Natural Resource Impacts of Mountain Biking

A summary of scientific studies that compare mountain biking to other forms of trail travel

By Gary Sprung

This article was originally published in *Trail Solutions: IMBA's Guide to Building Sweet Singletrack* (2004). For a more recent and complete review of scientific studies, see *Environmental Impacts of Mountain Biking: Science Review and Best Practices* by Jeff Marion and Jeremy Wimpey published in *Managing Mountain Biking: IMBA's Guide to Providing Great Riding (*2007).

In recent years, hiking and environmental groups have lobbied to ban mountain bikers from trails on the grounds that mountain bikes damage the environment. Some land managers have closed trails to bicycling because of alleged, excessive resource damage.

Do mountain bikers *truly* cause more impact on natural resources than other trail users?

Very little research has been in done in an attempt to answer this question, but the empirical studies that have been conducted do not support the notion that bikes cause more natural-resource impact. What studies *do* demonstrate is that *all* forms of outdoor recreation—including bicycling, hiking, running, horseback riding, fishing, hunting, bird watching, and off-highway-vehicle travel—cause impacts to the environment.[1]

Social scientists have conducted surveys to study the feelings, perceptions, and attitudes of cyclists, hikers, equestrians and motorized trail users toward one another. This information, along with anecdotal evidence and media reports, shows that trail users don't always get along. User conflict, as a concept, is fairly well understood and demonstrably real.

In a democracy, the allocation of trails based on users' differing interests is a normal, appropriate course of action. Land managers must consider the opinions and concerns of the people who use their trails. But when individuals make unsubstantiated allegations regarding natural resource damage to justify the prioritization of their type of trail use, land managers should be wary.

Objective information, independent of conflicting human desires, must be the basis for sound policy decisions. The results of scientific studies can provide land managers and

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[1] Science also demonstrates that roads -- whether used or not, or regardless of which groups use them -- can cause harmful environmental effects. A more limited body of science indicates that trails may cause somewhat similar effects. But this document addresses only the comparison of user groups' impacts, not the effects of roads and trails.

recreationists with a better understanding of user impacts, and should guide political debate and public policy.

This document examines three main categories: physical impacts to trails or facilities, vegetation damage, and effects on wildlife.

In each case, several studies have examined the topic, but only a handful have compared the effects of bicyclists with other trail users.

No scientific studies show that mountain bikers cause more wear to trails than other users.

Trails deteriorate over time. To what extent do bicyclists cause this deterioration, and how does the impact of bicyclists compare with that of other trail users? Many people have hypothesized about impact, basing their theories on ideas involving the characteristics of tires versus shoes, skidding, area and pressure of impact, and other factors. But as of 2003, only two empirical studies have scientifically compared the erosion impacts of bicycling with other forms of trail travel. (editor: For a more recent and complete review of scientific studies, see *Environmental Impacts of Mountain Biking: Science Review and Best Practices* by Jeff Marion and Jeremy Wimpey published in *Managing Mountain Biking: IMBA's Guide to Providing Great Riding (*2007).

Wilson and Seney: Hooves and feet erode more than wheels

In 1994, John Wilson and Joseph Seney of Montana State University published "Erosional Impacts of Hikers, Horses, Motorcycles and Off-Road Bicycles on Mountain Trails in Montana" (12). The study tracked 100 passages by each of the four groups over control plots on two trails in national forests. For some of the passages, the researchers prewet the trail with a fixed quantity of water using a rainfall simulator. The researchers measured sediment runoff, which correlates with erosion.

Wilson and Seney found no statistically significant difference between measured bicycling and hiking effects. They did find that horses caused the most erosion of the trails, and that motorcycles traveling up wetted trails caused significant impact. They also concluded, "Horses and hikers (hooves and feet) make more sediment available than wheels (motorcycles and off-road bicycles) on prewet trails, and that horses make more sediment available on dry plots as well" (p.74). Wilson and Seney suggested that precipitation will cause erosion even without human travel, and this factor may significantly outweigh the effects of travel. Trail design, construction, and maintenance may be much more important factors in controlling erosion than excluding specific user groups.

Chiu and Kriwoken: No significant difference between hiking and biking trail wear

In a study whose publication in *Annals of Leisure Research* is pending, two researchers at the University of Tasmania, Australia, conducted an experiment on an abandoned fire road to compare track ("track" is the term for trail in Australia) impacts from hiking and bicycling. For the study "Managing Recreational Mountain Biking in Wellington Park, Tasmania, Australia" (2), the authors had hikers and bicyclists pass test plots 400 times each, and measured the surface profile of the track before, during, and after the passes. They compared flat, steep, wet, and dry conditions. Chiu and Kriwoken found no significant difference in the trail wear caused by the two user groups. They did find significant impact from skidding tires, and they also found that impacts on wet trails were greater than on dry for both types of use.

Goeft and Alder: Erosion trends not clear
Other, non-comparative studies have looked at the erosion effects of bicycling. Goeft and Alder (5) investigated erosion on two trails in western Australia for one year, including various combinations of uphill, downhill, and flat sections as well as curved and straight stretches in their study. They found that trail width varied with time, narrowing a little but not showing a clear trend. Soils on older sections of trail were more compacted than newer. Erosion was influenced by slope, time, and age of trail, but did not show a clear trend.

Bjorkman: Artificially hardened trails erode less
Bjorkman, 1996, (1) cleared vegetation from two very steep slopes (62 %) in a state park in southern Wisconsin and left one bare while protecting the other with artificial hardening surfaces. Trail users traveled over these surfaces and the study measured sedimentation from each slope. The protected path generated 0.11 tons of sediment per acre while the untreated slope produced 10.86 tons per acre.

Crockett: Minimal change from repeated bicycle passage
In 1986 the Santa Clara County Parks and Recreation Department of northern California studied the erosional effects of bicycling on the Edwards Field Trail (3). Forty-five cyclists made a total of 495 passes over 12 transects. Measurements were taken before and after these passes. Trail width increased at some plots and decreased at others, and the cross-sectional area of the transect, which is a measurement of the amount of soil in that spot, also varied. The researcher, Christopher S. Crockett, observed minimal change in the visual trail characteristics in most cases. The data led the county parks department to open trails to mountain biking.

Discussion:
The two comparative studies discerned minimal differences between bicycling and hiking. These studies may not resolve the continuing debate over who does what to trails. This scientific inquiry needs to be repeated in other geographic locations, on other soils, with more passages by each user group.

Because the Goeft and Alder and Bjorkman studies allowed multiple users on the same trails without measuring differences, and the Crockett/Santa Clara study involved only bicyclists, those studies do not provide information to compare erosion processes among users. However, these studies do indicate that the impacts of bicycling on trail condition are minimal.

No scientific studies indicate that bicycling causes more degradation of plants than hiking.

Trails tread itself is primarily devoid of vegetation, so impacts to vegetation are not usually a concern. However, this issue is relevant with regard to the widening of trails and travel off of established trails.

Thurston and Reader: Hiking and bicycling trample vegetation at equal rates

Again, only one study has compared bicycling with other recreation with regard to the damage to vegetation caused by trampling. In 2001, Eden Thurston and Richard Reader of the University of Guelph, Ontario, published "Impacts of Experimentally Applied Mountain Biking and Hiking on Vegetation and Soil of a Deciduous Forest" (10). The authors set up two identical lanes of travel over natural vegetation in a deciduous forest. They measured plant stem density, species richness, and soil exposure before, during, and after the 500 passages in each lane by hikers and bicyclists. Results: "Three principal findings emerged from this study. First, impacts on vegetation and soil increased with biking and hiking activity. Second, the impacts of biking and hiking measured here were not significantly different. Third, impacts did not extend beyond 30cm of the trail centerline" (Thurston and Reader, 2001, p.405).

Bjorkman: Vegetation on shared-user trails occurs mostly in center of trail
Weesner/NPS: Moderate trail widening controlled by volunteers

Bjorkman, 1996, (1) studied erosion of existing and brand new trails in a state park in southern Wisconsin. Measurements on existing trails indicated a rapid and substantial loss of vegetation along the trail centerline. The disappearance of vegetation 2 meters to the side was much less and slower. Along the centerline, soil compacted steadily, but there was little compaction 2 meters to the side. The width where no vegetation existed increased rapidly at first, then a bit more slowly, was more rapid in shade than in sun, and was more pronounced where the soil had more sand, or less silt. Weesner, 2003, (11) reported the results of National Park Service observations of a trail in southern Arizona over almost a decade. Results: Some trail segments widened moderately and some just a little. Volunteer trail maintenance occurred on some plots and effectively kept the trail narrow.

Discussion:

The Thurston and Reader study provided high-quality information through a solid process. Neither Bjorkman nor Weesner controlled for multiple-uses, and thus those studies do not provide a basis for comparison of vegetative impacts of trail users.

Science has yielded mixed results in comparing the impacts on wildlife of hiking and bicycling.

To date, four studies have rigorously compared bicycling's impact on wildlife with the impacts of other users. The studies involved bison, mule deer, pronghorn antelope, desert bighorn sheep, European alpine chamois, and American bald eagle. A fifth study provided a statistical suggestion regarding grizzly bear.

Taylor and Knight: Hiking and biking cause same impact to large mammals on Utah island

In 1993, Audrey Taylor and Richard Knight published "Wildlife Responses to Recreation and Associated Visitor Perceptions" (9), a study on Antelope Island, situated in the Great Salt Lake of Utah. They measured behavioral responses of bison, mule deer, and pronghorn antelope to the passages of hikers and bicyclists. In each case, an assistant acted as a hiker or cyclist while a researcher collected data as a hidden observer. The recreationists moved at a typical pace, did not stop nor look at the animals, and did not talk. The study measured alert distance, flush response, flight distance, and distance moved. Recreationists stayed on trails for the bison and antelope trials, while the mule deer observations involved recreationists traveling both on and off trails. Taylor and Knight wrote, "…the large degree of overlap between the 95% confidence intervals for hiking and biking is indicative of a lack of biological difference between wildlife responses to these activities" (p.955).

Calculating the amount of trails and the sensitivity distances of wildlife, Taylor and Knight estimated that approximately 7% of the island "was potentially unsuitable for wildlife due to disturbance from recreation." (Only the northern half of the island has trails, and the southern half is off limits to public recreation.)

Taylor and Knight also surveyed recreationists on the island and found that hikers, bicyclists, and equestrians blamed other groups more, and their own groups less, for wildlife impacts. The study also found that all recreationists underestimated the distances at which wildlife were sensitive to human presence.

Papouchis, Singer, and Sloan: Hikers have greatest impact on bighorn sheep

Christopher Papouchis, Francis Singer, and William Sloan, reported in 2001 on "Responses of Desert Bighorn Sheep To Increased Human Recreation" (7). The authors observed 1,029 bighorn sheep/human interactions in two areas, a high-use and a low-use, of Canyonlands National Park, Utah, in 1993 and 1994. They compared behavioral responses, distances moved, and duration of responses to vehicles, mountain bikers, and humans on foot. Hikers caused the most severe responses in desert bighorn sheep (animals fled in 61% of encounters), followed by vehicles (17%) and mountain bikers (6%), apparently because the hikers were more likely to be in unpredictable locations and often directly approached sheep.

Gander and Ingold: Hikers, joggers, and mountain bikers—all the same to chamois

In 1996 Hans Gander and Paul Ingold published, "Reactions of Male Alpine Chamois *Rupicapra rupicapra* to Hikers, Joggers, and Mountain bikers" (4). The authors measured the effects on male alpine chamois of the passage of hikers, bicyclists, and joggers. Thirty-two passages were carried out by single persons traveling on a trail that runs through a meadow above timberline in a game reserve in the Bernese Oberland of Switzerland. The animals responded similarly to each of the human activities. Subsequent to the passage of people, the chamois tended to avoid the pasture.

Spahr: Hikers have greater impact on eagles than cyclists
In her 1990 graduate thesis, Robin Spahr examined "Factors Affecting The Distribution Of Bald Eagles And Effects Of Human Activity On Bald Eagles Wintering Along The Boise River" (8). Spahr observed people recreating and also "simulated" recreational behaviors on a section of the Boise River in Boise, Idaho, in order to measure the effects on eagles.

Spahr found that walkers caused the highest frequency of eagle flushing, with 46% of walkers causing eagles to flush. Fishermen were second at 34%, with bicyclists at 15%, joggers at 13%, and vehicles at 6%. Bicyclists caused eagles to flush at greatest distances, with a mean of 148 meters, a minimum of 96 meters, and a maximum of 200 meters. Walkers' mean was lower, at 87 meters, but their minimum was closer, at 17 meters, and their maximum was higher than bicyclists', at 300 meters. Mean distance of eagle flushing by vehicles was 107 meters, by fishermen was 64 meters, and by joggers was 50 meters. "The disturbance indexes, which reflect both flushing distance and frequency, indicated that walkers were the most disturbing to eagles. Bicyclists, followed closely by fishermen, were the next most disturbing," Spahr wrote.

Herrero and Herrero: Bikers more likely to suddenly encounter bears
In 2000 Jake Herrero and Stephen Herrero published, "Management Options for the Moraine Lake Highline Trail: Grizzly Bears and Cyclists" (6). The authors' firm was hired by Parks Canada to provide recommendations for managing bicycling on a particular trail in Banff National Park in Alberta Canada. Intended primarily as a management strategy, the report was not an experimental investigation of grizzly bear responses to bicyclists. However, the authors referenced their compiled database of human/grizzly bear interactions and found a statistical *suggestion* that bicyclists, because they travel quietly and quickly, are more likely to have sudden confrontations with grizzly bears on that trail than are other trail users, such as hikers and equestrians. The authors also found no difference between the effects of bicycling and hiking on bear habitat and stated there was no evidence that bicyclists should be managed differently than other users in that regard.

Discussion:
These studies scratch the surface of a complex topic. The diversity of species and their differing responses to human recreation make generalizations across species difficult. However, this group of studies at least suggests that the impacts of bicycling on wildlife are generally similar to the effects of hiking.

Conclusion

Mountain biking, like other recreation activities, does impact the environment. On this point, there is little argument. But people often debate whether or not mountain bikes cause *more* damage to trails, vegetation, and wildlife than other forms of recreation such as hiking and horseback riding.

A body of empirical, scientific evidence now indicates that **mountain biking is no more damaging than other forms of recreation, including hiking**. Thus, managers who prohibit bicycle use (while allowing hiking or equestrian use) based on impacts to trails, soils, wildlife, or vegetation are acting without sound, scientific backing.

A land manager's decision to prohibit one user group on the basis of providing a particular type of experience for another group may or may not be justified by evidence provided by social studies, as the wisdom of prohibiting a particular user group in order to satisfy the desires of another is a matter for politics rather than science.

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