Eucalypt woodlands with heath and button grass understorey, with Mount Oakleigh in the background. Pencil Pines, *Athrotaxis cupressoides*, line the stream.

ANALYSIS OF VISITOR IMPACT ON THE ENVIRONMENTS OF THE CRADLE MOUNTAIN LAKE ST. CLAIR NATIONAL PARK AND IMPLICATIONS FOR RECREATIONAL MANAGEMENT

by

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A thesis submitted to the Faculty of Science
in fulfillment of the requirements for the
degree of Master of Science

THE UNIVERSITY OF TASMANIA
DEPARTMENT OF GEOGRAPHY

1981

STATEMENT OF AUTHOR

Except as stated herein this thesis contains no material which has been accepted for the award of any other degree of diploma in any university. To the best of my knowledge and belief, this thesis contains no copy or paraphrase of material previously published or written by another person, except when due reference is made in the text.

Signed Satwant Calais

Satwant Singh Calais

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GLOSSARY OF TERMS

(1) Wilderness - defined as land remote from access by mechanised vehicles, and from within which there is little or no consciousness of the environmental disturbance of western man (Kirkpatrick 1979).

(2) 2-3 day backcountry walkers - hiking of an extended nature requiring the carrying of overnight equipment, but not walking the complete overland track.

(3) Overland walkers - those walkers traversing the overland track from Cradle Valley to Cynthia Bay or vice versa.

(4) Daywalkers - those participating in daywalks emanating from developed zones. Overnight stay is in the developed zone.

(5) Dayvisitors - those participating in daywalks emanating from developed zones but returning to over-night destinations outside the park.

(6) Dayvisitors or non-walkers - visitors who do not go walking or hiking. Generally, sight-seers, picnickers, etc.

ABSTRACT

The Cradle Mountain - Lake St. Clair National Park is one of the most popular tourist destinations in the state, having 135,000 day visitors and 16,000 daywalkers and back-country walkers in 1979/80. The majority of visitors were well educated and were either in professional and administrative positions or were students. Seventy percent of the backcountry visitors were from the mainland states.

The large number of walkers in the park have contributed towards the deterioration of the track system, with 29% of the tracks in a poor state. Badly damaged tracks are concentrated at high altitudes and on ill-drained areas where user intensity exceeds 1500 persons per annum.

Track rehabilitation and relocation to allow comfort near the vehicle access points and to avoid further environmental damage elsewhere will cost approximately $700,000.

The rate of recolonization of alpine areas bared and eroded by trampling is extremely slow and active rehabilitation may be required. Recolonization of subalpine heaths, sedgelands and grasslands seems to be adequate.

The problems of littering and track deterioration recognised by the questionnaire respondents seem partly susceptible to solution through manipulatory techniques of

park management. A fee system, overwhelmingly supported by questionnaire respondents, could easily cover the costs of solving the physical problems of track deterioration.

The key to successful park management is the education of actual and potential park users. Without their support and appreciation of management problems and strategies, the most well thought out management plan would not realize its goals.

CHAPTER I

INTRODUCTION

The increase in mobility, educational level, ease of access, leisure opportunities, discretionary income and the promotion of outdoor recreational activities by schools and Government instrumentalities have all contributed to the increasing number of Australian and overseas tourists visiting and experiencing the natural beauty and the diverse environments of National Parks in Tasmania.

This increase in participation in outdoor recreation has environmental implications. For instance, the level of track damage in National Parks is a visual manifestation of the impact of visitors on the natural ecosystems. An understanding of the impact of visitors is therefore an essential prerequisite to the sound management of recreational areas.

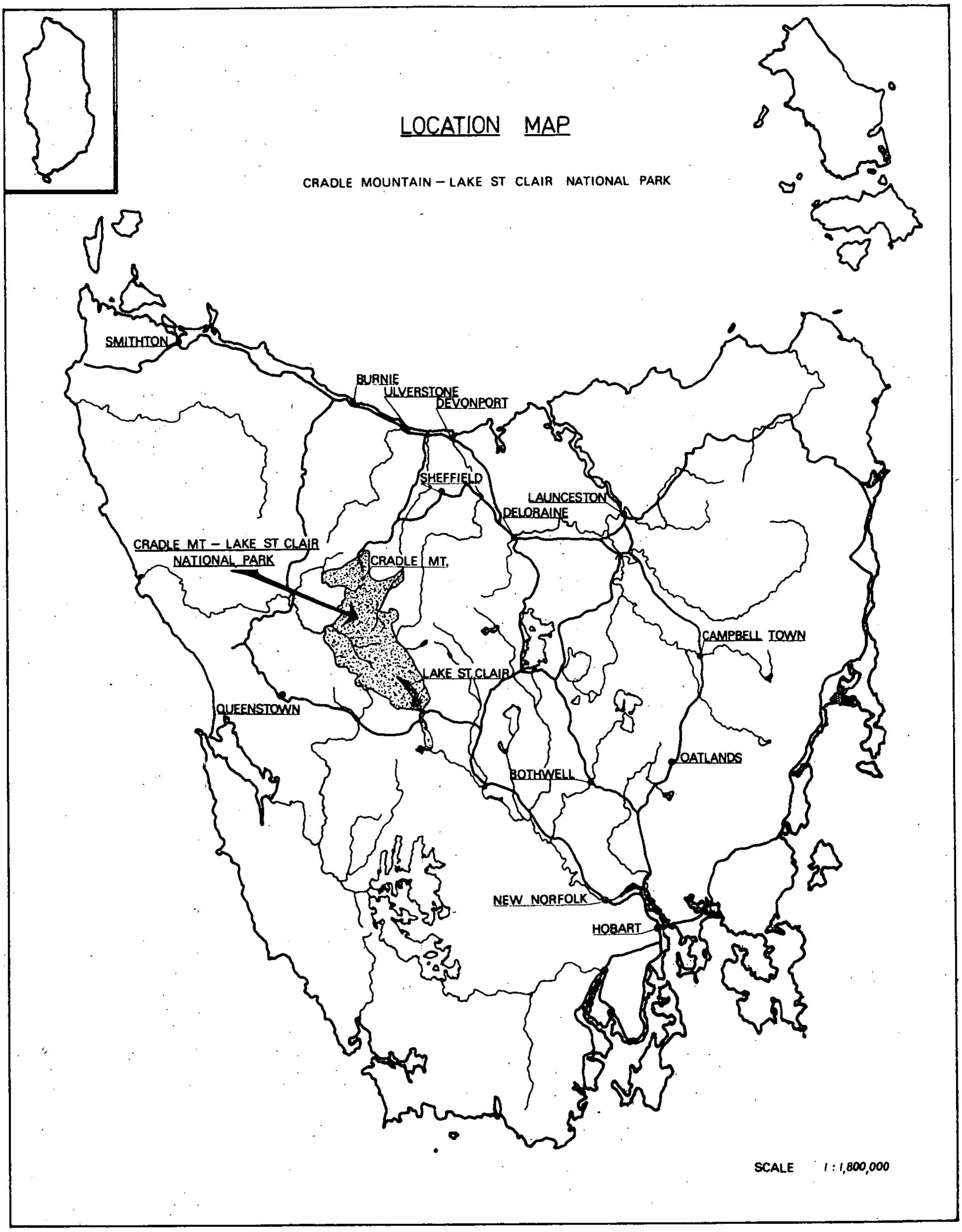
Some of the most popular and heavily used walking tracks in Tasmania are located in the Cradle Mountain - Lake St. Clair National Park, most notably the Overland Track and the daywalk routes in the Cradle Mountain area.

The primary objective of this study is to provide a quantitative assessment of the impact of visitors on the natural environments of the Cradle Mountain - Lake St. Clair National Park. The implications of this

Fig. 1.1

LOCATION OF THE STUDY AREA -

CRADLE MOUNTAIN - LAKE ST. CLAIR NATIONAL PARK


LOCATION MAP
CRADLE MOUNTAIN – LAKE ST CLAIR NATIONAL PARK
SMITHTON
BURNIE
ULVERSTONE
DEVONPORT
SHEFFIELD
LAUNCESTON
DELORAINE
CRADLE MT – LAKE ST CLAIR
NATIONAL PARK
CRADLE MT.
CAMPBELL TOWN
LAKE ST CLAIR
QUEENSTOWN
OATLANDS
BOTHWELL
NEW NORFOLK
HOBART
SCALE 1 : 1,800,000

impact assessment for recreational management are subsequently discussed.

The Cradle Mountain - Lake St. Clair National Park is particularly appropriate for a study of recreational impact on the environment as it has a great diversity of natural ecosystems and has, at least in recent years, an adequate record of visitor use.

1.1 THE STUDY AREA

The Cradle Mountain - Lake St. Clair National Park is located in the mountains of the northwest of Tasmania (Fig. 1.1). The Park covers an area of 126,205 hectares and is accessible by road through Cradle Valley in the north and Cynthia Bay in the south.

Cradle Valley is about 85 kilometres from Devonport, whilst Cynthia Bay is 173 kilometres from Hobart via the Lyell Highway and is about the same distance from Launceston. The last 32 kilometres of the road to Cradle Valley is narrow and with a gravel surface.

The Park can be divided into four regions; the Cradle Mountain Region in the north, the Pelion Region in the centre of the Park, the Ducane Range in the south-west and the Lake St. Clair Region in the south. The Pelion Region is accessible by foot tracks from the Arm River Road and the Wolfram

Road (Appendix 1).

The Overland Track runs from Cradle Valley to Cynthia Bay, a distance of 80 kilometres.

1.2 REVIEW OF PREVIOUS LITERATURE

Pioneering scientific and experimental work on the impact of recreational activities was undertaken by Bates (1934). A considerable subsequent literature describes and analyses the effects of trampling on soils and vegetation.

In Britain, Bayfield (1970, 1971, 1973), Goldsmith *et al* (1970), Burdon and Randerson (1972), Liddle (1975), Liddle & Greig-Smith (1975a) focus their investigations on the effects of trampling on surface vegetation. Liddle (1975) in his review of literature on the effects of trampling defined the approaches adopted to date as being analytical and experimental. The analytical approach presumed that the vegetation was homogenous prior to track formation and that there has not been an overall change in the environment since the area was made available to users. The differences between the impacted sites and adjacent areas are then attributed solely to the effects of trampling.

The experimental approach described the impact of controlled trampling intensities on the vegetation and soils. This involved the use of either hikers of specific weights trampling over undisturbed vegetation at different frequencies or the use of artificial rollers (Cielinski & Wagner 1970) and mechanical feet (Kellomaki 1973) to simulate trampling damage. Although useful as scientific studies, these have limited application in management as trampling does not represent all the effects of recreation on soils and vegetations.

Soil compaction has been assessed using indices of bulk density, penetration resistance and moisture content. Bulk densities were found to increase on paths by between $0.2gm^{-3}$ to $0.6gm^{-3}$ when compared with the undisturbed soil (Lutz 1945, Liddle & Greig-Smith 1975b).

Soil penetration resistance has been measured by penetrometer. However, while this method produced a reasonable index of compaction it is also sensitive to soil moisture, root and stone content (Liddle & Greig-Smith 1975b).

In an attempt to relate user patterns to vegetation destruction, Bayfield (1971) developed a unique method of placing short, thin lengths of copper wire upright over an area of path and estimated the intensity and distribution of foot traffic by counting and noting the bending of wires. In a later paper Bayfield (1973) applied regression analysis to obtain a higher degree of explanation between environmental variables and track damage. He found that the width of tracks increased with wetness, roughness and steepness of the path surface, but decreased with the roughness of the adjacent ground. Similar conclusions were also attained by Weaver and Dale (1978) in their investigations of trampling effects of hikers, motorcycles and horses in meadows and forests.

Liddle (1975b) summarised the main concepts of impact of trampling on plant species:

(i) plants with basal apices and meristems tolerate trampling better than those that do not have these features (Bates, 1935, 1938; Liddle & Greig-Smith 1975b);

(ii) plant communities are less tolerant to trampling when the ground is wet than when it is dry (Edmond, 1962; Wagar, 1966);

(iii) the numbers of species in a community will at first rise and then fall as the amount of trampling gradually increases (Grime, 1973);

(iv) tall grasses will at first give way to lower growing dicotyledonous species but as the amount of trampling increases the monocotyledonous species will replace the broad-leaved plants before they, in turn, are eliminated (Liddle & Greig-Smith 1975b);

(v) as plant succession proceeds (and the community becomes more productive) the vegetation becomes tolerant to trampling (Goldsmith 1974);

(vi) trampling will at first stimulate and then reduce primary production as its severity rises (Goldsmith, 1974);

(vii) plants with high potential productivity are common on paths (Grime & Hunt, 1975).

Unlike Britain where ecologists are the dominant force in recreational impact research, a wide spectrum of disciplines have been involved in recreational impact assessment and management in the United States of America.

La Page (1967) reports on observations made over a 3 year period on a newly opened campsite. He found that initial impact was greater than that after the third season. Although camping intensity was higher the vegetative cover was greater than that at the end of the first season, owing to the elimination of the more sensitive species and the recolonisation by resistant species.

A number of studies of human influence on trail-side vegetation were carried out in the seventies. These included Willard & Marr (1970, 1971), Bell & Bliss (1973), Dale & Weaver (1974), Grellar (1974), Hartley (1976). Concurrently, a number of studies investigating the influence of soil factors on the quality of recreation and the use of soil surveys for predicting the susceptibility of wildlands to recreation were also published: (Legg & Schneider, 1977, Klock, 1973, Klock

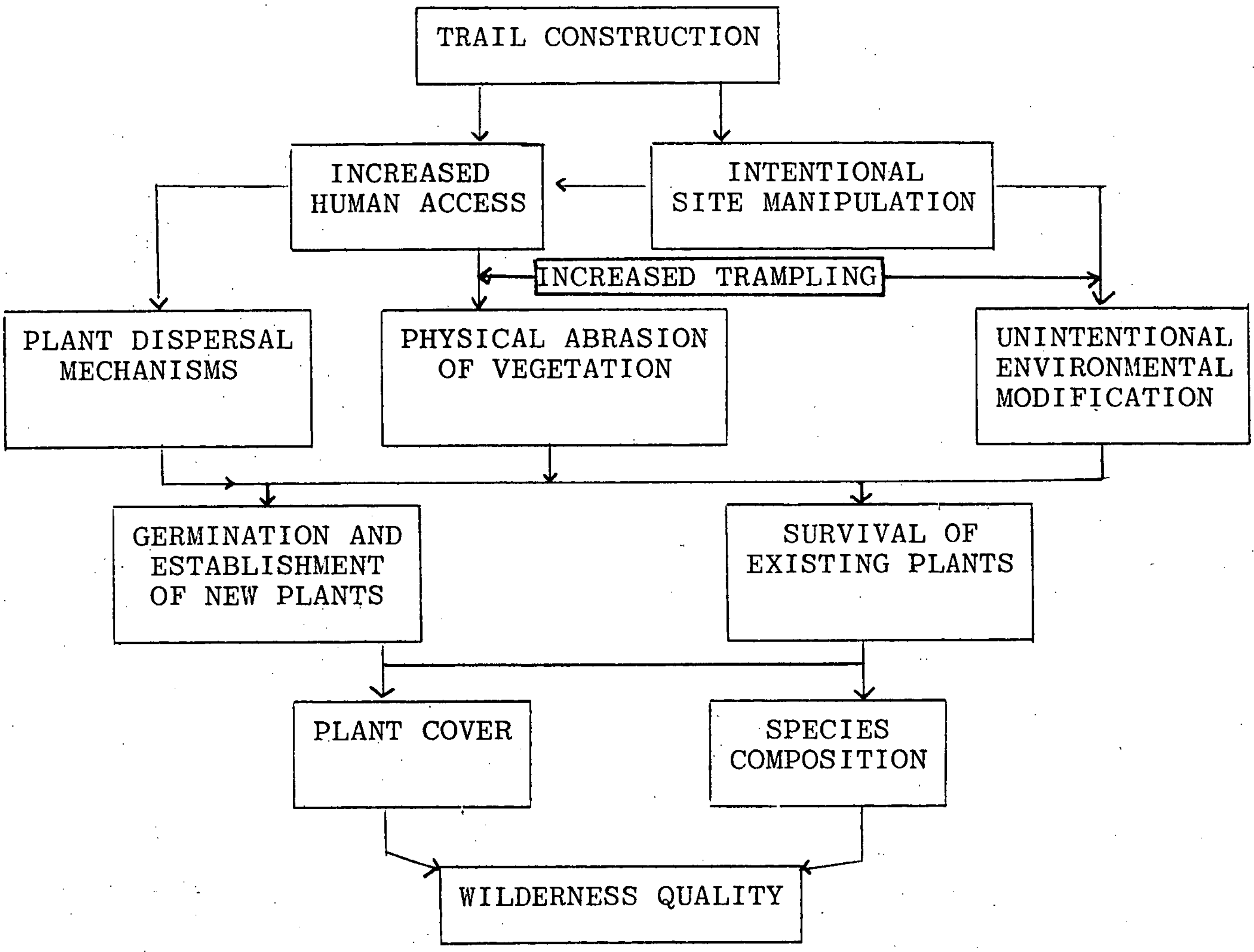


Fig. 1.2

CAUSALLY LINKED FACTORS RELATED TO TRACK CONSTRUCTION

(Cole, 1978)

and McColley 1979, Ballard, 1979).

Cole (1975) in his investigations on the susceptibility of vegetation communities to trampling established a flow diagram of causally linked factors related to trail construction (Fig. 1.2), based on the model developed by Liddle (1975) on the ecological effects of trampling.

The classic work of Lucas (1964) on wilderness perception and use stimulated great interest in the assessment of trail users themselves and the use of a great variety of survey techniques including the use of questionnaires. This study was followed by works by Merriam and Ammion (1967) and Hendee *et al* (1968) which provide information on the socio-economic characteristics of wilderness users, their values, and attitudes to management issues. This further stimulated research into the social and psychological makeup of users, with investigations using motivation analysis (Stankey 1971).

The natural extension of the impact assessment is to be able to predict changes in the future and the relative consequences of these changes; and this in turn has led to the seeking of a rationale for limiting use in order to protect the natural values of the land. The concept of carrying capacity was then introduced to the managers of recreation resources. Stankey and Lime (1973) collated an extensive bibliography of references on recreational carrying capacity. Since then, there has been a continuous debate on the definition, virtues and limitations of such a concept (Wagar 1964, Godin & Leonard 1977).

In an attempt to clarify the concept and measurement of carrying capacity, Frissell *et al* (1980) argued that there is no fixed limitation on the level of use that a site can sustain. The limitations on use are subject to the management objectives of the area, and not necessarily on the physical property of the site. In other words, it is a judgemental and prescriptive measure, one which identifies with the environmental and social conditions prevailing at the particular location. In the final analysis, it is a managerial prerogative and responsibility as to what the appropriate carrying capacities ought to be. The authors then developed a framework upon which an estimation can be made on the consequences of alteration of the carrying capacity.

Investigations on the impact of recreation on wildlife have been few, probably because wildlife species are mobile and as such recreational effects are not immediately evident. Nevertheless, Ream (1980) has compiled an annotated bibliography on the impact of back country recreationists on wildlife.

In Australia, the literature on recreation has, in the main, concentrated on assessing the visitor and user characteristics (Mercer 1969 , McLoughlin 1977, McKenry 1975 ; Waterman 1979). Bowen & Ovington (1973) studied recreation use patterns, whilst Mercer (1977) and Ferguson & Greig (1971) have investigated the economics of recreation. Edwards (1977) and Keane (1979) provided qualitative descriptions of the impact of trampling on trailside vegetation. In short, there is a dearth of research on the quantitative assessment of visitor impact on the Australian natural environments.

1.3 APPROACH

One of the major drawbacks of many recreational impact studies is the tendency to describe the effects of trampling while failing to advise on appropriate measures for management action. Much of the information obtained is more suitable for the "advanced" rather than the initial phases of management.

There is often difficulty in translating the complex scientific data into simple field solutions. In addition, many of the techniques used for impact assessment involve the use of sophisticated equipment and computer analysis, all of which are beyond the means of a great number of park managers.

The approach adopted in this study is management-orientated. The investigations focus on the broad spectrum of visitor impact, recognising the interdependent nature of the social and physical impacts on the park environment. There are three phases in the impact assessment. The first, undertakes to determine what sorts of people participate in back country recreation, the trails used, the types of activities carried out whilst in the park, and their attitudes on trails and management options. The second phase determines the scale and location of visitor impact in the Park, using a simple but effective survey technique. An attempt is made to relate site factors, visitor use and the level of impact. The third phase attempts to measure the resistance and resilience of plant species, and the rate of recolonisation of previously eroded areas. The viability of different track rehabilitation techniques is also assessed.

In the final chapter, an attempt is made to integrate and synthesize the management implications of the above investigations.

CHAPTER II

EXISTING ENVIRONMENT

2.1 PHYSICAL ENVIRONMENT:

2.1.1 Climate

Climatic data are available for the two developed areas - Cradle Valley and Cynthia Bay, Lake St. Clair (Table 2.1). The climate is cool perhumid with the prevailing westerlies having a predominant influence on the weather.

In the north, it rains on an average of 237 days per year, with no month receiving less than 120 mm of precipitation. There is a marked north-south rainfall gradient as reflected by 2770 mm precipitation received annually at Cradle Valley and the 1500 mm received at Cynthia Bay, even though there is only a slight variation in the number of rainy days. The months of July and August are the wettest, whilst February is the driest month in the park.

Snow falls on the average of 52 times a year at Cradle Valley, with the greatest snow accumulation in August and September. Snowfall at Cynthia Bay is less frequent with an average of 26 days per annum. It has been known to snow at all times of the year on the mountain peaks and plateaus.

TABLE 2.1

CLIMATIC DATA ON CRADLE VALLEY AND LAKE ST. CLAIR

(Source: Bureau of Meteorology, Dept. of Science and the Environment, 1979)

Station Name CRADLE VALLEY TASMANIA

Number 096005 Latitude 41 Deg 38 Min S Longitude 145 Deg 57 Min E Elevation 914.4 M

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
9 am Mean Temperatures (C) and Mean Relative Humidity (%)													
Dry Bulb	12.1	12.6	10.1	7.8	4.3	2.3	2.1	2.2	3.4	6.1	8.0	9.2	6.7
Wet Bulb	9.7	10.6	9.2	6.8	3.4	2.0	2.0	2.2	2.5	4.4	5.9	7.0	5.5
Dew Point	7	9	8	6	2	2	2	2	1	2	3	5	4
Humidity	73	78	89	87	86	95	99	100	86	76	72	72	84
3 pm Mean Temperatures (C) and Mean Relative Humidity (%)													
Dry Bulb	15.4	15.9	13.1	9.8	6.0	4.1	3.6	4.2	5.3	8.2	10.6	11.9	9.0
Wet Bulb	11.5	12.2	10.9	8.0	4.6	3.8	3.1	3.3	3.6	5.8	7.6	8.7	6.9
Dew Point	8	9	9	6	3	3	2	2	1	3	4	5	5
Humidity	61	64	76	78	80	95	92	86	75	69	65	64	75
Daily Maximum Temperature (C)													
Mean	17.2	17.6	14.7	11.2	7.5	5.1	4.6	5.2	6.6	9.8	12.3	13.7	10.5
86 Percentile	21.9	22.5	19.4	15.0	10.3	7.5	6.5	8.2	9.5	14.9	17.0	19.0	
14 Percentile	12.5	13.0	9.6	7.8	4.4	2.2	2.5	2.8	3.6	5.0	7.4	8.9	
Daily Minimum Temperature (C)													
Mean	6.3	7.8	5.9	4.3	1.5	0.1	0.1	0.0	0.3	1.6	3.0	4.0	2.9
86 Percentile	9.5	12.0	9.9	7.3	5.0	3.1	2.5	2.4	2.7	4.5	6.0	7.2	
14 Percentile	3.3	3.5	2.2	1.1	-1.9	-2.8	-2.2	-2.8	-2.5	-1.1	-0.3	0.7	
Rainfall (mm)													
Mean	147	135	154	228	280	275	320	307	275	251	219	183	2774
Median	137	121	138	216	245	243	285	305	252	240	212	171	2755
Raindays (No)													
Mean	16	14	18	20	21	21	24	23	22	21	19	18	237

Station Name LAKE ST.CLAIR TASMANIA

Number 096015 Latitude 42 Deg 6 Min S Longitude 146 Deg 13 Min E Elevation 735.2 M

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
9 am Mean Temperatures (C) and Mean Relative Humidity (%)													
Dry Bulb	11.8	11.6	9.8	7.5	5.0	3.7	2.7	2.8	4.4	6.7	8.5	10.3	7.1
Wet Bulb	8.6	8.9	7.6	5.7	3.6	2.5	1.7	1.7	2.8	4.3	5.7	7.3	5.0
Dew Point	5	6	5	3	2	1	0	0	0	1	2	4	2
Humidity	64	69	73	76	79	81	83	82	75	67	64	64	73
3 pm Mean Temperatures (C) and Mean Relative Humidity (%)													
Dry Bulb	14.8	16.1	12.4	10.3	7.5	7.0	5.5	6.8	8.2	8.6	12.4	12.2	10.2
Wet Bulb	9.3	10.6	8.5	6.9	4.9	4.5	3.1	4.2	4.8	5.2	8.1	7.9	6.5
Dew Point	3	5	4	3	1	1	-1	1	0	1	3	3	2
Humidity	45	47	57	59	65	66	65	64	56	57	53	53	57
Daily Maximum Temperature (C)													
Mean	18.3	18.5	15.9	12.5	9.1	7.6	6.5	7.6	9.3	11.7	13.8	15.8	12.2
86 Percentile	24.4	24.4	21.2	16.7	12.2	10.0	8.5	10.6	13.3	17.0	19.4	22.2	
14 Percentile	11.1	12.8	10.6	8.3	6.1	4.4	4.4	5.0	5.6	6.7	8.3	10.0	
Daily Minimum Temperature (C)													
Mean	7.1	7.6	6.0	4.3	2.5	1.1	0.4	0.5	1.5	3.0	4.5	6.1	3.7
86 Percentile	11.1	11.7	9.9	7.8	5.6	4.4	3.3	3.3	4.0	6.1	7.8	10.0	
14 Percentile	3.3	3.9	2.2	0.6	-0.6	-2.2	-2.2	-2.2	-1.1	0.0	1.1	2.2	
Rainfall (mm)													
Mean	75	82	82	127	137	147	162	166	158	141	124	113	1514
Median	73	61	67	115	121	128	140	145	145	131	117	107	1499
Raindays (No)													
Mean	13	13	15	18	21	19	23	22	20	21	19	18	222

Humidity is relatively high throughout the park, with an annual mean of 84% and a range in annual means of 28% at Cradle Valley as compared with a mean of 73% and a range of 17% at Lake St. Clair (Table 2.1).

The average monthly and annual maximum and minimum temperatures are listed in Table 2.1. Bureau of Meteorology records (D.S.E. 1980) have shown temperatures up to 30°C during the summer months and below -10.9°C during the winter of 1972. January and February are the warmest months in the park, whilst the months of June, July and August are the coldest.

On the average, there are 160 days of frost per year in the Cradle Valley area as compared to only 99 days at Lake St. Clair. Frosts are frequent between May and October.

<u>2.1.2 Geology</u> (Fig. 2.1)

The park is underlain by Precambrian rocks, Permo-Triassic sediments and Jurassic dolerite (Jennings 1959).

The complexly folded Precambrian basement is overlain by sedimentary deposits of Permian and Triassic age. Along the uncomformity between the Permian-Precambrian boundaries, dolerite intrusions occur. Some of these are in excess of 300 metres thick.

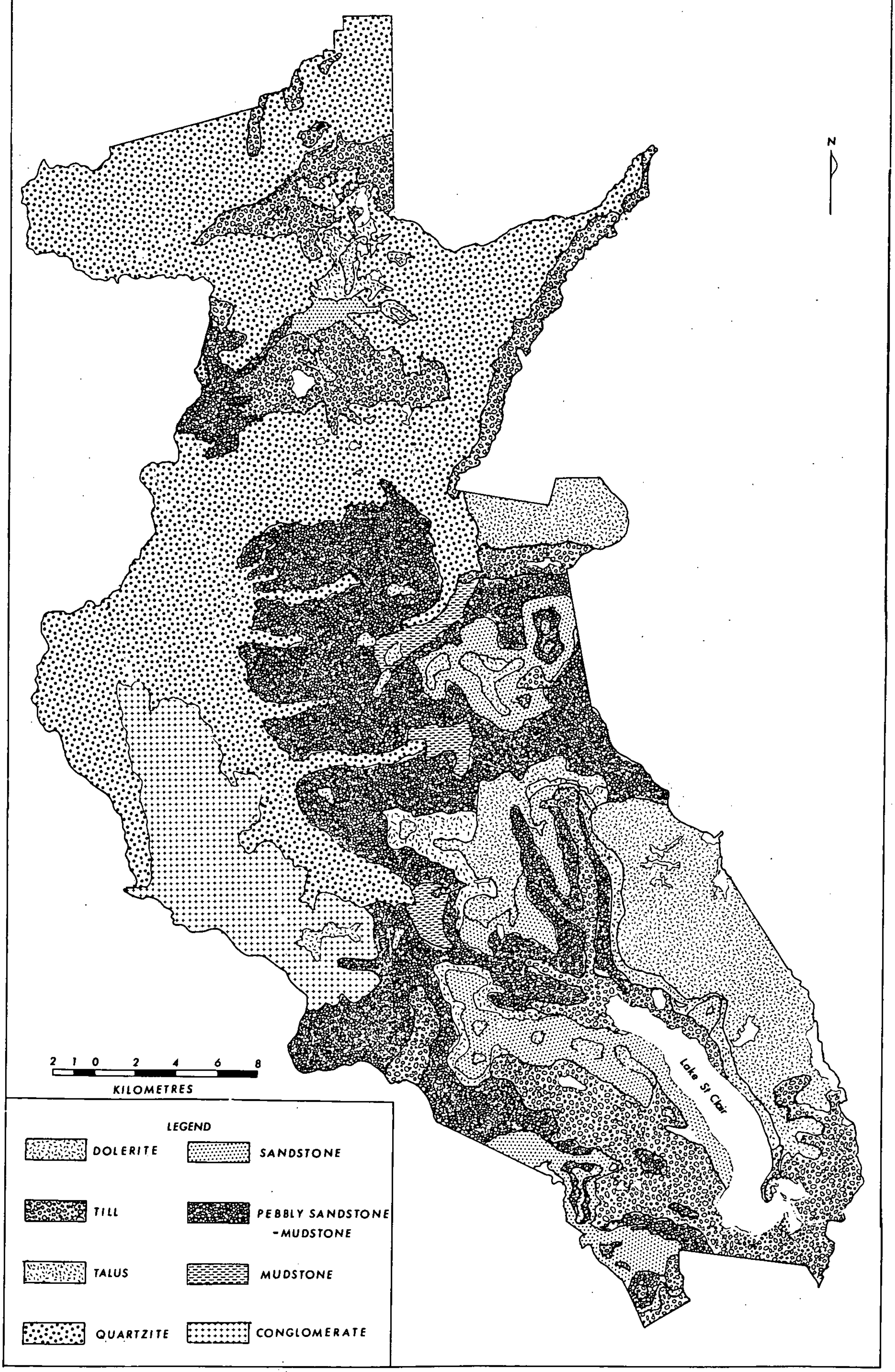
Fig. 2.1

GEOLOGY MAP OF THE CRADLE MOUNTAIN - LAKE ST. CLAIR NATIONAL PARK

(Source: Dept. of Mines Tasmania (1975), Geological Atlas, 1:250,000 series)

FIG 2.1

CRADLE MT. – LAKE ST. CLAIR NATIONAL PARK :- GEOLOGY



The Precambrian rocks consist of thinly bedded quartzite and quartz mica schists. The Permian sequence on the other hand consists of basal conglomerates overlain by marine sequence of mudstones, pebbly sandstones and conglomerates. These are in turn overlain by a freshwater sequence consisting mainly of sandstone. The uppermost layer is another marine sequence of mudstones, siltstones and impure sandstones (Jennings 1959). Outcrops of Permo-Triassic formations are found throughout the park. They are characterized by bench-like formations around the slopes of all major mountains. Capping the higher mountain peaks and ranges is Jurassic dolerite, characterized by its prominent columnar structure.

Overlaying these formations are extensive Pleistocene glacial and peri-glacial deposits, Quaternary talus and screes and peaty deposits. Examples of these widespread superficial deposits are glacial moraines and lake deposits, erratics, talus, scree deposits.

Glacial activity has interrupted the local drainage, resulting in the formation of vast swampy or peaty plains.

2.1.3 Landscape

The present topography is largely the result of glacial and preglacial activity; in the Pleistocene epoch an ice cap approximately 65 kilometres wide occupied the North Western section of the Central Plateau.

Fig. 2.2a

RECONSTRUCTED FOREGLACIAL DRAINAGE ROUTES IN THE CRADLE MOUNTAIN AREA

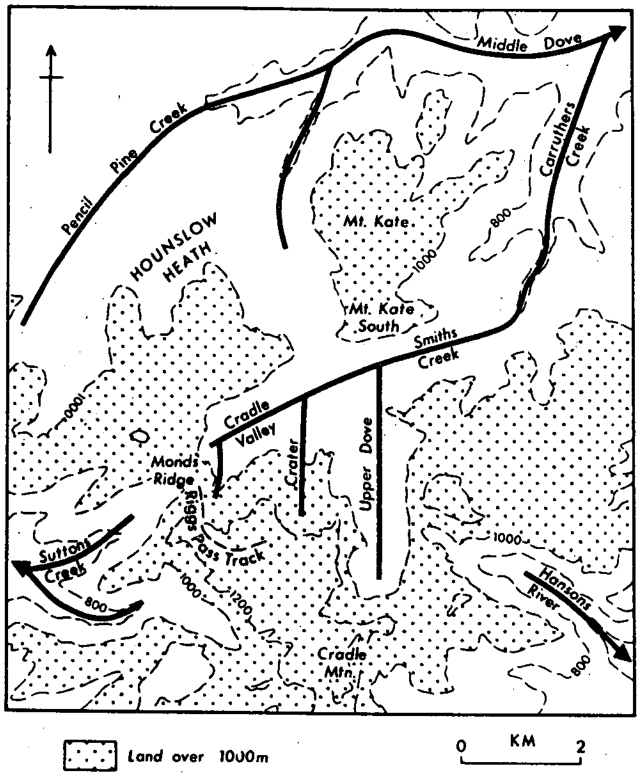
Fig. 2.2b (LHS)

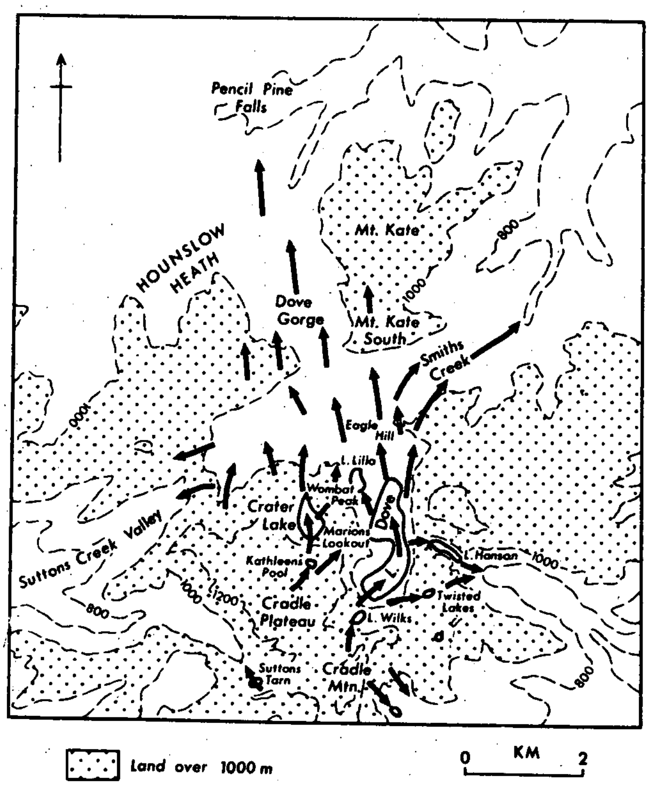
LATE PLEISTOCENE ICE FLOW DIRECTION IN THE CRADLE MOUNTAIN AREA

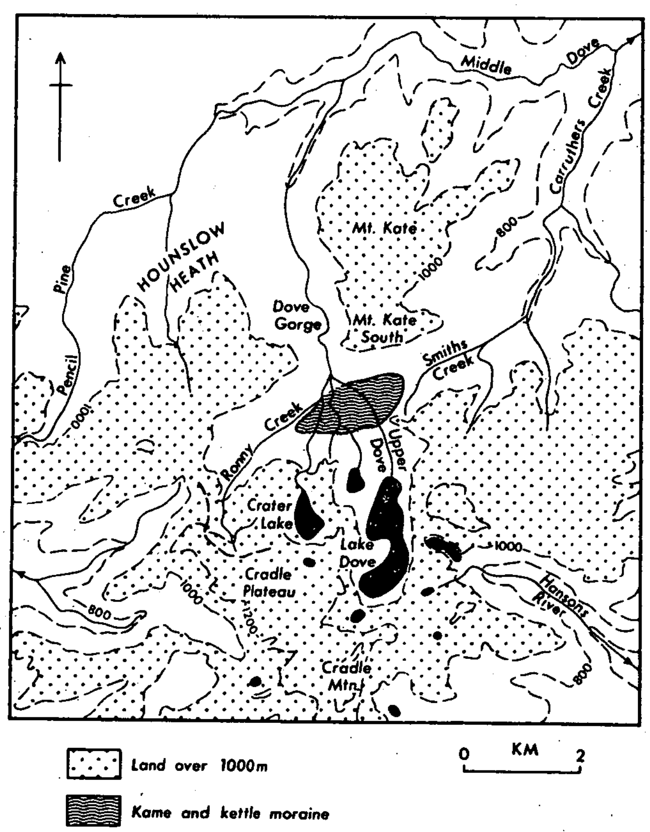
Fig. 2.2c (RHS)

PRESENT DRAINAGE IN THE CRADLE MOUNTAIN AREA

(Source: Colhoun, 1980)


Middle Dove
Pencil Pine Creek
Carruthers Creek
HOUNSLOW HEATH
Mt. Kate
Mt. Kate South
Smiths Creek
Cradle Valley
Monds Ridge
Crater
Upper Dove
Riggs Pass Track
Suttons Creek
Hansons River
Cradle Mtn.
800
1000
1200
Land over 1000m
0 KM 2


Pencil Pine Falls
HOUNSLOW HEATH
Mt. Kate
Dove Gorge
Mt. Kate South
Smiths Creek
Eagle Hill
L. Lilla
Wombat Peak
Crater Lake
Marions Lookout
Dove
L. Hanson
Kathleens Pool
Suttons Creek Valley
Cradle Plateau
Twisted Lakes
L. Wilks
Suttons Tarn
Cradle Mtn.
800
1000
1200
Land over 1000 m
0 KM 2


Middle Dove
Carruthers Creek
Creek
Pine
Pencil
HOUNSLOW HEATH
Mt. Kate
Dove Gorge
Mt. Kate South
Smiths Creek
Ronny Creek
Upper Dove
Crater Lake
Lake Dove
Cradle Plateau
Hansons River
Cradle Mtn.
800
1000
1200
Land over 1000m
Kame and kettle moraine
0 KM 2

The widespread examples of glacial striations in the Cradle Mountain area provide evidence on the pattern of the Late Pleistocene ice movements in the area. For instance, it is evident that the glacier which created Dove Lake flowed from the Cradle Mountains plateau via Lake Wilks and northwards through the Cradle Valley with ice attaining depths of over 350 metres in areas (Colhoun 1980, Fig.2.2.).

The Cradle Mountain area is also said to have one of the best examples of alteration to the courses of pre-existing drainage routes in Australia (Colhoun 1980).

Quite apart from the juxtaposition of lakes, tarns and other examples of glacial processes, the National Park is well known for its mountains and ranges. In the north, Cradle Mountain, Barn Bluff, Little Horn, Mount Campbell are all within a day's walk from Cradle Valley. The middle region of the park is dominated by the West Pelion Range, Mount Oakleigh followed by Mount Ossa, the highest mountain in Tasmania. Diagonally opposite Mount Ossa, is the pimple top, Mount Pelion East. The mountainous southern region is dissected by the Narcissus, Pine and Cuvier Valleys. The mountain ranges include the Ducane Range, the Travellers Range, and Mount Olympus with Mount Rufus being the southernmost mountain in the park (Appendix 1).

These mountainous areas also serve as catchment areas for some of the major river systems in the State, which in turn serve as vital components of a number of hydroelectric schemes. For example, the Forth and Mersey Rivers to the north and north east, Mackintosh and Murchison on the West and the Derwent in the south.

The swampy hummock sedgelands which are dominant over vast areas of the park play an important role in the hydrology of the above-mentioned river systems. These act as sponges, storing large amounts of water, which is gradually released maintaining a sustained water yield (Keane *et al* 1979).

2.1.4 Soils

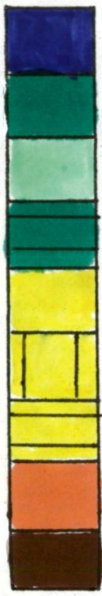
Alpine humus soils are characteristic of most of the Park. These are associated with periglacial solifluction deposits. Such soils are at c.600 m and above but where slopes are sufficient they may go well below this. These deposits consist of boulders and fragments mainly of dolerite in an earthy matrix which is usually coloured a strong brown. Its texture varies with the source from sand to clay but within any profile it changes little with depth (Davies 1965).

Soil profiles vary mainly with drainage. On free draining sites where the rainfall is relatively low the profile formation is often limited to incorporation of organic matter in the surface foot or more. In wetter locations the situation becomes more marshy and thus the organic matter increases and the soil profile tends towards

FIGURE 2.3

VEGETATION MAP OF THE CRADLE MOUNTAIN - LAKE ST. CLAIR NATIONAL PARK

Key



Closed forest

Eucalypt forest

Eucalypt woodland dominated by *E. coccifera*

Eucalypt/closed forest mosaic

Alpine

Alpine, *E. coccifera* and *Athrotaxis cuppressoides*

Alpine, *E. coccifera* and grassland mosaic

Gymnoshoemis sphaerocephalus moorland scrub

Scrubland

FIG 2.3

moor peat. The peats are commonly 40-50 cm and sometimes up to 150 cm deep. Some iron leaches from the upper mineral horizons leaving them paler coloured and thus iron pans form below. All soils are moderately to strongly acidic.

There are some localities in the park where soils are absent or skeletal. These tend to be on the upper slopes and summit of the main mountains and in the plateaux and valleys where morainal deposits are exposed.

2.1.5 Vegetation

This National Park contains a wide variety of plant communities. Specht *et al* (1970) have provided a comprehensive list of the various plant alliances (Appendix 2). The vegetation is mapped in Figure 2.3.

Climate, altitude, geology, soils, and fire frequency seem to have been the principal determinants of the types of vegetation patterns found in the park (Sutton 1929; Jackson 1965, 1973; Kirkpatrick 1980).

Heath and herbfield communities dominated by austral-montane elements are found above the climatic tree-line (c.1200 m) and between 1000 m and 1200 m where exposure is high and/or drainage is poor.

Gymnoschoenus sedgeland is found on the ill-drained and infertile ground where the fire frequency is high and grades into *Leptospermum* scrub, which in turn grades into *Eucalyptus* forests at its margins. Restricted areas of *Poa* grassland are found where trees are excluded by frosts and fire on fertile, deep soils.

Eucalyptus forest and woodland is widespread throughout the lower altitudes of the park where soils are well drained and fires occur occasionally. The better sites are occupied by *Eucalyptus delegatensis* and other communities dominated by *E. dalrympleana, E. pauciflora, E. amygdalina,* and *E. gunnii* occupy poorer sites. Above 1000 m ASL, there are extensive areas of *E. coccifera* woodland which may not require fire for regeneration.

Areas of low fire frequency are occupied by closed forest dominated by *Nothofagus cunninghamii, Atherosperma moschatum* and *Anodopetalum biglandulosum* at lower altitudes. At higher altitudes, the dominants are *Nothofagus cunninghamii, N. gunnii, Athrotaxis selaginoides* and *A. cupressoides*. Extensive areas consist of mosaics of alpine heath and herb-field, *Eucalyptus coccifera* woodland, *Poa* grassland and *Athrotaxis cupressoides* woodland to closed forest.

2.1.6 Wildlife

Over twenty different species of mammals have been recorded, with the marsupials being the dominant group.

The Bennetts Wallaby, *Wallabia rufogrisea*, is a common sight in the developed areas of Cradle Valley and Cynthia Bay. Its smaller cousin, the rufous wallaby, *Thylogale billardierii*, is more a nocturnal animal and hence less conspicuous.

Popular nocturnal species found around the huts include the wombat, *Vombatus ursinus*, the native cat, *Dasyurus viverrinus*, and tiger cat, *Dasyurus maculatus*.

The endemic Tasmanian devil, *Sarcophilus harnsii*, together with the brush possum, *Trichosurus vulpecula*, are also frequently seen in the developed areas of the park.

The platypus, *Ornithorhynchus anatinus*, is found in the mountain lakes and streams. The species was particularly plentiful in areas close to the Narcissus Hut, until hunted out in the mid 1930's.

The endemic mountain shrimp, *Anaspides tasmaniae*, and freshwater crayfish, *Astacopsis franklinii*, are also found in the highland streams and tarns. The 10-12 cms long freshwater crayfish is reported to be the largest of its type in the world.

There are only three snake species in the park, but nevertheless they are all venomous. The most common is the deadly tiger snake, *Notechis ater*. The copper-head snake, *Austrelaps supuba*, favours the swampy areas, whilst the smaller whipsnake, *Drysdalia coronoides*, occurs in most environments.

Because of the cold, harsh environments of the park, birdlife is not as abundant as in other parts of the state.

The common birds in the rainforest include the black cockatoo and currawong, green rosellas, pink robin, Tasmanian thornbill and scrub tit. Apart from the green rosella and black currawong, the dominant species in the subalpine woodlands include the raven, yellow-throated honeyeater and yellow wattlebird.

Birdlife in the high altitude hummock sedgelands is sparse, with the two most commonly encountered birds being the striated field-wren and dusky robin. In the high mountain heath and moorlands, birds are present only during the warmer periods, being forced down below the snowline in the autumn and winter months. Common species include the raven, black currawong, Tasmanian hornbill, the pipit and flame robin. The wedge-tail eagle and peregrine falcon are two birds of prey which also frequent these areas.

In all, over eighty birds have been recorded inside the park boundaries (NPWS undated).

2.2 SOCIAL ENVIRONMENT

2.2.1 History

The park was first discovered in 1826 by Jorgen Jorgenson, who was the first white man to visit Lake St. Clair. The northern end was first visited by Henry Hellyer, a surveyor with the Van Diemens Land Company in 1827. He penetrated the thick forest to reach Waldheim.

The discovery of mineral deposits in Pelion region saw an influx of miners along the Innes Track working on deposits of coal and copper. The Old Pelion Hut became the focal point for accommodation.

In 1910, Gustav Weindorfer, an Austrian migrant, visited Cradle Valley and climbed Cradle Mountain. While on the summit, Weindorfer remarked "This must be a National Park for people for all time. It is magnificent and people must know about it and enjoy it". He and his wife returned in 1912, with a lease of Crown Land in Cradle Valley. He then embarked on building a house which he named "Waldheim". The house was Austrian in design and constructed from King Billy pine *(Athrotaxis selaginoides)*.

Through Weindorfer's persistent efforts, the State Government gazetted 63,943 hectares as a scenic reserve. Gustav Weindorfer was found dead beside his motorcycle in 1932.

The construction of the Lyell Highway in 1932, and the subsequent connecting road to Lake St. Clair in 1934, increased the popularity of the park. The first ranger appointed to the park was Albert Dundas Ferguson, who ran a popular tourist camp at Cynthia Bay.

The scenic reserve experienced a number of boundary changes over the years. On the 17th April 1974, an additional area of 1214 hectares in the vicinity of Mount Rufus was added, making a total area for the park of 126,064 hectares.

2.2.2 Ancillary Services and Facilities

This section attempts to describe the facilities and public amenities available in the park.

(a) Developed Areas

The National Parks and Wildlife Service has embarked on a policy of providing chalet-type accommodation in both the developed areas. These are serviced and maintained by the Service. Charges are reasonable, and the chalets are very popular amongst tourists and visitors.

TABLE 2.2

Public Amenities Available at

Cradle Valley and Cynthia Bay

Facilities	Cradle Valley	Cynthia Bay
Huts	8	5
Bunk space	44	28
Serviced caravan sites	Nil	12
Tent pads	Nil	40
Showers/ablution block	Yes	Yes
Laundry facilities	No	Yes
Museum	Yes	No
Day-Use Hut	Poor condition	Good condition
Picnic facilities	Sparse	Good
Boat ramps	No	Yes
Kiosks	No	Yes

Table 2.2 provides a comparative assessment of the two developed areas. It is quite apparent that the facilities in the south are far more comprehensive than those at the northern end of the park.

The occupancy of the chalets and caravan sites is high and seasonal. During the peak summer, the bed occupancy in Cradle Valley for example, averages at 70%, peaking up to 96% on a number of days (Fig. 2.4). The variable, percentage bed occupancy, does not accurately represent the demand for accommodation. For instance, in the month of January 1979, all the chalets were fully booked even though the bed occupancy level varied between 50 and 98%. During the off season, it is quite apparent that chalets were in demand in the weekends, with minimal bookings during the weekdays. This pattern reflects the recreation trends in this state (RLUS 1979). The average bed occupancy during the off-season is 30%.

Quite apart from the services founded by the National Parks and Wildlife Service, there are a number of private tenures within the park. These include:

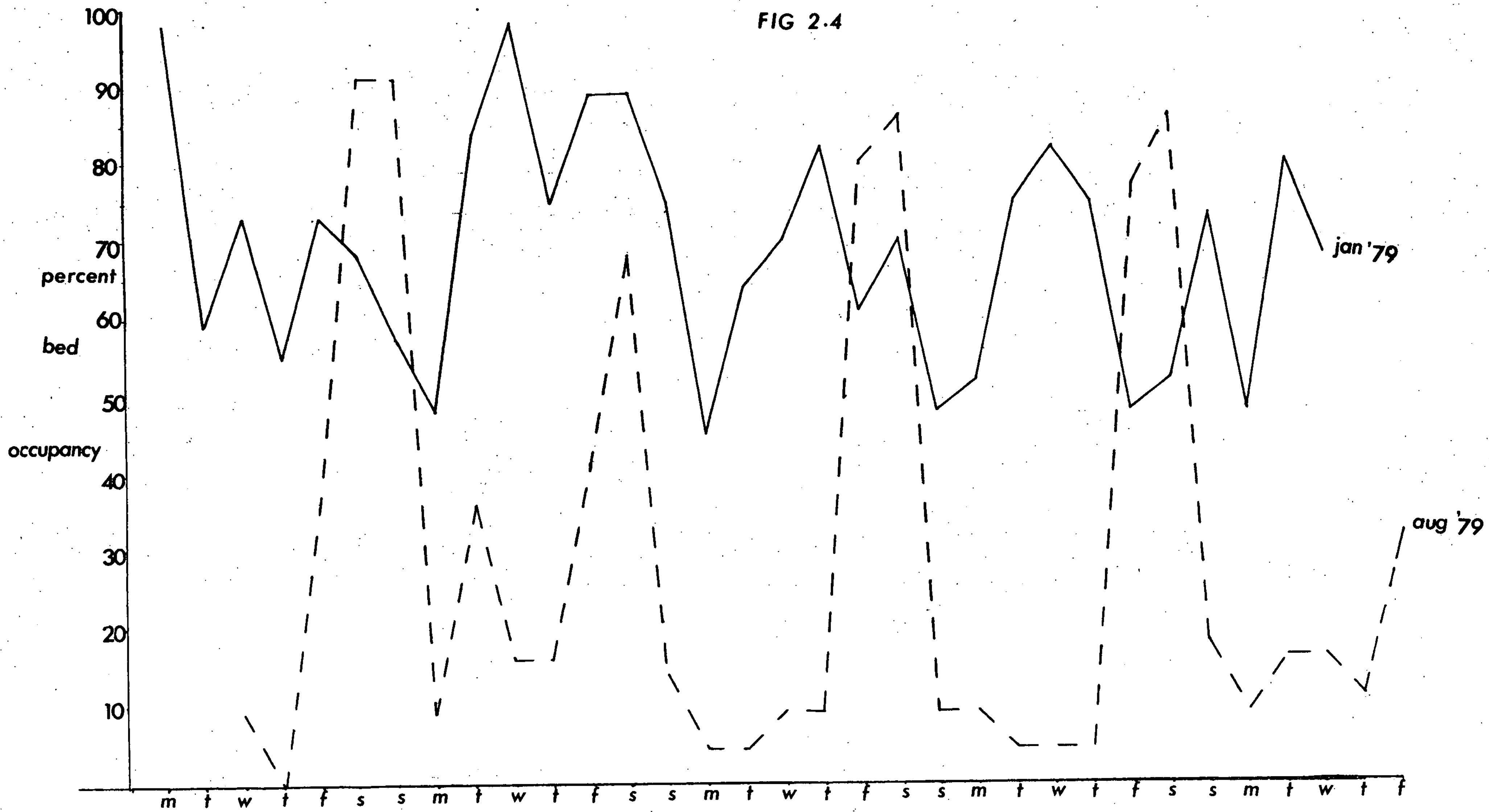
<u>Waldheim Area</u>

- Blandfordia Alpine Club
- NorthWest District Scouts Association - Scout Hut
- Hydro Electric Commission - a recording hut at Lake McRae.

Fig. 2.4

BED OCCUPANCY TRENDS AT THE NPWS CHALETS,
CRADLE VALLEY, FOR THE MONTHS OF JANUARY AND AUGUST 1979.

FIG 2·4


100
90
80
70
60
50
40
30
20
10
percent
bed
occupancy
m t w t f s s m t w t f s s m t w t f s s m t w t f s s m t w t f
jan '79
aug '79

Cynthia Bay

- Hobart Walking Club - one hut
- Wellington Ski Club - two huts
- Lessee operating the Cynthia Bay Kiosks and a Jet boat service on Lake St. Clair.
- The Hydro Electric Commission has the right to vary the level of Lake St. Clair within specified limits.

Located just outside the boundary entrance to Cradle Valley, is a private holiday lodge style accommodation - Pencil Pine Lodge. Also associated with this lodge is a public kiosk, milk bar and petrol station.

(b) Overland Accommodation

In total 13 shelter huts are located along the overland track (Appendix 1). The condition and facilities available at each of the hut sites are summarized in Table 2.3. Hut conditions are quite variable depending, in the main, on the age of the huts. Huts located at Pine Valley, Ducane, Old Pelion, and Kiaora require upgrading (Plate 2.1).

In general, however, hut conditions and surrounds are satisfactory. The policy of installing pot belly stoves in huts is a positive attempt to discourage defoliation. There is a need, however, to provide simple and precise how-to-use instructions. Almost all huts are serviced by a rubbish pit. In a number of locations (Narscissus, Pine Valley, New Pelion) these have reached

TABLE 2.3

Summary of Hut Conditions Along the Overland Track

Hut	Bunk Space	Camping	Wood Supply	Water	Toilets	Rubbish Tip	Hut Condition
Echo Point Hut	8	Poor	Plenty	5 m	No	No	Fair
Narcissus	28	Good	Fair	15 m	Yes	Yes	Good
Pine Valley	12	Poor	Plenty	50 m	No	Yes	Poor
Windy Ridge	16	Poor	Fair	50 m	Yes	No	Good
Ducane	16	Good	Plenty	50 m	No	No	Poor
Kiaora	20	Poor	Poor	30 m	Yes	No	Fair
New Pelion	20	Good	Plenty	75 m	Yes	Yes	Good
Old Pelion	8	Poor	Poor	75 m	No	No	Fair
Windermere	16	Good	Good	50 m	Yes	Yes	Good
Cirque	25	Poor	Fair	50 m	Yes	Yes	Good
Waterfall Valley	8	Good	Poor	10 m	Yes	Yes	Fair
Scott Kilvert Memorial Hut	Open floor space	Poor	Fair	40 m	Yes	Yes	Good
Kitchen Hut	8 Emergency Only	Poor	Poor	15 m	No	No	Poor

Plate 2.1 : The historic Ducane Hut.

Plate 2.1

their limited carrying capacity.

Wood supply, although plentiful in most areas, is particularly scarce at Waterfall Valley Hut, Kiaora and Old Pelion Hut. In the other cases, although plentiful, the wood requires to be cut into smaller sections.

To summarize, huts play a useful role in the provision of shelter and tend to focus user activity within a narrow corridor.

2.2.3 Visitor Statistics

The collection of statistics in the park only began after the establishment of the National Parks and Wildlife Service in 1971. Changes of personnel within the Service and in the park have led to a number of inconsistencies in the collation of visitor statistics.

Tables 2.4 and 2.5 summarize the data available since the commencement of visitor statistics at Cradle Valley and Lake St. Clair respectively. As a consequence of the inconsistencies of data collection between the two areas, the following analysis is "area" based.

(a) Cradle Valley

(i) From the period 1971 to 1980, the number of overland bushwalkers increased from 1404 to 2266 respectively. This represents an overall increase

TABLE 2.4

VISITOR STATISTICS - CRADLE VALLEY

Year	Overlanders	2-3 Daywalkers	Daywalkers	Campers	Overnight Guests	Total Visitors
1971/72	1404	N/A	N/A	N/A	N/A	N/A
1972/73	1598	466	1205	N/A	N/A	N/A
1973/74	2021	86	3408	N/A	N/A	N/A
1974/75	1899	119	4073	1525	7250	N/A
1975/76	1859	N/A	4740	2289	6854	N/A
1976/77	2313	623	4425	3080	6764	32448
1977/78	2495	985	4902	2883	6751	47203
1978/79	2233	959	4736	2480	6553	N/A
1979/80	2266	994	5143	2753	7204	40000 (est)

TABLE 2.5

VISITOR STATISTICS - LAKE ST. CLAIR

Year	Day Visitors	Vehicles	Bus Visitors	Buses	Overnight Guests	Campers	Overlanders	Daywalkers
1971/72	N/A	N/A	N/A	N/A	N/A	N/A	1,504	N/A
1972/73	20,000	6,667	11,000	440	10,470		1,663	1,671
1973/74	25,000	8,333	12,000	600	13,311		2,066	3,164
1974/75	38,883	12,961	13,775	551	15,631		1,810	2,800
1975/76	51,464	17,155	12,140	607	16,396		1,780	3,228
1976/77	56,098	18,699	22,000	880	7,665	9,474	N/A	N/A
1977/78	57,456	23,422	22,700	908	7,664	9,997	2,375	5,351
1978/79	130,877	N/A	N/A	N/A	7,103	8,656	N/A	N/A
1979/80	101,034	N/A	N/A	N/A	6,954	11,737	2,037	7,658

of 61.4%.

(ii) Since 1972, there has been a 113% increase in the number of 2 to 3 day bushwalkers. Similarly, the number of day walkers has increased by 77% over the same period.

(iii) The number of visitors staying overnight in this section of the park is a function of the availability of chalets and the ground conditions of the unofficial camping areas. The number of campers has increased by 81% since 1974, whilst the number of overnight guests in the chalets has averaged around 6940 since 1974.

Table 2.6a depicts the seasonal variation in visitation rates as well as user activities for the 1977/78 season. It is apparent from the table that the tramping activities are concentrated during the months of December, January and February. Four out of five overlanders tramp during the summer months. These months also coincide with the growth season for most plants. The 2 or 3 day walkers seem to be evenly distributed over the summer and autumn months, unlike the summer concentration of day walkers. The table also reveals that unlike the tramping activities, the day visitor arrivals appear to be fairly evenly distributed throughout the year.

TABLE 2.6

Seasonal Variation in Park Users

During the 1978/79 Period

(a) Cradle Valley

Seasons	Day Visitors	Day Walkers	Overlanders	2-3 Day Walkers
Summer	30%	40%	79%	32%
Autumn	22%	25%	13%	31%
Winter	23%	15%	1%	17%
Spring	25%	20%	7%	20%

(b) Lake St. Clair

Seasons	Day Visitors	Day Walkers	Overlanders
Summer	36%	48%	84%
Autumn	29%	26%	11%
Winter	14%	13%	1%
Spring	21%	13%	4%

(b) Cynthia Bay

Table 2.5 summarizes the visitor statistics available at Lake St. Clair since 1972. The conversion factor utilized in assessing vehicular visitation rates is 3 persons and 25 persons respectively for a car and bus. The results highlight a significant increase in visitor numbers between 1975 and 1976. This could perhaps be attributed to the upgrading and sealing of the road to Cynthia Bay from Derwent Bridge in the financial year 1974/75 by the Department of Main Roads.

The southern region of the park experienced an increase of 400% in the number of day visitors from 1972 to 1979 and 250% and 125% increases in the number of vehicles and buses respectively since 1972. There has also been a 36% increase in overland bushwalkers and a 360% increase in day walkers since 1972. In the interpretation of the day walker statistics, it must be noted that this figure also includes the 2-3 day walkers. No differentiation is made between these two user groups.

Seasonal analysis of user activities and visitation rates reflect trends similar to Cradle Valley (Table 2.6b). However, day visitors are more concentrated in the summer months at Cradle Valley.

(c) Visitor Trends

The inconsistencies in data collection between the two developed areas and the lack of continuous data for a number of variables, create~~s~~ difficulties in the assessment of changes in visitation rates, which in turn reduces any accurate estimates of user trends and future projections. Figure 2.5 illustrates the fluctuations in the number of trampers through the park as recorded at Cradle Valley. It is apparent that

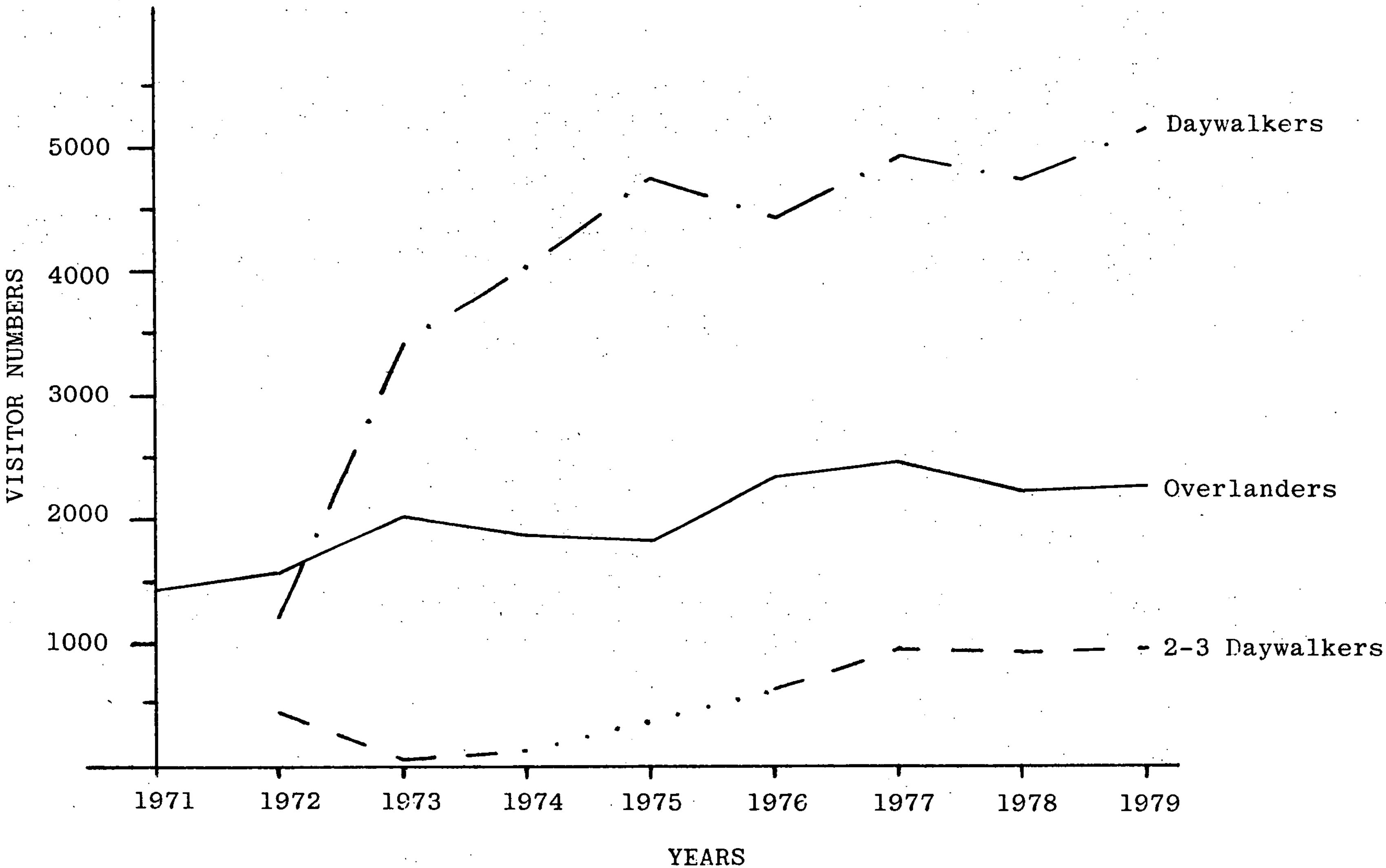
(i) since 1976, the average annual growth rate of overland track walkers has stabilized and is fluctuating about 2300 walkers per annum.

(ii) There has been a slow but steady growth in the number of day walkers. If accommodation is upgraded, with the provision of improved camping facilities, further growth in walkers could be envisaged.

(iii) The number of 2 to 3 day backcountry walkers is increasing steadily and the growth rate in this group could continue to increase as a result of the improved access to the central region of the park via the Wolfram Mine track and the Arm River track. This diversion of walkers may relieve the user pressures on the Cradle Mountain region.

(iv) Analysis of bed occupancy and the patronage of the National Parks and Wildlife Service chalets would suggest that demand is greater than supply during the summer months and during the weekends in the

Fig. 2.5: VISITOR TRENDS - CRADLE VALLEY



off season. The costs and benefits of additional chalets should be assessed prior to any further expansion.

Lake St. Clair

Analysis of the data would suggest that the visitor clientele at this location is different to that received at Cradle Valley. In the first instance, day visitor numbers have exceeded the 100,000 level over the past two years. Secondly, the number of overnight guests and campers is double that of Cradle Valley. Thirdly, although the total number of visitors exceeds that recorded in the northern section of the park, the absolute number of walkers registered at Cynthia Bay is equivalent to those at Cradle Valley. In relative terms, in the year 1979/80, only 10% of all visitors to Lake St. Clair were registered walkers as compared to 30% at Cradle valley.

The high visitation rate experienced at Lake St. Clair could be attributed to two major factors: Cynthia Bay is only 7 kms detour off the Lyell Highway, a major tourist route in the state, and the sealing of the road has encouraged a number of tourist bus operators to schedule Cynthia Bay on their itinerary. Cradle Valley, on the other hand is about 1½ hours from the nearest tourist route, the Bass Highway and the final 32 kilometres of road is narrow and unsealed.

(d) Statistics Collection

In view of the inconsistencies highlighted previously, and in recognition of the need to maintain standardized statistics for management and planning purposes it is suggested that the overland and 2 to 3 day back country walks register books be replaced by a single registration form. It is envisaged that the form would request the following information: name, address, number in party, place of entry, proposed route, duration and location of camps. The advantages of such registration forms, include:

(i) standardized statistics collection;

(ii) information on routes, camps etc. could provide invaluable data for park managers;

(iii) provide assistance and guidance for search and rescue operations;

(iv) enable park authorities to have direct contact with users, thus providing an opportunity for information dispersal, advice on equipment required etc.

It is further suggested that the location of registration booths be reviewed with the aim of maximizing registration of day walkers. Finally, the use of vehicle counters should be regarded as an integral part of park management, and therefore they should be installed at all major entrance points.

CHAPTER III

VISITOR SURVEY

3.1 INTRODUCTION:

The survey of visitors to the Cradle Mountain - Lake St. Clair National Park was carried out in the form of a self-administered eleven page questionnaire (Appendix 3). The objectives of this survey were to gain information on:

(a) geographic, demographic and socioeconomic characteristics of the park users;

(b) the spatial and temporal distribution of visitors in the park;

(c) visitor perception of park facilities;

(d) visitor attitudes to some hypothetical management policies and practices.

The objectives of this visitor survey form an integral part of the overall assessment of visitor impact on the natural environment of the park. The survey was, therefore, primarily aimed towards visitors who had participated in walking activities and not sight-seers, picnickers, and day-trippers. These latter park user groups have minimal impact on the bio-physical environment of the natural areas of the park. Given that there were a number of pre-coded questions on specific issues relating to park facilities and management policies, there is a possible risk that answers may have been forced into categories to which they may not rightly belong. Nevertheless, in all cases respondents were given the opportunity to express any qualifications to their responses or express alternative views in the "general comments section" of each question.

3.2 SURVEY METHOD:

A total of 800 questionnaires was distributed between July 1978 and June 1979 inclusive.

A stratified random method of questionnaire distribution was employed. The number of questionnaires distributed per month was proportionate to the percentages of the total number of 1977/78 walkers visiting the park in each month, the data being obtained from registration books at Cynthia Bay and Waldheim. The monthly quota of questionnaires was equally subdivided and distributed on four random days in each month.

The visitor survey forms were distributed at the two main entrances to the park - Cradle Valley and Cynthia Bay. At each of the entrances, the forms were placed in the Walker Registration/Deregistration booths, where signs inviting the nominal leaders of a party to co-operate in the survey of visitors were placed at prominent locations. Similarly, notices were also placed in the huts along the overland track advising the walkers of this survey. If the respondents were unable to deposit their completed questionnaires in the park, they were provided with a return address pre-stamped envelope by the Ranger Staff.

Even though the questionnaire was designed to randomly sample the total population of walkers, the location of the questionnaire forms limited the possible survey population to those actually visiting the Registration booth and noticing the questionnaire. The number of respondents would, therefore, be a function of those visitors signing the Registration Book.

Discussions with N.P.W.S. staff numbers, and field observations, revealed that approximately 10% - 15% of overland walkers fail to register themselves in the log book, and this percentage increases to about 20% - 25% amongst the day walkers. It was also apparent through field interviews that a large number of chalet dwellers failed to register their walking activities in the log books. By the end of June 1979, 510 questionnaires were received, of which 493 were utilised in the analysis. 3.34% of the returned forms were declared invalid because they were either incomplete or had been vandalised. The completed questionnaires, one for each party, represented the activities of 2034 people, 24.2% of the total number of walkers for 1978/79.

The surveyed visitors were categorised into four groups, namely, overland bushwalkers, 2-3 day back-country users, daywalkers and non-walking activities, and were expressed as a proportion of the total in each group as indicated by N.P.W.S. statistics (Table 3.1). The table suggests that with the exception of the "non-walkers" visitors, the sample sizes for each of the walking groups would be adequate for the purposes of

TABLE 3.1

SAMPLE SIZE OF RESPONDENTS AS RELATED TO THE ACTUAL NUMBER OF VISITORS WITHIN EACH OF THE USER GROUPS FOR THE YEAR 1978-79

(Source: NPWS Visitor Statistics)

User Group	Sample Size	Actual Group Size	Percentage Sampled
Overland	877	2233	38.37
2-3 day Backcountry	188	959	19.6
Daywalkers	886	4736	18.7
Non-Walkers	83	24000	0.4

determining the objectives of this study.

3.3 ANALYSIS:

The data were analysed by cross-tabulation using the Statistical Package for the Social Sciences run on the Burroughs 6700 computer at the University of Tasmania.

The only statistical test applied to these data was chi-squared. Chi-squared is used to determine whether the actual (observed) frequency distribution of independent samples is significantly different from that expected, given the total number of categories and sample groups. A significant difference is defined as one that would have occurred from chance no more than 5% of the time (0.05 level of significance).

3.4 CHARACTERISTICS OF PARK USERS:

The general purpose of this section is to describe the people who participated in the outdoor recreational activities in the park and the nature of their participation. Data were collected on: residence, age, sex, marital status, educational status, occupation, salary and transport. An attempt is also made to determine the relationship between the different user groups and their socioeconomic backgrounds.

Fifty-two per cent of the respondents had either

Fig. 3.1

PERCENTAGE USER GROUP RESPONDENTS

Fig. 3.2

RESIDENCE OF RESPONDENTS

Fig. 3.1

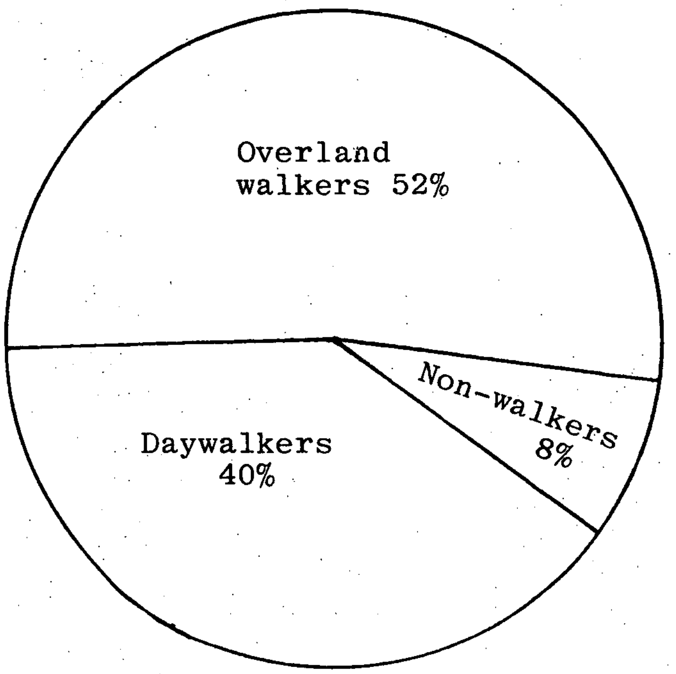
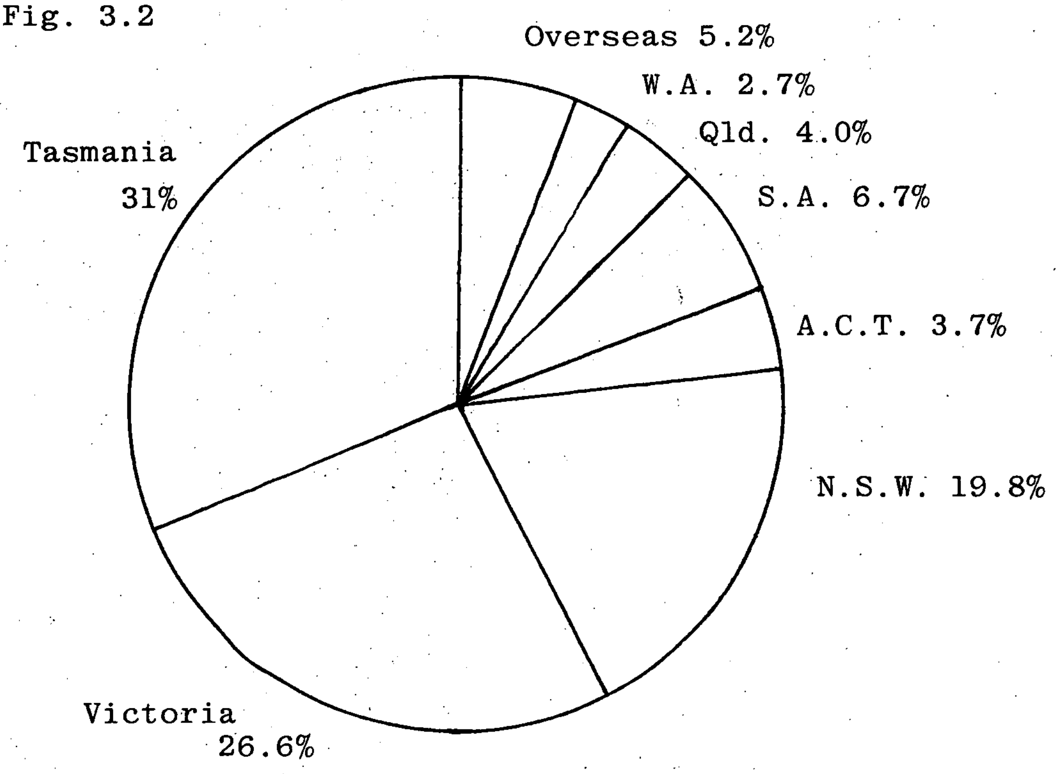

Overland
walkers 52%
Non-walkers
8%
Daywalkers
40%

Fig. 3.2


Overseas 5.2%
W.A. 2.7%
Qld. 4.0%
S.A. 6.7%
A.C.T. 3.7%
N.S.W. 19.8%
Victoria
26.6%
Tasmania
31%

walked the overland track or spent 2 to 3 nights camping within the backcountry areas of the park. Forty per cent were persons who tramped along the daywalk routes around Cradle Valley and Cynthia Bay. Of these, only 5% were day visitors. Thus, the overwhelming majority of day-walkers had spent at least one night in the park. The remaining 8% of respondents included sightseers, picnickers and other non-walkers, (Fig. 3.1).

Fifty-one per cent of those surveyed arrived in their private cars, whilst another 15% were in hired cars. One-fifth of the respondents journeyed from Devonport to the Cradle Valley in a private bus operated by Mr. D. Maxwell, his clients being interstate and overseas residents. In short, all visitors arrived in this park in motorized road vehicles.

3.5 RESIDENCE:

Sixty-four per cent of the respondents were interstate visitors, 31% were Tasmanians and 5% were from overseas.

Amongst the Tasmanians, the highest proportion (37%) came from Hobart and its surrounds, followed by visitors from the North West Coast (34%) and 15% from the Launceston area.

On-site and household surveys of visitors to other parks and reserves in Tasmania (Hazelwood 1978, R.L.U.S. 1979) have indicated that the travelling time to and from recreational destinations in private cars is an important factor affecting the level of usage, the frequency of use, and the length of stay of visitors. The R.L.U.S. Outdoor Recreation Participation Survey showed that in the majority of cases, where the return travelling time exceeds four hours, visitors were inclined to stay overnight. Periods of peak usage therefore coincided with weekends and public holidays, with 63% of Tasmanian respondents arriving in the park on Fridays and Saturdays. Furthermore, 76% of the day-tripper respondents were residents of the North West District, which is only 1-2 hours from Cradle Valley.

Of the interstate visitors, 39.0% were from Victoria, 34.2% from New South Wales and the A.C.T., 6.7% from South Australia, 4% from Queensland and 2.7% from Western Australia. Figures collated by the Department of Tourism Visitor Survey for the year ending June 1979, show that 49.2% of visitors were from Victoria, 25.6% from N.S.W./A.C.T., 8.4% from S.A./N.T., 7.1% from Queensland, 3.9% from W.A. and 5.8% from overseas (Fig.3.2). Thus the pattern of visitation to the park reflects the general pattern of interstate arrivals. A survey conducted by the Tasmanian Tourist Council in 1977 revealed that Cradle Mountain was only exceeded by Port Arthur as a tourist destination in this State. Therefore, it is not surprising that 7 out of every 10 walkers on the overland track were normally resident outside Tasmania. Tasmanians only accounted for 20% of the overlanders, the remaining being visitors from overseas. An absolute count of all registered walkers on the overland track for the season 1978-79, verified the above survey results. In contrast, the proportion of Tasmanian daywalkers was 42% while the interstate and overseas users accounted for 58%.

3.6 DEMOGRAPHIC CHARACTERISTICS

3.6.1 Sex:

Sixty-three per cent of the total number of visitors sampled in the Cradle Mountain - Lake St. Clair National Park during the 1978-79 season were males while 37% were females.

3.6.2 Age (Table 3.2):

The majority of respondents (58.4%) were in the 18-40 years age bracket, with another 25% below 17 years of age. When compared with the population age structure of Australia, it is evident that 18-24 years of age group is well over-represented. Given that 32.7% of Australia's population were aged below 17 years in 1976 and in view of increasing emphasis on outdoor recreation in schools, through programmes like "Life Be in It" and orienteering, the potential park user population may increase substantially in the next decade.

All age groups were represented in each of the user groups. However, the proportion varied between the more strenuous overland track and the daywalk routes around Cradle Valley and Cynthia Bay. The middle-aged

TABLE 3.2

AGE DISTRIBUTION OF RESPONDENTS COMPARED WITH AUSTRALIA'S POPULATION

Age groups (yrs)	Respondents	Absolute %	Australia
0-11	0.2	7.3	18.0
12-17	3.3	19.5	14.7
18-24	32.0	29.7	9.6
25-40	43.9	28.7	21.4
41-65	20.2	13.6	25.4
65-	0.4	0.9	8.9
	n=493	N=2034	n=13.5 million

TABLE 3.3

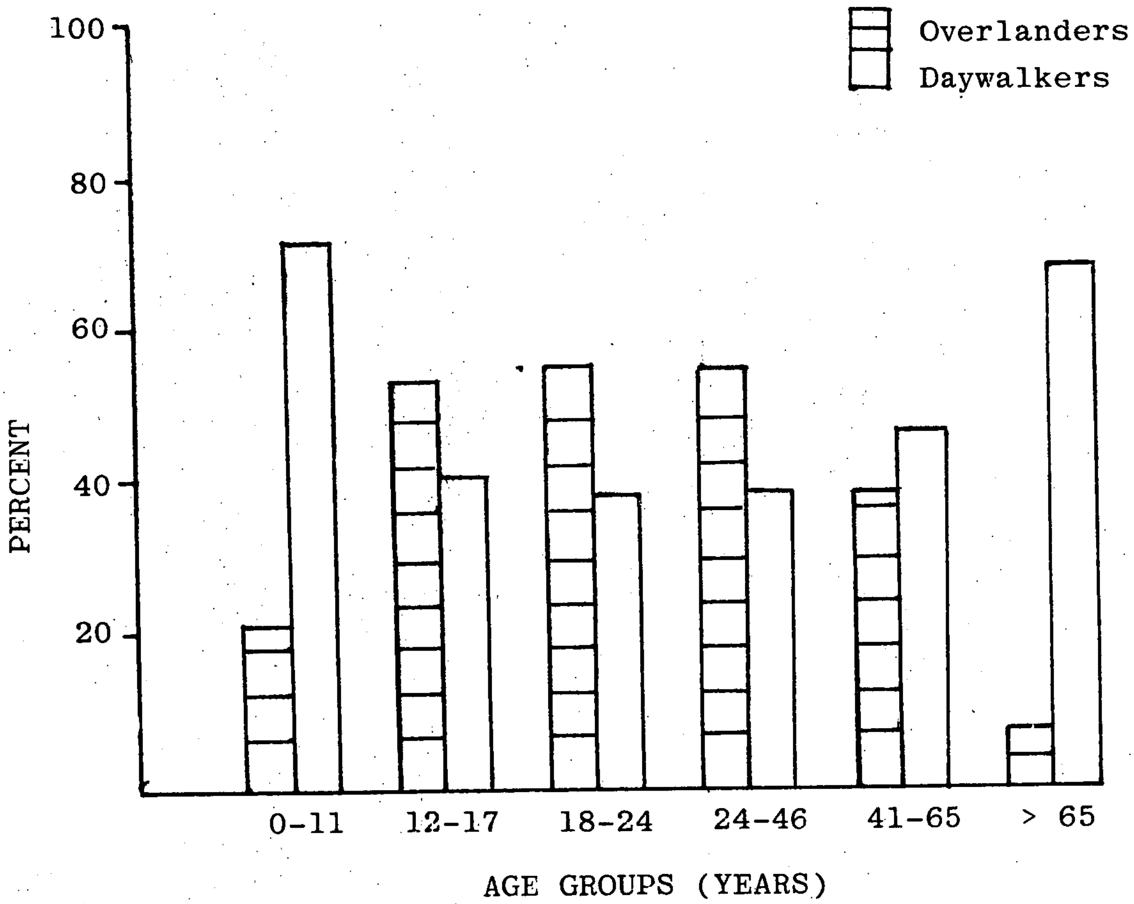
EDUCATIONAL ATTAINMENT OF RESPONDENTS

Education	%
(a) High school or below	16.6
(b) Matriculation	9.5
(c) Technical education	11.8
(d) Tertiary (university/college)	60.9
(e) Other	1.3

Fig. 3.3

RELATIONSHIP BETWEEN AGE CLASSES AND USER GROUPS

Fig. 3.3


Overlanders
Daywalkers
100
80
60
40
20
PERCENT
0-11
12-17
18-24
24-46
41-65
> 65
AGE GROUPS (YEARS)

groups constitute the majority of overlanders, whilst the younger and older age groups have a higher representation in the daywalk activities (Fig.3.3).

3.6.3 Marital Status:

Fifty-one per cent of the respondents were single and 44% were married, the remaining being divorced, widowed or separated.

3.7 SOCIOECONOMIC CHARACTERISTICS

3.7.1 Education (Table 3.3):

Sixty-one per cent of respondents had attained or were in the process of obtaining tertiary qualifications. In terms of educational attainment, these 61% of the sample would come from the most highly educated 4.4% of Australia's population (A.B.S.1976). However, it may also be argued that persons with tertiary education would be more motivated to respond to self-administered questionnaires of this length, and hence, there may be a certain amount of bias in these results.

The results of this survey concur to a large extent with the findings of an Australia wide survey (Age Poll November 1979). This nationwide poll revealed that up to 49% of those partaking in bushwalking were University educated. Similarly, studies in America, Hendee *et al* (1968); ORRRC (1963); and Stankey (1978), concluded that wilderness and park users were a special group in that most of them had tertiary qualifications.

TABLE 3.4

OCCUPATION OF RESPONDENTS AS RELATED TO THE TYPE OF ACTIVITY UNDERTAKEN IN THE PARK

Occupation	Overlanders	Daywalkers	Others	Total Percentage
Professional	53.4	41.3	5.3	44.6
Administrative	31.9	54.5	13.6	4.8
Clerical	43.5	39.1	17.4	5.0
Sales Workers	47.1	41.2	11.8	3.7
Farmers	30.0	70.0	0	2.2
Miners	40.0	60.0	0	1.1
Transport Workers	42.9	42.9	14.3	3.0
Tradesmen	40.5	50.0	9.5	9.1
Service Workers	72.7	18.2	9.1	2.4
Armed Services	66.7	33.3	0	0.6
Tertiary Students	75.9	22.4	1.7	12.6
1° & 2° Students	47.4	36.8	15.8	4.1
Home duties	20	80	0	2.2
Unemployed	80	10.0	10.0	2.2
Pensioners	11.1	55.6	33.3	0.6
Others	66.7	54.4	0	0.9

3.7.2 Occupation:

With such a high proportion of bushwalkers having attained tertiary qualifications, it is not surprising that a substantial majority of respondents were professionals or persons with administrative, executive and managerial skills. The next biggest group were students currently enrolled in tertiary institutions. Blue collar walkers only accounted for 12.1% of those surveyed.

By cross-tabulating the user groups and occupational status, it is evident that nearly half of the overlanders had achieved professional occupational status, and another 22% were students with potential professional status (Table 3.4). The skilled and semi-skilled tradesmen accounted for only 9% of respondents. Amongst the daywalkers, the proportion of blue collared workers increases to 14%.

3.8 SPATIAL AND TEMPORAL DISTRIBUTION OF VISITORS

The determination of numbers and the distribution of people in a park forms an integral part of any recreational survey. This has been achieved in the past by the use of mechanical recorders or by personal counting. These methods provide only the absolute number of people passing through a point in a specific time period. They do not, however, provide data on the patterns of movement of people through an area.

In this survey, data collected included the length of stay of visitors, the type of accommodation used whilst in the park and the walking routes used by visitors. A considerable amount of the above information was obtained from questionnaire maps (Appendix 3). This method of investigation, which incorporates a map of an area and any appropriate questions related to visitor behaviour was first introduced by Goldsmith *et al* (1970) in their study of recreational impact on the ecology and amenity of semi-natural areas in the Isles of Scilly.

Respondents were asked to identify on the attached maps, the walking routes used by their parties. In the case of the overlanders, they were requested to indicate their overnight camping areas and length of stay at each of the camping sites. From these maps, the following data were obtained:

(a) the spatial distribution of visitors to the park;
(b) the location of camping areas;
(c) user frequency in areas beyond the marked routes.

3.8.1 <u>Length of Stay</u>:

Only 10% of the respondents were day trippers. The length of stay of the remaining respondents varied between one night and two weeks, depending on their types of activities.

TABLE 3.5

LENGTH OF STAY IN THE PARK OF THE

DIFFERENT USER GROUPS

Nights	Overlanders	Daywalkers	Others
1	0	22.4	73.3
2-3	6.7	56.9	26.7
4-5	19.7	16.7	0
6-7	41.3	2.3	0
8+	32.8	1.7	0

Seventy-three per cent of the overland bushwalkers spent more than six days in the park (Table 3.5). Of these, 32% spent up to 8 days or more in the backcountry and wilderness areas. Analysis of the questionnaire maps suggest that, in general, walkers spent 4 or 5 days camped in the backcountry areas with one day at either one of the entrances.

Fifty-seven per cent of daywalkers stayed for 2 or 3 nights in the park, whilst persons who participated in activities other than hiking were more inclined to only seek overnight accommodation in the park. Day-trippers, consisting mainly of car-based sightseeing parties, stay between two hours and one day in the park (Dutton 1979).

3.8.2 Accommodation:

Respondents were asked to indicate the types of accommodation they used during their stay in the park. Sixty-three per cent of the bushwalkers had either camped in their tents or stayed in one of the huts provided along the overland track. Twenty-eight per cent had relied on the shelter huts for accommodation while walking the overland track, and only 9% used their tents throughout their stay in the park.

The majority of daywalkers sought accommodation in the chalets serviced by the N.P.W.S. Twenty-three per cent used tents and 12% stayed in their caravans. Both the latter groups were camped in the unofficial camping area adjacent to the old sawmill site at Cradle

TABLE 3.6

DISTRIBUTIONS OF OVERNIGHT STOPOVER LOCATIONS
ALONG THE OVERLAND TRACK

Location	n	% of Overlanders
Cradle Valley	115	45.3
Crater Lake	3	1.2
Kitchen Hut	45	17.7
Ranger Hut	9	3.3
Scott-Kilvert Hut	45	17.7
Waterfall Valley Hut	87	34.2
Cirque Hut	62	24.4
Lake Will / Lake Holmes	6	2.4
Windermere Hut	138	54.3
Pelion Creek	24	9.4
Frogs Flats	9	3.5
Old Pelion Hut	63	24.8
New Pelion Hut	130	51.2
Pelion Gap	6	2.4
Pinestone Creek	3	1.2
Kiaora Hut	87	34.2
Ducane Hut	90	35.4
Ducane Gap	4	1.6
Windy Ridge Hut	95	37.4
Pine Valley Hut	84	33.1
Narsiccus Hut	105	41.3
Echo Point Hut	71	27.9
Lake Petrarch	3	1.2
Shadow Lake	1	0.4
Cynthia Bay	156	61.4
Others	20	7.9

Valley. The remaining daywalkers found accommodation at the only private motel - Pencil Pine Lodge at the Cradle Valley entrance and the Blanfordia Lodge - the only private accommodation concession in the park.

An analysis of the location of overnight stop-over sites of the respondents along the overland track is provided in Table 3.6. It is evident from the table that:

(i) the majority of overland parties had either camped or stayed overnight in areas designated as shelter huts on the Cradle Mountain - Lake St. Clair Overland Track Map (Appendix 1);

(ii) the high proportion of overnight campers in certain areas suggests that the majority of walkers adhere to the walking plan proposed by the N.P.W.S. on the map of the National Park. For example, most of the walkers stopped over-night at:

(a)	Waterfall Valley Hut or Cirque Hut	58.6%
(b)	Windermere Hut	54.3%
(c)	New Pelion or Old Pelion	76.0%
(d)	Kiora or Ducane	69.6%
(e)	Windy Ridge and/or Narcissus	78.7%

(iii) nearly all the parties surveyed had spent a night at either one of the two entrances to the park - Cynthia Bay or Cradle Valley;

(iv) only a small percentage of walkers surveyed had camped in non-designated camping areas;

(v) a relatively high proportion of respondents and their parties camped in the vicinity of Kitchen Hut, even though it is designated as an emergency rather than a shelter hut.

Areas where parties were more likely to spend more than one day were the Cradle Valley, the Pelion Plains and the Labyrinth. All these areas provided added attractions to the campers. Included amongst these were the variety of daywalk routes radiating out from Cradle Valley, the spectacular mountains in the Pelion area, and the magnificent glacial lakes and tarns on the Labyrinths. The other incidental factors which may have caused parties to remain longer at any of the camping areas were exhaustion, injury or bad weather.

3.8.3 <u>Walking Routes</u>:

For the purposes of this section, walkers have been classified into three categories.

1. The overlanders. This describes those respondents who traversed the length of the Cradle Mountain - Lake St. Clair Overland Track.

2. The second group consists of those who spend 2-3 days camping in the backcountry areas, but do not

tramp the length of the overland track. In previous analyses, walkers in this group were included in the broader category of overland bushwalkers.

3. The third group is the daywalkers or hikers. This describes those walkers who stayed in the developed areas at Cynthia Bay and Cradle Valley and walked from their bases each day.

Only a small proportion, 11.2%, of the overlanders departed from Cynthia Bay enroute to Cradle Valley. The north-south route is undoubtedly favoured because it is downhill for most of the way.

Fifty-seven per cent of the overlanders walked through the park without any deviations from the main thoroughfare. Of the destination loci off the overland track, Pine Valley and its surrounds was the most popular, followed by Lake Will. Thirty-two per cent of overlanders surveyed visited the Pine Valley area whilst another 10% visited Lake Will. Only six per cent of walkers included both Pine Valley and Lake Will on their itinerary.

Amongst those 2-3 day backcountry walkers using Cradle Valley as a base, Lake Rodway was the most popular destination, followed by Waterfall Valley. Walking times from Cradle Valley to Rodway, Waterfall Valley and Cirque Hut are in excess of 8 hours return. With the added attractions of Lake Rodway, Cradle Mountain, Barn Bluff and the

TABLE 3.7

FREQUENCY OF USE OF THE DAYWALK

ROUTES IN THE CRADLE MOUNTAIN AREA

Routes	Frequency	Distance ret.(km)	Average time(km)
Waldheim - Crater Lake - return	28	3.5	2
Lake Lilla	23	3	2
Hounslow Heath	22	6.5	3
Waldheim - Cradle Mt. - return	17	13	7
Weindorfers	17	2	2
Dove Lake - Ballroom Forest return	15	5	2
Dove - Lilla - Crater Falls - return	15	6	3
Waldheim - Crater Falls - Wombat Tarn - return	14	4.5	2.5
Dove - Hanson's - Face track - Ballroom	14	10	5
Dove - Mt. Campbell - return	13	3	1.5

Waterfall Valley itself, a typical journey would encompass camping overnight at Lake Rodway, climbing Barn Bluff the following day and either camping at Waterfall Valley or the Cirque Hut and returning to Cradle Valley after conquering Cradle Mountain. The survey shows that the furthest south ventured by walkers in this group is Lake Will. Of those departing from Cynthia Bay, 45% headed towards Pine Valley, with about 18% tramping further to Pelion Gap via Mt. Gould and Pine Valley. The drawcard of the Pelion region is Mount Ossa, the highest in the State.

Table 3.7 indicates the frequency of use, in order of priority, of the various walks from the Cradle Valley area, their distances in kilometres and the walking times. The most popular walks appear to be those in the sub-alpine areas, all below 1050m in altitude, with walking times not exceeding 3 hours return and distances not exceeding 5kms.

3.8.4 Mountaineering (Table 3.8):

Three in five of parties who either walked the overland track or spent 2-3 days in the backcountry areas, climbed at least one mountain in the park. The highest mountain in Tasmania, Mount Ossa (1617m) was attempted by one out of two of these mountaineering parties, followed by Cradle Mountain and the Labyrinth. However, in terms of absolute usage, Cradle Mountain would have much higher visitation figures since it is within a few hours walk from Cradle Valley and the temporal analysis

TABLE 3.8

USER INTENSITY ON SOME OF THE MOUNTAINS IN THE CRADLE MOUNTAIN - LAKE ST. CLAIR NATIONAL PARK IN THE YEAR 1978-79

Mountain	Number of Walkers
Cradle	2174
Ossa	1121
Barn Bluff	507
Labyrinth	399
Pelion East	305
Mt. Oakleigh	177
Mt. Pelion West	133
Mt. Gould	44
Little Horn	24

of the daywalk notes indicates that 30% of daywalkers surveyed climbed the summit of Cradle Mountain.

3.8.5 Traffic Intensity by Routes (Figs.3.4 and 3.5):

Data collated from the questionnaire maps were used to determine the relative pressures on the walking tracks of this park.

To calculate the absolute number of users on the tracks, the numbers in each of the three walker groups as gauged from the registration books were multiplied by 100 over the percentage in the sample, and a cumulative total was obtained from the three walker groups.

The heaviest traffic was concentrated on the main route leading from Waldheim into the backcountry areas. This track passes over the saddle between Crater Lake and Lake Lilla, up and across the Cradle Plateau, and beyond Kitchen Hut, with varying user intensity ranging from 3700 along the Plateau and greater than 5500 people at Kitchen Hut and in the vicinity of Waldheim. It is of interest to note the dramatic increases in user intensity at track junctions. The impact of this increase in intensity on the vegetation and soils will be discussed in a later section. It is also apparent that the spatial distribution map correlates positively with the popularity of the various daywalk tracks mentioned in the previous section.

Beyond the Kitchen Hut area, the high user intensity continues along the Fury Gorge up to the turnoff

Fig. 3.4

SPATIAL DISTRIBUTION OF WALKERS ALONG THE OVERLAND TRACK

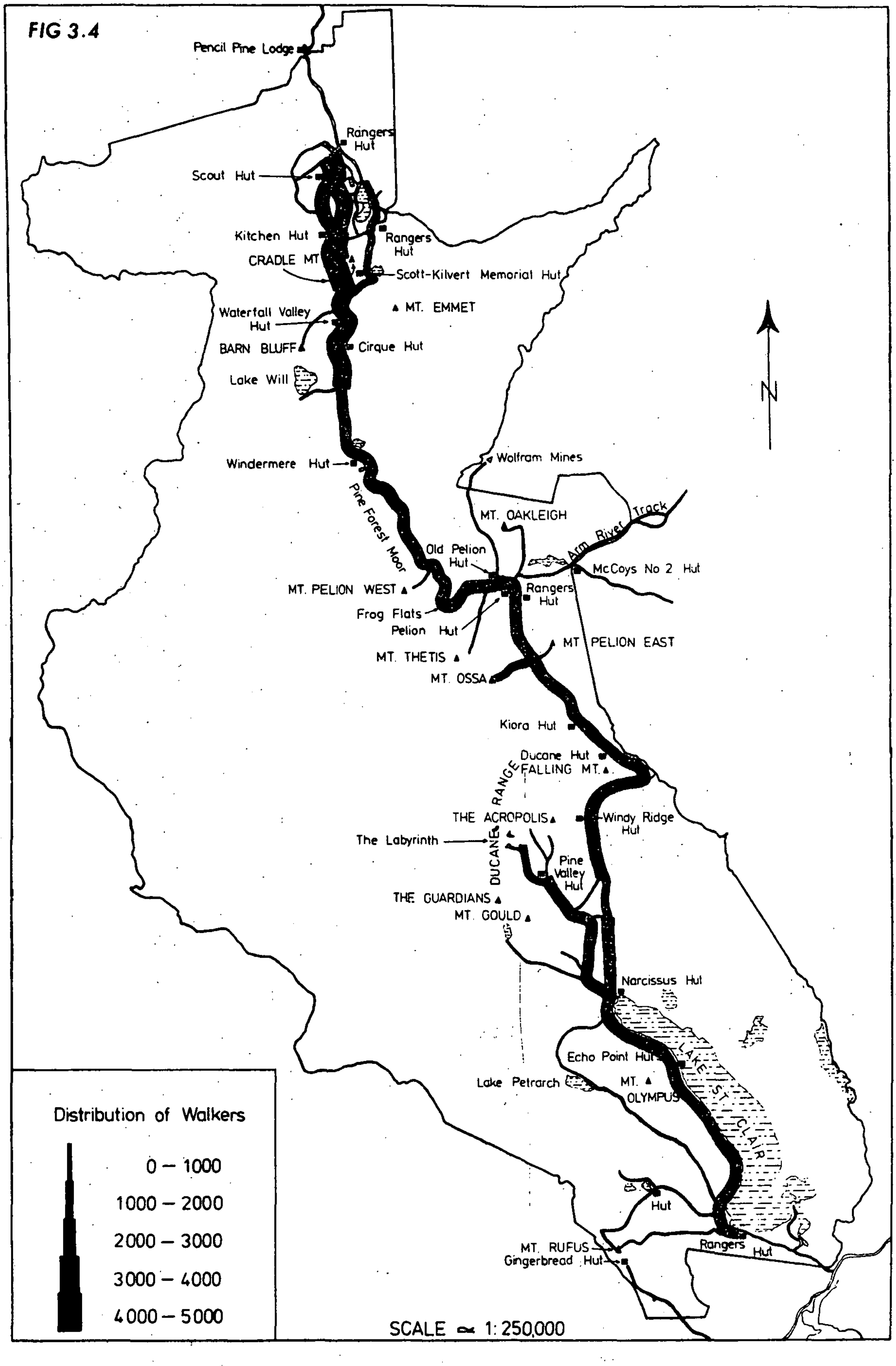
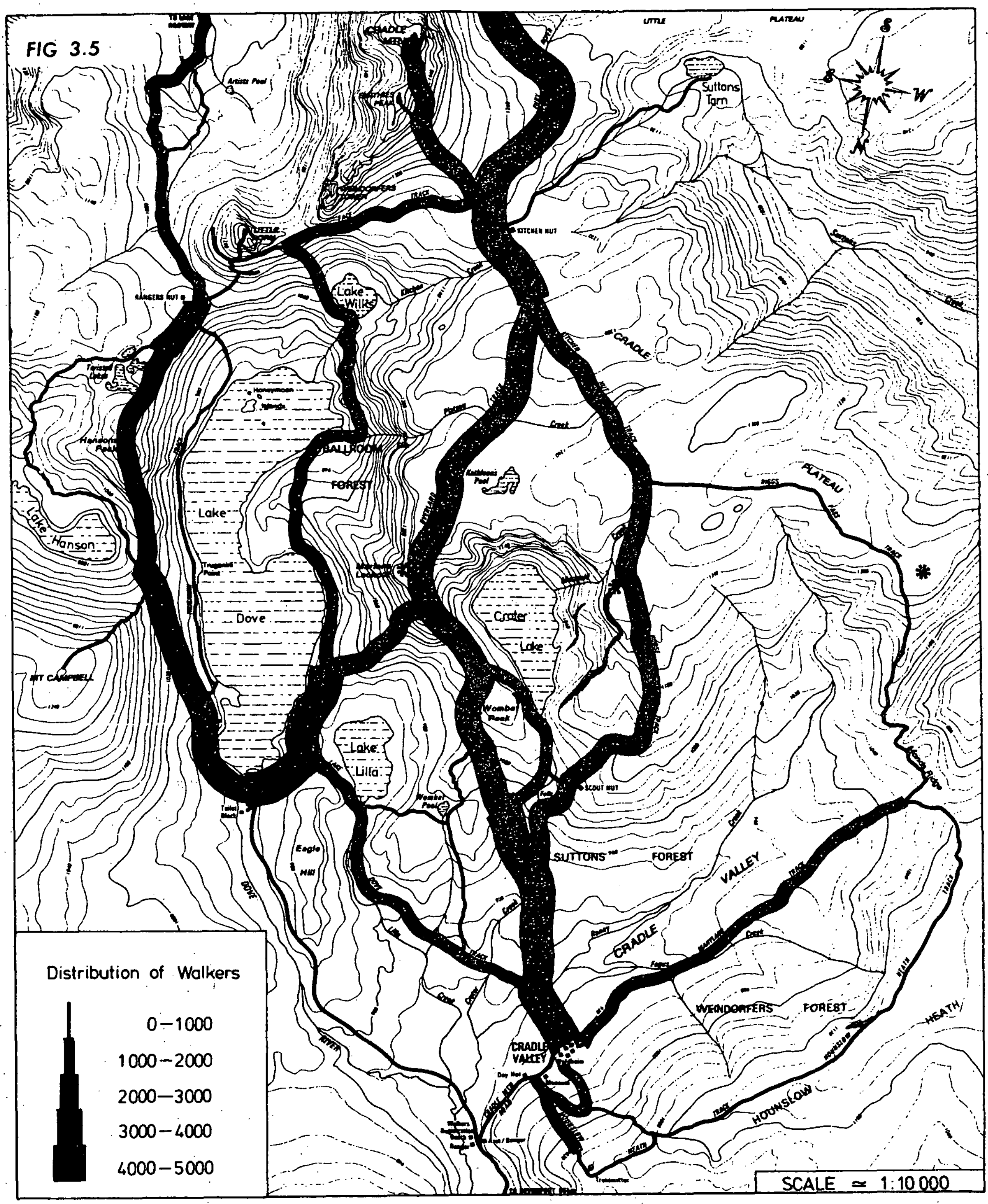


FIG 3.4
Pencil Pine Lodge
Rangers Hut
Scout Hut
Kitchen Hut
Rangers Hut
CRADLE MT
Scott-Kilvert Memorial Hut
MT. EMMET
Waterfall Valley Hut
BARN BLUFF
Cirque Hut
Lake Will
Windermere Hut
Pine Forest Moor
Wolfram Mines
MT. OAKLEIGH
Arm River Track
Old Pelion Hut
McCoys No 2 Hut
MT. PELION WEST
Rangers Hut
Frog Flats
Pelion Hut
MT. THETIS
MT. PELION EAST
MT. OSSA
Kiora Hut
Ducane Hut
FALLING MT.
DUCANE RANGE
THE ACROPOLIS
Windy Ridge Hut
The Labyrinth
Pine Valley Hut
THE GUARDIANS
MT. GOULD
Narcissus Hut
Echo Point Hut
LAKE ST. CLAIR
Lake Petrarch
MT. OLYMPUS
Hut
MT. RUFUS
Gingerbread Hut
Rangers Hut
N
Distribution of Walkers
0 – 1000
1000 – 2000
2000 – 3000
3000 – 4000
4000 – 5000
SCALE ≃ 1: 250,000

Fig. 3.5

SPATIAL DISTRIBUTION OF WALKERS ALONG THE DAYWALK ROUTES IN THE CRADLE VALLEY AREA

FIG 3.5


Distribution of Walkers
0–1000
1000–2000
2000–3000
3000–4000
4000–5000
SCALE ≃ 1:10 000
Suttons Tarn
Lake Wilks
Lake Dove
Lake Hanson
Crater Lake
Lake Lilla
Dove
BALLROOM FOREST
Wombat Peak
Hansons Peak
MT CAMPBELL
SUTTONS FOREST
CRADLE VALLEY
WEINDORFERS FOREST
HOUNSLOW HEATH
PLATEAU
KITCHEN HUT
SCOUT HUT
Eagle Hill
CRADLE

turnoff to Lake Rodway at the Cradle Cirque. The numbers tapered off beyond this point to 3191 at Cirque Hut and 2171 past the junction of the overland track and the track to Lake Will. This point also marks the common boundary for most of the 2-3 day back-country walkers.

Track usage close to the developed areas of Cradle Valley and Cynthia Bay may be under represented. Specifically, these include:

(i) the track from the Dove Lake car park up to the saddle between Hanson's and Dove Lakes;
(ii) the Lake Lilla Track;
(iii) Weindorfers Track;
(iv) Watersmeet Track.

All these tracks are heavily used by day visitors, in particular, young families and the more elderly. Two factors could be attributed to this under-representation: firstly, all the above walks are of a short duration, and secondly, the absence of registration facilities at the car parks at Dove Lake and Waldheim.

Another region where the usage may be under-represented are the tracks leading to the Pelion Plains - the Arm River and the Wolfram Mine Tracks. Again during the period of the survey, there were no registration facilities at either of the two tracks.

The accuracy of this method of calculation of population pressures is highlighted by the relatively small variation between the calculated figure of average user intensity for the overland track (approximately 2150) and that provided by N.P.W.S. from their registration books (2233).

3.9 VISITOR PERCEPTION OF PARK FACILITIES

Any form of recreational activity will be detrimental to the natural environment. The extent to which the damage is noted is dependent, however, on how the visitor or park manager perceives the concept of damage or degradation of the natural environment. This may be influenced by the visitor's background and personality as well as factors like site conditions. It is common knowledge that in the past, management practices have been developed based solely on the park manager's perception of damage. But studies have shown that visitors and park managers relate to damage and impact in different ways.

"Each group has different responsibilities, different backgrounds and viewpoints, different objectives and different time perspectives" (Lucas 1979). He concluded that unlike park managers, visitors have a tendency to relate mainly to individual sites rather than the large management units.

Visitors were asked which features of the park they enjoyed most (Appendix 4). The vast majority of respondents rank the scenery of the park as the most enjoyable feature, followed by openness and quietness of the park environment. Eleven per cent of visitors rank all the features as equally enjoyable. No respondents indicated that they were dissatisfied with the park and that their stay was not enjoyable.

A similar study, but one where the majority of respondents were day-trippers (Dutton 1979) revealed that the general scenery was ranked the single most important attraction of this area. Accordingly, it is suggested that the park's natural scenic beauty and the solitude it affords constitute the major attractive features which contributed to visitor enjoyment.

Conversely, respondents were asked if any of the given factors may have detracted from their enjoyment of the park. The overall visitor reaction to this question was very encouraging. With the exception of two factors, the majority of visitors did not notice any of the possible conditions which might have reduced their enjoyment of the park (Appendix 4).

The two factors which the majority of respondents complained about were the poor state of walking trails and the amount of litter in the park. Thirty-three per cent of respondents believed that the poor track conditions reduced their enjoyment of the park, whilst 22% stated that the amount of litter detracted from their enjoyment of the park.

TABLE 3.9a

RESPONSE OF USER GROUPS TO TRACK CONDITIONS

User Group	Did not Notice	Noticed	Reduced Enjoyment	Don't Know
Overlanders	17.1	36.7	44.5	1.6
Daywalkers	41.0	35.0	23.8	0.2
Non-walkers	10.4	1.9	2.0	87.7

TABLE 3.9b

RESPONSE OF USER GROUPS TO THE AMOUNT OF LITTER IN THE PARK

User Group	Did not Notice	Noticed	Reduced Enjoyment
Overlanders	32.1	34.0	32.9
Daywalkers	67.7	23.7	8.6
Non-walkers	76.5	8.8	14.7

Tables 3.9 a and 3.9 b show how the different user groups perceived the track conditions and litter problems respectively. Four out of five overland track parties noticed the poor tracks. Forty-five per cent of the overland parties complained that the poor physical conditions of the tracks had reduced their enjoyment of the park. The percentage of daywalkers complaining about the tracks was lower but nonetheless, 60% of them noticed the poor tracks. Because of their limited forms of activity in the park, the day-trippers were in general non-commital about these questions.

The results also show a marked sensitivity of overlanders to the litter problem in the backcountry areas. One in three parties surveyed remarked that littering along the overland track and in particular at the Kitchen, Windemere, Pelion and Narcissus Huts, affected their appreciation of the park environment. On the other hand, only 8% of daywalkers complained about the litter problem.

The dissatisfaction with the above two factors is strongest among the overland bushwalkers in areas where the supervisory and operational role of Ranger staff is minimal.

Two questions which may provide a cursory insight on the social carrying capacity of the Cradle Mountain - Lake St. Clair National Park were included in the questionnaire. Respondents were asked if they noticed large parties and crowded campsites and whether these factors caused any reduction in their enjoyment of the park.

It is apparent that the overland bushwalkers were the only group which indicated their resentment of large parties on the track. Forty-seven per cent of this user group had noticed the large parties and one in four of these respondents were dissatisfied with the large parties. Specifically, a number of comments were made on the presence of large school groups from interstate whose sizes varied between 25 and 48. The major complaints were the lack of solitude, cramped camping grounds and the associated litter and noise problems.

The above information, although inadequate to form the basis of determining an appropriate social carrying capacity does however highlight the existence of a problem.

There was overall satisfaction with the design and size of the campsites with only 8% of the overlanders suggesting that crowded campsites were a problem.

3.9.2 Facility Improvements

Respondents were asked the question "Do you feel that it is necessary to carry out further

TABLE 3.10

PERCENTAGE OF RESPONDENTS WHO FELT THAT THESE FACILITIES REQUIRE IMPROVEMENT

Facilities	% Agree
Walking trails	69.7
Signs	46.8
Camping facilities at Cradle Mt.	45.9
Litter disposal	43.1
Information centres	32.3
Huts - facilities and information	32.2
Toilets	30.0
Day visitor facilities	19.5
Rangers on tracks	19.5
Picnic areas	16.7
Commercial services	20.7

improvements to facilities in this park?". Eighty-two per cent of the respondents believed that further facility improvements were necessary in comparison with the 18% who felt that there was no need for any more developments or improvements.

A summary of visitor response to facility improvement within the park is provided in Table 3.10.

It is not surprising to find that 70% of those surveyed were of the opinion that the walking trails required upgrading. Eighty-one per cent of overlanders expressed their support for immediate track improvements. Likewise a majority of daywalkers (55%) registered the same request.

The analysis also highlighted walkers' dissatisfaction with signs currently located along tracks. This dissatisfaction was strongest amongst the daywalkers, with 57% of them indicating their support for improved signs. At present in the Cradle Valley area, sign-posting is concentrated at two focal points: the junction of the overland track and the top end of the Lake Lilla track and the junction of the tracks to the Ballroom Forest and the southern end of the Lake Lilla track. Other signs are located in obscure positions and/or are in a deteriorating state. On the other hand, a complete directory of signs is located at the start of the tracks at Cynthia Bay.

Hendee *et al* (1968) in their study of wilderness in the Pacific Northwest, found that "eight out of ten respondents disagreed that signs should be grouped into a single directory of all routes eminating from one trail-head, with no further signs along the various trails". Instead, the majority preferred signs at trail junctions.

Another facility which requires immediate improvement is the camping ground at the Cradle Mountain entrance area. It is commonly agreed that the current camping facilities here are one of the worst in the State (see Plates 3.1). During periods of heavy rainfall, the camping ground gets flooded, and on a number of occasions, the Ranger Staff have had to rescue campers from the raging floodwaters (Dwyer *pers comm*). Fifty-eight per cent of daywalkers and 67% of daytrippers felt that the camping ground should be improved. The development of a camping ground with the basic amenities like toilets and showers, and fireplaces would have the additional advantages of relieving the pressure of the N.P.W.S. huts at Cradle Valley and reduce unauthorised camping in the delicate alpine and subalpine environments close to this entrance. Visitors were generally satisfied with the camping and caravan facilities at Cynthia Bay.

One in three parties surveyed felt that an information centre was required, and this expression was strongest amongst the daywalkers and day-trippers - 45% and 55% respectively.

The museum at Cradle Valley is the only formalised information and interpretation centre in the park. It is, however, in an urgent need of repair and upgrading.

Plate 3.1 : The present camping area in Cradle Valley, adjacent to the Dove River and the Old sawmill site.

Plate 3.1

Forty-one per cent of the overlanders were of the opinion that the insulation and facilities of huts along the track should be improved. It was apparent from the general comments made that the huts at Lake Rodway, Pelion, Kiaora and Ducane required upgrading, with the complaints ranging from smoky fireplaces to inadequate maintenance of the huts.

Overall there was general satisfaction with the toilet facilities in the developed zones as well as the backcountry areas.

With the exception of the toilets, day visitor facilities in the Cradle Valley area are of a poor standard. One in three daywalking parties and 60% of day-trippers were dissatisfied with the facilities. The only facilities at present are a few picnic tables and a day hut. Numerous remarks were made about the smoky fireplaces and the congestion within the day hut.

Most of the respondents expressed satisfaction with the current commercial services and the ranger staff level on the overland track.

3.10 ATTITUDES TO MANAGEMENT ALTERNATIVES

The data subsequently presented in this section identify the attitudes of those surveyed to a number of management options for the Cradle Mountain - Lake St. Clair National Park. The options have been defined under the following titles:-

(a) exploitation of natural resources;

(b) tourist and commercial development;

(c) public access;

(d) public education;

(e) restrictions on use.

3.10.1 Exploitation of Natural Resources

Respondents were asked whether they would support or oppose the exploitation of timber resources in the park and the introduction of mining activities within the reserve. As Table 3.11 indicates, the overwhelming majority of respondents strongly oppose any of the above exploitative activities in the park.

3.10.2 Tourist and Commercial Development

Visitors were asked the following:-

"Do they oppose or support the introduction or expansion of the following facilities in the park?" (Table 3.12)

A clear majority of backcountry users including 2-3 day walkers were opposed to any form of tourist development and the construction of any private holiday shacks within the National Park. Respondents, however, appear to be evenly divided on the establishment of caravan and camping sites. An analysis of user group types showed that this result was consistent with previous visitor responses, with a clear majority of daywalkers and day-

TABLE 3.11

ATTITUDE OF RESPONDENTS TOWARDS EXPLOITATION OF NATURAL RESOURCES WITHIN THE PARK

Activities	Support	Neutral	Oppose
Logging	0.4	1.0	98.5
Mining	0.6	0.8	98.5

TABLE 3.12

ATTITUDE OF RESPONDENTS TOWARDS TOURIST AND COMMERCIAL DEVELOPMENTS

Activities	Support	Neutral	Oppose
Commercialisation	4.6	6.5	88.9
Hotels, Motels	5.2	2.7	92.1
Private holiday shacks	2.3	2.5	95.2
Kiosks and petrol stations	16.2	13.7	70.1
Caravan park	28.8	20.0	49.2

TABLE 3.13

ATTITUDE OF RESPONDENTS TOWARDS A NUMBER OF ACCESS OPTIONS

Access Options	Support	Neutral	Oppose
Airfields	5.6	5.6	88.7
Expansion of roads	7.7	4.2	87.1
Sealing road	37.0	15.4	47.6

trippers in support of improved camping facilities. The results of this questionnaire strongly suggest that visitors who arrive in the Cradle Mountain - Lake St. Clair National Park with the intention of indulging in hiking or bush-walking activities would prefer its wilderness and semi-wilderness environment rather than one which caters for the demands of ordinary motorised tourists.

3.10.3 Public Access

The question of improved access to the National Park in particular through its northern entrance has attracted a great deal of public comment in the media over the past two years. The Mersey-Forth Tourist Development Committee has argued for the sealing of the road to the entrance of the National Park; expansion of vehicular tracks from Cradle Valley through to Cynthia Bay, and the development and upgrading of a public airfield in or adjacent to the National Park (D.M.R. 1979). Consequently, visitors were asked to comment on the above access options (Table 3.13).

Respondents and their parties were vehemently opposed to:

(i) any expansion of vehicular roads in the park; and
(ii) the construction of an airfield.

A high percentage of respondents were opposed to the sealing of the road. It is of interest to note that while a majority of overland bushwalkers were opposed to sealing the road, the daywalkers were evenly divided over this issue, and 65% of the day-trippers were in favour of sealing the road. Dutton (1979) in his survey of visitors, of whom the majority were day-trippers, found that only 30% of his respondents (n = 762) were in favour of sealing the road.

Furthermore, visitors arriving in cars, both private and hired, were more likely to oppose the upgrading and sealing of the main access route to the Cradle Mountain area. The strongest support for the sealing of the road was from visitors arriving on motorcycles. The grit, dust and slippery condition of the gravel surface road may have induced these visitors to support the sealing of the road.

In arriving at any decision to seal the Cradle Mountain Road, the implications of increased visitor impact on the natural environments of the National Park and a probable increase of demand for park facilities would have to be carefully considered.

An Environmental Impact Study was undertaken by the Department of Main Roads on the proposed sealing of the Cradle Mountain Road, and the Department suggested a number of alternatives. These include:

(i) maintain the present gravel road;

(ii) upgrade the section from Leary's Corner to Pencil Pine Creek;

(iii) seal from the Celtana turnoff to Weaning Paddock Creek; and

(iv) seal as (iii) but extend to Pencil Pine.

The Department of Main Roads in its report dated September 1978, recommended the sealing of the road from the Celtana turnoff to Leary's Corner. However, their consideration of visitor attitudes and the problems that would result from sealing were cursory.

3.10.4 Public Education

Visitors were asked if they favoured the introduction of field interpretation facilities, in addition to the visitor information centre. Reaction to the latter has been documented previously. In the case of nature trails and guided bushwalking tours, the reaction was varied (Table 3.14); 80.7% of respondents were enthusiastic about the creation of a nature trail, whilst only 45% supported guided bushwalking tours. The reaction to the latter alternative could be interpreted into two ways:

(i) visitors preferred an individualistic approach to park enjoyment, doing their own "thing" in their own time;

(ii) the concept of guided tours may have been vague to the respondents. This may explain the high percentage of respondents in the neutral category.

In any case, there is real demand for interpretive facilities in the park, be it a well designed visitor centre or an interesting nature trail.

TABLE 3.14

ATTITUDE OF RESPONDENTS TO INTERPRETIVE FACILITIES

Activity	Support	Neutral	Oppose
Guided Bushwalk Tours	45.1	35.1	19.1
Nature Trails	80.7	17.3	2.9

TABLE 3.15

ATTITUDE OF RESPONDENTS TO CONTROLS ON VISITOR ACTIVITY WITHIN THE PARK

Control Policies	Support	Neutral	Oppose
Wooden Walkways	70.3	19.5	10.1
Remove own litter	95.7	3.3	0.8
Use own fuel	67.4	19.8	12.7
Close damaged tracks and campsites	69.2	16.0	14.8
Limit party size	63.5	25.6	10.8
Limit visitors to the park	22.7	59.2	18.1
Fees	84.2	2.7	13.1

3.10.5 Restrictions on Use

Respondents were provided with a list of policies advocating a number of restrictions and controls on visitor activity within the park. The measures included limits on the numbers and size of parties; closure of damaged sites and trails; provision of own cooking fuels; voluntary removal of personal litter from the park and the introduction of entrance fees to the park.

Visitor response was in the affirmative in all cases except limiting visitor numbers to the park (Table 3.15).

Respondents were strongly in favour of more wooden walkways on the trails for the purpose of limiting damage to vegetation. This reaction strongly correlates with an earlier analysis where respondents had expressed concern over the deteriorating conditions of the track. Visitors who had previously used the park commented on the remarkable natural rehabilitation of damaged areas where the tramping pressures had been removed with the use of wooden walkways, especially in the Waldheim area.

Ninety-six per cent of respondents were in favour of public participation in litter removal. This encouraging response could be capitalised on by the park authorities with a campaign educating wilderness and backcountry users that litter and mess are not intrinsic to the wilderness experience. In other words the "burn, bash and bury" ethic of yesterday should now be "burn, bash and bring out".

Two-thirds of visitors surveyed, were amenable to using their own cooking fuels instead of wood. Support for this policy was strongest amongst the overland track bushwalkers with 7 out of 10 in favour. The impact of defoliation around huts has reached a critical limit in a number of areas including Kitchen Hut, Waterfall Valley, Kiaora, Ducane and Narcissus huts.

The policy of closing damaged campsites and trails was supported by 69% of the respondents. However, research on the concept of rotating campsites in the U.S.A., has highlighted two major drawbacks. Firstly, the perception of a damaged campsite of a park manager may differ from that of a wilderness user. This problem was highlighted by Lucas (1979) who showed that attempts to redirect visitors from damaged campsites especially those located adjacent to lakes, were not as successful as initially envisaged. He concluded that this was basically due to the different backgrounds of the two groups. Secondly, studies have shown that once the soil at a recreation site has become compacted through heavy use, it may take many years for the site to recover (Echelberger *et al* 1974). Depending on vegetation and soil types, this rotation of camping areas may result in overuse of sites all over the park instead of particular locations.

Three out of four overland bushwalking parties surveyed were in favour of imposing a limit on party size Needless to say, further research would need to be carried out to determine the maximum, socially acceptable party size. This would include determination of social carrying capacity, psychological distances and motivation levels of wilderness and backcountry users.

Sixty per cent of respondents were opposed to the policy of introducing limitations on the number of visitors to the park as a whole. Most of the respondents believed that access to public land and, in particular, to wilderness is a basic human right and any attempt to alter this would be regarded as an infringement of personal freedom. Even so, one in five were in support of this concept.

The collection of fees can be regarded as a straight fiscal policy of revenue raising or as an indirect method of regulating demand levels. Because the level of visitation to the park has not reached a critical level this question was designed to gauge visitor reaction to the concept of entrance fees if the monies collected were used on maintaining or expanding the facilities in the park. Eighty-four per cent of the respondents and their parties were in favour of some form of entrance fees in these circumstances. The level of fees, however, varied between the different user groups with the majority of daywalkers and wilderness users suggesting that between $1.00 and $2.00, while the daytrippers preferred fee levies between 50 cents and a dollar.

Bardwell (1973) in her study of wilderness users of the South-West of Tasmania, found that the idea of specific charges e.g. for the use of huts in the wilderness areas, were not very popular, if an entrance fee had already been levied. Therefore, it would seem appropriate that if fees are to be levied by the N.P.W.S., an all-encompassing fee structure be used, instead of a marginal cost pricing policy, where the fee is calculated on the cost of facilities actually used.

3.11 VISITATION RATES

The visitor survey highlighted an apparent high re-visitation rate to this park. Forty nine percent of those interviewed had been to the park previously, whilst for the remaining 51% it was their first visit to the park.

Approximately one in five of the revisiting respondents had been to the park at least 9 or more times, with either 20% visiting twice previously (Table 3.10). Fifty percent of these respondents had their last visit within the last year, and extending the time period to five years previous to the survey, over 80% of these respondents had visited the park (Table 3.17).

It is further apparent that this high revisitation rate would be maintained, with at least 66% of visitors surveyed indicating that they would return to the park within the next 5 years. Twenty percent were not sure, while 14% indicated that they would not be returning. Of those

TABLE 3.16

NUMBER OF PREVIOUS VISITS TO THE PARK

No. of visits	%
1	15.9
2	19.7
3	13.4
4	10.9
5	5.4
6	7.1
7	1.3
8	3.8
$\geq$ 9	22.6

TABLE 3.17

RESPONDENTS LAST VISIT TO THE PARK

Time Period	%
6 months	26.5
1 year	24.8
2 years	17.5
3 years	7.3
4 years	6.8
5 years	4.7
6-10 years	2.6
$\geq$ 10 years	9.8

unlikely to return, 25% indicated that they would be leaving Australia, and 57% indicated that the high costs associated with travelling from the mainland states was the main inhibiting factor. Only 3% of respondents suggested that the loss of wilderness qualities of the park discouraged their return to the park.

CHAPTER IV

THE STATE OF THE TRACKS

4.1 INTRODUCTION:

Research on the recreational carrying capacity of land has considered variables such as soil erosion, soil moisture, soil compaction and soil permeability, as well as the physiology and morphology of plant communities, (Liddle & Greig Smith 1975a,b; Grime 1973; Goldsmith 1974). With the exception of the work of Hickler *et al* (1979) and Helgath (1975), there is little published research on the effects of edaphic and topographic factors on track conditions, and the spatial expression of these relationships.

This chapter:

(i) provides quantitative information on the physical conditions of existing tracks and thereby provides baseline data for future track monitoring purposes;

(ii) analyzes the relationship between track conditions and environmental variables, including vegetation type, substrate, slope and elevation;

(iii) suggests the volume of foot traffic that could lead to the progressive deterioration of tracks in different environments.

The analysis assumes that the differences between the tracks and the adjacent vegetation are solely attributable to the direct and indirect effects of trampling.

4.2 METHODS

Data were collected on most tracks in the National Park. Limitations of time and money prevented data collection from the Pine Valley track, the Wolfram Mine track, the Arm River track, the Mount Rufus track and the Lake Petrarch track, and the Riggs Pass track in the north. Sample sites were located at half kilometre intervals. Field location was aided by aerial photographs, topographic maps and pacing between the sample sites. The total sample size was 218, of which 142 were located on the Overland Track to the south of Kitchen Hut. The trails were divided into a number of sections, with the location of huts being the major nodes, and the internode being the basic trail unit. Each survey site was identified with a permanent marker.

At each sample site, the following observations and measurements were made; aspect, elevation, geology, track depth, ground and crown cover over the track, slope, vegetation type defined on the basis of species composition and dominance, soil depth and the width of the track (Appendix 5). A line transect was placed perpendicular to the track at each sample site. The transect length was sub-divided into deciles. Each decile was then described under one of the following headings:-

(a) untrampled - undisturbed vegetation;

(b) trampled - vegetation showing first signs of trampling - decrease in height and/or foliage being flattened or broken;

(c) dying - where plant foliage is partially removed, but roots are still capable of reproducing. Soil surface is partially exposed;

(d) dead - where foliage is completely destroyed, roots are not capable of vegetative reproduction, and where the soil surface is exposed;

(e) eroded - devegetated zone, where the track surface is covered with mud, mineral soil, rock fragments, peat, leaf litter or where the natural bedrock is exposed through erosion.

The dominant trampling class and ground material in each decile were recorded.

Species cover at each site was also mapped along three line transects at 1 metre intervals. Finally, a rough cross-sectional diagram was drawn at each sample site.

A single index of track damage was derived for each site by calculating the mean of the decile damage classes where "eroded" was given a weighted factor of 5, dead = 4, dying = 3, trampled = 2, untrampled = 1, and multiplying this figure by the transect length, a measure of the cross-sectional width of disturbance.

$$\text{T.D.I.} = \frac{\Sigma d}{10} \times \text{T1}$$

where T.D.I. = Track Damage Index

d = degree of disturbance

T1 = transect length.

The relative use of tracks was obtained from the questionnaire survey (Appendix 3). Absolute use on any section of the track was calculated as described in Section 3.8.5. In explaining the relationship between the track condition and use, it is assumed that the pattern of use has remained the same over the years. There has only been a slow increase in the number of users of the tracks over the past five years (Section 2.2.3).

Therefore, the 1978/79 track usage statistics provide a surrogate measure for the total cumulative trampling intensity, which in turn, determines the equilibrium between the destruction and rehabilitation rates of the ecosystems within which the walking tracks are located.

4.3 ANALYSIS

The two statistical tests applied were:

(i) χ^2 (chi squared) which was used to show whether the systematic relationships between the Trampling

Index and the other variables were due to chance.

(ii) Pearsons-product moment correlation coefficient which was used to indicate the direction and strength of the relationships between continuous variables and the trampling index.

4.4 RESULTS

4.4.1 Environmental Factors

Sixty percent of the sample sites were located in areas where elevation exceeded 900 m. These areas are generally covered by heath, hummock sedgeland or herbfield. The dominant geological substrates found in these upland areas are quartzite, dolerite and conglomerate.

Areas below 900 m ASL, were characterized by forest communities dominated by eucalypts on well-drained and more drought prone sites and by temperate rainforest trees in the wetter, and less exposed areas in the park. Pleistocene glacial deposits and the relatively fertile Permo-carboniferous sandstones and mudstone were the most common geological types in these lowland areas.

The tracks appear to be evenly distributed on all aspects, with a marginally higher proportion of tracks located on the northern and eastern aspects.

The steepness of the terrain at each site provides a surrogate measure of the drainage properties of an area.

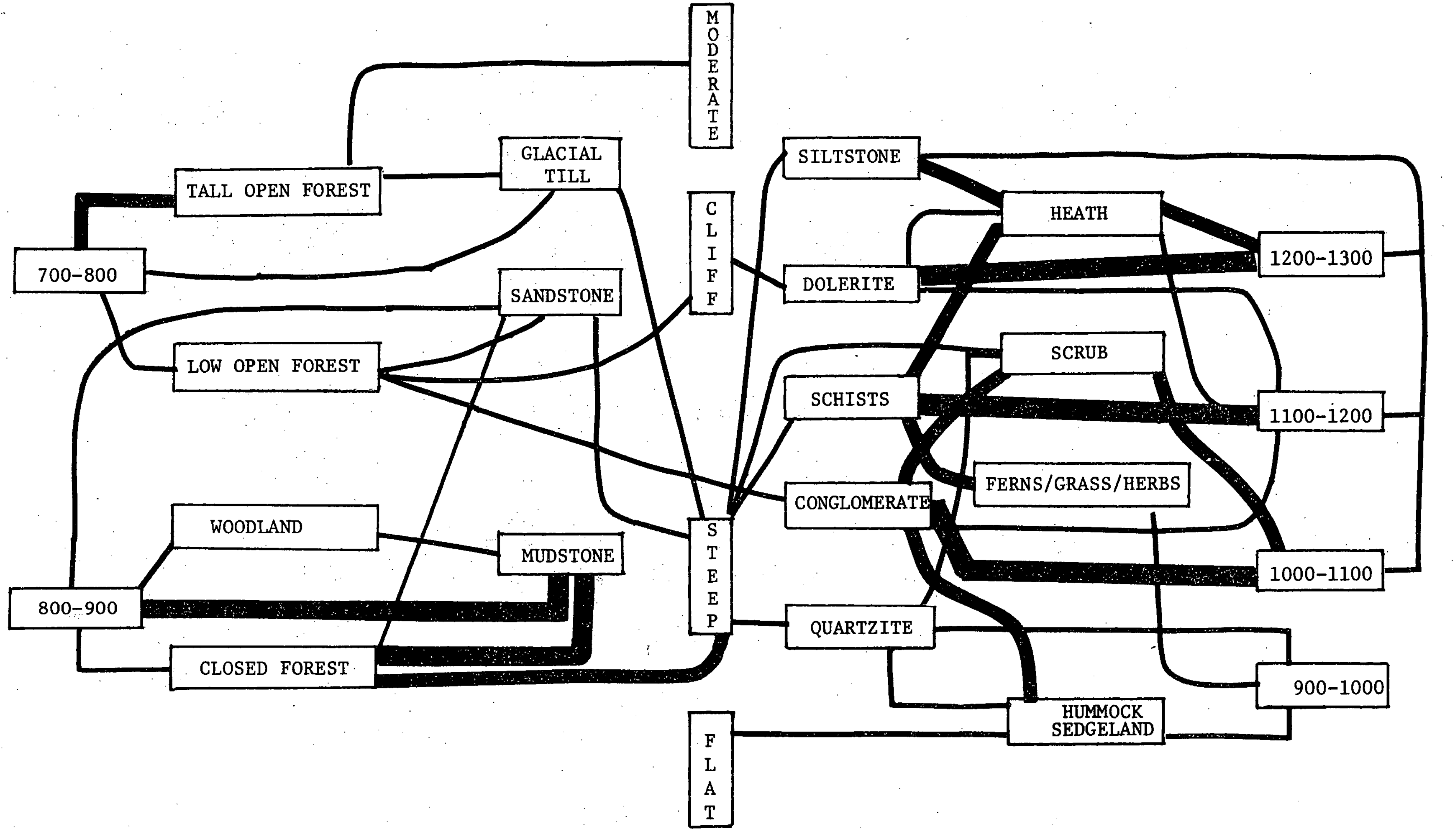
Fig. 4.1 : Constellation diagram showing the relationships between the measured environmental variables.

X2 Expected

X3 Expected

X4 Expected

Fig. 4.1



MODERATE
GLACIAL TILL
TALL OPEN FOREST
700-800
SANDSTONE
CLIFF
LOW OPEN FOREST
WOODLAND
MUDSTONE
800-900
CLOSED FOREST
STEEP
FLAT
SILTSTONE
HEATH
1200-1300
DOLERITE
SCRUB
SCHISTS
1100-1200
FERNS/GRASS/HERBS
CONGLOMERATE
1000-1100
QUARTZITE
900-1000
HUMMOCK SEDGELAND

One in three sites surveyed were on flat terrain, the majority of which was located at the higher elevations. The highlands were also associated with the steepest slopes, where the tracks were located in many instances on outcrops or deposits of dolerite and quartzite.

The relationships between the observed or measured environmental variables are shown in Fig. 4.1, where the thickness of the connecting lines is related to the degree to which the two subvariables occur together more than would be expected by chance.

4.4.2 Track Profile

(a) Track depth

The vast majority of tracks surveyed (86.7%) had depths of less than 30 cm. Thirty-eight percent of these tracks were less than 10 cm deep. The deep tracks were associated with morainic land forms, steeper slopes and plant communities growing on shallow peat soils, e.g. Horses track, Crater Lake Track and Hounslow Heath. On some of the tracks located on dolerite soils, south of Kitchen Hut and along the Face Track, track depth varied from 30 to 50 cm. The deeper tracks are concentrated in the northern end of the park.

(b) Track Damage Classification

The trampling damage index values for the sites sampled in this survey ranged from 80 to 3850, for track widths varying from 0.4 m to a maximum of 12 metres. The index values were divided into 4 classes.

Trampling Index	Track Width Range (metres)	Track Damage Class
0 - 600	0.4 - 3	Good
601 - 1200	1.5 - 5	Fair
1201 - 1800	3 - 6	Bad
1801 - 4000	4 - 12	Very bad

Table 4.1 indicates the varying proportion of the different degrees of disturbance on each track group. The small standard deviation from the mean highlights the homogeneity of the data in each of track classes.

Table 4.2 shows the damage profile of the tracks after removing figures for the untrampled zone. The lack of any discernable trend in the relative proportions of the disturbance classes between the fair and the bad track classes belies the reality. The diagrammatic representative of the different track types in terms of absolute lengths (Fig. 4.2) indicates that as tracks deteriorate, the absolute width of disturbance zones increases, even though the proportions may fluctuate. The mean width of the "good" tracks was 1.58 m. This figure concurs with that recommended by a number of park authorities as the optimal width of a track. As a rule of thumb tracks wider than 3 metres can be classed as either bad or very bad.

TABLE 4.1

PROPORTIONAL VARIATION IN THE DEGREES OF DISTURBANCE

WITHIN EACH TRACK CONDITION GROUP

Standard Deviation, s = (-----)

Track Condition	Untrampled	Trampled	Dying	Dead	Eroded
Good	15.6 (1.174)	53.2 (2.998)	5.7 (0.872)	1.0 (0.379)	24.6 (2.189)
Fair	16.6 (0.849)	28.8 (1.738)	9.0 (1.172)	3.9 (1.039)	41.7 (2.101)
Bad	10.0 (1.024)	20.0 (1.746)	10.5 (1.174)	4.5 (0.912)	55 (2.483)
Very Bad	7.7 (0.942)	30.3 (2.036)	12.9 (1.319)	4.5 (0.98)	44.6 (2.525)

Fig. 4.2

SCHEMATIC REPRESENTATION OF THE TRACK DAMAGE CLASSES

Figure 4.2

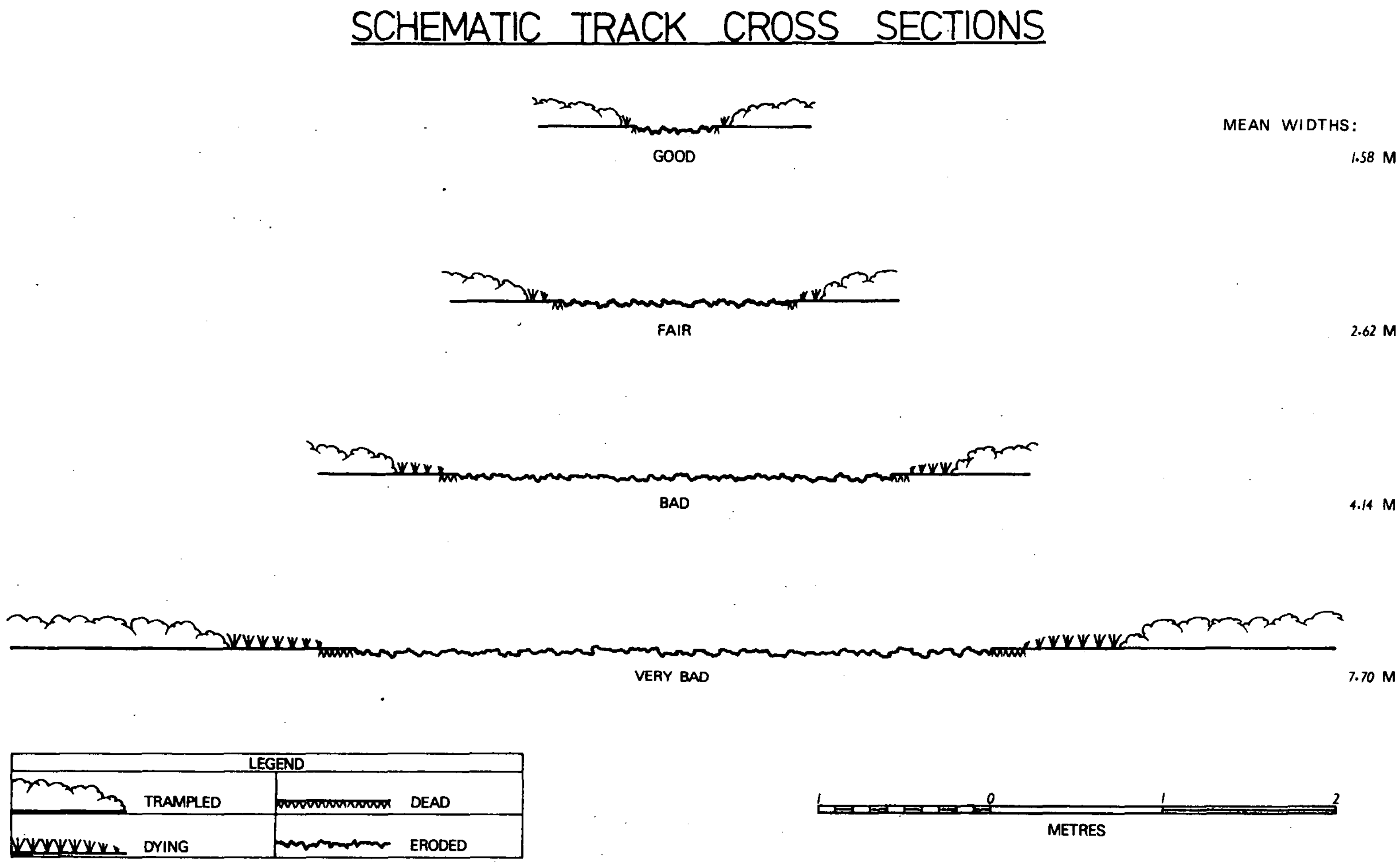

SCHEMATIC TRACK CROSS SECTIONS
MEAN WIDTHS:
GOOD
1.58 M
FAIR
2.62 M
BAD
4.14 M
VERY BAD
7.70 M
LEGEND
TRAMPLED
DEAD
DYING
ERODED
1
0
1
2
METRES

TABLE 4.2

PROPORTIONAL VARIATION OF THE DEGREES OF DISTURBANCE WITHIN EACH TRACK DAMAGE CLASS AFTER COMPENSATING FOR THE UNTRAMPLED ZONES

Track Condition	Trampled	Dying	Dead	Eroded
Good	63.0	6.7	1.2	29.1
Fair	34.5	10.8	4.7	50.0
Bad	22.2	11.7	5.0	61.1
Very Bad	32.8	14.0	4.9	48.3

TABLE 4.3

TRACK CONDITIONS ALONG THE OVERLAND TRACK AND THE DAYWALK ROUTES

Track Condition	Overland Track (%)	Daywalk Routes (%)	Total
Good	21.1	14.2	35.3
Fair	24.3	11.9	36.2
Bad	6.0	4.6	10.6
Very Bad	13.8	4.1	17.9

Similarly, the distribution of the ground material types between the different track groups display a lack of any discernable trends. This could be attributed to the fact that the trampling index is essentially a function of the transect length and the rate of vegetation destruction, but not the degree of erosion. Nonetheless, the nature of the ground material is important in assessing the type of track damage and the rate of recovery of tracks under different track rehabilitation techniques.

4.4.3 Spatial Variation of Track Conditions in the Park

Thirty-five percent of the 120 kms of tracks surveyed were in good condition, 36% were fair, while the remaining 29% were eigher in a bad or very bad state of degradation (Table 4.3). Twenty percent or 15.6 kms of the overland track was badly damaged. As shown in Figure 4.3, these tracks are disproportionately located in the northern region of the park. Sixty-three percent of the track surfaces north of Pelion Hut are either in a bad or very bad state, as against only 10% in the south (Table 4.4).

The bad sections of the overland track are:

(1) Kitchen Hut and the turn off to Lake Rodway, where the trampling has caused the formation of anastomosing track system (Plates 4.1 and 4.2).

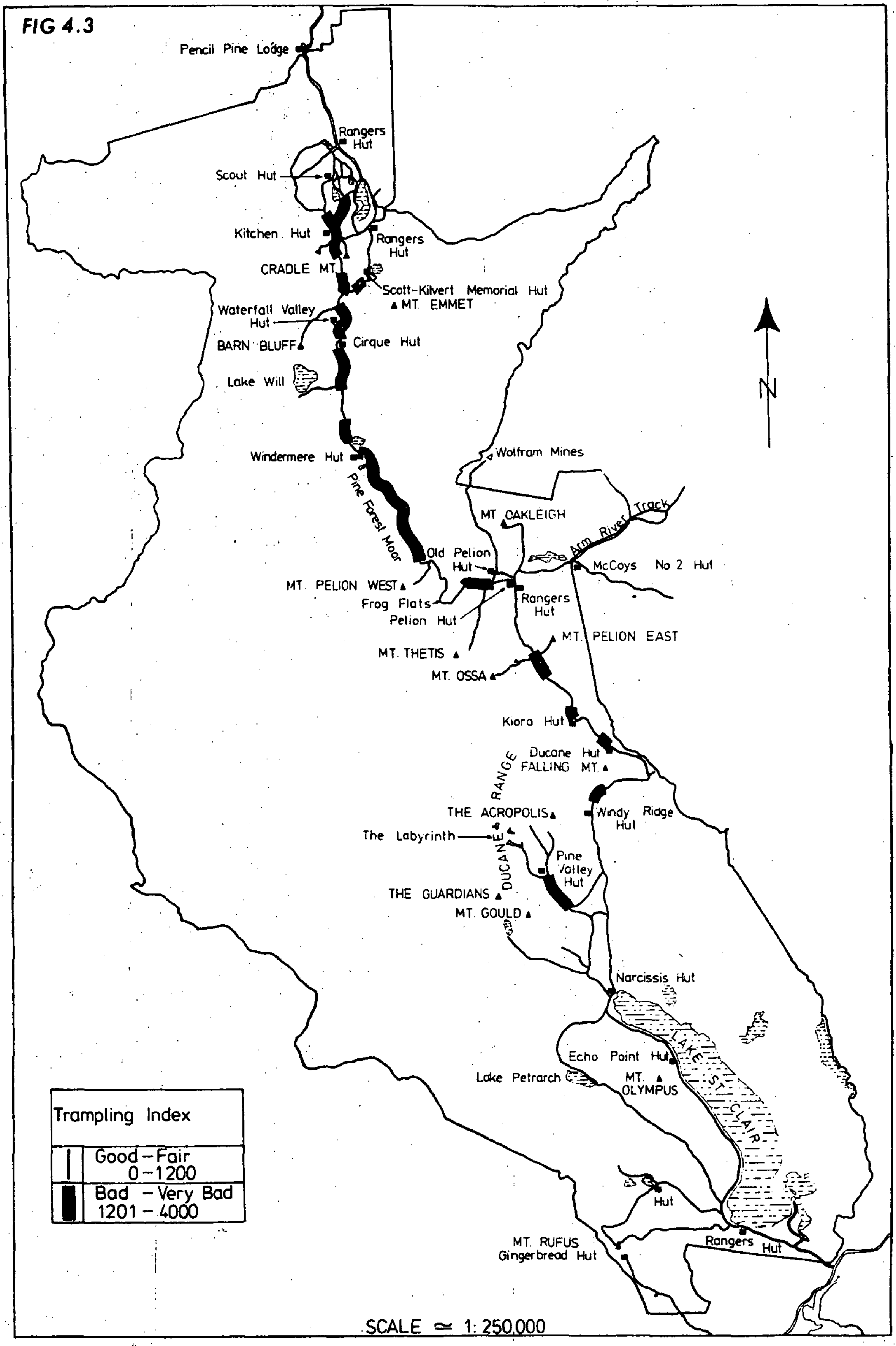
(2) Cradle Cirque and Waterfall Valley Hut. Here the track is located on steeply sloped terrain, with

Fig. 4.3

SPATIAL VARIATION OF TRACK CONDITIONS

ALONG THE OVERLAND TRACK

FIG 4.3


Pencil Pine Lodge
Rangers Hut
Scout Hut
Kitchen Hut
Rangers Hut
CRADLE MT.
Scott-Kilvert Memorial Hut
MT. EMMET
Waterfall Valley Hut
BARN BLUFF
Cirque Hut
Lake Will
Windermere Hut
Pine Forest Moor
Wolfram Mines
MT. OAKLEIGH
Arm River Track
McCoys No 2 Hut
Old Pelion Hut
MT. PELION WEST
Frog Flats
Pelion Hut
Rangers Hut
MT. PELION EAST
MT. THETIS
MT. OSSA
Kiora Hut
Ducane Hut
FALLING MT.
DUCANE RANGE
THE ACROPOLIS
Windy Ridge Hut
The Labyrinth
Pine Valley Hut
THE GUARDIANS
MT. GOULD
Narcissis Hut
Echo Point Hut
LAKE ST. CLAIR
Lake Petrarch
MT. OLYMPUS
Hut
MT. RUFUS
Gingerbread Hut
Rangers Hut
N
Trampling Index
Good – Fair 0 – 1200
Bad – Very Bad 1201 – 4000
SCALE ≃ 1: 250,000

Plates 4.1 and 4.2 : Examples of the anastomizing tracks on the Cradle Plateau and between Kitchen Hut and the turnoff to Lake Rodway.

4.1 on dolerite

4.2 on quartzite.

Plate 4.1

Plate 4.2

Plate 4.3 : The wide tracks across Pine Forest Moor.

Plate 4.4 : Quagmire along the track across Frogs Flats.

Plate 4.3

Plate 4.4

a south-westerly aspect, and because of the deep peat cover it is poorly drained, resulting in a quagmire surface.

(3) Section of track half a kilometre south of the Waterfall Valley Hut turnoff. The track overlies a sandstone substrate and is poorly drained with tracks up to 8 metres wide.

(4) Cirque Hut and Lake Holmes. This area is characterized by its high water table and a number of small streams criss-crossing its slightly undulating terrain. Track surfaces are frequently waterlogged and washouts are quite common.

(5) Windermere Hut, across Pine Forest Moor to Pelion Creek. This 5 km section is one of the most badly deteriorated lengths of the overland track. Like the preceding section, this area has a high water table, a near-flat terrain, a deep peat layer and is exposed to the strong rain and snow bearing south-westerly winds. *Gymnoschoenus sphaerocephalus* and *Richea scoparia* are the dominant plant species. The desire of most walkers to avoid quagmires has resulted in tracks up to 12 metres wide. The track shows signs of severe gully erosion as it approaches Pelion Creek. (Plate 4.3).

(6) Frog Flats - east of the Forth River to the turn-off to Old Pelion Hut. This section of the overland track is famous for its "bog monster" stories. Walkers have reported to have waded waist deep in mud through some sections of these Flats (Maynard

pers. comm.). (Plate 4.4).

(7) Pelion Gap and Pinestone Creek. The presence of large prickly thickets of *Richea scoparia* and *R. sprengelioides* has caused walkers to spread over a wide, poorly drained area.

(8) 1 km section north of Kiaora Hut - the track passes through poorly drained peat soils and plant communities dominated by *Gymnoschoenus sphaerocephalus* and *Leptospermum lanigerum*.

(9) Between Kiaora and Ducane Huts - a badly waterlogged track.

Only 8.7% or 3.5 kms of the daywalk tracks were badly damaged, even though they experience a higher user traffic in comparison to the overland track (Table 4.3). It is evident that these damaged tracks are concentrated on the Cradle Plateau (Fig. 4.4). These poor tracks have wide visual zones of disturbance but, unlike parts of the overland track, the original ecosystem is characterized by shallow peat. Consequently, quagmires are not common, but the tracks are generally eroded down to rock fragments. (Plates 4.5 and 4.6).

A distinctive feature of this northern section of the park is its glacial lakes and moraines. Tracks located in the moraines have greater depths than those located on the Valley flats or on the Plateau. Sections of tracks in the vicinity of the two trail heads - Dove Lake Car Park and Waldheim were noticeably more degraded

Fig. 4.4

SPATIAL VARIATION IN TRACK CONDITIONS ALONG THE DAYWALK ROUTES IN THE CRADLE MOUNTAIN AREA

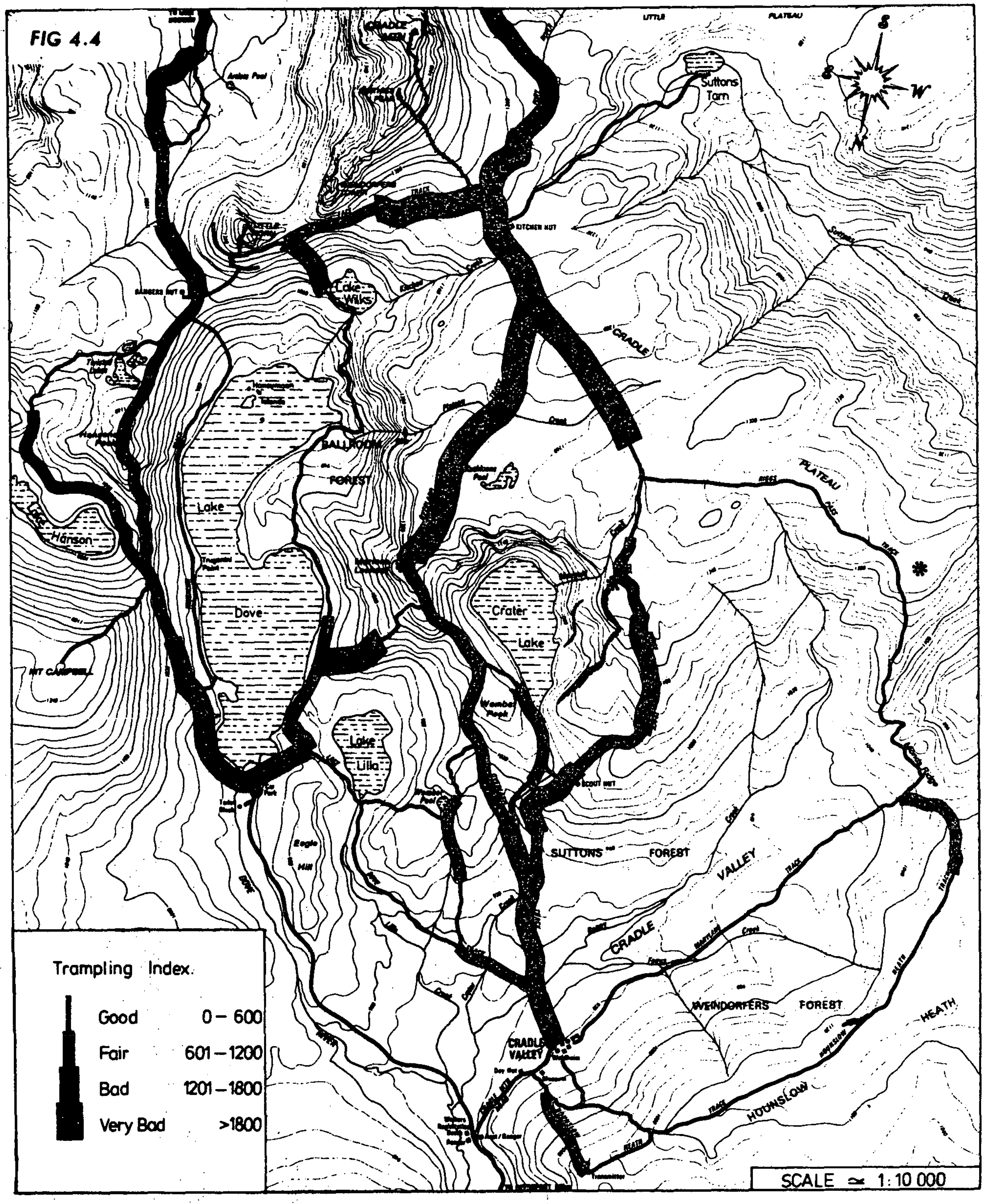


FIG 4.4
Trampling Index.
Good 0 – 600
Fair 601 – 1200
Bad 1201 – 1800
Very Bad >1800
SCALE ≃ 1:10 000
Lake Dove
Crater Lake
Lake Lilla
Lake Wilks
Lake Hanson
Suttons Tarn
BALLROOM FOREST
SUTTONS FOREST
WEINDORFERS FOREST
CRADLE VALLEY
CRADLE
PLATEAU
HOUNSLOW HEATH
KITCHEN HUT
SCOUT HUT
Eagle Hill
MT CAMPBELL
Wombat Pool

Plates 4.5 and 4.6 : Examples of track deterioration in the alpine ecosystems of Cradle Plateau. Note the shallow peat layers.

Plate 4.5

Plate 4.6

TABLE 4.4

TRACK CONDITIONS ALONG THE OVERLAND TRACK, NORTH AND SOUTH OF THE NEW PELION HUT

Track Condition	North	South
Good	5%	49%
Fair	32%	41%
Bad	20%	3%
Very Bad	43%	7%

TABLE 4.5

CHI^2 VALUES FOR THE RELATIONSHIPS BETWEEN THE TRACK DAMAGE INDEX AND THE ENVIRONMENTAL VARIABLES

Variable	χ^2	d/f	P
Aspect	12.3947	21	0.9283
Elevation	40.086	15	0.0004
Substrate	46.3138	21	0.00012
Track Depth	90.7736	18	0.0001
Ground Cover	28.414	12	0.0048
Vegetation Structure	63.8813	21	0.0001
Track Slope	28.4788	24	0.2404
Terrain Slope	22.007	24	0.5788
Track Width	300.946	18	0.0001
Ground Vegetation	119.34076	60	0.0001
Crown Cover	27.3935	12	0.0060
Trampling Population	61.9	9	0.0001

than those beyond. Track sections at a number of nodal regions were severely damaged compared with the internodal sections (e.g. the junction of the Face and Hanson's Peak Track, Marion's Lookout and Ballroom Forest, the Horse and the Overland Track) compared with the intervening sections .

4.4.4 Relationship between Track Conditions and Environmental Variables

Chi-squared analysis of the relationships between the Track Damage Index and the environmental variables indicate that with the exception of aspect and slope, all other variables had a systematic relationship with the Trampling Index at the 95% confidence limit (Table 4.5). However, at the 99.9% confidence limit, the factors were reduced to those of elevation, substrate, track depth, track width, vegetation and track usage.

(i) Vegetation (Table 4.6)

The vegetation types most susceptible to trampling pressures were heath and hummock sedgeland. Heaths were the least durable, especially those dominated by bolster plants and dwarf pines. The worst affected areas were located on the Cradle Plateau. Subalpine heath communities dominated by *Richea scoparia, R. sprengelioides, Melaleuca squamea* and *Epacris lanuginosa* were likewise strongly associated with poor tracks. Forty seven percent of tracks throughout heathlands and 43% of tracks through hummock sedgelands dominated by *Gymnoschoenus sphaerocephalus* were classed as badly damaged.

The tall and low open forest types, dominated by *Eucalyptus delegatensis, E. dalrympleana, E. coccifera* and *E. gunnii* had the highest tolerance to trampling. These communities were generally associated with the better drained sites.

Closed-forest, woodland and scrub had trampling tolerance levels between the treeless communities and the open forest types. Poorly drained sites, the lack of vegetative cover on the soils and the high humidity levels may perhaps contribute to the lower tolerance levels within the rainforest communities. Woodland and scrub communities were dominated by *Nothofagus gunnii* or dwarf *Eucalyptus cocifera* at the higher elevations and by *Leptospermum lanigerum* at the lower elevations. The poorly drained and highly acidic nature of soils associated with these scrub communities may provide an explanation for their low tolerance to trampling.

(ii) <u>Elevation</u> (Table 4.7)

The skewed distribution of tracks in the lower elevations towards the first two classes of track damage would suggest that tracks in the lowlands have a higher carrying capacity. To provide a higher degree of explanation for this dichotomy between track damage in the lowlands and the highlands, the elevation data were stratified

TABLE 4.6

RELATIONSHIP BETWEEN VEGETATION TYPES
AND TRACK CONDITION

Vegetation	Good	Fair	Bad	V. Bad
Closed forest	27.3	63.6	9.1	0
Tall open forest	75.0	20.0	0	5.0
Tall open woodland	14.7	55.9	14.7	14.7
Low open forest	45.1	39.2	11.8	3.9
Scrub	36.0	52.0	8.0	4.0
Heath	26.3	26.3	14.0	33.3
Hummock sedgeland	30.8	23.1	0	46.2
Herbs, grass, ferns	71.4	14.3	0	14.3

TABLE 4.7

RELATIONSHIP BETWEEN ALTITUDE AND TRACK CONDITIONS

Elevation (m)	Good	Fair	Bad	V. Bad
700-800	64.8	31.5	1.9	1.9
801-900	31.4	42.9	11.4	14.3
901-1000	27.5	41.2	9.8	21.6
1001-1100	20.5	43.6	17.9	17.9
1101-1200	33.3	33.3	16.7	16.7
1201-1300	23.8	28.6	9.5	38.1

TABLE 4.8a

RELATIONSHIP BETWEEN ALTITUDE AND TRACK CONDITION

Elevation (m)	Track Condition Good	Fair	Bad	V. Bad
≤ 900	58.2	39	22.7	17.1
≤ 901	41.8	61	77.3	82.9

TABLE 4.8b

RELATIONSHIP BETWEEN ALTITUDE AND VEGETATION TYPE

Elevation (m)	Tall Closed Forest	Tall Open Forest	Wood-land	Low Open Forest	Scrub	Heath	Hummock Sedgeland	Fern Grass Herbs
≤ 900	63.6	100	47.1	66.7	16.0	3.5	23.5	42.9
≥ 901	36.4	0	52.9	33.3	84.0	96.5	76.5	57.1

TABLE 4.8c

RELATIONSHIP BETWEEN ALTITUDE AND GEOLOGICAL SURFACE

Elevation (m)	Quartzite	Dolerite	Conglom-erate	Sand-stone	Glacial Till	Mudstone	Schists	Silt-stones
≤ 900	3.9	0	0	75	61.1	67.9	0	0
≥ 901	96.1	100	100	25	38.9	32.1	100	100

into two classes 0 - 900 m and 901 - 1300 m. Eleven percent of tracks surveyed below 900 m were badly damaged as compared with 86% of tracks above 900 m (Table 4.8a).

The stratified elevation classes were cross-tabulated with vegetation and geology (Tables 4.8b and 4.8c). From the spatial distribution of vegetation types, it is apparent that the more susceptible communities - heath, hummock sedgelands, ferns, grasses and herbs, woodlands and scrub, are disproportionately located on the higher elevations. Similarly, the distribution of geological substrates appear to disaggregate sharply at the 900 m altitude, with dolerite, conglomerate, schists and siltstones not occurring in areas surveyed below 900 m. Additionally, 96% of sites surveyed located on Precambrium quartize were found in areas with elevations above 900 m. Most of the surveyed sites below 900 metres were located on sandstone, glacial till or mudstone.

(iii) <u>Surface Geology</u> (Table 4.9)

The results would suggest the order of increasing trampling susceptibility of geological types is schists, mudstone, sandstone, conglomerates, glacial till, dolerite and quartzite, from least to most susceptible. However, this ordering may be misleading as the latter two rock types are concentrated at high altitude.

TABLE 4.9

RELATIONSHIP BETWEEN GEOLOGICAL SURFACE AND TRACK CONDITION

Substrate	Good	Fair	Bad	V. Bad
Quartzite	31.4	35.3	9.8	23.5
Dolerite	40.0	20.0	6.7	33.3
Conglomerate	0	40.0	40.0	20.0
Sandstone	34.4	43.8	9.4	12.5
Glacial till	45.8	30.6	9.7	13.9
Mudstone	21.4	67.9	3.6	7.1
Schists	77.8	22.2	0	0
Siltstone	0	33.3	50.0	16.7

TABLE 4.10a

RELATIONSHIP BETWEEN TRACK WIDTH AND TRACK CONDITION

Width (cms)	Good	Fair	Bad	V. Bad
0 - 100	100	0	0	0
101 - 150	71.0	29.0	0	0
151 - 200	40.6	59.4	0	0
201 - 300	8.3	75.0	16.7	0
301 - 500	0	28.6	46.4	25.0
501 - 1000	0	0	11.5	88.5
≥ 1000	0	0	0	100

TABLE 4.10b

RELATIONSHIP BETWEEN TRACK WIDTH AND ALTITUDE

Width (cms)	≤ 900 m	≥ 901 m
0 - 100	46.4	53.6
101 - 150	51.6	48.4
151 - 200	51.6	48.4
201 - 300	41.7	58.3
301 - 500	32.1	67.9
501 - 1000	7.7	92.3
≥ 1000	20.0	80.0

TABLE 4.10c

RELATIONSHIP BETWEEN TRACK WIDTH AND VEGETATION TYPE

Width (cms)	Closed Forest	Tall Open Forest	Wood-land	Low Open Forest	Scrub	Heath	Hummock Sedgeland	Fern Grass Herbs
0-100	0	10.7	3.6	17.9	10.7	32.1	10.7	14.3
101-150	6.5	19.4	6.5	25.8	22.6	12.9	3.2	3.2
151-200	4.7	12.5	15.6	35.9	7.8	21.9	1.6	0
201-300	11.1	5.6	30.6	16.7	16.7	16.7	2.8	0
301-500	7.1	3.6	17.9	25.0	14.3	25.0	3.6	3.6
501-1000	0	0	15.4	7.7	0	53.8	19.2	3.8
≥1000	0	0	20.0	0	0	60.0	20.0	0

(iv) Track Width

As the trampling index is a function of the track width, the figures shown in Table 4.10a highlight the variation of widths in relation to the track classes. All tracks less than 1 metre wide are classified as "good" regardless of their track surface profile. Tracks with a cross-sectional length greater than 5 metres would, similarly, be classified as badly damaged regardless of their surface characteristics. The classification of the intervening track widths were, on the other hand, dependent often on the degree of surface damage.

The variation in track widths with elevation is shown in Table 4.10b. The majority of tracks with widths greater than 3 m were located in ecosystems above 900 m and the reverse is true for tracks located below 900 m. The narrower tracks on the higher elevations were associated with steep slopes and block streams.

Trail widths differed considerably between the different plant communities (Table 4.10c). Tracks through the open and low communities like heath and sedgeland were much wider than those through forested areas. The absence of any form of physical barriers enables hikers to walk abreast and/or leave the trails over most of the treeless communities. Consequently, there is the negative association of the high crown cover and the wide and badly deteriorated tracks.

Cole (1978), Dale and Weaver (1974) and Hartley (1976) in their studies of visitor impact on different vegetation types, concluded similarly that the impact of hikers was limited to a smaller trampling zone in the forested areas as compared to the meadow communities.

(v) Slope (Table 4.11)

The chi-squared analysis showed that there was no significant relationship between the slope and the track condition at the 95% confidence limit. In contrast, the Pearsons Product Moment Correlation Coefficient - a stronger test of association, demonstrated that at the 99% confidence limit, there was a negative correlation between the slope of the terrain and the level of deterioration of the tracks.

This corroborates other data which suggest that the badly deteriorated sites were located on the flatter, slightly undulating country, generally associated with poor drainage.

In addition, it was observed that where the major traffic flow was in an uphill direction, tracks were narrower and deeper - Marion's Lookout, Hansons Peak and the Face track, in contrast to the major downhill track routes, which were much wider, in particular through the treeless communities.

TABLE 4.11

PEARSONS PRODUCT MOMENT CORRELATION COEFFICIENTS FOR THE RELATIONSHIPS BETWEEN THE TRAMPLING DAMAGE INDEX AND THE CONTINUOUS ENVIRONMENTAL VARIABLES

(i)	Elevation	0.26212 S=0.300
(ii)	Track Width	0.9566 S=0.001
(iii)	Soil Depth	0.0407 S=0.275
(iv)	Slope	-0.2053 S=0.001
(v)	Population Intensity	0.3169 S=0.001

(vi) Depth

Eighty percent of tracks classed as good and fair were less than 20 cm in depth. The number of survey sites with depths greater than 30 cm were 29 or 13.4% of the total sample. A number of these deeper sites were associated either with subalpine heath or woodland communities, and were characteristically located in areas above 900 m A.S.L. and on quartzite, glacial till and dolerite substrates.

The deepest track enountered was found on the Horses Track, north of the Scout Hut. The track, located on a glacial moraine is approximately 2 m deep and 1.5 m wide.

Approximately 33% of sites surveyed were located in areas with slopes varying between 0° and 4°, and another 30% of the tracks were located on the gentle undulating terrain. Assuming that terrain slope is a reliable surrogate measure of drainage, this high incidence of tracks on the gentler slopes, could perhaps explain the paucity of deep tracks within the park. Instead, the deeper tracks are more a function of water channel erosion and steeper slopes rather than trampling pressure.

(vii) Track Usage

As indicated in Table 4.12a, the state of the walking tracks is consistently related to the amount of track usage. Three out of four tracks which experienced traffic densities of up to 1000 persons per annum were recorded as being in good condition, as compared to only 6% of tracks receiving more than 3000 persons.

In areas below 900 m altitude, regardless of trampling intensities, the majority of tracks were either in "good" or "fair" condition (Tables 4.12b and 4.12c). In all cases the track conditions worsen with increasing traffic.

An interesting feature of the above analysis is the relationship between the medium traffic levels (1000 - 2000 people) and the level of track disturbance. It is evident that under medium intensity use, all tracks below 900 m and 80% of tracks above 900 m altitude, were either in "good" or "fair" condition. One possible explanation for this, similar to that of La Page (1967) for campsite deterioration is that after the initial loss of soil and vegetative cover in an area exposed to trampling pressures, the medium traffic intensity compacts the trail enough to inhibit erosion. However, with continued increases in walking pressures, the trafficability of the trails decreases and erosion is accelerated.

TABLE 4.12a

RELATIONSHIP BETWEEN TRACK USAGE AND TRACK CONDITION

Track Usage	Good	Fair	Bad	V. Bad
Light	77.3	22.7	0	0
Medium	61.9	27.0	3.2	7.9
Heavy	22.0	45.0	13.0	20.0
Very Heavy	6.1	42.4	24.2	27.3

TABLE 4.12b

RELATIONSHIP BETWEEN TRACK USAGE AND TRACK CONDITION

IN AREAS WITH ALTITUDES $\leq$ 900 m

Track Usage	Good	Fair	Bad	V. Bad
Light	100	0	0	0
Medium	68.8	28.1	0	3.1
Heavy	34.7	46.9	8.2	10.2
Very Heavy	0	0	100	0

TABLE 4.12c

RELATIONSHIP BETWEEN TRACK USAGE AND TRACK CONDITION

IN AREAS WITH ALTITUDES $\geq$ 901 m

Track Usage	Good	Fair	Bad	V. Bad
Light	64.3	35.7	0	0
Medium	54.8	25.8	6.5	12.9
Heavy	9.8	43.1	17.6	29.4
Very Heavy	6.3	43.8	21.9	28.1

Tables 4.12b and 4.12c also illustrate that even though the tracks may be exposed to the same amount of traffic, the rate of their deterioration is related to a number of other site factors. Therefore track location may be of greater significance to the park manager than track usage.

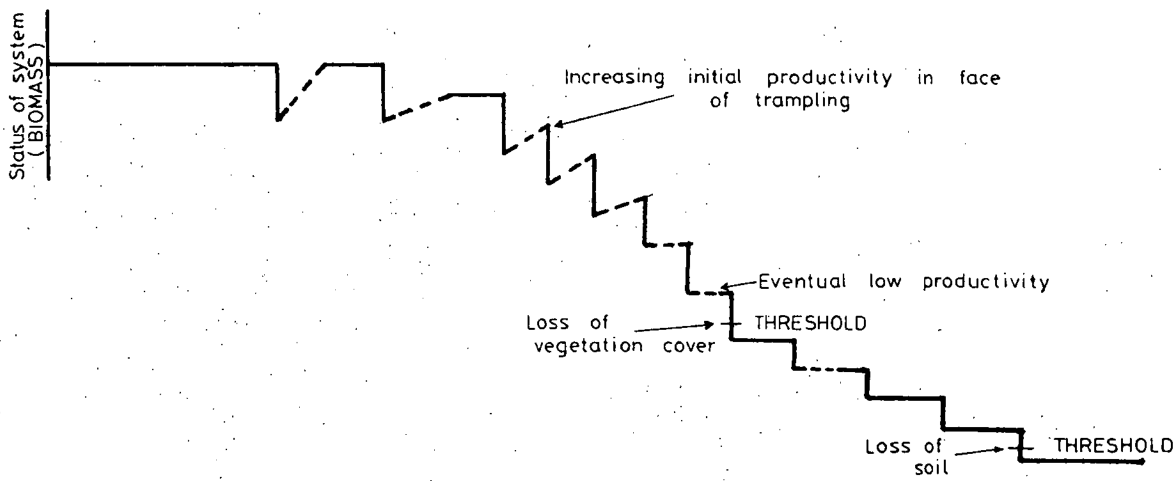
4.5 THRESHOLD VALUES

The stability of any ecosystem experiencing trampling pressures is dependent on the growth rate or the productive capacity of the plant communities. Where destruction due to trampling pressures is equal to or less than the growth rate of the plant communities, conditional stability of the ecosystem is achieved (Trudgill 1977). Where the trampling pressures are greater than the natural growth rates, the ecosystem deteriorates and stability is only achieved when the system is exhausted and all the soil is lost. This, therefore, prevents any natural recovery of the system to its original state (Fig. 4.5).

Based on the above premises, two threshold levels are operative in an ecosystem subjected to trampling pressures. The first is attained when trampling reduces the vegetative cover exposing the soil to the forces of erosion, but the disturbed area is able to rehabilitate naturally to its original state if the traffic is removed - "conditional stability". The second threshold level is achieved when all the soil is completely eliminated,

Figure 4·5

BIOMASS AND TRAMPLING
(Trudgill, 1977)



exposing the rock surface. Trampling index of 1200, the upper limit of tracks classed as "fair" would seem to be at the first threshold level. Beyond this level, the rate of track deterioration seems to exceed the rate of natural recovery resulting in the subsequent disintegration of all plant growth, as well as an acceleration in the rate of soil erosion. Stability will be achieved at the second threshold level, where recovery of the ecosystem to its original state is not possible.

In order to determine the trampling intensity at which the shift from conditional stability takes place for each of the major environmental types in the park, linear regression was used. Thus, the trampling index was regressed against trampling intensity for each of several vegetation, elevation, slope and geological classes, the point at which the regression line crossed the value of 1200 for the trampling index being assumed to be the threshold level.

<u>4.5.1 Vegetation</u> (Fig. 4.6)

The results obtained in this analysis concur with those obtained previously, insofar as the treeless vegetation types are more susceptible to trampling than the taller forested vegetation types. The threshold levels for the different vegetation types were: hummock sedgeland, 1250; heath, 1550; grass, ferns and herbs, 1750; closed-forest, 2300; low open-forest, 3600; scrubland, 4000; tall open forest, 4250; and tall open woodland, 5000.

The hummock sedgelands, dominated by *Gymnoschoenus sphaerocephalus* were the most susceptible to trampling pressure, occurring in environments characterised by poor drainage.

Unlike hummock sedgelands, the alpine heath communities are characteristically located on skeletal soils with a shallow covering of peat. Growth rates are slow and the soils are subject to frost heaving and needle ice formation. With an annual traffic in the vicinity of 5000 persons, tracks on the Cradle Plateau region have substantially exceeded their biophysical carrying capacity.

Subalpine heath communities dominated by *Richea scoparia, R. spengelioides, Leptospermum nitidum, Baeckea gunniana* and *Epacris serpyllifolia* have, from observation, higher threshold levels than the alpine heaths. On the other hand, the lowland heaths have a higher carrying capacity. These lowland communities are often located on well drained sites.

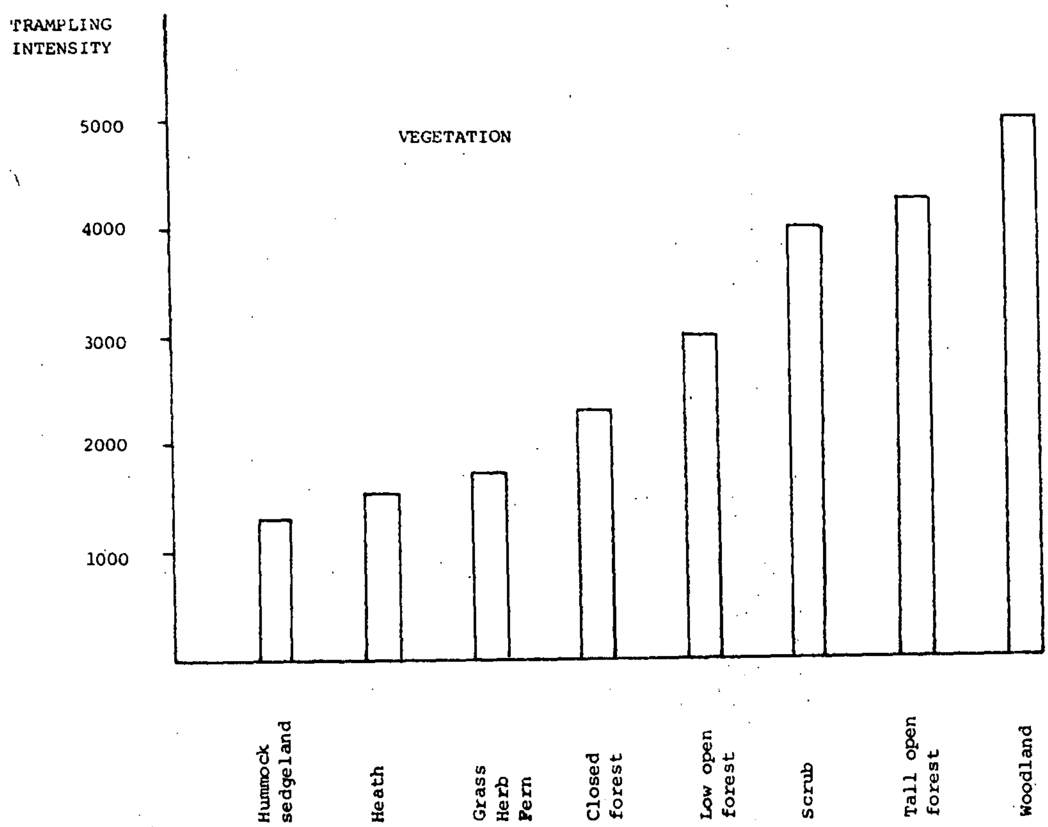
The threshold level for herbfield-grass-fern was the highest of all the treeless vegetation types; perhaps due to the association of this vegetation type with fertile soils, at medium to low altitudes. Thus, the herb-grass-ferns could be expected to recover more quickly than sedgelands or heath.

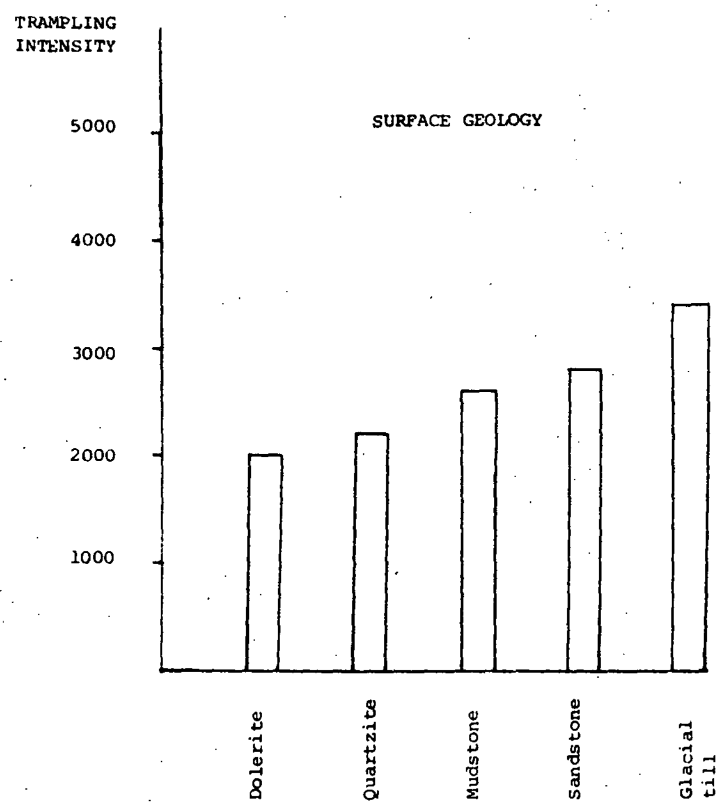
Fig. 4.6

THRESHOLD VALUES FOR VEGETATION TYPES

Fig. 4.7

THRESHOLD VALUES FOR SURFACE GEOLOGY TYPES


TRAMPLING INTENSITY
5000
4000
3000
2000
1000
VEGETATION
Hummock sedgeland
Heath
Grass Herb Fern
Closed forest
Low open forest
Scrub
Tall open forest
Woodland


TRAMPLING INTENSITY
5000
4000
3000
2000
1000
SURFACE GEOLOGY
Dolerite
Quartzite
Mudstone
Sandstone
Glacial till

4.5.2 Surface Geology (Fig. 4.7)

The threshold level differential between the substrate types investigated is small in comparison with the other environmental variables studied.

The most sensitive substrate dolerite, with a threshold level of 2000, is characterised by a yellowish brown soil with a high clay content. The removal of the top vegetation and peat layers, through foot traffic, exposes the lower clay loam. The lack of pore space decreases the infiltration rate and hence creates stagnant ponds of water. Maximum damage, therefore, is incurred during the wetter periods in the peak walking seasons, when walkers are forced on to the drier undisturbed sites. Even though the nutrient value of dolerite soils may be relatively high, the environmental stresses associated with the higher elevations where dolerite is common, mitigate against rapid recovery of the plant species.

Quartzite, a nutrient poor substrate, would appear to be as sensitive as dolerite. In this case, however, the major limiting factor to natural plant recovery is the depth of peat above the substrate. In areas like the Cradle Plateau, where the peat layer varies between 5 and 20 cm, plant recovery is a slow process, in contrast to Pine Forest Moor, where peaty soils of 1 metre in depth appear conducive to plant recolonization.

Mudstone and sandstone, with threshold values of 2600 and 2800 respectively, are generally associated with the lowlands of the southern region of the park. Forests and woodlands dominated by the family Myrtaceae are found on these substrates. Peat levels are shallow and the mineral soils beneath are coarse textured and hence have a higher resistance to erosion.

Morainic ground materials classified as "glacial till" pose low erosional risks on flatter terrain as compared with the deposits on the steeper slopes. Trampling on the latter exposes the subsurface drainage which in turn follows the line of least resistance down the track itself.

4.5.3 Slope

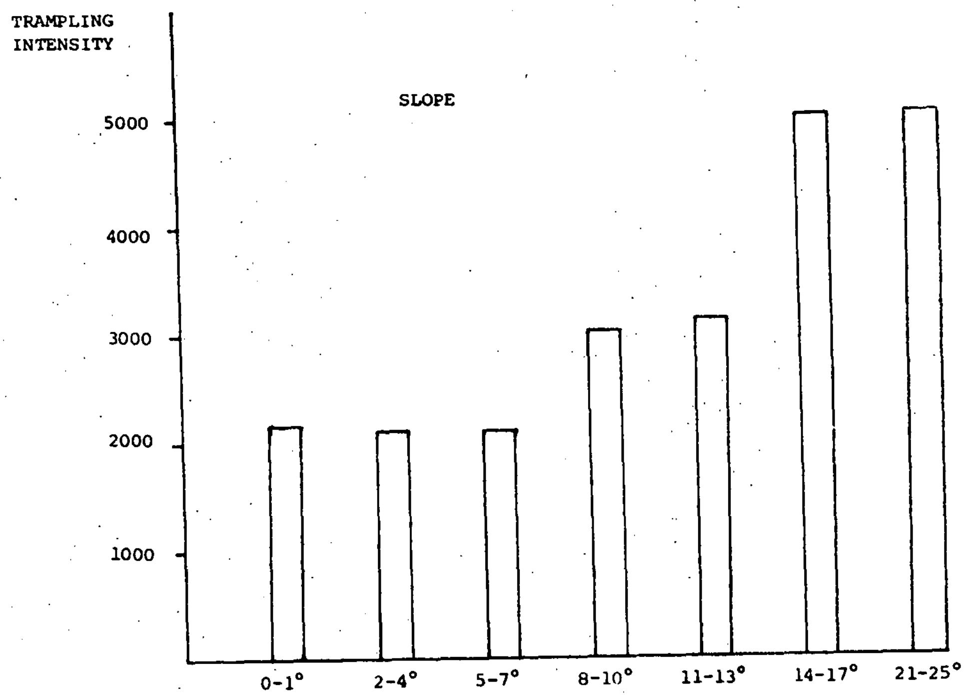
The threshold values (fig. 4.8) are consistent with the earlier analysis. The flatter the terrain, the lower is the threshold level. The optimal slope to minimize the horizontal extent of damage would appear to be between 14-17° with a threshold value of greater than 5000. On steep slopes visitors are naturally channelled along narrow pathways. Further, many of the steep tracks are on naturally exposed bedrocks or boulder streams where there is little potential for damage.

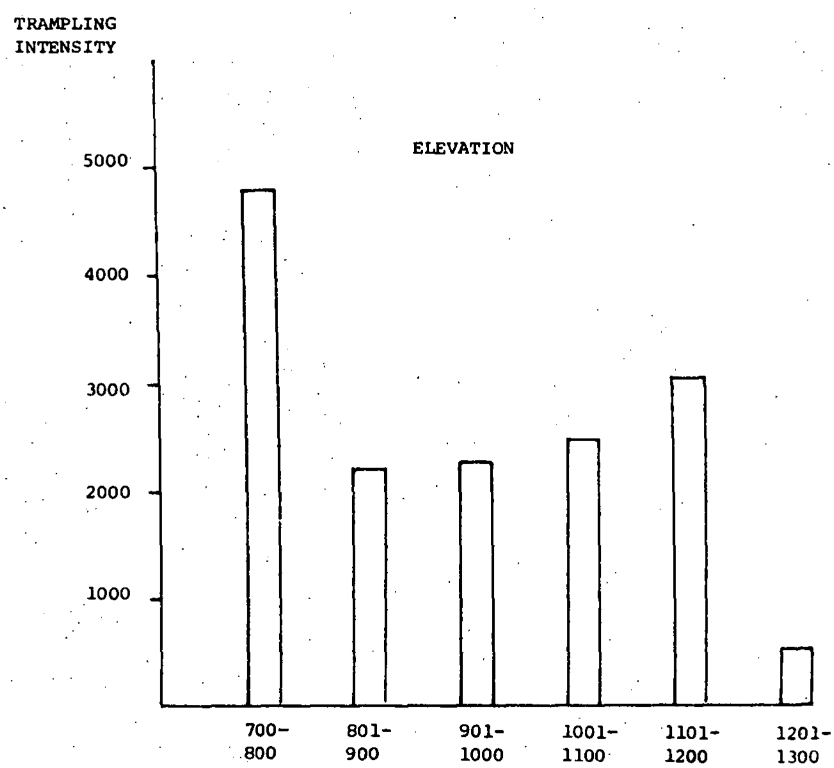
Fig. 4.8

THRESHOLD VALUES FOR SLOPE CLASSES

Fig. 4.9

THRESHOLD VALUES FOR ELEVATION CLASSES


TRAMPLING
INTENSITY
SLOPE
5000
4000
3000
2000
1000
0-1°
2-4°
5-7°
8-10°
11-13°
14-17°
21-25°


TRAMPLING
INTENSITY
ELEVATION
5000
4000
3000
2000
1000
700-
800
801-
900
901-
1000
1001-
1100
1101-
1200
1201-
1300

4.5.4 Elevation

It is apparent from the data that there is a polarization of the threshold levels between the two extremities in elevation classes, with the intermediate classes fluctuating about a mean of 2600. Areas located below 800 m are less prone to frost heaving and drainage problems. Further, with the relatively stable climatic variables, the regeneration rate of species damaged by trampling forces is sufficient to sustain an equilibrium between destruction and rehabilitation. Hence the high threshold level (Fig. 4.9).

Conversely, threshold levels of ecosystems above 1200 m are very low, in many cases not exceeding 500 persons per annum.

The small range differential between the intermediate classes would suggest that other factors may be more important than elevation in determining the threshold levels of ecosystems in these elevation classes.

4.6 TRACK DAMAGE MATRIX

Figure 4.10 represents examples of profiles of badly damaged tracks found within the different environments in the park. In Table 4.13, the common environmental variables associated with these track types are shown together with the lowest threshold value of the

TABLE 4.13

CHARACTERISTICS AND THRESHOLD VALUES OF DIFFERENT TRACK TYPES

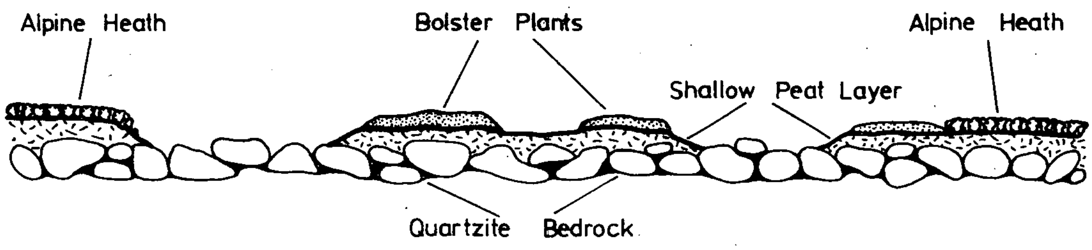
Track Type	Vegetation	Elevation	Geological Surface	Slope	Lowest Threshold level
Type A	Alpine Heath	1200-1300	quartzite	2-4/8-10	500
Type B -	(i) Hummock sedgeland	900-1000	quartzite	0-1/2-4	1250
	(ii) Heath				
	Richea scoparia				
	Richea sprengeloides	1000-1200	sandstone	17-25	1500
	Bakea gunninea		quartzite	2-4	1500
	Orites revoluta		dolerite	5-7	1500
Type C	Alpine heath	1100-1200	dolerite	5-7	1500
	Subalpine heath	900-1000	glacial till/schists	0-2	1500
Type D	Open-forest				
	Eucaluptus delegatensis	900-1000	sandstone	0-4	1500
	Leptospermum lanigerum				
Type E	Woodlands	1100-1200	dolerite	21-25	2000
Type F	Scrub	900-1100	glacial till	21-25	2200
Type G	Closed forest	700-800	mudstone	2-4	2300
		900-1000	sandstone	8-10	2200
Type H	Tall open forest	700-800	mudstone	14-17	2600

Fig. 4.10

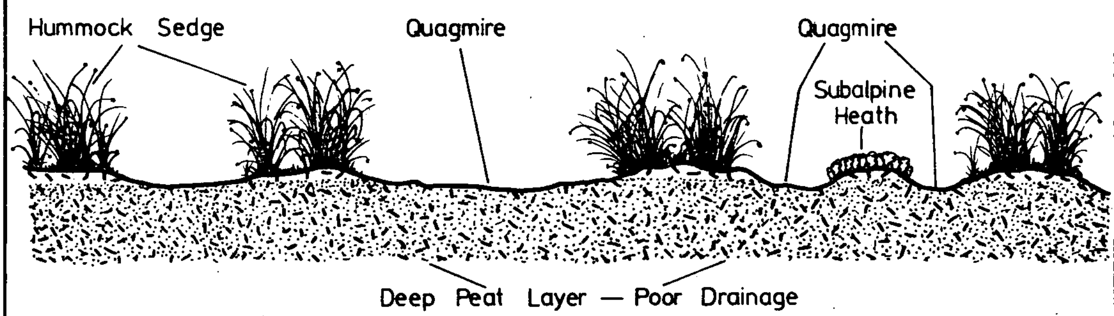
REPRESENTATIVE PROFILES OF BADLY DAMAGED TRACKS FOUND IN DIFFERENT ENVIRONMENTS

TRACK TYPES

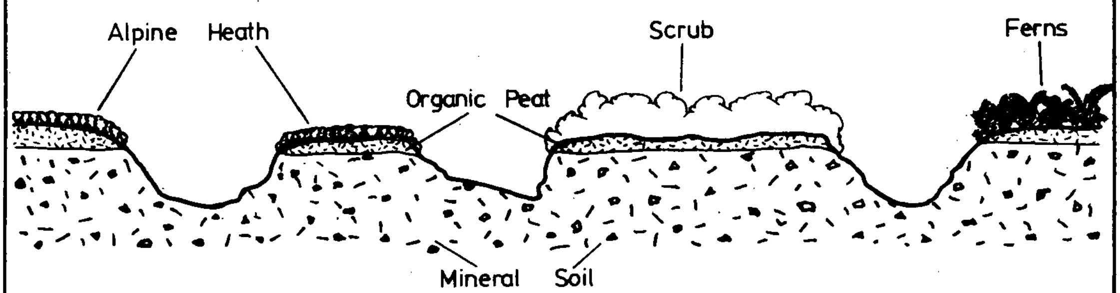
TYPE A.



TYPE B.

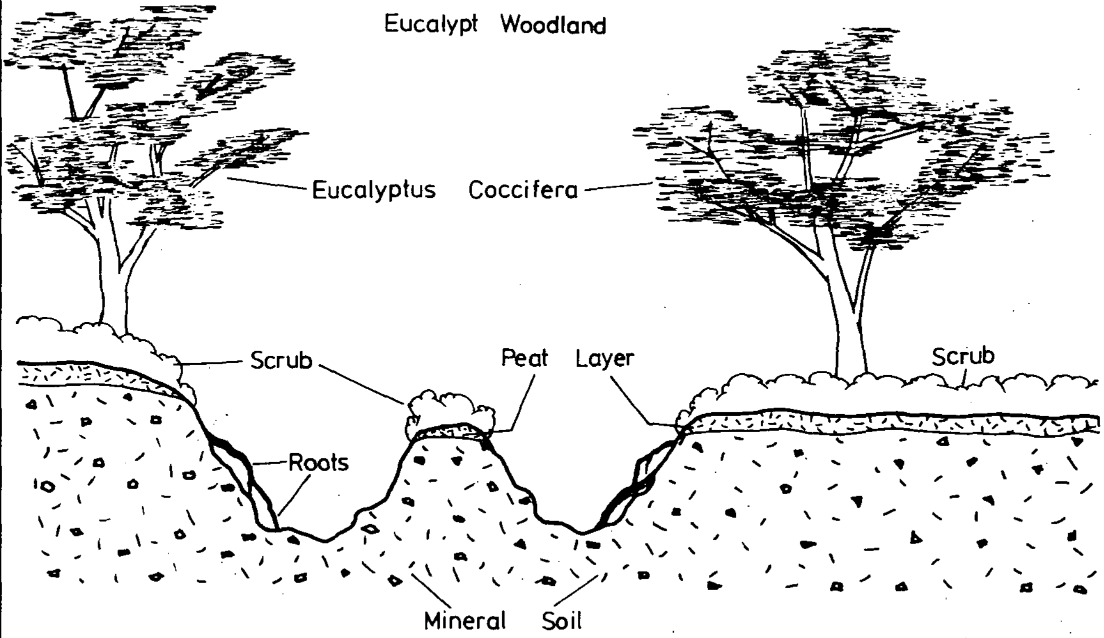


TYPE C.

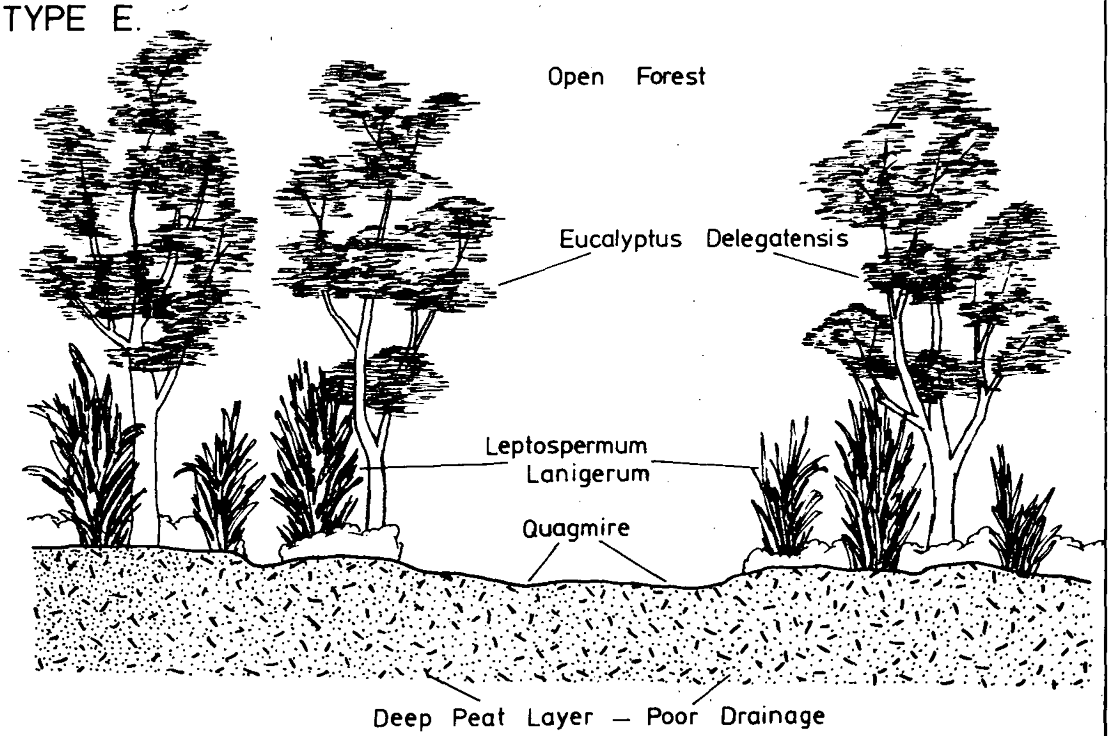


TRACK TYPES

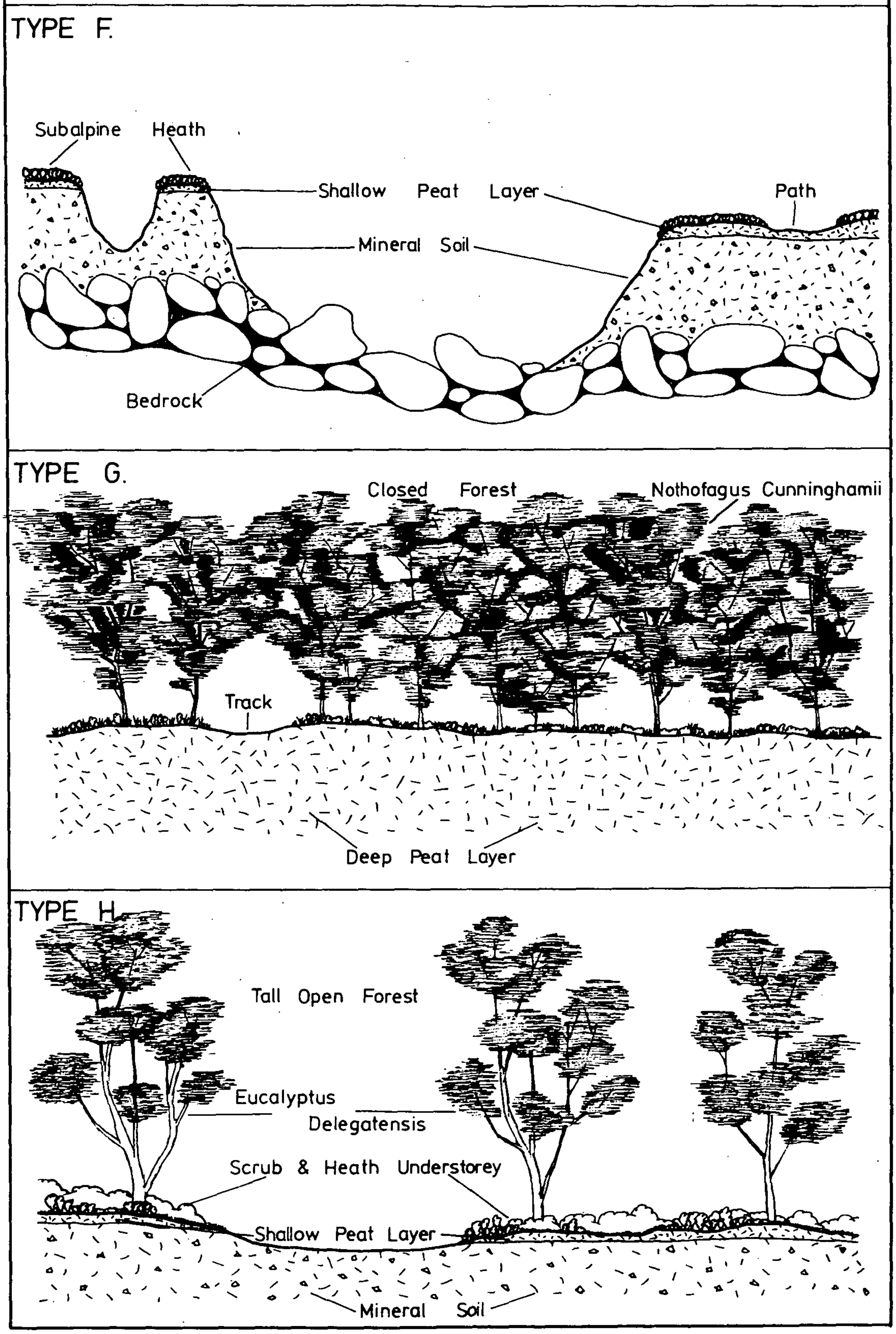
TYPE D.



TYPE E.



TRACK TYPES


TYPE F.
Subalpine Heath
Shallow Peat Layer
Path
Mineral Soil
Bedrock
TYPE G.
Closed Forest
Nothofagus Cunninghamii
Track
Deep Peat Layer
TYPE H.
Tall Open Forest
Eucalyptus Delegatensis
Scrub & Heath Understorey
Shallow Peat Layer
Mineral Soil

components of the respective track environments. These values would therefore represent the minimum traffic the ecosystem would be able to sustain before it is impaired. The figure does not necessarily represent the optimum carrying capacity of the ecosystem. The results, nevertheless, provide a guide to the vulnerability of the various ecosystems and the consequential track formation where traffic is left unchecked.

The following track damage types were identified in order of increasing threshold levels.

Type A

The environment in which this track type is found is characterized by its thin peat cover, and shallow soil depth in the flat and undulating parts of the alpine zone, where quartzite is the major geological substrate.

Trampling causes the destruction and subsequent removal of foliage. This is followed by erosion which exposes the quartz rock fragments. The impervious nature of this underlying substrate causes the creation of miniature streams during wet weather. The end result is the formation of wide anastomosed tracks, with little or no recolonization occurring on the exposed rocks.

Type B

The characteristic features of the environment in which this track type occurs are:

(i) the presence of deep peat;

(ii) the predominance of button grass tussocks;

(iii) poor drainage;

(iv) high water table.

All the above factors cause the formation of quagmires and wide tracks, for example, in the Pine Forest Moor. But, unlike Type A, recolonization of disturbed zones occurs as the tracks widen.

Type C

This track type is associated with the more fertile and clayey soils on dolerite. The tracks vary in width, depending on the terrain as well as the vegetation community. The removal of plant cover by trampling pressure compresses the underlying clayey soil, resulting in characteristic deep narrow grooves interspersed with stripes of ~~undisturbed~~ vegetation.

Type D

Tracks of this nature are commonly found in open woodland, with a thin peat layer and underlying mineral horizons. The track width is regulated by the distribution of larger trees which act as natural barriers. As

Plate 4.7 : Examples of tracks eroded down to bedrock on glacial moraines close to Waldheim. Tracks vary in depth from 0.5 to 2 m.

Plate 4.7

such, tracks are generally between 1-2 metres wide but feature deep channels formed through soil erosion and compression.

Type E

Tracks of this type are found in poorly drained sites with deep underlying peat. But, unlike Type B, the type of track is commonly associated with forested communities where the overstorey is dominated by *Eucalyptus delegatensis* and *Leptospermum lanigerum* and the understorey is dominated by *Gahnia grandis*.

Trampling reduces the plant cover and churns the moist peat soils into quagmires. Walkers find these boggy stretches unavoidable due to the thick undergrowth. Track widths vary from 2-5 metres.

Type F Plate 4.7

This track type is commonly associated with glacial moraines. Track construction, especially across the natural drainage lines on the moraine slopes, accelerates soil erosion, in particular channel erosion. This exposes the glacial till, and in most cases creates permanent scars. Tracks are narrow (1 - 2.5 metres) and natural colonization is non-existent on the exposed till.

Plate 4.8 : Example of tracks through closed forest cominated by *Nothofagus cunninghamii*.

Plate 4.9 : Examples of tracks located in the southern part of the National Park through tall open forest.

Plate 4.8

Plate 4.9

<u>Type G & F</u> (Plates 4.8 and 4.9)

These are examples of tracks in environments which have higher threshold levels - closed-forest and tall open-forest. Tracks are narrow and there is an insignificant amount of soil erosion.

The study has shown that the general threshold level for tracks in most ecosystems is 1500. This figure compares well with Bell and Bliss (1973) observations from Olympic National Park, United States and Bryan (1977) assessment of trail capability in the highlands of Sweden. They concluded that the general threshold level for complete breakdown of ground vegetation cover appears to be between 800 to 1000 users.

The threshold analysis has also shown that damage can occur at any location with sufficient use but at lower use densities, the degree of damage is closely related to vegetation, topography, and drainage. In addition, the survey highlights the need for further research on the relationships between soil properties and the level of degradation on the tracks.

In conclusion, the track survey described in the preceding sections, provide critical information for the management of national parks. It provides basic information:

(i) on the state of the tracks

(ii) for making decisions on carrying capacity,

(iii) for efforts to redirect use or visitor traffic,

(iv) for guidance in the construction and development of new tracks,

(v) for planning the works programme for park rangers,

(vi) for the monitoring of the rate of track deterioration over time and space.

CHAPTER V

VEGETATION AND SOIL DYNAMICS

5.1 INTRODUCTION

The objectives of this section of the study were:

(a) to ascertain the relative susceptibility of plant species to trampling pressure;

(b) to determine, the spatial and temporal patterns of species recolonization after the removal of trampling pressure; and

(c) to identify the impact of trampling on the physical condition of the tracks.

Researchers have in the past developed three major approaches to the study of recreational impact on the physical and biological environments:

1. after the fact analysis: Bogucki *et al* (1975), Cole (1975);
2. monitoring of change through time: La Page (1967), Frissell (1978); and
3. simulation experiments: Kellomaki *et al* (1975), Quinn *et al* (1980).

The methodology used in this particular study monitors changes to the physical environment through time both on a short and long time scale. The short term approach monitors firstly, the effect of trampling pressure

Fig. 5.0

LOCATION OF EXPERIMENTAL SITES

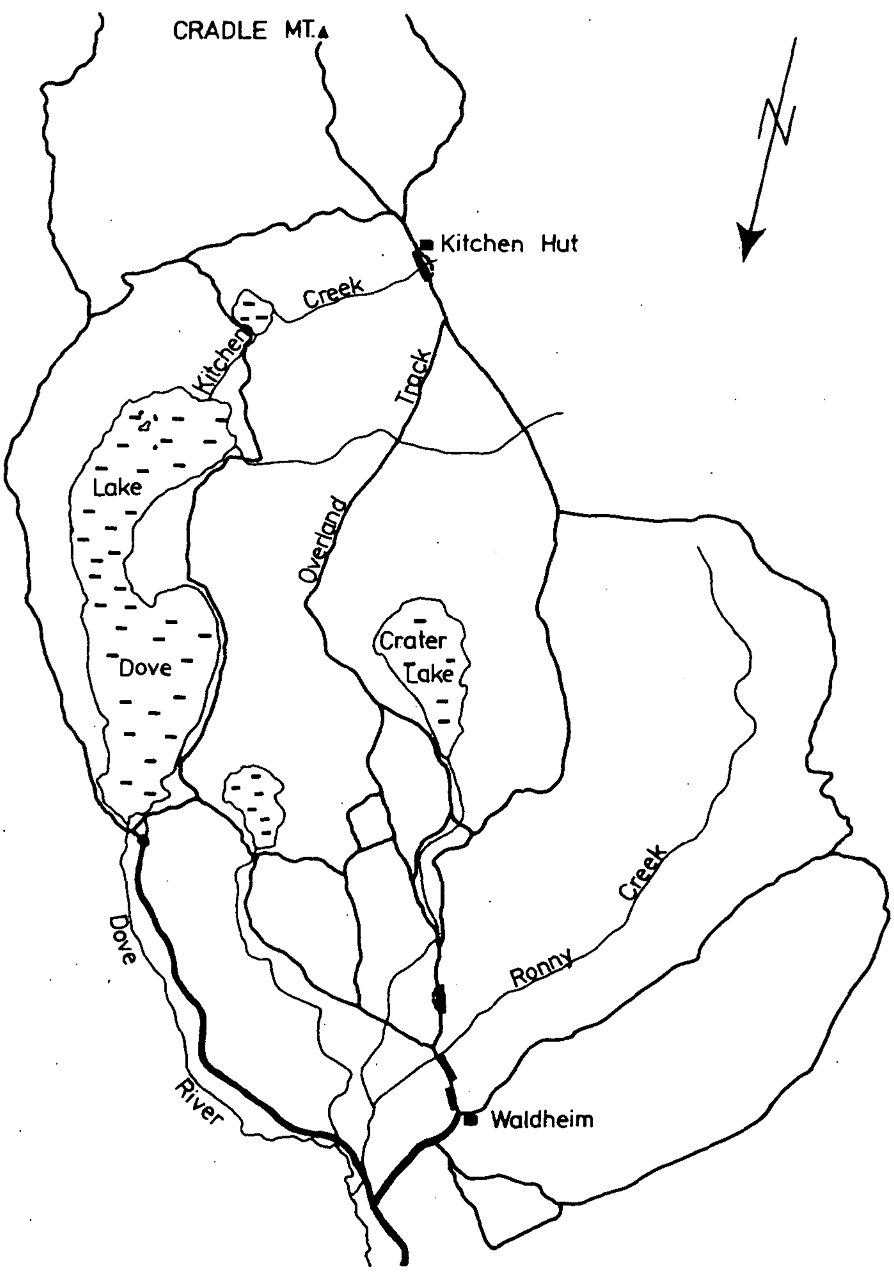
- KITCHEN HUT

  RONNEY CREEK

  WALDHEIM

Figure 5.

EXPERIMENTAL SITES - LOCATION MAP



New Tracks

Recolonization Transects

SCALE ≃ 1:32,000

on previously undisturbed areas in two different ecosystems over a period of a year and secondly, the variation of track widths and the degree of soil erosion over the same period. The long term project monitors recolonization on adjacent previously eroded areas.

5.2 EXPERIMENTAL SITES

The experimental sites were located to include alpine heath (Kitchen Hut), tussock grassland and hummock sedgelands (Cradle Valley), (Fig. 5). The alpine experimental site has a plant community dominated by bolster plants and prostrate gymnosperms growing on shallow peat over quartzite. In Cradle Valley, there were two geographically different experimental sites, the first close to Waldheim and the second located on undulating terrain 50 m south of Ronney Creek. The vegetation of the site near Waldheim is dominated by tussock grasses and sedges. The site near Ronney Creek was covered by sedges, rushes and ferns. The soils of the latter site are mainly derived from quartzitic till and as a consequence are probably less fertile than those found under grasslands on the schists near Waldheim.

5.3 METHODS

5.3.1 Susceptibility of Plant Species

In order to determine the susceptibility of the vegetation to trampling, two new diversions around previously established tracks were created in the Ronney Creek area and on the Cradle Plateau, 100 metres north of Kitchen Hut. The new tracks, located on previously lightly trampled and untrampled vegetation, were 21 metres and 30 metres in length respectively. The impact of trampling on the plant species was determined by calculating the change in species cover in thirty, metre-square quadrats, located orthogonally in groups of three across each of the above tracks. The cover measurements were recorded twice, once before the trails were used by walkers (June 1978) and at the termination of the 1978-79 walking season (May 1979).

5.3.2 Recolonization

The patterns of species recolonization on previosly eroded tracks were studied in three areas, Kitchen Hut, Ronney Creek and Waldheim. In each case, transects of metre-square quadrats were located across tracks which displayed varying stages of soil erosion ranging from trampled vegetation to areas with exposed mineral soil subsurfaces to tracks eroded to rock fragments and natural bedrock. Further transects were also situated on poorly drained areas, typical of the quagmires present on many trails. In total there were 25 quadrats at Kitchen Hut, 30 at Ronney Creek and 30 at Waldheim. The transects at Ronney Creek and Kitchen Hut were located in areas adjacent to the new tracks created for the earlier investigations. This enabled the simultaneous monitoring of the trampling susceptibility and the regeneration rate of plant species. All quadrats were identified with permanent markers.

The distribution of plant species and eroded zones within each quadrat were mapped to scale and the plant cover noted. The spatial distribution of seedlings and vegetative shoots which survived the preceding summer were also mapped and their densities recorded. In the case of the vegetatively reproducing plants each separate shoot was counted as an individual. Similarly, at the end of the following growing season, the location of all new individuals were mapped together with the variation of the existing plant cover. In the cases of Kitchen Hut and Ronney Creek the results pertain to the first year in which the trampling ceased. In the case of Waldheim, the construction of a walkway which removed trampling pressure from the old track took place in December 1976. Thus the results pertain to the third growing season after trampling was discontinued.

At all the experimental sites, large signs with brief explanations of the objectives of this project were erected. Visitors were requested to keep to marked paths or to wooden walkways (Plate 5.1). Field observations indicated a high degree of compliance with the directions on the signs.

Accurate estimations of trampling pressure across the newly erected diversions were obtained from an electric pedestrian counter, consisting of a pressure sensitive mat, long life battery and an electronic counter. The pressure sensitive mat was designed so that a walker stepped on it only once at a normal gait. The battery, the mechanical counter, and the transitorised circuit were enclosed in a sealed plastic container. As a preventive measure against vandalism and deliberate distortion of readings, the mat was camouflaged and the electronic equipment well hidden.

5.3.3 Bulk Density

Soil cores were obtained from all sites. After removing the surface vegetation, a metallic cylinder with a volumetric measurement of 415 c.c. was driven carefully into the soil. The cylinders were extracted and the bases levelled with a knife. The soil cores were then immediately placed into polythene bags and sealed with a wire fastener to prevent any moisture loss.

The field water content of the cores was determined after drying the soil samples for 48 hours at 105°C, and the bulk density expressed as grams of oven dry soil

Plate 5.1 : The site of the experimental area at Ronney Creek. A sign explaining the objectives of the research was erected, and field observation indicated a high level of compliance with the instructions.

Plate 5.2 : The erosion monitoring equipment.

Plate 5.1

Plate 5.2

per cubic centimetre. In any soil sample the bulk density is regulated by the quantity of pore spaces as well as soil solids. Limitations of time and money, prevented any standardization of soil samples following the removal of large particles.

5.3.4 Soil Erosion

Soil loss was measured at monitoring stations located across a previously lightly trampled track and the new track diversion created at Ronney Creek. Thirteen pairs of wooden stakes were located along the path. A horizontal bar was placed between these stakes and a rod inserted vertically through holes drilled in the bar. A small spirit level was attached to the bar, ensuring the heights were always measured from a horizontal position (Plate 5.2). The sampling interval chosen for measurements across each section was 5 cm. Vertical readings were obtained at 5 different periods between June 1978 and May 1979. The variation of the vertical measurements during each reading, was used to monitor soil loss.

The following equation was used to calculate the area (A) from the horizontal bar to the ground surface within the two fixed points -

$$A = \frac{V1 + V2}{2} + \frac{V2 + V3}{2} + \ldots + \frac{Vn + Vn{+}1}{2} \times D$$

where

A = area in square mm^2

Vn = vertical distance measurement (mm)

D = interval on horizontal axis (50 mm)

An increase in area from one measurement to another at each individual site indicates soil loss (Leonard & Whitney 1977).

One possible disadvantage of the above method is the restriction on the width caused by the positioning of the fixed points (1.5 metres apart in this case). Nevertheless, after one season of trampling, the tracks did not exceed this width.

5.4 VEGETATION DYNAMICS

The data have been grouped by species and locations and are expressed as percentage of overlapping cover and mean density, where the latter is defined as the number of individuals less than 12 months old per quadrat. Further, species data are aggregated into six lifeform groups: tussocks, shrubs, rosette plants, forbs, rhizomatous monocotyledons and lower plants. Data on the regenerative densities and the distribution of the colonizing plant species over the different track surfaces are tabulated in Appendix 7.

5.4.1 Kitchen Hut

(a) The New Track - Cover Analysis

During the period June 1978 to May 1979, approximately 5000 hikers had trampled over this new track, resulting in a 42% reduction in the total overlapping cover as well as an 18% reduction in species diversity.

The life forms most susceptible to foot traffic were the shrubs (Table 5.1). Their overlapping cover was reduced from 76.5% to 30.2%. The major susceptible species included the endemic gymnosperms *Diselma archeri* and *Michrocachrys tetragona* whose overlapping covers decreased from 22.2% to 13.3% and 16.4% to 4.8% respectively. *Epacris serpyllifolia* and *Cyathodes dealbata* were the other sensitive shrub species.

The bolster plants were the more resistant species in this life-form group. *Donatia novae-zelandiae* and *Dracophyllum minimum* experience less damage than the softer *Pterygopappus lawrencii* and *E. meredithaeae*. Bolster epiphytes such as *Drosera archeri* were the immediate victims of trampling. The more compact bolster plants were often found in boggy ground and were therefore partially cushioned by mud and water from direct trampling forces.

All other lifeforms suffered only marginal decreases in overlapping cover. Rhizomatous monocotyledons had

TABLE 5.1

THE CHANGE IN THE OVERLAPPING COVER OF DIFFERENT LIFEFORMS IN THE KITCHEN HUT AREA

AFTER ONE YEAR OF TRAMPLING

Lifeforms	Percentage Overlapping Cover Original	Final	Percentage Cover Change
Tussocks	18.3	9.5	- 8.8
Rhizomotous monocotyledons	36.6	25.4	-11.4
Rosettes	9.6	3.1	- 6.5
Forbs	10.5	3.2	- 7.3
Mat Covers and Shrubs	76.5	30.2	-46.3
Moss and Lichen	4.1	1.5	- 3.6
Bare Ground	11.1	25.5	+14.4

an 11.4% reduction, with the largest decrease incurred by *Empodisma minus*, 8.9% to 3.4% after the first season of trampling. The other rhizomatous monocotyledons affected were *Oreobolus pumilio* and *Astelia alpina*.

The tussocks, *Carpha alpina*, *Poa* sp and *Microleana tasmanica* had their overall overlapping cover reduced by 8.8%, the most susceptible species being *C. alpina*. This species is commonly found in the permanently wet and acidic environments. *Hierochloe fraseri*, an alpine grass, was completely eliminated.

The rosette plants encountered along the new track included *Celmisia saxifraga*, *C. longifolia*, *Helichrysum milliganii* and *Actinotus suffocata*. Together the rosette plants had an original overlapping cover of 9.6% which was subsequently reduced to 3.1%, representing an overall reduction of 67%. Moss and lichen, similarly, experienced a 70% reduction of the original cover.

The soft leaved forbs seem to resist trampling to a lesser extent than the above lifeforms. The most drastically reduced forb was the prostrate fern *Lycopodium fastigiatum*. *Erigeron pappachroma* and *Mitrasacme archeri* were totally eliminated by trampling. Approximately 69.5% of the total forb cover was lost during the first year of trampling. Whilst the overall vegetative cover was reduced, the percentage of bare soil more than doubled

Plates 5.3a, b and c : The impact of trampling on a newly created track at Kitchen Hut;

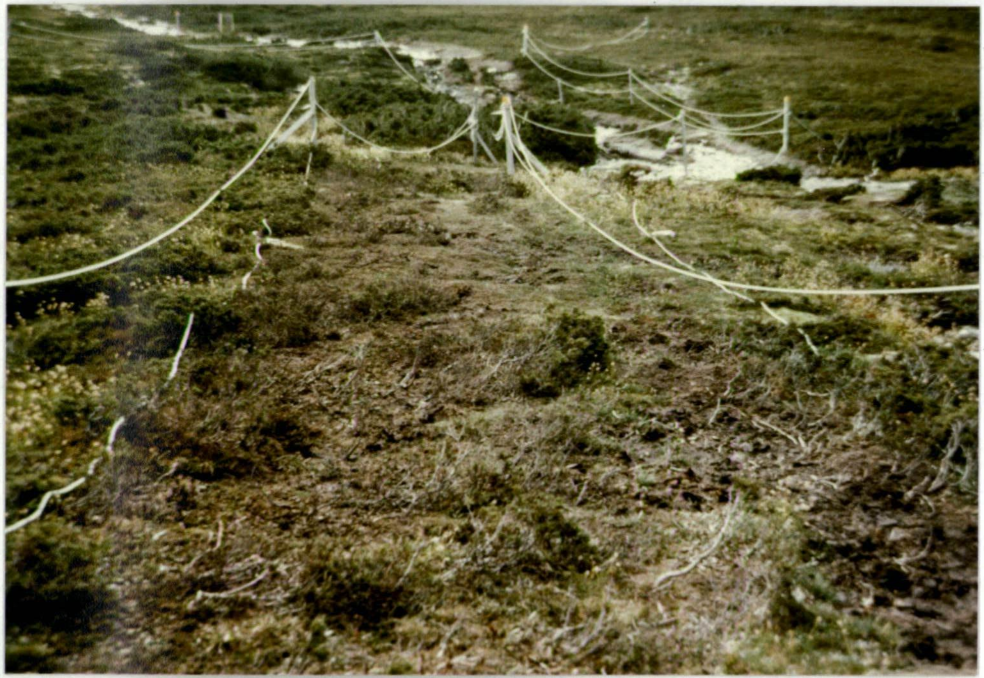
(a) before trampling in June

(b) January the following year

(c) October the following year

5.3a

5.3b



5.3c

in the first season, increasing from 11.1% to 25.5% of the track.

What began as a new track, became a muddy quagmire 30 cms deep in sections. The rate of deterioration of the track is best illustrated by the photographs (Plates 5.3a,b,c). The 1500 walkers who had passed through by January were sufficient to cause severe damage.

(b) <u>Recolonization</u>

The results that follow were derived from field surveys conducted after the growing season. Measurements taken in June 1978 included only those plants which survived the preceding summer's trampling, whilst those taken in 1979, also included plants that survived the natural forces of frost heaving and erosion.

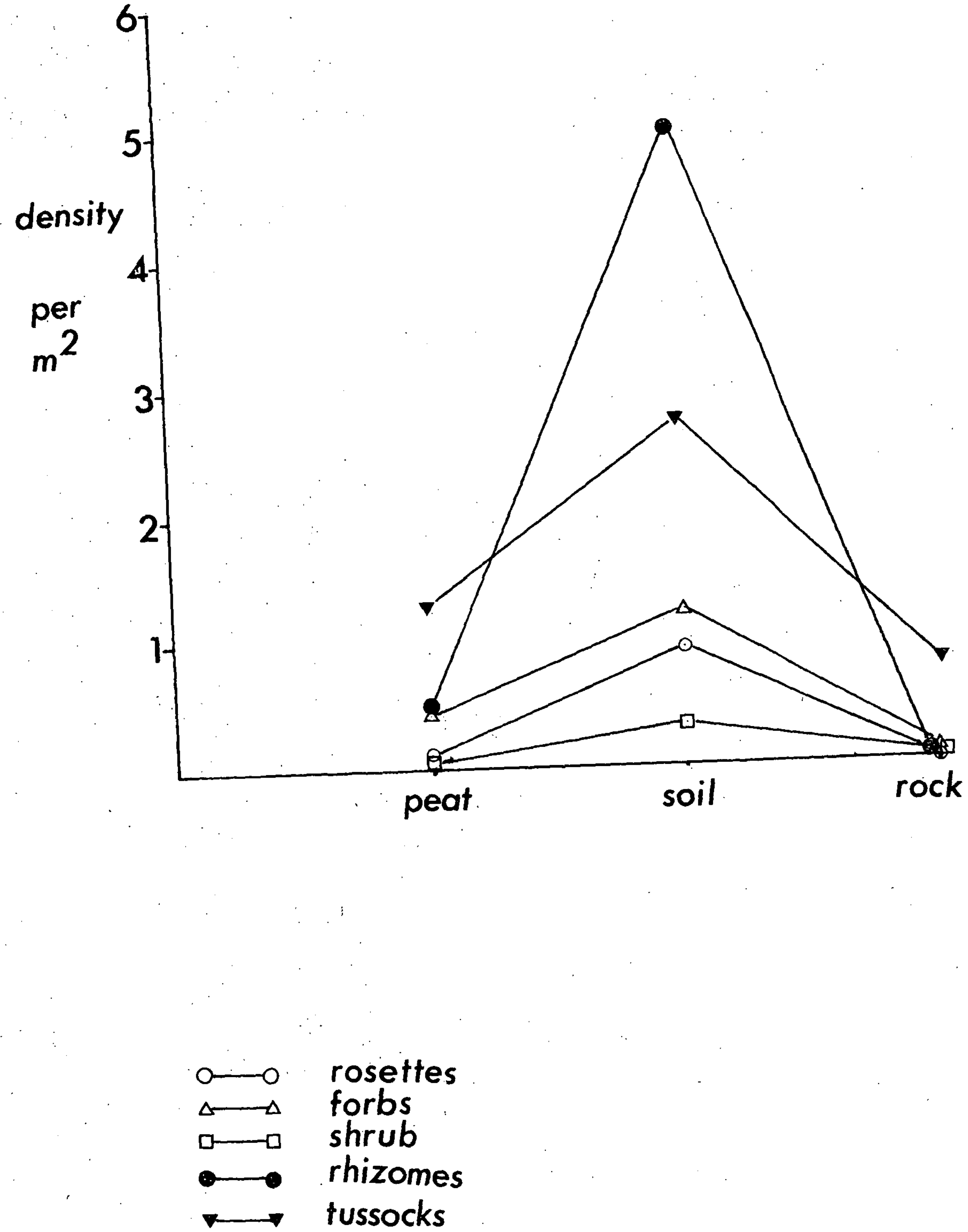
Appendix 7.1 shows the variation in species densities between the seed regenerators and the vegetative reproducers. It is apparent that, with the exception of *Ewartia mereditheae* and *Gentianella diemensis*, all species increased their density over one season. The most prolific colonizer in this alpine zone was *Empodisma minus*, whose density increased from 0.08 per m^2 to 3.24 per m^2, followed by *Abrotanella scapigera*, *Scirpus aucklandicus*, *Carpha alpina* and *Poa gunnii*. In this area of severe environmental stress, the vegetative mode of reproduction is more successful than reproduction by seed. Seedlings

Fig. 5.1

DENSITY OF LIFEFORMS ON DIFFERENT TRACK SURFACES

IN THE KITCHEN HUT AREA

FIG 5·1



6
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3
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1
density
per
m2
peat
soil
rock
rosettes
forbs
shrub
rhizomes
tussocks

had an overall increase in their mean density of 5.6 per m^2 as compared to an increase of 8.6 per m^2 among the vegetative reproducers. However, in terms of overlapping cover the vegetative reproducers actually experienced a slight reduction from 19.54% to 19.2%, whilst the seed producers increased their cover from 14.56% to 15.0%.

The spatial distribution of the colonizing species, grouped accordingly to their morphological characteristics, on the different track surface materials is illustrated in Figure 5.1.

Rhizomatous monocotyledons

Empodisma minus, *Scirpus aucklandicus* and *Oreobolus pumilio* were the dominant colonizing species in this group. Their combined density increased by 5.5 per m^2 (Appendix 7.2). They were strongly associated with areas eroded down to the silty loam subsurface. Only *O. pumilio* regenerated on acidic peaty soils.

Tussocks

Unlike the rhizomatous monocotyledons, the tussock seedlings were germinating in all three types of track surface. Field observations indicated that the regeneration of tussock species was most frequent in the protected niches along the track shoulders and in particular on their leeward side. *Poa gunnii* is the major colonizer of tracks eroded down to rock fragments or bedrock. *Poa* establishes on moss cover in small pockets of soil trapped between rock fragments. *Microlaena tasmanica* was commonly associated with the better drained sites. *Carpha alpina*, with a mean density of 1.08 per m^2 was the most prolific colonizer of any of the tussock species.

Shrubs

Four shrub species displayed colonizing abilities in the first growing season. Of these, *Epacris serpyllifolia* was the only erect shrub, the remainder being bolster plants. Like the tussocks, *E. serpyllifolia* seedlings were located on the sheltered parts of the eroded tracks. The major colonizing bolster plants, *Donatia novae-zelandiae* and *Pterygopappus lawrencii*, were strongly associated with the mineral soil environments, whilst *Dracophyllum minimum* did not expand in the first season. *Ewartia mereditheae* seedlings were removed by water erosion. The mean density of the shrubs was the lowest of all the lifeforms.

Rosettes

The germinating rosette species included *Actinotus suffocata*, *Diplaspis cordifolia*, *Celmisia saxifraga* and *Rubus gunnianus*. Together these species increased their mean species density by 1.0 per m^2. *C. saxifraga* and *D. cordifolia* increased their density by a single individual each. The mineral soil surface is apparently the most favourable environment for rosette colonization.

Forbs

The forbs were represented by *Abrotanella scapigera*, *Euphrasia striata* and *Gentialla diemensis*, of which *A. scapigera* was the most prolific colonizer. It germinated in all soil types, but showed a marked preference for the mineral soils. *E. striata* and *G. diemensis* on the other hand displayed epiphytic characteristics and established on bolster plants. The forbs increased their species density from 0.04 per m^2 to 1.80 per m^2.

(c) Cover

The paucity of species regeneration in this alpine zone would therefore explain the small increase of 1.2% in the total overlapping plant cover within the quadrats.

The percentage of bare ground, on the other hand, increased from 59.9% in 1978 to 61.5% in 1979, with a corresponding reduction of plant cover of 1.6%. This decrease occurred in transect 3, where the existing plant cover consisted of disintegrated clumps of *Donatia novae-zelandie* and *Dracophyllum minimum*. Water erosion may have contributed to their removal. In an attempt to obtain a rough estimation of soil movement down the slope, five six-inch nails were embedded in to the ground level, at the beginning of the investigation. A year later, there was an average

TABLE 5.2

CHANGE IN THE OVERLAPPING COVER OF DIFFERENT LIFEFORMS IN THE RONNEY CREEK AREA AFTER ONE YEAR OF TRAMPLING

Lifeforms	Percentage Overlapping Cover Original	Final	Percentage Cover Change
Tussocks	36.5	26.4	-10.1
Rhizomotous monocotyledons	50.1	24.7	-25.4
Rosettes	0.7	+ 1.2	+ 0.5
Forbs	49.6	21.3	-28.3
Shrubs	13.2	3.6	- 9.6
Moss	0.1	0	- 0.1
Bare Ground	0.80	15.1	+14.3

of 5 cm of soil eroded from each nail, representing a total loss of 2500 cm^3 of soil during the course of one year over an area of 5 m^2.

5.4.2 Ronney Creek

(a) New track - Cover analysis

During the period June 1978 to May 1979, the quadrats on the track across the subalpine meadow vegetation dominated by *Gleichenia dicarpa, Restio australis* and *Empodisma minus* had a 48% reduction in total overlapping plant species cover. The estimated foot traffic during this period was 6500. This amount of traffic resulted in a reduction in species diversity by 15% and increased the amount of bare ground from 0.8% to 15.1%.

As in the previous section, the species are grouped according to this morphological characteristics and the variation in overlapping cover monitored over one full season of trampling (Table 5.2).

Forbs

Gleichenia dicarpa experienced the largest reduction in cover from 49.1% in 1978 to 20.8% in 1979.

Rosettes

Unlike other species which either had reductions in cover or remained unaffected, *Rubus gunnianus* was the only species to increase its overlapping cover during the first summer from 0.7% to 1.2%. It colonized areas devoid of vegetation, usually along the track edge.

The other rosettes - *Viola hederacea*, *Celmisia longifolia* and *Laginifera stipitata* were unaffected by walkers. They were generally found in the lightly trampled grass close to the edge of the new track.

Rhizomatous Monocotyledons

The rushes *Restio australis* and *Empodisma minus* were the major representatives of the rhizomatous monocotyledons. Trampling reduced their cover by 14% and 11.4% respectively.

Shrubs

The overlapping shrub cover was reduced by 9.6% of which *Boronia rhomboidea* accounted for 7.6%, followed by *Epacris lanuginosa* and *E. gunnii*. The prostrate, yellow flowered *Hibberta procumbens* had its cover reduced by 0.4 percent. *Boronia citriodora* and *Baeckea gunniana* both had marginal decreases in cover of 0.2%.

Tussocks

About a third of the vegetative cover along the track consisted of tussock species, of which *Lepidosperma filiforme*, *Gymnoschoenus sphaerocephalus* and *Poa gunnii* were the most important. The tussocks experienced a 10% reduction of overlapping cover. *L. filiforme* was the most susceptible tussock, its cover being reduced from 18% to 12.6%. There were only two *Gymnoschoenus* tussocks located on the track, both of which were found on the southern end of the track, over which all bushwalkers had to pass. After 6500 people its overlapping cover was reduced by 2.4%, whilst the overlapping cover of the other tussock species *Poa gunnii*, *Carpha alpina* and *Diplarrhena moraea* decreased by 1.8%, 0.3% and 0.2% respectively.

The absolute reduction in the vegetative cover, within the quadrats as indicated by the increase in bare ground was similar to the alpine area.

The path formation process in this subalpine zone, differed considerably from that in the alpine zone. The first signs of trampling damage was the lighter colouration of the dominant species, *Gleichenia dicarpa* and *Empodisma minus*, as well as the flattening of the upright parts of *L. filiforme*, *B. rhomboidea* and *Restio australis*. By the end of November (1500 people) bare patches of ground began to appear, especially in the moister sites. As traffic increased, the ground beneath the dead plants became exposed and foot and water erosion invariably led to soil loss and the expansion of the bare areas. Traffic appeared to have aligned itself to the path initially formed and the rate of lateral expansion was slow as compared to the Kitchen Hut track, where the traffic was evenly distributed between the constraining ropes. (Plates 5.4a and b).

(b) Recolonization (Appendix 7.3 and 7.4)

The overall density of plants apparently less than a year old increased from 5.8 per m^2 in 1978 to 44.7 per m^2 in 1979 with the increase in species marginally higher amongst the vegetative reproducers (24.5 per m^2) as against the seedlings (21.0 per m^2). Similarly, the variation in the percentage of overlapping cover between the two groups was insignificant, an increase of 5.3% and 5% within the seedlings and the vegetative reproducers respectively.

Unlike the alpine zone, there was little evidence of mortality amongst the young plants which survived the 1978 walking season. However, there was evidence of animal grazing, which may have reduced growth rates.

Rhizomatous Monocotyledons

Twenty-two percent of all colonizing species were rhizomatous monocotyledons. Their increase in species density and overlapping cover was the highest of all lifeform groups - 14.9 per m^2 and 4.3% respectively. *Scirpus aucklandicus* was the dominant colonizer, increasing from an initial density of 2.9 to 12.5 per m^2 in 1979, with a simultaneous increase in cover of 2.6%. This

Plate 5.4a : The vegetation cover of the new track in the Ronney Creek prior to trampling.

Plate 5.4b : The vegetation cover of the new track at Ronney Creek after one years' trampling.

Plate 5.4a

Plate 5.4b

increase mainly occurred in moist peaty areas, where the number of individuals per square metre increased from 2.5 to 9.5. It also proved to be an effective colonizer of tracks eroded down to rock fragments. In this case, its mean species density was 2.5 per m^2 (Fig. 5.2).

Empodisma minus and *Restio australis* were the other major colonizers in this group, with regeneration rates higher on peat surfaces as against the other track environments.

Tussocks

The tussocks formed the biggest group of colonizers and their overall density increased by 8.4 per m^2, whilst their overlapping cover increased by 2.4%. *Microlaena tasmanica*, with a density increase of 3.6 per m^2 and was strongly associated with peaty soil surfaces. *Poa gunnii* seedlings were located in all three track surface types but were concentrated on peaty soils. *Schoenus apogon* and *Luzula* were found in both peat and rock fragments and were closely associated with *Scirpus* regeneration. The only buttongrass seedling was found germinating on the eroded section of Transect 3.

Rosettes

The solitary rosette colonizer was *Rubus gunnianus*, the native strawberry. Its seedlings were established

Fig. 5.2

LIFEFORM DENSITIES ON TRACK SURFACES

IN THE RONNEY CREEK AREA

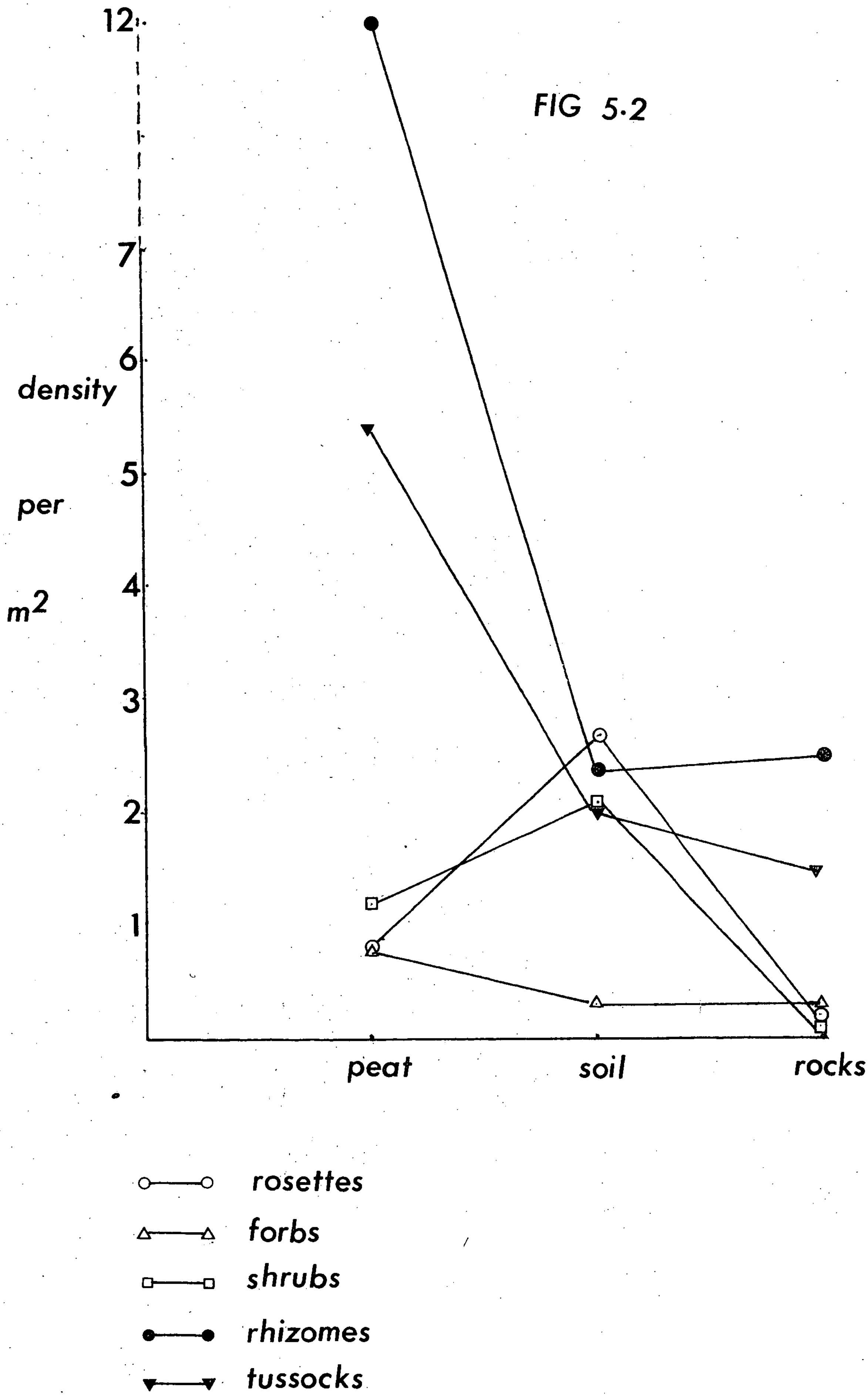
FIG 5·2
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6
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per
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peat
soil
rocks
rosettes
forbs
shrubs
rhizomes
tussocks

along track shoulders where the top peaty layers had been removed by erosive forces. The mean density of *R. gunnianus* increased by 3.8 per m^2 resulting in a cover increase of 1.0%.

Shrubs

The sole shrub colonizer was *Hibbertia procumbens*. It established itself on all track surfaces but was most abundant on mineral soils. Even though it had an increase in species density of 3.4 per m^2, or less than a third the density of rhizomatous monocotyledons, the percentage increase in overlapping cover was 1.6 or approximately 40% that of the rhizomatous monocotyledons. Therefore, in terms of increased cover and soil stabilization, *H. procumbens* would appear to be one of the most important natural recolonizers in this environment.

Forbs

The herbs *Gonocarpus micranthus* and *Acaena novae-zelandiae* had an overall increase in abundance of 1.5 m^2. *G. micranthus* was the more vigorous colonizer, establishing in all environments, and was most abundant in the moist sites, while *A. novae-zelandiae* was commonly located on the drier track shoulders.

(c) Cover

The mean overlapping plant cover increased from 29.6% in 1978 to 40% in 1979, an overall increase of 10.4% in cover in the quadrats. The absolute cover, determined by the decrease in the percentages of bare ground, increased by 7.1%. The percentage of peaty soils decreased by 4.4%, mineral soils by 1.4% and the rock fragments cover decreased by 1.3%.

5.4.3 Waldheim

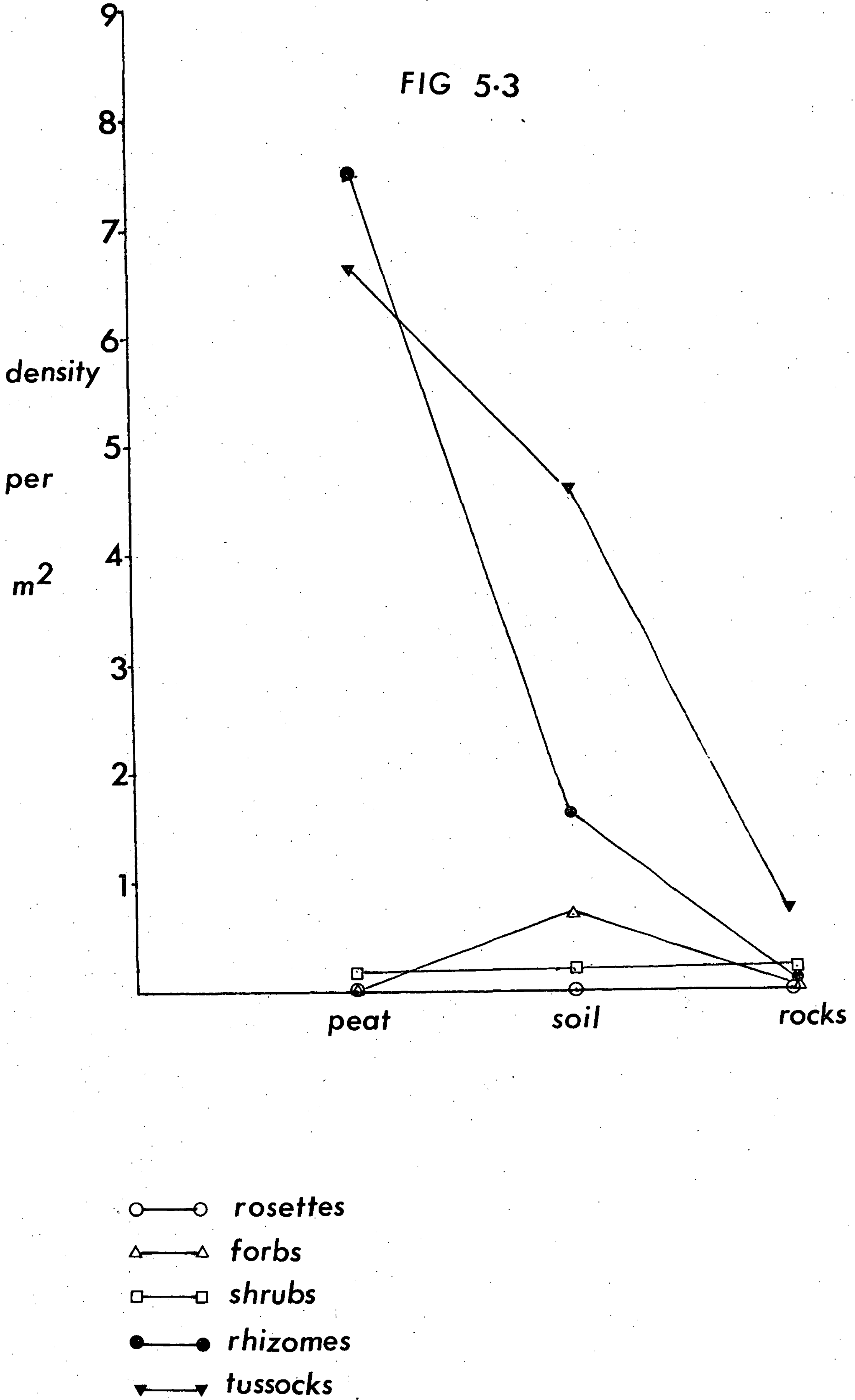
(a) Recolonization

As mentioned previously, no records, photographic or otherwise, were kept on the extent of erosion and track deterioration prior to the construction of the wooden walkway. The results obtained in this area, would therefore, only reflect the change in species density and cover for the 1978-79 period. Data analysis is along similar lines to the previous sections. Unlike the other experimental site, the regenerative rate of seedlings is higher than that of the vegetative reproducers. Seedlings increased their density from 4.5 per m^2 to 17.4 per m^2, whilst vegetative reproducers increased from 1.9 to 3.9 per m^2 (Appendix 7.6). In terms of cover, the same trend persisted, with the seedlings providing an increase in plant cover of 3.5%, as compared to the rhizomatous species cover of 1.48%.

Fig. 5.3

DENSITY OF LIFEFORMS ON DIFFERENT TRACK SURFACES

FIG 5·3



9
8
7
6
5
4
3
2
1
density
per
m^2
peat
soil
rocks
rosettes
forbs
shrubs
rhizomes
tussocks

Tussocks

The dominant tussock colonizer is *Poa* which increased its mean density from 3.4 to 9.9 per m^2. It exhibits the same trend as the other experimental sites, being distributed on the peaty soils and the mineral soil subsurface (Fig. 5.3).

Danthonia pauciflora also proved to be an effective colonizer. It increased its mean density from 0.7 per m^2 to 4.4 per m^2 in one season and was mainly associated with peaty soils. An unidentified grass colonized the intertussock spares between *Poa gunnii* and *Danthonia pauciflora*. *Microlaena tasmanica*, possibly because of the competition from the other graminoids, had a high frequency in mineral soils and amongst the rock fragments. Compared with the other experimental areas, it only had a marginal increase in density of 0.5 per m^2. *Luzula*, likewise, was a subordinate species within the rocky and mineral soil subsurfaces.

The tussock species as a group were the most prolific colonizers, increasing their mean density by 12 per m^2 and their overlapping cover by 2.36%, of which 1.2% was attributable to *Poa* seedlings.

Rhizomatous Monocotyledons

The regeneration pattern in this area resembled that in the other sites, with *Scirpus aucklandicus*, *Oreobolus distichus*, and the rushes *Empodisma minus* and *Restio australis* being the major representatives. The overall mean density increased by9.2 per m^2 with *Scirpus* and *E. minus* increasing in density by 6.7 and 2.3 per m^2 respectively. The other rhizomatous monocotyledons exhibited only small increases.

Forbs & Rosettes

Two soft-leaved forbs, *Gnaphalium* and *Gonocarpus micranthus*, displayed minor increases in their densities (0.07 per m^2) and were located on the protected niches of track edges. *Rubus gunnianus* increased by only one individual during the period of investigation.

Shrubs

As in the Ronney Creek area, *Hibbertia procumbens*, was the only germinating shrub species in the 1st season, with a density increase of 0.5 per m^2 over rock fragments. Its effectiveness as a soil stabilizer was again displayed in this area, where it increased its overlapping cover by 1%.

(b) Cover

The cumulative overlapping plant cover in this area increased by 5.2% in the third growing season, and the area of bare ground decreased by 6%. *Scirpus aucklandicus* accounted for 1.1% of the increase in cover.

5.5 SOIL EROSION

Table 5.3 shows the amount of soil loss at Ronney Creek over the period July 1978 and April 1979. The result is the average change in area in cm^2 per 5 cm interval. Erosion monitoring stations were grouped into 2 categories at the level sites, with a slope range from 0° to 4°, steeper sites, with slope ranges from 5° to 15°.

Figure 5.4 represents the mean area loss for each of the groups over the monitoring period. The data illustrate two points, firstly that the amount of soil loss on steep slopes is greater than on the level areas and secondly that the soil loss is greatest during the initial period of trampling, between July 1978 to September 1978. During this period 20,000 sq. cms of soil was eroded as compared with only 650 sq. cm^2 between September and November. The period July to September coincided with the highest rainfall months of the year and the lowest trampling pressures. It may be noted that vegetative cover was still intact over most of the area and was only showing the first signs of deterioration - discolouration and the

TABLE 5.3

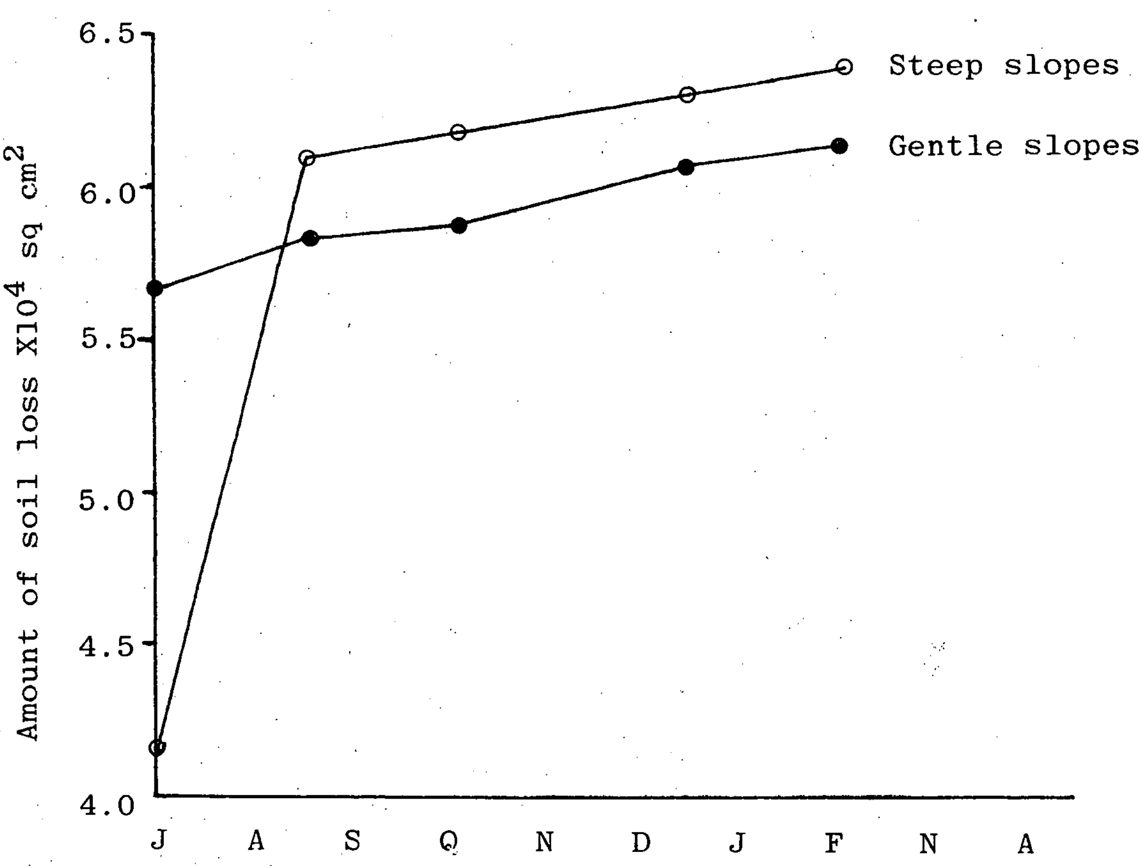
AMOUNT OF SOIL LOSS (SQ CMS) AT THE EROSION MONITORING STATIONS

OVER THE PERIOD JULY 1978 TO APRIL 1979

Erosion Monitoring Stations		14.7.78	9.9.78	11.11.78	6.2.79	24.4.79
SLOPE	4	59030	61495	62297	65385	65272
GENTLE	5	62242	63007	62905	64375	65110
0-4°	7	40075	41292	41875	45115	45145
	8	71125	71717	71535	72525	72305
	9	57902	57087	60277	63350	66115
	11	55010	59667	59802	62470	62972
	12	54602	55187	55627	56680	59060
	13	53505	56552	56382	56950	57930
SLOPE	1	33215	64095	64535	64095	66577
STEEP	2	20715	59255	60187	61782	62400
5-15°	3	40940	57457	58210	60140	61400
	6	58832	64037	64562	66307	66225
	10	53005	60215	60902	63017	63430

Fig. 5.4

MEAN AREA OF SOIL LOSS ON GENTLE AND STEEP SLOPES AT RONNEY CREEK, FROM THE PERIOD JULY 1978 TO APRIL 1979



flattening of fronds. The soil loss after September was at a steadier rate of 3000 cm^2 over a period of 9 months, during which 6,000 people walked over the track.

The erosion rate on the level sites was gradual, resulting in a loss of 5000 cm^2 of soil over the survey period. The pattern of soil loss appears to be step-like. The removal of plant cover and the disintegration of the soil structure associated with the early periods of trampling result in an initial rapid rate of soil loss. With increasing traffic, the bare soil goes through periods of compaction during which the infiltration rate decreases and the amount of run-off increases. Additional foot traffic increases the sheer stress of surface run-off, and when this exceeds the resistance of the soil, erosion occurs. This cyclic process is then repeated with increasing foot traffic.

5.6 TRACK WIDTH

The widths of tracks in the Kitchen Hut and Ronney Creek area were monitored three times - June 1978, before and after the peak walking season - November - and the following May respectively. Concurrently, the trampling population through these areas was also monitored initially through field counts and registration books and from November with the use of a pressure sensitive pedestrian counter. Figs. 5.5 and 5.6 depict the variation in track widths in the two areas as well as indicating the cumulative

Fig. 5.5

RELATIONSHIP BETWEEN TRACK WIDTH AND TRAMPLING PRESSURE (POPULATION INTENSITY) AT KITCHEN HUT OVER A PERIOD OF ONE YEAR

---- track width

—— population intentisy

Fig. 5.6

RELATIONSHIP BETWEEN TRACK WIDTH AND TRAMPLING PRESSURE (POPULATION INTENSITY) AT RONNEY CREEK OVER A PERIOD OF ONE YEAR

---- track width

—— population intensity

Fig. 5.5

KITCHEN HUT

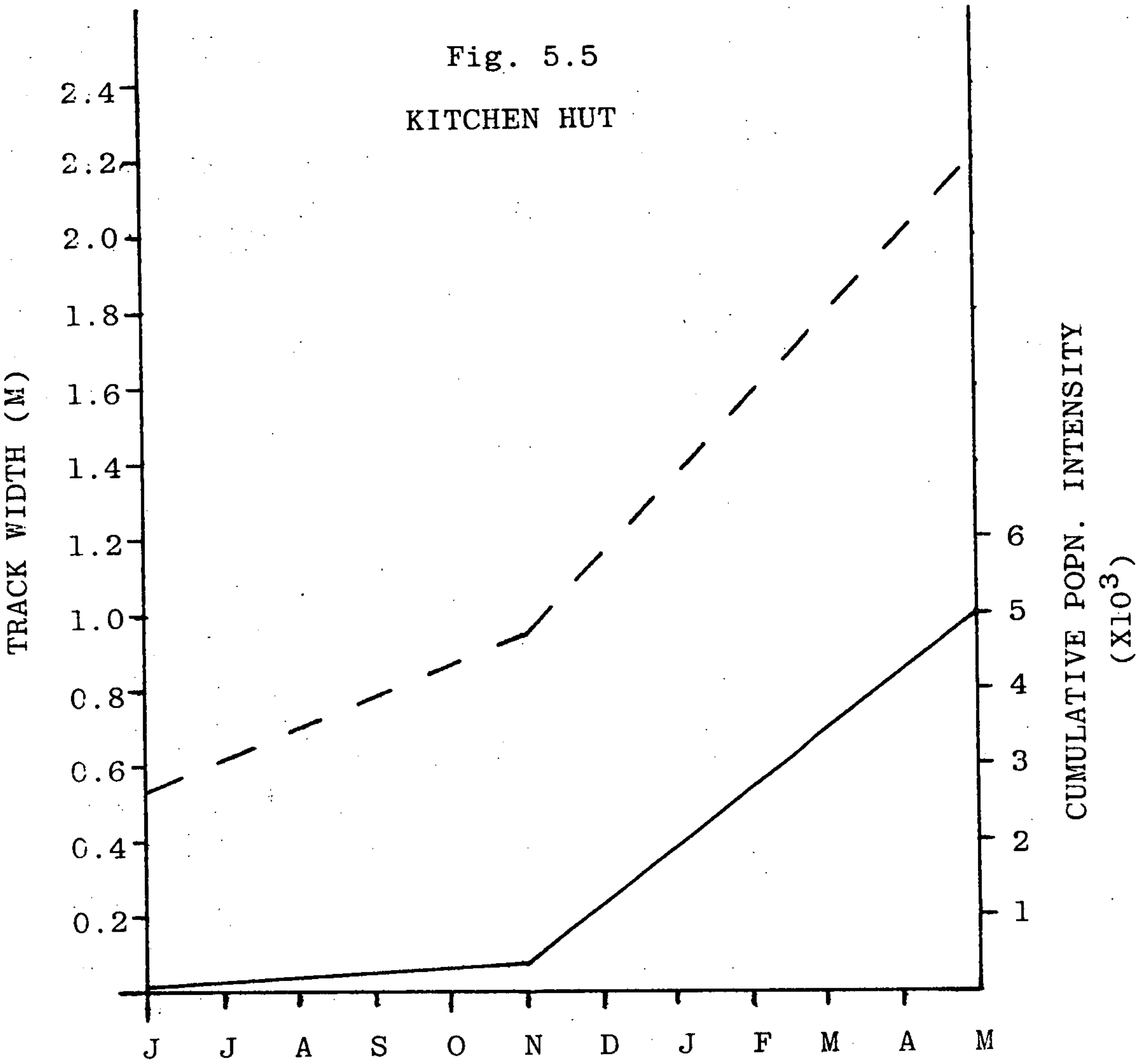
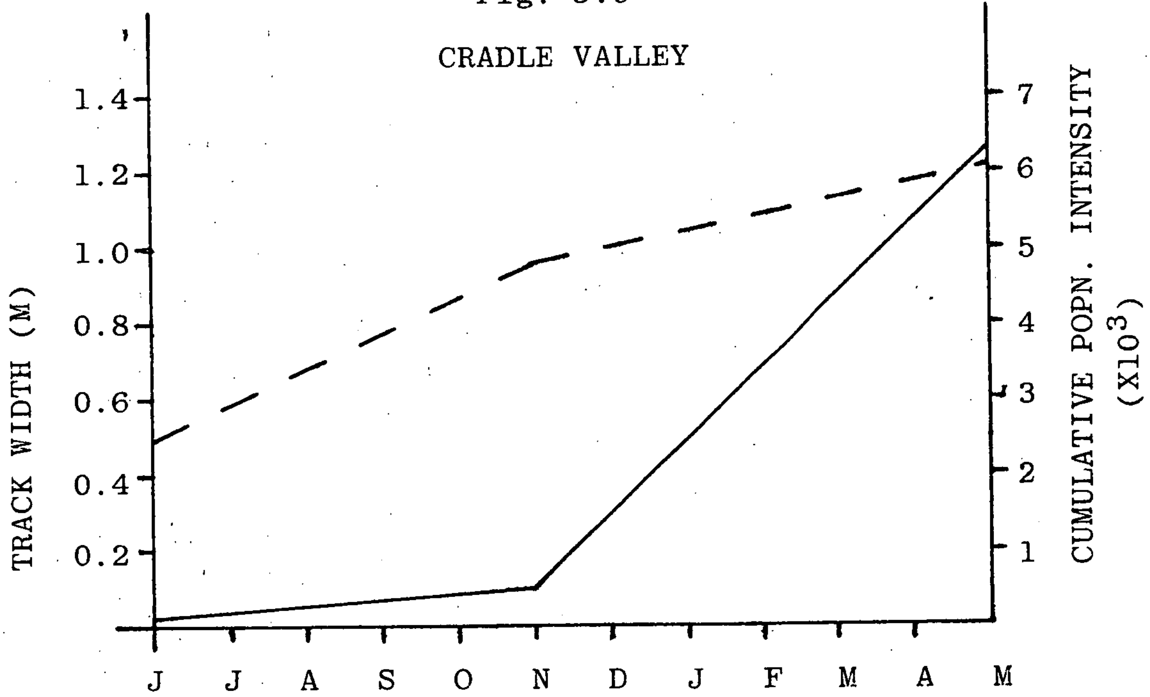


Fig. 5.6

CRADLE VALLEY



walking population through the same period.

Even though the Kitchen Hut track had half as many walkers as the Cradle Valley track between June and November, both had attained similar widths. With increasing pressure the Kitchen Hut track deteriorated at a rapid rate in comparison with the Ronney Creek, even though the latter experienced a higher trampling pressure. The track width at Kitchen Hut more than doubled during the peak season from 0.96 m to 2.2 m, whilst the trail at Ronney Creek increased from 0.98 m to 1.24 m. This difference may be the result of varying moisture contents of the soils of the two areas; the higher the moisture level, the wider the track.

5.7 BULK DENSITY

Bulk density measurements were obtained from a number of microenvironments representative of the various stages of track erosion, namely from tracks with peat, mineral soil and rock fragment surfaces. As a bench mark, readings were also obtained from undisturbed sites. Unlike other studies (Chappell *et al* 1971, Liddle and Grieg 1975, Beamish 1977) where measurements were obtained from tracks subjected to predetermined traffic levels, the bulk density measurements in this investigation were obtained from enclosed, traffic free, tracks. The tracks in the Kitchen Hut and Ronney Creek areas, had not been subjected to trampling pressures for one year, whilst those at

Fig. 5.7

BULK DENSITY VARIATION ON THE DIFFERENT

TRACK SURFACES AT KITCHEN HUT, RONNEY CREEK AND WALDHEIM

Θ mean, — standard deviation, ... range

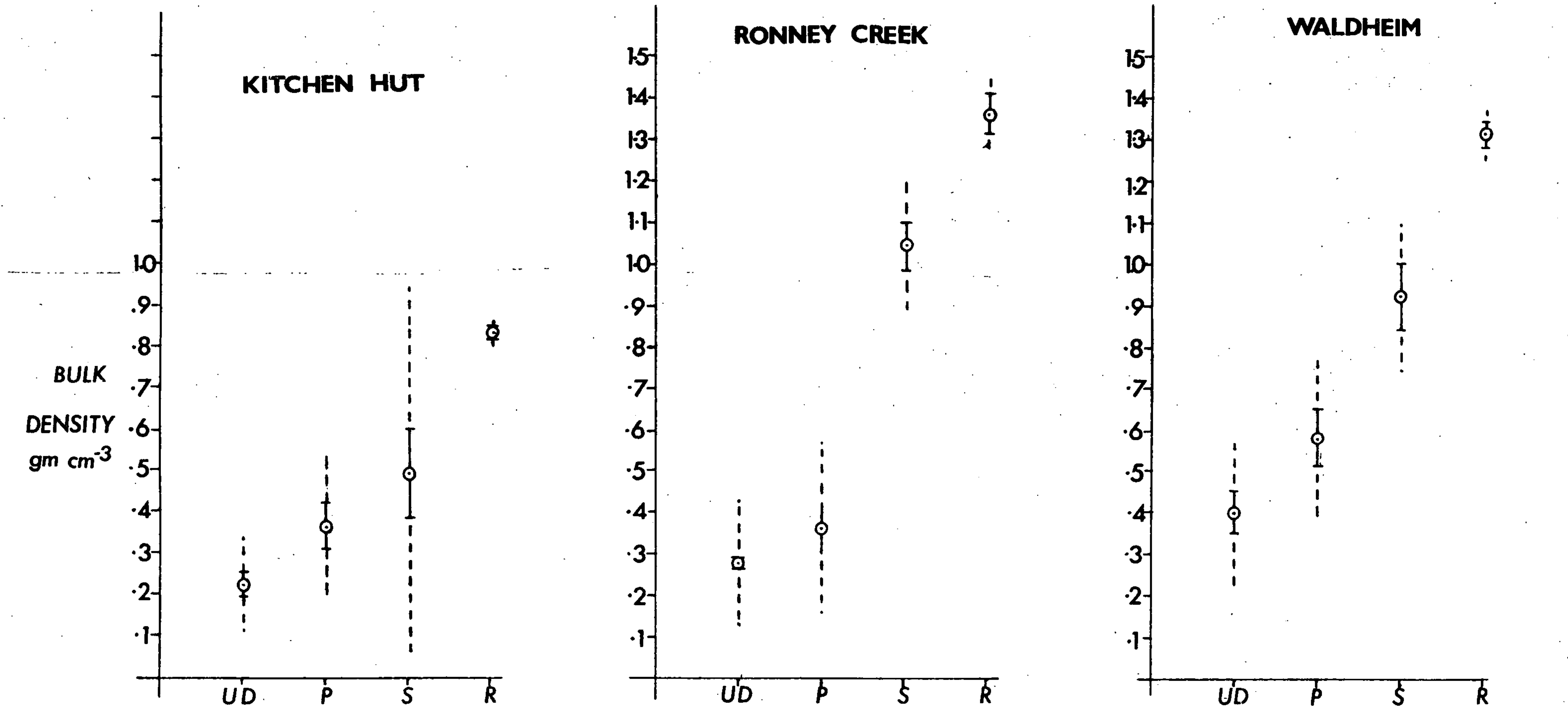
UD : undisturbed soils

P : peat soil surface

S : mineral soil surface

R : rock fragments surface

FIG 5·7


KITCHEN HUT
RONNEY CREEK
WALDHEIM
BULK
DENSITY
gm cm-3
1·5
1·4
1·3
1·2
1·1
1·0
·9
·8
·7
·6
·5
·4
·3
·2
·1
UD
P
S
R

Waldheim were devoid of traffic for 4 years. The assumption was that the various stages of track erosion were a surrogate measure of the impact of increasing traffic intensities.

Analysis of the data indicates that the bulk density values increased under the tracks by 0.62 gcm^{-3} in the Kitchen Hut area, 1.08 gcm^{-3} in the Ronney Creek area, and 0.91 gcm^{-3} at Waldheim, when compared to the surrounding undisturbed soils (Fig. 5.7). The mean bulk density under tracks with mineral soil surfaces were 0.26 gcm^{-3}, 0.75 gcm^{-3} and 0.53 gcm^{-3} greater than the adjacent natural vegetation at Kitchen Hut, Ronney Creek and Waldheim respectively.

It is apparent therefore, that the increase in bulk density is related to the increase in traffic levels. Further the spatial variation in bulk densities may be attributed to the difference in the soil properties between the three experimental sites. For instance, the differential in bulk density readings between the peat and mineral soil track surfaces were more pronounced in the subalpine Waldheim and Ronney Creek areas as compared to the alpine area. This could perhaps be attributed to the higher mineral content of the humic peat and the higher clay content of the subalpine soils. Similarly, the variation in the particle sizes of quartzitic rock fragments and the glacial till and schists rock particles may explain the difference between the bulk density readings between the alpine and subalpine areas eroded track surfaces. The results also show that compaction is still evident even after four years.

The following factors may also have an effect on the bulk density measurements:

(i) Seasons: Soil bulk density and soil compaction tends to increase in spring and become lower as the season progressed and soils dried (Weaver *et al*, 1979).

(ii) Temperature: Microclimate factors exert considerable influence on bare track soil and its susceptibility to compaction. As soil temperatures closely follow radiation conditions, variations in soil compaction may be produced by soils being subjected to considerable temperature fluctuations. Frequent freeze-flow cycles may partially neutralize soil compaction.

(iii) Soils: Previous research concentrated on determining bulk density in chalk soils (Chappell *et al* 1971) or sands or sandy loams (Lutz 1945, Liddle and Greig-Smith 1975). Increases in bulk density of up to 0.33 gcm^{-3} were measured by Chappell *et al*, 1971). Clayey soils, in particular, tend to react to compaction in a complicated manner.

(iv) Traffic: Liddle and Greig-Smith (1975) concluded that soil bulk density was directly related to the amount of traffic, when this occurs over a short period of time. Bulk density has a straight line relationship with the logarithm of the number of trampers.

5.8 DISCUSSION

Analysis of the results indicate that visitor impact exerts a differential effect on the three vegetation communities studied. Some plant species were eliminated or decreased whilst the more resistant ones took the opportunity of a change in the microenvironment to colonize new niches, thus creating qualitative as well as quantitative changes in plant communities subjected to visitor pressures.

The overwhelming majority of the literature on the impact of trampling has been concentrated on the vulnerability of flora and soils.

Few have studied the constitution of the walker's gait and the relationships between the impact of the different step formations and the morphological characteristics of plant species. With the exception of Holmes (1979) and Quinn *et al* (1980), little or no research has been cited on this particular aspect of trampling. Holmes (*op cit*) identified the following variations in the standard gait (Fig. 5.8).

> "1. Shearing:- occurs during the swinging phase in the standard gait, wherein the front edge of the boot and to a

certain extent the sole abrades or clips off any foliage above 3 cms off the ground. Leaf blades, stems and flowers are usually affected by this action.

2. Crushing:- the most destructive form of gait impacts. It occurs when the body's full weight is applied directly downwards on to the vegetation. Plants are flattened, flowers and fruits are crushed and if they possess brittle leaves or woody stems, these are broken.

3. Digging or Gouging:- occurs when the front end or the heel of the boot spears into the ground, which leads to a rapid loosening of soils around and beneath plants, in particular those on slopes.

4. Grinding:- where the foot undergoes a twisting motion, a position normally associated with a sharp turn. The impact is greatest when carried out from a standstill position, where the combined effort of the crushing and grinding forces would cause significant defoliation.

5. Ripping:- is associated with the downward motion along a slope, where quite often the grip of the boots is insufficient to provide stability. Pressure is, therefore, exerted by the heel to cut into the surface to attain a stable and comfortable footing. This form of motion is uncommon on flat terrain."

It is suggested therefore, that in order to obtain a comprehensive understanding of the impact of trampling, it is important to consider not only the environmental variables and the morphological characteristics of plant species but also the motions of the walker's boots.

The mat-formers and shrubs suffered the largest percentage loss of the overlapping cover in the alpine zone. The physiological formation of the cushion plants made them particularly attractive to the average walker

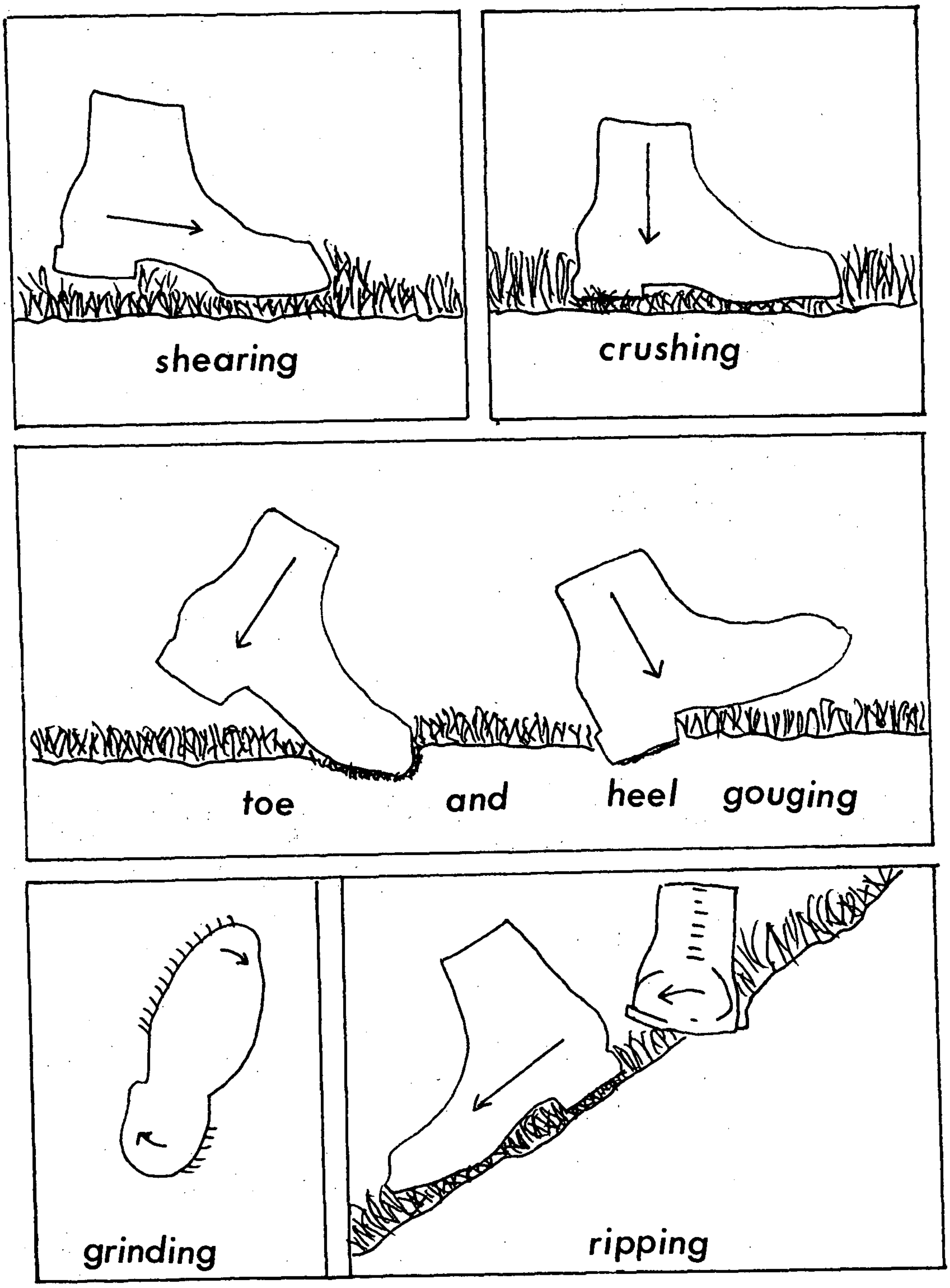


Fig. 5.8

EFFECTS OF GAIT ON VEGETATION (AFTER HOLMES 1979) who very often used them as stepping stones across the surrounding damp areas. Additionally, even though their morphological characteristics may be well adapted to the prevailing climatic conditions (Sutton 1929), they are inadequate to cope with direct forces exerted upon by walkers. The high moisture content of the bolsters and the brittle nature of their leaves make them particularly susceptible to the crushing and grinding effect of the walking boots. Likewise, the dominant shrub in the alpine area, with tall, erect woody stems is vulnerable to the shearing forces of the walkers' gait as well as the crushing effects when the immediate surrounding areas attain quagmire status.

The shorter stature of the rhizomatous monocotyledons like *Empodisma minus* rendered them vulnerable to the shearing forces of the boots. Field observations showed that their slender, narrow branches were initially trimmed off and with increasing traffic their weak basal meristems were gouged out.

The durability of the soft-leaved forbs and the erect rosette plants was minimal, with *Hierochloe fraseri* and *Mitrasceme archeri* being eliminated within the first season, whilst *Erigeron pappachroma* and *Gentianella diemensis* had their individual cover reduced by more than 90%.

The most durable plant form was the tussock. Thicker cuticled leaves, tough basal meristem and densely bunched leaves may increase their resilience.

The susceptibility of plant species in the alpine environment of Cradle Plateau concurs with field results by other researchers. Cole (1979), Holmes (1979), Hartley (1976), Willard & Marr (1971), suggested that woody shrubs, erect forbs and mat-formers were the most susceptible to trampling, whilst tussocks displayed strong resistance to trampling pressures.

The physical characteristics of the subalpine track - its flat topography and low soil moisture content, resulting in the shearing motion being the major walking constitution, followed by crushing.

The response of the dominant subalpine species, *Gleichenia dicarpa* and *Empodisma minus*, to trampling pressures differed to that of the alpine vegetation. Whilst the alpine plants were broken and crushed and finally gouged, the subalpine vegetation initially experienced a period of discolouration and flattening mainly due to the destruction of the photosynthetic tissues by the shearing motions of the walkers' boots. This is followed by their eventual displacement and the development of bare areas on the track.

Rubus gunnianus was the only rostte species which increased its cover. Being close to and spreading along the ground, it was not subjected to the shearing forces associated with the walkers' gait. These seedlings were noticed colonizing the bare soils on track shoulders, sites relatively free from competition from tufted herbs and grasses.

In terms of absolute cover in both the alpine and subalpine vegetative types, shrubs, mat-formers and forbs were the most susceptible to trampling, followed by rhizomatous monocotyledons. On the other hand, in terms of relative cover, the percentage loss in overlapping cover was also significant amongst the forbs in the alpine area and the shrubs in the subalpine zone. Rosettes and tussocks displayed stronger resistance to trampling respectively. In short, the trampling resistance of any meadow vegetation in increasing order of resistance would be shrubs and mat formers, forbs, rhizomatous monocotyledons, rosettes and tussocks.

Constraints of time and labour, prevented any accurate measurements of soil erosion in the alpine zone. The results obtained from the Ronney Creek area, have indicated that in relation to soil loss on slopes, the critical limit is attained during the initial periods of trampling, well before the visible signs of vegetation deterioration occur. The toe and heel gouging loosens and removes soft soil around and beneath plants. Coincidentally, this initial period was also associated with the high rainfall months, and consequently the movement of water down the slope accentuates soil erosion. Quinn *et al* (1980) in a laboratory study of the mechanics of soil erosion involving measurements of soil loss and run-off, showed that soil loss increased with slope in particular slopes between 5 and 20°. They found that the rate of soil erosion increased with increasing soil moisture content and the breakdown of soil occurs whilst the wear of vegetation was still in progress and not as previously thought, after the removal of the vegetative cover. On the level sites, soil erosion followed a step-like pattern, of an initial period of soil loss, compaction and then further soil loss. The major gait pressures exerted on these sites were shearing and crushing. Analysis of track widths showed that on areas of higher elevation, where rainfall and the soil moisture content are higher, the tracks have a lower threshold level when compared with tracks as relatively dry sites. These results concurred with those of Weaver *et al* (1979) who stated that tracks through soils of high moisture content were more vulnerable to trampling than tracks through drier areas.

As a corollary to the studies on vegetation resilience, the monitoring of natural recovery rates of plant species provides land managers with a wider perspective of the impact of visitors on natural ecosystems within the park.

Two plant types, the rhizomatous monocotyledons and tussocks, exhibited prolific recovery rates. The latter were the more dominant in the less fertile environments whilst the former were the dominant colonizers in the probably more nutrient rich environments close to Waldheim. The major ubiquitous colonizing rhizomatous monocotyledons were *Scirpus aucklandicus* and *Empodisma minus*. Both species were successful at Kitchen Hut, with *S. aucklandicus* being more successful at Ronney creek.

The tussocks species varied from site to site with *Carpha alpina* and *Microlaena tasmanica* being dominant in the alpine zone, *M. tasmanica*, *Poa* and *Lepidosperma filiforme* in Ronney Creek and *Poa*, *Danthonia pauciflora* and *M. tasmanica* being prolific on the Waldheim sites.

Field observations and the experimental data have highlighted a number of trends in the recolonization process.

(i) It is apparent that although adequate germination does occur, seedling survival is a critical factor. Protection from winds and frosts seems critical for survival.

(ii) The recolonization of eroded areas by native species is a slow process.

(iii) Regeneration in the middle of most paths is non-existant. If regeneration does occur, it is by vegetative regrowth, the common species being *Empodisma minus* on mineral soils and *Scirpus* *aucklandicus* on peat.

(iv) Plants regenerate on stable microenvironments, which in most cases, are along the track edge or on the track shoulder. In the harsher alpine environments the track shoulder, unless well protected, is colonized by tussock and rhizomatous species.

(v) There is a high density of seedlings on the windward side of the track as compared to the leeward side. Seedling regeneration occurs on sites already colonized and stabilised by moss, or on pockets of soils trapped behind and between rock fragments close to the track.

(vi) The most effective mode of reproduction in areas of high environmental and climatic stresses is vegetative, where the extensive fibrous and rhizomatous root system gives the plants soil-binding characteristics.

The ability of rhizomatous species to regenerate effectively, partially compensates their lower tolerance to trampling pressures. This could also be attributed to the amount of carbohydrates stored in their roots and rhizomes . The pattern of the carbohydrate cycle in alpine and subalpine plants has been described by Billings (1974). The stored carbohydrates are utilized in early spring for the growth of new shoots. By the end of the growing season, photosynthesis replenishes the carbohydrate reserves and by the onset of dormancy, the underground carbohydrates are back to high levels.

Trampling initially destroys the aerial portions of the plant, and therefore lowers its ability to replenish its carbohydrate reserves for the overwintering period and the consecutive growth season. This decrease in carbohydrate level results in smaller plants and eventual death, although the rhizome system provides a regenerative buffer until complete depletion occurs.

Soil compaction increases bulk density and so decreases the percentage of soil moisture (Hartley 1976). This decrease in soil moisture content results in the simultaneous decrease in the amount of pore space between soil particles, hence reducing the void volume and the volume of non-capillary water. As a consequence, anaerobic conditions may prevail, and these have the secondary effect of diminishing root growth. Further, Leonard and Plumley (1979) suggested that the removal of the surface organic matter and humus preceding the exposure of the mineral soil surface by the forces of erosion creates a nutrient deficient environment adversely affecting the vegetation that can be sustained by the surface. Anaerobic conditions and a relative lack of nutrients may perhaps explain the lower seedling regeneration on mineral soil and rock fragments. The peaty soils with their lower bulk densities, and probably higher moisture and nutrient availability might be more congenial for species regeneration. This is suggested by the results obtained in the Ronney Creek and Waldheim areas.

In the alpine zones, however, species regeneration showed a preference for the mineral soil subsurface. Its bulk density was lower by a factor of two when compared with that of the subalpine mineral soil subsurfaces. In addition to being less compact, the higher rainfall and field capacity of the silty loam soils may contribute towards establishment of an environment conducive for species regeneration. The lack of stability and the continuous erosion and deposition of peaty soils in the alpine area may explain the lower seedling densities on these soils.

In summary, it is apparent that trampling changes the structure of the plant community within the zones of disturbance. Rhizomatous monocotyledons and tussocks become dominant in the alpine communities previously dominated by mat-formers and shrubs, and in the subalpine communities they displace the forbs. In the alpine zone, the recolonization of the mineral soil subsurface represents the first phase of reconstituting the vitally important organic and humus layers. Willard and Marr (1971) in a similar study concluded that the estimated recovery time for damaged alpine areas to climax conditions could be between 700 to 1000 years. Insufficient data were gained from this study to estimate recovery times for the three monitored ecosystems. However, the results do indicate that recovery is much slower from the alpine ecosystem than the two subalpine ecosystems, and suggest that the Waldheim grassland may recover more quickly than the sedges, ferns and rushes which dominate communities in the Ronney Creek area.

CHAPTER VI

ASPECTS OF RECREATIONAL MANAGEMENT

The common goal in the management of most national parks is to devise means of ensuring high quality recreational experiences, while avoiding the degradation of natural ecosystems. In other words, park managers address themselves to resolving two often conflicting aims: maximizing recreational enjoyment and minimizing recreational impact. Except, perhaps in the lowest range of user intensity, these aims are achieved through the management of visitor behaviour.

Two visitor management strategies can be recognised. The first strategy is regulatory. Regulatory park management (Bury and Fish 1980) involves the exertion of a high degree of control over visitor behaviour, including:

(i) policy enforcement such as fines;
(ii) zonation;
(iii) restrictions on user intensity such as limitations on numbers, party sizes and length of stay.

The second strategy employs indirect or manipulative techniques with emphasis on modifying behaviour through the use of subtle methods and the distribution of information about appropriate visitor behaviour and the natural features of the park. Thus, although visitor behaviour is modified, some degree of personal freedom is maintained. Manipulatory options include:

(i) physical alterations such as the restoration of tracks and the improvement of facilities and access;

(ii) information facilities to encourage appreciation of natural environments, with the use of audio visual aids, education on the minimum impact concept;

(iii) eligibility requirements such as entrance and track fees (Bury and Fish *op cit*).

The literature suggests that managers of National Parks are of the opinion that manipulation of behaviour is more effective than regulation and enforcement. (Bury and Fish, 1980; Stankey *et al*, 1979; Lime and Lucas, 1979; Bradley, 1979). Nevertheless, in a few cases, they felt that direct regulatory measures were necessary to attain preservation and conservation objectives.

Visitor reaction to a number of management issues raised in the questionnaire survey, indicates that there was conditional support for some regulatory measure, such as limiting the size of parties and closure of damaged campsites or tracks. The majority of respondents were, however, opposed to limiting the numbers of visitors to the National Park.

There was also overwhelming support for manipulative techniques such as the use of one's own cooking fuels, removal of litter from the park, wooden walkways and marked tracks and nature trails.

This chapter discusses management issues highlighted in the preceding assessment and evaluation of the existing park environment and visitor activities. Strategy options are examined and appropriate management and administrative measures suggested.

6.1 PARK ZONES

The concept of zonation is recognised to be the basis of land use planning and management (Stankey *et al*, 1978; Brown & Yapp, 1979). It is an operational concept encompassing administrative and developmental control with the aim of achieving optimum use whilst recognising the goals and limitations of the park philosophy.

This enables the formation of broad policy guidelines for each zone and therefore affords a continuum of management options as well as ensuring continuity in the implementation of management strategies in spite of changes in park administration.

The draft management plan (NPWS 1977) although now officially withdrawn, suggests the following as likely zones:

(i) Wilderness;

Fig. 6.1

PROPOSED ZONES FOR THE CRADLE MT. - LAKE ST. CLAIR NATIONAL PARK

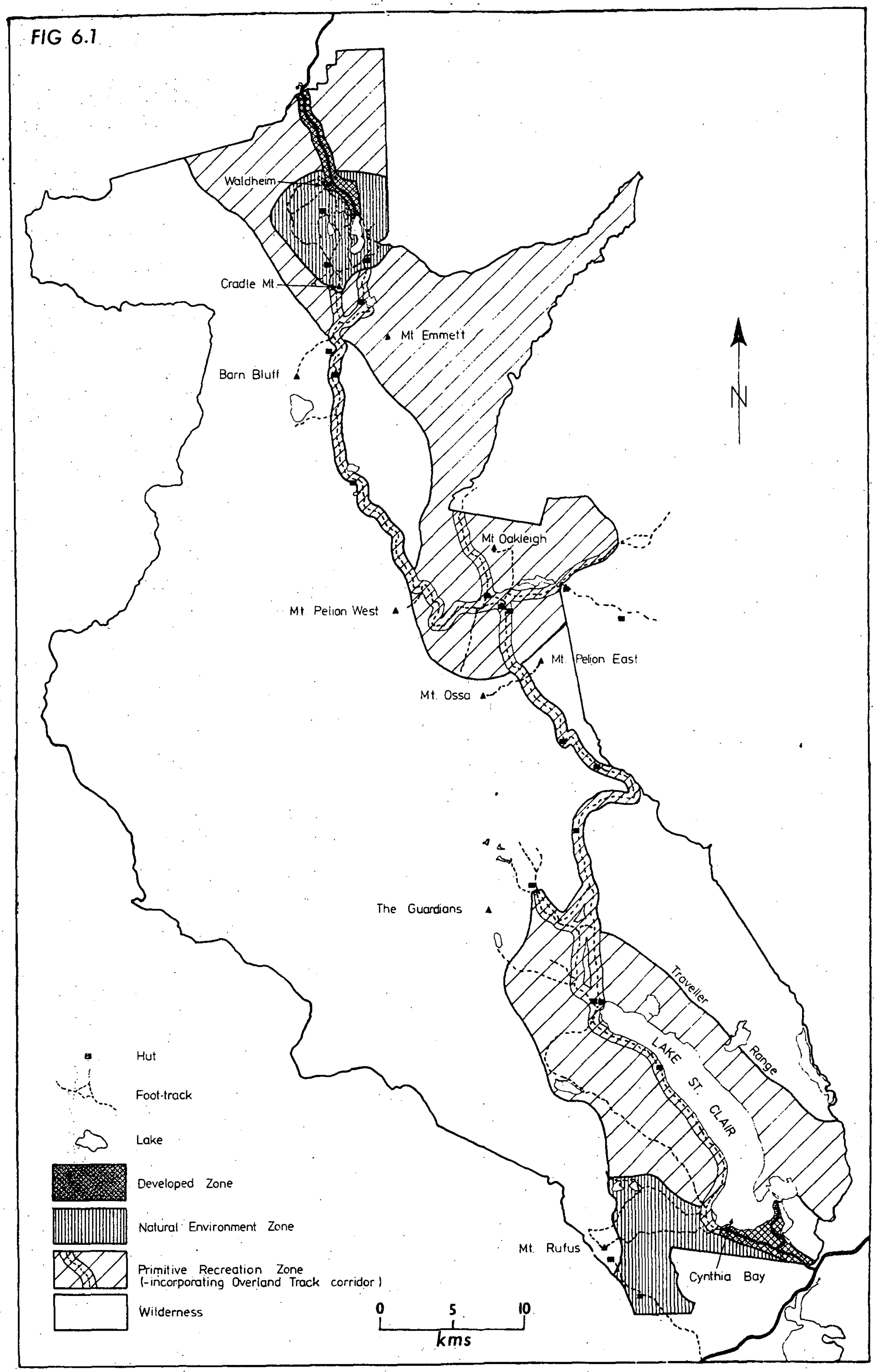


FIG 6.1
Waldheim
Cradle Mt.
Mt Emmett
Barn Bluff
Mt Oakleigh
Mt. Pelion West
Mt. Pelion East
Mt. Ossa
The Guardians
Traveller Range
LAKE ST. CLAIR
Mt. Rufus
Cynthia Bay
N
Hut
Foot-track
Lake
Developed Zone
Natural Environment Zone
Primitive Recreation Zone
(-incorporating Overland Track corridor)
Wilderness
0 5 10
kms

(ii) Primitive Recreation (encompassing the Overland track corridor);
(iii) Natural Environment;
(iv) Developed (Visitor Service Zone).

The distribution of these zones is shown in Fig. 6.1. The Wilderness Zone is characterized by the absence of any formed facility apart from unmarked tracks and camping areas. The Primitive Recreation Zone encompasses the major track corridors within the park, and is characterized by the provision of limited camping facilities, shelter huts, pot-belly stoves, pit toilets and marked trails.

The Natural Environment Zone forms a buffer between the primitive and wilderness areas and the developed zone. A high standard of track design may be necessary in this zone to accommodate higher trampling pressures. Public shelter huts and interpretative signs located at vantage points are also desirable.

The developed zone contains the visitor service areas with vehicular access, picnic and day use facilities, chalets and camping grounds and information centres.

6.2 TRACK PROBLEM

The visitor and the track surveys have identified that the poor state of tracks is a major problem area for park management. 67 percent of visitors were dissatisfied with the track conditions and 29% of tracks were assessed as being badly damaged. It is also apparent that only a small percentage of visitors travel off the tracks and then usually for short distances.

This dependence on tracks as a means of travel implies that the track system can be an important tool for directing use patterns and influencing the kind of experiences visitors receive.

Unfortunately, few tracks were constructed with the expectation of such high recreational use levels. Track surveys, field experiments and observations suggest that the physical carrying capacity of most tracks has been exceeded. The following options are available to cope with the problem.

Option 1: Reduce visitor use to the physical carrying capacity of tracks.

If this strategy is adopted, visitor numbers to the park would need to be drastically reduced. This option would be totally unacceptable to the public and the political ramifications would be severe.

Option 2: Rotation of tracks.

Field experiments have shown that vegetation is destroyed quickly and that the recovery of damaged vegetation and the recolonization of eroded track surfaces is slow (Section 5.4). Furthermore the data on soil erosion in the subalpine plots have shown that soil losses peak in the initial trampling period. A similar study in Canada concluded that 90% of the damage to tracks and campsites occurs during the first two years of use (Lesson 1979). The implementation of this strategy would therefore result in damaged and overused areas spreading all over the park.

Option 3: Construction and design of tracks to cope with visitors.

This appears to be the only feasible option. The rehabilitation techniques used need to be defined and evaluated in a systematic manner. Thus, it is suggested that a track classification based upon the zones described earlier be adopted. In the formulation of a track classification system, it would be desirable to consider the following factors:-

(a) user intensity
(b) proximity to developed zones
(c) visitor comfort
(d) sensitivity of the physical environment
(e) financial implications.

For each class and for the differing environments within each class, the most appropriate and economical methods for track repair and construction differ. Accordingly, the available methods are discussed and in Appendix 8 the most viable method is detailed for each section of track system in the park.

6.2.1 Track Classification System

A track classification system proposed for this park is as follows:

Class I: High density use over short distances, particularly to scenic vantage points within the developed zone, and close to car parks and day use areas. Tracks of low grades and of a high standard of construction and maintenance. Visitor comfort is important. Maximum width 2.5 metres.
Examples: Cradle Valley: Dove Lake car park area to boatshed and Suicide Rock; around Waldheim and in day-use areas. Cynthia Bay: track to Watersmeet.

Class II: Half-day and day walks into the Natural Environment Zone. Longer lengths than Class I with routes increasing in gradient. Incorporating resting places, information signs and plaques. Track standards between Class I and III. Mechanical aids may be used in track construction.

Maximum width 1.5 metres.

Examples: Daywalks in Cradle Valley and Cynthia Bay.

Class III: Longer tramping routes dissecting the "back-country". Steeper gradients, widths not exceeding 1 metre. Tracks with simple but effective construction, preferably with "local" material. Routes incorporate huts, campsites, pit toilets. Linear formation of tracks where nature conservation is of higher priority than visitor comfort.

Example: Tracks through the Primitive Recreation zone.

Class IV: Open range country and wilderness area, with no marked tracks or track construction. Areas with pristine features with absence of any formalised camping facilities.

Examples: Labyrinth, the Guardians, Ducane Range, Traveller Range, Mount Pelion area.

6.2.2 Track Construction Techniques

Duckboards, although considered by some to be aesthetically unpleasant, are useful for traversing over marshy and waterlogged areas, in particular hummock sedgeland (Plate 6.1). Experience has shown that the shearing strength of the treated radiata pine crossboards is weak, and annual maintenance is necessary. It has been calculated that the cost of installation of duckboards in the park, including labour costs, varies from $20 per metre to $30 per metre.

Plate 6.1 : Duckboard crossing over button grass plains near Crater Creek.

Plate 6.2 : Recently laid corduroy at Frog Flats.

Plate 6.1

Plate 6.2

Corduroy has proven most successful in track rehabilitation. The corduroy is derived from local timber stands. This minimizes transport costs. Where sections are slippery, wire mesh is installed on the corduroy surface. The major cost associated with this technique is labour, and total costs vary between $8 and $11 per metre. Corduroy is aesthetically pleasant, requires little maintenance, and moreover, is adaptable to almost all vegetation types. However, it does not provide the comfort of duckboards, bitumen or gravel (Plate 6.2).

The gravelling technique was first pioneered in this state in 1979, along sections of the Horses Track towards the Scout Hut close to Waldheim. This track suffered from severe gully erosion, with tracks up to two metres deep.

Prior to gravelling the erection of stabilization barriers across the track width and the construction of cross-drains is desirable. In the case of the Horses Track, gravel was transported by helicopter in 44 gallon drums (Plate 6.3 a,b,c). However, in sites close to formed access, the use of motorized wheelbarrows would suffice. A mixture of stones, gravel and clay preferably in a 25%: 50%:25% proportion respectively is desirable. This mixture not only imparts stability to the material and resistance to trampling but also allows seepage through the track material This method is quick, efficient, requires very little

Plates 6.3 :

(a) Helicopters transporting gravel in 44 gallon drums to a deeply eroded track section along the Horses Track.

(b) Cross barriers installed prior to gravelling to prevent downward movement of the gravel.

(c) The track after gravelling.

Plate 6.3a

Plate 6.3b

Plate 6.3c

maintenance and is aesthetically acceptable. The major costs are associated with the hire of the helicopter. It cost approximately $45 to $50 per metre to gravel the Horse Track although labour costs were lower in comparison with the other techniques.

Another alternative is the use of rafts, which are miniature versions of duckboards. These are assembled at the workshop and transported to the required sites and can be removed when necessary. Bitumen surfacing is suggested for the high use areas close to the developed zones, where visitor comfort is of high priority. This method would require little or no maintenance, and would provide access for visitors of all age groups and abilities to vantage points close to vehicle access. An estimate of costs associated with this technique is $10 per sq. metre.

In all cases, drainage is critical in controlling trail damage. The use of water bars, culverts, sloping track surfaces, batters and coffer dams would assist in diverting water away from the track.

Based on the cost of the techniques described above, it is estimated that at 1979 prices, it would cost the National Parks and Wildlife Service a sum of $700,000 to rehabilitate its track to a level where damage to the environment was prevented and a modicum of comfort was provided in the areas close to vehicle access.

Priorities for reconstruction can be guaged from the results of the track survey. It is evident that the majority of the badly eroded tracks are located in the northern section of the park (Fig. 4.3). These tracks were strongly associated with the treeless communities - sedgelands and the fragile alpine heath, and were characterized by their poor drainage qualities and/or their low resistance to trampling pressures. It was further evident that all these tracks had exceeded their threshold levels and were in fact expanding rapidly (Fig. 5.7). It is suggested, therefore, that these areas be given high priority in the works programme. The sections requiring urgent attention include the tracks on the Cradle Plateau, tracks on the Pine Forest Moor area and those in the vicinity of Waterfall Valley and Cirque Huts.

In a number of areas, it may be desirable to realign short sections of tracks in environments less susceptible to damage.

6.2.3 Track Relocation

In a number of instances, for reasons of public safety, economy, improved scenic vistas, and impact control, it would be desirable to relocate sections of the overland and other walking trails. For example:

(i) the track from the Scott-Kilvert Hut to Cradle Cirque;

Fig. 6.2

PROPOSED TRACK LOCATION FROM LAKE RODWAY

TO THE WATERFALL VALLEY HUT

Fig. 6.3

PROFILES OF THE TRACK RELOCATION OPTIONS

FROM LAKE RODWAY TO WATERFALL VALLEY HUT

Figure 6·2

PROPOSED TRACK RELOCATION –

Lake Rodway - Waterfall Valley

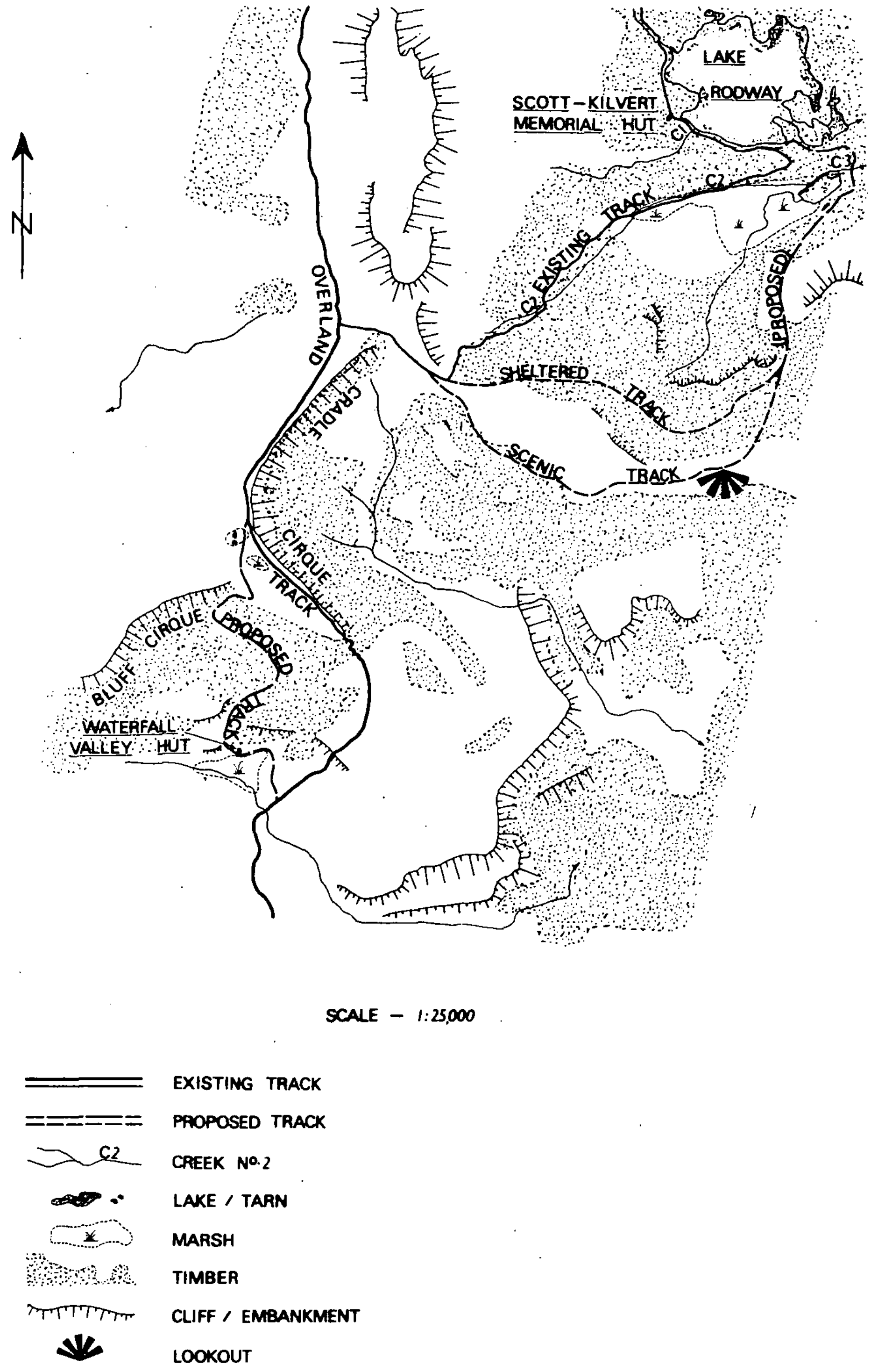
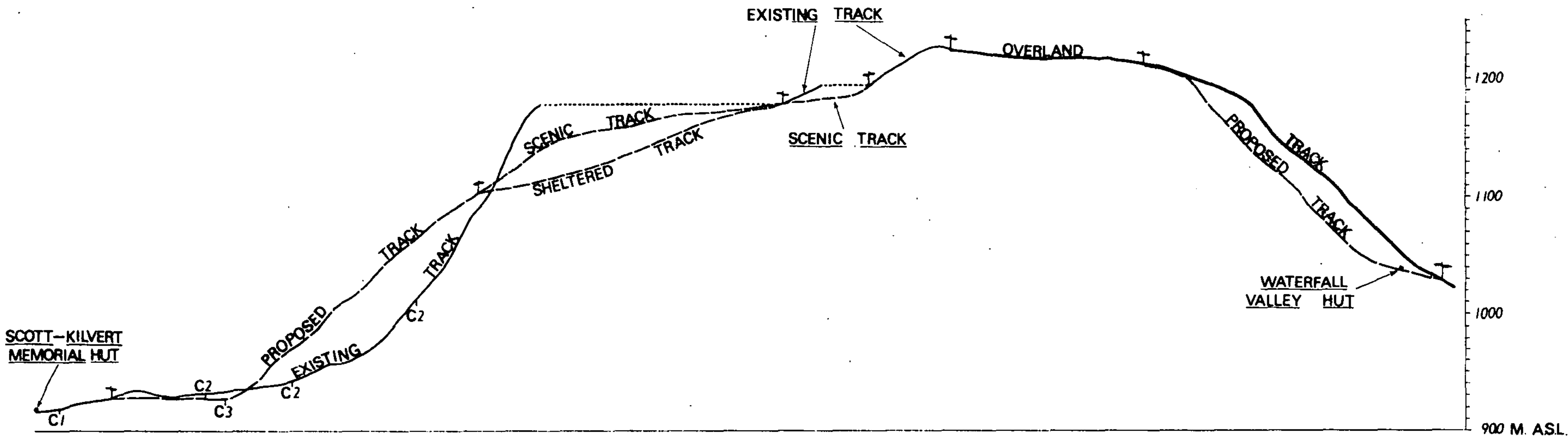


Figure 6·3

PROFILE - PROPOSED TRACK RELOCATION -

Lake Rodway - Waterfall Valley



═══	EXISTING TRACKS
═ ═ ═	PROPOSED TRACKS
T	TRACK JUNCTION
C2	CREEK No. 2

HORIZONTAL SCALE 1 25 000

VERTICAL SCALE 1 5 000

(ii) the track from Cradle Cirque to Waterfall Valley Hut;

(iii) sections of track from Cirque Hut to Windermere Hut;

(iv) the track through Pine Forest Moor;

(v) the Pine Valley track.

The proposed routes (i) and (ii) are shown in Figure 6.2 and 6.3 together with cross-sectional profiles of both the existing and proposed locations. In the case of the route to Cradle Cirque from Scott Kilvert Hut, two options are suggested. The first is a high level scenic track that brings into view the valley dissected by Harnetts Rivulet and a number of magnificent waterfalls, all of which were previously beyond the view range of the Overland Track. Further, the proposed track location is within a reasonable distance from the summit of Mount Emmet. In comparison to the second option, the low-level sheltered track, the high level scenic track is exposed to the prevailing winds. To summarize, the proposed route to Cradle Cirque although marginally longer, affords walkers new scenic vistas, better grade (1:8 as compared to 1:3 of the old track), improved track condition, as the vegetation types are less susceptible to trampling damage, and protection from the prevailing winds when desired.

Similarly, the proposed track from Cradle Cirque to the Waterfall Valley Hut is located through open wood-

Fig. 6.4a

PROPOSED RELOCATION OF TRACK ACROSS PINE FOREST MOOR

Fig. 6.4b

PROFILE OF THE PROPOSED LOCATION ACROSS PINE FOREST MOOR

Figure 6·4a

PROPOSED TRACK RELOCATION - Pine Forest Moor.

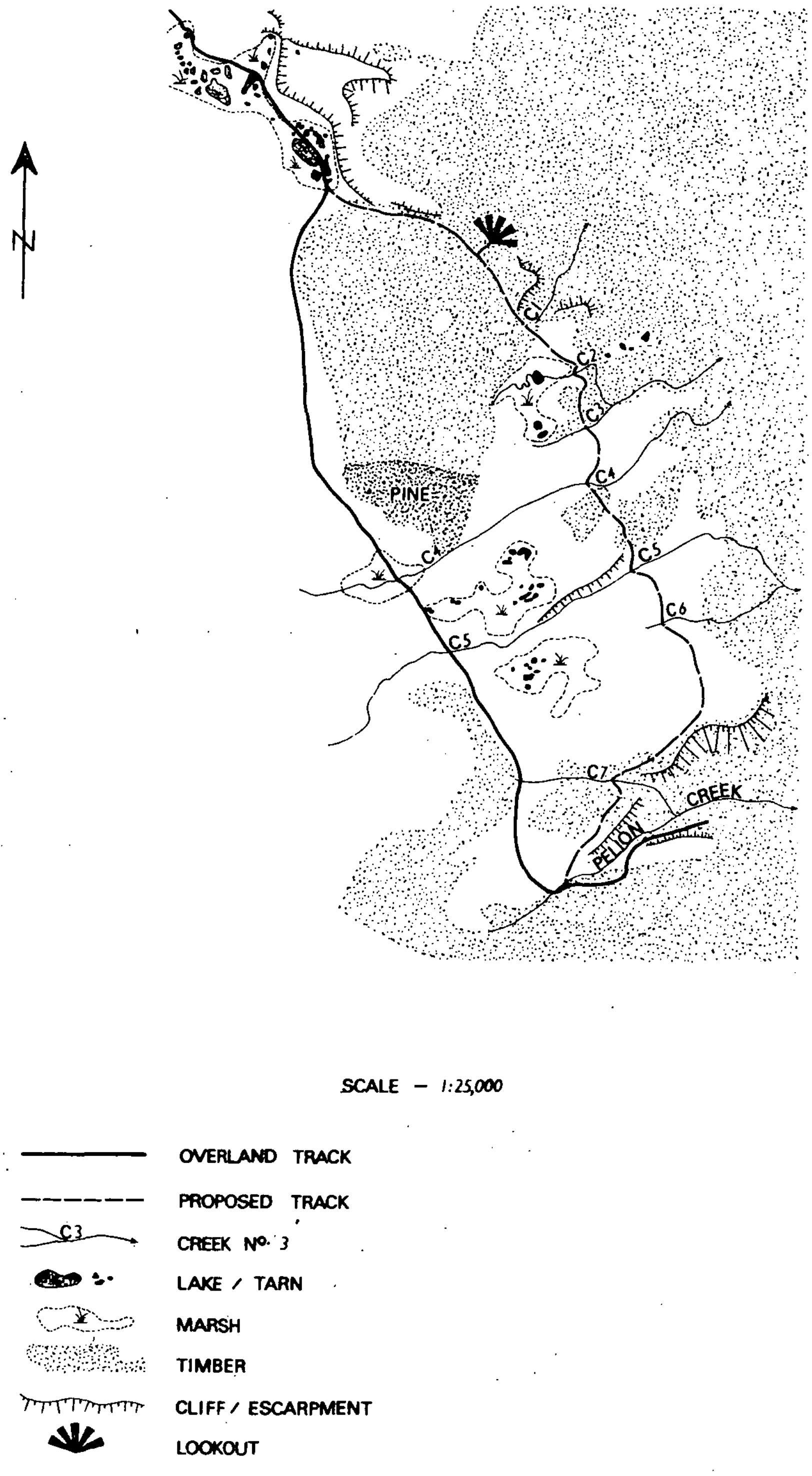
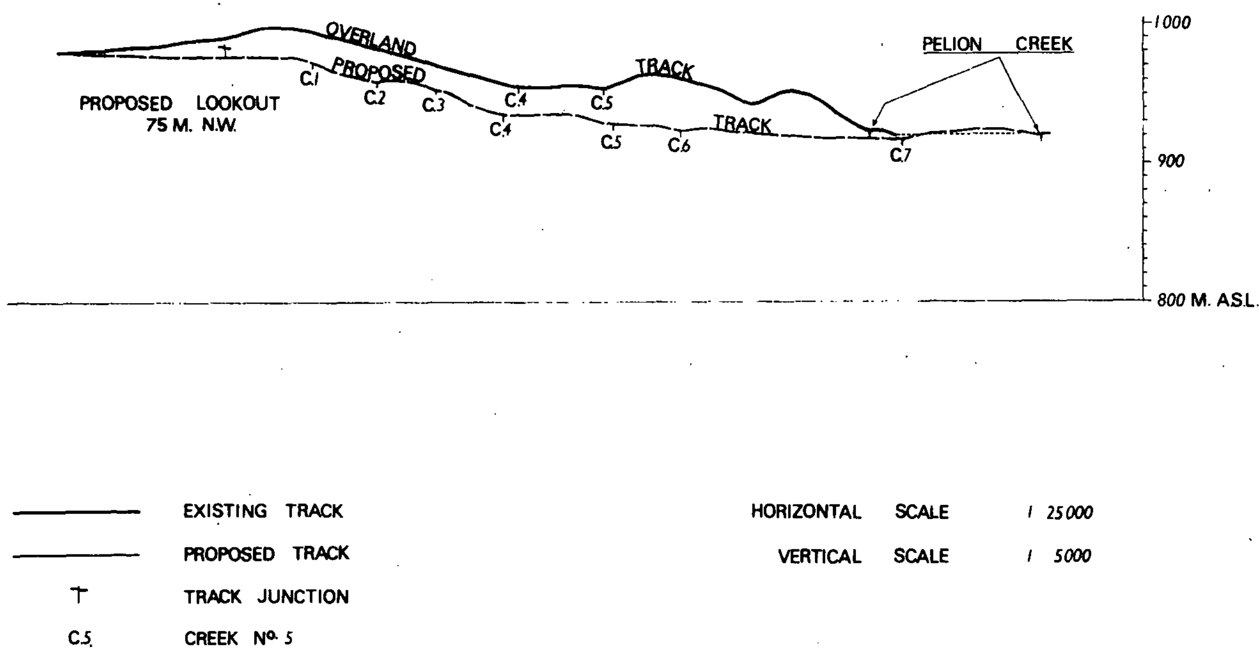


Figure 6·4b

PROFILE - PROPOSED TRACK RELOCATION -

Pine Forest Moor.



lands and rainforests, all of which have higher threshold levels that the vegetation in which the present track is located. This track is also well protected from the cold south-westerlies.

The track from Cirque Hut to Windermere, could be relocated on the parallel ridgelines above the poorly drained heath and hummock sedgeland communities.

The track to the Forth Lookout could be extended through and along the eastern edge of the patch of open woodland and on to the old Innes Track, before traversing the sloping terrain above Pelion Creek to the present campsite area (Fig. 6.4a,b). Sections of the track across the hummock sedgelands could be corduroyed and because of the natural slope, drainage is not a serious problem. The relocated track would provide improved shelter from the prevailing winds and additional views of the Forth Valley.

Finally, it might be desirable to close the track across the Valley to Pine Valley Hut. This track is poorly drained, and would require extensive upgrading. The adjacent Forest Track, on the other hand, is well drained and has a higher carrying capacity. In addition to the closure of the Valley Track, it is suggested that the bridge across the Cephissus Creek be redesigned and upgraded, to ensure visitor safety during flood periods.

6.2.4 New Tracks

Discussions with the overland bushwalkers and analysis of comments in the questionnaire survey, have indicated that there is an overall satisfaction with the number of tracks in the wilderness and primitive zones in the park.

There are, however, some good reasons for expanding the track network in the Natural Environment Zone. For example, a low-level circuit of Dove Lake incorporating the Truganini Track and sections of the Ballroom Forest track, would provide a round trip in sheltered conditions. This lake circuit would be further advantageous in diverting trampling pressure off the fragile high altitude areas.

6.2.5 Revegetation

Analysis of visitor statistics has shown that the peak visitation levels in January and February coincide with the short alpine and subalpine plant growing season (Table 2.6). If the plant damage is during the early spring period recovery may be rapid. But after the plants have attained seasonal maturity, trampling damage retards recovery (Hartley 1976). Further as the earlier investigations have shown, trampling has deleterious effects on the soils. It was also evident that the relationship between trampling and loss of plant cover was not necessarily linear, with lower trampling intensities removing

TABLE 6.1

LIST OF THE DOMINANT COLONIZING PLANT SPECIES IN THE ALPINE AND SUBALPINE AREAS, IN THE CRADLE MOUNTAIN AREA

Alpine Zone	Subalpine Zone
Empodisma minus	*Scirpus aucklandicus*
Abrotanella scapigera	*Poa gunnii*
Carpha alpina	*Empodisma minus*
Scirpus aucklandicus	*Microlaena tasmanica*
Poa gunnii	*Hibbertia procumbens*
Microlaena tasmanica	*Danthonia parvifolia*
	Gleichenia dicarpa

more cover per unit area than higher trampling levels. Similar conclusions were also obtained from the soil erosion measurements.

The track survey identified the width of trampling damage through the park track corridors. If cessation of visitor impact is achieved through the use of the track rehabilitation techniques described earlier, the disturbed areas would begin a slow recovery towards stability. The average annual increases in overlapping cover in the alpine and subalpine zones in the Cradle Valley area were 1.2% and 7.8% respectively. Table 6.1 lists the dominant colonizing species in the alpine and subalpine zones of the northern section of the park. *Scirpus aucklandicus* was the most effective colonizer on all poorly drained, peaty soils and would be the easiest to propagate and establish in both environments (Plate 6.4). *Hibbertia procumbens*, on the other hand, formed an effective colonizer on mineral soil and rock fragment track surfaces in the subalpine areas (Plate 6.5).

Because of the slow recovery process, it may be desirable to introduce other manipulative techniques to accelerate the recolonization of eroded areas by native plant species. Bryant (1971) and Keane (1976) in their assessment of problems of revegetation in the subalpine and alpine areas of the Snowy Mountains suggested that the use of mulching and fertilizers was effective in accelerating the rate of colonization by native ground species.

Plate 6.4 : *Scirpus aucklandicus*, *Luzula sp.* and *Poa* colonization, in the Ronney Creek Area.

Plate 6.5 : *Hibbertia procumbens* re-colonizing in the Ronney Creek area.

Plate 6.4

Plate 6.5

6.3 ACCOMMODATION PROBLEM

6.3.1 Primitive Recreation Zone

Data reported earlier identified a number of trends and issues related to the provision of accommodation in the primitive recreation zone of the park. These include:-

(i) an overall satisfaction with the number of huts along the overland track;

(ii) the shelter hut areas are the focal point of use and impact;

(iii) a high proportion of walkers (28%) are solely dependent on huts for accommodation;

(iv) with the exception of isolated incidents with parties in excess of 40 persons, there was satisfaction with the number of users within the primitive recreation zone;

(v) Only 11% of walkers surveyed camped in areas outside the designated shelter zones.

Field observations indicated that wood gathering has caused extensive damage around some huts. This activity has reached a critical level around Kitchen Hut, a designated emergency hut. Defoliation of the native endemic pine *Diselma archeri* is evident. The high concentration of urea on the periphery of the hut has resulted in the elimination of a number of alpine species, as well as an increase cover of introduced herb species including

Poa annua. Other huts facing a similar problem are Waterfall Valley, Cirque Hut and Kiaora Hut.

This problem is, however, not insurmountable. The National Parks and Wildlife Service has embarked on a policy of providing pot belly stoves in huts for heating purposes. Secondly, the survey of visitors showed that 67% of respondents were prepared to utilise their own fuel stoves for cooking. An educational campaign could therefore, in focussing attention on the virtues of using imported forms of heating and cooking fuels, assist in reducing the level of resource degradation around the huts.

The huts can be regarded as a management tool. Properly located and maintained, they are an aid in resource preservation and steer bushwalkers away from alternative sites which may proliferate over wide areas.

Campsites

Although the use of campsites outside the shelter hut areas is limited, it is suggested that a survey of campsites be carried out by the National Parks and Wildlife Service. The objectives of the survey may include the following:

(a) to identify the location of campsites;

(b) to describe their size and potential carrying capacity;

(c) to evaluate the impact of camping on the level of plant defoliation, soil compaction, vegetation recovery and degree of littering.

This would enable an assessment on the rate of increase or otherwise of the use and demand of camping areas by visitors. Frissell (1978) developed a set of criteria for the assessment of camping damage and this could be modified to suit local conditions.

6.3.2 Developed Zones

(a) Cynthia Bay

This site affords a number of accommodation options ranging from chalets, bunkhouses to caravan sites and camping pads. There was overall satisfaction with both the standards of accommodation and with the ancillary services provided.

(b) Cradle Valley

Unlike Cynthia Bay, the only official accommodation facility available at Cradle Valley are the Chalets behind Waldheim. Favourable comments were received on the conditions and maintenance of these chalets.

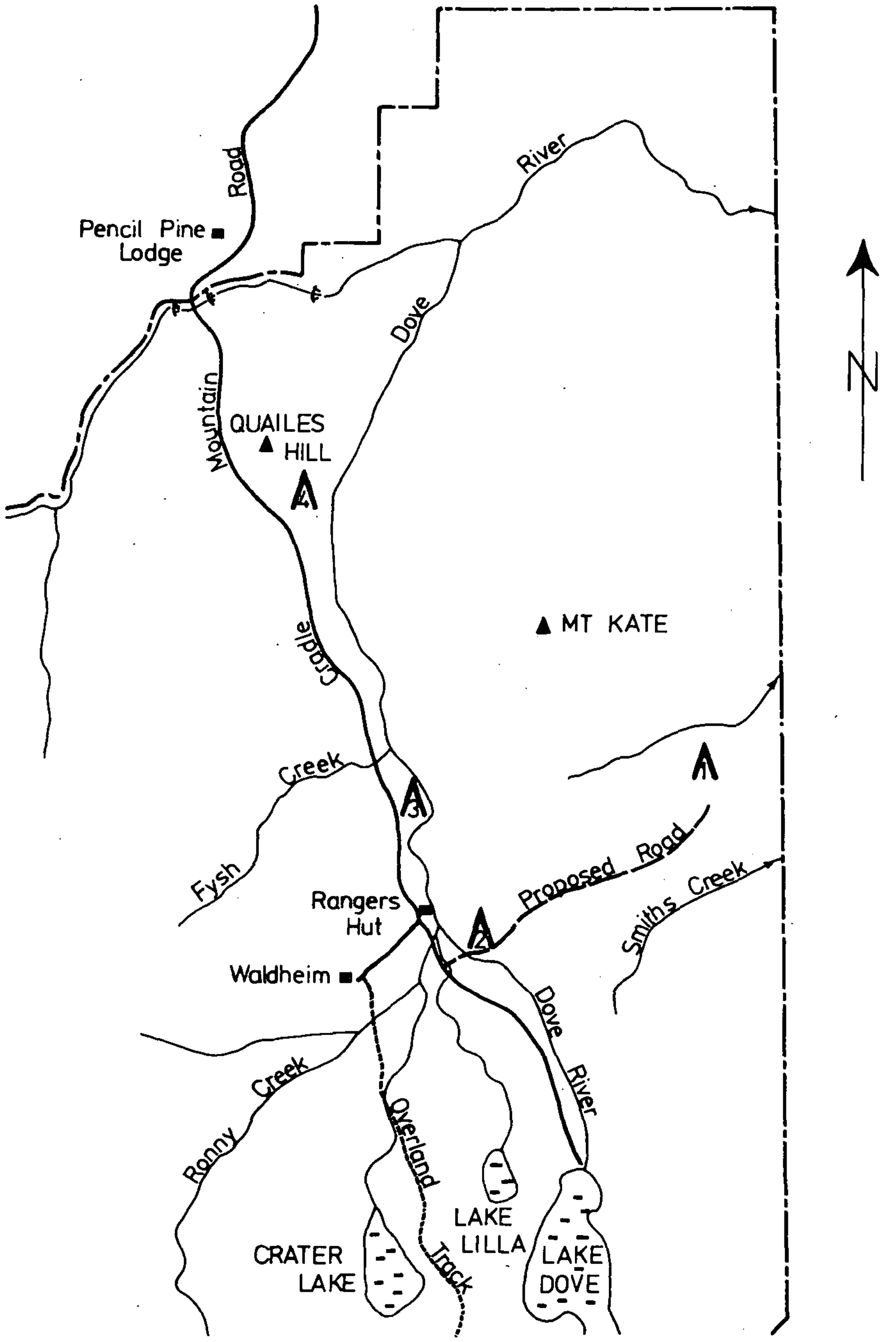
The Service does, however, permit camping in the vicinity of the old sawmill site and Major Smith's Hut.

Fig. 6.5

LOCATION OF PROPOSED CAMPING SITES AT CRADLE VALLEY

Figure 6·5

PROPOSED CAMPING SITES - CRADLE VALLEY



PROPOSED CAMPING SITES

1 Mt Kate

2 Sawmill Site

3 Dove River

4 Quailes Hill

SCALE 1 : 50,000

Visitors were singularly disenchanted with the standard of the camping ground. It is devoid of any amenity, poorly drained, exposed to the prevailing wind and is crowded during the summer period. 57% of daywalkers recommended urgent upgrading of the camping facilities at Cradle Valley.

In the opinion of the writer, there are four potential sites for a camping ground (Fig. 6.5). These are:

(i) Mount Kate;
(ii) The old sawmill site;
(iii) Dove River;
(iv) Quailes Hill.

In an attempt to obtain a comparative and objective assessment of the sites, a check list of factors was devised (Table 6.2). Because of the unique features of each site, it was decided not to ascribe weightings to the factors. Instead, they were used to provide an overall guide to assessing and interpreting the suitability of each site as an accommodation area.

On the basis of the above analysis, it is suggested that Mount Kate would be the most viable site for the provision of all types of accommodation except caravans. The area concerned has been logged for *Athrotaxis selaginoides* up to the late sixties, and is thus serviced by a

TABLE 6.2

COMPARATIVE ASSESSMENT OF POTENTIAL CAMPSITES IN THE CRADLE VALLEY AREA

Evaluation Criteria	Site Options			
	Mount Kate	Old sawmill	Dove River	Quailes Hill
(1) Carrying Capacity	High	Low	Moderate	High
(2) Accommodation Options				
Camping	Yes	Yes	Yes	Yes
Caravans	Yes	Yes	Yes	Yes
Chalets	Yes	No	No	No
(3) Exposure	Sheltered	Exposed	Sheltered	Moderately sheltered
(4) Potential for Ancillary Services	Good	Poor	Fair	Fair
(5) Reliability of Water Supply	Reliable	Reliable	Reliable	Reliable
(6) Proneness to Floods	Not prone	Prone	Not prone	Not prone
(7) Accessibility from Dove Road:	Poor	Good	Good	Fair
To walks	Good	Good	Good	Poor
(8) Landscape	Logged Rainforest	Heath	Heath	Heath
(9) Scenic Viewpoints	Excellent	Good	Good	Poor
(10) Ranger Supervision and control	Good	Good	Good	Poor
(11) Environmental Impact				
Physical	Negligible	Negligible	Negligible	Negligible
Human	Negligible	Significant	Negligible	Significant
Visual	Moderate	Moderate	Negligible	Negligible
(12) Development Costs	Moderate	High	Moderate	Moderate

number of snig tracks and logging roads. Regrowth is sparse and slow, and soil erosion will continue until the damaged areas are stabilised. This area has excellent views of Cradle Mountain, Cradle Valley, Mount Campbell and Dove Lake. The water resources of this area are reliable, and there should be little difficulty in sewerage and sludge disposal.

With proper planning and landscape design this area could be developed in the short term to provide for camping and campervan sites, and in the longer term additional chalets could be constructed, thereby relieving the pressure on the chalets behind Waldheim. It is estimated that about 40 hectares of the logged area would be sufficient to cater for the developments suggested above. At the preliminary stage, however, it would be necessary to construct a bridge across the Dove River and upgrade the road up to Mount Kate.

The second option is the Dove River site, followed by Quailes Hill and the Old Mill Site.

It is further suggested that provision be made at the entrance of the park for a basic caravan park. A number of caravan owners commented on the difficulty of negotiating the narrow roads in the park.

6.4 TOILET PROBLEM

Overall, there was general satisfaction with the toilet facilities in the developed zones as well as the primitive recreation zone. Nonetheless, it is the opinion of the writer that greater consideration should be given by the National Parks and Wildlife Service to the location of the deep pit toilet close to the major water spring at the Waterfall Valley Hut. Further, it was noted by a few respondents that they were unable to use the pit toilet at Windy Ridge Hut after a heavy downpour. In this case, the toilet is located in an area where the watertable is only a few feet below the ground surface.

6.5 LITTER PROBLEM

It is apparent that apart from the poor track conditions, litter was the major factor that detracted from visitor enjoyment of the park. The level of dissatisfaction was stronger amongst the backcountry walkers than the daywalkers. Similar studies of wilderness recreationists have repeatedly indicated that litter is perceived by users to be the most annoying problem encountered in the backcountry (Lime 1972, Stankey 1973).

At present, each hut in the park is serviced with a rubbish tip. These are poorly maintained and in almost all cases, have attained their capacity and hence are unaesthetic and pose a health hazard (Plate 6.6).

Plate 6.6 : The untidy surrounds of the rubbish pit at Narsiccus Hut.

Plate 6.6

Two approaches are suggested. As a short-term measure, it is proposed that all rubbish tips be sealed and be replaced with two 44 gallon drums. These could be serviced annually by a helicopter run. The second and long-term approach would be to be to institute an educational campaign expounding the virtues of the "pack it in and pack it out" principle. It is envisaged that this campaign would be executed concurrently with the short-term measure suggested above.

A similar Pack-It-Out program designed by the U.S. Forest Service resulted in numerous benefits including increased user participation, reduced litter levels and reduced costs (Muth and Clark 1978).

The fact that 97.5% of respondents surveyed supported the principle of removing their own litter from the park is a clear indication of changing values in the community and that it would take little persuasion to enforce this principle.

6.6 ACCESS PROBLEM

Visitors were questioned on a number of options regarding access to the park. The results indicated vehement opposition to any expansion of roads in the park interior, as well as to the upgrading of the airfield. They were also marginally opposed to the sealing of the road to the Cradle Mountain entrance.

In an environmental impact study commissioned by the Department of Main Roads (DMR 1978) it was recommended that the Cradle Mountain tourist road be sealed from the Cethana turnoff to Leary's Corner, which is about 5 kilometres before the entrance to the National Park. The study estimates that the traffic on the road could double its present volume in five years if the road is sealed as against 15-20 years if the road is left unsealed.

The preceding data on track conditions and public amenities in the developed zone and the natural environment zone have shown that facilities are currently inadequate and tracks have exceeded their carrying capacities. The consequence of sealing roads could be an immediate increase in traffic in the park. This, in turn, will only cause further deterioration of the existing facilities and an acceleration in track and environmental damage.

Accordingly, it is suggested that prior to the sealing of the road to Cradle Mountain, the carrying capacity of tracks be increased in accordance with the earlier proposals; provision of public amenities be upgraded and that improved camping facilities be made available. It is estimated that it would cost up to $300,000 to upgrade the daywalk routes in the Cradle Mountain area (refer section 6.2.2).

With the upgrading of roads to the Wolfram Mine Track and the Arm River Track, an increase in visitation rates to the central region of the park is anticipated. Appropriate management policies including the stationing of a Ranger at Pelion need to be considered by the National Parks and Wildlife Service.

6.7 PUBLIC AMENITIES

The lack of suitable public amenities in the developed zone at Cradle Valley was another issue which was given prominence by the day visitors surveyed. At present, the only facility available is a day-hut located adjacent to the car park in front of Waldheim. Visitors commonly expressed dissatisfaction with the hut and in particular its fireplaces. It is suggested that a new day hut be constructed and a picnic area be developed in the vicinity of the present camping area near the old sawmill site. This area would have a higher carrying capacity, and more importantly, would divert traffic away from the road to Waldheim, and thereby relieve the pressure on the fragile temperate rainforest environments close to Waldheim. It is further suggested that similar public amenities be made available at the Dove Lake car park.

In determining the options available for the development of public amenities, the visitor survey indicated that the public was again vehemently opposed to the development of any further commercial outlets and kiosks within the park. Visitor satisfaction with facilities at Cynthia Bay was noted.

6.8 INFORMATION PROBLEM

It is apparent from the data reported earlier, that visitors to the park perceived the provision of information to be inadequate. They were particularly concerned about the inadequate provision of signs and interpretative facilities.

6.8.1 Signs

Forty-seven percent of the respondents believed that signs within the park required improvement and up-dating.

Stankey *et al* (1978) identified four types of signs: directional, informational, interpretive and regulatory. It is suggested that map directories be erected at all major trackheads, including Dove Lake, Waldheim, Wolfram Mine, Arm River Track and at Cynthia Bay.

Low-level directional signs could be placed at track junctions, in particular along the daywalk routes. Information signs would be useful at camp sites and shelter huts, whilst interpretative signs would be useful along nature tracks, and at scenic vantage points.

Regulatory signs may be useful management tools. They may be used to inform visitors on management decisions like track closures and fire restrictions. Experience gained from this study has indicated that there was public co-operation where information on the management problem was provided, followed by a positive request to abide by the instructions.

In the provision of signs in the primitive recreation zone consideration needs to be given to the need to preserve the challenge and the sense of adventure in the back country.

6.8.2 Interpretive Services

Complaints over the lack of interpretive services and the lack of information about the local environment at Cradle Valley were common. On a number of occasions even daywalk maps were not available. It was not unusual to witness visitors tear off copies of daywalk maps from the questionnaire for use in the field.

Thirty-two percent of respondents believed that there was an urgent need to improve the provision of information. This could be realised through the conversion of the present Head Ranger's quarters, which will become vacant at the end of the 1980/81 financial year, as a visitor reception and interpretive centre.

Eighty percent of visitors surveyed were enthusiastic about a nature trail close to the developed zones. At Cynthia Bay, the existing nature trail to Watersmeet has proven to be particularly popular with the day visitors (Dwyer per comm). None exists at Cradle Valley. It is suggested therefore, that a nature trail be developed along the route shown in Fig. 6.6. The proposed route traverses a variety of vegetation types with increasing altitude, including hummock sedgelands, open woodlands, temperate rainforest and alpine vegetation. Other interesting features include waterfalls, glacial moraines, valleys and lakes and wildlife. The proposed route is about 4 kilometres and the walking time for the circuit would be between one to two hours and being below the 900 m level, it is reasonably sheltered from the prevailing winds.

In summary, it is suggested that the present Head Ranger's house-cum-camping ground could be developed as the administrative, visitor reception and interpretive centre and the major day use and picnic area respectively. This would, thus, effectively alleviate the pressures on the Waldheim area and would prove easier to manage as a result of the close proximity of the Rangers' residences and the above amenities. This proposal would also accommodate any future expansion of amenities or facilities.

6.9 EDUCATION ALTERNATIVE

The common dilemma confronting all National Parks revolves around fiscal cutbacks, reduced manpower, increasing costs and increased visitation levels. In most cases, managers have adopted a "survival" approach of only doing what is essential and resign with the attitude that "more could be done if only ...". As a consequence, the need to develop alternative approaches and strategies to minimise impact and maximise productivity becomes more important than ever.

From dialogues with visitors and ranger staff and from field observations, it is apparent that most of the impact on the natural environment of the park is not caused maliciously. Most of the damage is a product of ignorance of good bush ethics and a lack of sensitivity to the consequences of this behaviour.

The key to successful back country management is the education of the actual and potential back country and wilderness users (Bradley 1979, Simmer 1979). The common approach adopted is what is now known as "minimum impact education". It endeavours to give adequate explanation of the need for preserving the natural values of the park and a code of behaviour which every individual is requested to comply with whilst bushwalking.

A brief summary of the code is provided below:

1. Choosing a campsite well away from the main track.
2. The use of subdued colour tents, giving other visitors a feeling of solitude.
3. Discouraging camping in alpine zones and along lake shores.
4. Not using vegetation as mattresses.
5. The use of stoves instead of fires.
6. The use of existing sites for fires. The need to dismantle fireplaces when leaving, including the removal and dispersion of ash and coal after fires.
7. Keeping fires small. This conserves wood and reduces the size of the fire scar.
8. Planning a trip to minimise rubbish - avoid bottles and cans.
9. Pack it in and pack it out. Many visitors, for instance, believe that to bury their rubbish is an environmentally sound practise.
10. Keep party sizes to a minimum - crowds and solitude are not compatible.
11. The need to carefully put out fires lit on peaty and alpine humic soils.
12. Sanitation: where the site has to be at least 50 metres from the nearest water source. The need to dig the first 150 mm of soil, which forms the natural decomposition zone. There is a need to cover the hole after use.

13. The need to understand the sensitivity of plant communities to trampling pressures. For instance, the impact of trampling on cushion plants.

Sixty percent of visitors surveyed had attained tertiary qualifications, whilst most of the remaining had at least secondary education. As such, an educational campaign along a modified code structure to suit local conditions could be successful in inculcating a responsible attitude to the fact that litter, mess, and unnecessary damage to the natural environment are extrinsic to the backcountry experience.

The education programme could be embarked on through the media, schools and community groups, and advice in the park by the ranger staff.

In some instances, education may not change people who feel that they have a right to act differently to the detriment of other visitors and the conservation values of the park. In these cases, regulations, permits and law enforcement are necessary and the only reasonable options available.

The overseas studies have found that similar programmes have gained considerable support from the public and have led to a greater understanding and interaction between park staff and members of the community (Ittner

1979, Bradley 1979). It was found that as the level of awareness and consciousness increases, park staff have been able to utilise the voluntary services of bushwalkers in monitoring change and visitor impact in the backcountry areas. As well, they are encouraged to carry out a number of small but essential management tasks like the clearing of plant growth over tracks, removal of litter, displacement of fire places, the cleaning of huts and routine maintenance of track drains.

The promotion of such a programme is not only feasible but desirable in this State. It would go a long way to correcting the deficiencies described earlier and change visitor behaviour and attitudes to land and nature conservation values.

6.10 FEES

There is an apparent realisation within the community that nothwithstanding the annual grants from the State Government, some additional revenue source is desirable for the continuous maintenance of facilities in the National Parks. This was clearly demonstrated by the strong support (84%) given to the concept of entrance fees to the park, this support being conditional on the monies collected being utilised for the maintenance and expansion of facilities in the National Park.

Nevertheless, fees can only be a useful revenue source if the amounts received exceed the collection costs. Insofar as the Cradle Mountain - Lake St. Clair National Park is concerned, analysis of visitor patterns would suggest that for a cost-effective operation, fee collection should be concentrated during periods of peak usage, such as, weekends and public holidays during the off-peak season, and a daily collection between mid December and the end of March.

An appropriate fee schedule could be based on the following factors:

(1) number of vehicles;

(2) the fact that the overwhelming majority of day-walkers spent an average of two nights in the Park (Table 3.11);

(3) the fact that the average length of stay in the Park by the overland bushwalkers was 5 days (Table 3.11b);

(4) the most common fee supported by respondents was $1.00 per day (Table 3.25).

Accordingly, it is suggested that the following schedule of fees would be economically feasible:

(i) $2.00 per vehicle;

(ii) $20.00 per bus;

(iii) $2.00 track levy be added to the accommodation costs of campers and chalet residents at Cradle Valley, and $1.00 levy for those at Cynthia Bay;

(iv) $5.00 track levy be imposed on all overland track bushwalkers.

The levies proposed above, if implemented, would in one year (based on 1976/77 figures) provide an additional revenue of about $47,000 at Cradle Valley and about $96,000 at Cynthia Bay, a total of $142,000. If allowance is made for the wages of four persons, the levy collectors, and overheads, the Park Service would still receive an additional $90,000 for utilisation for management works within the park.

Alternatively, boom gates could be installed at each of the entrances with $2.00 (two dollar) note acceptors triggering the operation of the gates. Although initially expensive, the lower long term operating costs would facilitate greater savings and thus, divert more funds for park maintenance.

CHAPTER VII

CONCLUSIONS

(1) Visitor trend analysis would suggest that

(a) the average annual growth rate of the overland track walkers has stabilized and has been fluctuating around 2300 walkers per annum since 1976. The maximum number of overlanders recorded was 2500 in 1977/78;

(b) there has been a slow but steady growth in the number of daywalkers in the Cradle Valley region. Since in excess of 90% of daywalkers spent on the average 2-3 nights in the park, any further increase in numbers could be dependent on the availability of accommodation. Therefore, an improvement of the camping facilities and/or perhaps an increase in the number of chalets could result in an immediate increase in the number of daywalkers;

(c) the number of 2 to 3 day backcountry walkers is increasing steadily, and may continue to increase with the upgrading of the roads to the Wolfram Mine track and the Arm River track and with a reliable boat service across Lake St. Clair. The former access options may reduce the use in the Cradle Mountain area while resulting in higher use of the central region of the park.

(d) analysis of bed occupancy levels, suggests that demand was greater than supply during the peak summer months and during the weekends in the off seasons.

(2) The collection of visitor statistics at the entrances to the park have been irregular, inconsistent and inadequate. It is suggested that the overland track and 2-3 day backcountry walks registers be replaced by a single walker registration form. This would also enable the collection of additional visitor information which would assist park managers.

(3) The majority of overlanders and backcountry walkers had obtained tertiary qualifications or were in the process of doing so; held professional and/or administrative occupations and were in the 18-40 year age bracket.

(4) Seventy percent of the overland walkers were from the mainland states, 20% were Tasmanians and the remainder were visitors from overseas. Fifty eight percent of daywalkers were mainland visitors and 42% were Tasmanians.

(5) The average length of stay of overlanders was between 5-6 nights, daywalkers, 2-3 nights, and non walkers overnight.

(6) The pattern of overnight stopovers of the overland walkers and the 2-3 day backcountry walkers show a close resemblance to the recommended "walking plan" printed in the 1:100,000 topographical map series of this National Park.

(7) Up to 28% of the overland and 2-3 day backcountry walkers did not carry their own camping equipment.

(8) Eighteen percent of the overland track parties camped in Kitchen Hut, a designated emergency hut. The impact of camping in this area has been severe, with high level defoliation and the presence of exotic plant species.

(9) Analysis of visitor distribution in the park showed a strong tendency to adhere to the existing track corridors, and the hut areas are the main loci of camping activities.

(10) One of the major attractions of the overland track is accessibility to the mountains. Sixty percent of overlanders or the 2-3 day backcountry walkers had climbed at least one mountain, the most popular being Cradle Mountain.

(11) The most heavily used tracks in the Cradle Valley area are those around Dove Lake, Waldheim, and the track from Waldheim to Kitchen Hut via Crater Lake and Crater Falls.

(12) The two factors the majority of respondents complained about were the poor state of the tracks and the amount of litter around the the huts along the overland track.

(13) Fifty eight percent of daywalkers and 67% of daytrippers or non-walkers were dissatisfied with the camping facilities at Cradle Valley, and suggested immediate improvements.

(14) Sixty percent of non-walkers were dissatisfied with the day use and picnic facilities at Cradle Valley.

(15) The overwhelming majority of respondents were opposed to any form of resource exploitation, or any further tourist and commercial development in the park.

(16) A majority of respondents were opposed to the sealing of the road to the Cradle Mountain entrance.

(17) Respondents were in favour of wooden walkways, removal of their own litter from the park, using their own cooking fuels, closing damaged tracks and campsites, limiting the size of parties along the overland track and the introduction of entrance fees. They were opposed to limiting the number of visitors to the park.

(18) The common fee supported by the majority of respondents was between \$1-\$2 per day.

(19) There is a high revisitation rate to the park. Forty nine percent of respondents had been to the park previously. At least 20% of these respondents had been to the park 9 or more times previously.

(20) Sixty-six percent of visitors had indicated that they would return to the park in the next 5 years.

(21) The survey of 120 kms of tracks in the national park highlighted the following:

(a) Thirty-five percent were in good condition, 36% were fair, and 29% were either in a bad or very bad state of degradation.

(b) Twenty percent or 15.6 kms of the overland track are badly damaged.

(c) The badly damaged tracks appear to be disproportionately located in the northern half of the park. Sixty-three percent of track surfaces north of Pelion Hut are badly damaged compared to only 10% in the south.

(d) Only 8.7% or 3.5 kms of the daywalk tracks in the Cradle Mountain area were badly damaged. These are concentrated on the Cradle Plateau near the developed zone and at track junctions.

(22) Vegetation types most susceptible to trampling were heath communities dominated by bolster plants, dwarf pines, *Richea scoparia*, *R. sprengelioides*, and *Melaleuca squamea* and hummock sedgelands dominated by *Gymnoschoenus sphaerocephalus*. Followed by woodland, scrub, closed forest and low and tall open forests dominated by *Eucalyptus delegatensis*.

(23) Areas with altitudes greater than 900 m appear to be more susceptible to trampling pressures than those below 900 m ASL.

(24) Geological surfaces in order of increasing trampling susceptibility are schists, mudstone, sandstone, conglomerates, glacial till, dolerite, and quartzite.

(25) Tracks across treeless communities were wider than those through forested communities.

(26) There was a negative correlation between the slope of the terrain and the level of deterioration of the tracks. Thus, the badly deteriorated sites were located on the flatter, slightly undulating, terrain,

generally associated with poor drainage.

(27) Only 13% of tracks surveyed had depths greater than 30 cms. The deeper tracks were in general, associated with glacial moraines and steeper slopes through eucalypt woodlands.

(28) The state of tracks is consistently related to the amount of track usage. However, data analysis indicated that tracks below 900 m ASL had a higher carrying capacity than those above the 900 m level.

(29) The threshold levels of the different vegetation types were hummock sedgeland 1250, heath 1550, closed forest 2300, low open forest 3600, tall open forest 4250 and tall open woodland 5000.

(30) The threshold levels for the geological surfaces were dolerite 2000, quartzite 2200, mudstone 2600, sandstone 2800, glacial till 3200.

(31) Threshold levels for slopes were 0-1° 2000, 2-4° 2000, 5-7° 2000, 8-10° 3000, 11-13° 3100, 14-17° 5000, and 21-25° 5000.

(32) Threshold levels for the elevation classes were 700-800m 4800, 801-900m 2200, 901-1000m 2300, 1001-1200m 2500, 1101-1200m 3000, 1201-1300m 500.

(33) Trampling experiments showed that after one year of trampling, the overlapping cover of a new track in the alpine area near Kitchen Hut was reduced by 42% and there was an 18% reduction in species diversity.

(34) In the subalpine area close to Ronney Creek, the new track experienced a reduction of overlapping cover by

48% and a reduction in species diversity of 15%, after one year of trampling.

(35) Lifeforms most susceptible to trampling pressures in the alpine areas were mat covers and shrubs, rhizomotous monocotyledons, tussocks, rosettes, and forbs. The major susceptible species include *Diselma archeri, Michrocachrys tetragona, Empodisma minus, Celmesia saxifraga, Donatia novae-zelandiae.*

(36) Lifeforms most susceptible to trampling pressures in the subalpine areas were forbs, rhizomatous monocotyledons, shrubs, tussocks and rosettes. The major susceptible species were *Gleichenia dicarpa, Restio australis, Empodism minus, Boronia rhomboidea* and *Lepidosperma filiforme.* The rosette, *Rubus gunnianus,* was the only species to increase its overlapping cover.

(37) There was a 1.2% increase in cover over tracks where traffic had been terminated in the alpine area. The most prolific colonizers were *Empodisma minus, Abrotanella scapigera, Scirpus aucklandicus, Carpha alpina* and *Poa gunnii.*

(38) Even though traffic was removed off the tracks, soil erosion was continuously increasing. The percentage of bare ground increased by 0.6% and there was a loss of 2500 cu cms of soil across an area of 5 m^2.

(39) There was a 7.8% increase in overlapping cover in the subalpine, Ronney Creek area. The most prolific colonizers included *Scirpus aucklandicus, Poa gunnii, Empodisma minus, Microleana tasmanica,* and *Hibbertia*

procumbens.

(40) Bulk density increased with increasing traffic at all sites.

(41) There was a greater soil loss on steeper slopes as compared to gentle slopes. The erosional losses on the level sites were gradual, whilst the steeper sites experienced a high loss in soil area during the initial period of trampling, whilst further use resulted in lesser losses.

(42) The increase in track width in the alpine areas was greater than in the subalpine areas, even though the latter experienced high trampling intensities. The high moisture content of soils in the alpine area may account for the wider tracks.

(43) As a result of the above conclusions, the following management strategies and options are suggested;

(a) that manipulatory techniques be used to resolve the conflicting aims of maximizing recreational enjoyment and minimizing recreational impact;

(b) that the essential regulatory option is the concept of park zones.

(c) that because of the slow recovery rates of plant species, the rotation of tracks and campsites is not a viable option. Instead, the option proposed is the upgrading of the present tracks through the park, and where desirable the relocation of sections of the overland track.

(d) that the total cost of upgrading the tracks is estimated to be $700,000.00. The cost of improving the tracks in the Cradle Mountain area is estimated at $300,000;

(e) that the techniques suggested for track rehabilitation are in accordance with the proposed track classification system (Section 6.2.1);

(f) that a Dove Lake track circuit be constructed. It is envisaged that this low-level track would relieve some of the pressure from the fragile Cradle Plateau;

(g) that there appears to be an adequate number and distribution of huts along the overland track. No new huts are required;

(h) that there be a survey of all campsites in the park;

(i) that a new camping area be developed in the previously logged area on Mount Kate, Cradle Valley;

(j) that the litter problem on the overland track be resolved by

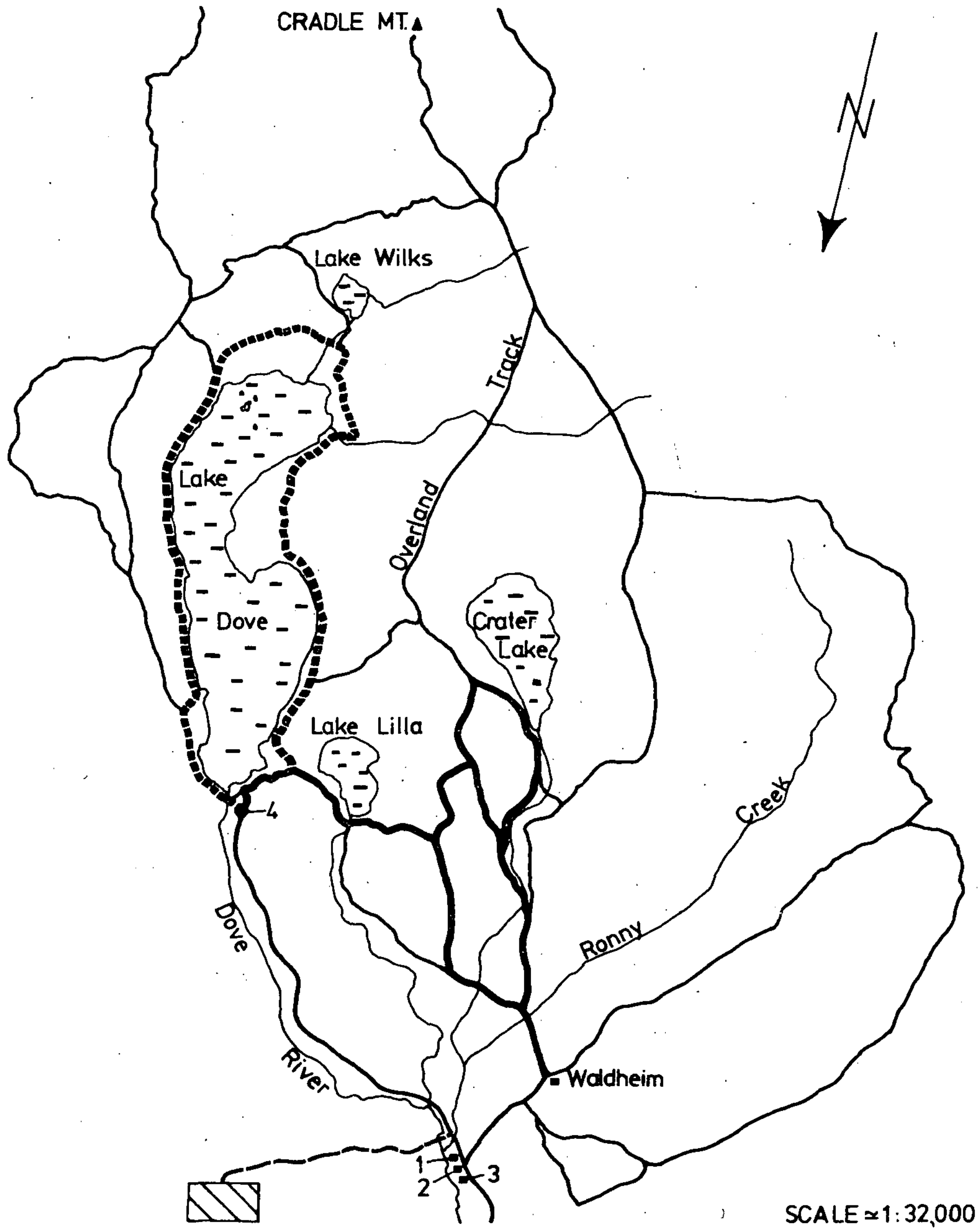
  (1) closing all present rubbish pits, and replacing them 44 gallon drums (short-term measure);

  (2) an educational campaign expounding the virtues of the "pack it in and pack it out" principle be initiated (long-term measure);

(k) that prior to the sealing of the road to Cradle Mountain, the carrying capacity of the tracks be

Figure 7·1

PROPOSED DEVELOPMENTS IN THE CRADLE MT. AREA



PROPOSED DEVELOPMENTS

	Nature Trails	1	Day Hut & Picnic Area
	Dove Lake Circuit Track	2	Visitor Reception Centre
	Camping Ground	3	Rangers Cottage
	Road	4	Car Park & Picnic Area

increased in accordance with the proposals in Appendix 8, provision of public amenities be upgraded and improved camping facilities be made available;

(l) that public pressures close to Waldheim be reduced. This could be achieved with redevelopment of the present campsite as a day-use and picnic area; the conversion of the present Head Ranger quarters into a public reception centre and the development of Mount Kate as the major camping area (Fig. 7.1);

(m) that the user-pay principle be introduced. This would take the form of a fee schedule based on the type of activity carried out in the park. It is anticipated that based on the 1976/77 visitor fitures, a sum of $154,000 could be collected.

(n) The key to successful management is the education of actual and potential park users. It is suggested that a "minimum impact education" program be instituted by the National Parks and Wildlife Service.

APPENDIX 2

PLANT COMMUNITIES IN THE CRADLE MOUNTAIN - LAKE ST. CLAIR NATIONAL PARK

(Source: Specht, 1974)

STRUCTURAL FORMATIONS IN AUSTRALIA

Life form and height of tallest stratum*	Projective foliage cover of tallest stratum*			
	Dense (70–100%)	Mid-dense (30–70%)	Sparse (10–30%)	Very sparse† (< 10%)
Trees > 30 m ‡	Tall closed-forest*	Tall open-forest	Tall woodland	Tall open-woodland
Trees 10–30 m ‡	Closed-forest*	Open-forest	Woodland	Open-woodland
Trees 5–10 m ‡	Low closed-forest*	Low open-forest	Low woodland	Low open-woodland
Shrubs 2–8 m ‡	Closed-scrub	Open-scrub	Tall shrubland	Tall open-shrubland
Shrubs 0–2 m ‡	Closed-heath	Open-heath	Low shrubland	Low open-shrubland
Hummock grasses 0–2 m	–	–	Hummock grassland	Open-hummock grassland
Herbs (including moss, ferns, hemicryptophytes, geophytes, therophytes, hydrophytes, helophytes)	Closed-herbland § (1) Closed-tussock grassland (2) Closed-grassland (3) Closed-herbfield (4) Closed-sedgeland (5) Closed-fernland (6) Closed-mossland	Herbland § (1) Tussock grassland (2) Grassland (3) Herbfield (4) Sedgeland (5) Fernland (6) Mossland	Open-herbland § (1) Open-tussock grassland (2) Open-grassland (3) Open-herbfield (4) Open-sedgeland (5) Open-fernland (6) Open-mossland	Ephemeral herbland

* Isolated trees (emergents) may project from the canopy of some communities. In some closed-forests, emergent *Araucaria*, *Acacia*, or *Eucalyptus* species may be so frequent that the resultant structural form may be classified better as an open-forest.

† Some ecologists prefer to ignore scattered trees and shrubs, equivalent to emergents in a predominantly grassland, heath, or shrubland formation.

‡ A tree is defined as a woody plant more than 5 m tall, usually with a single stem. A shrub is a woody plant less than 8 m tall, frequently with many stems arising at or near the base.

§ Appropriate names for the community will depend on the nature of the dominant herb.

(Appendix 2 Continued)

Conservation area	Plant communities	Est. area (%)
Cradle Mt.–Lake St. Clair S.R. (N.P.)	Tall closed-forest	
(extensive range of wet sclerophyll–temperate rainforest–montane and fresh water systems)	Lowland	
Co. Lincoln	*Nothofagus cunninghamii–Atherosperma moschatum*	4
Lat. 41°50′S.	Tall open-forest	
Long. 146°00′E.	Subalpine	
Area 124,943 ha	With rainforest understorey	
	(1) *E. delegatensis* ± *E. coccifera*	5
	(2) *E. gunnii, E. subcrenulata, E. nitida*	
	(3) *E. pauciflora*	
	With sclerophyll understorey	
Surveyor: W. D. Jackson	*E. delegatensis* ± *E. gunnii, E. coccifera, E. subcrenulata, E. pauciflora, E. nitida*	3
R.I.: A	Lowland	
	With rainforest understorey	
	(1) *E. nitida*	1
	(2) *E. obliqua–E. dalrympleana*	2
	With sclerophyll understorey	
	(1) *E. regnans*	< 1
	(2) *E. obliqua* ± *E. dalrympleana*	4
	(3) *E. nitida*	< 1
	(4) *E. robertsonii*	< 1
	(5) *E. pauciflora*	< 1

(Appendix 2 Continued)

Conservation area	Plant communities	Est. area (%)
Cradle Mt.–Lake St. Clair S.R. (N.P.) (*Continued*)	Tall woodland	
	Subalpine	
	With rainforest understorey	
	E. delegatensis ± *E. coccifera*, *E. gunnii*, *E. subcrenulata*, *E. pauciflora*, *E. nitida*	1
	Lowland	
	With rainforest understorey	
	(1) *E. obliqua–E. dalrympleana*	< 1
	(2) *E. nitida*	< 1
	Tall open-woodland	
	Subalpine	
	With rainforest understorey	
	E. delegatensis ± *E. coccifera*, *E. gunnii*, *E. subcrenulata*, *E. pauciflora*, *E. nitida*	< 1
	Lowland	
	With rainforest understorey	
	(1) *E. obliqua–E. dalrympleana*	< 1
	(2) *E. nitida*	< 1
	Closed-forest	
	Subalpine/Lowland	
	(1) *Athrotaxis selaginoides–A. cupressoides*	< 1
	(2) *Phyllocladus aspleniifolius–Anodopetalum biglandulosum*	
	(3) *Phyllocladus aspleniifolius–Nothofagus cunninghamii*	1
	(4) *Nothofagus cunninghamii–Eucryphia lucida*	3
	(5) *Nothofagus cunninghamii–Atherosperma moschatum*	5
	Open-forest	
	Alpine	
	Athrotaxis selaginoides–A. cupressoides	< 1
	Subalpine	
	With rainforest understorey	
	(1) *E. coccifera*	< 1
	(2) *E. delegatensis–E. urnigera*	< 1
	(3) *E. delegatensis–E. subcrenulata*	< 1
	(4) *E. gunnii*	< 1
	With sclerophyll understorey	
	(1) *E. coccifera*	< 1
	(2) *E. delegatensis–E. gunnii*	2
	(3) *E. delegatensis–E. subcrenulata*	< 1
	(4) *E. gunnii*	< 1
	(5) *E. rodwayi*	< 1
	Woodland	
	Subalpine	
	With rainforest understorey	
	(1) *E. coccifera*	< 1
	(2) *E. delegatensis–E. gunnii*	< 1
	(3) *E. delegatensis–E. subcrenulata*	< 1
	(4) *E. gunnii*	< 1

(Appendix 2 Continued)

Conservation area	Plant communities	Est. area (%)
Cradle Mt.–Lake St. Clair S.R. (N.P.) (*Continued*)	Open-woodland	
	Subalpine	
	With rainforest understorey	
	(1) *E. coccifera*	< 1
	(2) *E. delegatensis–E. gunnii*	< 1
	(3) *E. delegatensis–E. subcrenulata*	< 1
	(4) *E. gunnii*	< 1
	Low closed-forest	
	Alpine	
	(1) *Athrotaxis cupressoides–A. selaginoides–Diselma archeri*	< 1
	(2) *Nothofagus gunnii* (extends to Subalpine)	< 1
	(3) *Nothofagus cunninghamii*	< 1
	Subalpine	
	(1) *Nothofagus cunninghamii*	< 1
	(2) *Phyllocladus aspleniifolius–Anodopetalum biglandulosum*	< 1
	Low open-forest	
	Alpine	
	Athrotaxis cupressoides–A. selaginoides	< 1
	Subalpine	
	With rainforest understorey	
	(1) *E. coccifera–E. subcrenulata*	2
	(2) *E. coccifera–E. gunnii*	1
	(3) *E. subcrenulata*	1
	(4) *E. delegatensis–E. gunnii*	< 1
	With sclerophyll understorey	
	(1) *E. coccifera–E. subcrenulata*	1
	(2) *E. coccifera–E. gunnii*	2
	(3) *E. subcrenulata*	< 1
	(4) *E. delegatensis–E. gunnii*	4
	Low woodland	
	Alpine	
	Athrotaxis cupressoides–A. selaginoides	< 1
	Subalpine	
	(1) *E. coccifera*	4
	(2) *E. coccifera–E. subcrenulata*	2
	(3) *E. coccifera–E. gunnii*	1
	Low open-woodland/Closed-scrub	
	Alpine	
	Athrotaxis cupressoides–A. selaginoides	< 1
	Closed-scrub	
	Alpine	
	(1) *Diselma archeri–Microstrobos niphophilus*	< 1
	(2) *Nothofagus gunnii*	< 1
	Subalpine	
	(1) *Telopea truncata–Lomatia polymorpha*	< 1
	(2) *Orites diversifolia–Olearia persoonioides*	< 1
	(3) *Tasmannia lanceolata–Orites diversifolia–Olearia pinifolia*	< 1
	(4) *Nothofagus gunnii*	< 1
	(5) *Nothofagus cunninghamii–Trochocarpa gunnii*	1
	(6) *Leptospermum lanigerum–Callistemon viridiflorus*	< 1

(Appendix 2 Continued)

Conservation area	Plant communities	Est. area (%)
Cradle Mt.–Lake St. Clair S.R. (N.P.) (*Continued*)	Open-scrub	
	Subalpine	
	Richea pandanifolia–Phyllocladus aspleniifolius	< 1
	Tall shrubland	
	Subalpine	
	Richea pandanifolia	< 1
	Closed-heath	
	Alpine	
	(1) *Abrotanella forsterioides–Pterygopappus lawrencei–Donatia novae-zelandiae*	1
	(2) *Microcachrys tetragona–Pentachondra pumila–Cyathodes dealbata*	2
	(3) *Cyathodes petiolaris–Monotoca empetrifolia*	1
	(4) *Epacris serpyllifolia–Bellendena montana*	2
	(5) *Microstrobos niphophilus–Diselma archeri*	< 1
	(6) *Nothofagus gunnii*	< 1
	Subalpine	
	(1) *Richea sprengelioides–Cyathodes straminea*	< 1
	(2) *Podocarpus alpina–Leptospermum humifusum*	< 1
	(3) *Orites acicularis–O. revoluta*	< 1
	(4) *Tasmannia lanceolata–Trochocarpa thymifolia*	< 1
	(5) *Helichrysum ledifolium–H. hookeri–Olearia algida*	< 1
	(6) *Helichrysum backhousei–Olearia stellulata*	< 1
	(7) *Bauera rubioides–Leptospermum nitidum*	< 1
	Open-heath	
	Alpine/Subalpine	
	(1) *Leptospermum humifusum–Exocarpos humifusus*	1
	(2) *Podocarpus alpina–Olearia pinifolia–Coprosma nitida*	1
	(3) *Orites acicularis–O. revoluta–Richea scoparia*	3
	(4) *Olearia ledifolia–Helichrysum ledifolium*	1
	(5) *Helichrysum hookeri–H. backhousei–Olearia algida*	< 1
	(6) *Epacris serpyllifolia–Bellendena montana–Cyathodes petiolaris*	1
	Subalpine	
	(1) *Baeckea gunniana–Boronia citriodora*	< 1
	(2) *Bauera rubioides–Melaleuca squarrosa–Sprengelia incarnata*	< 1
	Low shrubland	
	Alpine/Subalpine	
	Orites acicularis–Olearia ledifolia	2
	Subalpine	
	Hakea lissosperma–H. sericea	< 1
	Low open-shrubland	
	Alpine	
	Orites acicularis–Olearia ledifolia	1
	Subalpine	
	Hakea lissosperma	< 1

(Appendix 2 Continued)

Conservation area	Plant communities	Est. area (%)
Cradle Mt.–Lake St. Clair S.R. (N.P.) (*Continued*)	Closed-grassland/Closed-herbland	
	Alpine	
	(1) *Caltha phylloptera–Ranunculus nanus–Plantago muelleri*	< 1
	(2) *Oreobolus pumilio–Carpha alpina*	< 1
	(3) *Mitrasacme archeri–Ewartia meredithiae*	< 1
	(4) *Rubus gunnianus–Euphrasia striata–Gentianella diemensis*	< 1
	(5) *Astelia alpina–Calorophus lateriflorus*	< 1
	(6) *Milligania densiflora–Gleichenia dicarpa*	< 1
	Subalpine	
	(1) *Plantago paradoxa–Ranunculus nanus–Velleia montana*	< 1
	(2) *Astelia alpina–Calorophus lateriflorus–Gleichenia dicarpa*	< 1
	(3) *Poa labillardieri*	< 1
	(4) *Restio australis–Carpha alpina–Sphagnum cristatum*	< 1
	(5) *Restio oligocephalus–Lepidosperma filiforme*	< 1
	(6) *Leptocarpus tenax–Xyris operculata*	< 1
	Grassland/Herbland	
	Alpine	
	Poa caespitosa–Helipterum anthemoides–Helichrysum acuminatum	< 1
	Alpine (aquatic)	
	Myriophyllum pedunculatum–Ourisia integrifolia	< 1
	Alpine (lithosere)	
	(1) *Umbilicaria cylindrica–U. polyphylla–U. subglabra*	2
	(2) *Andreaea eximea–Umbilicaria polyphylla*	1
	(3) *Siphula fragillus–Cladia retipora–Polytrichum alpinum*	< 1
	Subalpine	
	(1) *Restio oligocephalus–Lepidosperma filiforme*	< 1
	(2) *Restio complanatus*	< 1
	(3) *Gymnoschoenus sphaerocephalus*	2
	Open-grassland/Open-herbland	
	Subalpine	
	Gymnoschoenus sphaerocephalus	2
	Subalpine (aquatic)	
	(1) *Myriophyllum pedunculatum–Liparophyllum alpinum*	< 1
	(2) *Isoetes gunnii–Trithuria filamentosa–Gaimardia fitzgeraldii*	< 1
	(3) *Centrolepis monogyna*	< 1
	Subalpine (lithosere)	
	(1) *Andreaea eximea–Umbilicaria polyphylla–Trentepohlia* spp.	< 1
	(2) *Siphula fragillus–Cladia retipora–Polytrichum alpinum*	< 1
	Cleared land, buildings etc.	< 1
	Roads, tracks	< 1
	Lakes (alpine and subalpine)	4

The University of Tasmania

Postal Address: Box 252C, G.P.O., Hobart, Tasmania, Australia 7001
Telephone: 23 0561. Cables 'Tasuni' Telex: 58150 UNTAS
DEPARTMENT OF GEOGRAPHY

IN REPLY PLEASE QUOTE:

FILE NO. ....

IF TELEPHONING OR CALLING

ASK FOR ....

SURVEY OF VISITORS IN THE CRADLE MOUNTAIN-LAKE ST. CLAIR NATIONAL PARK

Introduction

The Cradle Mountain-Lake St. Clair National Park is recognised as one of Australia's foremost wilderness and natural recreational areas. It also contains a wide variety of ecosystems, several of which appear on *prima facie* evidence to be susceptible to disturbance associated with outdoor recreational activities. The popularity of the park is increasing rapidly, with approximately 100,000 visitors in 1977.

The following questionnaire has *two main purposes*. Firstly, it will help provide an overall impression of trends in outdoor recreation. Secondly, it will provide useful information on factors which influence users in their attitudes towards the management of the natural environments of the park.

This survey forms an integral part of a larger study which aims to assess the impact of visitors on the environments of the national park.

It is hoped that the results of this survey will help the National Parks and Wildlife Service to continue to provide services for visitors while avoiding damage to the park environment.

I would be grateful if you would assist in this project by filling in the questionnaire. It would be appreciated if the *nominal leader* of a party would complete the questionnaire.

Please deposit the completed questionnaire in the boxes provided in the registration huts located at both the Lake St. Clair and Cradle Mountain entrances. *If you are unable to do so*, it would be appreciated if the questionnaire could be mailed to the address given below. A return addressed stamped envelope is available from the Ranger.

Thanking you in anticipation for your co-operation.

Satwant Calais
Geography Department,
University of Tasmania,
G.P.O. Box 252C,
Hobart,
Tasmania 7001.

FOR OFFICE USE ONLY

CASE NO. 1 2 3 4 5 [ ][ ][ ][ ][ ]

AREA 6 [ ]

DATE RECEIVED 7 8 9 10 11 [ ][ ][ ][ ][ ]

VISITOR TYPE 12 [ ]

(Appendix 3 Continued)

GENERAL INSTRUCTIONS

1) *Please answer questions as accurately as possible.*

2) *Where boxes are provided against alternative answers, please place a tick in the appropriate box.*

3) *Respondents are invited to use the general comments sections to expand on issues they feel to be important.*

4) *All information supplied will be treated in strictest confidence. You do not need to write your name or address on this questionnaire.*

5) *Please return the questionnaire as soon as possible.*

6) *Please ignore numbered boxes on right hand side of pages as these are for office use only.*

QUESTIONS

1) Where is your normal place of residence?

Town/City ________________ 13 14 ☐☐

State ________________

Overseas ________________

2) What day of the week did you arrive in this National Park? 15 ☐

Date ________________

3) What time of the day did you arrive? *please state to the nearest hour.* 16 17 ☐☐

____

4) Where did you enter the Park? 18 ☐

Cradle Mountain ☐

Lake St. Clair ☐

Central Plateau ☐

Wolfram Mines track ☐

Arm River track ☐

Other - *please specify* ________________

5) What means of transport did you use to get to this Park?

Private Car ☐
Hired Car ☐
Private Bus ☐
Tour Bus ☐
Motorcycle ☐
Walking ☐
Hitch hiking ☐

Others - *please specify* ____________________

19 ☐

6a) Are you making this visit on your own?

YES ☐ *if yes go to Q 7*
NO ☐ *if no go to Q 6b*

20 ☐

6b) If not alone, are you in

1) family group ☐
2) with an informal group of friends ☐
3) friends and family ☐

go to Q 6d

4) with an organization or club ☐ *go to Q 6c*

21 ☐

6c) What is the name of the organization that planned this trip?

____

22 23 ☐☐

6d) How many are there in your group?

24 25 ☐☐

Adults ______________ persons

Children ______________ persons *(please regard children as being age 15 or less)*

26 27 ☐☐

7) Is your visit to the Park a one-day trip?

YES ☐ *If yes go to Q 10*
NO ☐ *If no go to Q 8*

28 ☐

8) How many nights did you stay or do you intend to stay in this Park? 29 30

_______________ nights

9) Since this is not a one day trip from home, what kind of accommodation did you use in the park?
(If a combination of types of accommodation was used, please indicate in the boxes, the number of nights spent in each).

31

- Tents
- Caravan/Campervan
- NPWS cabins at the Waldheims
- NPWS cabins at Lake St. Clair
- Pencil Pine Lodge
- Walkers huts

Other - *please specify* ___________________________

10) Which of the following best describe the purpose of your visit to the Park?

32

- Overland track bushwalking
- Camping and day bushwalking
- Day bushwalking
- Picnicking
- Coach tour visitors
- Boating

Other - *please specify* ___________________________

11) What types of activity will you/have you undertake(n) whilst in the Park?
If more than one activity please tick appropriate boxes.

33 34

- Hiking
- Camping
- Mountain Climbing
- Swimming
- Amateur nature & wildlife study
- Photography
- Fishing
- Boating
- Sight-seeing

Other - *please specify* ___________________________

12) Which one of the above will be your major activity? 35

____

DAY WALKERS AND OVERLANDERS

13) Could you please indicate on the map(s) provided, the walking routes you took or intend to take whilst in the park. 36 37

1. Please mark with arrows your complete route(s), thus →→→→→→→

2. Please mark with an 'X' those places at which you camped or stayed in the huts along the overland track and by each mark put an appropriate letter. 38 39

A - stayed overnight
B - stayed 2 nights
C - stayed 3 nights
D - stayed more than 3 nights

40

14) Which feature(s) of the Park did you enjoy best?

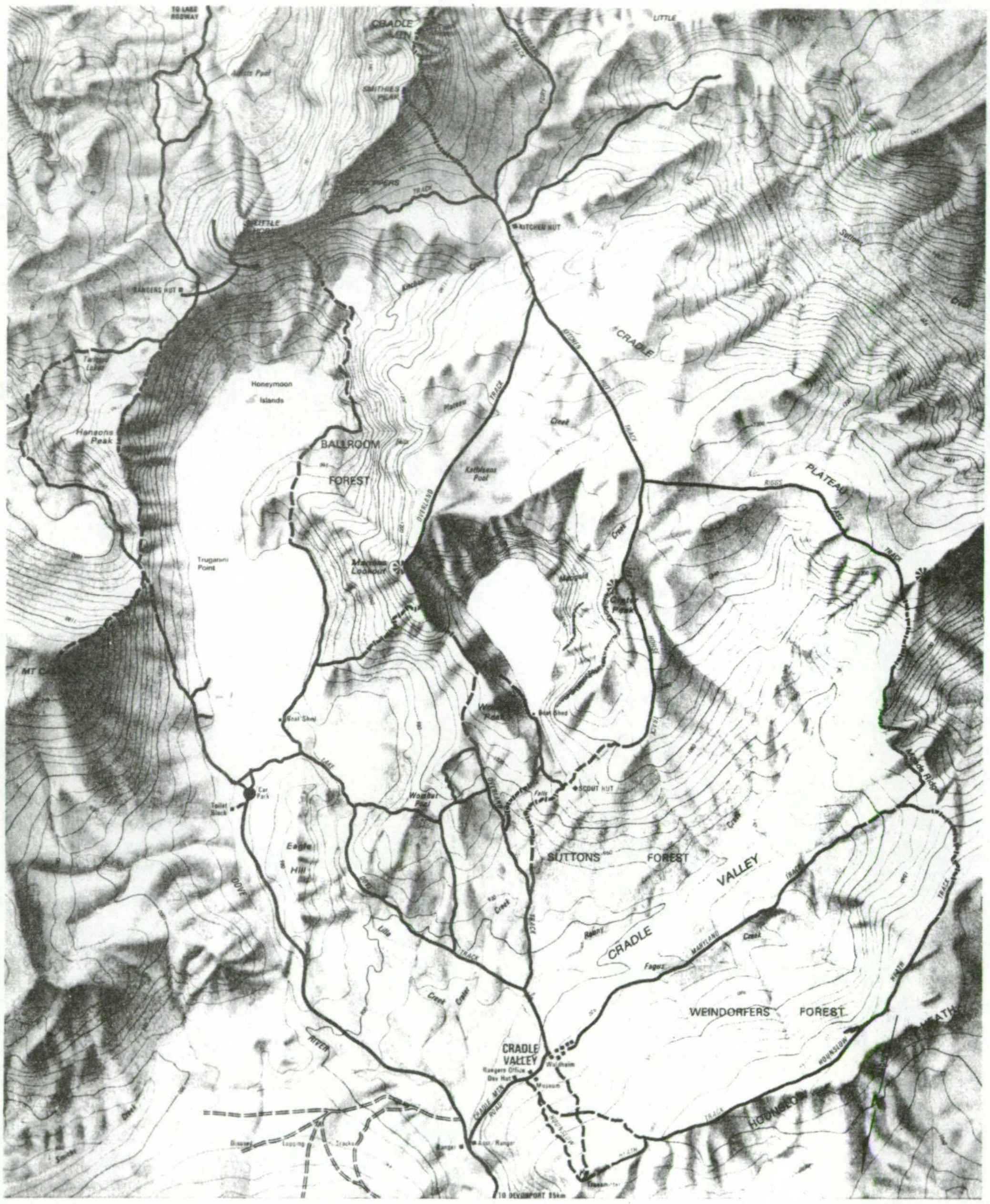
Please rank 1, 2, 3, etc. in order of importance to you.

41

Scenery	
Openness	
Quietness	
Geological features	
Flora (vegetation)	
Fauna (wildlife)	
Don't know	

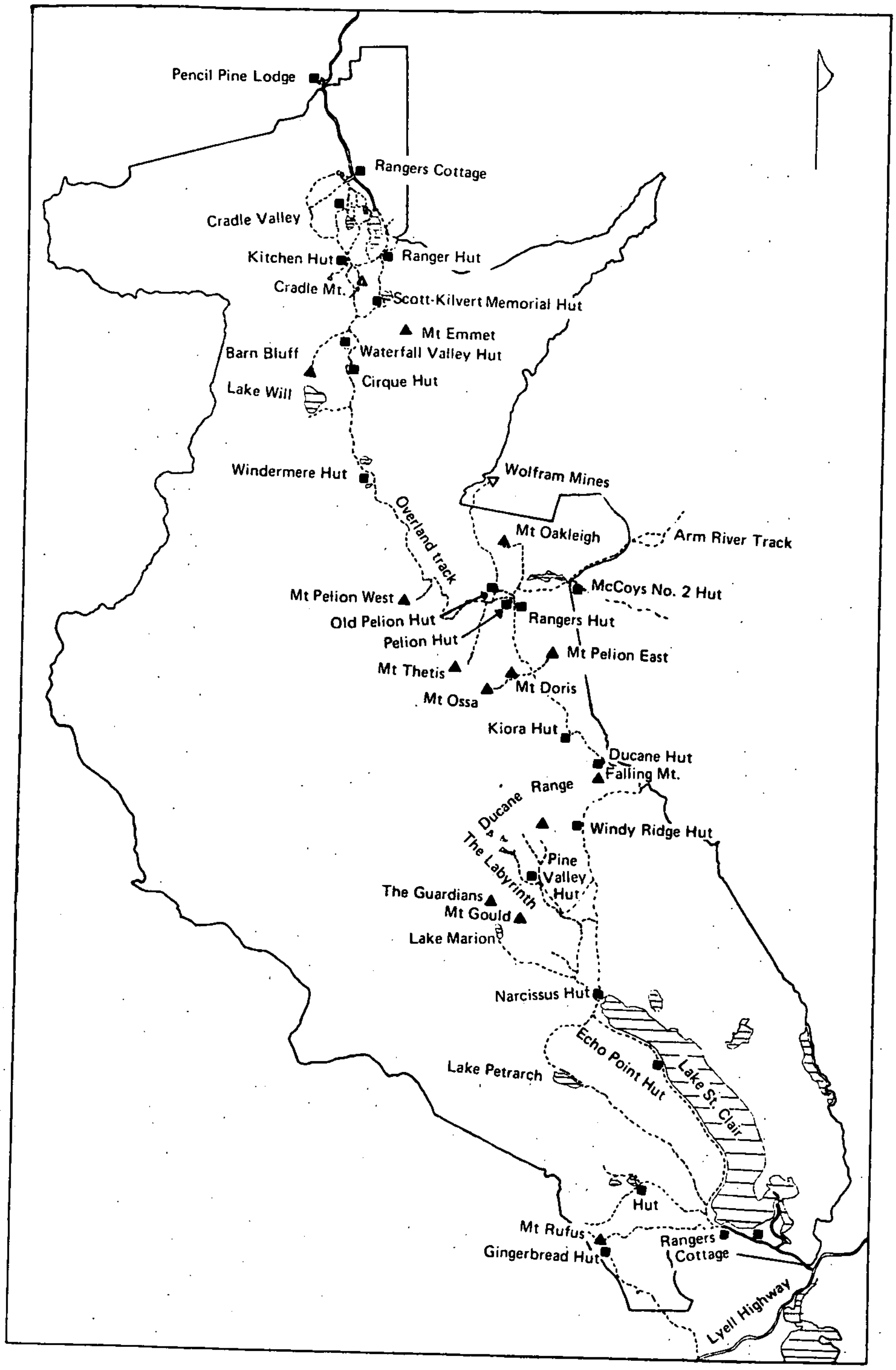
General comments ______________________________

____



MAP A. Cradle Mountain Day Walk Map

(Refer to Question 13)



MAP B. Cradle Mountain-Lake St. Clair National Park Walking tracks.

(Refer to Question 13)

15) Below is a list of factors which may have *detracted* from your enjoyment of the National Park. *For each of them please indicate by placing a tick in the appropriate box* -

1. *which you did not notice or feel concerned about*
2. *which you noticed*
3. *which reduced your enjoyment of the park.*

	Did not notice	Noticed	Reduced Enjoyment	Don't know	
a) Littering					42 ☐
b) Rundown campsites					43 ☐
c) Dirty or dilapidated shelter huts					44 ☐
d) Too few campsites					45 ☐
e) Too few huts					46 ☐
f) Crowded campsites					47 ☐
g) Very large parties					48 ☐
h) Plagues of insects					49 ☐
i) Poor condition of walking trails					50 ☐
j) Insufficient information about the park					51 ☐
k) Bad weather					52 ☐
l) Poor attitude of NPWS rangers					53 ☐
m) High costs of services and amenities provided					54 ☐
n) Inadequate picnic/ BBQ facilities					55 ☐

Others - *please specify* ________________________________ 56 ☐

General comments ________________________________

____

16) Do you feel that it is necessary to carry out further improvements to facilities in this park?

YES	☐	*If yes go to Q. 17*	57 ☐
NO	☐	*If no go to Q. 18*	

General comments ______________________________

____

17) Below are some facilities of the National Park that you may feel need improvement. *For each please indicate by placing a tick in the appropriate box whether you feel that the facility needs improvement or feel that the current facility is already adequate.*

	Facilities need improvement	Current facilities adequate	Don't know	
a) Walking trails				58 ☐
b) Signs indicating time and distance to campsites and huts				59 ☐
c) Simple pit toilets along trails				60 ☐
d) Insulation and facilities in huts				61 ☐
e) Information centres				62 ☐
f) Picnic areas				63 ☐
g) Camping ground facilities at Cradle Mt. and Lake St. Clair entrance areas				64 ☐
h) Litter disposal provision				65 ☐
i) Day visitor facilities				66 ☐
j) Rangers stationed on trails				67 ☐
k) Commercial services (e.g. boats/kiosks/huts etc.)				68 ☐

Others - *please specify* ______________________________ 69 ☐

General comments ______________________________

____

18) Would you support or oppose the *introduction* or the *expansion* of the following activities in the park? *Please put a tick under the appropriate descriptions for each activity.*

	Strongly support	Support	Neutral	Oppose	Strongly oppose	
a) Commercialisation e.g. souvenir shops						70
b) Buildings - hotels, motels						71
c) Private holiday shacks						72
d) Kiosks and petrol stations						73
e) Building of a sealed tourist road at the Cradle Mt. entrance						74
f) Exploitation of timber resources						75
g) Mining						76
h) Construction of public airfields						77
i) Development of camping and caravan sites						78
j) More wooden walkways on trails to prevent vegetation damage						79
k) Guided bushwalking tours around the Cradle Mt. and Lake St. Clair areas						80
l) Establishment of short walks with detail notes/notices available on features of interest (nature trails)						1 2 3 4 5 CASE NO. 6
m) Expansion of vehicular roads within the National Park						7

General comments ______________________________

____

____

19) In this Park, the public are advised to keep on the marked trails. Has this or will this restricted access reduce your enjoyment of the park?

YES ☐
NO ☐
Don't know ☐

8 ☐

20) Some people feel that ecosystems in the park are deteriorating. With this in mind, would you support or oppose the following actions? *Please tick appropriate box for each of the suggestions.*

	Support	Oppose	Don't know	
a) Limit the number of visitors to the park				9 ☐
b) Put a limit on party size for overland track bushwalkers				10 ☐
c) Close damaged campsites and trails				11 ☐
d) Encourage visitors to use their own cooking fuels - gas/kerosene, instead of wood				12 ☐
e) Encourage visitors to remove their litter from the camp-sites and huts along the trails				13 ☐

General comments ________________________________

____

____

21) Would you be willing to pay an entrance fee to support the continued maintenance and expansion of facilities within this Park?

YES ☐ *If yes go to Q 22*
NO ☐
Don't know ☐ } *go to Q 23*

14 ☐

General comments ________________________________

____

____

22) If you favour the levying of fees, *please tick below how much you think would be an acceptable charge per person?* 15

Less than 50 cents	☐	\$2.00 - \$2.99	☐
50 cents - \$0.99	☐	\$3.00 - \$4.00	☐
\$1.00 - \$1.99	☐		

Other amount ___________

23) Is this your first visit to this National Park? 16

YES ☐ *If yes go to Q 25*

NO ☐ *If no go to Q 24*

24) If no, how many times have you visited this park? ___________ 17 18

When was your last visit? _______________________ 19

25) Are you likely to visit this park during the next 5 years? 20

NO ☐ *If no go to Q 26*

YES ☐

Don't know ☐ } *go to Q 27*

26) Why are you unlikely to come back here again? 21

____

____

PERSONAL DATA

Explanatory Note:-

The questions asked in this section will help to identify what types of people participate in outdoor recreational activities. It also enables us to determine the relationship between types of users and their socioeconomic backgrounds. This information will thus enable us to ascertain the future trends in the use of national parks. All information given will be strictly confidential.

		Respondent		*If in a party, number of people in each sex group*	
27)	Sex:	Male	☐	☐	22 ☐ 23 24 ☐☐
		Female	☐	☐	25 26 ☐☐

28) Which age group do you fall in?

(a) *Age of respondent*		(b) *If in a party, number of persons in each age group*	27 ☐
under 11	☐	☐	28 29 ☐☐
12 - 17	☐	☐	30 31 ☐☐
18 - 24	☐	☐	32 33 ☐☐
25 - 40	☐	☐	34 35 ☐☐
41 - 65	☐	☐	36 37 ☐☐
over 65 yrs	☐	☐	38 39 ☐☐

29) What is your marital status?

Single	☐	40 ☐
Married	☐	
Other	☐	

30) What educational status have you acquired?

(a) High school or below
(b) Matriculation
(c) Technical education
(d) Tertiary (university/college)
(e) Other

41

42 43

31) What is your *specific* occupation? ______________________________

32) Please indicate which category comes closest to representing your annual income?

(a) Less than $2500
(b) $2500-5999
(c) $6000-7999
(d) $8000-9999
(e) $10000-12999
(f) $13000-15999
(g) $16000-19999
(h) $20000 or more

44

THANK YOU VERY MUCH FOR YOUR ASSISTANCE

Please note :

1) *return this completed questionnaire to the boxes provided at the registration huts*

2) *if unable to do so, please obtain an addressed, stamped envelope from the ranger and send to the address given in the introduction.*

APPENDIX 4

VISITOR SURVEY ANALYSIS

TABLE 4.1

ENTRANCE POINTS TO THE PARK

Cradle Mountain	91.3%
Lake St. Clair	7.7%
Central Plateau	0.6%
Wolfram Mines track	-
Arm River track	0.4%

TABLE 4.2

MEANS OF TRANSPORT USED TO GET TO THE PARK

Transport	
Private car	51.1%
Hired car	14.2%
Private bus	18.3%
Tour bus	2.6%
Motorcycle	1.0%
Walking	0.6%
Hitch-hiking	11.0%
Commercial bus	0.8%
Taxi	0.4%

(Appendix IV continued)

TABLE 4.3

(i) Are you making this visit on your own?

YES	9.5%
NO	90.5%

(ii) If not alone, are you in

1)	family group	36.9%
2)	with an informal group of friends	39.0%
3)	friends and family	13.1%
4)	with an organization or club	11.0%

(Appendix IV continued)

TABLE 4.4

FACTORS DETRACTING ENJOYMENT OF THE PARK

		Did not notice	Noticed	Reduced Enjoyment	Don't know
(a)	Littering	49.6	28.5	21.9	
(b)	Rundown campsites	68.2	17.6	8.8	5.4
(c)	Dirty or dilapidated shelter huts	54.1	30.2	11.3	4.5
(d)	Too few campsites	68.0	17.9	5.8	8.3
(e)	Too few huts	76.1	11.4	2.0	10.5
(f)	Crowded campsites	75.4	11.0	6.2	7.4
(g)	Very large parties	64.2	15.2	16.5	4.1
(h)	Plagues of insects	63.6	20.2	14.4	1.8
(i)	Poor condition of walking trails	29.9	34.7	32.5	2.9
(j)	Insufficient information about the park	68.6	17.8	12.0	1.6
(k)	Bad weather	54.1	27.0	18.0	0.9
(l)	Poor attitude of NPWS rangers	90.7	4.3	1.8	3.2
(m)	High costs of services and amenities provided	85.7	7.1	2.7	4.5
(n)	Inadequate picnic/BBQ facilities	81.7	8.6	3.3	6.4

TABLE 4.5

SALARY DISTRIBUTION OF RESPONDENTS

(a)	Less than $2500	16.4%
(b)	$2500-5999	7.9%
(c)	$6000-7999	5.6%
(d)	$8000-9999	10.1%
(e)	$10000-12999	22.7%
(f)	$13000-15999	17.6%
(g)	$16000-19999	10.6%
(h)	$20000 or more	9.0%

APPENDIX 4

TABLE 4.6

FEATURES OF THE PARK ENJOYED MOST BY THE RESPONDENTS

Scenery	67.6%
Openness	13.9%
Quietness	5.4%
Geological features	1.6%
Flora	0.4%
Fauna	0.4%
All of the above	10.7%

CRADLE MT.-LAKE ST. CLAIR NATIONAL PARK — TRACK SURVEY

1 2

3 4 5

6 7 8 9

a) LOCATION ____________________

b) SITE NO. ____________

c) DATE ____________

1. Aspect: 10

1. N	5. NE
2. S	6. NW
3. E	7. SE
4. W	8. SW

2. Elevation: ______ m ASL 11

3. Substrate: 12

- quartz
- dolerite
- conglomerate
- sandstone
- glacial till
- mudstone
- others

4. Depth of Track: 13

- 0 - 100 mm
- 100-200
- 200-300
- 300-450
- 450-600
- > 600

5. Ground Cover: 14

- 0 -1
- 1-10
- 10-30
- 30-70
- 70-100

6. Crown Cover: 15

- 0 -1
- 1 -10
- 10-30
- 30-70
- 70-100%

2

7. Vegetation Type:

forests	☐	tall	☐	
woodlands	☐	low	☐	
shrublands	☐	open	☐	
heathlands	☐	close	☐	
grasslands	☐			
herbfields	☐			
sedgeland	☐			
fernland	☐			
bolster moorlands	☐			
dwarf heathlands	☐			
dwarf sedgelands	☐			

dominant vegetation

16	17	18	19

secondary vegetation

20	21	22	23

8. Dominant Vegetation Species:

____

____

24	25	26	27	28	29

9. Slope: ______________________________

30	31

10. Width of track ____________ m

32	33	34	35

11. Depth of soil ____________ cm

36	37	38	39

3

12. a) Ground Material:

peat	1
mineral soils	2
rock fragments	3
natural bedrock	4
others	5

b) Degrees of disturbance:

untrampled	1
trampled	2
dying	3
dead	4
eroded	5

Profile of track transect:

i) Transect length ________ m

40	41	42	43

ii)

Distance	Width of Disturbance	Ground Material	Disturbance
1st decile interval			
2nd decile interval			
3rd decile interval			
4th decile interval			
5th decile interval			
6th decile interval			
7th decile interval			
8th decile interval			
9th decile interval			
10th decile interval			

44	45	46	47	48
49	50	51	52	53
54	55	56	57	58
59	60	61	62	63
64	65	66	67	68
69	70	71	72	73
74	75	76	77	78
5	6	7	8	9
10	11	12	13	14
15	16	17	18	19

1	2	3	4

Case No.

13. Topographical diagram of transect location

20	21

4

14. Line transects:

TRANSECT NO.

22	23	24	25	26	27

o

o

o

o

o

o

o

APPENDIX 6

TRACK SURVEY DATA

Distribution of surveyed sites by aspect, elevation, geological surface, ground cover, vegetation, slope, track width, and track depth

TABLE 6.1

ASPECT

Aspect	Frequency	Percentage Frequency
North	35	16.1
South	12	5.5
East	39	17.9
West	36	16.5
North East	46	21.1
North West	16	7.3
South East	18	8.3
South West	16	7.3

TABLE 6.2

ELEVATION

Elevation	Frequency	Percentage Frequency
700-800	54	24.8
801-900	35	16.1
901-1000	51	23.4
1001-1100	39	17.9
1101-1200	18	8.3
1201-1300	21	9.6

(Appendix 6 Continued) TABLE 6.3

GEOLOGICAL SURFACE

Geology	Frequency	Percentage Frequency
Quartzite	51	23.4
Dolerite	15	6.9
Conglomerate	5	2.3
Sandstone	32	14.7
Glacial Till	72	33.0
Mudstone	28	12.8
Schists	9	4.1
Siltstone	6	2.8

TABLE 6.4

GROUND COVER

Ground Cover (%)	Frequency	Percentage Frequency
0 - 1%	16	7.3
1 - 10%	65	29.8
10 - 30%	65	29.8
30 - 70%	62	28.4
70 - 100 %	10	4.6

(Appendix 6 Continued)

TABLE 6.5

VEGETATION

Vegetation	Frequency	Percentage Frequency
Closed forest	11	5.1
Open forest	20	9.2
Open woodland	34	15.6
Low open forest	51	23.4
Scrub	25	11.5
Heath	57	26.1
Hummock sedgeland	13	6.0
Ferns-grass-heath	7	3.2

TABLE 6.6

SLOPE

Slope°	Frequency	Percentage Frequency
0 - 1	23	10.6
2 - 4	51	23.4
5 - 7	36	16.5
8 - 10	31	14.2
11 - 13	22	10.1
14 - 17	20	9.2
18 - 20	2	0.9
21 - 25	9	4.1
< 25	24	11.0

(Appendix 6 Continued)

TABLE 6.7

TRACK WIDTH

Width (cms)	Frequency	Percentage Frequency
0 - 100 cm	28	12.9
101 - 150 cm	31	14.3
151 - 200 cm	64	29.4
201 - 300 cm	36	16.6
301 - 500 cm	28	12.9
501 - 1000 cm	26	12.0
> 1000 cm	5	2.3

TABLE 6.8

TRACK DEPTH

Depth (cms)	Frequency	Percentage Frequency
0 - 10	83	38.1
11 - 20	62	28.4
21 - 30	44	20.2
31 - 45	21	9.6
46 - 60	6	2.8
> 60	2	1.0

APPENDIX 7

VEGETATION DYNAMICS

TABLE 7.1

DENSITY CHANGES OF COLONIZERS AS RELATED TO REPRODUCTIVE MECHANISMS IN THE KITCHEN HUT AREA

Mainly Seedling	Density/m^2 1st Year	Density/m^2 2nd Year	Mainly Vegetative	Density/m^2 1st Year	Density/m^2 2nd Year
Carpha alpina	0.32	2.8	*Scirpus aucklandicus*	1.8	3.64
Poa	0.44	1.6	*Empodisma minus*	0.08	3.24
Rubus gunnianus	0.0	0.6	*Abrotanella scapigera*	0.24	1.88
Dislaspis cordifolia	0.0	0.4	*Microlaena tasmanica*	0.08	1.16
Celmisia saxifraga	0.0	0.4	*Oreobolus pumilio*	0.0	0.53
Actinotus suffocata	0.0	0.36	*Donatia novae-zelandiae*	0.12	0.44
Euphrasia striata	0.00	0.08	*Pterygopappus lawrencii*	0.12	0.20
Epacris serpyllifolia	0.00	0.08	*Ewartia meredithiae*	0.12	0.08
Gentianella diemensis	0.08	0.08			

(Appendix 7 Continued)

TABLE 7.2

COLONIZING SPECIES DENSITY CHANGES AS RELATED TO DIFFERENT TRACK SURFACES IN THE KITCHEN HUT AREA

Species	Peat	Soil	Rock Fragment
Carpha alpina	1.08	1.24	0.16
Actinotus suffocata	0.12	0.2	0.04
Abrotanella scapigera	0.28	1.2	0.16
Empodisma minus	0.0	3.2	0.0
Donatia novae-zelandiae	0.12	0.2	0.0
Pterygopappus lawrencii	0.0	0.08	0.0
Dislaspis cordifolia	0.0	0.04	0.
Poa gunnii	0.20	0.48	0.48
Oreobolus pumilo	0.44	0.04	0.04
Celmisia saxifraga	0	0.04	0.
Microlaena tasmanica	0	0.96	0.12
Rubus gunnianus	0	0.6	0
Epacris serpyllifolia	0.08	0	0

(Continued over)

(Appendix 7, Table 7.2 Continued)

Species	Peat	Soil	Rock Fragment
Euphrasia striata	0.12	0	0
Ewartia mereditheae	-0.12	0	0.04
Lichen	-0.04	0	0
Scirpus aucklandicus	0.04	1.8	0
Gentianella diemensis	0	0	0

(Appendix 7 Continued)

TABLE 7.3

DENSITY CHANGE OF COLONIZERS AS RELATED TO THEIR REPRODUCTIVE MECHANISMS IN THE RONNEY CREEK AREA

Seedlings	Density/m²		Vegetative Reproducers	Density/m²	
	1978	1979		1978	1979
Microlaena tasmanica	1.7	5.3	*Scirpus aucklandicus*	2.9	12.5
Rubus gunnianus	0.8	4.5	*Empodisma minus*	1.4	8.1
Hibbertia procumbens	0.4	3.9	*Gleichenia dicarpa*	1.0	2.4
Poa gunnii	0.8	3.2	*Restio australis*	0.5	1.2
Gonocarpus micranthus	0.1	1.1	*Acaena novae-zelandiae*	0.03	0.1
Lepidosperma filiforme	0.03	0.9	*Oreobolus distichus*	0.07	0.07
Schoenus apogon	0.03	0.7			
Carpha alpina	0.1	0.5			
Luzula spp.	0.0	0.2			
Gymnoschoenus sphaerocephalus	0.0	0.03			
Deyeuxia sp.	0.0	0.03			

(Appendix 7 Continued)

TABLE 7.4

COLONIZING SPECIES DENSITY CHANGES AS RELATED TO DIFFERENT TRACK SURFACES IN THE RONNEY CREEK AREA

Species	Peat	Mineral Soil	Rock Fragments
Empodisma minus	4.1666	2.3	0
Scirpus aucklandicus	7.0334	0.1334	2.5
Microlaena tasmanica	2.5	0.8334	0.3
Restio australis	0.8334	-	-
Rubus gunnianus	0.8	2.7	0.2
Gleichenia dicarpa	1.4	0.0334	0.0334
Poa gunnii	1.4	0.8667	0.3334
Gonocarpus micranthus	0.8334	0.2334	0.2667
Hibbertia procumbens	1.2333	2.0667	0.0667
Gymnoschoenus sphaerocephalus	-	-	0.0334
Schoenus apogon	0.4333	-	0.2334
Luzula spp.	0.0667	-	
Fungi		0.1667	

(Continued over)

(Appendix 7, Table 7.4 Continued)

Species	Peat	Mineral Soil	Rock Fragments
Deyeuxia sp.	-	0.0334	-
Lepidosperma filiforme	0.6333	0.2667	-
Oreobolus distichus	0.0	0.0	-
Acaena novae-zelandiae	-	0.1000	-
Carpha alpina	0.4334	-	-

(Appendix 7 Continued)

TABLE 7.5

DENSITY CHANGE OF COLONIZERS AS RELATED TO THEIR REPRODUCTIVE MECHANISMS IN THE WALDHEIM AREA

Seedlings	Density/m^2 1978	Density/m^2 1979	Vegetative Reproducers	Density/m^2 1978	Density/m^2 1979
Poa gunnii	3.4	9.9	*Scirpus aucklandicus*	1.6	8.3
Danthonia pauciflora	0.7	4.4	*Empodisma minus*	1.2	2.5
Gnaphalium sp.	0.03	0.6	*Oreobolus distichus*	0.01	0.10
Poa annua	0.0	0.6	*Restio australis*	0.01	0.10
Microlaena tasmanica	0.2	0.6	*Gonucarpus micranthus*	0.0	0.10
Hibbertia procumbens	0.0	0.5	*Cotula sp.*	0.03	0.03
Gramineae	0.03	0.5			
Luzula spp.	0.01	0.1			
Agrostis sp.	0.0	0.1			
Rubus gunnianus	0.0	0.03			
Deyeuxia sp.	0.0	0.03			
Diplarrhena moraea	0.1	0.03			

(Appendix 7 Continued)

TABLE 7.6

COLONIZING SPECIES DENSITY CHANGES AS RELATED TO DIFFERENT TRACK SURFACES IN THE WALDHEIM AREA

Species	Peat	Mineral Soil	Rock Fragments
Poa gunnii	3.1667	3.233	0.0667
Gramineae	0.1000	0.1666	0.0667
Empodisma minus	0.7667	0.6000	0.0667
Hibbertia procumbens	0.1334	0.1667	0.2000
Restio australis	0.1000	-	-
Oreobolus distichus	0.0667	-	-
Rubus gunnianus	0.0334	-	-
Diplarrhena moraea	-	-0.0667	-
Microlaena tasmanica	-	0.0334	0.4667
Deyeuxia sp.	-	-	0.0334
Scirpus aucklandicus	6.7000	1.0000	-
Luzula spp.	-	0.1334	0.0334

(Continued over)

(Appendix 7, Table 7.6 Continued)

Species	Peat	Mineral Soil	Rock Fragments
Gnaphalium sp.	-	0.6000	-
Gonocarpus micranthus	-	0.0667	-
Poa annua	-	0.6000	-
Agrostis sp.	-	0.0667	-
Danthonia pauciflora	3.2666	0.5000	-
Cotula sp.	0.0	-	-

APPENDIX 8

Track Section	Track Condition	Track Surface	User Intensity	Proposed Track Classification	Proposed Rehabilitation Technique
Wiendorfer's Forest	Fair	Peat	Medium	I	Rafts, Boardwalks
Hounslow Heath	Good	Peat/Soil	Low	II	Not required
Monds Ridge	Fair	Soil	High	II	Gravel; Drainage
Lake Lilla Track	Good	Peal/Soil	High	I	Not required
Wombat Tarn	Fair	Peat	High	I	Corduroy
Crater Falls	Fair	Peat	High	I	Rafts; Corduroy
Waldheim - Horse Track turnoff	Bad	Peat	High	I	Duckboard Gravel
Crater Creek - Wombat Peak	Bad	Rock Fragments	High	I	Gravel Benching
Marions Lookout	Fair	Rock Fragments and bedrock	High	II	Steps
Marions Lookout - Kathleen Creek	Very Bad	Peat, Rock Fragments	High	II	Gravel; Drainage; Bridge
Kathleen Creek - Kitchen Hut	Very Bad	Peat, Rock Fragments	High	II	Gravel; Drainage
Overland Track - Scout Hut	Bad	Rock Fragments and bedrock	High	II	Gravel; Drainage
Scout Hut - Kitchen Hut	Fair	Peat, Rock Fragments	High	II	Gravel; Drainage; Bridge
Riggs Pass	Good/Fair	Peat	Low	III	Bench; steps; Drainage

(Continued over)

(Appendix 8 Continued)

Track Section	Track Condition	Track Surface	User Intensity	Proposed Track Classification	Proposed Rehabilitation Technique
Dove - Marions Lookout					
Top End	Good	Bedrock	High	I	Steps
Bottom End	Very Bad	Peat	High	I	Corduroy
Truganini Track	Bad	Peat	Low	I	Corduroy; Bench
Dove Carpark - Suicide Rock	Bad	Peat	High	I	Bitumen
Dove Carpark - Boatshed	Very Bad	Peat	High	I	Bitumen
Dove Carpark - Hansons Peak	Bad/Fair	Scree, Rocks	Medium	II	Gravel
Twisted Lakes	Good/Fair	Peat	Medium	II	Benching; Drainage; Slash/Cut
Ranger Hug Area	Bad	Peat	High	II	Rafts
Ranger Hut - Little Horn	Very Bad	Peat	Medium	II	Bench; Drainage; Realignment
Face Track	Bad/Very Bad	Peat/Soil	Medium	II	Corduroy Drainage
Ballroom Forest	Good	Peat/Soil	Medium	II	Slash; Gravel; Steps
Rangers Hut - Artists Pool	Bad	Peat	Medium	II	Corduroy
Scout Kilvert Hut Cradle Cirque	Very Bad	Peat/Soil	Medium	II	Relocation
Kitchen Hut - Fury Creek	Very Bad	Peat/Soil	High	II	Realign; Gravel; Drainage

(Continued over)

(Appendix 8 Continued)

Track Section	Track Condition	Track Surface	User Intensity	Proposed Track Classification	Proposed Rehabilitation Technique
Fury Creek - Rodway Turnoff	Fair	Soil	High	II	Gravel
Rodway Turnoff - Waterfall	Fair	Soil	High	II	No works required
Valley Hut	Very Bad	Peat	High	III	Relocate
Waterfall Valley - Cirque Hut	Bad	Peat	High	III	Corduroy; Drainage
Track to Cirque Hut	Very Bad	Peat	High	III	Duckboards
Cirque Hut - Lake Holmes	Very Bad	Peat	Medium	III	Realignment; Corduroy
Lake Holmes - Lake Windermere	Fair	Peat/Soil	Medium	III	Rafts
Lake Windermere - Hut	Bad	Soil	Medium	III	Drainage
Hut to Lake Curran	Bad	Peat	Medium	III	Corduroy; Drainage
Lake Curran - Pine Forest Moor	Bad	Peat	Medium	III	Corduroy
Pine Forest Moor - Forth Lookout	Very Bad	Peat	Medium	III	Rafts
Forth Lookout - Pelion Creek	Very Bad	Peat	Medium	III	Relocation
Pelion Creek - Frog Flats	Bad	Peat/Soil	Medium	III	Drains; Benching; Corduroy
Frog Flats	Very Bad	Peat	Medium	III	Relocation; Footbridge

(Continued over)

(Appendix 8 Continued)

Track Section	Track Condition	Track Surface	User Intensity	Proposed Track Classification	Proposed Rehabilitation Technique
Frog Flats - Old Pelion	Very Bad	Peat	Medium	III	Corduroy; Bridges
Old Pelion - New Pelion	Fair	Peat	Medium	III	Corduroy
Old Pelion - Wolfram Mine	Fair	Peat/Soil	Low	III	Corduroy; Bridges; Realignment
Pelion - Arm River	Bad	Peat	Low	III	Corduroy; Drains
Pelion - Pelion Gap	Fair/Bad	Peat	Medium	III	Bridges; Corduroy; Gravel
Pelion Gap - Pinestone Creek	Very Bad	Peat	Medium	III	Corduroy
Pinestone Creek - Kiaora	Fair	Soil	Medium	III	Slash
Kiaora - Ducane	Bad	Peat	Medium	III	Bridge; Bench; Drainage; Corduroy
Ducane - Ducane Gap	Fair	Peat/Soil	Medium	III	Bench and Drainage
Windy Ridge - Narcissus	Fair/Good	Soil/Peat	Medium	III	Bench and Drainage
Narcissus - Pine Valley	Fair	Peat/Soil	Medium	III	Drainage
Narcissus - Valley Track	Very Bad	Peat	Low	III	Close
Narcissus - Forest Track	Fair/Good	Peat/Soil	Medium	III	Bridge; Drainage
Pine Valley Hut Area	Bad	Peat	Medium	III	Corduroy
Narcissus - Echo Point	Fair	Peat	Medium	III	Corduroy; Drainage
Echo Point - Cynthia Bay	Good/Fair	Peat/Soil	Medium	III	Bench; Slash; Drainage
Cynthia Bay - Petrarch	Bad	Peat	Low	III	Relocate; Corduroy; Drainage
Cynthia Bay - Watersmeet	Good	Soil	Low	I	Not required

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