

How Soil, Flora and Fauna React To Mountain Bikers – An Overview of the Current State of Research

Authors

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Abstract

In this basic paper, existing studies on the effects of mountain biking on soil, flora and fauna are briefly presented, evaluated, and compared with findings on the environmental effects of other common activities in natural spaces. The Mountain Bike Tourism Forum Germany e. V. wants to contribute to the scientific debate on possible user conflicts and the effects of biking on soil, flora and fauna and thus encourage dialogue on the need for action.

The comparison shows that, based on the available studies, mountain biking on existing trails is not associated with worse environmental impacts when compared to hiking or other common activities undertaken in natural spaces. It should be noted that the majority of the studies included in this overview took place outside of Central Europe. Carrying out these examinations in the German low mountain ranges and in the Alps will probably enable an even more reliable assessment in the future.

Keywords: environmental impact, nature sports, leisure sports, mountain biking, hiking, research, flora, fauna, soil, disturbance ecology, local recreation, active tourism

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Introduction

Since at least the 1990s, mountain biking has steadily gained popularity as a nature activity. It has long since become widespread in leisure and tourism - today there are already more active mountain bikers in Germany than football players (IfD Allensbach 2018). ²Alongside hiking, jogging and walking, mountain biking is the most popular outdoor sport among Germans (ibid.). Nevertheless, this recreational sport is still often perceived as new and is sometimes discussed critically in expert circles.

The aim of the Mountainbike Tourismusforum Germany e. V. is to conduct the debate on any conflicts of use as well as the effects of biking on soil, flora and fauna on a factual basis and thus promote productive dialogue on any need for action.

Already at the third German Mountain Bike Tourism Congress, which took place in 2017 under the motto "Our NATURE" in Winterberg in the Sauerland region of Germany, the Mountain Bike Tourism Forum Germany (MTF) approached the question of the impact of mountain biking on the natural and cultural environment together with attendees from different perspectives. Dr. Barbara Hendricks, Federal Minister for the Environment, Nature Conservation, Building and Nuclear Safety assessed the approach of the 2017 MTF as "an exemplary manner, [that] goes beyond the balance between sport and nature conservation and includes aspects of regional development, structural change and sustainable tourism. This is an important step into the future because it also asks what mountain bike tourism can contribute to sustainable regional development - a highly topical and exciting question!".

With regards to the environmental impact of mountain biking, common assumptions - discussed among mountain bikers and other nature users - were clearly formulated in the reviewed studies and can be summarized as follows:

1. all paths have consequences.
2. animals sometimes perceive recreational users surprisingly late.
3. even comparatively short disturbances have consequences.
4. wildlife has little seasonal retreat time.
5. mountain biking is a trail-based sport.
6. mountain bikers and hikers have similar motivations and demands for recreational and natural space

1. All paths have consequences

Like hiking, cross-country skiing or Nordic walking, mountain biking is a trail-based activity. Trails are usually not perceived as natural spaces because, unlike paths, they are usually man-made and stand out clearly from the surrounding natural space.

In the recreational sector, the most serious impact of trail-related activities is the initial creation of the trail. Mountain biking is responsible for an 80 percent reduction in flora and fauna in the core zone of a trail, while hiking is responsible for 81 percent (flora) and 71 percent (fauna). These values result from

² According to AWA 2018, 11.16 million Germans bike "now and then" in their free time and 3.77 million bike "frequently". By comparison, 10.97 million Germans play soccer "now and then" and another 3.19 million play "frequently".

trail establishment and initial use (see Thurston & Reader 2001).³ After only one year, both types of use have a significantly lower impact, though this recovery is sometimes lower for use by hikers especially along the edges of trails (ibid. and Marion & Wimpey 2007).

For the fauna, especially reptiles, even narrow paths can be insurmountable barriers. They cut habitats and make intermixing more difficult or, in the worst case, isolate populations. Landscape fragmentation is a major reason for the decline in biodiversity (cf. Mader 1984: 7).

Visible erosion and exposure of the soil are primarily a problem of trail maintenance and aesthetics.⁴ Exposure of soil by mountain biking and hiking differs only marginally here, at 30 percent (mountain biking) and 23 percent (hiking) (ibid.). Soil removal differs by only 3 grams (58 grams for mountain biking versus 55 grams for hiking; Wilson & Seney 1994).⁵

Other authors emphasize the dependence on slope and subsoil.⁶ Here, the soil erosion caused by walking on steep terrain exceeds that caused by mountain biking.⁷ Pedelecs cause slightly more erosion on trails - however, the impact is much closer to that of a mountain bike than to that of motorized two-wheel vehicles. Their impact depends significantly on soil conditions and weather conditions (IMBA 2015).

It is notable that there is hardly any difference between proper and poor walking technique. In the case of mountain biking, however, the user's riding technique is extremely relevant - poor riding technique can cause much greater erosion on the trail. It should be noted that erosion - of all the problems for the trail and possibly for the trail owner - is not an immediate conservation problem once the trail is established and compacted.

Problematic for both user groups are shortcuts, especially when making hairpin turns in steep terrain, and evasive behavior - especially when the ground is muddy and puddled. Goeft and Alder (2001: 195) prove that even creating new paths or widening narrow paths is fraught with consequences: After a path has been used only 50 times, forest soil needs about 19 months to recover to its original state, if at all possible.⁸ The higher the terrain, the longer it takes to regenerate.

2. Animals sometimes perceive recreational users surprisingly late – escape behavior differs depending on activity.

Wildlife responds in a differentiated manner to trail-bound activities. According to Papouchis (2001: 578), who studied wildlife responses to recreational use in open Utah landscapes, they respond to mountain bikers at an average distance of about 380 meters, compared to only 190 meters for hikers.

³ "For the response variables measured in this study, there were no significant differences between hiking and mountain biking treatments."

⁴ The aesthetic perception of other users, owners and trail keepers should not be neglected. This perception has an influence on the mutual acceptance of different user groups.

⁵ These findings are consistent with similar studies such as Bjorkman 1998; Hammit & Cole 1998; Goeft & Alder 2001; Marion & Olive 2006; and White et al. 2006.

⁶ Cf. Leung & Marion 1996.

⁷ Cf. Cessford 1995 as well as Froitzheim 1997. Point weight decreases when mountain biking on steep terrain.

⁸ Marion & Wimpey (2007) assuming twelve months - the value differs depending on vegetation, altitude and climate.

The response differs greatly. In the case of hiking, an initial phase of alertness is followed by a phase of flight that is almost twice as long. In the case of mountain biking, on the other hand, a slightly longer alertness phase is followed by a very short escape phase. On average, wild animals react for twelve minutes to hikers and only two minutes to mountain bikers (ibid.). These different times result in part due to contact duration- the animal's contact with the mountain biker is much shorter compared to a slower hiker. A flight response occurs in 60 percent of encounters when hiking, and in only six percent of encounters when mountain biking. As a reason, Papouchis (2001: 577) states that mountain bikers are more predictable because they are limited to trails. Hikers, on the other hand, often ventured outside of existing trails. It is here that wildlife feels the greatest stress, as also illustrated by Georgii (2001: 41).

Occasionally, the larger route radius of mountain biking compared to other nature users is discussed, though this has not been the subject of research so far. Based on Papouchis' results, the following picture emerges: the disturbance caused by hiking lasts six times as long as that caused by mountain biking (12 versus two minutes) and occurs ten times as frequently (60 versus six percent). Based on four to five kilometers per hour hiking speed and 15-20 kilometers per hour mountain biking speed, the total disturbance from mountain biking remains below that of hiking in duration and frequency, even with a greater distance radius.

Also noteworthy is the influence of altitude on the perception of grazing alpine animals. For example, mountain bikers are perceived later and more poorly on lower-lying trails due to the noise development, which makes them less predictable for grazing animals (cf. Fernandez-Juricic et al. 2001: 267).

Although much of the research on this topic has taken place in the USA, Canada and Australia, the (so far manageable) studies focusing on European or German areas confirm the core findings.

Georgii (2001: 37) describes, in addition to the effects mentioned above, a variety of other factors influencing the effect of recreationists on wildlife, such as sex, age, and reproductive status of the animals as well as the presence or absence of structures providing cover. For example, alpine areas are usually characterized by their openness, which can significantly determine wildlife's reactionary behavior.

Assuming regular repetition at a certain location and the absence of direct consequences for wildlife, both Georgii (2001: 40) and Ingold (2015: 82) observe that wildlife tends to become accustomed to the disturbance stimuli.

3. Even comparatively short disturbances have consequences

Disturbance stimuli as described above can elicit responses from increased alertness up to full flight. Depending on the time of year and day, wild animals are more susceptible to these disturbing stimuli from recreational activities. Red deer and roe deer are extremely susceptible to disturbance, especially at dusk. These disruptive stimuli cause increased alertness, decreased feeding, and increased movement. Depending on the time of year and the health of the animal, such disturbances can have serious consequences, especially at dusk (cf. Knight & Cole 1991: 240; Naylor et al. 2009; Reimoser 2013).

In Central Europe, roe deer are adapting to recreational pressure. This is noticeable as an increase in nocturnal behavior as well as decreases in foraging ranges near highly frequented recreational areas.

Additionally, forest roads or even whole regions are being avoided⁹, which is also leading to an ever increasing fragmentation of natural areas. Here, particularly strong disturbances have been shown in encounters taking place away from existing trails (cf. Graf et al. 2018).

Birds also respond to disruptive stimuli from recreational use. For example, breeding success in a designated bike region dropped to 35 percent compared to 70 percent breeding success in a region without bike use. At the same time, nest abandonment increased from an average of five percent to 15 percent (see Davis et al. 2010). In an analysis of studies on the influence of various nature activities on birds, Steven et al. (2011) found a negative influence on breeding success by both hikers and mountain bikers in 28 of 33 articles examined. More recent studies also support these findings for a central European context, e.g. Thiel et al. 2011 and Rösner et al. 2014.

Especially for breeding areas and bird protection, there have been positive results in various climbing and hiking regions¹⁰, such as the Fränkische Schweiz. Here, they were able to find a balance between animal protection and recreational activities through an intensive process. Breeding grounds in need of protection may not be entered or climbed in during the breeding season. These examples demonstrate the success of effective and sustainable recreational management. In Germany, Switzerland and Austria, numerous initiatives have already been launched to raise awareness among nature users.¹¹

4. Wildlife has little seasonal retreat time

Whether cycling, jogging or Nordic walking: the rhythms of recreational use, especially in meadows and forests close to settlements, have changed. In addition to a shorter working week¹² and greater interest in outdoor recreation (BMUB 2016: 62),¹³ milder winters and the widespread availability of high-quality functional clothing have also contributed to increasing levels of outdoor recreation.

As a result, mountain biking - like the other leisure activities mentioned - is now a year-round activity,¹⁴ even if the number of active people is still significantly lower in the colder season. From October to March, recreational sports in the Central European latitudes are naturally practiced after work in twilight or darkness (cf. Kopp 2017: 30).

At the same time, wild animals are particularly susceptible to disturbances during the cooler months of the year. The food supply decreases and the need for rest is particularly strong.

⁹ Cf. Summers et al. 2007, Arnet 2013 and Ricken 2015.

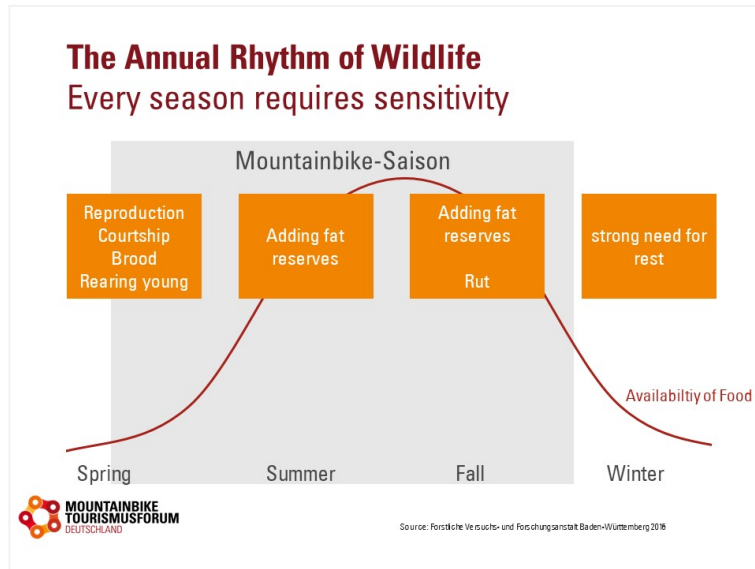
¹⁰ Cf. Kopp 2017, S. 32.

¹¹ E.g. www.respektiere-deine-grenzen.ch, www.respektiere-deine-grenzen.at, www.freiraum-lebensraum.info, www.bewusstwild.de.

¹² As recently as the 1950s, 48 hours spread over a 6-day week was normal. Testimony to this is the "Saturdays belong to Daddy" campaign of the trade unions. It was not until 1959 that the 5-day week was introduced in the coal mining industry and subsequently in other sectors. Starting in 1965, the 40-hour week was introduced in various industries.

¹³ The vast majority (85 percent) of the population tries to be in nature as often as possible. 92 percent associate "health and recreation" with nature.

¹⁴ Cf. Arlettaz et al. 2007; Zwijacz-Kozica et al. 2012.



Annual rhythm of wildlife in relation to the mountain biking season (MTD 2017 according to Forstliche Versuchs- und Forschungsanstalt Baden-Württemberg 2016)

Therefore:

- Nature activities at dusk and night should always be viewed critically and avoided if possible.
- Night runs and rides should be avoided, especially in sensitive areas. A uniform position and associated recommendation supported by both sports and nature conservation associations would be desirable.

In addition, a differentiated consideration of the respective natural area should take place with regard to its importance for nature conservation and recreation. Here, a mutually beneficial cooperation can arise from the collaboration of nature conservation and sports associations.

5. Mountain biking is a trail-based sport

Unlike backcountry skiers, snowshoe hikers or geocachers, mountain bikers depend on trails to practice their sport. This is also shown by the preferences of the various mountain bike segments: Open terrain away from paved trails is not preferred by any mountain bike segment, because the natural ground is structurally unsuitable for mountain biking (MTD 2018).

What Mountain Bikers want

One man's joy is another man's sorrow

MTB-segment	requirements of paths
Cross Country	unpaved paths: forest-/field-/gravel- and meadow-paths, singletracks
Tour	forestry roads, singletrails
All Mountain	singletrails, natural paths, steep climbs and descents
Enduro	technical trails with drops and jumps
Freeride	technical, (very) steep, kickers, obstacles
Downhill	steep and technically demanding descents; closed off, exclusively dedicated downhill route with many obstacles



Source: Mountainbike Tourismusforum Deutschland (2017), Newsome & Davies (2009)

Mountain bike segments and their trail requirements (MTD 2017; Newsome & Davies 2009).

When it comes to observing the legal situations, there is a clear differentiation between local closures and legal trail width restrictions. While the latter are "usually" or "always" observed by 52 percent of mountain bikers, this applies to 75 percent of mountain bikers in the case of local closures (DIMB 2010). According to Mountain Bike Monitor 2015 (MTD 2015), 42 percent of mountain bikers avoid regions that prohibit biking on narrow trails. These figures prove that steering measures are effective and accepted by users. Experience shows that their effect can be significantly increased if they are justified and communicated in a comprehensible manner. Ideally, they are developed with the involvement of those affected on site.

Informal trail networks and facilities, such as those that are created especially in close to urban centers, are problematic. Here paths, trails and structures for recreational use are often created illegally without knowledge of the conservation value of the areas concerned. In addition to fragmenting the landscape, trails can restrict the freedom of movement of animals (as described above) or even create a so-called edge effect by altering light, wind and ground conditions, which can result in strongly negative impacts on flora and fauna (cf. Ballantyne et al. 2014).

Well-known examples of illegal trail networks are ...

- ... John Forrest National Park in Australia, where an informal trail network was investigated in 2009. An area of 2,500 hectares was affected, with 2.5 kilometers of trails averaging one meter in width. On average, a constructed technical obstacle was found every 140 meters (Davies & Newsome 2009). Since then, an officially planned mountain bike trail network of about 40 kilometers has been built here in cooperation between the Department of Parks and Wildlife and local mountain bike groups.
- ... the Isar Trails in the Isar Valley south of Munich, a very important connecting and hiking axis between the Danube and the Alps and a flora-fauna habitat (FFH area). Since 2015, an elaborate municipal participation project has been dedicated to balancing local recreation and nature conservation. For this purpose, among other things, the project "Nature recreation Isar valley in the south of Munich" was developed. However, for a long time, unresolved questions

about the operator model and the obligation to ensure traffic safety stood in the way of an official designation of trails to counteract illegal trail construction (cf. Hilbert 2018).

As shown above, the strongest influence on the soil and the biodiversity comes from the creation of a path. Informal path networks have a particularly strong influence on wildlife. They bring disturbance to previously undisturbed areas and are unpredictable precisely because of their comparatively sporadic use. In contrast to established trails, they are thus significantly more dangerous from the perspective of wildlife.

6. Mountain bikers and hikers have similar motivations and demands for recreational and natural space

Many nature sports enthusiasts have similar motivations for their desire for outdoor exercise. This is particularly well studied for hikers and mountain bikers, the two highest-volume active sports segments away from paved surfaces.

For 96 percent of mountain bikers, enjoyment of nature is the main motive for engaging in the outdoor activity (MTD 2018). Taking a trip into the countryside for active recreation comes in second place, following the order of hiking (Quack 2017: 13). The requirements for natural spaces are also similar. Both user groups look for trails that are as natural as possible, different ground structures, and ideally a designated trail network with an organized guidance system for easier orientation (Federal Agency for Nature Conservation 2018).

In September 2018, the German Hiking Association presented the first results of the "Natursport.Umwelt.Bewusst" study on the effects of various nature sports and on raising awareness among those practicing them. Hiking is the most popular nature activity among participants in the survey, closely followed by biking. Around 93 percent of respondents said they rarely or never experience conflicts with other nature users when practicing their nature activity (German Hiking Association 2018: 35).

This generally peaceful coexistence can certainly also be explained by the similar motives and an overlap of the target groups. According to Mountainbike Monitor 2015, 41 percent of mountain bikers also do at least one other adventure or nature sport in summer.

Current situation and the need for research

Despite the sometimes vigorous public debate on the effects of mountain biking and other nature sports, there has been remarkably little primary research done in Europe. Most studies come from Anglo-American areas - above all the USA and New Zealand which both have some areas with comparatively low population density. A replication of these studies within a Central European context would be invaluable. Due to these differing population densities and the accompanying habituation to human presence, it can be assumed that critical distances related to flight responses as well as the duration of flight responses would decrease - albeit depending on the protection status, management concept and visitor volume of the respective area. Also, the effects on flora, fauna and soil certainly differ depending on habitat type, altitude and climatic conditions.

Due to differing research approaches, different nature sports and different animal species as well as trail-specific conditions it is difficult to compare the available studies. Improved results can be expected here if there were interdisciplinary agreements on minimum standards and uniform definitions as well as the regularly examined nature sports and species.¹⁵

Careful observation and, if necessary, research should be conducted into emerging recreational activities such as e-biking or trail running.

There is still a need for research on the relationship between the use of nature and recreational sports and hunting success. There are currently no reliable findings in this area, which often leads to unfounded debates.

There is also a gap in research regarding disturbances caused by litter and noise from different user groups.

Conclusion and need for action

With an average of 233 inhabitants per square kilometer (Eurostat 2018), Germany is a densely populated country by global standards. Especially in urban and peri-urban areas, residents have only very limited open space at their disposal (cf. IÖR 2018). Under these circumstances, the use and, if necessary, dedication of public space is always subject to social consideration and compromise, regardless of particular interests.

With this article, the authors would like to contribute to a fact-based and solution-oriented debate with regard to mountain biking. It becomes clear: Despite its social relevance, there are surprisingly large research gaps with regard to the environmental impacts of popular nature sports. However, based on the current state of research, it is not possible to justify the assumption that mountain biking has a larger negative impact compared to other nature sports. Until new, methodologically valid research results are available, the focus should therefore rest on three pillars:

1. developing awareness - here, first of all, professional circles as multipliers for respective users should develop a common awareness about the value of natural and recreational areas.
2. creating awareness - is the task of all stakeholders and institutions involved in the exercise and governance.
3. acting consciously - is the result of the two previous tasks and ultimately a call for everyone moving in the natural space.

The enjoyment of nature as the main motive of mountain biking suggests a high motivation to deal with topics of the natural environment and biodiversity. Initiatives such as the Trail Rules of the German Mountain Bike Initiative or the self-commitment MTB of the alpine associations, information campaigns such as the bike booklet of DAV, MTD, ZIV (2018) and environmental education measures of the natural parks are tried and tested means that still offer a lot of potential for expansion.

The problem of informal trail networks should be addressed proactively by all sides. Round tables have proven to be a suitable forum to work out a balance of the needs of nature conservation, active

¹⁵ Thus, current research considers mainly large mammals and in a few cases birds. Smaller classes such as reptiles or insects are usually not considered.

mountain bikers and other stakeholders. Given the ever-growing target group of nature sports enthusiasts - in addition to mountain biking, hiking and other active sports are becoming increasingly popular - and an accompanying increase in pressure on nature, sustainable and forward-looking approaches to raising awareness and guiding users are imperative.

Last but not least, the high intersection of people who participate in multiple nature sports requires cooperation between different interest groups for professional and sustainable development.

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