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forestry & natural resources
OUTDOOR RECREATION

Pathways for People

Trail Design to Minimize Environmental Damage and Enhance User Enjoyment

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Trails can add considerably to the enjoyment people experience in outdoor recreation areas. Developed for a variety of activities, including hiking, biking, horseback riding, cross-country skiing, snowmobiling, interpretation and off-road vehicle riding, trails can be used to challenge, to teach or simply to provide recreation for a broad spectrum of users. For trails to encourage these activities and achieve these purposes, however, requires advance planning and careful design.

Individuals who design and plan trails have a dual responsibility. They must design for both environmental protection and use. Trails must be easy for resource managers to protect and maintain and, at the same time, be easy for people to use and enjoy.

There are a number of information sources available which deal with trail construction and upkeep, covering such diverse topics as surfacing materials, trail standards, signing methods and periodic maintenance (see "References"). However, there are two other, equally important considerations often ignored during trail development: trail design to minimize damage and to enhance enjoyment.

Designing to Minimize Damage

Trails are a valuable recreational resource which must be protected, and the most critical time to consider their protection or maintenance is during the planning and building phases, when problems can be prevented. If a trail is inadequately designed with respect to maintenance, it will not only require costly upkeep but will also provide a poor experience for users. The most prevalent forms of damage and therefore the ones to be most aware of during the design phase are damage caused by water and damage caused by vandalism.

Minimizing Water Damage

Level Terrain. When trails are located on primarily level terrain, water tends to pool on the trail tread. Building the trail surface slightly above grade allows water to move off the trail. Although this technique does increase initial construction costs, it decreases later maintenance expenses required to cope with pooled water and also provides a more convenient pathway for users during wet periods. A less expensive technique involves center crowning the trail so water moves to the sides rather than pooling on the trail surface (Figure 1). With either of these techniques, drainage escape channels, or "gutters," along the edges of the trail should be provided for runoff water.

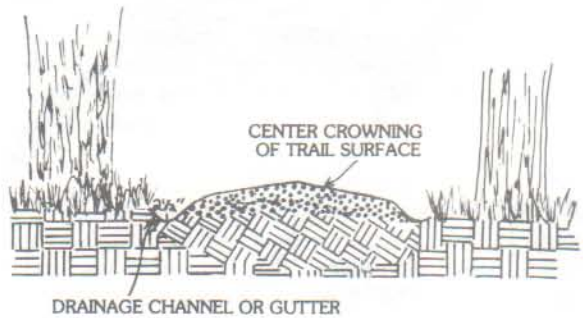

Figure 1. Center crowning of the trail surface allows water to move to the sides of the trail.

Hilly Terrain. Erosion caused by water movement is a major concern when trails are built in hilly terrain. Most such damage is caused by design and construction errors which allow water to build up volume and velocity. The key to reducing erosion created by water is to move the water off the trail surface as quickly as possible. One method to accomplish this is to outslope, that is, to build the uphill edge of the trail at a slightly higher elevation (2-3%) than the downhill edge (Figure 2). This encourages water to flow perpendicular to, rather than along, the trail surface, thus directing the flow off the trail before erosion can occur.

One of the most common methods for redirecting the downhill flow of water over trail surfaces is through the installation of water bars (Figure 3). This

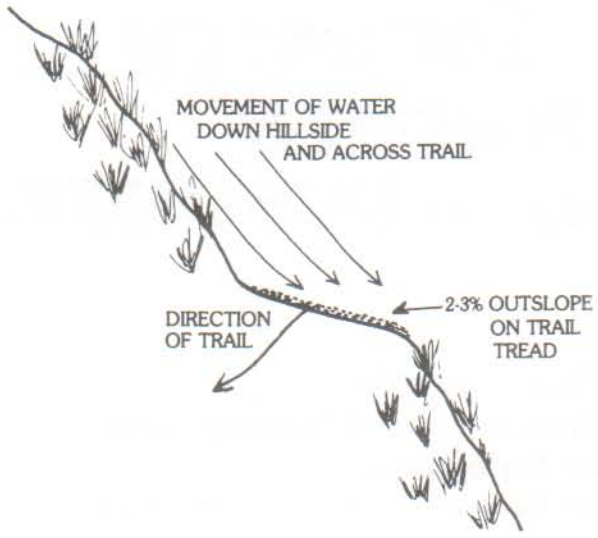

Figure 2. Section of a trail showing outsloped trail tread.

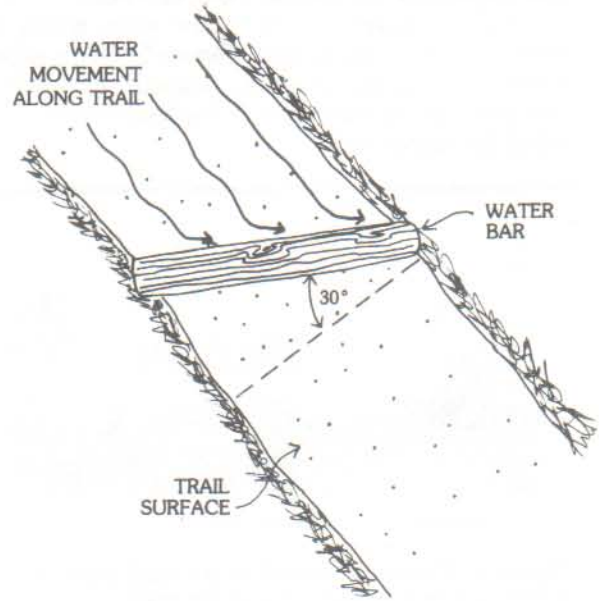

Figure 3. Water bars are used to redirect water off a trail surface.

involves placing sections of logs 4-6 inches in diameter across the trail surface at a 30° angle. The bars are placed at critical intervals to channel water off the surface of the trail. Water bars should be anchored firmly in place, with the uphill edge exposed to interrupt runoff and the downhill edge flush with the trail surface to permit users to step over them easily. Often, sections of logs, known as stabilizer bars, are also placed along the downhill side of trails to serve as retaining walls. However, stabilizer bars should be avoided in almost all situations, because the portion of these bars above the trail surface serves as a lip, encouraging water to remain on the trail where it can erode the tread.

A third method of minimizing the damage caused by water volume and velocity is through the use of grade dips (Figure 4). This technique works well on slow, steadily climbing trails. Short sections of trail, about 4-6 feet long, are designed at a grade opposite to the prevailing trail surface. These grade dips prevent water from building up downhill speed. The trail should be outsloped more at the point of the grade dip to provide a chance for the water to be channeled off the trail.

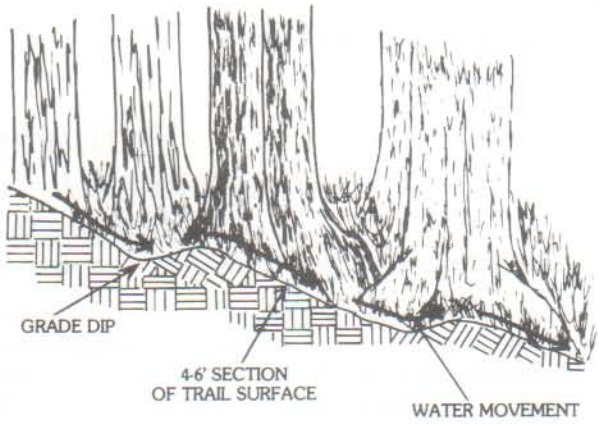

Figure 4. Grade dips work well on slow, steadily climbing trails.

Another method for protecting sloping trails from damage caused by water is armor plating. This involves placing a short section of reinforcing material (flat tiles or large stones) perpendicular to the trail surface wherever the trail crosses major drainages. This channels the water from the uphill side of the trail, across the trail surface, and down the continuation of the drainage. It is generally better to avoid placing culvert pipes under trails, since these tend to clog with leaf litter. Water then backs up and flows across the unprotected surface of the trail.

Finally, switchbacks, or hairpin-like turns, are frequently used on trails when the climbing grade is excessive (Figure 5). However, if the topography is steep enough for switchbacks to be necessary, then any type of trail construction will probably have an

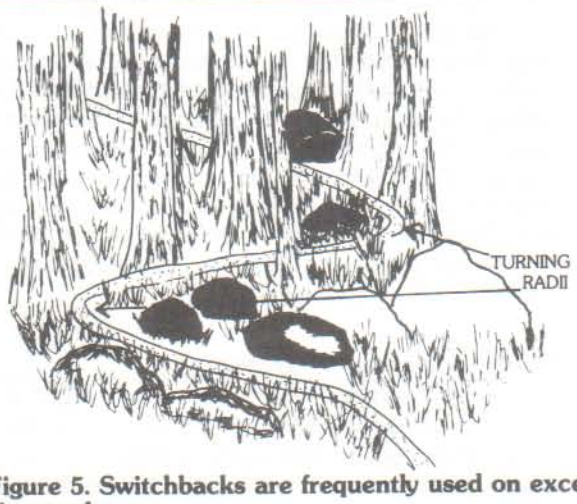

Figure 5. Switchbacks are frequently used on excessive grades.

erosive effect on the terrain. Thus, alternative trail alignments should be considered instead of using multiple switchbacks to cope with severe elevation changes. If inclusion of a switchback cannot be avoided, a 4 foot minimum turning radius is required for walking trails and an 8 foot minimum radius should be allowed for multipurpose or motorized use trails.

Minimizing Vandalism

Careful design can reduce the damage to trails caused by thoughtless users or vandals. For example, it is common along trails to see graffiti carved into smooth-barked trees such as American Beech. This problem can be reduced during the planning stage of trail development by two methods. First, the trail should be routed away from such trees as often as possible. Second, understory vegetation between the trail and these trees should be encouraged, and brush may be piled between the tree and the point on the trail nearest to it. While it is probably not possible to prevent users from leaving the trail to vandalize a tree, they can be subtly discouraged by measures making it difficult for them to leave the trail without an effort.

Combining incompatible trail uses can also lead to vandalism, as well as diminish the experience users have on a trail. Some trail functions, such as environmental or historical interpretation and hiking, should be kept segregated from each other. The moods you want to create on each of these trails is different. Compared to hikers, for instance, interpretive trail users seek a slower pace, more conducive to learning and observation than to vigorous exercise. Mixing these moods can lead to problems for users and management.

Another area of concern is vandalism of trail signs. Often, this type of vandalism is performed by people other than trail users. For instance, it is not uncommon for restless young people to cruise through parking lots looking for ways to release energy. A great deal of vandalism can be prevented by placing the signs designating the trail head out of sight of these parking lots, so they are not visible from passing cars. The beginning of the trail can be made obvious by opening the vegetation somewhat, and all necessary signing can be placed inside the trail head, but out of sight of the parking lot. With this technique, individuals who want to use the trail for its intended purpose will be able to determine where the trail starts, while those just passing through the area will not have any targets for vandalism. Similarly, most vandalism on trails seems to occur within the first 500 feet of a trail entrance. Placing expensive facilities, such as benches, beyond this zone should also reduce damage.

At times, damage to signs along trail sides may result from unintentional misuse. Given human nature, people may reach out and shake a sign post, just to see how secure it is. This behavior can be discouraged by placing signs just beyond arm's reach, although this will require using somewhat larger lettering on the signs in the interest of legibility and user convenience.

Designing to Enhance Enjoyment

It's not enough to design an easy-to-maintain trail or to design a beautiful trail winding through a scenic natural environment. A genuinely successful trail also requires that consideration be given to how the trail will be experienced by users. Designers can anticipate and thus enhance that experience by employing the techniques of design psychology.

The aim of design psychology is to use subtle planning and construction techniques to enhance the experience of trail users. The techniques should be unobtrusive enough to avoid calling attention to themselves. For example, a trail experience should convey a feeling of being in a natural environment, away from the intrusive influences of large numbers of other people. Toward this end, trails should be designed to reduce encounters with other users.

Loop Design

In addition to minimizing encounters with other users, loop trails avoid the need for users to backtrack. Backtracking can be monotonous for users, and it also doubles wear on the trail surface.

Loops permit users to "design their own experience" by providing alternative routes of varying length. A loop several miles long with cutovers, or internal connectors (Figure 6), provides trail options which might vary in travel time from 20 minutes to all day. Additionally, this design permits all users to end their experience where they began.

Figure 6. Loops with crossovers provide many options for trail users.

Curvilinear Design

Another method of reducing trail encounters is to use curvilinear design. This eliminates long tangents, which can create a boring experience, from line of sight and replaces them with gentle curves beckoning users to explore the next turn. However, caution must be exercised when designing motorized or bicycle trails. Although curves do present the users of these trails with varying degrees of challenge, the curves should not be designed so tightly that the trail becomes dangerous.

Curves should also be avoided where pedestrian trails cross a motorized pathway. These junctions should always be made at right angles to assure proper sight distance from all directions (Figure 7). Vegetation should also be thinned more heavily as a trail approaches an intersection. Safety is an important management concern when motorized trails cross other trails and when any trail crosses a roadway.

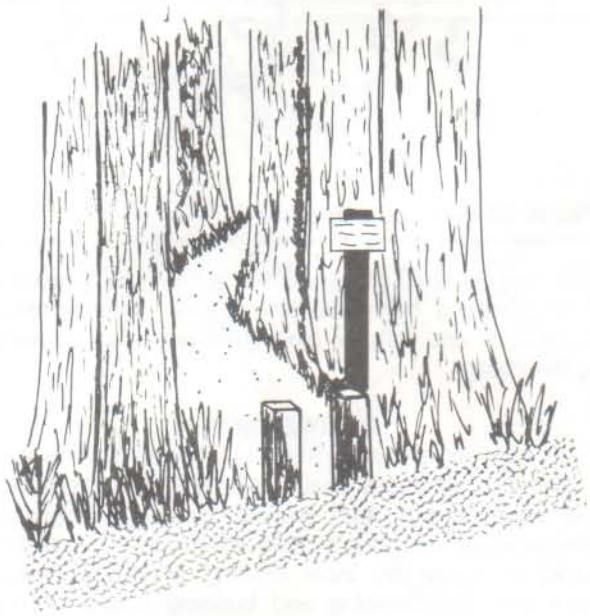

Figure 7. Trails crossing roadways should be at right angles to assure proper sight distance.

Using Vegetation

Even in areas of small acreage, it is possible to reduce encounters with other users. This can often be accomplished by taking advantage of existing vegetative cover. By leaving existing understory screening intact, it may be possible to have parts of a loop fairly close together, yet invisible from each other during some seasons of the year. Understory vegetation can also separate trails with differing purposes and users. For example, with proper vegetative screening, an interpretive songbird walk might be located near a segment of a hike and bike trail. Without the screening, the moods and behavior of the interpretive trails users and the hike and bike trail users would probably clash.

Deciduous trees and shrubs, however, will not provide dense screening from mid-fall to late spring. Thus, it is good practice to design trails during this period so planners can determine how much physical distance is needed between parallel sections of trails.

Using Topography

When a ridge system is part of the area being planned, the trail can be designed to circle the ridge. This approach reduces the encounters trail users will have by letting the ridge top separate parallel sections of trail. This practice affords a greater variety of scenery and allows any necessary gains in elevation to be made more gradually than climbing immediately to the ridge top. This technique should not be used, however, on longer trails where the severity of the slope of the ridge system precludes erosion-resistant cutovers or connectors.

Entries and Exits

Entranceways should be inviting and should encourage use. Thus, trails should not begin with a steep climb. Once into a loop trail, most climbs should be located where they can be traversed during the first half of the trail, before users tire. When the overstory vegetation at the trail entrance grows into the pattern of a tunnel, as in Figure 8, the results can have a negative psychological effect on trail users. The trail then becomes a darkened, uninviting place lacking in appeal. Variety in vegetative cover—mixing openings with vegetation—provides a

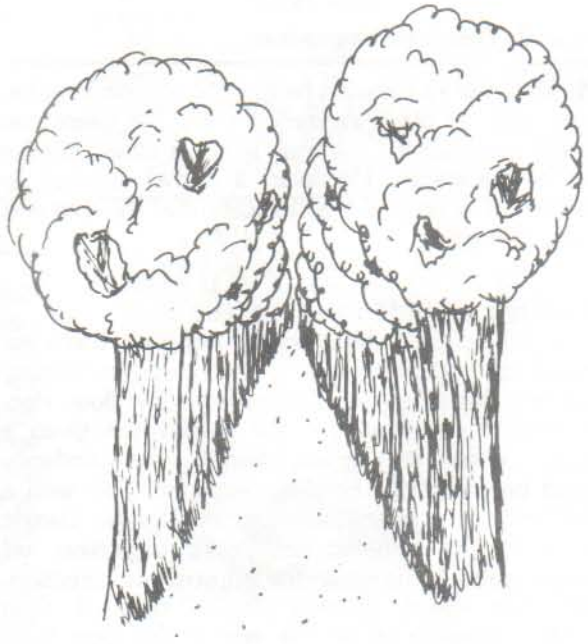

Figure 8. Overstory Tunnel Effect.

more appealing, interesting and secure environment for the trail user.

Whenever possible, a single entry/exit should be used for trail heads. This increases management's ability to control use of the trail. A single entry/exit also decreases user disorientation, since people exit the trail at the same point they entered it. As users approach the entry/exit point to begin the trail, design psychology can be used to focus their vision on the trail head. By creating an inverted "V" in the vegetation at the trail head (Figure 9), the user's vision is moved from a wide focal point into the narrower trail entrance. Coupled with this technique, the width of the trail tread can be reduced to draw users visually into the trail.

A single entry/exit will aid trail users in knowing where they are once they complete the trail. However, the final destination or reference point should not be visible from the trail until users reach the trail exit. This ensures that users will not leave the trail surface, taking shortcuts across and possibly damaging the natural environment.

At times, a single entry/exit is not feasible, due to existing terrain or other constraints. In these instances, the exit should be in sight of a parking lot, picnic area or other reference point the users can identify upon leaving the trail. In some cases, signing may be necessary. However, if a trail appears to need better signing, it may indicate that the trail was poorly designed.

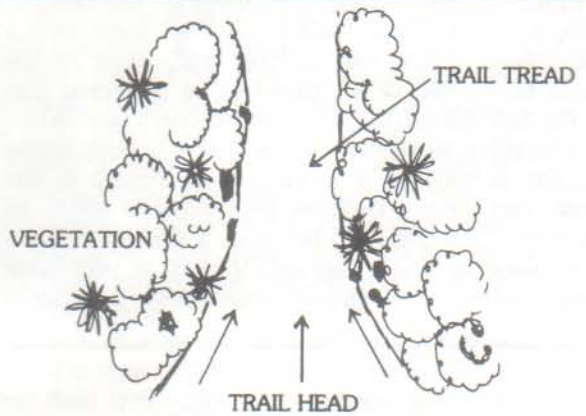

Figure 9. Trail head vegetation.

Directing Circulation Patterns

On a loop trail with a single entry/exit, there are several methods available to decrease uncertainty regarding the direction of intended traffic flow. People tend to move toward the right when given a choice. When the terrain permits, this tendency should be reinforced by designing loop trails with a right-hand, or counterclockwise, traffic flow. Gentle curves to the right at the trail's beginning will prompt users to move in the appropriate direction. With their vision focused to the right, it then becomes possible to tie the end of the loop back into the trail without making it appear as an alternative direction to follow. A reverse curve, in which an angle greater than 90° is used to tie the exit back to the trail, reinforces this effect. Note in Figure 10 that when the trail end might be visible from the trail head, physical objects, such as stones and vegetation, can be used to create a psychological blockade. Trail planning becomes much easier when existing vegetation and natural landforms are used to assist in the design.

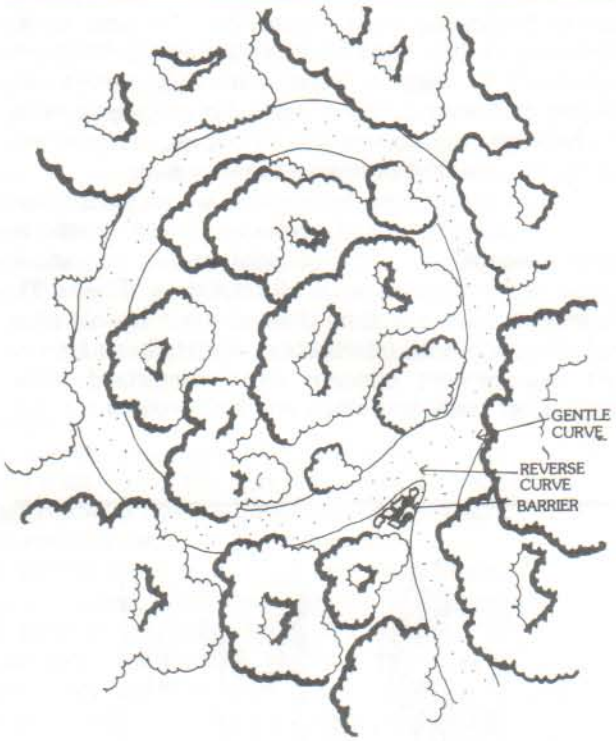

Figure 10. Reverse curve with barrier.

Summary

A number of design methods are compatible with a resource planner's dual responsibility of protecting the environment and enhancing user enjoyment. Maintenance efforts are most effective when used to avoid problems by incorporating preventive measures into the planning and building stages of trail development. Subtle techniques of design psychology can create positive experiences for users without intruding at a conscious level and destroying the "natural mood" sought on trails. With these methods, both new trails and old ones can be made to reduce problems and expenses for management personnel as well as offer a more enjoyable experience for trail users.

References

- Department of Natural Resources, "Indiana Trails Construction and Maintenance Manual." Division of Outdoor Recreation, Streams and Trails Section.
- Hultsman, John. "Design and Maintenance of Interpretive Trails," *Park and Recreation Resources,* Sept./Oct. 1982.

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