




Article

Getting Flow: The Place of Production Forests in the Rise of Mountain Biking

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Abstract: Mountain biking has increased in popularity in many countries over recent decades. Production forests provide not only an outstanding space for mountain bike riding, but also specific characteristics conducive to purpose-built track building. With recreational access to production forests, managers must balance commercial operations and industry environmental obligations with the interests and actions of riders. Production forests in New Zealand have accommodated mountain biking activities for decades. The trend from 1991 to 2022 showed overall increasing opportunities for mountain biking in production forests, particularly in smaller commercial peri-urban plantations and forest parks maintained as dedicated mountain bike parks. Over the same period, public mountain biking access to larger (>1500 ha) forests peaked in 2008. These recreational changes within forests, and the impact these changes have pressed onto forest managers, have not been well documented. This paper explores the rise in popularity of mountain biking in New Zealand's production plantation forests, and the response of forest owners and managers to increased mountain biking activities in their commercial forest estates. The paper discusses implications for forest planning to accommodate active recreational sports such as mountain biking in production forests, suggesting policies and procedures to help protect commercial interests and forest ecology, while allowing for a contemporary mix of recreational activities.

Keywords: mountain biking; recreation; trade-off; use conflict; ecosystem services; forest management; commercial forestry; plantation forest; *Pinus radiata*; New Zealand



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1. Introduction

Mountain biking is an increasingly popular form of outdoor recreation, competitive sport and adventure tourism. Since its experimental beginnings in the U.S. in the late 1970s [1–5], the fringe activity has steadily evolved into an established sport, occupying an important public interest and economic niche worldwide [6–9]. In recent decades, the popularity of mountain biking has increased in Australia [9–13], New Zealand [14–20], North America [21–24] and Europe [5,25–28]. Participation in the U.S. and Australia is estimated at 2.5% and 1.3%, respectively [9]; in the UK, an estimated 11.8 million people own a mountain bike with 1.3 million people (or around 2.1% of the population) using them regularly to ride off-road [29]. Mountain bike organisations, clubs [30] and competitions [31] are increasingly widespread internationally and the International Mountain Biking Association (IMBA), a body dedicated to growing mountain bike trail communities, is represented by more than 40 countries [7]. Economically, mountain biking contributed around USD 7 billion to the global market in employment, sales in retail, tourism, and competitions in 2020 [32–36]—just in terms of sales, a staggering 47,670 bikes are being sold each day [8]. Annual growth rates are rising and are expected to continue to rise with further advances in electronic technologies, expanding markets, and growing track networks [7,8,14,32,37–39].

With the expanding interest and improved technologies [40,41], mountain biking has developed to encompass several specialised disciplines, including cross-country, trail, enduro, freeride/downhill, all mountain, slopestyle, 4x, pump track and randonneuring/audax [42]. Mountain biking has been incorporated in multi-discipline races such as adventure racing, mountain bike orienteering and off-road multi-sport events. The sport has also expanded widely into adventure tourism with recreational riders going on multi-day adventures (bikepacking) [43] or touring combinations of cycle trails, forestry tracks and re-purposed disused railways (cycle touring) [44]. There is also a growing number of electric mountain bikes (e-bikes), particularly among riders who might otherwise be physically excluded [7,19,37,45,46]. With multiple riding styles and interest groups, a wide demographic with disparate motivations, vastly different track design requirements and wide-ranging environmental preferences has emerged [47–49].

Most mountain bikers—across disciplines of mountain biking—prefer riding on narrow trails (known as single track) in natural areas [47,50,51]; however, publicly owned natural land in many countries is tightly managed [52–54]. In many places, mountain biking has only recently been included within recreation permitted on public lands [40,41,54–58], largely as a consequence of persisting notions that mountain bikers cause disproportionate environmental damage [4,41,59–63] and promote use conflict from existing users [49,64]. The emergence of mountain biking—among a class of thrill seeking and adventurous outdoor sports—has changed local regional economies [14,16,23,32,40,41,65–69] and the way many natural areas are viewed and used for outdoor pursuit [13,24,25,41,47,70,71]. Mountain bikers are motivated by an appreciation of nature and the natural environment, as well as for the opportunities the environment provides for exercise and fun [25,71,72]. Mountain bikers show similar knowledge and perception of forest biodiversity to other forest users [25], and express commitment to the sustainability of the natural environment [47,71]. However, mountain biking and mountain bike trail building is accompanied by variable levels of concomitant modifications to the environment [13,41,62,63] that some see as a step level change [4,41,49,60,61,64]. Indeed, for many mountain bikers, enjoying the surrounding nature for the nature itself is a secondary interest [13,41,73]. With differences of view, challenging trade-off situations persist [47,49,74].

Production forests (including plantation forests) have emerged as an important alternative space for recreational mountain biking [50,63,72,74,75], particularly where access to public land has been difficult to attain or prohibited [63,76–78]. Notwithstanding, production forests provide outstanding environments with distinctive qualities conducive to track development, riding and competitions. For example, in production forests, a higher tolerance of environmental damage in comparison to natural forests enables more scope for purpose-built track building [41] and fewer environmental concerns for riders [60,61,79,80]. Mountain biking in production forests and the associated track development are seen to pose less of a risk to the ecosystem values, such as native biodiversity, habitat quality and water quality, than biking in natural forests [41]. Additionally, production forests typically have an already established network of roads and tracks to allow for management and harvesting that offers ready-built access across the forest. The importance of commercial production forests to the mountain bike community and the development of the sport raises the questions of how and why access to production forests progressed, and what deciding factors led forest managers to allow or promote mountain biking access. Though some forest managers monitor use of their forests (through permit data, etc.), there is a paucity of collated data available on mountain biking as a recreational activity within New Zealand's commercial production forests—(i) what cycling activities are being undertaken, (ii) by whom, and more importantly, (iii) why users are seeking access to recreate within plantation forests. While past studies have investigated the sport of mountain biking from a user preference perspective [2,41,49,71], as a social phenomenon [48] and the environmental consequences [4,41,60,79], very few have investigated the use of a commercially managed forest for mountain biking from a forest management perspective. Where this has been considered, the focus has been on either use conflict management between for-

est recreational users [49,75,81], or on the impacts of the activity on the physical forest environment [4,25,79,82,83], (although, see Hruža et al. 2021 [63]).

This paper considers the rationale and motivations behind mountain bike use of productive plantation forest environments, the response of forest management to societal recreational preferences, and the benefits and risks posed to forest managers with the introduction of mountain biking to their commercial estates. Using New Zealand's experience as a case study, we examine the growth in the sport of mountain biking, and implications for commercial forest managers due to increasing pressures to accommodate recreational mountain biking access and infrastructure within commercially established forestry estates.

2. Background

2.1. Mountain biking in New Zealand

Mountain biking in New Zealand began in 1984 with the importation of 15 off-road "mountain" bikes [15,77]. In these early years, a small cohort of hardy enthusiasts quickly re-defined bicycle touring in New Zealand [84,85], exploring (and reporting on) rural metalled roads, farms, bush tracks and forestry roads. These early riders were also among the first to start to build and improve tracks specifically for improving mountain bike access and rideability; while many of the earliest tracks were unsanctioned, an increasing number of tracks were being developed as a result of negotiations and partnerships between the fledgling mountain bike community and forest managers, both public and commercial [84].

As popularity of recreational mountain biking grew, so did competitive mountain biking. The first mountain bike races were held in 1985 [86]. The first national championship, "New Zealand Off Road Bicycle Race," was arranged by Paul Kennett in 1986 on a rugged course through native forests now known as the "Karapoti Classic" [59,77,86]. With just 45 competitors at the start line, the "championship" could easily have been underestimated with competitors sporting bush shirts and canvas backpacks and riding modified road bikes; however, the following year there was such interest in the competition that the field had to be limited to 1000 competitors [76]. By 1993, popularity had swollen such that New Zealand had laid claim to recreational forest with the "highest use" in the Southern Hemisphere at Woodhill Forest [76]. From latest national participation data (2018), an estimated 7.7% of the adult New Zealand population (>15 yrs) were regularly mountain biking—nearly 300,000 persons—incorporating both competitive level cyclists and recreational riders [14], 14% having participated at least once in the sport during 2018, and 8% wanting to give mountain biking a go [87].

2.2. Production Forests for Mountain Biking Trail Development

In the late 19th century, New Zealand was facing a dwindling supply of timber resources as a result of unsustainable harvest practices and slow growth rates in the merchantable New Zealand indigenous tree flora [88,89]. In response, the New Zealand Forest Service in 1925 led a programme to plant fast-growing, exotic, chiefly radiata pine (*Pinus radiata* D. Don), forests across 300,000 acres of State forest [90]. The success of the afforestation led, over the next decade, to increasingly large-scale exotic plantings across state and private forests, particularly on the North Island [90].

Although primarily managed for timber, planted exotic State forests were important for public recreation throughout the 20th century. By the 1970s, exotic State forests had become popular areas for recreation, as these were more accessible by motor vehicle than many indigenous National Parks and reserves [91–93]. With the closure of the New Zealand Forest Service in 1987, exotic production forest management was reverted to State-run Forestry Corporation, and then on-sold to private companies [89]. With the privatisation of the exotic forest estate, commercial timber extraction became of utmost priority while recreational right to access was left to individual forest companies [89,91,94]. In contrast, indigenous forests had a range of management objectives, both continued selective harvesting as well as the more predominant biodiversity protection and conservation objectives [89,91], including non-vehicular recreation. In the post-privatisation era, most

exotic planted forest management objectives included some forms of recreation [90]. In 2018, a concerned group of forestry professionals drafted a national forest policy to guide decisions on legislation and regulation across the sector [95]; in it, the authors acknowledge the importance of New Zealand's productive forests in providing non-productive public services, such as recreation.

Currently, of the 38% of New Zealand land covered in forests (10.1×10^6 ha), nearly 16.8% of these forests (1.8×10^6 ha) are occupied by productive exotic, primarily *Pinus radiata* D. Don, plantation forest [88,96]. Most of these planted forests are in the Central North Island region, although exotic planted forests extend throughout the country. In the drier regions, productive pine forests usually support a sparse understorey, whereas in wetter regions, a dense understorey of native ferns and shrubs, as well as exotic weeds such as blackberry (*Rubus fruticosus* agg.) and gorse (*Ulex europaeus*) persist (Figure 1). Production plantation forests provide important surrogate habitats for the conservation of threatened New Zealand biodiversity, including bats, beetles, kārearea (falcon) and kiwi [97–101].



Figure 1. Mountain bike single track in planted production forest in Rotorua, New Zealand.

Despite having expansive natural landscapes, New Zealand does not have the same public accessibility to private land as other nations (e.g., Scotland [73] and Sweden [102]). As mountain biking developed in New Zealand, the Department of Conservation (DOC), the government department managing public conservation lands, considered mountain biking to be in conflict with protecting the interests of conservation, biodiversity and other recreational users [2,4,40,41,77,92]. As with many other national land management agencies (e.g., U.S. National Park Service), DOC did not allow “road” development in National Parks, which included mountain bike tracks—mountain bikes being classed as a vehicle. Mountain bikes throughout the 1990s were legally excluded from most public tracks and restricted to formed roads in public conservation land [2,51]. Consequently, recreational use of public conservation land, which accounts for over 30% of NZ's land area and 79% of all forests [88,103], was largely devoid of opportunities for mountain biking [2]. In addition, most local governments held similar views on mountain bikes, disallowing access

to publicly managed exotic production forests until the late 1990s [78,104]. Electronic bikes (ebikes) are currently at the centre of a similar debate on policy around access [105,106].

Access limitations to public conservation land led enthusiasts in the 1980s and 1990s to look elsewhere to ride, build tracks and hold competitions. Exotic production (mainly pine) forests provided a range of conditions appealing to mountain biking and conducive to the development of purpose-built mountain bike track networks. Production forests typically had an established road and track network to connect regions of the forest; forest managers were tolerant of understorey vegetation clearance and earthwork required for track building; and many forest managers were already dealing with access for other recreational user groups (e.g., hunters and horse riders), so some existing offroad trails allowed for further development [76–78]. Some New Zealand production forests were established in peri-urban areas that offered easy access from population centres, whereas other forests were remote and completely undeveloped in terms of purpose-built track networks and with ideal opportunities for experiencing solitude and interacting with nature. Many planted forests were established on steep hill country or in unique landforms (e.g., historic mine sluicing), conducive to building interesting and challenging single-tracks [13,41,51,107].

Enthusiasts partnered with forest companies and local councils to build dedicated track networks within productive planted forest from the early 1990s [108]. The initial forested areas which became important recreational hubs for biking were located near larger population centres—these forests were some of the first to give access and permit track development. The proximity of some production forests in New Zealand to population centres (e.g., Bottle Lake; Hanmer Forest; Golden Downs Forest; Whakarewarewa Forest, and Flagstaff Forest, Figure 2) encouraged the development of track networks within planted production forests [76–78,109].

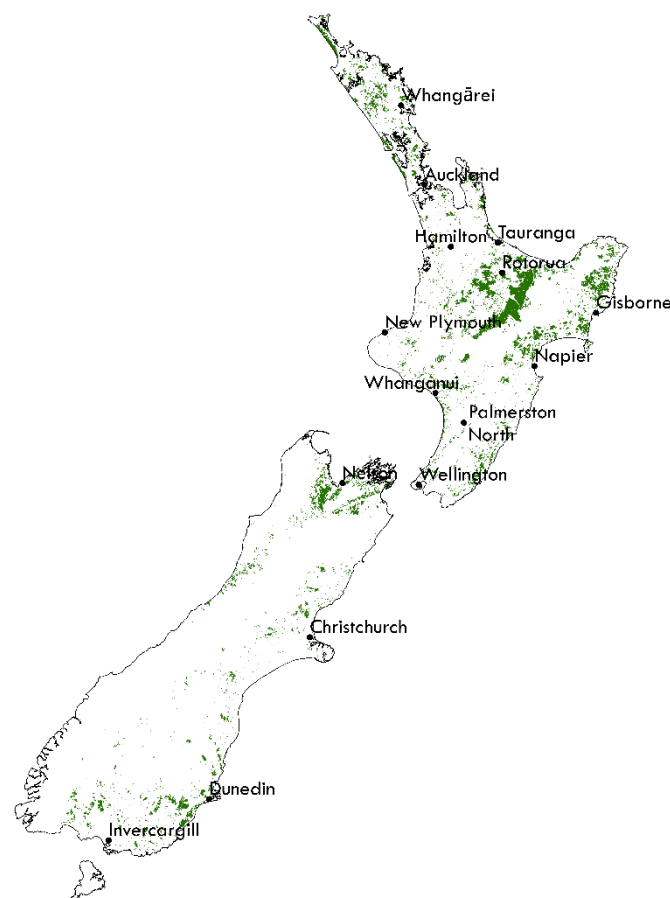


Figure 2. Production plantation forest areas in New Zealand.

Bottle Lake Forest, on the edge of New Zealand's second largest city, received over 200,000 visits per year from mountain bikers in 2002 [86] accounting for half of all visitors to the forest [3]. As the sport grew, forest managers were under increasing pressure to either restrict mountain bike rider forest access, or to accept the inevitable and address illegal track development and access through community engagement and recreational use policy. These forest managers shouldered the responsibility to safely manage an increasing population of people recreating in the forest, while continuing production operations.

Planted forests are used extensively for other social and recreational activities (hunting, angling access, firewood collection) [110] though these more traditional activities have neither experienced the same growth as mountain biking, nor involved such a large cross section of society participating.

2.3. Contribution of Mountain Biking to the NZ Economy and Society

The primary purpose of New Zealand's 1.8 million hectare planted forests is the extraction of wood products that contribute approximately NZD 10 billion in revenues annually to the New Zealand economy [111–113]. In addition to the above revenues, production forests provide revenue streams and non-market values from the space and infrastructure they provide recreation such as mountain biking [14,72,114]. Increasingly, tourists come to New Zealand to mountain bike [2,15]. In 1995, 22,000 international tourists out of 1.4 million mountain biked during their visit to New Zealand (1.6%), and a further 177,000 New Zealanders mountain biked in landscapes out of their local region [109]. By 2018, 25,000 (4%) of the annual international visitors indicated their prime reason for visiting was to mountain bike [14].

Economic impact studies show mountain biking in production plantation forests contributed to regional economies by generating revenues in retail and hospitality [14,16,18,68]. Mountain biking visits and events across the Nelson-Marlborough region (which include planted forests) contributed approximately NZD 17 million to the economy [14]. Mountain biking activities in the 5700 ha Whakarewarewa Forest in Rotorua have been found to annually provide between NZD 29 and NZD 47 million to the economy, as well as additional employment opportunities of between 210 and 340 full time employment units [16]. The collective value that repeat forest users (i.e., local users) placed on mountain biking access to the forest in 2010 was approximately NZD 5 million per annum, which was greater than the annual timber revenue at the time of the study [115]. Commercial forest owners also benefit from promoting recreational activities, such as mountain biking, as part of achieving industry compliance for international market access [112].

2.4. Mountain Bike Parks

During the late 2000s, dedicated mountain bike parks emerged in New Zealand (e.g., Woodhill Mountain Bike Park; Cougar Mountain Bike Park; Eskdale Mountain Bike Park). Mountain bike parks are dedicated trail centres, mainly in production forest areas (Table 1) set aside and operated as separate enterprises apart from the forest management company operations [116]; often, users pay fees for services although many are free to the public or rely on donations. Their popularity and contribution to increasing mountain bike participation is ascribed to the accessibility to urban centres or popular holiday destinations, the high density of highly engineered, serviced tracks across a range of difficulties, and for some mountain bike parks, the uphill services, such as gondolas, and purpose-built facilities and trail markers [48,109]. The inclusion of beginner level trails for young riders sees mountain bike parks considered safer and less "wild" locations to learn the sport [117]. A 10-fold increase in mountain biking activity occurred in Tangoio forest from the introduction of the Eskdale Mountain Bike Park, from 200 visits in 2001 to 2100 visits in 2009 [109]. Providing gondola lift access during 2011 to the Ben Lomond area also saw mountain bike club numbers in Queenstown grow from 60 in 2010 to 600 in 2011 [118]. Local mountain biking clubs that ride in nearby commercial planted forests have grown in membership,

such as Hawkes' Bay Mountain Biking Club, which has 2200 members [1], and the Nelson Mountain Biking Club, which has the largest membership, at over 2500 members [14].

Table 1. Mountain bike parks in production plantation forests (Source: [trailforks.com](https://www.trailforks.com) (accessed on 28 June 2022)).

Riding Area	Fees	Track Network (km)	Adjacent Production Forest
Whakarewarewa Redwoods, Rotorua	none	319	Whakarewarewa Forest
Riverhead, Auckland	none	222	Riverhead Forest
Pan Pac Eskdale, Hawkes Bay	use fee or club fee	113	Tangoio Forest
Craters of the Moon, Taupo	use fee or club fee	77	Waiarekei Forest
Woodhill, Auckland	use fee	63	Woodhill Forest
Hanmer Forest Park, Hanmer Springs	none	60	Hanmer Forest
Christchurch Adventure Park, Christchurch	gondola fee	56	McVicar Cashmere Estate
Lake Mangamahoe, Taranaki	donations	51	Mangamahoe Forest
Mcleans Island, Christchurch	none	50	West Melton Forest
Whangamata, Whangamata	use fee	48	Tairua/Matariki Forest
Nasby, Central Otago	none	46	Nasby Forest
Cougar Park, Tokoroa	donations	44	Kinlieth Forest
Bottle Lake, Christchurch	none	43	Bottle Lake Forest
Waitangi, Paihia	donations	40	Waitangi Forest
Arapuke, Manawatu	donations	39	Arapuke Forest
Harakake, Whanganui	donations	30	Harakeke Forest
FourForty, Clevedon	use fee	29	Waytemore Forest
Kingsland Forest, Nelson	donations	27	Silvan Forest
Parihaka, Whangarei	none	25	Onerahi Forest
Ben Lomond, Queenstown	gondola fee	24	Ben Lomond Hills
TECT Park, Bay of Plenty	none	23	OTPP Western Bay
Haven, Banks Peninsula	club fee	22	McQueens Forest
Onepu, Rotoma	none	18	Rotoma Forest
Uenuku Pines, National Park	club fee	17	Waikune Forest
Whitehorse, Waimate	donations	15	Waimate Forest
Tōtara Park, Upper Hutt	none	14	Akatere Forest
Millmore, Gisborne	none	10	Millmore Forest
Raincliff, Geraldine	none	8	Raincliff Forest
Blue Spur, Hokitika	none	6	Ngai Tahu Kaniere Forest Estate
Whitehills, Kerikeri	none	3.5	Whitehills Forest
Raumai Forest, Bulls	none	3	Santoft Forest
Wither Hills, Blenheim	none	77	
Mt Hutt, Canterbury	none	48	
Sticky Forest, Wanaka	none	34	
Te Miro, Piako-Morrinsville	none	29	
Parihaka, Whangarei	none	24	
Centennial Park, Timaru	none	23	
Sandy Point, Invercargill	none	23	
Codgers, Nelson	donations	21	
Summerhill Farm, Te Puke	donations	19	
Rivenrock, Wairarapa	use fee	16	
Oropi Grove, Tauranga	none	14	
Carterton, Wairarapa	none	8	
Hotoritori, Thames	none	8	
Whataupoko, Gisborne	none	7	
Wairoa, Hawke's Bay	none	7	

3. Materials and Methods

3.1. Determining Where Mountain Biking Has Been Present

Using published literature and online sources, we looked at production plantation forests in New Zealand (>1500 ha), aiming to answer the following questions: (1) How many production forests in New Zealand (>1500 ha) permit mountain biking? (2) How long has mountain biking been permitted? and (3) What are the policies for each forest relating to mountain biking? Using published mountain bike guides, brochures and mountain biking websites [76,77,86,108,116,119–124], we created a database of commercial forests to map the expansion of recreational and competitive mountain biking access in commercial plantation forestry land for 1991–2022. We created a time-series map of all operating commercial forest estates (both >1500 ha and <1500 ha) in New Zealand with access for mountain biking for the same time period using a forest industry database [125–127] and topographical maps series NZ TopoMap [128]. Statistical analysis using SPSS was conducted on yearly access based on the two size classes (>1500 ha and <1500 ha) via Chi Square. We also collated recorded transitions in forest management policies regarding mountain bike access, permission requirements, and user costs outlined within forest industry websites and annual management plans.

3.2. Assessing Impacts of Mountain Biking on Forest Management

To qualify the impacts to forest management, we interviewed four forest managers and surveyed a further 10 of the 22 forestry management companies with >1500 ha of forest. The aim of the survey questionnaire was to identify risks and benefits to forest management from the presence of mountain biking within their forest estate, and changes in current forest management practices because of these risks and benefits. Survey forms were sent by email directly to all 22 forest managers, inviting them to complete the survey and return the form via email. Responses were collated and open-ended questions were analysed thematically. The questions are provided in Supplementary Data (S1).

4. Results

4.1. Changes in Mountain Biking Access to Planted Forests, 1991–2022

In 1991, 27 commercial forest owners in New Zealand provided recreational access for mountain biking activity (Table 2); however, there were also limited numbers of mountain bikers using the forests.

Table 2. Number of planted forest areas being accessed for mountain biking activity, 1991–2022.

		1991	1993	1999	2002	2008	2013	2022
Number of commercial plantation forests with mountain biking	>1500 ha	18	49	34	36	56	38	40
	<1500 ha	9	15	18	21	35	33	75
Total number of forests		27	64	52	57	91	71	115
No of above forests requiring permits or landowner permission		11	25	19	26	31	32	24
No of above forests requiring payment for access		3	1	6	10	7	20	21

Kennett et al. [76,77] encouraged riders to explore (exotic) forests, advocating them as an ideal environment for mountain biking. Routes described in Kennett’s guide from both 1991 and 1993 largely follow 4WD and forestry roads, rather than developed single tracks. We found that in these years, only five of the large forest owners had any formal policy concerning access to the estate for recreational purpose, let alone for mountain biking, mostly through a permit system. In contrast, we found access to small forests (<1500 ha) was often regulated, with 67% requiring a permit and 33% with fees. One forest owner even actively excluded mountain bikers on their production forest trails [78]. By 1993, 49 large (>1500 ha) forests were allowing access for mountain biking [76], an almost three-fold increase from 1991 (Table 2). Access to many of these forests was informal. For example,

permission for the construction of one of the first bike-specific tracks—originally known as “the BMX track”—in New Zealand was based only on a verbal agreement between the owner, Forestry Corporation, and riding enthusiast Fred Christensen [86]. In 2022, 115 forests allowed mountain bike entry—more than any other year recorded—buoyed by the steadily increasing number of small (<1500 ha) forests. The number of larger (>1500 ha) forests over the same twenty-year period fluctuated, peaking at 56 in 2008 (Table 2). The main trend in access to forests shows that while in 1991, no significant difference was shown between forest access between forest size ($X^2(1, N = 225) = 0.258, p < 0.389$), a significantly larger proportion of forests >1500 ha had mountain biking occurring in 1993 than in small forests ($X^2(1, N = 225) = 7.825, p = 0.004$). However, by 2022, this trend has reversed, with significantly more small forests <1500 ha now having access ($X^2(1, N = 225) = 73.35, p < 0.000$). The extent of mountain biking in exotic forests during the period 1991–2022 is shown in Figure 3 and in supplementary Tables S2 and S3. We acknowledge some inconsistencies in access regulations in the web and grey literature, so all results are presented based on what was judged to be the most reliable sources.

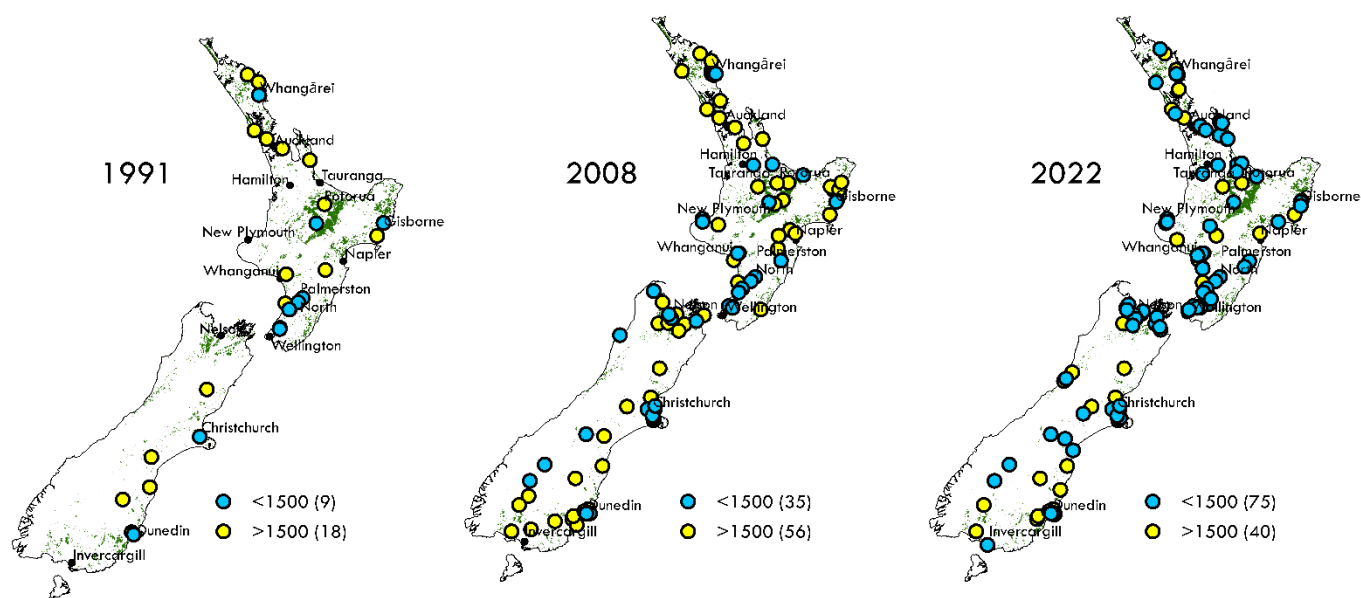


Figure 3. Permitted access for mountain bike users to New Zealand production plantation forests in 1991, 2008, and 2022. Forest counts in parenthesis. Yellow points = forests > 1500 ha; cyan points = forest < 1500 ha (including mountain bike parks); green shading = production plantation forest.

A comparison of track networks between 2008 and 2022 showed substantial network growth in some production forests (Figure 4). Some of these are known to have a strong relationship with local clubs, a dedicated bike park area, or are nearby New Zealand holiday destinations (e.g., Waitangi, Glenberrie (Northland), Whakarewarewa, Wairakei (Rotorua) Tangoio (Napier), Hira, Kingsland/Silvan (Nelson) and Hanmer). We also found that some tracks reported in earlier years by Kennett et al. [108,119,121] do not appear in more recent resources [116,124]. We hypothesise that this is due to the growing development of high-quality mountain bike tracks nationwide, concentrating biking activity on higher-quality tracks. Forests that have purpose-built concentrated track networks have potentially redirected riders from other parts of the forest, or other forests in the region. Examples that seem to support this include the decreased use of Nemonia Forest with the development of Blue Spur MTB Park; Rotoma Forest use decreased with the development of Onepu MTB park; and West Dome, Blue Mountains and Hokonui Forest tracks which are no longer listed in Trailforks [124], whereas Bluff and Sandy Point trails have expanded and are regularly referenced in Trailforks in 2022.

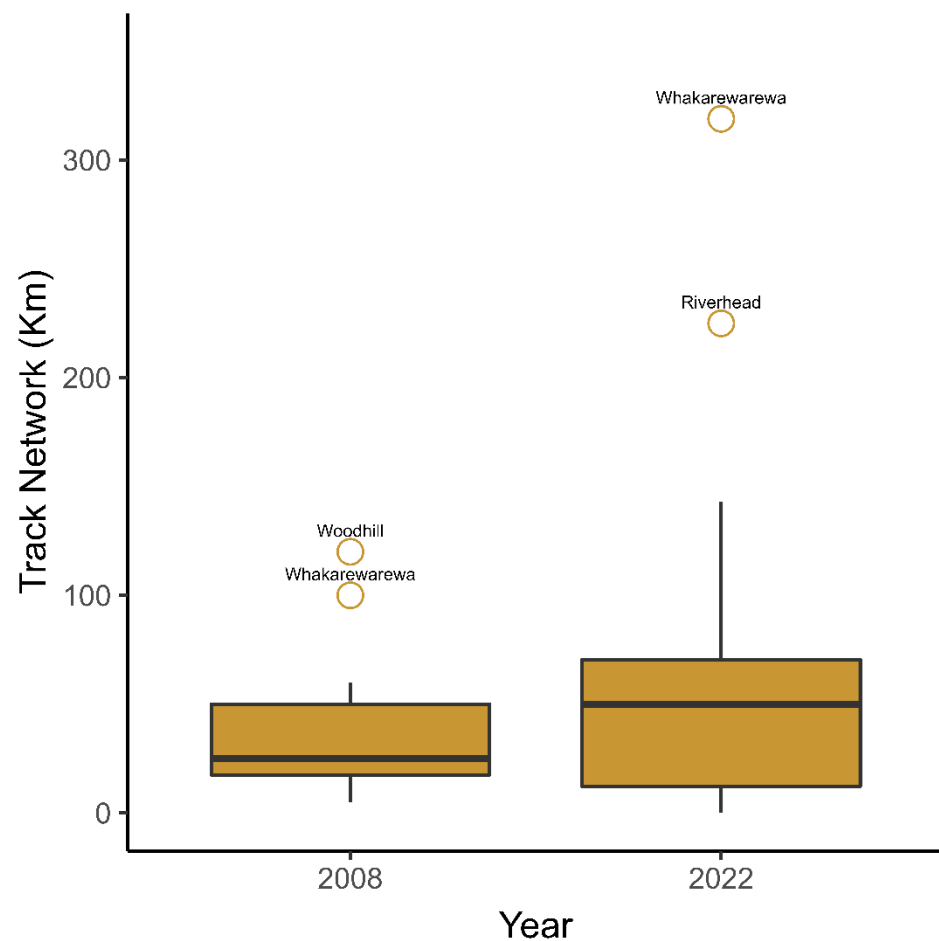


Figure 4. Boxplot showing change in mountain bike accessible track networks in production plantation forests (>1500 ha) between 2008 and 2022. The box bounds the interquartile range (IQR) divided by the median; whiskers extend to a maximum of $1.5 \times \text{IQR}$ beyond the box. Open circles are outlier sample data points. Figure based on 23 forests with >5 km track access in 2008, resampled in 2022.

The rise in dedicated mountain bike parks is attributed to the need for greater access to a few, dedicated trails for biking, separated from other recreational users, and for the protection elsewhere of sensitive vegetation. Mountain bike parks concentrate mountain bikers' usage within a defined access area to ensure safe forest operations in adjacent forest areas. Of dedicated mountain bike parks in production forests, nearly 50% were a subset of a larger plantation estate (Table 1).

4.2. Access Conditions for Mountain Biking in Planted Production Forests

From our review of the literature, our survey and online resources, we found that production forest managers have taken four approaches to access: (1) no access permitted, or only by permit for club/private events on a case-by-case basis; (2) only providing access at certain times (e.g., weekends) and require a permit or pass; (3) providing generally open access to mountain bikers, with an agreement with a local club or council of the protocols and procedures for the construction and maintenance of purpose built mountain bike tracks; (4) operating as in (3) but restricting open-access mountain biking and related track building to a portion of the production forest (e.g., mountain bike parks), and often outsourcing recreational management aspects to clubs or partner with a recreation provider.

During the 1990s, mountain bike access to commercial plantation forests was usually without a permit, largely free, but was often restricted to weekends [76–78,120]. We found that relationships between forest owners and cycling enthusiasts or mountain biking clubs helped develop long-term continued access for mountain biking; whereas forest

managers in absence of these relationships made access restrictions or destroyed tracks during felling operations to discourage further development [76,77,116,120,121]. Mountain biking enthusiasts worked together with local forest landowners for access and track building, lobbied local authorities, and were willing to put in their own labour to establish infrastructure and develop the sport [20,76,85]. Where strong relationships have been established over time between forest owners and local mountain biking clubs, the access conditions are clear, and they tend to result in an increased level of mountain biking recreation within the forest. For example, Whakarewarewa Forest, situated on the edge of Rotorua, a popular tourist destination, has had a longstanding engagement with the local mountain biking community. The forest management and club agreed, initially as an informal agreement, but later formalised through a “memorandum of understanding” that all tracks should be built in areas away from imminent harvest operations, and that all tracks would be documented, mapped and safely sign posted [85]. A formal track network group was set up from members of Kaingaroa Timberlands forest management, the local mountain bike club, and other interested individuals, to oversee track building. In 2004, Kaingaroa Timberlands further formalised access into the forest with an official document circulated through mountain bike websites and the Redwoods Visitor Centre. This set out the necessity for track mapping and marking and ensured that track construction and maintenance was carried out by sanctioned people under the guidance of the track network group [85]. This forged the way for further track building, and club membership leapt to around 300 members. We noted similar established relationships in the local biking club websites, forest management plans and permits relating to Akatarawa, Hanmer, Lismore, Belmont and Battle Hill, and Tangoio Forests.

4.2.1. Permit Requirements

Our database showed that, while in 1991 around 40% of production forest owners had required permits for mountain biking access, by 2002 this had risen to 46%. Fees have a strong association with permitting; by 2022, 88% of exotic forests requiring a permit to access (24) also required payment (sometimes via club fee registrations). In many cases, the hassles gaining a necessary permit were inefficient and complicated [78], paradoxically leading to uncontrolled entries and clandestine behaviour [76,78,86]. Of the large (>1500 ha) forests we surveyed with mountain biking activities, today 43% of forest companies provide access free of charge, though 62% have mountain bike club affiliations in the provision of access conditions, and trail maintenance. Forty-six percent require permits for access, most through local clubs, though one forest manager provided permits through a local bike shop, and another via a contractor. Fifty-eight percent of the small forests (<1500 ha) are managed by local government. Requirements for a permit to ride in the forest, along with fees for riding, have changed over time, due to changes in forest ownership; affiliations with local clubs; establishment of dedicated mountain bike parks; and forest security requirements. Some forest managers opted to recoup costs through selling maps of the forest trails at local cafes for a nominal fee rather than through permits [78]. Ironically, clandestine behaviour, illegal track building and lobbying worked in some ways to gain long term dedicated access for mountain bikers [129–131], although this behaviour has led to frustration and conflict with forest managers and other lawful users [132,133].

4.2.2. Forest Ownership Change

We found instances of access conditions changing because of a transfer in forest ownership. An example of this occurred in 2004 at forests at Riverhead and Tairua when ownership and management transferred from Carter Holt Harvey (CHH) to Rayonier. CHH had required mountain bikers to obtain a permit to ride in any of the Auckland forests, but by 2010 Rayonier no longer required any permits for passive recreational access on foot (including mountain biking). In a similar example, Baigents required a permit to ride in Hira Forest in 1993; CHH did not require any permit during the latter 1990s, and

both Hancock Forest Management and now Tasman Pine Forests require a paid permit (through the Nelson mountain bike club membership) to ride at Hira Forest.

4.2.3. Encouraging Access to Dedicated Areas

In some instances, clubs have actively worked alongside the local forest owners and managers to enable dedicated areas of the forest to be set aside on either long-term lease for mountain biking activity (e.g., Cougar Mountain Bike Park in Tokoroa) or the establishment of a dedicated bike park (e.g., Te Miro Mountain Bike Park and Woodhill Bike Park—the latter being a separate commercial mountain bike park outside the forest company's management). In the case of Eskdale Mountain Bike Park in Tangoio Forest, the relationship with PanPac Forests has seen the forest managed in such a way to accommodate continued mountain bike access safely during harvesting operations. When the Waipunga area of Tangoio forest was due for harvest in 2016, the Eskdale club website noted that new tracks were being established in another section of the park (Pakuratahi Valley) ahead of the closure of access to the area, to ensure continuation of access for mountain biking. Whakarewarewa Forest, managed by Kaingaroa Timberlands, developed a 10-year plan devised with the local mountain bike club to ensure continuous public access to the forest. Other forest owners and managers have subsequently adopted this type of access policy, and today track networks and mountain bike parks are plentiful. Close associations and engagement between forest owners and the local mountain bike clubs means that areas that are most suitable for track development can be identified and managed for recreation, and continued safer forest access for riders can be provided in conjunction with continued harvesting operation.

The last two decades have seen a change in forest company awareness of the need for better mountain biker access, towards at least a social contract for public access (if not a more formalised arrangement with a local biking and track-building club). Most forest management plans now report not only on recreation, but actively use the provision of access for recreational users as a promotional and social benefit. For forests that are Forest Stewardship Council (FSC) certified, the forest can be seen as having “High Conservation Value” if you allow people to recreate in the forest [112].

Today, very few managers of production plantation forests actively discourage recreational mountain bike users, but several management strategies are being employed to ensure safe and enjoyable mountain biking conditions for those recreating within the forest. While only 14 larger companies we surveyed have a formal policy around mountain biking access, most have some form of a public access policy or recreational access via permit (Table 2). The main reason for a permit is to monitor usage, and to ensure the public are aware of access conditions to mitigate hazard risks.

4.3. Risks to Production Forests from Mountain Biking and Associated Management Actions

Our survey of forest managers received responses representing 10 forestry companies. Where mountain biking is occurring within their forests, respondents outlined how they are presently accommodating this activity, the risks and benefits they foresee from the presence of the sport within a production forest, and any policies or procedures in place to mitigate disruption to forest production.

Respondents stated that they had identified risks relating to use conflict, liabilities, and emergency management connected to mountain biking. The following is a summary of identified management issues and risks from survey responses:

1. Fire risk and emergency management: Fire poses significant risk to managers of plantation forests in New Zealand, particularly because of the size and remoteness of many management units, a large cohort of weekend cyclists using the tracks, the difficulty in assessing the number or location of riders at risk, and the intensity of plantation forest fires [134,135]. Forest managers need the ability to evacuate the forest quickly should fire or an emergency event occur. Forest companies manage risk through forest closures in high wind or extreme fire conditions, and by keeping main

fire exit tracks well-cleared. A few companies now have the capability to instantly message club members in emergency or for updates on forest closures. A few forest managers hire security to deter unpermitted access during extreme weather and as part of a wider illicit behaviour management.

2. Illicit track building: Many early mountain biking trails in exotic plantations were developed without permission. Consequently, some tracks exposed riders to active forestry operations (e.g., thinning, felling, hauling, weed control) with serious safety risks. Sixty percent of respondents managed unauthorised track development through partnering with mountain bike clubs or entering formal contract with a trail building enterprise or local government. In some cases, forest managers destroyed clandestine tracks to deter illegal riding. By notifying local clubs of the five-year harvesting plans, this allows the clubs and track builders to schedule new tracks, so that these are available when tracks in compartments being harvested are no longer available. Forest managers want to work with the mountain biking community, but have long term operational plans to meet:

“We do not let mountain bike activities alter our forest management practices, but instead regularly engage with [Club] so as they can be up to date with 5 year harvesting schedules that may impact their track infrastructure”.

Some forest managers stipulated that some high hazard work (i.e., tree felling) was reserved for forestry company personnel. Some forests (e.g., Whakarewarewa Forest) have implemented innovative mechanisms for feedback and suggestions from the local riding community [132].

3. Use conflict with forest operations: Harvesting operations present risks to riders' safety if not managed well. Permits give the forest manager the ability to know how many people, and who, is accessing the forest. The benefit to the owner in clearly outlining the accessible trails on a permit should encourage users to keep to these areas of the forest, rather than providing blanket free access to all forest zones. Some mountain bike parks use counters to provide further details of track usage. This also allows forest managers to monitor track usage for management and planning future development. Managing riders around forest harvesting and thinning operations involves developing concentrated areas of riding to encourage riders to willingly stay on known rides, and using clear messaging (e.g., signage) for track and forest unit closures to avoid riders inadvertently entering operational areas. However, interactions between riders and forest operations are inevitable; one forest manager stated, *“we've had a few near hit reports from log trucks and crew vehicles with mountain bikers,”* in spite of having restricted access to non-operating hours and adequate warning signage at the entrance to forests.

Eighty-two percent of forest companies surveyed allow entities, such as mountain bike clubs, to run mountain biking events at the weekends to avoid the risk that forest crews and cyclists would be on the same roads. Two forest companies indicated that they also give private event organisers special access for hosting of larger events. Forest managers use permit conditions, such as time, area and expected behaviour, to avoid conflict with operations. Nevertheless, *“people may have a valid permit but sometimes see it as their right to use the forest ignoring warning and forest hazard signage.”* Several forest managers also reported warning signage were regularly ignored and conflicts between cyclists and forestry staff were not unusual, especially in non-permitted areas: *“We don't allow any other mountain biking (apart from specific events) in our other forests. There is also unpermitted mountain biking in most forests, but these people are asked to leave by whoever finds them”.*

4.4. Forest Management Benefits Accruing from Recreational Mountain Biking

Our survey of forest managers also revealed perceived benefits from the presence of mountain bikers in productive forest environments. Some of the benefits seen by forest managers in having mountain biking occurring in the forests include increasing forest

security and community engagement. In addition, forest access for mountain biking can lead to increased numbers of people visiting the forest and spending money in the local community, further promoting forestry social licence. This survey response from a forest manager emphasises how giving access helps improve the public perception and understanding of the need for commercial production forestry:

“Having stakeholder engagement with the forest also enables them to understand the business model and necessity of harvesting operations for the continued growth of mountain bike tracks in our estate. For if there was no forestry business, there would be no mountain bike tracks there”.

In the context of a commercial harvesting operation, forest managers perceive the construction of mountain bike tracks as having low environmental impact, and negligible economic impact on the forest production and returns. However, they can have positive economic benefits for the forest owners and much greater spinoff economic benefit to the regional economy, for very little effort on the part of the forest company. This is particularly the case where forest companies have entered a partnership arrangement with a local club or mountain bike park operator. Those we interviewed that had such an arrangement in place reported that this arrangement provided multiple benefits to the forest company, such as:

- Helping to prevent illegal entry into the forest. There is a perception that having lawful users in the forest deters other illegal activities: *“Good to have valid forest users which assists to deter unauthorised use of forest”*. Another forest manager stated rider presence *“stops some of the dodgy activity”*. In addition, such partnerships can alleviate the risk of illegal track construction, and ensure long term track building and maintenance that does not compromise commercial forest operations, including harvesting, thinning, pruning.
- Concentrating riders: By actively concentrating mountain bike track networks and permitting tracks to be built to meet a wide range of riding styles, forest companies benefit by having better control of where in the forest riders are recreating. This reduces the risk of interactions between mountain bikers, other recreational users and forestry operations as riders gravitate to purpose-built single tracks. Some forest managers have moved towards establishing dedicated mountain bike parks/zones rather than having recreational use coincide around the harvest plans or developing silvicultural plans that fit around the trail developments. This can be a useful strategy; however, consultation and approval for such long-term lease arrangements when proposals are received for a permanent recreational facility is required from the landowner.
- Public Liability insurance can be managed through the club via membership. Some forest owners partner with local mountain biking clubs and only allow forest access for riders with club member tags on their bikes, allowing access only to affiliated club members. Clubs can also more easily carry liability insurance for the events they hold.

Access via club memberships makes the access conditions straightforward and it is easy for all members to receive updates and know the rules for access and hazards to watch out for. Forest managers need only to engage with one group to inform all legal cyclists of the upcoming changes in forestry operations, track closures, hazards or events. Forest management plans relating to recreation or impacting on the club’s activities can also quickly and easily be shared, minimising misinformation and rumours. An example of misinformation is seen in an online forum from 2006 with a rider notifying recreationists that access to Riverhead Forest tracks was being revoked, where the forest manager was simply canvassing a review of users to provide improved access and had to spend time reassuring the user group [89]. In addition, it removes day-to-day management of recreationists from being the concern of the forest manager: *“It is great to have other organisations run the day-to-day management of bike trails and to be the go-between for forest managers to mountain bikers. It simplifies the management of it, while allowing mountain biking to occur”*.

5. Discussion

5.1. Forest Management Responses to the Sport of Mountain Biking

5.1.1. Management and Public Access

Production plantation forests are increasingly part of the fabric of mountain biking in New Zealand. However, we have found that the use of forests is changing. Larger forest areas are becoming less accessible, whereas smaller forests near urban centres and holiday destinations are becoming increasingly important. This trend is likely following people's expectations for higher quality, highly interconnected track networks (e.g., mountain bike parks) in lieu of the overgrown forestry roads once worthy of mention. In 1991, Kennett encouraged riders to explore forest plantations to seek out unknown trails that might exist [77]. Few forests had existing tracks available for mountain biking, and of those that did, most provided access for bikers only to existing operational forestry roads [77]; a lot of riding in plantation forests at the time was not explicitly permitted. In contrast, today's exotic production forest managers are more active in establishing protocols for mountain bike use in their forests than thirty years ago. Forest managers were aware of the potential for issues in having mountain bikers within a forest environment, and two decades ago, Wenita Forests raised similar concerns to those raised through our recent survey: "Uncontrolled public use of our forests is a concern to us due to the safety issues it raises, the potential risks to the forest and the problems associated with conflicting activities being carried out at the same time." (Wenita, 2002 in [78]). Where "illegal" trail building has occurred in the wrong forest locations, this has resulted in increased erosion, damage to ecology, and disturbance to nesting birds [136], along with fines to the track builders.

Whether or not forest owners desire to provide recreation, it is best to manage the recreational activities already occurring in the forest [73,137,138]. There are, however, many benefits for the forest owner in allowing recreational biking access to the forest. Reasons purported for the suitability of large exotic forests for mountain biking activity include the ability to provide economic benefit to neighbouring communities; the sheer size of the resource (provides potential for kilometres of track); and provision of economic returns to the forest owner through payment for ecosystem services (either through rider permits or land lease to clubs for dedicated bike-related enterprise) [41]. Promoting public use has proven to have positive economic, social, and environmental impacts to production forests worldwide. In the case of Coed Llandegla, a 650 ha mostly Sitka spruce (*Picea sitchensis*) forest in north Wales, public use of the forest for mountain biking rose from a handful of competitive events in the late 1990s to over 200,000 visits per annum today, through dedicated trail building. Contractors were hired to create trails, and a visitor centre created 20 local jobs with over £1m per annum turnover from visitors [139]. Similar examples can be seen in New Zealand, most notably in Auckland Forests, Tangoio Forest, the Whakarewarewa Forest, Christchurch Adventure Park, Ben Lomond and Codgers [14,16,68]. All these forests are near to larger urban centres, attracting a pool of local riders and those visiting at weekends.

In 1974, Rennison stated "It has indeed been claimed that if Whakarewarewa were managed for tourism and recreation it would be more profitable than managing it for wood production" ([93] p. 70), a proposition later proven in an economic study from 2012 [115], estimating an annual worth of NZD 10.2 million from mountain biking activity, and predicting biking revenues in the Whakarewarewa Forest could rise to even be five times the value of timber production [72]. A similar economic study from the same period showed indirect benefits of mountain biking to the local Rotorua economy amounted to NZD 33 million (RDC, 2006 in [137]). A related report shows that cycle tourists (mostly mountain bikers) in Rotorua spent about 52% more than average tourists (i.e., NZD 3800/stay and NZD 2500/stay, respectively) [140]. More recently, Nelson's regional mountain biking trails accounted for NZD 17.1 million in revenue in 2018, and mountain biking enterprise employed 211FTEs; however, by 2028, total annual economic impact for the region is forecast to be NZD 39.5 million in GDP and the total employment of 538 FTEs [14]. Planted forests maintained for commercial harvest therefore may offer a complementary tourism

economy resource to our national parks, while allowing for more adventurous cycling, but require different management than parks [41] for the safe and enjoyable accommodation of bikes and riders while continuing production forestry.

5.1.2. Managing Risk

A number of known risks exist for the forest manager in relation to permitting mountain biking activities [2]:

- (a) Social risks that develop due to use conflict between groups of users;
- (b) Physical risks to the trees, soil and water from mountain biking activities;
- (c) Safety and security risks due to presence of riders in an operational forest.

The likelihood for use conflict has increased where the number of riders and/or other recreational users has grown [2,17,51]. Recreational use of production plantation forests in the early 1990s was low, so mountain bikers were less likely to encounter use conflict with other recreationists. Still, Kennett et al. [76,77,121] does note incidences of use conflict between mountain bikers and motorised sports, hunters and fishermen [77], particularly where both were using the forest roads and 4WD tracks. Forest managers contributed to the legitimacy of mountain biking in the community through partnering with clubs and leading mountain bike development. The U.S. Forest Service had a similar effect by partnering with the IMBA and local clubs to encourage managed track development [141].

We found that trade-offs occur in shared use areas; for example, the Southland District Council advocated both hikers and mountain bikers avoid forested areas during peak hunting season [118]. The promotion of a mountain biker code [47] that promotes respect for the environment, landowner and other users and club affiliation may lessen use conflict.

Physical risks include soil erosion and compaction, disruption of soil structure, vegetation loss, bark loss and root disturbance, nutrient flow into waterways, and the introduction and spread of weeds and pathogens [41,60]. Several studies [2,4,25,41,50,51] have shown that mountain bikers consider the impact of their activity to be lower than what other users perceive as the impact. While the impact of mountain biking on flat dry trails is similar to walking [51], introducing speed, slopes and wet conditions can exacerbate riders' impacts [41,61–63,142]. Land managers have found the impacts to the landscape are reduced through observing the Mountain Biker's Code and development of dedicated mountain bike tracks [4,121]. However, the environmental impacts vary greatly depending on whether the tracks are wild/natural routes, or hand-dug, or highly mechanised machine built [79]. The sheer number of riders on the trails now makes mountain biking an intensive sporting activity in some production forests (e.g., Esk/Tangoio, Woodhill, Whakarewarewa). While the largest impact on the forest environment from mountain biking occurs during track building, competitive racing is thought to have greater impact than recreational biking, particularly as race events are not postponed due to wet conditions, and the faster speed coupled with tighter cornering can cause ruts and increased soil compaction [2,4]. Pickering et al. [82] suggests that informal trail development has a similar impact to hardened trails, though hardened trails may be effective in lessening damage on sloped or wet areas of track. Manmade jumps and downhill challenges are common in race conditions, and greater damage is likely from the downhill trails, which are often located in steeper exotic planted forest areas. Forest managers can manage mountain biking impacts through legislation and education [17,41].

Increasing recreational visits increases the risk of conflict between forest operations and riders that results in injury, but increasing recreational visits may also mitigate criminal activity. Rennison [93] noted that during the 1950s and 1960s, in response to a large fire event of 1946 forest managers removed all public access to exotic forests, issuing trespass notices at the forest gate and prosecuting those who entered unauthorised. Casual visitors were viewed at that time as a great danger to the planted forests. In contrast, today several forest managers see that providing public access can in fact reduce risks, as there are a greater number of lawful users to report on illicit activity, or able to note emergencies and smoke. Most forest managers control public access to their forested estate

for recreational purpose, usually managed via a permitting system, or a security firm. Other forest managers work in league with local clubs to jointly manage access, manage safety plans, and to provide information and support so that local riders are educated about best practice and any owner concerns around the use of their forested resource for mountain biking is discussed and rectified. Some regions have implemented governance and management groups for overseeing the mountain biking trails, as a collaborative community, landowner and sporting club partnership.

Forest managers' response to risks include signage in the forest entrances, and on both forest company and local club websites outlining access and any areas where poison bait (for pest control) or tree felling is occurring or scheduled; making forest maps available to the public, indicating trails that are for mountain biking, and roads or tracks that do not have access for biking; allowing access only by permit, or selling maps (most proceeds are used to maintain tracks); and restricting access during fire seasons or only allowing afterhours access during weekdays when the forest compartment is operational.

5.2. Forest Management Implications

Commercial forests in New Zealand have become an important recreational resource, and recreational needs are now being accommodated alongside production requirements. Forest policies and management must accommodate a growing social desire to recreate in local forests, particularly from mountain bikers. The introduction of mountain biking adds to the responsibilities of managing a commercial forestry operation, placing an impetus on forest managers to provide safe access for an increasing population of recreational users, while continuing production operations. The introduction of the FSC and forestry reporting under the Montreal Process are driving social and environmental responsibilities with respect to production plantation forest management [137,143]. Even if no legal contractual obligation is present, a growing social contract to the surrounding community, coupled with an increasing public desire to access the exotic forests in their locality, may require forest managers (particularly where forests are located close to urban centres) to actively manage and implement policies which accommodate recreational mountain biking access [144,145].

Recreation is compatible with production forestry with potential to enhance forest revenue. Local government bodies throughout New Zealand are increasingly developing bike parks in small-scale plantation forests owned by the local council. In some cases, a small fee for access and the establishment of dedicated track networks have seen exponential growth in recreational bikers entering the forest area. This growth has also given a boost to the local hospitality and retails, as well as mountain bike ventures such as shuttle services and bike repairs [14]. Forest managers now have the view that mountain biking has the potential to be a valued resource. While economic studies have estimated the value of recreation [115,146], determining preferences and use behaviour is important in determining what the public want and what is drawing them to recreate in a specific way. Making this model work economically demands that recreational use must be managed alongside an operational forest. In some cases, partnering with international investors has helped local governments to provide world-class commercial mountain bike parks in their forested estates. Having so much public experience of biking in a commercial plantation setting provides "*a superb shop window, showing how wildlife can thrive and people can enjoy themselves within an economically productive plantation*" [139], p. 2. Cooperating in the design of trails with local volunteer enthusiasts may provide similar public relations benefit to the forest sector [49]. Engagement with mountain bikers is paramount, not only for track building, but in wider aspects of forest management, such as land tenure change, finding ways to incorporate changing rider expectations from tracks, and to identify the most optimal areas of the forest for future track developments to avoid erosion-prone fall zones or note areas that might require additional wildlife and stream protection due to increasing track use [75,147].

In the 1970s, mountain biking was not part of planning and management for production forest plantations. Bignell [55] states that most forest-based recreation in New Zealand

was limited to half-day family exploration for short walks and picnics. How things have changed since 1981, when he noted “*there is not a requirement to provide “highly exciting” opportunities for recreational pursuits. Whilst a small segment of the population may enjoy this form of recreation, there is a considerable majority which does not.*” (p. 402). Spellerberg [138] stated that there were “*few requirements to provide for amenity or landscape issues*” (p. 21) in the management plans of production forests. The provision of recreation needs to be planned for, and public users educated around both the environment they are using, and best biking practices to adopt while recreating to avoid negatively impacting the forest ecology or potential production return. Determining attitudes to landscapes and recreational use behaviour is important in determining what the public want from the forest environment, what is drawing them to recreate in this landscape over other options. Gathering knowledge of this nature will help to determine the potential of a forested estate for various recreational pursuits and assist in the identification of areas suitable for track design and development.

In incorporating recreational facilities and trails within their forests, it is important that forest managers also look to the future, and account for demographic trends and emerging recreational behaviours as potential drivers of the future recreational activities in forested environments. Forest planners need to plan road and trail access, and construct forest blocks that can accommodate the needs of forest users both now and in the future.

There is also a lack of sufficient data and models concerning recreation and amenity values within forests to assist in investment decisions and forest planning for the incorporation of multiple values into forest management plans. The carrying capacity of production forests should be determined, in terms of balancing ecological and social requirements, while maximising production returns [47].

Experience shows that potential visitation rates of large commercial adventure parks can grow 10-fold within a year [118], compounding the need to plan and manage the resource sustainably. Forest managers we surveyed noted the rising trend of electrically assisted (e-bikes) bikes in their forests. E-bikes provide a new set of challenges for forest managers because of their speed and range [37]. In addition to the anticipated growth from an increased population base and local tourism, these technologies enable a greater number of potential cyclists to enter commercial forests.

Models and research data that increase understanding of how these multiple use complexities can best be incorporated into forest management policies could maximise the returns to forest owners. Incorporating mountain biking (and other) recreational pursuits is highly desirable, especially if best practice learnings can be incorporated into forest standards or management principles.

6. Conclusions

Results from the database of mountain biking presence and access conditions, review of annual forest management plans and analysis of the recent survey of forest managers show key trends in forest management to accommodate the sport of mountain biking. It is most notable that forest management plans have moved towards incorporating a statement regarding recreation and community access, and that mountain biking access is now being separated out in annual reporting from other recreational activities.

Consideration of policies, partnerships and processes for managing active recreational pursuits such as mountain biking has become an essential global aspect of forest management. There has been a long trend in New Zealand production plantation forests towards increased forest access, particularly in smaller forests near urban centres. Most forest management plans already include environmental and ecological management, and a growing number discuss community partnerships. Developing healthy relationships between forest managers and recreational stakeholders will be essential when drafting future forest management plans.

Forest managers are facing a growing recreational presence in their forests. While increased cyclists pose some risks to managers, mitigation strategies exist to ensure production forestry can continue to have a healthy association with mountain biking.

Supplementary Materials: The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/f13081326/s1>, Supplementary Information S1 Survey Questionnaire; Table S2: Known presence of mountain biking activity within planted production forests (>1500 ha) between 1991–2022. Sources: Kennett Bros “Classic New Zealand Mountain Bike Rides” Vol 1–8 and trailforks.com; Table S3: Known presence of mountain biking activity within planted production plantation forests (<1500 ha) between 1991–2022. Sources: Kennett Bros “Classic New Zealand Mountain Bike Rides” Vol 1–8 and trailforks.com (accessed on 28 June 2022).

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