Let the people ride singletrack: Understanding mountain bike trail usage

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Abstract

Mountain biking is a global sport with millions of participants. The sport has grown from a high-risk activity, undertaken by a handful of individuals in extreme environments, to one that can be enjoyed by many. Technological developments have made mountain biking increasingly accessible, in particular the advent of e-bikes. The most fundamental element to mountain biking is the location in which it is carried out. Although terrain can vary significantly, trails are integral to participation.

The objective of this study was to understand mountain bike trail usage within the UK through investigation of when trails are used, the demographic of mountain bikers, their motivations for riding, and the impact of refurbishment on trail use. Usage was considered for a popular singletrack trail in Bristol, UK, quantified through analysis of data from rider counters installed in the trail. Demographic, motivations and refurbishment impact were evaluated through an online survey made available to anyone who had ridden the trail in the previous 12 months. The survey was advertised to users by installing a sign on site, distributing leaflets and sharing on online platforms. The format and design of the survey ensures that it is transferrable for future application to allow comparison and for use at trails elsewhere.

Results from the analysis of rider counter data have identified temporal variations in trail usage dependent on time of year, day of the week, time of day, school holidays and events. The results suggest that daylight hours and other commitments, e.g. work, govern mountain bikers' use of the trail. From the survey, a profile of the typical participant was developed, in line with international studies of advanced mountain bikers and other lifestyle sports participants. Key motivations for mountain biking were identified as spending time outdoors, fitness and stress relief. This study provides evidence that could support construction of mountain biking facilities near urban areas to promote physical and mental health. Refurbishment of the trail with an all-weather surface yielded significant increase in the trails usage, providing a venue for year round participation.

It was concluded that mountain biking trail usage is a dependent of temporal variation but not necessarily weather conditions. For the site considered, the all-weather surface was imperative to the trail's use, particularly in winter months when natural trails are not rideable. The accessibility of the trail for all skill levels increased its' popularity within the urban environment and future construction of similar facilities would support growth of the sport. Such facilities promote well-being through time spent connecting with an outdoors environment, engagement in physical activity and escape from the pressures of daily life.

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1.0 Introduction

Mountain biking is one of the world's fastest growing lifestyle sports (Koepke, 2005) enjoyed by families through to adrenalin-seeking enthusiasts; a mountain bike is defined by the Oxford English Dictionary (2020) as "a type of bicycle typically having a sturdy but lightweight frame, broad, deeply treaded tyres, multiple gears, and straight handlebars, originally designed for riding in mountainous terrain." The sport is practiced today in a variety of locations including forestry roads, man-made singletrack routes and pump tracks (a built up skills loop of features). In addition to the number of purpose built trails, bikers use footpaths and establish illegal trails in woodland. The International Mountain Bicycling Association (IMBA) (2015) found that in Europe 70% of riders occasionally ride illegal trails and 16% did not realise that it was illegal to ride in certain locations. Several disciplines fall under the umbrella term mountain biking. Singletrack does not describe the style of riding but the type of trail. It is a track of approximately a bikes width, typically with a smooth, flowing surface and features including drops, jumps and berms. The difficulty of the trail can vary from family friendly rolling terrain to steep mountain passes.

Mountain biking is almost exclusively undertaken outdoors. The opportunity to experience nature and fresh air is a draw for all outdoor activities; 40% of the population would prefer to exercise outside (Gordon et al., 2015). It has been established that mountain biking, and other outdoors activities, can have positive impacts on mental wellbeing. 92% of people who participate in outdoor activities do so to relax and de-stress (Gordon et al., 2015). A quarter of the adult population in the UK suffer from mental health problems, which can have a further effect on friends and family (McManus et al., 2009). It has been proven that exercising in an outdoors environment can alleviate mental health conditions with more effectiveness than exercising indoors (Thompson Coon et al., 2011; Khan & Kumar, 2014). Outdoor activities also benefit physical health; they have been linked to reducing diabetes and obesity (Gordon et al., 2015).

The UK outdoor industry is one of growth; 8.96 million citizens currently partake in outdoor activities, of which 9% participate in mountain biking or cyclo-cross (Gordon et al., 2015). As well as informal rural trails and routes, there are pump tracks in urban environments, and an expanding network of trails built by volunteers. Most mountain bike trails are free to ride and rely on volunteers to establish new trails and maintain old ones. Some mountain biking centres, usually in mountainous regions, are run as a business, often offering bus rides or ski lifts to the top of the trails. These centres, such as BikePark Wales, charge riders in return for a variety of well-maintained tracks pitched at different abilities with exciting features.

This research is centred on the popular blue-graded singletrack Nova trail at Ashton Court in Bristol, UK. Ashton Court, a site owned by Bristol City Council, was one of the first locations of an official mountain bike trail, established in 2002, though riders have been using the estate since the 1990s (Bristol Trails Group, n.d.). Designed and constructed by local company, Architrail, in 2011, the Nova trail was intended to protect rare flora and fauna by providing a venue enjoyable for both beginners and expert riders and thus preventing damage from the creation of new lines by riders. It is approximately 5 miles in length and the blue-grade indicates the trail is of moderate level with small technical features and short steep sections (British Cycling, 2020). Though not technically demanding, there is a downhill red-graded section called the SuperNova to attract more advanced riders. It is well located to connect with Bristol's other mountain bike trails. Since its construction, the trail has been protected by an all-weather surface which has deteriorated overtime; during the last two years, fundraising efforts have allowed the trail to be refurbished and resurfaced. Archtrail and volunteers carried out the refurbishment, managed by the trails steering group and Pedal Progression. Pedal Progression run a mountain bike hire and coaching business from a retail unit at Ashton Court's hub. Here there is a car park, public conveniences, café and municipal golf course. In addition to mountain bikers the estate is popular with dog walkers and runners.

Figure 1.01: Beggar's Bush Lane trail section before refurbishment in September 2019. (Pedal Progression, 2019)

Figure 1.02: Beggar's Bush Lane trail section after refurbishment in October 2019. (Pedal Progression, 2019)

Existing mountain bike research to date has focussed on physiological impacts to riders and the influence of bike design on performance. Limited research has been conducted in Norway and the US concerning participants of the sport, but this has concentrated on experienced riders who compete and identify as 'mountain-bikers'. Particularly in an urban location, it is anticipated that a large number of riders will not be 'serious' riders, rather people using the trails for a variety of reasons, whether that be for general fitness or a family day out.

In order for provision, development and construction of both existing and future trails it is necessary to understand the needs, interests and incentives of users. Currently, there is no available quantified data on how mountain bike trails are being used on a day-to-day basis. The objective of this study is to have a wider understanding of mountain bike trail usage within the UK, resolving a lack of evidence both here and further afield as to how trails are used, by whom and why. This research uses two primary sources of data in order to quantify mountain bike trail use. Source one is the data available from two rider counters installed below the trail surface and two is an original, targeted survey designed for this research and made available to users of the trail. Four aims will be used to achieve the objective:

1) Quantification of trail usage - achieved through analysis of rider counter data to investigate how much the trail is being used and when, and, through the survey, disclosure of trail users riding habits including how often they ride and with whom.
2) Establishment of the demographic of mountain bikers - here previous research has focussed on advanced riders, Ashton Court is accessible for all levels of riders and the survey will be made available to all users of the trail to establish an accurate representation.
3) Understanding trail users reasons for mountain biking - considering existing research undertaken into mountain bikers' motivations, the survey here will reveal and quantify whether or not the motivations of amateur riders is in line with those of serious mountain bikers.
4) Consideration of any influence that refurbishment of the trail has on its' usage - the section across one of the trail counters was refurbished during the period of this study (Fig. 1.01 & 1.02) and the impact of the refurbishment will be determined using values from the rider counters and trail users' opinions from the survey.

Analysis of the rider counter and survey results will deliver quantifiable data to enable understanding of trail usage at Ashton Court and provide a sample of UK mountain biking trends. The outcome of this study will be able to support UK mountain biking groups, charities and communities in expansion and construction of trails and to inform concerned parties of the positive impacts, and indeed any negative consequences, that mountain biking can have in the wider community.

2.0 Literature Review

2.1 History of Mountain Biking

Mountain biking, like many other lifestyle sports, is relatively young. It became recognised globally in the 1970s as part of the late modernity movement alongside other outdoor recreation sports such as surfing and extreme skiing (Skår et al., 2008; Savre et al., 2010; Taylor, 2010). This second era of modernity is a product of globalisation, changes to work-life and family balances and an increased availability of disposable income (Taylor, 2010). Identity transitioned away from defined categories based on age, religion, class etc. towards self-definition based on cultural and leisure choices. Mountain biking grew as a consumer culture provided sport and leisure lifestyles to aspire towards. Lifestyle sports allowed individuals to obtain an identity based on the activities they chose to engage in, rather than their demographic (Wheaton, 2004). As the sport increased in popularity, manufacturers began to produce purpose-built bicycles with a dramatic rise in demand between 1980 and 1990; sales increased from three hundred to seven million in North America (Savre et al., 2010).

It is difficult to identify the origins of the sport before the 1970s as, since the invention of the bicycle in 1817, riding off-road has not always been a choice, but essential for many. In the UK, the 'Rough Stuff Fellowship' of cyclists was formed in 1955 for intentional escape from the roads, with similar groups being established across Europe and America at the same time (Savre et al., 2010). Although cyclists have been riding off-road since the advent of the bicycle, prior to the 1970s engaging in mountain biking for leisure was practiced by only a handful of individuals (Savre et al., 2010). There was not considered to be any international, or even national, community of riders. By 1996 mountain biking had become so widespread that it was introduced as an Olympic event, again accelerating the sports growth. The IMBA estimated that in 2005, people took more than 78 million rides in the UK.

Despite its continually growing popularity, there is limited understanding of the demographic of mountain bikers, the use of mountain bike trails and how purpose-built and 'wild' trails compare. Purpose-built tracks rely on engineering construction knowledge to meet demands of the rider; a poorly built feature can easily collapse under applied forces in saturated conditions. By enhancing understanding of the rider, the design of future trails can be optimised. It can be expected that characteristics of mountain biking participation will compare to those of other lifestyle sports.

2.2 Lifestyle Sport

The definition 'lifestyle sport' is commonly interchanged within the literature with action, extreme, alternative and adventure sport. Such sports are usually practiced in the outdoors, they are technical, mentally and physically challenging, and have an associated degree of risk. The level of risk necessary to define a lifestyle sport is difficult to quantify as it varies drastically between environments and variations of the same sport. For example, rock climbing at an indoor centre and free soloing outdoor rock faces have drastic differences in consequence. Other lifestyle sports include surfing, snowboarding and windsurfing.

Wheaton (2004, 2010) has carried out extensive research into understanding lifestyle sports and highlights that negative connotations can be associated with alternative terminology such as extreme sport. Many authors choose to recognise mountain biking as a lifestyle sport (McCormack, 2017; McEwan et al., 2018; Bordelon & Ferreira, 2019), as participants of these sports would deem it a lifestyle choice, not purely an activity. Wheaton (2004) discovered that participants are seeking a distinctive lifestyle that sets them apart from others and provides a prescribed identity. As part of a survey completed by 261 mixed ability riders, 61% stated that they perceived mountain biking to be an outing beyond just training (Koelme & Morawetz, 2016).

Wheaton (2004) identifies nine characteristics that determine lifestyle sports: they are new sports established in the last half-century; they encourage "'grass-roots' participation"; they utilise ever-developing technologies such as boards or bikes; they require commitment of time and money; they embody fun, flow and living in the moment; they are usually individual, rather than team sports; they are non-contact but welcome risk; they are practiced outdoors to bring participants closer to nature; and are dominated by middle-class, white participants. A lifestyle, and thus identity, is created from engaging in the sport as there

is commonly style, language and new technology associated. The communities value a subcultural capital of skills, brands and technologies. Lifestyle sports commonly have a core group of members which can exclude beginners. Core members can be recognised through the technology and style they possess, and there is an expectation to prioritise the sport over other activities including family life. (Wheaton, 2004)

McCormack (2017) discusses how mountain biking is more inclusive than other lifestyle sports, suggesting that this may be because of a fundamental need within the sport for grassroots organisations to fund and carry out the building and maintenance of trails. The community is considered to welcome beginners and helping out at a dig can be a fast-track route to becoming a core member. A 'dig' is time spent by volunteers to maintain and develop features of the mountain bike trail. The majority of informal trails are built by volunteers by digging out paths to create features and riding surfaces free of encroaching vegetation. Trails become eroded during wet weather by the formation of ruts, so one of the key processes of a dig is to level and shape the track, ensuring there is drainage at locations vulnerable to becoming waterlogged.

It must be realised that it is possible to partake in some lifestyle sports without engaging in the community at all. As the sports are predominantly individual, and with the development of remote resources, such as YouTube, it is possible to practice the sport and even develop skills without such engagement. It could be considered that it is the risk of the sports that feeds the community. At a higher risk level, a greater skillset is required that is much easier to obtain with tutoring and feedback from more experienced members. For dangerous activities, participating in groups is recommended for safety. The sports are often performed in remote locations, and should anything go wrong, help could be several hours away. The greater the risk the sport presents, the more it is necessary to be a part of a community.

Taylor (2010) defines mountain biking as a "hard" adventure sport due to its technicality, remote locations and associated risks. However, it could be considered that mountain biking on a purpose built trail in a controlled environment, such as Ashton Court, does not present the same challenges and consequences, thus may be described as soft in these circumstances. The hard-soft spectrum has been borrowed from the adventure tourism industry. Soft adventure tourism is focussed on discovery and exploration and may appear to present a level of risk but this risk is not realised. Beginners can partake in such experiences and are usually led by an experienced guide (Pomfret, 2006). Hard adventure sports entail real risk, demanding greater commitment and skill (Pomfret, 2006). In the relatively safe and busy location of Ashton Court, it is possible for cyclists to participate in mountain biking without engaging with the community. This may attract a wider variety of users, e.g. families, and more infrequent participants. Furthermore, as lifestyle sports become more commercialised, they can lose risk and competitiveness which can reduce the sports appeal to those seeking an adrenaline rush or a unique identity (Skår et al., 2008). As the sports become more mainstream, terminology such as lifestyle or adventure may no longer be an apt description.

2.3 Lifestyle Sports Participants

Studies have been carried out to identify participants of lifestyle sports, with the most reputable research being that carried out by Wheaton (2004, 2010). Wheaton (2004) established that an individual's commitment to a sport may vary significantly from an image-based identity, that may or may not be a projection of falsified media on platforms such as Instagram, to summer 'samplers' of various sports, to 'hard core' enthusiasts for whom the sport is centric to their life. Whilst style and image are associated with lifestyle sports, authenticity as a member of the community is dependent on participation (Wheaton, 2004). Despite this, fashion and language can make the community appear highly exclusive and discourage beginners.

Previous research has found lifestyle sports are dominated by white, middle-class men (Wheaton, 2004; Gordon et al., 2015; McCormack, 2017; Bordelon & Ferreira, 2019), though more women and other minority groups are beginning to take up the activities (McCormack, 2017). McCormack (2017) considers the sports to be dominated by men because links can be associated between risk and seeking masculinity. As sports become dominated by male participation, new female participants may be intimidated and thus the male dominance grows further (McCormack, 2017).

The commitments of time and money that lifestyle sports demand limits participation to those with the available resources. This is especially true for those who wish to associate with a 'core' membership group, where the sport is expected to be a priority (McCormack, 2017). Lifestyle sports, by definition, use expensive, ever-developing equipment, such as mountain bikes. And, as individual activities, are not constrained to the training timetables of team sports, thus, the more an individual engages, the more they are considered part of the community. For those busy with other commitments, such as work or family life, it can be easier to put off individual training, than a team training session where other community members will hold individuals accountable. It can however be possible to have a 'taster' of these sports. For example, surfing is a lifestyle sport that has become extremely commercialised; it is possible for a complete beginner to head to a crowded beach in the South-West of England, hire a foam longboard for £10 and try their hand at catching a wave. Whilst for some, this may be the start of their journey to fall in love with the sport, it makes the community of 'authentic' surfers even more exclusive. Furthermore, lifestyle sports are location specific, i.e. beaches with suitable surfing conditions, or legal mountain bike trails. These locations are not plentiful and there are time and monetary costs associated with travel. Those who can afford this are typically individuals established within their career, on a higher income and with less family commitment.

2.4 Mountain Biking Participants

Despite mountain biking being considered more inclusive than other lifestyle sports, participants are governed by the sports characteristics e.g. a dedication of time and money. Pickering and Leung (2016) comment that although the users of mountain bike trails are becoming more diverse, the sport is still dominated by younger, well-educated men. The general consensus is that mountain biking is a sport dominated by men in their late thirties and early forties, with disposable income to invest in equipment, often more advanced than their level of riding demands and availability of time free of family or work commitments.

Mountain biking describes any bicycle riding taking place on terrain other than a man-made hard surface such as tarmac. Therefore, it encompasses many different types of trail, including forestry tracks, singletrack and downhill. The type of trail and individual locations all demand a different skill level and thus attract a variety of participants; some forestry trails are suitable for families with young children, but some singletrack routes can only be tackled by the most skilled and experienced mountain bikers. Skår et al., (2008) highlight the difficulty in identifying how involved a rider is within the sport; experienced riders would commonly associate level of participation with risks taken, but risk cannot be quantified. Participation cannot be inferred from the equipment used by a rider either, as some riders will use bikes that are more sophisticated than the technicalities of the trails they are riding require (Skår et al., 2008) whilst others may be a regular participant, but cannot afford expensive equipment.

Some characteristics of mountain biking participants have been revealed as part of wider studies (Koelme & Morawetz, 2016; McCormack, 2017; Roberts et al., 2018). The results from these are limited to mountain bikers who already engage within the community; the sample for Koelme & Morawetz (2016) survey was collected through online cycling forums, and McCormack (2017) only interviewed participants who identified as 'mountain bikers' again contacted through online forums and Facebook groups dedicated to the sport. Whilst this provides a basic understanding of the profile of regular riders, it omits the large user group of infrequent participants or those who do not engage with an online community.

2.5 Motivations

Motivations determine why people mountain bike and can be considered in two categories; an individual's aspirations, including the possibility of creating an identity, and behavioural factors that the user may not be aware of such as psychological or societal influences (Skår et al., 2008). To analyse recreational behaviour, categorisation of motivations has been attempted in order to quantify participants reasoning. One such attempt at categorisation is to split reasons into 'push-and-pull' factors. For example, escapism is a push factor that encourages participants to engage, whilst pull factors are attributes that draw participants to a particular location (Taylor, 2010). Beard and Ragheb (1983) developed the 'leisure motivation scale' which classified motivations for participants into four categories (intellectual, social, competence-mastery and stimulus avoidance). However, Taylor (2010) highlights that participants reasoning for mountain biking may

not be able to be restricted to categories developed for recreational activities, due to the unusual set of motivations, risk and danger, associated with lifestyle sports.

The literature has previously identified some motivations for 'serious' mountain biking. One commonly recurring theme is that of excitement and the feeling of being a child again (Skår et al., 2008; Taylor, 2010; McCormack, 2017). Skår et al. (2008) considered motivations for defined "mountain bikers" in Norway, where a mountain biker was considered someone "who had cycled on rough trails or difficult terrain more than ten times in the previous year." By only considering those who met this definition, 57.1% of survey responses were ignored. The ignored responses were largely from the popular tourist trail Rallarvegen which attracts approximately 25,000 riders each year but is challenging enough to require a purpose-built mountain bike and a moderate level of fitness (Skår et al., 2008). The study discovered that motivations of bikers largely correlated with that for overall outdoor recreation in Norway. Physical exercise was the primary motivation, and contemplation and nature experience were also considered important, where contemplation encompassed reasons such as stress release. However, social relations was not as highly valued by mountain bikers as for general outdoor recreation (Skår et al., 2008). It could be supposed that the importance of sociability would increase if the sample had included all responses from the Rallarvegen trail.

Taylor (2010) used qualitative methods for understanding participation in mountain biking, conducting interviews in the UK and New Zealand with riders of at least an intermediate level for whom the sport was 'serious leisure'. Participants rode at least once a week, all year round, though it is unclear how the skill level of rider has been defined. The study yielded a variety of factors that inspired participants to ride and recurrent themes included novelty, exercise, escapism and challenge. Contrary to the findings of Skår et al. (2008), social engagement was considered a key motivation with nearly all participants preferring to ride with others than alone, though peer pressure was considered a hindrance to performance by several respondents (Taylor, 2010).

2.5 Site

Trail type and features are of significant importance when considering users of mountain bike trails and why they choose to ride. The site will often be a 'pull' factor to both advanced and new riders, because of the experience it provides. Taylor (2010) identifies the following pull factors associated with site attributes; scenery, adventure, singletrack, flow, extent of trail, climbs, thrill, signage, facilities, variety of trails and features, challenges, conflict avoidance, guidance, all-weather terrain. Taylor (2010) also highlights the importance of available information in attracting riders to a site such as reputation and media imagery.

For many recreational activity providers, it is important to ensure user demands are being met in order to prevent riders going off-trail and the associated concerns of safety and environmental damage (Koemle & Morawetz, 2016). Mountain bikers may ride illegally if they feel legal trails inadequate (Pickering and Leung, 2016). The mental and physical challenge of singletrack, especially within a natural environment, makes it the preferred choice of trail by experienced mountain bikers. (Cessford, 1995, 2003; Hopkin & Moore, 1995; Symmonds et al., 2000) In Austria, riders will often leave designated trails that are typically along logging roads to seek technical singletrack routes (Koemle & Morawetz, 2016). It was also found that riders with more experience would choose a trail with more vertical climbing than a new rider. Increased climbing was preferred by males compared to females, though this may be influenced by the small female sample size (Koelme & Morawetz, 2016).

Variety is considered important amongst riders, as many highlight novelty as an attraction to ride (Taylor, 2010). Koelme & Morawetz (2016) suggest that rider preferences will vary depending on the time they have available, e.g. a weekday evening ride or a full day weekend tour, and it has been realised destinations near cities, such as Ashton Court, are becoming increasingly popular (Pickering and Leung, 2016). Additionally, it is important for sites to be able to facilitate different preferences dependent on rider characteristics in the local area; those who would consider themselves predominantly a road cyclist seek a longer ride on a logging trail or bridleway, and older riders prefer a shorter trail (Koelme & Morawetz, 2016).

The trail also determines the style of riding, which is in turn influenced by the type of bike being used; the development of new types of bike, creates yet more demand for trails (Pickering and Leung 2016). For land

owners and managers unfamiliar with mountain biking, the relatively rapid developments of technology mean it can be difficult to continue to provide adequate facilities, consequentially inclining bikers to ride off-trail, thus creating a vicious cycle of insufficient facilities and conflict between riders and land stakeholders.

2.6 Trail Erosion

At multi-recreational sites such as National Parks, some conflict has arisen between mountain bikers and other interest groups, e.g. hikers, due to the assumed environmental damage from bicycle tyres (Thurston & Reader, 2001). A major concern is the formation of informal tracks, though, through experimental research, Thurston & Reader (2001) have shown that biking is no more detrimental to a deciduous forest habitat than hiking. However, the establishment of informal tracks forms very quickly for both activity types, with 86% loss of vegetation after only 25 passes (Thurston & Reader, 2001), highlighting the importance for adequate facilities to prevent long-term damage. Ashton Court is home to a number of rare species, including wild orchids and historically there was worry by Bristol City Council and local environmentalists that the formation of new mountain bike lines was damaging this. The construction of the Nova trail in 2011 was granted planning permission in order to protect the environment and to provide a clear and exciting line for riders to take to prevent them creating their own.

2.7 Trail Building

Mountain bike trail building varies with the style and formality of the trail. Trails can establish overtime with the erosion of ground forming a clear path, but they can also be engineered and built by small local groups and professional companies. With each advance in the level of engineering, more technical challenges, risks and safety considerations are presented. Within Bristol's mountain biking community, several trail builds are represented. 50 Acre Wood and Ashton Hill Plantation (also known as Belmont) are unofficial trails built up by small, formal groups of volunteers with permission from the land owners. These trails have an unprotected surface, meaning the tracks have roots, rocks and mud. The trails are well-defined and recognised and 'digs' (trail maintenance, improvement and development) can only be carried out on designated days organised by the managing groups (Fowler, 2013). Development of these trails relies on approval from the Forestry Commission, awareness for other land users including walkers and equestrians and consideration of safety. Ashton Hill Plantation presents some of the most challenging features of Bristol's mountain biking locations with cross-country routes, downhill sections and a skills park (Bristol Trails Group, n.d.).

The Ashton Court Nova trail and the Yer Tiz trail at Leigh Woods are more engineered than those above. They are purpose-built, officially graded trails that protect the soil from erosion with a hard wearing surface. Purpose-built trails are usually installed at the most popular locations, including Ashton Court and Leigh Woods which can experience approximately 75,000 passes each year (Morgan, 2020), and mountain bike trail centres such as BikePark Wales. At Ashton Court and Leigh Woods the soil depth is very shallow, so the surface protects exposed tree roots (Bristol Trails Group, 2020). The smooth surface makes the trail accessible for all abilities, and the track is rollable thus reducing risk. Features and optional routes can be constructed for more advanced riders. When designing purpose-built trails consideration is given to how the line can take advantage of the natural topography of the land and natural features to create flow (Global Mountain Bike Network, 2019). The trail is built up with three layers in a similar method to pavements. A foundation layer is built up from large stone of 200-300mm depth. Type 1 stone is then used to build up features such as berms and rollers. This is the same type of stone that is used as a sub-base for highways and domestic projects. The layer is compacted using a whacker plate, before the stone dust layer is applied on top and allowed to settle. The dust layer binds the coarser aggregate to create a smooth riding surface and all weather trail (Global Mountain Bike Network, 2019). Much of the work is done by professional trail building companies such as Architrail, but at Ashton Court, barrowing and feature creation was assissted by volunteers to reduce labour costs. The hard-surfaced trails provide a safer environment for families and allow riders to develop skills with a reduced risk of injury. But, the trail infrastructure requires greater engineering knowledge to deliver.

3.0 Methodology

Study of the literature exposed a lack of data for the UK and for the broader spectrum of users of purpose built trails such as at Ashton Court. This area of understanding is essential to assess the value, nature of construction and future development of trails. This research aims to obtain an understanding of trail usage for all abilities of rider. Two primary sources of data have been used for the purpose of this research. The first enabled the quantification of trail usage; two rider counters are installed along the trail recording the number of times the trail was used thus providing data for comparison to variables including weather conditions and time of day. The second source was an original survey distributed to riders of the Nova trail to identify the demographics of UK trail users and why they choose to ride. The rider counter data has been analysed for the period of 5th June 2019 to 20th March 2020, and the survey from 3rd February to 30th March 2020.

3.1 Counter Data

Rider counters indicate the amount of trail usage; installed below the surface and unnoticeable to anyone using the trail, they detect every time a bike passes. Pressure slabs, designed by Linetop, detect the distinctive double bump of a bike pass, in order to prevent double counting or false readings from animals or people passing on foot. The sensors are connected to a data logger that records values at hourly intervals. Data can then be transferred into softwares Numero and EcoPC for analysis. (Linetop, 2020) Originally, installed in 2010, the data loggers were reinstated in June 2019. The data obtained historically is unavailable for comparison. Both rider counters are located in refurbished sections of the Nova Trail at Ashton Court. The first (Fig. 3.01 C) is installed along a loop known as Quarry, located at the bottom of a hill and is the furthest section of the trail from the car park and visitor hub. For this reason, it is a convenient section to omit for shorter rides and family usage. As a distinct section, it is popular amongst regular riders for improving skills and they might repeat the loop up to several times. It is a competitive section amongst Strava app users who seek the fastest time.

The second rider counter, referred to as B3129, (Fig. 3.01 B) is on the Beggar's Bush Lane section; the most recently refurbished part of the trail. Refurbishment was completed in October 2019, thus it has been possible to compare data from before and after. This section of the trail runs parallel to the B3129 road, and is on a similar elevation to the car park so could be considered more accessible for children. The counter is located just after 'The Hole in the Wall', a crossing over the road into 50-Acre Wood, another popular volunteer-built trail. The number of counter bike passes will have been affected by users leaving and joining the trail here. In addition to the marked Nova trail at Ashton Court, the estate is interspersed with fire roads and bridleways, and there are several connections to roads for access to the estate. Thus, it must be realised that the rider counters provided an estimate for the number of users on the trail, as riders may repeat or skip sections, in addition to joining at different locations, and not always riding a full loop of the Nova trail.

3.1.1 Analysis

Data collected from the rider counters has been compared against a number of variables to understand the factors that influenced when people were riding the trails. The variables considered were: time of day (absolute and relative to sunrise/sunset); day of the week; time of year; school holidays; events at Ashton Court; weather conditions; and trail refurbishment. Historical weather data was obtained for the time frame of June 1st 2019 until 31st March 2020. The following records have been obtained for Almondsbury MET Office weather station from CEDA MET Office archives: UK Daily Temperature Data; UK Mean Wind Data; and UK Daily Weather Observation Data. Almondsbury weather station is 12.6km from Ashton Court. Rainfall data was collected from a local amateur weather station located in Totterdown, Bristol, 2.6km from site, due to an absence of Met Office archive data. Distance of the weather stations from site may mean there were slight localised discrepancies between the weather at Ashton Court and that recorded. However, the distances are short and differences in conditions would have been similar to those a rider would experience between their home location and Ashton Court. Care was taken to use weather stations that yield similar results. Wind speed may have been greater at site than the speeds recorded due to increased exposure across the open area, but the relative difference between day-to-day wind speeds is comparable. Both weather stations are based in Bristol, on the outskirts of the city. Other weather stations, such as Avonmouth, were ignored due to microclimates surrounding the Bristol Channel.

Figure 3.01: Map of Ashton Court estate. The Nova trail is shown in blue, the short red section is the more challenging Super Nova downhill trail. (Wallace, 2016)
A) Location of aluminium sign (Fig. 3.02). Location of survey leaflet distribution and rider observation.
B) B3129 rider counter. Start point 4 is the 'Hole in the Wall' connection to 50-acre wood.
C) Quarry counter.
D) Car Park, Café and Pedal Progression shop and bike hire.

3.2 Survey

3.2.1 Survey Design

The survey design was carried out by identifying the desired information to be obtained and observing good survey practice. With the intention for collection of both quantitative and qualitative data, the survey was a tool for accessing the opinions of mountain bikers. Survey research was considered the appropriate method of primary data collection as no secondary data is available on UK mountain bikers, it is possible to approach the target population both on site and online and the desired information is of an individual, self-reporting nature (Hardy, 2017: Rea & Parker, 2014). It has been assumed that the sample was representative of the wider mountain biking community in Bristol and the UK.

Sample survey research has numerous advantages. Time and money can be saved by extrapolating the opinions of a smaller sample to the wider population, and if conducted correctly can provide reliable insight into thoughts and points of view of individuals and communities, that would not be possible to quantify by other methods of primary data collection (Rea & Parker, 2014). A survey that has proved effective in gathering subjective data, and quantifying it, can be easily replicated at another location or a later date, to understand geographical and periodical development (Rea & Parker, 2014). The survey at Ashton Court could be repeated in the summer to assess whether the demographic shifts towards families riding, or at other UK mountain biking locations.

A reputable external platform, Google Forms, was used to host the survey to be as user friendly as possible. Google Forms allows different question styles to be included within one survey and for different sections to be made visible to respondents dependent on their answer to a previous question. Phrasing of questions was considered in the design to avoid bias response, technical or ambiguous language. Particular care was taken to avoid double-barrelled questions. A copy of the survey is available in the Auxiliary Material.

The survey introduction informed respondents of the purpose of the research, which, according to Rea & Parker (2014), alleviates concerns that participants may have. The introduction also assured respondents of anonymity, confidentiality and that any response is valuable. Survey participants can be inclined to give the answer that they feel is 'correct', so it was important to avoid unintentional bias in wording. The introduction gave instructions on how to enter the prize draw, and reassured participants that if they gave their email and name, this would not be associated with their responses. A preliminary question asked whether the respondent had ridden the Nova trail at Ashton Court in the last twelve months. The question was obligatory, with only a "Yes" or "No" answer available, ensuring the survey was only being completed by those of the desired sample population. Any respondents who answer "No" were directed to the end of the survey.

The aim of the survey was to gather information on three key areas (Section 1.0): demographic of mountain bikers; riding habits of trail users; and users' motivations for mountain biking. The first section of the survey concerned the demographic of respondents. Short answer and multiple-choice questions asked respondents their age, gender, ethnicity and income. Respondents were asked to answer their age to the nearest year, so the average age of riders could be calculated to allow comparison with other sports. The other characteristics were assessed by multiple choice to prevent the possibility that respondents felt their privacy compromised. The ordering of survey questions is important to prevent biased responses and confusion (Rea & Parker, 2014: Andres, 2012), thus the factual questions were included at the start of the survey. To maintain participants' interest and prevent respondents dropping out, the personal questions were broken up by asking respondents to state their method of travel and journey distance. Sensitive questions were kept to a minimum, with respondents only asked to disclose information that would allow comparison to existing mountain biking and lifestyle sports demographics.

The second part of the survey focused on respondents riding habits. Respondents were asked a series of multiple choice questions on how often they cycled on the road, as a practical means of transport, mountain biked and mountain biked at Ashton Court. Respondents were asked whether their most recent ride had been by themselves, with a partner or in a small or large group. Dependent on their response to this question, respondents were then directed to another section of the survey which asked a series of multiple choice questions about the nature of their riding group (i.e. friends, family or a formal group), how often they rode together, who else they mountain bike with and how often. All sections asked the same content but with different wording to provide clarity and prevent confusion. The last question of the section asked respondents to what extent they agreed with the statement "I prefer riding alone than with others."

The final part of the survey addressed respondents motivations for mountain biking. Such questions are not factual, but opinion-based and self-reporting. A survey provides an effective tool for "getting inside someone's head", but it is important to not limit the reasons they might give to what is expected (Hardy, 2017). This final section used a combination of long answer, short answer and scaling questions. The first two questions asked respondents their reasons for mountain biking and mountain biking at Ashton Court. Andres (2012) highlights the importance of asking open ended questions first, so that responses are not biased by the options given in any multiple choice questions. Respondents were then asked to what extent seven different factors motivated them to ride. They were not asked to rank the factors so they had the option of giving multiple factors the same level of importance, but all factors were presented in a single question, encouraging respondents to compare them against one another. The seven factors were 'adrenalin rush', 'fitness', 'stress relief', 'tackle challenging situations', 'spend time with friends and/or family', 'test out equipment' and 'spend time outdoors'. The factors were based on the main categories in Skår et al. (2008)'s study into motivations for serious mountain bikers in Norway. This research used a similar method of asking survey respondents how influential factors were in motivating them to mountain bike, however, this study gave 27 items. Skår et al. (2008) had selected the 27 items as those believed to be relevant to mountain biking from 43 Recreation Experience Preference (REP) scales identified by Driver et al. (1992) which describe why individuals desire to participate in leisure activities. The list of 27 items were reduced in this study to the seven main categories identified by Skår et al. (2008) in order to maintain respondents' interest. Too many categories can cause respondents to become disengaged and not give due consideration to a factor's importance (Andres, 20128). The sub-category items included in Skår et al. (2008)'s survey were covered by the open-ended questions in the Ashton Court survey, in which respondents had the opportunity

to include any particulars for why they mountain bike. Respondents were also asked in a short answer question if there were any other factors that would motivate them to ride. The final two questions considered the impact of the trail refurbishment on respondent's riding habits. They were asked in an open-ended question if their habits had changed since the refurbishment and if so how, and finally they were asked to what extent they agreed with the statement "I am more likely to the ride the Nova trail at Ashton Court since it has been refurbished." Asking similar questions in different formats is a powerful tool in survey design for the verification of answers. Towards the end of a survey with lots of scaled questions, respondents can become complacent; asking an open-ended question can prevent a patterned response (Rea & Parker, 2014).

Respondents were thanked for their participation, reassured of confidentiality and asked for any other comments. They were given the opportunity to enter into a prize draw for a £40 Pedal Progression voucher. The prize draw was advertised at the distribution of the survey to provide an incentive for participation creating a reliable sample size. The survey was estimated to take no more than five minutes to complete, reducing the risk of incomplete surveys. This was advertised to potential participants when distributed so they were aware of what was expected.

Prior to the distribution of the survey to Ashton Court mountain biking population, a trial was carried out on a sample of 10 respondents. Not all were mountain bikers, in which case they were asked to complete the survey in regard to their most recent hike. All trial respondents were given time to complete the survey without any intervention from the interviewer. Respondents were asked for their interpretation of each question, these were recorded by the interviewer to ensure that all questions could only be interpreted in the way intended. Trial respondents were also asked if they felt uncomfortable answering any of the questions or if there were any they did not understand. Any wording was then refined as appropriate before making the survey available to the public. A small-scale testing of a survey assesses clarity, comprehensiveness and acceptability to ensure its' validity as a research tool (Rea & Parker, 2014).

3.2.2 Sampling

The survey was advertised and distributed by three means to increase the overall sample size and ensure a broad range of trail users could access it. An aluminium sign was designed and fabricated describing the research and the potential influence it may have on their local trails. It was installed at a central location along the trail, the top of a steep hill where riders are likely to rest and the start of the red SuperNova downhill section. Riders were asked to follow a link to complete an online survey. The installation of a sign utilises the Citizen Science concept, whereby public volunteers enable the widespread collection of data to support research. It allows continuous data collection that would not be possible with the man-hours available (BBC citizen science). The sign was based on a global coastal research scheme known as CoastSnap, where signs on beaches and coastal footpaths ask members of the public to insert their phone into a purpose built cradle, take a photo of the beach and upload it online allowing researchers to monitor erosion and deposition without the installation of expensive equipment. Installing the sign at Ashton Court was also intended to allow continuous data collection; instead of taking a photo, users were asked to complete the survey. As the sign was permanent, it facilitated responses from all users of the trail including those who might ride at less popular times, when it would be impractical to have someone manually distributing surveys, and those such as families and occasional riders who may not engage in online mountain biking platforms.

Figure 3.02: Aluminium sign installed along the Nova trail advertising survey to users.

The second means of distributing the survey was by repeating the sign design onto a leaflet. Leaflets were made available at Pedal Progression, as well as the café, and were distributed to riders along the trail on two

separate occasions. When distributing the leaflets, observations of trail users were made; group size was observed and riders were asked for their gender and which age category they fell into (0-10, 11-20, 21-30 etc.). These observations were gathered for a sample of 132 riders, which were compared to the survey results to verify whether or not the survey sample was representative of Nova trail riders, or if certain demographics were more inclined to respond, such as those with children or those riding alone. Intercepting riders along the trail resulted in higher engagement from riders with the research. Only two riders did not stop when approached to ask if they could spare a minute. All those who did engage, took a leaflet to complete the survey and nearly all engaged in a conversation about the research and their experiences mountain biking. These conversations provided wider context into riders' motivations, experiences and what mountain biking features they would like to see in future. A large number of respondents commented on the trail refurbishment and all were supportive of the research. Users were more willing to engage having been introduced to the research by another mountain biker and given context. Asking users to take a leaflet away, reduced the number of those who declined participation as they were able to complete the survey in their own time with assured anonymity.

The final means of distribution was online. The survey was shared by Pedal Progression through an email newsletter, Facebook and Instagram. The distribution of the survey online made it accessible to anyone who engages with the online local mountain biking community. This included those who may not have been riding during the period of data collection due to external factors such as weather, injury or the Coronavirus outbreak. Furthermore, online distribution allowed for quick data collection, as responses can be gathered and processed in a matter of days (Rea & Parker, 2014). For this reason, the online survey was the last to be distributed, made available two weeks before the closing date for the prize draw (30th March 2020). The later online distribution was to encourage more people to respond to the sign and leaflet surveys rather than online. The sign and leaflet surveys were more likely to be completed within a short time frame of the respondent's most recent ride, making recollection of the experience easier thus improving the accuracy of results. Sign and leaflet responses also provided greater comparison with the rider counter data and understanding of who the present users of the trail were.

All three distribution techniques had overlapping advantages. Distributing a link to the survey and not requiring riders to complete the survey mid-ride, increased convenience to the respondent and removed time constraints allowing respondents to give considered responses and the availability to elaborate (Rea & Parker, 2014: Andres, 2012). By removing direct contact with the interviewer, the reassurance of anonymity supported honest answers, and any bias from the interviewers phrasing or tone when asking questions was removed.

3.2.3 Response Rate

113 completed surveys were returned, of which 111 could be used. Two respondents answered "No" to the initial filter question, thus were prevented from continuing the survey. From the 113 surveys, 23 (20.4%) responses were completed through the link given on the sign, 38 (33.6%) from the leaflet link and 52 (46.0%) from the link distributed online. There were no incomplete survey responses.

3.2.4 Survey Analysis

Analysis of the survey was split into four sections to address the four aims of the research (section 1.0); riding habits determining trail usage, demographic of riders, motivations for riding and the impact of the trail refurbishment. Travel to site was also considered to interpret whether the trail is used primarily by those local to Bristol. Rider demographics considered the typical trail user by calculation of mean age and identifying the most frequent gender, ethnicity and income bracket. Riding habits were quantified to understand trail usage frequency and riding companions allowing comparison through graphical representation. The impact of trail refurbishment and rider motivations were both assessed through the categorisation of responses from open-ended questions, and motivations were further analysed through a Likert-scale. Scaling of the seven motivational factors from 1 (Not at all) to 5 (A lot) was analysed by calculating the mean response and standard deviation for each factor, and then using this to rank the factors from most important to least.

Open-ended survey questions required categorisation of responses. For the motivational question, "Please describe why you choose to mountain bike", answers were initially processed to identify reasons that fell into the seven main categories for the Likert-scale question. Table 3.01 shows words used that were considered to be parallel with the category headings. Responses were studied further to identify any additional recurring themes, mentioned by more than one respondent. For the impact of the trail refurbishment, answers were separated into "Yes my riding habits have changed" and "No they have not" followed by determination of trends on how respondents' riding habits had changed since the trail refurbishment.

Main Category Heading	**Responses included**
Spend time outdoors	Outdoors/nature/fresh air/countryside/woodland
Fitness	Fitness/exercise/health
Stress relief	Stress relief/relax/mental health/well-being/switch off/escape/freedom/clears the mind
Adrenalin Rush	Adrenalin/exhilarating/excitement/speed/buzz
Tackle challenging situations	Challenge/technical challenge/skills
Spend time with friends and/or family	Friends/family/mates/social aspect/lifestyle/pub
Equipment	
Other identified themes	
Fun	Fun/enjoyment/pleasure
Improvement	Improvement/progression/getting better
Try something new	Something new/unique/have a go/glamourous
Flow	
Safety	Safer than road riding/away from traffic
Adventure	

Table 3.01: Response categorisation for question "Please describe why you choose to mountain bike."

3.3 Limitations

Data collected for this study has only been gathered from one purpose-built, legal mountain biking location, but could be expanded elsewhere within the UK. Such expansion would assess the accuracy with which the results gathered from this site represent the wider UK mountain biking community, or the usage of trails across the country. The rider counter data is expected to be significantly different from trails which are not protected by an all-weather surface in the winter.

Rider counters are only capable of recording the number of passes by a mountain bike, without indication if the same rider was making multiple passes within one trip. However, it is expected that riders repeating parts of the trail will have somewhat balanced with those skipping sections. Many riders will not have ridden the Nova trail as a complete loop, they may have run several loops, revisited a section or skipped those that they do not enjoy. The rider counters can give an accurate description of trail usage, but rider numbers can only be approximated.

A major limitation to the survey was the time period in which it was conducted. The survey was available to respondents for a total of one and a half months in February and March providing sufficient opportunity to gather a suitable sample size. It is feasible that the winter time period meant less regular riders and families with younger children in particular were not riding. In addition to comfort, riding the trails in winter conditions is more challenging, poses more risk and can accelerate erosion, widening the trails and damaging neighbouring habitat. Poor weather stops some riders who are conscious of damaging the trails.

Distributing a link to an online survey reduces the overall response rate, as individuals feel less obliged to respond, and can create bias in the sample. The survey was only available to those with internet access, and illiterate or less educated individuals may not participate (Rea & Parker, 2014: Andres, 2012). Without an interviewer, unclear questions could not be explained so the importance of ensuring questions can only be interpreted in the way intended was paramount. Open-ended questions were likely to be answered with less detail or left incomplete. (Rea & Parker, 2014)

4.0 Analysis of Rider Counter Data

4.1 Temporal

Trail usage has been analysed against the proposed hypothesis that temporal parameters influence the number of riders on the trail. Most persons prefer to engage in outdoor activities during daylight; longer daylight hours with generally warmer, drier weather means summer months are more popular (Gordon et al., 2015). A similar pattern was expected for mountain biking, so the time of day and time of year have been considered. In addition to nature driven factors (daylight and weather), working routine was expected to affect riders opportunity for mountain biking. The traditional Monday to Friday working and school week make the weekend the busiest days in the leisure industry though riders may try and fit rides around their working day, i.e. pre or post work, or during a lunch break. This is harder to assess as working schedules become more flexible, only 6% of the British population now work the traditional '9 'til 5' (YouGov, 2018).

4.1.1 Time of Year

Trail usage was assessed through comparison of monthly figures for both the Quarry and B3129 counters. The total number of passes across the counter each month was considered, with the exception of October when the Beggar's Bush Lane section of the track was being refurbished. If there was no partial trail closure, the October value could be expected to be an average of the September and November values. Rider counter data was available from 5th June 2019 to 20th March 2020. This allowed comparison of summer and winter passes, and an understanding of the transition into colder, wetter weather and fewer daylight hours. The absence of data for April and May mean no conclusion could be drawn from the spring season.

Month	**No. of passes**	
	B3129	*Quarry*
June	6725	7023
July	6769	8098
August	5970	7110
September	5242	6468
October	2158	5101
November	5796	5399
December	5835	5418
January	6811	6367
February	5383	5199
March	3714	3569

Table 4.01: Total passes for each month at Ashton Court Nova trail.

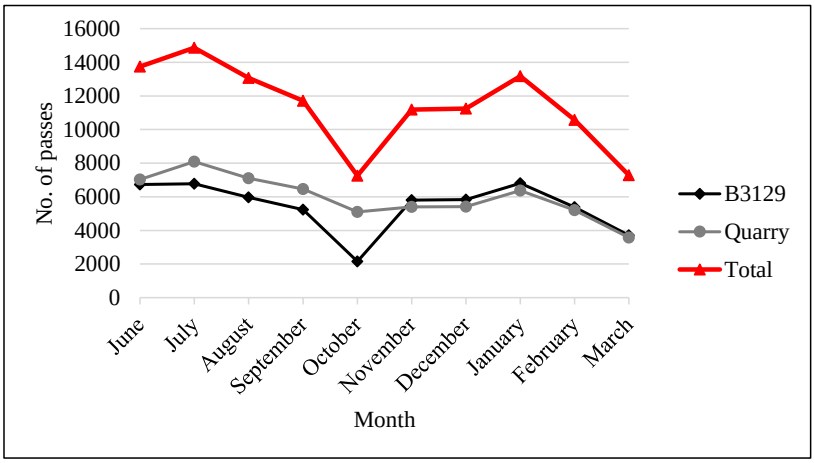

Figure 4.01: Graphical representation of bike passes at both B3129 and Quarry counter.

June and March were both incomplete months so it is expected that their totals would be higher, should data from the whole month have been available. For the B3129 counter there is only a difference 44 passes between June and July, and it is likely that the actual total for June would have been greater than July. The limited March data was further impacted by the Coronavirus outbreak; although strict guidelines were not put in place until the 23rd March 2020, 'social distancing' measures had already been established for a week, with people encouraged to avoid non-essential travel and busy locations. Vulnerable individuals and those with certain health concerns may have been 'self-isolating' since as early as February. It is expected that the total number of riders for March will have been significantly reduced by the spread of Coronavirus within the UK, and the number of riders for February could be lower than expected. Absence of data from previous years prevented comparative evidence of the extent to which rider numbers were affected.

Overall greatest trail usage occurred in July with nearly 8100 passes over the Quarry counter. Although this is the maximum overall and for the Quarry section, the maximum trail usage of the Beggar's Bush Lane segment occurred in January. Whilst the Quarry section had been refurbished in March 2019, Beggar's Bush Lane was in a poorer condition until October (section 6.0). The usage peak in July could be explained by a number of reasons. The Nova trail is recognised as accessible to all and a popular trail for children (section 5.3), especially the refurbished sections which have a smooth surface with less hazards. Bristol summer

holidays commenced in July, with private schools breaking up earlier, potentially explaining the surge in usage of the Quarry section. Also, weather in July 2019 was exceptionally pleasant; rainfall was only 53.3% of the expected rainfall, the month was calm and the 4th warmest July since 1937 (Horton, 2019).

Outside the anomalies of October and March the quietest month was February; the numbers of passes across both counters was low, possibly due to poor weather. February was warmer than the norm, a balmy 7.9°C, with no snowfall, but rainfall for the month was 257% higher than the annual average (Horton, 2020). Wet, icy weather along with poor visibility increases risk, liable to stopping less experienced riders using the trail. For the B3129 counter, September recorded the fewest number of passes. September was a wet month (127.5mm precipitation (Horton, 2019)), and this section of the trail was likely difficult to ride before the all-weather surface was restored in October.

Unaffected by refurbishment, the Quarry counter provided a more accurate description of changes in bike passes. Reduction in trail usage between summer and winter is clear with a steady decrease through August and September. Overall decrease in trail passes between summer (June, July and August) and winter (December, January and February) is on average 1,750 per month. The drop may be attributed to fewer users, or those who were riding taking shorter rides. In colder months, riders may choose to only complete one lap rather than multiple or may not repeat sections they might usually. Excepting August and October, both counters follow the same trend, and differences between the two rider counters are consistent when considered before and after the refurbishment.

January delivered an anomaly, with around 1000 more passes than December or February for both counters. Weather conditions in January were similar to December and February, and there is no clear explanation for the sudden increase. Possible suggestions are that it was caused by users testing out new bikes and equipment received over the Christmas period or by people practising New Year resolutions to exercise more. Alternatively, the January peak may follow a typical pattern of increase and the February and March decrease are the anomaly due to Coronavirus.

Summary: Overall decrease in trail usage was relatively small. Total decrease across the B3129 counter from summer to winter was only 7%, possibly attributed to refurbishment making the section more popular. Decrease for the Quarry counter was 24% which is likely to be an accurate representation. July experienced greatest trail usage, and February the least.

4.1.2 Day of Week

Day of the week trail usage was evaluated for the period Wednesday 14th June 2019 until Tuesday 17th March 2020 to ensure an equal number of dates for each day of the week. Days of the week were calculated on a monthly basis for comparison throughout the year. Longer daylight hours in June and July may provide greater opportunity for riders to schedule weekday rides alongside work commitments. It was anticipated that weekends would be busier than weekdays.

Day of Week	**No. of riders**	
	B3129	*Quarry*
Mon	4530	4915
Tue	4496	5449
Wed	5808	6927
Thu	4791	5496
Fri	5044	5516
Sat	13588	14337
Sun	15315	16272

Table 4.02: Total passes for each day of the week at Ashton Court Nova trail.

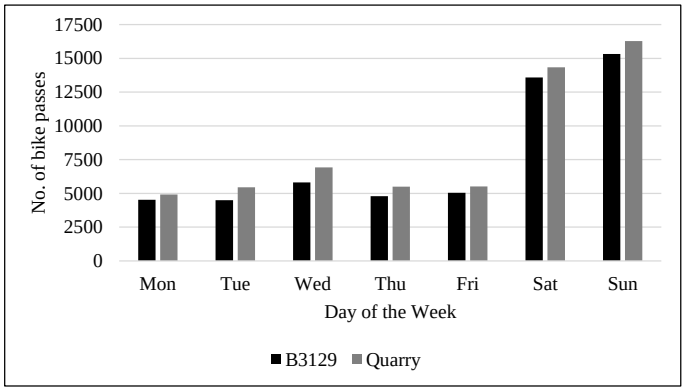

Figure 4.02: Total passes for each day of the week. B3129 passes are lower due to closure in October.

Figure 4.02 shows that the trail had significantly more usage on Saturdays and Sundays; Sundays had 2.4 times the number of passes than the third busiest day (Wednesday). People have more availability at the weekend, and likely greater time for longer rides, repeated laps or repetition of individual sections.

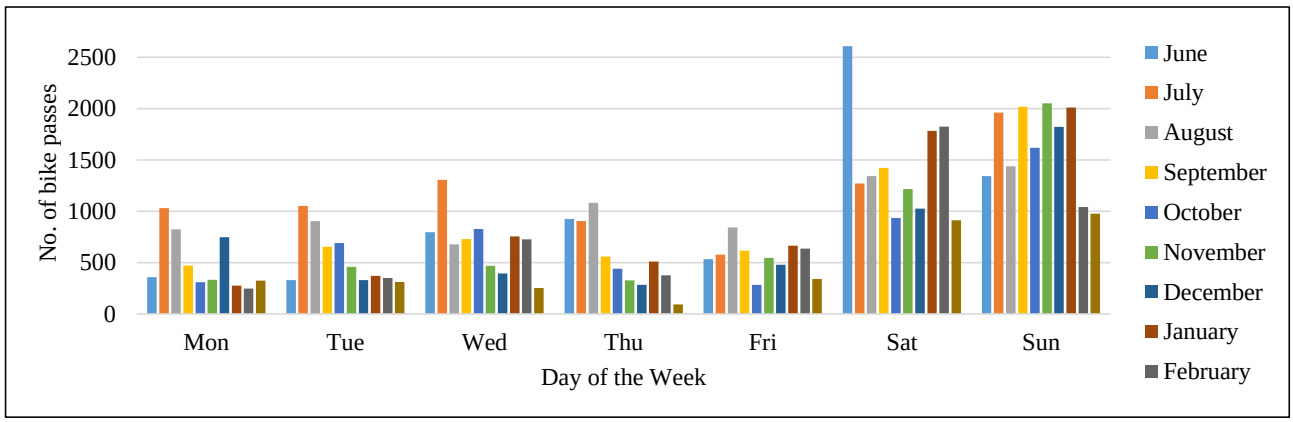

Figure 4.03: Number of passes across for the Quarry counter for each day of the week, by month.

Although all months followed the trend of busier weekends than weekdays, each month varied. Saturdays in June show greatest trail usage, however this is skewed by the Bristol BikeFest (section 4.1.5). June experienced the second highest trail usage overall which could be due to this one Saturday as other days of the week indicate lower activity. July was the busiest month for the Nova trail, but does not follow the trend of quiet weekdays and busy weekends. Very hot weather could have meant that trail users chose to ride in the evenings when it was cooler (Fig. 4.06), and thus weekdays were more appealing. Alternatively, it could be because July's more reliable weather and the school holiday makes it a popular time for people to take holiday leave from work, increasing weekday trail activity. Midweek Wednesdays in July saw 40 more bike passes than Saturdays. August followed a similar pattern to July; 61% of rides occurred on weekdays. August was also warm, and is another popular time for holidays.

The split between weekdays and weekends was more prominent in the winter months. During January and February, weekday totals for the whole month were as low as 247 (Mondays, February). Across January and February, 58% of rides occurred at the weekend, though January favoured Sundays and February Saturdays. Fridays in winter were more popular than summer for which there is no clear explanation, it may be a popular end of work week activity, or an organised group may have used the trails on this day. Reduced daylight in the winter mean it is dark before and after the working day; only a handful of riders practiced night riding (Table 4.03), so this is likely the reason for the majority trail usage at weekends.

Summary: Weekends were the dominant time for riding; Saturday and Sunday accounted for 53% of total trail usage for the period considered. July and August experienced more weekday trail usage than any other month, and the weekday-weekend split was more prominent in winter when daylight hours are reduced.

4.1.3 Time of Day

As with the day of the week, the time of day when users were riding was considered both overall and monthly. For each month, mean sunrise and sunset times were calculated to understand whether this is a driving factor. It was hypothesised that the day of the week would impact what time users were riding; numbers were expected to be highest early evening on weekdays, and midday to be the weekend peak.

Time of Day	Number of Passes	
	B3129	*Quarry*
00:00	12	3
01:00	11	0
02:00	17	0
03:00	16	0
04:00	17	3
05:00	46	100
06:00	223	462
07:00	709	1023

Time of Day	Number of Passes	
	B3129	*Quarry*
08:00	1545	2293
09:00	3238	4326
10:00	5175	6540
11:00	6683	6683
12:00	6169	6060
13:00	5710	6045
14:00	5949	6601
15:00	5666	5126

Time of Day	Number of Passes	
	B3129	*Quarry*
16:00	3683	3769
17:00	2904	3780
18:00	2898	3531
19:00	2284	2239
20:00	1009	709
21:00	203	142
22:00	68	24
23:00	11	3

Table 4.03: Total number of bike passes across both rider counters for each hour.

Table 4.03 and figure 4.04 show overall spread of trail usage. The most popular time was 10:00 to 14:00; the warmest hours with most sunshine. Greatest number of passes for both counters was recorded at 11:00, correlated with the dominance of weekend riding. The increase in the number of riders from 05:00 until 11:00 followed an exponential curve, dropping slightly over lunchtime before a smaller peak at around 14:00. The number of passes decreased in the afternoon, plateauing around 16:00, possibly post-work or school riders, before tailing off into the evening.

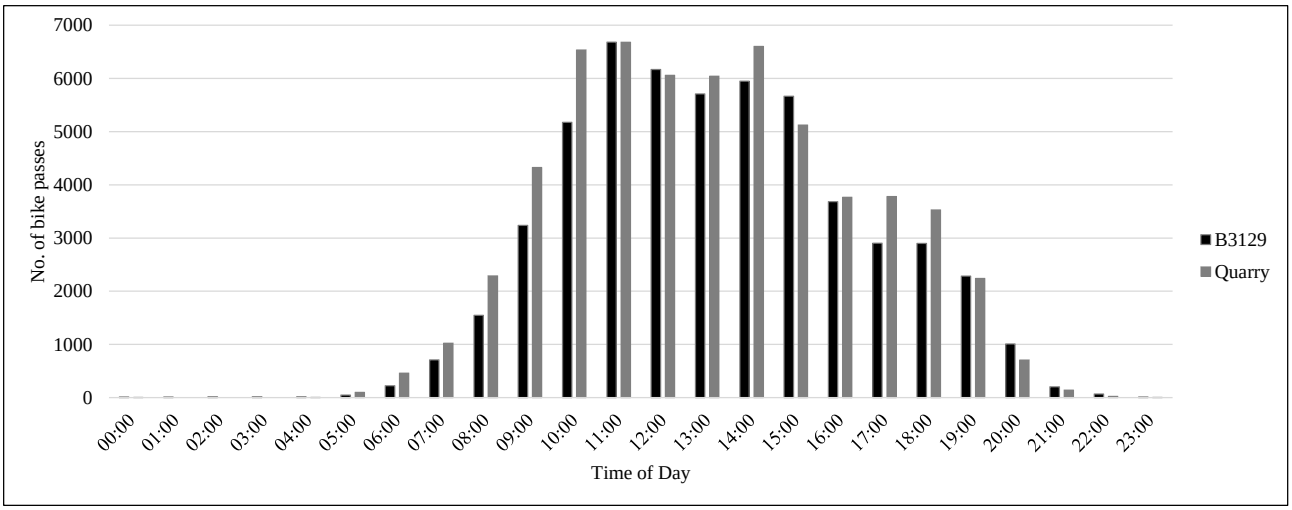

Figure 4.04: Total number of bike passes across both rider counters for each hour.

Figure 4.05 identifies how the number of riders fluctuated throughout the day for each day of the week. Clear distinction is evident between weekday and weekend riding, with a smaller distinction between midweek days and Monday and Friday. The trend shown for Saturdays and Sundays verifies that most trail usage occurred at weekends because users had more daytime availability. Preference is apparent for riding from 09:00 until 16:00, between sunrise and sunset at all times of year. Though Saturday mornings and afternoons were equally popular for riding, Sunday mornings were busier than the afternoons. Both days had a drop in numbers around lunchtime (13:00), which could have been due to riders stopping to eat but it is possible that, due to the high physical demands of the sport, people designated it a half-day activity. After 15:00 on Saturday and Sunday the number of bike passes dropped rapidly and Friday evenings saw reduced usage; these are times often spent with family and friends. Mid-week evenings were the most popular time during the week, supporting that trail usage is limited by work commitments. Wednesday evenings are notably the most popular and it could be seen in figure 4.02 that Wednesday is the busiest weekday from June to March. During daytime in the week, the numbers of riders was reasonably constant, indicating a steady stream of users who are not confined by a typical weekday working pattern.

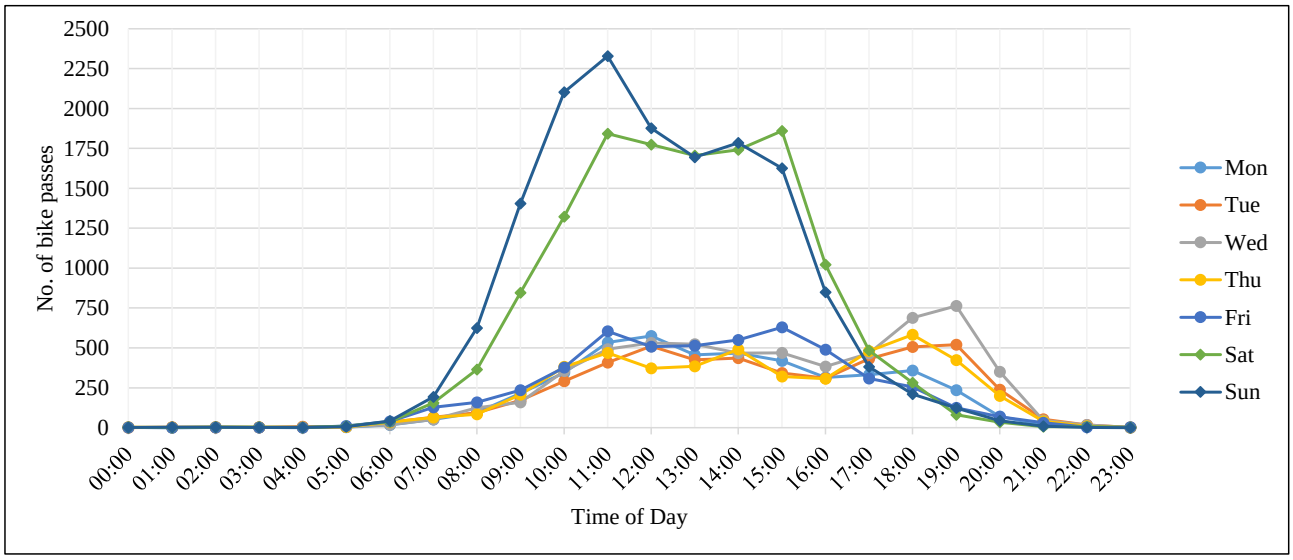

Figure 4.05: Total number of passes across B3129 rider counter on each hour for each day of the week.

Two further distinct patterns emerged when riding times were considered on a monthly basis (Fig 4.06); summer (June to September (inclusive)) and winter (November to March) months followed different trends. Daytime values for summer fluctuated between 400 and 700 passes per hour per month and for each month there was a noticeable dip in the number of passes at 16:00 before an early evening peak at 18:00, with as many as 733 passes in July. In these summer months, the number of passes dropped rapidly after 19:00, but in winter increased again between 18:00 and 20:00. Surprisingly, riders stayed out later in winter than in summer. Sunset between November and March was in the approximate range of 16:00 to 18:00, so there was evidence that a significant number of riders (up to 229 bike passes per hour per month) practiced night riding. From Table 4.03, it can be seen that the trail has been used on a number of occasions in the middle of the night. The Beggar's Bush Lane section was more popular than the Quarry loop for night riding, possibly because it is easier to access. Finally, rider numbers began increasing from 05:00 in the summer, with nearly 100 passes of the counter before 06:00 in July, but in the winter months the trail was not generally used before 06:00, again a likely consequence of temperature and daylight.

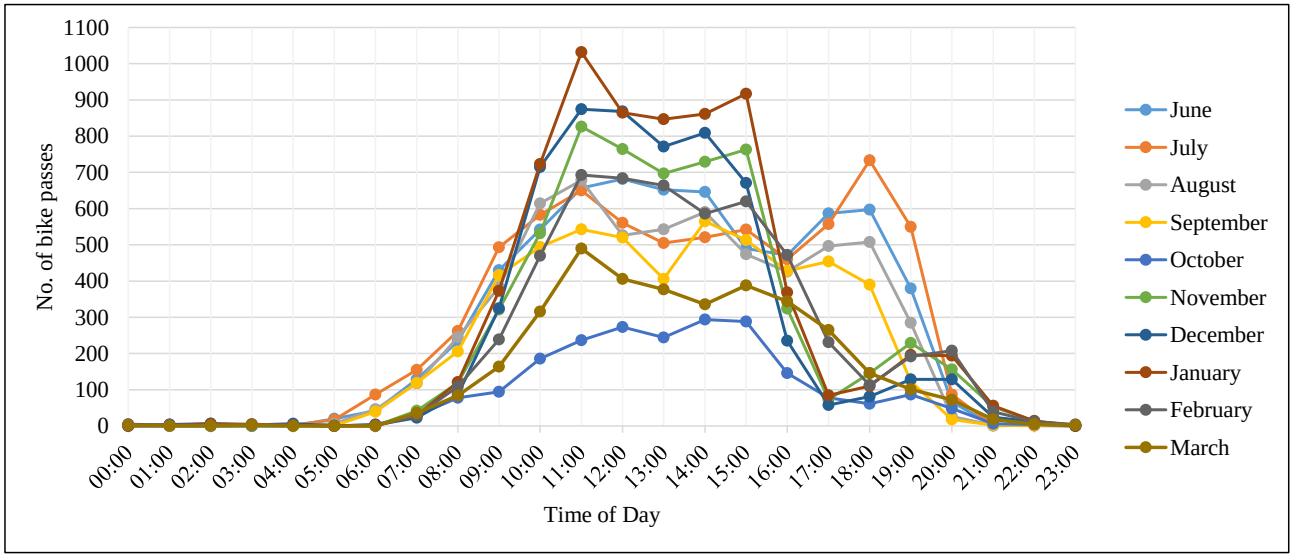

Figure 4.06: Total number of bike passes across B3129 rider counter on each hour for each month.

Trends compared to absolute time was supplemented by the consideration for the number of bike passes on a monthly basis relative to sunrise and sunset. For each month, the mean time for both sunrise and sunset was calculated using historical tables (Sunrise and Sunset, 2020), and graphical comparison was made to the rider counter data. Two observations were made from this; firstly, the second peak in rider numbers usually occurred between 2 and 3 hours before sunset and secondly, riding after sunset and later in the evening is only observed in the winter months. Otherwise, comparison with sunrise and sunset was inconclusive, but the graphical representations can be found in Appendix A.

Summary: The hours of 10:00 to 14:00 experienced the greatest overall trail usage. On weekdays, usage peaked in the early evening, especially during the summer months. During the winter months most riding was done during the daytime but there a number of users who practiced night riding in the evening after sunset.

4.1.4 School Holidays

The Nova trail is family friendly; several families were observed riding on Saturdays in March, and survey respondents commented that they chose to ride the trail because it is suitable for children. During school holidays, families may choose outdoor activities for entertainment and bonding. The number of passes during holidays has been compared to an equivalent period during the school term to determine any increase in trail usage.

Dates shown in table 4.04 were state school holiday dates published by Bristol City Council (Bristol.gov.uk, 2020). The equivalent period was based on dates either side of the holiday to reduce impact of other factors i.e. time of year. For half-term and Christmas, equivalent dates included an equal number of weekends. From table 4.05, it appears that the extent of influence of holiday periods on the number of bike passes varied.

Summer and half-term holidays had no impact with less than 2.5% difference. Over Christmas, trail usage was significantly increased compared to the surrounding period; despite the busy festive season, the number of passes was up 30-40%. Possibly people chose to take time off work, or were given time off between Christmas and the New Year. The increase may not have been just due to more families riding but also more individuals.

School Holiday	**Dates**	**Total no. of days**	**Total bike passes during holiday (n_h)**	
	(inclusive)		*B3129*	*Quarry*
Summer	24/07 - 01/09	40	8282	9885
Autumn half-term	26/10 - 03/11	9	2328	2022
Christmas	21/12 - 05/01	16	4952	4454
February half-term	15 - 23/02	9	1836	1761

Table 4.04: Number of bike passes during school holidays for both counters.

Dates of equivalent time period during term	**Bike passes during equivalent period (n_e)**		**Difference (n_h - n_e)**		**Percentage (n_h/n_e) (%)**	
	B3129	*Quarry*	*B3129*	*Quarry*	*B3129*	*Quarry*
04 - 23/07 & 02 - 21/09	8220	10004	**62**	**-119**	**100.8**	**98.8**
09 – 17/11	2263	2068	**65**	**-46**	**102.9**	**97.8**
13 - 20/12, 6, 7, 11, 12, 16 - 19/01	3556	3381	**1396**	**1073**	**139.3**	**131.7**
08 - 12/2 & 27/02 - 01/03	1847	1743	**-11**	**18**	**99.4**	**101.0**

Table 4.05: Number of bike passes for term time periods equivalent to length of school holidays, and difference to the number of passes recorded during holidays.

Summary: Summer and half-term holidays had no impact on trail usage, but usage increased during the Christmas period.

4.1.5 Events

Ashton Court hosts many events throughout the year, including a Parkrun every weekend. Two events have been considered for their impact on trail usage; an international festival, and a mountain biking event. Bristol International Balloon Fiesta is Europe's largest hot air balloon launch. The event typically attracts more than 100,000 visitors to Ashton Court, but extremely windy conditions in 2019 meant the three main ascents (Friday, Saturday and Sunday) were cancelled (Bristol International Balloon Fiesta, n.d.), though the ground show remained popular. Table 4.06 shows dates and counter passes for the fiesta and for the weeks before and after. The event weekend was extremely wet, with more than 34mm of rain over the four-day period, and very windy hence the balloons could not fly (mean wind speed of 17 knots on Sunday). The week before had much more pleasant conditions with highs of 25°C, no rain and light wind, but similar wet and windy conditions prevailed the weekend following the event.

Date	**No of riders**		**No of expected riders**				**Difference ($n_0 - n_1$)**				**Percentage (n_0 / n_1) (%)**			
	B3129	Quarry	B3129		Quarry		B3129		Quarry		B3129		Quarry	
			WB	*WA*	*WB*	*WA*	*WB*	*WA*	*WB*	*WA*	*WB*	*WA*	*WB*	*WA*
08/08	108	126	221	196	249	235	-113	-88	-123	-109	**48.9**	**55.1**	**50.6**	**53.6**
09/08	73	68	187	39	253	59	-114	34	-185	9	**39.0**	**187.2**	**26.9**	**115.3**
10/08	63	80	287	309	326	353	-224	-246	-246	-273	**22.0**	**20.4**	**24.5**	**22.7**
11/08	193	277	321	284	397	365	-128	-91	-120	-88	**60.1**	**68.0**	**69.8**	**75.9**

Table 4.06: Counter numbers over the Bristol International Balloon Fiesta weekend compared to the weekend before (WB) and weekend after (WA).

With the exception of the following Friday, trail usage was considerably less during the event weekend than for the weekends before or after. Bad weather may have stopped people riding but the following weekend with the same conditions saw many more riders. Low numbers suggest that mountain bikers may have avoided the estate expecting it to be congested, difficult to access and park.

Bristol BikeFest took place on the 29th June 2019. A single day mountain biking event, based at Ashton Court, it is a friendly, fun, singletrack competition aimed at involving beginners as well as more experienced riders. The festival is intended to be social rather than competitive and hosts races for children and ebikes as well as adult classes. The course follows the route of Bristol's Nova trail, plus an additional zig-zag section below Quarry. It is an opportunity for local mountain bikers to get together, celebrate the sport and experience some competitive fun, so it's no surprise that both rider counters recorded more than 1800 passes, five times the number of passes on the previous Saturday. Such events may increase the trail's exposure thus expanding its overall usage.

Summary: An event has the possibility to drastically increase or decrease trail usage.

4.2 Weather

In the UK, weather influences all outdoor activities; preparation must be made and bad weather can escalate risk. From the monthly analysis of counter data (Section 4.1.1), it is known that numbers fell in winter months. It cannot be assumed this is because of colder and wetter conditions, usage may have dropped due to reduced daylight, Hence trail usage was compared to rainfall, temperature, wind speed and sunshine hours.

Rainfall

For both counters, a scatter graph has been plotted comparing precipitation to the number of passes for each day. Dates 29th June and September 30th to October 27th have been excluded because of the external influence the BikeFest and refurbishment had on rider numbers.

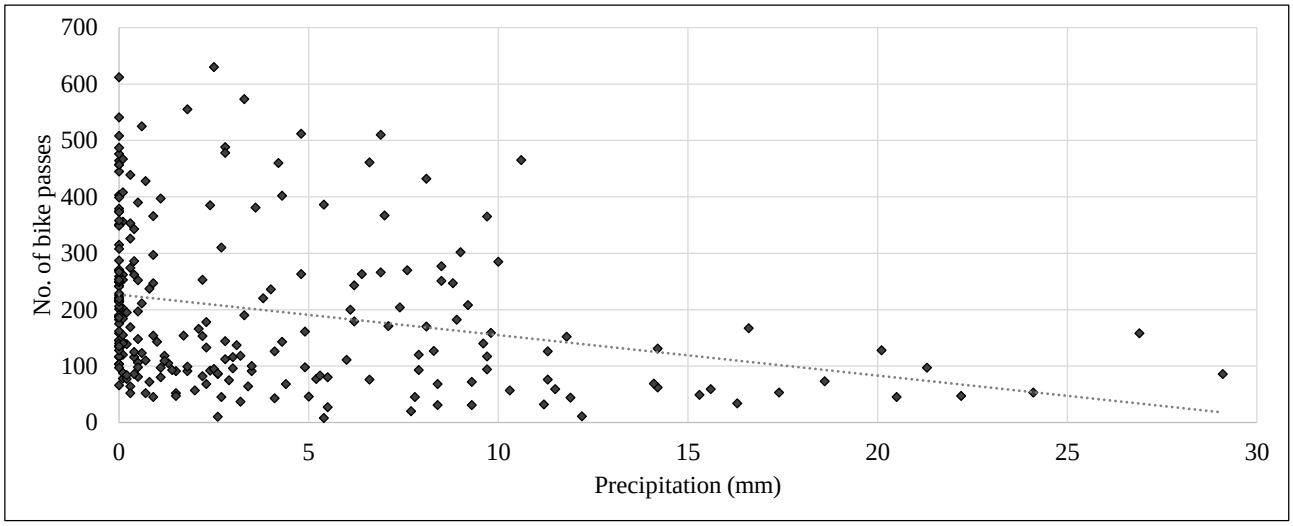

Figure 4.07: Number of bike passes against precipitation for the Quarry rider counter.

With no clear correlation between amount of precipitation and number of bikes passes, the trend line suggests that as precipitation increased, the average number of passes decreased. However, there were considerably more days when precipitation was less than 10mm and no definite conclusions could be drawn. There were many days when precipitation was less than 5mm and fewer bike passes were recorded than on days when precipitation was greater than 10mm. From figure 4.07, the hypothesis that greater rainfall stopped trail users mountain biking could neither be accepted nor rejected. Roberts et al. (2018) found that 63% of 1484 international mountain bikers disagreed that bad weather would stop them riding. Participating in outdoor activities in unfavourable conditions can reduce physical symptoms of anxiety by increasing their comfort with uncomfortable sensations (Roberts et al., 2018). Mountain bikers may not deliberately seek these positive effects by riding in poor weather, but they may be benefiting from them, improving their overall mental health and encouraging them to ride more. They may be happy to ride in poorer conditions because getting wet and muddy is considered fundamental to mountain biking, and letting the weather stop them would be going against the spirit of the sport. For the B3129 counter, precipitation was compared against data from before and after the refurbishment, to see if the installation of an all-weather surface increased usage on rain days. No conclusions could be drawn but the graphical representations of the data can be found in Appendix B.

Temperature

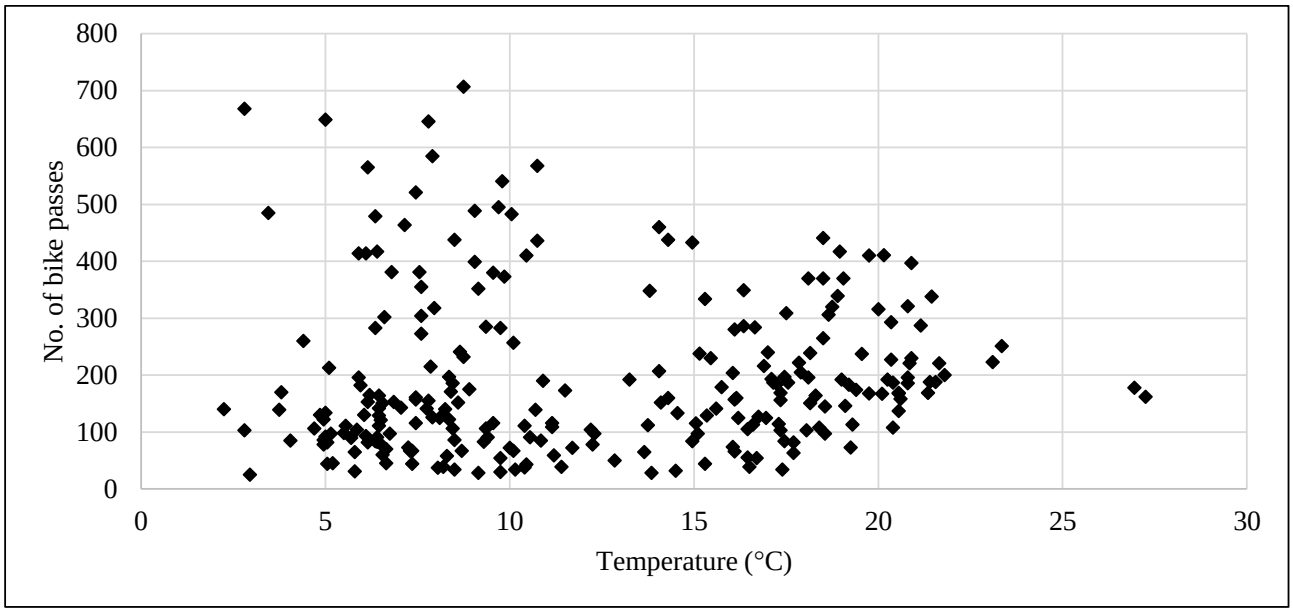

Figure 4.08: Mean daytime temperature against number of bike passes for the B3129 rider counter.

Temperature, as with rainfall, showed no clear correlation with the number of bike passes. At cooler temperatures, there was a wider range of numbers of passes. From day of the week data (Fig. 4.03), it is known that during winter there was greater difference between weekend and weekday usage which could explain this spread. The absence of data for 12-13°C may have been due to the removal of October data.

Sunshine hours

Data points were highly scattered, but a weak correlation was observed between the number of bike passes and the total sunshine hours for the day. As the amount of sunshine increased, more passes were recorded.

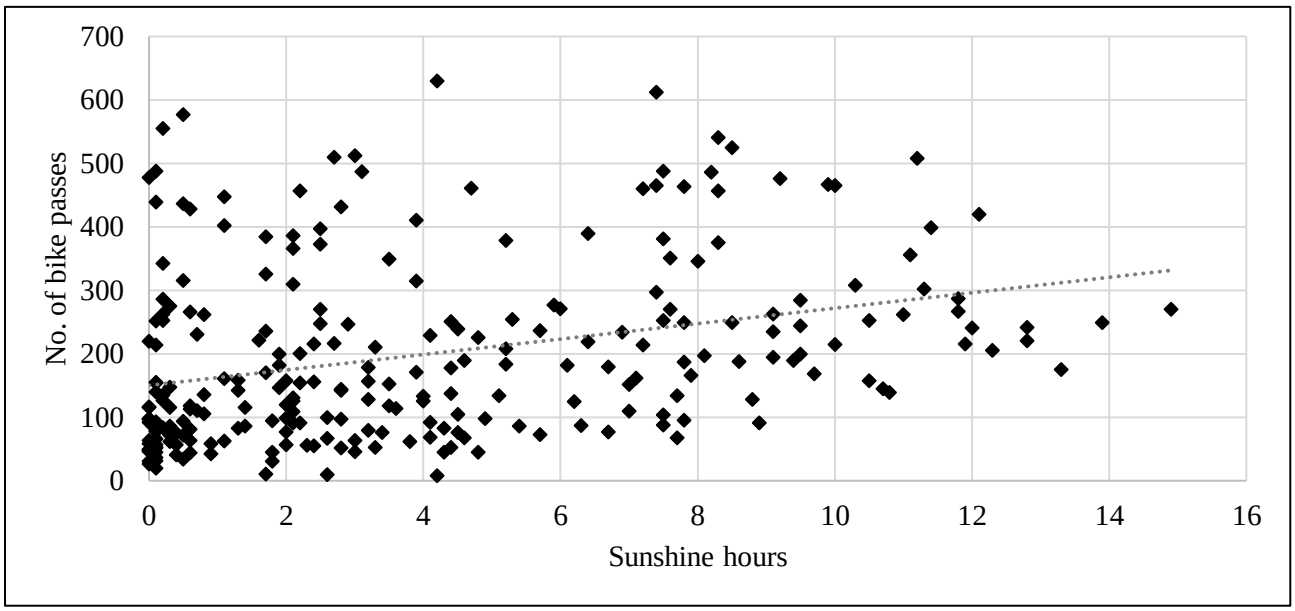

Figure 4.09: Number of rider counter bike passes against daily sunshine hours for the Quarry rider counter.

Wind speed

A comparison of bike passes against wind speed was also inconclusive. Graphs can be found in Appendix B.

Summary: No link could be identified between trail usage and rainfall, temperature or wind speed. There was a weak, positive correlation between sunshine hours and trail usage.

5.0 Survey Results and Demographic

5.1 Rider Demographic

Results from the survey carried out at Ashton Court supported Bordelon & Ferreira's (2019) hypothesis that the use of mountain bike trails is dominated by white, wealthy, middle-aged men. This somewhat distinguishes mountain biking from other lifestyle sports where the stereotypical participant is considered to be a young, white, middle-class man. But although the activities can appear 'youthful', Wheaton (2004) argues that age ranges of participants can be wider. The purpose of the demographic section of the survey was to identify any differences to previous studies. Previous research had focussed on competitive mountain bikers, participating in 'serious leisure' events, such as the Cape Epic mountain bike race in South Africa (Bordelon & Ferreira, 2019). The research at Ashton Court was intended to identify UK mountain bikers across a variety of skill levels from beginners to coaches and competitive participants. The Nova trail is a blue-graded trail thus dominated by amateur mountain bikers.

Age

98 of the 111 useable survey responses answered the question. Overall age range of respondents was 12 to 64, and the mean age was calculated to be 38 years. Average age of female respondents was much lower, 29 years, and the average age of male participants was 39 years. The age of riders is in line with that of 'serious mountain bikers' identified as 36, 39, 43 and 44 by Koelme & Morawetz (2016), Skår et al. (2008), McCormack (2017) and Bordelon & Ferreira (2019) respectively. The age of female participants may have been lower than men because it is only recently that mountain biking has increased in popularity with women. Though the discrepancy could be a product of the much smaller sample size of women. Given the location of Ashton Court, the average age of mountain bikers is high. Bristol is a city dominated by young professionals and students; the median age of the city is 32.5 years compared to the national average of 40 years (Bristol City Council, 2020).

Gender

The survey was completed by 98 men and 13 women, confirming that the sport is very much male dominated, providing 88% of the response. Rider observation periods confirmed results from the survey; of the 132 riders observed, 86% were male. Furthermore, only two girls under the age of 10 were mountain biking with family compared with seven boys, mostly as a father-son ride. It appears that encouragement into the sport from a young age is affected by a cultural stereotype that dirty, adrenalin sports are not feminine activities. In a study of international mountain bikers, Roberts et al. (2018) discovered that whilst 44% of men had participated in mountain biking as a child, only 20% of women had. When McCormack (2017) interviewed mountain bikers in the US, she found that male participants found gender to be of little importance, tending to answer the question regarding skill level, with responses such as "[…] it's not a gender specific sport. You can get pounded by women just as easily as by men […]". However, McCormack found that many of the 21 female participants desired women-only rides. Women found that when riding with men they were often specially accounted for and treated differently, receiving extra support and advice, and other women reported that they "needed to prove themselves" to ensure acceptance in the male dominated community. McCormack goes on to talk about how women-only rides give them skills in a more comfortable environment enabling confidence to challenge the sport's stereotype. In McCormack's study, 35% of participants were female, though it is unclear as to whether a more equal gender balance was sought out for diversity of opinion. Other studies have found the gender imbalance to be much closer to that at Ashton Court; Koelme & Morawetz (2016)'s study of cyclists in Austria yielded only 15 of 261 responses (5.7%) from women, the 2017 Cape Epic mountain bikers were 91% male (Bordelon & Ferreira, 2019) and Skår et al.,(2008) found that in their study of serious mountain bikers in Norway, 78% were men. The IMBA (2010) found that 60.6% of women believed the 'hard-core' image of mountain biking was stopping other women taking up the sport.

Ethnicity

Nearly all respondents were white; 108 (97%) respondents stated that they were white, 2 said they were mixed race or from multiple ethnic groups and 1 respondent did not answer. The results will be somewhat

biased by location, 16% of Bristol's population are the Black, Asian and Minority Ethnic (BAME) group, but, this is still much higher than 3% of mountain bikers at Ashton Court who were not white.

Income

Mountain biking can be an expensive sport. Although the majority of the trails are free to ride, and some trails (including the Nova trail at Ashton Court) can be ridden on any bike, most riders invest in specialist equipment. In addition to the cost of equipment, further expenses occur from maintenance and travel, and there is dependence on having time available to participate. The cost of the sport was reflected in the earnings brackets of participants. 61% of survey respondents declared an annual household income of more than £50,000, with 31% stating it greater than £75,000. Money is a sensitive topic and 15% of respondents selected the 'Prefer not to say/ Not applicable' option. Of the remaining 24% of respondents, only 8% had an annual household income of less than £20,000. In the UK, for the financial year ending in 2019, the average household income was estimated to be £29,600 (Office for National Statistics, 2020), and it is known that at least 78% of riders had an income greater than this. Unfortunately, there was an error in the survey, and the income bracket for £20,000 - £29,999 was not included. Respondents whose income was in this category may have chosen a neighbouring category or the not applicable option, which could have affected the accuracy of this result. In their study of Austrian cyclists, Koelme & Morawetz (2016) found the average monthly household income of participants to be €2562, this translates to €30,744 per annum which at an exchange rate of 0.8133 GBP (Exchange.org.uk, n.d.) for 2012, when the survey was carried out, converts to £25,004. Accounting for an average of 2.5 % inflation each year using the Bank of England's online calculator (2020), this is equivalent to approximately £29,750. The Austrian study found income to be higher than average, though not to the extent of the Ashton Court survey. It is important to consider the different country and that Koelme & Morawetz's survey was made available to all cyclists, not exclusively mountain bikers.

Overall the survey confirmed that mountain biking is almost exclusively undertaken by a niche demographic of middle-class, middle-aged, white men. Such a dominant group may appear intimidating to minorities, thus making them less likely to participate. Other lifestyle sports also experience the same focussed demographic. One study by Surfers against Sewage in 2013 found that surfers between the ages of 25 and 44 accounted for 63% of the sample. Although the study did not consider gender, ethnicity or income, it was found that on average an individual spent £3625 per year on surfing, including equipment, car parking, accommodation, fuel and international travel. The sport, like mountain biking, demands a large monetary commitment and is therefore inaccessible to many. A further study into the decline of participation in windsurfing, another lifestyle sport, yielded a very similar demographic to that for mountain biking. From the sample of 139 participants, 79% were male, the mean age was 43 and 57% of respondents had an income of $40,000 - $80,000 (Jeon and Ridinger, 2009), which is the equivalent of approximately £33,200 - £66,400 today, well in exceedance of the average income (OFX, n.d.; Bank of England, 2020).

It is clear that lifestyle sports do not attract young, white, middle-class men but rather middle-aged, white, middle-class men, probably because of the time and money that must be dedicated to become a core member of the sport's community. However, it could be that older sports participants have more time and patience to complete surveys for research. Observation of riders along the Nova trail found riders in the age groups 30-39, 40-49 and 50-59 formed 63% of the sample.

Age Group	**No. of riders**
0-9	9
10-19	19
20-29	13
30-39	22
40-49	29
50-59	24
60-69	3
70+	0

Table 5.01: Self-reported age categories for a sample of riders of the Nova trail during observation days.

There were fewer riders in their twenties than teenagers, despite Bristol having a much higher population for this age group than the rest of the country. Sport England's report (Gordon et al., 2015) found that engagement in outdoor activities goes through a 'lifecycle'. Of participants aged between 20 and 30, 25% will drop their activity, regardless of whether they are married or have children. Some individuals cease to participate at all after this, but, of the 25%, 20% will return to participating in their late thirties or early fourties because of influence by friends or family, more availability of time or to improve fitness. The type of activity they engage in also changes, people are more likely to enjoy the outdoors through safer and calmer activities than they had previously (Gordon et al., 2015). Notably, when asked for their reasons for mountain biking, three Ashton Court survey respondents mentioned it was part of a recovery process from injury and illness. The relatively simple Nova trail provides opportunity for outdoor activity participants to obtain an adrenalin rush in a reasonably safe environment.

Summary: The typical demographic of a UK amateur mountain biker is a white, middle-aged, middle-class male.

5.2 Travel

All respondents reported either driving or cycling to reach Ashton Court and 79% spent less than half an hour travelling. Cycling was more common than driving, with 68% of respondents doing so. The relatively short length of the journeys, indicated that most people who use the trail live in or near Bristol. The proximity of the trail to one of the countries 'Core Cities' (Bristol City Council, 2020), has meant overall travel times are relatively brief. Only 5 respondents travelled for more an hour which could mean riders are not willing to make long journeys, or that the Nova trail is rivalled by other mountain biking venues.

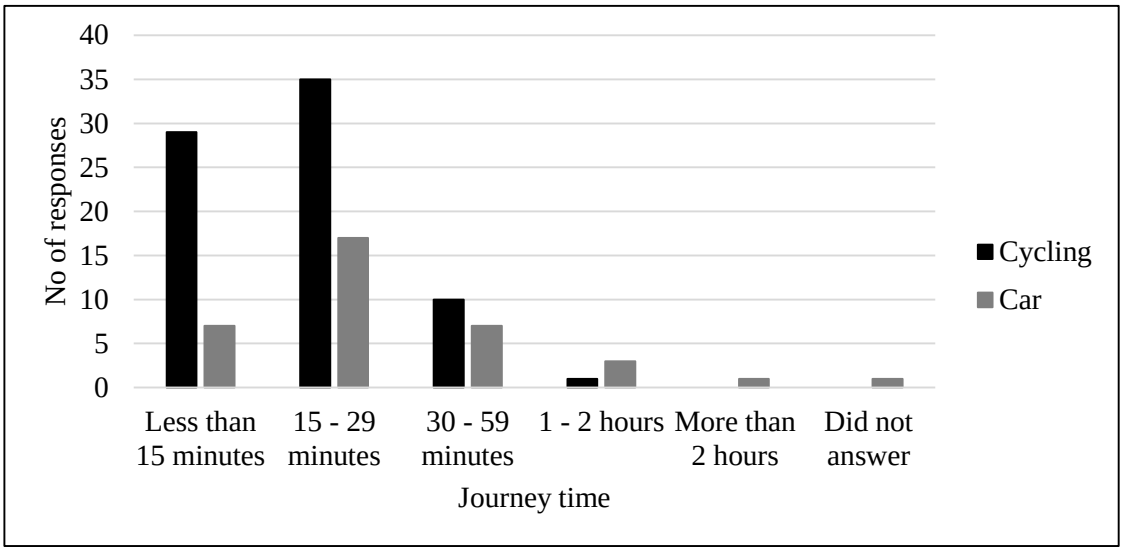

Figure 5.01: Transport method and time taken for respondents to reach Ashton Court.

When respondents were asked in the final section of the survey why they chose to ride at Ashton Court, 68 respondents out of the 110 completed responses to this question, stated local or close to home as the reason, or one of several reasons. A further 21 respondents said they chose to ride at Ashton Court because it was accessible. This could be interpreted to mean it is nearby, that transport to the site is straightforward or that the trail can be ridden by all abilities. One respondent commented that is easily accessible by cycle path from Nailsea, indicating that the trail is well linked to cycle transport routes.

Summary: All respondents cycled or drove to Ashton Court. The proximity of users to the trails, suggests that the majority of trail usage is by Bristol residents.

5.3 Riding Habits

Information on riding habits was investigated alongside the rider counter data to understand trail usage and further inform cycling in Bristol. Respondents were asked how often they cycled on the road, cycled as a practical means of transport (i.e. commuting or travelling to the shops), mountain biked and mountain biked at Ashton Court.

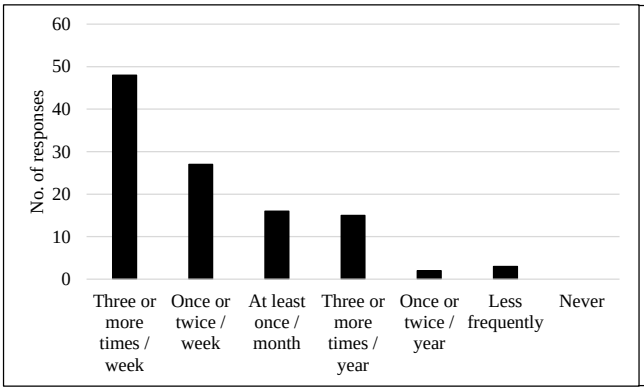

Figure 5.02: Frequency that survey respondents cycle on the road.

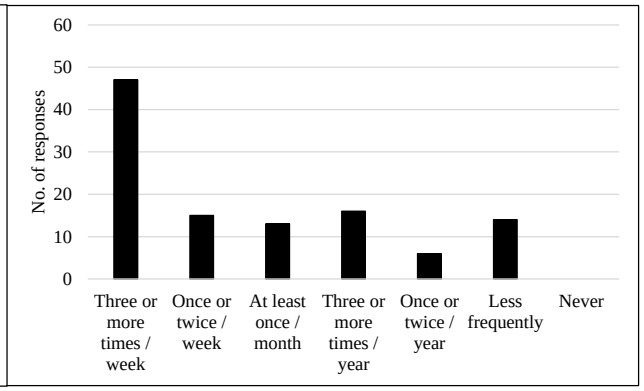

Figure 5.03: Frequency that survey respondents cycle as a practical means of transport.

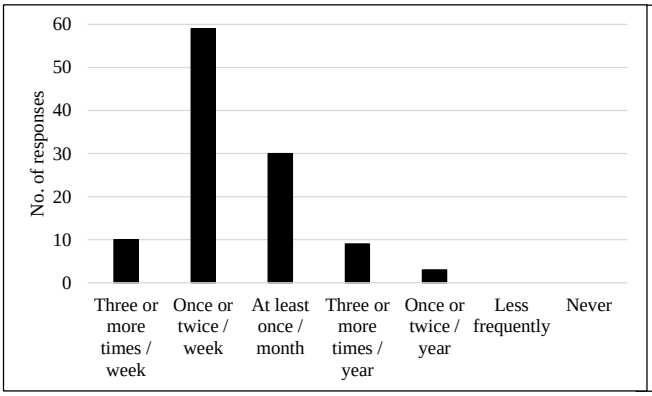

Figure 5.04: Frequency that survey respondents mountain bike.

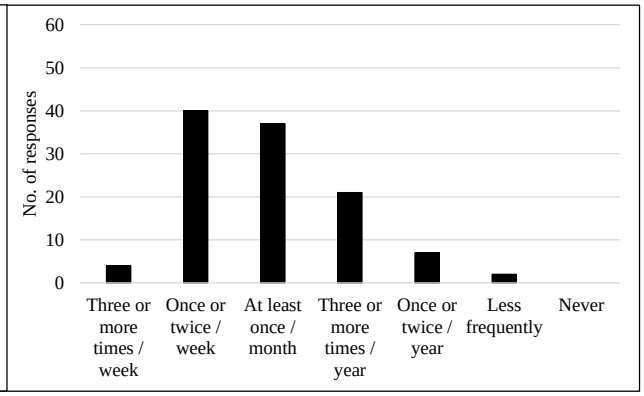

Figure 5.05: Frequency that survey respondents mountain bike at Ashton Court.

Mountain biking at Ashton Court was only part of respondents' routines. Most were road cyclists, with 67% of respondents cycling on the road at least once per week. Bristol has a vision to achieve carbon neutrality by 2030 (Regen, 2019). At present one-third (566 kt CO_2e) of the city's emissions are from the transport sector (Regen, 2019). Cycling is one of the most sustainable, low-emission forms of travelling, and it was encouraging that 47 respondents report cycling as a practical means of transport three or more times a week. Of those who reported cycling on the road three or more times a week, 90% stated they cycle as a means of transport at least three times a week, suggesting that for most, access to work or shops requires cycling on the road. Many mountain bikers consider their supposedly 'risky' sport to be safer than road cycling, and five respondents included safety as a reason for mountain biking. The number of people who cycle as a means of transport could potentially be increased through provision of bicycle-only infrastructure away from traffic.

Figures 5.04 and 5.05 portray how riders' mountain biking routines were spread between the Nova trail and other local trails; Bristol is fortunate to have a number of volunteer-built mountain biking locations. 53% of survey respondents' mountain bike once or twice per week, but only 36% of respondents' mountain bike once or twice per week at Ashton Court, suggesting that riders' use of the Nova trail as a regular ride, is alongside use of other locations. Despite this, 73% of respondents' mountain bike at Ashton Court at least once a month, proving its value as one of Bristol's most popular trails. Many trail users during the observation of riders mentioned riding at other locations and several said they combined a number of the sites for a half-day ride. The refurbished areas of the Nova trail have the advantage of an all-weather surface, meaning it is rideable when others are too wet. 27 respondent's mentioned the trails good condition in all weather as one of the reasons they chose to ride at Ashton Court. A few responses compared the Leigh Woods trail and two individuals expressed a desire for this to be refurbished to the standard of the Nova trail.

In addition to frequency, survey respondents were asked about those with whom they mountain bike. On the occasion of their most recent ride, 39% of respondents said they were riding alone, 36% were in a pair, 23% were in a small group of 3 to 5 riders, and 3% were in a larger group. Depending on their response to this question, respondents were then directed to a set of questions on those they were riding with, who else they rode with and whether they preferred riding with others or alone.

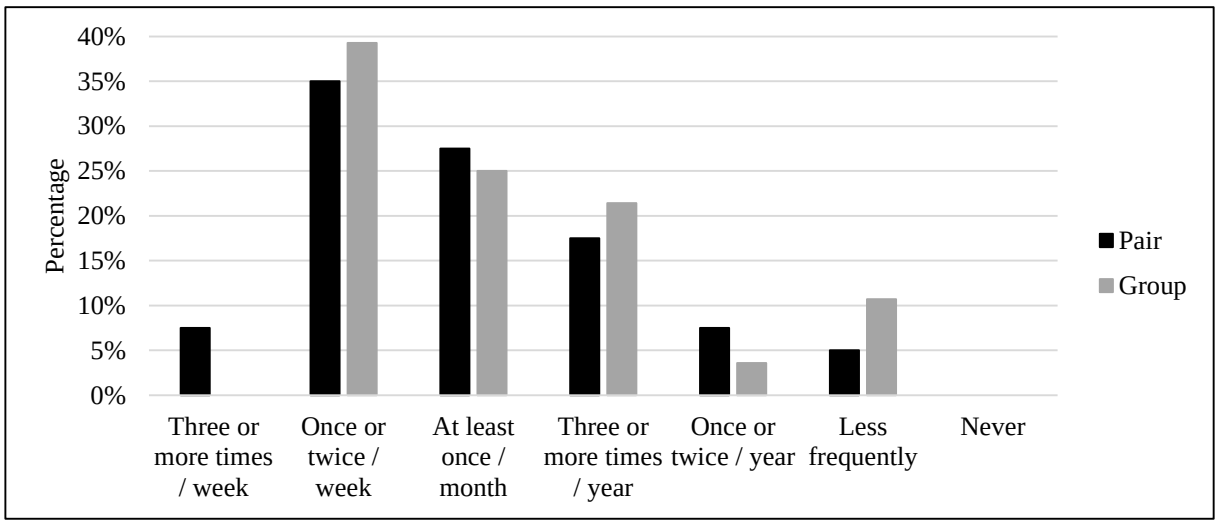

Figure 5.06: "How often do you mountain bike with the partner/group you were riding with on your most recent ride of the Nova trail at Ashton Court?" Answers given as a percentage of total riders for each series to allow for comparison.

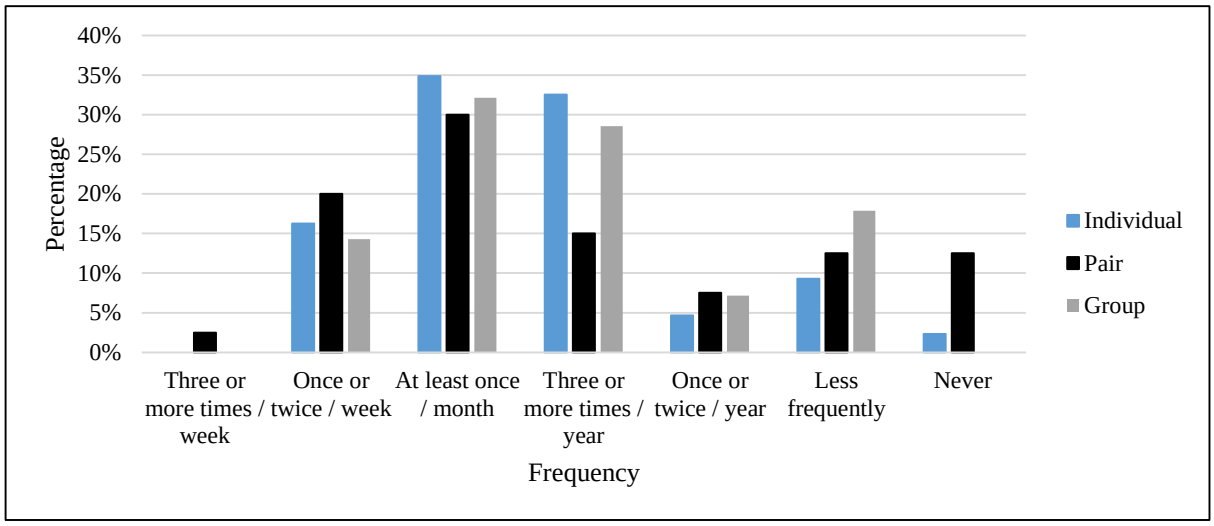

Figure 5.07: "How often do you mountain bike with others/other who are not your most recent partner/group?" Answers percentage of total riders for each series to allow for comparison.

Only 1 respondent reported never riding with anyone else. Although mountain biking is an individual sport, it has a strong community of riders helping build trails and exchanging anecdotes. When describing why they chose to mountain bike, 8 respondents mentioned the sociability or lifestyle, and a further 5 mentioned friends and family. In the other comments box, 5 individuals spoke of enjoyment from involvement in the community and volunteering at digs. Figures 5.05 and 5.06 indicate that many mountain bikers choose to ride with others on a regular basis, but little more conclusion could be drawn from this.

From figure 5.08, it can be seen that friends (informal arrangement) are who survey respondents chose to ride with most, accounting for 50% of total responses. Riding with family and friends in a regular arrangement also provides popular company. Two respondents reported mountain biking with their dog, with one commenting that the simple terrain of the Nova trail makes it suitable for trail riding with a dog, and a further two respondents said they were mountain biking with a multi-activity outdoors club. During the rider observations several groups were noticed using the trail. Larger groups often organised themselves through social media platforms. One such group had subsequently split into several smaller groups of varying riding abilities allowing everyone to get the most out of the ride, without feeling intimidated or held back. The groups would meet back again so less experienced riders could learn from those more advanced.

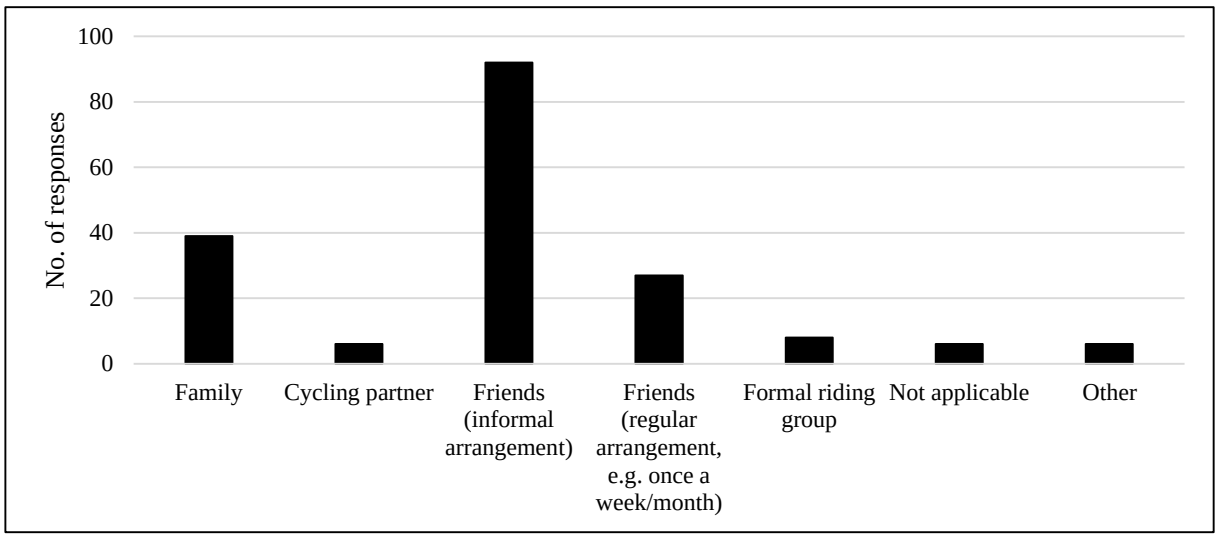

Figure 5.08: Responses from all riders on the nature of their relationship to those they mountain bike with, including who they were riding with on the survey date and on other occasions.

Riders who were mountain biking in a pair were asked to select the age category and gender of their partner. This confirmed the typical demographic; 44% of partners were between the ages of 30 and 49, and the gender balance was 90% male. One quarter of partners were younger than 18, verifying that the Nova trail is a popular place for parents to take children mountain biking; this percentage may be higher during summer. When asked how frequently they rode together, 43% said that they rode together at least once a week, implying that they are each other's primary riding partner.

Finally respondents were asked whether they prefer riding alone or with others. Overall, 35 respondents were neutral, suggesting that they enjoy both riding by themselves and with company. The majority (52%) of respondents disagreed with the statement, 18% strongly. It appears that for many, the social and community element of a lifestyle sport is important. When considering those riding individually the distribution was more even; 19 respondents were neutral, 11 disagreed and 13 agreed that they prefer to ride alone. This is unsurprising as these individuals had chosen to ride alone on the date that they completed the survey.

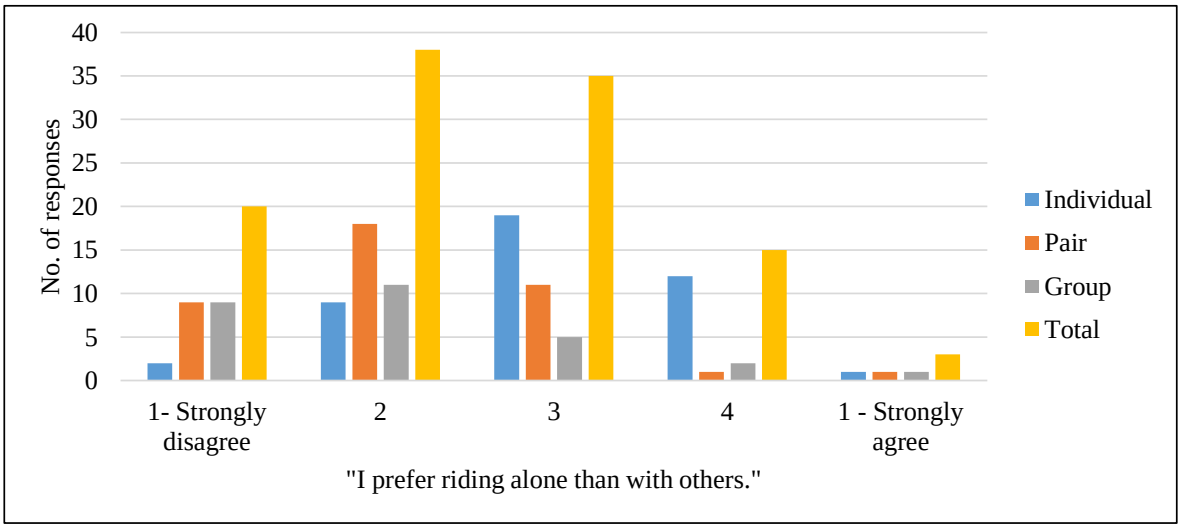

Figure 5.09: Survey responses when asked to what extent they agree with the statement "I prefer to ride alone than with others."

Summary: Most Nova trail users also cycled on the road and mountain biked at other locations. The majority of respondents preferred mountain biking with friends or family than alone.

5.3 Motivations

In their study of serious mountain bikers in Norway, Skår et al.,(2008) found 'physical exercise' was the primary motivation for the riders. 'Contemplation' and 'nature and place' were also important, followed by 'speed and excitement' and 'managing challenges' but 'social relations' and 'equipment and appreciation' held little value. The categories were presented to riders of the Norwegian trails through three of four short statements. Survey respondents from Ashton Court were presented the same seven categories that Skår et al. (2008) used, the wording was based on the most significant statement in each category that was presented to the Norwegian riders, but was simplified to ensure clarity. Respondents were asked to scale how important they felt each of the factors were. For each factor the mean score and standard deviation were calculated.

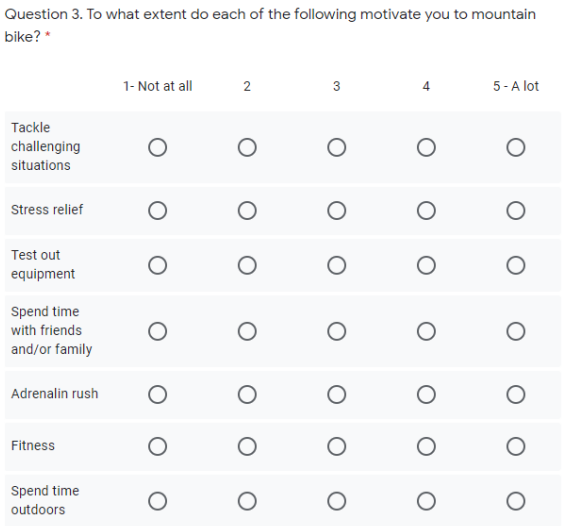

Figure 5.10: Screenshot from survey. Riders were asked to scale how important they felt each of the factors were.

Motivation factor	Mean	Standard deviation
Spend time outdoors	4.28	0.94
Fitness	4.01	0.98
Stress relief	3.85	1.02
Adrenalin rush	3.81	1.02
Tackle challenging situations	3.44	1.16
Spend time with friends and/or family	3.36	1.13
Test out equipment	2.24	1.11

Table 5.01: Mean scores and standard deviation for reasons why users of the Nova trail mountain bike from a sample of n=111 participants.

The three most important factors in motivating users of the Nova trail to mountain bike, matched the three most important factors found for motivating serious mountain bikers in Norway. At Ashton Court, spending time outdoors was the most significant factor. Fitness was also found to be a strong motivation, followed by stress relief and adrenalin rush. Tackling challenges and spending time with friends and family were reasons of lesser importance. As found by Skår et al. (2008), equipment was the least motivational factor. Taylor (2010) found that it was an intertwinement of reasons for why people choose to mountain bike. Some factors are more commonly recurring, but, the sport can fulfil many needs both physical and psychological.

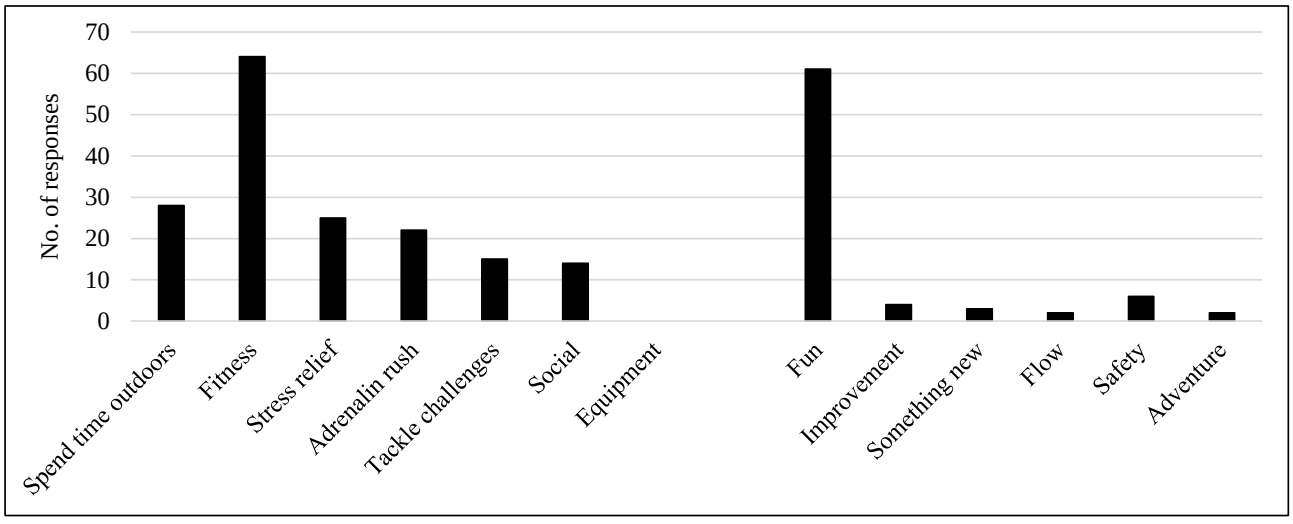

Figure 5.11: "Please describe why you choose to mountain bike." Categorisation of survey respondents to open-ended mountain bike motivations.

Long answer responses yielded the same general trend as the scaled questions, with the exception that fitness was by far the most commonly mentioned response. The reason for this discrepancy could be a result of the question wording. The long-answer question asked respondents to describe why they chose to mountain bike, but the scaled questions asked how much the factors motivate them mountain bike. Riders may have chosen to take up mountain biking as a sport to keep fit, but it is time spent outdoors and the mental wellbeing gained that motivates them to continue participating. The open-ended questions also identified six other themes for reasons people chose to mountain bike. Second only to fitness, having fun was considered a primary reason for participation; 55% of respondents mentioned this in their answer. Fun is an expression of satisfaction and engagement with the activity, but the term is considered too broad to be an identifying feature of understanding respondents' motivations and trail usage.

Spending time outdoors

Nature was found to be the most common reason why women mountain bike in a survey carried out by IMBA Canada (2010) for female mountain bikers. For Clough et al. (2016), public, outdoor and challenging environments are just as important as gyms and sports pitches. In the survey, respondents mentioned pleasure from the scenery and a 'connection' to nature through witnessing events such as the changing of seasons. Other studies into motivations of mountain bikers have yielded similar results; all respondents in a study by Roberts et al. (2018) agreed that they "love[d] being outdoors" and 98% that being outdoors was a stress relief. The open-ended answers revealed that mountain biking provided opportunity for exploration, opening up areas of the countryside. 90% of respondents in Roberts et al, (2018)'s study agreed that they had explored their local area more because of mountain biking.

Fitness

Several respondents commented that they chose to mountain bike as it provides a more enjoyable way to exercise than going to the gym for example. A report by Sport England (Gordon et al., 2015) considered outdoor activities to be undertaken by eight different character types. Fitness by nature individuals make up 17% of the outdoors activity market. These are considered to be people who engage in outdoor activities for health but also desire achievement and to challenge themselves. Gordon et al. (2015) found that mountain biking is one of the most likely activities for this character type, these people are most likely to participate within five miles of their home and 71% will participate all year round. From sections 4.1.1 and 5.2 it is known that the majority of trail users are local and that trail use remains substantial throughout winter. Respondents also stated that they used mountain biking as a tool to build up fitness for cycling events and road cycling as it provides a harder workout for the equivalent time on the road.

Stress relief

There is growing evidence within the literature, that lifestyle sports, even at the most extreme level, can have positive impact on mental wellbeing. Clough et al. (2016) suggest that such activities "should be included in large scale preventative health strategies". Lifestyle sports provide physical activity, time in a natural environment, opportunity for problem solving, increased resilience, and demand emotional engagement; all of which have been proven to better mental health (Clough et al., 2016). For many of the riders, it was the opportunity for escape from the pressures of daily life that attracted them to mountain biking. Survey respondents stated that they chose to mountain bike because "it allows [them] to relax", "gets [their] mind off everyday stress" and "gives [them] the ability to switch off."

Respondents were given the opportunity to provide additional reasons that were not included in the Likert scale which motivated them to ride. Some themes were repeated from earlier responses including mental health, safety away from the road and nature. The question yielded 62 responses that provided additional reasons and of these 10% mentioned the possibility to improve skills and master technique. Four individuals mentioned the community and social aspect, which arose again when respondents were invited to leave other comments. A number of respondents mentioned enjoyment from volunteering in the refurbishment of the trails. Involvement gave them a sense of ownership over the trail and it was apparent that there is a strong community. Taylor (2010) identified that the sociability of mountain biking, was not a factor that pushed people to mountain bike, but as an influence on the extent of a person's participation. For three respondents the image of themselves that mountain biking created was important, they were motivated by photos for Instagram and having "something to talk about". One respondent commented that they had "been riding

since 1988 – it's what I do". Participation in lifestyle sports provides the individual with a sense of identity that distinguishes them from others. Other factors for motivation included working in the bike industry and 6 respondents mentioned that they "love bikes" with several expressing interest in the engineering and maintenance aspects of the sport.

Summary: Spending time outdoors, fitness and stress relief were respondents key motivations for mountain biking. The sport is recognised to have substantial benefit to physical and mental well-being.

5.3.1 Site

Survey respondents were also asked why they chose to ride the Ashton Court Nova trail. From section 5.2 it is already understood that 62% of respondents gave locality as one of their reasons for mountain biking at Ashton Court, and a further 19% mentioned accessibility. After locality, the most commonly stated reason for riding the Nova trail was the all-weather surface. Respondents compared it to other local trails which are too wet to ride during winter. Several respondents commented on the skill level of the trail; four respondents considered the trail to be a good level for beginners and a further four that it was a good trail for children. It appears that the Nova trail is well pitched for introducing people to mountain biking, appropriate for a site near an urban hub where there is potential for growth of the sport. Other recurring themes also included the quality of the trail and the good maintenance as reasons for riding at Ashton Court.

Respondents provided suggestions for the future of the trail when asked if they would like to leave any further comments. Suggestions for expansion included more trails in steeper areas of the park, a skills trail "to practice fundamentals such as jumping and cornering", more challenging trails and a dual slalom section. The accessibility of the trail for all skill levels also arose in the other comments. Respondents expressed appreciation for a facility to introduce children and beginners to the sport whilst providing experienced riders with features that can be doubled-up to create gaps and jumps.

Summary: The all-weather surface and accessibility for all skill levels make the Nova trail a successful singletrack route all year round and for a broad spectrum of users.

6.0 Trail Refurbishments

Evidence for the influence of the constructional refurbishment on trail usage draws on both the rider counter data and the survey responses. The section of trail above the B3129 counter was refurbished in October 2019 so the number of passes before and after the refurbishment could be compared. (The Quarry section had also been renovated but in March 2019, before the period of this research.) The survey asked two questions regarding the trail refurbishment. The first, an open-ended question, asked respondents if their riding habits had changed since this had happened and if so, how. Second, a Likert-scale question asked riders to what extent they agreed with the statement "I am more likely to ride the Nova trail at Ashton Court since it has been refurbished."

Figure 4.01 (Section 4.1.1) shows the monthly totals of bike passes for both rider counters. During construction, Beggars Bush Lane section was closed from the 30th September until the 26th October, hence the large drop in trail usage. Despite closure some riders continued to use the trail, especially during the latter period from 17th to the 26th October when there were 675 passes across the counter. From figure 4.01 it can be seen that before October, the Quarry section of the trail was more popular than Beggars Bush Lane with an additional 998 passes each month (mean average). Following the refurbishment, the number of passes across the B3129 counter overtook the Quarry counter, with approximately 317 more passes each month. The refurbishment of the trail section, considerably increased usage with an estimated 1315 additional passes each month.

This evidence is supported by trail users' opinions; 71% of respondents agreed that they were more likely to ride the Nova trail since it has been refurbished, of which two-thirds strongly agreed. A further 21% of respondents were neutral, some because they were new to the location and had not experienced it before. Only 8% of respondents disagreed with the statement. The long-answer question was completed by 88 respondents, of which 40 commented that they now use the trail more. For 29 respondents the refurbishment had not affected their riding habits, however, 9 of these respondents said that they think the experience is better and that the refurbishments are an improvement. No responses stated 'riding the trail less' and only 1 rider commented that a less structured trail was to their preference. In addition to riding more often, a number of respondents commented that they will ride for longer or complete an additional loop due to the increased speed the resurfaced trail provides. The refurbishment of the trail affected riding style for 17 respondents; 5 respondents said that they practiced specific skills such as pumping technique and berm riding, a further 5 respondents said they were riding faster, 2 respondents commented that their riding style was now more aggressive as the trail provides greater support and 5 riders stated that their style was more flowing. Respondents expressed greater enjoyment since the refurbishment, saying that it had given the trail "a new lease of life".

For many, the smooth, all-weather surface increased accessibility of the trail and has meant more users are enjoying riding in winter. The evidence suggests people are riding at Ashton Court rather than stopping over winter months or distributing their time amongst some of Bristol's other trails; the decrease in trail usage over winter as shown in figure 4.01 is not as great as expected. Nearby, Leigh Woods mountain bike trail is owned by the Forestry Commision but is currently poorly maintained, making winter riding very difficult. There is a counter installed along the Leigh Woods trail but it has been providing unreliable data and is being upgraded. Historic data from the counter suggests that there are 65,000 – 70,000 passes per annum along Leigh Woods (Morgans, 2020). The Nova trail Quarry counter recorded 59,752 passes over the nine and a half months included in this report, so it is likely that over a 12-month period the Nova trail is more popular, possibly more so since the refurbishment.

Summary: Refurbishment of the trail has increased usage. It has allowed users to develop new skills and for parents to introduce children to the sport. The refurbishment has made the Nova trail the preferred venue for winter riding amongst Bristol's mountain bikers.

7.0 Further Scope

This research studies usage of the Nova trail at Ashton Court as a sample for mountain biking trails in the UK. To ensure an accurate representation of UK usage, other trails within the country should be considered. It addition to the factors identified in this survey, location, difficulty, condition and type of trail might be expected to influence the usage. The Nova trail is a well-maintained, straightforward, all-weather singletrack near an urban centre. Repeating the analysis and survey used in this research at other sites would allow the impact of additional variables to be investigated. Such other trails that may be considered are rural, unsurfaced, red or black graded, downhill and those that are in poor condition.

At Ashton Court, rider counter analysis should be carried out across a full twelve months, in order to thoroughly understand the changes in passes from the winter to summer season. Though the rider counters at Ashton Court are still in place and collecting data, it is not recommended that the spring months of 2020 are used to complete the data year. It is anticipated that the global Coronavirus pandemic and the UK Government's recommendations on social distancing, isolation and exercise will have significantly depleted rider counter numbers. Therefore, the spring months of this year would not provide an accurate representation of a typical full years trail usage. The impact of Coronavirus on rider numbers may be an interesting study in itself as there appears to be considerable debate within the community on whether riders should still be engaging in mountain biking. Responses throughout April on the live sign survey, indicate that the trail is still being used and these could be considered as part of further research.

Future investigation might build on areas identified in this survey to ascertain the best trail construction methods for specific requirements. Developments of trails for targeted parties will vary based on how such parties may use the trail. Research could be conducted with the objective to investigate specific areas such as family riding, coaching or night riding. An extension of this study that could be considered in future research is the impact of trail usage on degradation. Pressures and forces applied to trail features such as berms could be studied by scrutinizing riding habits e.g. skidding that are damaging the trails.

Furthermore, some areas of investigation within this research were unresolved. Additional examination is needed to understand the influence of weather conditions on trail usage, both at Ashton Court and other locations. The reasons behind temporal variations could be expanded, possibly through the use of a Likert-scale survey to realise what allows and prevents mountain bikers availability, similar to the research carried out by Roberts et al. (2018). This would further aid locating and developing new trails in the UK.

This study identified that the demographic of mountain bikers is narrow. To encourage further expansion of the sport for improved wellbeing, research must be undertaken to investigate why the range of participants is so limited despite being one of the more social and inclusive lifestyle sports. Research should identify reasons and opportunity to reduce the exclusivity of mountain biking.

8.0 Conclusion

The objective of this research was to build understanding of mountain bike trail usage. Four key areas were identified to achieve this: trail usage was quantified; mountain biker demographic was established; motivations for mountain biking identified; and impact of trail refurbishment realised. Two primary data sources, rider counter data and a comprehensive survey, were used at Ashton Court's Nova trail in Bristol to achieve this. The survey design and delivery ensured an appropriate representative sample of response from trail users, and resulted in an informative resource of both qualitative and quantitative data.

Trail use was quantified by comparison of the number of trail passes to temporal factors and weather conditions. Passes varied with the time of year, day of the week and time of day. In winter, trail usage fell to approximately 75% of its summer value. Gordon et al. (2015) found that 46% of mountain bikers only participate in the summer, so percentage trail usage at Ashton Court in winter is higher than the expected national average. The all-weather surface of the Nova trail is a valuable resource for winter riding, allowing participation regardless of the weather condition without risking erosion. Comparison of weather conditions with trail usage yielded insufficient evidence to support a correlation between the number of passes and precipitation, wind or temperature. This could be a consequence of the all-weather refurbishment, but must be investigated further before conclusions can be drawn. A weak, positive correlation was observed between trail usage and sunshine hours. In addition to annual variation, the trail usage varies weekly and daily. The average number of riders at weekends is approximately 281% of the weekday average. From time of day data it is known that trail use favours the daylight hours. Saturday and Sunday provide greater opportunity for riding during daylight than the weekdays for anyone restricted to a traditional working week. The difference between weekend and weekday passes is more exaggerated in winter than summer. During the summer months there is a peak of trail usage evident from 17:00 to 18:00, but this is post-sunset in winter months. A limited number of trail users practice night riding, and this is largely restricted to winter.

From the survey, the demographic of those who use the trails has been identified. The typical profile of mountain bikers determined correlates with international, advanced mountain bikers and participants of other lifestyle sports; a middle aged, middle class, white male. The average age of trail users was 38, and 88% of respondents were male. From investigating riding habits it can be suggested that gender imbalance is a result of girls not being introduced to mountain biking as much as boys. Trail usage is primarily by those able to access the site in less than half an hour either by cycling or driving, indicating the advantage of trail placement within an urban setting. 73% of respondent's use the Nova trail at least once a month. Ashton Court is not the sole mountain biking venue for the majority of respondents, and users commented on the advantage of a variety of trails near an urban hub.

Three primary factors were identified that motivate trail users to mountain bike. Spending time outdoors, improving fitness and providing stress relief interrelate. Time spent in a natural environment has been proven to reduce depression and anxiety (Clough et al., 2016). Encouraging exercise in outdoor environments by providing facilities easily accessible from urban centres can aid prevention and recovery from physical and mental illness. The locality of the trail was the overwhelming reason for mountain bikers using the Nova trail. Two further reasons can be accredited to the Nova trail's success. Trail refurbishment provides an all-weather surface allowing riders to practice the sport all year round when riding at other locations is not possible; over 70% of respondents agreed they are more likely to ride the trail since its refurbishment. Secondly, the Nova trail held value for many respondents as it is accessible for all skill levels, encouraging take up of the sport and providing suitable challenge for more experienced riders.

In conclusion, trail usage within the UK is a product of not only availability but location, accessibility and purpose. New trails and the refurbishment of existing ones should be designed with the target audience in mind. Good, reliable and durable construction of an all-weather surface can introduce children and beginners to mountain biking and ensure the sport can be practiced during all seasons. Where such trails are already provided, a natural surface and more technical features create variety for advanced riders. The construction of new trails, particularly surfaced ones, demands engineering knowledge to ensure longevity. Construction of trails near urban environments increases usage, especially in the evenings, and can promote physical and mental wellbeing.

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Appendix A Counter Data relative to sunrise and sunset

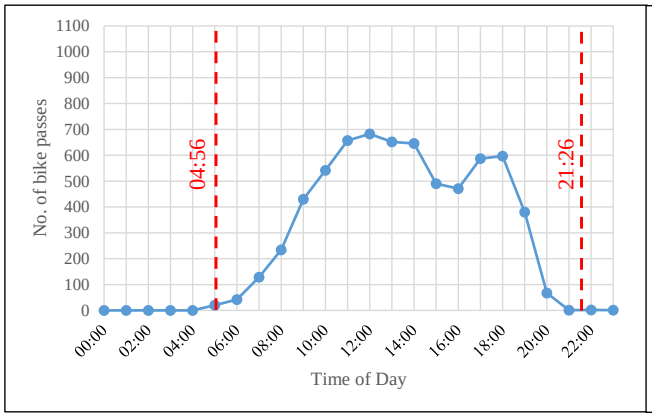

Figure A.01: June 2019.

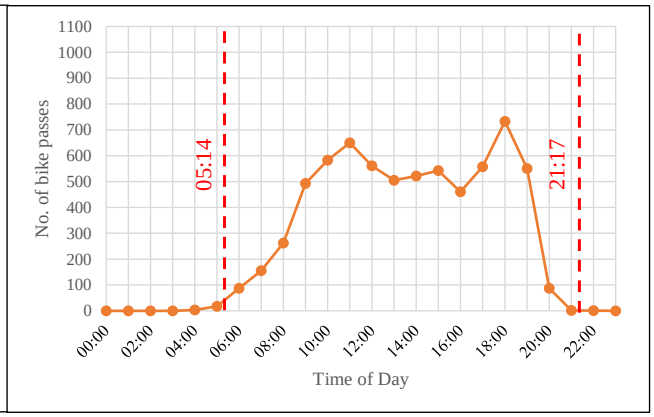

Figure A.02: July 2019.

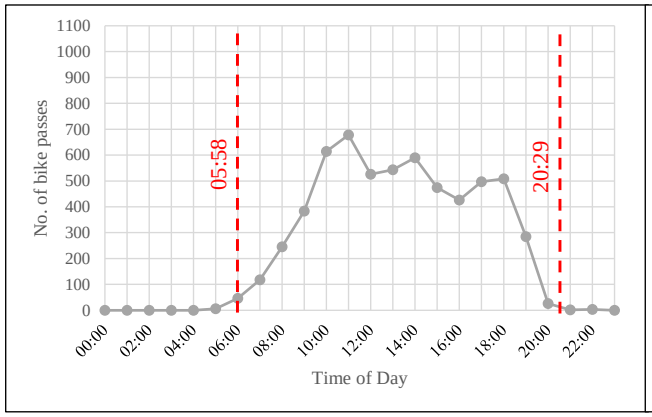

Figure A.03: August 2019.

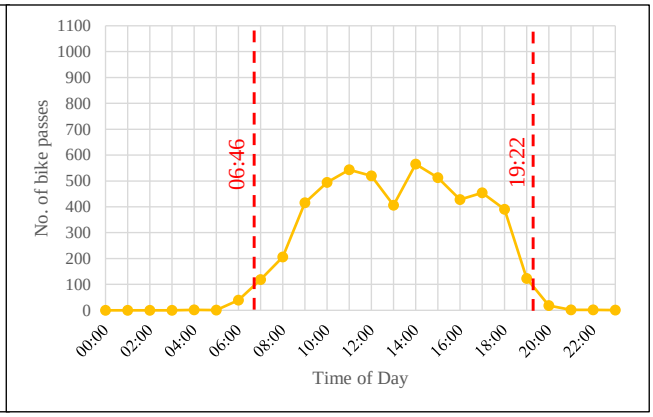

Figure A.04: September 2019.

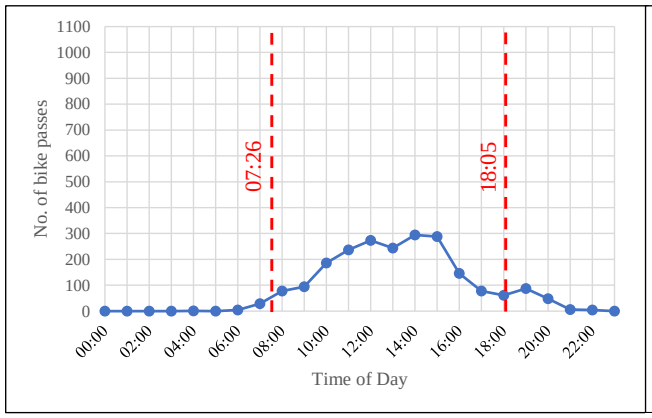

Figure A.05: October 2019.

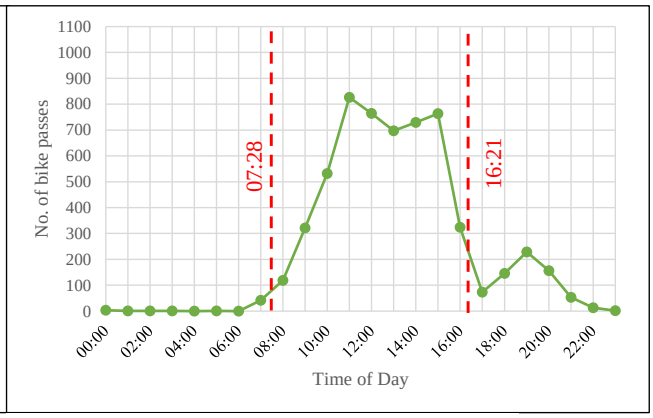

Figure A.06: November 2019.

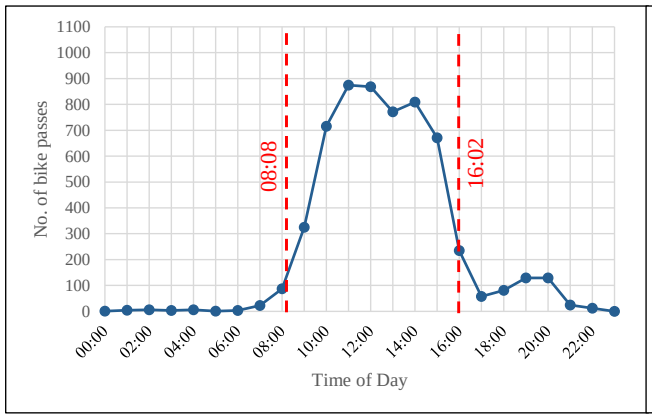

Figure A.07: December 2019.

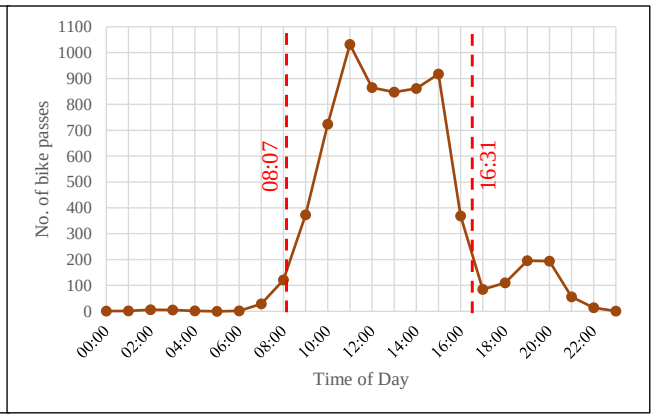

Figure A.08: January 2020.

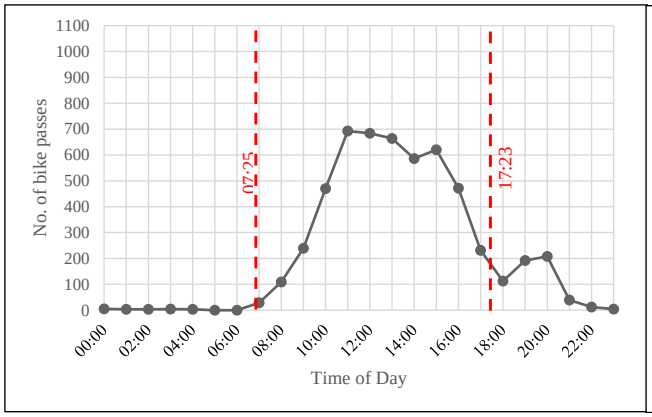

Figure A.09: February 2020.

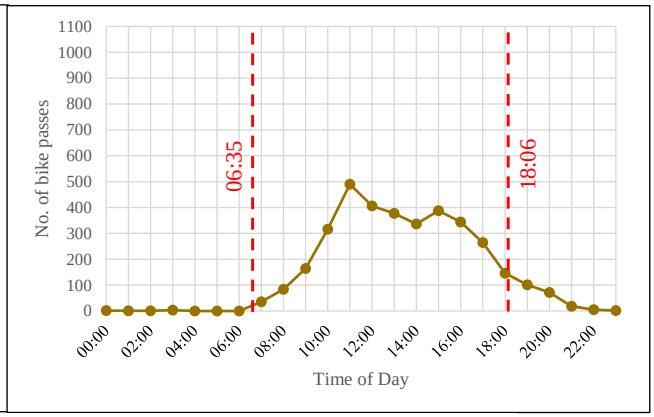

Figure A.10: March 2020.

Appendix B Counter Data compared to weather conditions

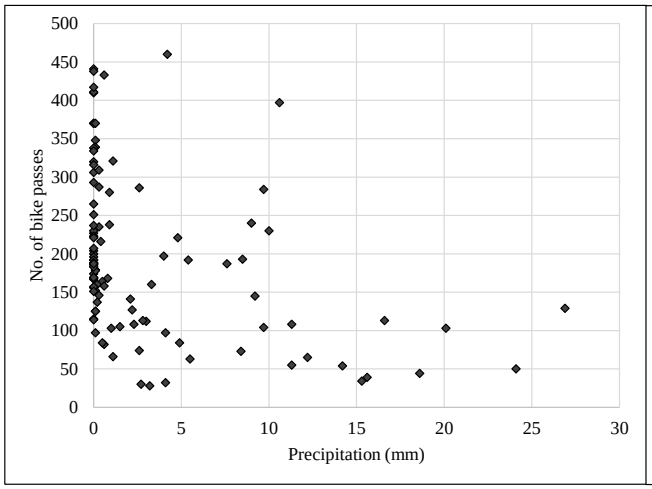

Figure B.01: Comparison of number of bike passes across the B3129 counter against precipitation before the refurbishment in October 2019.

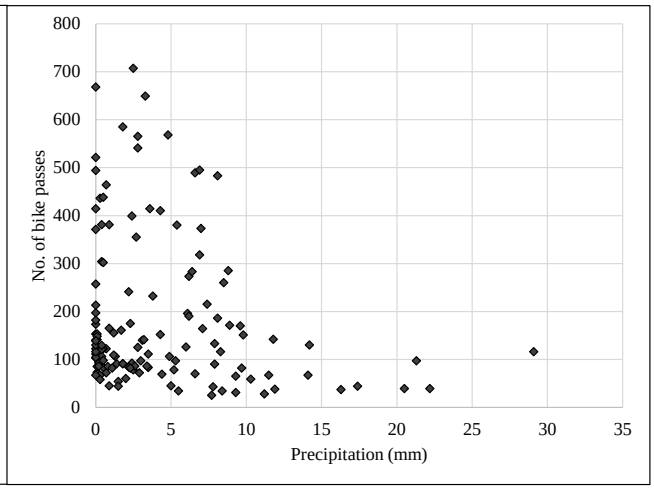

Figure B.01: Comparison of number of bike passes across the B3129 counter against precipitation after the refurbishment in October 2019.

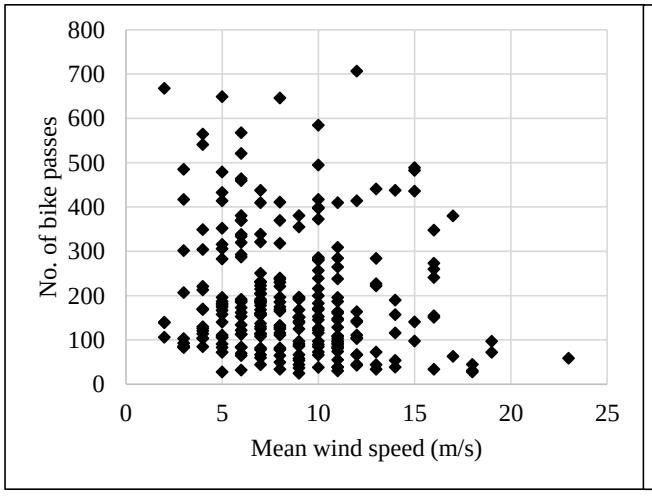

Figure B.03: Comparison of number of passes with mean wind speed for the B3129 counter.

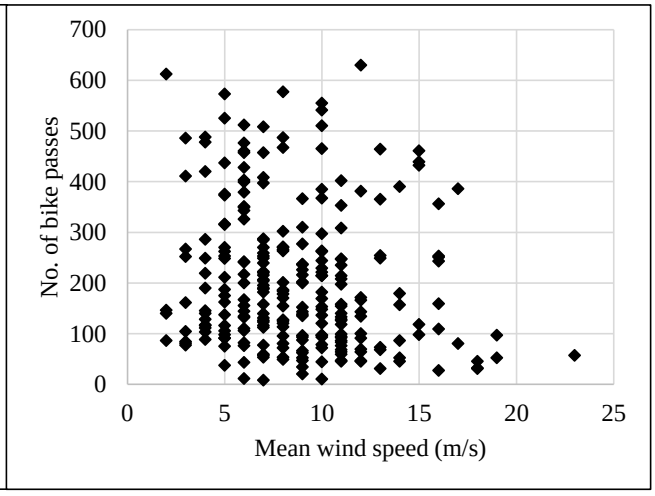

Figure B.04: Comparison of number of passes with mean wind speed for the B3129 counter.