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Environmental Impacts of Tourism on the Australian Alps Protected Areas

Judgments of Protected Area Managers

This article examines the judgments of staff from protected area agencies responsible for managing tourism and its environmental impacts in the largest area of snow country in Australia. In surveys, staff identified as having major responsibility for tourism management in the Australian Alps protected areas consider that tourism has important negative environmental impacts; the impacts of ski resorts on adjacent natural areas are often more important than impacts of more general tourism activities further away from ski resorts; the most important environmental impacts were on water quality; native fauna was adversely affected through tourism activities that resulted in increased numbers of feral animals and habitat reduction and fragmentation; there was a wide range of adverse impacts from tourism on vegetation; air quality was affected, particularly around the ski resorts, but it was a less important issue than impacts on water, fauna, and flora. The judgments of protected area managers as to the importance of environmental issues arising from tourism use of the Australian Alps protected areas correspond well with the documented impacts in research papers and management reports.

Keywords: *Tourism management; Australian Alps; protected areas; environmental impacts.*

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Introduction

The Australian Alps protected area network

Winter seasonal snow in Australia is restricted to the southeastern corner of the mainland and parts of Tasmania (Green and Osborne 1994). On the mainland, snow cover is regularly found only on a series of linked ranges and peaks know as the Australian Alps. The area is of outstanding biological importance, containing many endemic plants and animals as well as geological features of high conservation value (Mosley 1988). The protected area network of the Australian Alps includes Kosciuszko National Park, which contains the continent's highest mountain (Mt Kosciuszko, 2228 m), the entire alpine area, and most of the subalpine areas of New South Wales (Pulsford et al 2003). In Victoria, the high country is conserved in Alpine National Park, the Avon Wilderness, Snowy River National Park, and Mt Buffalo National Park (Figure 1; Pulsford et al 2003).

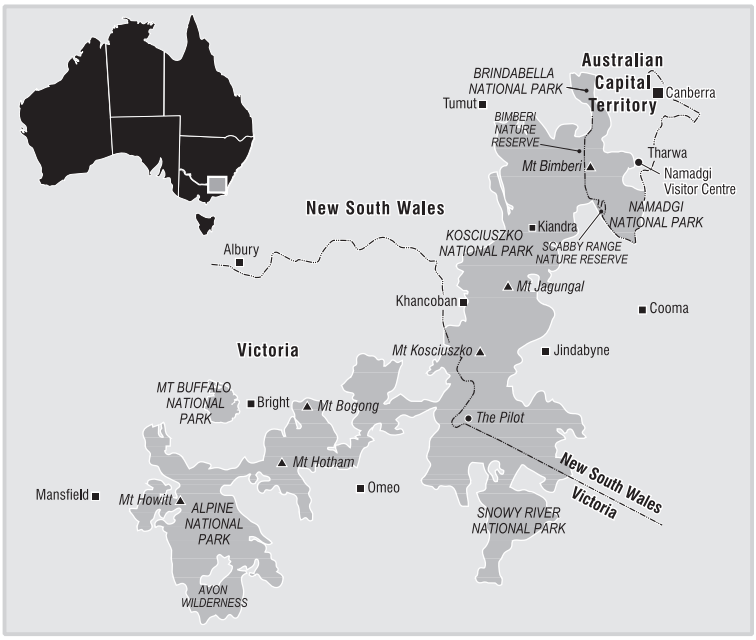


FIGURE 1 Australian Alps protected areas. Modified from AALC (1999).

Namadgi National Park in the Australian Capital Territory along with the Brindabella National Park in New South Wales are the northernmost reserves of the Australian Alps (Pulsford et al 2003).

Over 1.5 million people visit the Australian Alps national parks annually (Good and Grenier 1994; Good 1995). Winter tourism is focused on ski resort-based activities, such as alpine skiing and snowboarding. Summer tourism is more dispersed in location, and activities principally consist of bushwalking, sightseeing, car-touring, picnicking, camping, fishing, mountain-bike riding, horse riding, photography, as well as more specialized activities, such as hang-gliding, etc (Good 1992; Good and Grenier 1994; Buckley et al 2000).

Winter and summer tourism and recreation activities can have negative environmental impacts, such as trampling of vegetation, introduction and spread of weeds, littering, and nutrient enrichment of soils and water (Good 1992; Good and Grenier 1994; Buckley et al 2000; Pickering et al 2001; Eagles et al 2002; Newsome et al 2002). Ski resorts in and adjacent to the protected areas in the Australian Alps have negative environmental impacts that can often be more detrimental than those of backcountry activities (Buckley et al 2000). Tourism and recreation in resorts and in backcountry areas are important for management of protected areas (Buckley et al 2000).

Issues in assessing environmental impacts

Protected area management agencies responsible for the Australian Alps have a dual mandate to maintain

the natural and the cultural heritage values of protected areas while facilitating public enjoyment of these areas (NSW NPWS 1988; Good 1992; Worboys and Pickering 2002). Sustainable use of protected areas by tourists is therefore reliant on recognizing potential impacts of tourism, introducing effective management practices, and encouraging tourist awareness and responsible use of park facilities (Buckley 1999; Worboys et al 2001; Worboys and Pickering 2002). These tasks are the responsibility of management staff of the protected area agencies (Worboys et al 2001).

This study examines the assessed level of importance placed by these managers on various environmental impacts of tourism. It compares judgments made by managers about tourism impacts (as assessed in an operational environment) relative to contemporary published research to determine how well such judgments match known tourism impacts demonstrated by research. The judgments of managers are important because they are accountable for the protected area decision-making process in terms of planning and identifying the types of tourism activities permitted; prescribing policies about the way they are managed; implementing such policies; and planning and instituting work programs to prevent, rehabilitate, and ameliorate impacts (Worboys et al 2001).

Judgment refers to the cognitive aspects of the decision-making process (Bazerman 1998). The rational model for decision making recognizes 6 fundamental steps including defining the problem, identifying the criteria, weighting the criteria, reviewing alternative courses of action, weighting each alternative on each criteria, and computing the optimal decision (Bartol et al 1998; Bazerman 1998). Monitoring implementation of the decision is also important (Bartol et al 1998). Such an ideal model never really works in reality, and decision makers typically forgo the "best solution" in favor of what is acceptable or reasonable. This is particularly so when decision makers in an operational environment are making multiple decisions daily (Bazerman 1998). Time constraints, lack of information, or lack of capacity to analyze information ensure that the rational model will not work (Bartol et al 1998).

The alternative is to use "nonrational" model approaches including "satisfying" (managers seek alternatives until they find one that looks satisfactory), "incremental" (managers make the smallest response to reduce the problem to a tolerable level), and the "rubbish-bin" model (nonprogrammed decisions are made randomly, and decision outcomes occur by chance) (Bartol et al 1998). Decision makers, however, are encouraged to follow the rational model as closely as possible, given that it is far better than the alternatives (Bazerman 1998). In doing this, they need to be aware of how judgment in decision making can be flawed. Notable weaknesses include some 13 types of bias that may influence intuitive judgment, nonrational responses to uncertainty, escalation of problems arising from a poor initial decision, inconsistencies in evaluation of fairness, self-serving motivations, and joint gain in 2-party negotiations (Bazerman 1998).

In making decisions in the Australian Alps, protected area managers do have a number of advantages. Their decision-making framework is set within statutory plans of management. Policy guidelines have been developed by the protected area agencies. External reviews of performance are frequent, including coronial hearings examining fire-management performance, water quality management performance through external licensing requirements, and public scrutiny for all aspects of management, thanks to democracy and avaricious media. Regular competency-based training workshops also are held across the Australian Alps; these have helped streamline management standards for the 3 management agencies. Managers are expected to stay on top of their job. They need to be familiar with current literature and they need to have an understanding of the on-ground effects of use such as tourism. It is in this context that this research project was developed.

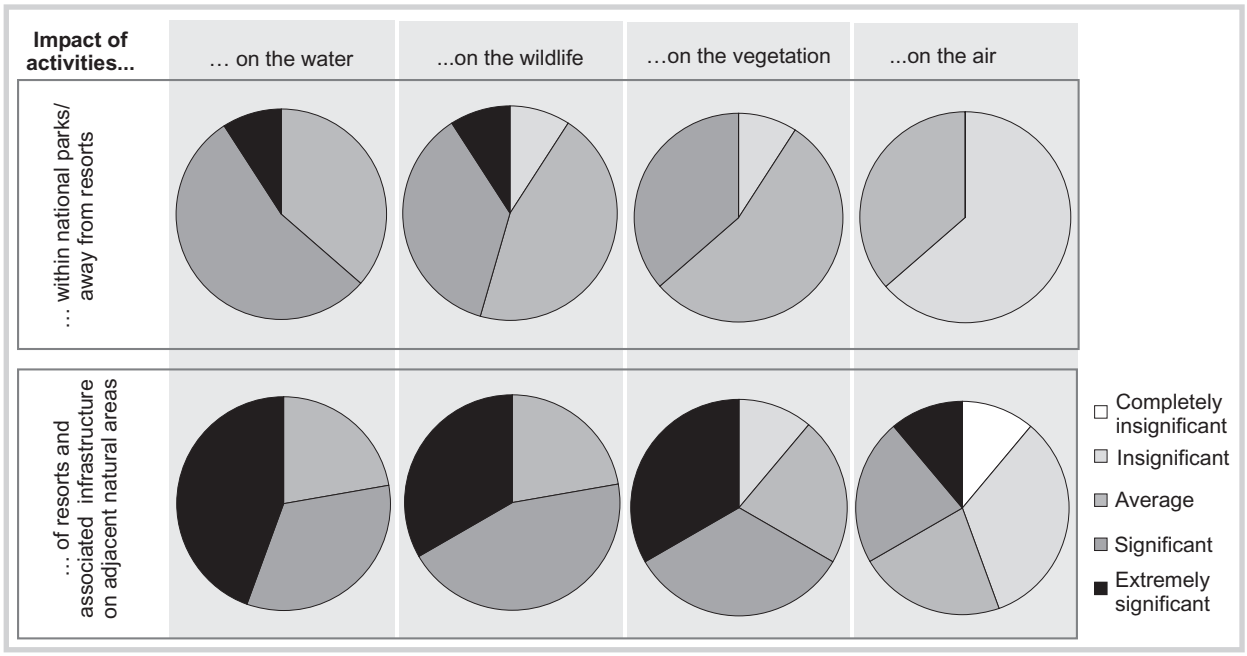
Judgments about the nature and degree of tourism-related environmental impacts were sought. Such judgments would be used as a basis for operational decision making within the Australian Alps. It was important to see how such judgments actually compared with the findings of scientific research on tourism impacts in the Alps, even though there was a basic expectation that managers would be familiar with the literature.

Survey methods

All designated Australian Alps protected area staff responsible for tourism management were surveyed. Approval for the survey was obtained (in April 2000) from the Australian Alps Liaison Committee (AALC) before surveying potential respondents in May 2000. The AALC coordinates cooperative cross-border management programs between individual parks within the Alps. Seventeen managers were identified by the AALC as the key staff responsible for the management of tourism within the Australian Alps protected areas. Thirteen out of 17 managers (76.5%) responded to the survey.

The survey was based on a previous study in the United States (Wang and Miko 1997), with questions modified to incorporate issues relevant to the Australian Alps, as outlined in the work by Buckley et al (2000). Because of the substantial use tourists make of the ski resorts and because the ski resorts are in or adjacent to protected areas, the survey included questions on the impacts of resort infrastructure and activities on

FIGURE 2 Overall judged significance of tourism activities on components of the natural environment. Values represent the number of managers who rated the impact at the listed level of significance.



surrounding natural (nonski resort) areas. These questions were not relevant for all protected areas in the Australian Alps.

Sixty-four survey questions were presented in 3 sections, examining, respectively, judgments about:

1. The impact of general tourism in the areas away from the alpine ski resorts.
2. The potential impact that ski resort facilities and activities (and use by visitors) could have on adjacent natural areas.
3. An overall summation of the impact of tourism use on flora, fauna, water, and air quality.

Respondents were asked to score their judgment of impacts using a 5-point Likert-type scale (1, completely insignificant; 2, insignificant; 3, average; 4, significant; 5, extremely significant). In addition, respondents were asked to add any possible impacts not listed in the survey and to record the judged significance of those impacts. Significance was not quantitatively defined but left to the judgment of the survey respondent.

Results and discussion

Survey results are presented in Figure 2 and Tables 1 and 2. The activities or impacts are ordered from the highest mean Likert score to the lowest. The number of managers who assigned each level of significance is given. Statistical analysis was inappropriate because of the small sample size and the large number of 0 values, which invalidated assumption of a chi-squared style analysis.

Tourism use was judged by protected area managers to have a series of negative impacts ranging from extremely significant to completely insignificant (Figure 2). The impact on water quality was considered to be the most important, followed by the impact on fauna and then flora, with air quality seen as being of insignificant to average importance. The rankings given for the impacts of ski resorts on water, fauna, flora, and air were on average higher than those for tourism away from resorts. This perception is consistent with studies on the effects of ski resort-based tourism in the Australian Alps and overseas. Ski resorts are an intensive form of tourism development in mountain areas resulting (in an Australian setting) in clearing; road construction; slope grooming; provision of utility services (water, sewage treatment, power supplies); accommodation services; and other tourism infrastructure, such as golf courses, tennis courts, swimming pools, and other facilities. Such development often leads to large, unavoidable, environmental impacts (NSW NPWS 1990; Buckley et al 2000).

Water quality

Table 1 shows that protected area managers judge tourism as having a range of impacts on water quality, with impacts from untreated human waste downstream of ski resorts the most important. Within the ski resorts, reduced water quality because of contamination of rivers and creeks by nutrients, bacteria, and other microorganisms in treated human waste, as well as runoff from ski slopes, roads, car parks, etc was thought to be the most important issue. Other factors considered important included changes in aquatic species composition and ecology downstream of ski resorts and sewage discharge points and modified creek flows as a result of snowmaking, runoff, and extended snow pack. Away from the ski resorts, the most important issue other than untreated human waste contributing to reduced

FIGURE 3 Dandelions (*Taraxacum officinale*) and clover (*Trifolium* spp) growing along the edge of one of the gravel tracks near Mt Kosciuszko. Gravel track types often have a weed verge, whereas other track types, such as raised steel mesh walkways, do not provide weed habitat. Weeds are a problem in the alpine area; the diversity and abundance of weeds is likely to increase with predicted climate change. (Photo by C.M. Pickering)

FIGURE 4 Sightseeing is the second most popular activity in the Kosciuszko alpine area. Lookouts such as this one at Charlotte's Pass provide visitors with interpretation and safety messages. This type of wooden structure protects the immediate environment from excessive trampling. (Photo by C.M. Pickering)

water quality was feral animals, such as horses, pigs, foxes, cats, and in-stream trout introduced for recreational purposes. The impacts of feral fish on stream ecosystems are well recognized, with trout shown to reduce native fish populations within mountain creek systems in Australia (Cullen and Norris 1989; Green and Osborne 1994).

The judgments of protected area managers are very similar to the actual impacts of tourism on water quality in mountain ecosystems, as determined by published research work. Contamination of rivers and creeks by treated and untreated human waste as well as runoff from ski slopes, roads, and car parks is a problem in mountain areas in Australia and overseas (Cullen and Norris 1989; NSW NPWS 1990; Cullen 1992; Marston and Yapp 1992; Good and Grenier 1994; Digance and Norris 1999; Growcock 1999; AALC 2000; Buckley et al 2000). Changes in creek flow regimes as a result of snowmaking, snow grooming, and harvesting have been found, although most research is for mountain regions overseas (Good and Grenier 1994; Growcock 1999).

The importance of effective management of human waste in the Australian Alps is already recognized. For the ski resorts, discharge from sewage treatment works is closely monitored by organizations such as the Environment Protection Authority of New South Wales. Discharge into alpine streams must be kept within strict limits. Management of human waste for low-use sites is also important. The AALC has previously run a "best practice" human waste management workshop to address this issue. In addition to monitoring, management responses discussed included the provision of

TABLE 1 Judged importance of impacts of tourism on water and air quality. Values represent the number of managers who rated the impact at the listed level of significance. A, completely insignificant; B, insignificant; C, average; D, significant; and E, extremely significant.

Impact on/of	A	B	C	D	E	Mean
On water quality						
Impact within national parks/away from ski resorts of:						
Untreated human waste	0	0	0	5	8	4.62
Feral animals (trout etc)	0	2	3	5	3	3.69
Fishing	1	3	5	4	0	2.92
Swimming	2	5	5	1	0	2.46
Impacts of ski resorts and associated infrastructure on adjacent natural areas:						
Reduced water quality (nutrients, bacteria, and other microorganisms in treated sewage discharge and from runoff from ski slopes, oil, grease, and trash etc, salt from roads etc)	0	0	1	4	6	4.45
Changes to species composition and ecology of aquatic communities (including algae and invertebrates) downstream of resorts and sewage discharge points	0	0	3	4	3	4.00
Modified creek flows (decrease in winter from snowmaking, increase in spring flooding, increased runoff, extended snowpack etc)	0	1	2	6	2	3.82
Introduced fish species such as trout	0	4	1	6	0	3.18
On air quality						
Impact within protected areas/away from ski resorts of:						
Bush fires caused by tourists	0	4	3	3	2	3.25
Traffic on dirt roads	0	4	5	4	0	3.00
Exhaust from tourists' cars	0	7	4	2	0	2.62
Smoke from campfires	1	5	5	2	0	2.62
Impacts of ski resorts and associated infrastructure on adjacent natural areas:						
Noise pollution (snowmaking, lifts, snowcats, snowmobiles, helicopters, access traffic, onsite vehicles, generators, maintenance, voices, construction etc)	0	0	4	5	2	3.82
Dust from dirt roads, cleared areas, and during construction of facilities etc	0	3	3	5	0	3.18
Exhaust (cars, snow-grooming vehicles, over-snow vehicles, generators etc)	0	4	2	5	0	3.09

more effective pump out and composting toilets, particularly at road heads, and the possible introduction of carry-out procedures for some wilderness areas (AALC 2000).

Air quality and other issues

Although most protected area managers perceived tourism use to have insignificant impacts on air quality away from ski resorts (Figure 2), there was wide divergence in views on the importance of impacts of tourism use on air quality near ski resorts. One impact that was generally considered to be important was noise pollution from machinery in and near the ski resorts (Table 1). Noise pollution associated with the ski resorts has been identified in a few environmental impact studies as an issue (Buckley et al 2000) but is potentially underreported. There appear to be no specific studies addressing the air quality of the Australian Alps.

Wildlife (fauna)

Tourism use is considered by protected area managers to have a range of adverse effects on native fauna. Increased feral animal numbers and activity (foxes, horses, pigs, and others), an indirect impact of tourism, was considered to be the most important issue (Table 2). Tourism use in the Australian Alps contributes to the presence of many feral animals, including house mice, black rats, rabbits, foxes, and cats because food and shelter are provided, particularly during the winter (Green et al 1992; Green and Osborne 1994; Budela et al 1998). One group of feral animals, nonnative trout, was introduced to rivers in the region solely for the opportunities they provided for tourism and recreation.

Foxes feed on endemic native mammals, several of which are listed as vulnerable or endangered (eg, the broad-toothed rat and the mountain pygmy possum; see Green and Osborne 1994). Organic waste from restaurants and accommodation facilities within the ski resorts is a supplementary food source for foxes in winter, resulting in higher levels of predation of native mammals (Budela et al 1998). Fox-baiting programs are run by protected area management agencies to reduce the negative impacts of these animals (Ken Green, personal communication).

Tourism use also indirectly contributes to the continued presence of horses in the Australian Alps. There are well-documented negative impacts of horses on snow country, including proliferation and perpetuation of weed species associated with disturbance and dung piles; alteration to drainage patterns; redistribution of nutrients; compaction and alteration of soil structure; trampling or grazing damage to grasslands, heaths, stream banks, and bogs (Costin 1954; Dyring 1992). However, the control of "brumbies" is highly controversial, with the animals often seen by tourists and the gen-

TABLE 2 Judged importance of impacts of tourism on wildlife and vegetation. Values represent the number of managers who rated the impact at the listed level of significance. A, completely insignificant; B, insignificant; C, average; D, significant; and E, extremely significant.

Impact on/of	A	B	C	D	E	Mean
On wildlife						
Impact within protected areas/away from ski resorts of:						
Feral animals (foxes, rabbits, trout etc)	0	0	1	5	7	4.46
Development of roads/trails	0	1	4	5	2	3.67
Tourists collecting firewood	0	2	2	6	2	3.67
Wildlife feeding by tourists	0	3	5	4	1	3.23
Littering by tourists	0	3	4	6	0	3.23
Noise pollution at campsites	0	4	3	6	0	3.15
Photographing by tourists	3	8	2	0	0	1.92
Impacts of resorts and associated infrastructure on adjacent natural areas:						
Increased density of feral animals (foxes etc)	0	0	1	6	4	4.27
Barriers to native animal movement (summer or winter)	0	1	0	7	3	4.09
Reduced/fragmented habitat	0	1	1	6	3	4.00
Road kills	0	1	2	6	2	3.82
Disturbance to native wildlife from noise, floodlighting at night, movement etc	0	0	4	5	2	3.82
On vegetation						
Impact within protected areas/away from ski resorts of:						
Weed introduction (shoes, cars, track construction etc)	0	0	2	5	6	4.62
Horse riding	0	0	0	6	7	4.54
Vehicles driven off road	0	0	1	8	4	4.23
Trampling/erosion/short cutting	0	0	3	6	4	4.08
Campsite design and use	0	0	3	7	3	4.00
Careless use of fire	0	0	5	3	5	4.00
On vegetation (continued)						
Impact within protected areas/away from ski resorts of:						
Addition of nutrients to site (detergents, fecal material, urine etc)	0	0	4	5	4	4.00
Collection of plants and firewood	0	0	5	4	4	3.92
Huts (presence and use)	0	0	5	6	2	3.77
Mountain biking	0	0	7	5	1	3.54
Littering by tourists	0	2	6	5	0	3.23
Impacts of ski resorts and associated infrastructure on adjacent natural areas:						
Introduction of weeds (deliberate in revegetation, accidental in mulch, seed dispersal from gardens etc)	0	0	0	4	7	4.64
Soil compaction, disturbance, erosion, and runoff	0	0	2	7	2	4.00
Changes to hydrology (surface drainage, slope wash and sediment runoff, ground water depletion, changed subsurface flow, spring flooding etc)	0	1	2	4	4	4.00
Increased nutrification (fertilizer from revegetation, nutrients in slope wash etc)	0	1	2	4	4	4.00
Vegetation clearance	0	0	1	9	1	4.00
Plant pathogens (in soil, mulch, tires etc)	0	1	3	5	2	3.73
Damage or compaction of vegetation under snow	0	1	3	6	1	3.64
Fire risk from stoves, machinery etc	0	2	4	3	2	3.45

eral public as an integral part of the high country experience (Dyring 1992). The strong emotive response to these horses limits the management options available to protected area managers, given that effective control requires a community-based approach (Dyring 1992).

Introduced trout (brown trout and rainbow trout) were actively stocked in mountain streams and can be found in the many creeks and rivers of the Australian Alps (Green and Osborne 1994). The control of introduced trout has not been effectively addressed even though harmful effects on stream ecology have been documented, including reductions in native fish numbers (Green and Osborne 1994).

Other tourism impacts considered important by protected area managers included barriers to native animal movement and fragmentation and reduction of habitat (Table 2). This level of concern is consistent with the findings of studies on the impact of tourism on the already fragmented and limited habitats of the mountain pygmy possum, Baw Baw frog, corroboree frog, and other animals (NSW NPWS 1990; Green et al 1992; Green and Osborne 1994; Green 2000).

Road kills and disturbance of native wildlife by external noise, floodlights at night, etc also were considered by protected area managers to be important impacts on native fauna (Table 2). Although studies

elsewhere in Australia and overseas have examined the importance of these impacts, equivalent research has not yet been carried out for the Australian Alps (Buckley et al 2000).

Vegetation (flora)

The impacts on flora were considered slightly less important than those on water quality and fauna, particularly in backcountry areas (Figure 2). Protected area managers assigned high importance to tourism activities affecting native vegetation. For example, weeds were considered to be the single most important individual impact of tourism use in the Australian Alps (Table 2). The current diversity and abundance of weeds in the Alps is closely associated with the provision of facilities for tourism (Figure 3), even though many weeds were introduced and spread during the grazing, forestry, and hydroelectricity periods (Mallen-Cooper 1990; McDougall and Appleby 2000; Johnston and Pickering 2001). Of the 175 taxa of alien plants recorded in the Australian Alps, 78% are found along roads and paths, whereas 58% are established around the ski resorts (Johnston and Pickering 2001).

Considerable effort and expenditure has been made by protected area management agencies to limit alien plants in the Australian Alps (Robinson 1996). This has included expensive—although in some cases ineffective—herbicide spraying programs (Robinson 1996), an active program of rehabilitation of disturbed areas (Parr-Smith and Polley 1998), and biological control programs for specific problem weeds (Robinson 1996; McArthur 1999).

Tourism activities and their impacts on vegetation that were considered important by protected area managers include horse riding, vehicles driven off-road, trampling, erosion and short cutting, soil compaction, disturbance, changes to hydrology and increased nutrification, and direct vegetation clearance (Table 2).

Horse riding was a particularly important issue for flora conservation (Table 2). In addition to the impacts of feral horses, as described in the previous section, horse riding has negative impacts, principally through trampling, resulting in loss of vegetation, erosion, and changes to hydrology (Gibbs 1993; AALC 1994; Whinam and Comfort 1996). As part of the strategy to reduce the impact of horse riding, a code of practice for riders was produced by the AALC (Gibbs 1993; AALC 1994). Commercial horse riding is restricted to fixed trails within the protected areas, and camping is restricted to designated areas (Gibbs 1993; AALC 1994). However, private riders are not restricted to fixed trails (Dave Darlington, personal communication).

Changes to soil conditions are considered by protected area managers to be an important impact of tourism use (Table 2), and this corresponds well with research results. Soil compaction, disturbance, and erosion are all well-documented negative effects of tourism use as a result of trampling and construction of tourism facilities (Edwards 1977; Keane et al 1979; Hardie 1993; Good and Grenier 1994; CDT 1996; Arkle 2000; Buckley et al 2000).

The importance of mitigating damage to vegetation caused by alteration of soil conditions is such that protected area agencies have active rehabilitation programs. In addition, they have implemented methods to minimize damage during construction of tourism facilities (Parr-Smith and Polley 1998). There also have been programs to upgrade walking tracks to reduce tramping damage (Good and Grenier 1994; CDT 1996; Arkle 2000; Figure 4) and proposals to put limits on numbers and access to some high-use areas by tourists (Mackay and Nixon 1995; Worboys 1997).

Conclusions

Environmentally sustainable tourism use is critical in protected areas, such as the Australian Alps protected areas. Results of this survey show that Australian Alps protected area managers judge that ski resorts and their associated infrastructure have a greater negative impact on adjacent natural areas than tourism activities away from ski resorts. Water quality was seen as most affected both in and away from ski resort areas. The effect on wildlife and vegetation also was considered significant, whereas air quality was not as important. These results indicate that protected area managers' judgments of tourism use and its impacts appear to correspond well with actual impacts determined by research in the Alps.

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