

Extreme sports in natural areas: looming disaster or a catalyst

for a paradigm shift in land use planning?

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Historically, visitors' motives for visiting protected areas included 'rest, relaxation and reinvigoration'. Ecological impacts were typically low. Recent trends have increased use of protected areas for extreme sports, with greater numbers undertaking more active recreation, such as extreme sports. The effect of this trend is considered, together with potential management options. We propose that the development of appropriately targeted and delivered educational programmes could minimise environmental degradation. However, to maximise ecological conservation in protected lands we consider that a major paradigm shift is required. This will require a more strategic, holistic approach to planning and managing outdoor recreation/sport destinations incorporating collaboration across stakeholders. Based on past experience, to continue with the current model will ultimately accelerate biodiversity loss, degradation of protected areas, and loss of recreational amenity.

Keywords: adventure recreation impacts; visitor impacts; national park management; protected areas visitation trends; speed climbing; mountain biking; snow sports; off-road driving; action sports; policy change

1. Introduction

Tourism, including recreation, is one of the most important industries worldwide, employing over 75 million people and representing 30% of the world's export of services (WTO 2009). One of the largest and fastest-growing segments is naturebased or 'ecotourism', with activity focused on natural areas of scenic beauty such as national parks (e.g. Ewert et al. 2006).

Historically, visitors' motives for visiting such areas included 'rest, relaxation and

reinvigoration', and 'solitude and escape'. For most people, the visit has traditionally been an end in itself and ecological impacts have been relatively low, with limited recreation infrastructure or habitat modification required (Hall et al. 2010). However, increasingly there are indications that motivations and associated activities of an increasing number of visitors to protected areas have begun to move from passive to more active forms of recreation. This change has important implications for the management and conservation of such areas. For example, the response to the perceived change in motivation for visitors to protected areas is indicated by a comparison between the National Park and Wildlife Service's Blue Mountains National Park draft management plans for 1988 and 1998 (NPWS 1988, 1998). The former makes negligible mention of active sports, while the latter devotes major sections to addressing these specific activities, and proposes major changes in management policy to combat potential impacts arising from them. This response reflects the long-recognised problem of balancing the conflicting objectives of recreation and conservation, which is likely to become more acute with increasing numbers of visitors to national parks seeking active recreation. In this paper we discuss major changes to visitation to natural areas, the rise in extreme sport as recreation in terrestrial protected areas, and offer potential management solutions.

2. The changing face of recreation in protected areas

2.1. Changing visitation patterns

Although visitation to the more than 630 protected areas comprising the United States of America (US) National Wilderness Preservation System (Cole 1996) and national parks have sustained increases in absolute numbers over decades, at least in these national parks, numbers have decreased per capita since 1988. The declining visitation has been significantly negatively correlated with increasing use of electronic media such as home/cinema movies, computer video games and the internet, together with travel costs due to increased oil prices (Pergams and Zaradic 2006). Comparison of visitation to protected areas among countries to verify if this is a global phenomenon is problematic, because even some of the most iconic World Heritage Areas lack long-term, accurate visitor data (Buckley 2004); and there is

argument among researchers (e.g. Jacobs and Manfredi 2008, Kareiva 2008, Pergams and Zaradic 2008) over underpinning assumptions and interpretation of results. In contrast to the apparent situation in the US presented by Pergams and Zaradic (2006), reporting on international patterns of visitation to protected areas, Balmford et al. (2009) suggested patterns showed 'spatial heterogeneity'. The majority (15) of the 20 countries they investigated were found to have increased levels of visitation. While more affluent countries, including North America and Australia, had experienced a decline, developing countries tended to have increased visitation to their protected areas.

In parallel with decline in visitation to domestic protected areas, most people in economically developed countries have increased available leisure time. Historically, advances in technology and management have meant that automation and organised labour have produced and transported more, faster and further than each preceding generation. This has resulted in greater individual leisure time, from 23% of a person's lifetime in the 1770s, to around 41% in developed countries in the 1990s. Based on projected trends, Molitor (2000) suggested that technological and organisational advances, together with longer life expectancy, earlier retirement and fewer children would mean that over 50% of a person's lifetime could become available for leisure in economically developed countries. Of these factors, most would probably not change substantially within a broad range of economic health in most developed countries; however, governments' actions associated with social security and other social transfer policies have a strong influence on retirement behaviour (Coile and Gruber 2007), and preference for leisure over the workforce may also be an important influence on reduced participation rates in the workforce among older workers, at least in Organisation for Economic Cooperation and Development (OECD) countries (Duval 2003). Increasing numbers of retirees will drive supply demand for an ever-widening range of products and services to meet people's leisure needs. Such needs encompass tourism (e.g. sightseeing, cruising), and recreation (e.g. hobbies, sports), based indoors or outdoors. The continuing escalation in the size of the leisure industry poses significant risks for environmental

impact, as leisure is the single largest driver of anthropogenic global carbon dioxide emissions (The Carbon Trust 2006).

Such macro-trends are reflected in the changing pattern of motivation of visitors to protected natural areas and the recreational activities undertaken within them (see e.g. expansion of adventure tourism – Swarbrooke et al. 2003). These trends have important implications for their management. ‘Adventure recreation’, defined as ‘outdoor activities in which the uncontrollable hazards of a natural environment or feature are deliberately challenged through the application of specially-developed skills and judgment’ (Brown 1989, p. 37) is one example. The definition covers a wide range of different activities, for example, rock/mountain climbing, skiing/snowboarding, mountain biking and scuba diving (Bentley and Page 2008). Owing to the dependency of many such activities on large and/or undeveloped landscapes, venues for such activities are typically protected natural areas (Ewert et al. 2006). A segment of the ecotourism market, adventure recreation, has demonstrated rapid growth in recent decades (WTTC 2006). Drivers include increasing commercialisation (Buckley 2007), use of adventure imagery in retail advertising (Buckley 2003a), and peoples’ increasing desire to experience thrills by overcoming (perceived) risks of personal danger in their leisure pursuits (Berno et al. 1996). However, adventure recreation has been criticised for its ecological impacts (e.g. vegetation loss, soil erosion) (Romeril 1989, Ewert and Hollenhorst 1994, Buckley 2003b). A recent change in recreationists’ motivation to visit natural areas and activities undertaken in them is the morphing of forms of ‘adventure recreation’ into ‘extreme’ sports (Ewert et al. 2006). Comprising a loose, constantly-evolving collection of new sports or the extension of existing ones, the term implies pushing existing boundaries of risk for thrill’s own sake to induce an adrenaline ‘buzz’ by overcoming fear induced by speed, gravity or height (Ewert et al. 2006, Carnicelli-Filho et al. 2010). Examples of extreme sports include speed rock climbing, BASE (Buildings, Antennas, Spans, Earth) jumping, heliskiing/boarding, and downhill mountain biking. The emphasis on thrill as an end product typically differentiates extreme sport from adventure recreation (Puchan 2005). Baker and Simon (2002) suggested that many extreme sports also

involve competition among participants, further changing the mental dynamic and reason for visiting natural areas largely due to the focus on competition. This focus may outweigh consideration of nature conservation. This is because these aspects of extreme sport switch the primary objective from 'experiencing' (passive recreation) to 'conquering or beating' (active recreation) nature (Baker and Simon 2002).

2.2. Extreme sports

The commercial potential of the emerging extreme sport phenomenon was initially realised with the staging and televising of the 1995 summer 'eXtreme Games' in the US by the sports media company ESPN. Subsequently, the games were re-branded the 'X Games' in 1996, and a 'Winter X Games' was added in 1997 (Hunter 2001).

ESPN's rival NBC followed by staging the 'Gravity Games' and 'Gorge Games'

(Bennet et al. 2003). Several extreme sports have subsequently been introduced into the Winter Olympic Games (Ewert et al. 2006) or in event-specific world

championships (e.g. ultramarathon running – IAU 2010, mountain biking – UCI 1997–2010; sport rock climbing – IFSC 2010).

Although not restricted by age, extreme sports are most popular among 'Generation Y' (cf. 'Echo Boomers'), individuals born between the late 1970s and mid-1990s (Bennett et al. 2003). This is the largest demographic group in history, totalling 71 million in the US alone in 2000. Almost twice the size of its predecessor ('Generation X'), Generation Y comprises 25% of the country's population. With a similar relative size in other economically developed nations, Generation Y are influential consumers of products and services and, as voters, potentially influence legislation regarding the use of public natural areas (Gardyn and Fetto 2000).

Extreme sport participants are concentrated in the teenage years, and are typically from a white/Asian, affluent, upper middle class and suburban culture. They are maledominated, have high self-esteem, athletic and skilled users of electronic media and, while socially conscious, are disaffected and celebrate danger (Bennet et al. 2003, Ewert et al. 2006). They typically participate in their chosen sport alone or in small peer

groups. This allows them to avoid supervision and authority, although they may also engage in public demonstrations of skills via 'stunts' in formal or semi-formal competitive environments (e.g. indoor rock climbing gyms, BMX/skateboard parks, snowboarding half-pipes) that offer social networking opportunities (Ewert et al. 2006). Another aspect of extreme sportspeople is that they 'individualise/customise' activities by inventing new activities or perform an existing activity unlike previous generations. This reflects this generation's self-focused expectations fostered by the commercial media (e.g. 'because you're worth it' – L'Ore'al Paris, 'have it your way' – Burger King). In contrast, previous generations tended to conform to 'doing it the right way' (Taylor 2006) or 'being a good team player' (Ewert et al. 2006).

A major factor driving change from traditional adventure recreation to extreme sports is the influence of the commercial electronic media. Media companies prefer sports 'packaged' into exclusive products that can be targeted at specific audiences in sufficiently large segments to produce a profit. Extreme sports offer the potential of spatial concentration on specialised infrastructure (e.g. freestyle ski ramps, rock climbing walls, mountain bike race courses) around which (1) spectators are physically concentrated and merchandised, and (2) the course can be viewed and televised. The need for specialised equipment (e.g. downhill mountain bikes and body armour), and fashionable 'lifestyle' clothing (e.g. rock climbing) also drives profitability, even among non-participants seeking to emulate their role models (Rinehart and Sydnor 2003, Puchan 2005).

These 'new age' extreme sports have shades of Huxley's 'Brave New World' where World Controller Mustapha Mond informs the 'Alpha' males Bernard and Helmholtz that to drive consumerism, no new sport is allowed to be introduced unless it requires at least the same amount of equipment as the most complex current one (Huxley 2006). The environment is therefore at risk of becoming increasingly subordinate to society's need for commercially-driven recreation.

3. Ecological impacts emanating from extreme sports activities

3.1. Sport rock climbing

One example of an emerging extreme sport is 'sport (or competition) climbing'.

Probably originating in mainland Europe in the 1980s, it is now represented by the International Federation of Sport Climbing (IFSC) in 76 countries and is an

Olympic sport, comprising three recognised disciplines: 'Lead', 'Bouldering' and 'Speed' (IFSC 2010).

Sport climbing is usually performed on single, rather than multiple pitches. This, together with its permanent safety bolting, tends to make it attractive to novice climbers. It also generally allows for more pitches to be accommodated along a cliff face and consequently allows more people to participate at a specific site. Sport climbing is a form of 'free climbing' and allows direct competition among participants, or individuals to test themselves against the clock (IFSC 2010).

In Yosemite Valley (US), one of the world's meccas for climbers, most routes have been climbed. Consequently, rather than competing to be the 'first climber', the challenge now for many is to use routes such as 'El Capitan's Nose', one of the wall's 42 'timed routes', as vertical racetracks with the aim of being the 'fastest climber', preferably solo and without safety gear. Such 'speed climbing' rivalry appears to be reaching fanatical levels among some participants, resulting in potentially fatal risks for personal glory (Yen 2002, Carnahan 2006). Identified ecological impacts due to rock climbing have been found to include vegetation disturbance and loss due to rock erosion, damage to rock features and rock bolting (NPWS 2001). Increased tracking, disturbance of wildlife and water pollution may also occur. All such impacts may also be influenced by the scale of the activity, soil type, slope and vegetation cover (Buckley 2001), and most are likely to be exacerbated by race conditions (e.g. competition, recreational) since the focus of the racer's attention is presumably on the competition rather than on concern for the environment.

Mount Everest is also increasingly popular for 'mountaineering tourists' who pay to 'conquer' the world's highest mountain, often with limited climbing experience and sometimes fatal results (Rosen 2007). Ecological impacts of visitors accessing

popular Himalayan sites have been widely commented upon (e.g. McConnell 1991, MacLellan et al. 1999, Brymer et al. 2009). For example, between 1990 and 1997, 255,000 (1990) and 418,000 (1997) tourists visited Nepal and mountaineering has remained an important form of revenue (Nyaupane et al. 2006). Even in 1991, the mountain slopes were considered the 'highest trash dump in the world' (McConnell 1991). The non-degradable/non-inflammable garbage generated by an average 15-person group over 10 days was 15 kg, in addition to human waste including 'toilet tissue trails' and inadequately covered toilet pits along popular walk-in routes (MacLellan et al. 1999). Vegetation removal for firewood is also a long-standing issue (e.g. Bjønness 1980, Byers 2005).

3.2. Mountain biking

Mountain biking, of which some derivatives are considered extreme sports, probably originated in the US in the 1970s (White et al. 2006), and has grown rapidly in popularity (Marion and Wimpey 2007). For example, in 2003 an estimated 10 million Americans regularly participated (Green 2003). Although growth has slowed, mountain/hybrid bikes still represented 44% of unit sales through American speciality bicycle retailers during 2006–2008 (NBDA 2010). Elsewhere, for example Canada (Koepke 2005), New Zealand (Cessford 1995, Leberman and Mason 2000), Australia (Chiu and Kriwoken 2003, Ryan 2005), Europe (Gaulrapp et al. 2001, Beedie and Hudson 2003), and the United Kingdom (Bartlett 2004, TRC 2005), the sport continues to grow. In 2001, 6.3 million people in the UK, more than 10% of the population, participated in mountain biking/off-road cycling more than once annually, and approximately 6% participated regularly (TRC 2005). Mountain biking is also popular in Germany (38.9% of 7.2 million recreational cyclists), and there are an estimated 800,000 mountain bikers in Switzerland and Austria (Koepke 2005). In Australia the number of cyclists grew by 15.3% during 2001–2004 (Faulks et al. 2008), and 70% of 753,843 bikes sold in 2004 were mountain bikes (Bradshaw 2006). The sport is expanding globally, and the International Mountain Biking Association is represented in 17 countries including the US, Australia, Canada, Italy, Mexico, Spain, the Netherlands and the UK (IMBA 2010).

In common with sport climbing, mountain biking has been taken to new extremes. In its 'traditional' form, 'cross-country/recreational' biking, riders use lightweight bikes on rides lasting a few hours for relaxation, endurance and/or skill. However, new extreme derivations (e.g. 'downhill', 'freeriding', 'trials', 'dirt jumping') have been developed, and are increasingly popular (Koepke 2005). 'Downhill' biking is focused on descending steep, rough terrain at speed on specialist bikes with long-travel suspension. Riders wear plastic body armour and full-face helmets for protection, and are typically transported to the top of (usually short) runs by ski lifts, 4WD vehicles or helicopter (Cessford 1995). In 'free-riding' (cf., 'North Shore') the focus is to develop technical skills to handle obstacles on purpose-built circuits (Cessford 1995, Koepke 2005). None of these more extreme versions of biking encompasses an appreciation of the natural environment as the key objective of the trip. In contrast to the more traditional reasons for visiting natural areas, the outdoors is apparently primarily a gigantic gymnasium in which 'toys' provide thrills and adrenaline-fuelled excitement (e.g. Baker and Simon 2002, Pizam et al. 2002, Self et al. 2007).

The increasing popularity of more extreme versions of the sport has caused concerns for potentially unacceptable ecological impacts (Wilson and Seney 1994, Thurston and Reader 2001). Pickering et al. (2010a) compared recreational impacts between Australia and the US and concluded that mountain bike specific impacts included soil and vegetation damage which would contribute to such impacts as erosion, compaction, trail widening/development, and potentially contribute to reduced plant biomass, changed species composition, and increased incidence of weeds and pathogens. However, the severity of the damage caused would differ with recreation type, ecosystem attributes and intensity of use. For example, while in flat, dry conditions, cross country/recreational mountain bike riding has comparable impacts with walking (e.g. Wilson and Seney 1994, Thurston and Reader 2001), higher impacts occur with high speed and steep, wet slopes, especially under strong braking, skidding and cornering (e.g. Goeft and Alder 2001, Chiu and Kriwoken 2003, White et al. 2006, Pickering et al. 2010a). Such manoeuvres are common in mountain biking, especially under race conditions. Additional ecological impacts also occur with the

creation of unauthorised, informal bike trails and/or construction of technical track features (e.g. concrete-reinforced jumps, wooden boardways) for use in freeriding/ North Shore mountain biking (e.g. Newsome and Davis 2009, Pickering et al. 2010b). Mountain biking trails are increasingly extensive, and the sport's commercial potential for 'destination mountain biking tourism' has been recognised. In the US, locations such as Moab (Utah) and Fruita (Colorado) offer hundreds of kilometres of bike trails in desert ecosystems (MATC 2010, OTEs 2010). In Canada, ski resorts such as Whistler Blackcomb offer over 200 km and 34 trails of lift-serviced downhill routes (Whistler Blackcomb, undated) while Scotland's 7stanes, one of the UK's 40 dedicated mountain bike centres, attracts 395,000 riders annually to 600 km of forest trails (TRC 2005).

3.3. Snow sports

Commencing in 1925 with the British 'Down Hill Only' club (Wengen, Switzerland – DHOWengen undated), downhill recreational skiing has developed into a multibillion dollar global industry. Reflecting its origins, the sport has had an up-market, elitist image, linked with specific times and places, rather than an overall lifestyle. However, since the 1980s skiing has increased its mass-market appeal, leading to higher participation and associated ecological impacts. There has been growth in the number and/or size of resorts, increased competition and reduced participation cost (George 2003, 2004, Rivera et al. 2006) and it has become culturally and economically important for many areas, for example, in Europe (Fredman and Heberlein 2003, Agrawala 2007, Wolfsegger et al. 2008) and North America (Scott and McBoyle 2006, Scott et al. 2003, 2008). Consequently, recreationists from countries with limited/no domestic snow industry can readily access resorts. Technological advances, such as snow-making machinery, have also allowed resorts to extend their effective season, prolonging ecological impacts. Located in sensitive alpine areas, often national parks, ski resorts have long been controversial, and are increasingly challenged to be more environmentally responsible. However, impacts continue, for example tree clearing, infrastructure construction (e.g. roads, chairlifts, accommodation), changed hydrology, water and air pollution, and wildlife disturbance (e.g. Buckley et al. 2000, George 2003, 2004, Rivera et al. 2006).

Product development advances and changed consumer demographics within the sport, most notably growth in snowboarding, have occurred. For example, although the number of Americans participating in downhill and cross-country skiing declined between 2002 and 2003 (downhill 8.5% to 6.8 million; cross-country 12.1% to 1.9 million), snowboarding increased by 12.9% to 6.3 million (RKM&A 2005).

The number of US ski resorts has also steadily declined over two decades, from 727 in 1984–1985 to 494 in 2003–2004, although the remaining resorts have typically increased in size. Despite the overall reduction in resorts, an estimated 56.4 million visits occurred during the 2004–2005 season, the third best season in the industry's history. The four most successful seasons occurred between 1999 and 2005 (RKM&A 2005).

In contrast to skiing, snowboarding evolved from skateboarding, which previously transitioned from surfing (Edensor and Richards 2007), and has subsequently transitioned into even more extreme forms, helisking and heliboarding (Buckley 2006). Unlike skiing, each of these recreational activities claims to be a 'lifestyle' rather than a discrete sport, with each contributing elements of clothing, language and attitude and, in particular, youthful rebellion and non-conformity against traditional social mores. The transition of many skiers' and boarders' recreational motivations towards more extreme and/or spectator-focused versions of their sport have increased demand for more resort-based built infrastructure (e.g. bowls, pipes, half pipes) that emphasise social networking and public demonstration of thrill-based 'freestyle' tricks and stunts, rather than an immersion in a naturebased experience (Edensor and Richards 2007).

More extreme forms of skiing and snowboarding continue to evolve. For example, the new discipline of 'snowboard cross/SBX' involves head-to-head speed competition between riders, as opposed to against the clock. This was added to the repertoire of Olympic sports in 2006 (Starr et al. 2006). Other emerging extreme snow sport mutations include ski-BASEing (combination skiing/parachuting), and 'speed flying' (skiing/parasail – Neville 2007). Although such sports currently have niche market appeal, they may potentially become more popular and expand further into natural areas.

Such potential has been demonstrated by the recent growth of 'heliskiing/boarding'. Participants are transported by helicopter into higher, more extreme and remote wilderness mountain areas, and they descend cross-country (Buckley 2006). Although no reliable statistics on participation exist, the sport is increasing in popularity, with private operators in most countries with a snow industry (e.g. Canada – GCH-S, 2010; US – VH-SG, undated; New Zealand – HMH-S, undated; Italy and Switzerland – H-AMG, undated), although it is banned in France, in part, because of environmental impact (Whitetracks Ltd, 2002-2009).

The growth of extreme snow sports has extended ecological impacts in alpine areas, temporally and geographically. For example, snow resorts were historically used in winter with some recovery time available between seasons, although at least some of the impacts did persist (Pickering and Hill 2003, Buckley et al. 2006). However, with fewer, larger resorts (at least in the US) that are increasingly expensive to build and maintain, there is commercial pressure to maximise revenue year-round (RKM&A 2005). Artificial snow-making that extends the winter season and/or promotion of complementary outdoor sports (e.g. downhill mountain biking) could appeal to resort operators but risk prolonging stress on the environment. For example, mountain bike riding at Whistler Blackcomb (Canada) in summer is estimated to be 75% of winter income (TRC 2005).

Until the mid-1980s most visits to Australian ski resorts occurred during winter and were focused around resort-based skiing. Since that time additional winter activities have become increasingly popular (e.g. cross country skiing, snowboarding) and the area is being used increasingly in summer. For example, by 1988 approximately 50% of visits occurred outside of the winter season. Although the focus of 70% of these summer visitors was car touring and sightseeing, other activities included bushwalking and camping, abseiling, paragliding and fishing (Buckley et al. 2000). Pickering and Hill (2003) suggested that the increased popularity of both traditional resort-based tourism and expansion of the range of activities that has occurred within and near these Australian snowfields substantially increase both direct and indirect impacts on the biota, much of it endemic to the area. A reflection of concern for the impacts of expanded use of ski resorts is that tension has increasingly

led to friction between developers and conservationists (Needham et al. 2004).

3.4. Motorised extreme sports

Allied with increasing affluence, off-road motorised recreation involving all-terrain vehicles (ATVs), four wheel drive vehicles (4WD), and off-road motorcycles (dirt bikes) has become a major use of many natural areas (Albritton and Stein 2010).

These activities are associated with 'profound' ecological management issues (Buckley 2003b, 2006, Albritton and Stein 2010).

As with mountain biking, 'dirt biking' is a recreational extension of a product traditionally used for transport. It has developed into an extreme sport with competitive disciplines driven by technological advances that improve power and performance. Unit sales of dirt bikes vary among countries, however similar trends

are evident. For example, US motorcycle sales (including scooters) increased from 300,000 in 1995 to around 1,100,000 in 2005, with subsequent annual decline to 550,000 in 2009, approximately equivalent to 1999 sales. This fall probably reflects the Global Financial Crisis (GFC) (WebBikeWorld.com, 2010). Between 2008 and 2009, US motorbike sales (excluding scooters) declined by 39%, however, dirt bike sales proved resilient and posted the smallest percentage unit decline of motorised recreational vehicles, and increased market share from 18% to 22% (WebBikeWorld.com 2010). In contrast, UK motorcycle sales remained generally stable during 2000–2008, and averaged 116,000 new registrations annually. Dirt bikes increased market share from 5.7% (2000) to 8.3% (2008, MCI 2008). In Australia, motorcycle (including scooter) registrations grew by an average of 9.5% annually between 2004 and 2009, faster than other vehicle types (ABS 2009). Despite a unit decrease of 13.6% between 2008 and 2009 (presumably due to the GFC), unit sales of new motorcycles, scooters, and ATVs combined were 115,981, the fourth highest annual sales recorded. Dirt bikes constituted 50.3% (42,848 units) of these sales (FCAI 2010). A substantial, although unquantified, market growth has also occurred recently in 'mini' or 'pocket' motorbikes. These typically have 550 cc engine capacity, are legally classified as toys, and are designed to be ridden by children under adult supervision on private land. However, they are increasingly

used illegally on public lands (MC NSW 2010a, Miniriders, 2010).

Reflecting riders' 'need for speed', dirt biking was an original X-Games sport.

There are currently five competitive disciplines: 'Moto X' (off-road racing); 'Freestyle' (jumping/aerobatic skills); 'Supermoto' (combined on/off-road racing); 'Step Up' and 'Best Trick' (specialised skills test; Dirt Bike 2007a). These are broadly parallel mountain bike disciplines. In addition to stadium-based events, dirt bike races are frequently staged over long-distance courses (4300 km, Dirt Bike, 2007b). Such growth in popularity of dirt biking, and perceived lack of available space on public lands for their use has led to friction with local residents and other recreationists (e.g. Ashworth 2003). In response, motorised recreationist lobby groups have been formed in several countries (e.g. FUEL Australia – ARRA 2010, MC NSW 2010b). Online fora and weblogs have increasingly strengthened such groups' lobbying power to influence laws governing use of natural areas.

There is limited information on the ecological impacts of dirt bikes relative to other motorised off-road recreational use vehicles (Priskin 2003). Dirt bikes have an immediate, temporary impact on vegetation cover, species diversity and soil compaction (Liddle 1997, Kutiel et al. 2000). Longer-term impacts include soil compaction and erosion (Priskin 2003), soil loss and structural change (Goossens and Buck 2009), and a reduction in fauna and flora abundance and/or diversity, either by direct impact collision, or due to habitat destruction (Moss and McPhee, 2006, Groom et al. 2007). Even at low intensity, impacts are higher than caused by walkers (Kutiel et al. 2000), and similar to 4WD vehicles (Shaw and Diersing 1990, Rickard et al. 1994). However, ATVs have been found to have significantly greater contribution to soil loss than other recreational vehicles (Olive and Marion 2009), and are likely to cause substantial ecological damage as a result of erosion. Already a dominant recreational tool, trends indicate that off-road motorised vehicles, including ATVs, will continue to be a dominant off-road recreational tool (Havlick 2002, Albritton and Stein 2010).

Although damage is greatest with direct contact with tyres, soil damage from offroad motor vehicles, including dirt bikes, concentrates in turning and manoeuvring areas, where the rear wheel rotates on itself without following the direction of travel. This typically causes high shear forces and soil spray, 'roostering' (Shaw and

Diersing 1990, Rickard et al. 1994). We assume that environmental impacts attributed to mountain bikes also occur with dirt biking, particularly those associated with braking, skidding and wheel spinning. Such impacts would logically be greater for dirt biking due to their weight, greater power and torque. Dirt bikes also rapidly create wide trails on dry, sandy soils even on level ground, after shortterm, low intensity use. These bikes are also more difficult to geographically restrict than 4WD vehicles. Their narrow profile allows the rider to readily circumvent fire trail barriers and/or move among trees that prevent 4WD passage (pers. obs.).

There are limited studies that have examined the psychological aspects of cycling; and motives for participating may differ based on gender, activity level and activity type (e.g. road cycling, mountain biking, LaChausse 2006). LaChausse (2006) reported that overall the most common reasons given for cycling (competitive, noncompetitive, leisure) were goal achievement and health orientation. Together with other factors that ranked relatively highly (e.g. self-esteem, affiliation, weight concern), these priorities overlap with the findings of a previous study undertaken on American riders competing in 'enduro' (long distance cross-country) dirt bike events. They listed (in order) as their motivation for undertaking competition riding: selfimage building, physical benefits, immediate gratification, separation, affiliation and status and prestige (Watson et al. 1980). In contrast, the motivation of noncompetitive riders was to enjoy nature and spend time with family and friends.

Motivation and benefit of their sport also apparently differs between dirt bike/ATV riders, who focused on trail riding enjoyments, while the focus of 4WD drivers was primarily to challenge one's vehicle and overcome obstacles (Albritton and Stein 2010). The extreme sportsman's focus was apparently on enjoying their 'toy' rather than the natural environment.

4. Issues and challenges of extreme sports for land managers

As outlined above, various forms of adventure recreation are morphing into extreme sports, with ultimate acceptance within the mainstream (e.g. Olympic sport). For example, skiing began as an activity for the elite, transitioned into mass-market recreation, and has since morphed into an extreme sport with an international

following. From a single skiing 'club' in Switzerland approximately 80 years ago, major infrastructure development has occurred internationally on many mountain slopes. Innovations have resulted in some resorts being used effectively year-around (Buckley et al. 2000, RKM&A 2005, TRC 2005). The development of extreme versions of mountain biking has a similar history of evolution and innovation. Although the introduction of the 'penny farthing' cycle for recreation dates back to the 1870s, until the introduction of the modern bicycle in the 1980s, bikes were predominantly used for conveyance and recreation, typically without specific infrastructure (Minetti et al. 2001). Post-1980s there has been a rapid transition to off-road biking with large networks of tracks, stadia and other associated purpose built infrastructure (section 3.2).

Many forms of niche recreation, currently in transition to more extreme derivatives, are likely to increase in popularity, for tourism/recreation and as competitive, formalised sports, probably originating in economically developed countries but not necessarily confined to such areas. Such 'new age' recreational/sporting activities often require large tracts of land, dedicated to a specific sport, for example, biking (section 3.2) or snow skiing/boarding (section 3.3), or increasing use of natural areas, for example sport rock climbing (section 3.1).

Potentially the lands used for these activities could be part of the national estate under state, federal and/or international reservation based, at least loosely, on the criteria of the International Union for the Conservation of Nature (IUCN) Protected Management Categories. The fundamental concept of recreation in such areas is for the appreciation of the natural area, its wildlife, and/or scenic beauty (see e.g. <http://www.ontarioparks.com/english/iuc.html>).

When 'new' recreational pursuits are mooted there are often protracted arguments regarding their appropriateness in protected areas. For example, in the Greater Blue Mountains World Heritage Area (GBMWhA) Australia, the rise in concern of park management over rope sports can be gleaned from comparison of management plans developed in 1988 (NPWS 1988) and 1998 (NPWS 1998). The former makes negligible mention of adventure recreation, while the latter devotes major sections of the plan to addressing use. Even when such recreation/sports are

permitted, perceived impacts typically differ between management and visitors (Martin et al. 1989). For example, Hardiman and Burgin (2010a) surveyed canyoneers on management's perceived needs for stricter controls on canyoning (cf. US canyoneering – a 'rope sport' of concern to management, NPWS 1998) in the GBMWA. The canyoneers claimed that they considered their potential impacts and adopted mitigating behaviour. However, Hardiman and Burgin (2010a) concluded that the rhetoric was unlikely to translate into environmental action sufficient to ensure sustainable management, despite 40% of those surveyed stating that they visited the canyons less frequently than in the past because they were 'too busy/crowds/loss of wilderness', and only 12% who visited frequently did so because they were 'exciting/challenging/fun'.

As previously indicated (section 3) among those seeking to undertake extreme sports, the dominant reason is more aligned with excitement, challenge and perceived risk than because of 'easy grade/safe for novices', 'scenic beauty' and 'easy access', all more important reasons than excitement and challenge for the canyoneers surveyed by Hardiman and Burgin (2010a). The typical demographics (see section 2.2) are less likely to conform to accepted behavioural patterns than previous generations, and there are many more of them than in any previous generation. The power of advocacy groups, either formal (e.g. specific sports associations) or informal (e.g. web fora) has become increasingly stronger and more sophisticated, aided by the reach of the internet. Their demands are also likely to be supported by the tourism and retailing industries, which recognise the commercial potential of this large, affluent demographic. For example, the cruise industry now caters to extreme sports enthusiasts by offering on-board thrills (e.g. 'zipwires', indoor rock climbing) on many cruise ships (USA Today, undated).

5. The potential risks

Despite the potential for major economic benefits from extreme sports (Puchan 2005), past experience suggests that there is an associated risk of degradation of protected areas (Mueller et al. 2004, McMillan and Larson 2002, Rusterholz et al. 2004, Buckley 2003b), although other factors may distort findings (e.g. physical

factors – Nuzzo 1996, avoidance of heavily vegetated cliff sites by climbers – Farris 1998, poor research design – Kuntz and Larson 2006). Evidence shows that once passive recreation is an established use of such areas, there is the potential for the sport to morph into more environmentally damaging activities (e.g. cross-country cycling into free-style racing – Newsome and Davies 2009) that utilise the natural resource more intensively than previously (e.g. traditional rock climbing into sport climbing – NPWS 2001). Alternatively, assisted by new communications (e.g. satellite mobile phones) and/or navigation (e.g. handheld Global Positioning by Satellite [GPS]) technology, enthusiasts may penetrate deep into pristine wilderness (Ewert and Shultis 1999). For example, before the 1960s when the adventure recreation activity of canyoning (an extension of bushwalking) began in the GBMWA, few of the more than 400 canyons had been visited. In contrast, substantial numbers of visitors, over an increasingly longer recreational 'season' (aided by better protective clothing) now visit a greater number of these canyons. While there has been no discernable impact on the fauna of the canyons to date (Hardiman and Burgin 2010b, 2011), there is the potential for them to be degraded if canyoning's popularity continued to grow or morphed into a more extreme derivation.

6. Potential solutions for protected areas

Mechanisms available to land managers to minimise environmental degradation include a range of legislative arrangements and educational programmes. Enforcement typically relies on regulation, focused on controlling behaviour with the potential for punitive action. This approach is frequently counterproductive and costly to enforce. A more effective approach to minimising the environmental impact is to employ education programmes aimed at raising awareness of the issues of environmental degradation (e.g. Environmental Guidelines for Tourists, Codes of Conduct, Leave No Trace – Marion and Reid 2007). Such programmes are favoured by visitors to protected areas (Hendee and Dawson 2002, Hardiman and Burgin 2010a, 2010c) and provide information to raise awareness of the local environment and thus improve the recreationist's knowledge and thus provide a greater appreciation of the natural attributes of the area (Hendee and Dawson 2002). Although design and

delivery (e.g. printed material with and without range contact) of such programmes influence the results, Marion and Reid (2007) found that the majority of such educational programmes resulted in an improvement in attitudes and behaviour. However, Hardiman and Burgin (2010a) were sceptical about the efficacy of selfmanagement of wilderness. Most canyoners did not consider their impacts to be substantial in contrast to the views of the local land managers (NPWS 2001).

Models have been developed in the US (Marion and Reed 2007) and Australia (Burgin and Hardiman 2011) of communities voluntarily supporting environmental restoration. For example, Australia-wide, volunteers of the Landcare movement are focused on environmental restoration (Burgin et al. 2005). In New South Wales alone, there were 2130 groups (57,454 individuals) registered under Landcare in December 2010 (LandcareNSW 2011). In addition, in 2010 Clear Up Australia Day attracted 588,000 volunteers (1 in 50 Australians) to remove rubbish from 7,000 registered sties (Landcare Australia Ltd, undated). Such commitment is a demonstration that with appropriately targeted and delivered educational programmes, minimisation of the impact of recreation is achievable.

Despite this potential to minimise impacts, environmental degradation will continue (Newsome et al. 2002, Marion and Reid 2007). To maximise biodiversity conservation on protected lands a major paradigm shift is required. This will require a more strategic, holistic approach to planning and managing outdoor recreation/sport destinations and activities. For example, rather than continuing to assume that protected areas are the major destination for outdoor recreation, there is a need to cast more broadly for appropriate lands (private or public) and to consider a more integrated approach to land use for recreation/sport. It will require thinking beyond the management of a single type of land tenure (e.g. national park), managed by a single entity (e.g. government agency), but rather, for example, across multiple land-tenures (public and private), land-uses (commercial or non-commercial), and include the full range of stakeholders (e.g. federal government departments, state agencies, local governments, tourism agencies, private enterprise, researchers, broader community) to work collaboratively to plan the appropriate placement of recreational/sporting destinations in a way that is ecologically and commercially sustainable. Critically, there

needs to be proactive, strategic planning; rather than reaction to individual demands and the associated conflict that may act as a drain on resources, maybe for decades. Forests maintained for commercial harvest may offer a complementary resource to national parks (see e.g. Forestry Tasmania 2009), and constitute a more appropriate setting, for at least some forms of extreme sports, than many areas protected predominantly for nature conservation. This is because such areas typically (1) provide extensive natural or plantation settings; (2) their use for recreation/sport may (in some circumstances) offer substantial economic benefits to their local communities (Koepke 2005, TRC 2005, TRC/EKOS 2007); and (3) such use may offer additional, complementary economic benefit to public and private owners of the timber resources. The approach of Tasmania (Australia) to tourism provides one such model. Land managers there have moved from national parks as the major focus for outdoor recreation, and have recognised commercial public forestry lands as viable extensions to recreation/sport in national parks. Rather than balancing conservation and recreation as mandated in national parks, the management of forestry lands has been historically focused most strongly on production. Many such areas are therefore potentially appropriate for the dual commercial roles of forestry and recreation/tourism. Tasmania (Australia) has recognised this with the introduction of forest ecoadventure centres (Forestry Tasmania 2009). Private lands and/or private enterprise, in partnership with government, or independently, are also options for the development of extreme sports destinations (see e.g. UK mountain biking destinations, section 3.2). In some regions, such integrated and strategic changes at the level required will need a fundamental change from the trend towards 'user pays' and the current drive, at least in Australia, of each agency separately to seek economic opportunities that support their budgets, thus encouraging counterproductive competition among agencies. Instead, it will require much greater collaboration across stakeholders, advantaged and disaffected. The alternative of not taking a strategic, holistic approach to the planning and development of destinations will potentially result in an acceleration of friction among land managers, recreationists, local communities and local commerce over conflicting demands for various forms of recreation/sports in protected areas. Based on past experience land managers will ultimately fail to

hold the line on conservation (see e.g. section 3). We predict the long-term result will be accelerated loss of biodiversity and degradation of protected areas, with the associated loss of recreational amenity, long-term friction between recreationists and park management, lost income opportunities and goodwill of the extreme sportsmen and their supporters.

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