4 | Managing Earthworks In Open Conditions

Introduction

For the purposes of this handbook, an open condition is defined as a site where little or no canopy of trees exists on or near the earthworks and a native grass-dominated plant community is present. An open condition is selected when interpretation of the earthworks is of primary interest and/or the earthworks have historically been in an open condition. Because of the body of knowledge that is already available on turf grass management, parks that manage earthworks in a monoculture of turf grass are not addressed at length by this chapter.

Grass Community Ecology and Physiology

A grass-dominated ecosystem is not a stable plant community in the Eastern United States. In natural succession processes, meadows or grasslands develop during the early stages (years) of succession on bare, sunny sites. Left unmanaged, however, natural succession will continue and a mixed hardwood forest will result in most environments.

Like the prairies of the Midwest, in which grasses and herbs represent a climax community, the grass stage in the East is comprised of a diversity of species. It is a long-accepted precept that a certain amount of species diversity contributes to the efficiency and resiliency of natural ecosystems. In the heterogeneous environments that are characteristic of earthworks, there is particular value in having a variety of species. Greater numbers of species increase opportunities for adaptation to the variable microhabitats: tops of slopes that are characteristically drier than the bases of slopes; south- and west-facing slopes that are hotter and drier than north- and east-facing slopes; and soil textures and nutrient levels that may be highly variable. Hence, the establishment and management of an array of plant species with slightly different ranges of environmental tolerances increase the likelihood that there will be at least one species successfully colonizing in each of several different microhabitats.

In addition to understanding the importance of species composition, one must also understand the basic physiology and life cycle of several categories of grasses that are important to this project including: annual grasses; short-lived perennial grasses; and long-lived perennial grasses.

Annual grasses, such as the native Foxtail (*Setaria* sp.) germinate, grow to maturity, and produce seed in one growing season. Because of the seed's ability to colonize on bare soil, it is desirable to include these species in a seed mix for unvegetated sites. Although the annual grasses will fade as perennial grasses take hold, seeds will continue to germinate wherever they come into contact with bare soil.

Figure 4.1. A mixture of grasses dominated by Little Bluestem (Schizachyrium scoparium) and Purple Top (Tridens flavus) at Prospect Hill in Fredericksburg NMP.

Short-lived perennial grasses, such as Wild Rye (*Elymus virginicus*), are similar to the annual grasses in that they also tend to colonize well on bare soil, but short-lived perennials will gradually phase out as long-lived perennial species take hold and spread. What distinguishes perennial from annual grass species is the multi-year life span of the perennials. The stems of both short-lived and long-lived perennial grasses die back to the base each year in the Mid-Atlantic and Southeastern climatic zones, but in the basal part of the stem, there are a number of nodes or "growing tips" capable of producing new growth the following year. If permitted to grow to maturity, perennial grasses also produce seed that would be available for germination the following growing season.

In addition to life cycle, the different species of grasses also differ in their temperature needs for growth. Depending on these requirements, they are categorized either as "cool-season" or "warm-season" grasses. Cool-season grasses grow most actively in late fall and early spring, i.e., with a minimum daily temperature of 40° to 45°F. Cool-season grasses typically produce their seed by May or June, before going dormant for the summer. Warm-season grasses, on the other hand, start growth only when the minimum daily temperature reaches 60° to 65°F, which means they are dormant during late fall, winter, and early spring. Warm-season grasses bloom and typically set seed in late summer with seeds maturing by October.

One additional distinction between grasses relates to their growth form. There are species, such as little bluestem (Schizachyrium scoparium) that form "clumps" of stems from a central point. These clumps grow outward over time, and the growing tips tend to be mounded, i.e., higher in the center of the clump than at the edges. The clump-forming grasses, or bunch grasses, generally have bare earth surrounding each clump. There are other species that produce rhizomes that spread laterally, such as sideoats grama grass (Bouteloua curtipendula) and effectively form a dense sod without visible open soil between plants. For erosion-control purposes, the inclusion of some sod-forming species in a seed mix is important.

OPEN CONDITIONS MANAGEMENT

If an open condition that is dominated by native grasses is the proposed or existing setting for an earthworks site in the Eastern, United States—where succession to a mixed hardwood forest is the norm—some level of hands-on landscape management will be required to achieve that goal. Before deciding the most effective way to establish or perpetuate a grass-dominated condition, park managers must first understand the existing plant community and what tools and techniques are necessary to achieve a native grass community. The following statements describe three basic management scenarios:

1. ***Decelerate succession or stabilize the vegetation at a particular stage of succession.*** This scenario implies the existence of an acceptable grass-dominated cover on earthworks and the goal is to inhibit the establishment of trees and shrubs.

2. ***Accelerate succession in order to achieve greater native grass cover, or to advance to a later stage of succession.*** This scenario implies that a bare site is being revegetated with perennial grasses and herbs and there is the need to enhance that process.

3. ***Modify species composition.*** This scenario implies that native grasses and herbs are present but do not dominate because they are competing with other less desirable species (trees, shrubs, or invasive exotics). To achieve the grass-dominated condition, removal or suppression of selected species and/or the active reintroduction of native grasses and herbs, or the creation of conditions that releases existing native suppressed species is necessary.

Once an existing condition is understood in terms of one of these scenarios, the tools and techniques for achieving the goal of a grass-dominated open condition must be considered. There are various tools for achieving and maintaining an open site. The following is a discussion of three tools and associated techniques and how they might be applied in carrying out an open conditions scenario. The tools are: (1) mowing, (2) prescribed burning, and (3) herbicide treatment. The labor/cost associated with implementing any selected tool is an important factor to consider, and while not discussed in this chapter, costs associated with park case studies are included in Chapter 7, Technical Support Topic 8.

Mowing

Mowing is defined by mechanical grass cutting on a predetermined regime to achieve a particular strategy. Three characteristics of a mowing regime that can be manipulated to affect the species composition of a particular site over time are: (a) the frequency of mowing, (b) the date(s) of mowing, and (c) the height of mowing.

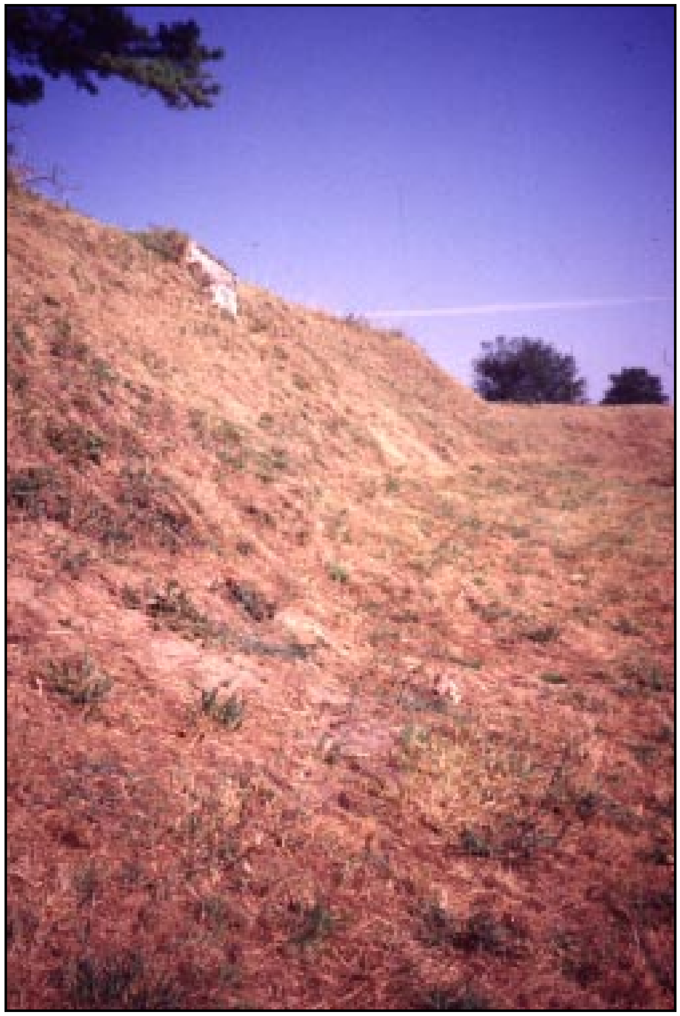
Frequency of Mowing

Mowing frequency is a relevant characteristic to consider because, as noted earlier, the erosion-controlling capability of grasses overall is based on the rainfall-interception capacity of the leaves combined with the soil-holding potential of the dense root system. Mowing has a direct effect on the amount of leaf surface area above ground and an indirect effect on the root development. In the USDA Agriculture Handbook No. 389, 100 Native Forage Grasses in 11 Southern States, authors Horace L. Leithead, Lewis L. Yarlett and Thomas Shiflet discuss the relationship of top removal to root development. They note that 50% of the leaf surface of grasses may be removed by grazing or mowing with no appreciable effect on root growth. If 70% of the leaf surface is removed, 50% of the roots stop growing for 17 days. If 90% of the top growth is removed, for example by mowing to a height of two inches, all root growth stops for a period of 17 days. Repeated removal of leaf surface has a cumulative effect of decreasing plant vigor and ultimately senescence (death) of the plant. Root development of most grass species is fibrous and dense and is, therefore, to be encouraged. Not only is this root network useful in holding soil in place, but the fine roots ultimately improve soil texture. If grass roots die, their decomposition improves the soil nutrient level, although the plants themselves, in most cases, would require replacement.

Dates of Mowing

Mowing dates have a pronounced effect on the growth of different grasses. Neither cool-season nor warm-season grasses are damaged by an early spring mowing, assuming the cut is higher than the bunch grasses' growing tips

Figure 4.2. Mowing too closely or at the wrong time of the year can lead to poor cverage as in this example from Colonial National Historic Park in Virginia. This can be especially problematic on slopes which are prone to drier conditions and vulnerable to erosion.



(approximately 4"-6"). Mowing at that time lays down an organic mulch in the form of grass clippings, which helps in erosion control. Such a mowing might be timed for February-March in the regions of this study (February in South Carolina, Tennessee, and Georgia, and March in Virginia, during most years). If there are desirable cool-season grasses at a site, the next logical mowing date is after those species have flowered and set seed (June, in most places). If, on the other hand, there are undesirable cool-season species present, they may be cut in April or May as a means of suppressing them. Sites that are covered predominantly by warm-season grasses should not be cut after early to mid-July, in order to permit full development of their leaves, flowering stalks, and the maturing of their seed (typically in October). If, for aesthetic or interpretive purposes, it is deemed that mowing of warm-season grasses must be performed after July 15, there should be an effort made to introduce sod-forming increaser species into such sites. For the health and longevity of the warm-season grasses in general, mowing height should be kept at five to six inches at a minimum.

Height of Mowing

Much of the effect of mowing height is covered by frequency of mowing: if the leaves of the plant are kept short, photosynthesis will not feed the roots. However, there is a differential response to mowing between bunch grasses and rhizomatous sod-forming species. Short mowing is more damaging to clump-forming grasses because mowing tends to gouge the higher centers of the clumps, which kills the growing tips. Weaver, in extensive prairie studies, noted that there is a tendency for bunch grasses to be decreasers under short mowing regimes, whereas rhizomatous sod-formers tend to be increasers under the same treatment (See Chapter 7, Technical Support Topic 7).

Mowing can also be an effective tool for the suppression of woody species in a grassland. Trees such as pine species; sweetgum, tulip poplar, and black cherry will be eliminated through once-a-year mowing. Mat-forming shrubs such as Japanese honeysuckle and blackberry, once established, are not as readily eliminated by mowing because of their ability to root along stems (or canes) that lie near the ground. Multiple cuttings during one year, however, have proven effective in preventing the spread of Japanese honeysuckle. An Ohio study cut honeysuckle on or about July 15 and September 15 and by doing so, prevented its spread (reported on by James E. Evans in Compendium on Exotic Species, published by the Natural Areas Association, 1992).

Prescribed Burning

Prescribed burning is a landscape management tool gaining in popularity, which uses fire to achieve predetermined objectives. Fire, as a natural phenomenon has been an integral part of many native plant communities including the Midwestern prairie and the Southeastern Longleaf Pine/ Wiregrass ecosystems. Early use of fire has a cultural tool includes use by Native Americans fire in pre-European settlement landscapes for agricultural, transportation, warfare and hunting purposes. Euro-American settlers often used fire to clear agricultural land, but as land-use patterns became increasingly more complex, naturally-occurring fires, which had once burned over large areas of land, were actively suppressed. In this country, the long-held view of fire only as a destructive force has in recent years been revised by ecological research. It has been proved that, not only is fire is an essential natural phenomenon to sustain certain plant communities, but fire has beneficial effects, especially in natural area management.

Earthworks covered by a mix of predominantly warm-season grasses could be effectively managed with prescribed burns. The burning process is beneficial to fire-tolerant plants in several ways. It returns nutrients to the soil in a usable form; it stimulates growth and seed production of many native warm-season grasses; and properly timed, it can suppress undesirable cool-season plant species, most notably, a number of woody species. If accomplished in early- to mid-spring, a prescribed burn facilitates an earlier warming-up of the soil than occurs on unburned areas because a higher rate of sunlight is absorbed on the exposed, charred earth. An additional benefit to burning is that an open condition can be accomplished without the impact of mowing machinery on the earthworks.

Prescribed burns could be conducted on many earthworks in open, non-canopied environments with a minimum of complication. A park's fire management plan can be modified to describe prescribed burns for natural and cultural sites. A prescribed burning plan locates firebreaks of ten feet or more in width, which at the time of the burn, are mowed to a height of two inches and wet down. Prescribed burning uses wind direction and slope to control the speed and heat of the burn. For example, burning against the wind and/or downslope will produce a slower-burning fire, which is a desirable attribute if a goal is to suppress Japanese honeysuckle or other woody species.

To date, park managers have made limited use of prescribed fire to manage earthworks vegetation. The one example in this study where prescribed fire is being used is at Fort Harrison, Richmond National Battlefield. As part of their approved fire management plan, burns were conducted at Fort Harrison in April of 1995 and April of 1996. Other park managers have noted that prescribed burns may not be a practical solution because of the NPS's self-imposed personnel requirements and restrictions as well as the restrictions that result from the urban/suburban environment that now surround most battlefield sites. In view of the fact that prescribed burns on many non-canopied, grass-covered earthworks sites could be controlled and managed with relative ease, it would seem appropriate for those parks to pursue fire management plans that address their management needs. Further, there is evidence that cooperating agencies such as the Virginia Fish and Game Department (for Virginia sites), local fire departments, and Nature Conservancy chapters would assist in fire management.

One disadvantage of burning the steep slopes of earthworks must be acknowledged: the removal of leaf litter, which potentially results in bare soil and the possibility of erosion in the first growing season after a burn. Vegetation sampling in the burned areas of Fort Harrison in August of 1995 found an average of 30% bare soil from the prescribed burn conducted in April of that year. To offset this negative effect, a thin mulching with oat or wheat straw, or native grass hay, could have been applied to the steep slopes after a burn. Because the application of mulch will offset the benefit of early soil warming, the potential for soil erosion should be weighed against stimulated seed germination.

Herbicide treatment

The NPS's Integrated Pest Management (IPM) program, as well as its policy of promoting sustainable landscape practices, suggests minimum application of herbicides for removal or suppression of invasive plant species. In some cases, however, when invasive species gain a foothold and are suppressing the development of a diverse native cover, herbicide application may be the only practical method of eradication. The selective and limited use of glyphosate herbicides is considered acceptable for eradication of plant species that cannot be controlled through a mowing or burning program. Blanket applications (i.e., spraying) of such substances should only be done when there is a solid stand of an undesirable species. More often, herbicides should be selectively applied with spot treatments, spraying specific small problem areas, or applying herbicide to individual plants with a wick applicator. A number of woody species, such as privet (*Ligustrum* sp.), autumn olive (*Elaeaganus umbellata*), and some honeysuckles have been effectively eliminated. An 80%-90% success rate results when herbicide is applied the growing season through the process of cutting, and then applying a solution of 10%-20% glyphosate in water onto freshly-cut stumps with a sponge-type paint applicator (See Chapter 7, Technical Support Topic 6 for more information on invasive species control).