Natural Resource Impacts of Mountain Biking

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

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In recent years, hiking and environmental groups have often lobbied to ban mountain bikes 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 attempted to answer this question, but the empirical studies thus far do not support the notion that bikes cause more natural resource impact. What science does 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. This information, along with anecdotal evidence and media reports, show that trail users sometimes do not get along. User conflict is fairly well understood and demonstrably real.

People involved in user conflict sometimes simply state their preferences and ask decision-makers to take action. In a democracy, the allocation of trails based on users' differing interests is a normal, appropriate course of action by land managers. But when people make unsubstantiated allegations regarding natural resource damage to justify prioritization of their type of trail use, land managers should be wary.

To make rational, non-arbitrary, less political decisions regarding which groups are allowed on particular routes, managers need scientific studies that compare the impacts of the various user groups. Objective information that is independent of conflicting human desires can form a basis for sound policy decisions. Better understanding of the differing impacts of the various recreation forms can guide political debate and public policy. This document looks at differences in 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.

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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.

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, and how does that compare with the impacts of other trail users? Many people have hypothesized based 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.[2]

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 pre-wetted 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 prewetted 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.

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 and steep and 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 did find 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 Austrailia for one year, with various combinations of uphill, downhill and flat sections, curved and straight. Trail width varied with time, narrowing a little but not showing a clear trend. Soils on older sections of trail were more

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[2] IMBA wishes to obtain and incorporate into future revisions of this document any new or additional empirical science regarding the impacts of mountain biking. IMBA welcomes input. To offer information, please contact the author at gary@imba.com.

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 .11 tons per acre, and on 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 the passes. Trail width both increased and decreased at various plots, and the same was true of the cross-sectional area of the transect, which is a measurement of the amount of soil in that spot. 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.

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

Trails are places primarily devoid of vegetation, so for trail use in the center of existing paths, impacts to vegetation are not a concern. This issue is relevant with regard to 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. Eden Thurston and Richard Reader of the University of Guelph, Ontario, published in 2001, “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 2.0 meters to the side was much less and slower. Along the centerline, soil compacted steadily, but there was little compaction two meters to the side. The width where no vegetation existed increased rapidly at first, then a bit more slowly, and was more rapid in shade than in sun, and 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 comparing impacts on wildlife of hiking and bicycling.

To date, four studies have rigorously compared the impacts of bicycling 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 recreationist 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 seven percent 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 general public recreationists on the island and found that hikers, bicyclists, and equestrians blamed other groups more, and blamed their own groups less, for wildlife impacts. They 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 & Ingold: Hikers, joggers & 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 Mountainbikers." (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, and measured 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%; bicyclists - 15%; joggers - 13%; and vehicles - 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 maximum was higher than bicyclists', at 300 meters. Mean distance of eagle flushing by vehicles was 107 meters; by fishermen, 64 meters; by joggers, 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 more quickly, are more likely to have sudden confrontations with grizzly bears on that trail than are other trail users (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 just 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 with regard to the non-human environment, 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 studies 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.

In contrast, if a manager prohibits one user group on the basis of providing a particular type of experience for another group, the evidence provided by social studies may or may not justify that decision. The wisdom of prohibiting particular user groups in order to satisfy the desires of other groups is a matter for politics rather than science.

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