

# Keystone Grasslands



## Restoration and Reclamation of Native Grasslands, Meadows, and Savannas in Pennsylvania State Parks and State Game Lands

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## Executive summary

Grasslands, meadows, and savannas (GMS) share two distinctions with wetlands: they are crucial for biodiversity conservation out of proportion to their small total area and they declined severely during the twentieth century. Recognition of their importance lags behind that of wetlands, but is making steady gains. In Pennsylvania, GMS are identified as a high priority for restoration, reclamation, and management by the state's Wildlife Action Plan. Worldwide, temperate grasslands, savannas, and shrublands are of acute conservation concern. The ratio of converted (developed) to protected land is ten to one in GMS, five times higher than even the beleaguered tropical rainforest. Only 4.6% of the land in temperate grassland, savanna and shrubland has been protected to date while 45.8% has already been destroyed. The figures are even more dismal for Pennsylvania, where native GMS have been under extreme pressure for more than 300 years and most were converted long ago to agricultural, residential, commercial, and other uses.

Twentieth-century changes in agricultural practices resulted in dramatic declines of most grassland birds and other grassland-dependent wildlife in Pennsylvania and other eastern states. The remaining hotspots for grassland plant species, as well as for the butterflies, moths, and other insects that are dependent on them, are far less extensive than even the declining habitats for grassland birds.

The Pennsylvania Department of Conservation and Natural Resources and the Pennsylvania Game Commission are two of the largest landowners in the Commonwealth, with a combined total of 3.8 million acres in state forests, state parks, and state game lands. A very small fraction of these lands is already in grassland, meadow, and savanna communities dominated by native plant and animal species but a great deal more is in open areas dominated by non-native species, well suited for restoration or reclamation of native GMS. This study was undertaken to address the question: Where and how can functional native grasslands be restored or reclaimed on Commonwealth lands? We sought to:

- identify potential native grassland/meadow reclamation sites on state-owned land;
- identify remnants of historical native grasslands, meadows, and savannas statewide, including those on state-owned land, to serve as models for native GMS reclamation and sources of local native genotypes; and
- identify and evaluate the plant and wildlife species native to grasslands, meadows, and savannas in Pennsylvania that have significance for restoration and reclamation.

Because the most dramatic declines in GMS habitats in Pennsylvania have been in the Great Valley and Piedmont regions, we included all 24 state parks and 38 state game lands in the 15 counties south and east of Blue Mountain as well as 15 state parks in other parts of the state in our analysis. Using interpretation of false-color infrared satellite imagery, maps, and information from past visits and consultation with colleagues, we identified areas potentially suited to native grassland/meadow reclamation in 35 parks and game lands, totaling approximately 14,790 acres or about 23 square miles.

To identify reference sites to serve as models for reclamation and sources of native genotypes, we compiled locations and vascular plant species lists for present-day grasslands, meadows, and savannas across the state that are dominated by native herbaceous species but where native species were never planted, and that are long-lived. The total area of the 64 sites identified is roughly 2,100 acres. Many of these sites are from less than one acre to just a few times that size; the largest is a “new” (post-European-settlement) area of approximately 900 acres. The sites with the greatest concentrations of rare species, mostly remnants of larger GMS pre-dating European settlement, account for about 20% of the area of all extant sites in this survey, perhaps 400 acres across the state. A few of these exceedingly rare and valuable (and, for the most part, still declining) remnants of historical GMS are on Commonwealth lands. They provide unique opportunities for the Department of Conservation and Natural Resources and the Game Commission to protect, restore, and manage irreplaceable reference sites and the rare, declining local genetic stock of the vascular plant species that are most valuable for reclamation.

To compile a comprehensive list of the native vascular plant species characterizing GMS in Pennsylvania, we made a progressive series of deletions from the 2,981 vascular plant taxa currently listed in the Pennsylvania Flora Project database<sup>1</sup> as occurring in the wild. In addition to non-natives, we excluded taxa that are aquatic or semi-aquatic, hybrids, and those whose habitat description lacks any of the keyword strings *barren*, *clearing*, *field*, *grassy*, *meadow*, *open/opening*, *roadside*, *pasture*, *serpentine*, or *shore*, or whose habitats in the state are mainly open woods, wooded swamps, peatlands, muddy shores, or tidal marshes. Native vascular plants that characteristically inhabit Pennsylvania’s grasslands, meadows, and savannas, including ephemeral, early-successional assemblages as well as persistent GMS communities, number 862. Of these, 765 are herbaceous and 97 are woody.

GMS species are disproportionately represented among vascular plant species of special conservation concern: 112 (38%) of the state-endangered species, 35 (41%) of the state-threatened species, and 38 (35%) of the species that have already been extirpated from Pennsylvania are characteristic of grasslands, meadows, and savannas. These percentages are about double the 19.5% of the state’s land currently estimated to be in GMS cover and are vastly disproportionate to the 1% to 3% of the land within Pennsylvania’s borders estimated from historical sources to have been in GMS vegetation around the time of European settlement.

The palette of native plants that may be used in reclamation plantings consists of at least 60 grasses, 80 other graminoids (sedges and rushes), and nearly 400 forbs. Of the native grass species suggested for reclamation use, 32 are cool-season and 28 are warm-season. These figures do not include plants on the state’s list of species of special concern; many of the 237 GMS plant species of special concern are also appropriate for some restoration and reclamation projects, but only where a science-based recovery plan or a carefully considered exemption from this requirement has been formulated.

At present, less than one-fifth of the native herbaceous species (but including more than one-quarter of the grasses) most qualified for GMS reclamation planting are commercially available as seeds of native Mid-Atlantic genotypes. Reclamation practitioners who hope to attain levels of native plant species richness and wildlife habitat diversity comparable to historical and remnant native GMS stands will need to obtain seeds by wild-collecting as well as by purchase. Of the plants suggested for GMS reclamation use, those commercially available include at least 7 of the

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<sup>1</sup> Maintained at the Morris Arboretum, University of Pennsylvania ([www.paflora.org](http://www.paflora.org)).

native cool-season grasses, 10 of the warm-season grasses, 14 of the other graminoids, and 65 of the forbs.

Pennsylvania's breeding bird fauna includes 15 species that are referred to as grassland-obligate or grassland-interior species, that is, in order to nest and successfully rear young they need access to large grasslands, meadows, or savannas or to artificial habitats that supply at least some of the same nesting cues and resources. Two are classified as endangered and five as threatened or candidates at risk and nearly all have undergone serious declines in recent decades. Several other endangered, threatened, and declining bird, mammal, and reptile species depend on native GMS habitats. Of the Lepidoptera species classified as endangered, threatened, or rare in the state, 49 (74%) of the butterfly species and 45 (38%) of the moth species are known to depend in part or wholly on GMS because their larvae are specialist feeders on hosts that are native to these habitats. Even higher percentages use GMS as adults as a source of nectar.

Grassland birds evolved in native grasslands characterized by high species richness of grasses and perennial forbs and patchiness in such environmental factors as litter depth and amount of bare ground, resulting from grazing, fires, and other disturbance. They have highest preference for, and achieve greatest survival and reproduction in, existing grasslands with comparable structural and species composition. Grassland bird species vary in their habitat requirements, so only a mosaic of patches in different stages of recovery from various intensities of disturbance will support a variety of species. A large, contiguous habitat area is critical for all grassland-obligate species, and density, diversity, and offspring survival increase with the size of a habitat "island." In the Mid-Atlantic region, it takes a minimum of 100 to 250 acres of contiguous GMS to support multiple grassland-obligate bird species, although patches as small as 12 to 25 acres sometimes support small numbers of a single species.

In converting existing cultivated fields, old fields, and other open habitats in state parks and state game lands to native GMS, cutting fencerows and narrow strips of trees between fields is recommended to create much larger fields. Because area-sensitive birds do not use the edges of fields as much as the interior area, the increase in the area of preferred nesting habitat can be a good deal greater than the area of fencerows and narrow wooded strips that is cut.

When time, funds, and land are allocated to native GMS reclamation in the hopes of attracting nesting pairs of grassland-obligate birds, a critical question is, will they come? There are no guarantees, but because eastern grassland birds have always depended on a habitat that is often short-lived, they have an innate ability to find and colonize new habitats that are remote from previously existing habitats. As evidence, abandoned strip mines "reclaimed" with mixtures of exotic grasses across western Pennsylvania have attracted breeding populations of Henslow's sparrows, upland sandpipers, and other grassland birds that had nearly disappeared from the area.

A primary goal of GMS reclamation on state park and state game lands should be to provide *source* habitats, that is, large areas of contiguous, high-quality habitat in which the population growth rates of a variety of grassland-obligate bird species are positive. A worthy secondary goal would be to expand the supply of *sink* habitats, lower-quality habitat areas that are nonetheless important to help sustain high overall population numbers and genetic diversity. Larger, more dispersed, and more genetically diverse populations are more resilient against setbacks and less vulnerable to potential catastrophes caused by unusual weather, disease outbreaks, and other environmental variability.

Promoting a high diversity of vascular plant species and habitat structure is a major key to benefiting moths and butterflies in GMS reclamation and management. The specific host plants of rare lepidopterans known to occur in the regions surrounding GMS reclamation projects should be special targets of the planting, monitoring, and management programs at all such sites in state parks and state game lands.

Diverse native GMS with a mix of native cool-season grasses, warm-season grasses, and forbs almost certainly support a higher biomass and diversity of wildlife than the mostly artificial environments that make up the majority of GMS or GMS-like habitats today, including annual crop fields, hayfields, pastures, old fields dominated by invasive non-native plants, reclaimed strip mines, and utility rights-of-way. Insects are vital links in many of the food chains that make up the trophic web in terrestrial ecosystems and many insects are specialist feeders on a narrow range of plant species. A higher species richness of native plants entails a higher insect diversity and can support a higher insect biomass in a given area of land. Non-native plants are eaten to a far lesser degree than native plants by insects and other herbivores (the relative lack of consumers is part of the reason why some non-native plant species are invasive), and so less of the biomass of non-native plants is converted, via the food chains that make up the trophic web, into animal biomass. Insects are the richest source of fats and protein for many small vertebrates, which in turn are food for many larger vertebrates. Higher plant species richness also means higher structural diversity of habitat for wildlife, which contributes to higher animal diversity and population numbers within a given area. It is axiomatic that rich mixtures of native species, such as we see today mainly in the small, rare, historical GMS remnants, provided native wildlife species exactly what they needed for millions of years.

A few widespread misconceptions about GMS can be dispelled based on the available evidence. For instance, not all native grasses are warm-season grasses and vice-versa; there are actually more species of *native* cool-season grasses than the number of commonly planted non-native grasses. Likewise, a monoculture — even a field of native warm-season grasses — in reality does *not* constitute good wildlife habitat. Converting state park lands and portions of state game lands that are now devoted to annual crops, non-native cool-season hay species, or warm-season grass monocultures to species-rich, structurally diverse native GMS communities should be a high priority if high wildlife diversity as well as high game production is the goal.

A regional or statewide GMS restoration/reclamation program should begin with a detailed assessment and prioritization of available sites. Although restoration is perhaps more urgent than reclamation from a conservation perspective, appropriate sites for restoration (those with existing native GMS remnants) are more limited and the potential GMS area is often relatively small. A regional or statewide GMS restoration/reclamation plan should take into account the need both for plant community restoration and for GMS reclamation and grassland-obligate bird recovery.

Selection of plant species for reclamation requires matching the soil parent-material preferences of native GMS plant species to the site, filtering the resulting list to yield those whose seeds are available from commercial suppliers or from sites available for wild-collecting, and further winnowing to those species that are appropriate for the local soil moisture regime. The provenance of the plants should be within or nearby Pennsylvania and preferably in the same ecoregion as the site to be planted. Because certain native grass species tend to be aggressive and crowd out other species, it is best to mass forb plantings and separate them spatially from the grass plantings. This type of patchiness is common in nature and should be imitated to the extent possible in restoration and reclamation.

Once grasslands, meadows, or savannas are established, maintenance is required to keep them from becoming shrubland or woodland, to halt the spread of invasive, non-native species, to maintain a mix of patches of different ages and species composition, and sometimes to keep native grasses from crowding out other species. The preferred method is prescribed burning, but grazing, spot-application of herbicides, winter mowing, and mechanical removal of the top layer of soil organic matter all have a place. Mowing is not ecologically equivalent to burning or grazing, in part because it fails to create areas of bare soil, which are a requirement for some wildlife species and as sites for seed germination and colonization for less-competitive plant species. Patches of bare soil commonly develop in prescribed fire “hot spots” and in places where grazers uproot, trample, or wallow. Winter mowing can be used in special circumstances, but mown material should be collected and removed. Prescribed burning should be rotated among patches in different years, with no more than one-fifth to one-third of a field or cluster of fields burned in any one year, to provide for quick recovery of local populations of wildlife that cannot escape the flames.

In planning for GMS restoration or reclamation, it should be very clear that failure is possible and beyond the control of even an excellent practitioner. Such temporary setbacks should be programmed into the operating plan for any grassland restoration/reclamation effort. The need for contingencies must be clear in the plan. A detailed, individual plan for each site should be drafted and vetted before proceeding with restoration or reclamation. It is recommended that a regional or statewide restoration/reclamation plan start with a few representative site types and that detailed plans, with contingencies, be written for each site.

## Introduction

Grasslands, meadows, and savannas (GMS) share two distinctions with wetlands: they are crucial for biodiversity conservation out of proportion to their small total area and they declined severely during the twentieth century. Recognition of their importance lags behind that of wetlands, but is making steady gains. In Pennsylvania, GMS are identified as a high priority for restoration, reclamation, and management by the state's Wildlife Action Plan, or PA-WAP (Pennsylvania Game Commission and Pennsylvania Fish and Boat Commission 2005). Scientists conducting a global study of total areas of habitat converted or destroyed compared with habitat protected in all major ecosystem categories showed a bleak picture for GMS worldwide (Hoekstra et al. 2004). Of all ecosystem types evaluated, temperate grassland is in the direst straits. For temperate grassland, savanna and shrubland together, the ratio of converted to protected land is ten to one, five times higher than even the beleaguered tropical rainforest. Only 4.6% of the land in temperate grassland, savanna and shrubland has been protected to date while 45.8% has already been destroyed. The figures are even more dismal for the eastern United States, where native grasslands have been under extreme pressure for more than 300 years and most were converted long ago to agricultural, residential, commercial, and other uses.

Grasslands, meadows, and savannas are plant communities dominated by herbaceous plants that do not have standing water or fully saturated soil for more than a few days per year at most and are mowed, if at all, no more than once a year. Even though there are no widely accepted quantitative definitions for these broad ecosystem categories, for this report GMS are defined roughly as follows. **Grasslands** are dominated by grasses (more than 50% cover) and have few or no trees (less than 5% cover). **Meadows** are dominated by forbs (non-grasses; more than 50% cover) with few or no trees. **Savannas** are dominated by either grasses or forbs with sparse, scattered trees or tall shrubs (between 5% and 25% canopy cover). Any GMS community may have a significant low shrub component, as long as herbaceous plant cover is at least 50%.

Several other distinctions require explanation at the outset, namely, the differences among restoration, reclamation, and maintenance, and the continuum between successional GMS and persistent GMS. "Ecological restoration is an intentional activity that initiates or accelerates the recovery of an ecosystem with respect to its health, integrity and sustainability" (Society for Ecological Restoration International Science and Policy Working Group 2004). **Restoration**, as we use the term in this report, applies only to remnants of long-persisting historical GMS that have been degraded as the direct or indirect result of human activities. Such remnants are exceedingly rare in Pennsylvania but they do exist, in a few cases on state lands.

**Reclamation** involves similar activities, but on land that probably did not support GMS historically. "The main objectives of reclamation include the stabilization of the terrain, assurance of public safety, aesthetic improvement, and usually a return of the land to what, within the regional context, is considered to be a useful purpose" (Society for Ecological Restoration International Science and Policy Working Group 2004). The best management practices for restoration and reclamation are similar, but there are important differences. For instance, GMS restoration usually involves the recovery of endangered, threatened, or rare plant species, whereas reclamation projects should avoid using seed of these species unless they are part of a scientifically sound, carefully planned reintroduction and recovery program.

**Maintenance** is an ongoing, permanent necessity for nearly all GMS in Pennsylvania, whether they are persistent remnants of historical GMS or the result of restoration or reclamation. GMS species are distinguished from others by their high tolerance for disturbance and generally low tolerance for the shade beneath a forest canopy. Virtually all GMS occurrences in the state are the result of disturbance. Given the prevailing soils and current climate of Pennsylvania, a prolonged lack of disturbance eventually leads to forest cover. Maintenance of native grasslands, meadows, and savannas consists of mimicking key aspects of the disturbances that maintained such plant communities in the past, either for the roughly 13,000 years of human occupation before European settlement or during the many interglacial periods when the climate was similar to today's, totaling several hundred thousand years over the past two million years.

A particular grassland, meadow, or savanna may fall anywhere along a continuum of stability between maintenance disturbances, from **successional (short-lived)** to **persistent (long-lived)**. This is a key concept for successful management. Anything that slows the growth of plant life can prolong the period during which a given GMS can persist between maintenance disturbances, with its structure and species composition intact. Certain soil conditions slow plant growth, including low soil nutrient levels, a droughty moisture regime, shallow soil over bedrock, a soil hardpan, or unusual bedrock chemistry. Micro- or mesoclimatic conditions also can slow plant growth; examples are frost-pocket conditions, chronic heat stress, or high wind exposure. Furthermore, dominant GMS plant species can impede invasion by forest tree seedlings, for instance, by creating dense shade, increasing soil acidity, decreasing nutrient availability by inhibiting decomposition, providing insulation that slows soil warming in spring, or competing more efficiently for water and nutrients (Berkowitz et al. 1995; Bramble et al. 1996).

Open areas dominated by non-native species, often with extremely low species diversity and little value as wildlife habitat, cover a much larger area in the state than GMS dominated by diverse mixtures of native plants. Recent estimates categorize 11.5% of Pennsylvania's land cover as cropland<sup>1</sup> and 19.5% in categories that include grassland, meadow, and savanna cover but also include other cover types with similar signatures in satellite images, such as pasture and regenerating forest<sup>2</sup> (Myers et al. 2000). The amount of land in GMS dominated by native species is unknown, but may account for less than 1% of the state's land area (R. E. Latham, unpublished data).

Twentieth-century changes in agricultural practices resulted in dramatic declines of most grassland birds and other grassland-dependent wildlife in Pennsylvania and other eastern states (Bollinger and Gavin 1992). Hayfields were mowed earlier in the summer, before the end of the nesting season. There was a gradual switchover from cropland rotation with long fallow periods to more intensive rotation among crops. Pesticide use was a contributing factor, in part from toxic effects on adults, juveniles, and eggs but more importantly by reducing the supply of insect prey essential for supplying fats, protein, and calories to fast-growing young birds. Besides the changes in the way farmers managed their land, much farmland was abandoned to revert to thicket and forest, or sold off for residential or commercial development.

In the latter half of the twentieth century, the most productive habitats for birds that breed only in large, unbroken tracts of grassland switched over from fallow farm fields to large, grassy former

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<sup>1</sup> "Annual herbaceous (row crops, grain crops, exposed mineral soil)" (Myers et al. 2000)

<sup>2</sup> The sum of "woody transitional (5% < cover of woody plant foliage < 40%), also shrubland or forest regeneration" and "perennial herbaceous (grasslands, pasture, forage, old fields < 5% shrubs)" (Myers et al. 2000)

strip mines, mainly in the west-central part of the state (Mattice et al 2005). Reclamation of these surface mines involved planting non-native cool-season grasses and legumes before the 1977 Surface Mining and Reclamation Act, which required that the surface of mined sites be planted with the cover type that existed prior to mining, most often trees. However, tree establishment had a poor success rate on many sites because of poor soils and competition from planted grasses and legumes (Pennsylvania Game Commission and Pennsylvania Fish and Boat Commission 2005).

The remaining hotspots for grassland plant species, as well as for the butterflies, moths, and other insects that are dependent on them, are far less extensive than even the declining habitats for grassland birds. The most valuable are the scattered remnants of historical grasslands. They include:

- serpentine grasslands/savannas in the Piedmont uplands of southeastern Pennsylvania;
- xeric limestone prairies in the Appalachian valleys;
- hairgrass savannas on Appalachian ridge tops;
- mesic calcareous meadows in the Pittsburgh Low Plateau region;
- mesic diabase meadows in the Piedmont Triassic lowlands;
- sand-plain grasslands, beach-grass dunes, and black oak savannas at and near the shores of Lake Erie;
- coastal-plain sandy meadows in the lower Delaware River valley; and
- riverside meadows/grasslands along the Susquehanna, Delaware, Allegheny, Youghiogheny, and other major streams.

Some of the historical GMS remnants have exceptionally high native plant species richness. Nearly all include significant clusters of endangered, threatened, and rare vascular plants and animals (mainly insects). Unfortunately, these remnants have declined from an estimated 230 to 240 square miles around the time of European settlement (0.5% of the state's total land area) to less than 1 square mile today, a 99.6% decline, which continues and is even accelerating at many sites (R. E. Latham, unpublished data). These remnant native grasslands, meadows, and savannas are irreplaceable resources of great value for:

- protection and stewardship of rare plant communities and roughly 300 rare plant and animal species;
- defining models of species composition for restoration of remnant grasslands;
- serving as templates for the creation of new native grasslands that will favor success in establishment and enhancement of wildlife habitat under particular sets of soil and microclimatic conditions; and
- collecting seeds of local genotypes for use in restoration and reclamation.

There are also a few sites where GMS of more recent origin are maintained, where non-local genotypes of native species were never planted and non-native species are scarce. The largest such site is the training corridor at Fort Indiantown Gap, owned and managed by the Pennsylvania Department of Military and Veterans Affairs (Figure 1). Portions of this high-quality 900-acre grassland complex provide habitat for the only known population of the critically endangered eastern regal fritillary (*Speyeria idalia idalia*). Another large site in this category is Valley Forge National Historical Park, with about 700 acres of grasslands altogether, although native plant species dominate only a fraction of the total. Among a number of smaller sites are grassy heaths maintained by wildfire and white-tailed deer browsing, scattered throughout the state.

The Pennsylvania Department of Conservation and Natural Resources and the Pennsylvania Game Commission are two of the largest landowners in the Commonwealth, with 2.1 million acres in state forests, 283,000 acres in state parks, and 1.4 million acres in state game lands. A very small fraction of these lands is already in grassland, meadow, and savanna communities dominated by native plant and animal species but a great deal more is in open areas dominated by non-native species, well suited for restoration or reclamation of native GMS. The purpose of this study is to address the question: Where and how can functional native grasslands be restored or reclaimed on Commonwealth lands? Specific objectives are:

- to identify potential native grassland/meadow reclamation sites on state-owned land;
- to identify remnants of historical native grasslands, meadows, and savannas statewide, including those on state-owned land, to serve as models for native GMS reclamation and sources of local native genotypes; and
- to identify and evaluate the plant and wildlife species native to grasslands, meadows, and savannas in Pennsylvania that have significance for restoration and reclamation.



Figure 1. Part of the 900-acre native grassland-meadow complex at Fort Indiantown Gap, managed by the Pennsylvania Department of Military and Veterans Affairs in part to provide habitat for the only known population of the critically endangered eastern regal fritillary (*Speyeria idalia idalia*).

## Methods

### ***Identifying potential native grassland/meadow reclamation sites on state-owned land in Pennsylvania***

We restricted our survey to state parks and state game lands. Because the most dramatic declines in grassland, meadow, and savanna habitats have been in the Great Valley and Piedmont regions (McWilliams and Brauning 2000), we included all state parks and state game lands in the 15 counties south and east of Blue Mountain (Kittatinny Ridge). We also investigated other sites, mainly state parks, in the rest of the state that we judged most likely to have potential grassland/meadow reclamation sites.

Our survey was based primarily on interpretation of false-color infrared satellite imagery taken in 2004 from the U.S. Department of Agriculture's National Agriculture Imagery Program (NAIP). For some sites, we also used grayscale imagery taken in 1997-2001 in the U.S. Geological Survey's digital orthophoto quarter quadrangle mosaics (DOQQ). Data on bedrock geology came from Berg et al. (1980), Berg and Dodge (1981), and Geyer and Wilshusen (1982). Additional information came from maps (U.S. Geological Survey, Pennsylvania Department of Conservation and Natural Resources, Pennsylvania Game Commission), past visits to some of the sites by R. Latham, and personal communication with Dr. Ann Rhoads.

### ***Identifying remnants of historical native grasslands, meadows, and savannas in Pennsylvania***

One of us (R. Latham) compiled locations and vascular plant species lists for present-day native GMS in Pennsylvania that meet a stringent set of criteria: (1) They are dominated by native herbaceous species. (2) They show no evidence that native species on the site were ever planted. (3) They appear to be relatively persistent, that is, influenced by conditions and processes that slow or prevent invasion by woody plants. The information came from nearly 25 years of fieldwork, from colleagues with similar levels of field experience in the state, including botanists and ecologists from the Pennsylvania Natural Heritage Program at the Western Pennsylvania Conservancy, and from others with a particular interest in individual sites or groups of sites. Contributors included Dr. Ann Rhoads, Dr. Larry Klotz, and Dr. Jim Bissell (see Acknowledgments for institutional affiliations).

One of the premises on which this analysis is based is that an exceptional diversity of GMS plants or a cluster of rare GMS plant species is a good indicator of a grassland, meadow, or savanna's longevity. We have little direct evidence farther back than the earliest botanical records in the mid-1800s, but high species diversity and multiple occurrences of rare species are circumstantial evidence that a site has supported non-forest vegetation for centuries or thousands of years (Latham 2003). Grasslands and meadows in the Mid-Atlantic region most often are dominated by common, opportunistic, early-successional plants, a category that includes many of the most aggressive, non-native invaders as well as many common, native herbaceous species, but few if any rare native species. Nonetheless, some of the region's globally rare species and many regionally rare, disjunct, and edge-of-range species are plants with high fidelity to GMS, and some GMS harbor clusters of rare plant taxa. These observations pose a conundrum; the longevity of these community occurrences seems to be the key.

Because grasslands, meadows, and savannas tend to be isolated and small in the Mid-Atlantic region and dispersal of rare plants is further limited by the sparseness of propagule-exporting populations, multiple rare species are likely to accumulate and persist only where a GMS occurrence is stable over a long time period. Certain conditions slow succession or repeatedly set it back, including soils at the two extremes of the moisture gradient, very shallow soils, and frequent fire, flooding, or ice-scour. However, slowed succession is not the whole story. Many plant species with high fidelity to long-lived GMS are virtually never seen in typical early-successional habitats such as abandoned farm fields, forest blowdowns, or clearcuts. They cannot be classified as early-successional plants because they do not inhabit true early-successional habitats. Assemblages dominated by native plant species that are restricted, or nearly so, to GMS are the focus of this study. They are termed *persistent* grasslands, meadows, and savannas, although it is not always necessary that they have existed for centuries at exactly the same spot to fall into this category. A localized cluster of grassland, meadow, or savanna patches interspersed with thicket or forest patches in a slowly shifting mosaic can also be termed persistent.

### ***Identifying the native vascular plant species characteristic of grasslands, meadows, and savannas in Pennsylvania***

The “palette” of species for restoration of historical GMS and reclamation of degraded land to new GMS consists of the set of native species most often, or exclusively, found in grasslands, meadows, and savannas in various parts of Pennsylvania. To identify all of the native GMS vascular plant species, we conducted a progressive series of deletions from the 2,981 vascular plant taxa currently listed in the Pennsylvania Flora Project database as occurring in the wild in the state (updated September 2007). First we deleted taxa that are non-native, aquatic or semi-aquatic, recognized hybrids, and those that do not include any of the keyword strings *barren*, *clearing*, *field*, *grassy*, *meadow*, *open/opening*, *roadside*, *pasture*, *serpentine*, or *shore*. Of the remaining taxa, we deleted those whose habitat is mainly open woods, wooded swamps, peatlands, muddy shores, or tidal marshes.

### ***Identifying the rare butterfly and moth species native to grasslands, meadows, and savannas in Pennsylvania***

We sought to identify the known food plants for larvae and habitat preferences of the entire roster of butterfly and moth species that are tracked, or proposed for tracking, by the Pennsylvania Natural Heritage Program because of their rarity or suspected rarity, mainly drawing on the rich variety of web-based sources of information on Lepidoptera in the United States. Currently, a total of 66 butterfly species and 92 moth species are tracked statewide; an additional 25 moth species have been proposed for tracking (J. E. Rawlins, personal communication, 2007).

## Results

### ***Potential native grassland/meadow reclamation sites on state-owned land in Pennsylvania***

We examined 24 state parks and 38 state game lands in the 15 counties south and east of Blue Mountain (Kittatinny Ridge) and 15 state parks elsewhere in the state. Of the 77 sites, we identified 35 with significant areas potentially suited to native grassland/meadow reclamation, totaling approximately 14,790 acres or about 23 square miles (Figure 2 and Tables 1 and 2; see Appendix A for details on our findings for each site).

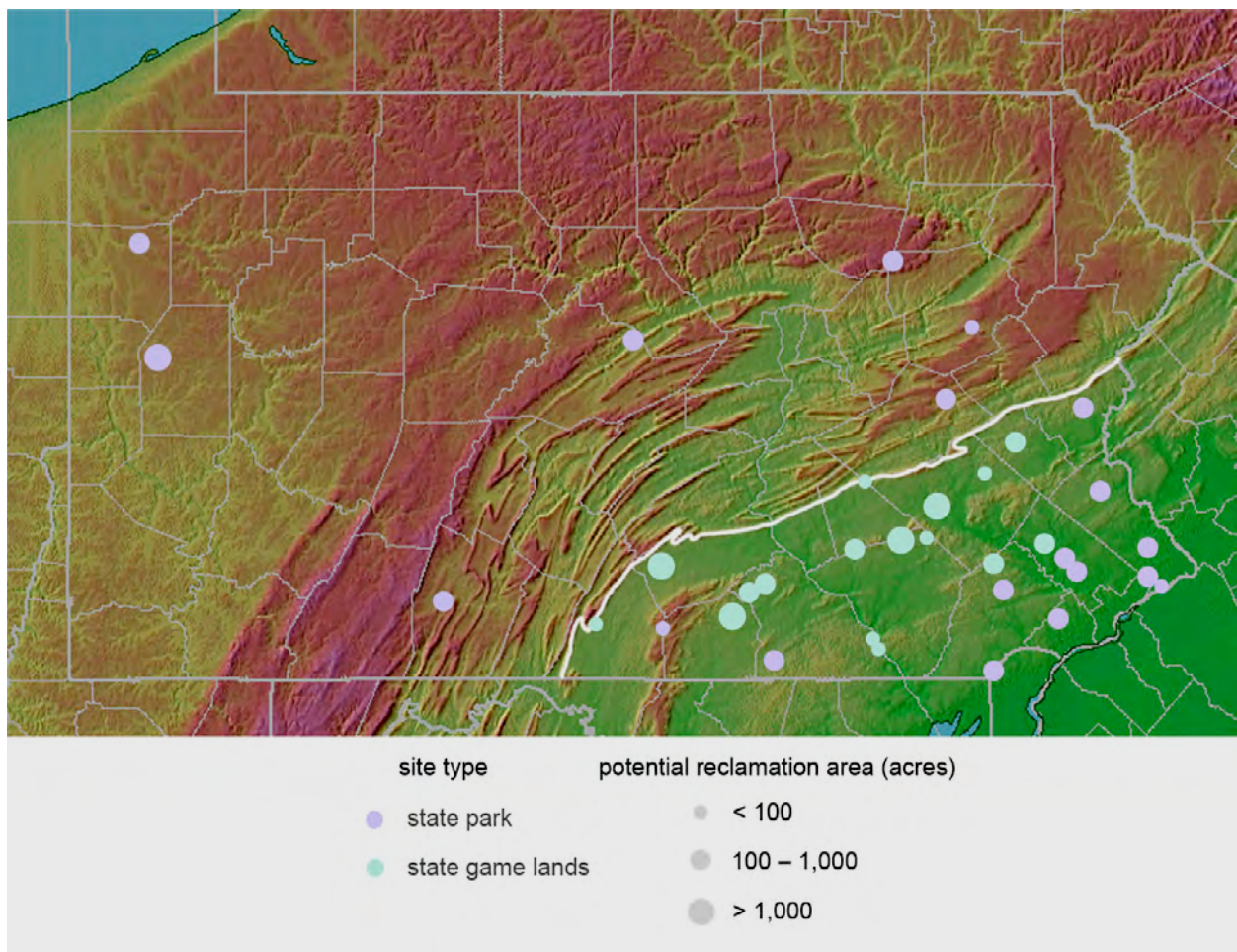


Figure 2. Potential native grassland/meadow reclamation sites identified in state parks and state game lands. Blue Mountain (Kittatinny Ridge) is highlighted. The symbols reflect relative sizes and are not to scale; the symbol size hierarchy on this map is the same as that used in Figure 3.

Table 1. Per-county estimated acreage of potential grassland/meadow reclamation areas in state parks and state game lands.

county/ies south and east of Blue Mountain	acres	sites
Berks	1,855	2
Lancaster & Lebanon	1,860	4
Montgomery	1,600	3
Bucks	1,505	3
Franklin & Adams	1,415	3
Cumberland	1,165	1
Chester	1,200	3
York	940	5
Lehigh	425	1
Delaware	200	1
Northampton	190	1
Philadelphia	125	1
subtotal	12,480	28
county/ies elsewhere in the state	acres	sites
Butler	1,060	1
Sullivan & Luzerne	455	2
Centre	290	1
Bedford	195	1
Mercer	180	1
Schuylkill	130	1
grand total	14,790	35

Table 2. Per-site estimated acreage of potential grassland/meadow reclamation areas in state parks and state game lands (see Appendix A for details on each site).

site name	acres	county/ies
SGL 280	1,785	Berks
SGL 182	70	Berks
SGL 46	1,585	Lancaster & Lebanon
SGL 145	145	Lebanon
SGL 220	70	Lancaster
SGL 80	60	Lebanon
Evansburg SP	755	Montgomery
Norristown Farm Park SP	570	Montgomery
SGL 234	275	Montgomery
SGL 249	1,265	Adams
SGL 235	80	Franklin
Caledonia SP	70	Franklin & Adams
SGL 169	1,165	Cumberland
White Clay Creek SP	465	Chester
Marsh Creek SP	415	Chester
SGL 43	320	Chester
Tyler SP	850	Bucks
Nockamixon SP	590	Bucks
Neshaminy SP	65	Bucks
SGL 243	350	York
SGL 242	290	York
Codorus SP	165	York
SGL 83	70	York
SGL 181	65	York
SGL 205	425	Lehigh
Ridley Creek SP	200	Delaware
Jacobsburg SP	190	Northampton
Benjamin Rush SP	125	Philadelphia
Moraine SP	1,060	Butler
Ricketts Glen SP	375	Sullivan & Luzerne
Nescopeck SP	80	Luzerne
Bald Eagle SP	290	Centre
Shawnee SP	195	Bedford
M. K. Goddard SP	180	Mercer
Tuscarora SP	130	Schuylkill

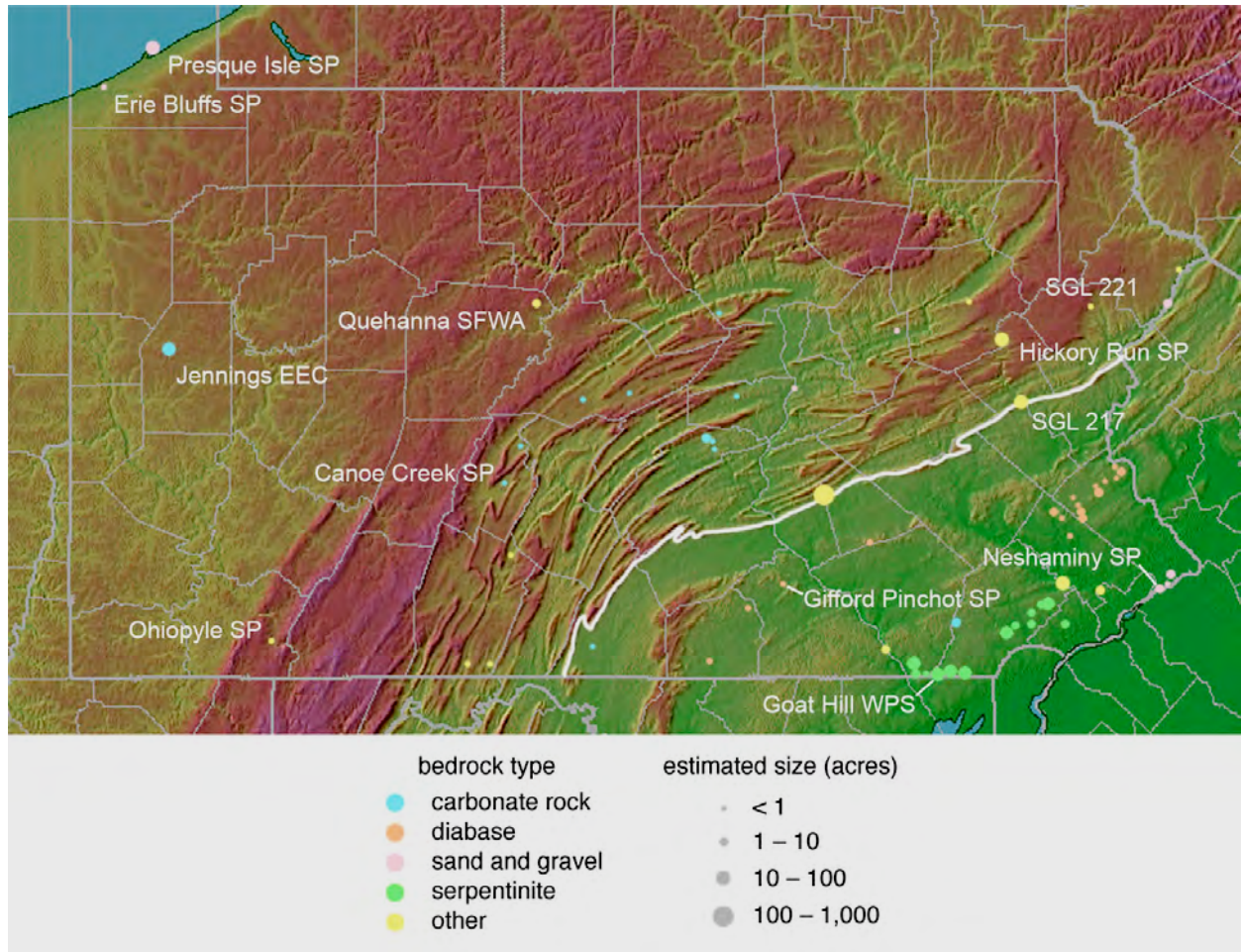


Figure 3. Present-day native grasslands, meadows, and savannas that are dominated by native herbaceous species but where native species were never planted, and that are long-lived (most are remnants of pre-European-settlement plant communities). State parks and state game lands that include occurrences are labeled. Blue Mountain (Kittatinny Ridge) is highlighted. The symbols reflect relative sizes and are not to scale; the symbol size hierarchy on this map is the same as that used in Figure 2.

### ***Remnants of historical native grasslands, meadows, and savannas in Pennsylvania***

The survey identified 64 sites of extant native GMS that meet the criteria for inclusion (Figure 3). Among them are as many as 27 remnants of approximately 200 historical GMS sites in Pennsylvania revealed in eyewitness accounts and herbarium records compiled for another study (R. E. Latham, unpublished data). The survey of extant native grasslands and meadows uncovered at least 28 additional sites not detected in the historical analyses, even though several that have clusters of rare or endemic species presumably have existed at or near their current locations for a long time. The remainder are assumed to be “new,” that is, of post-European-settlement origin. Most of the 64 present-day native grasslands and meadows are in three physiographic sections: Appalachian Mountain (18 sites), Gettysburg-Newark Lowland (17), and Piedmont Upland (17). The main bedrock types represented are diabase (18 sites), carbonate rock (13), and serpentinite (13).

Many of these sites are from a small fraction of an acre to just a few acres. Among the long-persistent sites, the largest acreage belongs to the serpentine grasslands/savannas of the Piedmont Upland, 13 sites estimated to total approximately 220 acres. The largest single native grassland-meadow complex is one of the “new” sites — the training corridor at Fort Indiantown Gap. Most of its several grassland patches, totaling approximately 900 acres, have been managed since the mid-1990s by the Nature Conservancy and the Pennsylvania Department of Military and Veterans Affairs as habitat for the only known surviving population of the eastern regal fritillary (*Speyeria idalia idalia*). The total area of the 64 sites identified so far, by very rough estimate, is perhaps 2,100 acres. The sites with the fewest rare species, and thus likely to be of recent origin, tend to be large and thus make a disproportional contribution to the total. It is likely that there are other, similar sites not found in this survey.

The sites with the greatest concentrations of rare species, thus probably remnants of very old GMS clusters, account for about 20% of the area of all extant native GMS sites in this survey, perhaps 400 acres across the entire state. A few of these exceedingly rare and valuable (and, for the most part, still declining) remnants of historical GMS are on Commonwealth lands (Table 3 and Figures 3 and 4).

Table 3. Known remnants of historical native grasslands, meadows, and savannas on state-owned land in Pennsylvania.

community description	approx. acres	site (county)
hairgrass ridge-top savanna <sup>1</sup>	~70?	State Game Land 217 (Carbon)
beach-grass dunes <sup>2</sup>	24	Presque Isle State Park (Erie)
dry sand plain <sup>2</sup>	17	Presque Isle State Park (Erie)
palustrine sand plain <sup>2</sup>	5	Presque Isle State Park (Erie)
serpentine grassland/savanna	~15?	Goat Hill Wild Plant Sanctuary (Chester)
mesic calcareous meadow	~12?	Jennings Environmental Education Center (Butler)
coastal-plain sandy meadow	< 10?	Neshaminy State Park (Bucks)
wild-ungulate “pasture”	< 10?	Quehanna State Forest Wild Area
hairgrass ridge-top savanna	< 3?	State Game Land 221 (Monroe)
riverside meadow/grassland	< 1?	Ohiopyle State Park (Fayette)
mesic diabase meadow	< 0.5?	Gifford Pinchot State Park (York)
xeric limestone prairie <sup>3</sup>	< 0.05	Canoe Creek State Park (Blair)
black oak savanna	< 0.05	Erie Bluffs State Park (Erie)

<sup>1</sup> Small fractions of the savanna are on National Park Service and Lehigh Gap Wildlife Refuge lands.

<sup>2</sup> Source for acreage: J. K. Bissell, personal communication (2005).

<sup>3</sup> Source for acreage: Laughlin and Uhl (2003).



Figure 4. Remnant historical grasslands, meadows, and savannas on Commonwealth lands provide unique opportunities to protect, restore and manage irreplaceable reference sites and rare, declining local genetic stock of many vascular plant species that are valuable for reclamation. A (above): State Game Lands 217 (Carbon County); B (below): Presque Isle State Park (Erie County).



### ***Native vascular plant species characteristic of grasslands, meadows, and savannas in Pennsylvania***

Native vascular plants that characteristically inhabit Pennsylvania grasslands, meadows, and savannas, including ephemeral, early-successional assemblages as well as persistent GMS communities, number 862. Of these, 765 are herbaceous (Appendices B and D) and 97 are woody (Appendices C and D). Of the herbaceous plants, the habitat descriptions of 336 include the keyword *woods*, which leaves 429 native herbaceous plants classified in this report as wholly or mostly restricted in Pennsylvania to grasslands, meadows, and savannas (identified in Appendices B and D).

Among the 765 herbaceous species, 69% have been classified by their wetland status in the region (summarized in Table 4, part A). In the broadest categories, 35% grow mainly in uplands, 20% mainly in mesic habitats, and 45% mainly in wetlands. The corresponding percentages for the subset that are wholly or mostly restricted in Pennsylvania to grasslands, meadows, and savannas are 75% classified (Table 6, part A), and of these, habitats for 30% are mainly upland, for 19% mainly mesic, and for 51% mainly wetland.

Of the 765 herbaceous species, 92 are grasses, 125 are other graminoids (sedges and rushes), and 548 are forbs (herbaceous plants in all other families). Those that do not have official state status (endangered, threatened, rare, extirpated, or tentatively undetermined and under study) and therefore may be used in reclamation plantings without need for a science-based recovery plan or a carefully considered exemption from this need, number 60 grasses, 80 other graminoids, and 388 forbs. Of the total number of grasses, 49 species have only the C<sub>3</sub> photosynthetic pathway (cool-season grasses) and 43 also have C<sub>4</sub> photosynthesis (warm-season grasses). Grasses on the GMS list without official state status consist of 32 cool-season and 28 warm-season species. In some restoration and reclamation projects it is appropriate to use many of the 237 GMS plant species of special concern, but only after a science-based recovery plan or a carefully considered exemption from this requirement has been formulated.

Of the 294 vascular plant species classified as endangered in Pennsylvania, 112 (38%) are characteristic of GMS habitats (summarized in Tables 4 and 5, part C; identified in Appendix C). There are 86 species classified as threatened in the state, of which 35 (41%) live mainly in GMS habitats. Out of 110 vascular plant species that have been extirpated from Pennsylvania since European settlement, 38 (35%) are characteristic of grasslands, meadows, and savannas. These percentages are about double the 19.5% of the state's land currently estimated to be in grassland, meadow, and savanna cover<sup>1</sup> (Myers et al. 2000) and are vastly disproportionate to the 1% to 3% of the land within Pennsylvania's borders estimated from historical sources to have been in similar vegetation around the time of European settlement (R. E. Latham, unpublished data).

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<sup>1</sup> The sum of Myers and colleagues' "woody transitional (5% < cover of woody plant foliage < 40%), also shrubland or forest regeneration" and "perennial herbaceous (grasslands, pasture, forage, old fields < 5% shrubs)" categories, mapped by analysis of satellite photography.

Table 4. Summary of native herbaceous vascular plants characteristic of grasslands, meadows, and savannas in Pennsylvania, categorized by wetland status, growth form, and rarity (includes all of the species summarized in Table 6). The species are listed in Appendices B and D.

A. Wetland status <sup>1</sup>		number of taxa	B. Growth form <sup>2</sup>		number of taxa
UPL		46	HA		142
FACU-		38	HB		24
FACU		92	HP		594
FACU+		10	VP		5
FAC-		15	total		765
FAC		80	<hr/>		
FAC+		11	C. PNHP status <sup>3</sup>		number of taxa
FACW-		9	PX		36
FACW		84	PE		102
FACW+		47	PT		32
OBL		94	PR		18
N		240	TU		49
total		765	total		237

<sup>1</sup> Wetland status codes:

OBL	obligate wetland species
FACW	mainly wet or mesic habitats
FAC	mainly mesic habitats
FACU	mainly mesic or upland habitats
UPL	mainly upland habitats
+	wetter
-	drier
N	not rated

<sup>2</sup> Herbaceous plant growth-form codes:

HA	herbaceous annual
HB	herbaceous biennial
HP	herbaceous perennial
VP	herbaceous perennial vine

<sup>3</sup> State status codes:

PX	extirpated in the state
PE	endangered in the state
PT	threatened in the state
PR	rare in the state
TU	status tentatively undetermined and under study





## Discussion

### ***Providing habitat for declining grassland-obligate birds***

Pennsylvania's breeding bird fauna includes at least 15 species that are referred to as grassland-obligate or grassland-interior species (see Table 7), that is, in order to nest and successfully rear young they need access to large grasslands, meadows, or savannas, or to artificial habitats that supply at least some of the same nesting cues and resources. Such "imitation" GMS habitats include annual crop fields, hayfields, pastures, grassy reclaimed strip mines, and other areas that are mowed occasionally such as utility line rights-of-way and airport runway approaches.

"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" (Peterjohn 2006). Conversion of some of the land in state parks and state game lands that is now in annual row crops, hay (non-native perennial cool-season grasses), or warm-season grass monocultures to diverse mixtures of native warm-season and cool-season grasses and forbs could greatly benefit these birds.

Grassland birds vary in their habitat requirements, so only a mosaic of patches in different stages of recovery from various intensities of disturbance will support a variety of species. For example, horned larks prefer open areas with sparse vegetation, grasshopper sparrows are most abundant where bunchgrasses are interspersed with patches of bare ground, Henslow's sparrows prefer tall, dense grass cover where there has not been a disturbance for several years, and eastern meadowlarks need dense vegetation with thick litter and scattered trees or other tall singing perches (see Table 8).

A large, contiguous habitat area is critical for all grassland species, and density, diversity and offspring survival increase with the size of a habitat "island." In Illinois, most grasshopper sparrows, savannah sparrows, bobolinks and Henslow's sparrows were absent from patches of less than 75 contiguous acres (Herkert 1994a), and this lower limit has been confirmed in eastern states as well (e.g., Vickery 1994). Upland sandpiper needs fields of at least 150 acres (McWilliams and Brauning 2000). Furthermore, only a large contiguous area of grassland can be maintained as a habitat mosaic, large enough to accommodate patches of a variety of habitat types (Herkert 1994b). As a general rule of thumb in the Mid-Atlantic region, Peterjohn (2006) has suggested that GMS patches of 12 to 25 acres sometimes support a small "sink" population of a grassland-obligate bird species, 25 to 50-acre patches do so more consistently, and it takes a minimum of 100 to 250 acres of contiguous GMS to support multiple grassland-obligate bird species.

Table 7. Grassland-obligate bird species that nest in Pennsylvania and their conservation status in the state (McWilliams and Brauning 2000; Pennsylvania Natural Heritage Program 2007).

species	state status <sup>1</sup>
northern harrier ( <i>Circus cyaneus</i> )	CA
northern bobwhite ( <i>Colinus virginianus</i> )	
upland sandpiper ( <i>Bartramia longicauda</i> )	PT
barn owl ( <i>Tyto alba</i> )	CA
short-eared owl ( <i>Asio flammeus</i> )	PE
loggerhead shrike ( <i>Lanius ludovicianus</i> )	PE
horned lark ( <i>Eremophila alpestris</i> )	
sedge wren ( <i>Cistothorus platensis</i> )	PT
vesper sparrow ( <i>Pooecetes gramineus</i> )	
savannah sparrow ( <i>Passerculus sandwichensis</i> )	
grasshopper sparrow ( <i>Ammodramus savannarum</i> )	
Henslow's sparrow ( <i>Ammodramus henslowii</i> )	
dickcissel ( <i>Spiza americana</i> )	PT
bobolink ( <i>Dolichonyx oryzivorus</i> )	
eastern meadowlark ( <i>Sturnella magna</i> )	



Henslow's sparrow

<sup>1</sup> State status codes:

- PE endangered in the state
- PT threatened in the state
- CA candidate at risk in the state

Table 8. Habitat preferences of grassland-obligate bird species that nest in Pennsylvania. Based on information in Peterjohn (2006) and McWilliams and Brauning (2000).

species	include patches of bare ground	dense ground litter	patchy, short grasses, forbs	dense, tall grasses, forbs	shrubs (cover or short singing perches)	sparse trees (tall singing perches)	include patches of wet vegetation
northern harrier				YES			YES
northern bobwhite				YES	YES		
upland sandpiper		avoid		YES			
barn owl						O.K.	
short-eared owl					YES		YES
loggerhead shrike				YES	YES	O.K.	
horned lark	YES		YES				
sedge wren							YES
vesper sparrow	YES		YES		YES		avoid
savannah sparrow			YES		O.K.		avoid
grasshopper sparrow	YES	YES	YES	avoid	YES		
Henslow's sparrow	avoid	YES		YES	avoid		O.K.
dickcissel					O.K.		
bobolink		YES		YES	O.K.		O.K.
eastern meadowlark		YES		YES	O.K.	YES	

In Appendix A, we list many specific locations where cutting fencerows and narrow strips of trees between fields is suggested to create much larger fields. Doing so, even when the resulting larger field is sinuous in shape, greatly enhances the attractiveness of GMS habitat for area-sensitive grassland-nesting species (O'Leary and Nyberg 2000). Area-sensitive birds do not use the edges of fields as much as the interior area, an effect that is measurable as far as 50 m (160 feet) from wooded edges or fencerows (Winter et al. 2000; Bollinger and Gavin 2004). Thus, when fencerows and narrow wooded strips between existing fields are removed, the increase in the area of preferred nesting habitat can be much greater than the area of brush or woods that is cut. There are trade-offs in fencerow removal; some fencerows and narrow strips of trees between fields may be dispersal and foraging corridors for wildlife, including small mammals and nocturnal predators. However, those same small mammals and nocturnal predators are among the chief nest predators of ground-nesting birds, and edges are where brood parasitism rates by brown-headed cowbirds are highest. Most, if not all, wildlife species that depend on fencerows and tree-lines between agricultural fields are secure in Pennsylvania, whereas grassland-obligate birds are of high conservation concern and most are undergoing rapid population declines. Weighing costs and benefits to wildlife habitat and biodiversity favors fencerow removal on public lands.

Some species require song perches within a particular height range, where males can advertise their territorial boundaries (Peterjohn 2006). Of the passerines, only sedge wrens and Henslow's sparrows sing from on or near the ground and horned larks while airborne. The rest need perches that are strong and stable enough to stay upright while bearing a bird's weight (see Table 8). No

grasses and few native forbs can serve the purpose (a non-native forb, common mullein, *Verbascum thapsus*, is regularly used). Randomly scattered shrubs, small trees, and dead snags are among the structural elements of native GMS that are critical to grassland-obligate birds.

When time, funds, and land are allocated to native GMS reclamation in the hopes of attracting nesting pairs of grassland-obligate birds, a critical question is, will they come? There are no guarantees, but because eastern grassland birds have always depended on a habitat that is often short-lived, they have an innate ability to find and colonize new habitats that are remote from previously existing habitats. As evidence, abandoned strip mines “reclaimed” with mixtures of exotic grasses across western Pennsylvania have attracted breeding populations of Henslow’s sparrows, upland sandpipers, and other grassland birds that had nearly disappeared from the area (McWilliams and Brauning 2000; Mattice et al. 2005).

A set of concepts in ecology and population biology often invoked to help illuminate the relationship between grassland-obligate birds and GMS reclamation is that of sources, sinks, and ecological traps. These terms describe particular areas of contiguous habitat in a region or landscape for a particular species. A *source* is an area of high-quality contiguous habitat in which the population growth rate of the species of interest is positive. A *sink* is an area of low-quality habitat in which the population growth rate is negative. All of the individuals of a species breeding in all of the habitats within dispersal distance of each other are termed a metapopulation. If there were no source in a metapopulation’s range, it would eventually die out. Sources are essential but sinks are important, too, because they allow a metapopulation to be larger and more genetically diverse than it would be if it occupied only its source habitats. Larger, more dispersed, and more genetically diverse populations are more resilient against setbacks and less vulnerable to potential catastrophes caused by unusual weather, disease outbreaks, and other environmental variability. A primary goal of GMS reclamation on state park and state game lands should be to provide source habitats for a variety of grassland-obligate bird species. A worthy secondary goal would be to expand the supply of sink habitats.

The strict definition of *ecological trap* is a low-quality habitat that is preferred over other available, higher-quality habitats (Donovan and Thompson 2001). It requires an inverse relationship between habitat preference and habitat quality. In computer models of populations and habitat arrays, the presence of ecological traps leads to extinction. Although inverse relationships between habitat preference and habitat quality may sometimes occur<sup>1</sup>, analogous situations may be more common where habitat preference and habitat quality have a more complex relationship. The term ecological trap is sometimes erroneously used for habitats where cues attract nesting animals at similar (not higher) rates as to either source habitats or sink habitats, but where almost no offspring ever get out alive. A common example is a hayfield that is mowed every May, destroying any nests, eggs, and nestlings. Such a situation does not cause a metapopulation’s extinction but it would certainly be a sign of failure of a GMS reclamation project.

It should be noted that other bird species depend on native grasslands, meadows, and savannas in addition to the grassland-obligate nesters, and some of them are declining and considered to be species of conservation concern in the state. The long-eared owl (*Asio otus*), endangered in Pennsylvania, nests in conifers but forages in grasslands and marshes. The GMS users American

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<sup>1</sup> A classic example is Cooper’s hawks in the city of Tucson, where nesting density is much higher than in the surrounding countryside but nestling survival is lower by more than an order of magnitude, due to a disease carried by urban pigeons and doves (Boal and Mannan 1999, cited by Battin 2004).

woodcock (*Scolopax minor*), prairie warbler (*Dendroica discolor*), whip-poor-will (*Caprimulgus vociferus*), Wilson's snipe (*Gallinago delicata*), and yellow-breasted chat (*Icteria virens*) are listed as species of "maintenance concern" in the state wildlife action plan (Pennsylvania Game Commission and Pennsylvania Fish and Boat Commission 2005).

The list of GMS wildlife species of conservation concern is not limited to birds. Other vertebrates depend on GMS habitats, including the least shrew (*Cryptotis parva*), eastern massasauga (*Sistrurus catenatus catenatus*), and Kirtland's snake (*Clonophis kirtlandii*), all endangered in Pennsylvania, and the shorthead garter snake (*Thamnophis brachystoma*), a Pennsylvania responsibility species<sup>1</sup> of maintenance concern. A host of insects and other arthropods utilize GMS habitats, including certain lepidopterans (see next section), dragonflies, damselflies, beetles, ants, wasps, bees, spiders, mites, and members of many other groups. Little is known about the conservation needs of most invertebrate groups in the state but entomologists at the Pennsylvania Natural Heritage Program, Carnegie Museum of Natural History, Academy of Natural Sciences, and other institutions are actively working to remedy this situation and their findings will doubtless inform GMS reclamation priorities and methods in the future.

### **Providing habitat for rare moths and butterflies of grasslands, meadows, and savannas**

Hundreds of species of moths and butterflies utilize the native plants of the Commonwealth's grasslands, meadows, and savannas. Adults of a high proportion of these species feed on the nectar of GMS forbs. Most rare lepidopteran species in the state are narrowly specialized to feed as larvae on just one or two host plant species or genera, in many cases of plants that are characteristic of GMS habitats (see Results and Appendix E).

These animals have suffered declines just as grassland-obligate birds and GMS vascular plants have. One indication of the severity of the decline is how many species have already been extirpated from the state. At least seven GMS butterflies have been extirpated or are presumed extirpated from Pennsylvania, including the arogos skipper (*Atrytone arogos arogos*), pink-edged sulphur (*Colias interior*), mottled duskywing (*Erynnis martialis*), karner blue (*Lycaeides melissa samuelis*), tawny crescent (*Phyciodes batesii batesii*), green comma (*Polygonia faunus*), and checkered white (*Pontia protodice*). The corresponding number for moths is at least six species, including the barrens dagger moth (*Acronicta albarufa*), sweet underwing (*Catocala dulciola*), precious underwing (*Catocala pretiosa pretiosa*), marsh fern moth (*Fagitana littera*), slender clearwing (*Hemaris gracilis*), and Thaxter's pinion moth (*Lithophane thaxteri*).

Another indication of the magnitude of the risk to GMS lepidopterans is the number of globally rare species that occur in Pennsylvania. The list includes five butterflies: the northern metalmark (*Calephelis borealis*), Persius duskywing (*Erynnis persius persius*), Appalachian grizzled skipper (*Pyrgus wyandot*), diana fritillary (*Speyeria diana*), and eastern regal fritillary (*Speyeria idalia idalia*). At least twelve moths in the state that often utilize GMS habitats are globally rare: the barrens dagger moth (*Acronicta albarufa*), quiet underwing (*Catocala dulciola*), precious underwing moth (*Catocala pretiosa pretiosa*), bird dropping moth (*Cerma cora*), a hand-maid moth (*Datana ranaeiceps*), slender clearwing (*Hemaris gracilis*), barrens itame (*Itame* sp. 1 nr. *inextricata*), Doll's merolonche (*Merolonche dolli*), flypoison borer moth (*Papaipema* sp. 1),

<sup>1</sup> Pennsylvania responsibility species are those for which the state plays an important regional, national, or global role in their conservation (Pennsylvania Game Commission and Pennsylvania Fish and Boat Commission 2005).

pink sallow (*Psectraglaea carnosa*), northeastern pine zale (*Zale curema*), and pine barrens zale (*Zale* sp. 1 nr. *lunifera*).

Key elements of GMS habitats for moths and butterflies are larval host plants, pupation sites, adult nectar sources, and adult resting sites. It is crucial to many species that a diverse array of adult nectar sources co-occur in their habitat, because adults of those species live and must feed for a longer period during the growing season than any one plant species is in flower. For instance, the eastern regal fritillary (*Speyeria idalia idalia*), a critically imperiled grassland butterfly whose sole remaining population lives in Pennsylvania, lives only where there is an abundance of violets (*Viola* spp.), its larval host plant; bunchgrasses (mainly little bluestem, broomsedge, and deer-tongue), where adults rest and hide; milkweeds (*Asclepias* spp.), its principal nectar source in the early-summer breeding season; and native thistles (mainly *Cirsium discolor* and *C. pumilum*), which females rely on for nectar in late summer when laying eggs (Latham et al. 2007).

Promoting a high diversity of vascular plant species and habitat structure is a major key to benefiting moths and butterflies in GMS reclamation and management. The specific host plants of rare lepidopterans known to occur in the regions surrounding GMS reclamation projects should be special targets of the planting, monitoring, and management programs at all such sites on state parks and state game lands.

### ***Increasing the diversity of native vascular plant species and management regimes used in grassland, meadow, and savanna reclamation***

Native grassland, meadow, and savanna plant species that do not have official state status (endangered, threatened, rare, extirpated, or tentatively undetermined and under study) may be used in reclamation plantings without the need for a science-based recovery plan or a carefully considered exemption from this need. This palette of native plants (listed in Appendix A) consists of 60 grasses, 80 other graminoids (sedges and rushes), and 388 forbs. Of the grasses, 32 species have only the C<sub>3</sub> photosynthetic pathway (cool-season grasses) and 28 also have C<sub>4</sub> photosynthesis (warm-season grasses).

There are two ways of obtaining seeds of these species: purchase from a supplier and wild-collecting. At present relatively few of them are commercially available or in widespread use for GMS reclamation projects in Pennsylvania. Ernst Conservation Seeds, LLP, in Meadville, Pennsylvania is the largest supplier of GMS seeds of native Mid-Atlantic genotypes and has the widest selection of species. Its current inventory of regional genotypes includes 7 of the native cool-season grasses (6 of them from within Pennsylvania), 10 of the warm-season grasses (5 Pennsylvania), 14 of the other graminoids (13 Pennsylvania), and 65 of the forbs (58 Pennsylvania) listed in Appendix A. Although these are impressive numbers and growing year-by-year as more species' seeds are collected and propagated, they still represent only 18% of the native herbaceous species (but more than one-quarter of the grasses) most qualified for GMS reclamation planting (Appendix A). Reclamation practitioners who hope to attain levels of native plant species richness and wildlife habitat diversity comparable to historical and remnant native GMS stands have to include collection of native plant seeds from the wild as part of their reclamation protocols. Much care must be taken in choosing collection sites and in seed-collecting methods to avoid introducing seeds from non-native, invasive species in the mix and to avoid planted areas where non-native genotypes of native species have been introduced.

A few widespread misconceptions may need to be dispelled at the outset for some of those involved in the planning of GMS reclamation projects. For instance, not all native grasses are warm-season grasses and vice-versa; there are actually more species of *native* cool-season grasses than the number of commonly planted non-native grasses. Likewise, a monoculture — even a field of native warm-season grasses — in reality does *not* constitute good wildlife habitat (Norment et al. 1999; Peterjohn 2006). Patchy mixtures of cool-season grasses, warm-season grasses, forbs, and shrubs have been the norm in native grasslands, meadows, and savannas in the Mid-Atlantic region throughout the evolutionary history of wildlife species that depend on these habitats. Structural diversity also characterizes native GMS habitats; they were, and are, a mosaic of bare ground, sparse short vegetation, dense tall grasses and forbs, and scattered shrubs. Landscapes with a high diversity of native species, species functional groups, vegetation structure, and patchiness should be regarded as the desired outcome of reclamation projects (see Figure 5).

Diverse native GMS with a mix of native cool-season grasses, warm-season grasses, and forbs almost certainly support a higher biomass and diversity of wildlife than the mostly artificial environments that make up the majority of GMS or GMS-like habitats today, including annual crop fields, hayfields, pastures, old fields dominated by invasive non-native plants, reclaimed strip mines, and utility rights-of-way. Although few, if any, scientific studies have addressed the question directly, the basic ecological principles involved give weight to this hypothesis. Wildlife diversity and, in most cases, total biomass decrease toward the simpler or more homogeneous end of the spectrum of ecological communities, or as the proportion of plant cover in non-native species increases.

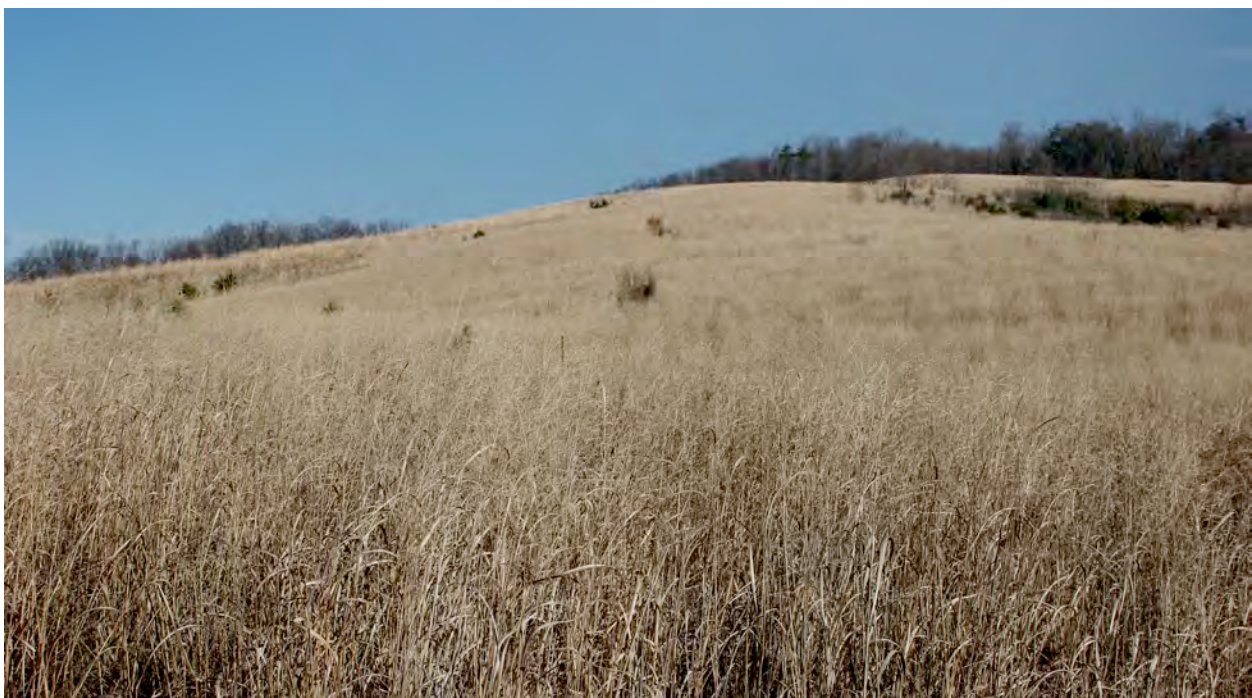
The food web is one of the most important factors contributing to this pattern. Insects are vital links in many of the food chains that make up the trophic web in terrestrial ecosystems. Many insects are specialist feeders to one degree or another, sometimes on a single plant species and often on a narrow range of plant species. A higher species richness of native plants entails a higher insect diversity and can support a higher insect biomass in a given area of land. Insects are the richest source of fats and protein for many small vertebrates, which are in turn food for many larger vertebrates. Higher plant species richness also means higher structural diversity of habitat for wildlife, which contributes to higher animal diversity and population numbers within a given area.

Non-native plants are eaten to a far lesser degree than native plants by insects and other herbivores. The relative lack of natural “enemies” (that is, consumers) is part of the reason why some non-native plant species are invasive. They have an unfair advantage over native plants, which have entire suites of co-evolved herbivores and parasites. With their lower average rates of herbivory, less of the biomass of non-native plants is converted into animal biomass. It is axiomatic that rich mixtures of native species, such as we see today mainly in the small, rare, historical GMS remnants, provided native wildlife species exactly what they needed for millions of years. After all, the native plants, the native vertebrates, and all of the native species in the food chains between them evolved together.

Converting those portions of state park lands and state game lands that are now devoted to annual crops, non-native cool-season hay species, or warm-season grass monocultures to species-rich, structurally diverse native GMS communities should be a high priority if high wildlife diversity as well as high game production is the goal. Annual crops in some cases foster high biomass and population numbers of one or a few game species, but the diversity of native wildlife they support is far lower than is supported by a diverse mixture of native plant species.



Figure 5. A (above). Part of a 175-acre meadow in Ricketts Glen State Park, Sullivan and Luzerne Counties. There is high diversity in native plant species and habitat structure, and the landscape is a patchy mosaic of areas with different soil moisture regimes, time since last disturbance, and type of disturbance. Such diversity at multiple scales enhances habitat quality for a wide variety of wildlife species. B (below). Switchgrass planting in Huntingdon County. High grass density, low species richness, low structural diversity, and lack of patchiness limits its value as habitat for wildlife.



Those rare remnants of historical GMS that are state-owned provide unique opportunities for the Department of Conservation and Natural Resources and the Game Commission to protect, restore and manage irreplaceable reference sites and rare, declining local genetic stock of many vascular plant species that are valuable for reclamation. Even the species found in these sites that are not listed as endangered or threatened in the state are imperiled in a sense, because the local genotypes are at risk of being swamped by inadvertent hybridization with planted stock of the same species, which until recently for many GMS plants have been predominantly from the Midwest and other sources outside the Mid-Atlantic region.

### ***Undertaking grassland, meadow, and savanna reclamation or restoration***

The initial approach to either reclamation or restoration of GMS involves site assessment. Sites should be classified broadly by soil/parent material type; cover types and their extent within the larger site; soil moisture; degree, pattern, and type of invasive cover; and an analysis of opportunities and constraints for restoration and reclamation. Sites can then be prioritized within a region or across the state to provide a mix of restoration and reclamation sites. Although restoration is perhaps more urgent from a conservation perspective, sites for restoration (those with existing native GMS remnants) are more limited. Such sites are often smaller, too, and one of the objectives of GMS restoration and reclamation is to create grasslands and meadows large enough to support grassland-interior birds — birds that require a minimum unfragmented area, often several hundred acres, in order to effectively reproduce. A regional or statewide GMS restoration/reclamation plan should take into account the need both for plant community restoration and for GMS reclamation and grassland-obligate bird recovery.

For reclamation sites, and in some cases even for restoration sites, it will be necessary to identify areas of heavy grass cover — cover heavy enough to exclude other species — and take steps to remedy this situation. For warm-season grasslands a late spring application of imazapic (Plateau®) with a three-week waiting period before trying to establish forbs is indicated. For cool-season grasses, an early season application of glyphosate (Roundup®) or similar material will suppress overly aggressive grass species. Again, it is necessary to wait three weeks before attempting plantings. In some specialized GMS, notably serpentine grassland/savanna that has been invaded by closed-canopy forest or woody vine cover, surface soil organic matter removal may be a necessary first step to restoring the grassland or savanna condition.

Plants for GMS reclamation or restoration are selected in a series of steps. First, there is a need to consult species lists compiled for this purpose or more comprehensive sources of information (for instance, Rhoads and Block 2007) that identify soil parent-material preferences of native plant species. The species lists then need to be filtered to yield those whose seeds are available from commercial suppliers or from sites available for wild-collecting, and further filtered to yield only those species that are appropriate for the local soil moisture regime. Nursery-raised plants can also be used if budget allows. For either seeds or plugs, it is important to make sure that the provenance of the plants is within or nearby Pennsylvania. Preferably, the seed or plant source should come from the same ecoregion as the site to be planted (see Appendix B for a local species availability listing; see [www.nativeseednetwork.org](http://www.nativeseednetwork.org) for a map of Pennsylvania's ecoregions and the areas of the surrounding states into which they extend).

Planting a GMS can be challenging, because there is often a tendency for the planted native grass species to become over-dominant. This is particularly true of some of the warm-season grasses,

notably big bluestem, Indian grass, and switchgrass. It is best to mass forb plantings and separate them spatially from the grass plantings. This type of patchiness is common in nature and should be imitated to the extent possible in restoration and reclamation. In no cases should grasses be planted in rates exceeding 1 to 2 pounds per acre if the goal is to obtain high species diversity. For savanna systems, trees can be planted or released as volunteers. Sites may require post-planting maintenance to reduce grass cover. Prescribed burning and tillage have been used to reduce grass cover, as has selective herbiciding. Though still uncommon in the East as an ecosystem management tool, grazing at low density (less than 0.5 “animal units” — 1,000 pounds of grazer — per acre) should be considered as an alternative, especially in meadows. Grazing is widely used in Europe as a tool for the conservation management of native grasslands, meadows, savannas, and shrublands.

Failure of GMS plantings is not uncommon. In planning for restoration and reclamation, it should be very clear that failure is possible and beyond the control of even an excellent practitioner. Such temporary setbacks should be programmed into the operating plan for any grassland restoration/reclamation effort. The need for contingencies must be clear in the plan.

For many plants on the GMS species lists, seeds or planting stock may not be available commercially. In most restoration situations, commercially supplied seeds and planting stock are not appropriate in any case, because sustaining the site’s unique set of genotypes, at least for the rarer species, is crucial to responsible stewardship of historical remnants and reference sites. In many cases, attaining levels of native plant species richness and wildlife habitat diversity comparable to historical and remnant native GMS stands would not be possible without collecting native plant seeds from the wild. Wild-collecting seed and raising seed stock in nursery beds in order to obtain seed (or plants) for planting should be planned for in any restoration/reclamation program. For rare species there are regulatory constraints on such activity, requiring state or federal agencies’ approval of wild-collection and production of seed stock.

Once a grassland, meadow, or savanna is established, maintenance is required to keep the area from becoming shrubland or woodland, halt the spread of invasive, non-native species, maintain a mix of patches of different ages and species composition, and in some cases keep native grasses from crowding out other species. For grasslands and savannas with a strong warm-season grass component, prescribed burning in early to mid-spring may be the most effective way of suppressing non-native invaders and preventing succession to thicket or woods. Alternatively, unwanted woody or non-native plants may be spot-sprayed with triclopyr (Garlon IV®) or similar herbicide. For grasslands with a strong cool-season grass component, winter mowing can be used to suppress woody invasives. Fall or spring burning or spot-application of herbicide can also be used to discourage non-natives.

It is preferable to remove the cut material when mowing is used as a GMS management technique. Otherwise, thick litter builds up, which tends to speed the rate at which grasses competitively suppress other plants and advance toward monoculture (Bascompte and Rodríguez 2000). Mowing should be considered as a stopgap measure until a prescribed burning program can be put into place or restricted to special circumstances where burning is not practical. Mowing is not ecologically equivalent to burning or grazing, in part because it fails to create areas of bare soil, which are a requirement for some wildlife species and as sites for seed germination and colonization for less-competitive plant species. Patches of bare soil commonly develop in prescribed fire “hot spots” and in places where grazers uproot, trample, or wallow.

Prescribed burning should be rotated among patches in different years, with no more than one-fifth to one-third of a field or cluster of fields burned in any one year. This provides for quick recovery of local populations of wildlife that cannot escape the flames, including small mammals, reptiles, amphibians, insect larvae, eggs, and pupae, non-flying insects, spiders, and other non-flying and non-burrowing species. It also enhances habitat heterogeneity, providing for the needs of species with a wide range of habitat requirements.

With all of these recommendations in mind, it is important to note that a detailed, individual plan for each site should be drafted and vetted before proceeding with restoration or reclamation. It is recommended that a regional or statewide restoration/reclamation plan start with a few representative site types and that detailed plans, with contingencies, be written for each site.

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## Appendix A. Descriptions of potential native grassland/ meadow reclamation sites in state parks and state game lands in Pennsylvania

### **Group 1. Fifteen counties south and east of Blue Mountain (Kittatinny Ridge)**

#### **State Game Lands 280, Berks County**

*Bedrock:* phyllitic (slaty) shale; small areas of limestone

*Description:* Large and small clusters of cultivated fields separated by fencerows, partly surrounded by woods and partly by adjoining neighboring landowners' cultivated fields, with a small amount of road frontage. Game land tracts are separated by Blue Marsh Lake and surrounding federal lands managed by the U.S. Army Corps of Engineers, much of which is also in highly fragmented cultivated fields. Cutting fencerows and clearing some brushy old fields could create as few as seven fields: three north of the upper end of the reservoir of about 625, 400 and 160 acres; two north of the main part of the reservoir of approximately 330 and 30 acres, and two west of the reservoir of about 130 and 110 acres.

#### **State Game Lands 182, Berks County**

*Bedrock:* shale, greywacke (clayey sandstone), phyllitic (slaty) shale

*Description:* Three isolated, small clusters of cultivated fields separated by fencerows, mostly surrounded by woods (35, 19, 14 acres).

#### **Middle Creek Wildlife Management Area (State Game Lands 46), Lancaster and Lebanon Counties**

*Bedrock:* sandstone, quartz-pebble conglomerate; may be some shale

*Description:* Large clusters of fields with only a few fencerows, mostly surrounded by woods and the shore of Middle Creek Lake, with some road frontage. With minor brush cutting, they could become as few as three large and two small fields: on the northeastern side of the reservoir, 920, 180 and 28 acres; on the northwestern side of the reservoir, 430 and 25 acres.

#### **State Game Lands 145, Lebanon County**

*Bedrock:* shale, sandstone, quartz conglomerate; may be some argillite

*Description:* A single cluster of fields separated by fencerows in the northwestern corner. Could be joined by cutting fencerows into a single field of about 145 acres.

#### **State Game Lands 220, Lancaster County**

*Bedrock:* quartzose sandstone, quartz conglomerate

*Description:* A single cultivated field of nearly 70 acres adjoining neighboring landowners' cultivated fields on three sides and the wooded part of the gameland on the other side.

#### **State Game Lands 80, Lebanon County**

*Bedrock:* sandstone, siltstone, shale, small area of limestone, calcareous shale, dolomite

*Description:* One field between I-81 and the Appalachian Trail of nearly 60 acres.

#### **Evansburg State Park, Montgomery County**

*Bedrock:* shale, mudstone, siltstone, argillite; may be some calcareous shale

*Description:* Widely scattered clusters of cultivated fields separated by fencerows and mowed turf areas (including a golf course), mostly surrounded by brushy old fields and woods with

minor frontage on neighboring landowners' cultivated fields and suburban residential areas. Site is bisected by the wooded riparian corridor of Skippack Creek. Clusters could be joined by cutting fencerows and clearing a few small brushy areas into as few as 10 fields: near the northeastern end, three fields of about 300, 70 and 30 acres; near the center, three fields of about 125, 25 and 20 acres; near the southwestern end, four fields of about 75, 55, 35 and 18 acres. Even larger fields could be created with more extensive clearing of brushy old fields.

**Norristown Farm Park**, Montgomery County (state park managed by Montgomery County Department of Parks and Heritage Services)

*Bedrock:* arkosic (feldspar-rich) sandstone; may be some shale, siltstone

*Description:* Three field complexes separated by a Y-shaped wooded riparian corridor along Stony Creek and one of its tributaries, Five Mile Run, surrounded by woods, suburban residential and institutional development, and roads. Minimal fencerow cutting could create three large fields of approximately 230, 220 and 120 acres.

**State Game Lands 234**, Montgomery County (tract near Schwenksville)

*Bedrock:* shale, mudstone, siltstone, argillite

*Description:* Cultivated fields, some separated by fencerows, mostly surrounded by woods and with some frontage on a few neighboring landowners' cultivated fields, residential lots, roads, a railroad, and an industrial area. Fencerow cutting in the southwestern tract could create a single field of about 140 acres. Four fields in the northeastern tract (formerly the Fisher State Game Farm or Eastern Game Farm) range in size from 16 to 75 acres and total 135 acres.

**Tyler State Park**, Bucks County

*Bedrock:* arkosic (feldspar-rich) sandstone, argillite; may be some shale, siltstone

*Description:* Large and small clusters of cultivated fields separated by fencerows, mostly surrounded by woods and with minor frontage on a few neighboring landowners' cultivated fields. Could be joined by cutting fencerows and clearing some adjoining brushy old fields to create as few as four large fields: at the eastern end, about 200 acres; southwestern corner, at least 250 acres; northwestern side, at least 325 acres; northern end, about 75 acres.

**Nockamixon State Park**, Bucks County

*Bedrock:* shale, mudstone, siltstone

*Description:* Two clusters of old fields recently planted in warm-season grasses, surrounded by woods: one north of Lake Nockamixon of 35 acres and one south of the reservoir and west of the dam of 55 acres. Brushy old fields are extensive along a 5-mile long, 2,000 to 3,000-foot wide strip of the park between Pa. 563 and the shore of the reservoir, dominated by invasive shrubs and small trees such as common buckthorn (*Rhamnus cathartica*), autumn-olive (*Elaeagnus umbellata*), and multiflora rose (*Rosa multiflora*). Clearing and planting could create one or more fields of up to perhaps 500 acres.

**Neshaminy State Park**, Bucks County

*Bedrock:* gravelly sand; may be some sand and clay-silt

*Description:* Three brushy old fields underlain in part by river-bottom dredging spoil and surrounded by woods, urban development, and stream frontage on the Delaware River and Neshaminy Creek, totaling 65 acres. The site provides a special opportunity to restore coastal plain grassland type; many of the species native to this type are still growing and reproducing on the site. Control of invasives, including black locust (*Robinia pseudoacacia*) and mile-a-minute weed (*Persicaria perfoliata*), is essential.

**Tyler State Park**, Bucks County

*Bedrock:* arkosic (feldspar-rich) sandstone, argillite; may be some shale, siltstone

*Description:* Large and small clusters of cultivated fields separated by fencerows, mostly surrounded by woods and with minor frontage on a few neighboring landowners' cultivated fields. Could be joined by cutting fencerows and clearing some adjoining brushy old fields to create as few as four large fields: at the eastern end, about 200 acres; southwestern corner, at least 250 acres; northwestern side, at least 325 acres; northern end, about 75 acres.

**Nockamixon State Park**, Bucks County

*Bedrock:* shale, mudstone, siltstone

*Description:* Two clusters of old fields recently planted in warm-season grasses, surrounded by woods: one north of Lake Nockamixon of 35 acres and one south of the reservoir and west of the dam of 55 acres. Brushy old fields are extensive along a 5-mile long, 2,000 to 3,000-foot wide strip of the park between Pa. 563 and the shore of the reservoir, dominated by invasive shrubs and small trees such as common buckthorn (*Rhamnus cathartica*), autumn-olive (*Elaeagnus umbellata*), and multiflora rose (*Rosa multiflora*). Clearing and planting could create one or more fields of up to perhaps 500 acres.

**Neshaminy State Park**, Bucks County

*Bedrock:* gravelly sand; may be some sand and clay-silt

*Description:* Three brushy old fields underlain in part by river-bottom dredging spoil and surrounded by woods, urban development, and stream frontage on the Delaware River and Neshaminy Creek, totaling 65 acres. The site provides a special opportunity to restore coastal plain grassland type; many of the species native to this type are still growing and reproducing on the site. Control of invasives, including black locust (*Robinia pseudoacacia*) and mile-a-minute weed (*Persicaria perfoliata*), is essential.

**State Game Lands 249**, Adams County

*Bedrock:* shale, sandstone; may be some quartzite, argillite

*Description:* Scattered clusters of cultivated fields mostly adjoining neighboring landowners' cultivated fields and partly surrounded by woods. The larger clusters could be joined by cutting fencerows and clearing some adjoining brushy old fields to create as few as ten fields: two in the western tract, at least 475 acres and 45 acres; three in the two middle tracts, about 140, 90 and 15 acres; and five in the eastern tract, approximately 150, 100, 100, 80 and 20 acres.

**State Game Lands 235**, Franklin County

*Bedrock:* magnesium limestone; may be some shale

*Description:* Two small clusters of cultivated fields separated by fencerows, mostly surrounded by woods. Cutting fencerows could create fields of about 50 and 30 acres.

**Caledonia State Park**, Franklin and Adams Counties

*Bedrock:* metarhyolite (metamorphosed silica-rich volcanic rock)

*Description:* Golf course of about 70 acres, surrounded by woods.

**State Game Lands 169**, Cumberland County

*Bedrock:* shale, sandstone, greywacke (clayey sandstone)

*Description:* Large and small clusters of cultivated fields separated by fencerows, partly surrounded by woods and partly by adjoining neighboring landowners' cultivated fields. Site is bisected by the mostly wooded riparian corridor of Conodoguinet Creek. The larger clusters could be joined by cutting fencerows and clearing some adjoining brushy old fields to create as

few as six large fields: on the northwestern side, about 260 acres; from the western end through the center, at least 575 acres; northern end, about 40 acres; south of Conodoguinet Creek, three fields of 125, 65 and 65 acres. Two other fields of about 18 acres each also lie south of the creek.

**White Clay Creek State Park, Chester County**

*Bedrock:* schist, marble, pegmatite, hornblende-bearing mafic gneiss

*Description:* Fragmented cultivated fields separated by fencerows, mostly surrounded by woods and with minor frontage on a few neighboring landowners' cultivated fields and residential lots. Site is bisected by the mostly wooded riparian corridor of White Clay Creek. Clusters could be joined by cutting fencerows to create eight larger fields: one on the north-central side of about 125 acres and seven others scattered around the park, ranging in size from 12 to 85 acres and totaling about 340 acres.

**Marsh Creek State Park, Chester County**

*Bedrock:* graphitic gneiss, gabbroic gneiss, gabbro, metadiabase dikes

*Description:* Clusters of cultivated fields separated by fencerows, surrounded by woods, the shore of Marsh Creek Lake, neighboring landowners' cultivated fields, and suburban residential areas. Could be joined by cutting fencerows to create as few as four fields: southwest of the reservoir, about 145 acres; northwest, about 150 acres; and northeast, two fields of about 80 and 40 acres.

**State Game Lands 43, Chester County**

*Bedrock:* gabbroic gneiss, gabbro, quartz monzonite, quartz monzonite gneiss; small areas of arkosic sandstone, siltstone, shale, sheet diabase, graphitic gneiss

*Description:* Clusters of cultivated fields separated by fencerows, partly surrounded by woods and partly by adjoining neighboring landowners' cultivated fields. Could be joined by cutting fencerows to create as few as five fields: in the middle tract, 160, 45, 40 and 25 acres; in the eastern tract, 50 acres.

**State Game Lands 243, York County**

*Bedrock:* sheet diabase, shale, sandstone, argillite

*Description:* Widely scattered cultivated fields, mostly surrounded by woods. The central cluster could be joined by cutting fencerows and expanded by clearing some adjoining brushy old fields to create a single field of at least 200 acres. Three other fields (60, 60 and 30 acres) adjoin both woods and neighboring landowners' cultivated fields.

**State Game Lands 242, York County**

*Bedrock:* sheet diabase

*Description:* Fragmented cultivated fields, mostly surrounded by woods. A cluster on the eastern side could be joined by cutting fencerows and expanded by clearing some adjoining brushy old fields to create a single field of at least 160 acres. A cluster on the western side adjoining a neighboring landowner's cultivated field could be joined by cutting fencerows and expanded by clearing some adjoining brushy old fields to create a field of at least 60 acres. Three other fields (30, 25 and 13 acres) are surrounded by woods.

**Codorus State Park, York County**

*Bedrock:* quartzite, quartz schist, mica-chlorite-quartzite schist

*Description:* Widely scattered, small cultivated fields or turf areas, mostly surrounded by woods, roads, and shore of Lake Marburg and with minor frontage on a few neighboring landowners' cultivated fields and residential lots and recreation areas within the park. There may be as many

as six potential grassland reclamation areas, ranging in size from 12 to 50 acres and totaling about 165 acres.

**State Game Lands 83, York County**

*Bedrock:* albite-chlorite schist

*Description:* A single cluster of fields mostly surrounded by woods. Could be joined by cutting fencerows to create a single field of about 70 acres.

**State Game Lands 181, York County**

*Bedrock:* albite-chlorite schist

*Description:* Fragmented cultivated fields, mostly surrounded by woods. A cluster on the western side could be joined by cutting fencerows and expanded by clearing some adjoining brushy old fields to create a single field of at least 45 acres. One other field of 18 acres adjoins a neighboring landowner's cultivated field on one side.

**State Game Lands 205, Lehigh County**

*Bedrock:* shale, greywacke (clayey sandstone)

*Description:* Highly fragmented cultivated fields separated by fencerows, mostly surrounded by woods and with minor frontage on a few neighboring landowners' cultivated fields. Located just west of the Trexler Game Preserve. Cutting fencerows and clearing some small brushy areas could create nine larger fields, ranging in size from 25 to 100 acres and totaling about 425 acres.

**Ridley Creek State Park, Delaware County**

*Bedrock:* hornblende-bearing and pyroxene-bearing felsic gneiss

*Description:* Scattered old fields, horse pastures, and cultivated fields, some with fencerows, mostly surrounded by woods. Cutting fencerows and clearing brushy old fields could create up to six fields, ranging in size from 18 to 65 acres and totaling about 200 acres.

**Jacobsburg State Park, Northampton County**

*Bedrock:* shale; may be some siltstone, metabentonite (claystone metamorphosed from volcanic ash), sandstone

*Description:* A single cluster of brushy old fields south of Bushkill Creek in various stages of succession, separated by old fencerows and surrounded by woods, a neighboring landowner's cultivated field, and suburban residences. Could be joined by clearing brush and cutting fencerows to create a single field of about 190 acres.

**Benjamin Rush State Park, Philadelphia County**

*Bedrock:* schist, sand and gravel (mostly of quartz, quartzite, and chert)

*Description:* Three adjoining fields separated by narrow fencerows, surrounded by woods and urban development. Part of the site is used for community gardens. The remainder could be joined by cutting fencerows to create a field as large as 125 acres.

## **Group 2. Scattered locations north and west of Blue Mountain (Kittatinny Ridge)**

### **Moraine State Park, Butler County**

*Bedrock:* sandstone, shale, limestone, clay, coal; bedrock in small part in northwestern corner may be overlain by glacial drift

*Description:* Cultivated fields or recently abandoned old fields at the eastern end around the upper reaches of the Swamp Run arm of Lake Arthur and in the northwestern corner. They are partly surrounded by woods and partly by either adjoining landowners' cultivated fields or the shore of the reservoir. Some brush-cutting could create six fields: three at the eastern end of about 140, 100 and 70 acres and three in the northwestern corner of 45, 30 and 25 acres. In addition, there is a network of old fields or reclaimed strip mines on both sides of Pa. 528 north of the upper reaches of reservoir arm where Muddy Creek flows in, mostly surrounded by woods. The more open portion totals about 650 contiguous acres in a sinuous shape nearly surrounding a central wooded area. Extensive brush-cutting could create a single field of this size or a series of smaller fields.

### **Ricketts Glen State Park, Sullivan & Luzerne Counties**

*Bedrock:* sandstone; may be some shale, siltstone

*Description:* An old field north of Lake Jean and south of the U.S. Air Force installation of about 175 acres. It is already a diverse mosaic of mostly native grasslands, meadows, and shrublands, lacking only newly disturbed (burned or scraped) areas to have a complete array of the grassland and meadow habitats typical of this region of the state. There is also an extensive area of hay-scented fern savanna on Red Rock Mountain in the western part of the park totaling over 200 acres. This community is a result of prolonged, extreme white-tailed deer density and is low in diversity and value as wildlife habitat. Herbiciding the ferns and planting native grassland and meadow species could greatly increase its value.

### **Bald Eagle State Park, Centre County**

*Bedrock:* siltstone, shale, sandstone

*Description:* Brushy old fields along 2¼ miles of Pa. 150 southwest of Schencks Cemetery, with woods along the side away from the road and toward the shore of Foster Joseph Sayers Reservoir. Clearing could create a single field of about 290 acres.

### **Shawnee State Park, Bedford County**

*Bedrock:* siltstone, shale, sandstone; may be some calcareous shale, argillaceous limestone, chert

*Description:* Three areas of relatively open old fields west of Shawnee Lake, mostly surrounded by woods, roads, and the reservoir and with minor frontage on a few neighboring landowners' cultivated fields and residential lots. Brush clearing could create fields of at least 80, 75 and 40 acres.

### **Tuscarora State Park, Schuylkill County**

*Bedrock:* shale, claystone, sandstone, siltstone

*Description:* Two cultivated fields or turf areas north and northwest of Tuscarora Lake, 40 and 35 acres. Several brushy old fields and cultivated fields south and southwest of the reservoir, including three in the range of 18 to 20 acres.

### **M. K. Goddard State Park, Mercer County**

*Bedrock:* sandstone, siltstone, shale; may be overlain in part by glacial drift

*Description:* Old fields at and east of the northern end of Lake Wilhelm Road bridge, surrounded

by woods, Georgetown Road, and the shore of Lake Wilhelm. Brush clearing could create two fields of 50 and 30 acres. A cluster of cultivated fields separated by fencerows south of the intersection of Georgetown and Deer Creek Roads, surrounded by woods, Georgetown Road, and the shore of Lake Wilhelm. Cutting fencerows could create a field of about 100 acres.

**Nescopeck State Park**, Luzerne County

*Bedrock*: calcareous sandstone; bedrock may be overlain in part by glacial drift

*Description*: Old fields near the southwestern end, between Nescopeck Creek and the park access road, surrounded by woods. Extensively invaded by non-native species such as autumn-olive (*Elaeagnus umbellata*). Brush clearing could create fields of 65 and 16 acres. Similar but smaller brushy old fields lie along the foot of Mt. Yeager farther eastward.

## Appendix B. Herbaceous vascular plant species commonly inhabiting long-lived grasslands, meadows, and savannas in Pennsylvania

( $N = 528$ ). Endangered, threatened, and rare species of special concern in Pennsylvania are not listed here; see Appendix D. Taxonomy, wetland status<sup>1</sup>, and growth form<sup>2</sup> are from Rhoads and Block (2007). Entries under Ernst Seeds are state abbreviations for the locations of wild-collected seeds of native genotypes sold in 2007-2008 by Ernst Conservation Seeds, L.L.P., the largest supplier of such seeds in the region (www.ernstseed.com, 9006 Mercer Pike, Meadville, PA 16335, 800-873-3321).

family / scientific name	common name(s)	wetland status	growth form	C <sub>3</sub> or C <sub>4</sub> (grasses)	Ernst Seeds
<b>SPIKEMOSSES AND CLUBMOSSES</b>					
<b>Lycopodiaceae</b>					
<i>Diphasiastrum tristachyum</i> [= <i>Lycopodium tristachyum</i> ]	deep-rooted running-pine	N	HP		
<i>Lycopodium clavatum</i> [= <i>L. lagopus</i> ]	one-cone clubmoss	FAC	HP		
<i>Lycopodium dendroideum</i>	tree ground-pine, northern tree clubmoss, prickly tree clubmoss	FACU	HP		
<b>Selaginellaceae</b>					
<i>Selaginella apoda</i>	meadow spikemoss	FACW	HP		
<b>FERNS AND HORSETAILS</b>					
<b>Ophioglossaceae</b>					
<i>Botrychium dissectum</i> [= <i>B. obliquum</i> ]	cut-leaved grape-fern	FAC	HP		

<sup>1</sup> Wetland status codes:

OBL	obligate wetland species
FACW	mainly wet or mesic habitats
FAC	mainly mesic habitats
FACU	mainly mesic or upland habitats
UPL	mainly upland habitats
+	wetter
-	drier
N	not rated

<sup>2</sup> Growth-form codes:

HA	herbaceous annual
HB	herbaceous biennial
HP	herbaceous perennial
VP	herbaceous perennial vine

family / scientific name	common name(s)	wetland status	growth form	C <sub>3</sub> or C <sub>4</sub> (grasses)	Ernst Seeds
<i>Botrychium multifidum</i>	leathery grape fern, northern grape fern	FACU	HP		
<i>Botrychium simplex</i>	least moonwort, least grape-fern	FACU	HP		
<b>Equisetaceae</b>					
<i>Equisetum arvense</i>	field horsetail, devil's-guts	FAC	HP		
<i>Equisetum hyemale</i>	scouring-rush	FACW	HP		
<i>Equisetum sylvaticum</i>	woodland horsetail	FACW	HP		
<b>Ophioglossaceae</b>					
<i>Ophioglossum pusillum</i> [= <i>O. vulgatum</i> var. <i>pseudopodium</i> ]	northern adder's-tongue	N	HP		
<b>Polypodiaceae</b>					
<i>Dennstaedtia punctilobula</i>	hay-scented fern	N	HP		
<i>Onoclea sensibilis</i>	sensitive fern	FACW	HP		PA
<i>Pteridium aquilinum</i>	northern bracken fern	FACU	HP		
<i>Thelypteris palustris</i>	marsh fern	FACW+	HP		
<b>FLOWERING PLANTS</b>					
<b>Melanthiaceae</b>					
<i>Amianthium muscaetoxicum</i>	fly-poison	FAC	HP		
<i>Chamaelirium luteum</i>	devil's-bit, fairy-wand	FAC	HP		
<b>Liliaceae</b>					
<i>Erythronium americanum</i>	yellow trout-lily	N	HP		
<i>Lilium canadense</i> ssp. <i>canadense</i>	Canada lily	FAC+	HP		
<i>Lilium philadelphicum</i>	wood lily	FACU+	HP		
<i>Lilium superbum</i>	Turk's-cap lily	FACW+	HP		PA
<b>Orchidaceae</b>					
<i>Calopogon tuberosus</i>	grass-pink	FACW+	HP		

family / scientific name	common name(s)	wetland status	growth form	C <sub>3</sub> or C <sub>4</sub> (grasses)	Ernst Seeds
<i>Liparis loeselii</i>	yellow twayblade	FACW	HP		
<i>Platanthera grandiflora</i>	large purple fringed-orchid	FACW	HP		
<i>Platanthera lacera</i>	ragged fringed-orchid	FACW	HP		
<i>Pogonia ophioglossoides</i>	rose pogonia	OBL	HP		
<i>Spiranthes cernua</i>	nodding ladies'-tresses	FACW	HP		
<i>Spiranthes lacera</i> var. <i>gracilis</i>	southern slender ladies'-tresses	FACU-	HP		
<i>Spiranthes lacera</i> var. <i>lacera</i>	northern slender ladies'-tresses	FACU-	HP		
<i>Spiranthes ochroleuca</i>	yellow nodding ladies'-tresses	FACW	HP		
<b>Hypoxidaceae</b>					
<i>Hypoxis hirsuta</i>	yellow star-grass	FAC	HP		
<b>Iridaceae</b>					
<i>Sisyrinchium angustifolium</i>	narrow-leaved blue-eyed-grass	FACW-	HP		PA
<i>Sisyrinchium montanum</i> var. <i>crebrum</i>	mountain blue-eyed-grass	FAC	HP		
<i>Sisyrinchium mucronatum</i>	needletip blue-eyed-grass	FAC+	HP		
<b>Alliaceae</b>					
<i>Allium cernuum</i>	nodding onion	N	HP		OH
<b>Ruscaceae</b>					
<i>Maianthemum stellatum</i> [= <i>Smilacina stellata</i> ]	starflower	N	HP		
<i>Polygonatum biflorum</i> var. <i>biflorum</i>	smooth Solomon's-seal	FACU	HP		
<i>Polygonatum biflorum</i> var. <i>commutatum</i>	smooth Solomon's-seal	FACU	HP		
<i>Polygonatum pubescens</i>	hairy Solomon's-seal	N	HP		
<b>Juncaceae</b>					
<i>Juncus acuminatus</i>	sharp-fruited rush	OBL	HP		
<i>Juncus secundus</i>	lopsided rush	FACU	HP		
<i>Juncus tenuis</i> var. <i>tenuis</i>	path rush	FAC-	HP		PA

family / scientific name	common name(s)	wetland status	growth form	C <sub>3</sub> or C <sub>4</sub> (grasses)	Ernst Seeds
<i>Luzula echinata</i> [= <i>L. campestris</i> var. <i>echinata</i> ]	common woodrush	FACU	HP		
<b>Cyperaceae</b>					
<i>Bulbostylis capillaris</i>	sandrush	FACU	HA		
<i>Carex aggregata</i> [= <i>C. sparganioides</i> var. <i>aggregata</i> ]	glomerate sedge	FACU	HP		
<i>Carex albolutescens</i>	green-white sedge, pale straw sedge	FACW	HP		NC
<i>Carex amphibola</i>	eastern narrow-leaved sedge	FAC	HP		
<i>Carex annectens</i> [= <i>C. vulpinoidea</i> var. <i>ambigua</i> , <i>C. xanthocarpa</i> ]	yellow-fruited sedge	FACW	HP		
<i>Carex arctata</i>	drooping woodland sedge	OBL	HP		
<i>Carex argyrantha</i>	hay sedge, silvery sedge	N	HP		
<i>Carex baileyi</i>	Bailey's sedge	OBL	HP		PA
<i>Carex blanda</i> [= <i>C. laxiflora</i> var. <i>blanda</i> ]	eastern woodland sedge	FAC	HP		
<i>Carex bromoides</i>	brome-like sedge	FACW	HP		
<i>Carex brunnescens</i>	brownish sedge	FACW	HP		
<i>Carex bushii</i>	Bush's sedge	FACW	HP		
<i>Carex canescens</i> var. <i>canescens</i>	silvery sedge	OBL	HP		
<i>Carex canescens</i> var. <i>disjuncta</i>	silvery sedge	OBL	HP		
<i>Carex caroliniana</i>	Carolina sedge	FACU	HP		
<i>Carex cephaloidea</i> [= <i>C. sparganioides</i> var. <i>cephaloidea</i> ]	thin-leaved sedge	FAC+	HP		
<i>Carex cephalophora</i>	oval-headed sedge	FACU	HP		
<i>Carex communis</i>	fibrous-root sedge, colonial oak sedge	N	HP		
<i>Carex conjuncta</i>	soft fox sedge	FACW	HP		
<i>Carex conoidea</i>	open-field sedge	FACU	HP		

family / scientific name	common name(s)	wetland status	growth form	C <sub>3</sub> or C <sub>4</sub> (grasses)	Ernst Seeds
<i>Carex cristatella</i>	crested sedge	FACW	HP		
<i>Carex cumulata</i>	clustered sedge	FACU	HP		
<i>Carex glaucoidea</i> [= <i>C. flaccosperma</i> var. <i>glaucoidea</i> ]	blue sedge	N	HP		
<i>Carex gracilescens</i>	slender loose-flower sedge	N	HP		
<i>Carex granularis</i> var. <i>granularis</i>	limestone meadow sedge	FACW+	HP		
<i>Carex granularis</i> var. <i>haleana</i>	limestone meadow sedge	FACW+	HP		PA
<i>Carex grisea</i> [= <i>C. amphibola</i> var. <i>turgida</i> ]	eastern narrow-leaved sedge, gray sedge	FAC	HP		
<i>Carex hirsutella</i> [= <i>C. complanata</i> var. <i>hirsuta</i> ]	fuzzy wuzzy sedge	N	HP		
<i>Carex interior</i>	inland sedge	OBL	HP		
<i>Carex intumescens</i>	greater bladder sedge	FACW+	HP		PA
<i>Carex leavenworthii</i>	Leavenworth's sedge	N	HP		
<i>Carex lucorum</i>	Blue Ridge sedge	N	HP		
<i>Carex lurida</i>	lurid sedge, shallow sedge	OBL	HP		PA
<i>Carex mesochorea</i> [= <i>C. cephalophora</i> var. <i>mesochorea</i> ]	midland sedge	FACU	HP		
<i>Carex molesta</i> [= <i>C. brevior</i> ]	field oval sedge, troublesome sedge	N	HP		
<i>Carex muhlenbergii</i>	Mühlenberg's sedge	N	HP		
<i>Carex nigromarginata</i>	black edge sedge	UPL	HP		
<i>Carex normalis</i>	greater straw sedge	FACU	HP		PA
<i>Carex pallescens</i>	pale sedge	N	HP		
<i>Carex pellita</i>	woolly sedge	OBL	HP		
<i>Carex scoparia</i>	broom sedge	FACW	HP		PA
<i>Carex sparganioides</i>	bur-reed sedge	FACU	HP		
<i>Carex stipata</i> var. <i>stipata</i>	stalk-grain sedge, owlfruit sedge	N	HP		PA

family / scientific name	common name(s)	wetland status	growth form	C <sub>3</sub> or C <sub>4</sub> (grasses)	Ernst Seeds
<i>Carex swanii</i>	downy green sedge, Swan's sedge	FACU	HP		PA
<i>Carex tenera</i> var. <i>tenera</i>	marsh straw sedge, quill sedge	FAC	HP		
<i>Carex tonsa</i> var. <i>rugosperma</i>	parachute sedge	N	HP		
<i>Carex tonsa</i> var. <i>tonsa</i>	shaved sedge	N	HP		
<i>Carex tribuloides</i> var. <i>tribuloides</i>	blunt broom sedge, bristlebract sedge	FACW+	HP		PA
<i>Carex trichocarpa</i>	hairy-fruited sedge	OBL	HP		
<i>Carex umbellata</i>	parasol sedge	N	HP		
<i>Carex vestita</i>	velvet sedge	N	HP		
<i>Carex vulpinoidea</i>	fox sedge, brown fox sedge	OBL	HP		PA
<i>Cyperus acuminatus</i>	short-pointed flatsedge	OBL	HA		
<i>Cyperus bipartitus</i>	slender flatsedge, umbrella sedge	FACW+	HA		
<i>Cyperus echinatus</i> [= <i>C. ovularis</i> ]	globe flatsedge, umbrella sedge	FACU	HP		
<i>Cyperus esculentus</i>	yellow nutsedge	FACW	HP		
<i>Cyperus flavescens</i>	yellow flatsedge, umbrella sedge	OBL	HA		
<i>Cyperus lupulinus</i> [= <i>C. filiculmis</i> ]	Great Plains flatsedge, sand sedge	UPL	HP		
<i>Cyperus odoratus</i>	rusty flatsedge, umbrella sedge	FACW	HA		
<i>Cyperus plukenetii</i> [= <i>C. retrofractus</i> var. <i>retrofractus</i> ]	Plukenet's flatsedge	N	HP		
<i>Cyperus retrofractus</i>	rough flatsedge	N	HP		
<i>Cyperus strigosus</i>	false nutsedge	FACW	HP		
<i>Cyperus tenuifolius</i> [= <i>Kyllinga pumila</i> ]	thin-leaved flatsedge	FACW	HA		
<i>Eleocharis engelmannii</i>	Engelmann's spike-rush	FACW+	HA		
<i>Eleocharis erythropoda</i>	bald spike-rush	OBL	HP		
<i>Eleocharis tenuis</i> var. <i>pseudoptera</i>	slender spike-rush	FACW+	HP		
<i>Eleocharis tenuis</i> var. <i>tenuis</i>	slender spike-rush	FACW+	HP		

family / scientific name	common name(s)	wetland status	growth form	C <sub>3</sub> or C <sub>4</sub> (grasses)	Ernst Seeds
<i>Fimbristylis autumnalis</i>	slender fimbry	FACW+	HA		
<i>Rhynchospora capitellata</i>	brownish beaksedge	OBL	HP		
<i>Scirpus atrovirens</i>	black bulrush	OBL	HP		PA
<i>Scirpus cyperinus</i>	wool-grass	FACW+	HP		PA
<i>Scirpus expansus</i>	wood bulrush	OBL	HP		PA
<i>Scirpus georgianus</i>	Georgia bulrush	OBL	HP		
<i>Scirpus hattorianus</i>	mosquito bulrush	OBL	HP		
<i>Scirpus microcarpus</i>	panicled bulrush	OBL	HP		
<i>Scirpus pendulus</i>	rufous bulrush	OBL	HP		
<b>Poaceae</b>					
<i>Agrostis hyemalis</i>	ticklegrass, spring bentgrass	FAC	HP	C <sub>3</sub>	NC
<i>Agrostis perennans</i>	autumn bentgrass, upland bentgrass	FACU	HP	C <sub>3</sub>	PA
<i>Agrostis scabra</i> [= <i>A. hyemalis</i> var. <i>scabra</i> ]	fly-away grass, ticklegrass, rough bentgrass	FAC	HP	C <sub>3</sub>	PA
<i>Alopecurus carolinianus</i>	Carolina foxtail, tufted foxtail	FACW	HA	C <sub>3</sub>	
<i>Andropogon gerardii</i> [= <i>A. furcatus</i> ]	big bluestem, turkeyfoot	FAC-	HP	C <sub>4</sub>	NY
<i>Andropogon virginicus</i>	broom-sedge	FACU	HP	C <sub>4</sub>	
<i>Aristida longespica</i> var. <i>longespica</i>	slender threeawn	UPL	HA	C <sub>4</sub>	
<i>Aristida oligantha</i>	prairie threeawn	N	HA	C <sub>4</sub>	
<i>Bromus ciliatus</i>	fringed brome	FACW	HP	C <sub>3</sub>	
<i>Calamagrostis canadensis</i> var. <i>canadensis</i>	Canada bluejoint	FACW+	HP	C <sub>3</sub>	
<i>Calamagrostis canadensis</i> var. <i>macouniana</i>	Canada bluejoint	FACW+	HP	C <sub>3</sub>	
<i>Danthonia compressa</i>	northern oatgrass	FACU-	HP	C <sub>3</sub>	
<i>Danthonia spicata</i>	poverty grass, poverty oatgrass	N	HP	C <sub>3</sub>	
<i>Deschampsia flexuosa</i>	wavy hairgrass, common hairgrass	N	HP	C <sub>3</sub>	

family / scientific name	common name(s)	wetland status	growth form	C <sub>3</sub> or C <sub>4</sub> (grasses)	Ernst Seeds
<i>Dichanthelium acuminatum</i> [= <i>Panicum acuminatum</i> ]	tapered rosette grass	FAC	HP	C <sub>3</sub>	
<i>Dichanthelium boscii</i> [= <i>Panicum boscii</i> ]	Bosc's panic grass	N	HP	C <sub>3</sub>	
<i>Dichanthelium clandestinum</i> [= <i>Panicum clandestinum</i> ]	deer-tongue, deer-tongue grass	FAC+	HP	C <sub>3</sub>	PA
<i>Dichanthelium columbianum</i> [= <i>D. sabulorum</i> var. <i>thinium</i> , <i>Panicum columbianum</i> ]	hemlock rosette grass	N	HP	C <sub>3</sub>	
<i>Dichanthelium commutatum</i> ssp. <i>ashei</i> [= <i>Panicum ashei</i> , <i>P. boscii</i> x <i>commutatum</i> ]	variable panic grass	N	HP	C <sub>3</sub>	
<i>Dichanthelium commutatum</i> ssp. <i>commutatum</i> [= <i>Panicum commutatum</i> ]	oval-leaved panic grass	FACU+	HP	C <sub>3</sub>	
<i>Dichanthelium depauperatum</i> [= <i>Panicum depauperatum</i> ]	poverty panic grass	N	HP	C <sub>3</sub>	
<i>Dichanthelium latifolium</i> [= <i>Panicum latifolium</i> ]	broadleaf rosette grass	FACU–	HP	C <sub>3</sub>	
<i>Dichanthelium linearifolium</i> [= <i>Panicum linearifolium</i> ]	slim-leaved witch grass	N	HP	C <sub>3</sub>	
<i>Dichanthelium sphaerocarpon</i> [= <i>Panicum sphaerocarpon</i> ]	round-fruited panic grass, round-seeded panic grass	FACU	HP	C <sub>3</sub>	
<i>Digitaria cognata</i> [= <i>D. cognatum</i> , <i>Leptoloma cognatum</i> ]	fall witchgrass	N	HP	C <sub>4</sub>	
<i>Digitaria filiformis</i>	slender crabgrass	N	HA	C <sub>4</sub>	
<i>Echinochloa muricata</i>	rough barnyard-grass, cockspur	FACW+	HA	C <sub>4</sub>	
<i>Elymus canadensis</i> var. <i>canadensis</i>	Canada wild-rye	FACU+	HP	C <sub>3</sub>	
<i>Elymus riparius</i>	riverbank wild-rye	FACW	HP	C <sub>3</sub>	PA
<i>Elymus virginicus</i>	Virginia wild-rye	FACW–	HP	C <sub>3</sub>	PA
<i>Eragrostis capillaris</i>	lacegrass	N	HA	C <sub>4</sub>	

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<i>Eragrostis spectabilis</i>	purple lovegrass, tumblegrass	UPL	HP	C <sub>4</sub>	VA
<i>Festuca obtusa</i> [= <i>F. subverticillata</i> ]	nodding fescue	FACU	HP	C <sub>3</sub>	
<i>Hordeum jubatum</i>	foxtail-barley	FAC	HP	C <sub>3</sub>	
<i>Leersia oryzoides</i>	rice cutgrass	OBL	HP	C <sub>3</sub>	PA
<i>Leptochloa fascicularis</i> [= <i>L. fusca</i> ssp. <i>fascicularis</i> ]	sprangletop	FACW	HA	C <sub>4</sub>	
<i>Muhlenbergia frondosa</i>	wirestem muhly	FAC	HP	C <sub>4</sub>	
<i>Muhlenbergia mexicana</i>	Mexican muhly satgrass	FACW	HP	C <sub>4</sub>	
<i>Panicum anceps</i>	beaked panic grass	FAC	HP	C <sub>4</sub>	MD
<i>Panicum capillare</i>	witchgrass	FAC-	HA	C <sub>4</sub>	
<i>Panicum dichotomiflorum</i> [= <i>P. proliferum</i> ]	smooth panic grass	FACW-	HA	C <sub>4</sub>	PA
<i>Panicum gattingeri</i> [= <i>P. capillare</i> (in part)]	Gattinger's panic grass	FAC	HA	C <sub>4</sub>	
<i>Panicum philadelphicum</i> [= <i>P. capillare</i> (in part)]	Philadelphia panic grass	FAC-	HA	C <sub>4</sub>	
<i>Panicum rigidulum</i> [= <i>P. agrostoides</i> , <i>P. condensum</i> ]	red-top panic grass	FACW+	HP	C <sub>4</sub>	PA
<i>Panicum stipitatum</i> [= <i>P. rigidulum</i> var. <i>elongatum</i> ]	tall flat panic grass	FACW+	HP	C <sub>4</sub>	
<i>Panicum virgatum</i>	switchgrass	FAC	HP	C <sub>4</sub>	WV
<i>Paspalum laeve</i>	field beadgrass	FAC+	HP	C <sub>4</sub>	
<i>Phalaris arundinacea</i>	reed canary-grass	FACW	HP	C <sub>3</sub>	
<i>Poa palustris</i>	fowl bluegrass	FACW	HP	C <sub>3</sub>	
<i>Schizachyrium scoparium</i> var. <i>scoparium</i>	little bluestem	FACU	HP	C <sub>4</sub>	PA
<i>Setaria parviflora</i>	perennial foxtail	FAC	HP	C <sub>4</sub>	
<i>Sorghastrum nutans</i>	Indian-grass	UPL	HP	C <sub>4</sub>	PA, VA
<i>Spartina pectinata</i>	prairie cordgrass, freshwater cordgrass	OBL	HP	C <sub>4</sub>	PA

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<i>Sphenopholis nitida</i>	wedgegrass, shiny wedgescale	N	HP	C <sub>3</sub>	
<i>Sphenopholis obtusata</i> var. <i>major</i>	slender wedgegrass	FAC-	HP	C <sub>3</sub>	
<i>Sphenopholis obtusata</i> var. <i>obtusata</i>	prairie wedgegrass	FAC-	HP	C <sub>3</sub>	
<i>Sphenopholis pensylvanica</i>	swamp-oats	OBL	HP	C <sub>3</sub>	
<i>Sporobolus cryptandrus</i>	sand dropseed	UPL	HP	C <sub>4</sub>	
<i>Sporobolus vaginiflorus</i>	poverty grass, poverty dropseed	UPL	HA	C <sub>4</sub>	
<i>Tridens flavus</i>	purpletop	FACU	HP	C <sub>4</sub>	VA
<b>Commelinaceae</b>					
<i>Tradescantia ohioensis</i>	Ohio spiderwort, blue-jacket	FAC	HP		PA
<i>Tradescantia virginiana</i>	spiderwort, widow's-tears, Virginia spiderwort	FACU	HP		PA, VA
<b>Ranunculaceae</b>					
<i>Anemone canadensis</i>	Canada anemone	FACW	HP		PA
<i>Caltha palustris</i>	marsh-marigold	OBL	HP		
<i>Ranunculus abortivus</i>	small-flowered crowfoot	FACW-	HA		
<i>Ranunculus hispidus</i> var. <i>caricetorum</i>	marsh buttercup, northern swamp buttercup	FAC	HP		
<i>Ranunculus pensylvanicus</i>	bristly crowfoot	OBL	HA / HP		
<i>Thalictrum pubescens</i>	tall meadow-rue	FACW+	HP		PA
<i>Thalictrum revolutum</i>	purple meadow-rue, skunk meadow-rue	UPL	HP		
<b>Papaveraceae</b>					
<i>Sanguinaria canadensis</i>	bloodroot, red puccoon	UPL	HP		
<b>Polygonaceae</b>					
<i>Persicaria arifolia</i> [= <i>Polygonum arifolium</i> ]	halberd-leaf tearthumb	OBL	HA		PA
<i>Persicaria hydropiperoides</i> [= <i>Polygonum hydropiperoides</i> ]	mild water-pepper, water-smartweed	OBL	HP		

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<i>Persicaria pensylvanica</i> [= <i>Polygonum pensylvanicum</i> ]	Pennsylvania smartweed, pinkweed	FACW	HA		
<i>Persicaria virginiana</i> [= <i>Polygonum virginianum</i> ]	jumpseed	FAC	HP		
<i>Polygonum achoreum</i>	homeless knotweed	FACU	HA		
<i>Polygonum erectum</i>	erect knotweed	FACU	HA		
<i>Polygonum tenue</i>	slender knotweed	N	HA		
<b>Caryophyllaceae</b>					
<i>Cerastium arvense</i> ssp. <i>arvense</i>	field chickweed	N	HP		
<i>Minuartia michauxii</i> [= <i>Arenaria michauxii</i> , <i>Arenaria stricta</i> ]	rock sandwort	N	HA / HP		
<i>Minuartia patula</i>	glade sandwort, Pitcher's stitchwort	N	HA		
<i>Moehringia lateriflora</i> [= <i>Arenaria lateriflora</i> ]	blunt-leaved sandwort	FAC	HP		
<i>Paronychia fastigiata</i> var. <i>pumila</i> [= <i>P. montana</i> ]	forked chickweed	N	HA		
<i>Silene antirrhina</i>	sleepy catchfly	N	HA		
<i>Silene caroliniana</i> ssp. <i>pensylvanica</i>	Pennsylvania catchfly, sticky catchfly	N	HP		
<i>Silene stellata</i>	starry campion	N	HP		
<i>Stellaria longifolia</i>	long-leaved stitchwort	FACW	HP		
<b>Amaranthaceae</b>					
<i>Atriplex littoralis</i>	seashore orach	N	HA		
<i>Chenopodium album</i> var. <i>missouriense</i>	lamb's quarters	N	HA		
<b>Phytolaccaceae</b>					
<i>Phytolacca americana</i>	pokeweed	FACU+	HP		

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<b>Portulacaceae</b>					
<i>Claytonia virginica</i>	spring-beauty	FAC	HP		
<i>Portulaca oleracea</i>	purslane	FAC	HA		
<b>Saxifragaceae</b>					
<i>Heuchera pubescens</i>	downy alum-root	N	HP		
<b>Geraniaceae</b>					
<i>Geranium carolinianum</i>	Carolina cranesbill, Carolina geranium	N	HA		
<i>Geranium maculatum</i>	wood geranium	FACU	HP		PA
<b>Onagraceae</b>					
<i>Epilobium angustifolium</i> [= <i>Chamerion angustifolium</i> ]	fireweed	FAC	HP		
<i>Epilobium leptophyllum</i>	willow-herb	OBL	HP		
<i>Gaura biennis</i>	gaura, biennial bee-blossom	FACU	HA / HB		
<i>Ludwigia alternifolia</i>	seedbox, false loosestrife	FACW+	HP		PA
<i>Ludwigia palustris</i>	marsh-purslane, marsh seedbox, water-purslane	OBL	HP		
<i>Oenothera biennis</i> [= <i>Onagra biennis</i> ]	common evening-primrose, biennial evening-primrose	FACU-	HB / HP		
<i>Oenothera fruticosa</i> ssp. <i>fruticosa</i>	sundrops, narrow-leaved evening-primrose	FAC	HP		
<i>Oenothera fruticosa</i> ssp. <i>glauca</i>	sundrops, narrow-leaved evening-primrose	FAC	HP		
<i>Oenothera laciniata</i>	cut-leaved evening-primrose	FACU-	HA		
<i>Oenothera nutans</i>	nodding evening-primrose	N	HB		
<i>Oenothera parviflora</i>	small-flowered evening-primrose	FACU-	HB		
<i>Oenothera perennis</i> [= <i>Kneiffia pumila</i> ]	small sundrops, little evening-primrose	FAC-	HP		
<i>Oenothera pilosella</i>	sundrops, meadow evening-primrose	FAC	HP		

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<b>Lythraceae</b>					
<i>Cuphea viscosissima</i> [= <i>C. petiolata</i> ]	blue waxweed, clammy cuphea	FAC-	HA		
<b>Melastomaceae</b>					
<i>Rhexia virginica</i>	meadow-beauty, handsome Harry	OBL	HP		
<b>Violaceae</b>					
<i>Viola bicolor</i>	field pansy	N	HA		
<i>Viola cucullata</i>	blue marsh violet	FACW+	HP		
<i>Viola labradorica</i>	American dog violet	FACW	HP		
<i>Viola lanceolata</i> var. <i>lanceolata</i>	lance-leaved violet	OBL	HP		
<i>Viola palmata</i>	early blue violet	N	HP		
<i>Viola pedata</i>	birdfoot violet	N	HP		
<i>Viola primulifolia</i>	primrose violet	FAC+	HP		
<i>Viola sagittata</i> var. <i>ovata</i>	ovate-leaved violet	FACW	HP		
<i>Viola sagittata</i> var. <i>sagittata</i>	arrow-leaved violet	FACW	HP		
<i>Viola sororia</i>	common blue violet	FAC-	HP		
<i>Linum medium</i> var. <i>texanum</i>	yellow flax	FACU	HP		
<i>Linum virginianum</i>	slender yellow flax	FACU	HP		
<b>Hypericaceae</b>					
<i>Hypericum gentianoides</i>	orange-grass, pineweed	UPL	HA		
<i>Hypericum mutilum</i>	dwarf St. John's-wort	FACW	HP		
<i>Hypericum punctatum</i> [= <i>H. maculatum</i> ]	spotted St. John's-wort	FAC-	HP		PA
<i>Hypericum pyramidatum</i> [= <i>H. ascyron</i> ]	great St. John's-wort	FAC	HP		PA
<i>Hypericum sphaerocarpum</i>	round-seeded St. John's-wort	FAC	HP		
<i>Triadenum fraseri</i>	Marsh St. Johns-wort	OBL	HP		

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<b>Euphorbiaceae</b>					
<i>Acalypha gracilens</i>	slender mercury	N	HA		
<i>Acalypha rhomboidea</i>	common three-seeded mercury	FACU-	HA		
<i>Acalypha virginica</i>	Virginia three-seeded mercury	FACU-	HA		
<i>Croton capitatus</i>	hogwort, wooly croton	N	HA		
<i>Euphorbia corollata</i>	flowering spurge	N	HP		
<i>Euphorbia dentata</i> [= <i>Poinsettia dentata</i> ]	toothed spurge	N	HA		
<i>Euphorbia nutans</i> [= <i>Chamaesyce nutans</i> ]	eyebane	FACU-	HA		
<i>Euphorbia vermiculata</i> [= <i>Chamaesyce vermiculata</i> ]	hairy spurge	N	HA		
<b>Oxalidaceae</b>					
<i>Oxalis dillenii</i> ssp. <i>filipes</i>	southern yellow wood-sorrel	N	HP		
<i>Oxalis grandis</i>	great yellow wood-sorrel	N	HP		
<i>Oxalis stricta</i>	common yellow wood-sorrel	UPL	HP		
<b>Polygalaceae</b>					
<i>Polygala sanguinea</i>	field milkwort, rose milkwort	FACU	HA		
<i>Polygala senega</i> var. <i>latifolia</i>	Seneca snakeroot	FACU	HP		
<i>Polygala verticillata</i> var. <i>ambigua</i>	whorled milkwort	UPL	HA		
<i>Polygala verticillata</i> var. <i>isocycla</i>	whorled milkwort	UPL	HA		
<i>Polygala verticillata</i> var. <i>verticillata</i>	whorled milkwort	UPL	HA		
<b>Fabaceae</b>					
<i>Baptisia tinctoria</i>	wild indigo	N	HP		PA
<i>Chamaecrista fasciculata</i> [= <i>Cassia chamaecrista</i> , <i>C. fasciculata</i> ]	partridge-pea, prairie senna	FACU	HA		PA
<i>Chamaecrista nictitans</i> [= <i>Cassia nictitans</i> ]	wild sensitive-plant	FACU-	HA		
<i>Crotalaria sagittalis</i>	rattlebox	N	HA		

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<i>Desmodium canescens</i> [= <i>Meibomia canescens</i> ]	hoary tick-trefoil	N	HP		
<i>Desmodium marilandicum</i> [= <i>Meibomia marylandica</i> ]	Maryland tick-clover	N	HP		
<i>Desmodium paniculatum</i>	panicled tick-trefoil	UPL	HP		
<i>Lespedeza capitata</i>	round-headed bush-clover, round-headed lespedeza	FACU-	HP		NY, RI
<i>Lespedeza hirta</i>	hairy bush-clover, hairy lespedeza	N	HP		PA
<i>Lespedeza procumbens</i>	trailing bush-clover, trailing lespedeza	N	HP		
<i>Lespedeza violacea</i>	violet bush-clover, violet lespedeza	N	HP		
<i>Lespedeza virginica</i>	slender bush-clover, slender lespedeza	N	HP		
<i>Senna hebecarpa</i>	northern wild senna	FAC	HP		WV, VA
<i>Tephrosia virginiana</i>	goat's-rue	N	HP		
<i>Vicia americana</i>	purple vetch	N	VP		
<b>Rosaceae</b>					
<i>Agrimonia gryposepala</i>	tall hairy agrimony harvest-lice	FACU	HP		
<i>Agrimonia rostellata</i>	woodland agrimony	FACU	HP		
<i>Agrimonia striata</i>	roadside agrimony	FACU-	HP		
<i>Aruncus dioicus</i>	goat's-beard	FACU	HP		
<i>Dalibarda repens</i>	dewdrop	FAC	HP		
<i>Fragaria virginiana</i>	wild strawberry	FACU	HP		
<i>Geum canadense</i>	white avens	FACU	HP		PA
<i>Geum laciniatum</i>	herb-bennet, rough avens	FAC+	HP		PA
<i>Geum rivale</i>	water avens, purple avens	OBL	HP		
<i>Potentilla arguta</i>	tall cinquefoil	UPL	HP		
<i>Potentilla canadensis</i>	dwarf cinquefoil	N	HP		

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<i>Potentilla norvegica</i> ssp. <i>monspeliensis</i>	strawberry-weed	FACU	HA / HB		
<i>Potentilla simplex</i>	old-field cinquefoil	FACU-	HP		
<i>Sanguisorba canadensis</i>	American burnet	FACW+	HP		PA
<i>Waldsteinia fragarioides</i>	barren strawberry	N	HP		
<b>Urticaceae</b>					
<i>Parietaria pennsylvanica</i>	pellitory	N	HA		
<b>Brassicaceae</b>					
<i>Arabis glabra</i>	towercress, tower mustard	N	HB		
<i>Arabis lyrata</i> [= <i>Arabidopsis lyrata</i> ]	lyre-leaved rockcress	FACU	HB / HP		
<i>Lepidium virginicum</i>	poor-man's-pepper, wild pepper-grass	FACU-	HA / HB		
<i>Rorippa palustris</i>	marsh watercress, yellow watercress	OBL	HA / HB		
<b>Cistaceae</b>					
<i>Helianthemum canadense</i>	frostweed, long-branch frostweed	N	HP		
<i>Lechea intermedia</i>	large-pod pinweed	N	HP		
<i>Lechea pulchella</i> [= <i>L. leggettii</i> ]	Leggett's pinweed	N	HP		
<i>Lechea racemulosa</i>	Illinois pinweed	N	HP		
<i>Lechea villosa</i> [= <i>L. mucronata</i> ]	hairy pinweed	N	HP		
<b>Balsaminaceae</b>					
<i>Impatiens capensis</i>	jewelweed, spotted touch-me-not	FACW	HA		
<b>Polemoniaceae</b>					
<i>Phlox maculata</i>	wild sweet-william	FACW	HP		
<i>Phlox subulata</i> ssp. <i>subulata</i>	moss-pink, creeping phlox	N	HP		
<b>Myrsinaceae</b>					
<i>Lysimachia ciliata</i> [= <i>Steironema ciliata</i> ]	fringed loosestrife	FACW	HP		

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<i>Lysimachia lanceolata</i> [= <i>Steironema lanceolatum</i> ]	lance-leaved loosestrife	FAC	HP		
<b>Ericaceae</b>					
<i>Chimaphila umbellata</i>	pipsissewa, prince's-pine	N	HP		
<b>Boraginaceae</b>					
<i>Hackelia virginiana</i>	beggar's-lice, stickseed	FACU	HB		
<i>Myosotis laxa</i>	wild forget-me-not	OBL	HP		
<i>Myosotis verna</i>	spring forget-me-not, early scorpion-grass	FAC-	HA		
<i>Phacelia dubia</i>	scorpion-weed, small flowered phacelia	N	HA		
<i>Phacelia purshii</i>	Miami-mist	N	HA		
<b>Rubiaceae</b>					
<i>Diodia teres</i>	rough buttonweed	N	HA		
<i>Galium aparine</i>	stickywilly, bedstraw, cleavers, goosegrass	FACU	HA		
<i>Galium boreale</i>	northern bedstraw	FACU	HP		
<i>Galium pilosum</i>	hairy bedstraw, cleavers	N	HP		
<i>Galium triflorum</i>	sweet-scented bedstraw	FACU	HP		
<i>Houstonia caerulea</i> [= <i>Hedyotis caerulea</i> ]	bluets, Quaker-ladies	FACU	HP		
<i>Houstonia longifolia</i> [= <i>Hedyotis nuttalliana</i> , <i>H. purpurea</i> var. <i>tenuifolia</i> , <i>Houstonia purpurea</i> var. <i>tenuifolia</i> , <i>H. tenuifolia</i> ]	long-leaved bluets	N	HP		
<b>Gentianaceae</b>					
<i>Bartonia virginica</i>	bartonia	FACW	HA / HB		
<i>Gentiana andrewsii</i>	bottle gentian, prairie closed gentian	FACW	HP		
<i>Gentiana clausa</i>	meadow closed gentian, bottle gentian	FACW	HP		PA
<i>Gentianella quinquefolia</i>	stiff gentian, ague-weed	FAC	HA / HB		

family / scientific name	common name(s)	wetland status	growth form	C <sub>3</sub> or C <sub>4</sub> (grasses)	Ernst Seeds
<i>Gentianopsis crinita</i>	eastern fringed gentian	OBL	HA / HB		
<i>Sabatia angularis</i>	common marsh-pink, rose-pink	FAC+	HA		
<b>Apocynaceae</b>					
<i>Apocynum androsaemifolium</i>	pink dogbane, spreading dogbane	N	HP		
<i>Apocynum cannabinum</i> [= <i>A. album</i> ]	Indian-hemp	FACU	HP		PA
<i>Asclepias amplexicaulis</i>	blunt-leaved milkweed	N	HP		
<i>Asclepias exaltata</i>	poke milkweed, tall milkweed	FACU	HP		
<i>Asclepias incarnata</i> ssp. <i>incarnata</i>	swamp milkweed	OBL	HP		PA
<i>Asclepias purpurascens</i>	purple milkweed	FACU	HP		
<i>Asclepias quadrifolia</i>	four-leaved milkweed	N	HP		
<i>Asclepias syriaca</i>	common milkweed	FACU-	HP		PA
<i>Asclepias tuberosa</i>	butterfly-weed	N	HP		PA
<i>Asclepias verticillata</i>	whorled milkweed	N	HP		
<i>Asclepias viridiflora</i> [= <i>Acerates viridiflora</i> ]	green milkweed	N	HP		
<b>Plantaginaceae</b>					
<i>Gratiola neglecta</i>	hedge hyssop, mud-hyssop	OBL	HA		
<i>Linaria canadensis</i> [= <i>Nuttallanthus canadensis</i> ]	old-field toadflax	N	HA		
<i>Lindernia dubia</i> var. <i>anagallidea</i>	yellow-seeded false pimpernel	OBL	HA		
<i>Penstemon digitalis</i>	tall white beard-tongue	FAC	HP		PA
<i>Penstemon hirsutus</i>	northeastern beard-tongue	N	HP		
<i>Plantago pusilla</i>	dwarf plantain	UPL	HA		
<i>Plantago rugelii</i>	Rugel's plantain, broad-leaved plantain	FACU	HP		
<i>Plantago virginica</i>	dwarf plantain, pale-seeded plantain	UPL	HA / HB		
<i>Veronica officinalis</i>	common speedwell, gypsyweed	FACU-	HP		

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<i>Veronica peregrina</i> ssp. <i>peregrina</i>	neckweed, purslane speedwell	FACU-	HA		
<i>Veronica peregrina</i> ssp. <i>xalapensis</i>	neckweed, purslane speedwell	FACU-	HA		
<i>Veronicastrum virginicum</i>	Culver's-root	FACU	HP		PA
<b>Scrophulariaceae</b>					
<i>Scrophularia lanceolata</i>	lanceleaf figwort	FACU+	HP		
<i>Scrophularia marilandica</i>	eastern figwort, carpenter's-square	FACU-	HP		
<b>Orobanchaceae</b>					
<i>Agalinis purpurea</i> [= <i>Gerardia purpurea</i> ]	purple false-foxglove	FACW-	HA		
<i>Agalinis tenuifolia</i> [= <i>Gerardia tenuifolia</i> ]	slender false-foxglove	FAC	HA		
<i>Aureolaria pedicularia</i>	cut-leaf false-foxglove	N	HA		
<i>Melampyrum lineare</i> var. <i>americanum</i>	cow-wheat	FACU	HA		
<b>Verbenaceae</b>					
<i>Verbena hastata</i>	blue vervain, simpler's-joy	FACW+	HP		PA
<i>Verbena simplex</i>	narrow-leaved vervain	N	HP		
<i>Verbena urticifolia</i> var. <i>urticifolia</i>	white vervain	FACU	HA / HP		PA
<b>Lamiaceae</b>					
<i>Agastache nepetoides</i>	yellow giant-hyssop	FACU	HP		
<i>Agastache scrophulariifolia</i>	purple giant-hyssop	N	HP		
<i>Calamintha arkansana</i> [= <i>Clinopodium arkansanum</i> ]	calamint	FACU	HP		
<i>Cunila origanoides</i>	common dittany, stone-mint	N	HP		
<i>Hedeoma pulegioides</i>	American pennyroyal, pudding-grass	N	HA		
<i>Lycopus americanus</i>	water-horehound	OBL	HP		
<i>Lycopus uniflorus</i>	bugleweed, water-horehound	OBL	HP		
<i>Mentha arvensis</i> [= <i>M. canadensis</i> ]	field mint	FACW	HP		

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<i>Monarda clinopodia</i>	white bergamot, basil bee-balm	N	HP		
<i>Monarda fistulosa</i> [= <i>M. mollis</i> ]	horsemint, wild bergamot	UPL	HP		
<i>Physostegia virginiana</i>	false dragonhead	FAC+	HP		
<i>Prunella vulgaris</i> ssp. <i>lanceolata</i>	heal-all, self-heal	FACU+	HP		
<i>Pycnanthemum incanum</i>	hoary mountain-mint	N	HP		MD
<i>Pycnanthemum muticum</i>	short-toothed mountain-mint, clustered mountain-mint	FACW	HP		PA
<i>Pycnanthemum tenuifolium</i>	narrow-leaved mountain-mint, slender mountain-mint	FACW	HP		
<i>Pycnanthemum verticillatum</i> var. <i>verticillatum</i>	whorled mountain-mint	FAC	HP		
<i>Pycnanthemum virginianum</i>	Virginia mountain-mint	FAC	HP		PA
<i>Salvia lyrata</i>	lyre-leaved sage	UPL	HP		
<i>Salvia reflexa</i>	lance-leaved sage	N	HA		
<i>Scutellaria galericulata</i>	common skullcap	OBL	HP		
<i>Scutellaria incana</i>	downy skullcap	N	HP		
<i>Scutellaria integrifolia</i>	hyssop skullcup	FACW	HP		
<i>Scutellaria lateriflora</i>	mad-dog skullcap	FACW+	HP		
<i>Scutellaria leonardii</i>	small skullcap	N	HP		
<i>Stachys tenuifolia</i>	creeping hedge-nettle	FACW+	HP		
<i>Teucrium canadense</i> var. <i>virginicum</i>	wild germander, wood-sage	FACW	HP		
<i>Trichostema brachiatum</i>	false pennyroyal	N	HP		
<i>Trichostema dichotomum</i>	blue-curly	N	HA		
<b>Phrymaceae</b>					
<i>Mimulus alatus</i>	winged monkey-flower	OBL	HP		
<i>Mimulus ringens</i>	Allegheny monkey-flower	OBL	HP		PA

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<b>Convolvulaceae</b>					
<i>Ipomoea pandurata</i>	man-of-the-earth, wild potato-vine	FACU	VP		
<b>Solanaceae</b>					
<i>Physalis heterophylla</i>	clammy ground-cherry	N	HP		
<i>Physalis pubescens</i> var. <i>integrifolia</i>	hairy ground-cherry	FACU-	HA		
<i>Physalis subglabrata</i>	long-leaved ground-cherry	N	HP		
<i>Solanum americanum</i>	black nightshade	FACU-	HA		
<i>Solanum carolinense</i>	horse-nettle	UPL	HP		
<b>Araliaceae</b>					
<i>Aralia hispida</i>	bristly sarsaparilla	N	HP		
<i>Hydrocotyle americana</i>	marsh pennywort, navelwort	OBL	HP		
<i>Hydrocotyle ranunculoides</i>	floating pennywort	OBL	HP		
<b>Apiaceae</b>					
<i>Angelica atropurpurea</i>	purple-stemmed angelica	OBL	HP		
<i>Angelica venenosa</i> [= <i>A. villosa</i> ]	deadly angelica, hairy angelica	N	HP		
<i>Cicuta bulbifera</i>	water-hemlock	OBL	HP		
<i>Cicuta maculata</i> var. <i>maculata</i>	beaver-poison, musquash-root, spotted cowbane	OBL	HP		
<i>Heracleum lanatum</i> [= <i>H. maximum</i> ]	cow-parsnip	FACU-	HP		
<i>Osmorhiza claytonii</i> [= <i>Washingtonia claytonii</i> ]	sweet-cicely	FACU-	HP		
<i>Sanicula canadensis</i> var. <i>canadensis</i>	Canadian sanicle, snake root	UPL	HB		
<i>Sanicula canadensis</i> var. <i>grandis</i>	Canadian sanicle, snake root	UPL	HB		
<i>Sanicula marilandica</i>	Black snake root, Black sanicle	UPL	HP		
<i>Sium suave</i>	water-parsnip	OBL	HP		
<i>Thaspium barbinode</i>	meadow-parsnip	UPL	HP		

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<i>Thaspium trifoliatum</i> var. <i>flavum</i>	meadow-parsnip	N	HP		
<i>Zizia aptera</i>	golden-alexander, meadow zizia	FAC	HP		
<i>Zizia aurea</i>	golden-alexander, golden zizia	FAC	HP		PA
<b>Campanulaceae</b>					
<i>Campanula aparinoides</i>	marsh bellflower	OBL	HP		
<i>Lobelia cardinalis</i>	cardinal-flower	FACW+	HP		PA
<i>Lobelia inflata</i>	Indian-tobacco	FACU	HA		
<i>Lobelia siphilitica</i>	great blue lobelia	FACW+	HP		PA
<i>Lobelia spicata</i> var. <i>leptostachys</i>	spiked lobelia	FAC	HP		
<i>Lobelia spicata</i> var. <i>scaposa</i>	spiked lobelia	FAC-	HP		
<i>Lobelia spicata</i> var. <i>spicata</i>	spiked lobelia	FAC-	HP		
<i>Triodanis perfoliata</i> var. <i>perfoliata</i>	Venus's looking-glass	FAC	HA		
<b>Asteraceae</b>					
<i>Ageratina altissima</i> var. <i>altissima</i> [= <i>Eupatorium rugosum</i> ]	common white snakeroot	N	HP		
<i>Ambrosia artemisiifolia</i>	common ragweed	FACU	HA		
<i>Ambrosia psilostachya</i>	western ragweed	FACU-	HP		
<i>Ambrosia trifida</i>	giant ragweed	FAC	HA		
<i>Anaphalis margaritacea</i>	pearly everlasting	N	HP		
<i>Antennaria howellii</i> [= <i>A. neglecta</i> var. <i>attenuata</i> , <i>A. neglecta</i> var. <i>neodioica</i> , <i>A. neodioica</i> ]	Howell's pussytoe	N	HP		
<i>Antennaria neglecta</i>	overlooked pussytoe	UPL	HP		
<i>Antennaria parlinii</i> [= <i>A. brainerdii</i> , <i>A. fallax</i> , <i>A. munda</i> , <i>A. plantaginifolia</i> var. <i>ambigens</i> ]	Parlin's pussytoe	N	HP		

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<i>Antennaria plantaginifolia</i>	plantain-leaved pussytoe	N	HP		
<i>Arnoglossum atriplicifolium</i> [= <i>Cacalia atriplicifolia</i> , <i>Mesadenia atriplicifolia</i> ]	pale Indian-plantain	N	HP		
<i>Bidens bipinnata</i>	spanish needles	N	HA		
<i>Bidens cernua</i>	bur-marigold, stick-tight	OBL	HA		PA
<i>Bidens connata</i>	beggar-ticks, stick-tight	FACW+	HA		
<i>Bidens frondosa</i>	devil's beggar-ticks, stick-tights	FACW	HA		PA
<i>Bidens vulgata</i>	beggar-ticks, stick-tights	N	HA		
<i>Brickellia eupatorioides</i> [= <i>Kuhnia eupatorioides</i> ]	false boneset	N	HP		
<i>Cirsium altissimum</i> [= <i>Carduus altissimus</i> ]	tall thistle	N	HB / HP		
<i>Cirsium discolor</i> [= <i>Carduus discolor</i> ]	field thistle	UPL	HB / HP		
<i>Cirsium muticum</i>	swamp thistle	OBL	HB		
<i>Cirsium pumilum</i> [= <i>Carduus odoratus</i> ]	pasture thistle	N	HB		
<i>Conyza canadensis</i> var. <i>canadensis</i>	horseweed	UPL	HA		
<i>Coreopsis tripteris</i>	tall tickseed	FAC	HP		PA, OH
<i>Doellingeria infirma</i> [= <i>Aster infirmus</i> ]	flat-topped white aster	N	HP		
<i>Doellingeria umbellata</i> [= <i>Aster umbellatus</i> ]	flat-topped white aster	FACW	HP		PA
<i>Eclipta prostrata</i>	yerba-de-tajo	FAC	HA		
<i>Erechtites hieraciifolius</i> [= <i>E. hieraciifolia</i> ]	fireweed, pilewort	FACU	HA		
<i>Erigeron annuus</i>	daisy fleabane	FACU	HA / HB		
<i>Erigeron philadelphicus</i>	daisy fleabane	FACU	HP		
<i>Erigeron pulchellus</i>	robin's-plantain	FACU	HB / HP		
<i>Erigeron strigosus</i> var. <i>strigosus</i> [= <i>E. ramosus</i> ]	daisy fleabane, whitetop	FACU+	HA / HB		

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<i>Eupatorium altissimum</i> [= <i>E. rugosum</i> var. <i>tomentellum</i> ]	tall eupatorium, tall thoroughwort	N	HP		
<i>Eupatorium hyssopifolium</i>	hyssop-leaved eupatorium, hyssop-leaved thoroughwort	N	HP		
<i>Eupatorium perfoliatum</i>	common boneset	FACW+	HP		PA
<i>Eupatorium pilosum</i>	ragged eupatorium, rough boneset	FACW	HP		
<i>Eupatorium sessilifolium</i>	upland eupatorium, upland boneset	N	HP		
<i>Euthamia graminifolia</i> [= <i>Solidago graminifolia</i> ]	grass-leaved goldenrod, flat-topped goldenrod	FAC	HP		PA
<i>Eutrochium fistulosum</i> [= <i>Eupatorium fistulosum</i> , <i>Eupatoriadelphus fistulosus</i> ]	hollow-stemmed joe-pye-weed, trumpetweed	FACW	HP		PA
<i>Eutrochium purpureum</i> [= <i>Eupatorium purpureum</i> ]	sweet-scented joe-pye-weed	N	HP		WV
<i>Gamochaeta purpurea</i> var. <i>purpurea</i> [= <i>Gnaphalium purpureum</i> ]	purple cudweed	N	HA / HB		
<i>Gnaphalium uliginosum</i>	low cudweed	FAC	HA		
<i>Hasteola suaveolens</i> [= <i>Cacalia suaveolens</i> , <i>Synosma suaveolens</i> ]	sweet-scented Indian-plantain	N	HP		
<i>Helenium autumnale</i>	common sneezeweed	FACW+	HP		PA, VA
<i>Helianthus decapetalus</i> [= <i>H. trachelifolius</i> ]	thin-leaved sunflower	FACU	HP		PA
<i>Helianthus divaricatus</i>	rough sunflower, woodland sunflower	N	HP		PA
<i>Helianthus giganteus</i>	swamp sunflower	FACW	HP		
<i>Helianthus strumosus</i>	rough-leaved sunflower	N	HP		
<i>Heliopsis helianthoides</i>	ox-eye	N	HP		PA
<i>Hieracium scabrum</i>	rough hawkweed	N	HP		
<i>Krigia biflora</i>	dwarf dandelion, two-flowered cynthia	FACW	HP		
<i>Krigia virginica</i>	Virginia dwarf dandelion	UPL	HA		

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<i>Lactuca biennis</i>	tall blue lettuce	FACU	HA / HB		
<i>Lactuca canadensis</i>	wild lettuce, Canada lettuce	FACU-	HA / HB		
<i>Lactuca floridana</i> var. <i>floridana</i>	woodland lettuce	FACU-	HA / HB		
<i>Lactuca floridana</i> var. <i>villosa</i>	woodland lettuce	FACU-	HA / HB		
<i>Liatriis spicata</i> var. <i>spicata</i> [= <i>Laciniaria spicata</i> ]	dense blazing-star	FAC+	HP		
<i>Packera aurea</i> [= <i>Senecio aureus</i> ]	golden ragwort	FACW	HP		
<i>Packera obovata</i> [= <i>Senecio obovatus</i> ]	round-leaved ragwort, squaw-weed	FACU-	HP		
<i>Packera paupercula</i> [= <i>Senecio crawfordii</i> , <i>S. pauperculus</i> ]	balsam ragwort	FAC	HP		
<i>Polymnia canadensis</i>	leaf-cup	N	HP		
<i>Prenanthes alba</i> [= <i>Nabalus albus</i> ]	white rattlesnake-root	FACU	HP		
<i>Prenanthes trifoliolata</i> [= <i>Nabalus trifoliatum</i> ]	gall-of-the-earth	N	HP		
<i>Pseudognaphalium macounii</i> [= <i>Gnaphalium macounii</i> , <i>G. viscosum</i> ]	clammy cudweed, western cudweed	N	HB		
<i>Pseudognaphalium obtusifolium</i> [= <i>Gnaphalium obtusifolium</i> ]	fragrant cudweed, rabbit-tobacco	N	HA / HB		
<i>Rudbeckia fulgida</i> var. <i>speciosa</i>	orange coneflower	FAC	HP		
<i>Rudbeckia hirta</i> var. <i>hirta</i>	black-eyed-susan	FACU-	HB / HP		NC
<i>Rudbeckia hirta</i> var. <i>pulcherrima</i>	black-eyed-susan	FACU-	HB / HP		
<i>Rudbeckia laciniata</i> var. <i>laciniata</i>	cutleaf coneflower	FACW	HP		
<i>Rudbeckia triloba</i> var. <i>triloba</i>	three-lobed coneflower	FACU	HP		WV
<i>Sericocarpus asteroides</i> [= <i>Aster paternus</i> ]	white-topped aster	N	HP		
<i>Silphium asteriscus</i> var. <i>trifoliatum</i> [= <i>S. trifoliatum</i> ]	whorled rosinweed	N	HP		PA

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<i>Solidago altissima</i> [= <i>S. canadensis</i> var. <i>scabra</i> ]	late goldenrod	FACU	HP		
<i>Solidago arguta</i> var. <i>arguta</i>	forest goldenrod	N	HP		
<i>Solidago bicolor</i>	silver-rod, white goldenrod	N	HP		PA
<i>Solidago canadensis</i> var. <i>canadensis</i>	Canada goldenrod	FACU	HP		
<i>Solidago canadensis</i> var. <i>hargerii</i>	Canada goldenrod	FACU	HP		
<i>Solidago gigantea</i> var. <i>gigantea</i>	smooth goldenrod	FACW	HP		
<i>Solidago gigantea</i> var. <i>serotina</i>	smooth goldenrod	FACW	HP		
<i>Solidago hispida</i>	hairy goldenrod	N	HP		
<i>Solidago juncea</i>	early goldenrod	N	HP		PA
<i>Solidago lepida</i> [= <i>S. canadensis</i> var. <i>salebrosa</i> ]	Canada goldenrod	FACU	HP		
<i>Solidago nemoralis</i>	gray goldenrod	N	HP		PA
<i>Solidago puberula</i>	downy goldenrod	FACU-	HP		
<i>Solidago rugosa</i> ssp. <i>aspera</i> var. <i>aspera</i>	wrinkle-leaf goldenrod	FAC	HP		
<i>Solidago rugosa</i> ssp. <i>rugosa</i> var. <i>rugosa</i>	wrinkle-leaf goldenrod	FAC	HP		PA
<i>Solidago rugosa</i> ssp. <i>rugosa</i> var. <i>sphagnophila</i>	wrinkle-leaf goldenrod	FAC	HP		
<i>Solidago squarrosa</i>	ragged goldenrod, stout goldenrod	N	HP		
<i>Solidago ulmifolia</i> var. <i>ulmifolia</i>	elm-leaved goldenrod	N	HP		
<i>Symphotrichum cordifolium</i> [= <i>Aster cordifolius</i> , <i>A. sagittifolius</i> ]	blue wood aster	N	HP		PA
<i>Symphotrichum laeve</i> var. <i>concinnum</i> [= <i>Aster concinnum</i> , <i>A. laevis</i> var. <i>concinnum</i> ]	smooth blue aster	N	HP		
<i>Symphotrichum laeve</i> var. <i>laeve</i> [= <i>Aster laevis</i> var. <i>laevis</i> ]	smooth blue aster	N	HP		PA

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<i>Symphiotrichum lanceolatum</i> ssp. <i>lanceolatum</i> var. <i>interior</i> [= <i>Aster lanceolatus</i> ssp. <i>interior</i> ]	eastern lined aster	N	HP		
<i>Symphiotrichum lanceolatum</i> ssp. <i>lanceolatum</i> var. <i>lanceolatum</i> [= <i>Aster lanceolatus</i> , <i>A. paniculatus</i> , <i>Aster simplex</i> ]	panicled aster	N	HP		
<i>Symphiotrichum lateriflorum</i> [= <i>Aster lateriflorus</i> , <i>A. vimineus</i> (in part)]	calico aster	FACW-	HP		PA
<i>Symphiotrichum lowrieanum</i> [= <i>Aster cordifolius</i> ssp. <i>laevigatus</i> , <i>A. lowrieanus</i> ]	smooth heart-leaved aster	N	HP		
<i>Symphiotrichum novae-angliae</i> [= <i>Aster novae-angliae</i> ]	New England aster	FAC	HP		PA
<i>Symphiotrichum patens</i> [= <i>Aster patens</i> ]	late purple aster, clasping aster	N	HP		
<i>Symphiotrichum phlogifolium</i> [= <i>Aster patens</i> var. <i>phlogifolius</i> , <i>A. phlogifolius</i> ]	late purple aster	N	HP		
<i>Symphiotrichum pilosum</i> var. <i>pilosum</i> [= <i>Aster ericoides</i> var. <i>pilosus</i> , <i>A. pilosus</i> ]	heath aster	UPL	HP		
<i>Symphiotrichum puniceum</i> [= <i>Aster puniceus</i> ssp. <i>puniceus</i> ]	purple-stemmed aster	OBL	HP		PA
<i>Symphiotrichum racemosum</i> [= <i>Aster fragilis</i> , <i>A. racemosus</i> , <i>A. vimineus</i> (in part)]	small white aster	FAC	HP		
<i>Symphiotrichum undulatum</i> [= <i>Aster undulatus</i> ]	clasping heart-leaved aster	N	HP		
<i>Symphiotrichum urophyllum</i> [= <i>Aster hirtellus</i> , <i>A. sagittifolius</i> , <i>A. urophyllum</i> ]	arrow-leaved aster	N	HP		PA
<i>Verbesina alternifolia</i>	wingstem	FAC	HP		PA
<i>Vernonia gigantea</i> [= <i>V. altissima</i> ]	giant ironweed	FAC	HP		PA
<i>Vernonia noveboracensis</i>	New York ironweed	FACW+	HP		PA

family / scientific name	common name(s)	wetland status	growth form	C <sub>3</sub> or C <sub>4</sub> (grasses)	Ernst Seeds
<i>Xanthium strumarium</i>	common cocklebur	FAC	HA		
<b>Caprifoliaceae</b>					
<i>Triosteum perfoliatum</i>	horse-gentian	N	HP		
<b>Valerianaceae</b>					
<i>Valerianella chenopodiifolia</i>	goose-foot corn-salad	N	HP		
<i>Valerianella umbilicata</i> [= <i>V. intermedia</i> , <i>V. patellaria</i> ]	navel corn-salad	FAC	HA		

## Appendix C. Woody plant species commonly inhabiting long-lived grasslands, meadows, and savannas in Pennsylvania

( $N = 75$ ). Endangered, threatened, and rare species of special concern in Pennsylvania are not listed here; see Appendix D. Taxonomy, wetland status<sup>1</sup>, and growth form<sup>2</sup> are from Rhoads and Block (2007).

family / scientific name	common name(s)	wetland status	growth form
<b>CONIFERS</b>			
<b>Pinaceae</b>			
<i>Pinus rigida</i>	pitch pine	FACU	TE
<i>Pinus virginiana</i>	Virginia pine	N	TE
<b>Cupressaceae</b>			
<i>Juniperus virginiana</i>	eastern red-cedar	FACU	TE
<b>FLOWERING PLANTS</b>			
<b>Smilacaceae</b>			
<i>Smilax glauca</i>	catbrier, greenbrier	FACU	VW
<i>Smilax hispida</i> [= <i>S. tamnoides</i> ]	bristly greenbrier	N	VW
<i>Smilax rotundifolia</i>	bullbrier, common greenbrier	FAC	VW
<b>Lauraceae</b>			
<i>Sassafras albidum</i>	sassafras	FACU-	TD

<sup>1</sup> Wetland status codes:

OBL	obligate wetland species
FACW	mainly wet or mesic habitats
FAC	mainly mesic habitats
FACU	mainly mesic or upland habitats
UPL	mainly upland habitats
+	wetter
-	drier
N	not rated

<sup>2</sup> Growth-form codes:

SD	deciduous shrub
SE	evergreen shrub
TD	deciduous tree
TE	evergreen tree
VW	woody vine

family / scientific name	common name(s)	wetland status	growth form
<b>Vitaceae</b>			
<i>Parthenocissus inserta</i> [= <i>P. quinquefolia</i> (in part)]	grape woodbine	N	VW
<i>Parthenocissus quinquefolia</i>	Virginia-creeper, woodbine	FACU	VW
<i>Vitis vulpina</i>	frost grape	FAC	VW
<b>Celastraceae</b>			
<i>Celastrus scandens</i>	American bittersweet	FACU-	VW
<b>Salicaceae</b>			
<i>Populus tremuloides</i>	quaking aspen	N	TD
<i>Salix eriocephala</i>	diamond willow	FACW+	SD
<i>Salix exigua</i> [= <i>S. interior</i> ]	sandbar willow	OBL	SD
<i>Salix humilis</i> var. <i>humilis</i>	upland willow	FACU	SD
<i>Salix humilis</i> var. <i>tristis</i>	dwarf upland willow, sage willow	FACU	SD
<i>Salix nigra</i>	black willow	FACW+	TD
<i>Salix petiolaris</i>	slender willow	FACW+	SD
<b>Hypericaceae</b>			
<i>Hypericum prolificum</i>	shrubby St. John's-wort	FACU	SD
<b>Fagaceae</b>			
<i>Quercus ilicifolia</i>	scrub oak, bear oak	N	SD
<i>Quercus marilandica</i>	blackjack oak	N	TD
<i>Quercus prinoides</i>	dwarf chestnut oak	N	SD
<i>Quercus stellata</i>	post oak	UPL	TD
<b>Myricaceae</b>			
<i>Comptonia peregrina</i>	sweet-fern	N	SD
<i>Myrica pensylvanica</i> [= <i>Morella pensylvanica</i> ]	bayberry	FAC	SD

family / scientific name	common name(s)	wetland status	growth form
<b>Betulaceae</b>			
<i>Betula populifolia</i>	gray birch	FAC	TD
<b>Rosaceae</b>			
<i>Amelanchier laevis</i>	smooth serviceberry, smooth shadbush	N	TD
<i>Amelanchier stolonifera</i>	low juneberry, low shadbush	FACU	SD
<i>Crataegus calpodendron</i>	pear hawthorn, blackthorn hawthorn	N	SD / TD
<i>Crataegus chrysocarpa</i>	fireberry hawthorn	N	SD / TD
<i>Crataegus coccinea</i>	red-fruited hawthorn	N	SD / TD
<i>Crataegus crus-galli</i>	cockspur hawthorn	FACU	SD / TD
<i>Crataegus intricata</i> [= <i>C. intricata</i> ]	Biltmore hawthorn	N	SD / TD
<i>Crataegus macrosperma</i> [= <i>C. flabellata</i> ]	fanleaf hawthorn	N	SD / TD
<i>Crataegus punctata</i>	dotted hawthorn, white hawthorn	N	TD
<i>Crataegus succulenta</i>	long-spined hawthorn, fleshy hawthorn	N	TD
<i>Malus coronaria</i>	sweet crabapple	N	TD
<i>Photinia melanocarpa</i> [= <i>Aronia melanocarpa</i> ]	black chokeberry	FAC	SD
<i>Physocarpus opulifolius</i>	ninebark	FACW-	SD
<i>Prunus americana</i>	wild plum	FACU-	SD / TD
<i>Prunus angustifolia</i>	Chickasaw plum	N	TD / SD
<i>Prunus pensylvanica</i>	pin cherry, fire cherry	FACU-	TD
<i>Rosa carolina</i>	pasture rose	UPL	SD
<i>Rubus allegheniensis</i>	common blackberry	FACU-	SD
<i>Rubus flagellaris</i>	prickly dewberry, northern dewberry	FACU	VW
<i>Rubus hispidus</i>	swamp dewberry	FACW	VW
<i>Rubus idaeus</i> var. <i>strigosus</i>	red raspberry	FAC-	SD

family / scientific name	common name(s)	wetland status	growth form
<i>Rubus pensilvanicus</i>	blackberry	N	SD
<i>Spiraea alba</i>	meadow-sweet	FACW+	SD
<i>Spiraea latifolia</i> [= <i>S. alba</i> var. <i>latifolia</i> ]	meadow-sweet	FAC+	SD
<i>Spiraea tomentosa</i>	hardhack, steeple-bush	FACW-	SD
<b>Rhamnaceae</b>			
<i>Ceanothus americanus</i>	New Jersey tea	N	SD
<b>Rutaceae</b>			
<i>Zanthoxylum americanum</i>	prickly-ash	FACU	SD
<b>Anacardiaceae</b>			
<i>Rhus aromatica</i> var. <i>aromatica</i>	fragrant sumac, squawbush	N	SD
<i>Rhus copallina</i> var. <i>copallina</i>	shining sumac, winged sumac	N	SD
<i>Rhus copallina</i> var. <i>latifolia</i>	shining sumac, dwarf sumac	N	SD
<i>Rhus glabra</i>	smooth sumac	N	SD
<i>Rhus typhina</i>	staghorn sumac	N	SD
<i>Toxicodendron radicans</i>	poison-ivy	FAC	VW
<b>Cornaceae</b>			
<i>Cornus amomum</i> ssp. <i>amomum</i>	kinnikinnik, red-willow	FACW	SD
<i>Cornus racemosa</i>	silky dogwood	FAC-	SD
<i>Cornus sericea</i>	red-osier dogwood	FACW+	SD
<b>Ebenaceae</b>			
<i>Diospyros virginiana</i>	persimmon	FAC-	TD
<b>Ericaceae</b>			
<i>Rhododendron canadense</i>	rhodora	FACW	SD
<i>Vaccinium angustifolium</i>	low sweet blueberry	FACU-	SD

family / scientific name	common name(s)	wetland status	growth form
<b>Bignoniaceae</b>			
<i>Campsis radicans</i>	trumpet-vine, trumpet-creeper	FAC	VW
<b>Araliaceae</b>			
<i>Aralia spinosa</i>	Hercules' -club	FAC	TD
<b>Adoxaceae</b>			
<i>Sambucus canadensis</i> [= <i>S. nigra</i> ssp. <i>canadensis</i> ]	American elder	FACW	SD
<i>Viburnum lentago</i>	nannyberry, sheepberry	FAC	SD
<i>Viburnum prunifolium</i>	black-haw	FACU	SD / TD
<i>Viburnum rafinesquianum</i>	downy arrow-wood	N	SD
<i>Viburnum recognitum</i>	northern arrow-wood	FACW-	SD
<b>Caprifoliaceae</b>			
<i>Lonicera sempervirens</i>	trumpet honeysuckle	FACU	VW
<i>Symphoricarpos albus</i> var. <i>albus</i>	snowberry	FACU-	SD
<i>Symphoricarpos orbiculatus</i>	coralberry, Indian-currant	UPL	SD

## Appendix D. Endangered, threatened, and rare vascular plant species native to grasslands, meadows, and savannas in Pennsylvania

( $N = 259$ ). Taxonomy, status<sup>1</sup>, and growth form<sup>2</sup> are from Rhoads and Block (2007).

family / scientific name	common name(s)	state status	growth form	C <sub>3</sub> or C <sub>4</sub> (grasses)
<b>CLUBMOSES AND SPIKEMOSSES</b>				
<b>Lycopodiaceae</b>				
<i>Lycopodiella alopecuroides</i>	foxtail bog clubmoss	PE	HP	
<b>FERNS AND HORSETAILS</b>				
<b>Ophioglossaceae</b>				
<i>Ophioglossum vulgatum</i>	southern adder's-tongue	PR	HP	
<b>CONIFERS</b>				
<b>Cupressaceae</b>				
<i>Juniperus communis</i>	common juniper	TU	SE	
<b>FLOWERING PLANTS</b>				
<b>Melanthiaceae</b>				
<i>Stenanthium gramineum</i>	featherbells	TU	HP	

<sup>1</sup> Pennsylvania status codes:

PX	extirpated in the state
PE	endangered in the state
PT	threatened in the state
PR	rare in the state
TU	status tentatively undetermined and under study

<sup>2</sup> Growth-form codes:

HA	herbaceous annual
HB	herbaceous biennial
HP	herbaceous perennial
SD	deciduous shrub
SE	evergreen shrub
TD	deciduous tree
TE	evergreen tree
VP	herbaceous perennial vine
VW	woody vine

family / scientific name	common name(s)	state status	growth form	C <sub>3</sub> or C <sub>4</sub> (grasses)
<b>Orchidaceae</b>				
<i>Cypripedium candidum</i>	small white lady's-slipper	PX	HP	
<i>Malaxis bayardii</i>	adder's-mouth	PE	HP	
<i>Platanthera ciliaris</i>	yellow fringed-orchid	PT	HP	
<i>Platanthera cristata</i>	crested fringed-orchid	PX	HP	
<i>Platanthera dilatata</i> var. <i>dilatata</i>	tall white bog-orchid	PE	HP	
<i>Platanthera huronensis</i>	tall green bog-orchid	PE	HP	
<i>Platanthera leucophaea</i>	eastern prairie fringed-orchid	PX	HP	
<i>Platanthera peramoena</i>	purple fringeless orchid	PT	HP	
<i>Spiranthes casei</i>	Case's ladies'-tresses	PE	HP	
<i>Spiranthes lucida</i>	shining ladies'-tresses	TU	HP	
<i>Spiranthes magnicamporum</i>	Great Plains ladies'-tresses	PX	HP	
<i>Spiranthes tuberosa</i>	slender ladies'-tresses	PX	HP	
<i>Spiranthes vernalis</i>	spring ladies'-tresses	PE	HP	
<b>Iridaceae</b>				
<i>Iris prismatica</i>	slender blue flag	PE	HP	
<i>Sisyrinchium albidum</i>	white blue-eyed-grass	PX	HP	
<i>Sisyrinchium atlanticum</i>	eastern blue-eyed-grass	PE	HP	
<i>Sisyrinchium fuscatum</i>	sand blue-eyed-grass	PX	HP	
<b>Juncaceae</b>				
<i>Juncus alpinoarticulatus</i> ssp. <i>nodulosus</i>	alpine rush	PT	HP	
<i>Juncus biflorus</i>	grass rush	PT	HP	
<i>Juncus brachycarpus</i>	short-fruited rush	PE	HP	
<i>Juncus dichotomus</i>	forked rush	PE	HP	
<i>Luzula bulbosa</i>	woodrush	PE	HP	

family / scientific name	common name(s)	state status	growth form	C <sub>3</sub> or C <sub>4</sub> (grasses)
<b>Cyperaceae</b>				
<i>Carex adusta</i>	crowded sedge	PX	HP	
<i>Carex alata</i>	broad-winged sedge	PT	HP	
<i>Carex atherodes</i>	awned sedge	PE	HP	
<i>Carex bebbii</i>	Bebb's sedge	PE	HP	
<i>Carex bicknellii</i>	Bicknell's sedge	PE	HP	
<i>Carex brevior</i>	shortbeak sedge	TU	HP	
<i>Carex bullata</i>	bull sedge	PE	HP	
<i>Carex buxbaumii</i>	brown sedge	PR	HP	
<i>Carex crawfordii</i>	Crawford's sedge	PE	HP	
<i>Carex cryptolepis</i>	northeastern sedge	PE	HP	
<i>Carex flava</i>	yellow sedge	PT	HP	
<i>Carex haydenii</i>	cloud sedge	PT	HP	
<i>Carex longii</i>	Long's sedge	TU	HP	
<i>Carex lupuliformis</i>	false hop sedge	TU	HP	
<i>Carex meadii</i>	Mead's sedge	PE	HP	
<i>Carex mitchelliana</i>	Mitchell's sedge	PE	HP	
<i>Carex ormostachya</i>	spike sedge	TU	HP	
<i>Carex polymorpha</i>	variable sedge	PT	HP	
<i>Carex prairea</i>	prairie sedge	PT	HP	
<i>Carex richardsonii</i>	Richardson's sedge	PE	HP	
<i>Carex shortiana</i>	Short's sedge	PR	HP	
<i>Carex sprengeii</i>	Sprengel's sedge	PR	HP	
<i>Carex tetanica</i>	Wood's sedge	PT	HP	
<i>Carex wiegandii</i>	Wiegand's sedge	PT	HP	

family / scientific name	common name(s)	state status	growth form	C <sub>3</sub> or C <sub>4</sub> (grasses)
<i>Cyperus houghtonii</i>	Houghton's flatsedge	PE	HP	
<i>Cyperus lancastricensis</i>	umbrella sedge	TU	HP	
<i>Cyperus schweinitzii</i>	Schweinitz's flatsedge	PR	HP	
<i>Eleocharis geniculata</i>	Canada spike-rush	PE	HA	
<i>Eleocharis tenuis</i> var. <i>verrucosa</i>	slender spike-rush	PE	HP	
<i>Eleocharis tricostata</i>	three-ribbed spike-rush	PX	HP	
<i>Eriophorum gracile</i>	slender cotton-grass	PE	HP	
<i>Eriophorum viridicarinum</i>	thin-leaved cotton-grass	PT	HP	
<i>Fimbristylis annua</i>	annual fimbry	PT	HA	
<i>Lipocarpha micrantha</i>	common hemicarpa	PE	HA	
<i>Rhynchospora recognita</i>	beak-rush	TU	HP	
<i>Scirpus pedicellatus</i>	wool-grass, stalked bulrush	PT	HP	
<i>Scleria muhlenbergii</i>	reticulated nut-rush	PE	HA / HP	
<i>Scleria pauciflora</i>	few-flowered nut-rush	PT	HP	
<i>Scleria triglomerata</i>	whip-grass, nut-rush	TU	HP	
<i>Scleria verticillata</i>	whorled nut-rush	PE	HA	
<b>Poaceae</b>				
<i>Alopecurus aequalis</i>	short-awned foxtail	TU	HP	C <sub>3</sub>
<i>Andropogon glomeratus</i>	broom-sedge	PR	HP	C <sub>4</sub>
<i>Andropogon gyrans</i>	Elliott's beardgrass	PR	HP	C <sub>4</sub>
<i>Aristida dichotoma</i> var. <i>curtissii</i>	povertygrass	TU	HA	C <sub>4</sub>
<i>Aristida purpurascens</i>	arrow-feather, three-awned grass	PT	HP	C <sub>4</sub>
<i>Bouteloua curtipendula</i>	side-oats grama, tall grama	PT	HP	C <sub>4</sub>
<i>Deschampsia cespitosa</i>	tufted hairgrass	TU	HP	C <sub>3</sub>

family / scientific name	common name(s)	state status	growth form	C <sub>3</sub> or C <sub>4</sub> (grasses)
<i>Dichanthelium annulum</i> [= <i>D. dichotomum</i> (in part)]	annulus panic grass	PT	HP	C <sub>3</sub>
<i>Dichanthelium commonsianum</i> var. <i>commonsianum</i> [= <i>D. ovale</i> var. <i>addisonii</i> ]	cloaked panicgrass	PX	HP	C <sub>3</sub>
<i>Dichanthelium laxiflorum</i>	panic grass	PE	HP	C <sub>3</sub>
<i>Dichanthelium scoparium</i>	velvety panic grass	PE	HP	C <sub>3</sub>
<i>Dichanthelium spretum</i>	panic grass	PE	HP	C <sub>3</sub>
<i>Dichanthelium villosissimum</i>	long-haired panic grass	TU	HP	C <sub>3</sub>
<i>Elymus trachycaulus</i>	slender wheatgrass	TU	HP	C <sub>3</sub>
<i>Festuca paradoxa</i>	cluster fescue	PE	HP	C <sub>3</sub>
<i>Gymnopogon ambiguus</i>	broad-leaved beardgrass	PX	HP	C <sub>4</sub>
<i>Hesperostipa spartea</i>	needlegrass, porcupine grass	TU	HP	C <sub>3</sub>
<i>Hierochloe odorata</i> [= <i>H. hirta</i> ssp. <i>arctica</i> ]	vanilla sweetgrass	PE	HP	C <sub>3</sub>
<i>Hordeum pusillum</i>	little-barley	PX	HA	C <sub>3</sub>
<i>Muhlenbergia capillaris</i>	hairgrass, short muhly	PX	HP	C <sub>4</sub>
<i>Muhlenbergia uniflora</i>	fall dropseed muhly	PT	HP	C <sub>4</sub>
<i>Panicum flexile</i>	old witchgrass	TU	HA	C <sub>4</sub>
<i>Panicum longifolium</i> [= <i>P. rigidulum</i> var. <i>pubescens</i> ]	long-leaved panic grass	PE	HP	C <sub>4</sub>
<i>Paspalum setaceum</i> var. <i>muhlenbergii</i>	slender beadgrass	TU	HP	C <sub>4</sub>
<i>Paspalum setaceum</i> var. <i>setaceum</i>	slender beadgrass	TU	HP	C <sub>4</sub>
<i>Piptatherum pungens</i>	slender mountain ricegrass	PE	HP	C <sub>3</sub>
<i>Piptochaetium avenaceum</i>	black oatgrass	PE	HP	C <sub>3</sub>
<i>Schizachyrium scoparium</i> var. <i>littorale</i> [= <i>S. littorale</i> ]	seaside bluestem	PR	HP	C <sub>4</sub>
<i>Sporobolus heterolepis</i>	prairie dropseed	PE	HP	C <sub>4</sub>

family / scientific name	common name(s)	state status	growth form	C <sub>3</sub> or C <sub>4</sub> (grasses)
<i>Triplasis purpurea</i>	purple sandgrass	PE	HA	C <sub>4</sub>
<i>Tripsacum dactyloides</i>	gammagrass	PE	HP	C <sub>3</sub>
<i>Trisetum spicatum</i>	oatgrass	PE	HP	C <sub>3</sub>
<b>Commelinaceae</b>				
<i>Commelina virginica</i>	Virginia dayflower	PX	HP	
<b>Ranunculaceae</b>				
<i>Anemone cylindrica</i>	thimbleweed, long-headed anemone	PE	HP	
<i>Ranunculus flammula</i> var. <i>reptans</i>	creeping spearwort	PX	HP	
<i>Trollius laxus</i>	spreading globe-flower	PE	HP	
<b>Papaveraceae</b>				
<i>Corydalis aurea</i>	golden corydalis	PE	HB	
<b>Polygonaceae</b>				
<i>Persicaria careyi</i> [= <i>Polygonum careyi</i> ]	pinkweed, smartweed	PE	HA	
<i>Polygonella articulata</i>	jointweed	PE	HA	
<i>Polygonum ramosissimum</i> ssp. <i>ramosissimum</i>	bushy knotweed	PX	HA	
<i>Rumex hastatulus</i>	heart sorrel, red sorrel	PX	HP	
<b>Caryophyllaceae</b>				
<i>Cerastium velutinum</i> var. <i>villosissimum</i> [= <i>C. arvense</i> ssp. <i>velutinum</i> var. <i>villosum</i> ]	serpentine barrens chickweed	PE	HP	
<i>Paronychia fastigiata</i> var. <i>nuttallii</i>	whitlow-wort	PE	HA	
<b>Amaranthaceae</b>				
<i>Chenopodium capitatum</i>	Indian-paint, strawberry-blite	TU	HA	
<b>Cactaceae</b>				
<i>Opuntia humifusa</i>	eastern prickly-pear cactus	PR	HP	

family / scientific name	common name(s)	state status	growth form	C <sub>3</sub> or C <sub>4</sub> (grasses)
<b>Portulacaceae</b>				
<i>Phemeranthus teretifolius</i>	round-leaved fameflower	PT	HP	
<b>Crassulaceae</b>				
<i>Sedum telephioides</i> [= <i>Hylotelephium telephioides</i> ]	Allegheny stonecrop	PR	HP	
<b>Geraniaceae</b>				
<i>Geranium bicknellii</i>	Bicknell's cranesbill	PE	HA / HB	
<b>Onagraceae</b>				
<i>Epilobium strictum</i>	downy willow-herb	PR	HP	
<i>Ludwigia polycarpa</i>	false loosestrife, seedbox	PE	HP	
<i>Oenothera argillicola</i>	shale-barren evening-primrose	PT	HB / HP	
<i>Oenothera oakesiana</i>	evening-primrose	TU	HB	
<b>Lythraceae</b>				
<i>Ammannia coccinea</i>	tooth cup, valley redstem	PT	HA	
<i>Lythrum alatum</i>	winged loosestrife	PE	HP	
<i>Rotala ramosior</i>	tooth cup, lowland rotala	PR	HA	
<b>Parnassiaceae</b>				
<i>Parnassia glauca</i>	grass-of-parnassus	PE	HP	
<b>Salicaceae</b>				
<i>Salix candida</i>	hoary willow, sage-leaved willow	PE	SD	
<i>Salix caroliniana</i>	Carolina willow	PE	TD	
<i>Salix serissima</i>	autumn willow	PT	SD	
<b>Linaceae</b>				
<i>Linum intercursum</i>	sandplain wild flax	PE	HP	
<i>Linum sulcatum</i>	grooved yellow flax	PE	HA	

family / scientific name	common name(s)	state status	growth form	C <sub>3</sub> or C <sub>4</sub> (grasses)
<b>Hypericaceae</b>				
<i>Hypericum densiflorum</i>	bushy St. John's-wort	PR	SD	
<i>Hypericum drummondii</i>	nits-and-lice	PX	HA	
<i>Hypericum stragulum</i> [= <i>H. hypericoides</i> ssp. <i>multicaule</i> ]	St. Andrew's-cross	TU	SD	
<b>Phyllanthaceae</b>				
<i>Phyllanthus caroliniensis</i>	Carolina leaf-flower	PE	HA	
<b>Polygalaceae</b>				
<i>Polygala cruciata</i>	cross-leaved milkwort	PE	HA	
<i>Polygala curtissii</i>	Curtis's milkwort	PE	HA	
<i>Polygala incarnata</i>	pink milkwort	PE	HA	
<i>Polygala polygama</i>	bitter milkwort, racemed milkwort	PE	HB	
<b>Fabaceae</b>				
<i>Astragalus canadensis</i>	milk-vetch	TU	HP	
<i>Astragalus neglectus</i>	Cooper's milk-vetch	PE	HP	
<i>Baptisia australis</i>	blue false-indigo	TU	HP	
<i>Desmodium laevigatum</i>	smooth tick-clover	TU	HP	
<i>Desmodium nuttallii</i>	Nuttall's tick-trefoil	TU	HP	
<i>Desmodium viridiflorum</i>	velvety tick-trefoil	TU	HP	
<i>Lathyrus japonicus</i> var. <i>glaber</i>	beach pea	PT	HP	
<i>Lathyrus palustris</i>	marsh pea, vetchling	PE	VP	
<i>Lathyrus venosus</i>	veiny pea, veiny vetchling	TU	HP	
<i>Lespedeza angustifolia</i>	narrow-leaved bush-clover	PE	HP	
<i>Lespedeza stuevei</i>	tall bush-clover	PX	HP	
<i>Lupinus perennis</i>	blue lupine	PR	HP	

family / scientific name	common name(s)	state status	growth form	C <sub>3</sub> or C <sub>4</sub> (grasses)
<i>Phaseolus polystachios</i>	wild bean, thicket bean	TU	VP	
<i>Senna marilandica</i>	southern wild senna	PE	HP	
<i>Strophostyles umbellata</i>	wild bean, pink fuzzy-bean	PE	VP	
<i>Stylosanthes biflora</i>	pencil-flower	PE	HP	
<i>Trifolium reflexum</i>	buffalo clover	PX	HA / HB	
<b>Rosaceae</b>				
<i>Amelanchier humilis</i>	low juneberry, low serviceberry	PE	SD	
<i>Amelanchier obovalis</i>	coastal juneberry, coastal shadbush	PE	SD	
<i>Amelanchier sanguinea</i>	roundleaf serviceberry, roundleaf shadbush	PE	SD	
<i>Crataegus dilatata</i>	broadleaf hawthorn	TU	TD	
<i>Crataegus mollis</i>	downy hawthorn	TU	TD	
<i>Filipendula rubra</i>	queen-of-the-prairie	TU	HP	
<i>Potentilla anserina</i> [= <i>Argentina anserina</i> ]	silverweed	PR	HP	
<i>Potentilla paradoxa</i>	bushy cinquefoil	PE	HA / HB	
<i>Prunus alleghaniensis</i>	Allegheny plum	PT	TD	
<i>Prunus maritima</i>	beach plum	PE	SD	
<i>Prunus pumila</i> var. <i>depressa</i>	sand cherry	PE	SD	
<i>Rosa virginiana</i>	wild rose, pasture rose	TU	SD	
<i>Rubus cuneifolius</i>	sand blackberry	PE	SD	
<b>Rhamnaceae</b>				
<i>Rhamnus lanceolata</i>	lanceolate buckthorn	PE	SD	
<b>Brassicaceae</b>				
<i>Cardamine pratensis</i>	cuckoo-flower, lady's-smock	TU	HP	
<b>Cistaceae</b>				
<i>Helianthemum bicknellii</i>	Bicknell's hoary rockrose	PE	HP	

family / scientific name	common name(s)	state status	growth form	C <sub>3</sub> or C <sub>4</sub> (grasses)
<i>Helianthemum propinquum</i>	low frostweed	TU	HP	
<i>Lechea minor</i>	thyme-leaved pinweed	TU	HP	
<b>Rutaceae</b>				
<i>Ptelea trifoliata</i>	hoptree, wafer-ash	PT	SD	
<b>Polemoniaceae</b>				
<i>Phlox ovata</i> [= <i>P. latifolia</i> ]	mountain phlox	PE	HP	
<i>Phlox pilosa</i>	downy phlox, prairie phlox	PE	HP	
<i>Phlox subulata</i> ssp. <i>brittonii</i>	moss-pink, creeping phlox	PE	HP	
<b>Theophrastaceae</b>				
<i>Samolus parviflorus</i> [= <i>S. valerandi</i> ssp. <i>parviflorus</i> ]	water pimpernel	PE	HP	
<b>Primulaceae</b>				
<i>Dodecatheon meadia</i>	shooting-star, pride-of-Ohio	PE	HP	
<b>Myrsinaceae</b>				
<i>Lysimachia hybrida</i>	lance-leaved loosestrife	PT	HP	
<i>Lysimachia quadriflora</i>	four-flowered loosestrife	PX	HP	
<b>Ericaceae</b>				
<i>Arctostaphylos uva-ursi</i> ssp. <i>coactilis</i>	bearberry	PX	SE	
<i>Lyonia mariana</i>	staggerbush	PE	SD	
<i>Rhododendron calendulaceum</i>	flame azalea	PX	SD	
<b>Boraginaceae</b>				
<i>Cynoglossum boreale</i> [= <i>C. virginianum</i> var. <i>boreale</i> ]	northern hound's-tongue, wild comfrey	PX	HP	
<i>Lithospermum canescens</i>	hoary puccoon, Indian-paint	TU	HP	
<i>Lithospermum caroliniense</i>	golden puccoon, hispid gromwell	PE	HP	

family / scientific name	common name(s)	state status	growth form	C <sub>3</sub> or C <sub>4</sub> (grasses)
<i>Onosmodium molle</i> var. <i>hispidissimum</i> [= <i>O. bejariense</i> var. <i>hispidissimum</i> ]	false gromwell, marble-seed	PE	HP	
<b>Rubiaceae</b>				
<i>Galium latifolium</i>	purple bedstraw	TU	HP	
<i>Houstonia purpurea</i> var. <i>purpurea</i>	purple bluets, southern bluets	TU	HP	
<i>Houstonia serpyllifolia</i>	creeping bluets, thyme-leaved bluets	PE	HP	
<b>Gentianaceae</b>				
<i>Gentiana catesbaei</i>	coastal plain gentian, Catesby's gentian	PX	HP	
<i>Gentiana saponaria</i>	soapwort gentian	PE	HP	
<i>Gentiana villosa</i>	striped gentian	PE	HP	
<i>Gentianopsis virgata</i>	narrow-leaved fringed gentian	PX	HA / HB	
<i>Swertia caroliniensis</i> [= <i>Frasera caroliniensis</i> ]	American columbo, green gentian	PE	HP	
<b>Apocynaceae</b>				
<i>Asclepias variegata</i>	white milkweed	PE	HP	
<b>Plantaginaceae</b>				
<i>Gratiola aurea</i>	goldenpert, hedge hyssop	PE	HP	
<i>Penstemon laevigatus</i>	eastern beard-tongue	TU	HP	
<b>Orobanchaceae</b>				
<i>Agalinis auriculata</i>	eared false-foxglove	PE	HA	
<i>Agalinis decemloba</i> [= <i>A. obtusifolia</i> ]	Blue Ridge false-foxglove	PX	HA	
<i>Agalinis paupercula</i>	small-flowered false-foxglove	PE	HA	
<i>Castilleja coccinea</i>	Indian paintbrush	PT	HA	
<i>Pedicularis lanceolata</i>	swamp lousewort, wood-betony	PE	HP	
<b>Lamiaceae</b>				
<i>Monarda punctata</i>	spotted bee-balm	PE	HP	

family / scientific name	common name(s)	state status	growth form	C <sub>3</sub> or C <sub>4</sub> (grasses)
<i>Pycnanthemum verticillatum</i> var. <i>pilosum</i>	whorled mountain-mint	PX	HP	
<i>Scutellaria saxatilis</i>	rock skullcap	PE	HP	
<i>Stachys hyssopifolia</i> var. <i>ambigua</i> [= <i>S. aspera</i> ]	hedge-nettle	PX	HP	
<i>Stachys hyssopifolia</i> var. <i>hyssopifolia</i>	hedge-nettle, woundwort	PX	HP	
<b>Acanthaceae</b>				
<i>Ruellia humilis</i>	fringed-leaved petunia	PE	HP	
<i>Ruellia strepens</i>	limestone petunia	PT	HP	
<b>Apiaceae</b>				
<i>Eryngium aquaticum</i>	marsh eryngo, rattlesnake-master	PX	HP	
<i>Ligusticum canadense</i>	lovage, Canadian licorice-root	PE	HP	
<i>Oxypolis rigidior</i>	cowbane, water-dropwort	PT	HP	
<i>Taenidia montana</i>	mountain pimpernel	PE	HP	
<b>Campanulaceae</b>				
<i>Lobelia kalmii</i>	brook lobelia	PE	HP	
<i>Lobelia nuttallii</i>	Nuttall's lobelia	PX	HP	
<i>Lobelia puberula</i>	downy lobelia	PE	HP	
<b>Asteraceae</b>				
<i>Ageratina aromatica</i>	small-leaved white-snakeroot	PR	HP	
<i>Antennaria virginica</i>	shale-barren pussytoe, Virginia pussytoe	PR	HP	
<i>Arnica acaulis</i>	leopard's-bane	PE	HP	
<i>Artemisia campestris</i> ssp. <i>caudata</i>	beach wormwood	PE	HB	
<i>Baccharis halimifolia</i>	groundsel-tree	PR	SD	
<i>Bidens laevis</i>	showy bur-marigold	TU	HA / HP	
<i>Boltonia asteroides</i>	aster-like boltonia	PE	HP	
<i>Chrysopsis mariana</i>	golden aster	PE	HP	

family / scientific name	common name(s)	state status	growth form	C <sub>3</sub> or C <sub>4</sub> (grasses)
<i>Cirsium horridulum</i>	yellow thistle, horrible thistle	PE	HB	
<i>Conoclinium coelestinum</i>	mistflower, wild ageratum	TU	HP	
<i>Coreopsis rosea</i>	pink tickseed	PX	HP	
<i>Echinacea laevigata</i>	Appalachian coneflower, smooth purple coneflower	PX	HP	
<i>Elephantopus carolinianus</i>	elephant's foot	PE	HP	
<i>Eupatorium album</i>	white-bracted eupatorium	PX	HP	
<i>Eupatorium godfreyanum</i>	Godfrey's thoroughwort	TU	HP	
<i>Eupatorium rotundifolium</i> var. <i>ovatum</i>	round-leaved eupatorium	TU	HP	
<i>Eupatorium rotundifolium</i> var. <i>rotundifolium</i>	round-leaved eupatorium	TU	HP	
<i>Euthamia caroliniana</i>	grass-leaved goldenrod, coastal plain flat-topped goldenrod	PT	HP	
<i>Helianthus hirsutus</i>	hairy sunflower	TU	HP	
<i>Helianthus microcephalus</i>	small wood sunflower	TU	HP	
<i>Hieracium trailii</i> [= <i>H. greenii</i> ]	Green's hawkweed, Maryland hawkweed	PE	HP	
<i>Hieracium umbellatum</i> [= <i>H. kalmii</i> ]	Canada hawkweed	TU	HP	
<i>Lactuca hirsuta</i>	downy lettuce	TU	HA / HB	
<i>Liatris scariosa</i>	northern blazing-star	PT	HP	
<i>Packera anonymsa</i>	Appalachian groundsel, plain ragwort	PR	HP	
<i>Packera antennariifolia</i>	shale-barren ragwort, cat's-paw ragwort	PE	HP	
<i>Packera plattensis</i>	prairie ragwort	PX	HB	
<i>Parthenium integrifolium</i>	American fever-few	PX	HP	
<i>Pluchea odorata</i> var. <i>succulenta</i>	marsh fleabane	PE	HA	
<i>Prenanthes serpentaria</i>	lion's-foot	TU	HP	
<i>Ratibida pinnata</i>	prairie coneflower	PX	HP	
<i>Rudbeckia fulgida</i> var. <i>fulgida</i>	eastern coneflower	TU	HP	

<b>family / scientific name</b>	<b>common name(s)</b>	<b>state status</b>	<b>growth form</b>	<b>C<sub>3</sub> or C<sub>4</sub> (grasses)</b>
<i>Sericocarpus linifolius</i>	narrow-leaved white-topped aster	PE	HP	
<i>Solidago arguta</i> var. <i>harrisii</i>	Harris's goldenrod	PE	HP	
<i>Solidago rigida</i> [= <i>Oligoneuron rigidum</i> ]	stiff goldenrod	PE	HP	
<i>Solidago roanensis</i>	mountain goldenrod	PR	HP	
<i>Solidago simplex</i> ssp. <i>randii</i> var. <i>racemosa</i>	sticky goldenrod	PE	HP	
<i>Solidago speciosa</i>	showy goldenrod	PT	HP	
<i>Solidago uliginosa</i>	bog goldenrod	TU	HP	
<i>Symphyotrichum depauperatum</i>	serpentine aster	PT	HP	
<i>Symphyotrichum dumosum</i>	bushy aster	TU	HP	
<i>Symphyotrichum novi-belgii</i> var. <i>novi-belgii</i>	New York aster	PT	HP	
<i>Symphyotrichum praealtum</i>	veiny-lined aster	TU	HP	
<i>Vernonia glauca</i>	Appalachian ironweed, tawny ironweed	PE	HP	

## Appendix E. Rare butterfly and moth species native to grasslands, meadows, and savannas in Pennsylvania

Species tracked by the Pennsylvania Natural Heritage Program ( $N = 86$ , plus 9 additional species proposed for tracking, marked by an asterisk). Where state rank is not given, data are currently insufficient to assign a rank (see Appendix F for explanation of ranking codes). The list is not exhaustive; the larval host plants for another 49 of the state's rare moth species and one rare butterfly species are unknown and many of them have been captured in grasslands, meadows, and savannas in the state.

family / scientific name	common name	global rank	state rank	larval host plant(s) native to Pennsylvania
<b>BUTTERFLIES</b>				
<b>Hesperiidae</b>				
<i>Amblyscirtes vialis</i>	common roadside-skipper	G5	S2S4	<i>Agrostis</i> , <i>Poa</i> , <i>Chasmanthium</i>
<i>Atrytone arogos arogos</i>	arogos skipper	G3T1T2	SX	<i>Schizachyrium scoparius</i>
<i>Atrytonopsis hianna</i>	dusted skipper	G4G5	S2S3	<i>Schizachyrium scoparius</i> , <i>Andropogon gerardii</i>
<i>Carterocephalus palaemon mandan</i>	arctic skipper	G5T5	S2	Poaceae, including <i>Calamagrostis</i> , <i>Bromus</i>
<i>Erynnis martialis</i>	mottled duskywing	G3G4	SH	<i>Ceanothus americanus</i>
<i>Erynnis persius persius</i>	Persius duskywing	G5T1T3	S1S2	<i>Baptisia tinctoria</i> , <i>Lupinus perennis</i>
<i>Euphyes bimacula</i>	two-spotted skipper	G4	S2S3	<i>Carex</i> , especially <i>C. trichocarpa</i> , <i>C. stricta</i>
<i>Euphyes conspicuus</i>	black dash	G4	S3	<i>Carex</i> , especially <i>C. stricta</i>
<i>Euphyes dion</i>	dion skipper	G4	S1	<i>Carex</i> , <i>Cladium</i> , <i>Scirpus</i>
<i>Hesperia leonardus</i>	Leonard's skipper	G4	S3S4	<i>Schizachyrium scoparius</i> , <i>Bouteloua</i> , <i>Agrostis</i>
<i>Hesperia metea</i>	cobweb skipper	G4G5	S2S3	<i>Schizachyrium scoparius</i> , <i>Andropogon</i>
<i>Hesperia sassacus</i>	Indian skipper	G5	S3S4	<i>Schizachyrium scoparius</i> , <i>Panicum</i> , <i>Dichanthelium</i> (?), <i>Festuca</i> (?)
<i>Nastra lherminier</i>	swarthy skipper	G5	S2S3	<i>Schizachyrium scoparium</i>

family / scientific name	common name	global rank	state rank	larval host plant(s) native to Pennsylvania
<i>Poanes massasoit</i>	mulberry wing	G4	S3	<i>Carex</i> , including <i>C. stricta</i>
<i>Polites mystic</i>	long dash	G5	S3	<i>Poa</i>
<i>Pyrgus wyandot</i>	Appalachian grizzled skipper	G1G2Q	S1	<i>Potentilla canadensis</i>
<i>Thorybes bathyllus</i>	southern cloudywing	G5	S3S4	Fabaceae, including <i>Desmodium</i> , <i>Lespedeza</i> , <i>Trifolium</i> , <i>Astragalus</i> , <i>Strophostyles</i>
<b>Lycaenidae</b>				
<i>Callophrys augustinus</i>	brown elfin	G5	S3S4	Ericaceae
<i>Callophrys gryneus</i>	juniper hairstreak	G5	S2S4	<i>Juniperus virginiana</i>
<i>Callophrys irus</i>	frosted elfin	G3	S1S2	<i>Baptisia tinctoria</i> , <i>Lupinus perennis</i>
<i>Callophrys niphon</i>	eastern pine elfin	G5	S3	<i>Pinus</i> , <i>Juniperus virginiana</i> , <i>Larix laricina</i>
<i>Callophrys polios</i>	hoary elfin	G5	S1	<i>Arctostaphylos uva-ursi</i>
<i>Celastrina ladon lucia</i>	northern spring azure	G5	S3S4	<i>Prunus</i> , <i>Vaccinium</i> , <i>Viburnum</i> , <i>Cornus</i> , <i>Ceanothus americana</i> , <i>Collinsia</i>
<i>Glaucopsyche lygdamus lygdamus</i>	silvery blue	G5T4	S1S2	Fabaceae, including <i>Astragalus</i> , <i>Lupinus</i> , <i>Lathyrus</i> , <i>Vicia</i>
<i>Lycaeides melissa samuelis</i>	karner blue	G5T2	SX	<i>Lupinus perennis</i>
<i>Lycaena epixanthe</i>	bog copper	G4G5	S2	<i>Vaccinium</i>
<i>Lycaena hyllus</i>	bronze copper	G5	SU	Polygonaceae
<i>Parrhasius m-album</i>	white M hairstreak	G5	S3S4	<i>Quercus</i>
<i>Satyrium edwardsii</i>	Edwards' hairstreak	G4	S3S4	<i>Quercus ilicifolia</i>
<b>Nymphalidae</b>				
<i>Boloria selene myrina</i>	silver bordered fritillary	G5T5	S1S3	<i>Viola</i>
<i>Chlosyne gorgone</i>	Gorgone checkerspot	G5	—	Asteraceae, including <i>Helianthus</i> ; <i>Lysimachia</i>
<i>Chlosyne harrisii</i>	Harris' checkerspot	G4	S3	<i>Doellingeria umbellata</i>

family / scientific name	common name	global rank	state rank	larval host plant(s) native to Pennsylvania
<i>Chlosyne nycteis</i>	silvery checkerspot	G5	S3S4	Asteraceae, including <i>Rudbeckia</i> , <i>Helianthus</i> , <i>Verbesina</i>
<i>Enodia anthedon</i>	northern pearly-eye	G5	S3S4	Poaceae, including <i>Leersia</i> , <i>Brachyelytrum</i> , <i>Elymus</i> , <i>Chasmanthium</i>
<i>Euphydryas phaeton</i>	Baltimore checkerspot	G4	S2S4	<i>Chelone</i> , <i>Penstemon</i> , <i>Plantago</i> , <i>Aureolaria</i>
<i>Phyciodes batesii batesii</i>	tawny crescent	G4TH	SX	<i>Symphytotrichum undulatum</i>
<i>Phyciodes cocyta</i>	northern crescent	G5	S3S4	Asteraceae, especially <i>Symphytotrichum</i> (?)
<i>Polygonia faunus</i>	green comma	G5	SH	<i>Salix humilis</i> , <i>Betula lenta</i> , <i>Alnus</i> , <i>Ribes</i>
<i>Satyroides eurydice</i>	eyed brown	G4	S1S3	<i>Carex</i>
<i>Speyeria aphrodite</i>	Aphrodite fritillary	G5	S3S4	<i>Viola</i>
<i>Speyeria atlantis</i>	Atlantis fritillary	G5	SU	<i>Viola</i>
<i>Speyeria diana</i>	diana fritillary	G3G4	—	<i>Viola</i>
<i>Speyeria idalia idalia</i>	eastern regal fritillary	G1	S1	<i>Viola</i>
<b>Papilionidae</b>				
<i>Papilio cressphontes</i>	giant swallowtail	G5	S2	<i>Zanthoxylum americanum</i> , <i>Ptelea trifoliata</i>
<b>Pieridae</b>				
<i>Anthocharis midea</i>	falcate orangetip	G4G5	S3	Brassicaceae, including <i>Arabis</i>
<i>Colias interior</i>	pink-edged sulphur	G5	SH	<i>Vaccinium</i>
<i>Euchloe olympia</i>	Olympia marble	G4G5	S1	<i>Arabis</i>
<i>Pontia protodice</i>	checkered white	G4	SH	Brassicaceae, Cleomaceae
<b>Riodinidae</b>				
<i>Calephelis borealis</i>	northern metalmark	G3G4	S1S2	<i>Packera obovata</i> , <i>Erigeron philadelphicus</i>

family / scientific name	common name	global rank	state rank	larval host plant(s) native to Pennsylvania
<b>MOTHS</b>				
<b>Geometridae</b>				
<i>Apodrepanulatrix liberaria</i>	a geometer moth	G4	S3	<i>Ceanothus</i>
<i>Erastria coloraria</i>	broad-lined erastria moth	G4	S1	<i>Ceanothus americanus</i>
<i>Glena cognataria</i>	blueberry gray	G4	S1	<i>Vaccinium, Prunus, others(?)</i>
<i>Hypagyrtis esther</i>	Esther moth	G5	S2S3	<i>Pinus</i>
<i>Itame</i> sp. 1 nr. <i>inextricata</i>	barrens itame	G3G4	S1	<i>Quercus ilicifolia</i>
<b>Megalopygidae</b>				
<i>Lagoa crispata</i>	black-waved flannel moth	G5	S1	generalist, including <i>Quercus, Sassafras</i>
<i>Cicinnus melsheimeri</i>	Melsheimer's sack bearer	G4	S1	<i>Quercus ilicifolia</i>
<b>Noctuidae</b>				
<i>Acronicta albarufa</i>	barrens dagger moth	G3G4	SX	<i>Quercus</i> , especially <i>Q. ilicifolia</i>
<i>Apharetra purpurea</i>	a noctuid moth	G4	S2	<i>Vaccinium(?)</i>
<i>Catocala dulciola</i> *	sweet underwing	G3	SH	<i>Crataegus</i>
<i>Catocala gracilis</i> *		G5	—	<i>Vaccinium, Lyonia</i>
<i>Catocala praeclara</i> *	praeclara underwing	G5	—	<i>Prunus</i> , including <i>P. virginiana, Photinia</i>
<i>Catocala pretiosa pretiosa</i>	precious underwing moth	G4T2T3	SX	<i>Photinia</i>
<i>Catocala</i> sp. 1 nr. <i>jair</i>	pine woods underwing	G5	S1	<i>Quercus ilicifolia, other Quercus(?)</i>
<i>Cerastis fishii</i> *		G4G5	—	<i>Vaccinium</i>
<i>Cerma cora</i>	bird dropping moth	G3G4	—	<i>Prunus pensylvanica</i>
<i>Chytonix sensilis</i>	marvel moth	G4	S1	fungi(?) following fire
<i>Cucullia speyeri</i> *	a noctuid moth	G4	S4	Asteraceae, including <i>Conyza canadensis</i>
<i>Diarsia rubifera</i>		G5	SU	<i>Vaccinium(?)</i>
<i>Epiglaea apiata</i>	pointed sallow	G5	S3S4	<i>Vaccinium</i>
<i>Eueretagrotis attentata</i> *	attentive dart	G4	—	<i>Vaccinium</i>

family / scientific name	common name	global rank	state rank	larval host plant(s) native to Pennsylvania
<i>Fagitana littera</i>	marsh fern moth	G4	SH	<i>Thelypteris palustris</i>
<i>Hydraecia immanis</i>	a noctuid moth	G4	SU	Poaceae
<i>Lithomoia solidaginis germana</i>	a moth	G5T5	S3S4	<i>Vaccinium</i>
<i>Lithophane thaxteri</i>	Thaxter's pinion moth	G4	SH	<i>Comptonia peregrina</i> , Ericaceae(?)
<i>Merolonche dolli</i>	Doll's merolonche	G3G4	S1	<i>Vaccinium</i>
<i>Papaipema pterisii</i> *		G5	—	<i>Pteridium aquilinum</i>
<i>Papaipema</i> sp. 1	flypoison borer moth	G2G3	S2	<i>Amianthium muscaetoxicum</i>
<i>Phoberia orthosoides</i>	an oak moth	G4	S3	<i>Quercus</i> , including <i>Q. ilicifolia</i>
<i>Psectraglaea carnosae</i>	pink sawfly	G3	S1	<i>Vaccinium</i> (?), <i>Quercus ilicifolia</i> (?)
<i>Sideridis maryx</i>		G4	S1S3	<i>Vaccinium</i> (?)
<i>Syngrapha epigaea</i> *	a noctuid moth	G5	S1	<i>Vaccinium</i> , <i>Kalmia angustifolia</i>
<i>Xestia elimata</i>	southern variable dart moth	G5	S2S3	<i>Pinus</i> (?)
<i>Xylotype capax</i>	broad sawfly moth	G4	S3	<i>Vaccinium</i> (?), <i>Quercus ilicifolia</i> (?)
<i>Zale curema</i>	a zale moth	G3G4	S1	<i>Pinus rigida</i>
<i>Zale</i> sp. 1 nr. <i>lunifera</i>	pine barrens zale	G3G4	S1	<i>Quercus ilicifolia</i>
<i>Zale squamularis</i>		G4	S2S3	<i>Pinus rigida</i>
<i>Zale submediana</i>	a zale moth			<i>Pinus rigida</i>
<b>Notodontidae</b>				
<i>Datana ranaeiceps</i>	a hand-maid moth	G3G4	S1	<i>Lyonia</i> , <i>Leucothoe</i>
<b>Saturniidae</b>				
<i>Anisota stigma</i>	spiny oakworm moth	G5	S1S2	<i>Quercus</i> , especially <i>Q. ilicifolia</i> , <i>Q. prinoides</i>
<i>Citheronia sepulcralis</i>	pine devil	G4	S2S4	<i>Pinus</i>
<i>Hemileuca maia</i>	barrens buckmoth	G5	S1S2	<i>Quercus ilicifolia</i> , <i>Q. prinoides</i> , rarely <i>Q. velutina</i>

family / scientific name	common name	global rank	state rank	larval host plant(s) native to Pennsylvania
<b>Sphingidae</b>				
<i>Hemaris gracilis</i>	slender clearwing	G3G4	SH	Ericaceae, including <i>Vaccinium</i>
<i>Paonias astylus</i> *	huckleberry sphinx	G4G5	—	<i>Vaccinium</i> , <i>Gaylussacia</i>
<i>Sphinx gordius</i>		G4	S1S3	Ericaceae(?), Myricaceae(?)

## Appendix F. Explanation of global and state rank codes

Ranks describe rarity both throughout a species' range (globally, or "G" rank) and within Pennsylvania (statewide, or "S" rank). The rarity of subspecies and varieties is indicated with a taxon ("T") rank. For example, a G5T1 rank shows that the species is globally secure (G5) but the subspecies is critically imperiled (T1).

code	examples	description
1	G1 S1	Critically imperiled because extreme rarity (generally one to five occurrences), steep decline, or some factor of its biology makes it particularly vulnerable to extinction or extirpation.
2	G2 S2	Imperiled because rarity (generally six to 20 occurrences), steep decline, or other factors demonstrably make it very vulnerable to extinction or extirpation.
3	G3 S3	Either very rare and local throughout its range (generally 21 to 100 occurrences), or found locally (even abundantly at some of its locations) in a restricted range, or vulnerable to extinction because of other factors.
4	G4 S4	Widespread and apparently secure, although the species may be quite rare in parts of its range, especially at the periphery.
5	G5 S5	Demonstrably widespread and secure, although the species may be quite rare in parts of its range, particularly at the periphery.
U	GU SU	Status uncertain, but possibly in peril. More information needed.
H	GH SH	Known only from historical records, but may be rediscovered. A G5 SH species is widespread throughout its range (G5), but considered historical in Pennsylvania (SH).
X	GX SX	Believed to be extinct. May be rediscovered, but evidence indicates that this is less likely than for historical species. A G5 SX species is widespread throughout its range (G5), but extirpated from Pennsylvania (SX).
E	SE	An exotic that is established in the state, but may be native in nearby regions.

The following modifiers indicate that there is some question about a species' rank.

code	examples	description
Q	G5Q GHQ	Questions or problems may exist with the species' or subspecies' taxonomy, so more information is needed.
?	G3? S3?	The rank is uncertain due to insufficient information at the state or global level, so more inventories are needed. When no rank has been proposed the rank may be "G5T?" or "S?"

The following modifiers indicate when the breeding status of a migratory species is considered separately from individuals passing through or not breeding within Pennsylvania. These modifiers are only attached to state ranks.

code	examples	description
B	SHB	Indicates the breeding status in Pennsylvania of a migratory species.
N	S1N	Indicates the non-breeding status in Pennsylvania of a migratory species. These species are typically over-wintering birds with regular aggregation areas that could be conservation targets.
Z	SZN	Indicates that non-breeding occurrences of a species are not tracked by the Pennsylvania Natural Heritage Program. These species are typically birds that over-winter sporadically in Pennsylvania.

Breeding-status modifiers may be used alone or in combinations. For example:

S3B,SZN	Breeding occurrences are uncommon (S3B), and over-wintering birds are not tracked (SZN).
SHB,SZN	Only historical records of breeding are known (SHB), and over-wintering birds are not tracked (SZN).
S3B	Breeding occurrences are uncommon (S3B), and the species does not over-winter in Pennsylvania.
SUB,S1N	The breeding status of the species is unknown (SUB), and any wintering site is critically imperiled or extremely rare (S1N) regardless of breeding status.

When ranks are somewhat uncertain or the species' status appears to fall between two ranks, the ranks may be combined. For example:

G4G5	The species may be globally secure (G5), but appears to be at some risk (G4).
G5T2T3	The species is globally secure (G5), but the subspecies is somewhat imperiled (T2T3).
G4?Q	The species appears to be relatively secure (G4), but more information is needed to confirm this (?). Further, there are questions or problems with the species' taxonomy (Q).
G3G4Q S1S2	The species is globally uncommon (G3G4), and there are questions about its taxonomy (Q). In Pennsylvania, the species is very imperiled (S1S2).