

Pennsylvania Bureau of Forestry Planting and Seeding Guidelines



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I. Introduction

Plants play a major role in every ecosystem found throughout the Commonwealth by providing habitat structure, food sources, and by influencing environmental factors such as temperature, water quality, and air quality. One key way to enhance or improve ecosystem function and viability of forested habitats is the use of supplemental planting of native trees, shrubs, grasses and forbs (wildflowers). Plants that were historically native to Pennsylvania prior to European colonization are better adapted to local climates and site conditions and therefore require less water, fertilizer, and less maintenance. The reduced need for site maintenance helps save time while benefiting the ecosystem. Native plants also offer nectar and pollen sources for our native insects and pollinators.

The Bureau of Forestry's mission includes the conservation of the commonwealth's native wild plants. While planning and carrying out any type of activity on state forest lands where seeding or planting is necessary, the Bureau is committed to planting native species as often as possible. As a leader in conservation in Pennsylvania, the Bureau of Forestry should serve as a leader in the use of native plants in all management projects and set an example to all citizens of the Commonwealth.



Native seed mix planted at site of new bridge construction, Michaux State Forest.

II. Key Principles

Supplemental planting on state forest lands is a common practice for activities such as re-vegetating a log landing after harvest, erosion and sedimentation control, forage and cover habitat in wildlife openings, and reclamation and restoration in gas development areas. The Bureau of Forestry utilizes native species in supplemental plantings whenever possible; however, there are occasions when native species do not fully support the purpose of the planting and non-native species may be justified. This document provides guidance on how best to plant native grasses, forbs, shrubs, and trees on state forest lands, as well as information regarding non-native species that can be planted with caution on state forest lands. This document also provides information on general seed mixes recommended by the Ecological Services Section and alterations for specific needs.

A variety of sources can be used to help select native plant species in addition to the Bureau's Planting and Seeding Guidelines. The Bureau considers a plant species to be native if it is historically known to be naturally occurring in Pennsylvania at the time of European colonization, or its natural range occurs within U.S. Forest Service's ECOMAP ecological regions that occur in the Commonwealth. Refer to the Bureau's *Strategy for Maintaining & Enhancing Natural Genetic Diversity of Plant Populations on Pennsylvania State forest Land* (also called the Genetic Guidelines) for clarification on seed sourcing. The Flora of the Southeastern United States ([Flora of the Southeastern US \(unc.edu\)](#)) is now considered the primary botanical source used by the Bureau of Forestry. This botanical guide extends into Pennsylvania and has been developed with input from the PA Natural Heritage Program. County-level plant species distribution maps for Pennsylvania also can be found at [Biota of North America's Plant Atlas](#). Surveying potential planting sites prior to selecting species may also provide insight into which native plants thrive locally at each site.

It is recommended that Bureau staff also review the Bureau's Genetic Guidelines prior to sourcing any planting stock or seed (whether native or non-native). Any non-native species planted on state forest lands are to be monitored following planting and are subject to review as per the "Assessment and Justification for the Use of Non-Native Plantings" process. Monitoring responsibility may fall to field staff, central office staff, or third-parties, depending on the nature of the projects. Monitoring protocols and requirements should be established prior to any planting or restoration project being undertaken.

The Bureau of Forestry has researched many species being considered for planting on state forest lands and have determined that species generally fit into three categories. These categories are discussed in greater detail in Section 4 (herbaceous species) and Section 5 (tree and shrubs), including recommended species and seed mixes.

1. Invasive: Deemed Invasive: Do Not Plant

Any plant classified as a [noxious weed](#) by the PA of Department of Agriculture is barred for use on State forest lands. It is illegal to cultivate, sell, transport, or plant any species classified as a noxious weed in PA.

Plants on [DCNR Invasive Plant List](#) are prohibited from use on State forest lands, according to principles set forth in the [State Forest Resource Management Plan](#) and the Bureau of Forestry's Invasive Plant Strategy. Some of these species may have been planted on state forest lands in the past. However, current standards do not allow the use of these plants on state forest lands. This includes species on DCNR's 'Invasive Plant Watch List.'

2. Potentially Invasive: Avoid planting except in special circumstances or situations

Some species may have invasive potential, depending on conditions, or as noted by other states. In addition, some non-native species do not provide quality wildlife habitat/forage and may not be compatible with planted tree seedlings during reforestation activities. There may be special circumstances

or situations that require the use of these species, such as unique erosion control needs or limited availability of native seed or planting stock. Some notable special circumstances are described within this document. The species mentioned in this category **should be avoided** whenever possible in favor of more acceptable native alternatives. Consultation with Ecological Services is required prior to the use of these species, and monitoring may be required following planting. Bureau of Forestry policies also require research into the ecological benefits or impacts of the use of non-native tree or shrub species. Please refer to the “Assessment and Guidance for the Use of Non-Native Trees and Shrubs” document for further information.

3. Non-invasive: Native and non-native species recommended for use on state forest lands.

For non-native species listed in this category, there is no evidence to suggest that any of these non-native species will have invasive tendencies. Some of these species have been planted without incidence of invasive spread for many years. Others have been subject to monitoring which demonstrated that they were not acting aggressively. In addition to the acceptable non-native species, this category also includes the many native species available for seed mixes and planting on state forest lands throughout Pennsylvania.

Non-native Plantings Monitoring (See Appendix II for more information)

Non-native plant species in Category 1 (invasive) should not be planted. If they have been planted in the past, treatment or removal is recommended. Species listed under category 2 (potentially invasive) will require monitoring. Species listed under Category 3 (non-invasive) species may require monitoring after consultation with Ecological Services. This monitoring should take place once within 5 years of planting and should be completed by district staff. Ecological Services can provide identification assistance in the field if requested.



Wild bergamot growing on permanent herbaceous opening.

III. Planting Guidance for Native Grasses and Herbaceous Plants

The sowing of grass seed mixes is a long-standing practice used on state forest lands to stabilize soils following disturbance. While the Bureau has traditionally used non-native, cool-season turf grass seed mixes to retire log landings and timber sale haul roads, there has been an increased use of native grasses for retiring timber sales, permanent herbaceous openings for wildlife and for reclamation practices in areas surrounding gas infrastructure and right-of-way development. Combining native wildflowers with native warm season grass seed mixes increase the ecological value of restoration practices, attracting pollinators and other insects which then builds a more diverse food web and provides additional food sources for wildlife. Plantings of native warm season grasses and forbs allow for natural succession, which over time can limit the establishment of invasive plant species.

When undertaking a seeding project please consider the following:

Pre-planning:

- Begin completing site preparation (invasive removal, mowing, herbicide treatments, prescribed fire) the summer **prior** to the desired planting time. This allows for adequate site preparation, which is one of the most critical factors that dictates success of native seeding projects.
- Anticipate ordering seed several months in advance to ensure seed availability. The best time to purchase native seed is in winter and early spring (December through April) to be sure the supplier has enough in stock for spring plantings. Be sure to specify **PLS (pure live seed)** when ordering native seed and request **PA Ecotypes** when available.
- Please consult with Ecological Services before planting state-listed or PA Plant Species of Concern (species classified as PA Endangered, PA Threatened, PA Rare, PA Vulnerable). State-listed species included in Appendix I of this document are approved for use in conservation plantings on State Forest lands. The complete list of state-listed plant species can also be found here: <https://www.naturalheritage.state.pa.us/Species.aspx>.
- When choosing species for a seed mix (grasses and/or forbs), attempt to use species found historically within the same USDA seed zone as the planting site and consider the management objectives (wildlife opening, road corridor, log landing revegetation, recreational use, pollinator habitat) for the site. Any mix should have both warm-season and cool-season growing species. Plan ahead for long-term maintenance of the species selected.

Soil and Site Preparation:

- If the site to be planted with native warm season grasses or wildflowers is currently occupied by cool season turf grasses, an herbicide application is required. Some fields that have been in turf grasses for many years may require two herbicide applications. The treatments should begin in mid-summer for fall plantings. For spring plantings, herbicide treatments should begin in late summer or early fall of the previous year. A standard mix of glyphosate and surfactant is typically sufficient. If the site is heavily colonized by invasive plants, additional targeted and/or broadcast treatments may be necessary. Staff from Ecological Services can tailor herbicide treatments based on invasive species present.
- Immediately prior to seeding (typically a week before seeding), disking should be used to break up dense thatch and allow the new seed to have more contact with mineral soil. If a native seed drill is to be used, disking may not be necessary.



UTV-mounted sprayer applying herbicide to reduce existing cool-season grasses prior to meadow seeding.

- In activities that cause excessive soil compaction, such as log landings or gas development, the **topsoil and subsoil should be segregated and piled** before disturbance and returned to original contour with as little compaction as possible before seeding.
- Ripping the soil sublayer prior to spreading topsoil is recommended to lessen compaction and increase infiltration. Ripping to a depth of 8" should be sufficient to alleviate compaction for most land uses on state forest lands. Appalachian Reforestation Regional Initiative Low Compaction Grading Techniques can also be used. Please see [ARRI Forestry Reclamation Advisory No. 3](#) for further details.
- Lime and fertilizer aren't typically needed for native seed mixes; however, it is recommended that a soil test be performed at the proposed planting site to determine existing soil chemistry. Soil testing is available from the [Penn State Soil Lab](#). When seeking a PSU soil test, use the "Soil Test Information Form for Agronomic Crops" and choose code 1078 (established warm season grasses). The ratios of calcium to aluminum should typically be above 1 and a target pH of 5.0-5.5 can benefit soil biota, nutrient availability, and is in the preferred range for most of the native species commonly used in seed mixes. If lime and fertilizer are used, be sure to **reduce the nitrogen content** (first number in the N-P-K ratio), as this could promote weeds or invasive plants and can potentially kill or inhibit the germination of native seed, which typically prefer mildly to slightly acidic soils.
- Engineered Soil Media (ESM) are options for establishing organic material and a weed-free growing medium quickly. Many of these media contain microbiota such as beneficial bacteria and are inoculated with mycorrhizae to promote plant health and soil development.
- Seed may be lightly worked into the soil using a rake, cultipacker or drag harrow, but disking will likely bury the seeds too deep and may not be successful. Disking should only be conducted prior to spreading seed to alleviate compaction or break up existing non-native turf grass.
- On steep slopes or poorer growing sites, higher rates (pounds per acre) may be necessary to achieve desired stabilization and final conditions. The Bureau's right-of-way seed mixes provide options for sites with greater than and less than 15% slope.

Planting:

- Use straw, **not hay**, to protect the seed from predation and the site from surface erosion after seeding. Straw is used instead of hay to help lessen the potential for weed seed to be introduced into the site. A general rule of thumb is to use between 10 and 20 square bales of straw per acre.
- While spreading straw can protect the native seed, it can also be a source of introduction of some agricultural weed species. Seeding projects utilizing straw and also projects skipping this step have both been successful on state forest lands. If the source of straw is unknown or untrusted, it may be better to skip this step, particularly if the district has a drag harrow or cultipacker to improve seed to soil contact or if the district is using a native seed drill.
- Invasive and weed seed can also be introduced from contaminated fill material or contaminated seeders. Be sure seeding equipment is clean and free of any seed used previously whether on or off State forest lands. This is particularly important if seeding contractors are used.
- Temporary cover crops should be added to all mixes to improve soil stabilization and increase initial establishment. Cover crops can be applied before the desired mix if waiting for the optimum time to plant native seed. When using in combination with another mix, they should be applied at a rate of 20lbs per acre. If used alone on a site, for initial E&S coverage until the appropriate seeding timeframe is reached, the cover crops should be applied at 40lbs per acre.

Use spring oats (*Avena sativa*) if seeding prior to August 15th

Use winter rye (*Secale cereal*) if seeding after August 15th

**Annual rye (*Lolium multiflorum*) may be used instead of oats or winter rye

- Both Spring (mid April – early May) and Fall (late September – late October) offer the appropriate conditions for the seeding of native warm season grasses and wildflowers. Spring seeding results in some blooms during the same growing season. Fall seeding mimics the natural timing of seed release and allows for cold-scarification of some wildflower seeds prior to germination of next spring and summer's annual weeds. If initial reseeding of a project takes place in mid-summer, plant a cover crop for stabilization and seed natives in October or the following April.



Partridge pea and black-eyed susan establishment – three months after Spring seeding

- Many native warm season grasses and some native wildflowers will germinate the first year; however, most species invest heavily in root growth before shoot growth. During the first growing season (assuming spring planting), typically the cover crop, cool season grasses (like wildryes), partridge pea, and black-eyed susan are the only species that exhibit full establishment. The majority of species in the mix will germinate but may only produce basal rosettes or 2-4" leaves during the first growing season. For late fall/early winter plantings, native warm season grasses and wildflower seed benefits from cold scarification in winter and can germinate well the first spring after seeding.
- Seeding can be carried out by hand, with specialized native seed spreaders, or with a native seed drill. Consider how the seed will be spread prior to ordering seed so you can specify to have each species bagged separately or pre-mixed by the seed supplier.
 - o If spreading by hand without a spreader, mix seed together in a large trash can with equal parts cat litter. Split the seed into smaller amounts to ensure enough seed for the entire area. Walk first in rows in one direction, then use the remaining seed to walk in perpendicular rows. The stepping and throwing motion should be done consistently across the entire site and at a pace slightly faster than normal walking.
 - o Specific hand crank seeders are available commercially for spreading native seed. These seeders typically have two hoppers, one for harder seeds and a larger compartment for fluffy seed. These seeders are calibrated to spread the ideal amount of seeds per square foot. As such, they release seed at a much lighter rate than traditional hand-seeders for lawn grass. Ecological Services has these seeders available for loan to district staff. Traditional hand crank seeders are likely to be clogged by fluffy seed and will not produce reliable results.
 - o The Bureau of Forestry owns a Truax native seed drill and several smaller seed drills pulled by a UTV. For larger restoration projects (greater than 2-3 acres), a native seed drill is ideal. If you are interested in using a native seed drill, please contact Ecological Services **the fall or winter prior to seeding** to discuss how best to borrow one of the drills. Larger projects can take significant time to spread seed by hand. Also, when restoring forest savannah habitat, the seed drill may help ensure proper seed to soil contact in variable soil conditions over a larger site.
- Spreading of native seed in an equal mix across an entire site to create a meadow habitat is certainly acceptable and is advised for staff who are trying native seeding for the first time. However, some districts design more elaborate planting schemes with varied mixes or monocultures of species in strips or designs across an herbaceous opening to establish varying vertical structure. Another option is to spread some of the warm season grass seed in "patches" to create openings for wildlife between tufts of grass. While bare ground is not desired for meeting E & S permit guidelines, some bare ground is desirable for ground-nest insects and bees.
- If districts are considering managing planted sites with prescribed fire in the future, the planting of non-native cool season grasses (timothy, perennial ryegrass, creeping red fescue) and clover around the edges of the site as a firebreak is acceptable.



Seeding an opening using hand-crank native seed spreaders.

Ecological Considerations:

- The use of synthetic matting is prohibited on state forest lands. If matting is to be used for erosion and sedimentation control, it should be made of bio-degradable, jute material. Synthetic matting is made of a stiff, microfilament netting that may entangle and cause injury or mortality to wildlife.
- When the objective is long-term restoration, rather than temporary cover, it is important that stock is from local genetic material. Seed companies may provide the genetic origin or offer species collected from different stock. When available, select PA Ecotypes. If PA Ecotypes are not available, attempt to choose an Ecotype within the same [USDA seed zone](#) as the planting site. If this is also not possible, please contact Ecological Services to discuss options.
- For wildlife habitat, it is important to provide varied structure with good interspersions of bare ground, beneath a shaded canopy which allows small mammals and birds to move freely at ground level, and search for seeds, insects and roosting cover. Ecological Services biologists can provide specific plant species recommendations based on the individual ecology of target wildlife species.
- When planting to improve habitat and foraging for native insects, consider flowering time and attempt to have at least one species in flower during each month of the growing season. Specific guidance is provided in the seed mix section of this document regarding flowering time of some commonly used wildflower species. Bare patches with sun exposure are also important as nest sites for ground-nesting solitary bees.
- During the first and second year of growth, native warm season grasses typically invest more initial resources in root growth rather than vegetative growth. This enhanced root growth improves soil

retention to alleviate erosion and sedimentation issues; however, this enhanced root growth cannot always be confirmed by the quantity of above-ground, green vegetative growth. Initially, it may appear that the seeding was unsuccessful. Patience is important during these projects; most native species require two growing seasons to fully establish. If a seeding failure is suspected, please contact Ecological Services, who can join district staff in the field to evaluate a suspected failure.

- Prior to conducting any work, larger existing grassland sites such as reclaimed strip-mines (>20-30 acres) should be surveyed to identify the grassland bird species that are presently using them. Depending on the survey results, it may be necessary to adjust the timing of the management activity to avoid impacting nesting birds (avoid disturbance from April 15th to August 15th if possible). Contact the Ecological Services Section for further assistance.

Maintenance to Sustain Native Herbaceous and Grass Plantings or Permanent Herbaceous Openings:

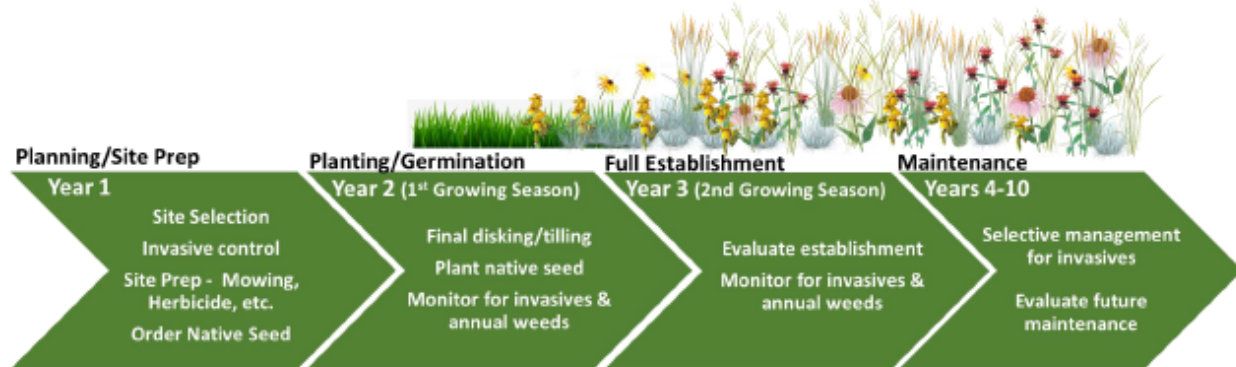
- Typically, mowing of native grasses or the use of prescribed fire should take place for the first time no earlier than the 4th year following initial planting at the earliest and then on a 3-5 year cycle as needed. When mowing or fire is necessary, consider treating only 1/2 of the planting per year. This allows for refugia for wildlife and insect species in un-mowed or un-burned sections. These species can then move into the mowed/maintained portions of the site.
- The ideal time to cut native grasses is very early spring (February or March), after snow melt. Mowing can also take place following the first frosts in November, but native grasses are ideal winter shelter for small mammals and birds so this is only encouraged if spring mowing is not feasible. The eggs of some native insects are laid in summer and fall and overwinter in hollow stems of native plants.
- Some sites establish very well and do not require maintenance until years seven or eight following seeding. **Conduct mowing only when absolutely necessary.** Mowers can carry undesirable species propagules or seed and create openings for invasive plants. Disking or prescribed fire are more desirable for long-term maintenance.



Dormant season maintenance mowing in early March

- In the second and subsequent growing seasons, the site should be checked for problematic weeds or invasive plants and spot-treated if necessary. Selective herbicides like Milestone can be useful for specific invasive issues, such as non-native thistles, knapweed or crown-vetch. Following the second growing season (assuming all natives have established), Japanese stiltgrass and mile-a-minute can be controlled using pre-emergent herbicides such as Prodiamine.
- If invasive treatment is necessary, in lieu of using herbicides to control non-native weeds and volunteer woody species, native seed mixes can be cut back to 8" in height by a brush-hog or similar piece of equipment. **Cutting lower than 4" may harm the development of the native grass and forb seedlings.**
- Prescribed fire provides the best maintenance of warm season grass openings; however, in areas such as rights-of-way, this may not be practical. Spring burns tend to benefit native grasses over native wildflowers. Alternatively, fall burns may benefit wildflowers and forbs over native grasses.
- Disking could also be considered to break-up and create more space between grass clumps, break up root mats, and to provide better habitat for wildlife. This treatment should be conducted from November 1st to April 1st. It is likely that disking may only be necessary every 5-10 years. If this treatment is undertaken, consider adding additional forbs to the site to improve wildflower diversity. Suggestions for which species to plant are included later in this document.
- For more information on sustaining openings, see the "Permanent Herbaceous Openings" and the "Maintaining ROWs for Wildlife" documents on Intraforestry

Timing for Native Seed Planting and Maintenance of Seeded Areas



Activity	Pre-Seeding	Post-Seeding	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Ordering Native Seed	X		X	X									X	X
Clearing woody vegetation	X		X	X	X						X	X	X	X
Initial mowing of existing vegetation	X					X	X	X	X	X				
Initial Site-prep herbicide treatment	X								X	X	X			
Disking/Tilling for initial seeding	X			X	X									
Planting Trees and Shrubs	X	X		X	X	X					X	X		
Sowing Native Seed					X	X					X	X		
Initial mowing to 8" after germination		X				X	X	X						
Milestone Herbicide Treatment	X	X		X	X							X	X	
Cut-stump Herbicide Treatment		X								X	X	X		
Pre-emergent Herbicide Treatment	X	X	X	X	X								X	X
Maintenance Mowing (Years 4-10)		X	X	X	X									
Maintenance Disking (Years 4-10)		X		X	X								X	

IV. Grass and Herbaceous Plant Lists and Mixes

1. Invasive: Deemed Invasive: Do Not Plant

A number of grasses and forbs are considered invasive by DCNR. Plants on [DCNR Invasive Plant List](#) are prohibited from use on State forest lands, according to principles set forth in the [State Forest Resource Management Plan](#). Please carefully review this list prior to making seeding or planting selections. Plants that are included on the Department of Agriculture's list of [Noxious Weeds](#) are also listed as invasive plants by DCNR.

2. Potentially Invasive: Avoid planting except in special circumstances or situations

The use of the non-native species listed below should be limited in most circumstances. This list was created through examining neighboring states' invasive plant lists, communications with foresters, specialists and resource managers, and research on species behavior. Native and non-native alternatives to these species are provided within Category 3. This list is revised periodically based on field observations and literature review.

Two common situations where non-native cool season grasses may be more appropriate are 1) fire breaks and 2) steep slopes. If the intention at a project site is to conduct prescribed fire on a periodic rotation, fire breaks comprised of cool season grasses (such as timothy, creeping red fescue, and perennial rye) are acceptable. Orchard grass should only be used after consultation with Ecological Services. For steep slopes or banks prone to erosion, the same non-native cool season grasses (timothy, creeping red fescue, and perennial rye) should be utilized before those on the list below.

Non-native Cool Season Grasses

Kentucky bluegrass	<i>Poa pratensis</i>	Orchard grass	<i>Dactylis glomerata</i>
Non-native bluegrasses	<i>Poa species</i>	Redtop grass	<i>Agrostis gigantea</i>

Non-native Legumes

Yellow sweet-clover	<i>Melilotus officinalis</i>	White sweet-clover	<i>Melilotus alba</i>
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3. Non-invasive: Recommended native and non-native grasses and herbaceous species.

There are many species to choose for seed mixes and planting on state forest lands, both native and not native to Pennsylvania. For these species below, there is little to no evidence to suggest any of these non-native species will have invasive tendencies, or that any of these native species will have over-aggressive tendencies. Other native grasses, legumes, and wildflowers not included on this list may also be used if conditions are appropriate.

Native Warm Season Grasses

Big Bluestem	<i>Andropogon gerardii</i>	Switchgrass	<i>Panicum virgatum</i>
Indiangrass	<i>Sorghastrum nutans</i>	Purpletop	<i>Tridens flavus</i>
Deertongue grass	<i>Dicanthelium clandestinum</i>	Little bluestem	<i>Schizachyrium scoparium</i>

Native Cool Season Grasses

Virginia wildrye*	<i>Elymus virginicus</i>	Autumn bentgrass	<i>Agrostis perennans</i>
Canada wildrye*	<i>Elymus canadensis</i>	Povertygrass	<i>Danthonia compressa</i>
Riverbank wildrye*	<i>Elymus riparius</i>	Povertygrass	<i>Danthonia spicata</i>

Native Legumes

Partridge pea	<i>Chamaechrista fasciculata</i>	Showy tick-trefoil	<i>Desmodium canadense</i>
Senna	<i>Senna herbearpa</i>		

Native Wildflowers

Black-eyed susan	<i>Rudbeckia hirta</i>	Tall white beardtongue	<i>Penstemon digitalis</i>
Cardinal flower	<i>Lobelia cardinalis</i>	Ox-eye sunflower	<i>Heliopsis helianthoides</i>
Common milkweed	<i>Asclepias syriaca</i>	Goldenrods	<i>Solidago spp.</i>
Butterfly milkweed	<i>Asclepias tuberosa</i>	Asters	<i>Symphotrichum spp.</i>
Evening primrose	<i>Oenothera biennis</i>	Hoary mountain-mint	<i>Pycnanthemum incanum</i>
Ironweed	<i>Veronica altissima</i>	Narrowleaf mountain-mint	<i>Pycnanthemum tenuifolium</i>
Wild bergamot	<i>Monarda fistulosa</i>		

Native Species for Riparian or Wetland Habitats

Fox sedge	<i>Carex vulpinoidea</i>	Pennsylvania sedge	<i>Carex pensylvanica</i>
Woolgrass	<i>Scirpus cyperinus</i>	Bluejoint grass	<i>Calamagrostis canadensis</i>
Soft rush	<i>Juncus effusus</i>	Blue lobelia	<i>Lobelia siphilitica</i>
Joe-pye weed	<i>Eupatorium purpureum</i>		

Non-native grasses and cover crops

Perennial ryegrass	<i>Lolium perenne</i>	Oats	<i>Avena sativa</i>
Creeping red fescue	<i>Festuca rubra</i>	Millet	<i>Millium spp.</i>
Timothy	<i>Phleum pratense</i>	Hard fescue	<i>Festuca trachyphylla</i>
Winter wheat	<i>Triticum aestivum</i>	Alfalfa	<i>Medicago sativa</i>
Cereal rye	<i>Secale cereale</i>	Barley	<i>Hordeum vulgare</i>
Buckwheat	<i>Fagopyrum esculentum</i>		

Non-native legumes

White clover	<i>Trifolium repens</i>	Birds foot trefoil	<i>Lotus corniculatus</i>
Red clover	<i>Trifolium pratense</i>	Flat pea	<i>Lathyrus sylvestris</i>
Alsike white clover	<i>Trifolium hybridum</i>	Crimson clover	<i>Trifolium incarnatum</i>

* The seed awns of the wildryes (*Elymus spp.*) have been shown in certain circumstances to become ingested or attached to a dog's fur or paws, penetrating the skin and leading to the potential for grass awn migration disease. Use these species with caution in areas that may be utilized by hunters.



Native meadow planting at Tiadaghton Resource Management Center

Choosing and Creating Native Seed Mixes

Why mix a variety of species seed?

It is difficult to understand and predict all growing conditions within a site, or the microsite conditions across a large area. By including a variety of species, it is likely that at least a portion of the species will establish successfully across a site or within portions of a site. Similarly, a variety of grasses, legumes and wildflowers increase diversity of structure, food sources, and habitat conditions furthering the ecological value of the project. Customizing unique native seed mixes for state forest management projects can provide opportunities to use the most appropriate species for site conditions and species that help achieve management goals. Included below is useful information for formulating mixes. Staff from Ecological Services can help with specific questions about sites, projects, or individual species.

If using a native seed mix for the first time, it may be easier to use one of the Bureau's pre-formulated mixes. The following pages include the "standard" Bureau of Forestry native seed mix as well as mixes for particular projects or situations. Some districts have also formulated some of their own mixes.

Choosing a pre-formulated mix from a commercial native seed supplier is also an acceptable option as long as it is made up of native or acceptable non-native species. Some commonly used commercial mixes on State forest land include Ernst's "Plateau-tolerant Wildflower and Grass Mix" and "Showy Northeast Wildflower and Grass Mix." If you find a mix from a native seed supplier and have questions, please contact Ecological Services

Cover Crop

Given that native seed mixes take some time to fully establish, it is important to include a cover crop. It is recommended that Bureau staff use spring oats (*Avena sativa*) if seeding prior to August 15th and winter rye (*Secale cereale*) if seeding after August 15th. Some projects have utilized annual rye (*Lolium multiflorum*) and grain barley (*Hordeum vulgare*) as well. Regardless of species, cover crops should be sowed at a rate of 20 lbs/ac.

Legume Component

It is recommended that at least one native legume is added to each mix. Partridge pea (*Chamaecrista fasciculata*) is the native legume used most often on state forest lands. This species has tremendous value for native bees and pollinators as well as being a food source for wildlife in the fall. Partridge pea, along with the cover crop and black eyed susan, typically establish during the same growing season as the planting (if planted in Spring). Tick-trefoils (*Desmodium* spp.) are another native option that benefit pollinators with both floral resources and nest sites for solitary bees, but do not typically fully establish in the first growing season. Non-native legumes such as bird's foot trefoil (*Lotus corniculatus*) and some clovers can be added to the mix in certain circumstances but may require additional fertilizer or maintenance. In some districts, if a clover component is desired, it is planted separately in one area of a project, rather than mixed with native species.

Native Grasses

Grasses provide structure and habitat value to every seed mix. Some native grasses also provide food sources as well. Not all native grasses are created equally consider the goals of your site before choosing which native grasses to include in a seed mix. Ecological Services can provide specific guidance on which native grasses or mix of native grasses is best utilized for each project.

It is important to include at least one cool season grass to a native seed mix. These grasses typically establish immediately following planting and grow best in spring and fall. Unfortunately, few native cool season grasses that can stay competitive with native warm season grasses are available commercially. Wildryes (*Elymus virginicus*, *Elymus canadensis*, and *Elymus riparius*) are the most common species used. However, if the project area is to be utilized by hunters, use these species with caution. The seed awns of the wildryes (*Elymus* spp.) have been shown in certain circumstances to become ingested or attached to a dog's fur or paws, penetrating the skin and leading to the potential for grass awn migration disease. If wildryes are inappropriate for a specific project, perennial ryegrass (*Lolium perenne*), has been found to be the least aggressive non-native cool season grass and should always be the first non-native choice on state forest lands.

Warm season grasses make up the majority of the native grasses used in mixes. Many of the commercially available bunch-forming grasses are tall in stature and clumps can grow quite large. Consider carefully the desired future conditions for a site. Rates around 1-2 lbs/ac should allow for sufficient growing space for wildflowers. If denser habitat is desired, increase rates to 3 lbs/ac (4 lbs/ac if only using two grass species). If a more sparse habitat is desired, consider using only little bluestem (*Andropogon gerardii*) or only 0.5-1 lb/ac of two or more grass species. Deertongue grass (*Dicanthelium clandestinum*) in particular can grow densely and outcompete other native species, this grass should typically be seeded at a rate no higher than 1 lb/ac. If Japanese stiltgrass or other invasive grasses are a potential threat at the project site, densely-growing warm season grasses can be utilized to attempt to minimize the spread of invasive plants.

Native Wildflowers

Many wildflowers native to Pennsylvania are available commercially. Specific species listed in this document are not meant to be an exhaustive list, but rather species that have succeeded in mixes throughout the state in a variety of applications. Commercial seed dealers typically have easy to use websites that discuss in detail the specific site conditions necessary for certain species. One rule of thumb is to attempt to include enough species to have at least one in bloom throughout the entire growing season. Typically, a rate of 0.5 or 1 lb/ac is sufficient to have an ecologically significant component of each wildflower species present following establishment. When using a monoculture of one wildflower species, a higher rate of 2-3 lbs/ac may result in denser patches.

"Pure Live Seed"

When placing an order for seed, it is important to specify "pure live seed" rather than bulk weight. The "pure live seed" of a species describes much of the seed germinates out of the total seed weight. Most suppliers can do this calculation based on their germination tests. It typically takes slightly more than a pound of bulk seed to equal a pound of viable seed that will successfully germinate.

Native Seed Suppliers

Ernst Conservation Seeds – Meadville, PA
800-873-3321
<http://www.ernstseed.com/>

Prairie Moon Nursery – Winona, MN
866-417-8156
<https://www.prairiemoon.com/home.php>

Ohio Prairie Nursery – Hiram, OH
(866) 569-3380
<http://www.ohioprairienursery.com/>

Prairie Nursery – Westfield, WI
1-800-476-9453
<http://www.prairienursery.com/>

Roundstone Native Seed, LLC – Upton, KY
888-531-2353
<http://www.roundstoneseed.com>

BOF General Native Seed Mix

20 lb	Cover Crop (Spring oats, cereal rye, or winter wheat)
3 lb	Little bluestem (<i>Schizachyrium scoparium</i>)
1 lb	Big bluestem (<i>Andropogon gerardii</i>)
1 lb	Indiangrass (<i>Sorghastrum nutans</i>)
1 lb	Deertongue (<i>Dicanthelium clandestinum</i>)
1 lb	Virginia wildrye (<i>Elymus virginicus</i>)
4 lb	Partridge pea (<i>Chamaecrista fasciculata</i>)
1.5 lb	Showy tick-trefoil (<i>Desmodium canadense</i>)
0.5 lb	Black-eyed susan (<i>Rudbeckia hirta</i>)
0.5 lb	Common milkweed (<i>Asclepias syriaca</i>)
0.5 lb	Wild bergamot (<i>Monarda fistulosa</i>)
0.5 lb	Tall white beardtongue (<i>Penstemon digitalis</i>)
0.5 lb	Ox-eye sunflower (<i>Heliopsis helianthoides</i>)

Total: 15 lbs/acre

PA Ecotype should be specified for as many species as possible. All rates are in lb/ac. PLS refers to "Pure Live Seed." Please specify quantities in Pure Live Seed when ordering.

To add additional habitat and forage for wildlife and insects (including pollinators), consider these additional native wildflower species. Flowering time is included for each species. Typically, a rate of 0.5 or 1 lbs/ac is sufficient to have an ecologically significant component of each wildflower species present following establishment.

Butterfly milkweed (<i>Asclepias tuberosa</i>)	June-July
Swamp milkweed (<i>Asclepias incarnata</i>)	June-July
Narrowleaf mountain-mint (<i>Pycnanthemum tenuifolium</i>)	June - August
Hoary mountain-mint (<i>Pycnanthemum incanum</i>)	July-August
New York ironweed (<i>Vernonia noveboracensis</i>)	July-August
Southern wild senna (<i>Senna marilandica</i>)	July-August
New England aster (<i>Symphiotrichum novae-angliae</i>)	September-October
Heath aster (<i>Symphiotrichum pilosum</i> var. <i>pilosum</i>)	September-October
Grass-leaved goldenrod (<i>Euthamia graminifolia</i>)	September-October
Grey goldenrod (<i>Solidago nemoralis</i>)	September-October

BOF General Native Seed Mix – Species Benefits to Wildlife and Insects

Species	Food Value	Cover Value	Pollinator Value	Benefits to Wildlife and Insects
Big Bluestem	Medium	Medium	Medium	Consumed sparingly by northern bobwhite and seed-eating songbirds like the dark-eyed Junco, and field sparrow. Poor deer forage.
Little Bluestem	High	High	Medium	Little bluestem is one of the best grasses for nesting and roosting habitat. The clump type of growth habit and many fine leaves at the base provide excellent nesting sites. The seeds are consumed by small mammals and birds, including upland game birds, rosy finches and juncos, as well as chipping, field, and tree sparrows. The seeds are a high value food source for birds that spend the winter on grasslands, such as prairie chickens and sharp-tailed grouse. Meadowlarks nest in areas where little bluestem grows. The dusky skipper butterfly caterpillars overwinter in tube tents above the base of the clumps.
Indian Grass	Medium	Medium	High	Flowers are visited by bees for the pollen, while the seeds are eaten by a variety of birds. The foliage provides nest-building material for songbirds. The blades are also a food for the larvae of the Pepper-and-Salt Skipper butterfly
Switchgrass	Medium	High	Medium	Ground-feeding songbirds and gamebirds, ring-necked pheasant, turkey, woodcock, field sparrow, grasshopper sparrow, white-crowned sparrow, muskrat, cottontail rabbit
Deer-tongue grass	High	High	Medium	Important food source for ground-feeding songbirds, small mammals, and gamebirds
Virginia wild rye	High	Medium	High	Deer, mallards, birds and small mammals
Partridge pea	High	Medium	High	<p>The seed is one of the major food items of northern bobwhite and other quail species because it remains in sound condition throughout the winter and early spring. Partridge pea seeds are high in phosphorus content and protein value, and low in crude fiber and lignin making digestibility generally high. Seeds of this legume are also eaten by the ring-necked pheasant, mallard, grassland birds, and field mice. Partridge pea often grows in dense stands, producing litter and plant stalks that furnish cover for upland game birds, small mammals, small non-game birds, and waterfowl.</p> <p>Partridge pea is considered an important honey plant, often occurring where few other honey plants are found. Nectar is not available in the flowers of showy partridge pea but is produced by small orange glands at the base of each leaf. Ants often seek the nectar and are frequent visitors. The common sulfur butterfly lays its eggs on the leaves, and the larvae use the leaves as a food source.</p>

Species	Food Value	Cover Value	Cover Value	Benefits to Wildlife and Insects
Showy-tick trefoil	High	Low	High	It ranks as one of the most important species in the diet of northern bobwhite, is used heavily by ruffed grouse and turkey, and is preferred browse for White-tailed Deer. Hummingbirds frequent the brightly colored blooms along with a host of insects. Long-tongue bees, bumblebees, miner bees, leaf-cutting bees, and some short-tongued bees can be found using this species.
Tall white beardtongue	High	Medium	Medium	Desirable forage for deer and birds either as herbage or seed. They may also provide some cover for selected small bird species. They flower earlier than most other wildflowers in most seed mixes.
Grey Goldenrod	Low	High	High	A wide range of insects visit the flowers for pollen and nectar, including long-tongued bees, short-tongued bees, Sphecids and Vespids wasps, flies, butterflies, moths and beetles. Bee pollinators include honey bees, carpenter bees, Halictid bees and Plasterer bees. Fly pollinators include Syrphid flies, Tachinid flies, flesh flies, blow flies and Muscid flies. The caterpillars of many moths, including the goldenrod scarlet plant bug, net-veined beetle and leaf-footed bug, feed on the foliage and other parts of this plant. The seeds are also eaten by the eastern goldfinch to a limited extent.
Common milkweed	Medium	Low	High	Milkweeds are excellent producers of nectar that is attractive to numerous butterflies and other insects. It is also occasionally consumed by northern bobwhite.
Wild Bergamot	Low	Medium	High	Bees, butterflies and hummingbirds use the plant for nectar
Black-eyed susan	Medium	Medium	Medium	Offers protection and food to several song and game birds
Ox-eye Sunflower	Medium	High	High	The nectar of Heliopsis attracts butterflies and other pollinators. Birds utilize the seed as a food source, and stems provide winter cover for beneficial insects.
Butterfly milkweed	Low	Low	High	Attractive to many insect species, including the large milkweed bug, common milkweed bug, red milkweed beetle, blue milkweed beetle, and bees.
New England aster	Low	Medium	High	New England aster is known for attracting butterflies and moths to areas where it is found growing. This is a good bee plant providing nectar in autumn.
Mountain-mints	Low	Medium	High	Native bees, beneficial wasps, flies, beetles, skippers and small butterflies (especially hairstreaks) frequent the blossoms.

BOF Native/Non-native Seed Mix for Rights-of-Way

ROW Areas with slopes less than 15%

30 lb	Cover Crop (Spring oats, cereal rye, or winter wheat)
3 lb	Big bluestem (<i>Andropogon gerardii</i>)
3 lb	Little bluestem (<i>Schizachyrium scoparium</i>)
3 lb	Indiangrass (<i>Sorghastrum nutans</i>)
3 lb	Switchgrass (<i>Panicum virgatum</i>)
1 lb	Deertongue (<i>Dicanthelium clandestinum</i>)
4 lb	Partridge pea (<i>Chamaecrista fasciculata</i>)
3 lb	Virginia wildrye (<i>Elymus virginicus</i>)
2 lb	Showy tick-trefoil (<i>Desmodium canadense</i>)
0.5 lb	Common milkweed (<i>Asclepias syriaca</i>)
0.5 lb	Wild bergamot (<i>Monarda fistulosa</i>)
0.5 lb	Black-eyed susan (<i>Rudbeckia hirta</i>)
0.5 lb	New England aster (<i>Symphiotrichum novae-angliae</i>)
0.5 lb	Tall white beardtongue (<i>Penstemon digitalis</i>)

TOTAL: 24.5 lbs/acre

ROW Areas with slopes greater than 15%

30 lb	Cover Crop (Spring oats, cereal rye, or winter wheat)
4 lb	Timothy (<i>Phleum pratense</i>)
6 lb	White clover (<i>Trifolium repens</i>)
4 lb	Perennial ryegrass (<i>Lolium perenne</i>)
4 lb	Virginia wildrye (<i>Elymus virginicus</i>)
2 lb	Switchgrass (<i>Panicum virgatum</i>)
2 lb	Big bluestem (<i>Andropogon gerardii</i>)
2 lb	Indiangrass (<i>Sorghastrum nutans</i>)
2 lb	Deertongue (<i>Dicanthelium clandestinum</i>)
2 lb	Partridge pea (<i>Chamaecrista fasciculata</i>)
0.5 lb	Black-eyed susan (<i>Rudbeckia hirta</i>)

TOTAL: 28.5 lbs/ac

PA Ecotype should be specified for as many species as possible. All rates are in lb/ac. PLS refers to "Pure Live Seed." Please specify quantities in Pure Live Seed when ordering.

Bureau of Forestry Wetland Seed Mix

The Bureau of Forestry has developed this native wetland seed mix to be used in situations where impacts to wetlands or riparian areas cannot be avoided and restoration of disturbed sites is necessary.

Seeding Rate: 20 lbs/acre

35%	Fox sedge (<i>Carex vulpinoidea</i>)
15%	Riverbank wildrye (<i>Elymus riparius</i>)
10%	Lurid sedge (<i>Carex lurida</i>)
10%	Hop sedge (<i>Carex lupulina</i>)
10%	Soft rush (<i>Juncus effusus</i>)
5%	Blue vervain (<i>Verbena hastata</i>)
5%	Pointed broom sedge (<i>Carex scoparia</i>)
3%	Woolgrass (<i>Scirpus cyperinus</i>)
1%	Swamp milkweed (<i>Asclepias incarnata</i>)
1%	Hollow Joe-pye weed (<i>Eupatorium fistulosum</i>)
1%	Sneezeweed (<i>Helenium autumnale</i>)
1%	Allegheny monkeyflower (<i>Mimulus ringens</i>)
1%	Turtlehead (<i>Chelone glabra</i>)
1%	Duck potato (<i>Sagittaria latifolia</i>)
1%	Arrow arum (<i>Peltandra virginica</i>)

PA Ecotype should be specified for as many species as possible. All rates are in lb/ac. PLS refers to "Pure Live Seed." Please specify quantities in Pure Live Seed when ordering.

This mix includes a variety of species that provide nectar and pollen to pollinators. The species included bloom from June – October, providing good summer and fall floral resources.

Ecological Services has received requests from multiple districts for a "standard" wetland seed mix. This mix is to be used in situations where impacts to wetlands or riparian areas cannot be avoided and restoration of disturbed sites is necessary. As a rule, the Bureau of Forestry seeks to avoid and minimize impacts to wetlands and riparian areas. Seeding in these areas should only be done by hand.

Please contact Ecological Services prior to including this mix in any project specifications. It is possible that this mix will be changed or altered slightly depending on the site conditions and specific project situation. This native mix should be planted in spring (April-May), if reclamation projects begin outside the planting window, consider planting only a cover crop then returning the following spring to seed this mix.

Bureau of Forestry Specialist Pollinator Seed Mix

20 lb	Cover Crop (Spring oats, cereal rye, or winter wheat)
18%	Little bluestem (<i>Schizachyrium scoparium</i>)
16%	Partridge pea (<i>Chamaecrista fasciculata</i>)
14%	Showy tick-trefoil (<i>Desmodium canadense</i>)
7%	Indiangrass (<i>Sorghastrum nutans</i>)
7%	Black-eyed susan (<i>Rudbeckia hirta</i>)
7%	Tall white beardtongue (<i>Penstemon digitalis</i>)
7%	Golden alexanders (<i>Zizia aurea</i>)
3%	Common milkweed (<i>Asclepias syriaca</i>)
2%	Wild bergamot (<i>Monarda fistulosa</i>)
2%	New England aster (<i>Symphiotrichum novae-angliae</i>)
2%	Ox-eye sunflower (<i>Heliopsis helianthoides</i>)
2%	Heath aster (<i>Symphiotrichum pilosum</i>)
2%	Gray goldenrod (<i>Solidago nemoralis</i>)
2%	Tall coreopsis (<i>Coreopsis tripteris</i>)
2%	Narrowleaf mountainmint (<i>Pycnanthemum tenuifolium</i>)
2%	Southern wild senna (<i>Senna marilandica</i>)
1%	Evening primrose (<i>Oenothera biennis</i>)
1%	Giant sunflower (<i>Helianthus giganteus</i>)
1%	Boneset (<i>Eupatorium perfoliatum</i>)
1%	Grass-leaved goldenrod (<i>Euthamia graminifolia</i>)
1%	Culvers root (<i>Veronicastrum virginicum</i>)

Total: 12 lbs/acre

PA Ecotype should be specified for as many species as possible. All rates are in lb/ac. PLS refers to "Pure Live Seed." Please specify quantities in Pure Live Seed when ordering.

While this seed mix emphasizes pollinator conservation, these species will also benefit wildlife by providing high quality forage and habitat.

Bureau of Forestry Abandoned Mine Lands Restoration Mix

30 lb	Cover Crop (Spring oats, cereal rye, or winter wheat)
3 lb	Little bluestem (<i>Schizachyrium scoparium</i>)
1 lb	Indiangrass (<i>Sorghastrum nutans</i>)
2 lb	Canada wildrye (<i>Elymus canadensis</i>)
4 lb	Partridge pea (<i>Chamaecrista fasciculata</i>)
2 lb	Showy tick-trefoil (<i>Desmodium canadense</i>)
1.5 lb	Black-eyed susan (<i>Rudbeckia hirta</i>)
1.5 lb	Wild senna (<i>Senna hebecarpa</i>)
0.5 lb	Ox-eye sunflower (<i>Heliopsis helianthoides</i>)
0.25 lb	Common milkweed (<i>Asclepias syriaca</i>)
0.25 lb	Wild bergamot (<i>Monarda fistulosa</i>)
0.25 lb	Narrowleaf mountainmint (<i>Pycnanthemum tenuifolium</i>)

Total: 14.25 lbs/acre

PA Ecotype should be specified for as many species as possible. All rates are in lb/ac. PLS refers to "Pure Live Seed." Please specify quantities in Pure Live Seed when ordering.

When using this mix for abandoned mine lands projects, lime should be added to the soil at the site to reach a pH of 5.5.

Consider adding a total of about 2,000 seeds per acre of early successional woody species to the seed mix:

Chokecherry (*Prunus virginiana*): 2,000 seeds = 0.4 lb/ac
Staghorn sumac (*Rhus typhina*): 2,000 seeds = 0.04 lb/ac
White Pine (*Pinus strobus*): 2,000 seeds = 0.1 lb/ac
Black Chokeberry (*Aronia melanocarpa*): 2,000 seeds = 0.008 lbs/ac
Black Locust (*Robinia pseudoacacia*): 2,000 seeds = 0.08 lbs/ac
Black Cherry (*Prunus serotina*): 2,000 seeds = 0.4 lbs/ac
Silky dogwood (*Cornus amomum*): 2,000 seeds = 0.167 lbs/ac
Elderberry (*Sambucus canadensis*): 2,000 seeds = less than 1 ounce/ac

Bureau of Forestry Tree-Compatible Seed Mix

This mix has been formulated to be seeded at a very low rate to allow for the success of tree planting efforts during gas reclamation activities, while still meeting initial coverage goals for Erosion and Sedimentation regulations. *This mix was created in 2024 and it is likely that this mix will be edited/changed after being tested in the state forest.*

30 lb	Cover Crop (Spring oats, cereal rye, or winter wheat)
1 lb	Little bluestem (<i>Schizachyrium scoparium</i>)
1 lb	Virginia wildrye (<i>Elymus virginicus</i>)
0.5 lb	Purple lovegrass (<i>Eragrostis spectabilis</i>)
0.5 lb	Broomsedge (<i>Andropogon virginicus</i>)
0.5 lb	Autumn bentgrass (<i>Agrostis perennans</i>)
3 lb	Partridge pea (<i>Chamaecrista fasciculata</i>)
0.5 lb	Showy tick-trefoil (<i>Desmodium canadense</i>)
0.5 lb	Black-eyed susan (<i>Rudbeckia hirta</i>)
0.5 lb	Wild bergamot (<i>Monarda fistulosa</i>)
0.5 lb	Tall white beardtongue (<i>Penstemon digitalis</i>)
0.5 lb	Common milkweed (<i>Asclepias syriaca</i>)
0.25 lb	Blazing star (<i>Liatris spicata</i>)
0.25 lb	Narrowleaf mountainmint (<i>Pycnanthemum tenuifolium</i>)
0.25 lb	Grey goldenrod (<i>Solidago nemoralis</i>)
0.25 lb	Common yarrow (<i>Acillea millefolium</i>)

Total: 10 lbs/acre

PA Ecotype should be specified for as many species as possible. All rates are in lb/ac. PLS refers to "Pure Live Seed." Please specify quantities in Pure Live Seed when ordering.

Bureau of Forestry Bridge/Culvert Mix

30 lbs/ac	Cover Crop (Spring oats, cereal rye, or winter wheat)
4 lb	Virginia wildrye (<i>Elymus virginicus</i>)
3 lb	Autumn bentgrass (<i>Agrostis perennans</i>) 'PA Ecotype'
2 lb	Birds-foot trefoil (<i>Lotus corniculatus</i>)
2 lb	Deertongue (<i>Dicanthelium clandestinum</i>) 'Tioga' Variety
0.5 lb	Common milkweed (<i>Asclepias syriaca</i>)

Total: 11.5 lbs/acre

PA Ecotype should be specified for as many species as possible. All rates are in lb/ac. PLS refers to "Pure Live Seed." Please specify quantities in Pure Live Seed when ordering.

Bureau of Forestry Dam Breeches/Repairs Mix

(For riparian and streambank areas)

30 lbs/ac	Cover Crop (Spring oats, cereal rye, or winter wheat)
3 lb	Riverbank wildrye (<i>Elymus riparius</i>) 'PA Ecotype'
2 lb	Fox sedge (<i>Carex vulpinoidea</i>)
1 lb	Big bluestem (<i>Andropogon gerardii</i>)
1 lb	Autumn bentgrass (<i>Agrostis perennans</i>) 'PA Ecotype'
1 lb	Deertongue (<i>Dicanthelium clandestinum</i>) 'Tioga' Variety
1 lb	Soft Rush (<i>Juncus effusus</i>) 'PA Ecotype'
3 lb	Partridge pea (<i>Chamaecrista fasciculata</i>)
0.5 lb	Joepy weed (<i>Eupatorium fistulosum</i>)
0.5 lb	Swamp milkweed (<i>Asclepias incarnata</i>)
0.5 lb	New York ironweed (<i>Vernonia noveboracensis</i>)
0.5 lb	Boneset (<i>Eupatorium perfoliatum</i>)
0.5 lb	Duck potato (<i>Sagittaria latifolia</i>)
0.5 lb	Arrow arum (<i>Peltandra virginica</i>)

Total: 15 lbs/acre

PA Ecotype should be specified for as many species as possible. All rates are in lb/ac. PLS refers to "Pure Live Seed." Please specify quantities in Pure Live Seed when ordering.

Bureau of Forestry Firebreak Mix

20 lbs/ac	Cover Crop (Spring oats, cereal rye, or winter wheat)
4 lb/ac	Perennial rye (<i>Lolium perenne</i>) – Specify a "turf type"
4 lb/ac	Creeping red fescue (<i>Festuca rubra</i>)
4 lb/ac	Timothy (<i>Phleum pratense</i>)

Total: 12 lbs/acre

Reduced mix for shaded sites...

30 lbs/ac	Cover Crop (Spring oats, cereal rye, or winter wheat)
3 lb	Virginia wildrye (<i>Elymus virginicus</i>)
3 lb	Autumn bentgrass (<i>Agrostis perennans</i>)
2 lb	Creeping red fescue (<i>Festuca rubra</i>)
0.5 lb	Path rush (<i>Juncus tenuis</i>)
2 lb	Deertongue (<i>Dicanthelium clandestinum</i>)
4 lb	Partridge pea (<i>Chamaecrista fasciculata</i>)

Total: 14.5 lbs/acre + Cover Crop

PA Ecotype should be specified for as many species as possible. All rates are in lb/ac. PLS refers to "Pure Live Seed." Please specify quantities in Pure Live Seed when ordering.

Reduced mix to simply control Erosion and Sedimentation...

30 lbs/ac	Cover Crop (Spring oats, cereal rye, or winter wheat)
5 lb	Deertongue (<i>Dicanthelium clandestinum</i>) or Switchgrass (<i>Panicum virgatum</i>)
3 lb	Virginia wildrye (<i>Elymus virginicus</i>)
3 lb	Autumn bentgrass (<i>Agrostis perennans</i>)
3 lb	Perennial ryegrass (<i>Lolium perenne</i>)
2 lb	Partridge pea (<i>Chamaecrista fasciculata</i>)
0.5 lb	Black eyed susan (<i>Rudbeckia fulgida</i>)

Total: 16.5 lbs/acre

PA Ecotype should be specified for as many species as possible. All rates are in lb/ac. PLS refers to "Pure Live Seed." Please specify quantities in Pure Live Seed when ordering.

Non-native Lawn/Turf Mix:

10 lbs/ac	Cover Crop (Spring oats, cereal rye, or winter wheat)
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This mix should be spread at a rate of 4lb/1000 ft²

50 %	Perennial rye (<i>Lolium perenne</i>) – Specify a "turf type"
30 %	Creeping red fescue (<i>Festuca rubra</i>)
20 %	White Clover (<i>Trifolium repens</i>)

Comparison Chart: Warm Season vs. Cool Season Grasses (Source: NRCS)

Use this comparison chart when creating a unique seed mix to help decide which grass type best fits the desired goals or outcomes of the planting. Generally, cool season grasses prefer growing when temperatures are between 65 and 80 degrees and warm season grasses prefer temperatures between 80 and 95 degrees. Differences between the two types are described below.

Topic	Warm Season Grasses	Cool Season Grasses
Erosion Control and Water Quality	Provide long-term benefits for erosion control and sediment trapping. Provide nutrient uptake during the summer when cool-season grasses are dormant.	Provide short-term and long-term benefits for erosion control and sediment trapping. Provide nutrient uptake earlier in spring and later in the fall than warm season grasses.
Wildlife Habitat	Excellent nesting and feeding habitat. Bunchgrasses provide openings for feeding, maintaining overhead protection from predators. Remain standing for good winter protection. Diverse - supporting a balanced mix of native plant species and insect populations.	Due to earlier "green-up," provide a better source of food (green foliage and insects) in early spring than warm season grasses. Mat down more rapidly than warm season grasses as they age, which could provide lower quality nesting habitat, feeding, and overhead protection.
Establishment	Seed may be more expensive and less readily available than cool-season grasses. Usually do not need much lime or fertilizer. Tolerates poor soil conditions (drought, nutrient- poor and/or low pH) better than cool-season grasses. Seeds are slow to germinate and seedlings usually need 2 to 3 years to establish. However, root structures are forming and providing erosion control even when not noticeably green aboveground.	Relatively inexpensive, readily available seeds. Have higher nutrient requirements than warm season grasses. Less tolerant of poor soil conditions. May need fertilizer maintenance. Seedlings are usually well established 1 to 2 years after planting. Rapid seedling growth results in less weed competition during establishment. Can be seeded in spring or late summer. Can also be seeded with cool season legumes. More susceptible to drought.
Maintenance	Maintained by using prescribed burning or, mowing to 6 inches tall. Grasses are long-lived and usually do not need reseeding. Selective herbicides may be used for weed control.	Maintained by mowing on 2- to 3-year rotation, and by over-seeding with legumes every 3 to 4 years. As stands mature, grasses may thin out and need to be reseeded. Selective herbicides may be used for weed control.

V. Planting Guidance for Native Shrubs and Trees

Pre-planning Considerations:

There are occasions when planting seedlings is the most efficient method of ensuring that the next forest contains a desired species or to help forests recover after negative forest health impacts. For example, eastern white pine is commonly planted in areas without mature pines to produce seed. Please also consider what the predicted future climatic conditions of a specific region may be when considering species, please see the DCNR Climate Change Adaptation Plan for more specific information.

Supplemental planting is the planting of species already present in the stand, but at less than desirable levels. This artificial regeneration supplements the regeneration present and should target relatively open areas. A wide spacing is normal for supplemental planting (10-15 ft. spacing). Underplanting, a form of supplemental planting, is simply planting shade tolerant seedlings under an existing canopy. This can be done for the same reasons as enrichment planting, or to add understory species to the existing stand.

Enrichment planting is done in stands to establish desirable tree species, often after timber harvests. This can be done to increase diversity and wildlife value of the stand. Planting trees and shrubs along riparian areas can also be considered enrichment planting.

Reforestation planting is done to establish forest cover over an area previously forested, but not currently forested. This is done in areas where natural regeneration is lacking.

One of the keys to successful planting is matching the species with existing site characteristics. A soil test may be appropriate to identify growing conditions. Some species, such as white pine, can grow almost anywhere there is adequate light. Site preparation often required for successful regeneration.



Additional Considerations

In addition to the above pre-planning considerations on specific species/genera, the following tree and shrub planting guidelines should be followed on State forest lands:

- The planting of non-native species in State forest Wild and Natural Areas requires approval via a State forest Environmental Review (SFER).
- Pennsylvania stock is preferred and cultivars should be avoided. Use Penn Nursery as the primary supplier of seedling stock when possible or a suitable alternative that uses regional genetic stock if particular species are unavailable from Penn Nursery. As per the Bureau's Genetic Guidelines, any seedlings purchased outside Pennsylvania should come from the same USDA seed zone as the district where seedlings will be planted.
- Former plantations of exotic species (Norway spruce, red pine, etc.) may be replaced to the same species. Conversion of plantations to more natural, native stands is encouraged unless there is special historical significance to the plantation (e.g. CCC plantation).
- Newly planted seedlings need protection from deer browse damage in many forest districts. Consider fencing entire planting areas with woven-wire fencing or protecting individual trees with tree tubes or similar materials.

Tree and Shrub Species Categories:

1. Invasive: Deemed Invasive: Do Not Plant

A number of trees and shrubs are considered invasive by DCNR. Plants on [DCNR Invasive Plant List](#) are prohibited from use on State forest lands, according to principles set forth in the [State Forest Resource Management Plan](#). Please carefully review this list prior to making seeding or planting selections.

2. Recommended native tree and shrub species

Conifer and shrubs may provide cover, food, or structure for various wildlife species. Soft mast producing trees and shrubs provide food for many birds and small mammals. Hard mast producing trees and shrubs provide food for mammals and some birds. Hard mast can also be stored for consumption later. The following species may be used in openings, ROWs, early successional habitats, where underrepresented in the forest, or other suitable places on state forest lands. This list is not all inclusive, many other PA native species can be considered.

3. Non-native and hybrid tree and shrub species

While native trees and shrubs are preferred over non-native options, there may be situations where non-native species or hybrids are considered. Non-native species and hybrids must be evaluated utilizing the *Assessment Guidance for the Use of Non-Native Trees & Shrubs on State forest Lands* process to determine if a non-native tree or shrub species is approved for planting. In addition to the evaluation, any non-native or hybrid plantings must be monitored per FSC guidance. The Planning or Ecological Services Sections can be contacted with any questions pertaining to FSC required monitoring.

Conifers

White pine	<i>Pinus strobus</i>	Red spruce	<i>Picea rubens</i>
Virginia pine	<i>Pinus virginiana</i> (south of route I-80)	Red pine	<i>Pinus resinosa</i> (north of route I-80)
White spruce	<i>Picea glauca</i>	Pitch pine	<i>Pinus rigida</i>
Black spruce	<i>Picea mariana</i> (wet areas)		

Non-native (or hybrid) Conifers

Norway spruce	<i>Picea abies</i>	Pitch x loblolly hybrid	<i>Pinus rigida x taeda</i>
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Soft-mast Producing Trees/Shrubs

Serviceberry	<i>Amelanchier arborea</i>	Washington hawthorn	<i>Crataegus phaenopyrum</i>
Smooth serviceberry	<i>Amelanchier laevis</i>	Sweet crabapple	<i>Malus coronaria</i>
Staghorn sumac	<i>Rhus typhina</i>	Low serviceberry	<i>Amelanchier stolonifera</i>
American mtn-ash	<i>Sorbus americana</i>	Cockspur hawthorn	<i>Crataegus crus-galli</i>
Large-seed hawthorn	<i>Crataegus macrosperma</i>	White hawthorn	<i>Crataegus punctata</i>
Frosted hawthorn	<i>Crataegus pruinosa</i>		

Hard-mast Producing Trees

Dwarf chinquapin oak	<i>Quercus prinoides</i>	Red oak	<i>Quercus rubra</i>
Scrub oak	<i>Quercus ilicifolia</i>	Allegheny chinquapin	<i>Castanea pumila</i>
Swamp white oak	<i>Quercus bicolor</i>	Native Hickory species	<i>Carya spp.</i>
Black locust	<i>Robinia psuedoacacia</i> (south of route I-80)	Pin oak	<i>Quercus palustris</i>

Non-native (or hybrid) Hard-mast Producing Trees

Chinese chestnut	<i>Castanea mollissima</i>	American chestnut hybrids	<i>Castanea dentata x mollissima</i>
Sawtooth oak	<i>Quercus acutissima</i>		

Blackberry / Raspberry Species

Common blackberry	<i>Rubus allegheniensis</i>	Black raspberry	<i>Rubus occidentalis</i>
Smooth blackberry	<i>Rubus canadensis</i>	Red raspberry	<i>Rubus idaeus</i>

Shrubs

Arrow wood viburnum	<i>Viburnum dentatum</i>	Graystem dogwood	<i>Cornus racemosa</i>
Nannyberry viburnum	<i>Viburnum lentago</i>	Silky dogwood	<i>Cornus amomum</i>
Buttonbush	<i>Cephalanthus occidentalis</i>	Elderberry	<i>Sambucus canadensis</i>
Speckled Alder	<i>Alnus incana</i>	Native chokeberries	<i>Aronia spp.</i>
Smooth alder	<i>Alnus serrulata</i>	Ninebark	<i>Physocarpus opulifolius</i>
American hazelnut	<i>Corylus americana</i>		

Riparian Areas

Streams impacted by management activities and the riparian areas may be planted for canopy coverage or habitat enhancement. Forested riparian areas provide filter capabilities, stream bank stabilization, stream shading, additions of organic material to the stream, and shelter and food for wildlife.

Please consult the riparian trees and shrub list below. When planning riparian habitat planting projects, please partner with Ecological Services to develop structure and composition specifications to meet habitat goals. For instance, Norway spruce is not desired in riparian areas since it decreases pH, increases available aluminum, lessens the soil buffering capacity leading to decreased water quality, and does not produce quality food to the aquatic ecosystem. Different riparian species may require different habitat and proper planning will help ensure suitable habitat is created.

Some species especially beneficial to riparian plantings include the aspens, willow, and pin oak. These species benefit both terrestrial wildlife and the aquatic life. Aspens and willows grow fast and can provide shade quickly, while pin oak is very valuable for terrestrial wildlife and wood ducks. Species recommended for stream crossings can include the following list but be sure to use species native to the geographic region of interest.

Trees

Bigtooth aspen	<i>Populus grandidentata</i>	Black gum	<i>Nyssa sylvatica</i>
Quaking aspen	<i>Populus tremuloides</i>	Eastern hemlock	<i>Tsuga canadensis</i>
Pin oak	<i>Quercus palustris</i>	Red maple	<i>Acer rubrum</i>
Swamp white oak	<i>Quercus bicolor</i>	Shellbark hickory	<i>Carya laciniosa</i>
Black willow	<i>Salix nigra</i>	Yellow birch	<i>Betula alleghaniensis</i>
Silver maple	<i>Acer saccharinum</i>	American sycamore	<i>Platanus occidentalis</i>
Tulip poplar	<i>Liriodendron tulipifera</i>	Eastern white pine	<i>Pinus strobus</i>
Black spruce	<i>Picea mariana</i>	Red spruce	<i>Picea rubens</i>

Small Trees

Flowering dogwood	<i>Cornus florida</i>	Serviceberry	<i>Amelanchier arborea</i>
Staghorn sumac	<i>Rhus typhina</i>	Smooth serviceberry	<i>Amelanchier laevis</i>
Smooth sumac	<i>Rhus glabra</i>	Low serviceberry	<i>Amelanchier stolonifera</i>
Winged sumac	<i>Rhus aromatica</i>	Redbud	<i>Cercis canadensis</i>

Shrubs

Alder	<i>Alnus spp.</i>	Winterberry holly	<i>Ilex verticillata</i>
Chokeberry	<i>Aronia melanocarpa</i>	Silky dogwood	<i>Cornus amomum</i>
Buttonbush	<i>Cephalanthus occidentalis</i>	Elderberry	<i>Sambucus canadensis</i>
Choke cherry	<i>Prunus virginiana</i>	Highbush blueberry	<i>Vaccinium corymbosum</i>
Gray dogwood	<i>Cornus racemosa</i>	Arrow-wood viburnum	<i>Viburnum dentatum</i>
Blackhaw	<i>Viburnum prunifolium</i>	Inkberry	<i>Ilex glabra</i>
Witch hazel	<i>Hamamelis virginiana</i>	Red-osier dogwood	<i>Cornus sericea</i>
Ninebark	<i>Physocarpus opulifolius</i>		

Live Stakes

Planting live-stakes is an effective practice to revegetate stream banks; reducing erosion and providing shade and food input to streams. Utilizing live-stakes can enhance riparian buffer planting. Black willow, native willow shrubs, red osier dogwood, silky dogwood, and elderberry are the best sources of live-stakes in Pennsylvania. Live-stakes should be collected and planted in early spring while still dormant. When collecting cuttings, do not remove more than 5% of the source plant. Live-stakes should be around 2 feet long and at least ½ inch in diameter. Make a straight cut on the narrow end, removing the terminal bud and any side branches, and cut the thicker end at an angle. Plant the stakes within 24 hours of collection for best results. Drive the stakes at least one foot into the stream bank using rebar to create a pilot hole.



Direct Seeding of Woody Species

There are cases where direct seeding of woody species may be desirable. Some examples include restoration of oil and gas sites and abandoned mine lands. This can be an efficient way to get woody vegetation on site quickly and easily, especially if short notice is given for a restoration project. Direct seeding of woody vegetation can eliminate risks of transplant shock and allows for roots to develop within the soil on site. Seeding rates should total 1,000 seeds per acre where competition is low, and total about 2,000 seeds where a seed mix is used for site stabilization. Suitable species for direct seeding include: choke cherry, staghorn sumac, black cherry, white pine, and black chokeberry, and black locust.

VI. Wildlife Use of Native Shrub and Tree Species

Species	Wildlife Species
Shrubs	
Arrowwood viburnum (<i>Viburnum dentatum</i>)	Fruit eaten by songbirds
Northern bayberry (<i>Myrica pensylvanica</i>)	Fruit and seeds eaten by songbirds. Provides habitat for ground-dwelling wildlife.
Sweet crabapple (<i>Malus coronaria</i>)	Fruit eaten by birds, deer, small mammals.
Dogwoods	Bluebird, Cardinal, Cedar waxwing, rabbit, ruffed grouse, wild turkey, wood thrush.
Gray dogwood (<i>Cornus racemosa</i>)	Fruit eaten by pheasant, turkey, grouse.
Red osier dogwood (<i>Cornus sericea</i>)	Fruit eaten by songbirds, grouse, quail, turkey. Twigs browsed by deer and turkey.
Silky dogwood (<i>Cornus amomum</i>)	Sometimes browsed by rabbits and deer.
Elderberry (<i>Sambucus americana</i>)	Fruit eaten by many birds including bluebird, brown thrasher, cardinal, indigo bunting, rose-breasted grosbeak, pheasant and dove. Recommended for rabbit, quail and turkey.
American hazelnut (<i>Corylus americana</i>)	Nuts eaten by squirrel, deer, jays, grouse, and pheasant. Recommended by quail and turkey.
Nannyberry (<i>Viburnum lentago</i>)	Fruit eaten by songbirds. Recommended for turkey.
Hawthorn (<i>Crataegus spp.</i>)	Fox sparrow, gray fox, raccoon, ruffed grouse.
Alder (<i>Alnus spp.</i>)	Beaver, goldfinch, ruffed grouse
Pines/Softwoods	
Eastern white pine (<i>Pinus strobus</i>)	Roosting trees for birds. Seeds eaten by a wide variety of birds, squirrels, and mice. Recommended for turkey.
Pine (<i>Pinus spp.</i>)	Beaver, black-capped chickadee, brown creeper, gray squirrel, mourning dove, porcupine, and nuthatches.
Non-mast producing Species	
Aspens (<i>Populus spp.</i>)	Twigs and barks eaten by deer and beavers. Buds and catkins eaten by ruffed grouse. Recommended for porcupine.
Soft Mast Producing Species	
Serviceberry (<i>Amelanchier arborea</i>)	Fruits eaten by bluebird, cardinal, cedar waxwing, grey catbird, scarlet tanager, and veery. Recommended for turkey, beaver, and deer.
Hard Mast Producing Species	
Oaks (<i>Quercus spp.</i>)	Black bear, blue jay, raccoon, ruffed grouse, white-tailed deer, turkey, wood duck

Adapted from :

MacGowan, B.J. "Designing hardwood tree plantings for wildlife." USFS FNR-213. North Central Research Station, USDA Forest Service & Department of Forestry and Natural Resources, Purdue University.

Forest Stewardship #5: Wildlife. Penn State Extension publication.

VII. Species Considerations for Conifer Planting

Species	Wildlife Habitat Characteristics	Present Distribution	Site Requirements	Shade Tolerance/Growth
Red Spruce (<i>Picea rubens</i>)	Lacking lower limb structure & thermal characteristics of hemlock. Northern flying squirrel feeds on the fruiting body of the mycorrhizae.	Northern PA, and higher elevations in northern Appalachian mountains.	Higher elevation, good moisture regime. Grows well on poor sites, acidic and shallow soils.	Tolerant- Very Tolerant. Long-lived (350-400 years), slow growing.
White Spruce (<i>Picea glauca</i>)	Retains lower limbs.	Northern PA	Tolerant of wide range of moisture regime and pH.	Intermediate shade tolerance. Long lived (250-300 years)
Black Spruce (<i>Picea mariana</i>)	Small dbh at maturity, retains lower limbs, shallow rooting.	Northern PA	Moisture regime important, prefers peat, and wet organic soils. Common in swamps or bogs.	Tolerant. 200 year lifespan typical.
White Pine (<i>Pinus strobus</i>)	Gets large, provides thermal cover, retains more lower limbs than red pine	Throughout PA	Tolerant of wide range of moisture regime and pH in northern North America.	Intermediate shade tolerance. Long lived.
Red Pine (<i>Pinus resinosa</i>)	Medium to large tree. Does not retain lower limbs	Northern PA	Tolerant of xeric sites, does well on sandy soils	Very intolerant, fast growth
Pitch Pine (<i>Pinus rigida</i>)	Medium sized tree	Mainly southern and eastern PA	Acidic soil, tolerant of fire	Intolerant
Virginia Pine (<i>Pinus virginiana</i>)	Relatively short	Southern PA	Grows well on xeric, nutrient poor sites	Intolerant
Norway Spruce (<i>Picea abies</i>) Non-native	Retains lower limbs.	Throughout PA.	Tolerant of wide range of moisture regime and pH.	Very shade tolerant.

Appendix I. State-listed Plant Species Approved for Use in Conservation Plantings on State Forest lands.

State-listed Plant Species Approved for Use

Grasses		
Tall gramma grass	<i>Bouteloua curtipendula</i>	PA Threatened
Wild oats	<i>Chasmanthium latifolium</i>	Proposed PA Rare
Bushy bluestem	<i>Andropogon glomeratus</i>	Proposed PA Rare
Elliot's beardgrass	<i>Andropogon gyrans</i>	PA Rare
Tufted hairgrass	<i>Deschampsia cespitosa</i>	Proposed PA Threatened
Wild rice	<i>Zizania aquatica</i>	PA Rare
Forbs		
Blue false indigo	<i>Baptisia australis</i>	PA Threatened
Sweet flag	<i>Acorus americanus</i>	PA Endangered
New York aster	<i>Symphotrichum novi-belgii</i>	PA Threatened
Aster-like boltonia	<i>Boltonia asteroides</i>	PA Endangered
Appalachian beardtongue	<i>Penstemon canescens</i>	Tentatively Undetermined
Smooth beardtongue	<i>Penstemon laevigatus</i>	Tentatively Undetermined
Eastern coneflower	<i>Rudbeckia fulgida</i>	Proposed PA Threatened
Hard-leaved goldenrod	<i>Solidago rigida</i>	Proposed PA Endangered
Showy goldenrod	<i>Solidago speciosa</i>	Proposed PA Threatened
Trees		
American holly	<i>Ilex opaca</i>	PA Threatened
Umbrella magnolia	<i>Magnolia tripetala</i>	PA Threatened
Red mulberry	<i>Morus rubra</i>	Proposed PA Threatened
Shortleaf pine	<i>Pinus echinata</i>	Proposed PA Threatened
Southern red oak	<i>Quercus falcata</i>	PA Endangered
Willow oak	<i>Quercus phellos</i>	PA Endangered
Shumard's oak	<i>Quercus shumardii</i>	PA Endangered

Appendix II. Assessment Guidance for the Use of Non-native Trees and Shrubs

Revised August 2019

Introduction

Restoration or artificial regeneration practices are sometimes performed on State Forest lands to enhance, restore or re-vegetate forest and plant communities to maintain their health, productivity and sustainability. Plantings are performed throughout state forest lands for a variety of reasons including re-vegetation of rights-of-way, restoration of gas pads, and artificial forest stand regeneration. Due to many stressors including a changing climate, fragmented landscapes, and new pests and diseases, restoration and supplemental planting have become valuable management tools.

To address environmental stressors and climate change, the bureau should maintain a diversity of approaches to enhance the ability of a natural system to cope with these changes. It is anticipated that supplemental plantings using native plants and non-native plants, when necessary, may provide opportunities for the bureau to enhance the ability for forest systems to survive changes or stressors. Opportunities to provide resistance/tolerance, build resilience, or provide natural community transition opportunities in natural systems should be investigated and may be used when appropriate and available—and in certain situations the use of a non-native plant may be an acceptable option.

Purpose of this Document

The Bureau's guidelines on the *Management of Natural Genetic Diversity on Pennsylvania State Forest Lands* allows for the thoughtful planting of non-native plants for the purposes of addressing climate change, non-native insects and pathogen destruction, and rehabilitating severely disturbed sites. Additional guidelines, recommendations, and considerations for the use of non-native plants on state forestlands are found in the *Pennsylvania Bureau of Forestry Planting and Seeding Guidelines*. Furthermore, the bureau maintains sustainable management certification by the Forest Stewardship Council (FSC). According to the FSC standard, the use of non-native species should be carefully controlled and actively monitored to avoid negative ecological impacts. This document provides an assessment and justification process to plant non-native trees or shrubs on state forest lands. All plantings of non-native trees or shrubs should go through this assessment and justification process prior to use.

Non-Native Definition

For the purposes of this document only, a non-native plant species is:

A plant species NOT historically known to be naturally occurring in Pennsylvania at the time of European colonization, or the species' natural range does NOT occur within the U.S. Forest Service's ECOMAP ecological regions located within Pennsylvania; or the species is a hybrid or cultivar (see Figure 1). For additional information on the use of non-natives on state forest lands, please see the *Management of Natural Genetic Diversity on Pennsylvania State Forest Lands* document.

Use of Non-Native Plantings

Typically, state forest land sites are restored using native plant species found within Pennsylvania's eco-regions and seed zones, however, under certain circumstances the use of non-native species may be warranted. The use of non-native species may be accepted when a native species is unavailable or is becoming extirpated, and/or sick or dying due to disease or pests. The careful use of non-native species in restoration practices may be desirable to provide resilience to forest habitats, reduce the impact of environmental stressors, and fill ecological niches from species loss. When used properly in restoration

practices, non-native species could have positive effects on an ecosystem. For example, when a native species is not available or practical, a non-native species may provide habitat structures for wildlife, serve as functional substitutes for declining or extinct plants, or provide desirable ecosystem functions. However, this process is expected to be utilized very rarely because the current definition of native species should encompass most desirable species that may exist outside of Pennsylvania's borders.

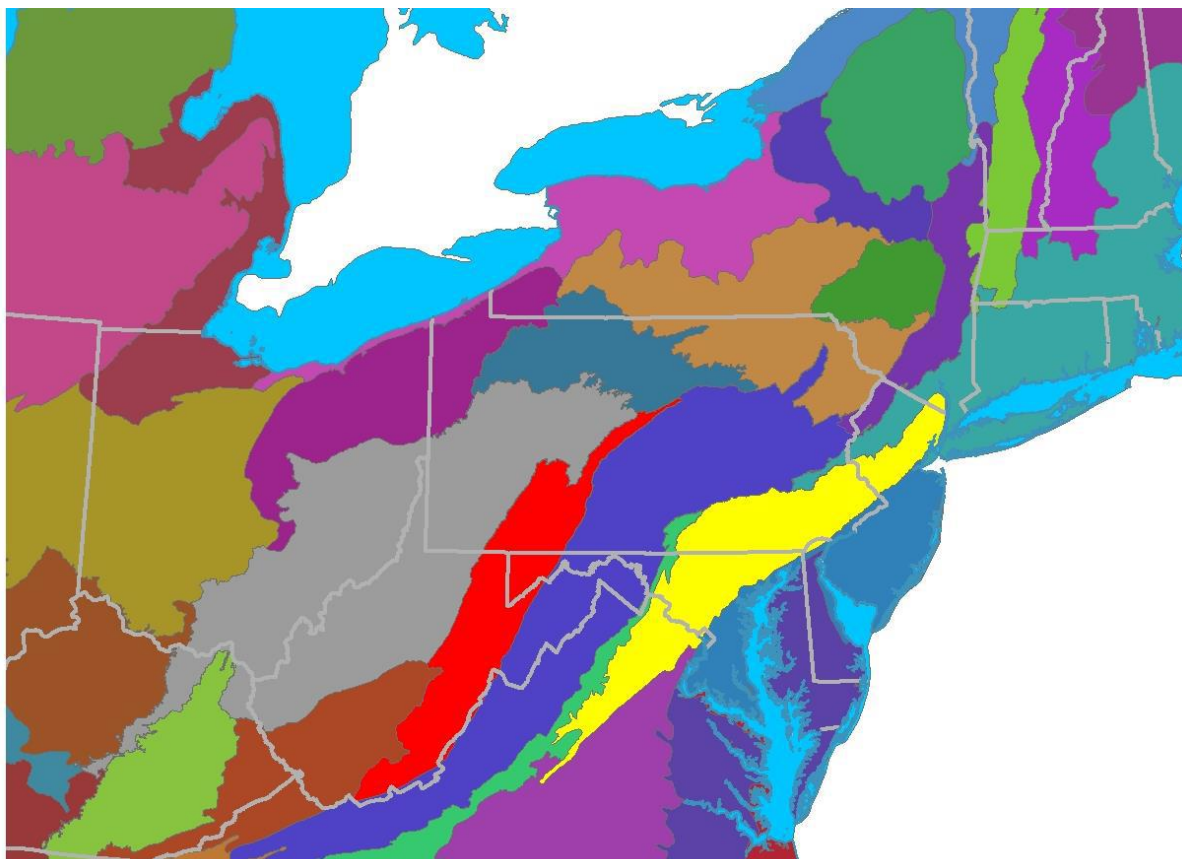


Figure 1. Ecomap Ecological Regions (USDA Forest Service, 1993). The Bureau considers a species native if it was present in Pennsylvania at the time of European colonization or if it naturally occurs within one of the zones that extends into Pennsylvania, as shown on this map.

The management of non-native plants and their potential integration into conservation plans depends on how management goals are set in the future. It is important to consider that the use of non-native plants involves certain risks, such as potential invasive tendencies or unintended effects on food web dynamics. Additionally, non-native plants may fail to provide appropriate food or habitat for other important native species in the ecosystem. Monitoring will play a critical role in mitigating potentially unexpected effects. Refer to *Pennsylvania Bureau of Forestry Planting and Seeding Guidelines* for non-native species that are considered invasive and should not be considered for planting.

Planting Activities on State Forest lands

Many state forest land projects require supplemental planting and should be assessed when proposing the use of a non-native plant in the planting practice. These projects include but are not limited to:

- Supplemental forest tree plantings
- Log landing plantings
- Rights-of-way
- Post-construction/disturbance plantings
- Nursery stock
- Wildlife plantings
- Acoustic buffers around compressor stations

Assessment Development & Review Process

Non-native shrubs and trees proposed for use on state forest land will be assessed and monitored to ensure the plant is meeting its desired function and reproduction throughout the planted area and that the non-native does not become invasive or cause negative ecological effects. An inter-disciplinary team within the Bureau of Forestry will assess each proposed species by reviewing the considerations and justifications. Staff involved in the assessment will be:

Coordination: The Planning Section will coordinate the review and assessment with staff and assemble a team for the species being considered.

Research & Writing Team: This team will provide research, analysis and proposal preparation and will be comprised of the non-native planting proponent and staff from Planning, Ecological Services, Silviculture, Penn Nursery, Forest Health and other staff or programs depending on the species and its intended use. The “non-native planting proponent” should include an individual or a group (district and/or central office staff) seeking to use a non-native species to fulfill management objectives. The research and writing team should prepare a written proposal, detailing the rationale for using the non-native species and using data and observations as support. Program sections should provide guidance and critical feedback and determine compliance with state forest policies and regulations.

Review Team: Comprised of all applicable Central Office Divisions and Sections, Assistant State Foresters and District staff. Review staff will vary depending on the species being assessed. This team will review, discuss and provide recommendations to State Forester.

Approval: The State Forester may approve or disapprove the use of non-native species based on the team recommendations and are subject to change.

Assessment Considerations

There are a number of important factors that should be evaluated when considering the use of a non-native species. Assessments will be focused on a certain species; however, there may be circumstances where assessments would be for a specific project or projects using several species. Assessments of the use of non-native trees and shrubs should address the following:

- A clearly defined problem: why a non-native needs to be planted and where (wildlife habitat, species replacement, resilience building, etc.)
- Information about the non-native: a literature study of phenology, use, community etc.

- Seed sources intended to be used
- Ecosystem services the non-native will provide the plant community:
 - o Use of fruit or seed for wildlife
 - o Biomass opportunities
 - o Soil chemistry changes
- Potential negative or positive effects of planting the non-native:
 - o Invasive characteristics: Does the non-native readily hybridize with natives in the same genus
 - o Food web dynamics
 - o Displacement of other species
 - o Pros and cons of certain plants
- To ensure the plantings do not produce a monoculture of non-natives, a native should be planted along with each non-native species; provide information on the native species to be used and its ability to coexist with the non-native.
- Environmental site conditions examined to ensure planting will be successful (soils, topography, hydrology etc)
- Monitoring needs based on the assessment

Assessment Outcomes

Following the assessment, a decision will be made regarding the appropriate use of the species on state forest lands. Guidance will be developed as part of the assessment outcomes that outlines the appropriate use of the species. Assessment outcomes may be used as justification for the use of a non-native species as per the *Pennsylvania Bureau of Forestry Planting and Seeding Guidelines* and may be effective at the bureau-wide level. It is important to note that considering monitoring outcomes, field observations, or new research findings a re-evaluation of the non-native plant may be necessary to determine next steps with planting and management and approvals are subject to change.

Assessment Outcomes:

- **Recommended for Use on state forest Lands**—the species may be planted at any time on state forest land without any further approval
- **Plant Only in Special Circumstances or Situations**—the species may be planted on state forest land only given specific conditions or situations. If there is deviation from the approved use, then a specific project plan should be submitted and approved by the State Forester (example: screening planting of conifers).
- **Do Not Plant**—this species may have been planted on state forest lands in the past. However, this assessment and current standards do not recommend or allow the use of these plants on State Forest lands (example: invasive, noxious weed or not compatible within ecosystem).

Monitoring of Plantings

Forest resource monitoring plays an essential role in ecosystem management, by measuring ecological health of the forested systems over time, which allows managers to identify trends and adjust management techniques. Monitoring is an important component in non-native plantings to understand any short-term stresses and adapt to any long-term changes in the habitat as a result of introducing non-native plants. The goal of monitoring non-native plantings on state forest land is to ensure that

resource management activities are compatible with the long-term ecological health of the state forest system and habitat in which the planting took place. Therefore, the Bureau of Forestry monitors species plantings to ensure that intended goals and objectives are being met and that the plants are not acting aggressively, decreasing forest health, or negatively impacting natural communities or wildlife. A monitoring plan that includes study details and staff responsibilities will be developed for species needing monitoring, and followed accordingly.

The Monitoring Plan may include the following information based on the species:

- A baseline study of the area receiving the non-native plantings
- For each non-native species, at least 10% of the plantings should be monitored. Effort should be given to choose monitoring sites with a variety of ecological conditions.
- Monitoring should be performed after at least a full growing season and once within 5 years of planting establishment. Long-lived species may require longer monitoring periods
- Opportunities for efficient monitoring techniques should be applied when possible such as remote sensing or photo monitoring, both of which can be effective in showing change in plant community composition. This should be used to supplement, not replace on the ground monitoring.
- The *Non-Native Plant Monitoring Form* (attached) should be used or adapted as needed for all studies and monitoring efforts.
- Any spatial information collected in association with these plantings should be housed in a central location such as FIMS.
- Monitoring should be carried out by the non-native planting proponent(s) or district staff where the planting is located. Monitoring results should be reported to Ecological Services Section, to compile the information for FSC reporting.

Items to be monitored:

- The reproductive ability of the planted species, by evaluating the vigor of flowering and fruiting
- The spread of the species beyond the planted area, by tracking any new individuals present
- The presence or absence of native competitors by evaluating understory species present
- Forest health: insects and diseases present and understory or seedling health
- Ecological effects within plant/forest community
- Effects on wildlife
- Whether the non-native species is meeting the intended objective

Non-Native Plant Monitoring Form

BOF monitors non-native plantings in accordance with FSC's standards. Please use this data sheet to collect information on plantings in your district for species in the "Avoid planting unless special circumstances or situations" list from the *Planting & Seeding Guidelines* and trees/shrubs deemed acceptable to "Plant only in Special Circumstances or Situations" on state forest land with monitoring as per the *Assessment Guidance for the Use of Non-Native Trees & Shrubs*. Each non-native species should be monitored once during the 5-10-year period after its establishment.

District: _____ Date: _____ Collected by: _____

Reason for revegetation/tree planting (e.g. log landing, haul road, wildlife opening, pest damage):

Lat/Long: _____ Compartment and/or Sale #: _____

Date seeded/planted: _____ Date and rate fertilized: _____

Rough size (square or linear feet): _____ % Bare soil: _____

Other treatments (e.g. shelterwood, herbicide, prescribed fire, etc., and date):

Species planted (including relative rates of application):

Species Observed in Revegetated/Replanted area (following establishment):

Species:

% Cover:	Vigor: <i>Scale of 1-3, 1 lowest, 3 best</i>			Reproduction? <i>Flower/Fruit</i>	Is this species spreading beyond planted area? (Y/N, if Y, explain below)	Is the non- native species meeting its goals? (Y/N, Explain below)	Problems noted? (Y/N; if Y, explain below chart)	
	1	2	3					
	1	2	3	Fl. / Frt.	Y	N	Y	N
	1	2	3	Fl. / Frt.	Y	N	Y	N
	1	2	3	Fl. / Frt.	Y	N	Y	N
	1	2	3	Fl. / Frt.	Y	N	Y	N
	1	2	3	Fl. / Frt.	Y	N	Y	N
	1	2	3	Fl. / Frt.	Y	N	Y	N
	1	2	3	Fl. / Frt.	Y	N	Y	N
	1	2	3	Fl. / Frt.	Y	N	Y	N
	1	2	3	Fl. / Frt.	Y	N	Y	N

Fill out if Planted Species is Spreading into Surrounding Area:

List seeded/planted species found beyond the originally planted/seeded area:

Approximate size (square feet):

Percent cover: _____

General plant community or habitat type: _____

Describe How Seeded/Planted Species are/are not Meeting Goals:

Additional site notes/Problems: