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**IMPACT STUDY AND MANAGEMENT RECOMMENDATIONS FOR PRIMITIVE
CAMPGROUNDS IN THE SUNSHINE-EGYPT LAKE AREA, BANFF NATIONAL PARK**

by G. L. Lesko and E. B. Robson

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ABSTRACT

A visitor impact study was conducted in the Sunshine - Egypt Lake area during the summer of 1974. Eleven primitive campgrounds were examined within the 324 km² study area. Six of these campgrounds showed the effects of only light impact, but five suffered severe damage. The severely affected campgrounds are located at popular destinations or on the trails leading to them. Damages included alteration and destruction of the vegetation cover, partial erosion of the surface soil, and littering. Backcountry use was limited to about 50 km² of the total area and visitor impact was restricted largely to the immediate area of the campground and trails.

Limitation of the total number of visitors in the area, the limitation of the number of tents within each campground, and the prohibition of campfires are suggested to decrease future damage. Campground reclamation and maintenance by seeding to native grasses, fertilizing, and weed control were also recommended for some sites.

RESUME

Les auteurs ont effectué une étude sur les effets des visiteurs dans la région Sunshine - Egypt Lake, lors de l'été 1974. Ont été étudiés, 11 terrains de camping situés dans l'aire de 324 km². Six des terrains n'ont été que légèrement endommagés, et cinq sérieusement. Les terrains sérieusement endommagés sont situés dans des zones fréquentées par la majeure partie des visiteurs, ou sur des pistes y conduisant. Les dommages consistaient en l'altération et la destruction du couvert forestier, l'érosion partielle du sol de surface, et des déchets répandus. Dans l'arrière-pays, seulement environ 50 km² de la surface totale avaient été utilisés, et par ce, les effets avaient été surtout restreints à la région immédiate des terrains de camping et des pistes.

Les auteurs suggèrent comme moyens de limiter les dommages, la restriction du nombre total de visiteurs, la restriction du nombre de tentes dans chaque terrain de camping, et la défense de faire des feux de camp. On recommande également de réparer certains terrains de camping par l'ensemencement de graminées indigènes et l'amendement du sol, et la lutte contre les mauvaises herbes.

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INTRODUCTION

The growing popularity of hiking and wilderness recreation puts an increasing pressure on park resources. Every year, more and more persons have the desire and the means to enjoy nature in its unaltered condition in relative solitude.

Because of its exceptional scenic beauty, Banff National Park is one of the most popular regions in Canada for outdoor recreation. However, the available area in the park is limited, and the increasing number of visitors pushes the human density above desirable levels. The number of overnight hikers, for example, has increased from 1,000 to 14,000 per season between 1963 and 1973 (Superintendent's Annual Report 1963-1973). The consequences of this influx are deterioration of the land resources and a lower quality of recreational satisfaction. This deterioration can be minimized by protection and management of the natural resources and by controlling the number and activities of the visitors. Concerned park officials intend to base their regulations on the best possible knowledge of visitor impact and the environment under their management. The objective of this study, therefore, was to provide information on backcountry use by:

1. describing the present conditions of existing campgrounds
2. assessing visitor impact in and around the campgrounds
3. estimating the carrying capacity of the campgrounds and the study area
4. proposing management procedures
5. recommending alternative campgrounds.

THE STUDY AREA

The study area, known as the Sunshine-Egypt Lake area, is bordered by the Trans-Canada Highway on the east, the Invermere Highway on the north, the continental divide on the west, and the Sunshine Road on the south. These boundaries encompass about 324 km² total area, between 51°05" - 51°16' N and 115°41' - 116°03' W (Figure 1). Only about 50 km² of this area are used intensively for backcountry recreation. Nine trails provide access to the backcountry, three leaving from the Trans-Canada Highway, one from the Invermere Highway, two from the Sunshine Road, and three crossing the continental divide from British Columbia. The nearest town is Banff, about 6 km east on the Trans-Canada Highway.

GEOLOGY

The study area is part of the main ranges' structural subprovince of the Rocky Mountains (North and Henderson 1954; Price 1971), east of the continental divide. Geologic structure is dominated by northwest-trending thrust sheets, modified by local faults and folds in Precambrian to Mississippian sedimentary strata (Baird 1966; Price 1971). Lithologically the mountains vary from Precambrian shales and conglomerates to paleozoic dolomites and limestones (Price 1971).

The present landforms are mainly the result of alpine glaciation. Cirques and hanging valleys are numerous, and the greatest part of the surface is covered by a thin layer of glacial drift. Cliffs and talus slopes are also common features of the landscape. The highest mountain peaks in the area approach 3000 m elevation. The watersheds are drained by three major creeks all flowing into the Bow River in the main valley. Most of the trails leading into the backcountry follow these creek valleys.

CLIMATE

The nearest climatic stations to the center of the backcountry area are Banff (30 km east) and Lake Louise (40 km northwest). Although

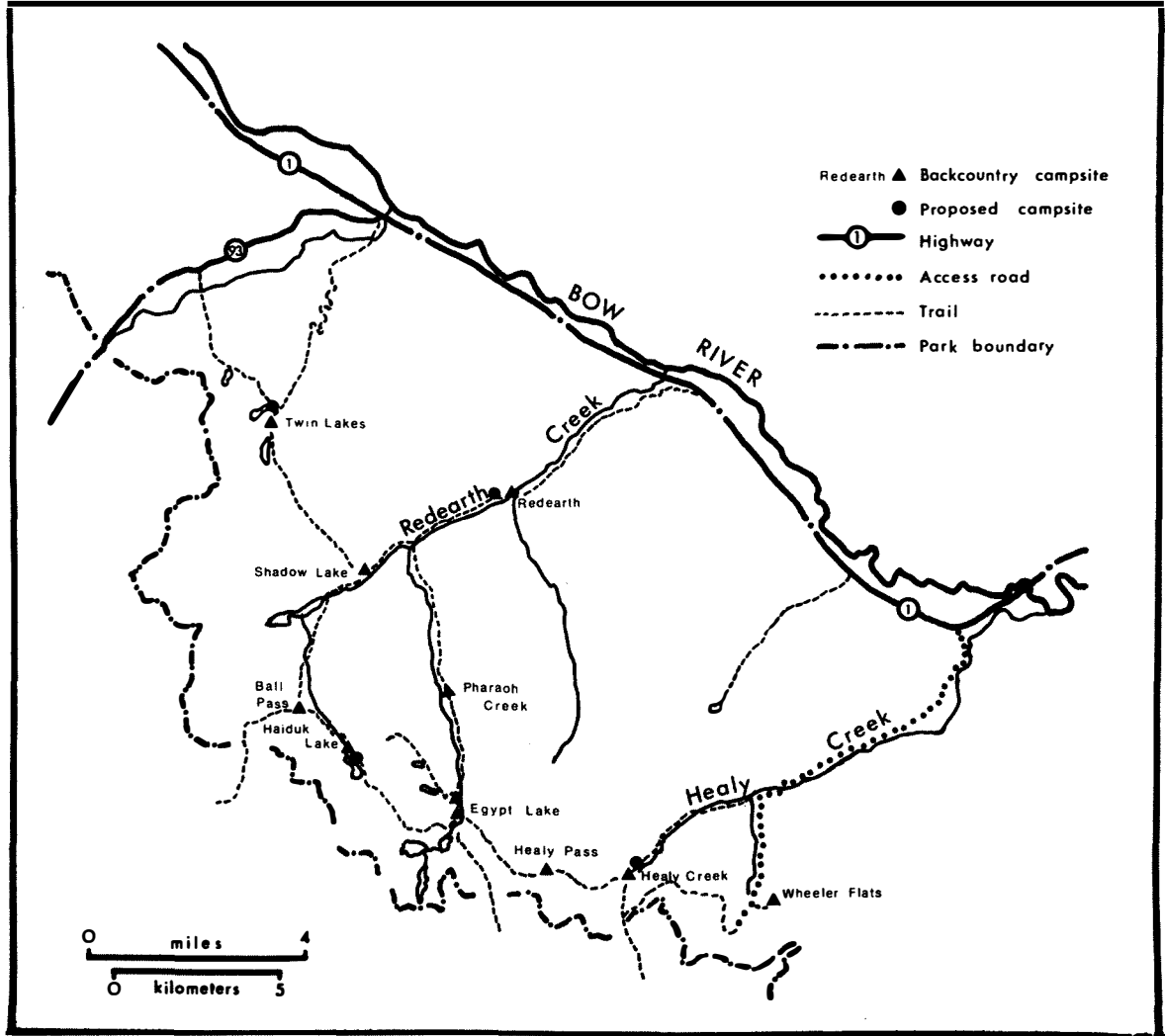


Figure 1. Map of the study area

Banff (1397 m) is the closer station the climate of Lake Louise is more similar to that of the study area because of its physiography and higher elevation (1534 m). The mean annual temperature and precipitation at Lake Louise are 0.1°C and 771 mm (Canada Department of Transport 1968). About 64% of the total precipitation is snow. Mean monthly temperatures corrected to the average elevation of the major campgrounds (2062 m) are compared to those at Lake Louise in Figure 2. The corrections were made using the method of Hopkins (1938). The climate is humid and cold with 508 mm average annual water surplus at 100 mm soil water storage (Government and University of Alberta 1969). The precipitation has a definite winter maximum, and May, July, and September are the driest months.

SOILS

Most soils under forest vegetation in the Rocky Mountains have been developed from calcareous till or alluvial parent materials (Ogilvie 1963). At higher elevations colluvial deposits are also important as parent materials (Knapik et al. 1973). Root and Knapik (1972) and Knapik et al. (1973) described Regosol, Eutric Brumisol, Dystric Brumisol, and Rego Humic Gleysol soils in the study area between 2027 and 2545 m elevations. Most of these soils are shallow and rocky with high organic matter content in the A horizons, and strongly acid to moderately alkaline. Luvisolic soils with deeper profiles and higher clay content are present at lower elevations.

VEGETATION

About 65% of the area is forested, and the balance is alpine tundra, rock, ice, or snow. The forest belongs to the East Slope Rockies Section of the Subalpine Forest Region (Rowe 1972), extending to 2050 or 2250 m elevation depending on exposure and drainage. Three major altitudinal zones can be distinguished within this section of the sub-alpine zone. The forests of the different altitudinal zones are not sharply separated but gradually change along an irregular border:

1. The lowest zone (1400 - 1700 m) is dominated by lodgepole pine-white spruce-engelmann spruce-buffaloberry communities.

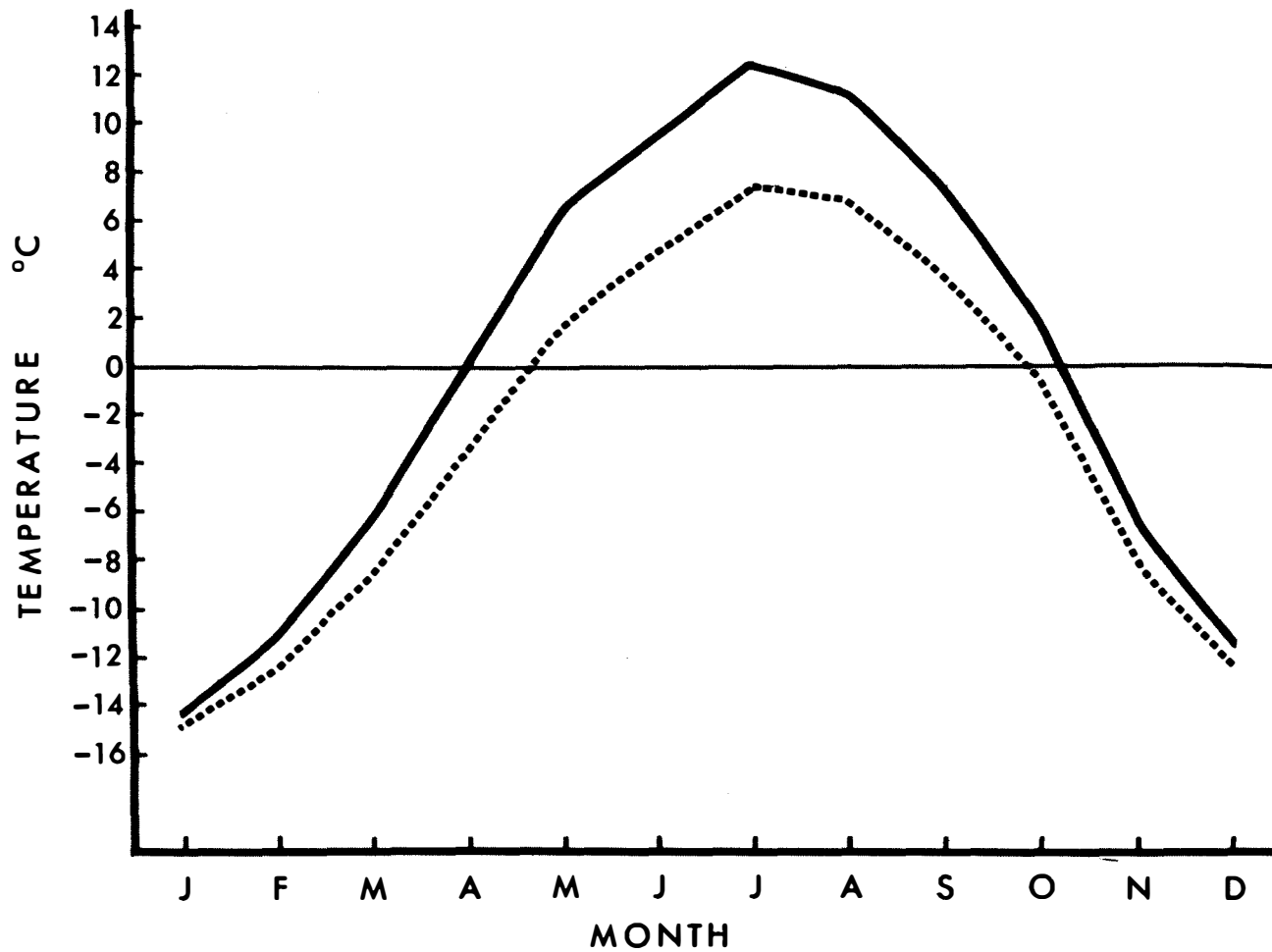


Figure 2. Mean monthly temperature at Lake Louise and at mean elevation of backcountry campgrounds. Lake Louise———, Campgrounds-----

Stands of Douglas fir-lodgepole pine-aspen also occur on dry slopes. These stands are isolated fragments of the Douglas Fir-Lodgepole Pine Section of the Montane Forest Regions (Rowe 1972).

2. Forest types of engelmann spruce and alpine fir dominate the middle altitude zone (1700 - 2000 m). An engelmann spruce-alpine fir-false azalea forest type occurs at the lower part of the zone, while the upper part is occupied by engelmann spruce-alpine fir-grouseberry forest type. An edaphic spruce-alpine fir-horsetail forest type occurs in river or creek floodplains in this and the first altitudinal zone.
3. Alpine larch-engelmann spruce-alpine fir forests occupy the the high altitudinal zone from 2000 m to the tree line. Two major forest types may be distinguished in this part, one on moist soils with mostly herbaceous vegetation, and the other on drier soil with mainly heather ground cover.

More detailed descriptions of these forest types are contained in Appendix I.

Numerous plant communities with restricted distribution occur through all three altitudinal zones in special edaphic conditions. Avalanche tracks, bogs, marshes, rock slopes, and subalpine meadows have rich vegetation, but with the exception of some subalpine meadows, they were not examined.

Alpine vegetation in the Sunshine area was studied by Knapik et al. (1973), who recognized communities of yellow heather-wooly pussy-toes, white flowered mountain aven - Carex scirpoidea, Salix barattina, western anemone, red-stemmed saxifrage, white mountain heather, Kobresia myosuroides, Carex - cottongrass, and Carex nigricans. In the Lake Louise area Trottier and Scotter (1973) observed yellow flowered mountain aven-Carex rupestris, yellow flowered mountain aven-alpine bearberry, Salix nivalis, and Luzula parviflora alpine communities in addition to those already mentioned. These communities are probably also present in the study area.

Pollen studies by Heusser (1956) indicated that lodgepole pine has been a dominant species in Banff National Park since the retreat of the glaciers. However, increased occurrence of forest fires due to man's activity in modern times has probably increased its distribution. Walker (1971) found that most of the lodgepole pine stands in Banff National Park originated from fires in the 1880's, 1900, 1910-1920 and 1930's. The improved fire protection of recent years will probably cause a decline in the importance of lodgepole pine in these forests and increase the percentage of white or engelmann spruce.

METHODS

PLANT COMMUNITY SURVEY

Plant communities were observed in the vicinity of campgrounds and along the trails leading to the camps. A limited number of the stands were described according to the following vegetation layers:

- A₁ - dominant tree layer
- A₂ - second tree layer
- B₁ - high shrub layer (over 1.5 m height)
- B₂ - low shrub layer
- C - herbs
- D - mosses

The percentage cover of each layer was estimated separately and the species present in the layer were listed. Described stands were classified into community types on the basis of field observations.

SOIL DESCRIPTION AND ANALYSIS

Soils were described by major horizons and tentatively classified according to the System of Soil Classification for Canada (Canada Soil Survey Committee 1970). Soil samples were collected from selected profiles and analysed for pH, organic matter, total nitrogen, and particle size distribution according to methods used by the Northern Forest Research Centre's Soil Science Laboratory (Kalra 1971).

CAMPGROUND SURVEY

A sketch map was produced for each campground and the camp was described in terms of:

1. location
2. distance from road and other campgrounds
3. elevation
4. landform
5. vegetation in and around the campground
6. soil
7. physical capability rating
8. size of the campground
9. number of available tent sites
10. number of fire places
11. facilities (shelters, toilets)
12. water supply
13. wood supply
14. scenery
15. recreational possibilities

CAPABILITY RATING OF CAMPGROUND ECOSYSTEM

Campground ecosystems were evaluated by a site capability rating system (Lesko 1973) based on the following factors:

1. degree days above 5°C
2. mean annual water deficit
3. shrub cover
4. grass cover
5. slope and total ground cover
6. depth of rooting
7. thickness of the A_h soil horizon
8. thickness of the organic layers (LFH layers)
9. soil texture and drainage

Detailed description of the rating procedure is in Appendix II.

Monthly mean temperatures for the campgrounds were calculated using the method of Hopkins (1938, 1968) with the climatic data for Lake Louise as a base, and degree days were calculated from the monthly mean temperatures for May to September by the method of Holmes and Robertson (1959).

VISITOR IMPACT ON CAMPGROUNDS

Visitor impact was evaluated by examining the vegetation and the top layers of the soil profile for changes brought about by use. Littering was also considered as an impact factor. Impact on the vegetation was evaluated by examination of the trees for broken branches or wounded trunks and by one or more transects across the campgrounds. The vegetation in the transects was examined on 1-m² sample plots at 5-20 m intervals, depending on the rate of change and on the length of the transect, for total ground cover and species composition. The observed cover and composition were related to unaffected parts of the community to establish the degree of change. The thickness and quality of the top soil horizons were also described at each sample plot. On the basis of these evaluations the campground was rated for visitor impact using a scale developed by Willard and Marr (1970):

Visitor Impact Scale

- Degree 0 - vegetation receiving no known impact; total vegetation cover = 100% of natural
- Degree 1 - vegetation receiving visitor impact, but is not showing any measurable or visible alteration; total vegetation cover = 100% of natural
- Degree 2 - ecosystem obviously affected by visitor impact, but vegetation is not significantly altered; total vegetation cover = 85-90% of natural
- Degree 3 - ecosystem definitely altered by visitor impact; plants show reduced vitality; attrition effects to normal growth rate; normal growth persists in protected sites; soil exposed and eroding; total vegetation cover = 25-85% of natural

- Degree 4 - ecosystem radically altered by visitor impact; vegetation gone except in very protected sites; A horizon exposed over most of area and eroding; total vegetation cover = 5-25% of natural
- Degree 5 - ecosystem virtually destroyed by visitor impact; plants existing only in very protected sites, if at all, and not growing normally; B and C horizons exposed by erosion; total vegetation cover = 0-5% of natural

Botanical nomenclature of vascular plants follows Moss (1959) and definitions in the glossary are from the Canada Department of Agriculture (1972).

RESULTS

APPROACH CAMPGROUNDS

Approach campgrounds are located by the trails leading from the access roads to destination camps or by the trails connecting destination camps within the backcountry. Most visitors stop at these camps for lunch break or for overnight rest on the way to their main target.

REDEARTH CREEK CAMPGROUND

Description

Location: Located near the center of the study area, west of the confluence of Redearth and Lost Horse Creeks. Access trail begins from Highway No. 1, about 19.3 km west of Banff.

Distance to the highway or other camps:

Highway No. 1 - 6.7 km
 Shadow Lake Camp - 5.3 km
 Pharaoh Creek Camp - 6.9 km
 Egypt Lake Camp - 11.8 km

Elevation: 1676 m

Landform: floodplain

Vegetation: Disturbed and partly introduced vegetation covers the campground. The alluvial forest in the floodplain is an engelmann spruce-alpine fir-horsetail forest, and the stand on the slope above the camp is a engelmann spruce-buffaloberry forest. For more detail see Appendix I.

Soil: The ground is artificial, derived from rock fragments quarried from the hill side.

Capability rating: 19 (very low). The low rating is due to the scanty vegetation cover and poor rooting media. However, in spite of the low rating, the campground will not deteriorate further because the crushed rock surface has a high resistance to erosion.

Size: 1450 m² (Figure 3)

Number of available tent sites: 7

Number of fireplaces: 4 corrugated metal rings.

Facilities: 1 toilet

Water supply: Redearth Creek, right at the camp

Wood supply: A good supply of firewood is available at the camp. Resupply is possible from the old logging site west of the camp.

Scenery: The camp does not have any special scenic value.

Recreational possibilities: Fishing or hiking to Copper Mountain north of the camp.

Impact Assessment

Degree of impact: 3. About 40% of the ground lacked vegetation cover (Plate 1 A). The existing vegetation was partly introduced species such as Kentucky bluegrass, common dandelion, common yarrow, and Dutch clover. The sparse vegetation growth was probably due partly to the gravelling of the area and partly to visitor impact. Vegetation damage by visitors was mostly by trampling but the six fire rings outside of the provided fireplaces also added to the damage.

Littering was of little importance, mainly as garbage left in the toilet or in the fireplaces (Plate 1 B). Visitor impact in the surrounding forest was low, with the exception of a tent site which destroyed all vegetation in a 3 x 3 m area. The tree trunks at this site were also damaged. A few trails leading into the alluvial forest and a

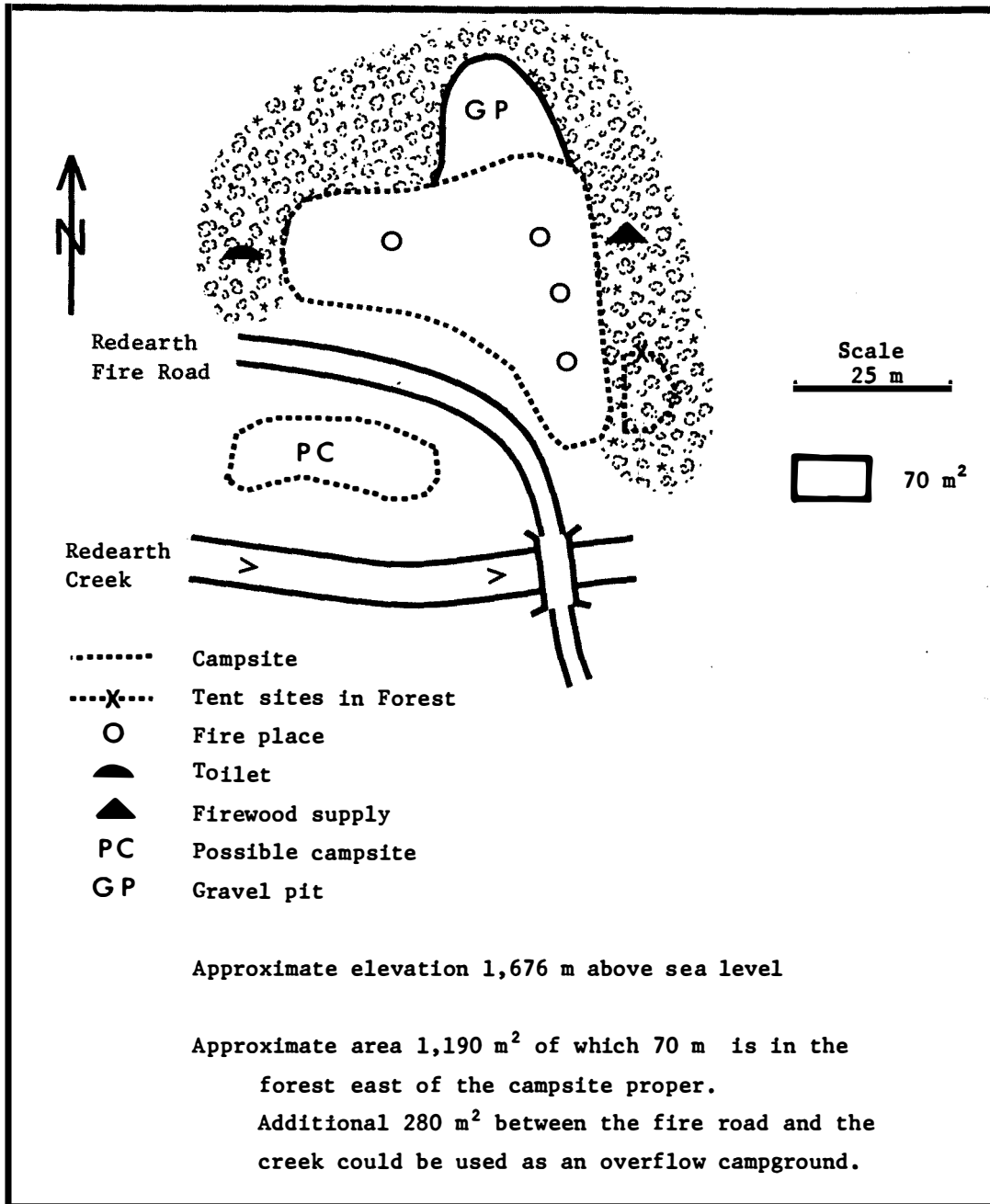


Figure 3. Sketch map of Redearth Creek campground



Plate 1A. View of Redearth Creek campground showing exposed soil.



Plate 1B. Garbage left in the fireplace at Redearth Creek campground.

fishing trail along the creek were in good condition, posing no danger of erosion. A steep trail, leading up the slope behind the camp, showed some sign of erosion.

Management and Maintenance

Although the campground presently accommodates seven tents, the ideal capacity is only four tents or 12 persons because the campground is small. One toilet is sufficient for the size of the camp. The use of campfires should be permitted as long as firewood can be supplied from the cull trees of the nearby old logging area.

To improve the quality of the campground, top soil should be spread over the gravel and seeded with a mixture of native grasses and legumes. A clearing about 200 m west of the present camp could be used as an alternative campsite until the new vegetation became established.

Firewood supply, periodic garbage pick-up, toilet cleaning, and occasional fertilizing of the grass should be sufficient for general maintenance.

PHARAOH CREEK CAMPGROUND

Description

Location: The campground is located by Pharaoh Creek about half-way between Egypt Lake Camp and the junction of Pharaoh and Redearth Creeks.

Distance from highway and other camps:

Highway No. 1 - 13.6 km

Redearth Camp - 6.9 km

Egypt Lake Camp - 4.9 km

Elevation: 1890 m

Landform: Alluvial terrace about 10 m above present creek level.

Vegetation: Vegetation is a shrubby meadow in the campground with gray leaf willow, shrubby cinquefoil, and dwarf birch. The herb layer is dominated by alpine timothy, alpine blue grass, grouse berry, and common yarrow. An open engelmann spruce-grouseberry forest surrounds the camp.

Soil: A Eutric Brunisol with 1.5-cm LFH and 1.5-cm Ah layers.

Texture of the mineral soil is sandy loam.

Capability rating: 34 (medium)

Size: 840 m² (Figure 4)

Number of available tent sites: 6

Number of fireplaces: 0

Facilities: nil

Water supply: Pharaoh Creek, with access about 75m from the camp.

Wood supply: nil

Scenery: The high terrace position provides a good view of the Pharaoh peaks to the west.

Recreational possibilities: Fishing, relative solitude, hiking.

Impact Assessment

Degree of impact: 1. The low visitor impact on this campground was due to the light use and the medium capability of the ecosystem to withstand use. The only visible signs of impact were three fire rings, where vegetation was completely missing in a small area.

Management and Maintenance

The greatest value of this camp is the low level of use, which offers relative solitude to visitors. To preserve this value and avoid crowding, the number of tents should be limited to two or three, with not more than 10 persons for overnight camping.

Building of campfires should be prohibited because the lack of firewood could lead to the damage of nearby trees. A toilet should be installed to prevent littering around the camp.

No special maintenance, besides periodic cleanups, is required if the present low use level continues in the future. If use increases the occasional application of fertilizer would help maintain a satisfactory vegetation cover.

HEALY CREEK CAMPGROUND

Description

Location: Located in the south corner of the area in the valley of Healy Creek. The camp can be approached from Highway No. 1 via Sunshine Road.

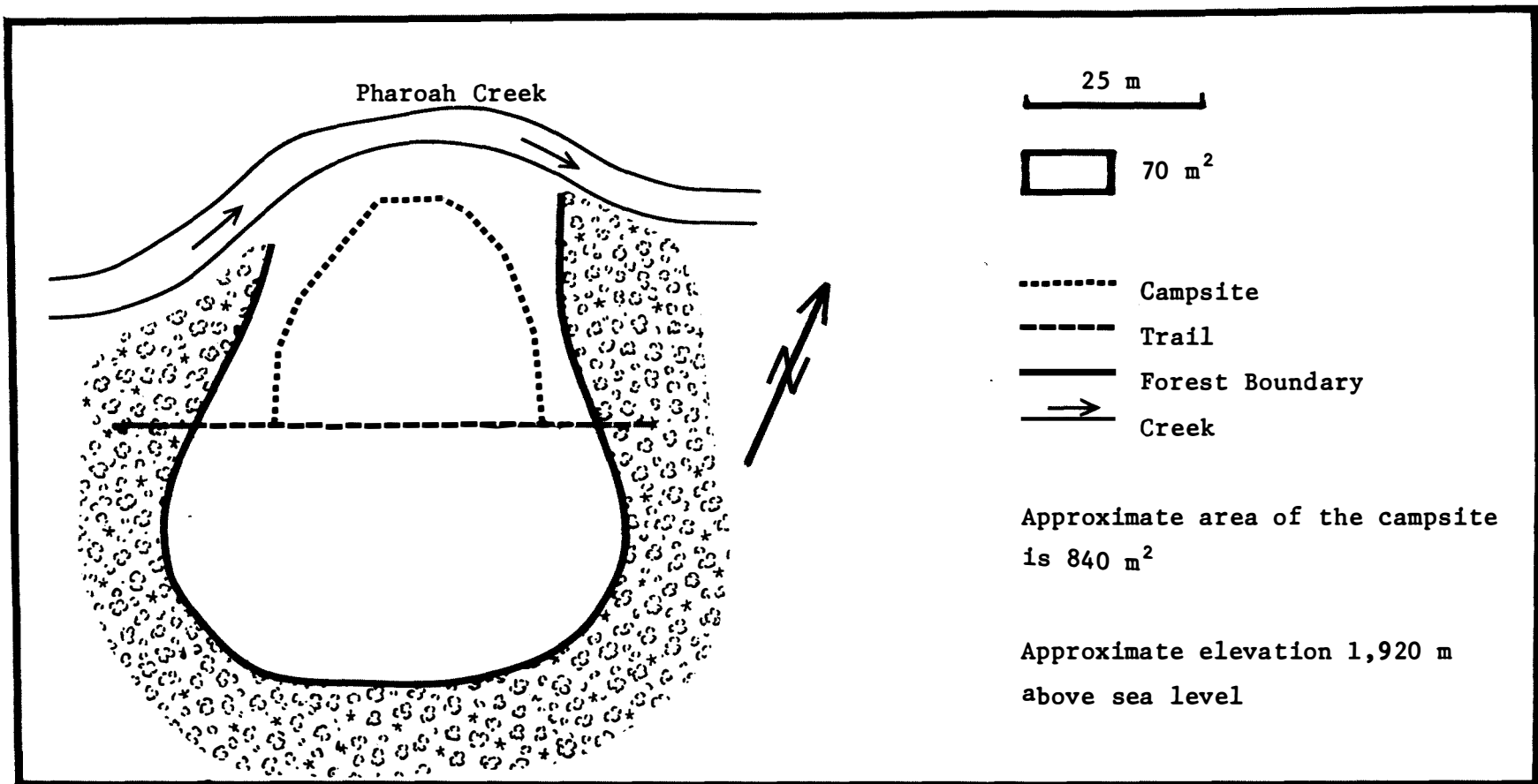


Figure 4. Sketch map of Pharaoh Creek campground

Distance from highway and other camps:

Highway No. 1 - 13.0 km
 Bourgeau Parking - 4.2 km
 Healy Pass Camp - 2.8 km
 Egypt Lake Camp - 6.8 km

Elevation: 1981 mLandform: Alluvial fan

Vegetation: An open engelmann spruce-alpine fir forest covers the camp with scattered ground vegetation of sibbaldia, grouseberry, shrubby cinquefoil, and glacier lily. The surrounding vegetation is a mature engelmann spruce-alpine fir-grouseberry forest (Appendix I).

Soil: An eroded Orthic Ferro Humic Podzol (Plate 3 A).

LFH - Eroded

Ahe - 0-2.5 cm, discontinuous, gray yellow red 10.0 YR 6/2, silt loam (S-29.5%, Si-60.5%, Cl-10%), pH-5.2, organic matter-22.8%, nitrogen-0.76%.

Bhf - 2.5 - 10 cm, yellow red 10.0 YR 5/4, silt loam (S-28.7%, Si-59%, Cl-12.3%), pH-5.0, organic matter-21.4%, nitrogen-0.73%

Bfh - 10 - 17.5 cm, yellow red 7.5 YR 5/6, loam (S-39.2%, Si-43.8%, Cl-17.0%)

Undisturbed soils are similar but with a thick organic horizon, 2.5 cm L-F, 10-12 cm H.

Capability rating: 21 (low)Size: 3150 m² (Figure 5)Number of available tent sites: 12Number of fireplaces: 0Facilities: nilWater supply: Healy Creek at the campgroundWood supply: plentifulScenery: Forest around the camp blocks the view completely.Recreational possibilities: nil

Impact Assessment

Degree of impact: 4. Ground vegetation was entirely missing from 30% of the campground and very sparse in the remaining 70% (Table 1). Soil was also partly eroded and compacted in the top 3 - 4 cm. The greatest damage to the ecosystem was due to the campground's long period of use as a staging area for horseback riders. Most of the soil compaction and erosion is due to the hard hooves of the horses. Fourteen scattered fire rings added to the bleakness of the area, and firewood stored haphazardly all over the camp also damaged the vegetation (Plates 2 A, 2 B).

Although the number of overnight visitors was low, the camp was heavily used as a lunch and rest area by hikers to Egypt Lake. Littering did not seem to be a problem, but some garbage, including a wood stove left by the equestrian campers, should be removed.

In spite of the severe damage within the campground the impact did not extend far into the forest. Vegetation changed to the unaltered forest type within 10 m of the camp boundaries.

Management and maintenance

The campground is large enough to handle five tents or 15 people without the impression of crowding. Fireplaces should be supplied to avoid the proliferation of fire rings all over the campground. Firewood should also be stored at a single place and wood-cutting should be restricted to the same location. Installation of two toilets is necessary to accommodate the large number of daytime users. The need for toilets was clearly demonstrated by piles of human excrement close to the trail or right on it in the vicinity of the campground.

To reduce the use of the campground, especially in the early summer, the access trail should be kept closed until the trail across Healy Pass becomes accessible. Reclamation of the site should be assisted by spreading peat moss on the soil and seeding local grasses and legumes. The seeding would need fertilizing, because the soil has been impoverished by erosion and compaction. A clearing about 0.3 km east of the present campground could serve as an alternative campsite during the years of reclamation.

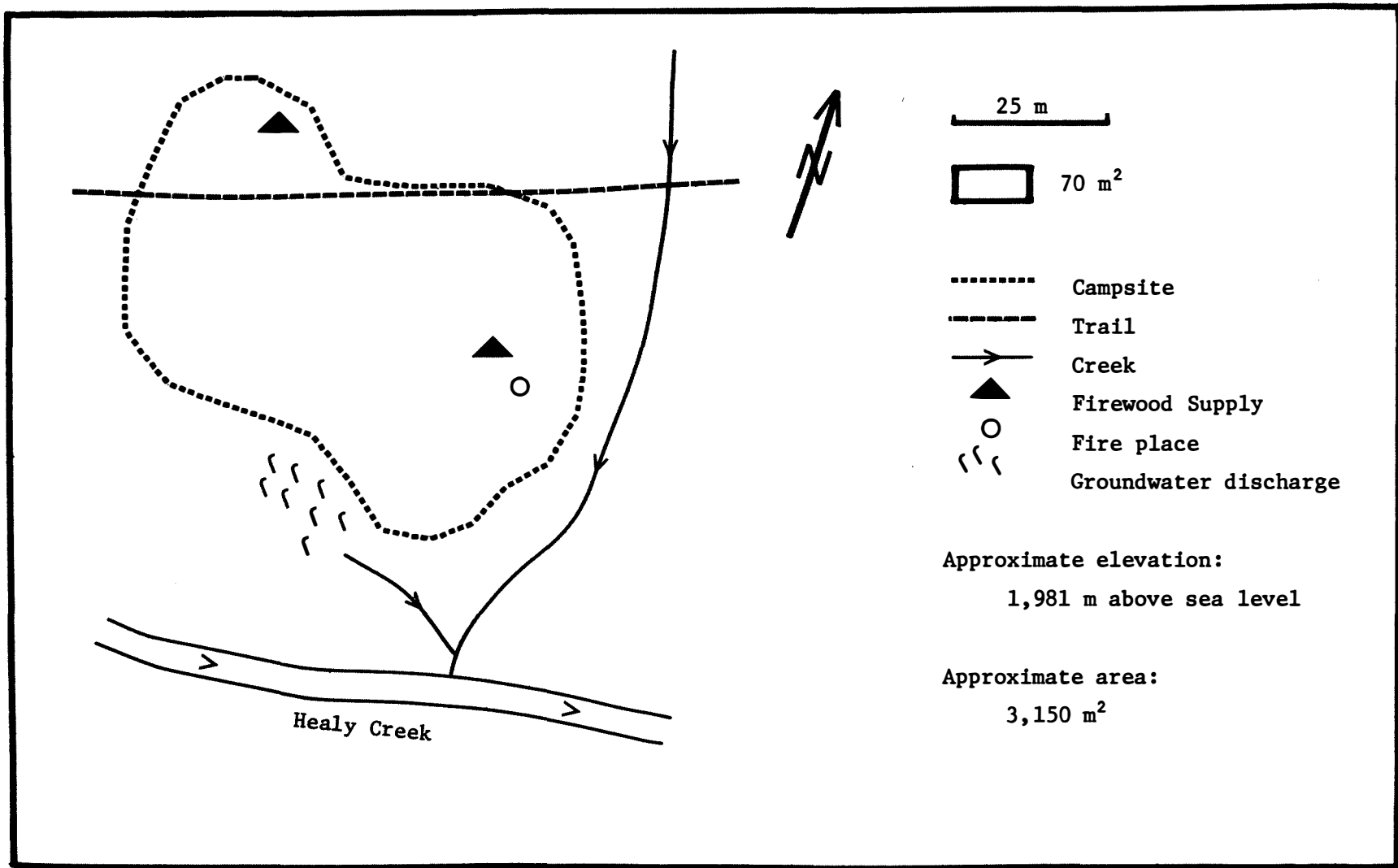


Figure 5. Sketch map of Healy Creek campground

TABLE 1. Vegetation transect at Healy Creek Campground

	Distance						
	0 m	6 m	12 m	18 m	24 m	30 m	45 m
	% Cover	% Cover	% Cover	% Cover	% Cover	% Cover	% Cover
	0	10%	10%	15%	25%	65%	90%
<i>Sibbaldia procumbens</i>		x	x	x	x	x	
<i>Erythronium grandiflorum</i>		x	x	x	x	x	x
<i>Vaccinium scoparium</i>		x			x	x	x
<i>Potentilla diversifolia</i>		x		x	x	x	x
<i>Carex nigricans</i>		x	x		x	x	x
<i>Draba crassifolia</i>		x	x		x		
<i>Veronica alpina</i>		x			x	x	
<i>Senecio eremophilus</i>		x	x	x	x	x	x
<i>Fragaria virginiana</i>			x		x	x	x
<i>Antennaria lanata</i>			x			x	
<i>Luzula wahlenbergii</i>				x	x		
<i>Ranunculus eschscholtzii</i>					x	x	
<i>Epilobium palustre</i>					x		
<i>Equisetum scirpoides</i>					x		
<i>Achillea millefolium</i>					x	x	
<i>Cerastium sp.</i>					x		
<i>Salix sp.</i>						x	
<i>Pedicularis groenlandica</i>						x	
<i>Valeriana sitchensis</i>						x	x
<i>Potentilla fruticosa</i>							x



Plate 2A. Exposed mineral soil and haphazardly stored firewood at Healy Creek campground.



Plate 2B. More scattered firewood at Healy Creek campground.

HEALY PASS CAMPGROUND

Description

Location: This campground is about 1.1 km east of Healy Pass on the Egypt Lake trail. Access is from Bourgeau Parking via Healy Creek.

Distance from highway and other camps:

Highway No. 1. - 15.8 km

Bourgeau Parking - 7.0 km

Healy Creek Camp - 2.8 km

Egypt Lake Camp - 4.0 km

Elevation: 2225 m

Landform: Broad till-covered ridge with 12% southerly slope.

Vegetation: Open alpine larch-engelmann spruce-alpine fir forest with herbaceous ground cover (Plate 4 A and Appendix I).

Soil: Gleyed Distric Brunisol (Plate 3 B).

LFH - 2.5 - 0 cm, dark brown with many roots

Ahe - 0 - 7.5 cm, yellow brownish gray loam with many roots

Bmg - 7.5 - 20.0 cm, yellow brown gravelly, sandy loam with mottlings, few roots

Cg - 20+ cm, yellowish gray gravelly silty sand

Capability rating: 15 (very low)

Size: 665 m² (Figure 6)

Number of available tent sites: 5

Number of fireplaces: 0

Facilities: nil

Water supply: A small creek 20 m west of camp

Wood supply: nil

Scenery: Alpine meadows and excellent panoramic view of the mountains along the continental divide give a high scenic value to the location.

Recreational possibilities: Hiking, photography, botanizing.



Eroded Orthic Ferro Humic Podzol at Healy Creek campground.

Plate 3A



Gleyed Distric Brunisol at Healy Pass campground.

Plate 3B

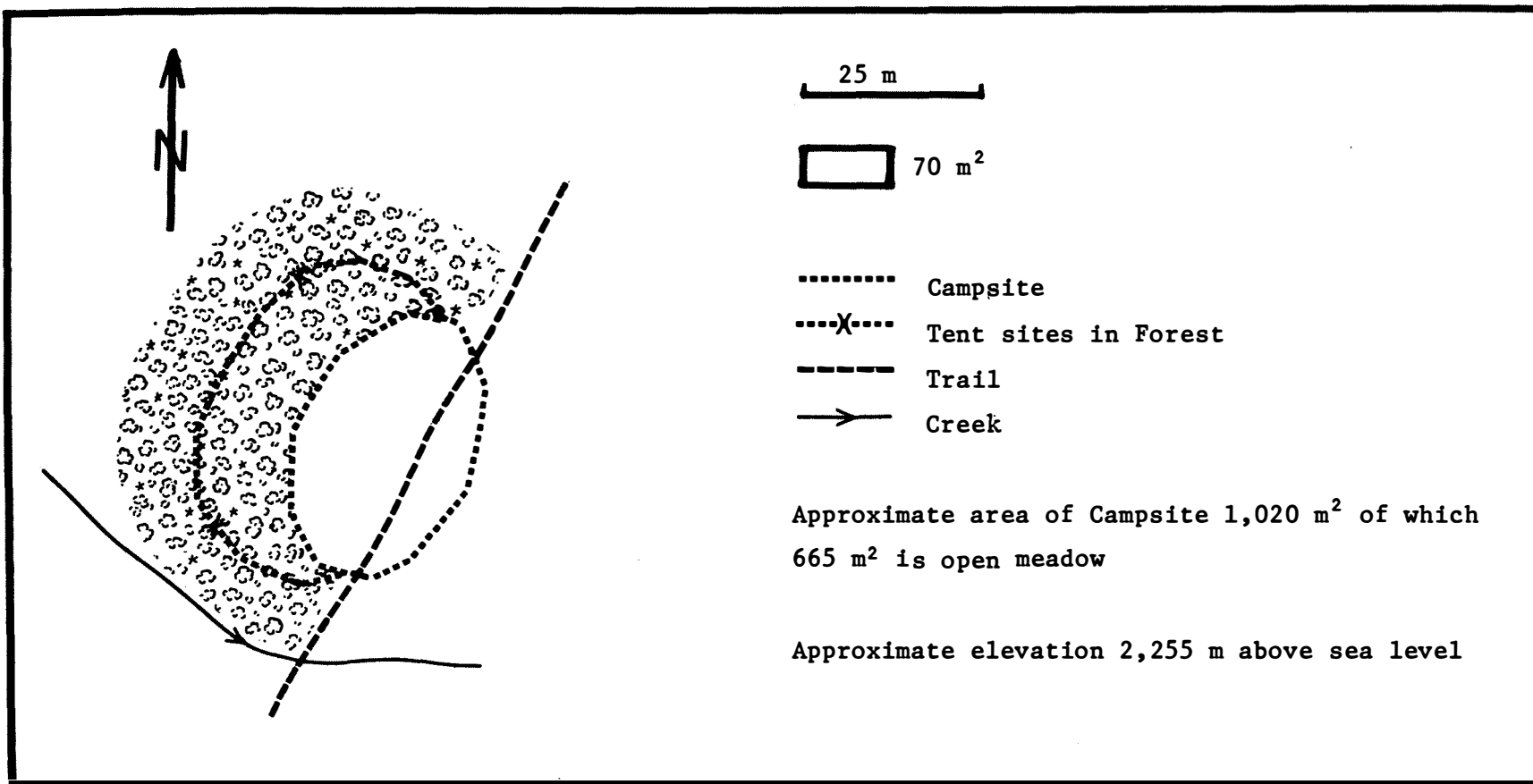


Figure 6. Sketch map of Healy Pass campground.

Impact Assessment

Degree of impact: 1. There was no visible damage to the vegetation with the exception of three fire rings, a wood-splitting area, and the trail (Plate 4 B). Vigorous vegetation with unaltered composition covers the rest of the campground. A branching in the trail indicated that wet conditions make a section of the trail impassable in the spring or early summer. This poses the danger of multiple trails in the future. Daytime traffic through the camp is heavy, but few visitors stay overnight because of the short distance to the Egypt Lake Campground.

Management and Maintenance

The number of overnight campers should be limited to two tents or six persons because of the low capability of the ecosystem to withstand campground use. High soil moisture and fragile vegetation render the area easily vulnerable to deterioration. Recovery of the vegetation from any damage would be very slow because of the short growing season and low thermal regime of the location.

The prohibition of camp fires should be continued because very little firewood is available in the vicinity. Concentrated trampling around the fireplace would also increase damage to the vegetation. A chemical toilet should be installed at the camp for both campers and passers-by.

There is some old metal garbage in the camp area that should be picked up. Otherwise, the camp does not need any special maintenance if present low level of use is maintained in the future. The wet section of the trail needs improvement to avoid multiple trail development.

BALL PASS CAMPGROUND

Description

Location: The campground is located 2.4 km east of the continental divide at the junction of Ball Pass and Haiduk Lake trails. It may be approached from Bourgeau Parking via Egypt Lake or from Highway No. 1 via Shadow Lake.



Plate 4A. Vegetation and trail through Healy Pass campground.

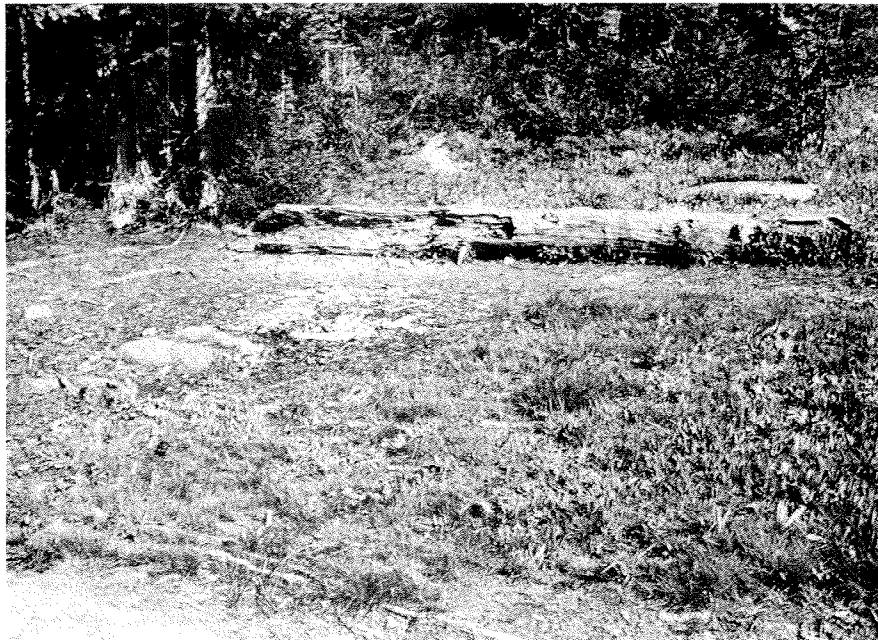


Plate 4B. Vegetation was destroyed around a log used for firewood at Healy Pass campground.

Distance from highway and other camps:

Highway No. 1 - 16.1 km
 Bourgeau Parking - 18.1 km
 Shadow Lake Camp - 5.0 km
 Egypt Lake Camp - 7.1 km
 Haiduk Lake Camp - 3.1 km

Elevation: 1950 m

Landform: alluvial fan

Vegetation: An open, shrubby meadow, dominated by willows, shrubby cinquefoil, and alpine blue grass.

Soil: Alluvial Regosol with 4 cm LFH layer (Plate 5 A)

Capability rating: 30 (low)

Size: 1330 m² (Figure 7)

Number of available tent sites: 2

Number of fireplaces: 0

Facilities: nil

Water supply: Creek at the west border of the camp.

Wood supply: A small amount was supplied.

Scenery: Very nice view of mountain peaks (Plate 5 B)

Recreational possibilities: Solitude, mountain climbing, hiking, photography.

Impact Assessment

Degree of impact: 1. Impact within the campground was restricted to the trail and to a small area around the fire ring. There were two garbage pits in the meadow with some non-combustible garbage in them. Very few visitors stop here overnight and even the number of daytime users is low.

Management and Maintenance

There were only two tent sites available in this campground. However, with some shrub clearing and levelling, three tents or up to eight people could be accommodated without the danger of rapid deterioration. The use of campfires should be phased out because supplying firewood to this location would be very expensive and would require the cutting of standing trees. A toilet should be installed to prevent littering around

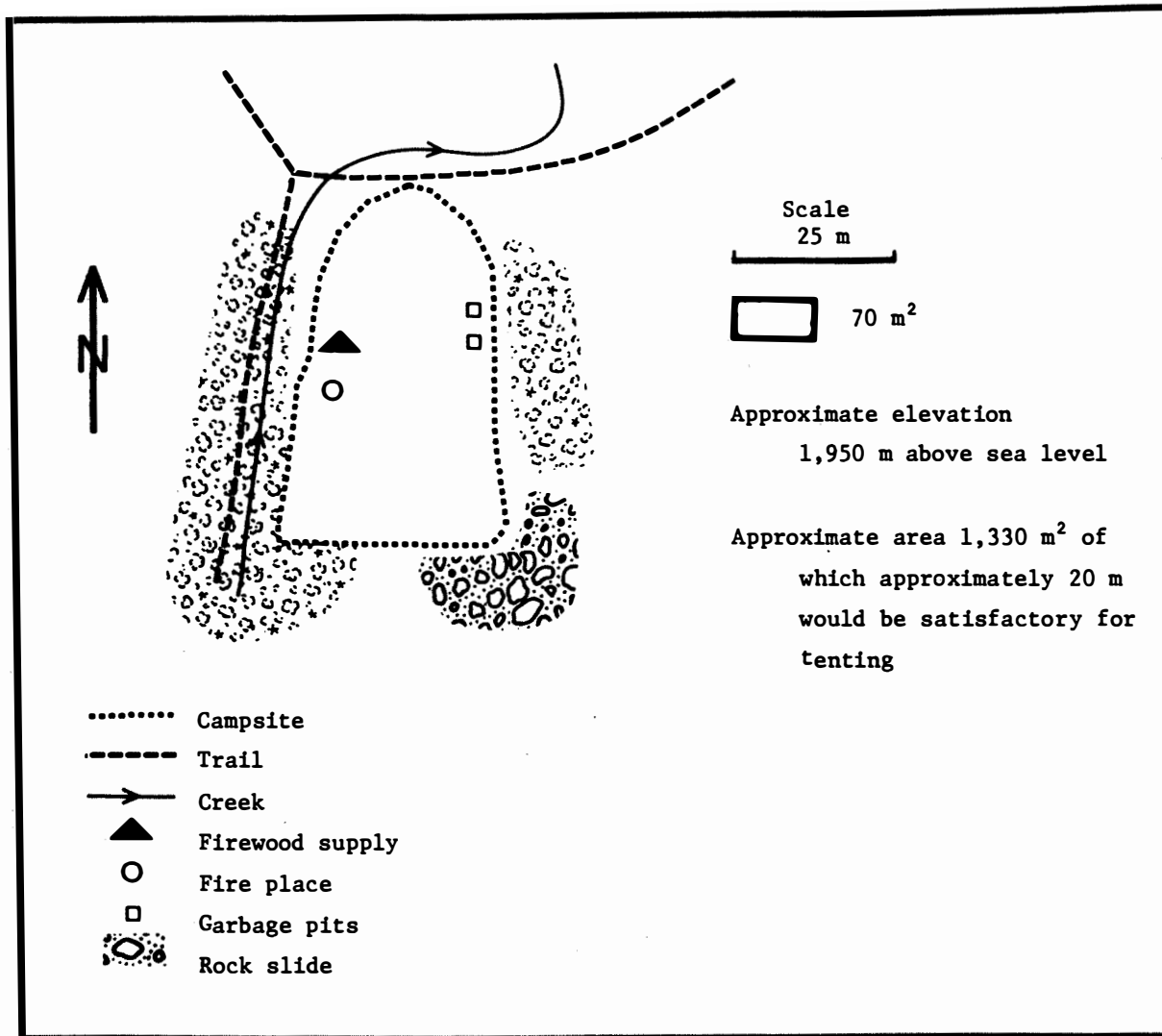


Figure 7. Sketch map of Ball Pass campground

the camp. The two garbage pits should be filled because there is no need for them.

There is no need for special maintenance if the present low use continues in the future. In the case of increased use the campground should be fertilized occasionally.

DESTINATION CAMPGROUNDS

Destination campgrounds are those in which visitors usually stay longer than one night, making short one-day hikes in the surrounding area. These camps are located in the vicinity of very picturesque landscapes such as alpine lakes, glaciers, and mountain peaks.

TWIN LAKES CAMPGROUND

Description

Location: The camp is located in the northwest part of the study area near Storm Mountain and Lower Twin Lake. It may be approached from the Eisenhower junction via the trail east of Altrude Creek or by the trail about 6 km west of Eisenhower junction on Invermere Highway.

Distance from highway or other camps:

Highway No. 1 - 7.8 km

Invermere Highway - 6.5 km

Shadow Lake Camp - 5.8 km

Elevation: 2072 m

Land form: hummocky meadow, groundwater discharge areas.

Vegetation: Willow-shrubby cinquefoil meadow with heavy moss cover, including peat moss.

Soil: Rego Gleysol

Capability rating: 0 (not recommended for campground use)

Size: 840 m² (Figure 8)

Number of available tent sites: 0

Number of fireplaces: 0

Facilities: nil



Alluvial Regosol at Ball Pass campground.

Plate 5A



View of Ball Range from Ball Pass campground.

Plate 5B

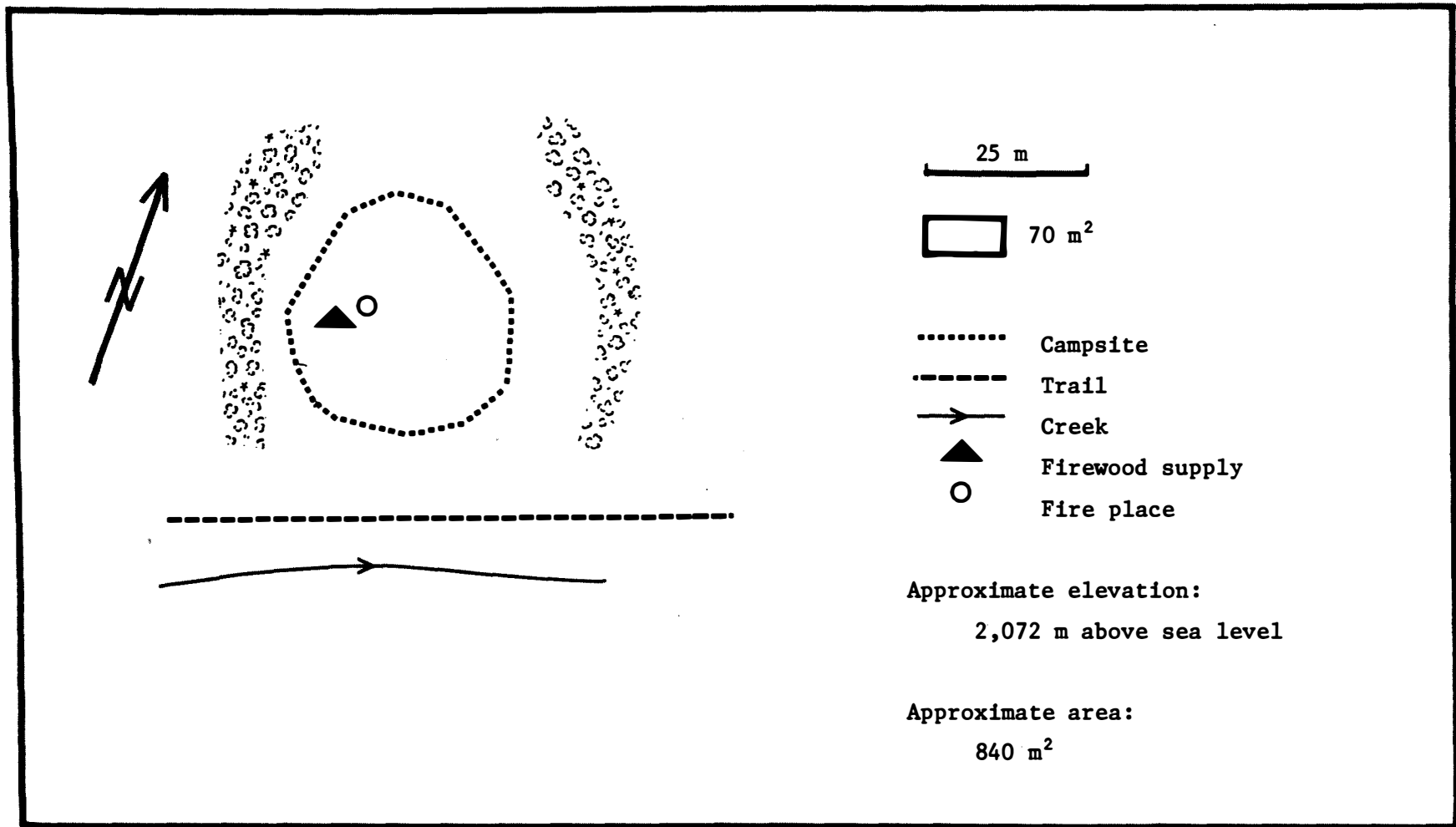


Figure 8. Sketch map of Twin Lakes campground

Since the site was rated unsatisfactory for campground use it will not be discussed further. Visitors also discovered the uselessness of this campground and pitched their tents on the lakeshore instead of in the designated area (Plate 6 A). An alternative campground for the Twin Lakes area was considered and is described below.

TWIN LAKES ALTERNATIVE CAMPGROUND

Description

Location: The alternative campground is located about 0.8 km north of the junction of Gibbon Pass and Lower Twin Lake trails.

Distance from highway and other camps:

Highway No. 1 - 9.0 km

Invermere Highway - 5.5 km

Shadow Lake Camp - 6.2 km

Elevation: 2073 m

Land form: broad till ridge

Vegetation: The vegetation is a transition between engelmann spruce, alpine fir-grouseberry and alpine larch-engelmann spruce-alpine fir-heather forest types (Appendix I and Plate 6 B).

Soil: Orthic Gray Luvisol (Plate 7 A)

LFH - 5-0 cm, dark yellow red organic matter, pH-5.0, organic matter-88.4%, nitrogen-1.26%.

Ae - 0-10 cm, light yellow red, 10 YR 7/2, silt loam (S-21.4%, Si-62.6%, Cl-16.0%), pH-4.1, organic matter-5.6%, nitrogen-0.11%.

Bt - 10-30 cm, light redish yellow, 2.5 Y 7/4, loam (S-41.2%, Si-31.8%, Cl-27.0%), pH-4.7, organic matter-1.5%, nitrogen-0.07%.

The entire profile is stony.

Capability rating: 15 (very low)

Size: 1000 m² (Figure 9)

Number of available tent sites: 5

Number of fireplaces: 0

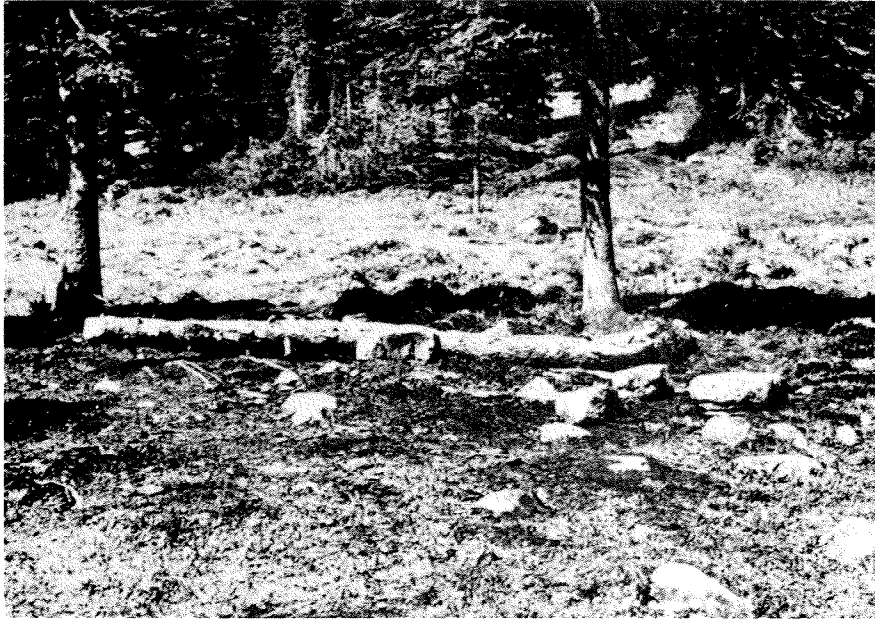


Plate 6A. Illegal campsite on the shore of Lower Twin Lake.



Plate 6B. Forest stand at the proposed alternate Twin Lake campground.

Facilities: nil

Water Supply: Upper Twin Lake, about 60 m from the campground.

Wood Supply: nil

Scenery: There is no scenery visible from the campground because of its location in the forest, but the nearby Twin Lakes are beautiful (Plate 7 B).

Recreational possibilities: Hiking, photography, fishing.

Impact Assessment

The campground has not been used yet. The only impact has been on the trail leading through the area.

Management and Maintenance

Although the capability rating of the campground is very low, this site was selected because the vicinity of Twin Lakes does not offer any better choice.

The campground could be arranged along the trail to provide four or five tent sites accommodating not more than 12 persons. Cutting down some trees would open up the forest, and the increased light on the forest floor would encourage a more vigorous vegetation growth than the existing one. The trees removed should be dragged some distance into the forest to discourage their use as firewood, because the building of campfires should not be permitted. One chemical toilet should be supplied and then periodic fertilizing and cleanup should be sufficient maintenance after establishment.

SHADOW LAKE CAMPGROUND

Description

Location: The camp is about 1 km northeast of Shadow Lake near Ball Mountain.

Distance from highway and other camps:

Highway No. 1. - 12.0 km

Redearth Camp - 5.3 km

Twin Lakes Camp - 5.8 km

Ball Pass Camp - 5.0 km

Haiduk Lake Camp - 8.0 km

Egypt Lake Camp - 12.0 km



Orthic Gray Luvisol at Twin Lakes alternate campground.

Plate 7A



View of Upper Twin Lake near Twin Lakes alternative campground.

Plate 7B

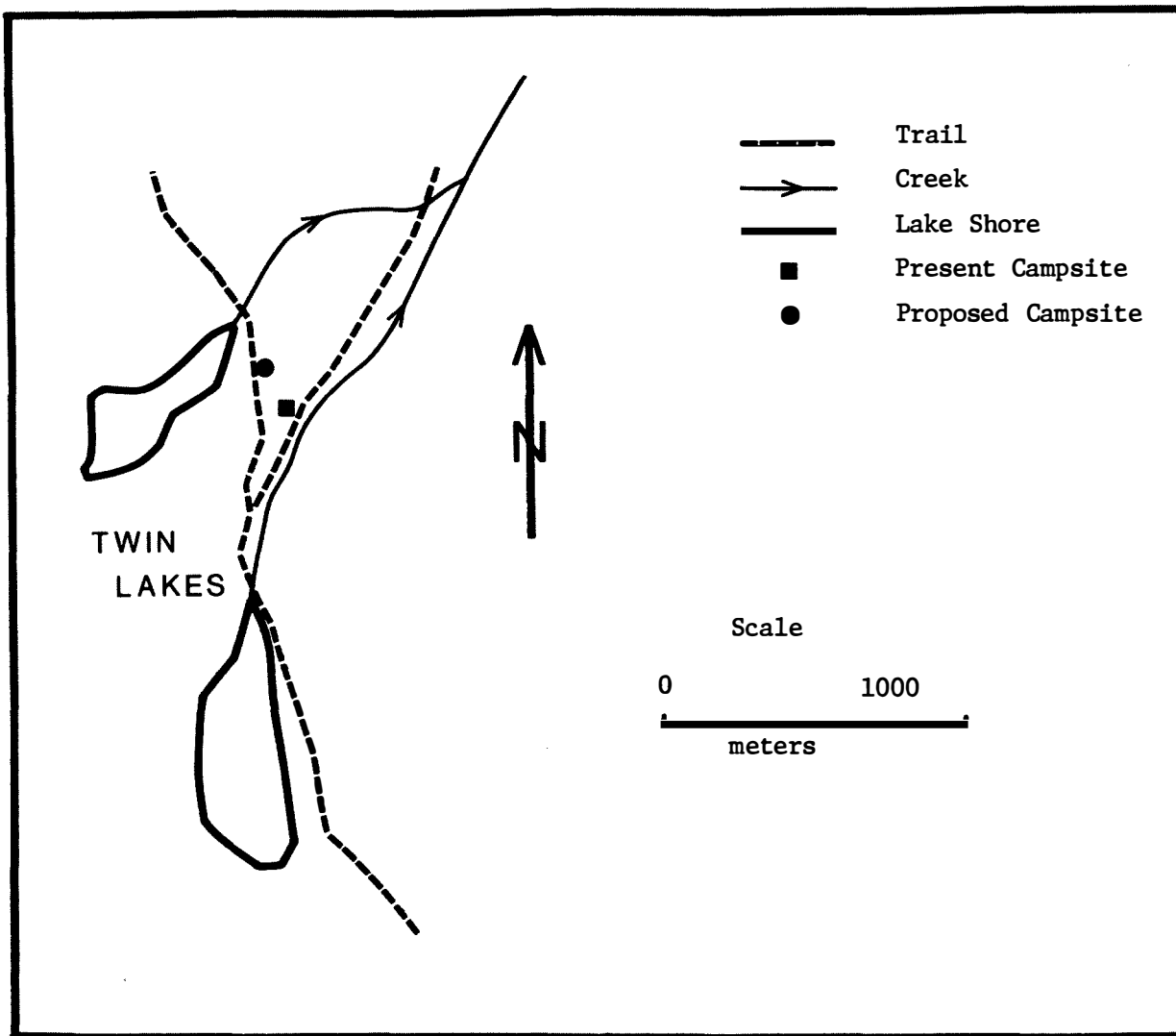


Figure 9. Location of Twin Lakes alternate campground.

Elevation: 1820 m

Landform: alluvial plane

Vegetation: The vegetation in most of the utilized area of the campground is a disturbed meadow of alpine timothy and Sibbaldia. This meadow grades into a wet Carex - mountain marigold meadow on the south. The north and east edges are engelmann spruce-alpine fir-white flowered rhododendron forest (Appendix I).

Soil: Cumulic Regosol (Plate 8 A)

LFH - 2.5-0 cm, dark gray partially decomposed organic matter with many roots.

Ah - 0-4 cm, dark yellow red, 10.0 YR 4/2, loam (S-28.6%, Si-46.4%, Cl-25%), nitrogen-0.75%, organic matter-16.6%.

C - 4 cm +, yellow red 10 YR 5/2, clay loam (S-42.4%, Si-28.6%, Cl-29%), pH-6.3, organic matter-3.5%, nitrogen-0.18%.

There are buried Ah horizons within the C layer.

Capability rating: 31 (medium)

Size: 3540 m² (Figure 10)

Number of available tent sites: 34

Number of fireplaces: 4 corrugated metal rings

Facilities: 2 toilets

Water supply: The creek out of Shadow Lake.

Wood supply: Some cut firewood is supplied.

Scenery: There is an excellent view of Ball Mountain (Plate 8 B) and Shadow Lake at the base of the mountain is of high scenic quality.

Recreational possibilities: Hiking, photography, fishing.

Impact Assessment

Degree of impact: 3. About 15% of the campground is within the forest margin. This part of the camp suffered a complete loss of vegetation (Plate 9 A). On the meadow part of the camp the vegetation cover is adequate, except around the fire rings. However, even this vegetation has been severely altered by many years of use, including horse grazing in the past. The vegetation changed to hardy species, such as alpine



Cumulic Regosol at Shadow Lake campground.

Plate 8A



View of Ball Mountain from Shadow Lake campground.

Plate 8B

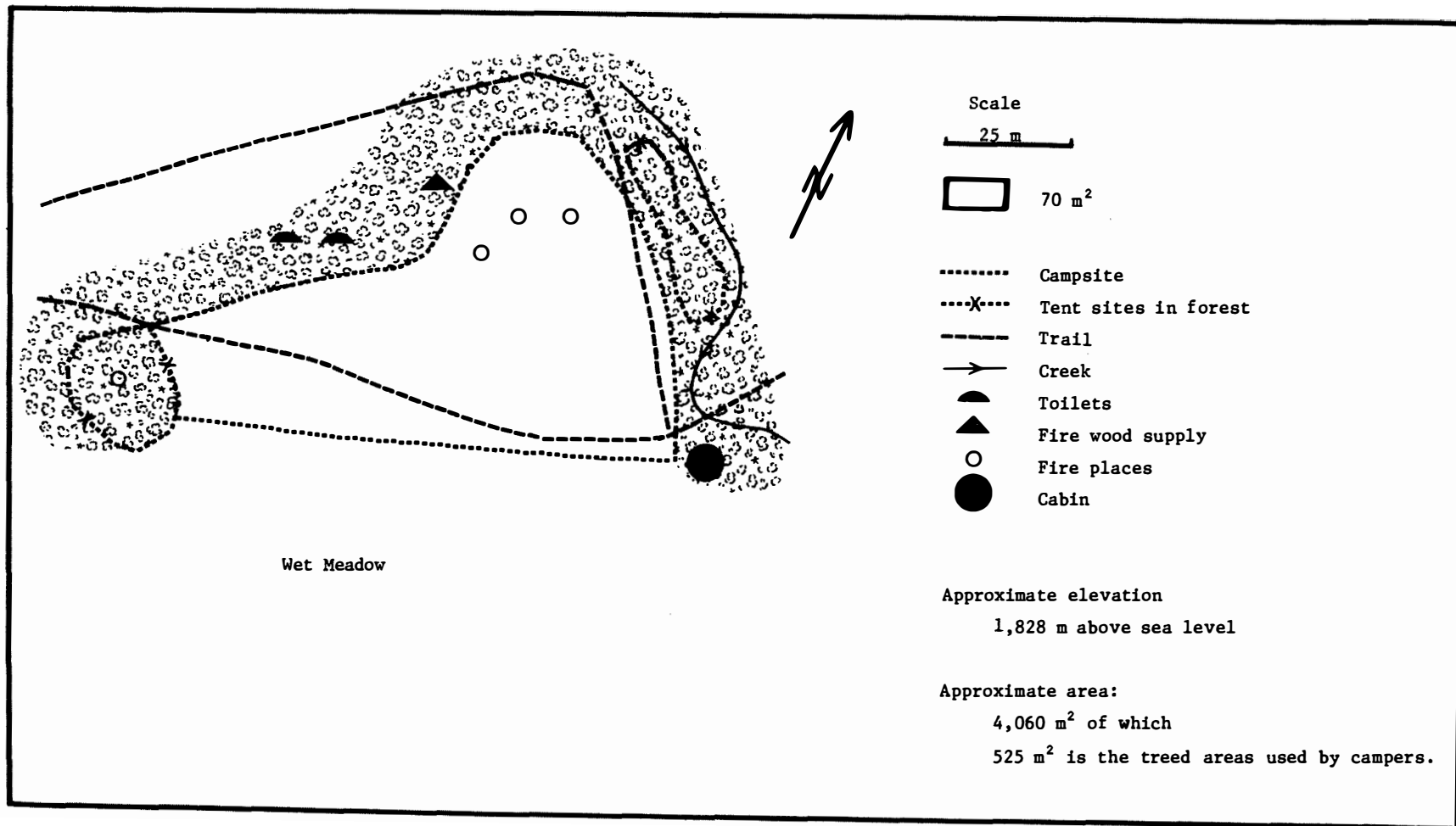


Figure 10. Sketch map of Shadow Lake campground

timothy, Carex, Sibbaldia, wild strawberry, and common yarrow (Tables 2 and 3). These species tolerate a large degree of trampling and have profited from the elimination of willows and shrubby cinquefoil by receiving more direct sunshine (Plate 9 B). The most unfortunate aspect of this vegetation change is the aggressive spread of common dandelion, an introduced weed from Europe. A private cabin on the meadow puts additional pressure on the campground.

The presence of 23 fire rings scattered over the campground was responsible for the elimination of vegetation by fire or by concentrated trampling around the fire. Further damage was caused by teepees erected in the past by campers. These old teepee sites are either barren or overgrown by common yarrow and pussy-toes. Damage to vegetation was severe around the wood piles, but at least the soil was protected here by wood-chips (Plate 10 A).

Some inconsiderate visitors left combustible and non-combustible garbage in the fireplaces, and others left human excrement only a couple of meters in front of the toilet. Unfortunately manure and toilet paper resist decomposition for a long time in the cold climate of the camps and can spoil the recreational satisfaction of many other visitors.

Management and Maintenance

The flat meadow and forest edge at Shadow Lake Campground provide many more suitable tent sites than the ecosystem can bear without severe damage. Therefore, the number of overnight users should be limited to eight tents or 20 persons.

The capability of the ecosystem to withstand campground use is much lower in the forest edge than in the meadow. However, most campers prefer to tent in the forest for added protection and privacy. To prevent future damage, tenting could be prohibited in the forest or the forest could be thinned to allow the development of a stronger grassy vegetation. This process could be assisted by seeding and fertilizing. Weed control, grass seeding, and fertilizing also seem necessary in the meadow to eliminate dandelions and common yarrow. A vigorous grass cover would also increase the carrying capacity of the camp.



Plate 9A. Vegetation was completely destroyed by campers in the forest edge at Shadow Lake campground.



Plate 9B. View of the meadow at Shadow Lake campground.

TABLE 2. Vegetation transect from fireplace to wet meadow at Shadow Lake Campground

Species	Distance					
	0 m	10 m	20 m	30 m	40 m	50 m
	% Cover	% Cover	% Cover	% Cover	% Cover	% Cover
	0%	25%	99%	98%	100%	100%
<i>Potentilla fruticosa</i>		x	x	x	x	x
<i>Potentilla diversifolia</i>		x	x			
<i>Vaccinium scoparium</i>		x	x	x	x	
<i>Fragaria virginiana</i>		x	x	x	x	x
<i>Sibbaldia procumbens</i>		x			x	
<i>Achillea millefolium</i>		x	x	x		x
<i>Draba crassifolia</i>		x		x		
<i>Carex media</i>		x		x	x	x
<i>Epilobium alpinum</i>		x				
<i>Polytrichum juniperinum</i>			x	x		
<i>Taraxacum officinale</i>				x	x	x
<i>Zizia aptera</i>				x	x	
<i>Claytonia lanceolata</i>				x	x	
<i>Viola adunca</i>				x		x
<i>Castilleja miniata</i>				x	x	
<i>Salix glauca</i>					x	x
<i>Phleum alpinum</i>					x	
<i>Luzula wahlenbergii</i>						x
<i>Aster ciliolatus</i>						x
<i>Poa alpina</i>						x

TABLE 3. Vegetation transect from fireplace to forest at Shadow Lake Campground

Species	Distance			
	0 m	10 m	20 m	30 m
	% Cover	% Cover	% Cover	% Cover
	0%	1%	3%	95%
<i>Phleum alpinum</i>		x		
<i>Vaccinium scoparium</i>			x	
<i>Arnica cordifolia</i>			x	x
<i>Equisetum arvense</i>			x	
<i>Carex media</i>			x	
<i>Polytrichum juniperium</i>			x	
<i>Dicranum sp.</i>			x	
<i>Peltigera aphtosa</i>			x	
<i>Lonicera ivolucrata</i>				x
<i>Ribes lacustre</i>				x
<i>Thalictrum occidentale</i>				x
<i>Pyrola asarifolia</i>				x
<i>Fragaria virginiana</i>				x
<i>Osmorhiza depauperata</i>				x
<i>Mitella nuda</i>				x
<i>Equisetum scirpoides</i>				x

Keeping the toilets clean and reasonably empty is an important part of the maintenance because filled and dirty toilets are not used. The control of campfires is also very important because the severest damage is concentrated around the fire rings. Withdrawal of fire permits at the exhaustion of the present wood supply would be the most effective solution.

HAIKUK LAKE CAMPGROUND

Description

Location: The campground is located 0.8 km north of Haiduk Lake. Trails from Bourgeau Parking via Egypt Lake and from Shadow Lake provide access to this camp.

Distance from highway and other camps:

Highway No. 1 - 20 km
 Bourgeau Parking - 15.1 km
 Shadow Lake Camp - 8.0 km
 Ball Pass Camp - 3.0 km
 Egypt Lake Camp - 4.1 km

Elevation: 2042 m

Landform: moraine

Vegetation: The higher part of the campground is an open alpine larch-engelmann spruce-alpine fir forest with heather ground vegetation. The lower part is a Carex-Sibbaldia meadow (Plate 10 B and Appendix I).

Soil: Melanic Brunisol (Plate 11 A) with less than 1 cm LFH and 3 cm Ah layers. Texture of the mineral horizon was silty clay loam.

Capability rating: 20 (very low)

Size: 1300 m² (Figure 11)

Number of available tent sites: 6

Number of fireplaces: 0

Facilities: nil

Water Supply: Haiduk Creek east of the campground.

Wood Supply: nil



Plate 10A. Ground vegetation was completely destroyed around the wood storage and cutting place at Shadow Lake campground.



Plate 10B. Vegetation of Haiduk Lake campground.

Scenery: The view of Haiduk peak and Pharaoh Peaks is of high scenic value (Plate 11 B).

Recreational possibilities: Hiking, mountain climbing, fishing, photography, and solitude.

Impact Assessment

Degrees of impact: 1. In spite of the exceptionally scenic setting of Haiduk Lake, few visitors stop here for overnight stay. Even most of those who intended to stay overnight could not find the poorly marked camp and pitched their tents by the lakeshore. The low level of use left very little impact on the campground. With the exception of two small fire rings there were no visible signs of use.

Management and Maintenance

Relocation of this camp may be considered because of its nearness to an avalanche pass. (Some trees were knocked down by an avalanche less than 100 m above the camp during the winter of 1973-74.) However, the avalanche danger is over by the time the campground is in use and the danger of anybody getting hurt by avalanches there is very remote. The lack of a good alternative campsite in the general area, with the exception of the lakeshore, is also a reason to keep the camp at its present location.

Because the ecosystem is of low capability, the number of visitors should be restricted to not more than 10 persons or three tents at one time. The camp could be supplied with a toilet and fireplaces if the avalanche-killed trees can be used as firewood. However, the campground would suffer less damage without campfires.

Under the present use level the campground does not need any special maintenance besides periodic cleanups.

EGYPT LAKE CAMPGROUND

Description

Location: The camp is located 0.8 km north of Egypt Lake by Pharaoh Creek.

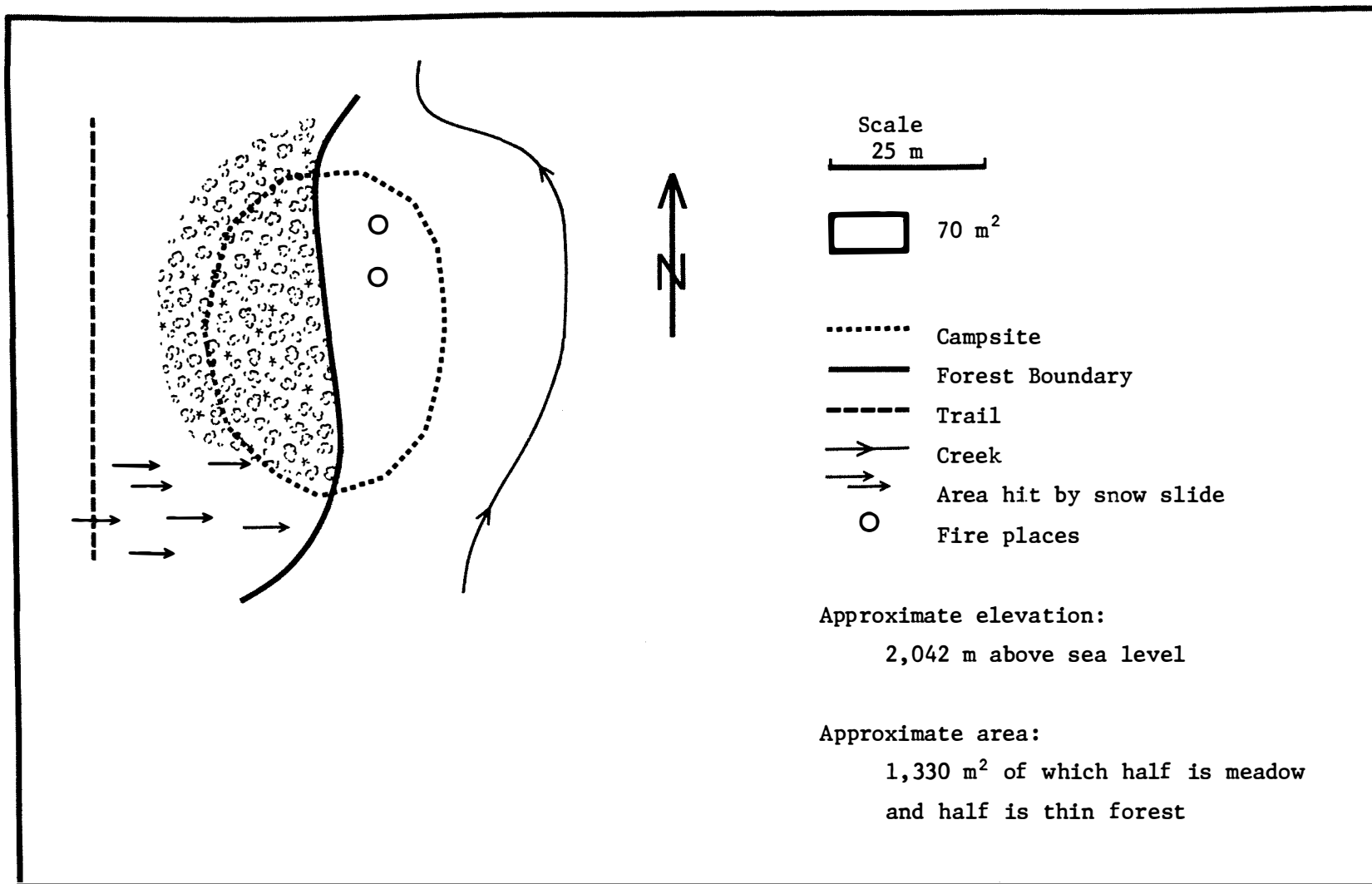


Figure 11. Sketch map of Haiduk Lake campground



Melanic Brunisol at Haiduk Lake campground.

Plate 11A



View of Haiduk Lake.

Plate 11B

Distance from highway and other camps:

Highway No. 1 - 18.5 km
 Bourgeau Parking - 11.0 km
 Pharaoh Creek Camp - 4.9 km
 Haiduk Lake Camp - 4.1 km
 Shadow Lake Camp - 12.1 km
 Healy Creek Camp - 6.8 km

Elevation: 2011 m

Landform: terrace

Vegetation: The open area is an altered subalpine meadow of Carex, spike woodrush, and timber oatgrass, and the forest surrounding the camp is an engelmann spruce-alpine fir-grouseberry community (Table 3).

Soil: Orthic Regosol (Plate 12 A)

LFH - 1.5-0 cm, missing at some places.

Ah - 0-20 cm, dark yellow red 10.0 YK 3/4, loam (S-41.6%, Si-46.8%, Cl-11.6%), pH-4.7, organic matter-21%, nitrogen-0.7%.

C - 20 cm+, yellow red 10.0 YR 5/6, sandy loam (S-67.4%, si-23.4%, Cl-9.2%), pH-4.5, organic matter-2.1%, nitrogen-0.08%.

Capability rating: 32 (medium)

Size: 8505 m² (Figure 12)

Number of available tent sites: 16

Number of fireplaces: 2 concrete rings

Facilities: 2 toilets, 1 cabin shelter

Water Supply: Pharaoh Creek

Scenery: There is an excellent view of the Pharaoh Peaks (Plate 12 B).

Recreational possibilities: Hiking, mountain climbing, photography, fishing, botanizing.

Impact Assessment

Degree of impact: 3. Change in species composition is the most widespread impact in the campground. The number of herbs decreased as they were replaced by the more prolific growth of grasses and other hardy



Orthic Regosol at Egypt Lake campground.

Plate 12A



View of Pharaoh Peaks from Egypt Lake campground.

Plate 12B

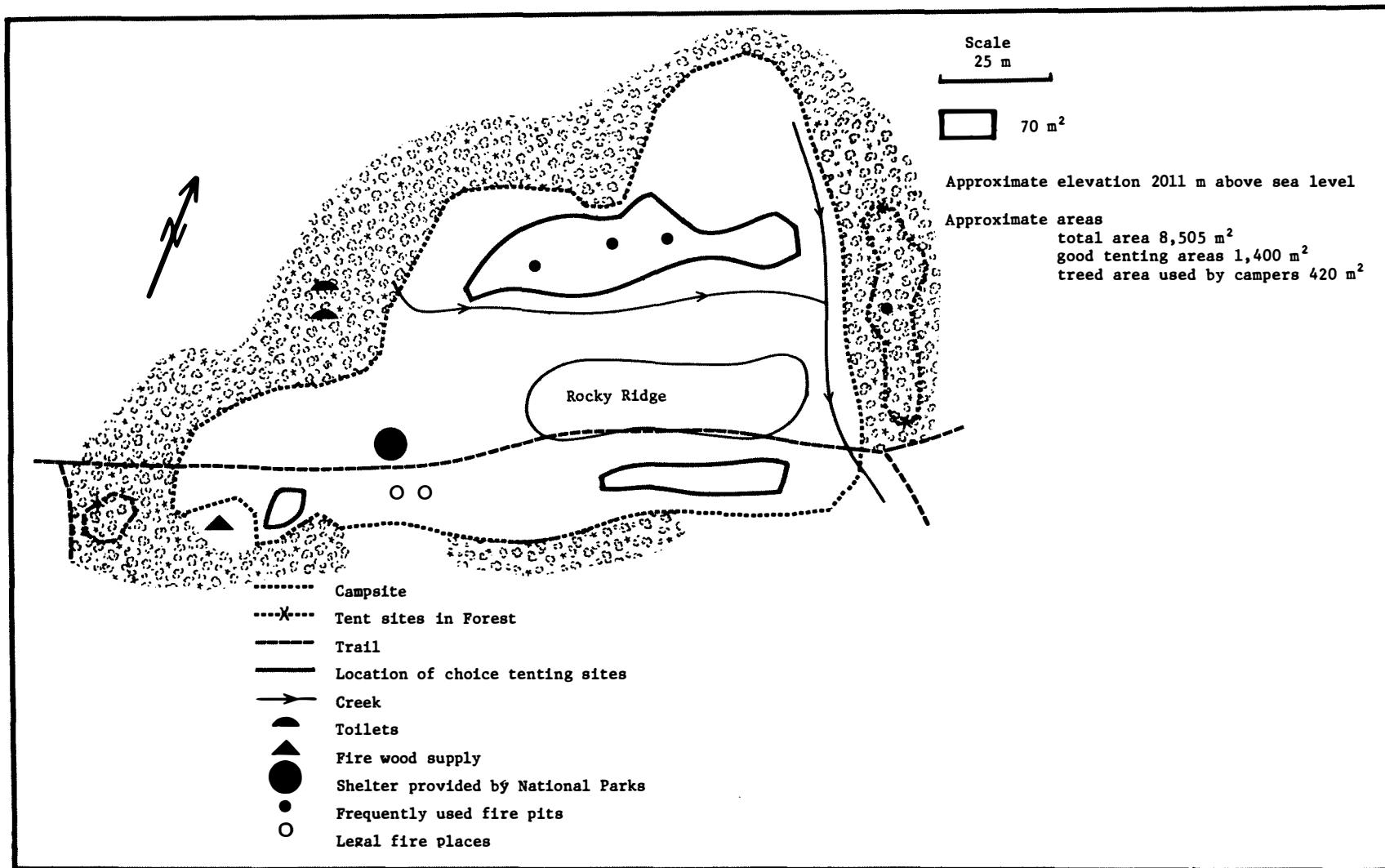


Figure 12. Sketch map of Egypt Lake campground.

species (Table 4). Heavy use is also reflected by the small number of species. At 10 m in the transect the larger number of species was due to the protection by rocks on the ground surface.

Areas of heavier impact were found at the front of the shelter, around the fireplaces, and at the wood-splitting place (Plate 13 A). Here the ground was entirely denuded of vegetation and the soil was either exposed or covered with wood chips. The shelter and the two fireplaces in this heavily used campground concentrated activities in a relatively small area. In all, 5-10% of the total area was denuded to the mineral soil. Eight fire rings were scattered throughout the camp, further damaging the vegetative cover.

The forest margin at the north end of the camp had also been heavily used for camping and was denuded of all ground vegetation.

Toilets were very dirty and their roofs were damaged. Windows in the shelter were broken and there was evidence of wood-splitting inside the building.

Management and Maintenance

The presence of the shelter cabin lowers the aesthetic value of the campground and contributes to its deterioration. Therefore we suggest its removal from the area. Limitation of the number of visitors to about 10 tents and 25 persons also seems necessary. Larger numbers not only crowd the campground but also destroy the vegetation.

The use of campfires should be gradually phased out because the greatest damage to vegetation and soil was around the fires and wood-cutting places. Undoubtedly, campfires contribute much to recreational satisfaction but these can be enjoyed at other campgrounds where the ecosystem is not as fragile as in the alpine or high subalpine regions.

Reclamation work on the campground is also necessary. Cleaning up the wood fragments and seeding and fertilizing would heal the scars because the soil is good and not much damaged yet. During the reclamation period tents should be scattered along the narrow terrace between this campground and the auxiliary campground about 0.5 km to the north.

TABLE 4. Vegetation transect at Egypt Lake Campground

Species	Distance			
	0 m	10 m	25 m	40 m
	% Cover	% Cover	% Cover	% Cover
	90%	90%	95%	90%
<i>Carex nigricans</i>	x	x	x	x
<i>Antennaria lanata</i>	x			
<i>Erythronium grandiflora</i>	x	x	x	x
<i>Ranunculus</i> sp.	x	x	x	x
<i>Potentilla diversifolia</i>	x	x	x	
<i>Claytonia lanceolata</i>	x	x	x	
<i>Anemone occidentalis</i>	x	x		
<i>Draba crassifolia</i>	x	x		
<i>Achillea millefolium</i>	x	x		
<i>Luzula parviflora</i>		x	x	x
<i>Valeriana sitchensis</i>		x		
<i>Vaccinium scoparium</i>		x		
<i>Fragaria virginiana</i>		x		x
<i>Picea Engelmanni</i>				x

The toilets should be cleaned, repaired, and moved to another location. General cleanups and occasional fertilizing should be part of annual maintenance.

EGYPT LAKE AUXILIARY CAMPGROUND

Description

Location: About 0.5 km north of the main camp on the same side of the creek.

Elevation: 1981 m

Landform: Terrace

Vegetation: Subalpine meadow dominated by Carex, alpine timothy, and glacier lily. The forest is as at the main camp (Plate 13 B and Appendix I).

Soil: Orthic Regosol with 2-cm thick organic layer.

Capability rating: 14 (very low)

Size: 1505 m² (Figure 13)

Number of available tent sites: 10

Number of fireplaces: Fire is not permitted at this camp.

Facilities: nil

Water supply: Pharaoh Creek or a small stream on the southwest side of the camp.

Wood supply: Some fire wood was stored there in spite of the fire prohibition.

Scenery: As from the main camp.

Recreational possibilities: As at the main camp.

Impact Assessment

Degree of impact: 1. Three fire rings were the only sign of use in the campground. Otherwise the vegetation was complete and not much altered. The greatest part of the campground was too wet for use and most visitors preferred to use the main camp where building of fires was permitted.

Management and Maintenance

Because of the low carrying capacity not more than two tents or five persons should be permitted at the same time. The store of firewood



Plate 13A. View of Egypt Lake campground showing the destruction of vegetation by woodcutting and trampling.



Plate 13B. View of Egypt Lake auxiliary campground.

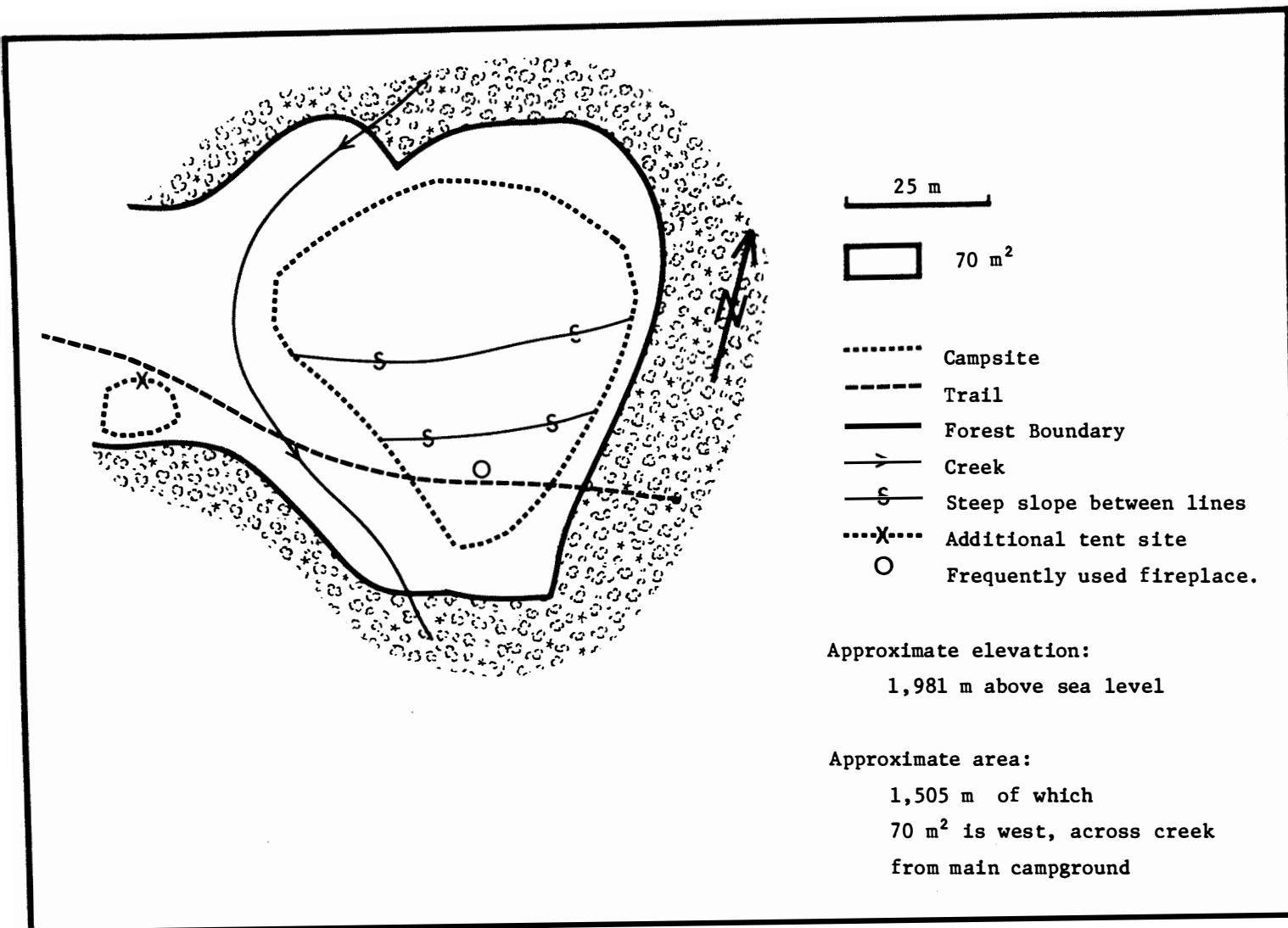


Figure 13. Sketch map of Egypt Lake auxiliary campground

should be removed from the camp to discourage illegal use of fire. A toilet should be installed and kept clean. Otherwise, no special maintenance is required if the present low level of use continues.

WHEELER FLATS CAMPGROUND

Description

Location: Southeast corner of the study area, about 1 km east of Sunshine Valley.

Distance from highway and other camps:

Highway No. 1 - 12.8 km

Bourgeau Parking - 4.0 km

Healy Pass Camp - 7.8 km

Elevation: 2164 m

Landform: Depressional moraine plain

Vegetation: Carex-wooly pussy-toes subalpine meadow surrounded by alpine larch-engelmann spruce-alpine fir-heather forests (Plate 14 A, Appendix I).

Soil: Humic Podzol (Plate 14 B)

LFH - 2-0 cm

Ahe - 0-5 cm, yellow red 10.0 YR 6/2, silt loam, (S-29.5%, Si-60.5%, Cl-10%), pH-5.0, organic matter-8.0%, nitrogen-0.25%.

Bh - 5-15 cm, dark yellow red 10.0 YR 5/4, silt loam (S-28.7%, Si-59.0%, Cl-12.3%), pH-5.0, organic matter-21.4%, nitrogen-0.75%.

Bf - 15-20 cm, reddish, yellow red 2.5 YR 5/6, loam (S-45%, Si-40%, Cl-15%), pH-5.0, organic matter-4.4%, nitrogen-0.23%.

C - 15 cm+, light yellow red 10.0 YR 7/2, loam (S-35.3%, Si-48.0%, Cl-16.7%), pH-6.2, organic matter-1.1%, nitrogen-0.06%.

Capability rating: 16 (very low)

Size: 4620 m² (Figure 14)



View of Wheeler Flats campground.

Plate 14A



Humic Podzol at Wheeler Flats campground.

Plate 14B

Number of available tent sites: 5

Number of fireplaces: 0

Facilities: 2 toilets

Water supply: Creek at southwest border of the campground.

Wood supply: nil

Scenery: Pleasant but not spectacular

Recreational possibilities: Hiking, exploring the Sunshine area.

Impact Assessment

Degree of impact: 1. Vegetation covered 60-80% of the area but it was worn and stunted. Heavy burrowing and grazing of ground squirrels also contributed to the damage. A vegetation transect from the center of the meadow demonstrated the extent of damage in loss of cover and species diversity (Table 5). The greatest impact was around the fire ring where the mineral soil was exposed in places and the number of species was reduced to about 1/3 of the original.

Management and Maintenance

The number of visitors per night should be limited to three tents or not more than 10 persons. Fire permits in the campground should be discontinued and the fireplace area should be cleaned up and seeded. Annual cleanups and fertilizing seems necessary as general maintenance to save the area from further deterioration.

GENERAL OBSERVATIONS AND RECOMMENDATIONS

CARRYING CAPACITY OF THE BACKCOUNTRY

The carrying capacity of an area must be examined from both the physical and social points of view. The physical carrying capacity depends on the capability of the ecosystems to withstand use, while the social carrying capacity is related to the tolerance of individual users to crowding or to encounters with other users. To a great extent this tolerance depends on expectations. Participants do not complain about the crowd at a rock festival, but in the backcountry visitors expect to find solitude and great expanses of undisturbed nature without signs of human presence.

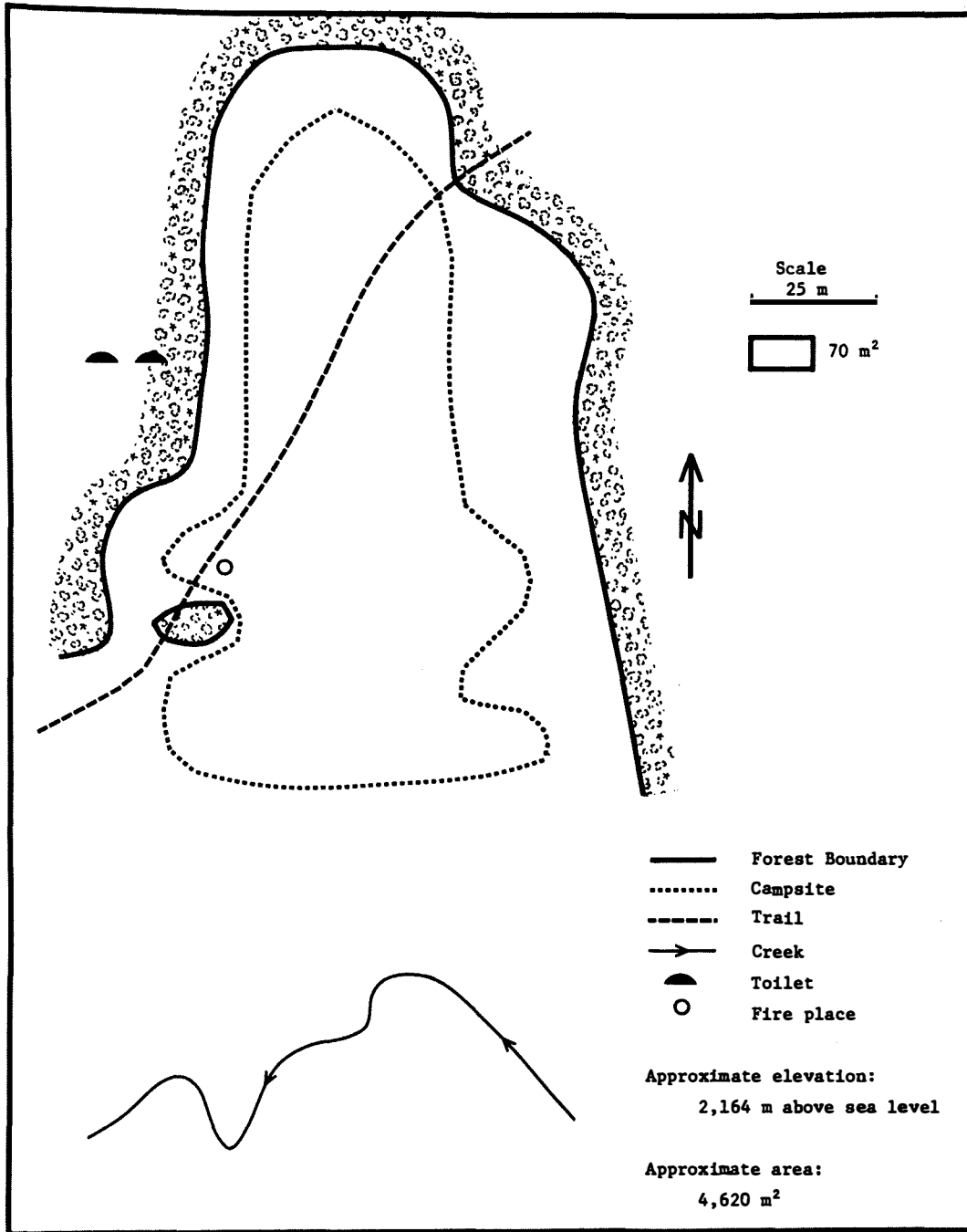


Figure 14. Sketch map of Wheeler Flats campground

TABLE 5. Vegetation transect at Wheeler Flats Campground.

Species	Distance			
	0 m	6 m	15 m	30 m
	% Cover	% Cover	% Cover	% Cover
	70%	80%	60%	78%
Carex sp.	x	x	x	
Antennaria lanata	x	x	x	x
Sibbaldia procumbens	x	x	x	
Ranunculus sp.	x	x	x	
Fragaria virginiana	x		x	x
Polytrichum juniperinum	x	x	x	
Salix arctica		x	x	x
Juncus drummondii		x		
Potentilla diversifolia		x		x
Vaccinium scoparium		x	x	
Veronica alpina		x	x	
Draba sp.		x	x	
Anemone occidentalis		x	x	
Epilobium latifolium			x	x
Valeriana sitchensis			x	
Pedicularis groenlandica			x	
Anemone parviflora			x	x
Achillea millefolium			x	
Phyllodoce glanduliflora				x
Carex nigricans				x
Larix lyallii				x

In our study area 51% of the visitors complained about crowded campgrounds and 31% regarded the whole backcountry as overcrowded (Trottier and Scotter 1975). At the time of these complaints the estimated number of users was 6100 during an approximately 100-day season (Trottier and Scotter 1975). The ratio of overnight and day users was close to 1:1. Considering that the overnight users stayed for an average of two nights, the total use amounted to about 10 000 visitor-days.

The study area encompasses about 325 km² total area, but the backcountry use is concentrated within not more than 50 km². Assuming even distribution, $\frac{10\ 000}{100 \times 50} = 2$, the visitor density is two persons per square kilometre. However, due to weather conditions, available free time, and differences in popularity of locations the distribution is uneven in time and space, and concentrations are probably increasing to 10 people per square kilometre. This density is too high for backcountry expectations. A more reasonable density would be five persons per square kilometre, or two parties of two or three persons. At this density the backcountry would accommodate 250 people per day or 25 000 visitor-days during a 100-day season. Since half of this number is expected to be daytime users, camping accommodation for 125 persons per night seems sufficient. With an average of two nights spent in the mountains, 6250 overnight users and 12 500 daytime users would have the opportunity to visit the area in a season. The suggested maximum capacity is 133 campers per night in all campgrounds, and 106 per night in campgrounds within or in easy reach of highly attractive target areas.

REGULATIONS AND WARDEN SERVICE

The above objective can be attained only by regulating the number of users in the area by enforced registration and permit issues to specific camps. Permits could be issued through reservation or on a first-come/first-served basis. Daily visits to each campsite by park wardens will be necessary to ensure the adherence to registration and camping regulations. Four full-time personnel would be able to cover the whole area. Two wardens from Redearth Cabin could cover Shadow, Ball, Haiduk, Twin Lake,

and Redearth campgrounds. Egypt, Healy Pass, and Pharaoh Creek campgrounds could be supervised by one warden from the Egypt Lake cabin, while one warden from Banff could visit the Healy Creek, Wheeler Flats, and Bourgeau Lake areas.

LOCATION OF CAMPGROUNDS

Destination campgrounds are located in the vicinity of points of attraction, while the approach campgrounds serve as resting places along the trails. The average distance between the campgrounds or from the highways to the closest campgrounds is 5 km, with a maximum distance of 7.8 km. Since these distances can be covered within 1 or 2 hours by hikers with packs, any further increase of campground density seems both unnecessary and undesirable.

From the biophysical point of view subalpine meadows on alluvial fans or terraces with Regosol soils provide the best campsites in the study area. These soils have relatively thick Ah layers and no restriction to rooting depth. The grassy vegetation of these meadows also tolerates high use. Forest margins are much less capable to withstand campground use because soils there are shallower and the vegetation wears out under the shade of trees instead of changing to a grassy community.

TOILETS

The presence of well-kept toilets at every campsite is very important. Location of toilets half-way between more distant campgrounds is also desirable. Some of the visitors are reluctant to go far off the trail and as a consequence the aesthetics of the trails suffer.

TENT SITES

Tent sites within the campgrounds should be marked and numbered to avoid the setting up of more tents than the capacity of the campground.

CAMPFIRES

At campgrounds where the use of campfires is permitted, every tent site should be supplied with a fireplace. People prefer privacy

and would rather build their own fire near their tents than share a common fireplace farther from it.

Heavy concrete ring fireplaces are more suitable than the light corrugated metal ones. The latter are overturned and moved about in the camps.

FIREWOOD

If firewood is supplied it should be neatly stored at a single location, and splitting of firewood should be permitted only at the wood storage.

VISITOR IMPACT OUTSIDE OF CAMPGROUNDS

Visitor impact outside of campgrounds and off the trails is very small. Most hikers do not seem to go off the trails at all. The only obvious damage was found by the lakeshores where tents had been pitched or fires built. At Lower Twin Lakes alone, six unapproved tent sites were counted. There was also some littering along the trails, mainly of small items such as cigarette butts, chocolate wrappings, eggshells, etc.

HORSE USE

Use of horses should be restricted to wardens because horses damage the trails, disturb hikers, and introduce exotic plants if special care is not taken.

PARTY USE

Party use should be limited to single families or not more than four unrelated persons.

TIME LIMIT

Overnight use of the camps should be limited to four nights.

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APPENDIX I
FOREST COMMUNITIES

Species List	Plot Location													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
A1 <i>Abies lasiocarpa</i>					x			x		x	x	x	x	
<i>Larix lyallii</i>										x	x	x	x	
<i>Picea engelmannii</i>	x		x		x	x	x	x	x		x	x	x	
<i>Picea glauca</i>			x											
<i>Pinus contorta</i>	x	x		x										
<i>Pseudotsuga menziesii</i>				x										
A2 <i>Abies lasiocarpa</i>						x	x	x		x	x			x
<i>Larix lyallii</i>										x	x			
<i>Picea engelmannii</i>							x			x				
<i>Picea glauca</i>	x													
<i>Populus tremuloides</i>				x										
B <i>Abies lasiocarpa</i>						x	x	x	x	x	x			x
<i>Amelanchier alnifolia</i>		x		x										
<i>Juniperus communis</i>	x	x	x	x	x									
<i>Larix lyallii</i>										x	x			
<i>Populus tremuloides</i>				x										
<i>Ribes lacustre</i>			x		x	x								
<i>Rosa acicularis</i>	x	x	x	x										
<i>Salix farrae</i>	x				x									
<i>Shepherdia canadensis</i>	x	x	x	x										
<i>Spiraea lucida</i>		x												
<i>Vaccinium membranaceum</i>								x	x					x
<i>Betula glandulosa</i>														x
<i>Ledum groenlandicum</i>						x								
<i>Lonicera involucrata</i>					x	x								
<i>Picea engelmannii</i>							x							x
<i>Pinus contorta</i>														x
<i>Potentilla fruticosa</i>				x	x						x			x
<i>Rhododendron abiflorum</i>						x								
<i>Salix glauca</i>						x								x
C <i>Achillea millefolium</i>	x	x		x										
<i>Agoseris aurantiaca</i>												x		
<i>Agoseris glauca</i>				x										
<i>Allium cernuum</i>				x										
<i>Anemone occidentalis</i>							x				x	x		
<i>Anemone parviflora</i>												x		x
<i>Antennaria lanata</i>							x			x	x		x	
<i>Antennaria nitida</i>	x	x												
<i>Antennaria pulcherrima</i>												x		

APPENDIX I (cont'd)
FOREST COMMUNITIES (cont'd)

Species List	Plot Location													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
C <i>Arctostaphylos uva-ursi</i>	x	x		x										
<i>Arnica alpina</i>												x		
<i>Arnica cordifolia</i>	x		x			x		x						
<i>Arnica latifolia</i>								x		x			x	
<i>Aster ciliolatus</i>					x									
<i>Aster conspicuus</i>		x												
<i>Bromus sp.</i>													x	
<i>Caltha leposepala</i>												x		
<i>Campanula rotundifolia</i>				x										
<i>Carex nigricans</i>											x	x		
<i>Cassiope mertensiana</i>								x		x		x		
<i>Castilleja miniata</i>				x								x		
<i>Castilleja occidentalis</i>												x		x
<i>Claytonia lanceolata</i>										x		x		
<i>Cornus canadensis</i>	x		x		x									
<i>Elymus glaucus</i>					x									
<i>Elymus innovatus</i>	x	x	x	x										
<i>Epilobium angustifolium</i>	x	x	x		x								x	
<i>Equisetum arvense</i>					x	x								
<i>Equisetum scirpoides</i>						x	x							x
<i>Equisetum variegatum</i>											x			x
<i>Erigeron peregrinus</i>												x		
<i>Erythronium grandiflorum</i>							x		x			x		
<i>Fragaria virginiana</i>	x	x	x		x		x							
<i>Galium boreale</i>		x		x										
<i>Hedysarum alpinum</i>				x										
<i>Hieracium gracile</i>													x	
<i>Juncus balticus</i>												x		
<i>Juncus drummondii</i>												x		
<i>Linnaea borealis</i>	x				x									
<i>Luzula parviflora</i>												x		
<i>Lycopodium annotinum</i>													x	
<i>Lycopodium selago</i>														
<i>Mitella nuda</i>					x	x								
<i>Parnassia fimbriata</i>						x								x
<i>Pedicularis bracteosa</i>												x		x
<i>Pedicularis groenlandica</i>					x									
<i>Petasites palmatus</i>					x	x								
<i>Phleum alpinum</i>												x		
<i>Phyllodoce empetriformis</i>							x	x		x			x	
<i>Phyodoce glanduliflora</i>						x				x			x	
<i>Poa alpina</i>												x		

APPENDIX I (cont'd)

FOREST COMMUNITIES (cont'd)

Species List	Plot Location													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
C														
Potentilla diversifolia												x		x
Potentilla fruticosa														
Pyrola asarifolia					x									
Pyrola secunda			x		x	x		x	x					
Pyrola virens	x													
Ranunculus eschscholtzii												x		
Rubus pubescens					x									
Salix arctica											x			
Salix glauca												x		
Senecio triangularis						x				x		x		
Sibbaldia procumbens							x					x		
Stenanthium occidentale						x	x							
Taraxacum officinale														x
Thalictrum occidentale								x						
Trollius albiflorus						x	x					x		
Vaccinium caespitosum	x													
Vaccinium scoparium						x	x	x	x	x		x	x	
Vaccinium vitis-idaea	x													
Valeriana sitchensis								x		x	x	x		
Veronica alpina										x		x		
Viburnum edule		x												
Viola glabella						x	x							
Viola palustris														x
Zygadenus gramineus														x
D														
Cladonia sp.						x								
Dicranum sp.						x		x	x		x			
Hylocomnium splendens			x											
Mnium sp.						x								
Peltigera aptosa	x		x			x		x						
Pleurozium schreberi						x								
Polytrichum juniperinum								x		x		x		
Sphagnum sp.						x								

Key to plot location:

- Lowest subzone
- 1-) lodgepole - white spruce - engelmann spruce - buffaloberry
 - 2-) forest at Copper Lake.
 - 3- white spruce - engelmann spruce - hyocomium forest on steep north slope.
 - 4- Douglas fir - lodgepole pine - aspen Montane Forest.
 - 5- edaphic spruce - alpine fir - horsetail forest.

Key to plot location: (cont'd)

- | | | |
|------------------------|-----|--|
| Middle altitude zone | 6- | engelmann spruce - alpine fir - rhododendron - grouseberry forest at Shadow Lake. |
| | 7- | engelmann spruce - alpine fir - grouseberry forest at Healy Creek. |
| | 8- | engelmann spruce - alpine fir - grouseberry forest at Egypt Lake. |
| | 9- | engelmann spruce - alpine fir - grouseberry forest at Egypt Lake auxiliary camp. |
| | | |
| High altitude zone | 10- | alpine larch - engelmann spruce - subalpine fir heather forest at Weeler Flats. |
| | 11- | alpine larch - engelmann spruce - subalpine fir heather forest at Haiduk Lake. |
| | 12- | alpine larch - engelmann spruce - subalpine fir herbaceous Forest at Healy Pass. |
| | 13- | Transitional community between middle and high altitude zones Twin Lakes alternate campsite. |
| | | |
| Successional community | 14- | Successional community from meadow to forest at Ball Pass campground. |

APPENDIX I (cont'd)

MEADOW COMMUNITIES

Species	Plot Location					
	1	2	3	4	5	6
<i>Achillea millefolium</i>	x	x				x
<i>Alopecurus aequalis</i>				x		
<i>Anemone parviflora</i>					x	x
<i>Antennaria lanata</i>						x
<i>Arnica alpina</i>					x	x
<i>Aster foliaceus</i>						x
<i>Betula glandulosa</i>		x		x		
<i>Caltha leptosepala</i>				x	x	
<i>Carex nigricans</i>					x	x
<i>Cassiope mertensiana</i>			x		x	
<i>Castilleja miniata</i>				x		
<i>Castilleja occidentalis</i>					x	
<i>Claytonia lanceolata</i>			x		x	x
<i>Epilobium alpinum</i>					x	x
<i>Eriophorum latifolium</i>				x		
<i>Erithronium grandiflorum</i>						x
<i>Fragaria virginiana</i>	x			x		x
<i>Gentiana</i> sp.				x		x
<i>Luzula parviflora</i>						x
<i>Parnassia fimbriata</i>				x	x	
<i>Pedicularis bracteosa</i>				x		
<i>Pedicularis groenlandica</i>	x		x		x	
<i>Petasites palmatus</i>					x	
<i>Picea engelmannii</i>				x		
<i>Picea glauca</i>				x		
<i>Phleum alpinum</i>						x
<i>Poa arctica</i>					x	
<i>Polygonum viviparum</i>					x	
<i>Populus tremuloides</i>	x					
<i>Potentilla diversifolia</i>		x		x	x	x
<i>Potentilla fruticosa</i>		x	x	x	x	
<i>Ranunculus eschschaltzii</i>		x			x	x
<i>Rubus acaulis</i>				x		
<i>Salix arctica</i>					x	
<i>Salix glauca</i>			x	x	x	
<i>Senecio triangularis</i>			x	x	x	
<i>Shepherdia canadensis</i>	x					
<i>Sibbaldia procumbens</i>				x	x	x

APPENDIX I (cont'd)
MEADOW COMMUNITIES (cont'd)

Species	Plot Location					
	1	2	3	4	5	6
<i>Habenaria dilatata</i>				x		
<i>Taraxacum officinale</i>	x					
<i>Trollius albiflorus</i>			x		x	
<i>Valeriana sitchensis</i>						x
<i>Vaccinium scoparium</i>		x				x
<i>Veronica alpina</i>					x	

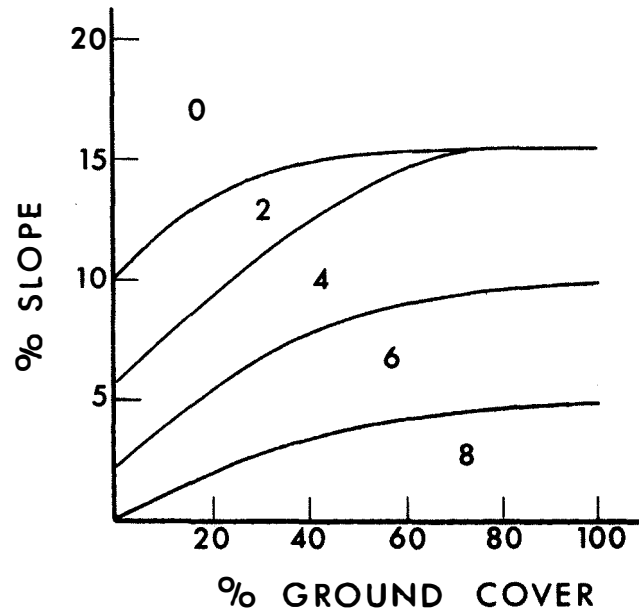
- 1 - Redearth Creek Campground
- 2 - Pharaoh Creek Campground
- 3 - Twin Lakes Campground
- 4 - Shadow Lake Campground wet meadow
- 5 - Haiduk Lake Campground meadow
- 6 - Egypt Lake auxiliary Campground

APPENDIX II

SITE CAPABILITY RATING

The first step in the site capability rating is the assessment of individual factors according to the following numerical scale:

F ₁ Degree days above 5°C		
0	to 200	..... -8
201	to 400	..... -6
401	to 600	..... -4
601	to 800	..... -2
801	to 1000	..... 1
1001	to 1600	..... 2
1601	to 2300	..... 3
2301	to 3000	..... 4
F ₂ Mean annual water deficit		
20.1	to 30 cm	..... 2
10.1	to 20 cm	..... 4
0.1	to 10 cm	..... 6
	0 cm	..... 8
F ₃ Shrub cover in percent		
0	to 10	..... 1
11	to 25	..... 2
26	to 50	..... 4
51	to 75	..... 6
76	to 100	..... 8
F ₄ Grass cover in percent		
0	to 10	..... 1
11	to 25	..... 2
26	to 50	..... 4
51	to 75	..... 6
76	to 100	..... 8

F₅ Slope and total ground cover

Graphical determination of slope and total ground cover rating for values from 0 to 8.

F₆ Depth of rooting

0 to 12.5 cm	.....	0
12.6 to 25 cm	.....	2
25.1 to 50 cm	.....	4
50.1 cm +	.....	8

F₇ Thickness of the Ah soil horizon

0 to 1.3 cm	.....	2
1.4 to 2.5 cm	.....	4
2.6 to 5.0 cm	.....	6
5.1 cm +	.....	8

F_8 Thickness of the forest floor (LFH layers)		
0 to 1.3 cm	.....	+1
7.6 cm +	.....	+2
5.1 to 7.6 cm	.....	+3
1.4 to 5.0 cm	.....	+4
F_9 Soil texture and drainage		
Organic		
	.....	x0
Dune sand		
Wet clay		
Wet loam	.....	x0.6
Dry sand		
Dry clay		
Dry loam	.....	x0.8
Gravel		
Semi-dry clay		
Semi-dry loam	.....	x1.0
Wet sand		

The resulting numerical values are summarized in the equation below as the second step, to obtain a capability value (CV) for the examined site:

$$CV = (F_1 + \dots + F_8) (F_9 \times F_n)$$

Where F_n is the factor with 0 rating. The higher the obtained CV, the better the capability of the site to withstand recreational use. If any of the factors is rated zero, the CV will also be zero and the site is not recommended for campground development.

The CV has a range from 0 to 56 and five capability levels may be distinguished within this range.

<u>CV</u>	<u>Capability Rating</u>
0	Not recommended for campground use
7 to 20	Very low
21 to 30	Low
31 to 40	Medium
41 to 56	High

The aforementioned rating system may be used in both forested or non-forested land in Alberta. The evaluation of individual factors, with the exception of degree days above 5°C and mean annual water deficit, are carried out on the field with the aid of shovel, a ruler, and an abney level or any other clinometer.

APPENDIX III

CHECKLIST OF VASCULAR PLANT SPECIES

<i>Abies lasiocarpa</i> (Hook.) Nutt.	alpine fir
<i>Achillea millefolium</i> L	common yarrow
<i>Agoseris aurantiaca</i> (Hook.) Greene	false dandelion
<i>Agoseris glauca</i> (Pursh) RaF.	
<i>Agrostis alba</i> L	bent grass
<i>Allium cernuum</i> Roth.	nodding onion
<i>Alopecurus aequalis</i> Sobol.	water foxtail
<i>Amelanchier alnifolia</i> Nutt.	Saskatoon-berry
<i>Anemone multifida</i> Poir.	cut-leaved anemone
<i>Anemone occidentalis</i> S. Wats.	chalice-flower
<i>Anemone parviflora</i> Mishx.	
<i>Antennaria lanata</i> (Hook.) Greene	
<i>Antennaria neglecta</i> Greene	
<i>Antennaria nitida</i> Greene	
<i>Antennaria pulcherrima</i> (Hook.) Greene	showy everlasting
<i>Antennaria racemosa</i> Hook.	
<i>Aquilegia flavescens</i> S. Wats.	yellow columbine
<i>Arabis holboellii</i> Hornem	
<i>Arabis lyallii</i> S. Wats.	
<i>Arctostaphylos rubra</i> (Redher & Wils.)	alpine bearberry
<i>Arctostaphylos uva-ursi</i> (L.) Spreng.	common bearberry
<i>Arenaria obtusiloba</i> (Rydb.) Fern.	
<i>Arenaria rubella</i> (Wahlenb.) J.E. Sm.	
<i>Arnica alpina</i> (L.) Olin	
<i>Arnica cordifolia</i> Hook.	
<i>Arnica latifolia</i> Bong.	
<i>Aster alpinus</i> L.	
<i>Aster ciliolatus</i> Lindl.	Lindley's aster
<i>Aster conspicuus</i> Lindl.	showy aster
<i>Astragalus bisulcatus</i> (Hook.) A. Gray	two-grooved milk vetch
<i>Astragalus frigidus</i> (L.) A. Gray var. <i>americanus</i> (Hook.) S. Wats	

<i>Betula glandulosa</i> Michx.	dwarf birch
<i>Bidens comosa</i> (Gray) Wieg.	
<i>Bromus pumpellianus</i> Scribr.	northern awnless brome
<i>Caltha leptosepala</i> DC.	mountain marigold
<i>Campanula rotundifolia</i> L.	bluebell
<i>Carex media</i> R. Br.	
<i>Carex nigricans</i> C.A. Meyer	
<i>Carex phaeocephala</i> Piper	
<i>Carex scirpoidea</i> Michx.	
<i>Cassiope mertensiana</i> (Bong.) D. Don	white mountain heather
<i>Castilleja miniata</i> Dougl.	common red paint-brush
<i>Castilleja occidentalis</i> Torr.	Indian paint-brush
<i>Castilleja raupii</i> Pennell	Indian paint-brush
<i>Cerastium nutans</i> Faf.	mouse-ear chickweed
<i>Chimaphila umbellata</i> (L.) Bart.	
<i>Claytonia lanceolata</i> Pursh	western spring beauty
<i>Corallorhiza trifida</i> Châtelain	pale coral-root
<i>Cornus canadensis</i> L.	bunchberry
<i>Delphinium glaucum</i> S. Wats.	tall larkspur
<i>Draba crassifolia</i> R. Grah.	
<i>Dryas hookeriana</i> Juz.	white mountain avens
<i>Elymus glaucus</i> Buckl.	smooth wild rye
<i>Elymus innovatus</i> Beal.	hairy wild rye
<i>Ephilobium alpinum</i> L.	alpine willow-herb
<i>Epilobium angustifolium</i> L.	fireweed
<i>Epilobium latifolium</i> L.	
<i>Epilobium palustre</i> L.	
<i>Equisetum arvense</i> L.	common horsetail
<i>Equisetum scirpoides</i> Michx.	
<i>Equisetum variegatum</i> Schleich.	
<i>Erigeron compositus</i> Pursh	daisy fleabane
<i>Erigeron perigrinus</i> (Pursh) Greene	showy fleabane
<i>Eriophorum angustifolium</i> Honckeney	cotton grass
<i>Erythronium grandiflorum</i> Pursh	glacier lily

<i>Fragaria virginiana</i> Duchesne	wild strawberry
<i>Galium boreale</i> L.	northern bedstraw
<i>Gentianella amarella</i> (L.) Börner	felwort
<i>Habenaria dilatata</i> (Pursh) Hook.	tall white orchid
<i>Habenaria orbiculata</i> (Pursh) Richards	blunt-leaved orchid
<i>Hedysarum alpinum</i> L.	
<i>Heuchera cylindrica</i> Dougl.	alum-root
<i>Hieracium albiflorum</i> Hook.	white hawkweed
<i>Hieracium gracile</i> Hook.	slender hawkweed
<i>Juncus balticus</i> Willd.	wire rush
<i>Juncus drummondii</i> E. Meyer	
<i>Juncus mertensianus</i> Bong.	
<i>Juniperus communis</i> L.	ground juniper
<i>Kalmia polifolia</i> Wang.	mountain laurel
<i>Larix lyallii</i> Parl.	alpine larch
<i>Ledum groenlandicum</i> Oeder	Labrador tea
<i>Linnaea borealis</i> L.	twin-flower
<i>Lonicera involunrata</i> (Richards) Banks	bracted honeysuckle
<i>Luzula parviflora</i> (Ehrh.) Desv.	
<i>Luzula wahlengergii</i> Rupr.	
<i>Lycopodium alpinum</i> L.	alpine club-moss
<i>Lycopodium annotinum</i> L.	stiff club-moss
<i>Lycopodium selago</i> L. subsp. <i>appressum</i> (Desv.) D. Love	mountain club-moss
<i>Menziesia glabella</i> A. Gray	
<i>Mitella nuda</i> L.	bishop's cap
<i>Moneses uniflora</i> (L.) A. Gray	one-flowered wintergreen
<i>Montia parviflora</i> (Moq.) Greene	
<i>Osmorhiza depauperata</i> Philippi	sweet cicely
<i>Parnassia fimbriata</i> Konig	grass-of-Parnassus
<i>Pedicularis bracteosa</i> Benth.	bracted lousewort
<i>Pedicularis groenlandica</i> Retz.	elephant head
<i>Peltigera aphtosa</i>	
<i>Penstemon albertinus</i> Green	beard-tongue
<i>Petasites palmatus</i> (Ait.) A. Gray	palmate-leaved coltsfoot

<i>Phleum alpinum</i> L.	mountain timothy
<i>Phleum pratense</i> L.	timothy
<i>Phyllodoce empetriformis</i> (Smith) D. Don	red heather
<i>Phyllodoce glanduliflora</i> (Hook.) Coville	yellow heather
<i>Picea engelmannii</i> Parry	engelmann spruce
<i>Picea glauca</i> (Moench) Voss	white spruce
<i>Pinus contorta</i> Loudon var. <i>latifolia</i> Engelm.	lodgepole pine
<i>Plantago</i> sp.	
<i>Poa alpina</i> L.	alpine bluegrass
<i>Poa arctica</i> R. Br.	
<i>Poa epilis</i> schribn.	
<i>Poa palustris</i> L.	fowl bluegrass
<i>Polygonum viviparum</i> L.	bistort
<i>Polytrichum juniperium</i>	
<i>Populus tremuloides</i> Michx.	aspen
<i>Potentilla diversifolia</i> Lehm.	
<i>Potentilla fruticosa</i> L.	shrubby cinquefoil
<i>Potentilla glandulosa</i> Lindl.	
<i>Potentilla gracilis</i> Dougl.	graceful cinquefoil
<i>Pseudotsuga menziesii</i> (Mirb.) Franco	Douglas fir
<i>Pyrola asarifolia</i> Michx.	common pink wintergreen
<i>Pyrola elliptica</i> Nutt.	white wintergreen
<i>Pyrola secunda</i> L.	one-sided wintergreen
<i>Pyrola virens</i> Schweigg	greenish-flowered wintergreen
<i>Ranunculus eschscholtzii</i> Schlecht.	alpine buttercup
<i>Rhododendron albiflorum</i> Hook.	white-flowered rhododendron
<i>Ribes lacustre</i> (Pers.) Poir.	bristly black currant
<i>Rosa acicularis</i> Lindl.	prickly rose
<i>Rubus acaulis</i> Michx.	dwarf raspberry
<i>Rubus pubescens</i> Raf.	dewberry
<i>Salix arctica</i> Pall.	arctic willow
<i>Salix barrattiana</i> Hook	
<i>Salix farrae</i> Ball	
<i>Salix glauca</i> L.	gray leaf willow

<i>Salix scouleriana</i> Barratt	
<i>Salix vestita</i> Pursh	rock willow
<i>Saussurea densa</i> (Hook.) Rydb.	
<i>Saxifraga bronchialis</i> L.	spotted saxifrage
<i>Saxifraga lyallii</i> Engler	red-stemmed saxifrage
<i>Senecio eremophilus</i> Richards	
<i>Senecio fremontii</i> T. & G.	
<i>Senecio indecorus</i> Greene	
<i>Senecio lugens</i> Richards	
<i>Senecio triangularis</i> Hook.	triangular-leaved ragwort
<i>Shepherdia canadensis</i> (L.) Nutt.	Canadian buffaloberry
<i>Sibbaldia procumbens</i> L.	sibbaldia
<i>Solidago multiradiata</i> Ait.	alpine golden rod
<i>Spiraea lucida</i> Dougl.	white meadowsweet
<i>Spiranthes</i> sp.	
<i>Stenanthium occidentale</i> A. Gray	bronze-bells
<i>Taraxacum officinale</i> Weber	common dandelion
<i>Thalictrum occidentale</i> A. Gray	western meadow rue
<i>Thalictrum venulosum</i> Trel.	veiny meadow rue
<i>Trollius albiflorus</i> (A. Gray) Rydb.	globe flower
<i>Vaccinium caespitosum</i> Michx.	dwarf bilberry
<i>Vaccinium membranaceum</i> Dougl.	tall bilberry
<i>Vaccinium scoparium</i> Leidberg	grouseberry
<i>Vaccinium vitis-idaea</i> L.	cow-berry
<i>Valeriana sitchensis</i> Bong.	mountain valerian
<i>Veratrum eschscholtzii</i> A. Gray	false hellebore
<i>Veronica alpina</i> L.	alpine speedwell
<i>Veronica serpyllifolia</i> L. var. <i>humifusa</i> (Dickson) Vahl	
<i>Viburnum edule</i> (Michx.) Raf.	low bush cranberry
<i>Vicia americana</i> Muhl.	wild vetch
<i>Viola adunca</i> J. E. Smith	early blue violet
<i>Viola glabella</i> Nutt	yellow mountain violet
<i>Viola nephrophila</i> Green	bog violet
<i>Viola palustris</i> L.	marsh violet
<i>Zizia aptera</i> (A. Gray) Fern.	meadow parsnip
<i>Zygadenus gramineus</i> Rydb.	death camas

APPENDIX IV

GLOSSARY

- Alluvial fan - a fan-shaped deposit of alluvium laid down by a stream where it emerges from an upland into less steeply sloping terrain.
- Alluvial parent material - material deposited by rivers and streams from which the solum of the soil has developed.
- Alluvial plain - large flat area deposited by a river.
- Alluvial terrace - a nearly level plain bordering a river that is made of material deposited by that river.
- Backcountry campgrounds - campsites designed to accommodate persons interested in hiking to remote areas of the National Parks.
- Biophysical - considering both the physical and biological components of the environment.
- Calcareous till - unstratified glacial drift deposited directly by ice that contains sufficient calcium carbonate to effervesce visibly when treated with cold 0.1N hydrochloric acid.
- Cirque - a deep steep-walled basin on a mountain shaped like half a bowl.
- Colluvial deposits - a heterogeneous mixture of material that as a result of gravitational action has moved down a slope and settled at its base.
- Corrugated metal rings - fireplaces made by cutting off 1-foot sections of 18-inch culvert.
- Edaphic - influenced by factors inherent in the soil or other substrate rather than by climatic factors.
- Floodplain - the land bordering a stream, built up of sediments from overflow of the stream and subject to inundations when the stream is at flood stage.
- Groundwater discharge - an area where the water in the soils comes to and flows over the surface.

Horizons - a layer of soil or soil material approximately parallel to the land surface; it differs from adjacent genetically related layers in properties such as color, structure, texture consistency and chemical, biological and mineralogical composition.

- LFH - Organic layers developed under imperfectly to well-drained conditions, often forest litter.
- L - the original structures of the organic material are easily recognized.
- F - the accumulated organic material is partly decomposed.
- H - the original structures of the organic material are unrecognizable.

Master mineral horizons and layers contain less than 30% organic matter.

- A - a mineral horizon formed at or near the surface in the zone of removal of materials in solution and suspension or maximum in situ accumulation of organic matter or both.
- B - a mineral horizon characterized by one or more of the following:
 - 1) an enrichment in silicate clay, iron, aluminum, or humus.
 - 2) a prismatic or columnar structure that exhibits pronounced coatings or stainings associated with significant amounts of exchangeable sodium.
 - 3) an alteration by hydrolysis, reduction, or oxidation.
- C - a mineral horizon comparatively unaffected by the pedogenic processes operative in A and B, except gleying, and the accumulation of carbonates and more soluble salts.

Lowercase Suffixes

- e - a horizon characterized by removal of clay, iron, aluminum, or organic matter alone or in combination.
- f - a horizon enriched with hydrated iron. It usually has a chroma of 3 or more.

Bf, less than 5% organic matter.

Bfh, 5% to 10% organic matter.

Bhf, greater than 10% organic matter.

- g - A horizon characterized by gray colors, or prominent mottling indicative of permanent or periodic intense reduction, or both; for example, Aeg, Btg, Bg and Cg.
- h - A horizon enriched with organic matter.
- Ah - An A horizon of organic matter accumulation. It contains less than 30% organic matter.
- Ahe - this horizon has been degraded as evidenced by streaks and splotches of light and dark gray material and often by platy structure.
- Bh - this horizon contains more than 2% organic matter, and the organic matter to oxalate-extractable Fe ratio is 20 or more.
- m - A horizon slightly altered by hydrolysis, oxidation, or solution, or all three, to give a change in color or structure or both.
- p - A layer disturbed by man's activities, for example, Ap.
- t - A horizon enriched with silicate clay.

Hummocky meadow - a meadow covered by rounded knolls, very uneven ground.

Moderately alkaline - soils that have a pH value between 7.9-8.4.

Organic matter - plant and animal residue at various stages of decomposition in the soil.

Particle size - the diameter of the sand, silt, and clay.

sand - between 0.05 and 2.0 mm diameter

silt - between 0.05 and 0.002 mm diameter

clay - less than 0.002 mm diameter

loam - 7 to 27% clay, 28 to 50% silt, and less than 52% sand.

sandy loam - 30% or more very coarse, coarse and medium sand, but less than 25% very coarse sand and less than 30% very fine or fine sand.

silt loam - 50% or more silt and 12 to 15% clay or 50 to 80% silt and less than 12% clay.

silty clay loam - soil material containing 27 to 40% clay and less than 20% sand.

pH - The degree of acidity or alkalinity of a soil; the hydrogen - ion activity of a soil.

Strongly acid - soils that have a pH value between 5.1-5.5.

Till ridge - a ridge of unstratified glacial drift deposited by the ice.

Total nitrogen - the amount of nitrogen in the soil expressed as a percent by weight.