

HIGH IMPACT ACTIVITIES IN PARKS

Best management practice and future research



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National Library of Australia Cataloguing-in-Publication entry

Cater, C.

High impact activities in parks: best management practice and future research

ISBN: 9781920965723 (pbk. and online)

Notes: Bibliography

Subjects: National parks and reserves—Management. Protected areas—Management. Recreation—Management. Tourism—Environmental aspects

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Dewey Number: 354.328

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First published in Australia in 2008 by Cooperative Research Centre for Sustainable Tourism Pty Ltd

Edited by Kelly Van Asperen

Printed in Australia (Gold Coast, Queensland)

Cover designed by Sin Design

Acknowledgements

The Sustainable Tourism Cooperative Research Centre, established and supported under the Australian Government's Cooperative Research Centres Program, funded this research. Support from staff of the following organisations is also acknowledged:

- Queensland National Parks and Wildlife Service
- Sport and Recreation Queensland
- Parks Victoria
- New South Wales Parks and Wildlife
- Parks Tasmania
- Conservation and Land Management Western Australia

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Abstract

Off-road driving, horseriding, rock climbing and similar activities can be lucrative for tour operators and important for local recreational groups, but contentious for management of national parks and protected areas, both because of safety and liability and because of potentially high environmental impacts. These include spreading weeds and pathogens, starting fires and crushing bird nests on beaches, amongst many others. In Australia as elsewhere, off-road vehicles and horses are allowed only in some places in some parks, and often only under permit. We have very little reliable scientific information to-date on just how serious these impacts may be, and on how well they might be managed through minimal-impact practices such as vehicle washdowns, stockfeed processing and seasonal closures. Such information can only be obtained through site specific ecological studies of the plants, animals and watercourses likely to be affected, differentiating tourism impacts from natural causes and fluctuations. This report examines management strategies for these activities worldwide and in Australia. Suggestions for best management practice and future research agendas are set.

SUMMARY

Objectives of Study

The aim of this study was to examine three types of tourist activity which are currently prohibited or restricted by Australian land managers because of their relatively high environmental impacts, the legal and geographic constraints on these activities and the economic significance of these constraints for the Australian tourism industry. This was to be completed through:

- a meta-analysis of relevant international material and Australian research
- scientific information on the actual impacts under different management regimes
- suggested topics for future research
- management options for horseriding and management recommendations for off road vehicles and climbing.

Methodology

A comprehensive review methodology was utilised in 2004–2005 including:

- examination of the international literature on the impacts of relevant activities to determine;
 - which activities have highest impacts overall
 - which types of impact have the greatest shortfall in specifically Australian research
- consultations with land managers, particularly those where high-impact activities are currently controversial; to determine which ecosystems they view as of particular concern. This was conducted for off-road vehicle and climbing sections as these have had less previous focus.

Key Findings

Core management recommendations are made including:

- clear communication of approved sites for high impact activities and maintenance of infrastructure in high use areas
- monitoring biophysical impacts at the precinct level
- limiting the growth of new areas for these activities
- if the park size permits, using zoning systems to regulate particular types of activity to limit environmental and social impacts
- maintain open liaison with user groups to encourage joint development of user-based codes of conduct (for example, Sustainable Tourism Cooperative Research Centre's *Green Guides*) and minimal impact and rehabilitation strategies. Each park where there is high-impact activity should have a specific code of conduct which includes management plan strategies
- production of information leaflets detailing acceptable sites, codes of conduct and temporary closures for impact management

Specific activity management recommendations include:

Horseriding

- education e.g. trailside signs
- limit use
- limit the number of horses that visit per year
- limit the number of groups with horses
- limit the length of time horse users can access the natural area; usually used to limit the length of stay in campsites. Ineffective if most visits are generally short.
- zoning—setting aside areas for horse use only for example, bridle trails; locate trails near perimeter of reserves and/or in modified zones; exclude horseriding from ecologically sensitive areas
- trail hardening/surfacing techniques for instance use materials such as gravel, earth, crushed stone, and geosynthetics such as geotextiles
- water control, for example, bridges, drainage dips, outsloped treads, water bars and earth or rock ditches
- short trail reroutes used to stop trail degradation in problem areas
- reinforce soil structure that is, use of chemical binders such as liquid concentrates and latex polymer products
- vegetation management e.g. clearing overhanging vegetation on trail

Off-road Vehicles

- If they are permitted in parks at all, off-road vehicles should be restricted to special-use zones or to a small number of narrow well-maintained tracks, preferably not crossing between catchments.
- In closed-canopy forest, the canopy should be maintained above the track wherever possible.
- Tracks should be separated from ecologically sensitive areas by a wide buffer zone so that vehicle engines are not audible beyond the buffer.
- Where tracks cross creeks, crossing points should be fixed and if necessary maintained.
- Maintenance of tracks should aim to minimise secondary impacts such as spread of weeds, reduction of canopy cover, etc.
- Signs requiring off-road vehicle drivers to keep to tracks should be prominent and plentiful.
- In general, off-road vehicles should not be allowed on wet areas, steep terrain, or on dunes and beaches.
- If off-road vehicles are permitted to drive along beaches, they should be allowed only on wide sandy beaches, only in the intertidal zone, and only at low tide, and entry and exit from the beach should be at designated access points only.
- If off-road vehicles are permitted on beaches, signs at access points should require that all vehicles must be removed from the beach at high tide and may not use the dunes or supralittoral.
- Beaches may also be completely closed to vehicles during exceptionally high tides.
- The possibility of mandatory off-road vehicle driver training and licensing programs as a precondition of off-road vehicle use in public lands, should be investigated.
- Driver training and licensing can be used as a precondition for use of controlled-access trails, e.g. in forested areas where trails can be gated and locked.

Rock Climbing

- If rope based activities are permitted in parks designated climbing sites should be clearly advertised to the user groups by the management authority. This will confine impacts to a smaller number of sites.
- Tracks to the cliff should be sign posted and descent routes from cliff tops should be clearly marked to avoid multiple track formation.
- In some circumstances fixed anchors (bolts or slings around trees) for descent from cliff tops should be installed where the potential for erosion or damage to vulnerable vegetation is high.
- Monitor cliff, vegetation and soil impacts at the precinct level (site specific).
- Monitor nesting bird activity and signpost or inform climbers via leaflets when nesting bird closures are in force.
- Monitoring of rock wallaby numbers and distribution should be undertaken at certain sites.
- The codes of conduct presently in use should be developed further. Each park where there is climbing should have a specific code of conduct which includes management plan strategies. These should be developed in partnership with the climbing communities.
- New climbs and cliff development appears to be a major concern of land managers only if there is large amounts of people visiting the new cliffs. Limiting the type of climbing is a way of limiting numbers. Managers should decide on what types of climbing and abseiling activities are appropriate. This makes reference to allowing group abseiling routes and sport climbing as these two types of activities can generate large numbers of people to new sites.
- If the park size permits use zoning systems to regulate particular types of climbing to limit environmental and social impacts, (e.g. banning power drills in wilderness areas (or whole parks) will limit sport climbing to more appropriate areas. This has occurred in some parks.
- Liaise with climbing communities to organise cliff care type activities to decrease impacts at high use sites.

Future Action

Gaps in existing knowledge, particularly that relating to the impacts of these activities in an Australian context, need to be filled. The impacts on indigenous wildlife need to be ascertained, as well as the long-term impacts of user behaviour, especially that of new technologies. Studies of stakeholder cooperation between high impact groups, land management agencies and other users will greatly assist in the development of sustainable management strategies for the future.

Specific research needed for each activity includes:

Horseriding

- Research needs to be conducted as to how horseriding is perceived by other users, for example the extent to which horseriding is incompatible with other trail users. In addition attitudes towards horseriding in national parks. Little research in Australia has been done on non-mountainous areas.
- There is need for research that investigates evidence of environmental damage caused specifically by horses when they are ridden along well-constructed and maintained trails.
- There is a need for research that examines whether weed spread is associated with horse trails that are well constructed and maintained.
- There is a need for research that examines the influence of horse use on wildlife.
- There is very little information on the attitudes, expectations and reactions of horse riders to proposed management strategies.
- Monitoring systems (including key performance indicators) need to be designed and tested for effectiveness.
- Many existing horseriding trails need to be audited for impact management effectiveness.

Off-road Vehicles

Ecological

- overall risk assessment: probabilities and severity of consequences
- aggregate impacts; compare areas with high and low or zero off-road vehicle use
- impacts of tracks; creek crossings, spores and seeds, access for ferals, weeds on verges, fragmentation, illegal tracks, source of fire and noise, regeneration on closure
- sandy beaches; impacts on populations of turtles, shorebirds, shore-nesting birds (especially threatened species), dune vegetation, beach infauna; relation of impact severity to use intensity, seasonality etc; effectiveness of management measures; secondary impacts. Note: The simplest management measure is to ban all off-road vehicles from all beaches, and some states do this. Other states, however, allow either recreational or fishing off-road vehicles on some beaches at least, so impact research is still important.
- for shorebirds on beaches, the main issues are probably:
 - disturbance to feeding birds
 - damage to nests and chicks
 - disturbance to parents so gulls eat eggs.
 - loss of prey populations such as crabs and smaller invertebrates may also be important.
- forests and woodlands; effects of tracks as above; effects of noise disturbance on birds and mammals, including nocturnal species and taking into account potential habituation. Significance for populations of rarer species.
- montane environments; impacts on vegetation, and including mountain bikes as well as motorised off-road vehicles.

Social

- How are non-off-road vehicle users affected by off-road vehicles? For example, avoiding areas, safety issues, loss of amenity, conflicts.
- If governments were to require a special training program and licence for off-road vehicles, would the public accept it?
- If Protected Area Management Authorities (PAMAs) were to establish special-use zones for off-road vehicles, how should these be designed and located and how could they be enforced?
- If PAMAs were to limit off-road vehicle access to particular areas, e.g. certain beaches or forest trails, how should access quotas and patterns be established? (i.e., a 'carrying capacity' approach, both social and ecological)

Rock Climbing

- Peregrine Falcon disturbance research is needed, in particular, examining the disturbance regimes of climbers across various climbing sites in Australia. Bird behavioural indicators and minimum approach distances on the ground and on cliffs in Australia need to be determined.
- The effect of chalk on the cliff environment (e.g. lichens and other vegetation growing on rock substrate) needs to be determined.
- The methods of bolting currently used in the climbing community should be assessed as to the sustainability of this practice. The life of many bolts is less than a human lifetime and creates the need to drill new holes in the rock at frequent intervals. Current practices may be unsustainable. Sustainable bolting techniques need to be examined to meet the needs of climber safety but limit impact on a geological time frame as opposed to the shorter time frames seen in current bolt replacement strategies.
- Trends in climbing participant numbers, type of climbing activity and locations of climbing activity needs research. This quantitative research needs to be triangulated with qualitative research on recreational succession of sites and changes in participant activities throughout the 'lifestages' of climbers.
- Research on the values and attitudes of various climber sub-groups towards regulation of their activity needs to be undertaken so that land managers can be more effective in the regulation and education that minimises impacts. If conducted in the appropriate form of consultation, the efficacy will be increased for both groups.

Chapter 1

HORSERIDING IN PROTECTED AREAS

Amanda J Smith and David Newsome

Introduction

Horseriding is a major tourist and recreational activity that takes place in a wide spectrum of environmental situations and countries (Newsome, Cole and Marion 2004). Equestrian sports and pastimes include racing, eventing and dressage, polo and rodeos, pony clubs and trail riding (Beeton 2001). In Australia, the image of the adventurous Australian bushman has been successfully used internationally to promote Australia and its products overseas. Horsemanship, particularly the vision of the early stockman on horseback, is seen and promoted as an integral part of the Australian image and used extensively to market the country (Beeton 1999a, 1999b, 2001). For example, the Victorian high country is promoted as 'Man From Snowy River Country' after the success of the film produced in the 1980's (Beeton 2001). Horseriding tours and treks are widely marketed and are available in countries such as Australia, New Zealand, Scotland, Spain, USA, Canada, Thailand, South Africa and Costa Rica (Buultjens and Witsel 2004; Newsome et al. 2004). Riding in natural areas usually occurs on tracks, specifically designated bridle trails and multiple use trails and cross-country riding where there is no designated pathway (Newsome et al. 2004; Newsome, Milewski, Phillips and Annear 2002a). This report explores the environmental issues associated with horseriding and provides a brief review of management strategies designed to reduce any negative environmental impacts. This review also identifies a number of future research areas in which data are needed to effectively manage and monitor horseriding activity in natural areas in the future.

Impacts of Horseriding on Trails in Natural Areas

Research on the biophysical effects of recreational horseriding on the natural environment has received moderate attention. Of the ten studies relating to biophysical impacts of horseriding, five are from USA and the other five are from Australia (Appendix B). Work emerged in Montana, USA in the Northern Rocky Mountains in the 1970's (Weaver and Dale 1978) that focused on trampling comparisons between different user types which included horses. This comparative research continued in the subalpine and alpine environments of this region (Cole and Spildie 1998; Deluca, Patterson IV, Freimund and Cole 1998; Wilson and Seney 1994), with Summer (1980) conducting research in the Rocky Mountain National Park, Colorado being the first to focus explicitly on the impacts of horse traffic. The geographic range of these studies expanded to include research conducted in Australia. One of the first studies in Australia was by Royce (1983), which focused on horse impact on bridle and multiple use trails in dry sclerophyll forest in Western Australia. This was followed by other Australian studies that examined recreational horse impact in various environments. These environments included alpine and subalpine wilderness areas in Tasmania (Whinam 1992; Whinam, Cannell, Kirkpatrick and Comfort 1994; Whinam and Comfort 1996); Mediterranean coastal woodlands in Western Australia (Barrett 1999); and sub-Mediterranean coastal shrub and woodlands in Western Australia (Phillips and Newsome 2002). Most of this research was conducted on experimental plots while Royce (1983) and Wilson and Seney (1994) examined horse impact on multiple use trails.

Before impacts as a result of horse use can be discussed in detail, it first must be considered that some environments are more susceptible to damage than others. A number of environmental factors act together in a complex and dynamic way and cannot be considered in isolation.

Environmental Factors Influencing Trail Degradation

Once a trail is established the soil comprising its tread is subject to the continuing erosional forces of rainfall, running water, wind, gravity and visitor traffic (Leung and Marion 1996). The most influential biophysical factors found to be affecting trail degradation are soil parent material, that is geology, soil texture and organic content; grade of trail and side-slope; rockiness and type of vegetation and drainage (Table 1) (Beavis 2000; Landsberg, Logan and Shorthouse 2001). Accelerated water erosion occurs as a consequence of increased runoff, increased channel flow of water, increased detachment of soil particles and increased transport of detached soil particles (Table 1) (Deluca *et al.* 1998).

Table 1: Environmental factors that influence the process of trail degradation

Environmental Factor	Description
Climate and Geology	<p>Affects trail condition primarily through their influence on other factors.</p> <p>Precipitation Precipitation directly erodes tread surfaces from raindrop impact and water runoff. Aggregates are broken down by raindrop splash and detached soil particles can be transported by overland flow in thin sheets (sheet wash) or result in rill (small channels) and gully (large deep channels).</p> <p>Elevation Trails at higher elevations erode more severely (exhibit greater soil loss). This may be attributed to higher precipitation rates and extended periods of snowmelt in cold climates that creates muddy soils and a higher potential for erosion.</p> <p>Seasonal effect Rainfall and snowmelt in cold climates, which create wet soils, increases the susceptibility of the trail tread to erosion.</p> <p>Wind Wind is an important erosional force in peat or sandy soils in environments that are prone to surficial desiccation.</p>
Vegetation	<p>Vegetation type Foliage dissipates the kinetic energy of raindrop impact while the root networks of vegetation stabilises the ground surface by binding the soil, enhancing the infiltration capacity and adding organic matter, which contributes to the development of soil structure. At low use levels, vegetation types with high trampling resistance and resilience can sustain use with little degradation. Vegetation types that are resistant to trampling have features such as low growth habit, growing points that are not easily damaged, flexibility and toughness.</p> <p>Vegetation density Canopy continuity and height as well as the density of root mats and groundcover density influence the erosion potential of trails. For example, rain falling through an open canopy or dripping off tall trees can erode soil in the absence of ground cover. Dense trailside vegetation confines the lateral spread of trail users. Further, the density of forest types also determines the composition and trampling resistance of trailside vegetation. Open vegetation permits trail users to spread out or create new trails.</p> <p>Succession stage Trails in mature forest have greater impact than those in successional forest.</p>
Topography	<p>Trail slope Steep slopes have a strong positive relationship with soil loss. The greater velocity and erosivity of surface runoff on steep slopes, in association with particle displacement caused slippage of feet and hooves, is the predominant cause of erosion.</p> <p>Trail side-slope (the terrain adjacent to either side of the trail): Trails with a low side slope angle relative to the plane of the trail tread are susceptible to degradation because their flatter side slopes offer little resistance to trail widening, and hinder or block the drainage of water from incised trail treads.</p> <p>Trail alignment Trails that more closely follow the contour (that are perpendicular to the slope) are subject to less degradation while tails that directly ascend the slope are more susceptible to degradation.</p> <p>Slope position Wider trail treads and soil loss is often more pronounced on the steeper sections of upper slope positions.</p> <p>Proximity to water Trails located in close proximity to groundwater discharge areas or streams are more susceptible to degradation due to excessive wetness and periodic flooding of trail treads.</p>

Soil and Surface Characteristics	<p>Soil texture Soil texture controls cohesion (ease with which soil particles resist detachment). Soils dominated by sand and gravel are less cohesive than those with moderate to high clay content. Trails on soils with fine and homogenous textures have been found to have greater tread incision. Further, soils with a wide range of particle sizes such as loams and those with low organic content are prone to compaction.</p> <p>Soil type The presence of organic matter and ‘cementing’ agents such as calcium and magnesium also assist in the formation of stable soil aggregates which resist the splash impact of raindrops. Highly organic soils retain water long after rains.</p> <p>Soil moisture Field capacity (the amount of water held in the soil after water is added) is increased on trampled sites however, an increased field capacity comes at the expense of reduced air capacity and a reduced rate of water infiltration. Wet, muddy soils are more susceptible to erosion, especially when trail slopes are steeper.</p> <p>Infiltration capacity Factors that contribute to a decrease in infiltration capacity include:</p> <ul style="list-style-type: none">• fine textured soils• poorly structured soils• hard surficial crusting• very shallow soils• sub-surface impermeable layers <p>These factors promote the risk of surface runoff and muddiness, particularly in flatter terrain where trails become incised as a result of user activity and water is difficult to drain from treads.</p> <p>Rockiness/stoniness Trails on soils with a high rock or gravel content have been found to be less susceptible to soil erosion. Rocks and gravel are less easily eroded by water or wind, and these materials act as barriers and traps, retaining and binding finer soil particles.</p> <p>Roughness Larger soil aggregates are more resistant to the detaching force of raindrops and their large size can increase the roughness of the ground which acts to slow down any water this is moving downslope. Small rocks and stones should not be removed from trail treads as their presence tends to slow the velocity of water runoff and protect underlying soils.</p>
Use Related	<p>Linked to trail widening, soil erosion and muddiness. Numerous studies have documented a curvilinear relationship between amount of use and most forms of trail impact. Initial low levels of use generate the majority of use related impact, with per capita impacts diminishing as use increases.</p> <p>The type and size of group including the behaviour of individuals also has an effect. For example, larger groups have more potential to cause impact.</p>

Derived from: (Beavis 2000; Bratton, Hickler and Graves 1979; Cole 1983, 1991; Cole 1992; Hammitt and Cole 1998; Leung and Marion 1996; Liddle 1997; Marion 1994, 1998; Marion and Leung 2001; Newsome, Moore and Dowling 2002b; Phillips and Newsome 2002; Sun and Liddle 1993b; Whinam and Chilcott 1999; Yorks, West, Mueller and Warren 1997)

Vulnerable Environments

Some environments are easily damaged and naturally fragile. Contributing factors include aridity and very cold environments (Newsome et al. 2002b). Trails that are most easily eroded occur in environments that, depending on the situation, include factors such as long and steep slopes, high elevation, high rainfall, unvegetated slopes, unsurfaced slopes, low soil organic matter, poor soil structure (no or very little aggregate development), fine texture (especially silt and fine sands), impeded infiltration of water and close proximity to streams or groundwater discharge areas (Table 1).

The Australian continent is characterised by the widespread occurrence of nutrient poor soils as a result of the evolution of highly weathered laterite profiles and the occurrence of sandy parent materials (Newsome et al. 2002a). Many of the dominant or common trees and shrubs native to Australia are susceptible to the presence of an introduced root-rot fungus *Phytophthora cinnamomi* (dieback), which causes the eventual death of susceptible species (e.g. in Western Australia some 2000 plant species are susceptible to dieback). This fungus can be spread by soil movement (Newsome et al. 2002a). In addition to this the resilience of many Australian ecosystems is likely to be low because of nutrient poor soils, a predominant desiccating climate, and the presence of diverse/complex ecosystems that are susceptible to infection by introduced pathogens. Further, in relation to the presence of horses, it is important to consider that there are no large native herbivores that have co-evolved with the present flora, and there is no extant native mammal of adult female body mass >40kg (Newsome et al. 2002a).

Biophysical Impacts

Horses have the potential to cause damage to soils and vegetation (Table 2). Newsome et al. (2004) stated that the most common and widely recognized impact is the ground level damage caused by horse’s hooves. Of the studies reviewed, many commented on the large force applied to the ground because the horse’s weight is transferred to ground level on four relatively sharp points (the hooves). Cole (1989) and Newsome et al. (2004) highlighted that many of the impacts of recreational horses are similar to those caused by hikers, except they are more pronounced and occur more rapidly. Liddle (1997), Weaver and Dale (1978) and Deluca et al. (1998) also showed that horseriding impacts are quantitatively greater than those caused by walkers. Impacts such as grazing are however unique to horseriding and various studies have examined this showing that grazing causes a reduction in productivity e.g. (Cole, Van Wagtendonk, McClaran, Moore and McDougald 2004; Loucougaray, Bonis and Bouzille 2004; Olson-Rutz, Marlow, Hansen, Gagnon and Rossi 2005; Olson-Rutz, Marlow, Hansen, Gagnon and Rossi 1996).

Table 2: Environmental impacts of horseriding in natural areas

Impact	Ecological effect	Social effect/impact on other uses
Soil erosion	Soil and nutrient loss, water turbidity/sedimentation, alteration of water runoff. Can constitute permanent impacts	Reduced aesthetics, decreased functional value, visitor safety risk
Soil compaction	Reduced infiltration, reduced germination, reduced vigour and growth of certain plant species	
Reduced water infiltration rates	Strong contributor to tread widening and multiple trail creation as users seek to circumvent muddy sections of trails	Decreased functional value, reduced aesthetics
Increased surface run-off	Accelerated erosion rates	Decreased functional value Decrease in visitor satisfaction
Churning and lifting of surface soil particles		Decreased functional value
Change in soil depth from baseline micro-topography	Accelerated erosion rates	Decreased functional value
Increased amount of bare ground (increased trails width)	Vegetation loss	Reduced aesthetics
Manure on trails	Introduction of weed species,	Reduced aesthetics
Informal trail development	Vegetation loss, wildlife habitat fragmentation	Evidence of human disturbance, reduced aesthetics
Multiple trail development		

Impact	Ecological effect	Social effect/impact on other uses
Trampling and loss of vegetative cover Reduction in vegetation height	Vegetation loss, replacement by trampling resistant species, increased amount of bare ground	Reduced aesthetics
Alteration of plant species composition	Species that are less tolerant to trampling are replaced by species that are more resistant to trampling such as more aggressive native colonisers e.g. grasses and/or exotic species	Reduced aesthetics Reduced biodiversity values
Tree damage and root exposure	Root damage, reduced tree health, intolerance to drought	Degraded aesthetics, visitor safety risk, decreased functional value Reduced biodiversity values
Spread of dieback disease (<i>Phytophthora cinnamomi</i>)	Vegetation loss, reduction in plant vigour	Reduced aesthetics, restriction of access due to quarantine areas
Plant defoliation	Reduction in plant vigour, damage to aerial parts of some plants thereby reducing flowering ability, hence reproductive success	Reduced aesthetics

Derived from: (Burden and Randerson 1972; Hammitt and Cole 1998; Huxtable 1987; Liddle 1997; Marion and Leung 2001; Newsome et al. 2002b; Sun and Liddle 1993a Newsome, Cole and Marion. 2004)

A further issue in regards to horseriding in natural areas is the contribution of horses to the spread of weeds. Various studies have shown that there is the potential for horses to act as a vector of weed spread e.g. in Australia, Whinam, Cannell, Kirkpatrick and Comfort (1994), Weaver and Adams (1996) and Barrett (1999) and in the USA, Campbell and Gibson (2001). These studies showed that weed species could be germinated from horse manure. However, Campbell and Gibson (2001) found that of the 23 weed species found in manure samples collected from trails in southern Illinois, USA, only one species was found in trail plots. Similarly, Whinam et al. (1994) found that four weed species germinated from manure collected in Tasmania, Australia in the glasshouse but not in field conditions and field experiments showed that weed establishment was highest in areas of previously disturbed ground but where that grazing animals had been excluded. Barrett (1999) found a lack of viable weed seeds in horse droppings collected on bridle trails in Western Australia. While Weaver and Adams (1996) recorded 29 weed species germinating from horse manure samples collected from horse trails in Victoria, Australia. Weaver and Adams (1996) commented that the presence of weed seeds in horse manure highlights that horses have the capacity to disperse viable propagules of both woody weeds and a range of herbaceous weeds. However, weed seeds are dispersed by a number of vectors including wind, water, and by ingestion or attachment to hair (or clothing) of native, feral and domestic animals, including humans, and by vehicles in tyres and mud encrustations (Liddle 1997; Weaver and Adams 1996). Therefore, weed dispersal cannot only be attributed to horse use in natural areas.

Trail degradation also has a social effect in that other users may find degraded trails unsightly, not in keeping with the overall concept of natural area integrity. The functional value of an area may also be decreased and there may be a visitor safety risk (Table 2). The social effect of horse use in natural areas will be discussed in greater detail in the following section ‘social impacts of horseriding in natural areas’.

Trails Formed by and/or Used by Horseriders

Research into the impacts of horseriding comprises two main areas; those studies undertaken on experimental trampling lanes and those investigating trail degradation. Leung and Marion (1996) commented that trail impact studies generally focus on one of three variables:

- a landscape scale that often considers the very existence of trails as a form of impact on the natural landscape; how trails as a resource can be protected from degrading; and
- assessments of processes and consequences of soil erosion on the trail tread.

However, one of the major weaknesses of horseriding impact research is the lack of standardisation for both the variable studied and the research methods employed. This situation was also reported by Leung and Marion

(1996) in the literature review of trail degradation studies. They commented that the lack of standardisation often hinders comparisons between studies. Additionally, the variation in environmental conditions further hinders and complicates such comparison.

Impacts on Poorly Defined and/or Informal Trail Situations

Those studies on impacts of horseriding in natural areas have been conducted on experimental plots can be taken as representative of the impacts associated with riding in an off-trail environment. These studies demonstrate that the impacts caused by horses in an off-trail situation cause considerable damage (Table 2). In all situations initial impacts to vegetation and soil are most pronounced.

Whinam et al. (1994) conducted a study in the alpine and subalpine environments of the Central Plateau in the Tasmanian Wilderness World Heritage Area, Australia. The study measured effect of horse trampling on shrubland, grassland and a fen site. The experiment measured the first stages of horse trail formation in a previously undisturbed environment. Horse intensities (2, 10 and 30 passes) were systematically applied to a 1.5m wide by 5m long plots. The horses were shod and weighed approximately 260 to 270 kg without the riders. The passage of 20–30 horses had substantial immediate and delayed effects on the soils of shrub land, herb field and bolster heath, but little affect on dry grassland soils with the damage to vegetation being most pronounced in the shrub land. Manure trials showed that the highest mean number of weeds in manure was found in the shrub land where grazing was excluded and the soil disturbed. Here up to 292 weeds were found in the ungrazed quadrates.

Whinam and Comfort (1996) conducted a study in the alpine and subalpine environments of the central plateau in the Tasmanian Wilderness World Heritage Area, Australia to measure the impacts of high level horse usage (142–231 horse riders per month) on the soils and vegetation. Measurements were taken in heathy sedgeland, *Eucalyptus delegatensis*, open forest with alpine shrub land mosaic and temperate rainforest. The results of two years monitoring showed that the majority of soil loss was in the first 12-month period with the greatest soil loss occurring in eucalypt forests. During the survey period, new tracks appeared, percentage cover of live vegetation declined and the amount of bare ground increased over a one year period. Further, faint ‘pads’ turned into new tracks in buttongrass moorland with loss of vegetative cover in as little as three months. Some of the results from this work should be considered carefully due to contrasting site variables that may influence impact. The transect located in eucalyptus vegetation was located at a site where horses had to step over a log therefore, as acknowledged by the author, all horses tend to step in approximately the same spot. There are further issues with the way in which soil loss was measured. The study measured changes in cross sectional profile (vertical difference between original trail condition and post pass multiplied by width of transect (1.5m) to give a cross sectional area of soil lost). This does not account for soil compaction or distribution. The authors stated that the churning and re-working of humus between roots may be partially responsible for soil gains experienced in one site (Whinam and Comfort 1996). However, the findings that there was an increase in new tracks and that percentage cover of live vegetation declined are important.

Phillips and Newsome (2002) conducted a study in D’Entrecasteaux National Park, Western Australia to determine horse impacts in a vegetated parabolic dune area in a sub-Mediterranean coastal environment. The study measured species composition, vegetation cover and height, micro-topography and penetrometry on previously undisturbed plots. Vegetation and soil impact parameters were measured using a point intercept frame. Horse intensities (20, 100, 200 and 300 passes) were systematically applied to each treatment transect and re-sampled after each level of horse trampling intensity. Additionally, a control transect was sampled in conjunction with the treatment transects. The horses were of a similar size (400–500kg), un-shod and included a saddle plus rider. This study showed that horse trampling caused a decrease in vegetation cover and height, a change in species composition, a reduction in the frequency of plant species, and increase in soil depth and amount of bare ground. The most impacted portion of the treatment cross-sectional profile was the central portion (40–60cm). Field observation showed that horses tended to walk through the centre of the treatment transects following the defined paths made by previous horses.

Impacts on existing trails

Weaver and Dale (1978) examined the effects of trampling due to hikers, horses and motorcycles on multiple use trails in the northern Rocky Mountains, Montana, USA. A level and a sloping (15 degree slope) site was chosen in an alpine forest and meadow site. The sites were subjected to 50, 100 and 1000 passes by horses, hikers and motorcycles. On level ground, horses were most destructive and hikers least destructive but on grassy slopes motorcycles were more destructive than horses. Similarly, horses had a greater effect on vegetation than either motorcycles or hikers. On both level and sloping sites, trail width was greatest for horses and least for hikers. Compaction was greater under horses than hikers or motorcycles because horses tended to exert the greatest

downward pressure on the soil.

Wilson and Seney (1994) examined the relative impact of hikers, horses, motorcycles and off-road bicycles in terms of water runoff and sediment yield on existing multiple use trails in the Gallatin National Forest area, Montana, USA. The sites were subjected to 50 and 100 passes by horses, hikers, motorcycles and off-road bicycle. Measures were taken on 108 sample plots on existing trails. Multiple comparisons test results showed that horses and hikers (hooves and feet) made more sediment available than wheels (motorcycles and off-road bicycles). This effect was most pronounced on pre-wetted trails. Of all users, horses produced the greatest sediment yield on both pre-wetted and dry trails.

Cole and Spildie (1998) conducted a study on trails to assess the relative impact of horses, llamas and hikers on the vegetation and groundcover conditions of two forested vegetation types in the northern Rocky Mountains, Montana, USA. Measures were taken in experimental trampling lanes (0.5m wide by 3m long) as recommended by Cole and Bayfield (1993). Horse and hiker traffic were applied to the lanes at intensities of 25 and 150 passes. Hikers weighed 75–80kg and wore lug-soled boots. Horses weighed 450–500kg and wore non-cleated shoes while llamas weighed 140–155kg. Measurements were taken prior to and after trampling (within 2 weeks) and also one year after trampling. In both vegetation types examined, relative vegetation cover was significantly lower after horse traffic than after llama or hiker traffic, while relative cover following llama and hiker traffic was not significantly different. Only horse use caused mineral soil exposure. One year after trampling, vegetation cover on lanes trampled by horses was still significantly less than on lanes trampled by hikers or llamas. The study concluded that horse traffic has more potential to disturb vegetation and groundcover than llama or hiker traffic.

Deluca et al. (1998) conducted a study on trails in the Lubrecht Experimental Forest near Greenough, Montana, USA in 1995. The trails were formed through repetitive use, had little entrenchment and were 1 to 1.5m wide, in a mountainous environment at an elevation of 1250m. The soil was a gravely loam with 35% coarse fragments by weight and the parent material was colluvium on an average slope of 6%. The horses were shod and of average size (400–500kg). Horse, llama and hiker traffic were applied to 56 separate plots at intensities of 250 and 1000 passes along with a no-traffic control under both pre-wetted and dry trail conditions. Horse traffic consistently made more sediment available for erosion from trails than either llama or hiker traffic, with the most pronounced difference observed following 1000 horse passes. However, pronounced impacts were detectable after 250 passes suggesting that the initial traffic creates the bulk of environmental damage. It was concluded that horse traffic tends to cause more trail erosion than hiker traffic. Additionally, sediment yields were higher on dry trail plots than on pre-wetted plots, suggesting that dry trail conditions made the trail more vulnerable to sediment detachment. However, levels of runoff were significantly greater on pre-wetted trail plots compared to dry trail plots, suggesting that traffic applied to wet trails fosters increased runoff resulting in greater down slope channelling of water and greater potential for sediment transport. It was suggested that the reasons horses have greater impact than llamas or hikers is because horses are heavier and their weight is carried on a shoe with a small bearing surface, moreover, horses' shoes are typically metal and frequently cleated. Horses are also less careful and deliberate than llamas or humans about where they place their feet.

Landsberg, Logan and Shorthouse (2001) reported that riding horses on existing trails may cause negligible damage in some environments such as dry, level landscapes. However, these findings are based on an absence of reports of damage, rather than any positive evidence that damage does not occur. Analysis of studies that have been conducted on existing trails (eg. Royce, 1983; Newsome Cole and Marion 2004) indicates that many of the impacts as described in Table 2 also occur on existing trails. Of these studies, Royce (1983) is the most comprehensive in scope.

Royce (1983) examined horse use in John Forrest National Park, Western Australia on approved horse trails (primarily fire management tracks) to quantify the environmental impacts of horse use in the park. Trails with different levels of use were analysed. Use levels were determined by staff estimations; no statistics on trail use were available. The study measured:

- soil compaction (penetrometry) on non-approved horseriding trails
- soil erosion where trail width and depth were measured along a cross section profile to calculate compacted soil-loss volumes
- trail anastomosis where total lengths of the main (approved horseriding trails)
- alternative trails were measured
- grass tree (*Xanthorrhoea preissii*) cropping
- weed cover in 1m² quadrats adjacent to trails
- floristic health and cover reduction in 1m² quadrats both adjacent to the trails and 10m from the trail
- dieback (incidence of *Phytophthora cinnamomi*) measured by the number of dead plants in 2m belt transects adjacent to trails.

A comparison was made to an earlier (1980) study where a photographic record of new horse trails was made. This study showed that soil compaction was significantly higher on all trails examined than in areas 1–3m off the trail and that the volume of soil-loss (soil erosion) increased with slope ($\geq 8\%$). There was a proliferation of alternative trails (measuring a total of 2.61 kilometres of alternative trails) dissecting the landscape as compared to 22.7 kilometres of approved trails. There was evidence of severe grass tree cropping on heavily used trails and an increase in percent cover of weeds with increasing trail use. Weeds were observed growing from piles of horse manure and were more prolific on trails with heavier use. Further, floristic health on trails deteriorated with perceived increased levels of use and improved with distance from trails and the incidence of dieback, as measured by the number of dead plants, also increased with higher trail use. It was concluded that horseriding had seriously deteriorated the environmental quality of large areas of the Park. The concluding recommendations from this report suggested that horseriding trails should be prohibited in all national parks in Western Australia where trails have not already been approved and that horse trails in John Forrest National Park should be phased out.

Analysis of the methods employed in Royce (1983) does however question some of the findings from this study and results should be considered with caution. Soil compaction was analysed using a 'drop block' soil penetrometer to 300mm depth on the trail and 1–3m from the trail edge on non-approved trails that included fire management tracks not designated for horse use and a ranger constructed trail. The finding that soil compaction was higher on all trails when compared to areas 1–3m off-trail is not surprising as these trails (fire management tracks) were constructed using mechanical means (e.g. bulldozers, front-end loaders) and one of the trails was cleared using rake hoes. Such an approach is problematic because the study was dealing with a constructed trail where a 'managerial footprint'¹ was already imposed. Dehring and Mazzotti (1997) also commented on the importance of recognising that equestrian trails themselves introduce changes in the vegetation and microhabitat conditions of an area, due to construction of the trails in the first instance. Further, one of the trails was also used by pedestrian traffic. With these factors taken into consideration, compaction cannot solely be attributed to horse use. Similarly, floristic health and cover reduction and weed cover results also did not take into consideration that the study trails were multiple-use (used by hikers, horses and service vehicles) and constructed by mechanical means. Summer (1980) also cautioned that horse traffic may not only be the single dominant process active on trails, nor may degradation always be a direct result of horse use. The multi-use nature of some trails may confound findings on studies conducted on bridle trails.

The methods used in Royce (1983) to determine the incidence of dieback (*Phytophthora cinnamomi*) should also be questioned. Dieback is a soil-borne disease, yet the presence of dieback was estimated by counting the number of dead plants in belt transects. No soil tests were taken to determine the presence of *Phytophthora cinnamomi*. Therefore, attributing plant death to *Phytophthora cinnamomi* is questionable. What was of interest from Royce's (1983) findings was the proliferation of informal trails, soil erosion on trails increasing with slope, the evidence of native vegetation being grazed upon (grass tree cropping), and the presence of horse manure on trails thus increasing the chance of horses being a vector of weed spread.

Social Impacts of Horseriding in Natural Areas

In addition to biophysical effects of horse use, trail impact studies are also concerned with social impacts such as user conflict, perceptions of users and depreciative behaviour. Conflicts with other users include objection to the presence of horse faeces, increased incidence of insects attracted to manure, introduction of smells and the sight of horses and horse related infrastructure, and general feelings of the inappropriateness of horses in wilderness areas that may conflict or accord with visitors' wilderness values. A further issue is that many non-horse riders perceive that horses cause environmental harm (Table 3).

One of the most cited studies is that conducted in a USA wilderness area by Watson, Niccolucci and Williams 1993 and 1994. Watson, Niccolucci and Williams (1993) surveyed hikers and stock users in June to November 1990 in three wilderness areas (John Muir Wilderness (N=501) in the Sierra and Inyo National Forests, Sequoia-Kings Canyon Wilderness (N=389) in California and at the Charles C. Deam Wilderness (N=502) in the Wayne-Hoosier National Forest in Indiana, USA) to provide a broad look at the interaction between hikers and recreational livestock (primarily horses) and the potential contributors of conflict. Up to 44% of hikers disliked encounters with horseback riders, although not all hikers disliked encountering horses in wilderness. In Deam Wilderness, 20% of hikers who encountered horses on their visit enjoyed meeting them and about one-half of all hikers reported that they did not mind meeting them. Only 4% of horse users disliked their encounters with hikers. A strong predictor of conflict between hikers and horse users were general feelings of inappropriateness of horse use in wilderness. Hikers also rated encounters with horses as somewhat undesirable

¹ Smith (2003) defined a managerial footprint as the deliberate clearing and construction of an area including campsites, roads, tracks/trails, and parking bays.

with almost half indicating the behaviour of horseback riders interfered with their enjoyment of the wilderness. The main behaviour of horse use that hikers complained of in John Muir and Sequoia-Kings Canyon Wilderness was horse defecating in places (mainly along trails) where hikers would have to walk; horse groups making too much noise and being rude. In Deam Wilderness the main behaviours complained of were horseriding groups making too much noise and horse users damaging trails. When asked to evaluate problems they encountered during their visit, horse users tended to evaluate problems as less severe than hikers with litter and human damage to vegetation as the most severe problems. Alternatively, hikers rated impacts to trails by horses, horse manure on trails and vegetation damaged by horses as most severe.

Udelhoven (2003) surveyed beach visitors (N=100) over a 4-day period in June/July 2003 on the North Beach section of the Seashore Conservation Area, Washington, USA. Respondents were asked which activities they participated in while visiting the Beach, 18% were involved with horseriding while the majority visited the area for walking/jogging/running and sun bathing/relaxing. When asked if visitor enjoyment would change if horses were no longer present on the beach, 60% of respondents indicated that their enjoyment of the area would not change. Further, 44% of respondents felt that the presence of horses had no effect on their feelings with 28% indicating it evoked happiness. Moreover, 59% of respondents felt that there were no attributes about the horses that affected their feelings.

Studies that have been conducted in Australia (e.g. Barrett, 1999; Beeton, 1999a, 1999b; Priskin, 2003; Davies, 2004) surveyed general visitors regarding their attitudes to horses and the perceived impacts caused by horses. Barrett (1999) surveyed general visitors (N=703) to Bold Park, Perth, Western Australia in December 1998 and September 1999. No horse riders were surveyed. Respondents were asked about their perceived views on the impact of horseriding in Bold Park, 14% said horseriding would improve usage, 57% thought there would be no impact and 29% said horseriding would detract from park values.

Beeton (1999a, 1999b) surveyed general visitors (N=62) to Alpine and Mt Buffalo National Parks, Victoria, Australia in January 1997 regarding attitudes to horseback use in these areas. A majority of the respondents were involved in bushwalking (100%) or camping (68%) while only 6% participated in horseriding activities. The study showed that there was generally a strong negative attitude towards horseback groups at their campsite, with a high percentage either staying but not enjoying themselves, or moving to another location. Further, a majority of respondents perceived horse tour groups as environmentally careless with concern being expressed in relation to the prevalence of horse dung. However, the low number of responses in this survey does not permit any firm conclusions to be drawn; rather it raises indicative areas for consideration.

Priskin (2003) surveyed general visitors (N=702) to nature based tourist attractions in the Central Coast Region of Western Australia in regards to what degree they believed individual recreation activities caused harm to sandy coastal environments. Horseriding was amongst one of these activities. Respondents generally considered that horseriding was moderately harmful to the environment with 24% of respondents actually participating in horseriding activity. Although the survey was of general visitors that participated in a range of activities of interest is the result that horse riders themselves recognised that the activity could be harmful to the environment.

Davies (2004) surveyed general visitors (N=200) to Bold Park, Perth, Western Australia in May to August 2004. No horseriders were surveyed. Respondents were asked about the impact potential of the main user groups, horseriding included. The majority of respondents visited the park to walk (52%) or exercise their dog (27%). There was a high level of support for horseriding in Bold Park (77%). When asked what activities had the potential to have an environmental effect, 18% of respondents listed horses as an activity that caused environmental impacts with 12% of those respondents indicating that horses caused damage to soils.

Table 3 Social impacts of horseriding in natural areas

Impact	Source
Conflict between users	Australia (Beeton 1999a, 1999 b; Davies 2004; Landsberg et al. 2001) USA (McClaran and Cole 1993; Udelhoven 2003; Watson, Niccolucci and Williams 1993)
Perception of users that horseriding causes environmental harm.	Australia (Barrett 1999) USA (Watson, Niccolucci and Williams 1993; Watson, Niccolucci and Williams 1994)
Horse users harassed by non-equestrian recreational users	USA (Watson Niccolucci and Williams. 1993)

Management of Horseriding in Natural Areas in Australia

Beyond restriction of access and/or confinement to certain areas the options for the management of horseriding fall within two main areas: namely voluntary codes of practice/user attitudes (Table 4) and site/trail management actions (Table 5). Voluntary codes of practice, however, are as good as the level of user compliance and because of the high impact potential of horseriding it is recommended that any trails utilised by horses be subject to trail management plans. Such plans should detail trail location and design, erosion and drainage controls, approaches to trail hardening, aspects of visitor regulation, educative strategies and policy on policing and enforcement (Newsome et al. 2004). Landsberg et al. (2001) have developed a number of principles to guide the management of horseriding in natural areas. Important elements of these principles are:

- riders to use specified horse trails
- management to construct and maintain trails
- users apply a code of conduct
- management to implement and maintain a monitoring system and to modify the management system if unacceptable impacts are detected.

Newsome et al. (2002) emphasize that management needs suitable resources and capacity in order to ensure that any implemented management system is successful in containing and reducing impacts.

Although this section (see Tables 4 and 5) identifies a number of approaches to the management of horseriding in natural areas, few studies exist that fully evaluate the effectiveness of operational management strategies. Moreover there is very little information on monitoring systems that can be utilised by managers as a basis for key performance reporting and auditing the effectiveness of horseriding trail management.

Table 4: Techniques reliant on appropriate human behaviour to manage horseriding in natural areas

Voluntary codes based on education, advice and the direction of management	Source
Horses must be easily handled and under control at all times. Do not take young, inexperienced or recently broken horses unless you are confident you can maintain control at all times.	(Australian Alps National Parks 2005; Parks Victoria 2004)
Riding single file within the centre of the maintained tread can reduce trail width and eliminate the formation of multiple treads	(Widner and Marion 1993)
Ride horse on trails designated for horseriding. Do not take short cuts.	(Australian Alps National Parks 2005; McClaran and Cole 1993; Parks Victoria 2004)
If riding in untracked country, spread out rather than riding in single file. This spreads the impact and assists trampled plants to recover.	(Australian Alps National Parks 2005)
Visit in small groups (4–8 people/horses). This reduces potential user conflict.	(McClaran and Cole 1993; Parks Victoria 2004; Widner and Marion 1993) (Royce, 1983)
Concentrate use on existing trails and campsites. Use provided facilities.	(Widner and Marion 1993)
Do not blaze or mark tracks or routes in any way.	(Australian Alps National Parks 2005; Parks Victoria 2004)
Focus activity in areas where vegetation is absent.	(Widner and Marion 1993)
Avoid places where impacts are just beginning.	(Widner and Marion 1993)
If possible, do not shoe a horse before a trip. New shoes tend to cut up the ground more than worn shoes.	(Australian Alps National Parks 2005; Parks Victoria 2004)
Feed horses on commercial grain, proprietary and processed feeds e.g. pellets prior and during the trip into a natural area. Weed seeds can remain in a horse gut for up to 14 days and these can germinate in manure. Feed horses using a nosebag while in the natural area. Do not spread feed on the ground and clean up any uneaten or spilled feed. Begin using permitted feeds at least 24 hours before entering a natural area. Feed permitted includes good quality, clean chaff, cracked grain and processed feed preparations. All feeds must be as weed free as possible.	(Australian Alps National Parks 2005; Parks Victoria 2004)
Hold horses at least 30m from water sources e.g. lakes and streams, huts and camping areas.	(Australian Alps National Parks 2005; McClaran and Cole 1993; Parks Victoria 2004)
Horses should be watered downstream from camping areas and at least 30 metres from camping areas on lake foreshores. It is preferable to bucket water to horses or use watering troughs where provided.	(Australian Alps National Parks 2005; Parks Victoria 2004)
Restraining horses away from tree trunks can eliminate tree damage and root exposure. Use hitching rails or other holding facilities provided.	(Australian Alps National Parks 2005; McClaran and Cole 1993; Parks Victoria 2004; Widner and Marion 1993)
If camping overnight, use low power portable electric fencing, allowing at least 15m ² for each horse. Avoid including areas with saplings and shrubs which may be trampled. Electric fence warning should be displayed prominently on the fence. Ensure that horses have been trained to electric fencing in a large yard or paddock prior to being confined to a small yard.	(Australian Alps National Parks 2005; Parks Victoria 2004)
Hobbles ² and ground tethering should be used where facilities are not provided. A lead rope from a headstall to the hobble chain can further reduce straying.	(Australian Alps National Parks 2005; McClaran and Cole 1993; Parks Victoria 2004)
Avoid crossing areas easily damaged by horses such as sphagnum moss beds, swamps and steep or boggy creek crossings.	(Australian Alps National Parks 2005; Parks Victoria 2004)
When meeting other people, ensure all horses in your party are walking quietly when passing other users on a track.	(Australian Alps National Parks 2005; Parks Victoria 2004)
Introduce horse users to the consequences of their use	(Widner and Marion 1993)
Encourage horse users to adopt low-impact horse use practices	(Widner and Marion 1993)

² Hobbling: binding two of the horse's legs together.

Table 5: Techniques to manage horseriding in natural areas

Site regulation and trail management techniques	Source
Educate riders by using for example, trailside signs.	(McCool and Cole 2000)
Limit use of areas. Limit the number of horses that visit per year. Limit the number of groups with horses. Limit the length of time horse users can access the natural area; usually used to limit the length of stay in campsites. Ineffective if most visits are generally short.	(McClaran and Cole 1993)
Zoning; setting aside areas for horse use only e.g. bridle trails; locate trails near perimeter of reserves and/or in modified zones; exclude horseriding from ecologically sensitive areas.	(Landsberg et al. 2001)
Use trail hardening/surfacing techniques e.g. use materials such as gravel, earth, crushed stone, and geosynthetics such as geotextiles.	(Newsome et al. 2004)
Use water control methods, for example, bridges, drainage dips, outsloped treads, water bars and earth or rock ditches.	(Newsome et al. 2004)
Create short trail reroutes used to stop trail degradation in problem areas.	(Newsome et al. 2004)
Reinforce soil structure e.g. use of chemical binders such as liquid concentrates and latex polymer products.	(Newsome et al. 2004)
Manage vegetation e.g. clearing overhanging vegetation on trail.	(Newsome et al. 2004)

Research Priorities and Projects

The body of scientific literature in relation to horseriding and social conflict is relatively small. A majority of the research has been conducted overseas and is site specific. Australian studies have been largely limited to alpine and sub-alpine regions. Given these limitations of research to date on horseriding impacts, there is a wide range of potential research that would be of immediate value.

- Research needs to be conducted as to how horseriding is perceived by other users:
 - the extent to which horseriding is incompatible with other trail users
 - attitudes towards horseriding in national parks. The work of Beeton, 1999a, 1999b) is inconclusive as it is only a small sample and therefore not representative of the entire visitor population. Further it is in a mountainous environment. Little research in Australia has been done on non-mountainous areas.
- There is need for research that investigates evidence of environmental damage caused specifically by horses when they are ridden along well-constructed and maintained trails.
- There is a need for research that examines whether weed spread is associated with horse trails that are well constructed and maintained.
- There is a need for research that examines the influence of horse use on wildlife.
- There is very little information on the attitudes, expectations and reactions of horse riders to proposed management strategies.
- Monitoring systems (including key performance indicators) need to be designed and tested for effectiveness.
- Many existing horseriding trails need to be audited for impact management effectiveness.

Chapter 2

OFF-ROAD VEHICLES IN PROTECTED AREAS

Ralf Buckley

Introduction

The aims of this project were to analyse available published scientific information on the ecological impacts of off-road vehicles on natural ecosystems in Australia, and to identify priorities for further research in conjunction with relevant protected area management authorities. These aims have been achieved and this chapter describes the results.

The review and analysis of literature drew heavily on chapters in a recently published book (Buckley, 2004), which was not funded by Sustainable Tourism Cooperative Research Centre (STCRC). Without that source of up-to-date information it would not have been possible to carry out a worldwide literature review within the relatively limited budget for this project. This will need to be considered in budgeting any future comparable projects.

Consultation with protected area management agencies was carried out in several phases. First, I contacted all members of the TAPAF group, Tourism in Australia's Protected Areas Forum, and also other members of Australian parks agencies with particular interests in this project in late 2004. From responses I identified an up-to-date list of parks agency personnel likely to have an immediate interest in this sub-project and a possible role in supporting future PhD research. I circulated an email summarising the project and its outcomes and asking if respondents would care to see the draft report. I then circulated a draft of the report to respondents expressing interest. Detailed commentaries on the draft report, with particular reference to research priorities, were received from parks agencies in Qld, NSW, Vic and WA in 2005. Most of these responses reflected the consensus view of several personnel from the agencies concerned, collated by a single representative. As a result of these responses I rewrote the section on research priorities and circulated the revised draft report for further comment. This final report incorporates information from this entire consultation process.

Impacts of Off Road Vehicles in Natural Areas

Four-wheel-drive vehicles, trail bikes, quad bikes and other off-road vehicles are commonplace in Australia. They are permitted in a few areas in a few national parks, largely on formed roads but in some States also on beaches.

Whilst the broad types of impacts which off-road vehicles can produce are well documented, these impacts can vary in intensity and ecological significance by orders of magnitude between different ecosystems. Hence whilst impact measurements in e.g., the USA serve to alert us to the potential severity of off-road vehicle impacts, they do not substitute for studies specific to Australian ecosystems.

In particular, one major impact of off-road vehicles in many Australian ecosystems is the spread of the plant dieback fungus *Phytophthora cinnamomi*. Of the 80 or so research publications relevant to management of dieback in areas with high tourism visitation, about a dozen refer to the spread of spores on vehicle tyres (Buckley, King & Zubrinich 2004).

Other than dieback, there appear to be only eight publications on the impacts of off-road vehicles in Australian ecosystems (Buckley 2004). In the USA, which has a similar total area, a similar latitudinal range and a similar or smaller variety of ecosystems, there are many times more. This mirrors patterns in recreation ecology research more generally (Buckley, 2005). There are 99 publications on off-road vehicle impacts in North America, 30 in Europe, and six in Africa. Worldwide there are 177 publications on off-road vehicle impacts.

- off-road vehicles typically cause a range of environmental impacts including:
- soil erosion and/or compaction
- damage to vegetation and soil animals
- road-kill and noise disturbance to birds and other wildlife
- air and water pollution
- introduction of weeds and pathogens
- increased fire frequency
- slopewash and similar impacts from off-road vehicle tracks
- secondary impacts through increased number of visitors.

Off-road vehicles cause many times more damage than hikers. Typically, off-road vehicle tyres exert ten to 100 times as much pressure as a boot, especially if the vehicle is turning or braking; and cause five to 30 times as much damage to vegetation.

Impacts can occur even at very low levels of use. A single passage by a trail bike causes measurable compaction in desert soils. Even the distant sound of vehicle engine, at a noise level similar to a library reading room, is sufficient to drive away songbirds and small mammals.

Impacts can last a long time. Where vehicles fracture cryptogamic crusts on desert soils, they may take hundreds of years to recover.

Impacts can be intense. In marsh environments, 40 off-road vehicle passes reduce vegetation cover to zero. On sandy beaches, 100 passes can kill 98% of ghost crabs. Sand dunes crossed by off-road vehicle tracks can suffer soil erosion at up to 25cm depth per year ($0.25 \text{ cm}^3 \text{ m}^{-2} \text{ yr}^{-1}$).

In some cases, the degree of impact increases proportionally with the number of passes, e.g. for compaction under off-road vehicle tracks in dry sandy soils. In most cases, however, the first few passes cause the most damage, so the best management strategy is to restrict vehicles entirely to a small number of narrow well-maintained tracks well away from ecologically sensitive areas, and prohibit off-road use within parks.

Within Australia, Gilbertson (1983) contributed an example from the Coorong in South Australia to the classic study of off-road vehicle impacts by Webb and Wilshire (1983). This appears to have been the first published study of off-road vehicle impacts in Australia.

No further research seems to have been documented until the 1990's when Burnett (1992) and later Goosem (1997, 2000) examine the impacts of rainforest roads and tracks, used by a variety of vehicles as well as off-road vehicles, on a range of small mammal species. Also in the late 1990's, Hercocock (1998, 1999) described off-road vehicle impacts in the Kimberley region of WA, focusing on soil and vegetation damage.

More recently, impacts on beaches and coastal dunes have again attracted attention. Barros (2001) found that urban beaches in NSW have far fewer ghost crabs than more remote beaches, with off-road vehicles likely to be a strong contributing factor. Priskin (2003, 2004) quantified the broad scale impacts associated with proliferating access tracks to coastal dunes in the central of WA.

Impacts of off-road vehicles on the soils, flora and fauna of Australian ecosystems such as arid hummock grasslands, tropical tussock grasslands, temperate eucalypt woodlands, heaths and savannas, and montane ecosystems do not seem have been studied.

Similarly, the impacts of off-road vehicles on shore-nesting birds and on the infauna of sandy beaches, shown to be highly significant in the USA, have barely been examined in Australia, despite concerns by parks agencies. The impacts of off-road vehicle noise on bird species, widely studied in Europe, have apparently not been examined at all in Australia.

The role of vehicles in dispersing weed seeds has been studied to some degree in Australia (Wace, 1977; Lonsdale and Lane, 1994), but the studies are restricted to two geographic areas and have focused on identifying

the car-borne flora, without attempting to quantify either the significance of off-road vehicles in introducing weeds, or the effectiveness of management approaches.

The summary above is derived from published literature only. During the later phases of consultation, some parks agency personnel mentioned unpublished or ongoing research either by the agencies themselves or by university students. This has been taken into account in deriving the final list of research priorities.

Management Recommendations

For off-road vehicle users

For off-road vehicle users, and tour operators in particular, practical management recommendations for have been compiled and distributed extensively in the *Green Guide for 4WD Tours* (Buckley, 2001), which is now available for free download from the websites of various parks services and four-wheel-drive organisations such as Tread Lightly®, as well as Sustainable Tourism Cooperative Research Centre (STCRC) and International Centre for Ecotourism Research (ICER). Similar recommendations have been produced by several other organisations. For example, the NSW Department of Infrastructure, Planning and Natural Resources (DIPNR) has produced a leaflet on off-road vehicles and beaches (Hacking, 2003)

For Parks Agencies

For park management agencies, the principal management recommendations are as follows:

- If they are permitted in parks at all, off-road vehicles should be restricted to special-use zones or to a small number of narrow well-maintained tracks, preferably not crossing between catchments.
- In closed-canopy forest, the canopy should be maintained above the track wherever possible.
- Tracks should be separated from ecologically sensitive areas by a wide buffer zone so that vehicle engines are not audible beyond the buffer.
- Where tracks cross creeks, crossing points should be fixed and if necessary maintained.
- Maintenance of tracks should aim to minimise secondary impacts such as spread of weeds, reduction of canopy cover, etc
- Signs requiring off-road vehicle drivers to keep to tracks should be prominent and plentiful.
- In general, off-road vehicles should not be allowed on wet areas, steep terrain, or on dunes and beaches.
- If off-road vehicles are permitted to drive along beaches, they should be allowed only on wide sandy beaches, only in the intertidal zone, and only at low tide, and entry and exit from the beach should be at designated access points only.
- If off-road vehicles are permitted on beaches, signs at access points should require that all vehicles must be removed from the beach at high tide and may not use the dunes or supralittoral.
- Beaches may also be completely closed to vehicles during exceptionally high tides.
- The possibility of mandatory off-road vehicle driver training and licencing programs as a precondition of off-road vehicle use in public lands, should be investigated.
- For example, off-road vehicle drivers on beaches are not generally aware of the significance of the supralittoral zone and drift line.
- Driver training and licencing can be used as a precondition for use of controlled-access trails, that is, in forested areas where trails can be gated and locked.

Research Priorities and Projects

The focus of this project was on ecological impacts, but some parks agencies also drew attention to research requirements relating to social impacts, and these are also included here. In addition, some parks agencies emphasised that a clear distinction is needed between issues where impacts and management strategies are obvious and the critical issues relate to effective implementation, and those where research is required either to determine the significance of impacts or to demonstrate it to off-road vehicle users. Based on these comments, research requirements can be classified as follows. They are listed in order from the most general to the most specific, not necessarily in order of priority.

Ecological

- Overall risk assessment; probabilities and severity of consequences
- Aggregate impacts; compare areas with high and low or zero off-road vehicle use
- Impacts of tracks: creek crossings, spores and seeds, access for ferals, weeds on verges, fragmentation, illegal tracks, source of fire and noise, regeneration on closure
- Sandy beaches; impacts on populations of turtles, shorebirds, shore-nesting birds (especially threatened species), dune vegetation, beach infauna; relation of impact severity to use intensity, seasonality etc; effectiveness of management measures; secondary impacts. Note: The simplest management measure is to ban all off-road vehicles from all beaches, and some states do this. Other states, however, allow either recreational or fishing off-road vehicles on some beaches at least, so impact research is still important
- For shorebirds on beaches, the main issues are probably: (a) disturbance to feeding birds, (b) damage to nests and chicks and (c) disturbance to parents so gulls eat eggs. Loss of prey populations such as crabs and smaller invertebrates may also be important
- Forests and woodlands: effects of tracks as above; effects of noise disturbance on birds and mammals, including nocturnal species also taking into account potential habituation. Significance for populations of rarer species
- Montane environments: impacts on vegetation, and including mountain bikes as well as motorized off-road vehicles.

Social

- How are non-off-road vehicle users affected by off-road vehicles? For example, avoid areas, safety issues, loss of amenity, conflicts.
- If governments were to require a special training program and licence for off-road vehicles, would the public accept it?
- If PAMAs were to establish special-use zones for off-road vehicles, how should these be designed and located and how could they be enforced?
- If PAMAs were to limit off-road vehicle access to particular areas, e.g. certain beaches or forest trails, how should access quotas and patterns be established? (i.e., a 'carrying capacity' approach, both social and ecological).

PhDs and Parks Agency Support

Of the above, quantifying impacts of tracks and off-road vehicles in particular ecosystems would be suitable for PhD projects.

There are many potential projects, and students would need supervisors with ecological expertise related to the particular impact examined. That is, soil erosion and stream turbidity, or dispersal of weeds, or the effects of noise on bird behaviour. Such PhD projects should be based in university departments or faculties of science, ecology and environment.

The social impacts of off-road vehicles on non-off-road vehicle users would also be a possible PhD project, with implications for the various management issues outlined above. Students would need supervisors with expertise in social sciences, such as survey design and interview technique and analysis. Such PhD projects should be based in university departments or faculties of social science, human geography or tourism.

Parks agencies were generally keen to offer support to PhD projects in their own regions. Different agencies and regions have different priorities.

NSW NPWS has offered immediate operational support in the form of free accommodation for research on beach impacts, especially shorebirds.

WA Conservation and Land Management (CALM) has indicated support for research on social aspects as outlined above.

Chapter 3

ROCK CLIMBING IN PROTECTED AREAS

Carl Cater and Robert Hales

Introduction

In concert with increased popularity of outdoor activity in general, rock climbing and related pursuits have seen global growth in the number of participants. The latest results to emerge from the National Survey on Recreation and the Environment in the United States suggests that 9.2 million Americans climbed at least once in 2000–2001 (Cordell 2004), accounting for a total of 39 million recreation activity days, many of which would be spent in that nations' parks and protected areas. The survey also suggests that there has been a 26.9% growth in the number of participants from 1994–95 to 2000–2001. Clearly not all of these individuals are regular patrons, although Moser and Davidson (1999) suggest that there were at least 400,000 active climbers in the US compared with fewer than 100,000 a decade previously. Part of this growth has been led by the desire for winter sports locations to diversify through the promotion of leisure sports activities that can be pursued during the summer season (Bourdeau Corneloup and Mao 2002), although much has also been demand-led, with participants seeking to challenge themselves in the arena that rock climbing provides.

This increase in participation has resulted in rope-based activities being more formally controlled through management plans in protected areas. The increase has been the result of a number of factors. First the ease of obtaining equipment has allowed more people to participate. Second the availability of training from adventure companies has increased. Thirdly there has been a trend towards cultural acceptance of adventurous activities being seen as part of self-fulfilment and ones identity. Fourthly and most importantly there has been a change in the types of rock-based activities being undertaken that is the result of the above changes. The increasingly popular activities that rely on permanent fixtures in the rock to aid enjoyment and access that makes the sport more attractive to a wider range of people. Bolting has become the norm in the climbing community whereas it was not so common 25 years ago. This is quite possibly the greatest factor contributing to the increase in the overall impacts rope based activities, creating a great deal of controversy and debate within and surrounding the sport. Indeed as Kiewa (2002) suggests,

although climbing is depicted as a 'free area' in which climbers attempt to achieve a relative freedom from this society, the encroachment of rationalized society into the activity means that climbers find themselves both divided and besieged.

Australia has not been immune to this growing recreational area, with significant increases in the numbers of participants being seen since the 1980s. For example in the Grampians National Park there has been a dramatic increase in rock climbing and abseiling activities in the park in recent years to the point where there are at least 67 climbing sites with over 2000 recorded climbs in the park. This report seeks to examine the types of impacts that rock climbing activity may have and the management strategies that may be employed in order to ameliorate their effects. Initially we assume a global perspective, with a review of existing literature that has sought to quantify the impacts of rock climbing on rocks, vegetation, wildlife and other users. It is important to note that studies of recreational climbing impacts are at present largely confined to North America. This is followed by a discussion of significant management strategies and their practical implementation. In the third section the research examines the current situation in Australia, by firstly listing nationwide closure of sites for ecological reasons related to climbing activity and then discussing the management options for protected areas currently in place. The previous discussion of globally identified impacts is compared to the Australian context through impacts identified through the codes of conduct. We conclude with a summary of recommendations for rock climbing management and future research directions.

Impacts of Rock Climbing In Natural Areas

The central activity we are concerned with here is that of the ascent of rock faces through the use of ropes. Although there are some practitioners of free-climbing, where no ropes are used, most climbers are of either the 'traditional' or 'sport' persuasion, as described by Schuster, Thompson and Hammitt:

The major difference between traditional climbing and sport climbing is the gear used to protect the climber in the event of a fall. Traditional climbing relies on gear that is typically placed in weaknesses in the rock (e.g., a crack) and removed by the second climber in the climbing party. Sport climbing relies on gear that is fixed to the rock. A small (permanent) hole is drilled in the rock and a steel expansion bolt is placed in the hole. The bolts remain in the rock and create an established climbing route. Bolts may be used in traditional climbing; however, they are not a regularly used form of gear. Sport climbing can be considered an activity that is an offshoot of traditional climbing. Bolts are an advancement in technology that allowed climbers to place gear where gear could not be placed in the past. As a result of this advance in technology, many new climbing routes were developed, which subsequently resulted in the development of new climbing areas. Many new participants engage exclusively in sport climbing and do not use traditional climbing methods.(2001:405)

The nature of the sport branch of the activity is centred on the completion of specific routes, many of which are detailed in guidebooks, classified by difficulty and named by the original route pioneers. This leads to little deviation from popular vertical pathways, and can clearly concentrate impacts along very fixed trajectories.

Climbers usually use chalk in the form of magnesium carbonate in order to dry their hands and increase the coefficient of friction, thereby improving the grip of the holds. However, in an interesting study carried out in 2001 by Li, Margetts and Fowler, the suggestion is made that chalk may in fact hamper rock contact and reduce grip.

To improve the coefficient of friction in rock climbing, an effort should be made to remove all particles of chalk; alternative methods for drying the fingers are preferable (Li, Margetts & Fowler 2001:427).

Rock climbing is still probably dominated by independent participation, although the numbers of guided groups on commercial tours or training courses has certainly boomed. Two related activities have seen particular growth in Australia and worldwide over the last decade, abseiling and canyoning. Although abseiling is a technique used by rock climbers to descend routes following completion or impasse, as a commercial activity that requires limited skill from participants, its popularity has also grown. The sport of canyoning, which combines elements of rock climbing and scrambling, often in stream channels and canyons, has also seen a marked increase in popularity in the last decade, particularly in the commercial adventure tourism sector. Impacts from this activity may be significant, as a result of large groups moving through previously unaccessed locations.

Impacts on Rock

Clearly there are impacts that climbing may have on rock faces themselves. Although more resilient rock types are favoured, for obvious reasons, the potential for high levels of use to destroy the aesthetic or physical structure of the cliff face cannot be ignored. Although frowned upon, the practice of 'chipping' the rock for better holds is one that may occur. In addition the placing of permanent bolts can be damaging to the long term stability of the rock, and may also be a visual eyesore. In the Joshua Tree National Park in the United States, the Park Service is encouraging the use of rock coloured bolts to ameliorate this latter effect (Environmental News Network, 1999).

Impacts on Plants

Existing research into human activity on rock faces suggests a significant impact on vegetation cover. Plants will tend to grow in areas where conditions are more favourable, for example in the myriad of crevices that might cover a cliff. The so-called 'edge effect' (Reckess 2000) means that biological diversity is often the highest at the boundary of two or more different geological regions. Unfortunately these lines of weakness are those that are also exploited by climbers as handholds and suitable places for technical equipment. When first establishing a route, climbers will often remove plants from these regions, and often the miniature relic ecosystems that go along with them. These practices have an undeniable impact on the plant cover in these areas.

A number of studies carried out on the Niagara Escarpment in Canada have investigated the extent to which climbing can damage vegetation cover on cliff faces. McMillan and Larson (2002) examined the ecological effects on vascular plant, bryophyte, and lichen communities, comparing populations on the plateau (or cliff edge), cliff face, and talus (or cliff base) for both climbed and unclimbed sites. Species diversity and richness was lower for all three plant types on climbed outdrops, whilst vascular plants and bryophytes also had much lower density and frequency. A similar study carried out in Joshua Tree National Park, which sampled sites with intensive, moderate and zero climbing activity, produced comparable findings (Camp & Knight 1998). Plant species richness, numbers of individual plants and overall plant cover all decreased with increased climbing use. A species specific study on the cliff goldenrod, a weedy herb found on dolomite or sandstone cliffs in the upper Midwest found that position on the cliff face was the most significant factor affecting growth (Nuzzo, 1995). Findings indicated that climbing reduced the population of small weeds and produced a higher count of broken plants. There is also the possibility that climbers may introduce alien species to the cliff face, by transporting seeds from previously climbed routes. McMillan and Larson (2002) found that the proportion of alien plants was three times greater in climbed areas than in unclimbed areas on the Niagra Escarpment.

A recent study by Muller, Rusterholz and Baur (2004) in the Swiss Alps would concur with the North American findings. Impacts at the base of climbing routes were determined to be the most severe, and distance from a route was found to be highly significant, illustrating the band that defined routes may leave behind. Species density (number of species per square metre) at the cliff base, as well as plant cover and species density at the cliff face, tended to increase with distance from the route. A comparison with unclimbed cliffs highlighted that climbing significantly altered the plant composition, as specialised rock species occurred less frequently on climbed cliffs.

Impacts on the vegetation of a rock face is not limited to smaller species. Kelly and Larson (1997) detail the impacts of cliff use on populations of cliff-face and cliff-edge trees, particularly the eastern white cedar (*Thuja occidentalis* L.) on the Niagara Escarpment. Tree density and age structure were compared between four climbed and three unclimbed sites in the vicinity of Milton, Ontario. Results showed that density of living trees was significantly lower in climbed sites than unclimbed ones, and a high percentage of trees in climbed areas showed human-inflicted damage. Similar findings were determined from the Joshua Tree study, where trees, shrubs, forbs, and cacti had greater relative abundances on cliffs without climbing than on cliffs with climbing (Camp and Knight 1998). Notably disturbances for cliff-edge populations were not felt to be as severe, where other non-anthropogenic factors may be more significant.

Impacts on Animals

Quite apart from the removal of habitat, animals may also be subject to disturbance from climbing activity. In a study linked to those already mentioned, land snail populations were monitored on cliff sites on the Niagara escarpment. Snail density, richness, and diversity were lower along climbing routes than in unclimbed areas, and community composition differed between climbed and unclimbed samples (McMillan, Nekola & Larson 2003). As an important part of the food chain, it may be assumed that the impacts on gastropod communities may go far wider into the ecosystem. Cliff-based megafauna may also be threatened by the presence of rock climbing in their habitat. Studies of populations of the Spanish Ibex, which are still classified as vulnerable in the Pyrenees, indicate that human mountain leisure activities, such as climbing, may often exclude ibex from regular and favourable feeding habitats (Perez, Granados & Soriguer 2002). Similar impacts are suggested for the Bearded Vulture in this habitat (Margalida, Garcia, Bertran & Heredia 2003), as well as influences on breeding success. Indeed, the use of cliff faces as nesting sites for a wide range of bird species makes them particularly susceptible to human activity. Studies on the Peregrine Falcon in North America indicate that reaction to human disturbance is highly variable amongst individuals, but is acute during breeding periods (Ontario Ministry of Natural Resources, 1987). It is suggested that these raptors seem to be more sensitive to disturbances occurring above or at the same level as cliffside eyries, than to disturbances occurring below eyries.

Other Impacts

One also needs to consider the broader impacts of climbing related activity on the health of ecosystems beyond the cliff face. The desire for climbers to conquer previously unclimbed routes often brings them into wilderness areas of considerable fragility. Studies of the alpine ecosystems surrounding Sagarmatha (Mt. Everest) National Park, Nepal, indicate significant impacts over the past twenty to thirty years as a result of mountain tourism (Byers, 2005). Results from five separate research expeditions between 1984 and 2004 show dramatic landscape change within the Imja and Gokyo valleys as a result of over harvesting of fragile alpine shrubs and plants for expedition and tourist lodge fuel, overgrazing, accelerated erosion, and uncontrolled lodge building.

It should be remembered that impacts from climbing are not solely confined to the environmental sphere. Wilderness locations may have supported human populations in the past and often contain a variety of valuable heritage that needs to be protected from detrimental activity. The most obvious impacts would be on rock art sites, which could easily be destroyed by the erosive nature of climbing. Structures of significant heritage value, many of which may exploit the same shelter and points of weakness used by climbers, for example caves and mines, are also under potential threat from the climbing fraternity. In addition, sites of spiritual significance need to be respected. A dispute between American Indians and rock climbers over the appropriate use of Devils Tower National Monument in northeast Wyoming was resolved through the imposition of a voluntary ban by the United States Department of the Interior (USDI) National Park Service's (NPS) on climbing during the month of June in deference to American Indian cultural and religious practices. Despite this, some climbing groups attempted to challenge this policy in the courts, although all subsequent court rulings upheld the NPS policy (Dustin, Schneider, McAvoy & Trakt 2002). In general it is felt that, due to the minimalist nature of the sport, climbers have limited impacts on other users. However, the aesthetic impact needs to be considered by protected area managers.

Management of Rock Climbing

It is clear that from the discussion above concerning the growing popularity of such activity, and the potential for numerous impacts, active management of rock climbing and abseiling is necessary. A review of management techniques highlights that most successful policies are those that have attempted to engage the climbing community actively in the process.

Knowledge

The drafting of management plans must be fully informed if they are to minimise the detrimental impacts of rock climbing activity. To this end it is vital that accurate baseline studies are carried out in such locales. It is recognised that in some sites of existing intensive use the time for this may have passed, however, in sites that are of emerging popularity, and potential future sites, accurate surveys of the ecosystem composition are the only way to assess the impacts that rock based activity might have. All of the existing studies on rock climbing impacts on plant and animal life underline the importance of carrying out such work (for example Camp & Knight, 1998). On-going monitoring of impacts is also vital, so that levels of disturbance can be assessed and an adaptive management strategy can be implemented (Kelly and Larson 1997). Only with this accurate information can management plans take into account the condition and priorities for the protected areas under their control.

Exclusion and Zoning

Although likely to be unpopular with the rock climbing community, in the case of particularly rare or specialised species, there is clearly a need to exclude rock climbing activity altogether. However, 'the establishment of climbing-free protection areas on cliffs with a high number of specialized, relic plants and the protection of entire cliffs that are not yet climbed (Müller 2004), should only be considered in sites of great significance. Zoning of activities is a more appropriate way of managing the impacts of such activity. In this way areas of special interest can be protected, limited use can be granted in acceptable areas, and minimal restrictions may be in place in more resilient sites. It is only with the information from such studies as those discussed above, however, that adaptive management regimes like this may be put into practice. For example guidelines for reducing disturbance to Peregrine Falcons suggest that a buffer zone be demarcated during breeding periods, being wider at the top of cliffs where impacts are suggested to be higher, and narrower below the eyrie. Such guidelines indicate a multi-use perspective of protected areas, recognising that whilst rock climbing is of low impact in parks as a whole, the potential for close proximity to raptor breeding sites means boundaries should be wider:

Close existing trails, roads and recreational facilities within 0.6 to 0.8 km of a nest site, and do not establish new trails, roads or recreational facilities within the buffer zone. During the breeding season, March 15 to August 31, prohibit recreational activities, such as hiking, picnicking, camping, hunting and wildlife viewing within 0.6 to 0.8 km of the nest site. The buffer zones for rock climbing and trail bike or ATV use should be wide: 0.9 to 1.2 km. (Ontario Ministry of Natural Resources, 1987)

Equipment

The clearest form of management intervention concerns the use of different forms of technology in rock climbing areas. More specifically this relates to the use of fixed bolts discussed above, as hand drills are banned in most protected areas. In June 1998 the United States Department of Agriculture Forest Service (USFS) banned the use of fixed anchors, which includes bolts, in congressionally designated wilderness areas. Public response to

this action contributed to the USFS rescinding the ban in August 1998, for one year to initiate negotiated rulemaking to clarify national policy (USDA 1998). Grijalva, Berrens, Bohara, Jakus and Shaw (2002) utilised a random-utility model to analyze economic losses to climbers resulting from the USFS proposal, indicating that it would constitute a major regulatory change. This echoed the findings of Hanley, Wright and Koop (2002a).

Other Measures

Some work carried out in the United Kingdom suggests that reducing access for climbers may have an impact on the popularity of sites. Realising that simple entry fees to parks were not a useful barrier, Hanley, Alvarez-Farizo and Shaw (2002b) tested the implications of introducing car parking fees and measures to increase access time at three popular sites in Scotland. The study found that 'a 2h increase in walk-in time in the Cairngorms reduces predicted visits by 44% ... £5/day car-parking fee reduces predicted trips to the Cairngorms by 31%' Hanley (2002b:167). However, it was identified that knock-on effects would be felt at other, substitute sites. It is suggested that such policies may be rather reactive, and in the long run do nothing to combat the problems resultant from the increasing popularity of rock-based activities.

It is suggested that there is somewhat of a catch-22 in management approaches to popular climbing sites. Those that require most active management are likely to be those which are under greatest stress, where the possibility for conflict between different user groups and the environment is greatest. Climbing activity at front-country sites is likely to interact with other user groups and may be subject to regulations due to resource sharing. Signs of management activity, for example visitor centres, parking lots, and kiosks will be greater and thus front-country climbers may feel that unnecessary regulations are being imposed. In settings like these, "where there is a high level of manager/ climber interaction, climbers may feel over managed and have a decreased openness to management" (Schuster *et al* 2001)

At Mount Hood, Oregon, the USFS undertook to limit numbers of climbers as part of an environmental assessment exercise in January 1999. Interestingly this was as much to ensure that the 'solitude experience' of climbers was maintained as it was about protecting environmental integrity (Schuster *et al* 2001). Opposition from climbers resulted in a later removal of this control method. Again the issue at Mount Hood might have been avoided if the USFS had researched, and better understood, the climbing communities' attitudes concerning climbing the mountain and, more specifically, solitude, prior to proposing the action.

Conflict and Partnership

Studies suggest that conflict within the management process result from a lack of partnership and understanding in the early stages of a project. In a survey carried out in 2001 with climbers of both traditional and sport persuasions in the United States, concluded that 'they felt that managers did not adequately understand the activity of climbing, climbers did not adequately understand the management process, climbing was not treated fairly in the management process in comparison to other activities, and climbing was micromanaged' (Schuster *et al* 2001).

Managers should recognise the commonalities and differences among the management objectives they set and the attitudes of the recreation groups involved in the management process. It is worth considering, for example, that as a whole, the climbing community is 'very eco-conscious' Krajick (1999:1623). As regular users of the natural environment most climbers are aware of the fragility of these spaces and are 'conscientious stewards' of the environment. (Reckess, 2000). The Access fund, a conservation and lobbying group that represents some 10,500 climbers in the United States, undertakes studies to identify the sport's impact on the environment. They also highlight that some agencies use climbers to monitor the well-being of fauna on certain routes. According to the group, more than 90 climbing sites in the United States have restricted-access policies, and the climbing community is complying with these.

Informing the users themselves at all stages of the management process is thus felt to be enormously important. This communication should be ongoing, and flow on to interpretive facilities provided at climbing sites. As Kelly and Larson (1997) helpfully indicate, 'education of the climbing community would be the most effective long-term solution to limiting disturbance in sensitive areas'. Local communities need also to be involved in this process, particularly where this may involve commercial operators involved in the guiding of the experience. This applies in assessing the broader impacts of rock climbing activity as well as those confined to the rock-face, as illustrated in the Sherpa-led "Community-based Conservation and Restoration of the Everest Alpine Zone" project discussed by Byers (2005). These operators should be ultimately concerned with the long-term sustainability of the climbing resource, and as such will be advocates for environmentally sensitive use.

Certainly legal issues will always have to be taken into account in the outcomes from a management process. In the United States., all of the aforementioned policy directions to restrict access rules for rock climbers have involved the reinterpretation of the legislative intent of the 1964 Wilderness Act by the USFS. As discussed above, measures to control climbing at Devils Tower lead to challenges in the courts. Indeed, as suggested by Grijalva and Berrens (2003) ‘the legal process will ultimately determine the question of wilderness access for rock climbers’, although they point out that economic influences will play a strong part in these negotiations. Consequently any measures need to be carefully considered in light of existing and future legislation.

Management of Rock Climbing In Australia

In the section below a range of management policies and strategies are presented to illustrate the protected area management responses to increases in climber numbers and the various ecological impacts this has had in an Australian context. These management responses vary as a result of the ecological parameters that climbing impacts upon, the varying rates of participation rates across the parks and sites, the geological composition of the cliff, the implications of inheriting activities from prior land tenure and historical characteristics of the culture of climbing in a given area. The management responses are from protected area managers at the park level and at the regional staff. In the case of the Blue Mountains, The local city council was included in the analysis because of their involvement of management of a large number of climbing sites and their interests in managing the cultural and biodiversity values within their park systems. It is acknowledged that this work could not have been conducted if it were not for the cooperation of interested managers. The study is limited to management of lands in the three eastern seaboard states of Queensland, New South Wales and Victoria. In the proceeding text examples of closures of climbing sites are detailed, the management options that the protected areas currently undertake and codes of conduct are collated and analysed.

Temporary and Permanent Closure of Sites for Ecological Reasons

A list of temporary and permanent sites closed to climbing is displayed in Table 6. The information contained in the table was compiled from management plans, climbing web sites, and personal conversations with the rangers in charge of the parks. This list is not a complete and only indicates the types of closures found in Queensland, New South Wales and Victoria national parks in early 2005.

Table 6: List of Sites Closed to Climbers in Protected Areas (nature based impacts only)

Protected Area	Climbing Site	Reason for closure
Mt Warning NP NSW	Whole Park	Ecological damage when accessing cliff Not an appropriate recreational use (culturally and ecologically inappropriate—local custodians)
Warrumbungles NP NSW	Square Top Mountain and Chalkers Mountain	Rock wallaby habitat plus other environmental reasons
Lord Howe Island NSW	Balls Pyramid	Concern for rare Lord Howe Phasmid (Stick Insect), Nesting sea birds and other potential ecological impacts.
Kosciusko NP NSW	Blue Lake	In the past climber have been told not to climb because of vegetation impacts
The Organ Pipes NP Vic	The Organ Pipes	Potential damage to fragile rock face.
Wilson’s Promontory Vic	Skull Rock	Sea bird habitat
Grampians NP Vic	Red Rock conservation area	Endangered Brush Tailed Rock Wallaby habitat
Lamington National Park Qld	Poondarah	Impacts of access track, vegetation impacts on cliff site, Brush-tail Rock Wallaby site
Blue Mountains NSW	Various	Some sites have been closed by removing bolts at certain cliffs. Reasons are mostly because of cultural impacts
Bald Rock Boonoo Boonoo NSW	Whole park	Rare and threatened plant species at top and bottom of cliff faces

The main finding from this data is that the most common reason for closure was that of wildlife protection. The second most common reason was that of general climber impacts that degraded park values. In one instance the potential for climbers to damage the rock itself was cited as a reason closing a site. This occurred at the Organ Pipes in Victoria. It must be noted that most of the closures were in conjunction with other reasons for closure. It would seem that this combination strengthened the case for closure in many instances. These 'other' reasons included risk management issues and conflict with other users and cultural impacts. This was not an exhaustive list of closures of climbing sites in Australia but it serves as an exemplar of some current management concerns in relation to ecological and other impacts. Not included in the list are sites closed for conflicting users activities. For example, many cliff closures in the Blue Mountains National Park are for climbing sites below or above track and lookouts.

Management Options for Protected Areas

There are wide a range of management principles and strategies used by managers across Queensland, New South Wales and Victoria's national parks. These ranged from prohibition of the activity to allowing access with minimal management strategies. Blue Mountains City Council was also included in the survey as their lands are adjacent to world heritage areas and manage these sites as protected areas. A summary of concerns, causes and strategies concerning the impacts are outlined below.

Summary of Findings

The ecological impacts that were mentioned in the management plans included impacts to:

- vegetation disturbance in general
- rare and threatened fauna at the base of the climb and the cliff environment
- soil compaction
- soil profile from water erosion (gully erosion)
- nesting peregrine falcons
- nesting birds
- rock wallaby disturbance
- park values
- geological features (defacement of rock)
- the natural, landscape values

These impacts were caused by:

- creation of new tracks
- trampling of vegetation near existing tracks
- compaction and erosion of soil
- creation of new climbs and sites
- climber proximity to nesting birds and other wildlife
- marking the cliff to identify climbs
- re-bolting of existing climbs
- bolting of new climbs
- more climbers frequenting the cliff
- large groups visiting the cliffs (larger groups associated with educational and commercial groups)

Summary of strategies:

- conduct base line studies at the site level to help monitor impacts
- identify incompatible sites for climbing and identify carrying capacity for sites
- education to minimise damage on specific vegetation species
- education to minimise damage generally
- liaise with user groups developing codes of conduct and minimal impact strategies
- encourage clean climbing techniques
- liaise with user groups for management work i.e. track maintenance.
- upgrading ad-hoc climbing tracks and signage to direct climbers
- closing tracks where there are multiple track systems
- temporary closures of climbing near nesting birds
- permanent closures in high impact areas (damage to vegetation and soil)
- permanent closure of areas that conflict with fauna habitat (rock wallabies)
- banning new climbing site development

- banning bolting in the park
- the exclusion of new bolts from wilderness areas
- banning the use power drills for bolting in certain areas
- limiting bolting through regulation systems
- replacement of bolts on existing routes in accordance with park service policy.
- banning trees being used for anchors
- banning 'gardening' (removing plants in the way of climbing)
- establishment of abseiling anchors to minimise descent via walking tracks
- banning route marking, and other environmental modifications
- limiting groups sizes in certain areas
- limiting groups sizes for educational and commercial groups entering the park
- consult with climbing community on priority site actions
- develop fixed anchor point policy for parks after consultation with user groups (yet to be implemented)
- maintain communication channels with recreational and commercial groups

Appendix D summarises the relevant sections of rock climbing management from a range on national park management plans from Queensland, New South Wales and Victoria. In most cases the exact text has been used but in some instances paraphrasing and interpretation of the meanings of the plans have been undertaken to aid presentation and analysis. The conclusions that can be drawn from the information presented are as follows:

- It would seem that the impacts were caused by: the nature of climbing on the rock itself and the vegetation found there; disturbance to wildlife because of the proximity of climbers; impacts caused by pedestrian access to the bottom and the top of the cliff; inappropriate climber behaviour in terms of natural land management (e.g. marking climbs) and physical damage to rock caused by placing fixtures in the rock.
- Many management responses to the impacts were responses to the impacts caused by the development of new climbing sites and new climbs, particularly bolted climbs. Changes in the affordability of battery powered hammer drills and an increase in the number of people interested in new route development have resulted in this type of impact increasing across Australia. Depending on the management context the reaction to this phenomenon is quite varied across the parks surveyed.
- Whilst not all sites have experienced the increase in numbers of climbers where there has been ease of access and appropriate sites situated close to large population centres there has been an increase in climber numbers and impacts. In some cases the impact was caused by the frequent use by large climbing groups. This is evidenced by the type of management response attempting to minimise the causes of impacts in each park.
- There is a range of management concerns and strategies that reflect the types and extent of impacts that occur in each park. Of particular note was the Blue Mountains City Council that has a mandate to cater for recreational activities (tourism) as well as cater for the demands of nature conservation because of the climbing sites' proximity to world heritage areas. The council has started site monitoring and is proactive in developing site-specific management plans in consultation with climbing groups.
- Impacts from bouldering have not received much attention in the management literature.

Codes of Conduct

The websites of various climber and abseiling groups were used to source the codes of conduct and other environmental statements that indicate the identification and self-management strategies used by climbers and abseilers in the three states. A simple content analysis of the four codes of conduct was undertaken and the results are presented in Table 7. The codes of conduct were from Parks Victoria, Sydney Rock Climbing Club, Blue Mountains Cliff Care and Queensland Outdoor Recreation Federation, and are listed in Appendix D.

Table 7: Summary of concepts in codes of conduct

Concept found in code of conduct	Number of times cited
Do not chip holds	4
Climb clean: bolts/chains/fixes hangers should be kept to a minimum and should be placed in such a manner that they have minimal visual and environmental impact	4
Do not leave litter (including climbing equipment)	4
Dispose of human waste in a sanitary manner. Do not pollute water supplies	4
Observe cultural heritage sites	4
Avoid marking the start of climbs	3
Do not disturb wildlife (including nesting birds)	3
Do not disturb vegetation on, above or below the cliff	3
Where appropriate use a 'lower off' to reduce the wear and tear on vegetation at the top of the cliff	3
Avoid soil disturbance	3
Avoid/minimise use of chalk	3
Dogs are not permitted in parks	3
Used designated tracks	2
Wire brushing to remove mosses and 'gardening' in cracks and gullies is not permitted.	2
The consult with land manager before establishing new climbs and areas	2
Keep group sizes small	2
Find out and observe local regulation and traditions	2
Observe closures to cliff sites	2
Fixed equipment (bolts) are not permitted at many sites	1
Use slings to avoid damage to trees	1
Avoid using bolts	1
Avoid indiscriminate or excessive use of fixed equipment	1
Observe fire restrictions	1
Use rock coloured chalk	1

The key findings from this analysis is that although climbing clean is important across the codes of conduct, statements outlining specific strategies detailing when and where to use permanent fixtures are not common. This may be the result of the codes of conduct being drafted by climbers themselves (except the Parks Victoria Code of Conduct) and therefore the codes will not attempt to curtail the freedom of climbers establishing new climbing areas and new routes with bolts.

Also noted is that the specific details outlining how not to disturb wildlife is not mentioned. Minimum approach distances required not to disturb nesting birds should be detailed in codes of conduct. Specific behaviour should be outlined in codes of conduct for each major climbing area. As there is so much diversity in the management strategies between parks within a single state, specific codes of conduct for each site should be developed. This will result in the increased likelihood of more appropriate behaviour being adopted by the climbers themselves if codes of conduct are specific to certain areas/parks and if the exact behaviour expected is detailed in the code.

Management Recommendations

Management recommendations for cliff users, and tour operators in particular, have been compiled and distributed extensively in the *Green Guide for Climbing* (Buckley, 2001). Many other codes of conduct have been developed and are available in the appendix of this report.

For park management agencies, the principal management recommendations are as follows:

- If rope based activities are permitted in parks designated climbing sites should be clearly advertised to the user groups by the management authority. This will confine impacts to a smaller number of sites.
- Tracks to the cliff should be sign posted and descent routes from cliff tops should be clearly marked to avoid multiple track formation.
- In some circumstances fixed anchors (bolts or slings around trees) for descent from cliff tops should be installed where the potential for erosion or damage to vulnerable vegetation is high.

- Monitor cliff, vegetation and soil impacts at the precinct level (site specific).
- Monitor nesting bird activity and signpost or inform climbers via leaflets when nesting bird closures are in force.
- Monitoring of rock wallaby numbers and distribution should be undertaken at certain sites.
- The codes of conduct presently in use should be developed further. Each park where there is climbing should have a specific code of conduct which includes management plan strategies. These should be developed in partnership with the climbing communities.
- New climbs and cliff development appears to be a major concern of land managers only if there is large amounts of people visiting the new cliffs. Limiting the type of climbing is a way of limiting numbers. Managers should decide on what types of climbing and abseiling activities are appropriate. This makes reference to allowing group abseiling routes and sport climbing as these two types of activities can generate large numbers of people to new sites.
- If the park size permits use zoning systems to regulate particular types of climbing to limit environmental and social impacts. (e.g. banning power drills in wilderness areas (or whole parks) will limit sport climbing to more appropriate areas. This has occurred in some parks.
- Liaise with climbing communities to organise cliff care type activities to decrease impacts at high use sites.

Research Priorities and Projects

Given the small amount of research on the ecological impacts of climbing there is a need to examine the pressing concerns of land managers. Some examples include:

- Peregrine Falcon disturbance research is needed. In particular examining the disturbance regimes of climbers across various climbing sites in Australia. Bird behavioural indicators and minimum approach distances on the ground and on cliffs in Australia need to be determined.
- The effect of chalk on the cliff environment (e.g. lichens and other vegetation growing on rock substrate) needs to be determined.
- The methods of bolting currently used in the climbing community should be assessed as to the sustainability of this practice. The lives of many bolts are less than a human lifetime and create the need to drill new holes in the rock at frequent intervals. Current practices may be unsustainable. Sustainable bolting techniques need to be examined that meet the needs of climber safety but limit impact on a geological time frame as opposed to the shorter time frames seen in current bolt replacement strategies.
- Trends in climbing participant numbers, type of climbing activity and locations of climbing activity needs research. This quantitative research needs to be triangulated with qualitative research on recreational succession of sites and changes in participant activities throughout the 'lifestages' of climbers.
- Research on the values and attitudes of various climber sub-groups towards regulation of their activity needs to be undertaken so that land managers can be more effective in the regulation and education that minimises impacts. If conducted in the appropriate form of consultation, the efficacy will be increased for both groups.

APPENDIX A: Horseriding in the Australian Alps National Parks

Importance of Mountain Protected Areas

Worldwide, mountains are valued for their biological diversity, rich cultural heritage, ecosystem services and their economic value (Goode, Price and Zimmermann 2001; IUCN 2004; ISC 2004). Recreational use of mountain regions is increasingly popular and includes a wide range of high impact activities (Godde et al. 2001). These activities can result in damage or loss of vegetative cover leading to increased soil erosion and the introduction and spread of exotic plants and pathogens (Good 1992; Körner 1999; ISC 2004). Damage to mountain ecosystems is of concern as the vegetation has low resilience to trampling and is slow to recover, taking decades or longer (Willard and Marr, 1971; Bell and Bliss, 1973; Harris Liddle, 1975; 1993; Godde et al. 2001).

In Australia, horseriding is closely associated with European use of the high country of the Australian Alps as is the presence of feral horses (brumbies) (Walters 2002; Sullivan and Lennon 2004). For example, the romantic image of 'The Man from Snowy River' is an important cultural and marketing aspect of private and commercial horseriding (Drying 1992). As a result there is a conflict between the cultural heritage (brumbies, horseriding) and its impact on the natural values of the region (damage to vegetation, soil erosion, introduction and spread of weeds), with 62% (15,000 km²) of the mainland alpine and subalpine region protected within the Australian Alps National Parks.

A horseriding management strategy has been developed for the Australian Alps national parks (Gibbs 1993). However, several aspects of the regulation of horseriding still vary among and within these areas. For example there are park specific rules as to whether riding is permitted, restricted to certain areas and/or whether number of horses in groups are restricted. Also there are some differences in the restrictions placed on commercial vs. private riding (Hill and Pickering 2002). There are minimum impact guidelines for horseriding in the region including recommendations about holding horses, types of feed and methods for feeding, camping, watering, and meeting other users (AALC 2005). Further research is required into the numbers and areas of use by horseriders (commercial and private), into the impact of riding on vegetation and soils and its role in the introduction and spread of weeds and pathogens in the high country. Such information would assist park agencies in managing the balance between conservation values of these important ecosystems, and the desires of people to see horses, and ride horses in the Australian high country.

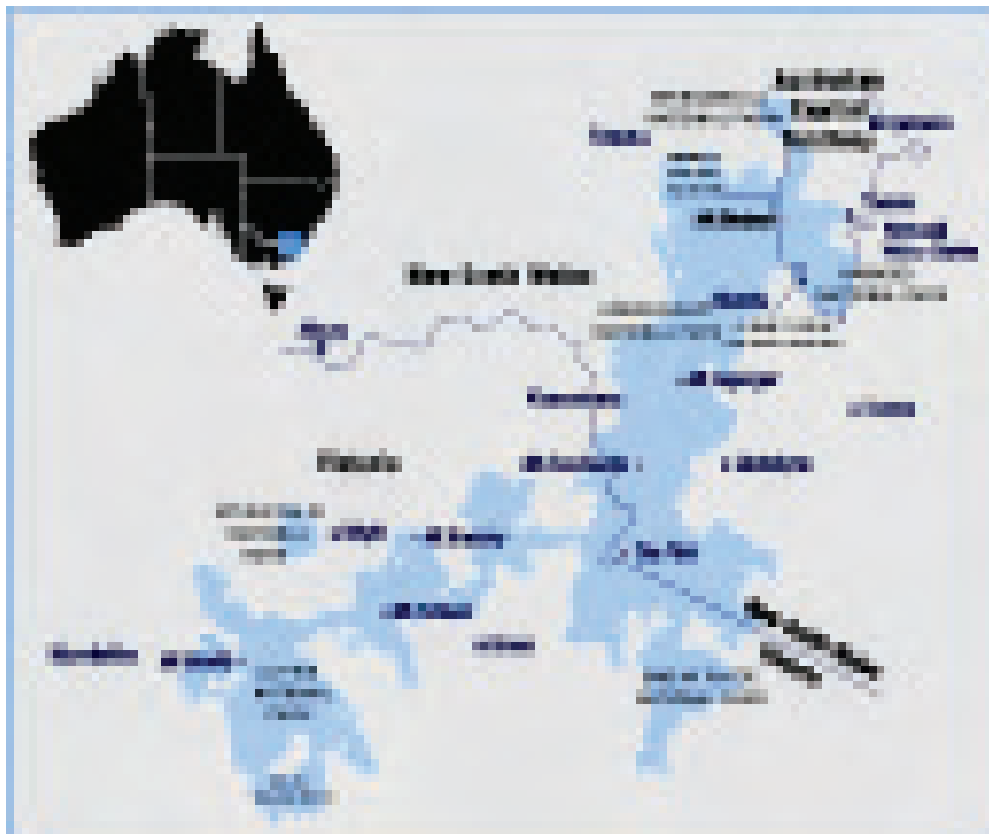


Figure 1: Australian Alps National Parks, modified from AALC (1999)

APPENDIX B: Studies of Biophysical Impact of Horses Worldwide

Location	Environment	Trail/experimental plot	Measures	Source
Western Australia, Australia Horses	Dry sclerophyll Jarrah forest John Forest National Park	Designated trail–bridle trail Multiple use trail	Soil compaction (penetrometry) Soil erosion Informal trails (no.) Grass tree cropping Floristic health and cover reduction Weed cover Dieback presence	Royce (1983)
Tasmania, Australia Horses	Alpine/sub-alpine Tasmanian wilderness Rainforest, shrubland, grassland, fen	Experimental plots 2, 10, 30 horse passes Shod horses (260–270kg)	Topography Vegetation cover % Exposed soil %	Whinam et al. (1994)
Tasmania, Australia Horses	Alpine/sub-alpine Tasmanian Wilderness	Bridle trail	Soil erosion Width of track Soil loss/gain Vegetation cover %	Whinam and Comfort (1996)
Western Australia, Australia Horses	Mediterranean coastal woodland Bold Park	Bridle trail; designated; maintained	Density and diversity of weed species	Barrett (1999)
Western Australia, Australia Horses	Sub-Mediterranean coastal D'Entrecasteaux National Park	Experimental plots 20, 100, 200, 300 horse passes Unshod horses (400–500kg)	Species composition and bare ground Vegetation cover and height Micro-topography Soil compaction (penetrometry)	Phillips and Newsome (2002)
Montana, USA Horses, hikers, motorcycles	Alpine/sub-alpine Northern Rocky Mountains	Experimental plots 50, 100, 1000 horse passes Shod horses (uncleated; 500–579kg)	Vegetation cover (% bare ground) Trail width Trail depth Soil compaction (bulk density) (dry)	Weaver and Dale (1978)
Colorado, USA	Alpine/sub-alpine Rocky Mountain NP	Designated trails		Summer (1980)
Montana, USA Horses, hikers, motorcycles, off-road bicycles	Alpine/sub-alpine Forested Northern Rocky Mountains	Experimental plots 50, 100 horse passes	Soil compaction (penetrometry) Trail roughness Soil moisture (dry/pre-wetted)	Wilson and Seney (1994)
MO, USA Horses, hikers, llamas	Alpine/sub-alpine Forested Northern Rocky Mountains	Experimental plots 25, 150 horse passes Shod horses (uncleated; 450–500kg)	Vegetation cover and height Mineral soil exposure (dry)	Cole and Spildie (1998)
MO, USA Horses, hikers,	Alpine/sub-alpine Northern Rocky Mountains	Experimental plots 250, 1000 horse passes Shod horses (cleated)	Soil compaction (bulk density) Surface roughness Run-off	Deluca et al. (1998)

Best management practice and future research

Location	Environment	Trail/experimental plot	Measures	Source
llamas	Forested		Sediment yield	

APPENDIX C: Management concerns and strategies – climbing across national parks in Qld, NSW and Vic

Bungonia State Recreation Area plan of management 1998, p. 35		
Management concern	Impact caused by	Strategies
Environmental impacts such as dislodgement of rock, placement of bolts and disturbance of nesting birds. It is of particular concern in Bungonia Canyon because of the very high geomorphological heritage value of the canyon	Large numbers of people	Permits and limiting of organised group size Monitoring and rehabilitation Activity is allowed away from day use areas
Ku-ring gai Chase National Park management plan 2002 54–55		
Management concern	Impact caused by	Strategies
Damage to rock faces by bolts		No new or replacement bolts are established without written approval from the Regional Manager
Impacts from these activities include damage to rare plants, damage to rock faces by bolts and disturbance of birds nesting on the cliffs.	Frequent use of the one site, the creation of a myriad of tracks to the top and bottom of cliffs,	Rock climbing and abseiling will be permitted on one site only providing that: <ul style="list-style-type: none"> participants minimise environmental impacts to the cliffs and surrounding vegetation; prior approval has been given by the regional manager for groups of ten or more, or for commercial rock climbing and abseiling activities Rock climbing and abseiling activities involving ropes and mountaineering equipment will not be permitted elsewhere in the park without the prior written approval of the regional manager Bolts which are placed in contravention of this plan, are no longer required or which may lead to unacceptable environmental or safety impacts will be removed
The Rock Nature Reserve plan of management 2000 p. 24–28		
Management concern	Impact caused by	Strategies
Rock sports have environmental impacts such as the dislodgment of rock, the placement of bolts and disturbance to vegetation and nesting birds	General climbing use	Environmental impacts associated with rock sports will be assessed and monitored so that policies regarding rock sports can be modified if unacceptable environmental impacts occur Regulatory signage and literature will be developed to educate rock climbers and abseilers about their responsibilities when using the reserve Users of the rock sports area will be educated in identification of <i>S garlandii</i> to prevent trampling and damage to the plants Limits on party sizes will be a maximum of four for rock climbing parties and eight for abseiling parties Appropriate signage and literature will be developed to educate rock climbers and abseilers about appropriate practices
At present, rock sports are not interfering with breeding Peregrine Falcons	At present Rocksports activities are carried out 1km away from nesting sites	Closure for rock sports between 1 st of July and 31 st of December will be imposed if nesting site changes

The Rock Nature Reserve plan of management 2000 p. 24–28		
Management concern	Impact caused by	Strategies
The base of the cliff face consists of loose rock which may be difficult to patronize and there is evidence of vegetation trampling. Erosion is occurring in the “descent gully” which is used by climbers to descend from the ridge	Access to top an bottom of cliff via unstable gullies	Options for site hardening and modification of rock climbing practices will be investigated to assist with erosion control and to minimise vegetation damage both at the base of the cliff and in the ‘descent gully’ Users will be encouraged to descend via the rockface to minimise damage to the environment. A bolt for abseiling descent from the Towers will be established and climbers and abseilers encouraged to use this instead of the descent gully
Rock sports have environmental impacts such as the dislodgment of rock, the placement of bolts and disturbance to vegetation and nesting birds	New climbs being established	New climbs are not to be established outside the designated rock sports area
Defacement of rock	In the past, the beginning of climbs have been marked on the rockface with paint	This practice will not be allowed climbs should be described in the appropriate literature
Damage to rock faces by bolts	New climbs being developed or abseiling anchors established	The use of permanent anchors (e.g. bolts) will not be allowed for rock climbing and “traditional” climbing practices using “natural protection” (i.e. removable gear) will be used by rock climbers and abseilers
Warrumbungle National Park new plan of management 1997 p. 23		
Management concern	Impact caused by	Strategies
Wildlife disturbance	The presence of climbers	Rock climbing is not permitted on Chalkers Mountain, Square Top Mountain and other peaks where climbing could disturb rock wallabies
Protect plant and animal communities of environmental significance, to protect fragile geological structures	Uncontrolled climbers	Rock climbers are required to obtain a permit before climbing in the park Temporary closures and restrictions on times and numbers of climbers may be imposed if necessary Climbing on the Breadknife not permitted do to proximity of walking track and fragility of rock
Defacement of rock (and maintaining present climbing experiences)	Bolting of new climbs and marking of climbs	The marking of climbs and the bolting of new climbing routes will not be permitted The replacement of existing bolts and abseil anchors will only be permitted on public safety grounds
Bald Rock Boonoo Boonoo National Park Management Plan 2002 p. 20		
Management concern	Impact caused by	Strategies
Potential to conflict with the natural, cultural and landscape values of the park	General climbing impacts	Prohibition of climbing and abseiling

Wollemi National Park plan of management 2001 p. 49–50		
Management concern	Impact caused by	Strategies
<p>Track formation, damage to vegetation and rock surfaces and camping impacts</p> <p>Adventure activities are likely to increase in the future, particularly as new canyon areas are discovered and popularised</p>	<p>Increase in participation rates</p>	<p>Maximum group size for abseiling is eight persons unless otherwise approved</p> <p>Bolting of new routes will not be permitted within the park</p> <p>Replacement of bolts on existing routes will be in accordance with service policy</p> <p>Rock bolts or anchors will be removed where they impact on natural or cultural values or where they do not conform with Service policy</p> <p>A code of conduct for abseiling and rock climbing activities will be developed, promoted and reviewed in conjunction with user groups to address environmental protection, self-reliance and safety issues and will be incorporated within recreational consents and licenses</p> <p>The service will promote minimal impact use for adventure activities within the park</p> <p>A visitor use monitoring program for specific well patronized adventure activity sites will be established e.g. for the Wolgan River valley</p>
Blue Mountains National Park plan of management p. 78–82		
Management concern	Impact caused by	Strategies
<p>Canyoning, abseiling and rock climbing tend to be focused on small areas of vertical and associated environments which are often of high conservation and aesthetic value with significant and restricted plant and animal species</p> <p>Impacts include vegetation disturbance, erosion, tracking, water pollution, damage to rock features and installation of rock bolts</p>	<p>The growth of these activities is leading to increased impacts on established sites and the opening up of new</p>	<p>Effective management can be achieved to some extent through communication and education programs, but there is an increasing likelihood that more formal regulation of activities may be required</p>
<p>There is a need to control the proliferation of recreational bolts in the park</p> <p>It is recognised that the installation of rock bolts is necessary for the maintenance of a range of climbing and canyoning opportunities in the park</p>	<p>New site and climb development.</p> <p>Replacement of existing fixtures.</p>	<p>Bolts which are placed in contravention of the provisions of this plan or the codes of conduct, which are no longer required or which are leading to unacceptable environmental or safety impacts may be removed following assessment of safety and environmental issues.</p> <p>The management strategy will incorporate codes of conduct for abseiling, rock climbing and canyoning in the park, to include...</p> <ul style="list-style-type: none"> • the exclusion of new bolts from wilderness areas, canyons and established rock climbs, except where the NPWS Regional Manager approves the replacement of existing bolts • control of bolting in other locations • acceptable bolting techniques, including the exclusion of power drills • exclusion of damage to vegetation and rock features, route marking, track development and other environmental modifications
Blue Mountains National Park plan of management p. 78–82		

Management concern	Impact caused by	Strategies
The degradation caused by abseiling and climbing on the Three Sisters is considered by the service and other stakeholders to be inconsistent with environmental sustainability and the feature's status as an internationally recognised natural icon and tourist attraction of the Blue Mountains	Rockclimbing has been a long-established activity on the Three Sisters, dating back to the 1930's, but recently the growth in commercial activities, particularly abseiling, has added significantly to use levels with resulting vegetation damage and erosion	As a result of this process, the Three Sisters has been temporarily closed to allow for stabilisation and vegetation regrowth Detailed precinct recreation plans will be prepared and implemented to manage the special issues at the Three Sisters (in conjunction with Blue Mountains City Council) and other areas
Environmental concerns at new sites	Development of new sites and climbs	Rock climbing routes which are established outside approved climbing sites without prior consultation with the service may be closed The establishment of new rock climbs at sites which are not approved climbing sites will require prior consultation with the service The regulation can be applied to exclude activities which are inappropriate in the park or at particular locations
Abseiling and rock climbing will be excluded from locations where they are in conflict with environmental protection	Overuse	A list of sites that are closed is tabled in Table 6 above Specific canyons or climbing and abseiling sites not included on this list may be temporarily or permanently closed for environmental or safety reasons
	Crowding in some canyons is leading to safety as well as environmental concerns.	Group sizes will be limited in order to reduce impacts and site crowding as follows: <ul style="list-style-type: none"> • four persons per roped party on individual rock climbs; • eight persons for abseiling and canyons involving abseiling; and • 12 persons (eight in wilderness) for canyons not involving abseiling.
Gardens of Stone National Park		

Blue Mountains City Council nature-based recreation strategy 2004 Appendix p. 13–16		
Management concern	Impact caused by	Strategies
<p>Concern about development of new cliff areas in light of managing land in close proximity to World Heritage areas</p> <p>Managing the sometimes conflicting objectives of preservation and conservation with recreational and tourism opportunities results in a need for a proactive approach to management</p>	Increase in cliff users	<p>Base line studies for a range of sites, plus flora and fauna studies commissioned and carried out by private consultant</p> <p>Map and assess all sites</p> <p>Identify incompatible sites for climbing</p> <p>Identify carrying capacity for sites</p> <p>Consult with climbing community on priority site actions</p> <p>Detailed survey of specific sites recommended</p> <p>Maintain communication channels with recreational and commercial groups</p> <p>Promote climbers code of conduct promoted</p>
Grampians National Park management plan 2003 p. 43		
Management Concern	Impact caused by	Strategies
<p>Allow rock climbing and abseiling in appropriate areas, consistent with the protection of park values</p>	General climbing	<p>There is ongoing consultation with the climbing community to identify sites used by climbers, the various groups using sites, the impacts on sites, and a range of actions aimed at providing sustainable climbing opportunities that do not conflict with other park users or values</p> <ul style="list-style-type: none"> • <i>Permit rock climbing and abseiling in the park, excluding Reference Areas or other specified areas, in accordance with Parks Victoria's operational policies</i>
<p>There has been a dramatic increase in rock climbing and abseiling activities in the park in recent years. There are only a few sites in the park suitable for instructional use, so these sites are heavily used</p> <p>Over 37 licensed tour operators are permitted to conduct rock climbing tours in the park, but less than one third of them use the park regularly</p>	Increase in climber numbers	<p>A walking track has been provided to the main climbs in Summerday Valley, and soil stabilisation has been carried out, with the assistance of volunteers, at Summerday Valley and the Watchtower.</p> <p><i>In conjunction with the rock climbing community, consider, and as appropriate:</i></p> <ul style="list-style-type: none"> • <i>further stabilise access to the base of climbs at Summerday Valley</i> • <i>close climbs that conflict with Aboriginal cultural sites, significant flora and fauna or other park values, and signpost accordingly</i> • <i>encourage the use of minimal impact and clean climbing technique</i> • <i>regulate licensed tour;</i> • <i>restore degraded sites</i> • <i>increase environmental awareness in the climbing community.</i>
Wilson's Promontory National Park management plan 2002 p43		
Management concern	Impact caused by	Strategies
Damage to rock	Bolting	To reduce site impact, only 'clean climbing' (those techniques which do not damage or deface the rock) will be permitted.
Minimising the impacts on park values.	Inappropriate climbing	Permit rock climbing using 'clean climbing' techniques at Little Oberon, Mount Bishop, Mount Oberon, Squeaky Beach Boulders, Turtle Rock and other appropriate sites
Decrease park values	Establishment of new climbing areas	Delineate the limit of developed climbing sites and prohibit the development of new climbing areas in the park.

Wilson's Promontory National Park management plan 2002 p. 43		
Management concern	Impact caused by	Strategies
Concern for track impact	Multiple track networks and new climbing sites	There may be a need to define access tracks to prevent the formation of multiple tracks to the top and base of climbs A permit system monitors levels of use and impact, and is also intended to enhance climbers' safety
Mt Buffalo National Park management plan 1996 p. 34		
Management Concern	Impact caused by	Strategies
None of the geological and geomorphological features of the Park are considered to be in any danger from use by climbers However, Peregrine Falcons nest on rocky cliffs and escarpments at Mount Buffalo. Climbing near nesting sites could disturb adult birds and interfere with breeding		Close areas containing known Peregrine Falcon nests from August to December inclusive Permit rock climbing and abseiling in accordance with National Park Services (NPS) guidelines
Provide for safe climbing and abseiling while minimising conflict with Park conservation values	New cliff and climb development	Maintain, and if necessary upgrade, existing tracks to the base of the climbs to a standard necessary to protect the park environment. Do not construct new tracks Encourage volunteer support from climbing groups to assist with maintenance
Low impact climbing will be encouraged to minimise the impact of the activity on the Park values	Bolting	Placing fixed equipment (bolts, pitons, chains etc.) without NPS approval contravenes the Park Regulations Liaise with rock climbing clubs and groups, in particular the Victorian Climbing Club
Cathedral Range National Park management plan 1998 p. 20		
Management concern	Impact caused by	Strategies
signs of degradation, particularly to trees at the tops of climbs which are used for climbing and abseiling anchor points	Regular and heavy use of some site	Do not permit the use of trees as anchors
Erosion and trampling on and around climbing tracks At the base of popular climbs where there is evidence of soil compaction and erosion	High participation rates	Monitor sites and access tracks, using methods such as photo monitoring points, and close as required Liaise with users on the operation of the booking system Provide suitable track access to climbing areas and undertake rehabilitation work at degraded climb sites in association with user groups
New site degradation	Tracks have been created by climbers seeking access to new sites	Delineate the limit of developed climbing sites and prohibit the development of new climbing areas
Many climbing routes have had anchor points installed over the years		The use of fixed equipment is actively discouraged under park guidelines Encourage users to use clean climbing techniques and conform to the relevant codes of conduct for their activities
Climbers disturbing Peregrine Falcon activity	Activities conducted too close to Peregrine Falcon activity	Monitor cliff sites for Peregrine Falcon activity, and close climbing and abseiling sites as required

Mt Arapalies Toooan State Park management plan 1991 p. 24–25		
Management concern	Impact caused by	Strategies
The use of chalk as an aid to climbing can result in the formation of unattractive deposits		With cooperation from climber these impacts can be minimised without the need to unduly restrict rock climbing Promotion of a code of conduct for climbers
Permanent fixtures (bolts) in particular and practices such as wire brushing and chipping can damage rock formations and be visually displeasing		With cooperation from climber these impacts can be minimised without the need to unduly restrict rock climbing Promotion of a code of conduct for climbers
Plant growing in crack on cliff faces, such as the Skeleton Fork Fern (psilotum nudum) can be destroyed		With cooperation from climber these impacts can be minimised without the need to unduly restrict rock climbing
Disturbances in the vicinity of raptor nesting sites, from immediately prior to nesting and through the breeding season may have a detrimental effect on breeding success. The notable species of Peregrine Falcon is particularly susceptible to disturbance in such periods	Climbing near nests	Monitor impact of climbers on Peregrine Falcon nesting Seasonal closures of areas where Peregrine Falcons nest Promotion of a code of conduct for climbers
Glass House Mountains National Park management plan		
Management concern	Impact caused by	Strategies
Secure conservation requirement of significant animal species	Human disturbance (climbers)	Temporarily close climbing areas–August to December
Marking of cliff face with climb names	Climber paint	Encourage guide books to be more accurate in describing start of climb
Gardening (killing plants in the way of climbing)	Climber behaviour	Ban
Fixed Anchors	Unregulated development	Fixed anchor point policy to be developed for the park with consultation with user groups (yet to be implemented)

Note: Moggerah Peaks National Park draft management plan, QLD is not yet ready for publication (this plan would include Frog Buttress)

APPENDIX D: Selected Australian Codes of Conduct for Rock Climbing

Parks Victoria: Code of conduct for climbing/abseiling

http://www.parkweb.vic.gov.au/1process_details.cfm?note=20

- Most climbing and abseiling in Victoria is in National and State parks and other areas of public land controlled by Parks Victoria and the Department of Natural Resources and Environment. Some places, such as Aboriginal sites, peregrine nesting areas, wilderness areas, tourist sites and conservation zones might have more stringent conditions on climbing than generally apply. Check with local offices and work centres before you climb.
- Climbing and abseiling will continue to be allowed and accepted as a valid recreation in most of Victoria's parks if climbers are responsible, observe the basic principles of conservation and respect local climbing values, ethics and traditions.

Climbing

- Chipping of rock is both illegal and unethical.
- Avoid indiscriminate or excessive use of chalk. Using coloured chalk to match the rock is less intrusive.
- Do not change the nature of an established climb, for example, by retro-bolting or by adding or removing other fixed equipment, without approval of the first ascent team or Parks Victoria and Victorian Department of Natural Resources & Environment NRE.
- Do not leave litter such as old slings, lolly wrappers etc. Take all your rubbish home.
- Vegetation, even on cliff faces, is protected. Wire brushing to remove mosses and 'gardening' in cracks and gullies is not permitted. Use slings to protect trees while belaying or abseiling if belay anchors are not provided.

General

- Before establishing a new climbing area, the approval of the land manager must be obtained. In existing (i.e. documented) climbing areas, be conscious of minimising the visual and environmental impact of new climbs.
- Do not mark the start of climbs. Good descriptions in guide books should suffice.
- Minimise the use of bolts (only for safety purposes) and avoid using galvanised bolts.
- Make yourself aware of and respect access arrangements and restrictions. On private property, do not disturb livestock or damage crops.
- Access to cliffs is only permitted on existing tracks. Contact Parks Victoria or Natural Resources and Environment if you believe a new track is required, or if a route to a cliff needs marking.
- Do not disturb vegetation, nesting birds or other wildlife. All native plants and animals are protected.
- Respect sites of geological, cultural or other scientific interest.
- Respect established climbing traditions in ethical matters such as the use of chalk, bolts etc. Avoid indiscriminate or excessive use of fixed equipment.
- Your life is precious. Think ahead and use a helmet! Helmets are required for all participants on commercial instruction programs.
- Large groups can create problems of crowding and excessive damage around cliffs.
- If you plan to take a group of ten or more people climbing, you are required to register to ensure there is space.
- Vehicles must stay on roads open to the public; off-road driving is illegal. Mountain bikes may be used on management roads except in the Grampians National Park and Wilsons Promontory National Park.
- Avoid disturbing soil at the top and base of cliff areas and hence prevent erosion.
- Abseil and climb over rock ledges where possible.
- Do not use popular lookout sites as belay points or abseiling venues as it causes danger to passive onlookers as well as unwarranted tampering with climber's equipment.
- Observe cliff and track closures where applicable.
- Climbers should adhere to NRE Park and Fire and other regulations.
- Abide by the 'clean climbing' ethic.

Climber's Code

- Find out about and observe access restrictions and agreements. Ensure access by not disturbing livestock or damaging crops.
- Use existing access tracks to minimise erosion and the need to mark new routes.
- Do not disturb nesting birds or other wildlife. Help protect all native plants; respect sites of geological, cultural, or other scientific interest.
- Do not leave any rubbish. Keep campsites clean. Avoid all risk of fire.
- Dispose of human waste in a sanitary manner. Do not pollute water supplies.
- Respect established climbing traditions in ethical matters such as the use of chalk, pitons, bolts etc.
- Avoid indiscriminate or excessive use of fixed equipment.
- In essence, climb clean
- Responsible climbing will protect cliffs and ensure continued rockclimbing

Blue Mountains Cliff Care: Minimal Impact Strategies

<http://www.cliffcare.org.au/impacts.htm>

(After the folding of Blue Mountains Cliff Care a new group is forming. At the time of writing it will be called Cliffcare Blue Mountains)

The Blue Mountains is a very fragile environment and some climbing areas are enjoyed by the public for their scenic qualities. Climbers should aim to minimise any impact they may impose on these areas.

So ... Tread lightly and avoid sensitive vegetation such as mosses and bog plants at the base of cliffs and heath areas at the top. Where possible keep to rocks, hard ground and established tracks. Avoid revegetation areas. Take all your rubbish out with you. Practice minimum impact toileting by GOING well away from tracks and creeks and digging a hole for your deposit. Domestic animals are not allowed in National Parks, and, on council owned lands dogs must be kept on a lead. Minimise chalk usage to reduce the visual impact in public areas, particularly on walls that stay dry during rain. Where possible use "lower offs" and avoid trampling cliff top vegetation. Avoid disturbing cliff dwelling flora and fauna.

Considerate Climbing Practices

So you're doing a new route ...

- Before establishing a new climb, carefully evaluate its impact compared with its benefit and consult with land management authorities where appropriate.
- Before placing fixed protection in conservation areas or where it may offend other users, such as bushwalkers or tourists, consider the visual impact and choose the most appropriate anchor e.g. bolt, fixed hanger, or ring.
- Use an accurate description in a guide book, rather than painting initials on the rock for others to locate the climb.
- If appropriate, equip the route with a "lower off" to reduce the wear and tear on vegetation at the top of the cliff. Use rings in preference to chains as they are less conspicuous.
- Never chip or manufacture holds.

Sydney Rock Climbing Club

<http://www.sydneyrockies.org.au/pdfs/srccode.pdf>

Below is an edited list of statements that indicate the minimisation of ecological impacts of rock climbing from the Sydney Rock Climbing Club.

At the cliff face:

- Tread lightly and avoid fragile vegetation at the base and top of cliffs.
- Once vegetation is removed erosion sets in and the resulting soil loss could mean that revegetation is not possible
- Avoid removing vegetation from cracks and ledges when developing new cliffs and climbs.
- Where possible on approaches to the bottom, and from the top of climbs, keep to rocks, hard ground, and established tracks.
- Avoid revegetation/regeneration areas until signs have been officially removed and the area has recovered.
- Carry all rubbish out with you.
- Practice minimum impact toileting by going well away (more than 50m) from tracks and creeks and digging a deep hole to bury all human waste matter, toilet paper and tissues; or use a 'Poo-tube' to carry it out with you.
- To avoid trampling cliff top vegetation where possible use "lower-offs" to return to the base of climbs.
- Minimise chalk usage. Chalk is unsightly; think before you dip! Consider using appropriately coloured chalk.
- Bolting can be unsightly; place them with consideration for low visual impact as well as safety. Consider using coloured brackets or painting them to match the rock.
- When choosing a site for a 'lower-off' point, consider proximity to other climbs below as well as visual impact.
- Marking the start of climbs should be done discretely and in keeping with accepted practices at particular cliffs.
- Chipping or enhancing of holds is unacceptable.
- Always comply with the regulations attached to particular areas.
- Respect the Aboriginal and European cultural heritage which exists in some areas.
- Please note: dogs are not allowed in national parks, and on council owned lands must be kept on a lead.
- **REMEMBER THAT WE DO NOT HAVE EXCLUSIVE RIGHTS TO CLIFF FACES.**

The Rock climbing Code of Conduct from Queensland Outdoor Recreation Federation

http://www.outdoorsqueensland.com.au/01_cms/details.asp?k_id=98#110

During the SEQ Rockclimbing and Abseiling Site Management Forum climbers and managers have developed a code of conduct to cover:

- access
- impact
- waste
- fire
- traditions
- safety

Access

- Be aware of and observe access requirements and agreements. Avoid disturbing wildlife, crops and livestock. Leave gates as you find them and report any problems or potential problems to the landowner or manager.
- Try to familiarise yourself with and observe any site-specific cultural or environmental conditions affected by your climbing.
- Carefully consider the consequences of your actions on the environment and the enjoyment of future visitors to the site.
- Endeavour to learn about and protect native plants, animals, geology and the cultural riches of the site.

- Help reduce impact and preserve a safe climbing environment; please try to keep groups to eight or fewer climbers. Respect other site users, both climbers and non-climbers. Rowdy behaviour is disruptive and inconsiderate. Please behave responsibly and keep noise to a minimum, including the use of electronic equipment and radios.

Impact

- Respect sites of geological, cultural or other scientific interest. Please avoid any actions that cause unnecessary erosion. Use existing access tracks and do not leave unnecessary way marks. Help protect all wildlife. Do not disturb nesting birds.
- Climbers can help secure continued access by supporting the existing environmental values of climbing sites.
- 'Gardening', or the removal of existing vegetation from a cliff, permanently alters the natural environment. Use established tracks and avoid shortcuts or blazing new trails. Don't manufacture holds or chip rock. On existing climbs avoid the installation of extra bolts; on new climbs avoid providing unnecessary protection.
- Limiting the interaction between climbers and native fauna reduces the chance of any impact. Pay particular attention to seasonal bans on cliffs during bird breeding seasons. Please avoid sites inhabited by endangered species: this includes many species of wallaby, bat and spider.

Waste

- To ensure our climbing sites stay beautiful please do not leave any rubbish. Keep campsites clean. Dispose of human waste in a hygienic and environmentally responsible manner. Do not pollute fresh water supplies.
- Take out what you take in and if you see rubbish left by other users please take it out too. Pay particular attention to the small things (cigarette butts, fruit labels and silver foil are quite often left behind). They are unsightly and also degrade the climbing site.
- Use toilets where provided. If they are not available, bury human waste at least 15 cm underground and at least 50 m from any water source or access track. In sensitive areas, please consider carrying out human waste. Please properly bury toilet paper or, even better, pack out your toilet paper as it takes a long time to decompose.
- Waste water, particularly soapy water from washing humans or dishes, should also be disposed of at least 50 m from any water source or access track.

Fire

- Fire is a serious threat to both safety and ecology. Avoid all risk of fire.
- Only light fires in designated fireplaces in well-cleared areas. Think about where you are using your fuel stove and be responsible with its use.
- Observe all fire restrictions. Remember restrictions apply to fuel stoves and smokers.

Traditions

- Consider ethical issues, such as the use of chalk, bolting and pitons, as well as appropriate climbing styles. Remember that placement of fixed equipment alters the climb and is not permitted at many sites.
- Avoiding climber conflicts ensures better climbing. Respect established climbing traditions related to specific site.
- Recognise and follow climbing traditions on existing sites. Some sites are appropriate for top roping; others for lead climbing. Please do not endanger the lives of other users by using a site inappropriately.
- Bolts are inappropriate on climbs that can be protected by natural means. Bolts should only be used as a last resort to enable a climb to be led without fatal consequences, not just to reduce the size of a fall. Bolts/chains/fixed hangers should be kept to a minimum and should be placed in such a manner that they have minimal visual and environmental impact.
- Avoid indiscriminate and excessive use of fixed equipment.

Safety

Keeping noise levels to a minimum ensures that all climbers can communicate with each other. Proper climbing checks and calls ensure that climbers at a cliff base are less likely to be in danger from falling rocks and climbing equipment, particularly ropes.

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The STCRC has grown to be the largest, dedicated tourism research organisation in the world, with \$187 million invested in tourism research programs, commercialisation and education since 1997.

The STCRC was established in July 2003 under the Commonwealth Government's CRC program and is an extension of the previous Tourism CRC, which operated from 1997 to 2003.

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The Commonwealth CRC program aims to turn research outcomes into successful new products, services and technologies. This enables Australian industries to be more efficient, productive and competitive.

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STCRC's objectives are to enhance:

- the contribution of long-term scientific and technological research and innovation to Australia's sustainable economic and social development;
- the transfer of research outputs into outcomes of economic, environmental or social benefit to Australia;
- the value of graduate researchers to Australia;
- collaboration among researchers, between researchers and industry or other users; and efficiency in the use of intellectual and other research outcomes.