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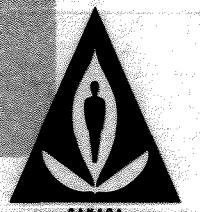

A FOREST LAND CLASSIFICATION FOR THE KANANASKIS RESEARCH FOREST ALBERTA, CANADA

Project A.111

by
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TABLE OF CONTENTS

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Kananaskis Research Forest, Alberta, Canada"[1]

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INTRODUCTION

The Kananaskis Research Forest (hereafter called the Research Forest) is a permanent research area (about 24 square miles) for studies in forest management and ecology. Work of this nature has been carried out there for about 35 years and recently the pace of scientific research has been stepped up with such additions as watershed management, insect, disease, and physiology investigations. Forest growth and yield and forest inventory continue to form an important part of the overall program. In 1966 the University of Calgary Environmental Science Station began operations within the Research Forest with emphasis on instruction and research in biology and ecology.

The purpose of this preliminary report is to describe the landscape on the Working Plan portion of the Research Forest together with the forest productivity potential of the recognized land units. This information is illustrated on a map at a scale of 4 inches to the mile. Further field work will be devoted to a completion of the study of growth rates on the individual land units.

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This study offered an opportunity to apply Amidon's (1964) Map Information Assembly and Display System (MIADS) and an IBM 1620 computer at the Department of Forestry and Rural Development Biometrics Research Services Unit, Ottawa. In addition The University of Calgary IBM 360 Model 30 computer was employed in area calculations.

THE STUDY AREA

Location

The Research Forest is situated in the valley of the Kananaskis River at a point where the foothills merge with the front range of the Canadian Rocky Mountains. The headquarters-laboratory complex, is located at 51°02' north latitude and 115°02' west longitude.

The total land area of the Research Forest is 15,270.1 acres (about 24 square miles) of which 6829.5 acres are in the Working Plan Forest and 8440.6 acres are in the Protection Forest (land in the high elevations and on rocky ground).

The Research Forest borders on the Bow Forest of the Alberta Rocky Mountains Forest Reserve on the east, south and west sides. To the north the boundary joins with the Stony Indian Reservation.

Geology and Topography

The geology and topography of the Research Forest has been described by Crossley (1951) and since there are no new reports available, that section of Crossley's paper (p. 6) is quoted here:

"The area lies in what was originally the Cordilleran Trough, and therefore contains great deposits of sedimentary origin--both marine and non-marine--muds, marls, sands, and gravels, deposited from Cambrian to Cretaceous times. The trough was destroyed by the Larimide Revolution--the climax of a series of disturbances resulting in the formation of great folded masses of rock being raised to great heights. The Rocky Mountains are today's visual evidence of the tremendous disturbance.

The marked difference in the resistance to erosion offered by the various lithological units of the bed-rock, and the extensive folding and faulting that are the result of the massive upheaval, have influenced the nature of the topography. The uppermost beds of the resistant Palaeozoic limestone form the summits of the mountains, the ridges mark the outcrops of massive sandstone and conglomerate beds, and the shales predominate in the flat-bottomed valleys (Beach, 1943).

Figure 1 illustrates the position and relation of the various geological formations as found in the area*. The Blairmore formation of the Lower Cretaceous Period and all the formations of the Upper Cretaceous at the north end of the station, together with the northern boundary of the Palliser formation, are part of a detailed geological survey (Beach, 1943), and these boundaries can be considered as accurately placed. However, the remainder of the Station was surveyed as part of the larger Rocky Mountain area (Dowling, 1905); the extensive nature of the survey did not permit a detailed examination of each section and the boundaries were only assumed.

With the advent of the Glacial Period in the Pliocene Epoch the Great Cordilleran Ice Sheet came into existence in the Rocky Mountains. All of the mountain region of Alberta was covered by this ice-cap. Ice advances were followed by retreats during the interglacial stages, and deep beds of boulder till and moraines were laid down throughout the valleys, together with lacustrine and alluvial deposits.

Since the area lies on the eastern range of the Rocky Mountains, the topography is characteristic of this upheaval. Flat-bottomed valleys are hemmed in by upthrust masses of rock displaying a variety of gradual and precipitous slopes, with raw unweathered ridges and outcrops. Altitude varies between 4,400' and 8,000', with timber line at approximately 6,500'."

The parent materials on the Research Forest are the result of Cordilleran ice movements during the Pleistocene Epoch and subsequent erosion and deposition by meltwaters and wind. Stalker[4] has reported that

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* LARSSON, O.G. 1946. Working plan of the Kananaskis Forest Experiment Station, Vol. 1. Canada, Dominion Forest Service, Unpubl.

[4] A. M. Stalker. 1966. Personal Communication. July 1966. Geological Survey of Canada. Pleistocene Section. Ottawa.

there is evidence of more than one glaciation in the area and that landforms from previous ice advances have been obliterated by the most recent transgression. Important surficial deposits are glacial till in different land forms, alluvial sands and gravels, interbanded alluvial-lacustrine silts and sands, and colluvial materials. Thin aeolian deposits are represented and there are some exposures of residual bedrock.

Soils

Great soil groups were used as units of mapping in the soil survey map of the Kananaskis Forest Experiment Station (Crossley, 1951). The only division below the great soil group level was to distinguish between highly calcareous and relatively non-calcareous soils. Such a classification was deemed to be adequate "until such time as it has been decided what characteristics are of importance in forest soils . . ." (Crossley, 1951). The following soil types were described:

1. Alluvium
2. Chernozem
3. Rendzina
4. Brown Forest
5. Podzols - Brown
   Grey
   Podzol
6. Hangmoor Peat
7. Half Bog
8. Sod Soils
9. Mountain Lithosols
10. Eroded Soil and Rock

Climate

The climate is characterized by a long cold winter with intermittent Chinook winds (warm air from the Pacific Coast) and a short warm summer. The mean annual temperature at the headquarters station is

36.8°F[5] and the mean annual precipitation is 25.09 inches about forty percent of which falls as snow[5]. The average frost-free period is 58 days (slightly under two months).

The Forest

The Research Forest lies at the eastern edge of the Rocky Mountains at a location where three forest regions merge.

1. The Subalpine Region, East Slope Rockies Section (SA.1) (Rowe, 1959) is found between the approximate altitude limits of 5,000 and 6,800 feet, the latter being an estimation of the upper limit of trees. The distinguishing tree species is the Engelmann spruce (Picea engelmannii) and the Engelmann spruce - white spruce hybrid. Lodgepole pine (Pinus contorta var. latifolia) is also important. Alpine fir (Abies lasiocarpa) is associated with spruce in the higher elevations.
2. The Boreal Forest Region, Upper Foothills Section (B.19c) lies between about 4,000 and 6,000 feet elevation. Lodgepole pine is the main species and white spruce (Picea glauca) is also important. According to Rowe (1959) a distinguishing characteristic is that mixedwood stands with trembling aspen (Populus tremuloides), balsam poplar (P. balsamifera) and white birch (Betula papyrifera) are not common.

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[5] Compiled from: ANONYMOUS, 1931-1960. Monthly records. Meteorological observations in Canada. Canada, Dept. Transport, Meteorological Branch, Toronto.

3. The Montane Forest Region, Douglas Fir and Lodgepole Pine Section (M.5) is found on warm, dry situations in the valley bottoms and lower elevations. Blue Douglas fir (Pseudotsuga taxifolia var. glauca) and lodgepole pine form the main association. Trembling aspen with scattered white spruce are also present.

Because of the proximity of these forest regions, changes in forest composition are to be found with changes in aspect, elevation, exposure, and soil type. Thus the forest composition is complex, being strongly influenced by the environment and by historical factors.

METHODS

Aerial photo interpretation

Complete aerial photo coverage was available at the nominal scale of 1:15,840 (4 inches = 1 mile). This was used to locate, identify and delimit the distinctive landforms on the Research Forest and to point out sites at which landforms could be conveniently studied. In some cases the landforms could be identified but some land units could not be named and were left for field examination.

Following photo interpretation, field transects were laid out on maps and photos in such a way that the land unit, the forest and the soil could be rapidly examined. A reconnaissance field examination of the conditions at 48 sites permitted an appraisal of the photo interpretation

as to its accuracy and completeness. Boundaries of land units were adjusted and the identification of parent materials was improved. On the basis of the reconnaissance, a field survey was set up to study the forest and soil conditions on each recognizable land unit. One hundred more plots were sampled bringing the total number of field plots to 148.

Field Survey

Use was made of the network of permanent sample plots on the Research Forest. This system consists of over one thousand one-fifth acre plots set out on a 10-chain grid. Forest stand data were used to select plots with fully stocked coniferous stands between 70 and 100 years of age.

Land data

Land data were recorded as follows:

1. parent material was identified
2. slope grade, in per cent
3. slope position, percentage of total slope above the plot centre.
4. aspect
5. elevation
6. drainage conditions, using the N.S.S.C.C. classification (1965).

Soil data

A soil pit was excavated to a depth of 3 to 4 feet and soil

samples were produced from depths of 5 to 6 feet using a soil augur. Information was noted on the following soil features:

1. soil texture for each horizon, by feel
2. total horizon thickness (soil plus stone), in inches
3. soil colour, using Munsell Colour Charts
4. structure and stone percentage
5. rooting characteristics
6. pH, using a Hellige-Truog Field Kit
7. depth to lime, using dilute hydrochloric acid.

Forest stand data

These data were recorded:

1. The forest cover type and ground vegetation were described.
2. Stand age was checked, using increment core counts from 5 to 10 trees.
3. Basal area per acre was estimated from one sample using a Spiegel relascope with a 10 factor.
4. Stand volume and mean annual increment (MAI) at 80 years were calculated from existing plot records.

One-quart size soil samples were taken from each important mineral horizon. About 300 soil samples were collected for laboratory analyses.

ANALYSIS AND MAP PREPARATION

Laboratory Analyses

All soil samples were air-dried and particle size analyses were run on 100 selected samples for sand, silt and clay fractions (under 2.0 mm. in diameter) using sodium hexametaphosphate ("Calgon"), as a dispersing agent and a modified Bouyoucos hydrometer method as described by Wilde and Voigt (1959).

Map Compilation

In order to produce a land classification map which would be useful for land description and for forest management analysis and decision-making, Amidon's (1964) Map Information Assembly and Display System (MIADS) was employed in map compilation. The following steps were taken:

1. The Source map (map of surface materials) was prepared by transferring the land units (field checked) from aerial photos to a base map at a scale 1:15,840 (4 inches to the mile). A Zeiss Aero-Sketchmaster was employed for the transfer operations.

2. Each land unit was assigned a reference number starting with unit 1 at the northern tip of the Research Forest and ending with unit 87 at the southern tip.

3. Each unit was then coded according to surficial material, using the following two-digit code:

00 - protection forest
01 - till (deep)

02 - till over bedrock
03 - till and colluvium

05 - colluvium
06 - alluvium (mixture of fine and coarse materials)
07 - coarse alluvium
08 - coarse alluvium over till
09 - coarse alluvium over bedrock
10 - fine alluvium
11 - fine alluvium over coarse alluvium
12 - fine alluvium over till
13 - organic soils
14 - bedrock

33 - water

The code 04 was not used because it is easily mistaken for other codes.

4. Hand Coding. The Source Map was placed over 80-column grid paper made up of rectangular units $\frac{1}{5} \times \frac{1}{6}$ inches in size. Carbon paper was placed under the grid paper, facing up. The Source Map was then traced onto the grid paper using a hard pencil. Each land unit was coded according to the surficial material code. Then using a light table and hard pencil each grid cell in each land unit was assigned the appropriate code number. The entire map was hand coded, a line at a time. Several sheets of grid paper were used because IBM punch cards are limited to 80 columns of digits.

5. Key punching. The hand coded data was then transcribed to punch cards at the Department Biometrics Research Service, Ottawa. The data was reproduced on punch cards and on a printout (overlay) which was used for visual checking of coding accuracy.

6. Using a mapping program described by Amidon (1964) and the University of Calgary IBM 360 Model 30 Computer, areas were computed

for each of the 14 codes and the percentage of the total area taken up by each code was calculated.

RESULTS

The main results to be presented are the forest land classification map and the tabular descriptions of the individual land units.

The surficial material map in Figure 1 shows the 87 land units which are described in Table 1. The acreage in each code is given in Appendix 1. The tabular description in Table 1 makes use of the following abbreviations:

1. Land unit numbers refer to the units as shown in Figure 1. Number 1 is at the northern tip of the map and the units are numbered up to 87 (south-western extremity of the area). The printout is shown in Figure 2.

2. Surface material is coded according to the numerical code given in the above text and in Figure 1.

3. The soil notation refers to the texture in the apparent tree rooting zone. The abbreviations are as follows:

s (sand)	scl (sandy clay loam)
si (silt)	sg (sand and gravel)
l (loam)	slg (sandy loam and gravel)
sl (sandy loam)	ls (loamy sand)
sil (silt loam)	0 (organic material)
cl (clay loam)	

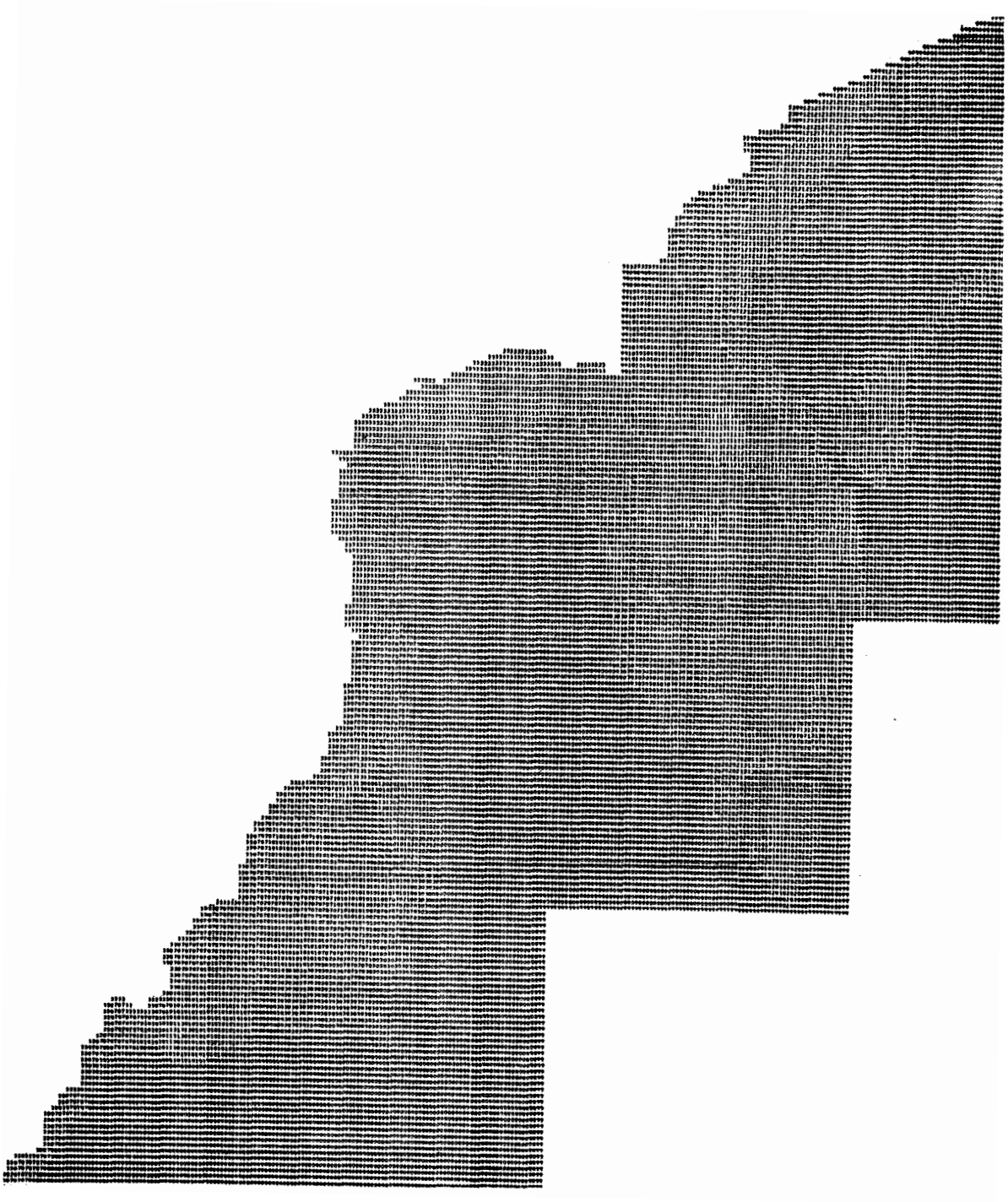

Figure 2. Printout of the coded surficial material map. Reduced to a scale of approximately 1 inch equals 1 mile.

TABLE 1

Land unit	Surface Material	Soil	Topog-raphy	Drainage	Cover Type	Stand Age	B.A./ Acre	Trees/Acre	MAI at 80 years	ARDA Class	Vegetation
1	09	sl	l	rd	PlTa					5	
2	12	l	ss	wd	TaPl	80	150	500	70	4-5	Alnus, Shepherdia, Salix
3	03	sl	ss	rd	PlSwTa						
4	05	sl	ss	rd	PlSwTa	All	150	700	40	5	Alnus, Rosa
5	07	sg	gs	rd	PlTa					5	Grass
6	13	o	l	vpd	SwTa					6	
7	13	o	l	vpd	Sw					6	Salix
8	03	l-cl	ms	wd	Pl	70	180	1000	60	4	Alnus
9	09	sg	l	rd	SwPlBp					5	
10	10	sl	ms	rd	Pl	75	180	1200	60	4	Shepherdia, Juniper
11	07	sl	gs	rd	Pl	83	115	700	40	5	Shepherdia, Alnus
12	07	sl	gs	rd	PlSw					5	Salix
13	10	sl	ms	rd	Pl	60-90	180	460	57	4-5	Shepherdia, Juniper
14	07	sl	gs	wd	SwPl		200	450	60	4	Shepherdia
15	06	sg	ss	rd	PlSw					4-5	Shepherdia
16	03	cl	ms	mwd	PlTa	67	160	1080	50-60	4	Alnus, Salix, Rosa
17	01	scl	ms	mwd	Pl	68	160	700-1600	50-60	4	Alnus, Shepherdia, Salix
18	01	sl	ms	wd	Pl	60	160	800-1900		4	Alnus
19	13	o	gs	vpd	Sw					7	Ledum
20	11	s	ms	rd	Pl	60				5	Shepherdia, Alnus, Rosa
21	06	sl	ss	rd	Pl	78	150	500	40	5	Shepherdia, Juniper
22	10	sl	gs	wd	Ta					4	Grass, Salix
23	07	sg	ss	rd	PlTa					6	Grass, Shepherdia
24	01	sl	ss	rd	PlSw	53	170	1000	70	4	Alnus, Salix, Rosa
25	02	cl	ss	wd	Pl	65	180	1000	70	4	Alnus
26	01	sl	ss	wd	Pl					4	Alnus
27	12	sl	ms	wd	Pl					5	Alnus, Shepherdia
28	14	sl	ss	rd	Pl						Juniper
29	07	sg	ms	rd	Pl					5	Shepherdia
30	01	scl	ss	wd	TaPl					4-5	Alnus, Grass

Land unit	Surface Material	Soil	Topog-raphy	Drainage	Cover Type	Stand Age	B.A./ Acre	Trees/Acre	MAI at 80 years	ARDA Class	Vegetation
31	05	sl	ss	rd	Ta					5	
32	03	scl	ss	wd	Pl	65	225	1700	75	4	Alnus
33	13	o	gs	vpd	Sw					6	Ledum
34	08	sg	ms	wd	PlSw					5	
35	07	sg	ms	rd	PlSw	65	150	300	60	4	Alnus
36	14	sl	ss	rd	SwPl						Alnus
37	02	scl	ss	rd	PlTa					5	
38	02	scl	ss	rd	Pl	65	160	3740	50	5	Alnus
39	02	sl-cl	gs	mwd	PlSw	87	150	2180	50	5	Alnus, Salix
40	12	scl	gs	mwd	Pl	52	170		70	4	Shepherdia, Juniper, Alnus, Salix
41	02	scl	ss	rd	Pl					5	
42	03	scl	ss	rd	PlTa					6	
43	03	sl	ss	rd	SwPl					5	
44	14	sl	ss	rd	Pl	45	150		40	6	
45	06	sl	gs	wd	TaPl					5	Grass
46	01	l-cl	gs	mwd	SwPl	150	170	500	60	4	Juniperus, Shepherida, Alnus
47	13	o	l	vpd	Sw						Ledum
48	02	scl	ss	rd	PlSw					5	
49	05	sl	ss	rd	PlTa					6	Arctostaphylos, Juniper
50	03	sl	ss	rd	PlSw						
51	13	o	l	vpd	Sw					6	
52	07	s-sl	l	rd	PlSw					5	Salix
53	07	sl	ms	rd	Pl	82	170	1000			Shepherdia, Rosa
54	02	sl	ss	rd	PlSw					5	
55	13	o	l	vpd	Sw					6	
56	07	sg	gs	rd	PlSw	55	170	1100	60	4	Salix
57	07	slg	gs	rd	Pl	80	150	1900	40	5	Shepherdia

Land unit	Surface Material	Soil	Topog-raphy	Drainage	Cover Type	Stand Age	B.A./ Acre	Trees/Acre	MAI at 80 years	ARDA Class	Vegetation
58	05	sl	ss	rd	Pl	82	170	1350	40	5	Shepherdia
59	13	o	l	vpd	Sw					6	
60	02	sl	ss	rd	SwPl	50	170		40	5	Alnus
61	06	sil	gs	wd	Pl	80	180		50	5	Cornus
62	01	cl	ms	wd	Pl	88	170		40	5	
63	05	sl	ss	rd	Pl	80			40	5	Shepherdia
64	13	o	l	vpd	Sw					6	
65	10	l-sl	gs	wd-rd	PlSw	96	180		50	5	Salix, Rosa, Cornus
66	01	l	ms	mwd	PlSw	92	200	1400	50	5	Salix
67	02	cl	ss	wd	Pl	93	170	2390	40	5	Shepherdia
68	03	sil	gs	mwd	PlSw					5	Ledum
69	02	scl	ss	wd	PlSw	65	180	1110	60	4	Alnus
70	01	cl	ms	wd	Sw					4	
71	07	sg	gs	rd	SwPl					6	
72	07	sl-l	gs	rd	Pl	86	180	1,000	50	5	Shepherdia Juniper
73	07	sl-l	gs	mwd	SwPl	72	160	1400	50	5	Ledum
74	03	sl	ss	rd	Pl				50	5	Shepherdia
75	02	scl	ss	rd	Sw					4	Alnus
76	02	scl	ss	rd	Sw					4	Alnus
77	07	sg	gs	rd	Sw					6	
78	07	ls-sl	gs	rd	Pl	95	180	1500	40	5	Shepherdia Salix
79	01	sil-l	gs	wd	Pl	87	180		40	5	Shepherdia
80	03	l-cl	ms-s	wd	Pl	74	150	3400	40	5	Alnus
81	03	sl-sil	s	wd	Pl	80	170	1530	50	5	Alnus Shepherdia
82	01	sl-l	ms	wd	PlTa					5	Shepherdia Salix
83	13	o	l	vpd	Ta					6	
84	07	sg	l	rd	SwPl					5	
85	07	sg	s	rd	TaPb					6	
86	07	sg	l	rd	SwTa					5	
87	03	sl	s	rd	SwTa					5	

4. Topography is described using the following abbreviations from the National Soil Survey Committee of Canada, (1965).

l (depressional to level)	ss (strongly sloping)
vgs (very gently sloping)	ses (steeply sloping)
gs (gently sloping)	vss (very steeply sloping)
ms (moderately sloping)	es (extremely sloping)

5. Drainage is described using these abbreviations (NSSCC, 1965):

r (rapidly drained)	id (imperfectly drained)
wd (well drained)	pd (poorly drained)
mwd (moderately well drained)	vpd (very poorly drained)

6. Cover type is given as follows:

Pl (lodgepole pine)	Ta (trembling aspen)
Sw (white spruce)	Pb (balsam poplar)

7. Stand age and number of trees/acre data were taken from permanent sample plot records.

8. Basal area per acre is given for fully stocked conditions. In the case of understocked or overstocked conditions, an estimate is given.

9. M.A.I. (Mean Annual Increment) is given for fully stocked stands (in cubic feet per acre per year).

10. ARDA Class is a productivity term given for fully stocked stands as follows:

Class 4	51-70 cubic feet per acre per year
Class 5	31-50 cubic feet per acre per year
Class 6	11-30 cubic feet per acre per year
Class 7	under 10 cubic feet per acre per year

11. Vegetation refers mainly to the dominant shrub species.

DISCUSSION

The mean annual increment data in Table 1 indicates that the best growth (ARDA Class 4) occurs on soils developed on deep till, and on the till and colluvium mixture. Where summer drought conditions are offset by the effects of seepage water, Class 4 productivity sites are found on fine alluvium and on coarse alluvium.

Relationships between forest growth and aspect became apparent in this study. Sites on steep north-facing slopes seem to be more productive for a given surfical material than those on south-facing slopes. Steep south-facing slopes are mostly in Classes 5 and 6.

The till sites are more productive than others, because the sandy loam and sandy clay loam soils, which are associated with tills, are more moisture retentive and have a better nutrient status than the coarse-textured alluvial and colluvial soils. Where a till deposit is capped with a coarse textured alluvial deposit the productivity is often lower by one class (Class 5 instead of Class 4).

The poorest growth (Class 6) is found on sites with extreme moisture conditions. Colluvial materials, dry coarse alluvium, deep organic soils and bedrock situations are examples.

Further field work is planned to identify the forest growth - soil relationships on the Research Forest. The preliminary inventory data given

in this report will be supplemented and developed to offer a land inventory base for future studies.

SUMMARY

A physiographic land classification was prepared for the Kananaskis Research Forest. Surficial materials were mapped from a preliminary photo interpretation of the landscape and from subsequent field checks at selected sites. Soil and forest stand data were recorded at 148 locations. Compilation of the data and preliminary analysis produced results given on a surficial material map at a scale of 4 miles to inch. Soil and forest stand conditions are described in tabular form. Further work is planned to elaborate on the forest land classification.

APPENDIX 1

Acreage of different surface materials

on the Kananaskis Research Forest.

Code	Surface Material	Area (acres)	Percentage of total
01	Till (deep)	1428	20
02	Till over Bedrock	890	13
03	Till and Colluvium	965	14
05	Colluvium	159	2
06	Alluvium (fine and coarse mixed)	338	5
07	Coarse Alluvium	1391	20
08	Coarse Alluvium over Till	26	1
09	Coarse Alluvium over Bedrock	66	1
10	Fine Alluvium	1045	15
11	Fine Alluvium over Coarse Alluvium	38	1
12	Fine Alluvium over Till	370	5
13	Organic Soils	146	2
14	Bedrock Exposures	33	1
		6895 acres	100%

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