3 | Managing Earthworks Under Forest Cover

Introduction

Earthworks under forest cover represent a typical condition throughout vhe battlefield parks. This condition results from an area's release from active management, which allows natural plant succession to occur. As noted in the history section, earthworks at the time of construction were in open situations that allowed for a clear field of fire, even if that meant the soldiers cut down the forest themselves. Following the war, earthworks were either kept open with the resumption of agricultural use, or reverted to forest because the land was undesirable for development. Even after earthworks were collected into battlefield parks, earthworks that were not considered primary interpretive features, were released from active management and woodlands allowed to return. Existing earthworks under forest cover are comprised of second-generation stands of trees dating to the area's release.

Ecological Processes

Before discussing management tools and techniques for earthworks under forest cover, it is important to have a basic understanding of forest ecology. Ecology is the field of study that relates to the interaction of living organisms with their biotic and abiotic environments. Forest ecology is simply a special case that includes forest environments. Numerous forest ecology textbooks are available that describe the full body of natural processes that occur in various forest ecosystems, however, two will be mentioned here because of their direct relationship to earthwork: forest succession and forest soil erosion.

Forest Succession

Forest succession is the process by which one plant community is replaced by another, over time (West and others 1981). When bare soil is abandoned, such as after plowing a field or constructing earthworks, the process of succession begins immediately. Seeds already present in the soil will germinate as soon as conditions permit. Wind-disseminated seeds dispersed over an area, will readily germinate. This first plant community generally consists of herbaceous plants, which add organic matter and nutrients to the surface soil. These plants increase the water-holding capacity of the soil, and generally increase the soil's productive potential. Woody shrubs and trees next invade the site, and gradually they shade out the shorter herbaceous plants. These trees are generally fast-growing and shade-intolerant. Over time, a litter layer builds to become the forest floor, which is one of the defining characteristics of an intact, functioning forest ecosystem. The shady, forest environment provides a site for trees and shrubs that germinate and grow in this condition. Over time, shade-tolerant trees will eventually occupy the overstory canopy, and create a climax forest condition. Usually, however, continued natural or man-caused disturbance prohibits a climax forest from developing or persisting for very long.

Figure 3.1. Field created to establish an authentic historical scene at Fredericksburg National Military Park. Forest succession is rapidly progressing with yellow-poplar, sweetgum, and other fast-growing tree species invading the site.

It is important for park managers to understand this natural process of succession, and the plant species that are most common to the various stages. Any vegetation management done in the forest is really an attempt to manipulate this process of succession in some way. Establishing and maintaining a field, for example, is a direct attempt to keep an early successional stage, or sere, in place (Figure 3.1). It cannot be done without a continued investment of time and money, because the natural process in the Eastern Woodlands is to replace the herbaceous vegetation with taller woody shrubs and trees. The stronger the tendency for succession to proceed, the more time and money must be spent on manipulations. For example, attempting to maintain a monoculture of any species, be it grass, shrub, or tree, is in direct conflict with natural succession, and can only be achieved with great time and expense. Manipulating forest vegetation is something foresters have been doing for a hundred years. Success is measured by working with nature as much as possible to achieve the desired condition at the least expense.

Forest Soil Erosion

Like succession, forest soil erosion is also a natural process. Soil erosion will always occur, however, in undisturbed forest ecosystems it is minimal. The U.S. Forest Service estimates that erosion rates in undisturbed eastern deciduous forests are 0.05 to 0.10 tons/ac/yr (Patric 1976). However, erosion rates on agricultural lands are typically 3 to 5 tons/ac/yr.

Erosion is a two step process. In the first step soil particles are detached, usually from the impact of falling raindrops. In the second step the soil particles are transported, either to a lower slope position or to a stream channel, where they are deposited as sediment. To halt or slow erosion, one or both of these steps must be interrupted. This can be done in a variety of ways, the most common is to maintain a cover crop over the bare soil. The canopy and stalks of the plants disrupt the impact of falling raindrops, and the roots tend to hold the soil in place, preventing transport. Obviously, the more complete the plant cover, the more effective the erosion control. Establishing plant cover is the most common soil erosion control method on disturbed lands be they agricultural fields, roadbank cuts, or earthworks.

There are, however, some very dramatic differences between erosion potential on open bare land and in a forest environment. In a fully-stocked forest the soil surface is covered with a built-in mulch blanket called the forest floor. Also, the multi-storied canopy common in most eastern deciduous forests greatly reduces the impact of falling raindrops. Separation and transport of soil particles are greatly hampered in this condition, and thus erosion from undisturbed forests is nil. Where the forest is relatively undisturbed, stream sediment comes from the cut banks of the stream itself, not from eroded soil in the watershed.

It is very important for park managers to understand this unique feature of erosion in the forest. By far the most critical element to arresting erosion is the forest floor. Soil erosion rates in agriculture are commonly estimated using the Universal Soil Loss Equation (USLE) developed by the U.S. Department of Agriculture. The USLE has been modified for use on forest lands by the inclusion of nine sub-factors that collectively account for the many differences between agricultural and forest systems (Dissmeyer and Foster 1981, 1984). One of the most important sub-factors is the presence of an intact forest floor. In fact, if an intact forest floor is present— potential soil erosion is zero! Therefore, the most critical factor to reducing erosion under forest cover is maintaining the integrity of the forest floor. Even if the entire forest overstory and understory is removed, erosion will still be zero as long as the forest floor remains intact. Of course, it is the overstory that keeps the forest floor replenished with litter each year, so the forest's complete removal hardly makes sense. However, controlling erosion on earthworks in the forest is largely a matter of managing the forest floor, rather than manipulating vegetation. The most important consideration is maintaining enough forest cover so that the forest floor does not become diminished over time. Maintaining a fully-stocked stand condition will generally insure this.

Overall, forest cover represents the safest, most natural, most effective, and most cost-efficient means of protecting earthworks (Helm and Johnson 1995). In general, earthworks under forest cover are well-preserved and protected, with some exceptions. Occasionally the forest floor is diminished because of disturbances like hiking trails and excessive bicycle use (Figure 3.2). While overstory forest cover will slow down the impact of falling rain (the first step in the erosion process), the lack of a forest floor will allow the second step, transport of soil particles, to occur unimpeded. Under heavy storm conditions this will undoubtedly result in serious erosion. Other disturbances like ground hog dens and tree tips are also a problem, though not on a wide scale. With these exceptions, most park natural resource managers agree that most earthworks should remain under forest cover for greatest long term protection.

Figure 3.2. Earthwork under forest cover at Yorktown Unit of Colonial National Historical Park. Forest floor has been removed due to excessive bicycle use, creating ideal conditions for erosion and subsequent degradation.

FOREST COVER CONDITIONS

With earthwork management there are really two objectives to achieve, and at times they may conflict. The first is to preserve the integrity of the earthworks themselves, the second is to display the earthworks in an historically accurate setting. The best strategy for preservation may not be the best for display, and vice versa. Earthworks in an historically accurate setting means, for most situations, cleared earthworks and that is covered in the preceding chapter. Therefore, the following discussion will only deal with earthworks in two different conditions: 1) full canopy and 2) partial canopy.

Earthworks Under Full Canopy

A full canopy often represents the most cost efficient condition for earthworks because it requires almost no maintenance. It is ironic that while representing the least effort a park can afford, a full forest canopy also represents the highest level of protection. With limited budgets, this condition may be the only or, at least, the default strategy available to parks. Because earthworks under continuous forest cover occur most often in out-lying areas of the park, they may for that reason be considered as having a low interpretive value (Figure 3.3). Overall, most earthworks in a given park are likely to fall in this category. Suggested management practices for these earthworks include the following:

1. identify and map the earthworks;
2. inventory the area for current condition and hazard trees;
3. remove hazard trees as budget permits;
4. monitor the earthworks biennially.

Figure 3.3. Protected earthwork on Main Unit of Petersburg National Battlefield. Forest canopy is closed and forest floor is intact, providing ideal protection. Erosion is nonexistent.

Over time, there should be a commitment to removing large trees from the earthworks themselves because of the potential for damage if they fall naturally. Obviously, the first trees to remove are those that are most hazardous because of disease or location. However, a long term goal should be to maintain a forest cover over the earthworks, with the largest trees being near but not one the earthworks.

Earthworks Under Partial Canopy

Where forested earthworks have intermediate interpretive value, either because they are situated where some significant event in the battle occurred, or they happen to be close to a road, or trail, it may be desirable for the park to pursue a partial canopy strategy. Preservation is still critical to these earthworks, but there is a dual objective of displaying them for visitor viewing (Figure 3.4). For these earthworks, the expense of clearing the forest is not warranted nor is establishing and maintaining early successional, herbaceous vegetation. However, these earthworks could be exposed for viewing, which entails removal of the woody understory. In many cases, only a section of earthworks should be opened up, which satisfies the interpretive objective without the expense of maintaining an open condition over a large area. For example, an earthwork may extend a half-mile along a trail, but it may only need the understory removed in a couple of 100 yard sections to satisfy the viewing public. The remainder of the earthwork line can remain in a protected condition.

Figure 3.4. Intermediately-managed earthworks at Richmond National Battlefield Park. Ground vegetation and forest floor provide protection, while understory removal opens up the earthworks for viewing.

For intermediately-managed earthworks the following management practices apply:

1. identify and map the earthworks;
2. inventory the area for current condition and hazard trees;
3. remove trees hazardous to visitors in the area;
4. remove all dead and downed logs on earthworks;
5. selectively thin earthworks trees that may become hazardous
6. selectively remove understory trees and shrubs
7. treat cut stumps that are prone to rootsprout with herbicides (optional);
8. cut understory annually or biennially;
9. monitor annually.

HAZARD TREE MANAGEMENT

There are two types of hazardous trees in parks—those that pose a threat to visitors or property and those that pose a threat to cultural resources such as earthworks. Clearly the human safety issues take precedent, and all attraction areas such as along trails, picnic grounds, parking lots, and near interpretative signs, should be checked annually. All hazardous trees and limbs should be removed. Likewise, hazardous trees near the park boundary that threaten neighbors and their property should also be removed. The NPS-Natural Resources Management Manual (NPS-77, pages 349-358) contains guidelines for inspection, classification, and rating of hazardous trees that pose a threat to visitors or property. What is missing, however, are specific descriptions of trees that may be hazardous to earthworks.

Assessing Potential Hazard Trees

The greatest concern with hazardous trees on earthworks is the threat of windthrow or tree uprooting, and the associated removal of soil from the earthwork in the form of a root ball (Figure 4.5). Tree uprooting is a natural process in forests throughout the eastern U.S. (Shaetzl and others, 1989a, 1989b). However, it is very difficult to predict whether or not a given tree will be uprooted. Many factors influence the process, including wind speed and direction; tree size, crown shape and position on a slope; soil depth and wetness; and tree rooting habit and presence of root pathogens. It is clear, however, that larger trees are more at risk than smaller trees, and shallow-rooted trees growing in wet soils with restricted rooting depth have a greater likelihood of being uprooted.

Figure 3.5. Tree blowdown and uprooting adjacent to an earthwork at the Yorktown Unit of the Colonial National Historical Park.

Generally, earthworks represent well-drained soil conditions without restrictive soil layers. However, based on root zone geography, it is possible to determine where on the earthworks's structure would trees be most weakly anchored and therefore more susceptible to being windthrown. If tree roots can grow in four cardinal directions in the horizontal dimension and one direction (down into the soil) in the vertical direction, then the most secure location would be in a flat area where roots can grow out and down freely. But earthworks consist of long mounds. Trees that are located on the nose slope, or end of an earthwork can send roots only in two directions, down and back into the earthwork. This area of the earthwork is at the greatest risk for tree fall damage. Trees growing on the top of the earthworks can send roots in three directions, down into the soil and out into the earthwork on either side. They are the second greatest risk. Finally, trees growing on the side slope of earthworks can send roots in four directions, down, or back into the earthwork, in three directions. These are the least susceptible.

Generally, trees develop windfirmness against the prevailing winds, but become especially susceptible to blow down when strong winds occur from the other directions. For example, assume the prevailing winds in an area are from the west. A storm out of the northeast with strong, gusty winds may cause more severe blow down, especially if the soil is wet.

Large trees with heavy crowns catch more wind and are much more susceptible to blow down (Shaetzl and others 1989a). While there is no magic measurement for the tree size, foresters have observed that tree seedlings, saplings, and poles rarely blow down and uproot. This is normally an affliction of "sawtimber" trees, which have a diameter at breast height (dbh) of 12 inches or greater. When identifying trees at risk of uprooting, 12 inches dbh may be considered a lower threshold.

Removal of Hazardous Trees

The simplest way of removing hazardous trees is to cut them with a chain saw, directionally-felling them away from earthworks. If earthworks are in isolated areas away from trails, the cut stems can simply remain in place to decompose. Where earthworks are near trails or interpretive zones, the cut stems should be removed. Cut stumps may be treated with a labeled herbicide to prevent resprouting of deciduous trees (this is unnecessary with coniferous trees, since they generally do not sprout from the stump). An option only in isolated areas where visitors rarely venture, is to girdle the hazardous trees rather than cutting them. Girdled trees die slowly over the growing season and, once dead, the crown begins to break up and fall down in pieces. This is cheaper and easier than cutting, and less obtrusive. The girdled trees also become attractive to wildlife. A couple of precautions are necessary:

1. girdling must be complete all around the tree, and must sever the vascular cambium and phloem tissue.
2. girdling coupled with a herbicide application insures tree death and also kills the roots, eliminating sprouting.
3. girdling is not a possibility in areas with regular visitation, because it effectively creates a tree that is hazardous to visitors.
4. girdling should not be used in areas where there is a large pine component in the overstory. Girdling creates stressed and dying trees that may be attractive to the southern pine beetle— a serious pest in southern pine forests.

Even under the best management scenario, some trees will blow down and uproot, breaking out sections of earthworks. Such trees should be cut off leaving a minimal stump. If cut soon after blowdown, the stump will occasionally spring back into place as soon as the tree is severed. Caution should be taken that no one is standing next to the root wad when it springs back into place. If the stump doesn't spring back, the stump can be grubbed out with hand tools and removed or left in place to decay over time. An attempt should be made to spread out the soil and smooth the surface, then cover all exposed soil with organic matter from the site. Chipped limbs would ideally suit ideally this purpose.

THINNING THE OVERSTORY IN EARTHWORKS AREAS

Thinning the overstory to achieve a partial canopy is a recommended management strategy. The first trees to remove are those hazardous to visitors and to the earthworks themselves. Additional thinning may be done, if desired, to improve visibility of the earthworks. It is important, however, to maintain a fully-stocked stand condition so that leaf litter buildup is heavy enough to replenish the forest floor. Also, under fully-stocked conditions light reaching through the canopy is reduced, which cuts down on understory growth. There are several ways to estimate stocking levels, but foresters typically use basal area. A rule of thumb is that in deciduous forests the lower limit of full stocking is around 60 square feet of basal area per acre, while in pine and pine-hardwood forests it is 80 square feet per acre. Basal area can be estimated quickly and easily using a 10 factor wedge prism. If removing all hazardous trees reduces the basal area below the recommended level, some of the hazardous trees should remain in place. When trees are thinned, the slash (branches and twigs) should be chipped and left on the site, or used to cover bare soil wherever it occurs.

Understory trees and shrubs should likewise be cut and chipped in areas with a partial canopy. Tree regeneration and the development of a shade-tolerant shrub layer is part of the natural succession process. Retarding that process is possible, but it will take continual effort. Brush cutting and weed whacking at least every other year will be necessary. As long as the forest floor remains intact, neither the understory shrubs and trees nor the ground vegetation play a significant role in arresting soil erosion. Removing this layer may, however, play a role in encouraging visitors from walking on the earthworks.