IMPACTS OF CAMPING AND TRAMPLING ON AUSTRALIAN ALPINE AND SUBALPINE VEGETATION AND SOILS

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Submitted in fulfilment of the requirements of the degree of Doctor of Philosophy

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October 2005
STATEMENT OF ORIGINALITY

This work has not previously been submitted for a degree or diploma in any university. To the best of my knowledge and belief, the thesis contains no material previously published or written by another person except where due reference is made in the thesis itself.

Andrew Jason William Growcock
This thesis examines the impact of recreational activities, specifically camping and trampling, on alpine and subalpine vegetation communities in Kosciuszko National Park, Australia. A survey approach was first used to determine visitor use levels and types of recreation activities within the main alpine area. An experimental methodology was then used to quantify the relationship between use and damage from camping and trampling to vegetation and soils. Specific questions addressed were: (1) what are the visitor numbers, demographics, activities and patterns of visitation to the Kosciuszko alpine area and have they changed since previous estimates?; (2) what is the relationship between levels of use and damage for camping in undisturbed alpine and subalpine vegetation communities and does this vary between tent and activity areas?; (3) (a) what is the relationship between levels of use and damage for trampling in the undisturbed alpine and subalpine vegetation communities when trampled once and (b) are thresholds and/or the relationship altered when trampling is repeated in the following year?; (4) what is the relationship between use and damage from trampling to plant communities following a large-scale disturbance (bushfire) and do natural processes during the following year of recovery eclipse any recreation impacts?; and (5) what recommendations can be made to minimise impacts of trampling and camping in high altitude sites in the Australian Alps?

Research assessing the impact of recreation on the environment is important for conservation of protected areas. Recreation can affect a range of environmental components including vegetation and soils. These impacts can be measured using a range of parameters including vegetation cover, composition and height and soil compaction. When assessing the impact of recreation on vegetation and soils, four factors need to be considered: (1) amount of use; (2) type of use and behaviour; (3) timing of use; and (4) environmental characteristics. In this thesis it is proposed that low levels of recreation use may not cause significant damage to vegetation until a primary threshold point is reached where increasing use results in rapidly increasing amounts of damage. A second threshold may then be found above which increasing use does not result in significantly more damage. Type and intensity of impacts can vary among different activities so the effects of camping and trampling (which are popular activities in the area) were both examined at varying intensities of use. As vegetation types may also vary in their response, the impact of activities on different communities were compared. Finally, the effect of trampling after large scale fires was examined.
Kosciuszko National Park is a unique mountain area that has been used for a variety of activities since European settlement. Tourism is now one of the largest land uses of the Park with indications of continued growth from the mid 1950's through until the early 1990's. As the area has high conservation values, minimising the amount of disturbance to the environment caused by tourists is important for the long term management of the Park.

Based on an extensive analysis of visitor survey data collected prior to the thesis in the 1999/2000 non-winter period, it was possible to characterise recreational use of the largest alpine area in Australia. Like many protected areas around the world, recreational use in Kosciuszko National Park is increasing during the non-winter period. During this survey, 102,000 visitors were estimated as entering the Kosciuszko alpine area with approximately 47,000 visitors undertaking activities of a half a day or more. This is a 10% increase since the previous estimate from the 1990/91 non-winter period. A variety of activities are undertaken within the area including sightseeing, day walking, mountain biking and camping.

For camping, most trips were undertaken by small groups for short periods. Therefore the impacts to vegetation from one and three nights camping by groups of four people were assessed using an experimental approach. Camping for both one and three nights affected vegetation height, but to different extents. After three nights camping, there was a decrease in vegetation height in the tent and activity areas while after one night camping, a decrease in vegetation height only occurred in the tent area. Camping for three nights caused a short term increase in dead material, however six weeks after camping there was no difference in the cover of dead material among the control, tent or activities areas indicating that the effect was short lived. One night camping did not result in any significant increase in dead material.

Bushwalking is one of the most popular activities to be undertaken in the Australian Alps including the Kosciuszko alpine area. Many visitors undertaking walks during this time depart hardened tracks in order to reach destinations such as mountain peaks and glacial lakes. An obvious impact of this trampling is the creation of pads and trails as the vegetation cover is replaced by bare soil that then becomes compacted and/or erodes. The thresholds before signs of disturbance occur as a result of trampling vary among vegetation communities and among parameters measured. Generally, primary thresholds were exceeded after moderate use with damage still evident one year later. Reduced vegetation height occurred at lower levels of use, but recovered quickly. Vegetation cover showed limited recovery once damaged. This was particularly apparent for bog communities, which also had very low resistance to damage. Repeat trampling in the following year compounded the damage and lowered the primary thresholds.
Impacts and thresholds from trampling in subalpine areas within weeks of the landscape level bushfires in 2003 differed from those in the undisturbed community. Where areas had been burnt, low levels of trampling caused exposure and loss of underlying bare soils with secondary thresholds reached at low to moderate use. These thresholds occurred for both extensively burnt and partially burnt areas. The damage caused by trampling however, was rapidly eclipsed by natural processes with no significant effects after one year.

When examining the impacts of trampling in extensively burnt subalpine grasslands one year after the bushfires the thresholds for cover were again lower than undisturbed conditions even though there was substantial vegetation recovery from the fires. Low to moderate use was required to exceed the primary threshold for vegetation cover with a secondary threshold achieved after moderate use. Twelve months of recovery had however, allowed soils to become more cohesive with moderate to high trampling use now required to cause significant losses of soil.

This research has shown that the identification of two thresholds of disturbance will be beneficial for management decision making. A primary threshold will define the upper limit of use for dispersed recreational use while a secondary threshold will define when concentrated use should occur. This information is valuable, as while the resistance of the vegetation communities examined in this research was moderate in some communities, resilience was always low. As such, recovery from disturbance will be slow and damage should therefore be minimised as much as possible.
<table>
<thead>
<tr>
<th>CHAPTER 1 INTRODUCTION</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1 INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>1.2 PROTECTED AREAS</td>
<td>1</td>
</tr>
<tr>
<td>1.3 MOUNTAIN PROTECTED AREAS</td>
<td>3</td>
</tr>
<tr>
<td>1.4 RECREATION IN PROTECTED AREAS</td>
<td>4</td>
</tr>
<tr>
<td>1.5 MOUNTAIN PROTECTED AREAS IN AUSTRALIA: THE AUSTRALIAN ALPS NATIONAL PARKS</td>
<td>5</td>
</tr>
<tr>
<td>1.6 RESEARCH QUESTIONS</td>
<td>7</td>
</tr>
<tr>
<td>1.7 STRUCTURE OF THIS THESIS</td>
<td>8</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CHAPTER 2 RECREATION ECOLOGY</th>
<th>11</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1 INTRODUCTION</td>
<td>11</td>
</tr>
<tr>
<td>2.2 RECREATION AND THE ENVIRONMENT</td>
<td>12</td>
</tr>
<tr>
<td>2.3 VEGETATION</td>
<td>13</td>
</tr>
<tr>
<td>2.3.1 Vegetation parameters for measuring recreation impacts</td>
<td>13</td>
</tr>
<tr>
<td>2.3.1.1 Vegetation cover</td>
<td>13</td>
</tr>
<tr>
<td>2.3.1.2 Vegetation composition</td>
<td>14</td>
</tr>
<tr>
<td>2.3.1.3 Vegetation growth</td>
<td>15</td>
</tr>
<tr>
<td>2.3.1.4 Tree condition</td>
<td>15</td>
</tr>
<tr>
<td>2.3.2 Direct and indirect impacts to vegetation</td>
<td>15</td>
</tr>
<tr>
<td>2.3.3 Responding to disturbance</td>
<td>16</td>
</tr>
<tr>
<td>2.4 SOILS</td>
<td>18</td>
</tr>
<tr>
<td>2.4.1 Organic Matter</td>
<td>18</td>
</tr>
<tr>
<td>2.4.2 Compaction</td>
<td>18</td>
</tr>
<tr>
<td>2.4.3 Soil moisture and infiltration</td>
<td>19</td>
</tr>
<tr>
<td>2.4.4 Erosion</td>
<td>20</td>
</tr>
<tr>
<td>2.5 WATER</td>
<td>20</td>
</tr>
</tbody>
</table>
CHAPTER 3  KOSCIUSZKO NATIONAL PARK.................................33

3.1  INTRODUCTION ........................................................................33

3.2  ENVIRONMENTAL, CULTURAL AND ECONOMIC VALUES..................33

3.3  ECOLOGICAL RESEARCH ..........................................................35

3.4  A HISTORY OF TOURISM AND RECREATION ...............................36

3.5  CLIMATE .................................................................37

3.6  SOILS .................................................................37

3.7  FLORA AND FAUNA ................................................................38

3.7.1  Adaptations of flora ..............................................................38

3.7.2  Major vegetation communities ...........................................39

3.7.3  Fauna .................................................................42

3.8  FIRE .................................................................42

3.9  CONCLUSION .......................................................................44

CHAPTER 4  MONITORING VISITOR USE........................................45

4.1  INTRODUCTION ....................................................................45

4.1.1  Tourism in Kosciuszko National Park ....................................45

4.1.2  Aims and objectives ............................................................46

4.2  METHODS ........................................................................47

4.2.1  Site location and description .................................................47

4.2.2  Numbers and activities .........................................................49

4.2.3  Analysis ........................................................................50

4.3  RESULTS ........................................................................51

4.3.1  Visitor numbers and patterns ...............................................51

4.3.1.1  Temporal patterns ...........................................................52
4.3.1.2 Weather influences ................................................................. 52
4.3.1.3 Party size .......................................................................... 53
4.3.2 User groups ........................................................................ 54
4.3.3 Duration of visit ................................................................... 55
4.3.4 Track use and destinations ..................................................... 55
4.3.5 The summit of Mt Kosciuszko ............................................... 56
4.3.3.3 Blue Lake ....................................................................... 57

4.4 DISCUSSION .............................................................................. 57
4.4.1 Visitor numbers and patterns .................................................. 57
4.4.1.1 Visitor numbers ................................................................. 57
4.4.1.2 Temporal patterns ............................................................. 58
4.4.1.3 Party size .......................................................................... 59
4.4.2 User groups ........................................................................ 60
4.4.2.1 Short stay visitors ............................................................. 60
4.4.2.2 Long stay visitors ............................................................. 61
4.4.2.3 Experience seekers .......................................................... 62
4.4.3 Recreation research .............................................................. 64

4.5 CONCLUSION ............................................................................. 65

CHAPTER 5 BACKCOUNTRY CAMPING ........................................... 67

5.1 INTRODUCTION ........................................................................ 67
5.1.1 Camping impacts ................................................................. 67
5.1.2 Camping in the Australian Alps ............................................ 68
5.1.3 Aims and objectives ............................................................. 69

5.2 METHODS ................................................................................ 70
5.2.1 Survey methods ................................................................. 70
5.2.2 Experimental (BACI) camping trials ..................................... 71
5.2.2.1 Sampling design ............................................................. 71
5.2.2.2 Camping protocols ......................................................... 72
5.2.2.3 Vegetation parameters .................................................... 73
5.2.3 Analysis .............................................................................. 74

5.3 RESULTS .................................................................................. 75
5.3.1 Camping survey ................................................................. 75
5.3.2 Experimental camping ......................................................... 77
5.3.2.1 Three nights camping on tall alpine herbfield and subalpine grasslands ......................................................... 77
5.3.2.2 One night camping on tall alpine herbfield ....................... 82
5.3.2.3 General observations ....................................................... 85

5.4 DISCUSSION ............................................................................. 86
5.4.1 Monitoring visitor use ........................................................... 86
5.4.2 Impacts of camping on vegetation ........................................ 86
5.4.3 Managing camping in Kosciuszko National Park ................. 89

5.5 CONCLUSION .......................................................................... 91

CHAPTER 6 TRAMPLING ............................................................... 93

6.1 INTRODUCTION ...................................................................... 93
6.1.1 Research approaches .......................................................... 94
7.4 DISCUSSION ....................................................................................................................... 176
7.4.1 Impact of trampling on burnt subalpine grasslands ................................................... 176
7.4.2 Managing recovering areas in Kosciuszko National Park ....................................... 179

7.5 CONCLUSION .................................................................................................................... 180

CHAPTER 8 TRAMPLING ONE YEAR AFTER BUSHFIRE .......... 181

8.1 INTRODUCTION .............................................................................................................. 181
8.1.1 Vegetation regrowth and recovery one year after 2003 fires ................................... 181
8.1.2 Aims and objectives .................................................................................................. 182

8.2 METHODS ....................................................................................................................... 183
8.2.1 Site location ................................................................................................................ 183
8.2.2 Experimental (BACI) trampling trials on subalpine grasslands one year post fire .... 183
  8.2.2.1 Surface cover ......................................................................................................... 184
  8.2.2.2 Species richness and frequency .......................................................................... 184
  8.2.2.3 Soil compaction and surface profile ................................................................. 185
8.2.3 Analysis ....................................................................................................................... 186

8.3 RESULTS .......................................................................................................................... 186
8.3.1 Surface cover ............................................................................................................ 186
8.3.2 Species richness and frequency ............................................................................... 191
8.3.3 Soil compaction and surface profile ........................................................................ 193

8.4 DISCUSSION ..................................................................................................................... 196
8.4.1 Recovery from fires in subalpine grasslands ............................................................. 196
8.4.2 Impact of trampling on recovering subalpine grasslands and soils ......................... 198
8.4.3 Comparing effect of trampling at one time compared to over time ....................... 199

8.5 CONCLUSION .................................................................................................................. 200

CHAPTER 9 DISCUSSION ................................................................................................. 201

9.1 INTRODUCTION .............................................................................................................. 201

9.2 VISITOR USE OF PROTECTED AREAS ...................................................................... 202

9.3 RELATIONSHIPS AND THRESHOLDS ...................................................................... 203
9.3.1 Primary and secondary thresholds ........................................................................... 205
9.3.2 Multiple thresholds and suitable indicators .............................................................. 208
9.3.3 Environmental function and condition ..................................................................... 209

9.4 MANAGING CAMPING AND BUSHWALKING IN THE AUSTRALIAN ALPS ...... 211
9.4.1 Camping in the Australian Alps ............................................................................... 211
9.4.2 Backcountry bushwalking in the Australian Alps .................................................... 211
9.4.3 Bushfires and subsequent visitation .......................................................................... 212

9.5 CONCLUSION .................................................................................................................. 213

REFERENCES ...................................................................................................................... 214

APPENDIX 1 VISITOR NUMBER ESTIMATES ................................................................. 229
**LIST OF FIGURES**

Figure 1.1: Location of the Australian Alps National Parks.................................................................6
Figure 2.1: Relationships among major environmental components that can be affected by recreational activities ........................................................................................................................12
Figure 2.2: The relationship between frequency of use and amount of disturbance.................................23
Figure 2.3: The proposed relationship between frequency of use and amount of disturbance assuming two threshold points ........................................................................................................24
Figure 2.4: The hierarchy among environmental parameters with changing amounts of use.....................25
Figure 2.5: Representation of how an environment in an intermediate state of function along a continuum of conserving to degrading can be assessed to be in varying states of acceptability based on value judgements and the landuse intent .................................................................29
Figure 3.1: Location of Kosciuszko National Park ..................................................................................34
Figure 4.1: The Kosciuszko alpine area showing main access points, main tracks and major destinations .................................................................................................................................................48
Figure 4.2: Linear regression model between the survey days at the two principal monitoring sites and chairlift ticket sales to estimate figures for non-surveyed days during the 1999/2000 non-winter period within the Kosciuszko alpine area ..................................................................................................................51
Figure 4.3: Estimated monthly visitor numbers within the Kosciuszko alpine area .....................................53
Figure 4.4: Weekly visitation pattern of visitors to the Kosciuszko alpine area ............................................53
Figure 4.5: The proportion of different party sizes entering the Kosciuszko alpine area ............................54
Figure 4.6: Distribution of recreational activities undertaken in the Kosciuszko alpine area ....................54
Figure 4.7: Average visitor numbers at the summit of Mt Kosciuszko ........................................................56
Figure 5.1: Size and arrangement of treatment areas and quadrats within experimental campsites for one and three nights camping ........................................................................................................72
Figure 5.2: Absolute and relative mean vegetation height in control, tent and activity areas at three night camping sites in tall alpine herbfields and subalpine grasslands before, immediately after, two weeks after, six weeks after and one year after camping ................................................78
Figure 5.3: Absolute and relative mean dead material in control, tent and activity areas at three night camping sites in tall alpine herbfields and subalpine grasslands before, two weeks after, six weeks after and one year after camping ...........................................................................................................81
Figure 5.4: Absolute and relative mean graminoid cover in control, tent and activity areas at three night camping sites in tall alpine herbfields and subalpine grasslands before, two weeks after, six weeks after and one year after camping ...........................................................................................................81
Figure 5.5: Absolute and relative mean herb cover in control, tent and activity areas at three night camping sites in tall alpine herbfields and subalpine grasslands before, two weeks after, six weeks after and one year after camping ...........................................................................................................82
Figure 5.6: Absolute and relative mean vegetation height in control, tent and activity areas at one night camping sites in tall alpine herbfields before, immediately after, two weeks after, six weeks after and one year after camping ...........................................................................................................83
Figure 5.7: Absolute and relative mean dead material in control, tent and activity areas at one night camping sites in tall alpine herbfields before, two weeks after, six weeks after and one year after camping ...........................................................................................................84
Figure 5.8: Absolute and relative mean graminoid cover in control, tent and activity areas at one night camping sites in tall alpine herbfields before, two weeks after, six weeks after and one year after camping ...........................................................................................................84
Figure 5.9: Absolute and relative mean herb cover in control, tent and activity areas at one night camping sites in tall alpine herbfields before, two weeks after, six weeks after and one year after camping ...........................................................................................................85
Figure 6.1: The main effects of trampling and the associated follow on impacts ........................................95
Figure 6.2: Size and approximate layout of treatment lanes used for experimental trampling at each of five sites in tall alpine herbfields, subalpine grasslands and valley bogs ..............................................101
Figure 6.3: Absolute vegetation height, dead material cover, graminoid cover and herb cover for tall alpine herbfields and subalpine grasslands before, immediately after, six weeks after and one year after principal trampling treatments ................................................. 107
Figure 6.4: Relative vegetation height, dead material cover, graminoid cover and herb cover for tall alpine herbfields and subalpine grasslands immediately after, six weeks after and one year after principal trampling treatments ................................................... 108
Figure 6.5: Number of species for tall alpine herbfields and subalpine grasslands before trampling, six weeks after and one year after principal trampling treatments .................... 115
Figure 6.6: Absolute species net difference for tall alpine herbfields and subalpine grasslands at two weeks, six weeks and one year after principal trampling treatments .................... 116
Figure 6.7: Soil bulk density for principal trampling treatments in the tall alpine herbfields immediately after trampling ................................................................. 122
Figure 6.8: Absolute vegetation height, dead material cover, graminoid cover and herb cover for tall alpine herbfields and subalpine grasslands at baseline, six weeks and one year after repeat trampling treatments ............................................................. 124
Figure 6.9: Relative vegetation height, dead material cover, graminoid cover and herb cover for tall alpine herbfields and subalpine grasslands at baseline, six weeks and one year after repeat trampling treatments .................................................. 125
Figure 6.10: Number of species for tall alpine herbfields and subalpine grasslands before re-trampling, six weeks after and one year after repeat trampling treatments ................... 131
Figure 6.11: Absolute species net difference for tall alpine herbfields and subalpine grasslands before re-trampling, six weeks and one year after repeat trampling ......................... 132
Figure 6.12: Absolute mean vegetation cover for dead material, graminoids, herbs, shrubs, Sphagnum and number of species for bog communities before trampling, two weeks after, six weeks after and one year after trampling treatments ........................................ 137
Figure 7.1: Method and equipment used to measure changes in surface profile within each trampling treatment lane. ........................................................................................................ 157
Figure 7.2: Vegetation cover, bare ground, all burnt material and all dead material for extensive and partially burnt sites before, immediately after, two weeks after, six weeks after and one year after trampling treatments ........................................................................ 159
Figure 7.3: Graminoid cover, herb cover, shrub cover and litter cover for extensive and partially burnt sites before, two weeks after, six weeks after and one year after trampling treatments .......................................................... 162
Figure 7.4: Species richness before trampling, two weeks after, six weeks after and one year after increasing intensities of trampling for extensively and partially burnt subalpine areas...... 169
Figure 7.5: Soil bulk density and soil moisture for increasing intensities of trampling immediately after trampling in extensively burnt and partially burnt subalpine areas. .................. 173
Figure 7.6: Change in surface profile and change in surface profile adjusted against controls for increasing intensities of trampling before trampling, immediately after trampling and two weeks, six weeks and one year after trampling in extensively and partially burnt subalpine areas. ........................................................................................................ 174
Figure 8.1: Vegetation cover, dead material, bare ground and burnt material on sites one year after bushfires before, two weeks and six weeks after trampling treatments ................. 187
Figure 8.2: Relative cover for vegetation, dead material and bare ground on sites one year after bushfire before, two weeks and six weeks after trampling treatments ...................... 189
Figure 8.3: Species richness before trampling, two weeks after and six weeks after increasing intensities after trampling treatments ............................................................. 193
Figure 8.4: Soil compaction, mean change in surface profile and mean change in surface profile adjusted against the control one year after bushfire before, after, two weeks and six weeks after trampling treatments ........................................... 194
Figure 9.1: Representation of how an environment in an intermediate state of function along a continuum of conserving to degrading can be assessed to be in varying states of acceptability based on value judgements and the landuse intent and how this will reflect the management action. .................................................... 210
LIST OF TABLES

Table 1.1: Percentage of protected land areas around the world by region..........................................2
Table 4.1: Surveying days at the two primary monitoring sites at Charlotte Pass and the Crackenback chairlift during different periods of visitation intensity during the 1999/2000 non-winter period for the Kosciuszko alpine area.................................................................................................49
Table 4.2: Classification of the non-winter period into periods of visitation levels.................................51
Table 4.3: Visitors counted at secondary survey points within the alpine area........................................52
Table 4.4: Visitor numbers and percentage of total according to weather conditions during the 1999/2000 survey in the Kosciuszko alpine area........................................................................................................53
Table 4.5: Percentage distribution according to age of visitors for recreational activities in Kosciuszko alpine area during the 1999/2000 survey.................................................................55
Table 4.6: Duration of visit at the two major access areas to the Kosciuszko alpine area during the 1999/2000 visitor survey ..............................................................................................................55
Table 4.7: Estimations of visitors accessing and dispersing into the Kosciuszko alpine area from the two main access points of the Crackenback chairlift and Charlottes Pass........................................58
Table 4.8: Changing visitor numbers within the Kosciuszko alpine area over the last 25 years..............58
Table 4.9: Comparison of party size distribution for users in the Kosciuszko alpine area.......................60
Table 5.1: Location of experimental camping sites in tall alpine herbfields and subalpine grasslands in Kosciuszko National Park..................................................................................................................72
Table 5.2: Size of camping groups entering the Kosciuszko alpine area during the 1999/2000 visitor survey ........................................................................................................................................75
Table 5.3: Age groups of campers entering the Kosciuszko alpine area during the 1999/2000 visitor survey ........................................................................................................................................75
Table 5.4: Total groups and total number of visitors undertaking camping in the Kosciuszko alpine area during three major visitation periods ....................................................................................................76
Table 5.5: Number of groups and individuals camping in the Kosciuszko alpine area for each day of the week during each period........................................................................................................76
Table 5.6: Number of groups and individuals departing for camping within the Kosciuszko alpine area for each day of the week during each time of the day ....................................................................77
Table 5.7: Results from Two-Way Repeated Measures ANOVA examining changes in vegetation height for three nights camping ..................................................................................................78
Table 5.8: Contrast results between times from Two-Way Repeated Measures ANOVA in the first six weeks for vegetation height for three nights camping ....................................................................................78
Table 5.9: Results from a series of Randomised Block ANOVAs comparing communities and treatments for vegetation height for three nights camping ..................................................79
Table 5.10: Significance values for post hoc test between treatments for vegetation height for three nights camping in tall alpine herbfields and subalpine grasslands...........................................79
Table 5.11: Results from Two-Way Repeated Measures ANOVA examining changes in components of vegetation cover for three nights camping ...............................................................80
Table 5.12: Contrast results between times from Two-Way Repeated Measures ANOVA in the first six weeks for components of vegetation cover for three nights camping ..................................80
Table 5.13: Results from a series of Randomised Block ANOVAS comparing communities and treatments for dead material cover for three nights camping ...............................................80
Table 5.14: Significance values for post hoc test between treatments for dead material cover for three nights camping in tall alpine herbfields and subalpine grasslands........................................80
Table 5.15: Results from One-Way Repeated Measures ANOVA examining changes in vegetation height for one night camping in tall alpine herbfields ............................................................83
Table 5.16: Contrast results between times from a One-Way Repeated Measures ANOVA in the first six weeks for vegetation height for one night camping in tall alpine herbfields....................83
Table 5.17: Results from a series of Randomised Block ANOVAS comparing zones treatments for vegetation height for one night camping in tall alpine herbfield ........................................................................83
Table 5.18: Significance values for post hoc test between treatments for vegetation height for one night camping in tall alpine herbfields ................................................................................................83
Table 5.19: Results from One-Way Repeated Measures ANOVA examining changes in cover categories for one night camping in tall alpine herbfields .......................................................... 84
Table 5.20: Additional damage or evidence of campsite use at camping sites in tall alpine herbfields and subalpine grasslands ................................................................. 85
Table 5.21: Comparison between Stankey (1986) and this study of camping group sizes entering in the Kosciuszko alpine area during the non-winter period ........................................ 86
Table 6.1: Site locations for trampling in tall alpine herbfield, subalpine grassland and valley bog communities in January 2002 ................................................................. 101
Table 6.2: Contrast results between times from Two-Way Repeated Measures ANOVA for absolute vegetation height from principal trampling experiment in tall alpine herbfields and subalpine grasslands ................................................................. 106
Table 6.3: Results from a series of Two-Way ANOVAs comparing community and treatments for absolute vegetation height at principal trampling sites ........................................ 109
Table 6.4: Significance values for post hoc test between treatments for absolute vegetation height for principal trampling in tall alpine herbfields and subalpine grasslands .................. 109
Table 6.5: Results from a series of Two-Way ANOVAs comparing community and treatments for absolute dead material cover at principal trampling at sites ........................................ 110
Table 6.6: Significance values for post hoc test between treatments for absolute dead material cover for principal trampling in tall alpine herbfields and subalpine grasslands .................... 111
Table 6.7: Results from a series of Two-Way ANOVAs comparing community and treatments for absolute graminoid cover at principal trampling sites ........................................... 112
Table 6.8: Significance values for post hoc test between treatments for absolute graminoid cover for principal trampling in tall alpine herbfields and subalpine grasslands .................... 112
Table 6.9: Results from a series of Two-Way ANOVAs comparing community and treatments for absolute herb cover at principal trampling sites ........................................... 113
Table 6.10: Significance values for post hoc test between treatments for absolute herb cover for principal trampling in tall alpine herbfields and subalpine grasslands .................... 114
Table 6.11: Mean shrub cover and mean bare ground cover values for initial trampling of trampling in tall alpine herbfields and subalpine grasslands ........................................... 114
Table 6.12: Significance values for post hoc test between treatments for absolute species diversity for principal trampling in tall alpine herbfields and subalpine grasslands .............................. 115
Table 6.13: Results from a series of Two-Way ANOVAs comparing community and treatments for absolute species net frequency at principal trampling sites ........................................ 116
Table 6.14: Significance values for post hoc test between treatments for absolute species net frequency for principal trampling in tall alpine herbfields and subalpine grasslands .......... 117
Table 6.15: Frequency of species occurrence for each level of trampling intensity in tall alpine herbfields ........................................................................................................... 118
Table 6.16: Frequency of species occurrence for each level of trampling intensity in subalpine grasslands ......................................................................................................... 120
Table 6.17: Results from a Two-Way ANOVAs examining soil weight, soil bulk density, and soil water content for principal trampling tall alpine herbfields ........................................ 122
Table 6.18: Results from a series of Two-Way ANOVAs comparing community and treatments for absolute vegetation height at repeat trampling sites ........................................... 126
Table 6.19: Significance values for post hoc test between treatments for absolute vegetation height for repeat trampling in tall alpine herbfields and subalpine grasslands .................. 126
Table 6.20: Results from a series of Two-Way ANOVAs comparing community and treatments for absolute dead material cover at repeat trampling sites .................................... 127
Table 6.21: Significance values for post hoc test between treatments for absolute dead material cover for repeat trampling in tall alpine herbfields and subalpine grasslands .................. 128
Table 6.22: Results from a series of Two-Way ANOVAs comparing community and treatments for absolute graminoid cover at repeat trampling sites ......................................... 129
Table 6.23: Significance values for post hoc test between treatments for absolute graminoid cover for repeat trampling in tall alpine herbfields and subalpine grasslands .................. 129
Table 6.24: Results from a series of Two-Way ANOVAs comparing community and treatments for absolute herb cover at repeat trampling sites ........................................... 130
Table 7.16: Results from Two-Way ANOVAs comparing burn type and treatments for absolute dead material cover from trampling in extensively and partially burnt subalpine grasslands

Table 7.17: Contrast results between times from Two-Way Repeated Measures ANOVA for absolute litter cover from trampling on extensively burnt and partially burnt subalpine grasslands

Table 7.18: Results from Two-Way ANOVAs comparing burn type and treatments for absolute litter cover from trampling in extensively and partially burnt subalpine grasslands

Table 7.19: Post hoc results comparing trampling treatments for absolute litter cover from Two-Way ANOVAs for extensively and partially burnt subalpine grasslands

Table 7.20: Frequency of species for each level of trampling intensity in extensively burnt subalpine grasslands

Table 7.21: Results from Two-Way Repeated Measures ANOVA for absolute species richness from trampling on remaining surface cover on extensively burnt and partially burnt areas in subalpine grasslands

Table 7.22: Contrast results between times from Two-Way Repeated Measures ANOVA for absolute species richness from trampling on extensively burnt and partially burnt subalpine grasslands

Table 7.23: Results from Two-Way ANOVAs comparing burn type and treatments for absolute species richness from trampling in extensively and partially burnt subalpine grasslands

Table 7.24: Frequency of species occurrence for each level of trampling intensity in partially burnt subalpine grasslands

Table 7.25: Results from Two-Way ANOVAs immediately after trampling comparing burn type and treatment for bulk density and soil moisture from trampling in extensively and partially burnt subalpine grasslands

Table 7.26: Results from Two-Way Repeated Measures ANOVA for surface profile from trampling on remaining surface cover on extensively burnt and partially burnt areas in subalpine grasslands

Table 7.27: Contrast results between times from Two-Way Repeated Measures ANOVA for surface profile within trampling lanes on extensively burnt and partially burnt subalpine grasslands

Table 7.28: Results from Two-Way ANOVAs comparing burn type and treatments for surface profile from trampling in extensively and partially burnt subalpine grasslands

Table 7.29: Post hoc results comparing trampling treatments for surface profile from Two-Way ANOVAs for extensively and partially burnt subalpine grasslands

Table 8.1: Location of trampling sites for subalpine grasslands community one year after bushfires

Table 8.2: Results from One-Way Repeated Measures ANOVA for cover types from trampling on recovering vegetation, one year after extensive burning in subalpine grasslands

Table 8.3: Contrast results between times from One-Way Repeated Measures ANOVA for selected cover types from trampling on recovering vegetation, one year after extensive burning in subalpine grasslands

Table 8.4: Results from One-Way ANOVAs comparing treatments for absolute vegetation cover from trampling on recovering vegetation, one year after extensive burning in subalpine grasslands

Table 8.5: Post hoc results comparing trampling treatments for absolute vegetation cover from One-Way ANOVAs on recovering vegetation, one year after extensive burning in subalpine grasslands

Table 8.6: Results from One-Way ANOVAs comparing treatments for absolute graminoid cover from trampling on recovering vegetation, one year after extensive burning in subalpine grasslands

Table 8.7: Results from One-Way ANOVAs comparing treatments for absolute herb cover from trampling on recovering vegetation, one year after extensive burning in subalpine grasslands
Table 8.8: Results from One-Way ANOVAs comparing treatments for absolute dead material cover from trampling on recovering vegetation, one year after extensive burning in subalpine grasslands ................................................................. 190

Table 8.9: Results from One-Way Repeated Measures ANOVA for selected cover types from trampling on recovering vegetation, one year after extensive burning in subalpine grasslands ...................................................................................................................... 191

Table 8.10: Contrast results between times from One-Way Repeated Measures ANOVA for selected cover types from trampling on recovering vegetation, one year after extensive burning in subalpine grasslands ........................................................................................................... 191

Table 8.11: Results from One-Way ANOVAs comparing treatments for absolute bare ground cover from trampling on recovering vegetation, one year after extensive burning in subalpine grasslands ....................................................................................................................... 191

Table 8.12: Frequency of species for each level of trampling intensity within recovering subalpine grasslands ........................................................................................................................................ 192

Table 8.13: Results from One-Way Repeated Measures ANOVA for absolute species richness from trampling on recovering vegetation, one year after extensive burning by fire in subalpine grasslands ............................................................................................................................. 193

Table 8.14: Results from One-Way Repeated Measures ANOVA for soil compaction and surface profile from trampling on recovering vegetation, one year after extensive burning in subalpine grasslands .......................................................................................................................... 194

Table 8.15: Contrast results between times from One-Way Repeated Measures ANOVA for soil compaction and surface profile measurements on recovering vegetation, one year after extensive burning in subalpine grasslands .......................................................................................................................... 195

Table 8.16: Results from One-Way ANOVAs comparing treatments for soil compaction from trampling on recovering vegetation, one year after extensive burning in subalpine grasslands .......................................................................................................................... 195

Table 8.17: Post hoc results comparing trampling treatments for soil compaction measures from One-Way ANOVAs on recovering vegetation, one year after extensive burning in subalpine grasslands .......................................................................................................................... 195

Table 8.18: Average frequency for which each species was found within subalpine grasslands communities under undisturbed conditions, six weeks after extensive fire damage and one year after extensive fire damage. .......................................................................................................................... 197

Table 9.1: Summary of relationships between intensity of use and damage to vegetation from camping for one and three nights in tall alpine herbfields and subalpine grasslands .......... 204

Table 9.2: Summary of relationships between intensity of use and damage to vegetation from trampling in tall alpine herbfields, subalpine grasslands and valley bogs at different intensities of use and under different conditions ................................................................. 205
LIST OF PLATES

Plate 3.1: The Poa-Celmissia alliance within tall alpine herbfields………………………………………40
Plate 3.2: Subalpine grasslands surrounded by Snow Gums (Eucalyptus niphophilia)...........42
Plate 4.1: The Snow Gums walk, a hardened track with views over the Kosciuszko alpine area located at Charlotte Pass……………………………………………………………………...61
Plate 5.1: A small fire scar vs. a large fire scar where camping group behaviour was poor at an experimental campsite in subalpine grasslands .....................................................90
Plate 5.2: Hatchet marks in Snow gums (Eucalyptus niphophilia) where group behaviour was poor at an experimental campsite in subalpine grasslands ..........................................................90
Plate 6.1: Trampling in valley bog communities causes compression and disturbance to underlying Sphagnum leading to channels developing ..................................................144
Plate 7.1: Partially burnt and extensively burnt areas one month after the 2003 bushfires in subalpine grassland communities of Kosciuszko National Park.................................152
Plate 7.2: Surface conditions are very unstable after the fire and easily disturbed with repeat trampling rapidly resulting in loss of remaining burnt material and ash and exposure of underlying soils ........................................................................................................177
Plate 7.3: Stellaria pungens before trampling and six weeks after 100 passes............................179
ACKNOWLEDGEMENTS

This project would not have been possible without the financial support of Griffith University, the Sustainable Tourism Cooperative Research Centre and the NSW National Parks and Wildlife Service.

I am extremely grateful to all those who helped make this thesis happen and would like to profusely thank the following people:

My principal supervisor, Dr Catherine Pickering, for your belief in me, enthusiasm in the project and continued encouragement. This project may never have been completed without your assistance, suggestions, comments and recommendations during all stages of the project. Many thanks.

My two associate supervisors: Professor Ralf Buckley for his timely advice and suggestions during the early and end part of the research; and Stuart Johnston for his wicked sense of humour, ideas, comments and enthusiasm from the beginning until the end.

Wendy Hill for her field assistance, suggestions, support and comments.

Tanya Fountain for her continued assistance over all three field seasons (thank you so much!!).

Dave Woods for teaching me so much about plant identification during my first field season.

Ruth Lawrence for your continued interest and suggestions.

Marama Hopkins for your patience and assistance in the field.

All those that helped undertake the trampling or camping over the three field seasons: Mark Jordan, Tanya Fountain, Wendy Hill, Jeremy Carrington, Eamon Parker, Rebecca Bromhead, Stephen Wilkenson, Bikram Ray, Mathew Mitchell, Marama Hopkins, Rohan Curnow, Mary Clare Swete Kelly, Ruth Lawrence, Melinda Larkin, Petra Weisner, Kelvin Huang, Pascal Scherrer, Michael Campbell, Zarni Bear, Kristy Barry and anyone else who’s name temporarily escapes me. Thank you all.

Fran Johnston provided much appreciated suggestions on project development.
Michael Arthur, the school statistical consultant, who patiently helped analyse and interpret the data collected.

Dr Ken Green for your never ending sense of humour, assistance with field equipment and assorted permissions and unique view of all things alpine and subalpine.

All those who assisted in collecting the visitor monitoring data.

The Green Globe office in Canberra for providing me with desk space for 12 months in 2002.

Dr Richard Greene from the Australian National University who lent equipment for field studies.

Those in the post grad office who were in it from almost the start and who provided welcome support and laughter: Pascal Scherrer, Carolyn Littlefair, Daniel Stock, Michelle Stock, Simon Hogkison, Skye Page, Narelle King and Eyla Rerega.

And finally, my family: Michelle Whitmore for her continued patience, support, understanding and love; my grandparents Don and Kath Greenwood for their long Sunday lunches, lively conversation and support along the way; and finally my parents Donna and Allan who provided me with more opportunities than I could have ever dreamed of, who have looked out for my best interests and have continued to encourage me to achieve more.
GLOSSARY OF TERMS

**Alpine area:** the area between the climatic limit of tree vegetation (~1860 m in Kosciuszko National Park) and the zone of permanent snow and ice cover in other mountains.

**Graminoids:** sedges, rushes, and grasses combined.

**Impact:** any undesirable visitor related biophysical change in the of the environmental resource (Leung & Marion 2000)

**IUCN:** World Conservation Union – International Union for the Conservation of Nature.

**Non-winter period:** in this thesis refers to the period between the middle of October and the end of May for Kosciuszko National Park in Australia.

**NSW NPWS:** New South Wales National Parks and Wildlife Service.

**Primary threshold:** maximum amount of use that can occur before there is significant damage to the pre-existing condition.

**Recreation ecology:** scientific research that examines the effect of recreation on the natural environment.

**Resistance:** the relative ability of individual plant species to withstand disturbance before being damaged.

**Resilience:** the capacity of a plant species to recover after disturbance.

**Secondary threshold:** level of use at which the proportion of damage associated with use begins to decrease.

**Subalpine area:** located between the upper limits of the montane zone and the climatic limit of tree vegetation (treeline) approximately 1500 and 1860 m in Kosciuszko National Park. The subalpine zone in the Park receives snow for an average of one month per year.

**Subalpine grasslands:** often found interspersed between the Snow Gum woodlands, in basin areas and within frost hollow areas in the Australian Alps. They are dominated by tussock forming grasses (\textit{Poa} sp.) with inter-tussock areas dominated by a variety of herb species.

**Tall alpine herbfields:** widespread vegetation community found in the alpine zone of the Australian Alps with high species diversity. Prominently consists of species associated with the \textit{Celmisia} – \textit{Poa} alliance (sensu Costin \textit{et al.} 2000).

**Tolerance:** the ability of vegetation to withstand a cycle of disturbance and recovery.

**Valley bogs:** wet vegetation communities dominated by \textit{Sphagnum} species with underlying peat soils.