Vermillion Pass Burn.

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Figure 1. Physiographic and Orientation Map of the Study Area. Scale 1:12,500.

Legend

1 Sandy to loamy till mantle of the Vermilion River Valley. Gentle slopes.

2 Rocky till or lateral moraine along south-east facing flank of Mount Whymper. Very rough terrain with large boulders. Slopes from 25 to 35°.

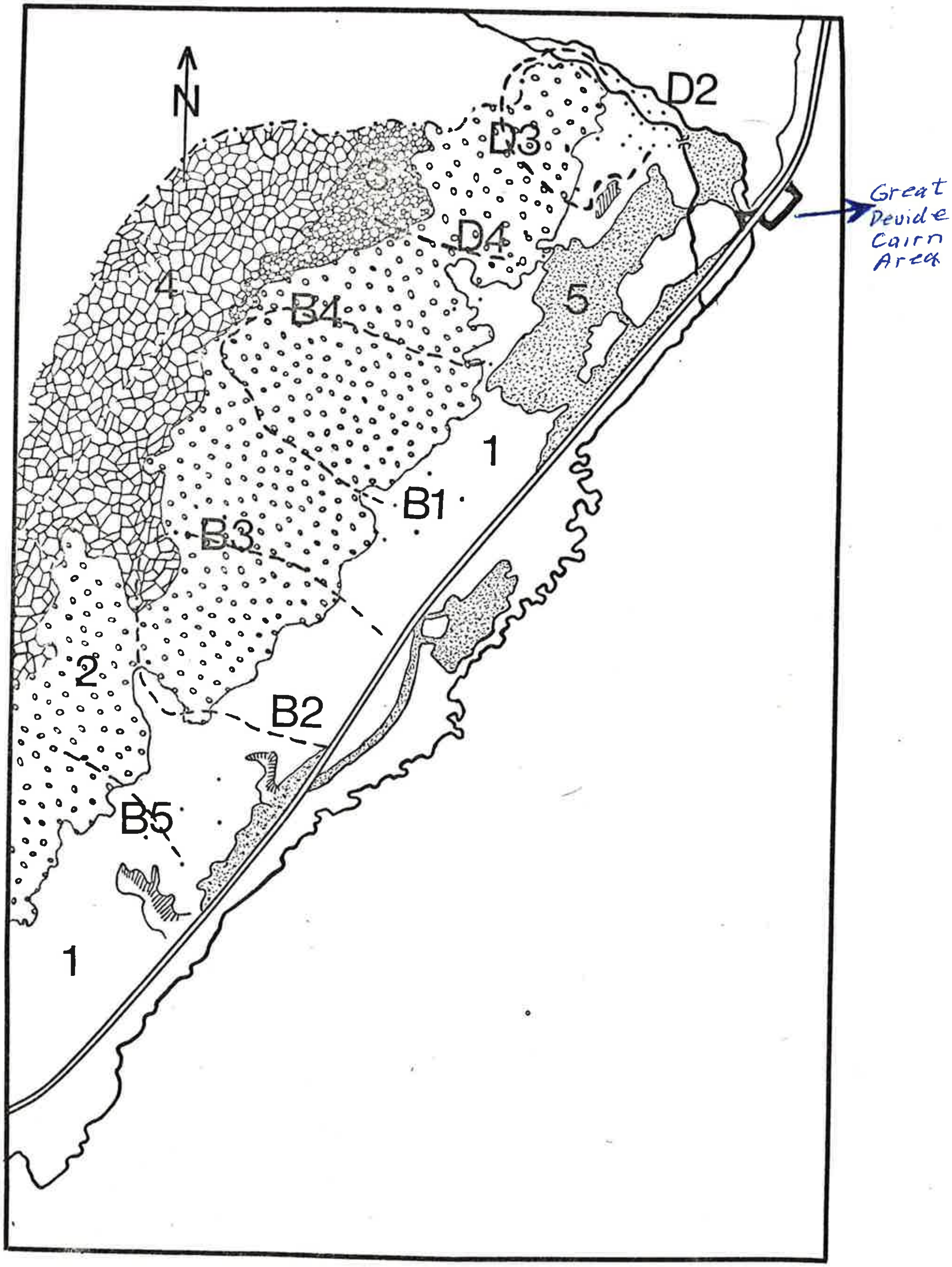
3 Rocky till, like 2, but much steeper. Slopes of 35 to 40°.

4 Very steep terrain, mostly bedrock out-crops. Slopes more than 40°.

5 Gravel pits, roadcuts and other human-caused disturbances.

Edge of burn.

Paths along which transects were set out. Individual plots are indicated by *


N
D2
D3
D4
4
3
5
B4
1
B1
B3
2
B2
B5
1
Great Devide Cairn Area

File: 90/5-R2·11D

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REPORT ON GROUND VEGETATION COVERAGE ESTIMATES, 1972.

VERMILLION PASS BURN

General Observations

In general, the growing season of 1972 was cold, windy, and showery. As a result of this, pine seedlings put forth much better growth shoots than in 1971, when an uninterrupted dry period occurred from early July through most of August. Herbaceous vegetation also was denser, and some moisture-loving species not found in 1971 were encountered in 1972. Also, a few mushroom species not found earlier, were found in 1972. These include Coprinus comatus, several clumps of which occurred on the rim of the large gravel pit near the northern entrance to Kootenay Park. This is a sand-gravel habitat where soil moisture drains easily, so that it should be expected to be dry. Another mushroom species also found on the gravel pit rim, and later identified as Polypilus umbellatus, is described by Smith (1970) as follows:

> During most seasons it is rare, but during seasons of copious rainfall it is not hard to find in the typical habitat. It has been reported across the continent and undoubtedly comes up from buried wood.

The "typical habitat", however, is ". . . low forests containing beech and maple." This makes the occurrence of this interesting fungus rather unique, and certainly points to well-above-average moisture conditions in the northern part of Kootenay Park during the summer of 1972.

Plot size for ground vegetation sampling was 10 x 10 m. This size was found the best because of the rather scant, patchy vegetation of this burned-over habitat, where often as much as 75-80 percent of the ground was bare, or covered with rock or charred debris.

The square size was usedwherever possible, except in such places as the seepage plots where the type vegetation covered narrow strips of ground. Plots were then adjusted accordingly to cover a total surface area of 1Øxxx1Ø 100 m^2.

The percentages coverage tallied for the plots in each vegetation type are estimates, but they were were made as accurately as possible, so that they should be adequate representations of the various habitats.

Field data were entered on a card system for easier handling and sorting of the various vegetation types of each habitat-type. These data were then entered on a large table, from which dominants and co-dominants, as well as constant elements of each vegetation type could be read off easily for the compilation of the classification.

The following more detailed plot-by-plot descriptions are based on this work.

Plot-by-Plot Comments

The following comments are given for each group of subplots comprising a vegetation type or community type within the burned area in the northern part of Kootenay Park, and for a few transition plots and plots in non-burned forest in adjacent areas of Banff National Park.

D1 - Grass, Salix spp., including Salix vestita, and Thalictrum are constant elements of all these plots, while Senecio is typical and co-dominant in most of them. In one plot Senecio was dominant. Parnassia, Petasites, and Fragaria are common, and may locally be abundant.

D2 - Elymus is conspicuously dominant in this site, which appears drier than D1, and has far less grass and little Senecio than D1, although these two sites are directly across the Vermilion River headwaters from each other.

D3 - These plots are situated on a river terrace. It is characterized by a mixture of invaders and regeneration from roots that survived the 1968 fire, such as Menziesia, ~~and~~ Ledum, ~~but~~ and also Linnaea. Arnica and Epilobium are the most conspicuous invaders. Taraxacum is a constant invader but has only incidental coverage (+).

D4 - The D4 plots are typically Spiraea plots. ~~Typically~~, The habitat is very rocky and ~~hilly~~ rough with locally steep slopes. The rocks and boulders may be of considerable size, and are often discolored and cracked as if by the heat of the fire. Between them may occur small pockets of washed-in humus on top of mineral soil. There often occurs a surface layer of friable, black particles of wood on this humus. Very much of the surface is bare mineral soil, however.

Besides Spiraea, Rosa is a common shrub of these plots, although it never is abundant.

Carex sp. (tall) is also a typical plant of the D4 communities, although this plant is common over much of the drier parts of the burned area, as is Carex sp. (small). In the D4 habitat, these species are forming clumps and coverage is not high except locally.

Vaccinium myrtillus, V. myrtilloides, and V. scoparium are constants, but never of high coverage either. Epilobium does well on these plots in that individual plants are large and vigourous, but coverage is nevertheless small. Linnaea covers a few percent. Pinus seedlings are quite abundant in the D4 habitat, and mostly very vigourous, but still too young to reach high total coverage.

D5 - These are seepage plots. Seepage springs issue forth at various places along the lower boundary of the very rocky D4-type habitat and the D3 river terrace habitat. Seepage sites with deep organic soils and rather dense, moisture-loving herbaceous and shrub vegetation as well as dense moss carpets, develop along the tiny creeks issuing from the springs. The water may be running, as in D5.1, or stagnant, as in D5.4, or both may occur in the same plot (D5.2 and D5.3). The plots never dry out. D5.4 is a very large seepage site with a narrow rim of the typical, dense seepage vegetation surrounding a large area of shallow, stagnant water, and underlain by deep muck. Moss here was largely Sphagnum sp., and herbaceous vegetation was dense, coverage being 100% or more (double coverage by lower and taller vegetation). Interesting in this plot was also the total absence of Carex sp. (medium) which occurred faithfully in all three the other seepage plots. There were no Carex spp. at all in this site.

The seepage plots tended to have a few small spruce seedlings in them although no source trees were very near any of these sites. Pines in these plots tended to be few, small, and sickly, except where they had germinated on small hummocks or along the edges of the actual organic-soil area. Seed source trees were never found within any of the seepage plots, but there generally were some mature pines, killed in the 1968 fire, but still with open cones on dead branches, nearby. Petasites and Equisetum arvense and E. scirpoides were recurring components of the herbaceous vegetation, while Menziesia resprouted from hummocks it had occupied before the fire. Epilobium was confined to high ground and a few dry spots in these high-moisture plots.

B1 - Epilobium-Arnica-Linnaea plots with Anaphalis margaritaceae as a recurrent constant in all plots but B1.6, and two species of Carex in all. This vegetation structure makes these plots very similar to the B5 plots, but in the latter, there is much Elymus and Rosa which are absent from B1.

B2 - These plots are strung out along a small ravine where cold air drainage is suspected. Lower temperatures and evaporation would point to this. Aster conspicuus, also a constant of the B5 plots, is a constant here, but never abundant. These plots are typical Epilobium-Arnica plots with Carex spp. and Taraxacum common in all.

B3 - The B3 plots of 1971 ~~are believed~~ were found to be in the same habitat as the B5 plots of 1972, and will be treated as part of the report on the B5 plots.

Plots in the new (1972) B3 series, and in the B4 series, were strung out along trails which are indicated on the main map and on the sketch below by broken lines. The B3 and B4 plots were all 10x10m in size, alternating with transect plots of 2x30m, used for pine seedling counts only. The 10x10m plots were used for making ground vegetation cover estimates, taking soil samples and soil temperatures, and for collection of pine seedlings. Results of laboratory work done on the seedlings and on the soil samples appear elsewhere in this report.

B3 - The 1972 B3 plots occur mostly on very rough, extremely rocky terrain with strong relief and slopes of up to 40^{o} in the steepest part of the transect trail. The series consists of 16 plots which show changes in vegetation cover with the changes in steepness of terrain. Possibly this is due to changes in moisture regime. Species composition also changed rather markedly through this series of plots. In the less steep parts of the trail, which also was less rocky, *Epilobium* was clearly the dominant herb with *Carex* spp. and *Linnaea* prominent, while *Lonicera* was the most common shrub. As slopes became steeper than the 20^{o} maximum of the lower part of the area, *Lonicera* was replaced by *Menziesia*, while the smallest species of *Carex* began to occupy more ground space at the expense of the other two Carex spp., Epilobium decreased in percentage coverage, and Spiraea made its appearance. In the steepest part of the area, Aster conspicuus came in, and the smalles Carex sp. began to assume dominance, while Linnaea dropped out altogether. There was no moss in this part of the area either. Slopes here were 35-40°, and enormous boulders occupied large areas of surface.

When slopes became gentler again, the smallest Carex sp. decreased in importance, while Linnaea and Epilobium regained their former ~~dominant~~ prominent roles.

Pine regeneration was excellent on the sloping part of the trail, but very few or no pines at all were found in the plots of the highest part of it. However, no seed source trees were seen there either!

B4 - The ten plots of this series also showed changes in vegetation cover and composition, but in this case the changes were not so easily correlated with changes in habitat. Spiraea was dominant in the first three plots, on a very rocky substrate like that of the D4 plots, while the smallest Carex sp. was the dominant herb, with Epilobium and Aster conspicuus only slightly less prominent.

After these three plots, Spiraea disappeared entirely from the habitat, and Aster conspicuus occurred in only one other plot, but Epilobium increased in importance as slopes became steeper. The smallest Carex sp. remained a prominent member of the plant communities of the entire series, while the tall Carex sp. increased in abundance with increased slope. It reached dominance in the herb layer of plots B4.7 and B4.8, on very rocky terrain with slopes of 40°. In these two plots, Alnus crispa was the dominant shrub, with Sambucus and Rubus prominent, and some Ribes present. Descending from this steep slope to more gently sloping and less rocky terrain, all four of these shrub species disappeared entirely. Menziesia remained an important shrub in all plots.

Lodgepole pine seedlings were very numerous in the first four plots, but diminished much after that. Here again, seed source tree presence played an important role.

In a lower area between knolls, a curious patchwork occurred, made up of patches of intermixed Carex sp. and grass, and of intermixed Linnaea and a legume. Senecio and Thalictrum also were common members of this rather extensive community which had a surprisingly consistent composition. The plot set out in it, was called B4.10, and, although it does not belong in this series, will be treated here because of its geographical location directly adjacent to the plots of the series. Its composition was as follows:

Carex sp. (small)	25 - 30 %
Grass	20 - 25
Linnaea	10 - 15
Legume	20 - 25
Senecio	9 - 10
Thalictrum	5 - 6

Coverage throughout was 95 - 100 %. This patchy vegetation seems to be of highly local occurrence in the northern part of Kootenay Park. No such vegetation was encountered anywhere else by the present writer.

B5 - These are ridge-top plots on till with a podzolic soil horizon, the Ah of which is usually less than 1 inch thick. There is much bare mineral soil, pointing to more severe burning than in most of the area. Within this area are remnants of an attempt to dig a gravel pit. The material exposed here was very course gravel to pebbles of 4 inches or more in diameter. This material may be of much larger extent beneath the above mentioned soil profile. The surface material is much finer-grained. The coarser material in the subsurface may be very important in terms of soil moisture and underground drainage and seepage in this rough terrain. Some large boulders are also found in this area, including within the B5 plots. Their number increases northwards, and reaches an extreme in the D4 plots.

The B5 plots are Epilobium-Arnica-Linnaea plots with Elymus as a conspicuous constant. Rosa also is a common element of these plots. Pines do well here, but are neither as abundant nor as vigourous as in D4 or in the better areas of the B3 and B4 series.

All three Carex spp. are constants in the B5 plots but they vary in coverage percentages.

Spiraea does occur in this habitat, but is local only and never reaches abundance.

Transition Plots and Green Plots.

There is not always a transitional zone between burned and green forest: often the change-over is very abrupt, as for instance, upstream from the D-plots in the Vermilion River headwaters. There, a lush herbaceous valley bottom vegetation with its Elymus, Senecio, Thalictrum, and grass, and but a few Lonicera and Salix spp. in the shrub layer, quite suddenly gives way to green forest with a dense understorey vegetation. The latter consists of four distinct layers: ground, herb, low shrub, and tall shrub. The most conspicuous of these is the Menziesia-dominated layer.

Distinct transition areas were found to the north of this in adjacent parts of Banff National Park, between the Continental Divide and Storm Mountain Lodge. These plots do not appear in the map, nor do the Green Plots, also taken in this same area in Banff Park, adjacent to, or very near, the transition plots.

Epilobium is the dominant herb in the transition plots as well as in most of the burned area, and the vegetation of the transition plots in general is reminiscent of that of the valley bottom plots D1 and D2. Pine regeneration in the transition plots is poor, while spruce regeneration is better than that found in the wet D5 seepage plots.

In the transition plots an average of 21% of the ground surface is bare, the range being from 10% to about 40%. In the fully burned area these figures are: average percentage bare - 49%, and range from 25 to 75%. Thus, the transition plots are less than half as bare as the burned plots.
The green plots are in subalpine successional forest, where mature to old lodgepole pine trees are still common, spruce reaches maturity, and alpine fir is a component of the shrub layer. The latter is dominated by Menziesia glabella, which forms a dense understory with coverage of from 50 up to 85%. Spruce regeneration in this forest is also good, and spruces of all ages are generally present.
The herb layer in the green plots is not dense, nor did it have an impressive number of species. Vaccinium scoparium is a typical species, often reaching dominance in that layer.
The ground layer consists of a dense moss carpet, mostly of feather mosses, but there may also be other mosses, and a green, leafy liverwort also occurs.

LEGENDS AND CAPTIONS FOR MAP AND FIGURES 2 - 5.

MAP Done on a separate sheet, see next sheet.

Figure 2. Micro-environmental data from two temporary weather stations, D2 and B5, during July and August 1972. Values are averages for the time periods indicated.

D2 ————————

B5 - - - - - -

Figure 3. Maximum (above) and minimum (below) temperatures for two temporary weather stations, D2 and B5, during July and August of 1972. Temperatures are in degrees centigrade, and values were plotted in the centre of the time periods during which they occurred.

D2 ————————

B5 - - - - - -

Figure 4. Some micro-environmental data from two temporary weather stations, B1 and B2, during July and August of 1972. Temperature values are plotted in the centre of the time period to which they apply. Evaporation values are averages for their time periods.

B1 ————————

B2 - - - - - -

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2 Rocky till or lateral moraine along south-east facing flank of Mount Whymper. Very rough terrain with large boulders. Slopes from 25 to 35°.

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4 Very steep terrain, mostly bedrock out-crops. Slopes more than 40°.

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Edge of burn.

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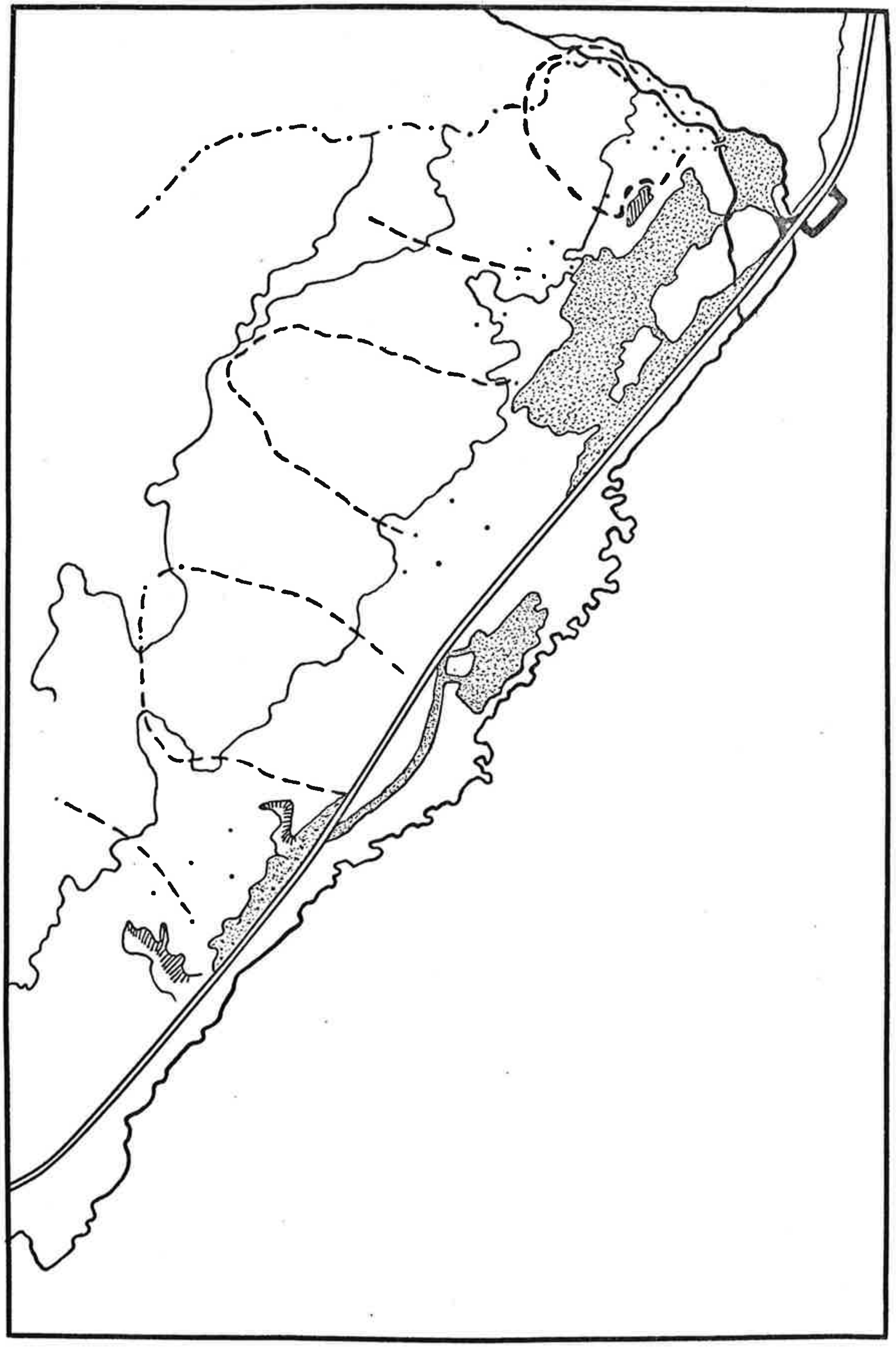
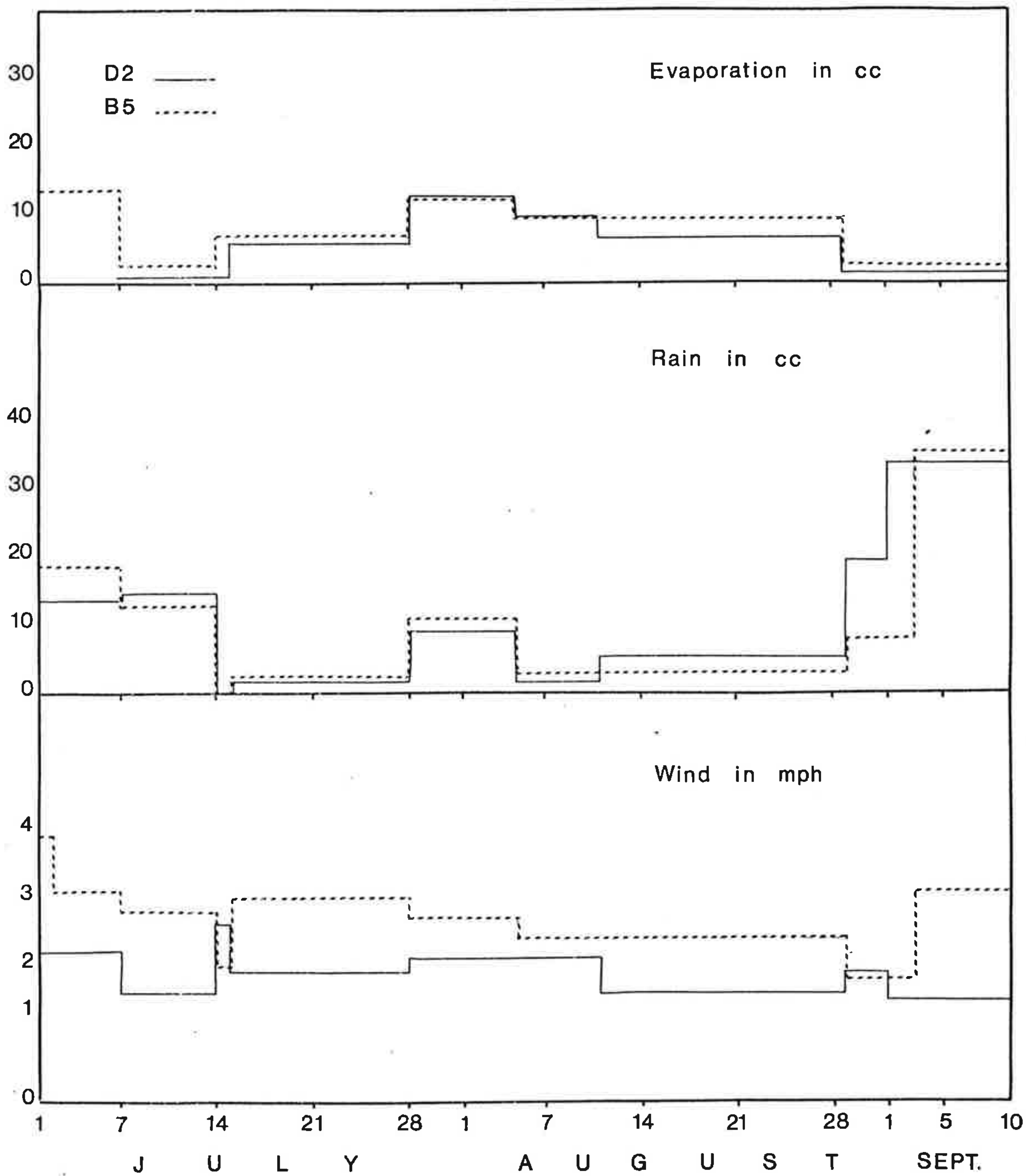
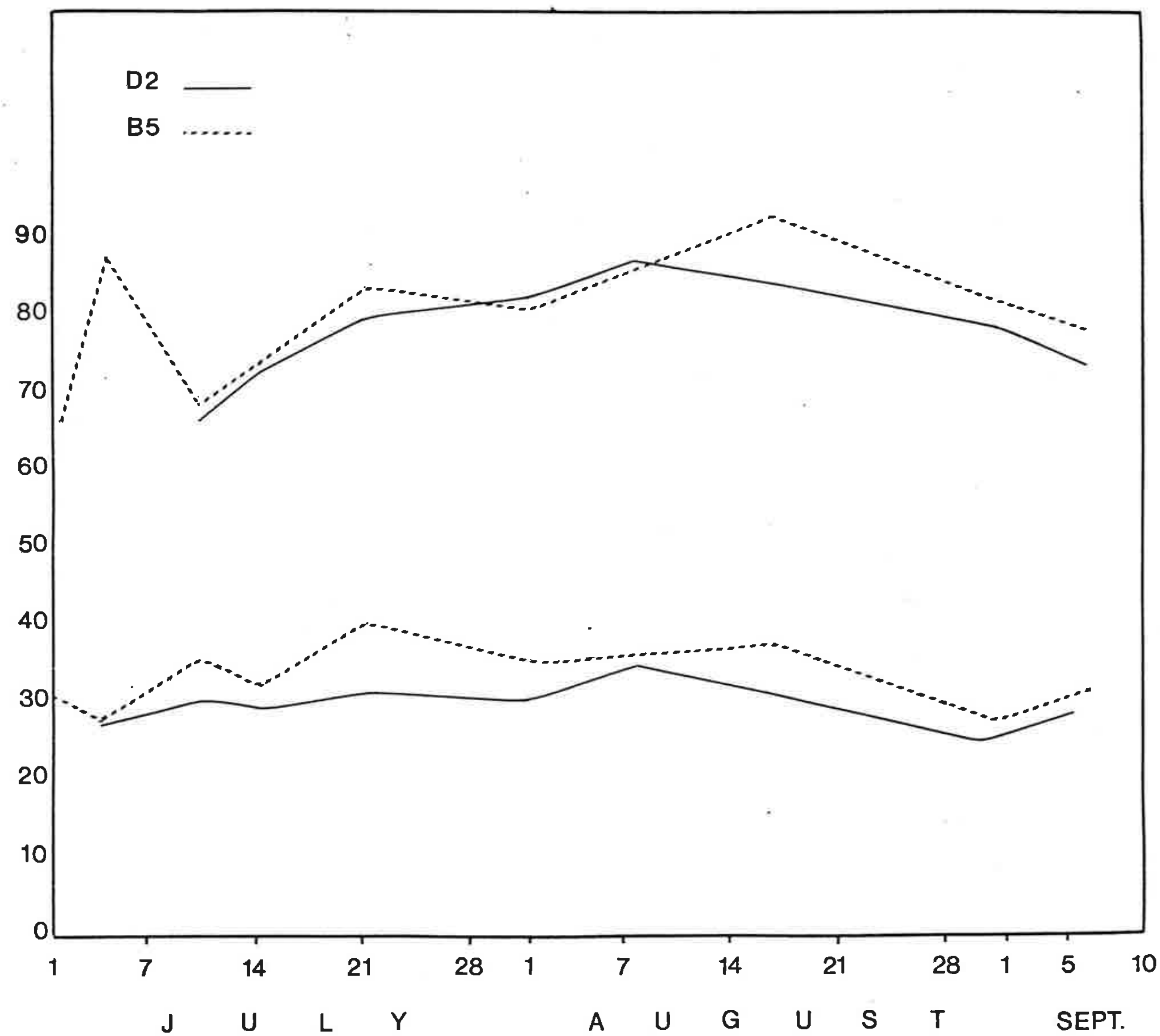



D2
B5
Evaporation in cc
30
20
10
0
Rain in cc
40
30
20
10
0
Wind in mph
4
3
2
1
0
1 7 14 21 28 1 7 14 21 28 1 5 10
J U L Y
A U G U S T
SEPT.



D2
B5
90
80
70
60
50
40
30
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10
0
1
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28
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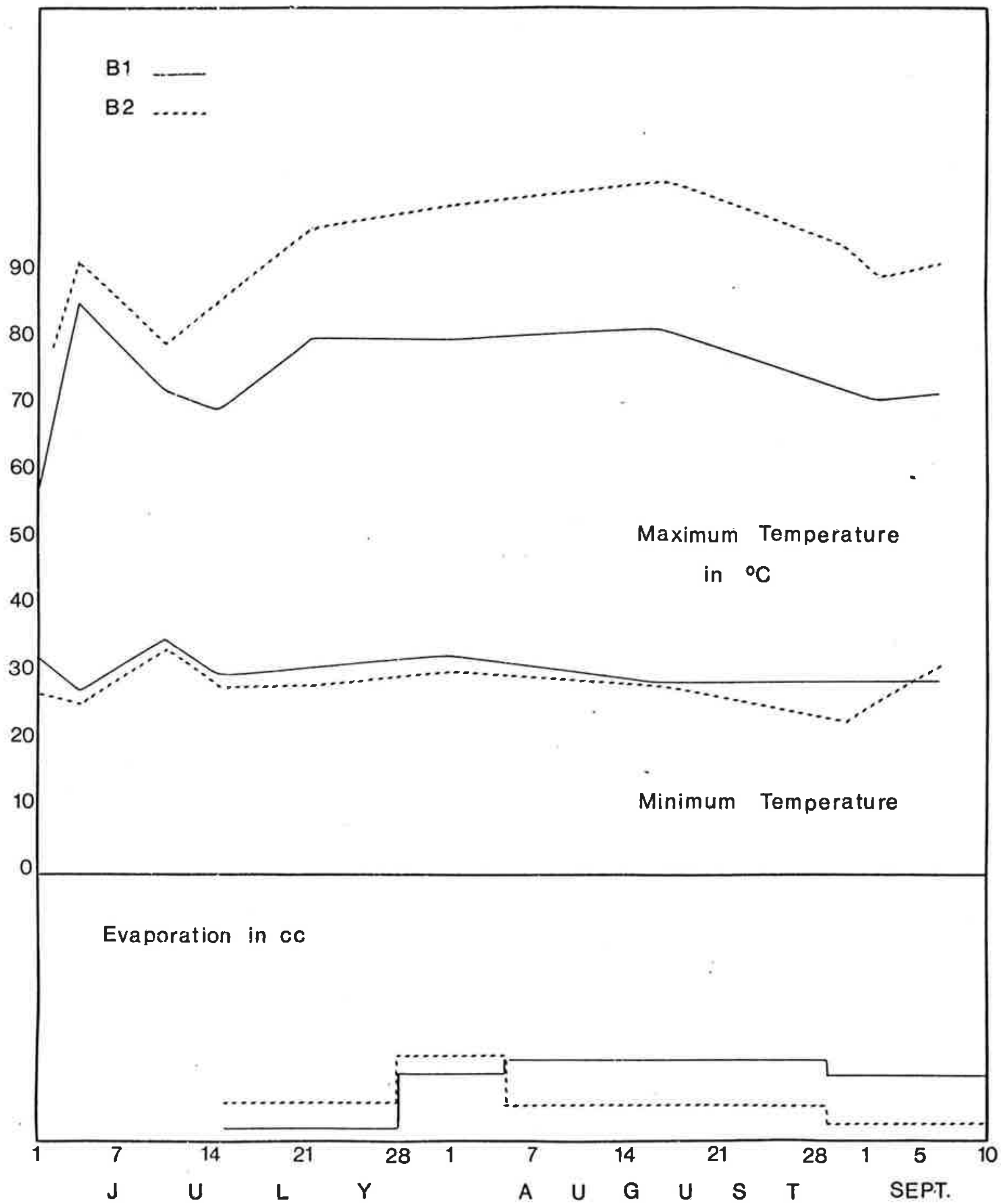
7
14
21
28
1
5
10
J U L Y
A U G U S T
SEPT.


B1
B2
90
80
70
60
50
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30
20
10
0
Maximum Temperature
in °C
Minimum Temperature
Evaporation in cc
1
7
14
21
28
1
7
14
21
28
1
5
10
J U L Y
A U G U S T
SEPT.

LODGEPOLE PINE SEEDLING DATA

Lodgepole pine seedling data were grouped into two kinds, those correlating regeneration density to seed source abundance, and those giving an impression of the vigour of seedlings from different habitats.

The first group of data is brought together in a table and a diagram which show very definite correlation between number of seedlings and number of seed source trees. These latter are mature pines, killed in the 1968 fire, but with mostly open cones still attached to their branches. Such trees were considered source trees when they occurred within 10m of the transects in which seedlings were counted, but it is highly likely that trees farther away than this have contributed seeds, such as, for instance, when a strong wind blew in the right direction. This explains the occurrence of seedlings on transects with no seed trees nearby.

Thus, the presence of seed source trees within the burn itself is a critical factor in lodgepole pine regeneration in this area.

Substrate or slope as such apparently did not have nearly so much effect on seedling density, but moisture conditions, presumably resulting from such characteristics, had a definite effect on both seedling density and vigour. This was particularly evident in seepage areas with their extremely high soil moisture contents, dense moss carpets and herbaceous vegetation, and very few pine seedlings, even though there usually were several seed source trees sufficiently close to such areas to have supplied enough seed for better regeneration. These seed source trees were never found within the seepage areas, and seedlings occurring in them tended to be small and sickly. However, a few tiny but quite vigourous spruce seedlings grew in each one of the seepage plots. No mature spruce trees were very near any of the seepage sites, but spruce seeds are smaller than those of lodgepole pine and can, therefore, be carried by wind much easier, and over longer distances. Spruce regeneration was better also with seed trees nearby, as along the edge of the burn: spruce seedling counts in transition plots were consistently higher than those in the seepage plots.

In the valley bottom plots set out along the Vermilion River headwaters to the edge of the burn, there did occur a number of mature, burned lodgepole pines which could have served as seed sources, but regeneration in these plots was very scant. However, the individual seedlings encountered here showed good vigour.

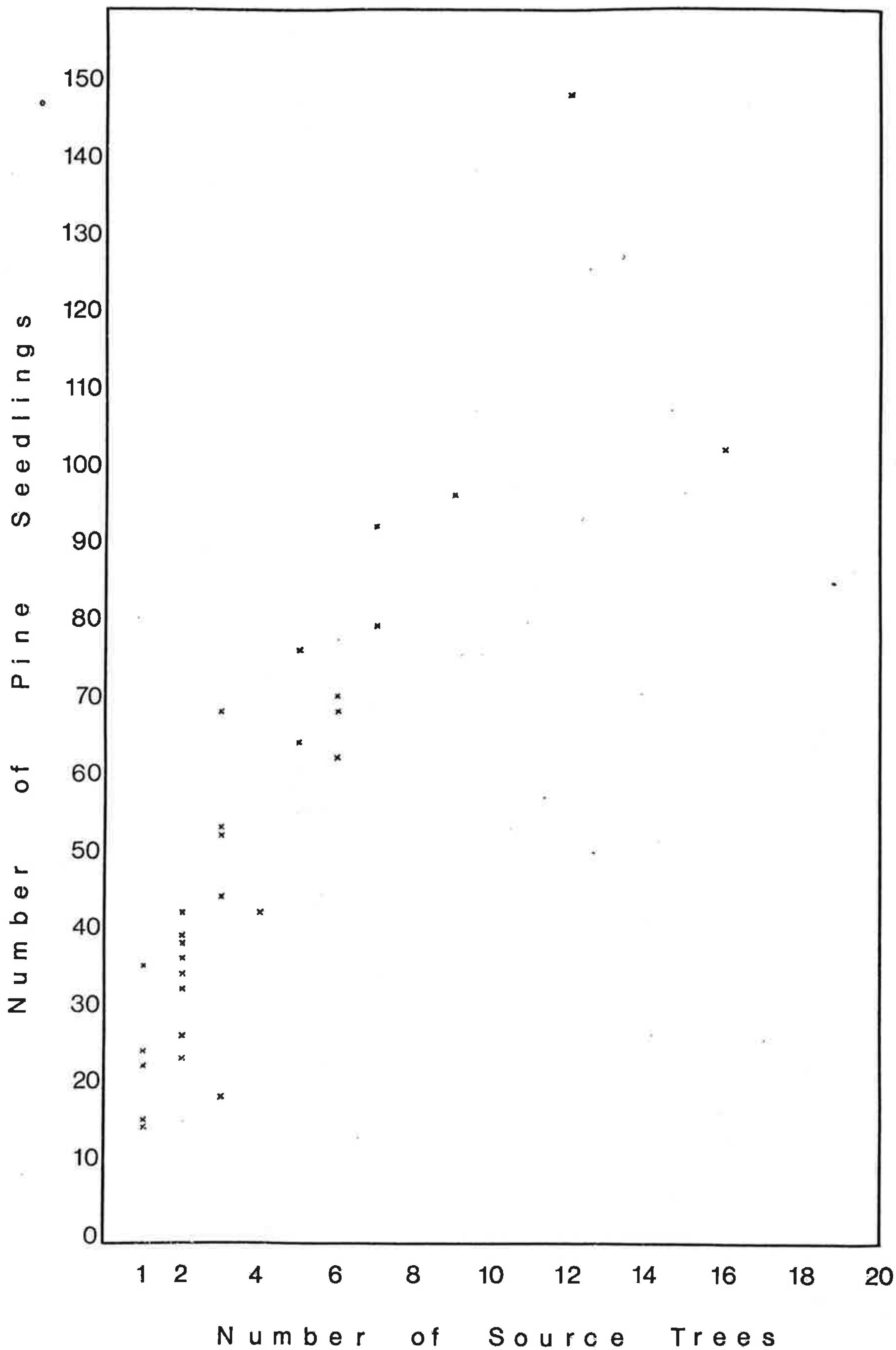
The second group of data was used to compile a diagram which shows the correlation between shoot height and root depth as measures of vigour, and weight, another measure of vigour, and the habitat in which the seedlings were found. Lodgepole pine roots have been classified into three distinct types by Smithers (1961). These three root types could already be recognized in most of the young seedlings collected during the present study. In some cases it was, therefore, considered more realistic to "compile" total root depths by including lateral root lengths in the measurements.

The pines used for these measurements were collected from all 87 10x10m sampling plots established in 1972.

Similar collections were carried out, and measurements taken from pines collected in 1971 (germinated in 1969, 1970, and 1971). These data may be compared with those from pines germinated in 1970, 1971, and 1972 from the 1972 collections. This should give some idea of differences in pine growth vigour between a dry and an abnormally wet growing season.

An effort will also be made to correlate lodgepole pine seedling density and vigour with the various herbaceous vegetation types found in the area of study.

Figure 5. Correlation between seed source trees and regeneration for lodgepole pine in the Vermilion Pass burn, Kootenay National Par., British Columbia.
Trees were considered source trees when they occurred within 10m of the transects on which the lodgepole pine seedlings were counted.
Transects were 2x30m in size, and strung out along trails which are indicated on the map as broken lines.



150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
Number of Pine Seedlings
1 2 4 6 8 10 12 14 16 18 20
Number of Source Trees

PINE SEEDLING AND SOURCE TREE COUNTS

ON 30x2 m TRANSECTS

Location	Number of Seedlings	Number of Source Trees
B1.1 to B1.6	33	2
B1.6 to B1.7	43	2
B1.7 to B1.8	12	-
B1.8 to B1.9	77	5
B4.1 to B4.2	35	2
B4.2 to B4.3	97	9
B4.3 to B4.4	103	16
B4.4 to B4.5	15	1
B4.6 and B4.7 had no pines		
B4.8 to the road:		
1st 30 m	15	-
2nd 30 m	23	1
3rd 30 m	54	3
4th 30 m	24	-
5th 30 m	22	-
6th 30 m	53	3
B5.6 to B5.7	63	6
B5.7 to B5.8	39	2
B5.8 to B5.9	-	-
B5.9 to B5.1	69 37	3 2

PINE SEEDLING AND SOURCE TREE COUNTS

ON 30x2 m TRANSECTS

Location*	Number of Seedlings	Number of Source Trees
B3.1 to B3.2	26	-
B3.2 to B3.3	69	6
B3.3 to B3.4	43	4
B3.4 to B3.5	23	-
B3.5 to B3.6	40	2
B3.6 to B3.7	36	1
B3.7 to B3.8	93	5
B3.8 to B3.9	26, 55, 68 } 149	12
B3.9 to B3.10	29	-
B3.10 to B3.11	-	-
B3.11 to B3.12	11	-
B3.12 to B3.13	25	1
B3.13 to B3.14	65	5
B3.14 to B3.15	71	6
B3.15 to B3.16	23 57	7
B3.16 to road	27	2

*) See map

**) A tree was considered a source tree when it was within 10m of the transect.

PINE SEEDLING AND SOURCE TREE COUNTS

ON 30x2 m TRANSECTS

Location	Number of Seedlings	Number of Source Trees
Road to D4.1	12	-
D4.1 to D4.2	45	3
D4.2 to D4.3	22	-
D4.3 to D4.4	24	2
D4.4 to D4.5	16	1
D5.1 to D5.3 (Habitat: D3-type)	19	3

ENVIRONMENTAL DATA

Date installed: 28 June 1972.

PLOT: B 1

Date:		Wind	Rain in cc	Evap. in cc	Max. in °C	Min. in °C
July	1				58.0	32.5
	7				85.5	27.5
	14				72.5	35.3
	15			inst.	69.8	29.9
	28			26.5	80.4	31.1
Aug.	5			82	80.2	-
	29			290	81.9	28.3
Sep.	3			-	71.0	-
	10			118.5	72.1	29.2

PLOT: B 2

Date:		Wind	Rain in cc	Evap. in cc	Max. in °C	Min. in °C
July	2				79.0	27.2
	7				91.8	25.3
	14				79.8	33.9
	15			inst.	85.6	28.3
	28			75.5	97.0	28.4
Aug.	5			103	100.2	30.4
	29			129	104.0	28.2
Sep.	1			-	94.2	23.0
	3			-	89.5	26.2
	10			31.5	91.3	31.2

Date installed: 28 June 1972. **PLOT: D 2**

Date	Wind	Rain in cc	Evap. in cc	Max. in °C	Min. in °C
June 28	0000.1				
July 1	132.3				
July 7	450.2	81	leaking	-	27.5
14	716.2	103	7	67.0	30.5
15	778.8	0	-	73.2	29.8
28	1363.9	22	82	80.3	31.8
Aug. 5	1770.8	72.5	96.5	82.8	30.4
11	2072.5	11	58	87.5	35.0
29	2759.1	96	122	84.5	31.5
Sep. 1	2894.8	58	-	79.0	25.0
10	3211.4	304.5	18.0	74.9	28.8

Plot D 2 is situated along the Vermilion River headwaters, between Mount Whymper and Boom Mountain in a valley at a right angle to the main valley. Winds affecting the anemometer here would be mainly those blowing through this side valley. Proximity to the river was thought to provide considerably more moisture in both air and soil than was expected for most of the other plots.

Instruments were installed close together, as close to the ground as possible while still protected from kicking by ungulates. The thermometers were on the shade side of a large tree trunk.

Elevation: 5400 feet.

Date installed: 28 June 1972. **PLOT: B 5**

Date		Wind	Rain in cc	Evap. in cc	Max. in °C	Min. in °C
June	28	5078.3				
July	1	5272.0				
	2	5366.1	0	-	67.0	33.0
	7	5743.3	92	82	88.0	28.0
	14	6214.1	89	18	69.0	36.0
	15	6262.5	-	-	74.2	32.5
	28	7203.1	31	98	84.0	40.6
Aug.	5	7729.3	87	98	81.2	35.6
	29	9119.5	72.5	228	93.2	37.9
Sep.	3	9332.9	40	-	82.5	27.5
	10	9847.0	239	30.5	78.4	31.8

Plot B 5 is situated on top of a hill on the south-east facing slope of Mount Whymper, elevation approximately 5450 feet. The instruments were installed in close proximity to one another, with the thermometers hung on the north facing side of a large tree trunk, shielded from direct sun during most of the day, and about three feet above the ground to protect them from kicking by passing ungulates. The rain gauge was as close to the ground as possible, as was the evaporimeter. The latter was installed between some closely crowded tree trunks - again, to be safe from animal kicking.

% SOIL MOISTURE CONTENTS

ON A WEIGHT BASIS

Plot		July 1-8	July 14-15	July 28	August 5	August 11	August 29	Sept. 1-3
D1.1	top	49.5	67.2	25.8	13.9	5.9	2.0	-
	2"	94.6	56.7	26.1	42.2	23.9	51.7	-
D1.2	top	-	69.9	3.9	13.7	1.7	1.3	-
	2"	-	177.7	27.7	27.9	54.3	28.7	-
D1.3	top	-	139.5	47.6	5.5	6.5	2.9	-
	2"	-	105.6	54.4	17.8	120.3	25.5	-
D1.4	top	-	55.4	6.0	1.7	14.1	29.4	-
	2"	-	43.4	51.4	57.0	48.9	36.1	-
D1.5	top	-	180.0	48.5	7.0	2.9	3.3	-
	2"	-	89.3	38.4	28.8	32.5	53.4	-
D2.1	top	33.5	61.5	2.9	7.7	3.0	13.3	-
	2"	23.9	-	53.6	31.5	43.4	59.7	-
D2.2	top	-	128.8	5.6	24.7	12.1	22.1	-
	2"	24.6	64.5	47.5	59.1	123.0	27.6	-
D2.3	top	-	18.0	19.4	20.1	1.1	12.5	-
	2"	-	13.0	47.3	46.1	149.1	62.4	-
D2.4	top	-	138.4	19.4	17.5	16.0	2.4	-
	2"	-	40.8	35.8	8.6	34.0	35.5	-
D2.5	top	-	50.8	20.9	1.5	2.5	7.6	-
	2"	-	41.0	42.1	60.0	102.4	140.0	-

% SOIL MOISTURE CONTENTS

ON A WEIGHT BASIS

Plot		July 1-8	July 14-15	July 28	August 5	August 11	August 29	Sept. 1-3
D3.1	top	54.8	80.7	30.4	11.4	3.1	0.8	-
	2"	56.8	47.6	33.2	62.4	63.5	89.1	-
D3.2	top	68.3	73.3	0.7	10.8	33.7	6.6	-
	2"	56.6	58.7	25.2	60.7	50.2	49.2	-
D3.3	top	6.2	93.4	9.8	17.7	5.9	1.9	-
	2"	66.1	48.5	41.4	48.0	33.7	78.2	-
D3.4	top	67.7	79.0	0.8	9.9	4.1	7.9	-
	2"	70.2	47.9	25.8	50.2	36.7	32.0	-
D3.5	top	52.2	72.2	26.5	11.3	2.0	2.0	-
	2"	72.4	70.5	58.0	41.8	40.5	66.0	-
D4.1	top	-	55.6	4.9	5.7	2.6	-	51.3
	2"	-	33.2	36.6	51.4	18.8	-	39.6
D4.2	top	-	36.9	4.3	25.6	18.1	-	5.0
	2"	-	15.3	12.0	39.3	64.3	-	14.0
D4.3	top	-	72.2	27.5	11.4	9.5	-	5.8
	2"	-	75.0	32.4	49.4	123.8	-	21.7
D4.4	top	-	78.0	3.2	5.2	20.5	-	12.2
	2"	-	85.3	52.4	29.8	26.5	-	13.3
D4.5	top	-	61.3	5.9	3.9	4.5	-	8.2
	2"	-	66.3	28.3	38.2	8.4	-	38.4

% SOIL MOISTURE CONTENTS

ON A WEIGHT BASIS

Plot		July 1-8	July 14-15	July 28	August 5	August 11	August 29	Sept. 1-3
D5.1	top	288.9	568.3	525.0	260.0	180.0	-	-
	2"	665.4	753.3	804.5	436.8	225.9	-	-
D5.2	top	-	-	-	-	-	-	396.2
	2"	-	-	-	-	-	-	726.5
B1.1	top	56.6	100.9	10.5	10.8	-	6.4	-
	2"	45.7	45.6	47.1	35.0	-	37.5	-
B1.2	top	67.8	83.8	10.9	6.9	-	4.1	-
	2"	48.7	49.8	-	26.5	-	18.3	-
B1.3	top	146.3	77.6	8.3	18.0	-	5.2	-
	2"	171.0	47.4	68.9	94.4	-	20.4	-
B1.4	top	38.5	86.1	14.8	9.1	-	10.6	-
	2"	48.1	68.7	40.0	29.6	-	80.1	-
B1.5	top	58.3	124.6	4.0	31.2	-	2.1	-
	2"	49.1	60.8	28.3	51.2	-	16.8	-

% SOIL MOISTURE CONTENTS

ON A WEIGHT BASIS

Plot		July 1-8	July 14-15	July 28	August 5	August 11	August 29	Sept. 1-3
B2.1	top	63.0	101.3	20.1	6.9	-	14.6	-
	2"	84.6	76.2	35.9	59.2	-	22.1	-
B2.2	top	95.0	100.7	15.6	15.0	-	3.9	-
	2"	59.6	91.2	41.0	40.9	-	38.6	-
B2.3	top	79.7	91.0	19.2	10.0	-	7.6	-
	2"	-	66.7	36.7	54.6	-	22.8	-
B2.4	top	143.6	98.7	24.3	3.3	-	2.2	-
	2"	39.6	57.9	40.6	53.3	-	29.2	-
B2.5	top	-	-	-	34.3	-	3.0	-
	2"	-	-	-	47.3	-	16.9	-
B5.1	top	20.0	56.8	3.3	6.2	-	15.8	-
	2"	29.1	63.2	31.8	57.8	-	31.2	-
B5.2	top	24.4	142.9	21.3	23.1	-	7.0	-
	2"	26.5	34.3	42.6	37.5	-	24.1	-
B5.3	top	50.3	100.0	6.4	14.0	-	12.5	-
	2"	40.2	62.3	47.4	26.2	-	14.0	-
B5.4	top	119.0	98.6	28.6	9.3	-	3.4	-
	2"	48.1	16.5	57.0	29.2	-	18.3	-
B5.5	top	31.2	105.2	7.8	15.9	-	10.5	-
	2"	45.5	54.0	29.1	37.7	-	13.8	-

% SOIL MOISTURE CONTENTS

ON A WEIGHT BASIS

Plot		July			August			Sept.
		1-8	14-15	28	5	11	29	1-3
B4.1	top							8.3
	2"							113.0
B4.2	top							56.3
	2"							29.9
B4.3	top							3.8
	2"							30.9
B4.4	top							8.9
	2"							20.0
B4.5	top							16.1
	2"							20.8

Table of Soil Temperatures

The following table of average soil temperatures is based on data gathered during the summer of 1972.

The warm part of each day was divided into late morning (a.m.), early, and late afternoon (p.m.), because it was thought that this would show increased differences between surface temperatures and those at 2" depth as the day progressed and the soil would warm more at the surface due to insolation. The data generally support this view, although not always consistently.

Two factors are held responsible for the inconsistencies. In the first place, the summer of 1972 was very cloudy and windy with much shower activity, so that temperatures showed large fluctuations over short periods of time, upsetting the normal daily course of temperatures.

Secondly, soil surfaces which have been blackened by fire can be expected to heat and cool faster than soils of a less dark color. Investigations by Tranquillini et al. (   ) also showed swift changes in temperature with changes in insolation. While taking surface temperatures, the vanishing of the sun behind a cloud was directly reflected in the temperature reading of the instrument. Differences could be as much as 10° C. Temperatures at 2" depth did not show such rapid fluctuations.

There does occur a notable shift in temperature changes with the passing of the season, however. It was found that, even in early July, temperatures at the soil surface and at 2" depth did not reach the values of mid and late August under similar insolation conditions.

Surface temperatures generally were higher than those at 2" depth, as should normally be expected. In late afternoon, however, temperatures at 2" were often found to be slightly higher than those at the surface.

This is seen as a result of more rapid cooling at the surface while temperatures at 2" depth took longer to decrease. Also, the soil at 2" depth generally had a higher moisture content retarding temperature changes. This latter might also explain why surface temperatures were sometimes found to be lower than those at 2" depth during the middle of the day, when cloud cover may have caused a temporary decrease of surface temperature.

The ~~enormously~~ extremely high soil moisture contents of the seepage areas (D5 plots) were thought to be the cause of the consistently lower temperatures, both at the surface and at 2" depth, in these organic soils. Soils in the D1 and D2 plots (valley bottom) did not have moisture contents that were much different from those of soils in other plots, and soil temperatures did not differ much from those of other plots either. Soil moisture and temperature differences could have become evident for these valley bottom plots if the summer of 1972 had had a prolonged period of dry weather, such as occurred in 1971.

SOIL TEMPERATURES IN DEGREES CENTIGRADE
(Averages)

Date	Plot	late a.m. top	late a.m. 2"	early p.m. top	early p.m. 2"	late p.m. top	late p.m. 2"
June 28	D2	11.5	11.8				
29	B1	11.5	12.3				
July 1	D2	20.5	11.5				
2	B2					21.7	15.1
	B5					12.1	12.5
4	D1			38.0	12.5		
	D3			31.8	19.2		
	D5			32.5	22.5		
7	D2	15.0	11.8				
	B1	14.5	12.5				
	B2			15.5	12.5		
	B5			14.0	12.8		
14	B1					16.3	11.1
	B2					12.1	12.3
	B5					12.5	13.1
	D1			17.1	14.2		
	D2			21.2	14.4		
	D3			16.7	14.5		
	D4					21.6	17.2
	D5					16.5	13.5
28	D1			36.4	23.5		
	D2			38.5	24.5		
	D3			42.3	26.6		
	D4			32.3	23.5	32.0	24.1
	D5			25.1	17.0		
	B1					17.6	18.0
	B2					25.8	20.0
	B5					26.8	21.4

SOIL TEMPERATURES IN DEGREES CENTIGRADE
(Averages)

Date		Plot	late a.m. top	late a.m. 2"	early p.m. top	early p.m. 2"	late p.m. top	late p.m. 2"
August	5	B1					25.2	18.6
		B2			33.8	23.7	27.3	19.1
		B5			32.7	18.7		
	11	D1			26.2	18.2		
		D2	37.0	12.4				
		D3			36.3	18.1		
		D4					24.9	22.1
		D5	26.5	11.9				
	29	D1					31.3	20.4
		D2	36.2	17.0				
		D3					36.0	20.6
		B1			36.7	21.1	36.9	21.4
		B2			39.9	23.2		
		B5			41.1	20.1		
Sept.	1	D2			28.8	16.7		
		D3			27.9	20.6		
	2	D4			25.6	18.6		
		D5	15.4	8.6				

SOIL TEMPERATURES IN DEGREES CENTIGRADE

Date	Plot	late a.m. top	late a.m. 2"	early p.m. top	early p.m. 2"	late p.m. top	late p.m. 2"
June 28	D2.1	11.5	13.0				
	B5.1	11.5	10.5				
June 29	B1.1	10.5	11.5 (in moss)				
	B1.1	12.0	12.5 (mineral soil)				
	B1.5	12.0	13.0				
July 1	D2.1			22.0	12.5		
	D2.1			19.0	10.5		
July 2	B2.1					20.7	13.5
	B2.2					20.0	14.5
	B2.3					20.8	14.8
	B2.4					25.1	17.5
	B5.1					12.5	12.5
	B5.3					11.5	12.5
	B5.5					12.5	12.5
July 4	D1.1			38.0	12.5		
	D3.1	36.5	16.0				
	D3.2			27.0	17.0		
	D3.3			35.5	15.5		
	D3.4			29.5	22.0		
	D3.5			35.0	22.5		
	D5.1			37.5	23.5		
	D5.1			27.5	21.5		

SOIL TEMPERATURES IN DEGREES CENTIGRADE

Date	Plot	late a.m. top	late a.m. 2"	early p.m. top	early p.m. 2"	late p.m. top	late p.m. 2"
July 7	D2.1	15.0	11.8				
	B1.1	14.5	12.5				
	B2.1			15.5	12.5		
	B5.1			14.0	12.8		
July 14	B1.1					15.5	11.0
	B1.2					19.0	10.8
	B1.3					16.0	11.5
	B1.4					15.0	11.5
	B1.5					16.0	11.0
	B2.1					11.5	12.3
	B2.2					11.9	12.5
	B2.3					12.0	11.8
	B2.4					12.8	12.8
	B5.1					13.0	12.8
	B5.2					13.5	13.0
	B5.3					11.0	13.2
	B5.4					13.0	14.3
	B5.5					11.8	12.5

SOIL TEMPERATURES IN DEGREES CENTIGRADE

Date	Plot	late a.m. top	late a.m. 2"	early p.m. top	early p.m. 2"	late p.m. top	late p.m. 2"
July 14	D1.1			18.0	11.7		
	D1.2			17.3	14.8		
	D1.3			17.5	15.0		
	D1.4			16.5	14.5		
	D1.5			16.0	15.2		
	D2.1			22.5	12.8		
	D2.2			19.0	14.8		
	D2.3			22.0	17.5		
	D2.4			21.8	11.8		
	D2.5			20.5	15.0		
	D3.1					19.2	16.7
	D3.2					16.5	13.5
	D3.3					15.8	14.0
	D3.4					16.0	13.8
	D3.5					16.0	14.3
	D4.1					17.5	16.5
	D4.2					21.2	16.5
	D4.3					21.3	17.5
	D4.4					27.5	19.0
	D4.5					20.5	16.5
	D5.1					16.5	13.5

SOIL TEMPERATURES IN DEGREES CENTIGRADE

Date	Plot	late a.m. top	late a.m. 2"	early p.m. top	early p.m. 2"	late p.m. top	late p.m. 2"
July 15	B2.1			28.9	23.0		
	B2.2			31.5	21.5		
	B2.3			35.2	19.9		
	B2.4			29.0	19.2		
	B5.1					31.9	18.0
	B5.2					28.9	22.5
	B5.3					29.2	22.0
	B5.4					29.2	21.0
	B5.5					33.5	24.0
July 28	B1.1					17.9	18.1
	B1.2					17.2	17.9
	B2.1					22.0	18.4
	B2.2					30.6	22.2
	B2.3					26.3	17.9
	B2.4					24.2	21.6
	B5.1					26.3	21.0
	B5.2					24.0	18.1
	B5.3					29.9	23.1
	B5.4					28.9	23.8
	B5.5					24.8	21.0

SOIL TEMPERATURES IN DEGREES CENTIGRADE

Date	Plot	late a.m. top	late a.m. 2"	early p.m. top	early p.m. 2"	late p.m. top	late p.m. 2"
July 28	D1.1			25.2	22.1		
	D1.2			44.5	25.8		
	D1.3			36.6	17.9		
	D1.4			39.0	25.2		
	D1.5			36.8	26.7		
	D2.1			46.1	26.6		
	D2.2			46.0	21.8		
	D2.3			25.1	16.0		
	D2.4			34.8	23.5		
	D2.5			40.4	20.9		
	D3.1			33.6	25.3		
	D3.2			45.7	35.8		
	D3.3			43.6	18.4		
	D3.4			46.2	26.7		
	D4.1					36.9	20.9
	D4.2			34.3	24.9		
	D4.3			30.3	22.1		
	D4.4					32.0	26.1
	D4.5					27.1	25.3
	D5.1			25.1	17.0		

SOIL TEMPERATURES IN DEGREES CENTIGRADE

Date	Plot	late a.m. top	late a.m. 2"	early p.m. top	early p.m. 2"	late p.m. top	late p.m. 2"
August 5	B1.1					25.0	18.9
	B1.2					27.9	19.0
	B1.3					23.1	18.1
	B1.4					24.3	19.0
	B1.5					25.9	17.9
	B2.1			31.1	20.1		
	B2.2			31.4	25.4		
	B2.3			35.3	25.2		
	B2.4			37.3	24.0		
	B2.5					27.3	19.1
	B5.1			30.9	19.9		
	B5.2			30.8	12.2		
	B5.3			32.1	21.9		
	B5.4			33.9	17.1		
	B5.5			35.6	22.2		
August 11	D1.1			31.9	19.5		
	D1.2			24.3	18.6		
	D1.3			24.9	20.1		
	D1.4			23.0	16.3		
	D1.5			28.0	16.3		

SOIL TEMPERATURES IN DEGREES CENTIGRADE

Date	Plot	late a.m. top	late a.m. 2"	early p.m. top	early p.m. 2"	late p.m. top	late p.m. 2"
August 11	D2.1	38.2	11.8				
	D2.2	37.6	13.8				
	D2.3	31.3	14.8				
	D2.4	38.8	11.1				
	D2.5	39.1	10.3				
	D3.1			39.9	12.0		
	D3.2			50.9	19.0		
	D3.3			34.3	21.8		
	D3.4			32.0	21.9		
	D3.5			24.2	15.6 (shade)		
	D4.1					23.5	22.1
	D4.2					21.2	18.6
	D4.3					24.8	24.4
	D4.4					29.9	22.6
	D4.5					24.9	22.7
	D5.1	26.7	12.7				
	D5.2	26.2	11.0				
August 29	D1.1					31.7	19.4
	D1.2					28.4	20.1
	D1.3					33.8	21.6

SOIL TEMPERATURES IN DEGREES CENTIGRADE

Date	Plot	late a.m. top	late a.m. 2"	early p.m. top	early p.m. 2"	late p.m. top	late p.m. 2"
August 29	D2.1	36.1	12.4				
	D2.2	36.1	12.3				
	D2.3	37.8	21.2				
	D2.4	36.2	18.0				
	D2.5	34.7	21.2				
	D3.2					35.2	18.9
	D3.3					32.1	20.8
	D3.4					39.5	23.6
	D3.5					37.2	18.9
	B1.1			36.7	21.1		
	B1.6					35.7	25.2
	B1.7					40.7	20.4
	B1.8					38.7	18.3
	B1.9					32.4	21.8
	B2.1			37.9	22.4		
	B2.2			44.3	22.0		
	B2.3			38.2	28.1		
	B2.4			39.4	21.7		
	B2.5			39.7	21.9		
	B5.1			41.3	22.2		
	B5.6			39.2	24.0		
	B5.7			39.6	14.9		
	B5.8			37.2	17.9		
	B5.9			48.3	21.4		

SOIL TEMPERATURES IN DEGREES CENTIGRADE

Date	Plot	late a.m. top	late a.m. 2"	early p.m. top	early p.m. 2"	late p.m. top	late p.m. 2"
Sept. 1	D2.1			29.0	12.0		
	D2.2			30.6	17.0		
	D2.3			28.0	18.0		
	D2.4			30.8	19.0		
	D2.5			25.5	17.6		
	D3.6			23.0	15.5		
	D3.7			19.0	13.2		
	D3.8			29.8	25.2		
	D3.9			32.8	19.0		
	D3.5			37.8	30.2		
Sept. 2	D4.1			29.6	22.2		
	D4.2			25.0	17.0		
	D4.3			24.2	18.0		
	D4.4			24.8	18.0		
	D4.5			24.5	17.8		
	D5.2	15.4	8.6				