A BACKGROUND OF THE *EARTHWORKS MANAGEMENT HANDBOOK*

INTRODUCTION

In this appendix, a review of the methods employed in the current study will be provided. This will be followed by a summary evaluation of current conditions of earthworks in the seven subject parks, based on late summer and fall observations made in 1995. Special attention will be given to those earthworks on which the 1989 *Manual*'s recommendations were adopted to some degree.

METHODS

The initial activities associated with this project included familiarization with the 1989 *Manual* and an orientation to the project at an introductory meeting at Colonial National Historical Park in Yorktown, Virginia, with representation from the Park Service including staff from each of the seven subject parks:

Richmond National Battlefield, Richmond, Virginia
Colonial National Historical Park, Yorktown, Virginia
Fredericksburg National Military Park, Fredericksburg, Virginia
Petersburg National Battlefield, Petersburg, Virginia
Ninety-Six National Historical Site, Ninety-Six, South Carolina
Stone's River National Battlefield, Murfreesboro, Tennessee
Kennesaw Mountain National Battlefield, Marietta, Georgia

After this earliest orientation, the following sequence of activities was conducted: (1) field observation and data collection; (2) analysis and evaluation of field-collected data; (3) review of relevant literature of landscape management and restoration techniques; and (4) development of the *Handbook*, including information on methods and techniques for earthworks management planning and implementation.

Field Observation and Data Collection

A key step in developing an understanding of the range of earthworks and their conditions under different levels of interpretation and management was to visit each of the subject parks and, within each park, a representative cross-section of earthworks. These visits were carried out during the last ten days of August 1995 for the four Virginia battlefield parks included in the 1989 study and in September-October 1995 for the South Carolina,

Tennessee, and Georgia units, which are included additionally as Southeastern parks that are actively managing earthworks.

During this phase of the project, one or more staff members in each park provided an orientation, with a reconnaissance of representative sites within the respective parks. Staff members also provided information on the current earthwork management practices within a range of different site conditions, from highly-interpreted and managed sites to non-interpreted sites in secondary successional forests, requiring a minimum of management. This orientation was followed by field data collection, which ranged from quantitative quadrat sampling (see Figure A.1) to qualitative visual observations at other representative sites within each park.

Figure A.1. Example of quadrat for vegetation sampling. Star Fort slope, Ninety-Six National Historic Site, September 1995.

At sites where one-meter-square quadrat sampling was done, the plots were distributed in such a manner as to insure objective sampling; e.g., twenty plots were placed a uniform number of paces apart, to gain a representative look at the vegetative cover, as opposed to subjectively selecting sample plots. In such quadrat studies, the following measures were recorded:

a. % cover of living herbaceous plants (as viewed from 3' above, looking straight down)

b. % cover of living woody plants

c. % cover provided by non-living "litter" (standing dormant material and fallen leaves, stems or clippings)

d. % bare soil

e. % tree canopy overhead, where applicable

f. Number and identity of species present

In addition, slope orientation, evidence of wildlife (e.g., groundhog) impacts and obvious human impacts (e.g., trampling and compaction of soil, and erosion) were noted.

Where qualitative visual observations were made, the following characteristics were noted:

a. Approximate tree canopy cover percentage

b. Checklist of dominant (canopy) species present

c. Checklist of prevalent understory and/or groundlayer species present

d. Notable signs of erosion, and wildlife or human impacts

Throughout the field observation and data collection phase of the project, particular attention was given to noting plant species which appear to have potential as vegetative cover in a variety of microhabitats, e.g., those growing under different percentages of canopy cover; those which are capable of growing on dry, sandy exposed sites; those which tolerated mowing at various heights; and those which are capable of colonizing on recently-disturbed bare sites. These plants are incorporated and noted in Appendix A at the end of the *Handbook*. Some of these plant species are commercially available at present; others are not commercially available, but could be propagated experimentally from field-collected seed, by NPS, interested commercial growers, or possibly the Natural Resource Conservation Service (NRCS) of the U.S. Department of Agriculture..

Black-and-white photographs, as well as slides, were taken at all fieldwork sites. These provide: (1) a basis for analysis and evaluation, (2) illustrations for this and other publications emanating from the project, and (3) a semi-permanent record of the late summer/early fall 1995 conditions at the subject earthworks, with which future photographs may be compared.

Analysis and Evaluation

This phase of the project entailed, first, the compilation of field data at each site where quantitative data were recorded. From such data, the following specific analytic measures were obtained:

a. Frequency of occurrence of all species noted, expressed as a percentage, i.e., the number of plots within which a particular species occurred, divided by the total number of plots observed at the particular site.

b. Average percentage of aerial cover in all plots at a particular site, broken into the following categories:

   Herbaceous species
   Woody species
   Litter (dead plant material, fallen leaves and clippings).

c. Average percentage of bare soil.

d. Species diversity: the number of plant species in each square-meter quadrat, and average diversity in all quadrats at a particular site.

e. Average percentage of overhead tree canopy for wooded sites.

These data, along with descriptive notes recorded at each of the visited sites, were correlated with photographic documentation of earthwork characteristics in the field as a basis for evaluating the condition of the subject earthworks.

From the aggregated observations, a quantitative evaluation system for rating the condition of specific earthworks sites was devised. The first step in developing this system was to determine the criteria for evaluation and the relative weight assigned to each criterion, or category. The criteria, along with the relative value for each criterion, are shown in Table A.1.

Weight	Criterion Category
50%	The degree of protection from soil erosion, based on the amount of cover provided by living vegetation and organic litter (dormant standing cover, fallen leaves, twigs, and clippings). The greater the cover percentage, the higher the rating.
10%	The average species diversity within sample plots. The greater the diversity, the higher the rating.
10%	The prevalence of persistent invasive species. The lower the presence of invasive species, the higher the rating.
10%	Visual quality and earthworks legibility. Consistency of vegetation texture and scale, in combination with the "readability" of the form of the earthwork, contribute to a higher rating.
10%	Human use and wildlife impacts. The less obvious and less damaging these impacts, the higher the rating.
10%	A "sustainability" rating, based on the number of treatments per year (e.g., number of mowings or burnings, and fertilizer or herbicide applications) required to maintain the earthwork. The fewer treatments per year, the higher the rating.

Table A.1. Criteria for Evaluating Earthworks and Relative Weights

Within each criterion category for evaluation, a rating scale of 1 to 5 was devised. This rating is, in spite of its numerical orientation, subject to some interpretation, especially in the "Visual Quality and Legibility" category. Nevertheless, when applied by one team across several sites, this method of evaluation provided a useful basis for comparison of earthwork conditions on a scale which ranges from 20 for the worst condition to 100 for the "perfect" score. See Table A.2 for a complete breakdown of the bases for rating within the six major criterion categories.

Criterion Category	Rating Scale
Cover as indication of erosion control (x 10):	5 pts. - >80% living cover 4 pts. - >80% living cover & mulch/litter 3 pts. - 60-80% cover 2 pts. - 40-60% cover 1 pt. - <40% cover Maximum points possible: 50
Average species diversity (x 2):	5 pts. - >8 average species per square-meter quadrat 4 pts. - 6-8 average species 3 pts. - 4-6 average species 2 pts. - 2-4 average species 1 pt. - 1-2 average species Maximum points possible: 10
Presence of aggressive, persistent exotics (x 2):	5 pts. - None observed 4 pts. - <25% frequency of exotics 3 pts. - 25-50% frequency 2 pts. - 50-75% frequency 1 pt. - >75% frequency Maximum points possible: 10
Visual quality and legibility (x 2):	5 pts. - Legible earthwork form; attractive 4 pts. - Generally legible; discordant spots 3 pts. - Partially legible; discordant spots 2 pts. - Generally "rough"; inconsistent 1 pt. - Chaotic and illegible Maximum points possible: 10
Presence of negative human/animal impacts (x 2):	5 pts. - Neither evident 4 pts. - Minor trampling or animal burrowing 3 pts. - Major trampling or burrowing 2 pts. - Both trampling and burrowing evident 1 pt. - Extreme impact (e.g., ATV compaction) Maximum points possible: 10
Maintenance/ management treatments required (cutting, mowing, burning) (x2):	5 pts. - One treatment annually or less 4 pts. - 2-4 treatments per year 3 pts. - 5-6 treatments 2 pts. - 7-8 treatments 1 pt. - >8 treatments Maximum points possible: 10
Overall Rating	90-100 pts. - Highly Successful 80-89 pts. - Successful 70-79 pts. - Acceptable 60-69 pts. - Reevaluation needed < 60 pts. - Unacceptable Total Maximum Points Possible: 100

Table A.2. An Evaluation System for Rating Earthworks

Literature Review

Concurrently with the analysis and evaluation phase of the project, a review of recent literature was conducted, with emphasis on: (1) landscape restoration and management techniques; (2) control of invasive species (especially persistent woody species); and (3) those plant species which show particular potential as protective cover for earthworks, based on their observed presence on or near existing earthworks in the subject parks. Especially relevant to this research were the following journals: *Restoration and Management Notes*, *Restoration Ecology*, and *Natural Areas Journal*. These journals, as well as publications from several public agencies, indicate that the experience and information base on land management practices for difficult sites is broadening.

Earthworks Management Field Handbook. This Handbook represents the culmination of the project to date, incorporating observations and information gained in the various phases outlined above, and providing recommendations regarding planning for and implementation of earthworks management practices.

Overall Condition of Earthworks at Selected Sites

The earthworks in the seven parks that are the subject of this project fall along a broad range of the types outlined in Chapter Three. There is also a wide range of environmental contexts within which these earthworks occur in terms of soils, slopes, moisture, and vegetative cover. The intensity of use for interpretation and recreational purposes similarly spans a wide range, as does the degree of landscape maintenance or management activity. Categories of the intensity of interpretation and management include: (1) protected earthworks, with little interpretation or management, usually in secondary forest cover; (2) intermediately-managed earthworks where vegetation may be managed to increase the legibility of earth forms, usually within a secondary forest context; and (3) intensively-visited and interpreted sites that have been cleared or partially-cleared at some time in the past, with management activity devoted to keeping them cleared, and oftentimes to maintaining a manicured or semi-manicured appearance.

To the extent that widely varying situations permit, the following is a summary of the condition of representative earthworks in each of the three categories outlined above, based on observations and data collected in late summer and fall of 1995.

Protected Earthworks

In general, as noted in the 1989 Manual, those earthworks that have been permitted to develop a secondary forest cover during the period since the respective Revolutionary or Civil War battles occurred, are in excellent to good condition now (see Figure 4.2). The combination of a protective tree

canopy of 70%-90% when trees are in leaf, a variety of midlayer saplings and/or shrubs, and a groundlayer which often includes living herbs and vines, as well as a deep litter layer including slow-to-decompose oak leaves, provides excellent protection against erosion. The exceptions to the generally high level of protection on re-forested earthworks occur: (a) where heavy-impact recreational uses, e.g., use of "dirt bikes," have resulted in vegetation removal, soil compaction and gully erosion; (b) where large trees growing on earthworks have blown down in windstorms, bringing up large tip-up mounds of roots and soil from the earthworks (See Figure 4.3) and (c) where groundhogs have burrowed in the earthworks, bringing soil from within to the surface, and compacted bare soil outside the entrances.

Intermediately-Managed Earthworks

The majority of these earthworks tend to be in good condition because they too usually have canopy cover overhead, and at least some shrub or vine cover, living groundcover, and leaf litter (See Figure 4.4). By virtue of greater visibility and accessibility associated with these earthworks, there is an increased likelihood of use by park visitors and recreationists. If activities such as hiking and jogging, occur directly on the earthworks, they lead to compaction and erosion.

The potential for uprooting of trees on these earthworks is again a problem. However, when the management involved in these intermediately-managed sites entails cutting of shrubs and saplings to a height of two to three feet, there are two positive effects: an increase in the density of shrub growth, and a long-term reduction in large trees, with their potential for blow-downs, growing directly on earthworks (See Figure 4.5).

Cleared or Partially-Cleared Earthworks with More Intensive Interpretation and Management Programs

On earthworks in this category, there is a whole spectrum of different conditions reflecting past and current management activities, as well as different interpretive goals. Based on the evaluation system explained earlier in this chapter (see Tables 1 and 2, pages 9-11), nine specific earthworks sites in this category rated from 66 to 92 points on the 100-point scale, with a median score of 76, or in subjective terms, an "acceptable" condition.

On frequently-mown earthworks that are treated very much like lawns, e.g., those at Fredericksburg's Prospect Hill and Bloody Angle, the cover is almost totally comprised of herbaceous plants, including a variety of native and non-native grasses and low rosette-forming plants (See Figures 4.6 and 4.7). Woody plants are almost non-existent. During the dry period of late August 1995, the appearance of such sites was that of a spotty lawn, especially where sloping earth forms and sandy soil create very xeric conditions. Maintenance requirements for this earthworks treatment are high, with bi-weekly mowing during a normal season. The frequent, low mowing increases the chances

for physical damage from the mowing activity each time it occurs. Further, the very low cover does nothing to inhibit visitors' walking on the earthwork.

Taller vegetation occurs on a number of non-forested earthworks in the subject parks, either as a result of changes in the mowing frequency and height, or of the active planting of warm-season native grasses as seedling "plugs" or as a seed mix. These various approaches to establishing a cover dominated by native warm-season grasses are to varying degrees in response to the recommendations made in the 1989 Manual (See Figure 4.8).

The most direct adoption of Manual recommendations is at Richmond National Battlefield Park, where the installation of Little Bluestem seedlings was initiated in 1989 and 1990 on several different earthworks at Fort Harrison, on sites with varying light conditions ranging from full sun to semi-shade. During the period from 1990 through 1992, woody species were mechanically removed from these plantings by cutting or pulling. Very little management activity occurred between 1992 and 1995, when a prescribed burn was initiated on April 20. During the interim, a dense growth of woody plants, both native and non-native, colonized on the unmowed earthworks. The fire had a suppressing effect on the woody plants, but herbaceous species (Little Bluestem in combination with approximately ten other species) provided only about 20% average cover in sample plots within the burned area in late August 1995. Bare soil occupied an average of 30%. (See Figures 4.9 through 4.12).

At Ninety-Six National Historic Site in South Carolina, seeding of a mix of native grasses and a legume was initiated in the spring of 1994 on the Revolutionary War Star Fort and restored siegeworks. No management activity occurred during the 1994 growing season, but monthly mowing at a six-inch height was initiated during the summer months of 1995. A high percentage of live herbaceous cover was noted in the seeded areas in September 1995, comprised predominantly of grasses. One of the major components was the annual, Crabgrass (Digitaria sanguinalis), a characteristic early successional species in Southeastern Piedmont fields once cultivation ceases. It is expected that a continuing program of monthly mowing at a six-inch height during the spring and early summer will permit increasing dominance of perennial grasses, both of species that were seeded in the spring of 1994, and other species whose seed is present in the soil (See Figures 4.13 and 4.14).

At Fortress Rosecrans at Stone's River National Battlefield Park in Tennessee, a native warm-season grass seeding was done in the fall of 1994 on a site that had previously been a forest with a dense understory growth of Privet (Ligustrum sinense). The tree canopy had been thinned and the Privet removed prior to seeding. Later during the fall of 1994, the warm-season native grass seeding was over-seeded with Tall Fescue (Festuca pratensis), a cool-season exotic grass. In September of 1995, the seeded area had only a

small percentage of bare soil, but a large presence of woody species' seedlings (See Figure 4.15). The living herbaceous plant cover, which averaged 56.5% in twenty sample quadrats, was overwhelmingly dominated by Tall Fescue. This reflects the phenomenon of allelopathy, whereby one plant species releases chemicals which inhibit the growth of others. In recent research on grassland restoration, reported in Restoration and Management Notes, it has been observed that Tall Fescue inhibits the colonization of native warm-season grasses. In the future, a determination will need to be made regarding the potential of destroying the Fescue and re-establishing warm-season native grasses. Also, a mowing program will be necessary to suppress the growth of numerous woody seedlings on the Fortress, especially those of Privet.

In some of the battlefield parks included in this study, there have been no programs to actively introduce native warm-season grasses, but reducing the mowing frequency and/or raising the height of mowing has facilitated the development of a diverse cover of predominantly native, warm-season grasses.

At Colonial National Historical Park at Yorktown, Virginia, for example, the mowing of the major earthworks near the Visitor Center has been reduced to once per year, and is done with a boom-arm mowing unit. The mowing of these earthworks is typically done during late summer, at a height of two inches or less. The resultant cover is diverse, with an average of 7.1 species recorded in twenty quadrats, comprised of a mix of native and non-native grasses and forbs along with woody plants such as Japanese Honeysuckle and Blackberry. Average cover by herbaceous plants in the plots was 39% just prior to the summer 1995 mowing, with a 16.5% cover by woody species. Average bare soil per meter-square quadrat was 26% in the sampled area. Species distribution varied with the position on the slope, with a greater frequency of native warm-season grasses on the upper slopes, and a greater frequency of Japanese Honeysuckle and Blackberry on the middle and lower slopes (See Figures 4.16 through 4.18).

For the purpose of increasing the percentage of cover by warm-season grasses, it would be beneficial to change the annual mowing to May-June, and to raise the mowing height to six inches, since many of the warm-season native grasses are damaged by short mowing. If these options are not practicable because of interpretive needs, an alternative would be to supplement the existing cover with a sod-forming native grass which is tolerant of shorter mowing, Sideoats Grama Grass (Bouteloua curtipendula), whose seed could be introduced into bare patches.

At Petersburg National Battlefield Park in Virginia, a variety of approaches to clearing and revegetation have been followed, and have been well-documented in terms of procedures and costs. At Battery Five, near the Petersburg Visitor Center, the floor continues to be mowed weekly during the growing season at 2"-3". Contrasting with this, the earthwork berms are

now being mowed approximately on a monthly basis at a height of 5", using a Dew-Eze self-levelling mower. In August of 1995, in sample plots on Battery Five, herbaceous cover averaged 31.5%, woody cover averaged 17.7%; organic litter accounted for almost 43% of the cover. Species diversity averaged 7.5 species per quadrat. Warm season grasses are invading the berms, especially the upper slopes. There is a seed source of these in an annually-mown field adjacent to the Battery (See Figure 4.19).

At Fort Gregg (Petersburg) during 1992-93, a major clearing project was executed, cutting trees and shrubs and treating with glyphosate herbicide to kill sprouts. Topsoil was applied to 1"-2" in eroded areas, and bare spots were seeded with Tall Fescue, mulched, and a jute mesh was applied on steep slopes. Unlike Battery Five, Fort Gregg does not have a nearby source of native warm-season grass seed, and provides the opportunity to observe whether such species will invade without introducing them. At Fort Wadsworth (Petersburg), in 1994, a clearing project similar to that at Fort Gregg was carried out. After clearing, the entire earthwork was hydroseeded with Tall Fescue. This cover is presently being maintained with periodic mowing at 3", liming and fertilizing, and watering during dry periods.

In summary, there is a very wide range of conditions on earthworks. The greatest challenge, management-wise, are those earthworks that have been cleared at some time, where the overall condition is oftentimes rated only in the “fair” to “good” range. This reinforces the importance of recognizing that presently-wooded earthworks sites should be cleared only after careful consideration of the long-range management implications and continuing resource needs.

B REVIEW AND EVALUATION OF THE *EARTHWORKS LANDSCAPE MANAGEMENT MANUAL*

INTRODUCTION

As noted in the Introduction to this *Handbook*, the 1989 *Earthworks Landscape Management Manual* was conceived as the first step toward developing a comprehensive approach to planning and management of earthworks in battlefield parks within National Park Service jurisdiction. As a first step, it is subject to review and evaluation as more experience is gained and as new information is accumulated. In this section of the *Handbook*, a review of the 1989 *Manual* is provided, with the perspective gained from six more years of earthwork management experience in the parks, where projects were initiated based on the *Manual* and from the growing body of literature on landscape restoration and management. This critique is intended purely as a constructive one, identifying areas where additional experience and information either supports the 1989 recommendations or raises questions about them. Next, modifications or additions that can further advance the art and science of earthworks management are suggested. These observations are based on field data collected in late summer and fall of 1995 in the seven subject parks, and on (sometimes extensive) discussions with NPS staff involved in earthworks management, particularly on sites where 1989 recommendations were adopted to some degree.

The *Manual* is an important document, in that it provides useful information about the evolution and effects of different earthworks management practices up to the time of its 1989 publication. It also developed a typology of vegetative cover types with a generalized evaluation of the effectiveness of these different cover types. Furthermore, the *Manual* provides generalized management guidelines and more specific plans for two sites, Fort Fisher at Petersburg and Cold Harbor at Richmond. The final section of the 1989 *Manual*, "Management Guidelines for the Restabilization and Revegetation of Damaged Ground Surfaces," provides a summary of bioengineering techniques (e.g., the use of live stakes, fascines, branch-packing, brush layering) for re-stabilizing eroded areas on earthworks.

The 1989 *Manual* recommendations have been adopted or adapted for earthworks vegetation management in an uneven manner at the study parks. Park personnel indicate that the bioengineering techniques identified in the *Manual* have been minimally utilized in their management practices. This may relate to the labor-intensive nature of such practices, but it also reflects a reluctance to utilize techniques which are invasive of the earthworks soil.

Furthermore, except in forested areas, the woody plant species recommended in bioengineering practices would diminish the legibility and textural consistency that is desirable on interpreted earthworks.

Recommendations in the *Manual* to establish warm-season grass cover on interpreted sites have been adopted to various degrees. In one park, active planting of Little Bluestem "plugs" was accomplished in 1990 and 1991. At others, a reduced mowing program has contributed to the development of a more diverse cover that includes "volunteer" warm season native grasses, with far fewer resources devoted to mowing.

The following review will summarize (1) strengths of the 1989 *Manual* and (2) portions of the *Manual* where revisions or modifications appear warranted and (3) areas requiring additional information.

STRENGTHS OF THE 1989 *MANUAL*

The 1989 work has served a very valuable role in raising awareness of the earthworks as irreplaceable resources, and of the complexities of balancing interpretive objectives with natural and cultural resource protection within a Federal agency in an era of changing management goals and diminishing or uncertain funding.

The *Manual* provides a set of "Guidelines for Earthworks Preservation" (pages B-6 and B-7) which includes particularly relevant perspectives on: (a) the need to monitor and evaluate management practices on a relatively small scale before they are applied on a larger scale (Guideline 3); (b) the fact that "no increase in the level of management required should be initiated unless it can be completed properly, adequately followed through, and maintained over time" (Guideline 5); (c) recognition of the need for annual monitoring (Guideline 6); and (d) noting that "the principle of 'economy of intervention' should be followed to minimize unnecessary effort and disturbance."

Also, Section B of the *Manual*, the "Interpretive & Management History of the Earthworks" (pages B-8 through B-15), provides valuable discussions of such issues as: (a) the importance of keeping visitors off earthworks; (b) the threats to earthworks posed by the presence of large trees on the berms; (c) the conflicts inherent in historic scene restoration within rapidly urbanizing areas; and (d) the importance of experimentation with new techniques on demonstration projects which are monitored and evaluated in an on-going manner. These discussions are as relevant in 1996 as they were in 1989, as efforts to improve management practices continue.

Section C of the *Manual* is on "Evaluation of Existing Vegetative Cover Types," divided into Forest Cover types, Field Cover types, and Special Conditions, based on observations in the four Virginia parks in this study. The observation that "the earthworks under forest cover are the most well

stabilized" is verified in 1995 observations. However, the *Manual* is correct in stating that earthworks under forest cover are subject to damage by trampling, erosion, and wind-thrown trees. Discussions of "Cleared Woodlands," "Rough Grass" and "Turf" accurately depict the problems associated with these increasingly manipulated cover types.

Section D of the *Manual* outlines "Recommended Vegetative Cover Types: Forest Cover, Light Forest Cover, Tall Grass Cover, and Turf Cover." In the Forest Cover Type, the *Manual* correctly points out the need to control access to earthworks in this condition or to provide slightly elevated boardwalks over earthworks to minimize impact. The discussion of Tall Grass Cover also correctly points out the fact that a tall grass cover will discourage trampling while still permitting visual access. It also recognizes the need for mowed paths that are located on level ground adjacent to earthworks with a minimum number of crossings, which again might be handled with slightly elevated boardwalks. This same section acknowledges that agricultural pasture or hayfields may be a logical cover in certain historic scene re-creations, but that these alternatives are not appropriate on actual earthworks. Section D closes with the point that turfgrass cover should be reduced, on earthworks and adjacent lands, due to the high costs and non-sustainability of this type of cover.

Sections F, G and H constitute the recommendation sections of the 1989 *Manual*. The importance of monitoring and evaluation is reiterated in Section F, but procedures for monitoring and recording observations are unclear (see 2., AREAS FOR MODIFICATION, below). Section G, "Management Guidelines for Recommended Forest Types," contains interesting commentary on such topics as forest configuration; natural processes and forest structure; and techniques such as prescribed burning, clearing, liming, and additional planting without specific information on how a park might apply these techniques.

Section H provides "Management Guidelines for Recommended Field Cover Types: Tall Grass and Turf." It is correctly observed that for the most part, the pre-Columbian Mid-Atlantic and Southeastern landscapes were naturally forested, and if permitted to, most presently open landscapes would become wooded ones today, albeit with a mixed composition of native and non-native species. Hence, to keep earthworks in an open, non-forested condition requires active management. This section again provides background information on configuration, natural processes and structure, but actual guidelines for field evaluation or application are difficult to winnow from the text (see 2., AREAS FOR MODIFICATION, below). Section H also includes information on establishing tall native grasses. Useful suggestions in this section include the use of a cool-season "nurse" crop in the seed mix for early protection against soil erosion, and the use of mowing during the first growing season to suppress competing species.

AREAS FOR MODIFICATION OF THE 1989 *MANUAL*

As suggested in the enumeration of the strengths of the 1989 *Manual*, it served a number of useful purposes in terms of its review and critique of then-current management practices in the four battlefield parks, its discussion of ecosystems and their dynamics, its development of a management planning approach, and its outlining of recommendations on the establishment or management of different cover types on earthworks.

At the same time, the recommendations in the *Manual* have not been widely adopted, because of a park's inability to assess its earthworks condition or needs based on the *Manual*. When they have, the results have not been uniformly effective, as noted later in this chapter under "Overall Condition of Earthworks." Hence, in the pages that immediately follow, we will identify areas in the 1989 *Manual* which might, with the experience and information gained since 1989, be reconsidered and revised, and other areas where additional information appears to be needed by managers in the field.

A recurrent question that arises in reviewing the *Manual* relates to the heavy reliance on one species of grass, Little Bluestem, in creating the Tall Grass Cover Type. The first reference to this occurs on page D-4 of the *Manual*, where it is correctly noted that its Latin nomenclature has changed from *Andropogon scoparius* to *Schizachyrium scoparium*. It is suggested that this grass is locally referred to as Broomsedge or Broomsage, a common name that is also used for *Andropogon virginicus*, probably the most abundantly-occurring and most visible native grass on impoverished soils of the Piedmont

Figure B.1. Native grass field at Prospect Hill, Fredericksburg National Military Park, August 1995.

regions of the Southeast. During the August 1995 fieldwork phase of this project, it was noted that in fields where mowing has been reduced to once a year (e.g., adjacent to Battery Five at Petersburg; on Prospect Hill at Fredericksburg), a diverse mix of native grasses and forbs has developed. This was noted in a walk-through survey at the Prospect Hill and Petersburg sites.(see Figures B.1 and B.2). Following are native grasses noted at each site during those surveys:

Prospect Hill Field, Fredericksburg

Andropogon ternarius (Splitbeard Bluestem)
Aristida purpurascens (Arrowfeather Three-awn)
Erianthus spp. (Plumegrass)
Paspalum spp. (Paspalum)
Schizachyrium scoparium (Little Bluestem)
Sorghastrum nutans (Indiangrass)
Tridens flavus (Purple Top)

Visitor Center, Petersburg

Andropogon ternarius (Splitbeard Bluestem)
Andropogon virginicus (Broomsedge)
Andropogon virginicus glauca (Broomsedge)
Panicum spp. (Panic Grass)
Paspalum spp. (Paspalum)
Schizachyrium scoparium (Little Bluestem)
Tridens flavus (Purple Top)

Figure B.2. Native grass field, mowed annually in fall, near the Visitor Center, Petersburg National Battlefield Park, August 1995.

It would seem logical that for earthworks in the same parks, these diverse stands would serve as a model for planting the tall grass cover type, as opposed to planting only one or two species.

On page D-4, it is also noted that "almost any open site with 40% or less tree cover can be stabilized with native grasses. In fact, the *Andropogons* and *Schizachyrium* need almost full sun to thrive as noted in the USDA publication, *100 Native Forage Grasses in 11 Southern States*. Other species of grasses, however, can tolerate the partial shade represented by a 40% canopy, as noted in the same publication.

> *Elymus virginicus* (Virginia Wildrye): upland and lowland sites.
> *Chasmanthium latifolium* (River Oats): floodplains, mesic uplands
> *Aristida purpurascens* (Arrowfeather Threeawn): sandy, uplands.

On page D-7, the comment is made that the "major obstacle in establishing this [tallgrass] cover type is the limited experience in creating and managing meadows." In fact, research has been going on since the 1930s in prairie restoration at the University of Wisconsin Arboretum and since the 1960s at the Morton Arboretum. A number of state transportation departments have subsequently worked on stabilization of steep slopes, using native grasses. This experience is particularly applicable in earthworks management. While much of the early work was done in the Midwest, techniques for establishment are transferable to other regions, using species native to those regions (and a surprisingly large number of species occur in sunlit openings throughout a wide range, from the Midwest to the geographic area covered by this study).

Regarding costs, the claim is made on page E-6 that "almost without exception, the recommendations made herein are cheaper, more cost effective in the long run, and easier to implement than many current practices." Indeed the recommendations that call for minimum intervention are less costly than many of the practices that had been in effect. However, such practices as plugging Little Bluestem are not economically practicable in most parks. Even the costs of doing prescribed burns for vegetation management purposes have escalated beyond the capability of most parks' ability to fund.

In the "Monitoring and Evaluation" section, page F-2, the instructions state:

> The site monitoring and evalutation [sic] team should be equipped with pencils, a clipboard, adequate evaluation forms, and blank site maps (8-1/2" x 11"), a duplicate of last year's evaluation forms and maps as well as a 100' measuring tape. A camera is advisable for recording site information. Surveyor's flagging tape may also be useful.

For purposes of the person(s) doing the monitoring, some guidance regarding what to look for is needed, as well as a sample evaluation form.

On page G-6, the practice of laying "shrub mats (collected locally or propagated commercially)" as a way of replacing shrub cover is recommended. This is questionable (a) on the basis of cost, in the case of commercially-propagated mats; and (b) out of concern for the potential damage to areas from which such mats might be collected locally and for resultant invasion by undesirable species. Tree planting details on pages G-8 and G-9 are of questionable value in that the cost of tree planting suggests that it would be far preferable to permit natural regeneration in areas where additional trees are desired (following the principle of " economy of intervention" generally promoted in the *Manual*).

There is a lack of clarity on page G-15 relative to the recommended treatment of Japanese Honeysuckle. On the one hand, it is noted that mowing the honeysuckle will "stimulate rooting and create a denser, more matlike cover, and improve effective stabilization." Then, it is observed that "continued and repeated mowing will gradually diminish the plant and should proceed [sic] any herbicide control."

On page G-16, except for Japanese Honeysuckle, the exotic species listed as needing control were not widely observed in the field during the 1995 fieldwork. Invasive exotics that were most frequently observed in addition to Japanese Honeysuckle (*Lonicera japonica*) were: Privet (*Ligustrum sinense*), Tall Fescue (*Festuca pratensis*), and Johnson Grass (*Sorghum halepense*).

Liming of forested areas is tentatively proposed on page G-17. This practice seems contrary to the "principle of economy of intervention;" it would appear far better to work with vegetation that is adapted to acidic conditions than to try to modify the pH even temporarily.

In Section H, "Management Guidelines for Recommended Field Cover Types: Tall Grass and Turf," the conversion from "rough grass" to tall native grasses is implied to be a simple process that can occur within a two- to three-year period with decreasing levels of (unspecified) management. In fact, if the "rough grass" cover is dominated by a cool-season, allelopathic grass such as Tall Fescue, it may require an intensive effort involving spring burning and/or herbicide application timed to suppress the cool-season Fescue without damaging warm-season native species.

The use of fire in tall grass sites, while potentially effective at suppressing cool-season herbaceous plants and some woody species if timed appropriately, is not a practicable tool in many situations because of the complexities of burning in urbanizing areas, and the costs associated with it.

The practice of liming Tall Grass Cover zones (page H-6) is questionable. A more sustainable approach would be to simply utilize plant species capable of growing in acid soils, based on selecting species growing in such situations already.

The commentary on "Establishing Tall Grasses" is subject to revision for two major reasons: (a) the recommendations revolve around single-species plantings of either Little Bluestem or Switchgrass which would lack the benefits of species diversity; and (b) establishment of Little Bluestem as plugs is impractical in all but very small areas because of cost and also the vulnerability of seedlings to seasonal droughts immediately after planting.

Section I of the *Manual* is devoted to Revegetation of Damaged Ground Surfaces using bioengineering techniques, e.g., inserting live stakes or live fascines into earthworks or branch-packing or brush layering. As noted earlier, there has been minimal application of these techniques in the subject parks. Since the techniques have been used elsewhere over a long period of time, there is reason to believe that they could be successful on earthworks. However, two considerations override this. First, the insertion of stakes and branches, as well as 2" x 4" boards, deeply into earthworks, and the excavation for branch-packing, is potentially damaging. Secondly, if visibility or legibility of earthworks is a goal, the woody species recommended are contrary to the goal. Additionally, of the four recommended species listed on page I-8, two are wetland species (Willow and Red Stem Dogwood) which would only be suitable in swales or other low, poorly-drained areas; and two are invasive exotic shrubs, Privet and Russian Olive. In two small demonstration applications at Fort Darling and Fort Gilmer (Richmond) in 1989, the use of willow fascines was ineffective because the light level was too low for the willows. There was greater establishment of willow on a small demonstration of branch-packing with willow on a sunlit portion of Fort Hoke, also at Richmond.

Areas Requiring Additional Information

Additional information is needed in several areas, as follows:

a. List of plant species for a variety of different micro-environments, based on field observations.
b. Information on range, habitat, appearance, and management needs of this greatly-expanded list of plant species.
c. Information on specific observed invasive species and on their control methods (mechanical, chemical, fire).
d. Sources of seed of additional species.
e. Key publications providing current restoration and management research results.
f. Information on management and equipment costs.
g. Evaluation forms for assessing condition of earthworks, before initiating management, and during subsequent monitoring.
h. More specific information on seeding techniques (e.g., seed mixes,seeding times, and methods of seeding).

Chapter Five as well as the Appendices in this Handbook will include information in the above areas.