Impacts of ATV Traffic on Undesignated Trails

by Randy B. Foltz and Dexter L. Meadows

The U.S. Department of Agriculture, Forest Service reports that driving motor vehicles off-road has become one of the fastest growing activities on national forest lands. The continued growth and use of all-terrain vehicles (ATVs) has created a demand upon many existing trail systems that were not designed for this level of use. This has challenged the capacity of trails and the ability of recreation managers to schedule and perform basic trail assessments and regular maintenance.

Although the Forest Service is committed to providing public access to recreational opportunities on national forests and grasslands, the ever-increasing ATV-management challenge is to provide public access to roads and trails that can be sustainable without compromising the aesthetic beauty and integrity of natural resources and ecological processes. The Forest Service has responded to this challenge by establishing Travel Management Regulations in 2005, often referred to as "the Off-Highway Vehicle Rule", that ensured the access to and protection of the natural resources on national forests and grasslands. The Forest Service also performed a study to determine the effects of ATVs on national forest resources. This article provides a brief summary of the study.

The objective of the study was to determine if ATVs had an effect on the natural resources and if so, which ATV types and tire treads created the impact. All phases of the study were performed at six locations across the country within representative ecoregions: Tonto NF, Arizona; Land Between the Lakes National Recreation Area, Kentucky; Kisatchie NF, Louisiana; Superior NF, Minnesota; Beaverhead-Deerlodge NF, Montana; and Wenatchee NF, Washington. Only the ATV traffic portion was performed on the Mark Twain NF, Missouri and is not discussed here.

Methods

The experimental approach was to make repeated passes over the same piece of the landscape and measure the effects on the natural resources. At each location four new loop trails characterized by uphill climbs, downhill descents, turns, and straight sections were setup for the study (fig. 1). Two ATV types (sport and utility) and two tire tread types (original equipment manufacturer and a more aggressive aftermarket tire) were selected for this study. The machines selected represent the most popular ATVs found across the country at the time of the study. The original equipment manufacturer general-purpose tire had a lug height not to exceed 0.5 inches and lug width not to exceed 1.5 inches. The aggressive-tread aftermarket tire for each location was the one most often used by local riders and accepted by the local regulatory authorities. None of the aftermarket tires had lug heights exceeding 0.75 inches.

Rather than attempt to measure each structural characteristic of the natural environment along the continuum of no disturbance to unacceptable disturbance, three disturbance classes (low, medium, and high) were developed. The three indicators that determined the disturbance classes were litter and vegetation, trail width, and ATV rut depth (table 1). To use the disturbance class matrix an observer walked along a trail section and chose the descriptor in each of the three indicators that best represented that section of trail, and circled it on the rating sheet. After all the indicators had been rated, the number of choices in each disturbance class was totaled. The disturbance class with the highest total was the condition of that trail section. Ties between low and medium or between medium

Figure 1. An ATV rider on the loop trail at the Superior National Forest, Minnesota.

Table 1. The trail disturbance class matrix used in the field to identify the disturbance level from ATV use.

Disturbance Indicator	Low Disturbance	Medium Disturbance	High Disturbance
Litter and vegetation	0- to 30-percent loss of ground cover, small roots exposed, rocks no more exposed than natural conditions.	30- to 60-percent loss of ground cover, small roots exposed and broken, rocks exposed and fractured.	Greater than 60-percent loss of ground cover, large roots exposed and damaged, large rocks worn around or displaced.
Trail width (both tread and displaced material)	54 inches or less.	Between 54 and 72 inches. Some trail braiding. Evidence of width increasing.	72 inches or greater. Braided trails evident. Trail width is growing.
ATV rut depth	Ruts less than 3 inches deep.	Ruts 3 to 6 inches deep.	Ruts greater than 6 inches deep.

and high were rounded down. Any observation of a high condition resulted in a condition classification of at least medium.

Removal of litter and vegetation causes both visual impacts and allows increased soil erosion. Visually, the reduction of cover distinguishes an ATV trail from the undisturbed forest. Continued ATV use also inhibits plant re-growth in much the same manner as vehicle traffic inhibits plant re-growth on unpaved forest roads. Trail width was a key indicator of trail conditions. Increasing trail width results in more area disturbed. ATV rut depth was the final indicator of trail conditions. Deeper ruts allow channeling of water on the trail and concomitant concentrated flow erosion.

The experimental design for the ATV traffic was one loop for each combination of vehicle and tire type for a total of four loops at each site. Each loop had four trail features (uphill climbs, downhill descents, turns, straight sections) and each feature was rated with the condition class matrix after approximately every 40 passes. While this results in a large number of observations, there are no replications in the experimental design. Further, the number of ATV passes was not the same on each loop and the goal of reaching the high disturbance condition was not achieved at all locations.

Rainfall simulation was used to determine soil erosion characteristics of infiltration and raindrop splash parameters for each combination of location and vehicle-tire combination. Differences in soil moisture, slope, and ground cover at each location made direct comparison of runoff and sediment loss inappropriate. To account for these differences, the Water Erosion Prediction Project (WEPP) model was used to determine the infiltration and erosion characteristics. The WEPP model (Flanagan and Livingston, 1995) is a physically based soil erosion model that provides estimates of runoff, infiltration, soil erosion, and sediment yield considering the specific soil, climate, ground cover, and topographic conditions.

Results

Some portion of the trail transitioned from low to medium disturbance class in 20 to 40 passes. This level of ATV traffic could be achieved in one weekend from a moderate sized ATV group. Similarly, all six locations had some portion of the trail transition from the medium to high disturbance class in 40 to 120 passes. This level of ATV traffic could be achieved in less than a month. Changes in ground cover, one of the components of the condition class matrix, are shown in figure 2. Noteworthy were the decrease in cover from undisturbed to low and the continuing decrease in cover from low through high. A high disturbance condition class was not achieved at the Minnesota, Montana, or Washington sites. At the Arizona site, a medium condition class was not observed.

Erosion parameters of hydraulic conductivity and interrill erosion were determined using the WEPP model for each set of rainfall simulation tests.

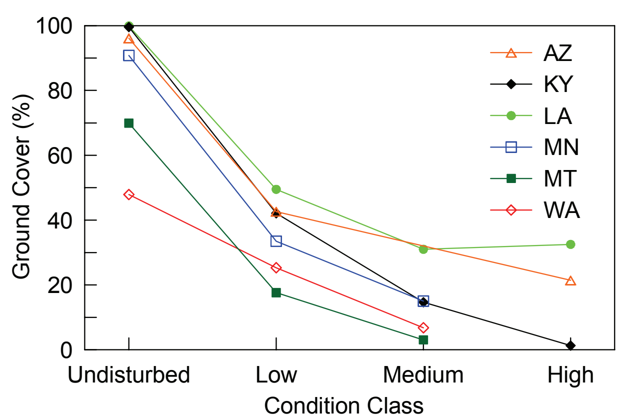

Figure 1. Percent ground cover each disturbance class at each site. The lack of a point for a given disturbance class indicates no data were available or obtained for that site.

Investigation of changes in both runoff and raindrop erosion can indicate how sediment loss changes due to ATV traffic. It is possible for runoff and raindrop splash erosion to independently increase, decrease, or remain the same. In this ATV study there were only four combinations of changes in runoff and raindrop splash erosion.

The locations with the largest potential increase in sediment loss were the loamy sand soil texture locations of Louisiana and Washington where runoff increased and raindrop splash erosion increased. At these locations, ATV traffic caused an increase in runoff and an increase in sediment loss in excess of that due to the increased runoff alone. At both of these locations, runoff was approximately doubled after traffic and raindrop splash was approximately doubled after traffic. These locations and ones with similar loamy sand soils will likely have increased runoff combined with sediment loss in excess of that due to the increased runoff alone.

Runoff increased and raindrop splash erosion remained unchanged at the gravelly sandy loam soil texture sites of Minnesota and Kentucky. Runoff increased due to impacts of ATV traffic by 3 to 40 times the undisturbed values. Both locations will likely have large increases in runoff from ATV trails. The increased runoff has the potential to make a proportionate increase in soil loss.

At the gravelly sand locations of Arizona and Montana runoff was unchanged and raindrop splash erosion increased. The gravelly sand did not compact during ATV traffic resulting in no change in infiltration. Soil erodibility at Arizona doubled, while at Montana, it tripled. These locations and ones with similar gravelly sand soils will likely have increased sediment loss with no increase in runoff when compared to undisturbed areas.

All of the vehicles tested had an impact on site conditions regardless of the combination of ATV type or tire tread. Sport model vehicles (lighter weight ATVs) caused as much disturbance as the heavier utility model vehicles. The heavier more powerful utility vehicles reached the targeted disturbance levels in fewer passes than the sports two wheel drive models, but when the number of passes was the same, the levels of disturbance were the same from each vehicle type. The study found no differences between the two tire types tested.

Conclusions, Management Implications

The study concludes that ATV traffic adversely affects natural resources. The study further concludes that all of the vehicles tested contribute to those effects regardless of the type of ATV or tire type. The effects are considered adverse because the natural resources (soil, water, air, and vegetation) have been reduced or changed in a manner that prevents them from maintaining and performing their naturally prescribed functions. The ramifications of the effects are manifested in the removal or destruction of vegetation including forest floor litter, the exposure and destruction of plant root networks, the exposure of bare soil, and soil erosion as a result of bare soil exposure.

The data also implies that straight sections of trail will require less maintenance especially if these sections are located away from weaker soils. This will be an important distinction to management as forests involve and work with volunteer groups in an effort to make their contributions meaningful and effective.

The study also suggests that to simply limit ATV traffic to trails is not enough to protect the natural resources. Trail planning and design, particularly trail location, are key considerations for limiting disturbances to natural resources. The design phase should identify destinations as well as areas to avoid such as soils that are easily disturbed, wet areas (riparian zones), and sensitive wildlife habitats and archeological sites.

References

Flanagan, D.C. and Livingston, S.J., eds. 1995. *WEPP User Summary*. NSERL Report No. 11. W. Lafayette, IN: National Soil Erosion Laboratory. 131 p.

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