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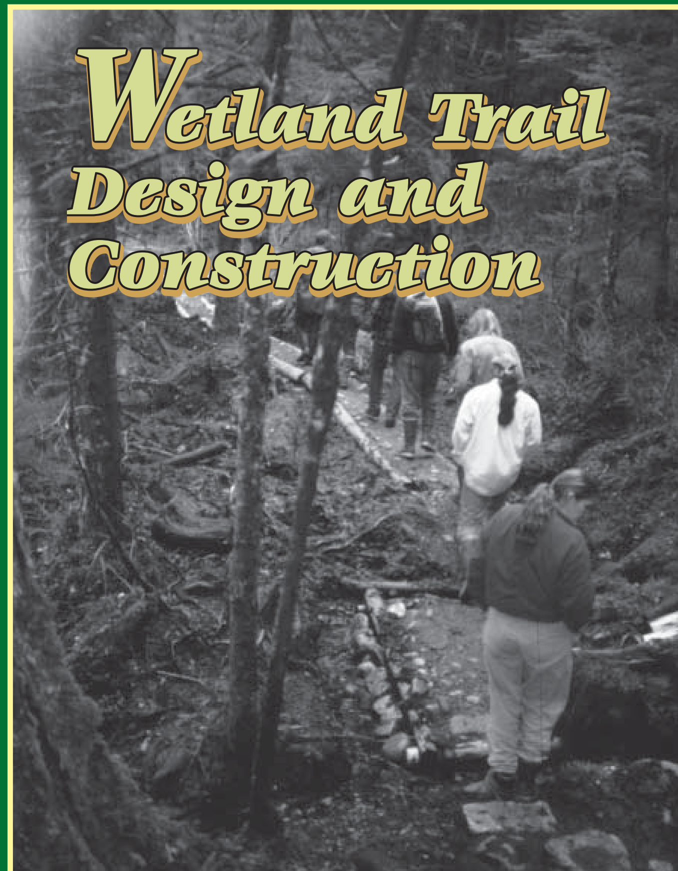
Wetland Trail Design and Construction



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Missoula, MT

8E82A3—Trail Treatment for Wet Areas

September 2001

Part 1 of 8

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Acknowledgments

Any document concerning trail construction must recognize the men and women who do the field work—whether they are professionals or volunteers. Some of the most unforgettable and fun-loving people we have known have worked on trail crews.

None of the construction techniques in this document are new. Most have been used for decades. Fortunately, trail crews took the time to explain and demonstrate the construction techniques to us. The techniques described in this manual have occasionally been modified slightly to make it easier to work with contemporary materials.

Christy Fischer was responsible for the initial editing of this manual. Thanks also to the staff at the USDA Forest Service Missoula Technology and Development Center (MTDC), who obtained additional photographs, scanned figures, provided review and additional content, and edited, laid out, and printed this document. This work involved Bert Lindler, Sara Lustgraaf, Mark Wiggins, Merv Eriksson, Jacob Cowgill, Bob Beckley, Lara Newburn, Michelle Beneitone, and Jerry Taylor Wolf. Bob Steinholtz drew the illustrations used throughout this manual. Thanks also to the U.S. Department of Transportation's Recreational Trails Program for funding additional distribution of this manual.

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Introduction

Most experienced trail crews try to avoid wetlands because of the construction and maintenance problems they pose. Little has been published on wetland trail construction, and materials that are available are often outmoded or are too regionally focused. By pulling this information together from our experiences, we hope to answer questions you didn't even know you had.

In this manual we have described the common techniques for building a wetland trail. We have also included information on some of the more unusual materials and tools.

Some of the techniques and tools we describe are suitable for wilderness situations where mechanized equipment cannot be used. Others are suitable for urban greenbelts where a wider range of techniques, material, and equipment can be used. Somewhere in between are the back-country sites where machines are permitted, but access and logistics are challenges. Although this book is written for wetland trails, the techniques described can also be used for correcting other poorly drained low areas in existing trails.

The manual is written for those who are untrained and inexperienced in wetland trail construction, but those with experience may learn a few things, too.

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Types of Wetlands

Wetland managers and specialists recognize 30 or more different types of wetlands. From a trail construction viewpoint, there are only six types of wetlands, perhaps seven. The basic differences in construction techniques for wetland trails depend greatly on the geologic, hydrologic, and vegetative factors influencing the site and, to a degree, on the wildlife species that live there.

Local indicator plants can help identify whether a site may be a wetland. Test holes and rod soundings can help determine the capability of the soil to support a trail. By studying the soil, the wildlife, and the subsurface water at the site, you can select the appropriate trail layout and construction techniques.

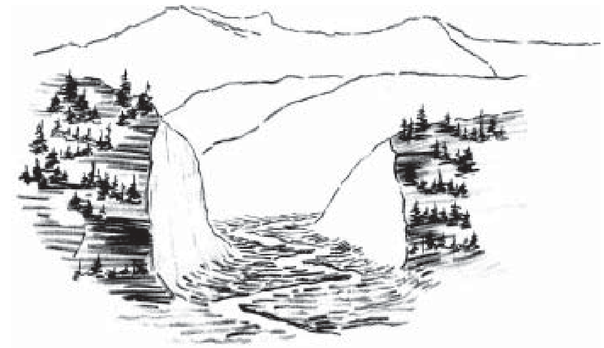


Figure 1—Glacial soils can be expected in U-shaped valleys typical of areas shaped by glaciers.

Wetlands Formed by Glacial Action

Generally, trails are easiest to construct in wetlands formed by glacial action. As a glacier melts, sand, gravel, boulders, and occasional blocks of ice are deposited in a narrow area in a mountain valley. The melting glacier creates a large creek or river that drains the valley. During spring runoff, adjacent wetlands may be underwater, but the ground will still be solid. Although you may be working in standing water, you will not sink in the soil. As the wetland dries out, the surface may be dry and solid. However, water will be just a few inches to a few feet below the surface. During the dry season, the level of the groundwater will normally drop, but it will fluctuate depending on upstream runoff.

Look for this site condition in northern areas that were glaciated during the Ice Age, or in U-shaped mountain valleys. Such valleys indicate previous glaciation (figure 1). To avoid being misled, dig a 4-foot-deep test hole to see whether characteristic sand and gravel are present.

Occasionally, small deep pockets of organic silt and clay are found within wetlands of glacial origin. When these occur near a river or creek, the soil mixture becomes saturated with groundwater and is extremely fluid. These pockets are rare, usually easily visible, and should be avoided. They can be extremely treacherous, especially if covered with a thin layer of ice or snow. One such pocket encountered on a trail project in the Rocky Mountains was 10 feet long, 8 feet wide, and more than 4 feet deep.

Wetlands With Organic Silt and Clay Soils

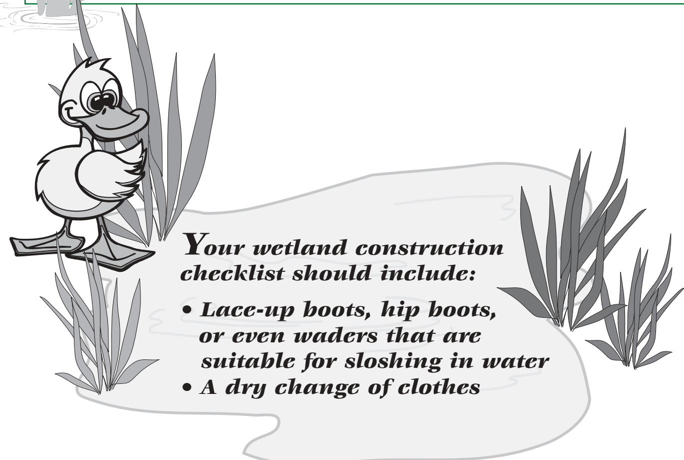
This type of wetland may be the most common. A test hole will indicate that the soil is not sand or gravel, but silt or clay—soils with fine particles. The silt and clay in most wetlands of this type are from organic materials such as leaves, bark, and wood. The terrain traps runoff and the soil particles hold this water, making the area soft underfoot.

Silt and Clay Soils With Some Water

Anyone building a trail through this type of wetland will find that footprints quickly fill with water. Hikers may sink up to their ankles in the unstable soil.

Silt and Clay Soils With Considerable Water

This type of wetland is similar to the one described above. A test hole will indicate that the soil consists of the same silt or clay material; however, it has considerably more water mixed with it. Work is difficult when you immediately sink to your knees or even to your waist.



A test hole should be as deep as possible. Due to the excessively wet soil, the sides of the hole will continually slough off. It may be impossible to dig deeper than 12 to 18 inches. In that case, rod soundings can help determine subsurface conditions.

Rod soundings are not too difficult to perform or to interpret. A 6- to 8-foot-long steel rod is driven into the ground with a sledge hammer. If the rod hits something solid, it will stop, or slow considerably. The rod may have reached a strata of rock or firm soil that will support construction, or it may have struck a root or an isolated boulder, a misleading indication of overall conditions. Take additional soundings nearby to determine the overall conditions.

An inexpensive and easily portable rod can be made from 2-foot lengths of galvanized, ½-inch diameter pipe. Screw a cap onto one end of one pipe section and screw a coupling onto the other end. Continue with 2-foot sections until at least 6 feet of pipe is assembled. Screw a T connection onto the upper end of the rod so that a ½-inch-diameter steel bar can be passed through the T for leverage in case the rod gets stuck in the ground. Tap the T with a hammer. (figure 2). The rod can be made as long as necessary. Usually 6 or 8 feet of rod is enough to determine whether a soil problem exists.

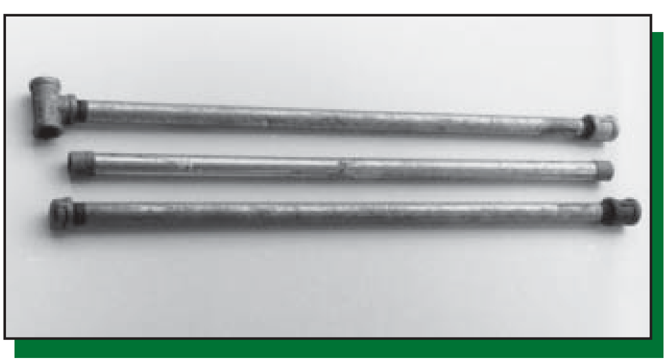


Figure 2—This sounding rod is inexpensive and easy to carry.

River Deposits and Deltas

Soil deposited along rivers and in their deltas may include inorganic clay and an extremely high percentage of water. Walking in this type of wetland is almost impossible. This type of wetland is found along the Missouri River and in the Mississippi River delta, and should be expected along other large rivers.

Floating Wetlands—Trembling Earth or Quaking Bog

Another type of wetland is the result of water-tolerant sedge and sphagnum moss invading lakes. Basically, these wetlands are areas of land floating on water or water-saturated peat. Over the years leaves, needles, twigs, and seeds are carried into a wetland or lake by wind and runoff, eventually forming a layer of organic soil. In areas where the soil and water are extremely acidic, the high volume and acidity of the water keeps organic matter from rotting. As this soil layer builds, the seeds of less water-tolerant plants will begin to grow. After many years a miniature forest of slow-growing, stunted trees will be found on the site. Expect plants such as sedges, sphagnum moss, pitcher plant, cranberry, blueberry, and Labrador tea. Tree species that will tolerate this site condition are alders, balsam fir, black spruce, tamarack, willows, and baldcypress.

This soil will support little foot traffic. Often the ground will compress with weight and quake slightly underfoot. At the extreme, the ground will undulate as it would if someone was walking on a mattress. In the Okefenokee Swamp, this type of wetland is referred to as “trembling earth.” In the Adirondack Mountains and Canada, a similar site is called a “quaking bog.” A test hole may show a thin layer of organic soil, perhaps 1 foot thick. Below it will be a layer of sphagnum moss and peat. Rod soundings in these layers will meet little resistance. When the rod is hit with a 4-pound sledge hammer, people standing 2 to 5 feet away may feel the shock through the ground.

Wetlands on Mountains

Carrs

In mountainous areas, wet trail problems sometimes show up only after the trail has experienced heavy use. The terrain may slope, perhaps by as much as 10 to 20 percent. Problems become evident only when trail traffic wears through a thin layer of soil and exposes a wet, fluid soil that may be 1 to 3 feet thick. Trail crews often refer to these sites as carrs.

If test holes and rod soundings had been taken before construction, they would have revealed this thin layer of soil on top of fluid soil. The fluid layer may be so wet that it would have been impossible to dig a test hole without the hole's side walls continually caving in. Once the fluid layer is reached, the weight of the rod can cause it to sink 1 to 2 feet without being hit by a hammer. Leaning on the rod might cause it to sink 2 to 3 feet. The rod should be hammered until firm soil is reached or the rod has penetrated 8 feet of soil.

Carrs can often be identified by indicator plants. River birch, shrubby willows, and alders growing on what appears to be solid ground should alert a trail designer to the potential problem (figure 3) and the need for soil testing.

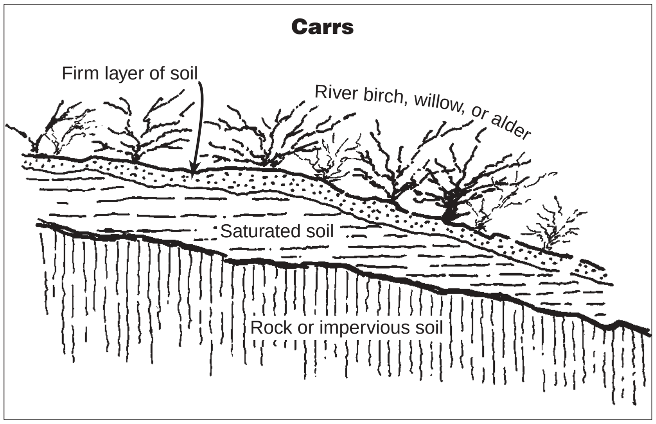


Figure 3—Carrs are characterized by a captive layer of saturated soil just under the surface that is sandwiched between two impervious layers.

Seepage

Some mountain wetlands are caused by subsurface water that seeps to the surface from a perched water table. A perched water table occurs where dense rock or an impervious soil layer is within inches to a few feet below the ground. Precipitation that would normally percolate deep into the ground is trapped near the surface and follows the slope of the impervious material downhill. This condition is common during the spring in high mountainous areas. In the dry season, the surface of the ground may be dry, but water will be only a short distance below. A trail designed and built in the dry season may be unsuitable during the wet season (figure 4).

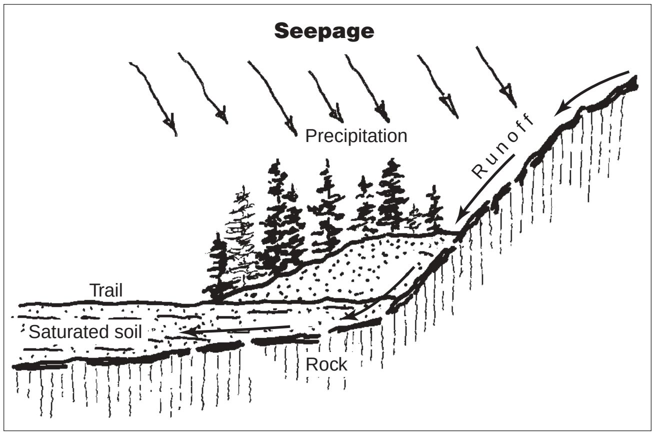


Figure 4—Seepage is sometimes caused by precipitation held in perched water tables.

Another more obvious condition occurs near limestone cliffs. Limestone covers millions of square miles of the Earth's surface, and some limestones are extremely porous. Water will percolate deeply through certain types of limestone. Other types of limestone may be highly fractured, permitting water to penetrate. Water will seep out of the exposed faces (figure 5). This condition also occurs in sandstone formations.

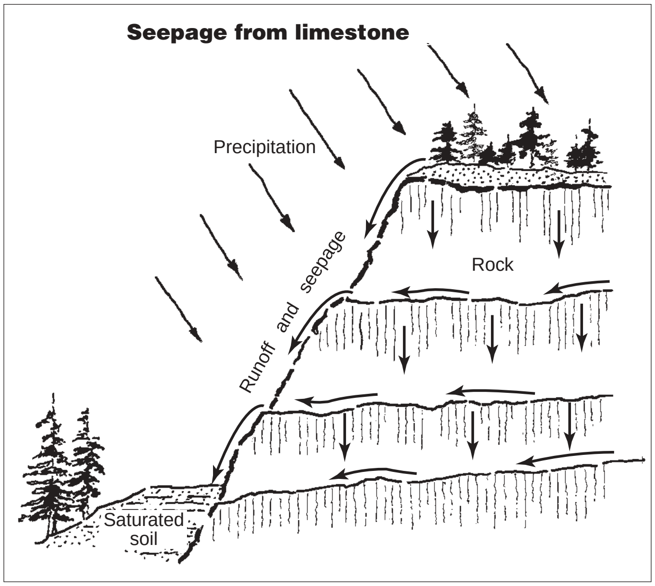


Figure 5—Limestone formations are very porous. Water will percolate through the limestone and seep out of exposed faces and cutslopes.

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Spruce Bogs

The spruce bog is a forest type found in the northern United States and throughout Canada and Alaska. The forest often consists of pure stands of black spruce, a slow-growing tree that survives in dense shade where the water table is high. Walking through a mature stand of these trees is a unique experience. The trees may be 6 to 12 inches in diameter, 25 to 40 feet tall, 15 to 40 feet apart, and 200 years old. Because they can withstand shade, the trees are often densely branched to the ground.

In spruce bogs, roots spread on the surface, presenting a problem for trail construction. The roots may be 15 to 20 feet long and as big around as the tree. Large tree roots on one side of the trail spread out and cross into the root system of trees on the opposite side of the trail. Cutting the roots for normal trail construction would leave roots on either side of the trail and unbalance the trees' support. Hikers may trip over the roots if they are left in place. The surface soil is organic and breaks down quickly into ruts and mudholes. Hikers detour around these spots, creating a braided trail with two, three, or four alternative routes.

Muskeg

Muskeg refers to an area covered with sphagnum mosses and tufts of sedges. Muskeg is very common in Southeast Alaska, where all relatively open peat bogs with sphagnum mosses or sedges are called muskeg. The following information about muskeg is from the *Alaska Region Trails Construction and Maintenance Guide* (1991).

Soils in Southeast Alaska maintain a thick, living, organic surface mat, a high percentage of iron oxides, and are often saturated with water. The soil structure breaks down readily under stress or disturbance.

Once the protective mantle and root layer are destroyed, the soil readily turns into water-muck. In some disturbed muskeg soils, there seems to be no limit to how far a person could sink. A site can go from solid footing to knee-deep muck after the trail crew makes just a few trips back and forth.

The volume of traffic these highly organic soils can support is directly related to the network of roots that exist in the soil. This network of roots strengthens the soil just as reinforcing bars strengthen concrete.

Wetlands With Wildlife That Bite Back

The last type of wetland has more to do with hydrology, climate, and wildlife than geology. Sites in the southeastern United States and tropical regions support species of wildlife that look upon man as prey. Building a normal wetland trail in these areas may be hazardous to the crew building the trail and to hikers unfamiliar with the potential dangers posed by local wildlife.

Alligators are often found in wetlands in the southern United States. Normally, alligators are not a problem to adult humans, but they may take an interest in a visitor's dog or small child. Little can be done to permanently keep them off the trail. Alligators may find a way through sturdy barrier fences that are improperly maintained, but may have a harder time finding their way off the fenced trail.

A loop trail should be considered in such areas. The loop trail provides the visitor with a route for hightailing it back to the trailhead, no matter where the alligator is encountered.

If alligators are the primary attraction for an interpretive trail, consider constructing an overlook. An overlook separates visitors from alligators and is an alternative to building a trail into the alligators' territory. In open areas, an overlook may be an effective way to see alligators. In areas with trees or dense brush, an overlook may not be worth the effort or expense. Guided boat trips might be another option for heavily-used locations.

Wetland trails in northern regions have their own potential wildlife challenges. Moose have a fondness for wetlands. Although usually docile, moose can be dangerous during some seasons. In the spring a cow moose is protective of her young. In the fall rutting season, a bull moose can be cantankerous and unpredictable. Moose have been known to attack people with no provocation and to follow wetland trails, including those with a wooden surface. Wetland trails in these areas might be designed with few abrupt curves and sight distances of at least 75 to 100 feet.

In the fall bull moose will demolish typical interpretive signs. One way to reduce sign damage is to use a vertical format for signs and place each sign on a single wide post (figure 6).

Wetlands with beaver, or where there is a possibility of beaver activity, pose different potential problems. Beavers are a natural draw for interpretive trails, but they might chew through wooden piles used to support the wooden deck of a trail. More importantly, they may change the water level of a wetland. A dam built upstream may reduce the flow of water into the wetland and reduce visitor enjoyment. A dam built downstream may raise the water level above the trail. Beavers may also plug culverts, weirs, and overflow structures. The level of the trail should be set higher to allow for higher water. A wetland trail that has been submerged because of beaver activity will require maintenance or reconstruction.

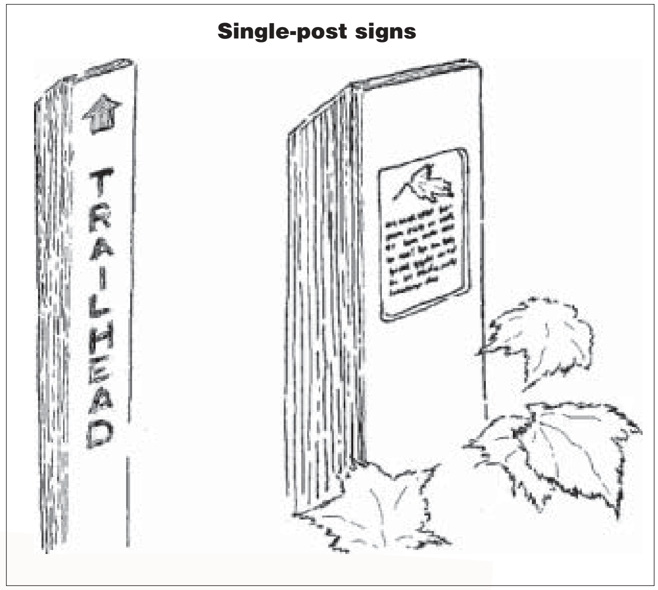
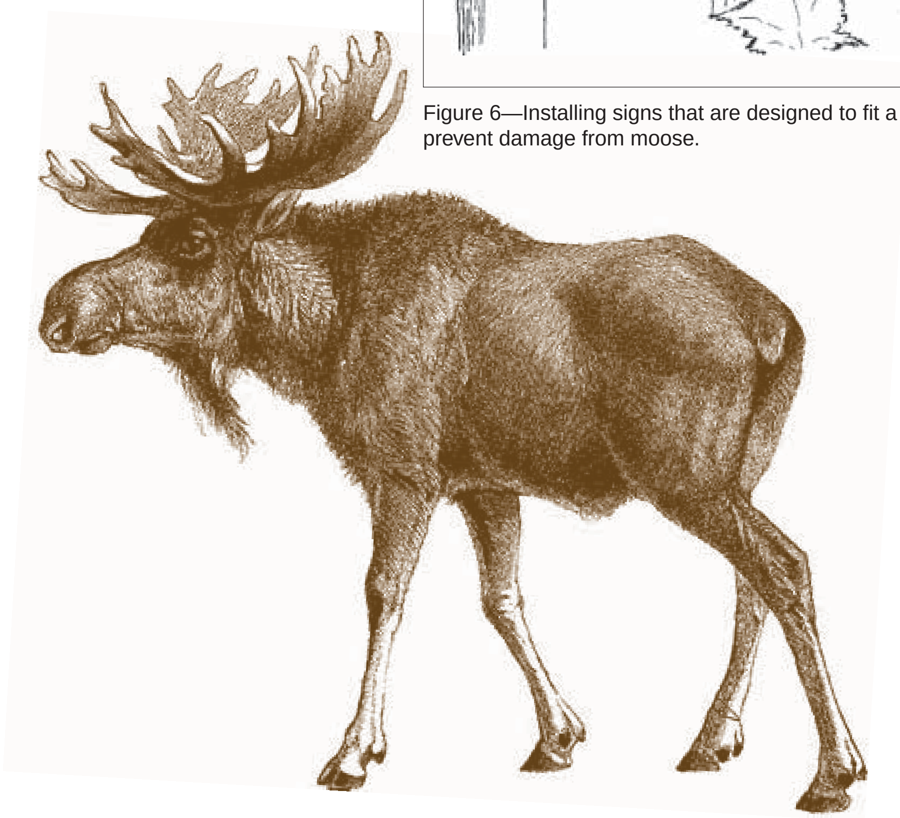


Figure 6—Installing signs that are designed to fit a single post helps prevent damage from moose.



Environmental and Accessibility Compliance

National Environmental Policy Act and Other Federal Laws

Laws, regulations, and management practices affect trail construction activities. Congress passed the National Environmental Policy Act (NEPA) in 1969. The purpose of this act is to ensure that Federal agencies consider the potential adverse effects their activities may have on the environment. The preservation of natural resources is the primary intent of this act, although the act covers cultural resources as well. The National Historic Preservation Act (NHPA) covers cultural resources. The Endangered Species Act (ESA) protects rare, threatened, and endangered plants and animals.

Trail construction on Federal lands, or lands where Federal funds are involved, must conform to these and other laws. Proposed trail routes should be walked by specialists knowledgeable about rare and endangered species of plants and animals. To avoid disturbing important cultural sites, archeologists and historians should be invited to participate. At some locations, cave specialists or fossil specialists will also be important. Trail planning needs to be coordinated with the land management agency that has jurisdiction over the trail.

Each U.S. Department of Agriculture, Forest Service jurisdiction must complete a formal environmental analysis before trail construction or major reconstruction. The process may be simple or complex, depending on the nature of the project and its affected environment. Checking with the District NEPA coordinator is a good first step. Other agencies will have similar review processes. Early in the planning stage, determine the regulations that govern development in the area being considered for construction. Where many agencies have jurisdiction, the agency with the most stringent regulations usually governs.

When Federal funds are not involved, professional ethics on the part of trail personnel suggests voluntary compliance with the intent of the NEPA and NHPA regulations.

The U.S. Army Corps of Engineers

The U.S. Army Corps of Engineers governs construction in navigable waterways and wetland areas of the United States. The agency's primary concern in wetland areas is to limit the volume of fill and avoid filling that would interfere with normal runoff entering the wetland. For a wetland trail the procedure generally involves a letter to the local district headquarters, perhaps a site visit by a Corps representative, and the issuance of a Corps 402 or 404 permit. Generally, complying with Corps requirements also results in construction that needs minimal maintenance.

State and Local Agencies

Many States have enacted regulations controlling wetland development, including trails. More States can be expected to do the same. Some counties and municipalities have their own wetland regulations. More and more trail projects cross agency and property boundaries, so Federal project managers need to be aware of other laws and regulations that might apply.

Occasionally, large areas have been established with uniform regulations applying to many towns and counties. The Adirondack Park Agency is a good example. This agency's regulations apply to 6 million acres of New York State's Adirondack Mountains. Included are all or parts of 12 counties and more than 100 towns and villages. Roughly 45 percent of the land is owned by the State; the rest is privately owned.

Accessible Trails

Trails need to be accessible to people with differing physical abilities. All trails do not have to be accessible to all people, but accessibility is to be considered for new trail construction and major reconstruction. It is a legal requirement to do so, under Section 504 of the Rehabilitation Act of 1973. It also makes sense, especially when there may be spectacular scenery or an opportunity to view wildlife. The USDA Forest Service policy is to follow the U.S. Access Board's draft guidelines for trails accessibility evaluation and construction (if the trail meets the evaluation criteria). These guidelines are available at *http://www.access-board.gov/outdoor/outdoor-rec-rpt.htm.*

Field Work

Turned Around

A legendary Maine guide, so the story goes, insisted that he had never been lost, but he admitted to having been "turned around real good once—for 3 days."

A wetland on an overcast day can easily provide an opportunity to get "turned around real good." Wetland terrain is often featureless. There are no hills, ridges, or rock outcrops, and no obvious slopes. Vegetation is often uniform. If the vegetation is dense and at least 6 feet high, everything looks the same. The problem worsens with fog, rain, or falling snow. Maps and even aerial photographs are useless. There may be no real danger of getting lost. However, it is frustrating and time consuming to lay out a route in the wrong direction or to learn that you are not where you thought you were.

In this situation, a compass is essential. Start using the compass ***before*** entering the wetland and ***before*** getting turned around. Bring vinyl flagging ribbon and a good sighting compass to the wetland on the first day. Hand-held global positioning systems (GPS) are another way you can keep track of your location (figure 7).

Figure 7—Knowing how to use a compass or GPS unit will help you locate the trail.

Sometimes the terrain and vegetation are so uniform you have to mark the general area that the trail will traverse. Using the compass and the vinyl ribbon, flag a straight line route on one particular compass bearing or azimuth. Tie the ribbon at shoulder to eye level. When standing at one ribbon, you should be able to see the next one (figure 8).

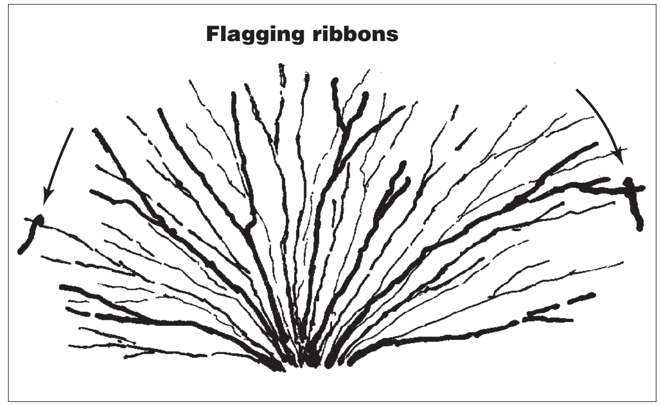


Figure 8—Dense, spreading shrubby plants such as willow and alder may require two flagging ribbons, one on each side of the plant.

Flag the outer perimeters of the general area wherever they are not obvious. Use different-colored ribbons as needed to help you find your vehicle at the end of the day. Not that *you* are likely to get turned around, of course.

Trail Layout

Reconnaissance

Reconnaissance (recon) involves walking over the area the trail will traverse and finding the places where the trail must go and the places you would like it to go. For example, there may be only one location where the trail can enter the wetland with minimal construction. This becomes a construction control point. There may be just one or two places where it is feasible to cross a small stream. These become construction control points. One of these points will probably be incorporated in the final route.

What about a location that provides a distant view? This becomes an esthetic control point. A small island in the wetland supports a variety of plant life that is of interpretive value. The island becomes another control point. A view of a sewer plant on the other side of the wetland is something to avoid. That location becomes a negative control point.

Preliminary Route (P-Line)

The trail must be laid out on the ground. The objective is to tie the control points together in a reasonable route, somewhat like connecting the dots, but on a much larger scale. This is normally done with vinyl flagging ribbon.