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OFF-ROAD IMPACTS OF MOUNTAIN BIKES: A REVIEW AND DISCUSSION

by

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PREFACE

This review was undertaken to aid Department of Conservation managers in their consideration of mountain biking issues. The recommendations of the review are advisory in nature, and do not represent Department policy. The Departmental response to mountain biking issues is governed by the "General Policy for National Parks" and the "Department of Conservation Guidelines on Mountain Bikes".

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ABSTRACT

The current research "state-of-knowledge" of the physical and social impacts of mountain bikes upon backcountry tracks and upon the recreational experiences of other track users is reviewed. Physical impacts of walking and mountain biking, including the effects of foot trampling, and the unique impact potential from wheels are discussed; and the impacts from different types of track use (e.g., mountain biking, walking, horses, motorbikes) are compared. Social impacts of mountain biking are discussed, beginning with description of recreation conflict, and the role played in developing these conflicts by perceptions of other track users of the environmental impacts, safety hazards, and "inappropriateness" of mountain biking. The setting and recreation experience preferences of mountain bike riders are also discussed. The main conclusion drawn from these discussions is that the physical impacts of mountain biking are not a good basis for decisions about allowing access, and that the focus needs to be on the recreation conflict issues, and that the actual environmental impact and safety hazards associated with mountain biking may well be considerably less than perceived by other track users.

1. INTRODUCTION

Mountain bikes began to appear in New Zealand from the mid 1980s, and now represent probably the most significant "new-use" issue facing managers of areas used for outdoor recreation. The main challenge for managers has been to determine how mountain biking fits into the range of recreation opportunities they currently provide. The Department of Conservation, and many other public land managers (e.g., local authorities), recognise mountain biking as a legitimate form of outdoor recreation. However, when they consider which tracks could be made accessible for mountain biking, they are faced with *three main information requirements:*

- What are the physical impacts of mountain biking upon tracks, facilities and the environment.
- What are the social impacts of mountain biking upon the other users of tracks and facilities.
- What recreation settings and experiences are preferred by mountain bikers.

To date, the discussions and debates associated with mountain biking issues have been mainly confined to subjective magazine articles, anecdotal accounts, and advocacy arguments both for and against mountain bike access. However, *managers require a more comprehensive and objective research resource* to aid their decision-making.

Since the advent of mountain biking has been very recent, little specific research on its impacts has been completed to date, or has been published in a form more generally available to managers. This *review presents a summary of research information which has been available*[1], and is structured to address each of the three information requirements (above) in turn. The main points raised in this review are summarised in Section 5, followed by conclusions and recommendations in Section 6. These provide some direction for future management and research options.[2]

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[1] This material was obtained by use of appropriate abstracts, reference to the more recent papers, and personal communications. The search was undertaken as part of a Department of Conservation research project on mountain biking, reported in Cessford, 1995.

[2] Readers wishing to obtain a brief overview of this review should focus upon Sections 5 and 6.

2. PHYSICAL IMPACTS - MOUNTAIN BIKES

Like any outdoor recreation participants, *mountain bike riders will have impacts* on the environmental conditions present, including the soils, vegetation, water, and wildlife. This review concentrates upon the soil and vegetation impacts, as the others relate more to the presence and overall level of use rather than its specific type. In a comprehensive review of physical impacts of outdoor recreation activities[3], Cole (1987) noted that recreationists altered soil and vegetation conditions in *three* main ways:

- Trampling by humans and packstock (e.g., horses).
- Collection and burning of firewood in campfires.
- Confinement and grazing of packstock (at campsites).

When considering the New Zealand situation, and making specific reference to mountain bike impacts, only those impacts related to "trampling" apply in most cases. The corresponding "roll-effects" of wheels could be termed "wheeling". The following sections summarise research on impacts from trampling by feet, impacts from wheel action (e.g., "wheeling"), and the comparative impacts from different activities (including mountain biking).

2.1 Physical Impacts of Trampling

When investigating the effects of trampling in an alpine setting in Sweden, Emmanuelsson (1985:66) described *three* types:

- Trampling outside of tracks, especially visible around hotels, huts, ski-lifts, riversides, viewpoints etc.
- Trampling on irregularly used tracks.
- Trampling on marked and formed tracks in regular use.

2.1.1 Impacts on undisturbed (non-tracked) surfaces Much early research concentrated upon the specific impacts of trampling on different vegetation and soil types, under different environmental conditions (e.g., slope, aspect, rainfall, moisture content). This work most often involved *experimental trials* of trampling across sample quadrats in previously undisturbed vegetation and soils, and dealt with the impacts on the *ecological and structural behaviour of these previously undisturbed environments*[4]. A brief synopsis of the findings from this work follows.

The early effects of trampling in this context were injury and destruction of susceptible ground-level vegetation. Some vegetation species and morphologies had greater capacity to survive trampling, so the species composition often changed along the route being formed. As further use damaged and removed vegetation the disturbance of the

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[3] Note that no mention of mountain bikes was made here, or in the other major review used (Kuss et a1, 1990).

[4] Some examples of experimental methodologies used in these types of trampling studies are presented in Cole and Bayfield (1993) and Cole (1985b).

underlying soils increased. In the case of well-drained soils, this disturbance was most often compaction and reduced water infiltration-capacity. The greater occurrence of runoff increased the effect of erosive processes, particularly on slopes. In the case of poorly-drained and highly organic soils, this disturbance was most often structural deformation, leading to unconsolidated muddy areas. In both types of situation, when the damage made walking along the defined track more difficult, people tended to avoid the difficult areas by taking easier routes on either side. This behaviour resulted in the types of track widening noted in studies of alpine tracks such as Calais and Kirkpatrick (1986) in Tasmania; Bryan (1977) in Sweden; Bayfield (1973, 1985) and Lance *et al.* (1989) in Scotland; and Simmons and Cessford (1989) in New Zealand.

Research into the rate at which trampling causes changes in soil and vegetation conditions, has consistently found that *the degree of impact is not related simply to the increase in use-levels:*

> "Perhaps the most important finding of these studies is the overwhelming evidence that the relationship between use and impact is curvilinear, with the greatest damage occurring with low use." (Kuss *et al.* 1990: 82), and:
>
> "Compaction and erosion impacts are greatest at the early stages of use (Cole 1982, 1986). Thereafter the negative impacts of additional use slow considerably (Stankey and Manning 1986)." (Cordell *et al.* 1990: 82)

The greatest proportion of trampling impact is represented by the initial damage and removal of vegetation, and the formation of unplanned bare earth tracks. Once these informal and unplanned tracks have developed, the same trampling processes which operate on management-defined tracks will apply. However, trampling processes operating on these unplanned tracks are likely to be more damaging, as these tracks would have developed without the *careful consideration of track route, construction, and impact control usually undertaken on management-defined tracks.* The remainder of the trampling discussion concentrates upon the *ongoing impacts on tracks once they are defined* (whether by formal or informal means).

2.1.2 Impacts on formed tracks The primary environmental impacts associated with formed tracks arise through their *initial construction.* As noted by Cole (1987):

> "It is difficult to define when trail impacts become problems because the majority of change is purposeful change caused by trail construction and maintenance ...
>
> Because most of this is planned by management and accepted by the visitor, trail alteration becomes a serious problem only where it is unusually obtrusive (for example, where parallel ruts scar on alpine meadow), or where deterioration of the trail makes use difficult, and requires expenditure of large amounts of money and manpower for maintenance." (Cole 1987: 149)

Once a track route is clearly defined by managers, and usually a new "hardened" track surface formed, the process of subsequent trampling impact will continue with use. *The management focus will now be more concentrated upon maintenance and cost implications* of *trampling rather than their environmental impacts.* Most of the impacts occurring will do so almost immediately. As found with the rate of trampling change on undisturbed surfaces, most subsequent impacts on new management-defined tracks occurred in the initial "settling" period (Simmons and Cessford, 1989). Simmons and Cessford (1989) noted:

> "Overall the intial effects of trampling on a new track may appear bad (e.g., loss of residual topsoil and vegetation). However, this change often leads to more stable soil conditions as the more compact underlying soils resist further damage. For example, "recent" soils formed on river gravels may lose surface soil with trampling, but subsequently provide ideal gravel walkways. The exceptions to this are where soils are poorly drained or become watercourses. Clearly local drainage conditions are important, since most damage to soils occurs when they are wet. Here the different properties of organic soils (e.g., peat) and mineral soils (e.g., sand/silt/clay) become important." (Simmons and Cessford, 1989: 58).

Once tracks are *established,* whether by formal or informal means, there are *four main* interrelated management problems arising from the ongoing trampling. Based upon the summaries of Cole (1985a, 1987), and the general finding of other studies, these track impact problems are:

- Excessive erosion from enhanced water flows and disturbed soil surfaces on sloping sections of track, or at drainage points across the track.
- Muddy stretches in water saturated sections of tracks, often including major soil structure disruption and widening of tracks.
- Development of multiple parallel tracks where the main track is harder to traverse than the adjacent surfaces (e.g., too rocky, muddy, wet etc).
- Development of informal tracks, including shortcuts on corners and switchbacks, and around focal sites such as huts, campsites and attractions.

The main questions, with regard to mountain bikes in particular, are the ways in which they contribute towards the occurrence of these impacts, and whether the impacts from mountain bikes are *any greater* than those generated by other users (e.g., walkers). While some research into possible relationships between recreational use and such problems has been done, almost none has been specific for mountain bikes. In a major review of the American situation (Keller 1990), only two specific studies of mountain bike physical impacts were noted. Neither was published in a form readily available to a wider management audience. In general, apart from anecdotal accounts of observations of environmental impacts by mountain bikes, managers have had to rely upon findings from research which has generally had a soil-science and botanical orientation. This work has concentrated upon the recreational trampling effects of walkers and horses, and the wheel-effects of motorised vehicles.

Overall findings of research related to the physical impacts of recreational use of trails' have been summarised by Wilson and Seney (1994). The main points they emphasised were:

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[5] Comprehensive summaries of research into all types of physical impacts are provided by Kuss *et al.* (1990), and in the USDA Forest Service report which is referenced under Cole (1987).

- The primary importance of rainfall intensity and slope gradient as key factors in explaining soil loss on trails.
- That soil properties such as structure, texture and moisture content determine the resistance to erosion, and play secondary roles.

Wilson and Seney (1994) concluded that trail degradation occurred *regardless of specific uses,* and that this was more dependent upon *geomorphic processes* than the types and amounts of activity. This reinforces the general finding that the type and degree of any track impacts vary more as a result of the environmental conditions of the tracks than on the types of uses present. In this context, clearly the most effective means of minimising impacts on tracks lies in the *initial selection of the route,* and ensuring that construction methods avoid situations conducive to impact development. As noted by Simmons and Cessford (1989):

> "Settings with high rainfall, low drainage and a highly organic soil regime were identified as being most susceptible. It was considered that care in the route chosen for tracks was central to minimising use-induced impact. Where such susceptible settings could not be avoided, or impacts were occurring, careful track construction with an emphasis upon control of drainage was considered most important." (Simmons and Cessford 1989: 58)

However, in most cases *managers are dealing with existing tracks* which already traverse such areas. For these, the most effective means of minimising further impacts would involve "re-routing" some sections of track and "hardening" others. This in itself would create additional impacts, and considerable costs in maintenance (Cole 1987, Chavez *et al.* 1993). In this situation, managers are faced with a trade-off between the initial establishment costs, major one-off maintenance actions, and ongoing incremental maintenance demands in the future (Simmons and Cessford 1989).

Another option for managers would be to consider the amount and type of track use occurring, and to consider whether any management actions could reduce the development of impacts. Particular areas for attention would be the effects of *user numbers,* and *different types of uses* on track impact levels.

(i) Use levels and impacts

Cole (1987) reviewed research on the effects of use volumes on the amount of physical impacts. As noted previously, the *bulk of impact on unformed routes was generally found to occur at the initial lower use-levels.* By the time higher use-levels were achieved, most of the site changes had already occurred. But in the case of formed tracks, much of this impact was incorporated into the process of *constructing the track*. With particular regard to research on these types of formed tracks, Cole (1987) stated:

> "In sum, these results suggest there is little value, in terms of reduced impacts, in limiting the use of constructed trails." (Cole 1987: 157)

This statement does assume that the formation of the track route and surface is such that the users of it prefer to stay on it. Bayfield (1973, 1985) and others noted however, that where the track is *more difficult* to travel on than the *adjacent vegetation and surfaces,* track widening and multiple parallel tracks can arise. In general, Bayfield (1973, 1985) found that on relatively new tracks in the Scottish highlands, track widths increased with increasing use, but that on old traditional tracks, the widths appeared stable. This suggests that these older tracks had long passed of the type of "settling" phase proposed by Simmons and Cessford (1989) for newly constructed tracks. The widening and parallel track impacts in the alpine wetlands of the Tasmanian highlands noted in Calais and Kirkpatrick (1986) appeared, however, to be occurring continuously as the successive informal alternative routes themselves became extremely wet and muddy. This degeneration of the track setting did *not* necessarily reflect increases in use levels, although this would have increased the rate at which these impacts spread.

(ii) Different activities and impacts

When considering different types of activities, the main question is whether *some are likely to cause disproportionately greater levels of impacts than others.* Given that most tracks were developed with a tradition of walking use, mountain bikes, as a new form of user with a new array of impact types, may present a particular problem for managers concerned with maintenance of tracks as satisfactory recreational resources. The following sections address this issue by briefly discussing the specific physical impact effects of mountain bikes, and reporting on comparisons between these effects and those of the main alternative use types (e.g., walking).

2.2 Physical Impacts of Wheels - Mountain Bikes

The physical impacts of mountain bikes are often associated with those of motorised vehicles through the common element of both having wheels. Thus, in many ways, their types of impacts could be considered similar, although important differences arise due to differences in wheel loadings and power, since mountain bikes are lightweight and non-motorised. The *key distinction* between the physical impacts of mountain biking and other non-motorised trail activities (e.g., walking, tramping, running, horse-riding) lies in the *unique effects of wheels* on surfaces, relative to those arising from *trampling by feet.*

Studies of human trampling have been extensive and diverse. For example, the trampling motions of feet were described in Holmes (1979), the effects of different types of boot sole were compared by Kuss (1983), and the forces exerted on surfaces by walking were investigated by Quinn *et al.* (1980). Quinn *et al.* (1980) noted that damage from feet was caused first by the downward compaction forces from the heel early in the step, and then from rotational shearing forces from the toe at the end. The *shearing action was* found to be most important, particularly through soil deformation and "smearing" in wet conditions, and was found to be greatest on up-slope travel. Downhill walking was not investigated in the analysis by Quinn *et al.* (1980), but seperate work by Weaver and Dale (1978) and Weaver *et al.* (1979), found that downhill stepping (by foot and hoof) was *more* erosive than downhill motorbiking. This was due to the greater downward forces exerted through the heels in down-stepping. The importance of this distinction between downhill and uphill stepping was emphasised by Bayfield (1973), who found that although 20 percent fewer steps were taken on downhills than uphills, the erosive impacts of downhill stepping was still higher.

Wheels also exert compactive and shearing forces on surfaces, but their transmission of these forces to surfaces is *different* from that of feet. Soane *et al.* (1981) identified three types of forces exerted on soils surfaces by powered wheels[6]. These included the downwards compaction force due to dynamic load on the wheel, the rotational shearing stress from the wheel torque acting around the axis, and vibration effects from the engine transmitted through the wheel. Clearly the latter does not apply in the case of mountain bikes.

Mountain bikes will exert downward force through their tyres, although the "mean ground contact pressure", which comprises the wheel load divided by the contact area (Soave *et al.* 1981, Smith and Dickson 1990) is likely to be less than that of heavier motorised vehicles, horses and heavily laden hikers. Weaver and Dale (1978) noted that motorcycles had *least* impact on downhill slopes, due to exerting lesser downward forces than hikers or horses. With the lower wheel loadings of mountain bikes, their impacts upon downhill slopes are likely to be *much less* than those from motorbikes. This does assume that the wheels continue to turn rather than *skidding with hard braking.* Such skidding can loosen track surfaces and move material downslope, and most significantly, promote the development of *ruts* which channel water-flow. The development of such ruts, which can promote erosive water-flows to a greater extent than by foot-step puddling, is the most distinctly unique "wheeling" impact. However, where skidding does not occur, impacts from the normal rolling effects of wheels would likely be less than those of foot steps.

It should be noted here that the compaction forces will only be contributing to impacts if they occur *off* formed tracks. Most tracks are constructed to provide a consolidated and compacted surface, which allows easy travel for users. Where tracks are soft and wet, the effect of downward forces will be less a case of compaction, and more one of soil smearing and deformation.

Mountain bikes will exert shearing forces from the torque applied to the rear wheel in particular. The front wheel is essentially "un-powered". When the shear strain of the soil is exceeded, particularly in wet conditions or on unconsolidated surfaces, "wheel-slip" occurs[7]. In motorbikes this can be generated on level surfaces and uphill sections over considerable distances by high acceleration and loss of most traction. Motorbikes were found to have their *greatest* erosive effects on uphill sections (Weaver and Dale 1978; Weaver *et al.* 1979). Mountain bikes cannot generate the power to match the degree of torque generated by motorbikes, and rotational wheel-slip for them can *only* occur on extremely wet or unconsolidated surfaces. Usually, the occurrence of wheel-slip means

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6 Much research on this topic area is available in agricultural and engineering soil science journals. (e.g., Soil and Tillage Research; Transactions of the American Society of Agricultural Engineers; Journal of Agricultural Engineering Research; Soil Science Society of America:- Proceedings; Journal of Terramechanics).

7 A similar trampling effect of "foot-slip" also occurs in these conditions.

the rider must dismount and walk, unlike motorbikes which can apply more power to maintain way until better traction is achieved. This power difference provides motorbikes with a far higher capacity for sustained wheel-slip and its associated gouging effects. Both motorbikes and mountain bikes can have downhill shearing effects through loss of lateral traction and side-slipping, although this is *more* likely in extremely wet conditions, on uncompacted surfaces, or due to poor braking practices. As becomes apparent in the next section, the *downhill effects of mountain bikes, where they have their greatest erosive potential, are not greater relative to those of other activities* (e.g., walking).

2.3 Impact Comparisons for Different Activities

Specific research on the physical impacts of mountain biking is rare, with the little which has been done not being readily accessible. Only one study which included mountain biking in a comparative assessment of impacts was available - Wilson and Seney (1994). The extensive review of mountain bike issues by Keller (1990) discussed two other American studies, which were not widely available. Other work has included comparisons of impacts from different activities such as hikers, horses and motorbikes (Dale and Weaver, 1974; McQuaid-Cook, 1978; Weaver and Dale 1978; Weaver, *et al.* 1979; Price, 1985; Summer, 1986).

While these comparative studies did not include mountain bikes, they did find that the degree of physical impacts increased from hikers through to motorbikes and horses. However, it was also found that these activities had impacts in *different* ways. Wilson and Seney (1994) summarised the most comprehensive of these studies (Weaver and Dale 1978) thus:

> "Motorcycles moving uphill established a narrow rut which increased the velocity and sediment transport capacity of trail runoff. The development of this linear channel was a direct result of the imprint of the tyre and the torque applied by the motorcycle which then led to increased erosion. However, motorcycles moving downhill, when torque is not needed, caused less erosion than hikers and horses, which tend to loosen soil when descending a steep trail because greater forces are applied when decelerating and moving down a steep trail." (Wilson and Seney, 1994: 78)

The general consensus from these comparative studies was that the *trampling impact was greater on slopes than on level sites; on wet rather than dry surfaces; and that it tended to be greatest for hikers and horses moving downslope, and motorbikes moving upslope.* However, as noted in Section 2.2, mountain bikes lack the weight and torque generating capacity of motor bikes. On this basis, mountain bikes should have far less impact than motorbikes. Jenkins (1987) concluded that while detailed research results were not available, it was obvious that the impacts from mountain bikes were far *less* than those of motorbikes, four-wheel drive vehicles, and horses; and that on consolidated tracks the degree of impact was similar to that of hikers. Keller (1990) reviewed two studies which compared mountain bike impacts to those of other activities, and found that on the basis of the impact indicators used, the *impact effects of hikers and* *mountain bikers could not be distinguished.* Keller (1990) and Chavez *et al.* (1993) both cited the overall findings from a detailed study by Seney **(1990)[8],** who stated:

> "It was difficult to distinguish bicycle impacts from hiker impacts on the measurements of sediment yield, water runoff, trail micro-relief changes and soil density changes." (Keller 1990: 18)

In addition, Wilson and Seney (1994) noted that:

> "The multiple comparisons test results further clarified the roles of the different treatments and in particular showed that horses and hikers (hooves and feet) made more sediment available than wheels (motorcycles and off-road bicycles) on prewetted trails and that horses make more sediment available on dry plots as well." (Wilson and Seney 1994: 86)

At the current stage of research knowledge, it has not been established that mountain bikes have greater impact than hikers. Wilson and Seney (1994) do note that further research into the different impacts of mountain bikes and hikers is necessary. It is obvious that *mountain bikes do have some different types of impacts.* While they cannot usually generate the uphill erosive channelling found for motorcycles, they can have a similar effect on downhill slopes, most particularly when the surfaces are unconsolidated and wet, and/or the bike is ridden badly. Kellor (1990) noted:

> "...down hill mountain bike travel has the greatest potential for environmental impact to the trail (caused by skidding and poorly executed braking)." (Keller 1990: 19)

As noted in Section 2.2, this is a type of impact unique to wheeled vehicles, and is the major source of impact potential unique to mountain bike use. As stated by Keller (1990):

> " Land managers and other trail users often point out that bicycles create a linear track, compared to hikers and horses, who leave behind distinct foot or hoof tracks - like pockets - in the soil. A linear track tends to promote channelling of water, as opposed to puddling. The concern that bicycles will create channels, gullies, or troughs, in the trails, leading to trail erosion, is legitimate." (Keller 1990: 21)

While this acknowledges that mountain biking can cause unique impacts, it does not recognise that this effect would depend particularly on having wet soils, or on the occurrence of repeated skidding. Wetter soils are generally associated with low-lying areas with poor drainage rather than slopes, and skidding from braking on downhill slopes is often a result of inexperienced riders. These points are included to illustrate that the occurrence of *erosive impacts will vary according to site conditions and rider behaviour.* Chavez *et al.* (1993) cited research showing the inappropriate riding behaviour of those who rode around log waterbars on a trail, thereby widening the trail and compromising the effectiveness of the waterbars in controlling water flows. This type of behaviour has parallels with the general track-widening behaviour demonstrated by walkers, as described in Section 2.1 (e.g., Calais and Kirkpatrick, 1986; Bryan, 1977;

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[8] Preliminary report of Masterate research results. Wilson and Seney (1994) was a scientific article based upon this work.

Bayfield, 1973; Lance *et al.* 1989). In other studies of user behaviour, horses were found to create deeper and wider tracks than walkers (Dale and Weaver 1974), although the effects were more localised to the track, and fewer informal parallel tracks were formed (Weaver and Dale 1978; Price 1985). Walkers and horses in particular were also more likely to short-cut corners than motorbikes (McQuaid-Cook 1978; Price 1985).

At this point, it is important to put physical impacts such as trampling and wheeling *into perspective.* The two main studies of manager attitudes toward impacts found that over 70 percent of managers mentioned track and campsite impacts as being most important (Godin and Leonard 1979; Washburne and Cole 1983). As noted by Cole (1985a):

> "Trail damage is a problem in most wilderness areas and more money is invested in mitigating this impact - primarily in the form of maintaining and relocating trails - than any other." (Cole 1985a: 149)

However, such impacts are generally *localised and confined to strips alongside tracks and around focal points* such as huts, campsites and viewpoints (Cordell *et al.* 1990). For instance, Price (1985) cited a study of a heavily used backcountry area in Banff National Park, which estimated only 0.035 percent of its area consisted of bare soils along tracks. As noted in this review, most of this type of track development is likely to have been undertaken by managers, and most of the initial impacts would have been incorporated into the track construction process. Any subsequent impacts would be more dependent upon the choice of track route and construction methods, than the types of use received (e.g., walking or mountain biking). The limited amount of research available provides *no conclusive evidence* that subsequent impacts on susceptible sites would be any greater from more mountain biking use, than they would be from more walker use. As stated by Ruff and Mellors (1993):

> "To date, however, there has been little solid evidence to suggest that mountain bikes are any more damaging to bridleways than many pairs of feet or horses hooves though in some cases they can contribute further to problems caused by over-use. The major problem would appear to stem from perceptions of the countryside and hence that mountain bikes are not an acceptable form of countryside recreation." (Ruff and Mellors 1993: 105)

The conclusion of this statement by Ruff and Mellors (1993) represents an alternative focus for the debate on mountain bikes in off-road (track) settings, into the area of *social perceptions,* and the role these play in how both physical and social impacts are perceived. The remainder of this review deals with research related to this area.

3. SOCIAL IMPACTS - MOUNTAIN BIKES

The social impacts of mountain biking on other users can be best understood through the concept of *recreation conflict*[9]. The principal conceptual foundation of recreation conflict research has been the theory of "goal interference" (Manning 1986). This proposes that perceptions of conflict arise when the *presence and/or behaviour* of one group of users is incompatible with the social, psychological, or physical goals of another group (Jacob and Schreyer, 1980; Gramman and Burdge, 1981). As stated more descriptively by Watson *et al.* (1991):

> "Conflict amongst outdoor recreationists is partly a result of behaviour evaluated as unacceptable by one party (such as making too much noise, taking good campsites or getting in the way at portages) and partly as a result of perceived inter-group differences (such as different lifestyles, differences in attitude about the environment, and basic differences in reasons for coming to the site)." (Watson *et al*. 1991: 61)

The large amount of research which has been done on conflict and the associated concept of perceived crowding,[10] has identified a number of factors which can influence how encounters with other users, both within activity groups and between them, are perceived. These factors generally relate to the *personal characteristics* of the individual perceiving some conflict, the *physical and behavioural characteristics* of those causing the conflict perceptions, and the *setting* where the encounters take place.

Based upon the review by Manning (1985), the types of factors which determined the recreation experience "goals" of individuals who perceived conflict, included:

- The personal motivations, preferences and expectations association with an activity.
- The personal experience levels in outdoor recreation activities.
- The personal attitudes toward wilderness, environment, nature, and the settings where encounters occur.

The features of other users which contributed to the "goal interference" outcomes for those perceiving a conflict:

- The type and group size of the other users encountered.
- The behaviour of the other users encountered.
- The perceptions of alikeness with the other users encountered
- The type or designation of areas where encounters occur.

The factors described are inter-related, and clearly indicate that *recreation conflict is a more complex phenomena than simply a case of "one activity versus another".* This complexity is reflected in the variety of subjective reasons usually given for disapprov-

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9 Hom (1994) provides the most comprehensive work on mountain bike conflicts to date.

10 Manning (1985, 1986) provides comprehensive reviews of factors contributing to perceptions of conflict (and crowding).

ing of mountain bikes in off-road settings (e.g., tracks). From consideration of all the studies and references available, these subjective reasons can be summarised as:

- Perceptions of greater environmental impacts and damage from mountain biking,
- Perceived safety hazards from fast and silent mountain bikes.
- Attitudes that mountain biking is an inappropriate activity in most natural settings.
- Perceptions that mountain bikes encroach upon walking opportunities.
- Perceptions that mountain bike riders are less interested in the setting and environment.
- A general dislike of mountain bikes and what they are perceived to represent.

In summary, these reasons can be categorised more simply as perceptions of *environmental impacts,* perceptions of *safety hazards,* and perceptions that mountain biking is *"inappropriate".* Each of these is discussed in turn, although it should be recognised that they are all interrelated.

3.1 Perceptions of Environmental Impact

A perception that mountain bikes cause more impacts on the environment (e.g., tracks) than do other uses (e.g., walking), is common to most statements about conflicts. This was demonstrated clearly in the examples presented in Keller (1990), and by the research findings of Coughlan (1994) and Horn (1994). Using an open-ended question, Coughlan (1994) found that some walkers (20%) and trampers (22%) stated "possible track damage" as a reason for disliking meeting mountain bikes. Using a listed option question, Horn (1994) found that over 75% of walkers sampled included "track damage" as one of their two main reasons for considering mountain biking a problem on tracks (the other was safety hazard). In addition, from a sample of land managers, Chavez *et al.* (1993) found that 35% reported some resource degradation from mountain biking in areas that they managed, although the extent of such impacts was usually limited to one or two tracks or susceptible track locations. The main reason managers attributed such importance to this concern was emphasised by Chavez *et al.* (1994):

> "A second reason for concern is trail maintenance, the need for which has increased while budgets have continued to be limited. If resource degradation results from mountain biking directly, or indirectly from increased trail use, maintenance will become a larger problem for the future. The extent of resource degradation attributable to mountain bikes is a matter of debate." (Chavez *et al.* 1993: 30)

Clearly, the potential for *physical impacts from mountain bikes is a predominant concern for managers and other users,* and it appears that they generally attribute a *disproportionately greater* level of environmental impact to mountain bikes.[11] But, as has been established, the research evidence to date has been inconclusive in establishing that mountain bike impacts are any "worse" than impacts from any other users. One question that should be addressed, is that if an increased number of users to a site come

[11] Riders consider that others over-estimate the environmental impacts of mountain bikes (Cessford 1995).

on mountain bikes instead of as walkers, would the environmental impacts of the increased use be any greater? Chavez *et al.* 1993) re-iterated the difficulty in objectively attributing resource damage to any one user group:

> "Respondents also cited examples of resource degradation believed to be caused by mountain bike use. And some respondents expressed concern that trails newly opened to mountain bike use might incur significant resource damage. It is difficult to tell how much trail degradation is due to mountain bike use, as it is difficult to identify damage caused by any one group when multiple groups use a trail." (Chavez et al. 1993: 35)

Despite the general perception to the contrary, it would appear from the limited research available, that mountain bikes may *not* necessarily cause a greater degree of impact to tracks than do walkers. However, the *impacts that mountain bikes do have are distinctive* (e.g., tyre tracks), and this obvious difference may play a significant role in how the overall effects of mountain bikes are *perceived.* When discussing the indirect perception of impacts, Jacob and Schreyer (1980) proposed a process they termed as "scapegoating", where perceived conflicts were disproportionately attributed to particular groups. In this context, observation of tyre marks on a track surface may lead to a conclusion that any general damage to the track is caused by mountain bikes, without acknowledgement of the other impact processes taking place. Here it seems that the problem relates more to *how mountain bikes are generally perceived* rather than the *actual effects* that they have.

3.2 Perceptions of Safety Hazard

A perception that mountain bikes present a safety hazard to other users is as common as perceptions that they cause greater environmental impacts. This is apparent from numerous examples in Keller (1990), Coughlan (1994) and Horn (1994). Keller (1990) summarised the types of hazards posed:

> "Other public safety matters are frequently intertwined with perceived or actual physical conflict with other trail users. Hikers and equestrians have voiced legitimate safety concerns about mountain bicycle use on unpaved trails, including:
>
> - cyclists may ride too fast for conditions (e.g., on crowded, multiple-use trails),
> - cyclists may not slow down and/or may not be prepared to stop when approaching blind comers,
> - cyclists may surprise hikers and equestrians on trails because they are quiet and move rapidly." (Keller 1990: 11).

These concerns are valid, and it is apparent that the *behaviour of some riders has posed a hazard.* Keller (1990) noted a number of accounts of problems from the reactions of horses to mountain bikes in particular. And in discussing the results from the widely cited project known as the "Los Padres Study" or "Kepner-Trego Analysis"[12], Grost (1989) stated:

[12] This is an unpublished series of reports prepared for the Santa Barbara Ranger District of Los Padres National Forest in California. It contains an extensive array of physical and social research results, but is not readily available.

> "Safety was the primary concern in the Los Padres Study, particularly because of a few rogue bikers with the habit of starting at the top of the trail and coasting down at kamikaze speeds. The obvious safety hazard was dealt with via a combination of education (a biking brochure) and trail design (rocks and other natural objects used as speed barriers in the trail). Yet of the 1400 trail users surveyed, most had encountered mountain bikes on the trail and found bikers to be polite and not a safety hazard." (Grost 1989: 76)

Jacoby (1990) provided more detail from the same study, noting that 67 percent of non-riders did not feel mountain bikes were a safety hazard, 89 percent characterised riders as being "polite", and only 11 percent cited "meeting mountain bikes" as being a source of dissatisfaction when hiking. From this study, Jacoby (1990) also noted that only 15 bike-related incidents were perceived by walkers as being hazardous, and the only accident actually reported involved bikes hitting each other while making way for a walker.

These types of findings suggest that while potential hazards do exist from *irresponsible riding,* cases of actual accidents or injuries are *not common.* From a sample of 40 resource managers, Chavez *et al.* (1993) noted that only one case was known which had resulted in injury. And Coughlan (1994) found that although 38 percent of walkers considered mountain bikes "compromise safety", only 10 percent reported safety concerns as a negative outcome from actual encounters with mountain bikes. Most mountain bike riders in Cessford (1995) considered the safety hazard to others from bikes was over-estimated, and that the actions of a few irresponsible riders caused most problems. It appears that in most cases, the "safety" concerns relate more to an *anticipation* of potential threat than any *actual experiences* of hazardous riding. As noted by Horn (1994):

> "Trampers' experiences can be diminished by the mere threat of a sudden meeting. For older trampers who may have slower reaction times and be less able to hear a bike approaching, it can be difficult to relax if they fear meeting a bike. For younger walkers with good hearing and quick reactions, this may not be such an issue. People who are familiar with the braking systems on the bikes may find meeting bikes less threatening..." (Horn 1994: 139)

Clearly, perceptual differences in assessing the hazard potential of mountain bike and walker encounters is important. Keller (1990) noted that a hiker might think "Boy that was close", while the cyclist felt in control of both the bike and the situation. *Familiarity with mountain bike riding and accumulated experience of previous off-road encounters with bikes may result in changes in the perception of the non-riders.* Such as process was suggested by some results in Chavez *et al.* (1993) and Banister *et al.* (1992), where negative attitudes by walkers toward mountain bikes appeared to remain constant despite an increase in riding use-levels. When referring to the Los Padres Study, Chavez *et al.* (1993) noted that:

> "... although mountain biking had risen from 7% to 24.4% of all trail use in the area, users [in 1989] did not perceive cyclists to be any more of a problem than in 1987, and the levels of safety problems remained minimal." (Chavez *et al*. 1993: 30).

And Banister *et al.* (1992), while not referring specifically to safety concerns, noted:

> "A tentative conclusion from the analysis is that, in the abstract, cyclists are going to be seen as much more of a problem than when users of shared facilities have some experience of coping with them." (Banister *et al*. 1992: 157)

As with environmental impacts, there is an insufficient body of research to draw solid conclusions about the real and perceived hazards posed by mountain bikes, and the effects of these on the experiences of other users. What does seem clear is that *some walkers will feel uncomfortable knowing that mountain bikes may be present, whether a real hazard exists or not.* There is some suggestion that as walkers become more familiar with mountain bike encounters, their hazard concerns may diminish. However, again the research is not conclusive to date. Also, as with environmental impacts, the degree to which perceptions of safety hazard may relate more to a general disapproval of mountain bikes is unclear. This third type of conflict perception with mountain biking relates to such feelings of disapproval. These represent a perception that mountain biking is not an "appropriate" activity in off-road track situations.

3.3 Perceptions that Mountain Biking is Inappropriate

Environmental and safety impact perceptions are the two most common specific reasons given for recreation conflict perceptions. However, it is apparent that these *can not be simply distinguished* from more complex perceptions that mountain biking is "wrong". Indeed, these first two concerns may be in part reflections of an underlying feeling mountain biking "should not be permitted in this area".

This third main type of conflict perception is based upon assumptions by walkers (and also often managers), that the personal characteristics, motivations, behaviour types, environmental attitudes, and activity-styles of mountain bikers are *fundamentally different* from their own. In this respect, conflict between walkers and mountain bikes represents the types of inter-activity conflicts already widely documented in crowding and conflict research.[13]

From these and other studies, the main general finding was that these types of conflicts arose when the presence and behaviour of other users was *perceived to alter the physical or social components* of recreation experiences (Jacob and Schreyer 1980).[14] How any particular conflicts arise will depend upon how each individual (and group), involved in different recreation settings and anticipating different recreation experiences, interprets the appearance, activity style, perceived motivations and preferences, and actual behaviour of others. More simply, perceived conflict in this context depends upon how "*different*" others are perceived to be. The two most common conflict patterns found, which summarise the factors leading to most inter-activity conflict perceptions,

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[13] Between canoeists and motorboaters (Lucas 1964, 1970: Stankey 1973; Adelman *et al*. 1982); canoeists and anglers (Knopf *et al*. 1973); anglers and waterskiers (Gramman and Burdge 1981); paddle and motorised rafting (Shelby 1980); backpackers and horse trekkers (Stankey 1973, 1980; Lucas 1980, 1985; Watson *et al*. 1993,1994); off road vehicles and walkers (Noe *et al*. 1983); and snowmobilers and cross-country skiers (Knopp and Tyger 1973; Butler 1974; Jackson and Wong 1982).

[14] When this effect occurs within an activity group, it has usually been interpreted as "crowding", while conflict is perceived to be an inter-activity effect. In reality, the concepts are integrated.

have been conflict between *"motorised"* and *"non-motorised"* activities, and the occurrence of *asymmetric "one-way"* conflict perceptions. Each is discussed in turn, although both are interdependent.

3.3.1 Motorised versus Non-motorised Activities The types of comments made about mountain bikes, particularly as summarised in Keller (1990) and Horn (1994), indicates that for many walkers (and managers), mountain bikes conceptually fall into the category of *motorised off-road vehicles.* As has been apparent for mountain bikes, the perceived impacts of motorised use have similarly emphasised environmental impact and safety; the appearance, noise, behaviour, presence of mechanisation; and the inappropriateness of such in natural settings. Implicit in this has been the assumption that the recreation objectives, environmental attitudes, and values of these other recreationists are also different.

In general, research has found *clear differences between motorised and non-motorised users* in the recreation experiences they are seeking. Studies of conflict between snowmobilers and cross-country skiers have found differences in the fundamental orientation of preferences and motivations between the two groups (Knopp and Tyger 1973; Butler 1974; Jackson and Wong 1983). Skiers indicated an aversion to mechanisation in recreation and tended to be motivated by needs for solitude, tranquillity and physical exercise. Snowmobilers were machine-oriented and tended to be motivated by needs for socialisation, adventure and escapism. Clearly when both are trying to use the same settings, perceptions of conflict are almost inevitable.

Research has also shown that similar patterns of experience preferences are generally carried by these groups into the other activities they participate in (Knopp and Tyger 1973; Bryan 1979; Devall and Harry 1981; Jackson and Wong 1983). For example, Jackson and Wong (1983) found that the alternative activities undertaken by cross-country skiers tended to be passive, self-propelled, low impact, and requiring perception of a high quality natural setting (e.g., hiking, cycling, tent-camping, jogging, canoeing, nature study). Jackson (1987) termed these types of activities as "appreciative", and noted they had a stronger "preservationist" orientation than other users. By contrast, Jackson and Wong (1983) found the alternative activities of snowmobilers tended to be active, mechanised, high impact, and have a more "consumptive" orientation (e.g., trailer-camping, motorboating, trail biking, dune buggying, hunting, fishing). Jackson (1987) termed these types of activities as **"mechanised"**[15], and noted they had stronger "pro-development" orientation than other users. Given these differences, it was concluded that these types of groups would *always tend to be in conflict,* even when engaged in *different activities and in different settings.*

Cycling was included as an "appreciative" activity along with hiking by Jackson and Wong (1983), although it is unlikely that they were aware of the impending variation posed by the development of mountain biking. An interesting question is how researchers such as Jackson and Wong (1983) and Jackson (1987) would have classified mountain bikes. It is clear that walkers and managers have a tendency to *associate*

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[15] With the exception of hunting and fishing, termed as "consumptive".

mountain bikes with "motorised" use.[16] Given the findings discussed here which emphasise perceptions of "difference" as being the key to conflict perceptions, and the relative consistency of fundamental differences between motorised and non-motorised activities, the question remaining is how different is mountain biking from walking?

3.3.2 Mountain Bike Rider Characteristics Visually, mountain biking appears to be very different. The obvious difference is in the use of bicycles and associated equipment (e.g., helmets, clothing, bags). Having different equipment has been the basis for perceptions of difference between people in different activities, or perceptions of different experience levels and commitment within the same activity (Bryan 1979). Comments made in Keller (1990), Horn (1994), and from general discussions of mountain biking (e.g., Ruff and Mellors 1993) indicate that the use of *bright cycling clothing and the mechanised appearance of cycle and rider can create conflict perceptions in walkers.*

In addition, although very generalised, it can be stated from the few studies that describe mountain bike riders (Cessford 1995; Coughlan 1994; Horn 1994; Ruff and Mellors 1993; Keller 1990; Gobster 1988), that mountain bikers will *over-represent males and younger age-groups* more often than all but the most extreme "wilderness" walkers. It was apparent that this effect becomes less pronounced as the riding setting used became more "developed" and "urban" (Cessford 1995; Ruff and Mellors 1993; Gobster 1988). Although stereotypical, this descriptive difference has often been associated with a "wild teenage" type of *image* for mountain biking in many comments and commentaries.

It is clear that these obvious visible differences have had an effect on the general perceptions of the activity. However, it is not clear whether these differences are also reflected in the actual motivations, preferences and environmental attitudes of mountain bike riders.

In the main studies that have compared the attitudes and preferences of walkers and mountain bike riders to date, the two groups seem generally *more similar* than was generally perceived (Coughlan 1994; Horn 1994; Watson *et al.* 1991). When Watson *et al.* (1991) asked different users their perceptions of similarity with users in other activity groups, and then compared the groups on their real features, they found that for hikers in particular, the perceptions were different from the reality (Watson *et al.* 1991):

> "Specific factors in which wilderness bicyclists exhibited significantly stronger similarity [with hikers] belief scores include the types of place they live, lifestyle, occupation, levels of education and income, attitudes about the environment, and values of the area. On most of these items the perceptions [of similarity with hikers] held by the wilderness bicyclist are very accurate. The mountain bike riders and hikers are hardly distinguishable on these factors.

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[16] Where regulations have been applied to prohibit mountain bikes, it has usually been based upon decisions to designate mountain bikes as "vehicles" under the guiding legislation.

Real differences between the groups, however, were few and did not follow the patterns of perceived dissimilarity [indicated mostly by hikers]. Mountain bike riders and hikers who entered the wilderness were similar in environmental attitude and activity focus." (Watson *et al.* 1991: 69)

In addition, Horn (1994) undertook an extensive series of in-depth interviews of both walkers and mountain bike riders, and from these concluded:

> "Trampers often feel that mountain-bikers have different attitudes towards the environment. While this is a reality in other recreational conflict situations, it is not so in the case of mountain-bikers and trampers. What differences there are may reflect the different ages or experience, of the two groups. Differences in focus, attitude, knowledge and in available free time could all be explained by the different preferences of older and younger participants, in the same activity." (Horn **1994[17]:** 55)

While the research comparing mountain bike riders and walkers has not been extensive, the findings to date suggest that the two groups are *more similar than is generally perceived,* particularly by the walkers. In this context, it would appear that continued association of mountain biking with the "motorised" types of activity groups and associated attitudes and behaviours would be misleading. As stated in summary by Watson *et al.* 1991):

> "Managers might also correct some of the misperceptions regarding how groups differ. The mountain bike riders and hikers, particularly those who go into the Rattlesnake to visit the wilderness, have more in common than the hikers realize. The bicyclists seem to be more aware of the similarities, probably because they are basically hikers who are using mountain bikes to gain quicker access to the wilderness boundary. But their interest in the setting and attachment to the wilderness resource are similar to those wilderness users who do not use a bicycle to gain quick access. Mountain bikers are also more likely to be hikers at other times than hikers are to be bicyclists." (Watson *et al.* 1991: 70)

At this point, to demonstrate further the complexities of conflict perceptions, it is useful to note that *other inter-activity conflicts* occur in association with mountain bikes and walkers. Both Horn (1994) and Coughlan (1994) noted that walkers also perceived inter-activity conflicts with *runners,* despite both being foot traffic. This reinforces the notion that the "*style*" of different uses and the *perceptions* associated with them are the fundamental basis of conflicts. Similarity between walkers and mountain bike riders was further indicated in Coughlan (1994), where they both perceived the same degree of inter-activity conflicts with motorised vehicles.

3.3.3 Asymmetric Conflict Perceptions The occurrence of "asymmetric" conflict perceptions has been a common finding from inter-activity conflict research. This occurs when those whose activities, appearance and behaviour are causing others to perceive a conflict, are themselves *unaware* that they are doing so and are unaware of any conflict. In general, those types of activities more susceptible to disturbance of this kind have been those of the *non-motorised* "*appreciative*" type. In general, the motorised

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17 This quote comes from an unpublished preliminary report to the Department of Conservation prepared by Hom, using draft material from the final thesis (Horn 1994).

users, who generally seemed to be involved in most of the recreation conflict perceptions of other users, have little perception of their own impacts on others. As noted by Jackson and Wong (1983):

> "Cross-country skiers choose their activity for precisely the reasons which make it susceptible to impact; whereas snowmobilers choose theirs precisely for the reasons which may generate those impacts." (Jackson and Wong 1982: 59)

There is some indication of such asymmetric perceptions between walking and mountain biking in the limited research available (Watson *et al.* 1991; Banister *et al.* 1992; Coughlan 1994; Horn 1994). These all suggested that walkers perceived mountain biking as a source of conflict *much more* than mountain bike riders perceived walkers as such. As stated in summary by Watson *et al.* (1991):

> "When asked to identify specific types of groups that interfere with enjoyment of trips to the Rattlesnake, only 9 percent of non wilderness and 4 percent of wilderness bicyclists cited day hikers or backpackers. Just over 23 percent of hikers attributed interference to bicyclists." (Watson et al. 1991: 64)

However, the conflict perceptions between mountain bike riders and walkers was *not* exclusively one-way. Adelman *et al.* (1982) considered such asymmetric conflicts ran counter to what could be expected according to socio-psychological attraction theory, which suggests that should one group perceive negative attitudes held towards them by others, such negative attitudes would be reciprocated. Jackson and Wong (1982) provided an example where the main conflicts perceived by snowmobilers were due to their awareness of the negative attitudes held toward them by cross-country skiers. In particular, this was related to the political implications for continued access to settings. Knopp and Tyger (1973) considered that this type of indirect impact arose particularly in situations of *perceived competition* for resources in setting *allocation politics.*

When Horn (1994) explored the reasons for conflict perceptions, walkers largely felt that their experiences were being compromised by mountain bike presence, while mountain bike riders perceived conflict arising from *potential threats to access* from walker attitudes and associated *anti-riding advocacy*. As has been noted widely in mountain biking magazines and articles (Keller 1990), the *main management response* to the advent of mountain bikes has been *track closures.* This appears to be considered by riders to represent the attitudes of managers when faced with a new demand, and the *greater* political lobbying power of walker and other non-rider groups. Horn (1994) considered that the responses of mountain bike riders indicated that such access-related political activity had made many riders feel more negative toward walkers. This usually also resulted in mountain bike riders *themselves becoming organised* to exercise their political voice in response to the actvity threats.

However, not all conflict perception by mountain bike riders toward walkers resulted in negative outcomes. As was evident in articles and reviews such as Baker (1990) and Keller (1990), and research such as Horn (1994), many riders were adopting encounter strategies which aimed to *reduce* the negative perception walkers held of mountain biking. Apart from responsible riding, these strategies included stopping to let walkers pass, offering friendly greetings, and becoming involved in volunteer track and resource protection work. As indicated in Cessford (1995), riders generally considered the *best* way to reduce conflict potential was through voluntary *self-regulation* of riding sites and behaviours.

4. SETTING AND EXPERIENCE PREFERENCES

When reviewing the findings of recreation conflict research, Manning (1986) concluded:

> "The evidence reviewed above strongly suggests that motivations play an important role in determining recreation conflict and that conflicts may be alienated by grouping recreationists according to similar motivations." (Manning 1986: 92), and

> "Closer definition of the relationship between motivations, settings and activities may enhance the degree to which outdoor recreation management can provide satisfying recreation experiences." (Manning 1986: 95)

Given the importance of understanding mountain bike riders and their demand characteristics, the lack of any research available which directly addresses their motivations and setting/experience preferences is important[18]. No research been done which contrasts these factors with those of walkers. Managers have been required to consider resource allocation decisions *without any research information on what types of settings and recreation experiences riders want.*

The only past experience of providing cycling opportunities has been based upon urban-style cycleways, such as that described by Pederson (1992). This example in an Australian National Park was a 2.5m wide sealed path suitable for sharing by cyclists, walkers and other users (e.g., wheelchairs). Preferences for a natural setting, scenery and a well-paved surface were predominant for riders on an urban "parkland" bicycle trail studied by Gobster (1988), who also found that almost half the survey sample had driven by car to use the trail for riding, indicating the recreational use of the trail was as important as the commuting opportunity.

However, these expensive options were designed for high-use situations and a wide variety of riding and non-riding users. While the majority of mountain-bike riders do not venture off-road,[19] those who do are likely to be looking for something more. Cessford (1995) and Horn (1994) in particular noted increased *preference for challenging physical and technical riding* amongst riders with greater experience. Riders in Cessford (1995) emphasised greatest preference for *challenging riding in natural forested areas* and on *single-track routes.* And for a proportion of riders interested in racing, a degree of competitiveness was also prominent amongst their most preferred riding experiences.

Through the interviews to identify conflict issues between walkers and mountain bike riders, Horn (1994) was able to summarise more generally the range of setting and experience preferences of off-road mountain bike riders. While noting that most walkers

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[18] Cessford (1995) and Horn (1994) provide the most comprehensive work on this issue to date. A summary table of setting and experience preferences from Cessford (1995) is provided in Appendix 1.

[19] Chavez *et al* (1993) referred to a study which indicated that only 30% of American mountain bike riders went off road. No data for New Zealand was available.

accepted that mountain biking was a valid outdoor recreation activity, Horn (1994) also noted that:

> "Walkers often seemed to think that providing one or two tracks for bikers would be enough. The difficulty with this is that bikers, like walkers, have a wide range of tastes and preferences and, in general, like variety. For example, many respondents felt that four wheel drive tracks in open country are ideal for biking, while others expressed distaste at the thought of using such places. To them, bush, trees and intimate narrow tracks are important parts of the experience." (Horn 1994: 142) and,

> "There is also a small group of more specialised bikers who travel long distances to get to good biking areas. For these people, the surroundings are much more important and it is unrealistic to expect them to use only tracks that motor vehicles can travel on or which run through exotic forested areas. Narrow bushed tracks provide a pleasant environment which challenges better riders." (Horn 1994: 143)

Preferences for riding in natural settings, and across a range of track types is apparent from these conclusions. Preferences for natural settings was also found amongst riders sampled by Ruff and Mellors (1933), of whom 51 percent favoured forest and woodland settings while only 8 percent favoured farmland. Bridleways were the most preferred track-type (65%), although being relatively wide and well-graded relative to walking-type tracks, they were perhaps less popular for more experienced riders. This type of pattern was apparent in Watson *et al.* (1991), where most riding was on wide trails that were once roads rather than the rough trails associated with hiking, which were less commonly used. These results do suggest that the *proportion of riders likely to be using walking-type trails, particularly of the rougher and less-developed type, will be small.* Rider preferences from Cessford (1995) indicated that *riders preferring more difficult tracks will be those generally more experienced and committed.* As noted by Grost (1989):

> "Regulations aside, there are still some places mountain bikes simply can't go. Steep boulder-strewn mountain trails are still the domain of the horse and hiker. Deep sand is nearly impossible to negotiate on a bike, as are swamps, bogs and wet meadows." (Grost 1989: 53)

It is likely that the difficulty of the tracks will act as a filter of the type of mountain bike rider present. Keller (1990) cited a statement from CORBA [20] :

> "In the same way that experienced hikers may range further and travel more difficult routes than the inexperienced without risking environmental damage and their own and other's safety; so may experienced riders ride safely on trails that less experienced riders could not ride." They add that advising cyclists "about difficult terrain is self regulating in that riders avoid terrain which is unrideable or unsafe at their riding level. It isn't enjoyable." (Keller 1990: 16)

Mountain bike riders have indicated preference for a *variety of riding conditions* and settings. They would appear to be as diverse a group as are people who walk outdoors for pleasure. For example, in a relatively early report on mountain biking in New

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[20] Concerned Off Road Bicyclists Association, from a memorandum to a park manager in America as cited in Keller (1990).

Zealand, Jenkins (1987) proposed four distinct categories of mountain bike riders. These included "City Bicyclists" who mostly commuted or travelled in town, "Bicycle Tourers" who did longer trips, "All-terrain Bicyclists" who ride off-road generally for fun, and "Trial Bicyclists" who challenge their technical skills in particular[21]. It is generally considered in most commentaries, and from most relavent research questions asked, that most mountain bike owners are only "City Bicyclists", and not venture off-road. However, the remainder of off-road cycists will include combinations of characteristics from these generalised categories used by Jenkins (1987).

Cessford (1995) summarised the variable setting and experience preferences of riders by grouping them according to experience levels (e.g., "Novice/Beginner/Casual", "Experienced Off-Road", and "Expert Off-Road"). This illustrated how rider preferences changed as riding skill, abilities and interests developed (refer Appendix 1). However, to date there have been no more definitive profile categories proposed for mountain biking.

The findings noted in this section concerning rider preferences for settings and experiences, indicate that mountain biking is more diverse activity than it may be initially perceived. The message to managers committed to making some provision for mountain biking opportunities, is that *a variety of settings and recreation experience types will need to be considered.*

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[21] Jenkins (1987) also included an "other" category for riders who enjoyed speed, although he made no mention of racing.

5. SUMMARY OF MAIN POINTS

This summary presents the main points raised from this review of current research "state-of-knowledge" about the impacts of mountain bikes. The key areas reviewed are the physical impacts of recreational use of tracks, the social conflicts between different track users and the recreation experience preferences of mountain bike riders. However, mountain biking is a recent development, and to date there has been little research done on its physical or social implications.

5.1 Physical Impacts of Recreational Use

The greatest proportion of trampling impact on previously undisturbed surfaces is represented by the initial damage and removal of vegetation, and the formation of unplanned bare earth trails. This represents an uncontrolled version of the basic process undertaken by managers when they develop a formed track. When a track is developed by managers, most of the environmental impacts are incorporated into this process. Once the track is established, it becomes the focus of visitor use, and effectively confines further use impacts to the controlled setting it provides. However, whether they are created formally or informally, four main types of track problems can arise from continued recreational use:

- Excessive erosion.
- Muddiness (with or without lateral spread).
- Multiple parallel trails.
- Development of impromptu trails at attraction sites.

While research into possible relationships between recreational use and problems like these has been extensive, almost none has addressed the specific impacts of mountain bikes.

In general, apart from anecdotal observations on mountain biking impacts, managers have had to rely upon the findings of the predominantly soil-science based research into recreational trampling by hikers and horses, and the effects of motorised vehicles.

In general terms, the overall findings of research related to physical impacts of recreational use of trails emphasised:

- The primary importance of rainfall intensity and slope gradient as key factors in explaining soil loss on trails.
- That soil properties such as structure, texture and moisture content determine the resistance to erosion, and play secondary roles.
- That trail degradation occurred regardless of specific uses, and that this was more dependent upon geomorphic processes than the types and amounts of activity.

5.2 Physical Impacts of Mountain Bikes

5.2.1 Physical Impacts of Wheels While the physical impacts of mountain bikes are often associated with those of motorised vehicles through the common feature of having wheels, they are non-motorised vehicles, and lack the weight and torque-generating capacity which contribute to the often extreme impacts from motorised vehicles such as motorbikes. However, the key physical impact distinction between mountain biking and other non-motorised trail activities does lie in the unique effects of wheels on surfaces, relative to those arising from trampling by feet. The development of ruts, mainly from skidding from braking on downhill slopes, can promote erosive water-flows to a greater extent than by foot-step puddling, and is the most distinctly unique mountain-bike impact. Similar gouging can also be caused on uphills, especially by over-powered wheels more characteristic of motor-driven wheels then pedal-driven.

5.2.2 Comparison of Mountain bike and other activity impacts Research to date has indicated that the degree of impacts from mountain bikes, relative to those of walkers who have their own unique forms of impacts, appear to be similar. The general consensus drawn from studies comparing activity impacts was that trampling impact was greater on slopes than on level sites; on wet rather than dry surfaces; and that it tended to be greatest for hikers and horses moving downslope, and motorbikes moving upslope. Mountain bikes were not included in these comparisons, but like motorbikes they would tend to roll downhill except when over-braking, and lacking the power to the wheels, generate far fewer gouging impacts from wheel-spin on uphills.

It has not been established in the research done to date, that mountain bikes have greater overall impact on tracks than do walkers. However, it is obvious that mountain bikes do have some different types of impacts. The research to date indicates that it would not be appropriate to state that one is any "worse" than the other. It would appear that the main physical impact implication from the advent of mountain biking really lies in the increase in user numbers they may represent, rather than in the nature of the new activity in itself. More research on the issue of comparative effects between activities is generally required.

In the types of impacts noted above, research has consistently indicated that the location of the track and condition of its construction through susceptible areas was more important in the occurance of impacts than the type of activity present.

5.3 Social Impacts of Mountain Biking

Recreation conflict is a more complex phenomena than simply a case of "one activity versus another". There are a number of reasons which are usually given for disapproving of mountain bikes in off-road (track) settings. From consideration of all the studies and references available, these subjective reasons can generally be summarised as:

- Perceptions of greater environmental impacts and damage from mountain biking.
- Safety hazards of fast and silent mountain bikes.
- Attitudes that mountain biking is an inappropriate activity in the environment.

- Perceptions that mountain bikes encroach upon walking opportunities.
- Perceptions that mountain bikers are less interested in the setting and environment.
- A general dislike of mountain bikes and what they are perceived to represent.

In summary, these reasons can categorised as:

- Perceptions of environmental impacts.
- Perceptions of safety hazards.
- Perceptions that mountain biking is "inappropriate".

5.3.1 Perceptions of Environmental Impact A perception that mountain bikes have more impacts on the environment (e.g., tracks) than do other uses (e.g., walking), is common to most statements about conflicts. But despite this general perception, the research evidence to date has not provided confirmation of greater impact. What little research is available appears to suggest that mountain bikes do not cause disproportionately greater impacts to tracks than walkers.

However, the impacts that mountain bikes do have are distinctive (e.g., tyre tracks), and this obvious difference may play a significant role in how the overall effects of mountain bikes are perceived.

5.3.2 Perceptions of Safety Hazard A perception that mountain bikes present a safety hazard to other users is as equally common as are the perceptions that they cause greater environmental impacts. The types of hazards posed can be summarised as:

- Cyclists may ride too fast for conditions (e.g., on crowded, multiple-use trails).
- Cyclists may not slow and/or be prepared to stop when approaching blind corners.
- Cyclists may surprise hikers and horses on trails as they move quietly and fast.

These concerns are valid, and it is apparent that the behaviour of some riders has posed a hazard. While potential hazards do exist from irresponsible riding, cases of actual accidents or injuries are rarely reported.

As with environmental impacts, there is insufficient research to draw solid conclusions about the real and perceived hazards posed by mountain bikes, and the effects of these on the experiences of other users. What does seem clear is that some walkers will feel uncomfortable knowing that mountain bikes may be present, whether a real hazard exists or not.

Some research suggests that with more familiarity of mountain bike encounters, hazard concerns may diminish, but to date this research is inconclusive. And as with perceptions of environmental impacts, the degree to which perceptions of safety hazard actually relate to disapproval of mountain bikes on principle, is unclear.

5.3.3 Perceptions that Mountain Biking is Inappropriate Environmental impact and safety hazard perceptions are the two most common reasons given for recreation conflict perceptions with mountain biking. However, it is apparent that these cannot be easily distinguished from more complex perceptions that mountain biking is "wrong", and "should not be allowed" in off-road settings.

This third type of conflict perception is based upon assumptions by walkers (and also often managers), that the personal characteristics, motivations, behaviour types, environmental attitudes, and activity-styles of mountain bikers are fundamentally different from their own. In this respect, conflict between walkers and mountain bikes represents other inter-activity conflicts already widely documented in crowding and conflict research.

The types of comments generally made about mountain bikes, indicates that for many walkers (and managers), mountain bikes fall into the category of motorised off-road vehicles. The impact perceptions associated motorised activities have also emphasised environmental impact and safety; the appearance, noise, behaviour, presence of mechanisation; and the inappropriateness of such in natural settings. Implicit here has been the assumption that the recreation objectives, environmental attitudes, and values of these other users are also different.

In general, research has found clear differences between motorised and non-motorised users in the recreation experiences they are seeking. However, while the research comparing mountain bike riders and walkers has not been extensive, the findings to date suggest that the two groups are more similar than is generally perceived. In this context, it would appear that continued association of mountain biking with the "motorised" activity groups would be misleading.

To highlight the complexities of conflict perceptions, it is useful to note that other inter-activity conflicts occur in association with mountain bikes and walkers. For example, some walkers perceive conflicts with runners, despite both being low impact and "passive" foot traffic. This reinforces the notion that the "styles" of different activities and the perceptions associated with them are the fundamental basis of most conflicts. It provides some indication of what underlies walker attitudes to mountain bikes.

5.4 Setting and Experience Preferences

Managers are currently required to consider resource allocation decisions for mountain biking without any research information on what riders want. The only past experience of providing cycling opportunities has been based upon urban-style cycleways. While the majority of mountain-bike riders do not venture off-road, those who do are likely to be looking for something more.

Preference for challenging physical and technical riding, riding on routes in natural settings, and variety in riding experiences are the main preferences indicated by riders in the limited research results availible to date. For a small proportion of riders interested in racing, a degree of competitiveness was also present in the preferred riding experiences.

6. CONCLUSIONS AND RECOMMENDATIONS

The general conclusion from the material reviewed here is that the focus of attention on mountain biking impacts should be on the social perception aspects. Although mountain bikes clearly do have physical impacts on tracks, these did not appear to be of any greater significance than those from other track users, despite the general perception to the contrary. And, although safety concerns were also commonly highlighted, the problem related more to apprehension about what might happen rather than concern based on any inherent danger, or an established record of incidents. The real difficulty faced by managers making provision for mountain biking opportunities, lies in addressing the recreation conflict issues that arise.

Based upon this general conclusion, assuming that managers are considering what opportunities for mountain biking may be available, and recognising that some tracks will not be suitable for mountain biking, a number of more specific suggestions for management and research consideration can be proposed. These are noted briefly below.

(i) Managers should note that when considering making opportunities available for mountain biking, rider preferences for riding conditions are diverse. As riders gain in experience, their setting and experience preferences appear to move more towards opportunities characterised by natural settings, challenge, variety, and single-track riding. Rides characterised by these features are likely to be more difficult, and use numbers correspondingly lower.

(ii) The significance of assessing use-impacts on tracks needs to be reconsidered, as it is not established that mountain bikes have any greater impact on tracks than do any other non-motorised activities (e.g., walking, running, tramping, horses etc,). Also, actual impacts upon tracks represent more of a management maintenance concern than a significant impact on the environment. It is questionable whether these impacts should be the key factors in decisions to allocate or limit oppotunities for mountain biking. If major damage is anticipated due to susceptible track conditions, the presence of any use would seem to be problematic.

(iii) If managers consider that physical impacts on certain tracks should remain a key factor in such decisions, then more objective research on the actual impacts occurring will be required. This research should compare relative longitudinal effects of mountain biking and walking use on specified track impact criteria. Such work should be incorporated into any general monitoring programmes for visitor impacts which may be implemented.

(iv) Where mountain biking is to be allowed, but concerns remain over walker safety, active management of tracks to minimise hazard potential should be considered. The main actions this would require would include the strategic location of natural and constructed obstacles to reduce downhill and cornering speed (e.g., steps, culverts, logs, roots, rocks, waterbars etc,).

(v) Where managers wish to discourage or minimise riding on certain tracks, the strategic use of such obstacles (above) to increase the riding difficulty of tracks could be considered. As track difficulty and inconvenience for riding increases, it is likely that fewer riders would be present. These types of managed difficulties would not be such a disincentive for walkers. Some trial work or social research may be necessary to test the effectiveness of the strategies suggested here and in (iv) above.

(vi) Where a track is being considered for possible mountain bike access, short-term visitor monitoring should be considered to identify the characteristics and use patterns of existing users. Tracks which are used by high numbers of walkers likely to be more susceptible to concerns such as perceived hazard from mountain biking (e.g., elderly walkers, young families etc,), may not be socially suitable or appropriate for mountain biking. On low volume tracks with more active users these concerns may be less significant. This may represent a further important area for social perception research. The assumptions about which visitors may be more concerned with mountain biking impacts should also be tested further.

(vii) There is some indication that the degree of conflict perceived with mountain biking may diminish over time as other users become more familiar with bike-encounters and riders themselves. Longitudinal research on tracks where mountain bikes are becoming more common should be undertaken to further identify the nature of the conflict perceptions arising, and how these may change over time.

Based upon these conclusions, a model for addressing provision of opportunities for mountain biking has been developed (Figure 1). This model describes some of the issues which should be considered by managers evaluating tracks for mountain bike use. It is based upon the degree of research and management knowledge to date, and should be considered as starting point, from which modified versions can be developed as new information emerges. It also provides some indication of where any research effort should be concentrated.

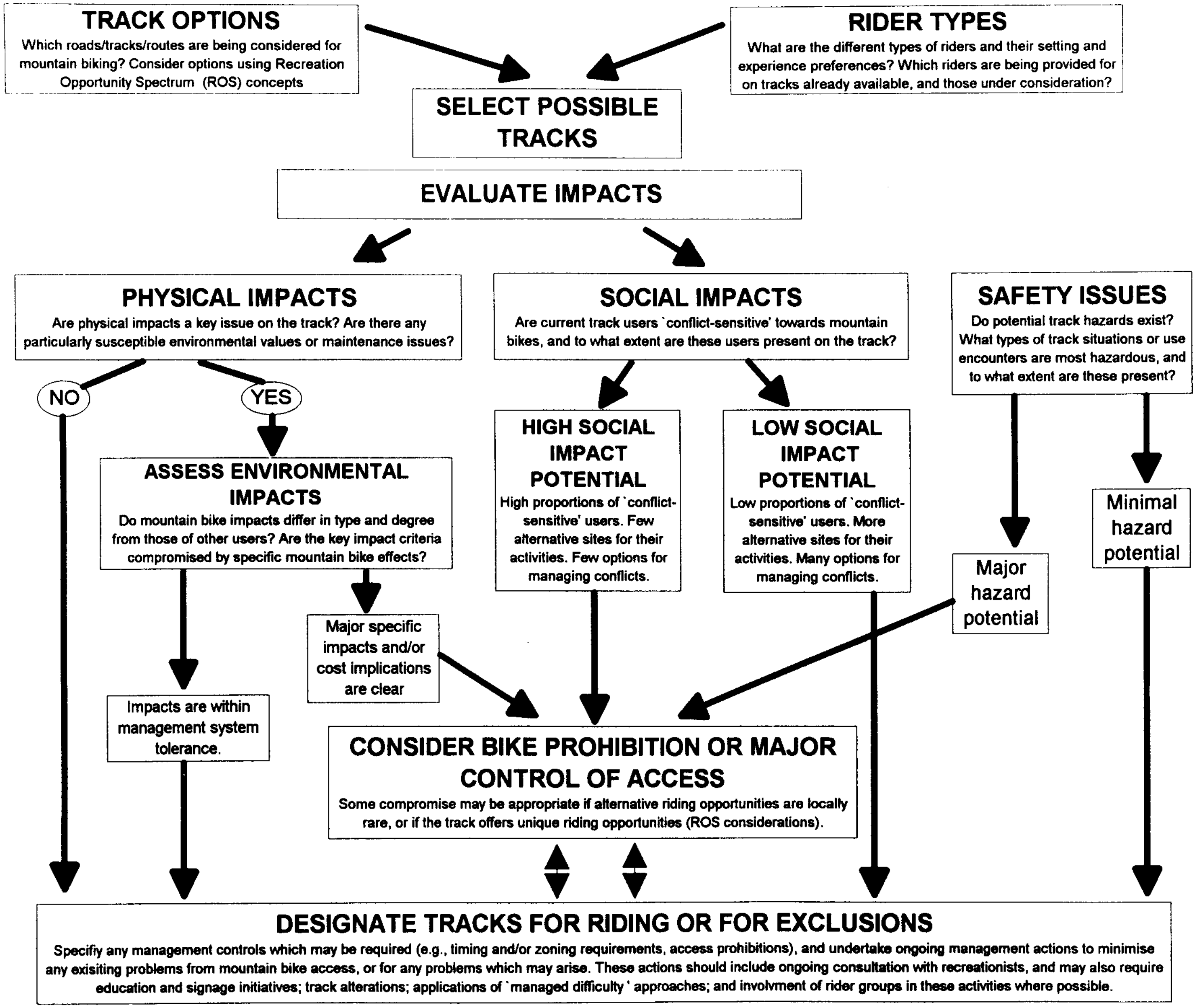

Figure 1. Model for decision making on mountain bike use of tracks.

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APPENDIX l: Summary Table: Mountain Bike Rider Preferences for Recreation Settings and Experiences

Setting/Experience Attributes	Novice/Beginner/Casual Riders	More Experienced Off-Road Riders	Expert Off-Road Riders
Preferred features of mountain bike riding. (as rated by riders)	*General preference for appreciating **views/scenery/nature**; **exploring** new areas; and **riding/socialising** with friends.*		
	The attribute of **exercise/fitness** is particularly important for these riders.	Attributes of **speed/excitement/risk**; **physical challenge**; **skill/technical challenge**; and **developing and improving skills** become more important for these riders.	**Increased** preference amongst expert riders for **speed/excitement/risk**; **skill/technical challenge**, and **racing/training** (latter reflects race-entry sample selection).
Statements of most preferred riding features. (from open-ended question)	*General preference for **undulating routes**; **forest settings**; **smooth/fast/open tracks**; good **scenery/viewpoints**; and rides of **2-3 hours**.*		
	Prefer **gradual/easy uphills**; tracks being **smooth/easy/open**; tracks being **not difficult/few obstructions**; and rides **1-2 hours** duration.	Preference for **technical difficulty/challenge**; down-hills being **fast/smooth/open** and **fast/technical/tight**; harder uphills; and **tight/narrow/winding single-track**.	**Increased** preference for **technical difficulty/challenge**; downhills being **fast/technical/tight**; and **tight/narrow/winding single-track**.
Landscape Preferences	*Greatest preference for **native forest/bush** settings (least for farmland). Beginners had least preference for forestry (pine) areas.*		
Track-Type Preferences	Greater preference for **sealed roads**, and more **tolerant of gravel roads**. Much lower preferences for single-track.	Emphasis shifts to **less-developed** routes, and **single-track** in particular.	Distinguished by much **stronger** preference for **single-track**.
Track Condition and Difficulty Preferences	Greater preference for tracks which are **smooth/benched/open/clear**. Much **lower** preference for obstructions/difficulties on tracks, or for pushing/carrying bikes.	Preference for **rougher tracks/more obstacles**; and **rough/uneven/tight/narr ow** tracks. More tolerance for pushing/carrying bikes.	Similar preferences for **rougher tracks**, but **less** interest in wet conditions and mud. Even **more tolerance** for pushing/carrying bikes.
Downhill Attribute Preferences	Strong preference for **slow/gentle/easy** downhills. **Least** preference for speed/excitement/risk.	Preference for **fast/rough/technical** downhills. **Increased** preference for **speed/excitement/risk**.	**Increased** preference for downhills which are **fast/rough/tight** and **slow/steep/more technical**, and for **speed/excitement/risk**.
Uphill Attribute Preferences	**Strong** preference for **gradual/easy/relaxed** up-hills.	**Increased** preference for uphills with **short/hard/steep** sections. Little specific preference for easy uphills.	**Increased** preference for more difficult uphills with **short/hard/steep** sections, and climbs which are **long/hard/steep.**
Social Encounter Attribute Preferences	*Riders strongly preferred to **avoid motorised vehicles**, and walkers (to a lesser extent). Most are tolerant of meeting other riders.*		