National Park Service
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Northeast Region
Philadelphia, Pennsylvania

Conceptual Ecological Model for Management of Breeding Grassland Birds in the Mid-Atlantic Region

Natural Resources Report NPS/NER/NRR--2006/005

ON THE COVER
Savannah sparrow (*Passerculus sandwichensis*); Savannah Sparrow nest with eggs.
Photographs by: Matthew Marshall, National Park Service

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Bruce Peterjohn

USGS Patuxent Wildlife Research Center
Laurel, MD 20708
bpeterjohn@usgs.gov

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Introduction

The status of grassland birds has become an increasingly important conservation issue. These species exhibit the most consistent population declines of any group of North American birds during the past 40 years. Anecdotal evidence suggests these declines have been occurring for nearly a century (Peterjohn and Sauer 1999). While the widespread conversion of grasslands into other habitats contributed to these declining populations, other factors such as habitat fragmentation and mowing regimes are also implicated (Vickery et al. 1999a). This plight of grassland birds has heightened awareness of the need for concerted conservation actions to reverse these seriously declining population trends.

The National Park Service (NPS) is positioned to potentially contribute to grassland bird conservation in the Mid-Atlantic Region. The NPS maintains a number of historic sites and former battlefields that are managed for their cultural significance but also support wildlife populations. Many of these "cultural parks" maintain open landscapes to recreate land use patterns that existed at the times of the historical events. These open landscapes are primarily managed grasslands which could be maintained to benefit grassland birds.

In 2005, the NPS initiated a project exploring the potential of "cultural parks" to support significant breeding grassland bird communities. This project involved parks within three NPS Inventory and Monitoring Program (I&M) networks, Mid-Atlantic, National Capital, and Eastern Rivers and Mountains. Five parks were selected for the initial focus of this study, all of which maintain open landscapes for interpretation of historic events. Most parks were selected because they represent the most extensive grassland habitats within their networks, with the rationale that if these parks cannot support significant breeding grassland bird communities, then parks with smaller acreages cannot support these communities either. The five parks included in this study are: Antietam National Battlefield, Fort Necessity National Battlefield, Gettysburg National Battlefield, Manassas National Battlefield, and Monocacy National Battlefield.

This conceptual ecological model is one product of this project. The information presented below allows NPS Network Coordinators to understand the factors to consider when making decisions concerning grassland management within their networks. This model provides park Resource Managers with information on grassland ecology in the Mid-Atlantic Region, the ecological requirements of grassland birds likely to occur in their parks, and management issues that influence whether significant breeding populations can be expected to occupy grasslands created and maintained in the parks. The Resource Managers can then make informed decisions concerning their ability to create and maintain grassland habitats.

The emphasis of this conceptual model is restricted to management of breeding grassland birds. Additional species may occur in this region during migration and winter, while habitat requirements of all grassland birds during nonbreeding seasons will differ from those described for the breeding season.

Terminology

Defining species considered to be "grassland birds" is invariably somewhat subjective. This document follows Vickery et al. (1999a) who define grassland birds "as any species that has

become adapted to and reliant on some variety of grassland habitat for part or all of its life cycle." Species occupying damp or seasonally flooded grasslands are included, while birds that normally breed over or adjacent to standing water are excluded. See Vickery et al. (1999a) for lists of obligate and facultative grassland birds for North America. This model is restricted to species identified as "obligate" grassland birds occurring in the Mid-Atlantic Region.

"Mid-Atlantic Region" refers to Pennsylvania, Maryland, Virginia, and the District of Columbia. Within this region, the most widespread obligate grassland birds are horned lark (*Eremophila alpestris*), vesper sparrow (*Pooecetes gramineus*), Savannah sparrow (*Passerculus sandwichensis*), grasshopper sparrow (*Ammodramus savannarum*), Henslow's sparrow (*A. henslowii*), bobolink (*Dolichonyx oryzivorus*), and eastern meadowlark (*Sturnella magna*). These species are the primary focus of this conceptual model. Additionally, northern harrier (*Circus cyaneus*), upland sandpiper (*Bartramia longicauda*), short-eared owl (*Asio flammeus*), sedge wren (*Cistothorus platensis*), and dickcissel (*Spiza americana*) occur very locally and in such small numbers that they are unlikely to be found in any park.

Habitat fragmentation is defined as "…the discontinuity, resulting from a given set of mechanisms, in the spatial distribution of resources and conditions present in an area at a given scale that affects occupancy, reproduction, or survival in a particular species" (Franklin et al. 2002). Fragmentation is species-specific and operates at multiple spatial scales. Below, fragmentation is discussed from the local scale of grassland birds establishing breeding territories in a park and from the landscape scale of birds finding suitable grasslands within a park among the mosaic of habitats present in the surrounding countryside.

Area sensitivity is defined similarly to the patch-size effects of Johnson and Igl (2001). These effects cause the "use or reproductive success to differ among habitat patches of different sizes." Area sensitivity may be induced by edge effects that occur at different levels at a habitat edge than in the interior or by isolation from similar habitats that can influence dispersal to habitat patches of different sizes (Johnson and Igl 2001).

Grassland Bird Distribution

Grassland birds are not uniformly distributed across the Mid-Atlantic Region and management activities should be directed to benefit those species most likely to occur within each park. The status of grassland birds in each state is summarized in Table 1.

Grassland bird diversity and abundance decreases from north to south and west to east across this region. These birds are most numerous in Pennsylvania where horned larks, vesper, Savannah and grasshopper sparrows, bobolinks, and eastern meadowlarks are widely distributed in most counties except for the southeast, where only grasshopper sparrows and eastern meadowlarks are likely to occur (Brauning 1992). Henslow's sparrows are locally distributed primarily west and north of the Appalachian Mountains, and Pennsylvania supports an important breeding population of this species of conservation concern. Other grassland birds tend to be rare and locally distributed within the state. Grassland habitats are more prevalent away from the mountains, primarily in agricultural lands where some pastures and hayfields have been maintained for centuries. In recent decades, however, the largest contiguous tracts of grasslands have been created on reclaimed strip mines (Brauning 1992).

In Maryland and Virginia, the Ridge and Valley and Appalachian Mountain regions support similar grassland bird communities as Pennsylvania although Savannah sparrows and bobolinks are much less numerous in Virginia than farther north. Only horned larks, grasshopper sparrows, and eastern meadowlarks are widely distributed in the Piedmont and Coastal Plain regions of both states, with small numbers of vesper sparrows occurring only in Maryland (Robbins and Blom 1996, Trollinger et al. 2001). Henslow's sparrows are very locally and sporadically encountered in both states where total breeding populations are currently very small. Other grassland birds are very rare and not likely to breed within parks in these states. Reclaimed strip mines augment grassland habitats found in agricultural fields in both states.

Table 1. Breeding status of obligate grassland birds in the Mid-Atlantic Region.

Species	Pennsylvania	Maryland	Virginia
Northern harrier	R—very local but widespread	R—primarily on Coastal Plain	R—restricted to salt marshes on Coastal Plain
Upland sandpiper	R—very local, few pairs remain	R—very local, few pairs remain	R—very local, few pairs remain
Short-eared owl	R—known from only 2 locations	Does not nest	Does not nest
Horned lark	FC—widespread	FC—widespread	FC—widespread
Sedge wren	R—very local	R—Coastal Plain and Piedmont, primarily in salt marshes	R— restricted to salt marshes on Coastal Plain
Vesper sparrow	FC—widespread	FC—western and central MD U—eastern MD	FC—Ridge and Valley only
Savannah sparrow	FC—widespread	FC—western MD U—central MD	FC—Ridge and Valley only
Grasshopper sparrow	FC—widespread but local	FC—widespread but local	FC—widespread but local
Henslow's sparrow	U—primarily west and north of Appalachians	R—Garrett and Allegany counties only	R—very local, few recent records away from Coastal Plain
Dickcissel	R—very local	R—very local	R—very local
Bobolink	FC—widespread	FC—western MD R—central MD	U—Ridge and Valley only
Eastern meadowlark	FC—widespread	FC—widespread	FC—widespread

FC (Fairly Common): Regularly encountered in appropriate habitats.
U (Uncommon): Observed only in small numbers and frequently absent from suitable habitats.
R (Rare): Known from only a few locations, frequently as isolated individuals and pairs. Most potential habitats are not occupied.

Sources: Brauning (1992); Robbins and Blom (1996); Trollinger et al. (2001).

Grassland Bird Ecological Requirements

Nesting grassland birds have specific habitat requirements dictated by their foraging habits, nest placement, territorial behavior, and other aspects of their breeding biology. While multiple species frequently occupy a single field, supporting an entire grassland bird community requires maintaining multiple grassland habitats within an area.

The ecological requirements for breeding grassland birds within the Mid-Atlantic Region are briefly summarized below. For the seven most numerous species, detailed summaries of their habitat requirements are provided in Appendix A (see the Appendix for relevant literature citations). With the exception of vesper sparrows that frequently occupy field margins, these grassland birds prefer large tracts of contiguous habitats.

Disturbance-tolerant Species

These grassland birds are most numerous around cultivated fields, grazed pastures, and other disturbed or agricultural habitats. They also occur in newly seeded grasslands and recently reclaimed strip mines, but disappear within 1–2 years as these habitats mature.

Horned Lark

In the Mid-Atlantic Region, horned larks prefer cultivated fields and other disturbed sites with bare ground and sparse vegetation. They may also occur on extensive mowed lawns and similar habitats where the grasses are only a few centimeters tall. These larks disappear as soon as the vegetation becomes too tall or too dense to allow easy movement on the ground. Although these larks are most frequently found by themselves, vesper and Savannah sparrows may coexist with horned larks.

Vesper Sparrow

Vesper sparrows frequent wooded field margins and fencerows bordering cultivated fields and also occur in overgrazed pastures and hayfields. They prefer dry upland habitats with fence posts, woody vegetation, or telephone wires as prominent song perches. They nest on the ground near the edges of these fields. They are most likely to occur with horned larks in cultivated areas and occasionally with Savannah sparrows.

Savannah Sparrow

Savannah sparrows' ecological requirements represent the transition from disturbed grassland to young grassland communities. In the Mid-Atlantic Region, this sparrow is frequently found in disturbed pastures and hayfields with relatively short vegetation and a few small bushes, saplings, or other low song perches. They also occupy cultivated alfalfa fields. As the breeding season progresses and the vegetative cover becomes taller and denser, these habitats may appear similar to the young grasslands described below. While Savannah sparrows may occur with horned larks and vesper sparrows in habitats with short vegetation, they also coexist with grasshopper sparrows in fields with taller grasses.

Species Preferring Young Grasslands

These grasslands represent a transition between the disturbed habitats described above and mature grasslands described below. They are most frequently found in fields 2–4 years post-disturbance. These grasslands have taller and denser vegetative cover than disturbed habitats, but the litter layer remains relatively sparse and patches of bare ground may be present. Management activities can maintain this grassland community through regular mowing or light grazing as long as a dense litter layer does not develop.

Grasshopper Sparrow

In eastern North America, grasshopper sparrow preferred habitats are grasslands where vegetation is <1 m (<3 ft) tall, there are suitable song posts near the height of the vegetation, and the grasses are clumped with a reduced litter layer that allows easy movement along the ground. Males also occur in no-till crops, heavily grazed pastures, and other disturbed agricultural fields, but most males found in these habitats are probably unmated. Grasshopper sparrows frequently occur with eastern meadowlarks and Savannah sparrows and occasionally with bobolinks.

Eastern Meadowlark

Eastern meadowlark ecological requirements represent the transition from young to mature grasslands. While meadowlarks frequently occur in fields suitable for grasshopper sparrows, they also occupy mature grasslands with denser vegetative cover, no bare ground, and relatively thick litter layers. They may occupy disturbed habitats if patches of dense cover are present. Meadowlarks prefer taller song perches, frequently singing from the tops of tall trees. They coexist with most grassland birds except horned larks.

Species that Prefer Mature Grasslands

These habitats are characterized by tall dense grasslands with fairly thick litter layers and no bare ground. They require 3–5 years post-disturbance to develop and may never develop in hayfields and pastures that are regularly harvested or grazed. If undisturbed, woody vegetation will encroach and dominate by 7–8 years post-disturbance.

Henslow's Sparrow

Henslow's sparrows prefer dense vegetation with litter layers that are 5–8+ cm (2–3+ in) thick and no bare ground. This species frequently occupies damp habitats as well as upland fields. They are found in fields where grasses are mixed with perennial herbs and scattered small shrubs or saplings. They most likely occur with bobolinks and eastern meadowlarks.

Henslow's sparrows are ranked as a species of high regional conservation concern due to their steep rate of population decline and relatively small global population. Creating suitable breeding habitats for this species should be viewed as a conservation priority.

Bobolink

Bobolinks prefer tall dense grassland habitats with thick litter layers and a scattering of perennial herbs. Dry and damp fields are equally preferred, but fewer occur in wet meadows. They are most likely to occur with eastern meadowlarks, but are also found with grasshopper and Henslow's sparrows.

Other Species

Five additional obligate grassland species are rarely encountered in the Mid-Atlantic Region, reflecting that this region lies at the peripheries of their normal ranges. The raptors maintain large breeding territories measured in square miles rather than acres; the presence of nesting pairs within the relatively small "cultural" parks is unlikely. These five species occur sporadically, normally a result of adverse weather conditions such as droughts, fluctuations in food abundance, and population fluctuations elsewhere within their ranges. Because of their scarcity, managing habitats to attract them into a park is unlikely to be successful.

Northern Harrier

While the northern harrier is frequently associated with marshes, it also breeds in upland grasslands and reclaimed strip mines. Pairs require large tracts of relatively mature grasslands for nesting and hunting. Breeding attempts are frequently driven by the abundance of its principal mammalian prey, with pairs changing nesting locations each year in response to fluctuating prey populations (Hamerstrom 1986). Their nests are placed on the ground in dense cover provided by brushy thickets or clumps of tall grasses and reeds.

Upland Sandpiper

Upland sandpiper breeding populations in eastern North America declined significantly during recent decades and nesting pairs are currently known from very few locations in the Mid-Atlantic Region (Brauning 1992; Robbins and Blom 1996). Upland sandpipers require large tracts of contiguous grasslands, generally habitats where the residual vegetation from the previous growing season is less than 64 cm (25 in) tall (Kirsch and Higgins 1976). These grasses provide cover from predators, but litter layers must be sparse to allow adults and young to walk freely through the vegetation (Houston and Bowen 2001).

Short-eared Owl

Short-eared owls are the nocturnal ecological equivalents of northern harriers (Clark 1975). They nest and roost on the ground, building their nests in dense thickets, grassy tussocks, and clumps of reeds or rushes. Nesting short-eared owls are nomadic, locating in areas where mammalian prey is abundant, and shifting their breeding sites in response to fluctuating prey populations. While damp habitats are preferred for nesting because of the denser vegetation, adults hunt over upland grasslands (Holt and Leasure 1993).

Sedge Wren

Sedge wrens occupy damp habitats dominated by grasses and sedges frequently at the margins of marshes. They avoid areas with persistent standing water. They are erratic nesting birds that may move considerable distances between broods (Bedell 1996). Some pairs establish territories in late May and early June, but disappear after their first brood is raised, while others are absent until July and initiate nesting in late summer. Their nests are balls of grasses woven to standing vegetation and located close to the ground (Herkert et al. 2001).

Dickcissel

The regional abundance of dickcissels varies between years. Relatively large numbers in the east are associated with movements from droughts elsewhere in its range, but when rainfall is normal in the midwest, few dickcissels may appear in the east (Temple 2002). Dickcissels prefer cultivated alfalfa fields and weedy hayfields and pastures. Their nests are located near the ground or up to 30 cm (12 in) above the ground in dense vegetation.

Grasslands As Viewed By Grassland Birds

Managing habitats for grassland birds requires an understanding of how these birds view the landscape. Just as all grasslands are not the same for all grassland birds, neither are all landscapes. The fundamental habitat and landscape requirements necessary to maintain healthy grassland bird populations are discussed below.

Area Requirements

Grasslands pose a challenging environment for birds. Despite dense cover, grasses provide limited vertical structure and are too flimsy to support the nests of most birds. Hence, grassland birds normally nest on or near the ground, but some also choose sturdy herbs such as jimsonweed (*Datura stramonium*) or emergent saplings and shrubs. Their nests are susceptible to predation by a host of predators from insects to snakes to mammals. While some predators target nesting birds, many predation events are incidental encounters by predators searching for other prey (Vickery et al. 1992). Nesting success for grassland birds tends to be low (Ricklefs 1969), frequently <50% of attempts fledge young even in habitats undisturbed by agricultural activities. Incubating or brooding adults are also susceptible to capture on the nest.

In addition to composition of the predator community, other factors affecting area sensitivity of grassland birds include vegetation characteristics, patch size, proximity to edge, and landscape characteristics (Winter and Faaborg 1999). Most studies examined area requirements based on population densities, showing these requirements vary by species and geographically within each species (Herkert 1994; Johnson and Igl 2001). Fewer studies documented area effects based on population demographics (Winter and Faaborg 1999). These results indicate that census data alone may not accurately represent the area sensitivity of all species. Until a better understanding of how the various factors interact to produce observed patterns of area sensitivity in grassland birds, few generalizations are likely to be applicable to every landscape or region. Fields <5 ha (<12 ac) are avoided by grassland birds (Norment et al. 1999). Within landscapes where grasslands are extensive, however, 5–10 ha (12–25 ac) fields are occupied by some species. Field sizes must be 10–20 ha (25–50 ac) before they are consistently occupied by some species, although horned larks frequent fields as small as 10 ha (25 ac) (Beason 1995). Contiguous 40–100 ha (100–250 ac)tracts are necessary to support entire grassland bird communities (Herkert 1994; Winter and Faaborg 1999).

The term “contiguous” should be viewed from the perspective of grassland birds, recognizing this perspective varies among species. A solid tree line interrupts the grassland landscape for passerines with small breeding territories, but this same tree line is viewed as part of the landscape mosaic by a meadowlark or raptor occupying larger territories. Any solid row of trees obscuring the horizon marks the boundary of “contiguous” grasslands for many passerines, even if this corridor is <5 m (<16 ft) wide. Isolated trees or shrubs do not interrupt this grassland landscape. Hence, 40 ha (100 ac) of grassy fields subdivided by narrow wooded fencerows may provide limited or no usable habitats for grassland birds if individual field sizes are small (<10 ha [<25 ac]).

Habitat Fragmentation

Fragmentation effects have been categorized into three types: patch size, edge, and isolation (Wiens 1995; Johnson and Igl 2001). At the local scale, patch size was discussed above with a minimum requirement of 10–20 ha (25–50 ac) of contiguous habitats for many species and preferred field sizes normally >40 ha (>100 ac). Isolation at the local scale was also discussed above. For passerines with small territories, any border of tall woody vegetation blocking the horizon effectively isolates a field. Edge effects reflect that predation is more likely to occur near habitat edges (Wiens 1969; Delisle and Savidge 1996). Hence, patch shapes that minimize the amount of edge are most beneficial for grassland birds. Narrow grassy corridors and fields dissected by wooded corridors are avoided regardless of their total acreages.

Fragmentation effects at the landscape scale are poorly understood reflecting a lack of information on large-scale patterns of dispersal by grassland birds. Dispersal is believed to be the most important factor influencing how habitat spacing effects populations, but dispersal distances differ among species and may also vary as a function of habitat (Wiens 1995). In general, high mobility should counteract some effects of habitat fragmentation, while sedentary species are most vulnerable to these effects (Bierregaard et al. 1992; Wiens 1995).

Grassland birds are relatively mobile, reflecting the ephemeral nature of their preferred habitats and the need to change breeding locations once habitats become unsuitable. Site fidelity rates vary among species and among populations within a species (Lanyon 1995; Vickery 1996; Herkert et al. 2002). Hence, few generalizations are possible concerning how grassland birds respond to habitat fragmentation at landscape scales. The distance of isolation from source populations and extent of suitable habitats influence colonization and retention of breeding adults. Species that are locally distributed in small numbers are unlikely to establish new breeding populations at distances of tens or hundreds of kilometers from established populations.

Habitat Structure and Vegetation Composition

Specific habitat requirements vary among species and are described in Appendix A. In the Mid-Atlantic Region, grassland birds have existed within man-made grasslands in agricultural landscapes for centuries (Askins 1999). These species originally evolved in native grasslands characterized by high species richness of grasses and perennial forbs, varying litter depths, and varying extent of bare ground resulting from grazing, fires, and other disturbance. Grassland birds prefer comparable structural and species composition within existing grasslands. Monocultures are much less desirable than mixed communities, and monocultures planted at maximum densities create habitats that are too tall and dense to support any grassland birds (Norment et al. 1999).

Song Perches

An overlooked component of grassland bird territories is the song perch. Grassland birds rarely sing from the ground. While sedge wrens and Henslow's sparrows sing from perches within the vegetation and horned larks declare their territories from the air, most grassland passerines require multiple perches at or above vegetation height. Grasses are too flimsy to support the smallest sparrow, so other perches are needed. In addition to maintaining territories, these

perches serve as sites to preen and dry their plumage on mornings with heavy dew or following rain storms (personal observations).

Most grassland passerines prefer song perches no more than 30–92 cm (1–3 ft) above the grasses. A variety of structures serve this function, including fences, small shrubs or saplings, rock outcrops, large perennial forbs such as thistles (*Cirsium* spp.), and cannons, monuments, or other objects placed in battlefields (personal observations). Multiple song perches should be available within each territory. Only vesper sparrows and eastern meadowlarks regularly use objects as high as 3–6+ m (10–20+ ft) above the vegetation.

Grassland Management Considerations

Grassland communities represent the earliest vegetative successional stages in the Mid-Atlantic Region and management activities are required to maintain grasslands. Management decisions related to grassland maintenance must consider available resources, staff time, and other factors unrelated to grassland bird ecology. Understanding how birds respond to management activities allows informed decisions that will maintain healthy grassland bird communities. This section summarizes important management activities and their influence on grassland birds (Table 2). Detailed descriptions of specific management activities are beyond the scope of this paper.

Warm-season vs. Cool-season Grasses

Warm-season grasses initiate growth in late spring when night temperatures exceed 10ºC (50ºF), normally late May or early June in the Mid-Atlantic Region. They are bunch grasses that create a three-dimensional structure with a labyrinth of bare ground between bunches that facilitates movements by grassland birds and protective cover from predators. The greatest growth occurs between June and September and ends with the first killing frost. Storage in the basal tillers controls winter hardiness, so 8–15cm (3–6 in) of stubble must remain at the end of the growing season to ensure plant vigor (Barnhart 1994). Warm-season grasses are mostly native species including switchgrass (*Panicum virgatum*), big bluestem (*Andropogon gerardi*), little bluestem (*Schizachyrium scoparium*), and Indian grass (*Sorgastrum nutans*).

Cool-season grasses start growing when soil temperatures exceed 4.5 ºC (40ºF), normally in April. The plants flower in June. Some regrowth occurs with the advent of cooler temperatures in autumn. Storage in rhizomes controls winter hardiness. Most cool-season grasses are nonnative to the Mid-Atlantic Region, including bluegrass (*Poa* sp.), brome (*Bromus* sp.), fescue (*Festuca* sp.), timothy (*Phleum pratense*), and orchard grass (*Dactylis glomerata*) (Ehlke and Undersander 2000).

Although this topic deserves study, the relative merits of warm-season versus cool-season grasses for grassland birds in eastern North America have not received any attention. Cool-season grasses provide more cover for first broods while warm-season grasses provide better cover for later broods; other differences are not readily apparent. However, harvesting these grasses for hay has important implications for grassland birds that are discussed below. Most existing grasslands are composed of cool-season grasses and grassland birds have occupied these habitats for centuries. Whether these species would actually prefer warm-season grasses if given a choice is uncertain, although responses may vary among species depending upon their specific habitat requirements. In the absence of comparative studies, there may be benefits for maintaining both grassland types to provide the greatest habitat diversity for grassland birds.

Maintaining Grassland Habitats

Grasslands in eastern North America will eventually succeed into wooded communities if left undisturbed. Periodic management is essential to eliminate woody vegetation. Native grasslands were historically maintained by a combination of soil moisture levels and fire (Askins 1999). In recent decades, management options for maintaining these communities include mowing, grazing, and prescribed burns.

Table 2. Characteristics of cool-season and warm-season grasses for grassland birds.

Cool-season Grasses	Warm-season Grasses
Primarily nonnative species in Mid-Atlantic Region	Primarily native species in Mid-Atlantic Region
Growth starts in spring when night temperatures >4.5°C	Growth starts in late spring when night temperatures >10°C
Winter hardiness maintained by storage in rhizomes	Winter hardiness maintained by storage in basal tillers; 8–15 cm of growth following haying necessary to maintain plant vigor
Growing season: mid-April through early June in Mid-Atlantic Region; some regrowth in autumn	Growing season: primarily June-September in Mid-Atlantic Region
Greatest hay value when mown during late May or June	Greatest hay value when mown after mid-July
Preferred timing of hay removal eliminates most first broods	Preferred timing of hay removal may interfere with later broods but not with initial nesting attempts
Provides good cover for first broods, but still satisfactory for later nesting attempts if not mown	Provides limited cover for first broods but better cover for later nesting attempts

Management with Fire

Controlled burns are normally conducted in late winter or early spring, prior to the onset of nesting, at 3–5 year intervals to control woody vegetation. Burning removes the litter layer and aboveground cover, exposing bare ground that horned larks and vesper sparrows prefer. While recently burned fields provide little cover when breeding birds return, vegetative regrowth occurs quickly and burning accelerates the return to dense tall conditions by promoting the growth of grasses. The litter layer usually requires 1–2 years to re-accumulate. Fire-induced habitat changes produce short-term changes in grassland bird communities, with species preferring bare ground moving into recently burned habitats, while species preferring dense thatch move into unburned areas (Zimmerman 1988; Herkert and Glass 1999; Vickery et al. 1999b). Because responses to fire vary among species, fields should be burned on a rotating basis so that both recently burned and unburned habitats are available to maintain the entire suite of grassland birds in an area.

Management by Mowing

While responses of grassland birds to management by fire have been studied recently, the effects of mowing have received less attention. Most published studies are directed towards the responses of waterfowl and upland game birds to mowing (summarized in Kirsch et al. 1978), but few have focused on nongame birds and most of these studies occurred in the Great Plains. Management by mowing must consider the balance between the accumulation and decomposition of litter, recognizing that litter depths influence the ecology of grassland communities (Dyksterhuis and Schmutz 1947).

Mowing can be used to harvest hay or simply control succession without removing the cut vegetation. Both activities control woody vegetation, but neither returns grasslands to younger successional stages as occurs with fire. Regular removal of the cut grass retards development of a thick litter layer, although this layer will accumulate slowly over time. A dense litter layer develops quickly if the cut vegetation is not removed. Management by mowing eventually results in mature grassland communities characterized by fairly dense vegetation and thick litter layers. Avian response to mowing also varies by species with greater densities of some birds reported from mowed fields than from burned fields (Swengel 1996).

Frequency of Mowing

Hay removal occurs annually and the timing of these activities is discussed below. Mowing to control woody vegetation can occur annually, although repeating these activities at 2–4 year intervals is normally sufficient. If woody vegetation becomes widely established, however, management by fire may be needed to restore grassland habitats.

Timing of Mowing

Mowing fields at inappropriate times of the breeding season and repeated mowing of hayfields are among the most important factors contributing to declines of grassland birds during recent decades. Nesting success is reduced in harvested hayfields as compared with undisturbed grasslands (Bollinger et al. 1990), so that insufficient numbers of young are produced to

compensate for annual adult mortality, resulting in population declines. Some species may disappear in fields that are regularly mowed (Owens and Myres 1973).

Grassland passerines require approximately 45–50 days for a complete nesting cycle and the fledged young to be sufficiently well flighted to evade mowing machinery (see Appendix A and references therein). Mowing at less than two-month intervals does not allow most birds to successfully reproduce. In the Mid-Atlantic Region, most grassland birds begin nesting during May and fledge their first broods during June or early July. Hay cutting during late May and June destroys most of these broods. When fields are harvested once in early summer, many species renest, but second broods tend to be smaller than initial attempts, and success of renesting efforts may be reduced for some species (Martin and Gavin 1995; Jones and Cornely 2002). Delaying mowing until after the peak of initial nesting activities (July 15) provides breeding grassland birds an opportunity to successfully rear their first broods, while waiting until after August 15 would allow virtually all nesting attempts to be completed unimpeded by mowing.

Timing with Respect to Grassland Type

Warm-season grasses start growing in late May or early June and are ready for harvesting during the last half of July and August. Delaying mowing until after the peak of breeding activities produces a hay crop of warm-season grasses that is at its maximum nutritive value as livestock feed (Barnhart 1994). In contrast, cold-season grasses normally mature from late May through mid-June. By mid-July these grasses have gone to seed, lost much of their nutritive value, and are of limited potential agricultural use. Delayed mowing can still be implemented for cold-season grasses, but farmers will have little or no interest in this crop as hay for livestock.

Timing and Control of Invasive Plants

Delayed mowing provides some invasive plants with an opportunity flower and produce seeds prior to cutting. In the Mid-Atlantic Region, Canada thistle (*Cirsium arvense*) and Johnson grass (*Sorghum halepense*) can become major problems in grasslands that are routinely harvested after mid-July (personal observations). Grasslands should be regularly monitored for this species with appropriate control measures taken as soon as plants are detected. Spot-spraying of individual plants or small patches with an appropriate herbicide can control its initial spread. Where large patches have become established, repeated mowing prior to flowering combined with herbicide treatments may be necessary to control this invasive.

Mowing, Burning, and Long-term Grassland Management

Since fire maintains many natural grassland systems, burning these habitats at 3–5 year intervals should maintain intact grassland communities. Combining mowing with burning is also an effective management strategy and may allow for less frequent fires (at 5–8 year intervals) if the grass is removed after cutting. Both strategies periodically set back grassland succession and allow birds preferring younger grasslands to maintain populations in an area. Mowing by itself results in more mature grassland communities. Species preferring mature grasslands may be more numerous in mowed fields than in fields that are burned or burned and mowed (Swengel 1996).

The Conceptual Ecological Model for Managing Grassland Birds

This conceptual model provides background information for decision making by NPS Networks and individual parks to manage grasslands for the benefit of breeding grassland birds. The Networks establish overall objectives for grassland management programs, potentially working across multiple networks to develop a coordinated regional approach. The Networks also decide which parks have sufficient habitat (existing and/or potential) to be included within these programs. The individual parks are responsible, perhaps in conjunction with I&M staff and/or funding, for managing grasslands in accordance with the suite of species occurring within each park and objectives established by the networks. This model and its associated recommendations are based on the professional judgment of the author as supported by the literature cited above.

NPS Network Level

Total grassland acreages available in parks constitute a tiny fraction of available regional habitats. Instead of concentrating on numbers of breeding pairs within parks, recognizing that abundance can be a misleading indicator of habitat quality (Van Horne 1983), the emphasis of Network grassland management programs should be directed towards creating and maintaining "source" populations of grassland birds in the sense of population source-sink dynamics described by Pulliam (1988). Maintaining populations producing more young than can be supported by habitats in the parks forces these young to disperse across the landscape and contribute to the recovery of regional grassland bird populations.

Which Parks to Include in a Grassland Management Program

This decision is largely based on acreages of contiguous grasslands available in each park and prospects for creating larger blocks of contiguous habitats, for example, by removing wooded fencerows isolating one field from another, as well as each park's cultural focus. Parks incapable of providing 20 contiguous hectares (50 ac) of grasslands could be excluded from these programs or treated as potential sink habitats (see below). Parks in large urban areas could also be excluded unless grasslands are >100 contiguous hectares (250 ac), because grassland birds are unlikely to discover small tracts of suitable habitats within largely unsuitable landscapes.

The greatest potential contributions to grassland bird conservation are provided by parks capable of maintaining >100 contiguous hectares (250 ac) of managed grasslands. However, parks supporting smaller (20–100 ha [50–250 ac]) tracts of contiguous grasslands should not be ignored. Grassland birds should become one of the Vital Signs for all of these parks and resources should be dedicated towards maintaining suitable grasslands. Management activities should be directed towards allowing successful reproduction by grassland birds. Monitoring activities should include assessments of population trends within the networks and individual parks. While monitoring reproductive parameters is not feasible for every park, selective monitoring of these parameters should be considered in parks with the largest managed grasslands.

The model for managing potential source populations is outlined in Figure 1. For parks with 100+ ha (250+ ac)of contiguous habitats, the goal is to provide fields composed of both warm-

season and cool-season grasses managed by mowing, prescribed burns, and/or light grazing to emphasize the young and mature grassland successional stages that support the most diverse grassland bird communities. Where prescribed burns are possible, these management activities can also support earlier successional grassland communities. For smaller parks supporting tracts <100 ha (<250 ac) in extent, the management emphasis within a park should be on either cool-season or warm-season grasses, but not both. The management emphasis towards particular grassland successional stages will vary depending upon whether these habitats are maintained by prescribed burns or mowing, as indicated in Figure 1.

Sink habitats are also important for maintaining equilibrium in regional populations. Assuming individuals never occupy poorer sites when better sites are available, when the local population in source habitats exceeds the number of available territories, surplus individuals achieve higher fitness by emigrating into other (=sink) habitats (Pulliam 1988). While population sizes in source and sink habitats depend upon numerous factors, if source habitats are rare while sinks are relatively numerous, large populations may exist in sink habitats. Figure 2 provides the proposed model for managing sink populations with the intent of trying to maximize reproductive success in these habitats while recognizing reproductive output will not be equivalent to that achieved in source habitats. Because most sink habitats are likely to be relatively small tracts of grasslands, these areas should be managed for single communities (either cool-season or warm-season grasses) and single successional stages.

Species Selection

In addition to deciding which parks are included in a grassland management program, the focal grassland species for this program also require careful consideration. Maintaining source populations of every grassland species within a park or even a Network may not be a realistic objective. The selection process should be based on those species likely to occur within the Network. Management for horned larks or vesper sparrows should be considered only if the cultural focus of individual parks includes maintaining significant acreages of cultivated crops or other agricultural activities. If few acres are cultivated, then the focus should be on the other grassland birds. Whether to create and maintain grasslands potentially supporting rare or locally distributed species (such as Henslow's sparrows) should consider the proximity of each park to known populations and whether the parks are located <200 km (<125 mi) from known populations.

Park Level

For individual parks, the main focus is on-the-ground management of grasslands to benefit breeding grassland birds. Monitoring to assess the success of habitat management also occurs at the park level. Developing specific monitoring protocols depends upon the species and habitats present within a park, the types of management activities, the Network objectives of the grassland bird conservation program, and possibly other factors. A detailed discussion of monitoring protocols for grassland birds is beyond the scope of this document.

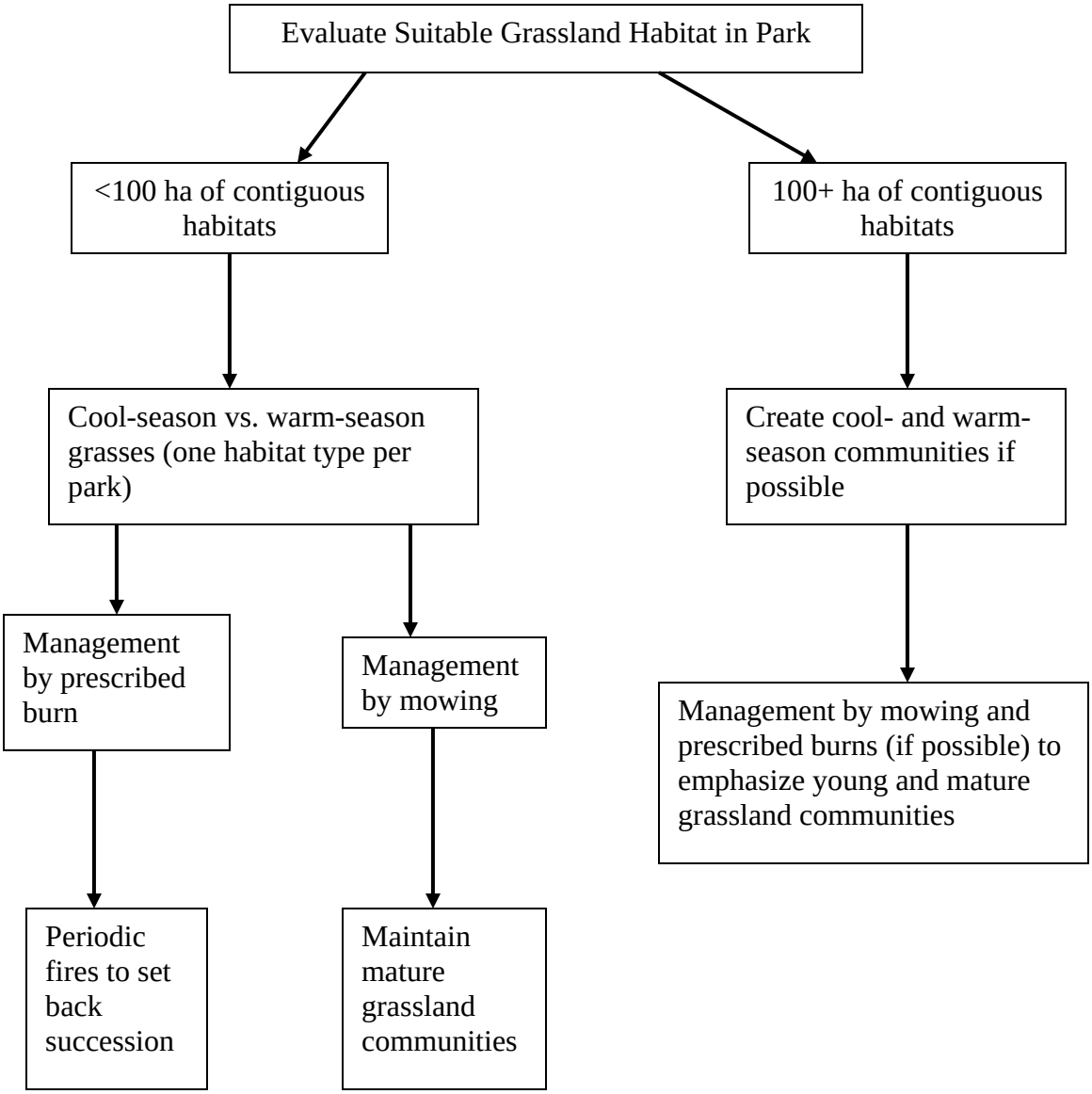

Figure 1. Management decisions allowing development of potential source populations of grassland birds within NPS networks.

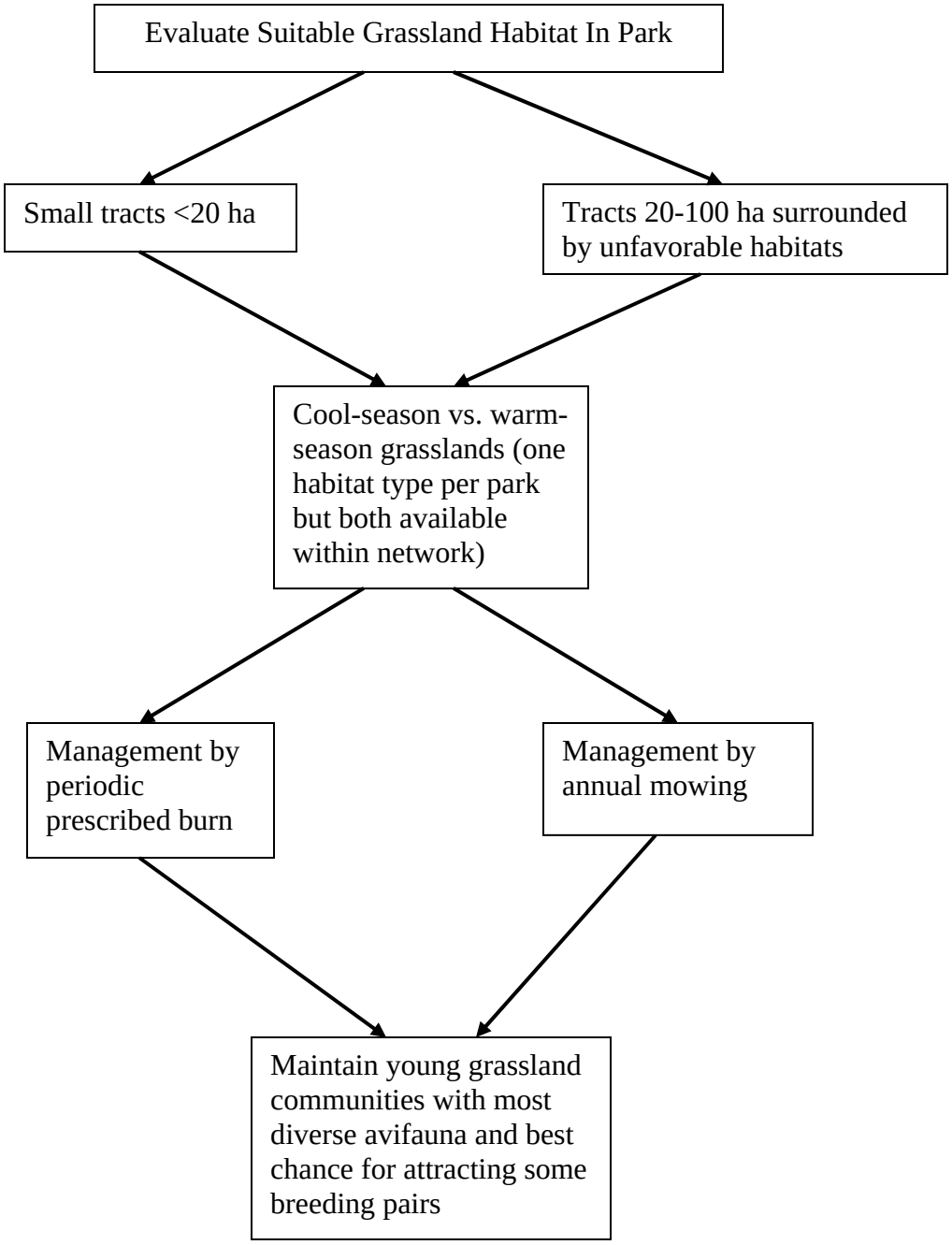

Figure 2. Management decisions for maintaining potential sink populations within NPS networks.

No Management Model

Figure 3 provides the model for unmanaged grasslands. These habitats undergo fairly rapid succession from planting to initial encroachment of woody vegetation. The timing of these successional changes varies depending upon a number of factors, including previous land use, soil type, hydrological conditions, and climate. Normally, within 5–7 years grasslands will succeed into shrublands in the absence of active management.

Management of Agricultural Fields

Parks with a focus to maintain cultivated fields and/or grazed pastures should consider the requirements of disturbance-dependent grassland birds occurring in their area. Field size is not an important consideration because these species tend to occur along field margins or in relatively small fields. Hence, management should be directed towards creating small fields with more edge. While horned larks require no special considerations in cultivated fields, the primary focus for vesper sparrows should be maintaining suitable habitats along field margins. Fencerows and other field borders should support scattered shrubs and small trees and some herbaceous cover in corridors at least 10–30 m (33–100 ft) wide. Grazed pastures should include areas that are not closely cropped and scattered small bushes to provide additional cover for breeding vesper and Savannah sparrows.

Managed Grasslands

The first consideration is the extent and juxtaposition of grasslands within the park with an objective of creating the largest possible contiguous grasslands while maintaining the required cultural focus. Options for creating larger tracts of contiguous grasslands should be explored, such as removing wooded fencerows, converting cultivated fields to grasslands, and removing wooded corridors that fragment grasslands.

If only one large grassland tract is present in a park, then this tract should be managed for young grasslands in Virginia and most of Maryland where grasshopper sparrows and eastern meadowlarks dominate the breeding grassland avifauna. In Pennsylvania, managing for either young or mature grasslands is beneficial. Because of the greater conservation concern for Henslow's sparrows, developing mature grasslands should take precedence in regions where this species is present.

Parks with two or more large tracts of contiguous grasslands should develop a management approach that maintains multiple grassland successional stages at all times. This approach manages some fields as younger habitats while maintaining mature grasslands in other fields. Younger grasslands would be allowed to mature to replace mature grasslands that are being reverted to younger habitats. The specific management actions necessary to accomplish this scheme vary depending upon the number of grassland tracts, available resources, whether grasslands are managed by mowing or burning, and the cultural focus of each park.

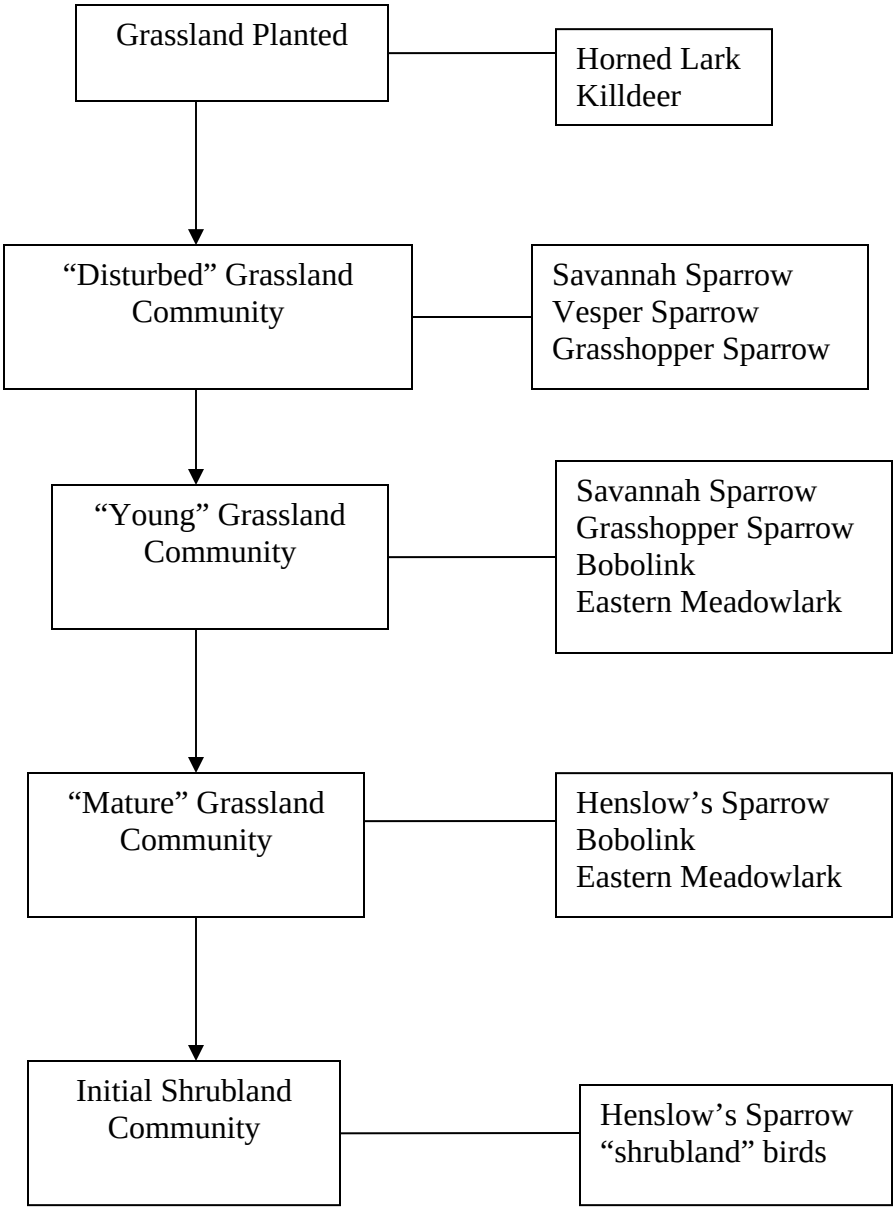

Figure 3. The "No Management Model" represents the grassland successional stages within the Mid-Atlantic Region and the bird species typically associated with each stage.

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The ability to perform specific grassland management activities will greatly influence the details of a grassland management plan within a park. The various general management scenarios are depicted in Figure 4. If prescribed burns are possible, fields should be burned at 3–5 year intervals to allow them to advance from young grasslands to maturity before the successional cycle starts over again. Burning should be conducted on a staggered basis so that fields in every grassland successional stage are present each year.

In the absence of fire, grassland succession is controlled through mowing with removal of the cut vegetation. If the cut vegetation is removed, the advancement of successional stages is delayed as compared with unmanaged grasslands. The initial successional stages may be prolonged by 1–3 years, with these fields eventually succeeding into mature grasslands. Once the grasslands reach maturity, the fields will remain at that stage through repeated mowing (Figure 4). If the cut vegetation is not removed, the fields will rapidly advance to mature communities and will quickly become unsuitable for most grassland birds. The progression of successional stages can be monitored indirectly by monitoring the grassland bird use of each field. If grassland birds no longer inhabit a field, then grassland habitats have matured to a stage where they must be replanted in order to reestablish suitable habitats for the breeding birds.

Because of the detrimental effects on reproductive success resulting from mowing during late spring and early summer, all mowing activities in the Mid-Atlantic Region should be delayed until after July 15 to provide breeding grassland birds with an opportunity to successfully rear their initial broods. If all fields are not cut simultaneously after July 15, then birds breeding in the last fields to be harvested have opportunities to raise multiple broods.

Other management considerations include whether to plant cool-season or warm-season grasses. Ideally, parks should support both grassland communities. Cool-season grasses are more readily available and less expensive to establish and manage but are mostly nonnative species. Warm-season grasses are predominantly native species but are still relatively expensive to establish at this time. If both types of grassland communities are present in a park, the management plan becomes more complicated if the intent is to have various successional stages of both communities present. Such complex management schemes may be possible in only those parks supporting very extensive grasslands.

Another management consideration is ensuring suitable song posts are scattered across the grasslands to encourage occupancy of each field. Ideally, these song posts would require low maintenance, not disappear during a fire, and not interfere with haying operations. Finding objects that meet these requirements, are 1–3 feet above the grasses, and suitable for use by small passerines requires additional study. Fencerows bordering fields are suitable for birds holding territories at the edges of fields. In the field centers, some potential approaches for song perch management include encouraging growth of tall native forbs, leaving a few large hay bales scattered in the fields after each season, and/or scattering large rocks or rock piles in the fields.

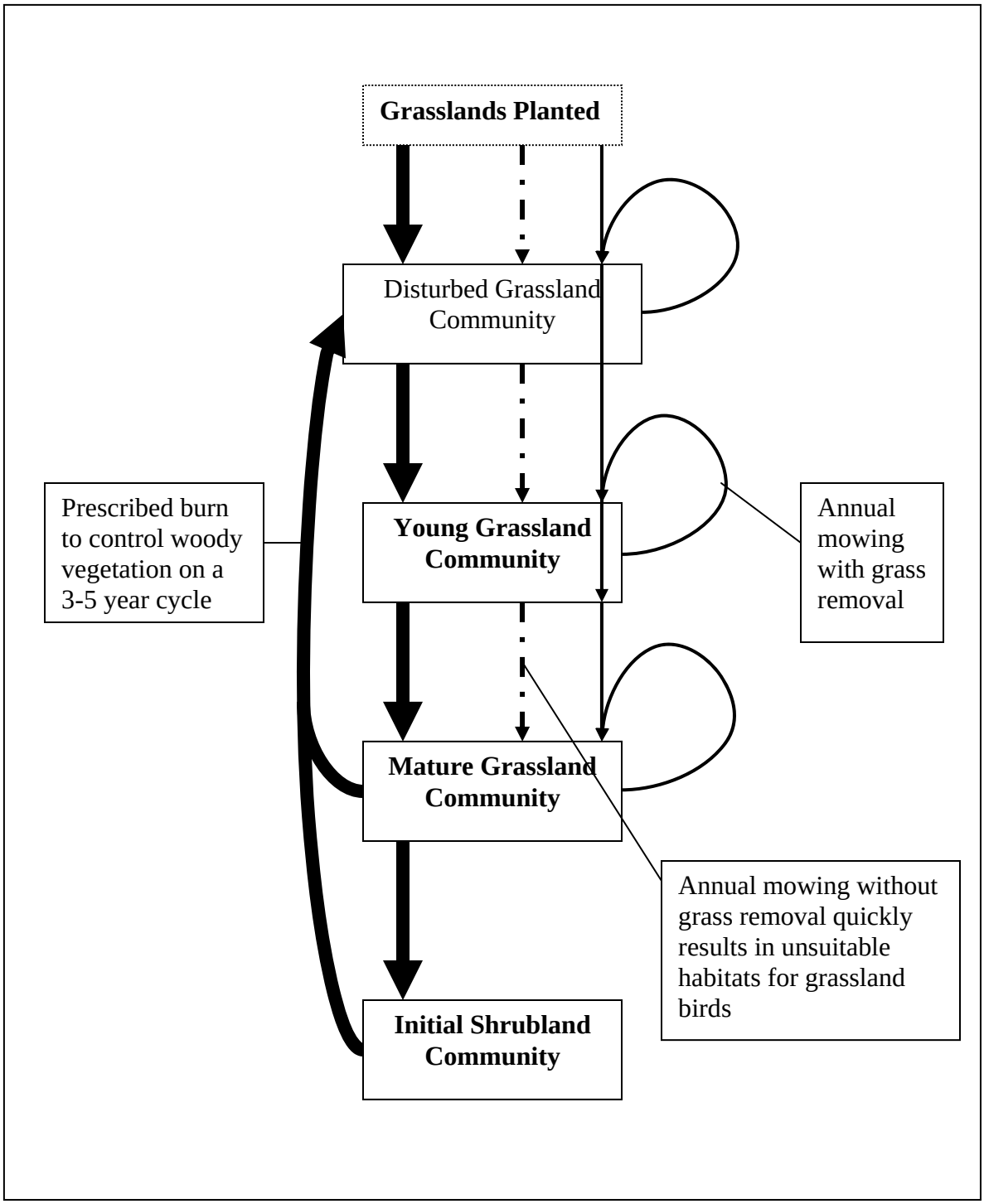

Figure 4. "Management Model" represents the grassland communities occurring with the management scenarios of regular prescribed burns, annual mowing with vegetation removal, and annual mowing without vegetation removal.

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Appendix. Life history information for the seven obligate grassland bird species that are most numerous within the Mid-Atlantic Region.

HORNED LARK (*Eremophila alpestris*)

Distribution in Mid-Atlantic Region: Breeds throughout all three states, but becomes locally distributed in forested areas and other localities where agricultural fields are sparse.

Status: Breeding populations are believed to be resident. Some local movements occur seasonally in response to food availability, but migratory movements are poorly understood.

Breeding Habitats: This species is not strictly restricted to grasslands. It prefers barren ground and is most frequently associated with plowed agricultural fields. In grasslands, it prefers disturbed areas where there is some bare ground and the vegetation is only a few centimeters tall, such as overgrazed pastures. Suitable nesting areas in early spring will be abandoned by late spring if the vegetation becomes too tall.

Nest Site: A shallow depression in the ground, either natural or excavated by the female, generally in sites with very little or no vegetative cover. A nest is weaved into this depression.

Territory Size: Varies with habitats, generally 0.6–3.1 ha (1.5–7.6 ac) in agricultural fields, but somewhat smaller (0.3–1.4 ha [0.7–3.5 ac]) in short-grass habitats. Territories are used for courtship, nesting, and feeding.

Mating System: Apparently monogamous for the breeding season, but will replace mate if one dies or disappears.

Breeding Phenology: Horned larks are generally the earliest nesting passerine in this region.

Pair Formation: Occurs during winter when males start to establish territories during January and February. These territories may be briefly abandoned during heavy snows, but larks return as soon as bare ground is exposed.

Nest Building: Late February through early June.

Egg Dates: In Maryland and Virginia, first week of March through first week of July; most first clutches between late March and late April. Nesting season may be delayed by several weeks in the mountains and Pennsylvania.

Number of Broods: Two in most of region, although three may be possible along the coastal plain and lower elevations of Virginia.

Nests with Young: Reported between March 10 and August 30 in Maryland; most first clutches in April and early May.

Fledgling Dates: The earliest fledglings could appear in late March. Most are noted between mid-April and mid-June with the latest young fledging in August.

References: Beason (1995); Clapp (1997); Robbins and Blom (1996); Wiens (1969).

VESPER SPARROW (*Pooecetes gramineus*)

Status: A summer resident across most of Pennsylvania, Maryland, and the Ridge and Valley region of Virginia. Recent population declines have caused this sparrow to become scarce and very locally distributed on the coastal plain and along the southern edge of its range. Vesper sparrows winter across the southern U.S. and Mexico.

Arrival Dates: Generally late March and April across the region.

Departure Dates: Late September and October, with a few late migrants into November.

Breeding Habitats: These sparrows prefer open habitats with short, patchy vegetation, some bare ground, and some small trees, shrubs, or other song perches, such as telephone wires. They avoid wet areas and habitats with dense vegetation. They are frequently found along fencerows and other edges along cultivated fields, overgrazed pastures, surface mines shortly after reclamation, and similar habitats. Vespers respond to changing habitats, colonizing new sites quickly when suitable habitats become available.

Nest Site: Nests on the ground in a slight depression, usually under or at the base of vegetation, such as grass tussocks, weeds, or small shrubs. Nests are frequently placed near habitat edges.

Territory Size: Generally averages between 2–3.5 ha (4.9–8.6 ac) in most areas, within a range of 0.3–8.2 ha (0.7–20.3 ac). This variability is apparently related to food availability with the larger territories having more dispersed food resources. Territories are used for courtship, nesting, and feeding.

Mating System: Normally monogamous through breeding season, but polygyny has been reported.

Breeding Phenology: Similar to other grassland sparrows in this region. Breeding success varies among years depending upon weather conditions, with poorest success during droughts.

Pair Formation: Males arrive first to establish territories and most are paired within two weeks of their arrival. Most pairs are formed by early May.

Nest Building: Nest building can begin in early April in this region, but is most prevalent between late April and mid-May. Continues well into July for later broods.

Egg Dates: The earliest clutches were reported during the last week of April, but most first clutches are produced during May. Later clutches are normally produced during the second half of June and July, with the latest during the first week of August.

Number of Broods: Normally one to two per year, but three have been reported.

Nests with Young: Most have been reports between mid-May and the second half of July.

Fledgling Dates: First broods normally fledge during June and early July, some as early as the first week of June. Later broods produce young into August.

References: Clapp (1997); Jones and Cornely (2002); Robbins and Blom (1996); Wiens (1969).

SAVANNAH SPARROW (*Passerculus sandwichensis*)

Status: A summer resident across Pennsylvania, central and western Maryland, and locally in the Ridge and Valley region of Virginia. These populations are migratory with a winter range extending from the southern U.S. to northern Central America. Savannah sparrows also winter in the Mid-Atlantic Region, primarily along the Coastal Plain and Piedmont where they do not nest.

Arrival Dates: Normally during last half of March and April, extending into early May at higher elevations and the northern portion of the Region.

Departure Dates: Primarily during October with some late migrants into November.

Breeding Habitats: In the Mid-Atlantic region, savannah sparrows seemingly prefer somewhat disturbed grassy pastures and meadows where most vegetation is relatively short (<15 cm [<6 in] tall). Vegetative cover is normally complete and can include some herbaceous species and a few scattered small bushes or saplings. They also occur in cultivated alfalfa fields. They prefer drier upland sites in this region.

Nest Site: Well hidden on the ground, frequently concealed by a canopy of dead grasses and herbs or tucked within a grass tussock with a tunnel entrance. A few nests are simple open cups under thick vegetation, built by inexperienced females.

Territory Size: Varies between regions, habitats, seasons, and years. Mean size normally 1.0–1.25 ha (2.5–3.1 ac), but boundaries are fluid and territories may enlarge as breeding season progresses. Area defended by males may shift to center around nest sites or incorporate additional mates. Large territories are more likely to attract multiple mates.

Mating System: A combination of monogamous and polygynous systems. Frequency of polygyny varies among populations and among years within a population.

Breeding Phenology: Few data for Mid-Atlantic Region, but probably similar to other grassland sparrows. Reportedly nests later in Pennsylvania.

Pair Formation: Males appear synchronously one to three weeks before the females. Most pairs formed during April and May.

Nest Building: Perhaps as early as late March during some years, but primarily during May for first broods and into July for subsequent breeding attempts.

Egg Dates: Reported as early as late March for Virginia. Most first broods are probably produced during May with later attempts into July.

Number of Broods: Probably two broods in most areas, but possibly three in Virginia.

Young in the Nest: Mid-April through late July, with peak activity in late June and July in Pennsylvania.

Fledgling Dates: By early May in Virginia, but most noted in June and July. Last broods fledge during first half of August.

References: Brauning (1992); Clapp (1997); Robbins and Blom (1996); Wheelwright and Rising (1993); Wiens (1969).

GRASSHOPPER SPARROW (*Ammodramus savannarum*)

Status: Widespread and fairly numerous across the region except for southeastern Virginia.

Arrival Dates: Normally during the last half of April and first half of May, but possibly slightly earlier in southern Virginia.

Departure Dates: Poorly known, but probably in September and October.

Breeding Habitats: Breeding pairs prefer somewhat open grasslands and patchy, bare, well-drained ground. In West Virginia, optimal habitat was defined as 73% litter cover, 24% bare ground, and 28% grass cover. These sparrows avoid areas with extensive shrub cover in eastern North America. Thick, tall grasslands with no exposed soil are avoided.

Nest Site: On the ground and very difficult to locate. Their nest is a domed structure with a side entrance, similar to the nest of an ovenbird (*Seiurus aurocapillus*), frequently at the base of a clump of grasses or under dead vegetation.

Territory Size: Mean territory size normally varies between 0.8–1.4 ha (2.0–3.5 ac), although territories as small as 0.2–0.3 ha (0.5–0.74 ac) have been reported from Pennsylvania and West Virginia. Territories may shift and sizes decrease during the breeding season after late-arriving males return to an area.

Mating System: Monogamous, although occasional polygyny is possible.

Breeding Phenology: Few data for Mid-Atlantic Region, given the difficulty in locating nests, but probably similar to other grassland sparrows.

Pair Formation: Males arrive three to five days before the females, with pair formation occurring immediately upon the arrival of the females.

Nest Building: Few data, but first nests are probably constructed during May with later broods into July or possibly early August.

Egg Dates: Published egg dates range between mid-May and mid-August.

Number of Broods: Generally two per season, possibly three in southern edge of range.

Young in the Nest: Published data are between late May and mid-August.

Fledgling Dates: Recently fledged young have been reported as early as the first week of June and as late as the second week of September, but are most evident during the last half of June and July.

References: Clapp (1997); Robbins and Blom (1996); Vickery (1996); Whitmore (1979); Wiens (1969).

HENSLOW'S SPARROW (*Ammodramus henslowii*)

Status: An uncommon and locally distributed summer resident in Pennsylvania, most likely to be found north and west of the Appalachian Mountains. In Maryland, Henslow's sparrows are rare and very locally distributed in Garrett and Allegany counties. This species formerly nested along the Eastern Shore where there have been no reports since 1989. In Virginia, breeding Henslow's sparrows are currently known from a few locations in the northern counties, although there are historic breeding records from other portions of the state.

Arrival Dates: Few data, probably during the last half of April and first half of May.

Departure Dates: Few data, most Henslow's probably leave during September and October.

Breeding Habitats: Preferred habitat is characterized as large fields with tall, dense grass, a well-developed litter layer, some standing dead vegetation, and sparse or no woody vegetation. Breeding pairs tend to occupy flatter portions of fields.

Nest Site: Nests are typically placed within thick litter at 6–8 cm (2–3 in)above the ground. Where litter layers are thin, nests will be placed in large clumps of grass close to the ground.

Territory Size: Henslow's often appear to be loosely colonial. Mean territory size is generally between 0.3–0.7 ha (0.7–1.7 ac). During course of breeding season, shifting territories, disappearance of singing males, and appearance of new males are common occurrences. Some movements are tied to the mowing of adjacent fields.

Mating System: Few data, but generally believed to be monogamous. Additional studies are needed.

Breeding Phenology: Few data for Mid-Atlantic Region, but probably similar to other grassland sparrows.

Pair Formation: No information.

Nest Building: Very little data. Primarily during May for the first broods and can continue into July for later nesting attempts.

Egg Dates: Published egg dates extend between May 10 and July 2 in Maryland, although later clutches could conceivably occur until mid- or late July. First clutches probably peak in late May and June.

Number of Broods: Few data, but believed to be double-brooded, at least within portions of its range.

Young in the Nest: Few data, peak for first broods is probably during June with later attempts producing broods into late July or possibly early August.

Fledgling Dates: Few data, but most first broods probably fledge in late June or early July, while later attempts could produce young as late as the first half of August.

References: Brauning (1992); Clapp (1997); Herkert et al. (2002); Robbins and Blom (1996); Trollinger et al. (2001); Winter (1999).

BOBOLINK (*Dolichonyx oryzivorus*)

Status: Summer residents are widespread across Pennsylvania, but become locally distributed in heavily forested regions and urban areas. In Maryland, they are numerous in Garrett and western Allegany counties, with very small numbers in the central counties. Summer bobolinks are very uncommon and locally distributed in northern Virginia and the Ridge and Valley region. Bobolinks are neotropical migrants and spend the winter months in South America.

Arrival Dates: The first migrants appear during the last half of April, but most spring migration occurs during May. Late migrants are noted into the first week of June.

Departure Dates: Bobolinks start forming flocks during late June and early July, while migrants can appear in coastal areas by mid-July. Migration peaks during August and early September, with a few late migrants lingering into early October.

Breeding Habitats: Relatively mature hayfields and pastures with dense litter cover, but variable densities of vegetative cover. Bobolinks prefer some forbs to be mixed with grasses in these fields and show a strong preference for larger fields.

Nest Site: Nests are located on the ground, often at the base of large forbs; and bobolinks avoid sites where grasses afford the only nest concealment. Most nests are placed in areas of poor drainage.

Territory Size: Males maintain well-defined territories until they begin feeding nestlings, after which, drifting males establish territories on better-quality sites. Territory size varies from 0.5–2.0 ha (1.2–4.9 ac), depending upon territory quality.

Mating System: Strongly polygynous, with successful males supporting multiple females simultaneously. Extent of polygyny varies geographically, perhaps due to vegetative structure or food abundance.

Breeding Phenology: Fairly consistent across the region.

Pair Formation: Occurs immediately upon the arrival of females, primarily during May.

Nest Building: Few reports, most first nests are initiated during the last half of May and early June. Later attempts may occur into early July.

Egg Dates: Few reports. Early clutches could be produced during mid-May, but most are probably laid during late May and early June. Later attempts could produce clutches through mid-July.

Number of Broods: Mostly one brood per season, although females regularly renest if the first attempt is unsuccessful. A small proportion of females are double brooded.

Young in the Nest: Few reports, but earliest attempts could produce nestlings by late May. Mostly during June for initial attempts and as late as the first half of August for renesting efforts.

Fledgling Dates: The earliest fledglings could appear by mid-June, but most first clutches should fledge by late June or early July. Later attempts have produced fledglings into the last week of August.

References: Brauning (1992); Clapp (1997); Martin and Gavin (1995); Robbins and Blom (1996).

EASTERN MEADOWLARK (*Sturnella magna*)

Status: Widespread and fairly numerous across the region during summer, while wintering meadowlarks are regularly encountered north to central Pennsylvania.

Arrival Dates: Spring migration is poorly defined due to presence of substantial wintering population. The first migrants appear with the advent of warming temperatures in late February or early March. Most migration occurs during March and first half of April.

Departure Dates: Also poorly known because of large numbers of wintering meadowlarks. Most fall migration probably occurs during October and November.

Breeding Habitats: Native grasslands, pastures, hayfields, reclaimed strip mines, and similar grassland habitats with fairly dense vegetative cover and thick litter layers. Normally found in fairly dry upland habitats. A prominent song post is present, such as tall trees or telephone wires.

Nest Site: On the ground and usually in a shallow depression with dead grasses pulled over the top in the form of a canopy, well concealed in dense vegetation.

Territory Size: Normally approximately 2.8–3.2 ha (7–8 ac), with a minimum of 1.2 ha (3 ac) and a maximum of nearly 6.1 ha (15 ac).

Mating System: The majority of males are polygynous, with most having two mates concurrently, and some may have three. Rates of polygyny may vary geographically and among years.

Breeding Phenology: In the Mid-Atlantic region, there may be a two to three week difference in initiating breeding efforts between southern Virginia and northern Pennsylvania.

Pair Formation: Males arrive in territories up to four weeks before the females, with pairing occurring as soon as the females arrive. These territories are maintained until the last brood fledges.

Nest Building: Limited data for region, but first nests probably built in April and early May. Nest construction may continue into early August.

Egg Dates: Initial broods may be laid by mid-April in southern Virginia, but most are between late April and mid-May. The latest clutches were reported into August in Maryland and Virginia.

Number of Broods: Successful females are double brooded. Unsuccessful females will repeatedly renest until successful.

Young in the Nest: Primarily during May and early June for first broods, with later broods into August. One report from the first week of September from Virginia.

Fledgling Dates: The earliest broods would fledge during mid-May in southern Virginia, but generally during June elsewhere. Later broods produce fledglings well into August.

References: Brauning (1992); Clapp (1997); Lanyon (1995); Robbins and Blom (1996); Roseberry and Klimstra (1970).

As the nation's primary conservation agency, the Department of the Interior has responsibility for most of our nationally owned public land and natural resources. This includes fostering sound use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

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National Park Service
U.S. Department of the Interior

Northeast Region
Natural Resource Stewardship and Science
200 Chestnut Street
Philadelphia, Pennsylvania 19106-2878

http://www.nps.gov/nero/science/