping. Based on experience in the Muskeg River area it is expected that this more detailed mapping could be accomplished with only minimal field checks once the relationships between the community types and their associated site features are understood. Site features (topography, suface material, type and texture, drainage) observable on aerial photographs orn

The more detailed mapping approach is recommended only for areas of special interest such as proposed development sites. In other areas, the benefits would probably not justify the costs of the very large air photo interpretation and remapping project which would be required.

5. DETAILED VEGETATION WORKSHOP

5.1 OBJECTIVES AND APPROACH

Recognizing that any modification of the existing maps or further vegetation studies in the AOSERP study area should be based on needs of potential users, a detailed vegetation study workshop was held on 26 November 1979. The objectives of this workshop were to:

1. Identify user needs with regard to vegetation maps and descriptions;
2. Determine the adequacy of the pilot study as a step towards meeting these needs; and
3. Determine the most applicable methodology for a future project to meet user needs.

During the first portion of the workshop, Hardy Associates presented an evaluation of the maps, the results of the pilot study, and recommendations for possible methods to enhance the maps. The discussion followed the following sequence of topics: 1) needs for vegetation descriptions and maps (with input from other workshop participants); 2) evaluation of information which is available in the form of descriptions and maps; 3) adequacy of the available information for meeting needs; and 4) description of pilot study results and a discussion of possible methods to enhance available maps to better meet user needs.

The latter portion of the workshop was devoted to group and open discussions regarding user needs and to recommendations resulting from the pilot study.

5.2 PARTICIPANTS

Forty persons were invited to attend the workshop. These persons represented:

Alberta Environment
Alberta Forest Service
Alberta Recreation and Parks
Alberta Public Lands and Wildlife
Alberta Research Council
Alsands Project Group

Amoco Canada Petroleum Co. Ltd.

AOSERP

Canadian Forestry Service

Canadian Wildlife Service

Esso Minerals

Esso Resources

Gulf Canada Resources Ltd.

Hardy Associates (1978) Ltd.

Home Oil Co. Ltd.

Intera Environmental Consultants Ltd.

LGL Ltd.

Northeast Alberta Regional Commission

Petro-Canada

Suncor Ltd.

Syncrude Canada Ltd.

University of Alberta, Botany Dept.

University of Calgary, Kananaskis Centre and Faculty of Environmental Design

Western Ecological Services Ltd.

The following persons attented the workshop:

S.B. Smith	- AOSERP
B.A. Khan	- AOSERP
B. Munson	- AOSERP
H. Johnston	- AOSERP
S. Grant	- AOSERP
L. Turchenek	- Alberta Research Council
P. Sims	- Alberta Environment
C. Bricker	- Alberta Environment
C. Bradley	- Alberta Recreation and Parks
W. Nordstrom	- Alberta Recreation and Parks
A.A. Khan	- Canadian Forestry Service
S.S. Malhotra	- Canadian Forestry Service
G. La Roi	- University of Alberta
P. Van Eck	- University of Calgary (Kananaskis Centre)
L. Callow	- Gulf Canada Resources
R. Fessenden	- Syncrude Canada Ltd.
D. Thompson	- Syncrude Canada Ltd.

A. Birdsall	-	LGL Ltd.
J. Green	-	LGL Ltd.
D. Thompson	-	Intera Environmental Consultants Ltd.
O. Steen	-	Hardy Associates (1978) Ltd.
D. Reid	-	Hardy Associates (1978) Ltd.

5.3 RESULTS AND RECOMMENDATIONS

In general, most of the participants expressed the opinion that the maps in connection with Stringer's (1976) descriptions are useful in their present form as an initial, generalized description of vegetation in the AOSERP study area. That is, the maps provide a generalized framework within which more detailed studies, which require on-site investigations can be organized. It was concluded that neither more detailed mapping nor inclusion of minor vegetation symbols on the maps can be justified at this date.

5.3.1 Uses of Existing Maps

The maps provide useful overview information for a variety of user studies including:

1. Ungulate Habitat Analyses. The distribution of major physiognomic vegetation types shown on the maps allows an initial, broad scale evaluation of ungulate habitat within a given area. The outline of bottomland and riparian vegetation is particularly useful.
2. Furbearer Habitat Analyses. The outline of major physiognomic types allows a preliminary, broad scale assessment of habitat and provides a basis for locating detailed study plots. Detailed studies require on-site analyses of vegetation and data appropriate to the needs of the particular study.
3. Avifauna Habitat Analysis. The maps show the distribution of waterbodies and the occurrence of generalized wetland vegetation. The new edition of the maps provide more detailed information on aquatic vegetation.

4. Forest Insect and Disease Survey. Since the maps show the distribution of major forest cover types, they are useful for locating plots to represent specific forest types for insect and disease survey.
5. Oil Sand Mining Development. The maps indicate the major physiognomic types which would be disturbed by industrial development. This provides a basis for an initial assessment of environmental impacts and framework for more detailed studies.
6. Recreation and Park Planning. The vegetation maps are useful in a general overview of a region to evaluate potential areas of interest for parks and recreation areas. The distinction between wetland and upland types is useful in this regard.
7. Biomonitoring The maps can be used to indicate potentially valuable biomonitoring sites such as forested areas which likely have an abundance of arboreal lichens or wetland areas which may be affected by industrial development.

5.3.2 Requests for More Detailed Information

For more detailed studies, most users present at the workshop require more detailed information than is avilable from the maps. Examples of more detailed requests expressed by participants are:

1. Recreation and Parks. A greater differentiation of wetland types is needed for purposes of preservation and interpretation of wetlands and for assessment of impacts resulting from potential changes in groundwater levels due to industrial developments.

   For siting campgrounds, more detail on minor vegetation is needed.

   Information regarding unusual plant communities or species would be useful in assessing impacts and devising preservation programs. These could be documented only by ground surveys but could be indicated on the maps.

2. Wildlife Habitat. The proportion of upland and wetland vegetation components within complex map units is important to ungulate habitat evaluation. A means to better indicate this proportion on the maps would be useful.

   Riparian areas are especially important habitat for ungulates and as a result more detailed descriptions and classifications of vegetation in these areas would be useful.

   For small mammal studies and habitat evaluations, detailed site specific information on vegetation composition is needed. This information has been collected by wildlife biologists on a project basis. A more detailed classification of vegetation communities than that presented by Stringer (1976) would be useful as a framework within which the results of various wildlife studies could be inter-related. Such a classification would also provide a basis for consistency among various studies.

3. Avifauna Habitat. More detailed information on the structure and species composition of wetland vegetation is needed for purposes of avifauna habitat analyses. Vegetation types of interest include aquatic and semiterrestrial types of shallow water areas, shorelines and streamsides. Although the required level of detail is too small to be mapped at 1:50 000, a more detailed classification would encourage greater consistency among various studies.

4. Biomonitoring. Selected biomonitoring areas could be rephotographed and remapped periodically to detect and measure certain man-caused changes in the vegetation cover. Although there was not universal agreement, most participants who expressed an opinion felt that this approach would be useful and that biomonitoring areas should be reflown every five to ten years. Biomonitoring areas would be in the vicinity of existing or proposed developments. Wetland areas potentially affected by altered watertables would be of principal interest.

5.3.3 Recommendations For Additional Study. Recommendations which emerged from the workshop for additional vegetation study programs are the following:

1. Classification and Description of Physiognomic Vegetation Types. Ground survey data should be collected from mapping units included in Intera's map legend or encountered in Hardy's pilot study but not described separately by Stringer (1976). These units include for example, the upland undifferentiated category (largely openings in aspen forests), upland shrub communities, bottomland white spruce forests, and the three white spruce-aspen forest types. Bringing the level of description of these units up to par with those of other units would complete the background descriptions for the map.
2. Ground Checking and Editing of Maps. The vegetation maps should be adequately ground checked especially in areas of proposed development. Ground checking would be based on the vegetation units included in Intera's legend but may include other major physiognomic types as encountered. At the same time, the maps should be carefully edited to eliminate editorial types of problems.
3. Rephotographing and Remapping at Intervals for Recording Vegetation Changes. Local areas should be rephotographed and remapped at intervals of five to ten years to record possible major changes in the vegetation caused by industrial activity. These local areas would be key areas in the vicinity of industrial developments and should be coordinated with other biomonitoring programs.
4. Detailed Vegetation Community Studies. Three participants recommended that a more detailed classification of plant communities, based on total species composition, be developed and described. This classification would not be mapped but would provide a framework for consistency and correlation among various user studies. It could also serve as a basis for anyone wishing to do detailed, large-scale mapping of local areas. Wildlife biologists

from LGL and Syncrude felt that the detailed types could be combined variously according to needs of their study into groups meaningful for wildlife habitat evaluations. Botanists developing the classification should work with wildlife biologists in establishing criteria for the classification.

5. Comprehensive Wetlands Classification. Recreation and Parks personnel reqested that a comprehensive classification and description of wetlands in the AOSERP study area be developed. It was felt that an adequately detailed classification of wetlands could be mapped at a scale of 1:50 000.

6. Site Mapping. One participant suggested that site mapping, rather than vegetation mapping, be carried out in the AOSERP study area. Site mapping would be based on surficial geology, soils, drainage, topography, etc. and would allow prediction of climax vegetation and other ecosystem characteristics not necessarily contained on a vegetation map.

7. Vegetation Dynamics. It was suggested that additional data on community dynamics be collected in order that natural succession following industrial disturbance could be better predicted, especially in wetland areas.

6. SUMMARY AND CONCLUSIONS

Vegetation maps of the AOSERP Study Area have been prepared at a scale of 1:50 000 by Intera Environmental Consultants Ltd. Although these maps provide a generalized overview of the vegetation and a framework for more detailed studies, the level of detail offered by the maps has not been sufficient for some map users.

This study was initiated to review the available vegetation maps and literature of the AOSERP area and to provide recommendations for means to enhance the vegetation detail on Intera's maps.

The mapping classification developed by Intera (Thompson et al. 1978) relies heavily on the preliminary vegetation classification presented by Stringer (1976) for descriptions of vegetation composition. The maps themselves present no information on vegetation composition other than for trees in forested areas and physiognomy in non-forested areas. Consequently, special attention has been given to Stringer's (1976) classification.

Stringer's (1976) vegetation classification describes principal physiognomic types at a level appropriate for overview mapping and description. However, the types contain considerable variability in species composition, especially of the lesser vegetation. In addition, some physiognomic types of the AOSERP study area, such as bottomland white spruce forests and shrub dominated seral stages of bog forests, are not included in Stringer's classification. Intera's maps include other physiognomic types, such as openings in aspen forests, which are not described by Stringer. As a result, the composition of the vegetation, other than trees at a specific site can seldom be determined from the maps. As intended, the maps are useful for a generalized overview of vegetation but have severe limitations if they are to be used for site specific evaluations.

In order to examine possible methods for adding additional detail to Intera's maps, a brief pilot study was conducted in the area of the lower Muskeg and MacKay rivers. Based on variation in lesser vegetation, 18 subdivisions (community types) of Stringer's types were described. In addition, three communities, representing types not documented by Stringer (1976) were described.

It is proposed that a code be developed for each of these and other additional community types that are described and that this code be added to the maps. This code could provisionally be added from interpretations of 1:60 000 scale FCIR airphotos and available surficial geology and soils maps but would require a field checking program.

The results and recommendations of the pilot study were discussed at a vegetation workshop on 26 November 1979. The general conclusion of the workshop was that the maps are useful in their present form and that a program to add more detailed information cannot be justified at this time. However, several recommendations for other vegetation study programs emerged from the workshop. These are discussed in the report.

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8. APPENDIX

8.1 PERCENT COVER OF SPECIES IN PROVISIONAL DETAILED PLANT COMMUNITIES OF STUDY AREA

The following 12 tables list the percent cover of plant species in the 21 community types described in Section 4.4.2. Each table presents data from a physiognomic type. The species are organized according to vegetation strata and thus, a species may appear more than once. Stand numbers are indicated in parentheses at the top of each table.

Table 5. Percent cover of species in fen community types.

	TYPE		
	Open Fen	Low Shrub Fen	
Species	(22)[a]	(8)	(19)
Low Shrub			
Betula pumila	6	40	50
B. glandulosa		2	
Salix maccalliana	4	20	2
Salix pedicellaris	2		8
Picea glauca		5	
Larix laricina	2	2	15
Salix myrtillifolia		1	
Dwarf Shrub/Herbaceous			
Arctostaphylos rubra		2	
Carex diandra	80		25
Carex aquatilis	5	25	40
Smilacina trifolia	10	1	5
Triglochin maritima	6		
Calamagrostis canadensis	4	2	
Galium trifidum	4		2
Potentilla palustris	2	1	3
Menyanthes trifoliata			2
Caltha palustris			2
Petasites sagitattus		2	
Mosses			
Drepanocladus spp.	65		5
Campylium stellatum	10		5
Aulacomnium palustre		14	
Tomenthypnum nitens		10	25
Hylocomium splendens		4	
Hypnum lindbergii			15

[a] (22) Stand number.

Table 6. Percent cover of species in tall willow-alder community types.

	TYPE	
	Tall Willow-Alder/ Reedgrass	Tall Willow-River Alder/Red Osier Dogwood
Species	(5)	(18)
Tree and Tall Shrub		
Alnus tenuifolia	60	30
Salix bebbiana	3	60
Betula papyrifera	8	
Populus balsamifera		3
Populus tremuloides		1
Low Shrub		
Picea glauca	1	10
Betula papyrifera	1	1
Cornus stolonifera	2	5
Viburnum edule	1	8
Salix maccalliana	8	
Ribes hirtellum		4
R. lacustre		1
Lonicera dioica		1
Rosa acicularis		1
Dwarf Shrub/Herbaceous		
Calamagrostis canadensis	20	
Impatiens capensis	15	
Sium suave	4	
Galium trifidum	5	1
Mitella nuda	2	10
Carex disperma	5	
Agrostis alba	3	
Carex aquatilis	4	
Aster foliaceus	5	1
Rubus acaulis	1	
Smilacina trifolia	1	
Rubus pubescens	1	5
Cornus canadensis		3
Linnaea borealis		10
Fragaria vesca		2
Equisetum scirpoides		3
Elymus innovatus		2
Equisetum palustre		2
Mertensia paniculata		2

Continued....

Table 6. Concluded.

	TYPE	
	Tall Willow-Alder/ Reedgrass	Tall Willow-River Alder/Red Osier Dogwood
	(5)	(18)
Mosses		
Plagiomnium spp.	8	3
Mnium spinulosum	10	
Aulacomnium palustre	20	
Hylocomium splendens		8
Tomenthypnum nitens		2

Table 7. Percent cover of species in upland white spruce/feathermoss community.

	TYPE		
	Jack Pine/ Lichen	Jack Pine/ Buffalo-Berry	
Species	(16)	(14)	(36)
Trees			
Pinus banksiana	25	65	70
Picea glauca			1
Populus tremuloides		2	P
Tall Shrubs			
Pinus banksiana		1	
Populus tremuloides		1	
Larix laricina		1	
Picea glauca			5
Low Shrubs			
Picea glauca	1	5	1
Populus tremuloides			1
Vaccinium myrtilloides	40	4	
Shepherdia canadensis		15	15
Rosa acicularis		8	5
Symphoricarpus albas		1	5
Viburnum edule		3	2
Ledum groenlandicum		4	
Potentilla fruticosa		1	3
Lonicera dioica		P	2
Cornus stolonifera		P	1
Dwarf Shrub/Herbaceous			
Arctostaphylos uva-ursi		40	70
Vaccinium vitis-idaea	10	15	3
Cornus canadensis	3	20	5
Oryzopsis pungens	1	8	5
Linnaea borealis		8	8
Epilobium angustifolium		3	
Elymus innovatus		5	3
Galium boreale		1	2
Rubus pubescens		1	2
Campanula rotundifolia			1
Fragaria vesca			1
Anemone multifida			1
Maianthemum canadensis			1
Lathyrus ochroleucus			1

Continued....

Table 7. Concluded.

	TYPE		
	Jack Pine/ Lichen	Jack Pine/ Buffalo - Berry	
Achillea millefolium			1
Aster ciliolatus			1
Viola rugulosa			1
Mosses - Lichens			
Cladina mitis	70	3	5
Cladonia uncialis	20		
Pleurozium schreberi		2	3
Dicranum polysetum			2
Cladina rangiferina		4	1
Peltigera apthosa		1	1
Peltigera malacea		1	
Hylocomium splendens		1	1
Polytrichum juniperinum		1	
Cladonia furcata			1
Cladonia gracilis			1

Table 8. Percent cover of species in bottomland and riparian forest communities.

	TYPE		
	Balsam Poplar-White Spruce/Red Osier Dogwood		White Spruce/ River Alder-Horsetail
Species	(11)	(28)	(17)
Trees			
Populus balsamifera	50	75	
Picea glauca	15		30
Abies balsamea	2		
Tall Shrub			
Cornus stolonifera	10	80	
Prunus virginiana	10	1	
Viburnum trilobum	4	P	
Alnus tenuifolia		3	35
Salix bebbiana		5	
Low Shrub			
Viburnum edule	5	8	1
Rosa acicularis	8	2	7
Prunus virginiana	15		
Rubus strigosus	3	3	
Ribes hirtellum		1	1
Cornus stolonifera		1	
Amelanchier alnifolia			2
Ribes lacustre		1	
Dwarf Shrub/Herbaceous			
Aralia nudicaulus	10		
Rubus pubescens	10	20	8
Matteuccia struthiopteris	10		
Equisetum palustre	8	2	2
Mertensia paniculata	15		8
Mitella nuda	5	2	
Calamagrostis canadensis		5	
Urtica gracilis	2		
Fragaria vesca	1		
Athyrium Filix-Femina	1		
Galium trifidum	1		1
Galium triflorum	1		
Maianthemum canadense	1		1
Galium boreale			

Continued....

Table 8. Concluded.

	TYPE		
	Balsam Poplar-White Spruce/Red Osier Dogwood		White Spruce/ River Alder-Horsetail
	(11)	(28)	(17)
Smilacina stellata		3	
Equisetum pratense		1	15
Cornus canadensis			4
Equisetum scirpoides			18
Linnaea borealis			8
Petasites palmatus			1
Mosses			
Plagiomnium spp.	2		5
Brachythecium sp.	2		
Hylocomium splendens			35
Pleurozium schreberi			20
Ptilium crista-castrensis			3

Table 9. Percent cover of species in aspen dominated upland forest stands.

	TYPE					
	Aspen-Jack Pine/ Buffalo Berry		Aspen/Low Bush Cranberry		Aspen/ Green Alder	
Species	(12)	(24)	(2)	(27)	(9)	(10)
Trees						
Populus tremuloides	65	50	85	80	90	90
Pinus banksiana	3	30				
Picea glauca		1				
Betula papyrifera		1		8		
Tall Shrub						
Picea glauca	2	1	3			
Populus tremuloides	4	1	1	1		
Salix bebbiana				3		
Salix spp.			10			
Alnus crispa		1	P	4	55	35
Amelanchier alnifolia				1		
Viburnum edule					1	
Low Shrub						
Rosa acicularis	5	15	10	10	2	4
Shepherdia conadensis	15	20	3			
Amelanchier alnifolia	4		2			
Symphoricarpos albus	3	2		2	1	2
Vaccinium myrtilloides	8	10	5			
Lonicera dioica	1	P	1			2
Veburnum edule		5	15	12	15	7
Ledum groenlandicum		8	3			
Betula papyrifera	P	P		2	1	
Picea glauca	3			1	2	P
Rubus strigosus				5	5	3
Vaccinium myrtilloides				P		
Salix spp.		3				2
Ribes lacustre					2	
Dwarf Shrub/Herbaceous						
Arctostaphylos uva-ursi	10	2				
Vaccinium vitis-idaea	3	15				
Elymus innovatus	10	3	2	4	1	1
Linnaea borealis	20	15	1	4	1	2
Cornus canadensis	10	8	8	3	4	3
Calamagrostis canadensis		2	20	2	1	
Petasites palmatus		5	3	2	1	1

Continued....

Table 9. Concluded.

	TYPE					
	Aspen-Jack Pine/ Buffalo Berry		Aspen/Low Bush Cranberry		Aspen/ Green Alder	
	(12)	(24)	(2)	(27)	(9)	(10)
Epilobium angustifolium	1	2	8	1	1	1
Equisetum pratense			5	1	2	
Aralia nudicaulis	3		2	12	12	4
Mertensia paniculata			1	2	8	
Rubus pubescens	4		3	1	3	3
Apocynum androsaemifolium	4		P			
Pyrola secunda	1	4	1	1		
Carex lasiocarpa		3				P
Maianthemum canadensis	2		2	P	1	P
Galium boreale	1	1	2	2		1
Pyrola asarifolia	1		2	3	1	2
Lycopodium complanatum		1		1		
Smilacina trifolia	1	1		1	1	
Lathyrus ochroleucus		1	1			
Equisetum scirpoides		2				
Aster ciliolatus			1	P		
Equisetum sylvaticum						
Aster conspicuus	1		1			
Lycopodium obscurum					1	
Mosses-Lichens						
Hylocomium splendens		8			1	
Pleurozium schreberi		5	2	1	1	
Dicranum polysetum	1		1	1		
Polytrichun juniperinum	2		P		1	
Tomenthypnum nitens			1			
Brachythecium sp.			1			
Aulacomnium palustre				P		
Ptilium crista-castrensis			P	P		
Peltigera apthosa		P				
Cladonia spp.	8	1				
Stereocaulon paschale	1					

Table 10. Percent cover of species in upland white spruce-aspen mixed forest stands.

	TYPE				
	Aspen-White Spruce/Buffalo Berry	White Spruce-Aspen/Low Bush Cranberry		White Spruce Aspen/Low Bush Cranberry-Feathermoss	
Species	(20)	(26)	(3)	(34)	(35)
Trees					
Populus tremuloides	30	65	5	10	20
Picea glauca	15	25	35	55	40
Pinus banksiana				5	
Betula papyrifera				3	
Tall Shrub					
Picea glauca		2	2	5	5
Salix bebbiana		1		4	
Alnus crispa			3	15	10
Populus tremuloides	1		10	1	1
Populus balsamifera			P		
Low Shrub					
Shepherdia canadensis	40		3		5
Rosa acicularis	15	8	20	5	3
Symphoricarpos albus	8		1	1	
Viburnum edule	3	5	10	3	10
Cornus stolonifera			8		
Ledum groenlandicum		1		12	
Potentilla fruticosa	1				
Vaccinium myrtilloides		4		2	2
Ribes lacustre			1		
Ribes hirtellum			2	1	
Ribes spp.					
Rubus strigosus				1	
Amelanchier alnifolia					2
Dwarf Shrub/Herbaceous					
Arctostaphylos uva-ursi	20				
Vaccinium vitis-idaea				4	3
Linnaea borealis	12	10	3	8	12
Rubus pubescens		2	15	4	3
Calamagrostis canadensis			12		3
Mitella nuda			12		
Cornus canadensis		8	8	4	5
Elymus innovatus	3	5	8	8	

Continued....

Table 10. Concluded.

	TYPE				
	Aspen-White Spruce Buffalo Berry	White Spruce-Aspen/Low Bush Cranberry		White Spruce Aspen/Low Bush Cranberry-Feathermoss	
	(20)	(26)	(3)	(34)	(35)
Petasites palmatus		2	5	1	2
Epilobium angustifolium			8	8	4
Equisetum pratense		P	5		
Mertensia paniculata			5		
Aralia nudicaulis		2	1	7	5
Lycopodium annotinum				5	
Fragaria vesca	3		2	1	
Galium boreale	2	1	2	1	1
Pyrola minor	2				
Smilacina stellata	3				
Anemone multifida	3				
Aster conspicuus	1		2		1
Pyrola secunda	1	1		1	
Equisetum sylvaticum		1			
Smilacina trifolia		1		1	
Carex lasiocarpa		3			
Maianthemum canadense		1	1	1	1
Trientalis borealis	1	1		1	
Achillea millefolium			1		
Galium trifolium			2		
Lathyrus ochroleucus			2		
Aster ciliolatus			2		
Equisetum scirpoides			2		
Lycopodium complanatum				3	
Pyrola asarifolia		P		1	1
Mosses-Lichens					
Hylocomium splendens	4	1	8	15	40
Pleurozium schreberi	1	3	15	40	8
Tomenthypnum nitens	2				
Ptilium crista-castrensis		2	5	2	
Plagiomnium spp.			2		
Drepanocladus sp.			1		
Brachythecium sp.			P		
Dicranum polysetum				3	
Peltigera apthosa	1				
Cladina spp.	1				

Table 11. Percent cover of species in an upland white spruce/ feathermoss stand.

	TYPE
	White Spruce/ Feathermoss
Species	(32)
Trees	
Picea glauca	45
Picea mariana	3
Tall Shrub	
Picea glauca	2
Picea mariana	1
Populus tremuloides	2
Betula papyrifera	1
Low Shrub	
Viburnum edule	3
Rosa acicularis	2
Amelanchier alnifolia	1
Shepherdia canadensis	1
Cornus stolonifera	2
Ledum groenlandicum	4
Dwarf Shrub/Herbaceous	
Vaccinium vitis- idaea	5
Linnaea borealis	10
Cornus canadensis	8
Rubus pubescens	5
Geocaulon lividum	4
Elymus innovatus	2
Calamagrostis canadensis	2
Epilobium angustifolium	2
Mitella nuda	1
Lathyrus ochroleucus	2
Petasites palmatus	1
Smilacina trifolia	1
Lathyrus ochroleucus	1
Equisetum scirpoides	1
Pyrola secunda	1
Maianthemum canadense	1
Aralia nudicaulis	1

Continued....

Table 11. Concluded

	TYPE
	White Spruce/ Feathermoss
	(32)
Mosses-Lichens	
Pleurozium schreberi	50
Hylocomium splendens	40
Ptilium crista-castrensis	4
Dicranum polysetum	4
Peltigera aphthosa	3
Peltigera canina	1

Table 12. Percent cover of species in upland jack pine stands.

	TYPE		
	Jack Pine/ Lichen	Jack Pine/ Buffalo Berry	
Species	(16)	(14)	(36)
Trees			
Pinus banksiana	25	65	70
Picea glauca			1
Populus tremuloides		2	P
Tall Shrub			
Pinus banksiana		1	
Populus tremuloides		1	
Larix laricina		1	
Picea glauca			5
Low Shrub			
Picea glauca	1	5	1
Populus tremuloides			1
Vaccinium myrtilloides	40	4	
Shepherdia canadensis		15	15
Rosa acicularis		8	5
Symphoricarpus albus		1	5
Viburnum edule		3	2
Ledum groenlandicum		4	
Potentilla fruticosa		1	3
Lonicera dioica		P	2
Cornus stolonifera		P	1
Dwarf Shrub/Herbaceous			
Arctostaphylos uva-ursi		40	70
Vaccinium vitis-idaea	10	15	3
Cornus canadensis	3	20	5
Oryzopsis pungens	1	8	5
Linnaea borealis		8	8
Epilobium angustifolium		3	
Elymus innovatus		5	3
Galium boreale		1	2
Rubus pubescens		1	2
Campanula rotundifolia			1
Fragaria vesca			1
Anemone multifida			1
Maianthemum canadensis			1
Lathyrus ochroleucus			1

Continued....

Table 12. Concluded.

	TYPE		
	Jack Pine/ Lichen	Jack Pine/ Buffalo Berry	
	(16)	(14)	(36)
Achillea millefolium			1
Aster ciliolatus			1
Viola rugulosa			1
Mosses-Lichens			
Cladina mitis	70	3	5
Cladonia uncialis	20		
Pleurozium schreberi		2	3
Dicranum polysetum			2
Cladina rangiferina		4	1
Peltigera apthosa		1	1
Peltigera malacea		1	
Hylocomium splendens		1	1
Polytrichum juniperinum		1	
Cladonia furcata			1
Cladonia gracilis			1

Table 13. Percent cover of species in pine-black spruce mixed forest stands.

	TYPE	
	Jack Pine-Black Spruce/ Labrador Tea	
Species	(31)	(33)
Trees		
Pinus banksiana	25	15
Picea mariana	15	20
Larix laricina		1
Picea glauca	2	
Tall Shrub		
Picea mariana	30	8
Betula papyrifera		1
Populus tremuloides	1	
Alnus crispa		1
Low Shrub		
Ledum groenlandicum	10	55
Vaccinium myrtilloides	3	15
Dwarf Shrub/Herbaceous		
Vaccinium vitis-idaea	8	8
Cornus canadensis	5	2
Mosses-Lichens		
Cladina mitis	80	45
Pleurozium schreberi		40
Cladina alpestris	1	8
Cladina rangiferina		5
Dicranum polysetum		5
Polytrichum juniperinum		1
Peltigera aphthosa		1
Cladonia cornuta		1
Stereocaulon paschale	1	
Cladonia furcata	1	

Table 14. Percent cover of species in an upland black spruce forest stand.

	TYPE
	Black Spruce/ Feathermoss
Species	(4)
Trees	
Picea mariana	60
Picea glauca	15
Tall Shrub	
Picea mariana	5
Salix bebbiana	5
Low Shrub	
Rosa acicularis	5
Ledum groenlandicum	3
Salix myrtillifolia	4
Ribes lacustre	1
Viburnum edule	1
Ribes hirtellum	1
Symphoricarpos albus	2
Dwarf Shrub/Herbaceous	
Vaccinium vitis-idaea	3
Arctostaphylos rubra	2
Carex capillaris	15
Calamagrostis canadensis	5
Equisetum scirpoides	8
Equisetum sylvaticum	5
Linnaea borealis	5
Mitella nuda	2
Equisetum pratense	3
Cornus canadensis	3
Petasites palmatus	2
Geocaulon lividum	3
Moneses uniflora	2
Rubus pubescens	1
Aralia nudicaulis	1
Petasites sagittatus	1
Mertensia paniculata	1
Achillea millefolium	1
Rubus acaulis	1
Rubus chamaemorus	1
Epilobium angustifolium	1

Continued....

Table 14. Concluded.

	TYPE
	Black Spruce/ Feathermoss
	(4)
Mosses-Lichens	
Pleurozium schreberi	65
Hylocomium splendens	35
Peltigera aphthosa	1

Table 15. Percent cover of species in black spruce bog forest stands.

	TYPE				
	Black Spruce/ Ledum-Sphagnum		Black Spruce/ Willow-Moss		
Species	(1)	(25)	(23)	(29)	(13)
Trees					
Picea mariana	25	35	2		
Larix laricina	1	2	2		
Tall Shrub					
Picea mariana		15	40	85	65
Larix laricina		2	1		2
Low Shrub					
Picea mariana	10		20		
Larix laricina	2				
Ledum groenlandicum	35	35	2	1	15
Betula papyrifera	3				
Salix maccalliana	2		10	4	4
Pinus banksiana	1				
Betula pumila			5		
Rosa acicularis				2	
Ribes hirtellum				1	1
Cornus stolonifera				2	
Potentilla fruticosa				1	
Salix myrtillifolia		8	20	8	10
Salix pedicellaris				1	
Dwarf Shrub/Herbaceous					
Vaccinium vitis-idaea	25	15	4	P	5
Arctostaphylos rubra		4	2	3	8
Oxycoccus microcarpus	8	2	1		
Equisetum sylvaticum	8				
Carex aquatilis	2	2	8	2	5
Calamagrostis canadensis	3			5	
Rubus chamaemorus	4				
Equisetum scirpoides		1	2	3	
Equisetum pratense	1	3	2		25
Carex rostrata					8
Carex diandra			15	3	2
Smilacina trifolia	1	1	3	1	3
Petasites sagittatus		1	1	1	

Continued....

Table 15. Concluded.

	TYPE				
	Black Spruce/ Ledum-Sphagnum		Black Spruce/ Willow-Moss		
	(1)	(25)	(23)	(29)	(13)
Agrostis alba		1			
Pyrola secunda			1		
Mitella nuda			1	1	
Deschampsia caespitosa			2		2
Linnaea borealis				2	
Geocaulon lividum		1		2	
Achillea millefolium			P	1	1
Petasites palmatus				1	1
Epilobium angustifolium		P		1	
Carex capillaris				1	
Mertensia paniculata				1	
Parnassia palustris					1
Mosses-Lichens					
Sphagnum fuscum	35	10			2
Sphagnum nemoreum	15	8	2		1
Sphagnum warnstorfii		15		P	
Hylocomium splendens		40			
Cladina mitis	2	30	2	8	8
Tomenthypnum nitens			60	40	50
Aulacomnium palustre		5	3	45	35
Cladonia bellidiflora	2				1
Cladonia gracilis	2				3
Cladina rangiferina	1	1	1		2
Polytrichum juniperinum	1	1	1		1
Dicranum polysetum	P	10	1		
Cladina alpestris		2			
Pleurozium schreberi	2	3			2
Cladina arbuscula		1		1	
Cladonia amaurocraea	1	1			
Drepanocladus spp.			1		
Cladonia furcata				1	
Peltigera aphthosa		1			2

Table 16. Percent cover of species in a shrub bog stand.

	TYPE
	Willow-Dwarf Birch/Bog Moss
Species	(6)
Tall Shrub	
Picea mariana	4
Picea glauca	1
Low Shrub	
Salix maccalliana	60
Salix pedicellaris	10
Salix myrtillifolia	2
Ledum groenlandicum	2
Alnus tenuifolia	1
Dwarf Shrub/Herbaceous	
Calamagrostis canadensis	35
Carex aquatilis	10
Petasites sagittatus	5
Carex diandra	2
Rubus acaulis	3
Smilacina trifolia	2
Aster ciliolatus	1
Equisetum pratense	1
Rubus pubescens	1
Pyrola asarifolia	2
Parnassia palustris	1
Mosses-Lichens	
Tomenthypnum nitens	60
Aulacomnium palustre	5
Sphagnum fuscum	1
Sphagnum warnstorfii	2
Sphagnum nemoreum	1
Polytrichum juniperinum	2
Drepanocladus spp.	4

Table 15. Concluded.

	TYPE				
	Black Spruce/ Ledum-Sphagnum		Black Spruce/ Willow-Moss		
	(1)	(25)	(23)	(29)	(13)
Agrostis alba		1			
Pyrola secunda			1		
Mitella nuda			1	1	
Deschampsia caespitosa			2		2
Linnaea borealis				2	
Geocaulon lividum		1		2	
Achillea millefolium			P	1	1
Petasites palmatus				1	1
Epilobium angustifolium		P		1	
Carex capillaris				1	
Mertensia paniculata				1	
Parnassia palustris					1
Mosses-Lichens					
Sphagnum fuscum	35	10			2
Sphagnum nemoreum	15	8	2		1
Sphagnum warnstorfii		15		P	
Hylocomium splendens		40			
Cladina mitis	2	30	2	8	8
Tomenthypnum nitens			60	40	50
Aulacomnium palustre		5	3	45	35
Cladonia bellidiflora	2				1
Cladonia gracilis	2				3
Cladina rangiferina	1	1	1		2
Polytrichum juniperinum	1	1	1		1
Dicranum polysetum	P	10	1		
Cladina alpestris		2			
Pleurozium schreberi	2	3			2
Cladina arbuscula		1		1	
Cladonia amaurocraea	1	1			
Drepanocladus spp.			1		
Cladonia furcata				1	
Peltigera aphthosa		1			2

Table 16. Percent cover of species in a shrub bog stand.

	TYPE
	Willow-Dwarf Birch/Bog Moss
Species	(6)
Tall Shrub	
Picea mariana	4
Picea glauca	1
Low Shrub	
Salix maccalliana	60
Salix pedicellaris	10
Salix myrtillifolia	2
Ledum groenlandicum	2
Alnus tenuifolia	1
Dwarf Shrub/Herbaceous	
Calamagrostis canadensis	35
Carex aquatilis	10
Petasites sagittatus	5
Carex diandra	2
Rubus acaulis	3
Smilacina trifolia	2
Aster ciliolatus	1
Equisetum pratense	1
Rubus pubescens	1
Pyrola asarifolia	2
Parnassia palustris	1
Mosses-Lichens	
Tomenthypnum nitens	60
Aulacomnium palustre	5
Sphagnum fuscum	1
Sphagnum warnstorfii	2
Sphagnum nemoreum	1
Polytrichum juniperinum	2
Drepanocladus spp.	4

Table 17. Percent cover of species in an open bog stand.

	TYPE
	Sphagnum Moss/Bog Birch
Species	(30)
Tall Shrub	
Picea mariana	3
Low Shrub	
Betula glandulosa	5
Salix maccalliana	10
Salix pedicellaris	2
Chamaedaphne calyculata	10
Ledum groenlandicum	2
Dwarf Shrub/Herbaceous	
Carex aquatilis	15
Carex diandra	10
Oxycoccus microcarpus	4
Carex chordorrhiza	4
Smilacina trifolia	2
Rubus acaulis	1
Potentilla palustris	1
Equisetum arvense	1
Mosses-Lichens	
Sphagnum warnstorfii	50
Sphagnum fuscum	20
Sphagnum nemoreum	20

8.2 TERMS OF REFERENCE FOR PROJECT LS 2.3.2

TITLE: Detailed Vegetation Studies in the AOSERP Study Area

BACKGROUND:

Stringer (1976) conducted a preliminary vegetation survey of the oil sands area in which he noted and described vegetation communities (VE 2.2). Using this base plus aerial photography (false color and infrared), and remote sensing techniques, INTERA Environmental Consultants (1978, 1979) have prepared preliminary vegetation and surficial geological maps of the entire AOSERP study area (LS 2.3.1). While intended for general use in project planning and design, the detailed offered by these maps, which are at 1:50 000 scale, has proven to be insufficient to satisfy the requirements of the users thus far identified.

Due to deficiencies in the detail of habitat descriptions for the AOSERP study area, Ryan (LS 28.1.1) encountered problems when attempting to select sample sites for terrestrial insect fauna.

Lumbis and Francis (LS 22.1.1), confronted by the problem of determining habitat relationships and requirements for breeding avifauna in the AOSERP study area opted for a methodology which involved detailed habitat quantification on 20 selected plots, each of a representative habitat type found within the oil sands area. Each plot (ranging in size from 15 to 45 ha) was surveyed and divided into 50 m^2 blocks, with a detailed habitat quantification from ground cover to overstory conducted on each block.

A similar type of methodology has been utilized by Green (LS 7.1.2) describing habitat associations of small mammals.

While these methods generated a tremendous volume of data which has a direct application in determining habitat relationships of breeding avifauna and small mammals, the value of the data to other potential users is, at this time, undefined.

RATIONALE:

A more detailed habitat description than that offered by the INTERA maps would have immediate application in biomonitoring plot selection with significant future contributions to wildlife managers involved in the assessment of the impact created by oil sands development. Land Use planners (involved in industrial development, townsite planning,

and park and wilderness area designation) have demonstrated a genuine requirement for detailed habitat descriptions of the oil sands area.

OBJECTIVE: Phase 1 1979-80

To prepare a project proposal for detailed habitat descriptions to be conducted in the AOSERP study area which will:

1. Synthesize currently available AOSERP data relating to vegetation type and habitat description;
2. Conduct a pilot study which will provide a forum to test and develop applicable methodologies;
3. Conduct a workshop which will:
   a) Identify potential users and their requirements;
   b) Determine the adequacy of the pilot study; and
   c) Review and suggest most applicable methodology for utilization during Phase II; and
4. On the basis of the results from objectives 1 to 3, provide a detailed project design for Phase II.

OUTLINE OF WORK: 1979-1980

1. To review, summarize, synthesize, and organize all currently available AOSERP data relating to vegetation types and habitat descriptions.
2. Provide a summary of the above with possible applications of the available data by 31 July 1979.
3. Conduct a pilot study of detailed vegetation descriptions in the Muskeg River area of four plant community types (riparian, bog-fen, deciduous upland, coniferous upland) in August 1979.
4. Select plots to be utilized for the above in consultation with AOSERP Land System personnel.
5. Prepare a report on the pilot study for utilization as an information base for attendees at the workshop.
6. Conduct a workshop in November to December 1979 which has the following objectives:
   a) Identification of users and their requirements;

b) Determine the adequcy of the pilot study in terms of data collection, analysis and reporting; and

c) Determine most applicable methodology in terms of data collection, analysis and reporting for utilization in Phase II; and

7. Prepare a final report incorporating all of the above and including a detailed proposal for Phase II 1980-81 to be submitted in draft form by 30 January 1980.

BUDGET:

Total funds available for Phase I are not to exceed $22 000.00

PERSONNEL:

The personnel who will undertake the work described in these Terms of Reference are as follows:

Name	Function
D. Reid	Project Biologist
O. Steen	Project Biologist
L. Hettinger	Senior Biologist
(not determined at this time)	Clerk

9. LIST OF AOSERP RESEARCH REPORTS

1.		AOSERP First Annual Report, 1975
2.	AF 4.1.1	Walleye and Goldeye Fisheries Investigations in the Peace-Athabasca Delta--1975
3.	HE 1.1.1	Structure of a Traditional Baseline Data System
4.	VE 2.2	A Preliminary Vegetation Survey of the Alberta Oil Sands Environmental Research Program Study Area
5.	HY 3.1	The Evaluation of Wastewaters from an Oil Sand Extraction Plant
6.		Housing for the North--The Stackwall System
7.	AF 3.1.1	A Synopsis of the Physical and Biological Limnology and Fisheries Programs within the Alberta Oil Sands Area
8.	AF 1.2.1	The Impact of Saline Waters upon Freshwater Biota (A Literature Review and Bibliography)
9.	ME 3.3	Preliminary Investigations into the Magnitude of Fog Occurrence and Associated Problems in the Oil Sands Area
10.	HE 2.1	Development of a Research Design Related to Archaeological Studies in the Athabasca Oil Sands Area
11.	AF 2.2.1	Life Cycles of Some Common Aquatic Insects of the Athabasca River, Alberta
12.	ME 1.7	Very High Resolution Meteorological Satellite Study of Oil Sands Weather: "A Feasibility Study"
13.	ME 2.3.1	Plume Dispersion Measurements from an Oil Sands Extraction Plant, March 1976
14.		
15.	ME 3.4	A Climatology of Low Level Air Trajectories in the Alberta Oil Sands Area
16.	ME 1.6	The Feasibility of a Weather Radar near Fort McMurray, Alberta
17.	AF 2.1.1	A Survey of Baseline Levels of Contaminants in Aquatic Biota of the AOSERP Study Area
18.	HY 1.1	Interim Compilation of Stream Gauging Data to December 1976 for the Alberta Oil Sands Environmental Research Program
19.	ME 4.1	Calculations of Annual Averaged Sulphur Dioxide Concentrations at Ground Level in the AOSERP Study Area
20.	HY 3.1.1	Characterization of Organic Constituents in Waters and Wastewaters of the Athabasca Oil Sands Mining Area
21.		AOSERP Second Annual Report, 1976-77
22.		Alberta Oil Sands Environmental Research Program Interim Report to 1978 covering the period April 1975 to November 1978
23.	AF 1.1.2	Acute Lethality of Mine Depressurization Water on Trout Perch and Rainbow Trout
24.	ME 1.5.2	Air System Winter Field Study in the AOSERP Study Area, February 1977.
25.	ME 3.5.1	Review of Pollutant Transformation Processes Relevant to the Alberta Oil Sands Area

26.	AF 4.5.1	Interim Report on an Intensive Study of the Fish Fauna of the Muskeg River Watershed of Northeastern Alberta
27.	ME 1.5.1	Meteorology and Air Quality Winter Field Study in the AOSERP Study Area, March 1976
28.	VE 2.1	Interim Report on a Soils Inventory in the Athabasca Oil Sands Area
29.	ME 2.2	An Inventory System for Atmospheric Emissions in the AOSERP Study Area
30.	ME 2.1	Ambient Air Quality in the AOSERP Study Area, 1977
31.	VE 2.3	Ecological Habitat Mapping of the AOSERP Study Area: Phase I
32.		AOSERP Third Annual Report, 1977-78
33.	TF 1.2	Relationships Between Habitats, Forages, and Carrying Capacity of Moose Range in northern Alberta. Part I: Moose Preferences for Habitat Strata and Forages.
34.	HY 2.4	Heavy Metals in Bottom Sediments of the Mainstem Athabasca River System in the AOSERP Study Area
35.	AF 4.9.1	The Effects of Sedimentation on the Aquatic Biota
36.	AF 4.8.1	Fall Fisheries Investigations in the Athabasca and Clearwater Rivers Upstream of Fort McMurray: Volume I
37.	HE 2.2.2	Community Studies: Fort McMurray, Anzac, Fort MacKay
38.	VE 7.1.1	Techniques for the Control of Small Mammals: A Review
39.	ME 1.0	The Climatology of the Alberta Oil Sands Environmental Research Program Study Area
40.	WS 3.3	Mixing Characteristics of the Athabasca River below Fort McMurray - Winter Conditions
41.	AF 3.5.1	Acute and Chronic Toxicity of Vanadium to Fish
42.	TF 1.1.4	Analysis of Fur Production Records for Registered Traplines in the AOSERP Study Area, 1970-75
43.	TF 6.1	A Socioeconomic Evaluation of the Recreational Fish and Wildlife Resources in Alberta, with Particular Reference to the AOSERP Study Area. Volume I: Summary and Conclusions
44.	VE 3.1	Interim Report on Symptomology and Threshold Levels of Air Pollutant Injury to Vegetation, 1975 to 1978
45.	VE 3.3	Interim Report on Physiology and Mechanisms of Air-Borne Pollutant Injury to Vegetation, 1975 to 1978
46.	VE 3.4	Interim Report on Ecological Benchmarking and Biomonitoring for Detection of Air-Borne Pollutant Effects on Vegetation and Soils, 1975 to 1978.
47.	TF 1.1.1	A Visibility Bias Model for Aerial Surveys for Moose on the AOSERP Study Area
48.	HG 1.1	Interim Report on a Hydrogeological Investigation of the Muskeg River Basin, Alberta
49.	WS 1.3.3	The Ecology of Macrobenthic Invertebrate Communities in Hartley Creek, Northeastern Alberta
50.	ME 3.6	Literature Review on Pollution Deposition Processes
51.	HY 1.3	Interim Compilation of 1976 Suspended Sediment Date in the AOSERP Study Area
52.	ME 2.3.2	Plume Dispersion Measurements from an Oil Sands Extraction Plan, June 1977

53.	HY 3.1.2	Baseline States of Organic Constituents in the Athabasca River System Upstream of Fort McMurray
54.	WS 2.3	A Preliminary Study of Chemical and Microbial Characteristics of the Athabasca River in the Athabasca Oil Sands Area of Northeastern Alberta
55.	HY 2.6	Microbial Populations in the Athabasca River
56.	AF 3.2.1	The Acute Toxicity of Saline Groundwater and of Vanadium to Fish and Aquatic Invertebrates
57.	LS 2.3.1	Ecological Habitat Mapping of the AOSERP Study Area (Supplement): Phase I
58.	AF 2.0.2	Interim Report on Ecological Studies on the Lower Trophic Levels of Muskeg Rivers Within the Alberta Oil Sands Environmental Research Program Study Area
59.	TF 3.1	Semi-Aquatic Mammals: Annotated Bibliography
60.	WS 1.1.1	Synthesis of Surface Water Hydrology
61.	AF 4.5.2	An Intensive Study of the Fish Fauna of the Steepbank River Watershed of Northeastern Alberta
62.	TF 5.1	Amphibians and Reptiles in the AOSERP Study Area
63.	ME 3.8.3	Analysis of AOSERP Plume Sigma Data
64.	LS 21.6.1	A Review and Assessment of the Baseline Data Relevant to the Impacts of Oil Sands Development on Large Mammals in the AOSERP Study Area
65.	LS 21.6.2	A Review and Assessment of the Baseline Data Relevant to the Impacts of Oil Sands Development on Black Bears in the AOSERP Study Area
66.	AS 4.3.2	An Assessment of the Models LIRAQ and ADPIC for Application to the Athabasca Oil Sands Area
67.	WS 1.3.2	Aquatic Biological Investigations of the Muskeg River Watershed
68.	AS 1.5.3 AS 3.5.2	Air System Summer Field Study in the AOSERP Study Area, June 1977
69.	HS 40.1	Native Employment Patterns in Alberta's Athabasca Oil Sands Region
70.	LS 28.1.2	An Interim Report on the Insectivorous Animals in the AOSERP Study Area
71.	HY 2.2	Lake Acidification Potential in the Alberta Oil Sands Environmental Research Program Study Area
72.	LS 7.1.2	The Ecology of Five Major Species of Small Mammals in the AOSERP Study Area: A Review
73.	LS 23.2	Distribution, Abundance and Habitat Associations of Beavers, Muskrats, Mink and River Otters in the AOSERP Study Area, Northeastern Alberta
74.	AS 4.5	Air Quality Modelling and User Needs
75.	WS 1.3.4	Interim Report on a Comparative Study of Benthic Algal Primary Productivity in the AOSERP Study Area
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