# A Handbook

for

# Forest Vegetation Management

in

# ecreation and Historic Parks



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# A Handbook for Forest Vegetation Management in Recreation and Historic Parks

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# Introduction

Most recreational and historical parks have a significant portion of their land area in forest cover. Forest vegetation is natural, aesthetically pleasing, and forms a comfortable, shady environment for recreational and interpretive purposes (Figure 1). However, often the forest that nature provides does not meet all park objectives; therefore, some vegetation management practices are necessary. Maintaining healthy, vigorous forests that meet specific park objectives requires a consideration of the ecology of the species involved, and a pro-active management policy. Simply allowing "nature to take its course" may not be satisfactory.

This handbook provides information on general forest ecology for parks in the Southeastern United States, as well as management advice for achieving many objectives common to recreational and historical parks in the region. Maintaining healthy forests, dealing with exotic species, controlling turf and meadow areas, and creating screens and windbreaks are all common issues faced by many park managers. These and more are addressed in this handbook.

The information in this handbook draws heavily from published literature, the experience of the authors, and the suggestions of various reviewers and park managers. This handbook is generic; therefore, it may not conform to specific guidelines and regulations of all state and federal park agencies. For historical parks especially, the sections on earthwork preservation, historic scene restoration, and agricultural use areas will be useful.

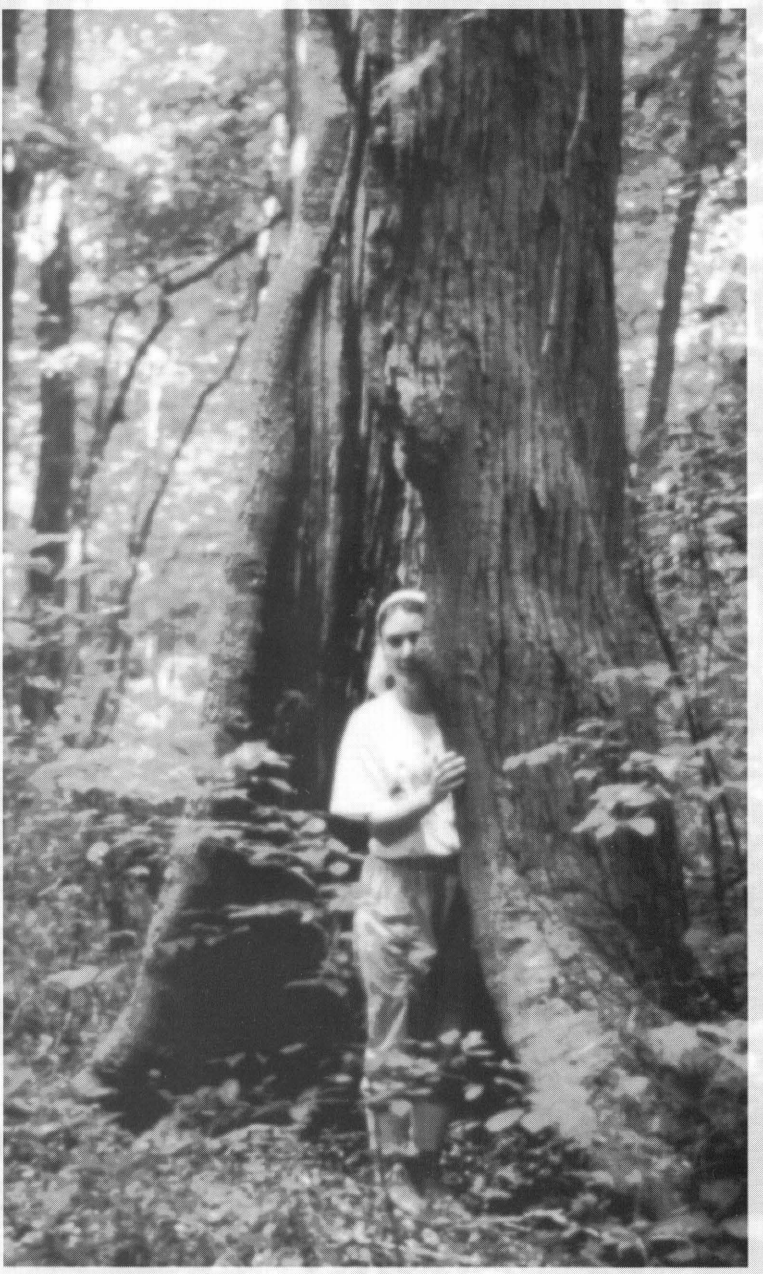


*Figure 1. Old growth tulip poplar provides a unique forest setting.*

# Management of Healthy Forests

A healthy forest can be defined as one with a majority of living trees that are part of a functioning forest ecosystem. The first step for managing healthy park forests is to become familiar with the existing forest in the park, by determining the species, size, density, age and health of the trees (Figure 2). Regular visits to notice recent disturbances due to natural or man-made forces and to gain an awareness of the "natural processes" that occur in forest ecosystems are critical to assessing the need for management practices. For example, forest succession is natural, causing changes in species composition and structure, and can be allowed to follow its natural course when this coincides with park objectives. Fire, insects, and disease, however, although "natural" and part of the dynamics that maintain certain forests, need to be carefully monitored and controlled in forests managed for most objectives other than wilderness or backcountry. In forests surrounded by urban development, these natural forest maintenance forces must often be continually monitored and carefully controlled or eliminated. The manager must also determine the objectives for the forest and park, determine whether human interaction is needed to reach the desired forest condition, and, when necessary, apply silvicultural activities and monitor the results.

In managing the forests of natural and historical parks, it should be recognized that dead or dying trees due to succession may be part of natural changes in healthy forest stands (Figure 3 on pages 8 and 9). Natural forest stands will always contain dead or dying trees as they move from pioneer to climax stages of succession and then regenerate themselves. The appearance of stands with dead trees should be investigated further. The dead trees may indicate serious insect or disease problems, or other unhealthy conditions. However, the dead trees may also merely indicate that the stand is transitional, with young trees and seedlings in the understory as evidence that the forest is still growing vigorously. Dead standing trees and logs on the ground are more than signs of death; they are sources of food and shelter for

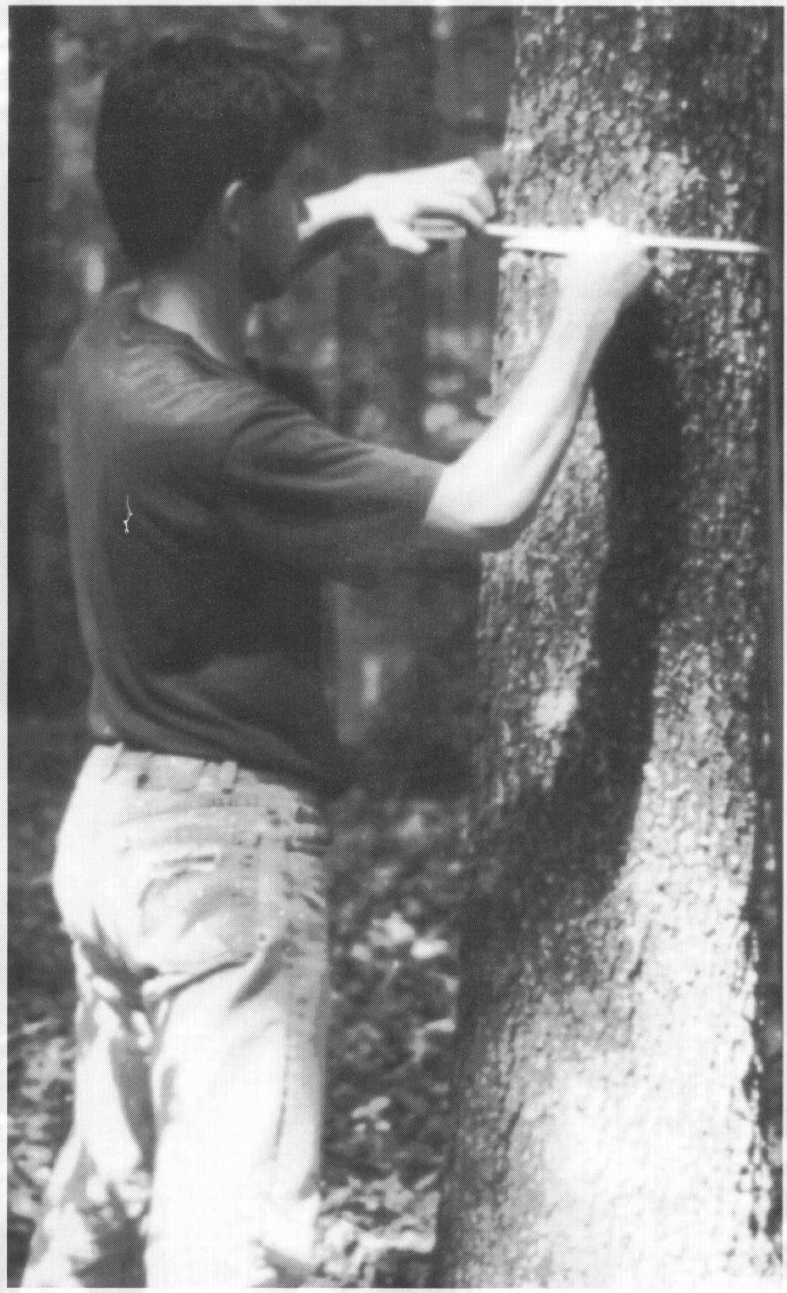


*Figure 2. An inventory is the first step in proper forest management.*

wildlife, numerous invertebrates, and countless species of microorganisms. They also hold nutrients for the young forest vegetation that are released as they decompose.

If the general objective is to maintain healthy park forests, the natural process of succession should be allowed to proceed without human interaction, except where other objectives, such as fuel hazard reduction, require additional maintenance activities. Insects and diseases that infest a stand, killing the dominant trees prematurely, are short-term disturbances that often simply move the stand towards its next stage of succession sooner. Natural disturbances such as these, plus windstorms, ice storms, and other events, are nature's way of cleaning, opening up and regenerating forest stands.

Some disturbances are beneficial and necessary for healthy forests. For example, southern pine stands regularly subjected to forest fires before fire control was practiced may have been more resistant to bark beetle attacks. When fire regularly occurred in the stands, it thinned out understory hardwoods and pines and promoted the healthiest pine trees. Past fire suppression in the south has resulted in denser pine stands with more potentially unhealthy individuals that are less able to resist beetle attacks today. Prescribed fire is now an excellent management tool for southern pine forests, and it should be considered for use in the parks when possible.

Where results of disturbances cannot be tolerated for reasons of public safety, visual appearance (dead trees can look unhealthy to visitors and may pose a direct hazard to people and structures), fuel buildup problems, or large-scale occurrences, they can be controlled by eliminating the disturbance. Spraying insects, cutting diseased trees, and putting out fires are common practices in intensely managed forests. Carefully planning activities and not proceeding with them until the consequences of today's actions on tomorrow's forest are known will promote healthy and vigorous forests for the future.

The continued existence and establishment of tree regeneration is key to a healthy future stand. Where forest cover is to remain "natural," succession and an undisturbed understory and forest floor should produce the next generation of overstory trees. In areas to be maintained as light forest cover, the regeneration of shade tolerant species should be selectively promoted and protected when understory thinning operations are undertaken. Since these areas typically cover small sites, the identification of individual trees as replacements of the current overstory is possible. In areas with thinned canopies of pines and hardwoods that are to be planted with tall native grasses and maintained with fire, trees will need to be planted to maintain light forest cover in the future. To continue to partially shade and diversify the landscape in these areas, the planting of pine species such as longleaf, shortleaf, and loblolly pine that will survive the possible maintenance burning of the tall grasses should be considered. Promoting a variety of southern pines in the historical parks will maintain species that may have historically been there, as well as provide

an enhanced degree of biological diversity.

Individual trees, whether they be old-growth specimen trees in the forest or landscape/shade trees near visitor areas, can be intensively maintained to insure good health, since these individuals are more valuable to the parks. Scattered old-growth trees are unique in their age and appearance, and in addition to inspecting them for insect and disease problems, care should be taken with any activities around them that might result in damage or increased stress. Specially planted shade or landscape trees and shrubs, such as around visitor centers and historic buildings, should be carefully selected to match the site and appropriately cared for. Intense care with young plants should take place to improve the chances of planting success. If old-growth specimen trees exist in the park, collecting seed from them and propagating seedlings for use in historically accurate landscaping is a worthwhile endeavor.

***Figure 3. Loblolly pine is an early successional species that eventually dies out and is replaced by deciduous species like oaks and hickories.***

# Identification and Removal of Non-Native Species

Due to the long history of human cultivation of plants from other continents on the lands of the eastern United States, it is not uncommon for some plants that grow in parks to be exotic, ie. species that were not native to the landscape before Europeans settled the east coast. Control of exotic species can be justified when they threaten to alter natural ecosystems; seriously restrict, prey on, or compete with native populations; cause a major scenic or aesthetic intrusion; or disrupt the integrity of an historic site.

Despite the potentially large number of exotic species found in some parks, there are actually only a few that are abundant enough to cause changes in the appearance and plant dynamics of park forests, fields, and historic sites. Some of the common species are Japanese honeysuckle, tree-of-heaven, royal paulownia, and kudzu. As an example, tree-of-heaven in the forest edges can block a visitor's view of native tree species and crowd out native edge plants, which are important to wildlife and part of a healthy forest habitat. The tendency of Japanese honeysuckle and kudzu to form continuous cover over the forest edge and forest floor, preventing the establishment and growth of native seedlings and herbs, is another example. The biology of these exotics is summarized in Appendix I.

Due to the relatively small land area of historical parks and the high amount of edge typical to their patchwork vegetation, control of exotics is usually only feasible for a few species and in small, highly used areas where intensive control efforts are cost-effective (Figure 4). Most exotic species are widespread in the southeastern U.S. and complete extermination of these species on park lands will be unlikely. Several exotic species should be considered unwelcome but permanent members of park forests, and these fall into two categories. First are those

*Figure 4. Most small parks have a large amount of forest edge, which creates ideal conditions for invasion by exotic species.*

that are less obvious to visitors and not very influential on the forest ecosystem, e.g. small herbaceous plants, such as money-wort. Second are those too difficult to eradicate without harming the environment more than they do, because of their numbers, location and nature, such as *Microsegium vimineum*, a short, soft grass found covering the forest floor in open bottomlands. Intermittent flooding and the extensive coverage of this species, and others that occur on wetland sites, make their control by mechanical or chemical means infeasible and undesirable.

Other exotics, such as tree-of-heaven and royal paulownia, can be controlled, if desired, depending on their abundance and rate of spread. Frequent monitoring will be necessary to insure complete removal due to their persistence and hardiness. Exotic species which spread rapidly, alter the landscape, and displace native plants, such as Japanese honeysuckle and kudzu, are the most destructive exotic species in park forests and warrant control in selected areas where economically feasible and physically possible.

Control of many exotic species is difficult because of their ability to sprout when damaged. Cutting tree stems and leaving root sys-

tems results in numerous sprouts where one stem once stood, and even pulling up smaller ones by the roots is ineffective when small pieces of root are left to regrow. Herbicides offer an effective control with some species, killing the whole plant including the roots. Some herbicides labeled for forestry use in the United States are listed in Table 1, along with woody exotic species that are susceptible to the specific herbicide. Japanese honeysuckle is effectively controlled by foliar applications of herbicide, since it has such a great percentage of foliage compared to stems and roots. On the other hand, tree-of-heaven is not completely controlled by herbicides, as their roots are so extensive that the chemical is not transported throughout the whole root system.

Cultural treatments such as cutting, mowing, or burning are alternative methods of controlling exotics. The small sites near visitor use areas suggested for exotic species control lend themselves to mechanical methods, which are more labor intensive than chemical applications. Cutting or mowing is an effective way to control tree-of-heaven if the treatments are persistently done until the root system has run out of reserves and can no longer sprout. Cutting may be necessary every few weeks, therefore these sites must be monitored frequently until the trees have died. Japanese honeysuckle is not tolerant of fire, and prescribed burning used to maintain warm season grasses can control it.

Exotic species control activities should be monitored and documented for future reference in other areas of the park, so that the effectiveness of various control measures can be determined. In general, the exotic species population should be mapped before treatment and monitored after treatment to determine effectiveness. For the purposes of many recreational and historical parks, with limited resources and a never-ending flow of plant materials into the small units by animals, birds, wind, and humans, control of exotic species where they interrupt the historic landscape and visitor interpretation is most important.

*Table 1. Forestry herbicides for foliar treatments and control of woody exotic species. Labels often change yearly. It is the user's responsibility to obtain and consult the most recent herbicide labels available. (Source: Miller and Mitchell 1990).*

| Herbicide Trade Name | Active Ingredient | Manufacturer | Species Controlled |
|---|---|---|---|
| Accord | Glyphosate | Monsanto | Honeysuckle<br>Kudzu<br>Multiflora Rose |
| Arsenal Applicator's Concentrate | Imazapyr | American Cyanamid | Honeysuckle<br>Kudzu<br>Multiflora Rose |
| Banvel 720 | Dicamba | Sandoz Crop Protection Corp. | Honeysuckle<br>Kudzu<br>Multiflora Rose |
| Oust | Sulfometuron methyl | DuPont | Honeysuckle<br>Kudzu |
| Roundup | Glyphosate | Monsanto | Honeysuckle<br>Kudzu |
| Tordon 101 Mixture | Picloram + 2,4-D amine | DowElanco | Tree-of-heaven<br>Honeysuckle<br>Kudzu |
| Velpar L | Hexazinone | DuPont | Honeysuckle |

# Maintenance of Turf and Meadows

The maintenance of turf-like areas for aesthetics and safety is common in most parks. Areas of rough grass (native and exotic grasses, weeds, and vines) are mowed almost weekly during the growing months. This heavy use of resources (manpower, time, and gasoline) is justified in heavily used areas, as it encourages visitors to use the area while protecting them from contact with ticks, chiggers, and poison ivy. However, mowing is also used to control woody vegetation and weeds within forts and on earthworks, and to keep roadsides from being overgrown with weeds (Figure 5). There are alternatives to intensively mowing all of these areas every 1-2 weeks. Eliminating intense mowing frees up labor and resources for other projects.

Mowing schedules, or the frequency of mowing, are usually a function of aesthetics or tradition. One alternative is to mow less frequently; approximately once a month is sufficient for most areas. Flowering weeds and grass growing at different rates in an area mowed monthly may look natural to some but neglected to others. Woody plants would still be easily controlled at this frequency, however. Problem plants, such as Japanese honeysuckle or poison ivy, could be controlled by selective woody plant herbicide treatments, which will kill them rather than prune and stimulate their growth as mowing does. Another alternative for the large areas where reduced mowing is proposed is to convert the open spaces to meadows.

The mowing of earthworks is a practice that is being phased out. The rough grass currently growing on the works is being replaced through planting of native warm season grass species such as big or little bluestem. These tall grass communities can be managed with prescribed fire, eliminating the physical disturbance of mowing and also indirectly controlling the spread of exotics such as Japanese honeysuckle. The conversion to native warm season grasses or other

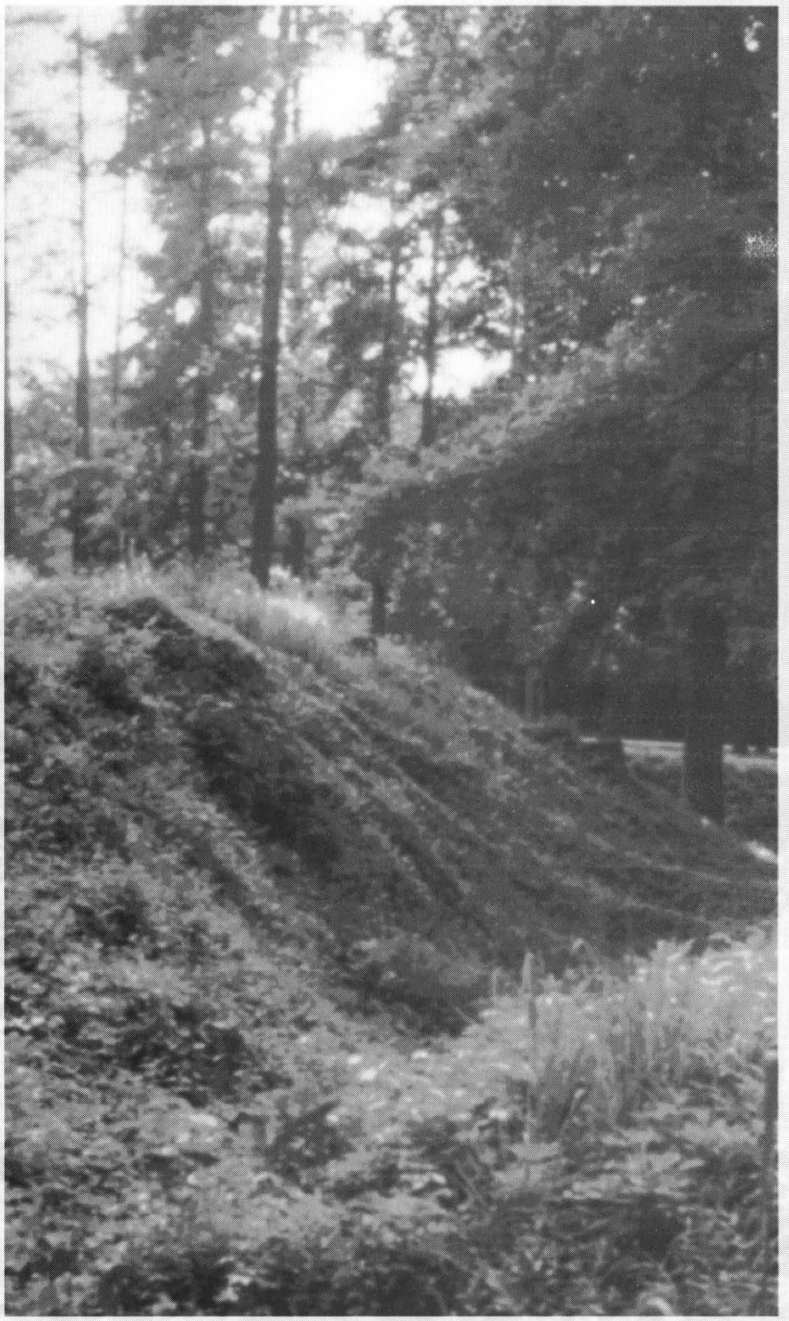


***Figure 5. Tall grasses and forbs provide protective cover for earthworks and other locations and do not require frequent mowings.***

native meadow species is a useful alternative for much of the open areas now mowed within parks. Warm season grasses were once more common in the Southeast, but their populations were reduced by plowing, overgrazing, and fire protection. Perennial grasses and flowers, annually maintained with prescribed burning or bush-hogging/mowing, add new plant communities to parks, increasing plant diversity. Birds, insects, and small mammals benefit from the additional undisturbed habitat, visitors would be able to observe new native plants growing and blooming, and the expense of maintenance would be considerably reduced after the meadows are established.

In large, open areas, prairie plants that benefit by fire could be established, and these areas could be annually burned. During burning, small buffer areas could be maintained to break up the blackened areas for aesthetic and erosion prevention reasons. Burning is not necessary for maintaining these prairie plants, however, so park fields near developments and roadsides, where burning is not an option, could also be planted with prairie species. Annual bush-hogging or mowing will control the invasive woody plants once the perennial species are well established.

The following are some general recommendations by Smith (1980) for establishing a meadow, or prairie, with warm season grasses and flowering herbs. A prairie is primarily a grassland, with 59 to 85 percent of the area covered by grasses.

## Planning

1. Select plant species that match the soil, topography and exposure of the site. The site should have 70 to 100 percent full sunlight. Sandy soil with good drainage is preferable. Prairie plants will tolerate a wide range of soil fertility and acidity. For suggestions of species for prairies see Table 2. Prepared seed mixes are also available from seed suppliers. Capel (1992) lists the best cultivars of the warm season grasses for Virginia. Before purchasing seeds or plants, discuss the species selection with the nursery to confirm that the variety to be planted matches the particular site and soils.

2. Select plant species to try for continuous color throughout the growing season, plan to plant species so they dominate small areas, then flow into another species' area, giving an unmanaged look.

3. On large areas, leave space for a firebreak.

## Site Preparation

1. Site preparation should begin in late summer, the year before establishment is to be done. This gives parts of two growing seasons to eliminate species that compete with prairie plants. The most persistent of these are the cool-season grasses.

2. The roots and rhizomes of cool-season grasses must be exposed to sun or frost to be killed. On large areas, plowing plus periodic cultivation with a spring-tooth harrow will work them to the surface and exposure. Herbicides are an alternative to disturbing the soil surface with a plow. Proper selection and timing of application should kill the undesirable plants and not harm the young prairie plants the following planting season. Where sod forms thick mats, it should be broken up to expose the soil before planting.

## Collecting Seed and Plants

1. There are nurseries that specialize in native perennial meadow plants. Purchasing seed from nearby sources is preferable, to improve the chances that the plants are adapted to the soil and climate. The costs involved will vary with the seed company and mixes purchased; sources should be contacted for estimated costs.

2. See Appendix II for sources of seed and young plants of prairie grasses and forbs.

*Table 2. Warm season grasses and perennial forbs for meadow plantings.*

## Warm Season Grasses

| Scientific Name | Common Name |
|---|---|
| *Andropogon gerardii* Vitman | Big Bluestem |
| *Andropogon scoparium* Michaux | Little Bluestem |
| *Andropogon virginicus L.* | Broom Sedge |
| *Bouteloua curtipendula* (Michaux) Torrey | Side-oats Grama |
| *Panicum virgatum L.* | Switch Grass |
| *Sorghastrum nutans (L.)* Nash. | Indian Grass |
| *Tripsacum dactyloides L.* | Eastern Gamma Grass |

## Forbs

| | |
|---|---|
| *Aquilegia canadensis L.* | Wild Columbine |
| *Asclepias incarnata L.* | Swamp Milkweed |
| *Asclepias tuberosa L.* | Butterfly-weed |
| *Aster pilosus Willd.* | Frost Aster |
| *Aster vimineus Lam.* | Small White Aster |
| *Echinacea purpurea (L.)* Moench. | Purple Coneflower |
| *Helianthus tomemtosus* Michaux | Sunflower |
| *Heuchera americana L.* | Alumroot |
| *Liastris spicata (L.)* Willd. | Dense Blazing Star |
| *Monarda fistulosa L.* | Wild Bergamot |
| *Monarda punctata L.* | Spotted Horsemint |
| *Oenothera fruticosa L.* | Sundrops |
| *Solidago juncea Aiton* | Early Goldenrod |
| *Solidago nemoralis Aiton* | Grey Goldenrod |
| *Solidago speciosa Nuttall* | Showy Goldenrod |

## Planting and Maintenance

1. Attempt to plant a ratio of 70-80% grasses to 20-30% forbs. Combining 5 to 7 grass species with 15 to 20 forb species is suggested; a study of prairie relics in Wisconsin found that only 19 species, of the 237 species found in the prairies, occurred in most of the stands. Daisy family and legume species are suggested, as they are sturdy and dependable. Plus, the legumes improve the soil with their nitrogen-fixing capacity.

2. Seeding rates vary with species and location. Survival and germination are affected by seed quality, site, rainfall, erosion, and temperature. Sowing of grasses on large areas can be done mechanically. Hand-broadcasting of forbs in smaller areas will break up the lines created by the mechanical planters. Hand planting should be done in no more than a slight breeze, throwing seeds in a half-circle ahead of the sower. A hand-operated whirlwind seeder is useful in sowing dense seeds, such as legumes, but not fluffy ones. After hand-planting, the soil surface should be dragged with a cultipacker. Seeding should be timed for fast germination and early growth before the hot, dry part of summer begins. Allow annual weeds, whose seeds were stored in the soil, to act as an early nurse crop for the prairie plants and to protect the soil surface from wind and rain.

3. Transplants are practical in small areas (1/4 acre or less). Transplanting should be done when the plants are dormant in the fall. Soil should be worked deeply and kept moist. Protect the new transplants from the sun. If the young plants show a lack of vigor, treat them with a liquid fertilizer.

4. Weed control is most important during the first summer. Mowing may be done with a rotary mower set at 5 to 8 in or high enough to not injure the prairie species. Weeds should be mowed before they become too tall or dense, or set seed, about 30 days after planting. Expect to mow 3 or 4 times during the first summer. On large areas surrounded by cool-season grasses that will invade, a disked or plowed strip 6-9 ft wide will control invaders and serve as a firebreak. Do not disturb the soil in the planted prairie, as this will only encourage more annual weeds.

5. By the second year, the site should begin to look like a prairie, with grasses and forbs blooming and bearing seed. Replanting of missing species or additional species should be done now. Again, mow back the annual weeds in May-June to 5-8 in, before the prairie plants reach a height that will be affected by mowing. Control woody species selectively with herbicides.

6. By the third year, the prairie plants should be crowding out the competition. After the third year, or fourth, burning can be considered to stimulate growth, break-up organic matter for fertilizer, and kill woody invaders and cool-season grasses. Burning is usually done in the early spring every 3 to 4 years; on light soils it may be less often. Burning only half of the prairie at a time protects wildlife. Redisk the firebreak before burning. On small sites where burning is not desirable, remove accumulated waste by cutting and raking in the early spring.

In summary, although the initial establishment phase is labor-intensive, meadows are low maintenance over the long-term, requiring a prescribed burn every few years or an annual mowing.

# Establishment of Vegetative Screens and Windbreaks

Vegetative screens create a pleasing environment for visitors by blocking unattractive views and reducing noise levels. This is especially desirable in areas where housing developments and businesses on nearby properties disrupt the recreational or historic scene. Most screens need to be planted, but some are often already partially present in the form of areas that have seeded in naturally with forest or fencerow vegetation. Shrub and tree barriers can also act as windbreaks, deflecting wind upward and reducing its velocity for short distances. Windbreaks also reduce blowing snow, protect living and working areas, improve working conditions, reduce wind damage, and control snow drifts.

Barriers will be established quicker and more easily in the sun, since most species recommended for screening grow best in full sun. Species selection should be based on site conditions such as available sunlight, soil drainage, soil moisture, and soil chemical properties. In addition to matching the site characteristics, several other traits are desirable for barrier plants: high survival rates, cold and drought hardiness, pest resistance, adaptability to poor soil, a fast growth rate, and a crown form suitable for a barrier. Shrubs can be planted among the trees for structural diversity and a more complete barrier. Many shrubs reach sufficient heights to be effective visual screens. Height, rate of growth, and foliage characteristics are the principal considerations for selecting windbreak species. Appendix III lists native deciduous and evergreen shrubs and small trees with dense foliage that may be used for screens. Appendix IV lists native species commonly used for windbreaks. Species should be selected from these lists with the use of a plant hardiness zone map to determine their suitability to the local climate. Evergreens are excellent as barriers because of their year-round foliage and high-density crowns (Figure 6). Combinations of both deciduous and evergreen species are commonly used

for barriers though, for several reasons. Many trees self-prune as they mature; a shrub row will maintain the density of the barrier when trees are planted that will not provide low-level density once they mature. Aesthetic beauty and diversity of wildlife food and cover are additional benefits of combined plantings.

The location of visual or noise barriers will be dictated by where the developments are in relation to visitor areas and interpretive or historical sites. Windbreak location should be carefully planned, however, to ensure that the barrier functions as intended. Windbreaks must be located to provide maximum protection and oriented perpendicular to the prevailing wind or the direction of troublesome winds from seasonal storms. For wind protection, the tallest row of trees should be placed approximately 2-5 times the height of the trees from the areas needing protection. The windbreak should extend 50-100 ft. beyond the areas needing protection. The density of the windbreak is determined by the width of the windbreak in number of rows, species selection, and within-the-row tree spacing. Where only wind protection is needed, a single row of coniferous species could provide the density needed. The recommended minimum is two rows of different species to minimize the impact of insect or disease infestations. Shorter trees and

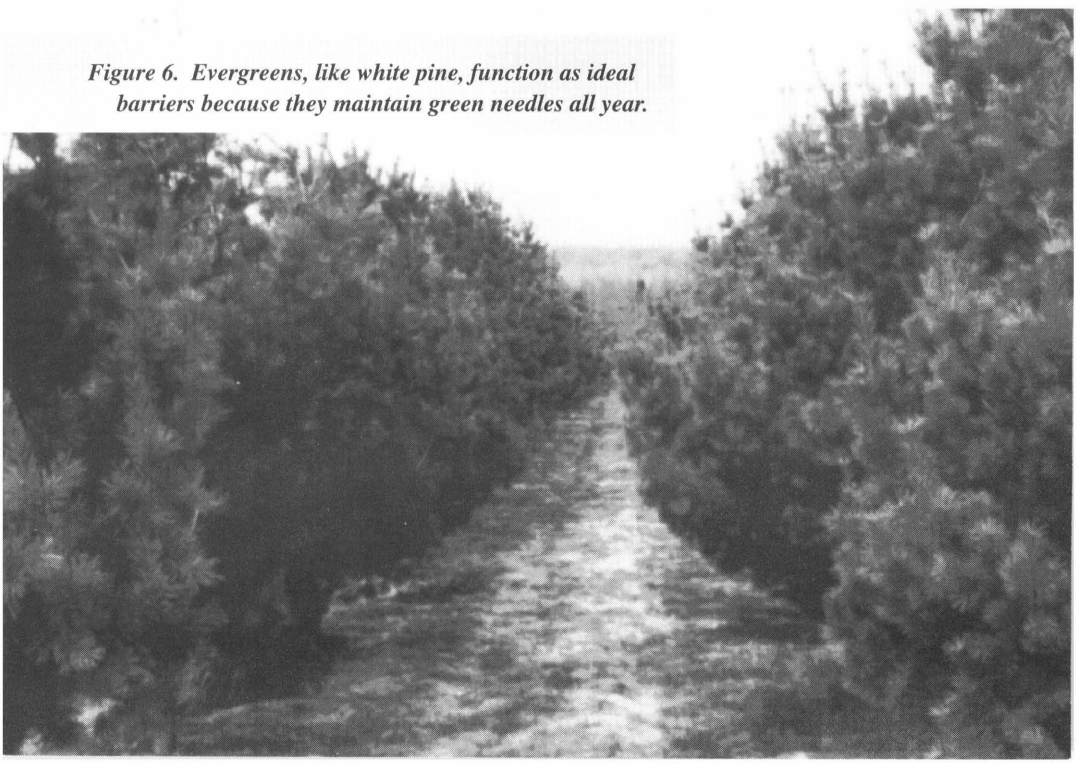
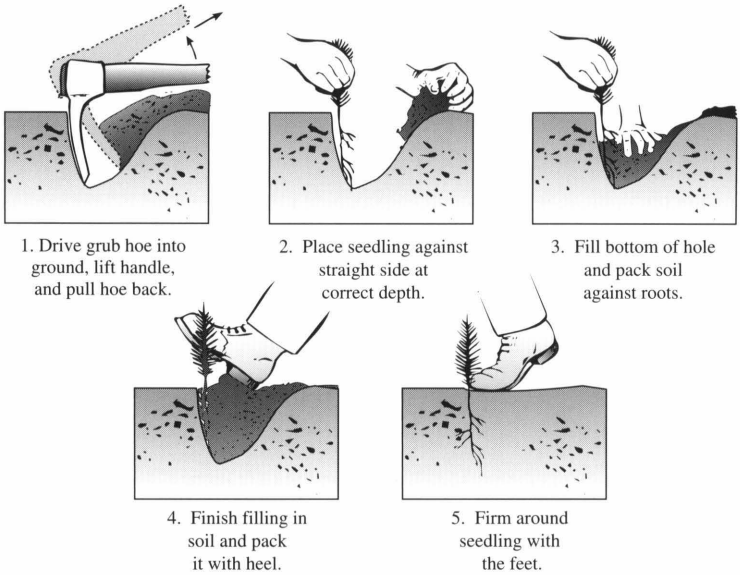
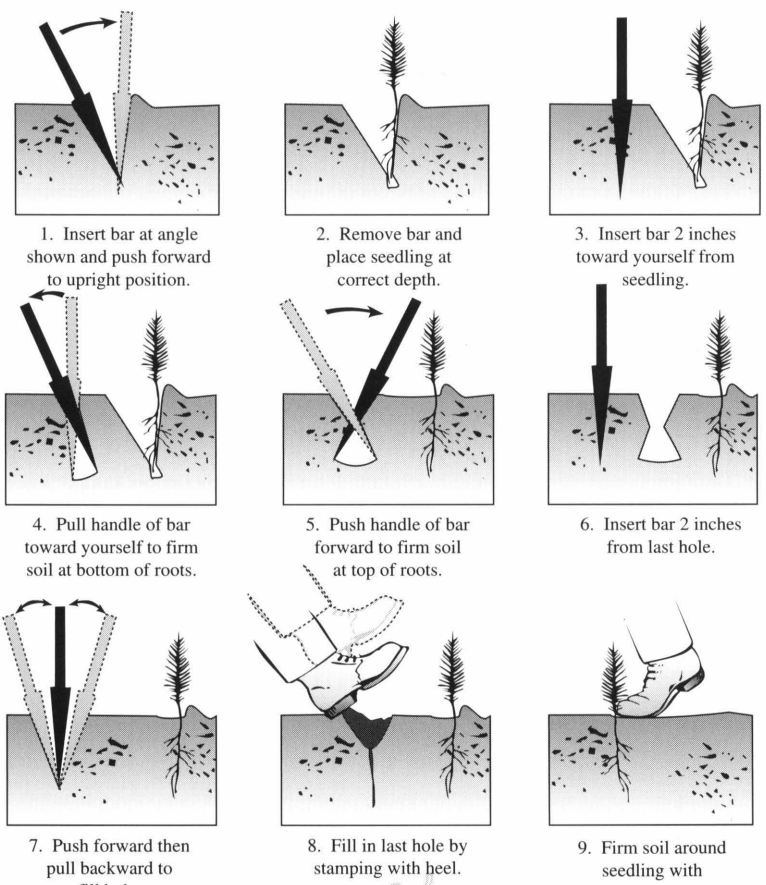


***Figure 6. Evergreens, like white pine, function as ideal barriers because they maintain green needles all year.***

*Figure 7. The side-hole (top) and bar-slit methods of tree planting.*



shrubs should always be located in the outer rows of barriers, to allow them adequate sunlight and room to grow.

Before planting, site preparation is necessary. Shallow plowing breaks up sod formations and populations of weeds, loosens soil, and provides better soil-moisture retention. Planting methods for screens and windbreaks are the same as those for planting most seedlings and shrubs. Figure 7 (on page 23) illustrates the proper method of planting bare root tree seedlings. Never allow the roots to dry out by exposing them to wind and sun. Plant on cool days in the fall through early spring, ideally when rain is expected soon. Otherwise, expect to water the plants for a few weeks until the roots get established and/or it rains. Planting dormant seedlings will prevent them from being too stressed by the move. Spacing will depend on the size of the plants; consult with the nursery where purchasing seedlings to learn specific spacings for the species.

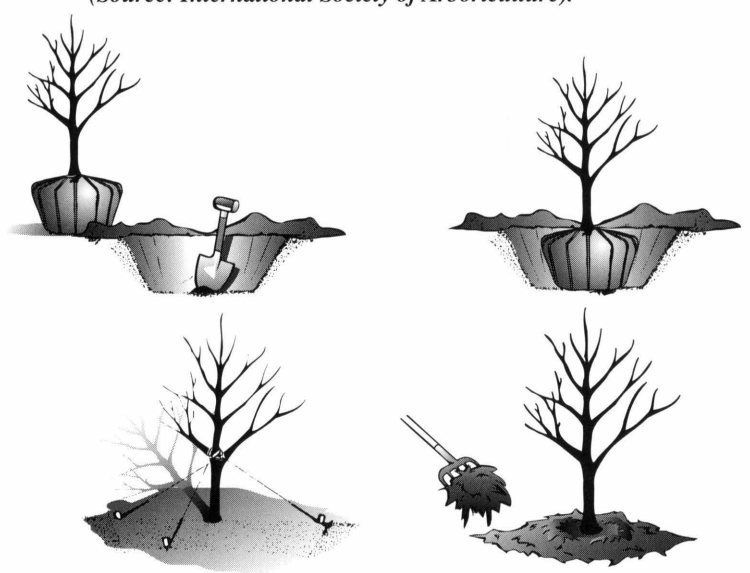
In general, plant small, bare-root seedlings 3 to 6 ft. apart. When planting multiple rows, offset the seedlings between rows to prevent gaps in the barrier. One row of trees should be planted close enough to form a complete barrier within 10 years. Imagine how the trees will fill in as they grow, perhaps finding some in the understory of the forest for examples, using this information to adjust spacing. Plant larger, more expensive trees and shrubs close to their final mature spacing to avoid thinning. If larger trees are to be used for planting, select balled and burlapped trees over those in containers as the root mass in the balls contains a few days of moisture, unlike those grown in potting material, and the root systems are much less disturbed in the planting process. When planting balled and burlapped trees (Figure 8), or those recently removed from a container, consider the following steps from the International Society of Arboriculture:

1. Dig a large planting hole, only as deep as the root ball but as wide as possible, at least twice as wide as the root ball.
2. Prune any injured roots or branches to a point just in front of the injury.
3. Break up the soil you take out of the hole and use it to refill. Also, break up the soil around the planting hole. Do not fertilize until the

plant is well established. Soil amendments are not recommended.

4. Place the tree in the hole by lifting by the root ball. Adjust the level of the tree so that the root collar is at the soil surface (be aware that the burlap may be tied higher than the root collar). Remove all accessible burlap.
5. Fill the hole gently with soil, settling the soil with water to remove air pockets around the roots. Do not use your feet to tamp, as it will compact the soil and inhibit root growth.
6. Stake the tree if it is too tall to stand alone or has a weak root system. Remove the stakes as soon as the tree has become established in the soil; stakes should not be left in place for more than a year.
7. Mulch around the base of the tree to conserve soil moisture, prevent weed competition, and protect newly-planted tree roots from temperature extremes. Maintain mulch to prevent damage to the tree stem from mowers or weed whackers.
8. Water at least once a week if the weather is dry to keep the soil moist but not soaked. Continue until mid-fall, then taper off to allow the tree to begin to grow dormant for winter. Be prepared to also water during dry periods the following year.

***Figure 8. Planting method for balled and burlapped trees. (Source: International Society of Arboriculture).***



The costs of establishing vegetative screens will vary with species and size of plants purchased; contact nurseries for estimated costs of plant materials. Monitor the trees monthly after planting to make sure they are well-established before the dry, hot months arrive, and replace any that die as early as possible to maintain the density of the screen or windbreak. Weed control will be necessary until canopy closure to prevent herbaceous competition from slowing the growth of the barrier plantings. Herbicides and tillage are common methods of weed control (Table 3); mulching and mowing can also be used. As the plants mature, their crowns should intersect and begin to crowd each other. Insect and disease outbreaks should also be watched for and treated if necessary. It will take several years for the newly planted screens and windbreaks to be effective. As they age, occasional careful thinnings of a few individuals, those that appear unhealthy or are suppressed, will improve the growth of the remaining plants and keep them healthy and vigorous.

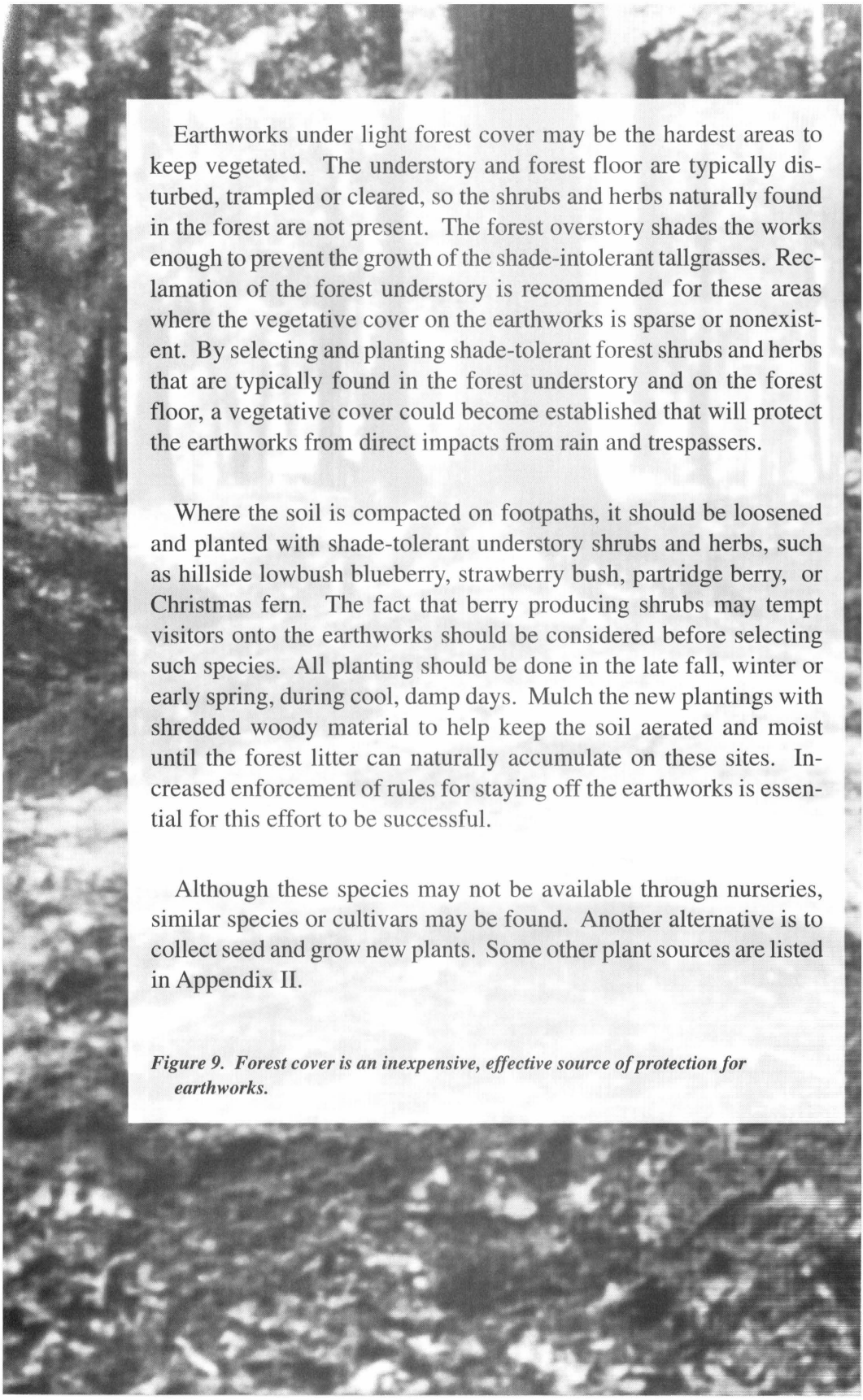
***Table 3. Forestry herbicides for herbaceous weed control. Labels often change yearly. It is the user's responsibility to obtain and consult the most recent herbicide labels available. (Source Miller and Mitchell 1990).***

| Herbicide Trade Name | Active Ingredient | Manufacturer | Species Controlled |
|---|---|---|---|
| Atrazine 4L | Atrazine | DuPont, Ciba-Geigy | Annual broadleaf weeds and grass, biennial and perennial weeds |
| Fusilade 2000 | Fluazifop-butyl | ICI Americas Inc. | Annual and perennial grass, weeds |
| Oust | Sulfometuron methyl | DuPont | Annual and perennial grass, broadleaf weeds |
| Poast | Sethoxydim | BASF | Annual and perennial grass, weeds |
| Pronone | Hexazinone | Proserve | Woody and herbaceous weeds |
| Roundup | Glyphosate | Monsanto | Woody and herbaceous weeds |

# Earthwork Preservation

The earthworks common in many battlefield parks were constructed in open fields during the war. Today, these earthworks are under forest cover except where regular mowing and clearing has kept them exposed for the public to view. Preservation of these fragile earth mounds depends on the control of erosion and other activities that disturb the soil, such as the uprooting of trees or people walking on footpaths over the earthworks. Under undisturbed forest conditions, the sheltering effects of the overstory and understory vegetation have protected the integrity of most earthworks. The undisturbed forest also discourages many visitors from entering and exploring the earthworks, resulting in fewer footpaths and less trampling of vegetation and compaction of soil. Problems do exist with earthworks under forest cover, however. In some places, poor soil and/or dry conditions prevent total cover from forming, and erosion occurs. In others, mature trees that blow over take earthwork soil with their root systems, leaving a gap in the mound. Overall, however, the forest cover type is one of the best, and least expensive, preservers of the earthworks, and the continued use of forest cover is recommended for the undeveloped forested areas of historical parks (Figure 9 on page 28 and 29).

The primary objective for vegetation management on the earthworks is to develop and maintain a cover of plants with a fibrous root system and continuous vegetation to control erosion. Tallgrasses such as Andropogon species are replacing areas formerly kept in rough grass, and regular burning can be used for maintenance rather than mowing. In areas where burning is not a desirable maintenance option, mowing once a year is another tool to maintain the tallgrass. Other perennial meadow species, such as those mentioned in Table 2, can be planted along with the Andropogon species to add diversity and color to the works that are also managed by burning or bushhogging. Different species could be used between the works to profile trenches and battlefield areas.



Earthworks under light forest cover may be the hardest areas to keep vegetated. The understory and forest floor are typically disturbed, trampled or cleared, so the shrubs and herbs naturally found in the forest are not present. The forest overstory shades the works enough to prevent the growth of the shade-intolerant tallgrasses. Reclamation of the forest understory is recommended for these areas where the vegetative cover on the earthworks is sparse or nonexistent. By selecting and planting shade-tolerant forest shrubs and herbs that are typically found in the forest understory and on the forest floor, a vegetative cover could become established that will protect the earthworks from direct impacts from rain and trespassers.

Where the soil is compacted on footpaths, it should be loosened and planted with shade-tolerant understory shrubs and herbs, such as hillside lowbush blueberry, strawberry bush, partridge berry, or Christmas fern. The fact that berry producing shrubs may tempt visitors onto the earthworks should be considered before selecting such species. All planting should be done in the late fall, winter or early spring, during cool, damp days. Mulch the new plantings with shredded woody material to help keep the soil aerated and moist until the forest litter can naturally accumulate on these sites. Increased enforcement of rules for staying off the earthworks is essential for this effort to be successful.

Although these species may not be available through nurseries, similar species or cultivars may be found. Another alternative is to collect seed and grow new plants. Some other plant sources are listed in Appendix II.

***Figure 9. Forest cover is an inexpensive, effective source of protection for earthworks.***

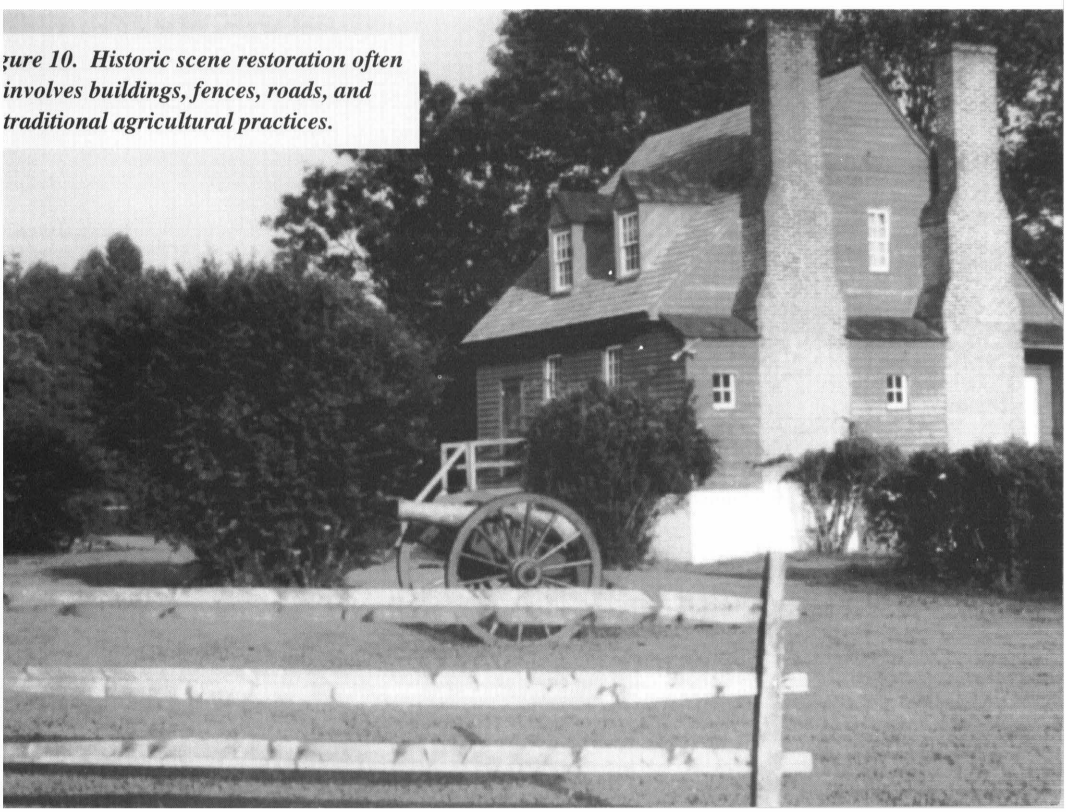
# Scene Restoration

Historic scene restoration often involves buildings, fences, roads, and traditional agricultural practices (Figure 10). Most old fields are now grown into forests, and scene restoration requires a major land use shift. Before beginning work to restore forested areas to their historically correct condition, the consequences of such activity must be considered and the method, timing and extent of the action decided. The quickest and most efficient method of removing forest is with a clear-cut. Slowly thinning the stand, gradually opening the area up, is an option, but this action would create an abundance of sprouts and prolong the disturbance of the area by tree-cutters and their equipment. However, thinning and gradually removing the overstory over 5-10 years would not be as drastic a change to the landscape, and it may disturb the visitors less than the sight of a fresh clear-cut.

Either way, woody regeneration will sprout up after any of the canopy is removed and it will need to be controlled. Herbicide treatment on the cut stumps and sprouts (Table 4) is an effective method of doing this, making it possible for the area to revert to field. Fall and winter are the best time for cutting as there are fewer visitors, dormant trees are less likely to be damaged, there are no nesting birds or animals in the stand, and there would be time to "clean" up the ground vegetation before spring growth. However, sprouting of cut stems will be greater if the cutting is done in the winter. After the leaves come out and the plants are actively growing in the spring, additional control of the woody vegetation could be done as necessary.

Consider the impact of tree removal on any forest or specimen trees that will be left. Remember that opening up the forest, or moving the forest edge further into a stand, will change the environment for trees that once were in the interior of the forest. Direct sunlight will stimulate the growth of vines, shrubs, and young trees along any forest edge. Exotic species, such as Japanese honeysuckle, will have new access into

stands. If old trees exist in the nearby forest that will be left, consider leaving at least a few trees around them to act as a buffer from such disturbances as high winds and storms. This type of work is expensive if the goal is to plow and harvest crops from the area, as the tree stumps will need to be removed with tools such as bulldozers or fire. Also, large ground-moving equipment may be restricted in certain historical sites. Even establishing meadows, pastures, or hay fields on the site would require the stumps to be removed for annual mowing. One option is to establish an orchard with fruit trees grown from historic stock if they would add to the historic scene restoration. This would be especially suitable near old homesteads where forest is being cleared to create agricultural fields that once existed there. Planting fruit trees would eliminate the need to make the field suitable for plowing, which would require removal of all tree stumps and surface roots. Whatever the final goal for the area, consider marketing the wood products from a stand that is to be removed to help cover the costs of the operation. Trees to be cut could be sold for pulpwood, poles, or sawtimber, depending on the size and quality of the trees and local markets.



*ure 10. Historic scene restoration often involves buildings, fences, roads, and traditional agricultural practices.*

An alternative to cutting the forest is to establish forest trails, with interpretive stops and signs, that would allow visitors to view the scene despite the trees. Mention of the natural succession of vegetation, and how the site has changed over the last century, would be an added educational benefit to visitors of the parks, especially in areas where mature forest is scarce due to development and agriculture.

***Table 4. Forestry herbicides for stump spray treatments and species controlled. Labels change yearly. It is the user's responsibility to obtain and consult the most recent herbicide labels. (Source Miller and Mitchell 1990).***

| Herbicide Trade Name | Active Ingredient | Manufacturer | Species Controlled |
|---|---|---|---|
| Banvel CST | Dicamba | Sandoz Crop Protection Corp. | Tree-of-heaven, cedar, cherry, dogwood, elm, black gum, hawthorne, hickory, hornbeam, maple, oak, persimmon, sassafras, serviceberry |
| Garlon 3A | Triclopyr-amine | DowElanco | Beech, black gum, New Jersey tea, cherry, chinquapin, choke cherry, hawthorne, dogwood, elm, hornbeam, locust, maples, mulberry, oaks, persimmon, pine, poison oak, sassafras, sweetbay magnolia, sweetgum, sycamore, yellow-poplar |
| Tordon 101R/Tordon RTU | Picloram | DowElanco | Tree-of-heaven, cedar, cherry, dogwood, elm, black gum, hawthorne, hickory, hornbeam, maples, oaks, persimmon, serviceberry, sweetbay magnolia |
| Tordon 101 Mixture | Picloram | DowElanco | Tree-of-heaven, New Jersey tea, cherry, elm, black gum, locust, maple, oak, persimmon, pine, sassafras, yellow-poplar |

# Managing Storm-Damaged Areas

Tree damage by ice, high winds, lightning, and other storm-related events is fairly common in the Southeast. When this damage is widespread, it can cause serious problems for park managers. Storm damage can result in such aesthetic disasters as ruined views and destroyed historic scenes. Storm-damaged trees may be hazardous to people and buildings, may result in severe pest problems, and may cause wildfire fuel buildups. Clearly, some management strategy for dealing with storm-damaged areas is necessary.

The first step after a storm is to survey the damage. This may take the form of an on-the-ground reconnaissance for smaller parks, or may require aerial viewing for larger parks. This survey will provide an overview of the damage areas and tree condition. Different types of storms will result in different types of damage. For example, ice often results in broken stems, bent stems, and branch breakage. Lightning usually affects single trees, often killing them. High winds usually result in bent trees, uprooted trees, and root damage. Severe storms can cause a variety of damage over broad areas (Figure 11).

Once the survey is completed, a course of action can be developed. The high hazard areas should be cleared first, removing trees or branches that threaten people or buildings, power lines, or roads. All access roads should also be cleared early. For forested areas, a decision needs to be reached to completely salvage, partially salvage, or leave the area alone. Aesthetic concerns, potential pest or fire problems, and the available budget to do the work all weigh heavily in the decision. Since parks don't usually manage timber commercially, concerns with stem quality and merchantability are not critical. However, the vigor and health of the remaining trees are important. Trees with broken tops or branches, or other wounds, are susceptible to invading organisms (Table 5).

*Figure 11. Two common storm-related damages are (A) stem breakage and (B) windthrow*

*A*

*B*

A common form of storm damage is broken tops or branches. This can be a serious injury and can even cause tree death, particularly

*Table 5. Sequence of invasion of damaging organisms in storm-damaged timber. (Source: Barry et al. 1993).*

| Species | Year 1 | Year 2 |
|---|---|---|
| Pine | Bark beetles, ambrosia beetles, sawyers, blue stain fungi, soft rot fungi | Decay fungi |
| Oak and hickory | Wood borers, ambrosia beetles, stains, soft rot fungi | Sapwood decay fungi |
| Other hardwoods | Wood borers, ambrosia beetles, stains, soft rot fungi | Sap and heartwood decay fungi |

with conifers. A rule of thumb is that if pines have three or more live branches remaining they should survive and recover; otherwise they will die and should be removed. Breakage will seldom kill deciduous trees, but it can result in serious wounds that allow decay to begin. For high value trees, pruning should be done to create a smaller wound surface that will heal quickly. Standard pruning guidelines (Figure 12) should be followed.

Trees that are windthrown may be left to decay on the forest floor if the fuel hazard is not too great. If they are salvaged, they can be severed and the stump pushed into an upright position so it is less visible. Occasionally, an upright root mat snaps violently back into place when the fallen tree is severed. This can pose a safety hazard to workers. Trees that are bent over often will recover, especially if they are under 15 ft in height. Again, these trees should be removed if they cause a hazard or if they are aesthetically unpleasing.

Wounding is often common in storms, due to falling trees and branches, twisting, etc. A major concern with wounds is that they often attract insect and disease pests. For example, wounded pine

trees may be very attractive to pine bark beetles. Wounded deciduous trees are subject to decay, especially if the wound penetrates more than 2 inches into the sapwood. Wounded trees may be removed if they are deemed a hazard. In forests, however, such trees often become decayed and result in good den trees for wildlife.

The course of action to take following a storm is difficult to predict ahead of time. Mother Nature seldom waits for an opportune time to have an ice storm or a tornado. The best course of action is to be prepared, with the necessary equipment and a budget available to deal with a problem. If forest stands are healthy and vigorous to begin with, they are likely to be resistant to some storm damage. Overmature or very dense stands with low tree vigor will be more susceptible. Finally, it should be noted that salvage and cleanup in storm-damaged areas is very hazardous work. Only trained and experienced personnel should be used for this work.

# How To Prune Storm-Damaged Trees

Because of its weight a large limb could tear loose during pruning, stripping bark and creating jagged edges that invite insects and disease. That won't happen if you follow these steps:

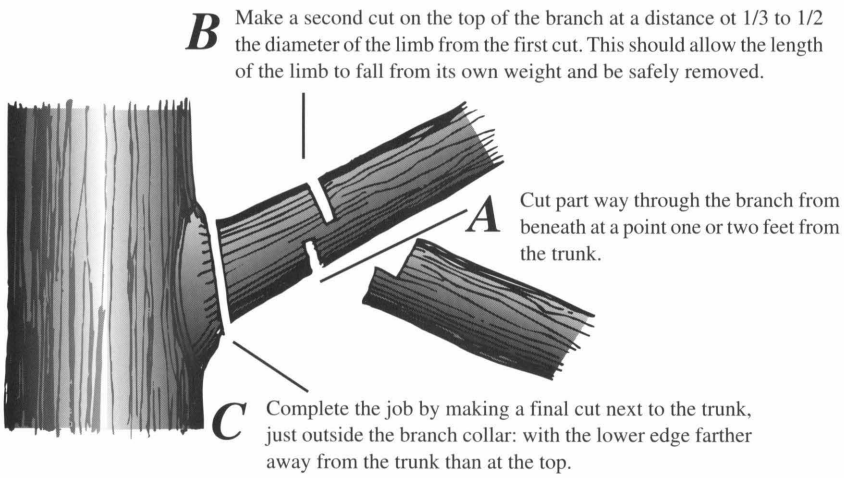



***Figure 12a. Pruning procedures for storm damaged trees. (Source: National Arbor Day Foundation).***

Cutting flush against a larger limb or the trunk was once believed to be the best way to prune. We now know that such a method is improper because it weakens a tree's natural defense against the invasion of disease organisms. The possibly harmful effects of pruning wounds can be minimized by making all cuts just the outside of the raised areas at branch intersections. These features are called bark ridges (above) and branch collars (underneath).

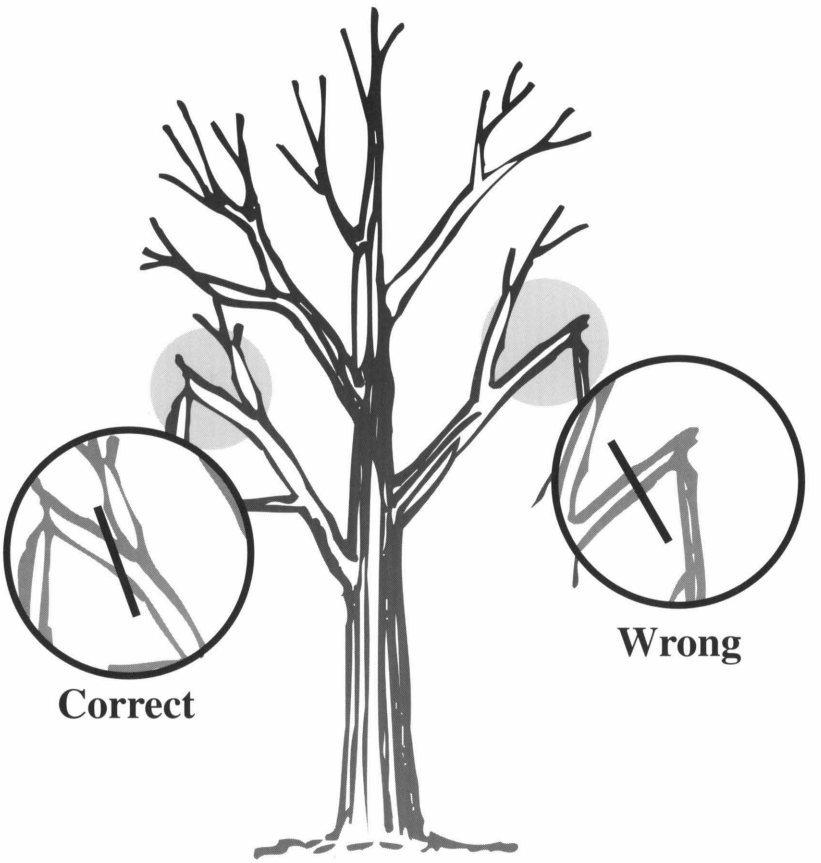
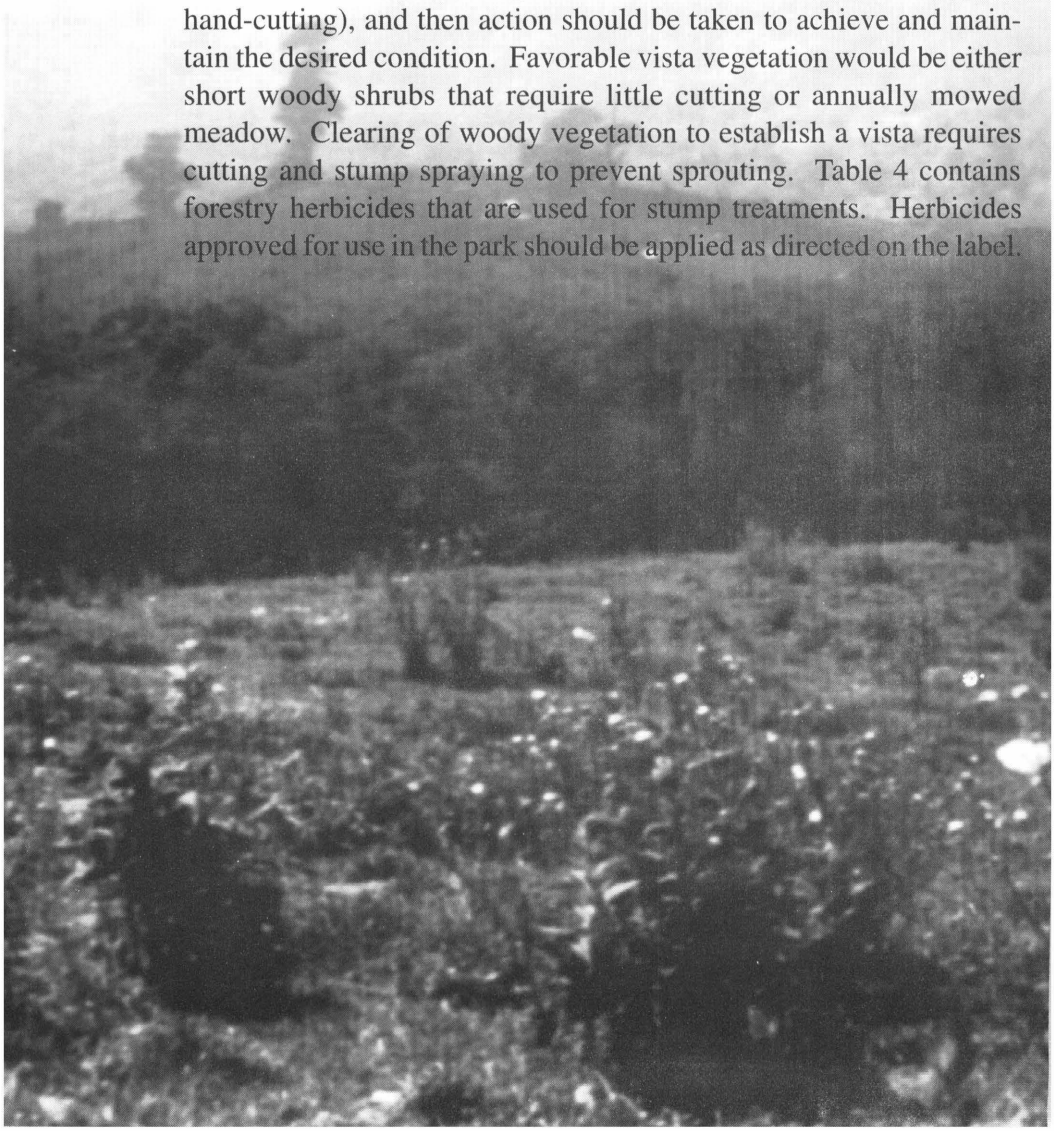



***Figure 12b. Pruning procedures for storm damaged trees. (Source: National Arbor Day Foundation).***

Removing the jagged remains of broken limbs is the most common repair that can be made after a storm. It is also an important task because, if done properly, it will minimize the risk of decay pathogens entering the tree. Following good pruning techniques, cut off limb stubs where they join the next largest branch or the trunk. Do not simply cut immediately below the break.

# Clearance and Maintenance of Vistas

The maintenance of vistas for scenic and interpretive purposes is labor-intensive, as vegetation is continuously regenerating and growing in the cleared areas. The target vegetation should be determined for the area below a vista according to the type of maintenance possible (herbicide application, prescribed burning, mowing, bushhogging, hand-cutting), and then action should be taken to achieve and maintain the desired condition. Favorable vista vegetation would be either short woody shrubs that require little cutting or annually mowed meadow. Clearing of woody vegetation to establish a vista requires cutting and stump spraying to prevent sprouting. Table 4 contains forestry herbicides that are used for stump treatments. Herbicides approved for use in the park should be applied as directed on the label.



Maintenance of vistas will depend on the target vegetation. For example, a stand of small trees and shrubs naturally regenerates from the cut stumps of cleared vegetation. Maintenance of this vegetation simply consists of cutting the plants back once they are too large for the vista (Figure 13). If shorter shrubs are desired that are not established on the site, the current vegetation will need to be cleared and the roots killed to prevent their regrowth prior to planting. Species such as huckleberries, blueberries, and mountain-laurel are potential medium to short-stature shrubs. They will dominate an area if given time to become established and shade out the competition. Monitoring and control of exotics such as Japanese honeysuckle would be necessary in these open areas.

Some vistas would be best maintained as meadow. Most perennial meadow plants can be maintained mechanically, by an annual/biannual mowing or bush-hogging, or by prescribed fire. Vistas bounded by earthworks could easily be rehabilitated to meadow with the establishment of tallgrasses on the nearby earthworks, and they could be maintained at the same schedule.

***Figure 13. Plants in the foreground of a vista should be short in stature and slow growing.***

# Agricultural Use Areas

The maintenance of historic vegetation and landscapes through an agricultural leasing program can be a cost-effective alternative for achieving a park's landscape management goals. By leasing the land to local farmers, the park forgoes the responsibility of maintaining equipment and expertise on agricultural practices, as well as the actual work of planting and harvesting. The areas are kept in the historic land use while providing the local community with additional farm products and income. Some of the crops grown in parks are not historically accurate; however, neither are the farming practices. What is important is that the crops selected are consistent with the cultural landscape needs and with the maintenance of a sound environment. Historic varieties should be considered for use when possible to support genetic variability and the perpetuation of historic species. Hay fields, grains and vegetable crop fields, and pasture are all possible uses of agricultural areas.

Agricultural use programs on parklands should be routinely inspected to check for erosion problems. The farming practices should protect the soil from water and wind erosion, not allowing the soil to remain bare for more than a week or two. Also consider providing additional food and cover for local wildlife populations by asking the farmers to leave several rows of the crop along the field borders as was common in the days before mechanical harvesters. Local Extension, Natural Resource Conservation Service, and Consolidated Farm Service agency offices have more information on local farming practices and erosion control.

# Erosion Prevention and Control

Areas that are unvegetated because of recent disturbance or poor growing conditions are most subject to erosion. Sparsely vegetated areas are also in danger, if sufficient vegetative cover does not exist to shelter the soil surface from rain and wind. The best prevention of erosion is to maintain adequate vegetative cover or to establish it as soon as possible when it does not exist (Figure 14). Local plants that are growing nearby are the best choices for revegetation, as they are known to be successful in the area. The native tallgrasses (Table 2) are excellent for revegetation; they can be used in mixed stands that, once established, require little maintenance. Native forbs that have been recommended are partridge pea, Illinois bundleflower, and common sunflower. Many of the annual forbs and perennial grasses and forbs (Table 2) will grow in poor, dry soils; these should be selected when establishing meadows on eroded sites. Planted as a mixture, the annuals provide quick, temporary cover as a "nurse" crop while the perennial grasses and forbs become established.

Shrubs and trees also are excellent for erosion control once crown-closure has occurred. Indigobush and other native shrubs, such as those recommended for vegetative screens (Appendix IV), can provide adequate cover. Small trees such as the hawthornes and silky dogwood, as well as any forest tree that will grow on the site in question, also can be used.

Do not expect miracles, however; if topsoil no longer exists on an area, extra work will be necessary to make sure the area has enough soil for rooting to occur and adequate moisture-holding capacity to allow growth. This may require tilling, topsoil replacement, organic matter amendment, or fertilization. Severely eroded areas often require structural repairs to stop erosion before planting can be successful.

Improvement techniques on sites where gullies have formed or where soil movement occurs during rains consist of two types• plugs and blankets. Plugs are structures such as strawbale barriers, fabric dams, and silt fences, while blankets reduce soil movement *in situ* and aid in the establishment of immediate vegetative cover. Strawbale barriers are bales of straw or hay placed into eroding gullies to form a semi-impervious barrier to trap sediment. Two small wooden stakes are placed through the bale to prevent the bale from being moved by storm flow. Fabric-brush dams are skeletal frameworks that are placed in eroding gullies. Rot-resistant, water permeable fabric allows water run-off to pass through while silt is trapped. Larger eroding areas can be protected with silt fences that remove silt from water flowing over the surface and through them.

Post and wire are erected at the site, and fabric is draped over the fence.

Blankets are erosion control fabrics that protect seeds and seedlings and remain in place during tree planting activities. Grasses germinate under the blanket and trees can be placed through the blanket. The blanket blocks the force of the rain, prevents wind erosion, and sometimes acts as a degradable mulch. This method is best for smooth, gentle terrain. Once erosion has been halted on an area and some sort of cover established to allow seedlings to germinate and tree roots to take hold, revegetation activities can proceed.

***Figure 14. An adequate vegetative cover is especially important to minimize erosion on steep slopes.***

# Hazard Fuel Management

Hazard fuel management requires that hazardous fuel situations be identified, modified, and monitored over time throughout the landscape (Figure 15). Hazardous fuel loads that lead to serious fires are created by a combination of the quantity and arrangement of fuel in a stand. Hazardous fires, those that generally cannot be controlled by people on foot and with handtools (Table 5), occur when such fuel loads are influenced by environmental conditions that favor fire: low humidity, high temperatures, and wind speeds that carry the fire to more fuel while supplying it with plenty of oxygen. The identification of a hazardous fuel load in an area requires an examination of the quantity of fuel and its arrangement.

The quantity of fuel in a stand can be determined with a fuel load model or a field inventory. Determining whether the quantity is potentially hazardous requires either extensive experience with fuels and fire or the use of fire behavior prediction systems such as BEHAVE or the National Fire-Danger Rating System (NFDRS). The use of these computer programs offers another source of fuels information, as they contain fuel models for many forest types within their systems. BEHAVE and NFDRS fuel models can be used when running these systems for a particular area, or specific inventoried information can be substituted. Since fire behavior is primarily influenced by the 1 to 100 hr. time-lag fuel sizes, only these fuels are considered in the fire behavior models. One hour time-lag fuels are those up to a quarter inch in diameter, while the 100 hr. time lag fuels range from one to three inches in diameter. Larger branches and boles do not carry the fire front as smaller fuels do. Larger fuels influence the fire's intensity and duration in close proximity to where they occur, and burning boles can cause severe damage to nearby vegetation because of their extended burning time at relatively high heat values. Smoldering boles can also be a source of firebrands should high winds fan them.

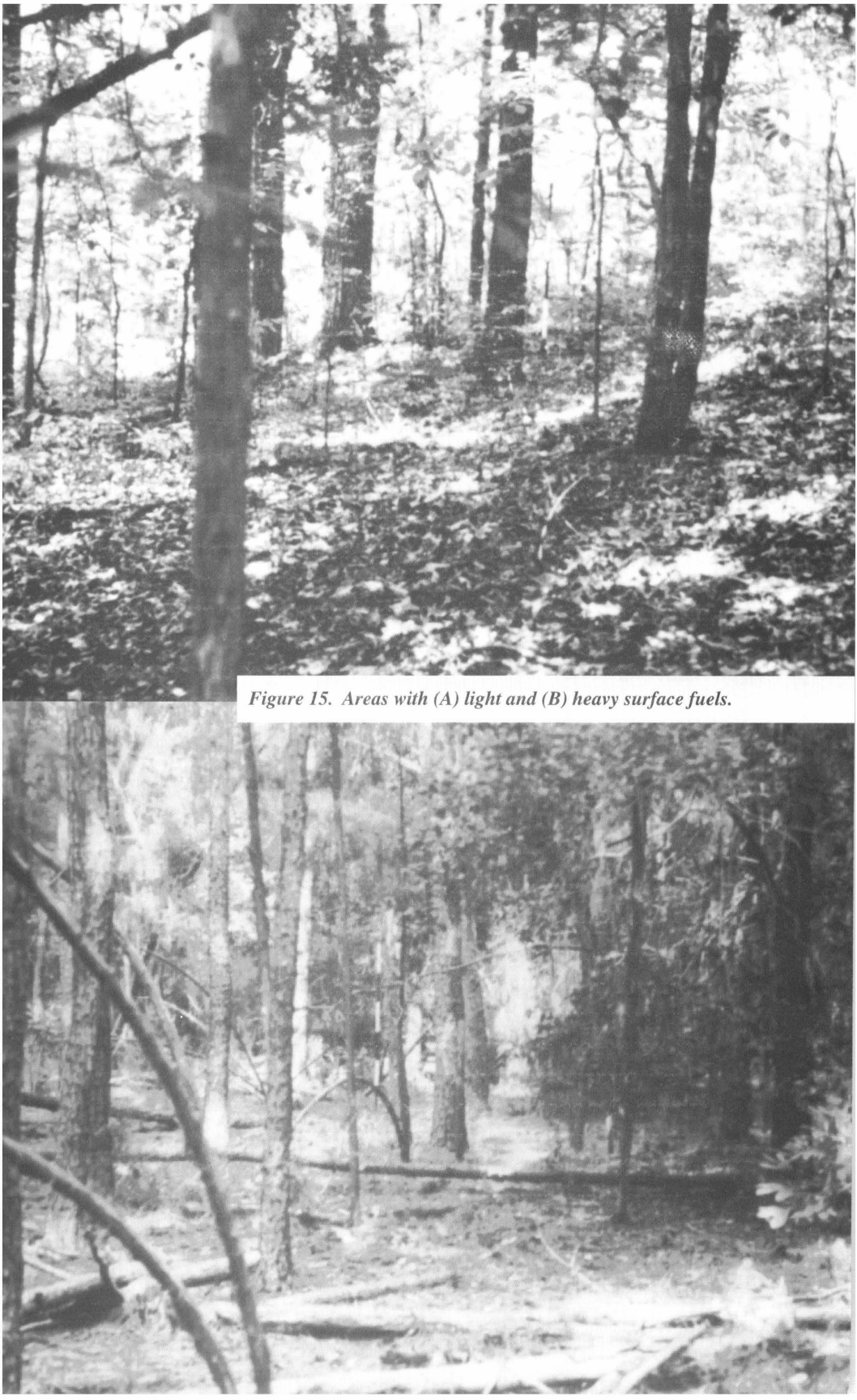


*Figure 15. Areas with (A) light and (B) heavy surface fuels.*

*Table 6. fire suppression interpretation of flame length and fireline intensity (Source: Andrews 1986).*

| Flame Length | Fireline Intensity | Interpretation |
|---|---|---|
| *Ft* | *Btu/ft/s* | |
| < 4 | < 100 | Fire can generally be attacked at the head or flanks by persons using handtools. |
| 4 - 8 | 100 - 500 | Fires are too intense for direct attack on the head by persons using handtools.<br><br>Hand line cannot be relied on to hold a fire.<br><br>Equipment such as plows, dozers, pumpers and retardant aircraft can be effective. |
| 8 - 11 | 500 - 1000 | Fires may present serious control problems – torching out, crowning and spotting.<br><br>Control efforts at the fire head will probably be ineffective. |
| > 11 | >1000 | Crowning, spotting, and major fire runs are probable.<br><br>Control efforts at head of fire are ineffective. |

The horizontal and vertical arrangement of the fuel bed is another consideration when determining whether a specific fuel situation is hazardous. Fuel levels may be high, but if they are patchy, the hazard is not as great as if they are continuous, allowing a fire front to quickly move through the stand. Aerial fuels, such as branches above four ft, leaning or upright snags, and standing vegetation, must also be considered when assessing the fuel hazard of a site. These are generally not considered in fire behavior programs as they are not dead and

down surface fuels. If a vertical continuum exists that could carry the fire off the ground and through a stand, this could be considered a hazardous situation, since a break in the fuel is usually needed to stop the fire.

Areas where maintenance activities have resulted in small build-ups of boles and branches, usually along roadsides, should be considered for fuel management. Often the branch and litter fuel loading in these areas is no greater than in the rest of the forest; but the great mass of bole fuels could smolder for extended periods of time if the piles were ignited by a passing surface fire. Greater damage would occur to the living vegetation of the area due to the longer duration of the fire. The hazard of a surface fire could also increase due to chance spreading of the fire to other areas by wind and firebrands. "Clean" these areas by completely removing the large piles of logs, or simply scatter small piles so each bole rests on the ground where it will decompose faster in contact with soil moisture and organisms.

On some sites the arrangement of dead fuels creates potential hazards. An example is where small gaps in mature pine or mixed pine-deciduous stands formed when a few trees died or fell, creating openings with masses of live and dead vegetation that temporarily could carry a surface fire off the ground. Pine and mixed pine-deciduous stands that are losing mature pine in patches are areas where fuel management would control the arrangement of the fuels. In these areas, scattered pines have fallen or are leaning against trees, creating ladders of dead fuel up into the lower canopy. Understory trees and vines, responding to light from the gap in the canopy, create masses of vegetation which could help carry a fire. A cleaning could be done at these sites to move the dead and leaning pines to the forest floor and cut and scatter piles of logs. Climbing vegetation could also be cleared with this activity. This would keep any passing surface fires on the ground and improve the conditions for decomposition of the boles.

Pine plantations are additional sites where preventive fuel management may be needed for the stand's health as well as its fuel situation. The species, age, and density of pine plantations will determine the

fuel hazard within it. Potentially hazardous conditions can exist in young loblolly pine plantations, for example, where the stand is dense, with codominant and suppressed stems beginning to die, occasionally falling and leaning against other standing trees. Species that do not self-prune completely create ladders of fuel from the ground to the canopy. One fuel management recommendation is to thin the pines to a level that will stimulate and maximize the growth of the remaining pines, to keep them vigorous and prevent the addition of more dead trees to the fuel load. Trees with larger canopies, no sign of insects or disease in the crowns or on the trunk, and those showing signs of being used by wildlife should be favored. A forester could mark the trees to be cut to insure that a well-stocked, healthy stand is left after the operation. Thinning will break the vertical continuum of fuel as the spacing increases between the trees and dead branches lower on the trunks are broken. Vigorously growing pines also will reduce the chances of pine beetle attack. In less dense and smaller pine plantations, another fuel management option is pruning. Pruning of the dead branches near the ground will break up the vertical fuels which could carry a fire off the ground.

A fuel monitoring program should be established to identify sites where the quantity or arrangement of fuels have the potential to be hazardous. Knowing how fuel loads will change in different cover types over time can aid in establishing the frequency of monitoring visits and plans for manipulating fuels when necessary. Oak and mixed hardwood stands, which contain a majority of climax species, should have relatively stable fuel loading rates, assuming they are healthy stands undisturbed by insect or disease outbreaks. As climax vegetation, these stands are made up by relatively long-lived and self-perpetuating shade-tolerant species, regenerating in gaps formed when mature individual trees die or blow over. Fuel loads may increase temporarily in these gaps where trees have died and fallen, but overall the fuels would support surface fires only.

Stands of early successional, shade-intolerant species or even-aged plantations dominated by a single shade-intolerant species have more fluctuating fuel loads. The initial density-induced mortality of trees that are suppressed or below the dominant canopy, common in such

stands, can result in a relatively large amount of dead fuel over a short period of time. Steep spikes in fuel loading can occur over a period of 2-5 years. An example is a young loblolly pine stand that needs a thinning to reduce stand density before the trees die. Following the initial mortality, the fuel load will decrease for a period of 10 years or so, as the stand grows, building up density without much mortality. If the density reaches high levels again, mortality and fuel levels will increase again. This phenomenon is not likely to occur in mixed stands typical of more advanced successional stages and/or when shade-tolerant species are present. Tolerant trees slow down in growth, rather than die, when the stand becomes dense.

Beyond monitoring fuels through the natural changes that occur in forest stands with time, the effects of natural disasters, severe storms, and disease and insect outbreaks on fuel loading need to be assessed when these occur in parks. Tree damage from natural disasters, such as hurricanes and severe storms, is typically from mechanical breakage or blowdown. Hard hit areas should be monitored to determine whether fuel reduction activities are necessary. If entire stands are destroyed in the park, cleanup activities will be necessary for aesthetic and safety reasons, as well as for fuel reduction. Economically beneficial operations, such as selling the down and damaged trees to firewood cutters, could be considered as a way to remove the wood and clean up the forest floor.

Insect and disease outbreaks should be monitored for their extent and severity. If large areas of trees are killed or are dying, salvage operations should be considered. Such a drastic action as removing the mature trees of a stand would be appropriate only for damage initiated by a gypsy moth outbreak in the park forests. Stands within the oak and oak-conifer cover types will be affected the most. Oaks and sweetgum are favored food for gypsy moth larvae during all larval stages. The later larval stages prefer all pine species too. When the preferred species are not available, American beech, black gum, elms, hickories, and red maple will be fed upon. The stands least affected by gypsy moth are those dominated by yellow-poplar. Eastern red cedar and American holly are also rarely fed upon.

The amount of mortality in a stand after gypsy moth attack is influenced by a number of factors: the intensity, distribution, and frequency of defoliation; tree vigor previous to attack; environmental conditions; and the extent of disease and insect invasion. Typically, the defoliation results in trees becoming stressed and succumbing to secondary organisms such as two-lined chestnut borer or shoe-string root rot. Trees killed after gypsy moth attack will not resprout since their root reserves have already been spent refoliating or fighting off insect or disease attacks. The understory will remain green and attractive, however, and shrubs, tree seedlings, and saplings should survive and grow quickly with the removal of the overstory.

# Timing of Silvicultural Practices

It is important to consider the season when planning work to meet a vegetation management objective. The impacts and success of a silvicultural practice depend on the time of year the work is done. In general, the main concern is the effect of the activity on the residual vegetation. A healthy, well-stocked and undamaged residual stand should remain after removing the undesirable vegetation.

If the objective is to clear out dead or dying trees and logs to reduce fuel or safety hazards, the work should be done in the fall or winter. The bark and cambial layer of the dormant vegetation will be less easily damaged and dormant stems will quickly resprout in the spring. Also, working conditions are usually more pleasant than in spring and summer months.

The fall or winter months are also best for the burning of meadows or earthworks to promote the warm season grasses. At that time the plants have stored up reserves for the next growing season, and a cleaning can be accomplished without harming the growth of the plants.

However, a fast-growing regeneration is usually not desired if vegetation is being removed for vista clearing or scene restoration or if non-desirable species are being cleaned out before establishing new species. Summer is the best time for these activities because vegetation is actively growing and energy reserves in the roots are low. Also, sprouting from damaged or cut stems is not as great as it would be if stems were cut in winter.

The effects of burning in a meadow or on the earthworks during the summer would be similar to cutting on the residual vegetation; fire would kill small woody stems and herbs while their root reserves

were low, thus lessening the chance of their recovery.

When timing silvicultural activities, it is also important to consider the work's impact on visitors. The high number of visitors in summer may make it an undesirable time of year for major activities such as scene restoration or vista cuts. Late summer or early fall is an alternative for these summer activities, but additional work will be needed to control those stems which have already built up root reserves. Perhaps the visibility of a silvicultural activity during the summer could provide an excellent opportunity for visitors to learn about forest management practices.

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Brian Heft and Rob Farrell provided many helpful comments on an earlier draft of the manuscript. Funding was provided, in part, by the mid-Atlantic Region of the National Park Service.

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**Appendix I.** Biology of several woody exotic species common to the mid-Atlantic states.
(Sources: Burns and Honkala 1990, Flint 1983, Whitcomb 1983)

*Ailanthus altissima* Tree of Heaven

Habitat

- native of China
- grows best in loamy, moist soils but tolerates a wide range of textures, stoniness, and pH
- intolerant of shade

Life History

- blooms in mid-April to July
- samaras persist on female tree through the winter
- bears seeds prolifically
- due to shade intolerance, reproduction in natural stands is sparse except by sprouting
- roots and stumps sprout prolifically when main stem is injured or killed
- 56-88 ft at maturity
- first year growth of sprouts rapid (10-13 ft)
- deciduous
- few insect pests or disease problems

*Albizia julibrissin* Mimosa

Habitat

- native from the Near East to central China
- very tolerant of hot, dry summers
- full sun

Life History

- blooms from June to August; flowers pink or red
- fruit large strap-shaped pod, 5-6 in long, seed is a smooth, brown bean

- very rapid grower
- 20 ft tall with even greater spread
- vascular and mimosa wilt occasionally kills; mimosa webworm problem in south and southwest
- soft wood easily damaged
- suckers and root sprouts can become a nuisance

*Lonicera japonica* Japanese honeysuckle

Habitat

- native to a wide range of eastern Asia
- grows in nearly any soil condition under any moisture regime
- grows best in full sun and on good soils
- shade tolerant

Life History

- blooms from mid-May to Sept./Oct.
- small black berry
- rapid grower into twining, tangled, dense mass, particularly in full sun
- 2-2 1/2 ft tall without support, climbs on other vegetation
- semi-evergreen in north, evergreen in south
- no serious pests
- difficult weed in the south to eradicate

*Paulownia tomentosa* Royal Paulownia/Princess-Tree

Habitat

- native of eastern Asia
- grows best in well-drained, moist soils, but will germinate and grow on almost any moist, bare soil
- intolerant of shade
- highly adaptable "escapee"

Life History

- blooms in April and May

• woody capsules turn brown as they mature and persist on the tree through the winter
• bear seeds at 8-10 years prolifically
• seeds germinate quickly, seedlings require bare soil, sufficient moisture and full sunlight
• roots sprout easily
• 30-70 ft height at maturity
• rapid grower on good sites, considerably slower on poor sites
• deciduous
• no major insect pests; minor damage from several foliage diseases

*Peuraria lobata* Kudzu Vine

Habitat

• native to China and Japan
• partial shade to full sun
• grows extremely rapidly

Life History

• blooms in late summer where winter dieback is not complete
• violet-purple, pealike flowers in upright clusters
• compound leaves borne on coarse, heavy, loosely twining stems
• trouble-free
• difficult weed in the south to eradicate; will climb over anything in its way

*Rosa multiflora* Rose

Habitat

• native of Japan and Korea
• full sun

Life History

- white clusters of flowers appear late spring or early summer
- fruits bright red
- up to 13 ft height, even greater spread
- few pests, vigorous grower
- serious weed problem in some states

**Appendix II.** Sources for warm season grasses and forbs for meadow plantings.

## Warm Season Grasses

*Bamert Seed Co.*, RR 3, Box 1120, Muleshoe, TX 79347. (806) 272-5506

*Bluestem Seed Co.*, 4045 Somerset Dr., Prairie Village, KS 66208. (816)786-2401

*C.P. Daniel's Sons, Inc.*, P.O. Box 119, Waynesboro, GA 30830. (404) 554-2446

*Hamilton Seeds*, HCR Rt. 9, Box 138, Elk Creek, MO 65464. (417) 967-2190.

*J. & J. Seed Co.*, Route #3, Gallatin, MO 64640. (816) 663-3157.

*Johnston Seed Co.*, West Chestnut, Box 1392, Enid, OK 73701. (405) 233-5800.

*Miller Grass Seed Co.*, P.O. Box 81823, Lincoln, NE 68501. (402) 475-1232

*National Wildlife Turkey Federation*, P.O. Box 530, Edgefield, SC 29824. (803) 637-3106.

*Osenbaugh Grass Seeds*, RR 1, Box 106, Lucas, IA 50151. (515) 766-6792.

*Sharp Brothers Seed Co.*, RR 4, Box 237A, Clinton, MO 64735. (800) 451-3779

*Stock Seed Farms*, Box 112, Murdock, NE 68407. (402) 867-3771.

*Wildlife Nurseries*, P.O. Box 2724, Oshkosh, WI 54903. (414) 231-3780.

## Perennial Forbs

*Applewood Seed Co.*, 5380 Vivian St., Arvada, CO 80002.

*Environmental Seed Producers*, 1851 W. Olive Ave., Lompoc, CA 93436.

*Lofts Seed*, 11417 Somerset Ave., Beltsville, MD 20705.

*North Creek Nurseries, Inc.*, RR 2, Box 33, Landenberg, PA 19350. (215) 255-0100.

*S & S Seeds*, P.O. Box 1275, Carpinteria, CA 93013.

*Virginia Natives*, Wildside Farm, P.O. Box 18, Hume, VA 22639. (703) 364-1665

*Wildseed, Inc.*, 1101 Campo Rosa Rd., P.O. Box 308. Eagle lake, TX 77434.

## Federal Cooperatives

*U.S.D.A. Soil Conservation Service Plant Materials Centers*. NPS Technical Advisor, Denver Service Center, FTS 327-2310. SCS National Plant Materials Specialist, Washington, D.C., FTS 447-5667.

**Appendix III.** Native species suggested for planting as vegetative screens (Sources: Flint 1983, Dirr 1990 and Hightshoe 1988).

Small-Medium Sized Deciduous (with dense canopies)

*Amelanchier arborea* Downy serviceberry

*Amelanchier canadensis* Shadblow serviceberry

Size and Habit: Shrub to small tree;
13 ft in 15 yrs, 40 ft in 40 yrs

Light: Full shade to full sun

Soil Moisture: Moist to average

Soil pH: 4-7

Comments: Select plants grown from material native to the same region where they will be used for best results. Subject to fire blight and mites which can be controlled without difficulty; scale insects can also be a problem in warmer areas, yet this is not considered a high maintenance tree.

*Carpinus caroliniana* American hornbeam

Size and Habit: Small tree; 16 ft in 25 yrs, 33 ft in 65+ yrs

Light: Full shade to full sun

Soil Moisture: Moist to average

Soil pH: 4-6.5

Comments: Relatively trouble-free and needs little maintenance.

*Cornus florida* Flowering dogwood

Size and Habit: Small tree; 13 ft in 18 yrs, 30 ft in 35 yrs

Light: Full shade to partial sun

Soil Moisture: Moist to average

Soil pH: 4-6.5

Comments: Susceptible to borers but less so with good maintenance, which includes fertilization and irrigation in times of severe drought. Good soil drainage is essential. Transplanting is difficult at

times and must be done carefully. Performs best with some shade in the south, but susceptible to dogwood anthracnose on moist, shady sites.

*Corylus americana* American hazelnut

Size and Habit: Shrub; < 10 ft

Light: Partial shade to full sun

Soil Moisture: Moist to dry

Soil pH: 4-7

Comments: Grows well in poor, gravelly soils.

*Crataegus crus-galli* Cockspur hawthorne

*Crataegus punctata* Dotted hawthorne

Size and Habit: Small tree with strong horizontal branching; 10-13 ft in 15 yrs, 23-30 ft in 60 yrs

Light: Full sun

Soil Moisture: Moist to very dry

Soil pH: 4-7

Comments: Well adapted to environmental stresses, including urban environments. Moderately susceptible to infection by the cedar apple rust fungus; plant away from eastern red cedar and its varieties, which are alternate hosts of the causal fungus, or be prepared to tolerate a certain amount of disease. Plant dormant trees after a few days' activation in a warm, moist atmosphere; prevent drying of roots during handling. The very large thorns these trees bear preclude their use near heavily used areas.

*Diervilla sessilifolia* Southern bush honeysuckle

Size and Habit: Shrub; 2 1/2 ft in 2 yrs, 4 ft in 5 yrs

Light: Partial shade to full sun

Soil Moisture: Moist to dry

Soil pH: 4-7

Comments: Unusually widely adapted to soils, light, and moisture conditions. Spreads by underground stems to make a dense mass. Unusually free of insects and diseases. Requires pruning

every 3 years to maintain form and density; cut off tops a short distance above ground level in spring.

*Hamamelis virginiana* Common witch hazel

Size and Habit: Shrub; 6 1/2 ft in 10 yrs, 13 ft in 25 yrs

Light: Full shade to partial sun

Soil Moisture: Average

Soil pH: 4-7

Comments: Grows best with at least light shade in the south. Relatively trouble-free and requires little or no maintenance.

*Ilex verticillata* Common winterberry

Size and Habit: Shrub; 6 1/2 ft in 15 yrs, 10 ft in 25 yrs

Light: Partial shade to full sun

Soil Moisture: Wet to average

Soil pH: 4-6

Comments: Foliage is frequently affected by leaf spots and mildew, but seldom completely disfigured. Otherwise is relatively trouble-free.

*Morus rubra* Red mulberry

Size and Habit: Small tree; 20 ft in 12 yrs, 46 ft in 40 yrs

Light: Full sun

Soil Moisture: Average

Soil pH: 4-8

Comments: Requires little or no maintenance.

*Ostyra virginiana* Hop hornbeam, ironwood

Size and Habit: Small tree; 20 ft in 25 yrs, 60 ft in 80 yrs

Light: Partial shade to full sun

Soil Moisture: Moist to average

Soil pH: 4-7

Comments: One of the most trouble-free deciduous trees. Hard wood result of slow growth rate. Difficult to transplant, so move in small sizes using container grown seedlings if available.

*Vaccinium corymbosum* Highbush blueberry

Size and Habit: Shrub; 5 ft in 6 yrs, 10 ft in 20 yrs

Light: Partial shade to full sun

Soil Moisture: Moist to average

Soil pH: 4-5.5

Comments: Tolerant of shade but requires full sun for best fruit production. For the fullness necessary for screening, the plants must grow vigorously; this requires sites where soil conditions are ideal. Several insects and diseases can be troublesome, depending on location. Iron chlorosis (leaf yellowing) is common in soils that are not sufficiently acidic; this can be corrected using chelated iron or foliage sprays.

*Viburnum acerifolium* Mapleleaf viburnum

Size and Habit: Shrub; 6 1/2 ft in 8 yrs, 11 1/2 ft in 15 yrs

Light: Full shade to partial sun

Soil Moisture: Moist to dry

Soil pH: 5-6

*Viburnum dentatum*, *V. pubescens*, *V. recognitum* Arrowwood

Size and Habit: Shrub; 6 1/2 ft in 8 yrs, 11 1/2 ft in 15 yrs

Light: Full shade to full sun

Soil Moisture: Moist to average

Soil pH: 4-7

Comments: One of the most trouble free viburnums.

*Viburnum prunifolium* Black haw

Size and Habit: Shrub or small tree; 8 ft in 10 yrs, 15 ft in 25 yrs

Light: Partial shade to full sun

Soil Moisture: Moist to average

Soil pH: 4-8

Comments: Unusually trouble free but occasionally subject to insect problems. Scale insects and borers can be serious enough to require control measures.

*Viburnum rufidulum* Rusty black haw

Size and Habit: Shrub or small tree; 26 ft

Light: Partial shade to full sun

Soil Moisture: Moist to average

Soil pH: 4-6.5

Comments: Southern counterpart of *V. prunifolium*, with more irregular, spreading growth habit. Select appropriate genetic material for region of use.

## Small-Medium Sized Evergreen

*Ilex opaca* American holly

Size and Habit: Shrub or small tree; 10 ft in 18 yrs, 40 ft in 80 yrs

Light: Half shade to full sun

Soil Moisture: Moist to average

Soil pH: 4-6

Comments: Grows well in full sun to half shade in summer, but for most compact growth full sun is best. Leaf miner is a serious insect pest that can be controlled with carefully timed sprays. Leafspot diseases area also troublesome. Many cultivars exist of *I. opaca*; local experience should be relied upon to select the best one for the area of use.

*Juniperus virginiana* Eastern red cedar

Size and Habit: Shrub or tree; 13 ft in 15 yrs, 66 ft in 90 yrs

Light: Full sun

Soil Moisture: Moist to dry

Soil pH: 4.5-8

Comments: Susceptible to *Phomopsis* blight and is also a principal alternate host to the fungus causing cedar apple rust. This disease is a serious problem to the alternate host species (the pome fruits of apples and hawthornes), and selection of *J. virginiana* should be done with these susceptible species in mind. Avoid planting this species near commercial apple orchards.

*Kalmia latifolia* Mountain laurel

Size and Habit: Shrub; 3 ft in 10 yrs, 10 ft in 30 yrs

Light: Full shade to full sun

Soil Moisture: Moist to average

Soil pH: 4-5.5

Comments: In the south this is useful only in relatively cool sites• shaded northern exposures. Relatively trouble-free, given a cool site and acidic soil, but susceptible to leaf-spot disease. Foliage is toxic to cattle, sheep, and humans.

*Myrica cerifera, M. caroliniensis* Southern bayberry, Wax myrtle

Size and Habit: Shrub or small tree

Light: Full sun

Soil Moisture: Wet to average

Soil pH: 4-6.5

Comments: A low maintenance plant for the south. Salt-resistance makes it very useful in coastal areas.

*Vaccinium arboreum* Tree huckleberry, sparkleberry, farkleberry

Size and Habit: Small tree; 20-26 ft; requires pruning as screen

Light: Full sun

Soil Moisture: Average

Soil pH: 4-5.5

Comments: Requires pruning to produce thick foliage for screen. Select appropriate genetic material for area of use. Fruits are not edible.

*Ilex opaca* American holly

Size and Habit: Shrub or small tree; 10 ft in 18 yrs, 40 ft in 80 yrs

See information in previous section.

*Juniperus virginiana* Eastern red cedar

Size and Habit: Shrub or tree; 13 ft in 15 yrs, 66 ft in 90 yrs

See information in previous section.

*Magnolia grandiflora* Southern magnolia

Size and Habit: Tree; 26 ft in 20 yrs, 79 ft in 80 yrs

Light: Partial sun to full sun

Soil Moisture: Moist to average

Soil pH: 4-7

Comments: Free of problems. Many cultivars exist, so local experience should be consulted for the area of use. Foliage burn occurs in some winters in the northern part of its range (Virginia).

*Pinus strobus* White pine

Size and Habit: Tree; 26 ft in 22 yrs, 79 ft in 75 yrs

Light: Full sun

Soil Moisture: Average

Soil pH: 4-7

Comments: Grows best in good soil of moderate moisture content. Not a good choice for roadsides, urban planting, very dry or windswept areas, or for very heavy soils. White pine blister rust is a serious disease that is eliminated by removal of the alternate host *Ribes* (currants) from the area. Very sensitive to road salt and ocean spray.

*Pinus taeda* Loblolly pine

Size and Habit: Tree; 26 ft in 20 yrs, 98 ft in 50 yrs

Light: Full sun

Soil Moisture: Moist to very dry

Soil pH: 4-7

Comments: Fast but temporary screen. Tolerates very poor soil and exposed sites. One of the most durable and trouble free of the southern pines in landscape use. Borers can be a problem on mechanically damaged trees. Difficult to transplant in larger sizes, so plant young seedlings or container-grown trees. Growth is so rapid that trees attain functional size even when started as young seedlings.

*Prunus caroliniana* Carolina laurelcherry, cherry laurel

Size and Habit: Tree; 10 ft in 8 yrs, 30 ft in 30 yrs

Light: Half shade to full sun

Soil Moisture: Moist to average

Soil pH: 4-7

Comments: Unusually sensitive to poorly drained soil, tolerant of salt at seashore conditions. Requires pruning for maximum fullness as a screen.

*Tsuga canadensis* Canada or Eastern Hemlock

*Tsuga caroliniana* Carolina Hemlock

Size and Habit: Tree or shrub; 26 ft in 22 yrs, 92 ft in 80 yrs

Light: Partial shade to partial sun

Soil Moisture: Moist to average

Soil pH: 4-6.5

Comments: One of the finest evergreens for formal or informal hedges. Avoid windswept sites and dry soils, as the foliage is very susceptible to desiccation in winter and during dry periods of the summer. Partial shade is recommended for the summer in the South. In the South, select areas with cool summers. Susceptible to damage by hemlock wooly adelgid.

**Appendix IV.** Native species suggested for planting as windscreens (Sources: Schroeder 1988, Cunningham 1988, and Flint 1983).

Small-Medium Sized Deciduous (with dense canopies)

*Castanea pumila* Allegheny chinquapin

Habit: Tree; Small, shrubby.

Light: Full sun

Soil Moisture: Average

Soil pH: 4-7

Comments: Useful in sandy soil.

*Celtis occidentalis* Hackberry

Habit and size: Tree; 26 ft in 20 yrs, 92 ft in 75 yrs

Light: Full sun

Soil Moisture: Average

Soil pH: 4-7

Comments: Medium hardiness, high useful life, low soil demands, medium growth rate. Unusually well adapted to cold, heat, dryness, wind, and alkaline soils.

*Cornus amomum* Silky Dogwood

Habit and size: Shrub; 7 ft in 5 yrs, 10 ft in 12 yrs

Light: Partial shade to full sun

Soil Moisture: Average

Soil pH: 4-7

Comments: Broadly adapted to soil type, acidity, and moisture conditions.

*Fraxinus pennsylvanica* Green or Red ash

Habit and size: Tree; 20 ft in 15 yrs, 59 ft in 50 yrs

Light: Full sun

Soil Moisture: Average

Soil pH: 4-7

Comments: High hardiness, high useful life, medium soil demands, medium growth rate.

*Prunus americana* Wild or American plum

Habit and size: Shrub; 8 ft in 10 yrs, 13 ft in 20 yrs
Light: Full sun

Soil Moisture: Average to slightly dry

Soil pH: 4-7

Comments: Medium hardiness, medium useful life, medium soil demands, medium growth rate.

## Large-Scale Deciduous

*Populus deltoides* Cottonwood

Habit and size: Tree; 26 ft in 15 yrs, 92 ft in 35 yrs

Light: Full sun

Soil Moisture: Wet to average

Soil pH: 4-7

Comments: Longer-lived than most poplars.

*Quercus rubra* Northern red oak

Habit and size: Tree; 26 ft in 22 yrs, 66 ft in 70 yrs

Light: Full sun

Soil Moisture: Average

Soil pH: 4-7

Comments: One of the best oaks for city street planting.

## Small-Medium Sized Evergreen

*Juniperus virginiana* Eastern red cedar

Habit and size: Tree; 13 ft in 15 yrs, 66 ft in 90 yrs

Light: Full sun

Soil Moisture: Average to dry

Soil pH: 5-7

Comments: High hardiness, high useful life, low soil demands, low growth rate.

## Large-Scale Evergreen

*Pinus strobus* White pine

Habit and size: Tree; 26 ft in 22 yrs, 79 ft in 75 yrs

Light: Full sun

Soil Moisture: Average

Soil pH: 4-7

Comments: Medium hardiness, medium soil demands, medium growth rate.

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