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SOIL AND VEGETATION CHARACTERISTICS OF BOUNDARY CABIN FAN, WATERTON LAKES NATIONAL PARK-GLACIER NATIONAL PARK; PRELIMINARY REPORT.

(Part I by G. M. Coen and W. D. Holland; Part II by John Nagy)

Northern Forest Research Centre
Environment Canada
Edmonton

SOIL AND VEGETATION CHARACTERISTICS

OF

BOUNDARY CABIN FAN

WATERTON LAKES NATIONAL PARK

GLACIER NATIONAL PARK

PRELIMINARY REPORT

PART I

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WATERTON, JUNE 1972

SUMMARY

The soil, trees and ground vegetation on the Boundary Cabin fan were examined, described, sampled, and evaluated. The conclusions are presented on pages 8 and 9. This fan could be used intensively provided certain precautions are taken. The two most important detriments to its use are the pollution threat and the danger of defective trees falling over.

SOIL AND VEGETATION CHARACTERISTICS OF BOUNDARY CABIN FAN

PART I: THE SOIL AND THE TREES

INTRODUCTION

A detailed study of soil and vegetation characteristics of the Boundary Cabin fan was undertaken in June, 1972, at the request of the Superintendent of Waterton Lakes National Park. The objective of the study was to determine the kind of soil present, the vegetation of the area, and an interpretation of what the soil and vegetation characteristics may mean for the management of this specific portion of Parks' land.

The Boundary Cabin fan is located on the west side of Waterton Lake. The area is approximately 10 acres of land originating from the alluvial fan deposit of a small creek flowing in a south-easterly direction from Mt. Richards in Waterton Lakes National Park. The fan is bisected by the International Boundary at 49° latitude and approximately 113° - 54 minutes longitude. Thus, about one-half the land lies in Waterton Lakes National Park, with the other half in Glacier National Park. The elevation of Waterton Lake is approximately 4,193 feet above M.S.L. and the fan rises from the water's edge with a general slope of 3 to 5% to the north-west. Slopes up to 8% were recorded in some parts. The fan is bordered on the south-west, west and north by steep slopes of bedrock controlled glacial till. To the south, a small portion of the fan merges with the northernmost part of the Boundary Creek fan just south of the International border.

The soil on Boundary Cabin fan is mostly a loose, coarse textured Cumulic Regosol, except for some tendency towards Brunisolic soil development towards the southwest. Stones and boulders are common on the upper portion, or

northwest part of the fan. The main matrix of the profile is a loose, structureless sandy loam with variable layers of silt loam and gravelly coarse sand. Fine pieces of argillaceous shales and other gravel and stones are common.

The area is well vegetated for the most part, except where certain areas have been disturbed; for example, clearing and spraying along the International border, blowdown, picnic areas, cabin area, and hiking trail. The trees are predominantly lodgepole pine about 100 years old. Douglas fir comprises nearly a fifth of the trees present and white spruce, balsam poplar, and birch occur in very minor quantities. A high proportion of the trees are defective, probably as a result of exposure to the strong winds of the Waterton Lake valley and to disturbance by man. These physical defects are mainly such things as broken tops, forked tops, uprooting of trees, scars from windfalls, one-sided crowns, lean, root exposure, and centre rot. The trees are of low height and diameter class for their age, thus indicating a low productivity and thriftiness as compared to other places in the Park.

The ground cover is extremely variable in species composition and density and is described in Part II of this report.

METHODS

Twelve soil pits were examined at various locations on the Boundary Cabin fan. Two of these were described in detail and sampled for chemical and physical analyses. Infiltration tests were made at three locations; two in relatively undisturbed locations west of the cabin and one immediately adjacent a picnic table area.

Six 1/10 acre plots were located at selected points to describe the variation in vegetation, including the overstory, and understory of ground vegetation. The data collected provided estimates of the kinds and quantities of trees present, their mortality and damage, total volume present, and an estimate of present growth rates. Similarly, the kinds and quantities of ground vegetation were identified, including shrubs, herbs and flowering plants.

RESULTS

A. SOIL:

A brief description of Profile 1 is as follows:

Horizon	Thickness	Characteristics
L-H	1½-2"	Leaves, needles, rotted wood, charcoal, mycelia, pH 5.2.
C_1	0-1"	Very friable, structureless brown loam, 10% coarse fragments.
C_2	1-7"	Loose, structureless dark reddish brown sandy loam containing 50% coarse fragments, pH 6.6.
C_3	7-15"	Loose structureless dark reddish brown gravelly coarse sand with 20% coarse fragments. pH 6.8.
C_4	15-18"	Very friable, structureless reddish brown silt loam, pH 6.6.
C_5	18-35"	Loose, structureless reddish brown gravelly coarse sand plus 10% coarse fragments, pH 6.8
C_6	35-44"	Loose gravelly coarse sand with 60% coarse fragments, pH 6.8.

Profile 2 is similar to the above description, except for a Bm horizon just under the forest litter layer.

Field pH measurements indicate that the mineral soil is nearly neutral, being only slightly acid. Infiltrometer tests were in the range of 14 to 22 inches of water per hour.

Chemical data of the soil samples from the described profiles will not be available for some months. From experience with similar soil elsewhere, it is anticipated that cation exchange capacity will be low and that levels of major nutrients such as nitrogen and phosphorus will also be low.

B. VEGETATION:

Tables I and II, summarize the tree plot data collected. Figure 1 gives a diagrammatic sketch of the plot locations.

See Part II for details on the ground vegetation cover.

TABLE I

Plot No.	Tree No.	Species	(o.b.) D.B.H. in inches	(o.b.) S.D. in inches	Total Ht. in feet	Age at one foot	Total Age	Radial Growth Last 10 yrs	Radial Growth Last 20 yrs	Radial Growth Last 30 yrs	Vigor	Crown Development	Crown Class
1	1	Lp	10.1	11.9	58	Rotten					Fair	Fair + one sided	Dominant
	2	Lp	12.5	13.5	56	"					Good	Good + even	Dominant
	3	Df	10.3	12.5	59	103					Good	Fair + One sided	Dominant
	4	Lp	9.8	10.6	61	106	102				Good	Poor + One sided	Dominant
	5	Lp	12.9	13.8	60	86					Fair	Fair	Dominant
	6	Lp	9.2	9.8	59	100					Good	Good + even	Dominant
2	1	Lp	12.7	13.8	65	rotten					Fair	Good + even	Dominant
	1A	Lp	9.8	11.2	60	96					Good	Good + even	Co-dominant
	2	Lp	10.5	11.0	65	110					Good	Fair + one sided	Dominant
	3	Lp	11.5	12.4	65	84	98				Fair	Fair + one sided	Dominant
	4	Lp	10.7	11.9	65	92					Good	Fair + one sided	Dominant
	5	Lp	10.5	11.9	64	99					Good	Good	Dominant
	6	Lp	12.0	13.8	67	90					Good	Good	Dominant
3	1	Lp	11.7	12.4	65	110					Good	Poor (Wolfy)	Dominant
	2	Lp	12.3	13.4	70	rotten					Good	Good + even	Dominant
	2A	Lp	9.3	11.1	62	87					Good	Good	Co-dominant
	3	Lp	10.6	11.8	66	109	107				Good	Good + even	Dominant
	4	Lp	10.3	11.3	63	108					Good	Fair + one sided	Dominant

TABLE I (continued)

Plot No.	Tree No.	Species	(o.b.) D.B.H. in inches	(o.b.) S.D. in inches	Total Ht. in feet	Age at one foot	Total Age	Radial Growth Last 10 yrs	Radial Growth Last 20 yrs	Radial Growth Last 30 yrs	Vigor	Crown Development	Crown Class
	5	Lp	12.0	14.0	70	rotten					Good	Poor (Wolfy)	Dominant
	5A	Lp	8.7	9.2	64	"					Good	Good	Dominant
	6	Lp	12.3	13.7	64	105					Good	Good	Dominant
4	Vegetative Plot Only										-		
5	1	Lp	8.1	9.0	53	110					Good	Fair + one sided	Dominant
	2	Lp	7.3	8.1	51	98					Good	Good	Dominant
	3	Lp	7.0	7.8	54	96					Good	Good	Dominant
	4	Lp	7.5	8.2	57	101	102				Good	Good	Dominant
	5	Lp	7.6	8.8	57	71					Good	Good	Dominant
	6	Lp	7.9	8.3	58	103					Good	Good	Dominant
6	1	Lp	11.1	12.0	59	105					Good	Good	Dominant
	2	Lp	9.0	9.5	60	105					Good	Fair	Dominant
	3	Lp	8.0	9.3	58	106					Good	Fair + one sided	Dominant
	4	Lp	7.7	8.7	60	95	101				Good	Good	Dominant
	5	Lp	7.8	9.0	57						Fair	Good	Dominant
	6	Lp	9.0	10.2	60						Good	Good	Dominant

DIAGRAMMATIC SKETCH OF SAMPLE PLOT LOCATION ON BOUNDARY CABIN FAN

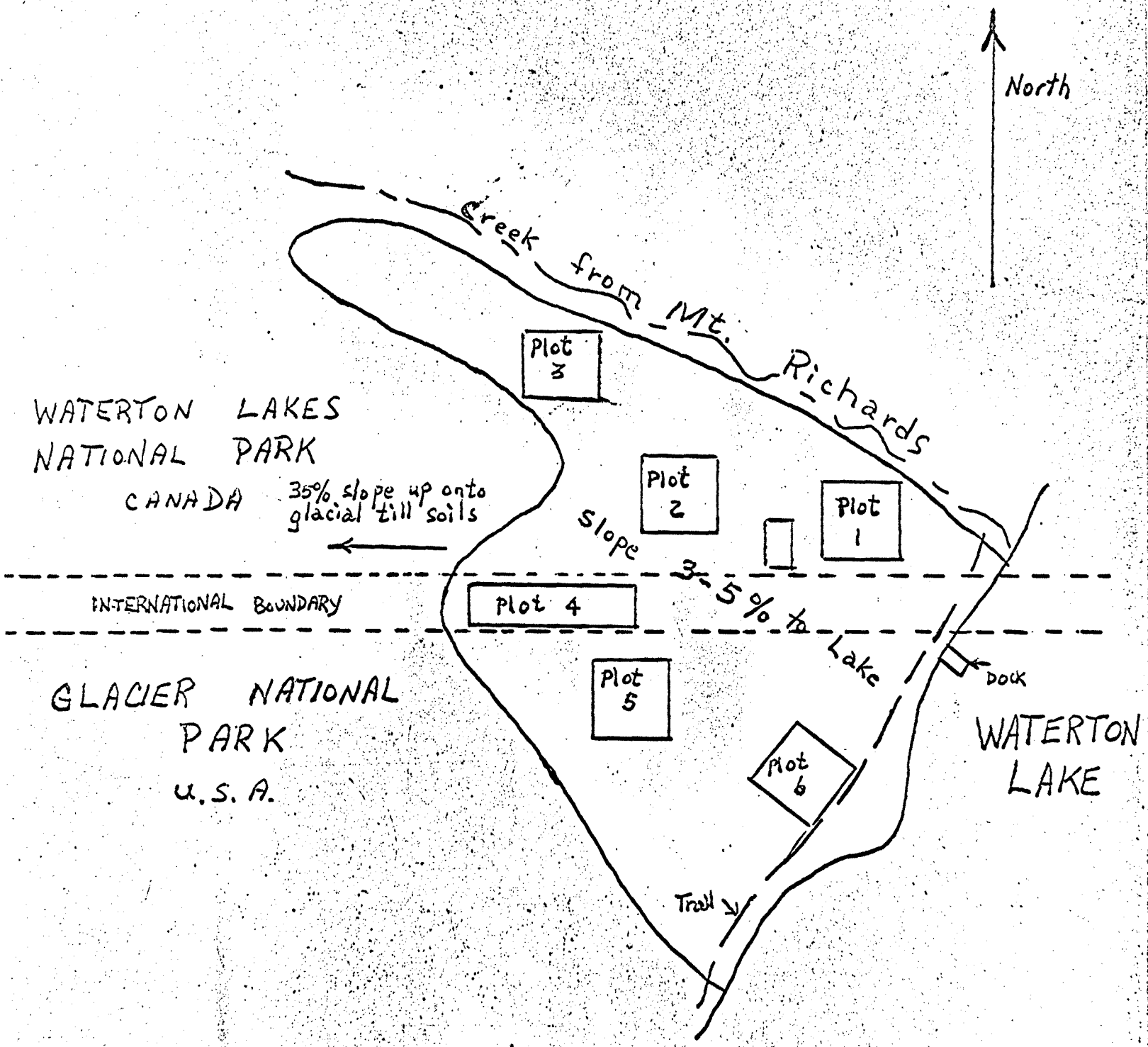

Figure 1

INTERPRETATION OF RESULTS

The soil is loose and very porous. Drainage is extremely rapid and water retention is sufficiently low that droughty periods likely occur. The site is of relatively low productivity for tree growth, probably because of low nutrient levels, poor moisture regime, short growing season, and large evaporation loss from the high amount of wind blowing down the valley.

The tree stand is over 100 years old; the oldest tree sampled being approximately 120 years. Regeneration of Douglas fir is good, but quite young. The plots indicate that the number of good vigorous trees range from 14 to 50% of the total trees found. The remaining trees had the defects previously mentioned. The 50% value was obtained in the plot with the lowest number of trees per acre, indicating that natural causes probably removed many of the defective trees. Centre rot is probably the most serious of the tree defects noted. From borings it was estimated that centre rot is present in 26% of the live trees. Root exposure was markedly higher in the plot near the picnic table. The mensurational data indicate slow growth rates and relatively low tree fibre volume.

The ground vegetation is reported in Part II.

CONCLUSIONS

1. Use of the soil on this fan will probably not create serious changes in soil physical characteristics such as compaction. Thus, physical soil changes in themselves are not thought to be a serious hazard at this site.

2. Infiltration rates are substantially higher than rainfall intensities that are likely to occur. Measurements in the present picnic area indicate that compaction does not appear to change these rates, so human activity will probably not result in accelerated erosion, except that concomitant with vegetation loss.

3. The soil has excessive percolation rates and low water-holding capacity. Thus, it will act as a poor biological and nutrient filter and if used in such a way that this soil receives more than minor amounts of sewage, the effluent could move into the lake water very quickly and contribute to a pollution problem.

4. The soil provides little impediment to irrigation. If fertilization is to be practiced, care should be taken to avoid the application of excessive rates of fertilizer because of the small amount of nutrient holding capacity this soil is likely to exhibit. This soil can be managed and modified with some success but it must be done with care.

5. Present picnic use of part of the area is assumed to be relatively light in intensity. Nevertheless, such use has resulted in tree root exposure and considerable loss of trees and ground vegetation. The sandy, coarse texture of this soil does not compact, but it is easily kicked about and shifted once the lower vegetation becomes worn.

6. The tree stand is old and has many defective trees, and poses a hazard for safe recreational use of the area, especially for overnight tent use. The large amount of tree defects (the centre rot alone was estimated at 26%) coupled with the high amount of wind in the area could result in serious accidents from falling trees.

7. The trees with good vigor and apparent lack of defects range from a high of 50% of the forest stand to as low as 14%. Thus, culling of the defective trees would leave the area understocked and may result in undesirable effects on the remaining stock. Furthermore, it may prove difficult to locate all of the trees with centre rot.

8. This report indicates the amount of variability that may be encountered on a small area of land (in this case, about 10 acres). The vegetation plots were more variable than the soil. The authors wish to point out the need for on-site investigations.

ACKNOWLEDGEMENTS

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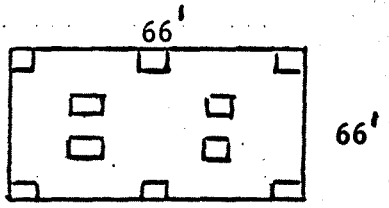
PART II: THE GROUND VEGETATION

An investigation of the ground vegetation cover was carried out on the Boundary Bay fan. A stratified quadrat analysis was employed to determine species composition and vegetation cover. Each stand investigated was then assigned a fragility value.

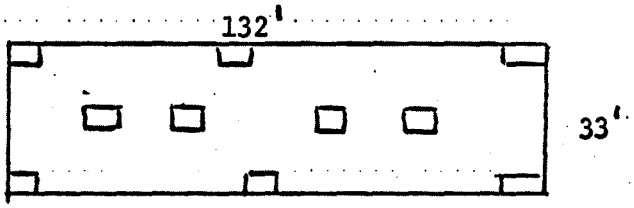
Methods

A total of 10 one square meter plots were employed to determine vegetation cover on each of six 1/10 acre plots. The following system of plot location was used:

(a) in unrestricted forest areas



(b) area restricted by border slash:



Each square meter plot was examined and an estimate made of the total % vegetation cover (including shrubs), total % shrub cover, total % dead fall cover and total % cover for each vascular species, bryophytes (Lumped) and lichens (Lumped) (see table I). Percent dead fall cover was estimated only if it prevented vegetation growth. Lichens, Bryophytes, and each vascular species were assigned % values using the following system:

Percentage	Value assigned
1-100%	- estimated actual % cover
1%	-+ (given value of 0.5% for $\bar{X}$ analysis)
0%	- P, if present in 1/10 acre plot but did not fall in meter plots.

$\bar{X}$ values were calculated for each cover category and are presented in Table I. Fragility ratings were determined using a fragility scale developed by Kuchar (1972). See Table II.

Discussion and Conclusion:

Past research on wilderness recreation sites have indicated major changes on forest vegetation. The major effect of park visitors on the ecosystem is a direct one: trampling of the vegetation (Kuchar 1972). Frissel et. al 1965 found a loss of 57-99% of the original ground cover with the amount of change not increasing with use. Indigenous species, depending upon their tolerance to trampling, may be replaced by exogenous, often exotic species characteristic of waste spaces (Bailey and de Vos, 1970). The vegetational ground cover is also affected indirectly through soil deterioration - that is soil compaction and breakdown of litter and humus. Soils become compacted (Settergren et. al 1970; Lutz, 1945; Appel, 1950; McCool et. al, 1969; La Page, 1962) inducing some reduced tree crown vigor (Settergren, 1970) and tree root exposure (McCool et. al, 1969). Deterioration of the upper soil layers affects small grasses and herbaceous species more than trees. They promote surface aeration and infiltration, preventing rapid surface runoff and sheet erosion. The loss of these features results in the inhibition of more permanent ground cover development. Different vegetation types will have different recreational use potential.

The six 1/10 acre plots investigated can be grouped into three main categories:

(a) areas indicating previous visitor use eg. presence of trails, picnic tables, and evidence of previous camping.
- areas clear or trees thinned by man (Plots 1 and 4).

(b) relatively untouched, heavily shrubbed Pine forest with relatively lush herbaceous vegetation (Plots 2 and 3).

(c) relatively untouched, sparsely shrubbed and vegetated Pine forest (Plot 5 and 6).

Each of these three plot categories would respond differently to visitor use. Group (a) areas have received previous visitor impact - camping, picnicing, and park maintenance. These areas support a number of species indicative of intensively used recreation sites - Achillea millefolium, Carex sp sp; Fragaria Virginiana, Galium sp., Rosa sp., Symphoricarpus albus, Taraxacum officianale (Bailey and deVos, 1970). The presence of these species is fortuitous as they prevent erosion and contribute to and maintain soil structure. Assuming the present vegetation cover to be "natural" a fragility rating of 2 would be assigned to these areas. Visitor use will cause moderate changes in the appearance of the area.

Group (b) areas are heavily shrubbed and support lush and relatively fragile ground vegetation cover. Passing over these areas while carrying out the vegetational investigation left notable trails on the easily crushed plant species - Arnica sp, Clintonia uniflora, Disporum trachycarpum, Goodyera oblongifolia, Osmorhiza sp.). This area would be assigned a fragility rating 3-4 as the ground vegetation is easily crushed. Visitor use will easily cause noticeable changes in plant cover and structure. Plant cover will probably become very low relative to natural condition (Kuchar, 1972).

Group (c) areas which are sparsely vegetated would be assigned a fragility rating of 3. Visitor use will cause noticeable but not serious or irreversible changes in plant cover and structure. Species such as the Arnica sp., Clintonia uniflora, Goodyera oblongifolia would receive the brunt of visitor impact. The thin layer of duff and litter may be easily worn away exposing subsoils to erosional forces.

Table I: Mean % Cover Values for Vascular Plant Species, Bryophytes and lichens found on six study plots on the Boundary Alluvial fan.

SHRUBS and Dwarf Shrubs:	1	2	3	4	5	6
Acer glabrum	0.5	2.5	5.7	1.3		0.1
Alnus sp.		P				
Amelanchier alnifolia	1.0	P	2.0	P	0.5	3.5
Berberis repens	1.8	0.3	2.1	1.1	0.5	P
Lonicera involucrata				0.5		
Lonicera utahensis			1.6		1.4	0.1
Menziesia glabella			2.5	3.0		
Pachystima myrsinites	1.0	1.0	1.8	0.6	2.9	0.4
Picea glauca					0.1	
Pseudo tsuga menziesii			1.1			2.0
Ribes lacustre	0.1		0.2	1.0		
Rosa sp.	1.7	P		0.1		P
Rubus idaeus	2.6					
Rubus paruiflorus	2.3	1.6	8.9	25.0	0.4	3.2
Shepherdia canadensis		2.5		P		
Sorbus sp.				P	0.2	P
Spiraeabetulifolia	17.2	5.9	10.1	4.1	1.2	0.3
Symphoricarpus albus	25.0	2.8	0.6	10.3		
Vaccinium sp. sp.	4.2	1.7	4.7	0.1	4.9	5.0

Table I: (continued)

HERBS:	1	2	3	4	5	6
Achillea millefolium	0.3	P				
Adenocaulon bicolor	0.1					
Anaphalis margaritacea		0.1				
Antennaria microphylla		P				
Antennaria neglecta		P				
Antennaria vacemosa	1.0					
Arnica sp.	10.5	2.6	10.4	5.5	0.4	0.9
Aster sp.	0.6		0.6	0.6		0.1
Athyrium felix-femina		1.0		1.1		
Calypso bulbosa		0.1				
Carex sp. sp.	0.1	1.8				P
Cerastium arvense		P				
Chimaphila umbellata		0.1	1.2		3.2	2.8
Cirsium vulgare		0.3				
Clematis verticellaris				0.1		
Clintonia uniflora	0.1	5.3	8.0	1.9	0.4	1.3
Collinsia parviflora		0.1				
Cystopteris fragilis		0.1				
Disporum trachycarpum			0.2	0.1		
Epilobiumangustifolium	0.4			P		0.1
Fragaria virginiana	1.3	P	0.1			
Galium boreale	0.3	0.1		0.1		
Galium triflorum	0.1	0.2		0.4		
Goodyera oblongifolia		0.2	0.7	0.7	1.1	0.4
Graminae sp. sp.	5.7	3.0	0.8	0.6	0.1	0.4

Table I: (continued)

HERBS:	1	2	3	4	5	6
Hackelia jessicae		0.1				
Hieracium albiflorum					0.1	0.1
Linnaea borealis	0.5	0.2	1.3		1.0	1.6
Listera sp.			0.1			
Lycopodium annotinum		0.5				
Osmorhiza sp.	0.8	P	0.1	0.5		
Penstemon confertus		P				
Plantago major		0.1				
Potentilla sp.		P				
Pyrola sp.					P	
Pyrola picta						0.1
Pyrola secunda	0.4	0.3	0.2	0.2	0.1	0.1
Ranunculus sp.		0.3				
Rumex acetosella	0.6					
Smilacina racemosa		P				
Smilacina stellata				0.2		
Stellaria sp.				0.1		
Taraxacum officianale	0.2					
Thalictrum sp.	0.3	1.0	0.6	4.6		P
Tiarella unifoliata				P	0.1	
Trifolium sp.		P				
Urtica sp.				2.0		
Veratrum sp.				0.8		
Veronica sp.		P				
Viola adunca	0.1					

Table I: (continued)

HERBS:	1	2	3	4	5	6
Viola orbiculata		0.2	0.7	0.2	0.5	0.3
Xerophyllum tenox		2.5	0.7		13.0	3.0
LICHENS:	1	4	2	3	5	6
		0.3	0.1		0.7	1.5
MOSSES	0.1	8.1	0.1	0.7	7.4	1.8
SHRUB COVER	45.0	17.5	31.5	44.0	3.5	9.0
DEAD FALL COVER				4.5	8.7	7.5
TOTAL VEGETATION COVER	66.5	36.7	56.5	63.5	31.0	25.0

PLOT DESCRIPTION

1 - Pinus contorta - Pseudotsuga menziesii forested picnic - camping area directly east of Wardens cabin.

2 - Moderately shrubbed Pinus contorta forest west of Wardens Cabin.

3 - Acer - Rubus - Symphoricarpus heavily shrubbed open Pinus contorta forest west of Wardens Cabin.

4 - Cleared Boundary Slash.

5 - Sparsely shrubbed Pinus contorta forest immediately south of USA-Canada border.

6 - Sparsely shrubbed Pinus contorta forest south of USA-Canada border adjacent to Lake Shore.

TABLE 2 FRAGILITY SCALE FOR PLANT COMMUNITIES AND ECOSYSTEMS.

RATING	POTENTIAL CHANGES IN VEGETATION/ECOSYSTEM	GENERAL ATTRIBUTES OF VEGETATION/ECOSYSTEM	EXAMPLES
1	Not forseeably changeable with visitor use.[1] Total plant cover = 100% of natural. Not erodable. No compaction of surface.	One or more of the following: a) very stable, durable, & trample-resistant plant cover. b) plants thriving through trampling. c) a very low natural plant cover, therefore chances very low that the extant vegetation will be walked upon. d) slope nil.	Pebbly shoreline; some weedy ground.
2	Lightly changeable. Visitor use will cause moderate changes in the appearance (plant cover = 90% of natural). No permanent shift in ecosystem structure: arresting visitor use would result in a reversion to 100% of natural cover of the original vegetation. Erosion potential nil or extremely low (i.e. negligible). Very little or no surface compaction.	On level terrain or gentle slopes, (or exceptionally on steep but very stable slopes); on rock substrata or stable soil. Mesic or xeric habitat.	Danthonia meadows; fellfield tundra; alluvial-fan spruce forest.
3	Moderately changeable. Visitor use will cause noticeable but not serious or irreversible changes in plant cover and structure (plant cover = 50-90% of natural). Erosion nil or mild, or not much greater than natural erosion. Some soil compaction possible.	On level terrain or stable slopes. Mesic or xeric habitat (exceptionally, dampish habitat). Usually a well-developed sod structure.	Most pine and spruce forest.

TABLE 2 (continued)

RATING	POTENTIAL CHANGES IN VEGETATION/ECOSYSTEM	GENERAL ATTRIBUTES OF VEGETATION/ECOSYSTEM	EXAMPLES
4	Rather fragile. Visitor use will rather easily disturb the normal plant patterns, and either shift them permanently or else not permit re-establishment of vegetation for a long time. Plant cover will probably become very low relative to natural condition. Erosion may be a problem, but usually not a permanent one.	Usually on steep slopes that are damp most of season, &/or large percentage of silt present. Or on level areas, but vegetation easily crushed.	Boulder rubble; damp alpine meadows on steep slopes.
5	Extremely fragile. Visitor use, even in moderate amounts, will destroy the plant patterns irreversibly (in our time anyway), and either a different vegetation will eventually arise (a seral stage, often of weedy-type colonizers), or no vegetation at all due to active erosion or chemical/nutritional problems for plants trying to establish there. Erosion serious or snowballing: artificial measures might be necessary to arrest erosion.	On steep, usually water-saturated or damp slopes; vegetation very easily dislodged. Or vegetation very easily crushed and destroyed ('one footstep's worth').	N slope shrub-moss-reindeer lichen vegetation; some boulder rubble fields.

[1]A saturation point can be reached in any vegetation or ecosystem, beyond which changes will become manifested. That is, extremely heavy visitor use will drastically affect all ecosystems. The use of the fragility scale involves the assumption that visitor use is moderate, not extremely heavy (handfuls rather than hundreds of people).

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