Effective Establishment of Native Grasses on Roadsides in New England

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16. Abstract

Grass species selection is a critical component of roadside plantings providing safe clear zones and effective control of slope erosion. Cool-season introduced turf grasses have been used for decades as a quick cover along the roads. However, recent policy requires the use of native plants as the first choice in roadside revegetation efforts. While considerable amount of literature exists on the subject of native plant establishment in various parts of the U.S., the practice of roadside native plantings is relatively new to New England and the knowledge-base for this region has only started to develop. Given the unique ecological conditions of the region this Manual provides region specific information which derived from the literature reviews, interviews with experts and practitioners, and field experiences obtained during the establishment of the regional demonstration plots. The goal of this Manual is to provide guidelines for the establishment of native species on roadsides in New England which will support transportation goals for safety and infrastructure reinforcement while providing economic, ecological and aesthetic advantages.

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SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	25.4	millimetres	mm
ft	feet	0.305	metres	m
yd	yards	0.914	metres	m
mi	miles	1.61	kilometres	km
		AREA		
in^2	square inches	645.2	millimetres squared	mm^2
ft^2	square feet	0.093	metres squared	m^2
yd^2	square yards	0.836	metres squared	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	kilometres squared	km^2
		VOLUME		
fl oz	fluid ounces	29.57	mililitres	mL
gal	gallons	3.785	Litres	L
ft^3	cubic feet	0.028	metres cubed	m^3
yd^3	cubic yards	0.765	metres cubed	m^3

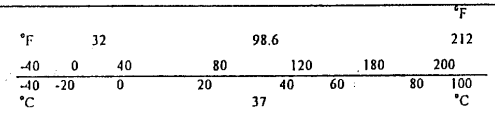
NOTE: Volumes greater than 1000 L shall be shown in m^3

		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams	Mg
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5(F-32)/9	Celcius temperature	°C

* SI is the symbol for the International System of Measurement

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimetres	0.039	inches	in
m	metres	3.28	feet	ft
m	metres	1.09	yards	yd
km	kilometres	0.621	miles	mi
		AREA		
mm^2	millimetres squared	0.0016	square inches	in^2
m^2	metres squared	10.764	square feet	ft^2
ha	hectares	2.47	acres	ac
km^2	kilometres squared	0.386	square miles	mi^2
		VOLUME		
mL	millilitres	0.034	fluid ounces	fl oz
L	litres	0.264	gallons	gal
m^3	metres cubed	35.315	cubic feet	ft^3
m^3	metres cubed	1.308	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.205	pounds	lb
Mg	megagrams	1.102	short tons (2000 lb)	T
		TEMPERATURE (exact)		
°C	Celcius temperature	1.8C+32	Fahrenheit temperature	°F



Preface

Research has long documented the ecological impact of roads and traffic and reinforced the importance of integrating ecological goals with transportation corridor landscaping (Christen & Matlack, 2006; Forman & Deblinger, 2000; Spellerberg, 1998). The National Highway System alone, which comprises only approximately 4% of the United States' public roads, consists of 163,000 miles of roads bordered by 3.4 million acres of unpaved land along rights-of-way in the contiguous United States (Ament et al., 2014). In total, over 10 million acres of roadsides exist in the United States (Forman et al., 2003). These extensive areas provide important ecosystem services, such as runoff reduction, carbon sequestration, improved air quality, and aesthetics. Roadsides represent one of the most widespread networks of linear habitats on earth, acting as corridors for species distribution by connecting fragmented existing landscape patches. This land supports a diversity of wildlife by providing shelter, food, and breeding opportunities for many species, including presently threatened pollinators (Hopwood et al., 2016).

Introduced cool-season turfgrasses have served Departments of Transportation well: they provide easily established vegetative cover, quick erosion control, and safe clear zones, which help reinforce driver safety. However, federal policy shifts over several decades first encouraged and then required the use of native plants as the first choice in roadside revegetation efforts. The Highway Beautification Act of 1965 (Johnson, 1965) initiated the beautification of highway roadsides and medians with plantings of wildflowers. The Federal Noxious Weed Act of 1974 gave the US Secretary of Agriculture the authority to declare some plants as "noxious weeds," and limit the interstate spread of such plants without a permit.

After encouragement from Lady Bird Johnson, Texas Sen. Lloyd Bentsen added an amendment to the federal 1987 Surface Transportation and Uniform Relocation Assistance Act (STURAA) that 0.25% of landscaping projects receiving federal funds would be spent on planting *native* wildflowers.

Using authority provided to combat invasive plant species by the Federal Plant Pest Act of 1957, the National Environmental Policy Act of 1969, and the Federal Noxious Weed Act, President Clinton reinforced the need to shift to native species with his 1994 Memorandum on Environmentally Beneficial Landscaping order (Executive

Order 13112, 1994) that established the Invasive Species Council, and the Greening the Government through Leadership in Environmental Management order (Executive Order 13148, 2000).

In 2005, President Bush signed the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU), which expanded on the 1987 STURAA bill by including funds for planting not only native wildflowers along highways, but also native grasses, shrubs, trees, and vines, in an effort to combat noxious and invasive weeds.

In response to the rapid decline of pollinator species, President Obama released Presidential Memorandum: Creating a Federal Strategy to Promote the Health of Honey Bees and Other Pollinators on June 20, 2014. The memorandum established the Pollinator Health Task Force, which is responsible for increasing and improving pollinator habitats. Since pollinator population decline coincided with the deterioration of native plant communities, the Task Force directed the US Department of Transportation (US DOT) to work with State Departments of Transportation (DOTs) to promote pollinator-friendly practices along transportation corridors. As a result, Congress included the provision in Fixing America's Surface Transportation (FAST) Act in December 2015 for states to use native plants along highways to restore pollinator habitats. States started to respond to the need for increasing pollinator habitats and health by passing state-specific bills. For example, in 2016 Connecticut passed a pollinator health law (“An Act Concerning Pollinator Health”) that encouraged the use of rights-of-ways to establish native plant communities to help restore pollinator habitats.

Native plants can sustain themselves without intensive human intervention to achieve long-term stability. The establishment of native plant communities initiates and accelerates processes of natural succession—a critical component of restoration efforts. Many native grasses, especially warm-season species, have deeper, more extensive root systems and longer lifespans than nonnative cool-season turfgrasses. Native plant communities provide long-term defense against invasive and noxious weeds while reducing maintenance costs associated with managing weedy vegetation. They improve slope stability and increase regional biodiversity.

Exploiting the vast acreage of roadsides to create biodiverse native plant communities helps combat the deterioration in wildlife habitats resulting from invasive species encroachment. Roadsides create opportunities for invasive plant species to colonize more rapidly than in landscapes that exist away from roads (Christen & Matlack, 2008). Research suggests that since "native insects have shared little or no evolutionary history with alien plants . . . [native insects] may not possess the adaptations required to use [alien] plants as nutritional hosts" (Tallamy, 2007). As a result, the complex food web created by ecosystems populated by native plants collapses, leading to the decline in pollinator and wildlife populations (Tallamy, 2007). Therefore, transitioning roadsides to native plant communities can have a significant ecological impact on the New England region.

Native species have evolved with local climates and soil conditions and generally require less maintenance after establishment. One of the most significant benefits native plant communities provide for DOTs is a reduction in the need for frequent mowing. Not only does this save money usually spent on fuel and machine maintenance; it also reduces the amount of emissions discharged by mowing equipment. Labor not used for mowing can be retrained and repurposed to control invasive species.

While a considerable amount of literature exists on the subject of native plant establishment in various parts of the United States, the practice of roadside native plantings remains relatively new to New England and the knowledge base for this region has only started to develop. Given the unique ecological conditions of the region, this manual provides specific information derived from literature reviews, interviews with experts and practitioners, and field experiences obtained during the establishment of the regional demonstration plots. The goal of this manual is to provide guidelines for the establishment of native species along roadsides in New England that will support transportation goals for safety and infrastructure reinforcement while providing economic, ecological, and aesthetic advantages.

The first chapter, **"**Plant Specifications: Selecting Native Species for Roadside Establishment in New England," discusses the concept of reference sites and ecoregions, and approaches to native species selection in New England. Input from conservation biologists was considered when developing species recommendations.

The second chapter, "Site Inventory and Assessment," provides a checklist for site characteristics. Site assessment is the first important step when making decisions regarding plant selection and establishment method in a specific location. The transition to biodiverse native plant communities along roadsides requires more deliberate plant selection and management practices compared to the relatively simple, linear process of establishing monocultural cool-season turfgrass. Even stretches of roadside that run concurrent with one another can have physical and ecological features that will result in plant communities that are composed of entirely different arrangements of grass and forb species. Such factors as the site's microclimate, soil texture, hydrology, topography, and light all influence which species will thrive.

The third chapter, "Establishment Methods for Native Plant Communities," outlines protocols for establishment and maintenance for natives along roadsides. The establishment of native plant communities involves consideration of the site preparation protocols, seeding techniques, and post-establishment monitoring and maintenance. This chapter describes various scenarios that need to be considered in the course of native plant community establishment to increase the likelihood for long-term success.

The fourth chapter, "Focus Groups of New England Departments of Transportation Managers," summarizes the interviews that were conducted to evaluate the current status of the use of native plants along roadsides, to assess the interest level in using native species, to examine the likelihood of roadside managers adopting these new approaches, as well as to identify the barriers that might impede transitioning from current roadside revegetation practices.

The fifth chapter, "Plant Profiles," contains the ecoregional list of plants suitable for roadside plantings. It includes species that establish well under varying roadside conditions, are of short or moderate stature to allow for sight lines, and provide food and shelter for pollinators and other wildlife species. The profiles include 89 species of forbs and 37 species of grasses and grass-like native species that can be used for roadside plantings in New England to achieve functional and diverse plant communities.

The sixth chapter, “Conclusions and Initial Actions,” summarizes recommendations and outlines challenges for establishing native plant communities along roadsides in New England.

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Chapter 1: Plant Specifications: Selecting Native Species for Roadside Establishment in New England

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The goals of roadside plantings—achieving functional and conservation priorities using diverse, resilient plant communities—can only be achieved through careful selection of native species with the best potential for specific roadside locations. The species selection decision-making process and the development of detailed specifications include the following considerations:

- which species to plant
- in what proportions (composition)
- where to procure native and adapted seed.

The concepts of reference sites, native and rare species**,** and ecoregions should be taken into consideration when developing specifications for roadside plantings in order to identify locally adapted and genetically appropriate species.

1.1. Reference sites

Roadside revegetation planting should be approached with the goal of establishing diverse, functional and resilient plant communities through the introduction of many native species of grasses and forbs. This can be achieved by starting the planning process by identifying reference sites (or natural model sites), which serve as benchmarks for planning, monitoring, and evaluating project success. This technique has been successfully applied in many ecological restoration projects, and is also useful in roadside planting design. When designing a seed mix, a reference site should be selected, inspected, and analyzed for the species composition of its native plant communities (Steinfeld et al., 2007).

Selection of a reference site. To be similar to a roadside revegetation project habitat (ecological or environmental area), an appropriate reference site would have undergone some type of disturbance in the fairly recent past, and would have revegetated into a herbaceous native plant community dominated by grasses and forbs. Grassland preserves, dry old fields or abandoned pastures, and certain roadside, utility line, open summits, or railroad rights-of-way may serve as useful reference sites. State Natural Heritage Programs, local chapters of The Nature Conservancy, botanical societies and local land trusts might assist with locating such sites.

It is recommended to identify a reference site for each roadside planting. If the conditions within a site are heterogeneous, a few reference sites can be identified corresponding to each condition or habitat.

Figure 1.1 After construction, stripped of topsoil, this road cut recovered through the establishment of a volunteer plant community dominated by little bluestem (*Schizachyrium scoparium*), tufted hair-sedge (*Bulbostylis capillaris*) and orange-grass St. John's-wort (*Hypericum gentianoides*)—all native species that thrive in mineral soil with low organic matter and little plant/litter cover.

Vegetation description. Reference sites with similar aspects, soils, and moisture conditions should be visited to assess vegetation and to develop comprehensive species lists in order to identify species and associations or communities that are suitable for each project. When visiting reference sites, environmental conditions (soil texture, moisture, slope, aspect, elevation, pH, etc.) should be described along with the vegetation.

Figure 1.2 Railroad and power-line rights-of-way corridors with poor, dry soils, regular vegetation management, and full sun exposure—similar to the harsh environments along roadsides – demonstrate the natural recovery from disturbances and formation of sustainable grass communities. Photos of power line right-of-way in Myles Standish State Forest, Plymouth/Carver, Massachusetts, with established native grassland vegetation.

It is beneficial to visit reference sites a few times during the growing season, as many species become more visible or easily recognizable throughout specific phenological (developmental) phases (for example, flowering) that occur at different times throughout the season. Multiple visits result in a comprehensive vegetation analysis and recording of species and plant associations suitable for roadside projects.

Andropogon virginicus *Lespedeza capitata* among grasses

Figure 1.3 A mix of grasses and forbs, which consists of broomsedge bluestem (*Andropogon virginicus*), purpletop tridens (*Tridens flavus*), round-headed bush-clover (*Lespedeza capitata*), gray goldenrod (*Solidago nemoralis*), yellow wild indigo (*Baptisia tinctoria*) along with many other species, was identified at a meadow located at the Mansfield Dam, Mansfield, CT. This species combination can be utilized along dry roadsides in the southern part of New England.

Figure 1.4 A portion of open land located at the Rocky Neck State Park, East Lyme, Connecticut, has developed into a volunteer plant community dominated by little bluestem (*Schizachyrium scoparium*), along with many other native species, after regular mowing ceased. Many other planted sites where successful restoration has already occurred can be used as a reference.

1.2. Seed mixes

A seed mix includes a group of species that commonly occur together in reference sites. These groups can be identified for different ecological conditions, and various mixes should be developed for dry, mesic and wet sites.

It is recommended to include at least 30 native species in each mix (Harper-Lore et al., 2013), each playing an important role in restoring a unique habitat. Various factors, such as functionality, ecological values, and aesthetics should be taken into consideration.

The following components of a seed mix are recommended:

- dominant or keystone species (warm-season grasses)
- cool–season grasses
- nurse or companion crops
- annuals
- legumes
- perennials with attractive flowers for pollinators and aesthetics.

The first step is to select a few dominant species—also called "workhorse species" (Steinfeld et al., 2007), or "core species" (MacDonagh and Hallyn, 2010)—a group of locally adapted native plants with broad ecological amplitude, recurring across a wide array of ecological conditions, abundant at many sites, and easily propagated. Native warm-season grasses that fulfill these requirements will be the keystone species used in the revegetation of most roadsides.

Various specialist species, such as nurse crops, legumes and other forbs (soft-stemmed herbaceous perennials other than grasses and grass-like plants), are then added to the mix that not only improve community resilience by increasing species diversity, and for management objectives, such as visual enhancement or soil stabilization, but also for specific ecological functions, such as for pollinator habitat.

Box 1.1 Little bluestem

Little bluestem (*Schizachyrium scoparium*) is a common, relatively short, warm-season grass species growing across the United States. In the Northeast it is often scattered through dry areas along rocky cliffs and ridges, and along highways and railroad rights-of-way. This grass gets its common name from the bluish color of stem bases in summer, but the most interesting aspect is its striking coppery color in fall, which persists throughout winter. Little bluestem can be included as a dominant species in roadside mixes throughout New England on relatively dry sites. It creates long-lived plantings capable of regenerating itself, and it is easy to manage after establishment.

In addition to the aesthetic appeal and ecological suitability for roadside planting, little bluestem has high wildlife value. Song and upland game birds eat its seeds while the plant provides ground cover for a variety of small mammals. The leaves of little bluestem are fed upon by grasshoppers, beetles, thrips, and several species of skipper butterfly caterpillars, and birds use its parts for nesting material.

Little bluestem resists lodging due to snowpack and maintains its distinct habit throughout winter, providing shelter important to many wildlife species (the bottom photo was taken at the end of March in Windham, CT). Thus it is recommended not to mow its stands from July to March.

Cool–season grasses should be added to the warm-season grass mix because they start growing early in spring and stay greener at the end of the season, thus adding some color to the roadside outside the peak time of the warm-season grasses. Native cool-season grasses for New England include common eastern wild-rye (*Elymus virginicus*) and Great Plains wild-rye (*Elymus canadensis*) for southern New England states, sedges (*Carex* species), flattened oatgrass (*Danthonia compressa*), and poverty grass (*Danthonia spicata*).

Figure 1.5 A naturally occurring combination of flattened oatgrass (*Danthonia compressa*) and little bluestem (*Schizachyrium scoparium)* provides continuous functionality and interest along Route 6, Connecticut. Both species are low-growing grasses that do not require mowing. Flattened oatgrass will be growing and blooming in May and early June (top photo) before little bluestem starts its growth; little bluestem starts growing in June and flowers in August (bottom photo).

Along with long-living native species, it is also recommended to include nurse crops (or companion crops), which are planted simultaneously with the native species. Nurse crops are different from cover crops. Cover crops are *temporary* plantings consisting of a monoculture of annual grasses planted for erosion control when planting of native warm-season grasses has to be delayed. The nurse crops, which are incorporated into permanent plantings, are represented by fast-growing, short-lived, upright species that do not form a dense cover, thus allowing slower-growing native species to establish. They prevent erosion and suppress weeds during the first year, and create favorable microclimatic conditions for the germination of other native seeds by reducing soil desiccation and providing aesthetic value. The common native grasses and forbs used as nurse crops include common eastern wild-rye (*Elymus virginicus*) and partridge sensitive-pea (*Chamaecrista fasciculata*).

Figure 1.6 Partridge sensitive-pea (*Chamaecrista fasciculata*) is a very prolific annual legume that can be used as a nurse or companion crop in a mix of native species in southern New England.

Figure 1.7 Native stand failure caused by excess application of annual rye. Photo courtesy of Mark B. Fiely, Ernst Conservation Seeds.

Nonnative annual species—annual rye, winter wheat or oats—can also be added to the seed mix as nurse crops. They all are not long-lived and will recede as native species establish. However, the proportion of seeds of nurse crop in a mix should not be excessive, only 15%–20% of the total mix, to allow sufficient resources for the establishment of long-living native species.

Native annual forb species, such as annual fleabane, *Erigeron annuus*, may also be added for weed and erosion control during the early stages of establishment as they germinate and grow quickly, rapidly producing groundcover for effective erosion control while protecting resources (space, moisture, and nutrients) from competing undesirable weedy species. This species is also attractive during the very early stages of meadow development.

While grasses should dominate any native roadside mix, forbs should also be included in a balanced proportion. Wild bee-balm (*Monarda fistulosa*) and narrow-leaved fireweed (*Chamaenerion angustifolium*; synonym *Epilobium angustifolium*) can serve the "early interest" function in new plantings because they are fast-establishing species providing color during the first few years. Also, rough fleabane (*Erigeron strigosus*), Canada hawkweed (*Hieracium kalmii*), tall lettuce (*Lactuca canadensis*), common selfheal (*Prunella vulgaris* subsp. *lanceolata*), and pink corydalis (*Capnoides sempervirens*) can be added to the native mix for prompt color if seed become available.

Native legumes should be added as nitrogen-fixing plants that improve soil nutrient content and establish quickly while providing food and cover for wildlife. The common species of legumes include round-headed bush-clover (*Lespedeza capitata*), showy tick-trefoil (*Desmodium canadense*), yellow wild indigo (*Baptisia tinctoria*), and partridge sensitive-pea (*Chamaecrista fasciculata*).

Figure 1.8 Showy tick-trefoil (*Desmodium canadense*) (top photo) and yellow wild indigo (*Baptisia tinctoria*) (bottom photo) are attractive native legumes. Photo courtesy of Mark B. Fiely, Ernst Conservation Seeds.

A subset of species valuable to pollinators should be added to the native mix, because the goal of increasing pollinator habitats has become a high-profile issue in the United States. These plants are also attractive to motorists and can be used in higher concentrations in high-visibility locations. Attractive, colorful species include wild bergamot (*Monarda fistulosa*), New England aster (*Symphyotrichum novae-angliae*), goldenrods (*Solidago* spp.) and many others.

Figure 1.9 Wild bergamot (*Monarda fistulosa*) (top) and gray goldenrod (*Solidago nemoralis*) (bottom) provide splashes of color during different seasons. Photo courtesy of Mark B. Fiely, Ernst Conservation.

The season of interest may be taken into consideration to provide a sequence of bloom and continuing interest throughout the growing period. While the majority of forbs bloom later in the season, special consideration should be given to the inclusion of early-flowering species. Forb plugs that allow for quick establishment can be utilized in high-visibility areas.

Figure 1.10 Golden Alexanders (*Zizia aurea*) (top photo) and foxglove beardtongue (*Penstemon digitalis*) (bottom photo) are early-flowering species. Photo courtesy of Mark B. Fiely, Ernst Conservation.

1.3. Native species

The most commonly accepted definition of a native species defines it as a plant that was in the area before European settlement occurred.

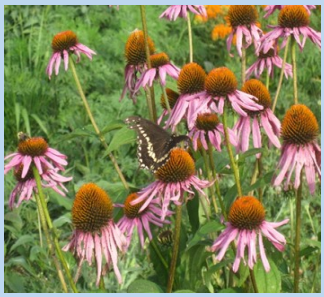
> A native plant species can be defined as one that has inhabited a particular region for thousands of years**.** More specifically, it includes those species understood as indigenous, occurring in natural associations in habitats that existed prior to significant human impacts and alterations of the landscape.

Defining what is meant by "a particular region" is a more complicated consideration than identifying the appropriate time period.

Some nurseries market many attractive species as native to the eastern United States or even to North America, and these species are generalized to be native to the entire continent or a large region therein. However, most of these species are present only in some parts of the continent or a region, and their presence in a specific region should be verified on a case-by-case basis. Inaccurate information regarding species natural distribution is common and widespread, and some species that are recommended by various organizations for restoration projects in our region, should be questioned.

For example, Table 1.1 was compiled from the *NRCS New England Pollinator Handbook* (USDA NRCS, 2009), and the *Xerces Conservation Cover for Pollinators: New England* (The Xerces Society, 2012) and other lists of recommended species for New England, and reflects many North American native species which are in fact not native to New England, although they may be naturalized (spreading in the wild after being introduced from elsewhere).

Blue wild indigo
(*Baptisia australis*)



Eastern purple coneflower
(*Echinacea purpurea*)

Sessile-headed blazing star
(*Liatris spicata)*

Figure 1.11 These species, which have become iconic images of native plants, are in fact not native to New England.

Table 1.1 Species incorrectly assumed to be native to New England in some planting guides.

Botanical Name (A-M)	Common Name	Botanical Name (M-V)	Common Name
Achillea filipendulina	fern-leaved yarrow	*Monarda media*	purple bee-balm
Agastache foeniculum	lavender giant-hyssop	*Oenothera missouriensis*	Missouri primrose
Allium cernuum	nodding onion	*Phlox maculata*	spotted phlox, wild sweet-William
Amorpha canescens	lead plant	*Phlox paniculata*	garden phlox, summer phlox
Baptisia australis	blue wild indigo	*Ratibida columnifera*	prairie Mexican-hat
Chelone lyonii	pink turtlehead	*Ratibida pinnata*	gray-headed Mexican -hat
Cichorium intybus	chicory	*Rudbeckia fulgida*	showy coneflower
Coreopsis lanceolata	lance-leaved tickseed	*Silphium species* (especially *S. perfoliatum*)	cup-plant
Coreopsis tinctoria	golden tickseed	*Silphium perfoliatum*	cup-plant rosinweed
Coreopsis verticillata	thread-leaved tickseed	*Stokesia laevis*	stoke's aster
Dalea purpurea var. *purpurea*	purple prairie clover	*Thalictrum dasycarpum*	purple meadow-rue
Delphinium exaltatum	tall larkspur	*Thermopsis caroliniana*	Carolina lupine
Echinacea purpurea	Eastern purple coneflower	*Thermopsis villosa*	Blue Ridge false lupine
Eryngium yuccifolium	button eryngo	*Tradescantia subaspera*	zigzag spiderwort
Helianthus giganteus	tall sunflower	*Typha angustifolia*	narrow-leaved cattail
Helianthus maximiliani	maximilian's sunflower	*Verbena stricta*	hoary vervain
Helianthus mollis	ashy sunflower	*Verbesina alternifolia*	wingstem crownbeard
Heliopsis helianthoides	sunflower-everlasting	*Vernonia fasciculata*	prairie ironweed
Hemerocallis species	daylilies	*Vernonia gigantea*	giant ironweed
Liatris spicata	sessile-headed blazing star	*Vernonia glauca*	broad-leaved ironweed
Liatris aspera	button blazing star	*Vernonia missurica*	Missouri ironweed
Lupinus polyphyllus	big leaf lupine	*Vicia americana*	American vetch
Monarda didyma	scarlet bee-balm		

In order to identify regionally appropriate native species, specialized references should be consulted. While there are many sources of information available on native plants in the US, regional treatments provide the most accurate information about species presence in each part of the country. The most reliable, recent references for New England include "Flora Novae Angliae" (Haines, 2011) and the "Go Botany" website maintained by the New England Wild Flower Society (https://gobotany.newenglandwild.org). These related references are based on accurate botanical records, primarily herbarium specimens (dried, pressed and identified plants from a specified location), of species presence. The "Go Botany" website contains range maps for each species in the region at the county level. Other useful references include:

Connecticut: Dreyer, G., C. Jones, R. Capers, P. Sweeney, N. Barrett, P. Sharp, C. Ultee, L. Brown, S. Saulys, E. Corrigan. 2014. *Native and Naturalized Vascular Plants of Connecticut Checklist.* Memoirs of the Connecticut Botanical Society, No. 5 (https://sites.google.com/a/conncoll.edu/vascular-plants-of-connecticut-checklist/home/files-for-download)

Massachusetts: Cullina, M. D., B. Connolly, B. Sorrie and P. Somers. 2011. *The Vascular Plants of Massachusetts: A County Checklist*. Massachusetts Natural Heritage & Endangered Species Program. Massachusetts Division of Fisheries and Wildlife (http://masslib-dspace.longsight.com/bitstream/handle/2452/120973/ocn747431427.pdf?sequence=1&isAllowed=y)

Vermont: Gilman, A. V. 2015. *New Flora of Vermont. Memoirs of the New York Botanical Garden*. Volume 110. NYBG Press

New England: Angelo, R. and D. Boufford. *Atlas of the New England Flora*. 2014, revised in 2015 (http://neatlas.org/).

Box 1.2 The *Rudbeckia* dilemma

In the field of ecological restoration, there is a debate about whether to include in seed mixes some naturalized or other noninvasive species that are not native to the New England, as they may provide some beneficial services.

For example, black-eyed coneflower (aka black-eyed Susan, *Rudbeckia hirta*), a fast-establishing species, is common in eastern US native meadow mixes, and as a biennial plant, makes the first few years of meadow establishment more attractive. It provides a burst of color during the second year after planting at a time in the development of seeded meadow when there is little color, since the more showy flowering perennials have not yet reached maturity. Aesthetic appeal is an important factor to consider: some state DOTs with long traditions of planting roadside native plant communities have received complaints during the first few years of meadow establishment because the plantings appear unkempt—weedy and not colorful.

Technically, the black-eyed coneflower commonly seen in New England is a naturalized variety (*Rudbeckia hirta* var. *pulcherrima*) from farther west. There is a native variety (*Rudbeckia hirta* var. *hirta*), but it should not be planted on roadsides in the region, because of its conservation concern.

One might think, since the naturalized variety has an important aesthetic function, is not invasive, and has been in New England for many decades, it is permissible to use it in meadow seed mixes, as long as one can be certain of the variety. This is also true of some other naturalized plants, which may have particularly useful functions in a planting.

However, *Rudbeckia hirta* var. *pulcherrima* does invade natural communities and is routinely found on some river shores with sand and gravel substrate as well as in the few remaining sand plain grasslands in New England—a very rare natural community (Arthur Haines, pers. comm., April 2016). The inclusion of this species in planting mixes represents another source population for adding nonnatives to habitats away from roads. Further, some very invasive plants were not aggressive until after being present in the region for a long time. “

“I certainly wish it were easier for everyone to simply take a stand and stop using nonnative species. We need to educate people to have more patience rather than simply provide them with rapid color from species that don't stay put (if that makes sense). I rarely see this approach used and it could be very beneficial in the long run. Consider that one could produce a brief communication through various media titled "why don't I see immediate color after DOT roadwork", providing another avenue for the public to learn about native vs. nonnative plants. I think we always assume the public can't grasp the concepts or are unwilling to change, even though we may not have honestly tried. “

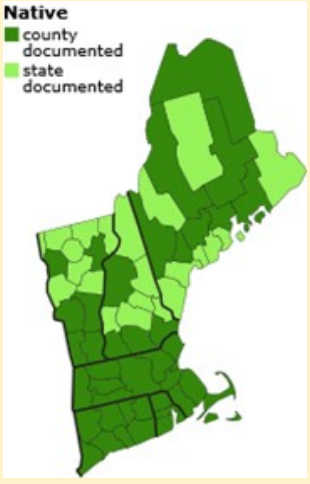
Arthur Haines, Research Botanist, New England Wild Flower Society

A few species that are not native to the United States, but could appear in seed mixes because they are often seen on roadsides and are therefore thought to be native, include dame's-rocket (*Hesperis matronalis*), wild carrot or Queen Anne's lace (*Daucus carota*); chicory (*Chichorium intybus*); oxeye daisy (*Leucanthemum vulgare*, synonym *Chrysanthemum leucanthemum*); swordleaf inula (*Inula ensifolia*); common and meadow dropworts (*Filipendula vulgaris* and *Filipendula ulmaria*); and false spiraea (*Sorbaria sorbifolia*).

A comprehensive master list of species appropriate for roadsides in New England, compiled with the assistance of botanists, is included in Chapter 6 of this manual. It contains 96 species of forbs and 39 species of grasses and grass-like plants (sedges, rushes etc.). While some species are found throughout the New England region, others have limited distribution through only parts of the region. This list should be narrowed down for each state or even portions of the state based on the species distribution maps at Go Botany and the EPA New England Level III ecoregions map.

1.4. How to read maps on species distribution in New England

The "Go Botany" website (https://gobotany.newenglandwild.org) contains maps with species distribution by state and county. The counties in dark green indicate where a species has been documented as occurring and is considered native; light green indicates that it is native to the state.

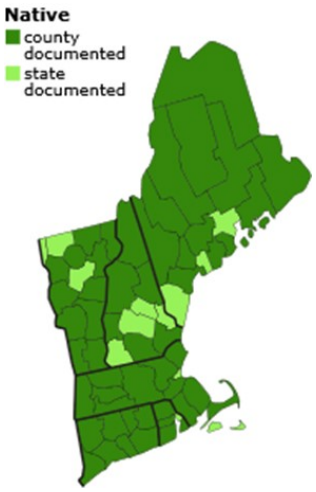


"*Think of the dark colors as dots showing where the species is known to occur within the state.*"

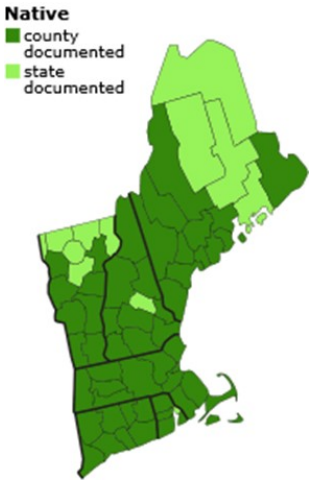
Arthur Haines,

Research Botanist, New England Wild Flower Society

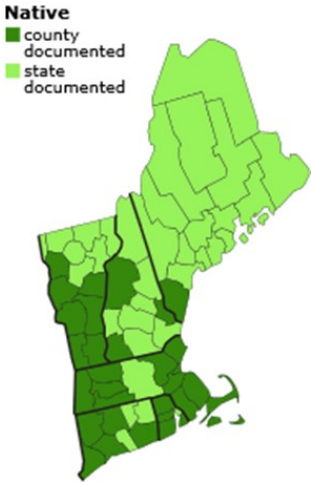
These maps can serve as useful guides to where different species can be expected to succeed when planted, without causing conservation issues. For example, swamp thistle (*Cirsium muticum*) and pasture thistle (*Cirsium pumilum*) occur throughout all six New England states, while field thistle (*Cirsium discolor*) has limited distribution in northern New England; it occurs primarily in the southern half of Vermont, a few counties of New Hampshire, and extreme southern Maine.



Cirsium muticum



Cirsium pumilum



Cirsium discolor

One consideration is to *not* introduce species that are not already known to occur in a project area, i.e., outside of their known historical ranges. Thus, field thistle (*Cirsium discolor*) should not be used in planting mixes in most of Maine and New Hampshire, or in northern Vermont.

> *"The use of some common species is not appropriate for all states or even for all areas within some states. Introducing species along highways to states or counties where they are not native is NOT good conservation."*
>
> William E. Brumback, Conservation Director, New England Wild Flower Society

For example, some popular species should be excluded from parts of New England based on where they are known to be native:

- Partridge sensitive-pea (*Chamaecrista fasciculata*) is absent or introduced in the northern New England states and should not be planted outside of southern New England.
- Purple Joe-pye weed (*Eutrochium purpureum*) is not found in Maine and should not be introduced to that state.

Figure 1.12 Smooth spiderwort (*Tradescantia ohiensis*) is an example of a species with restricted distribution. In New England. It is native only in Connecticut and Massachusetts and should not be planted outside of these states. Photo courtesy of Mark B. Fiely, Ernst Conservation Seeds.

1.5. Rare species

The inclusion of regional species of conservation concern (including designations such as “rare,” “threatened,” “endangered” and “special concern species”) into the planting mix is not recommended by botanists, as it causes problems for native plant conservation by introducing genotypes from other areas.

Native species of conservation concern should generally not be included in the planting mixes. One should always know which species are rare in the state before finalizing a seed mixture.

If a rare plant is present in a locality, inclusion of this rare species into new roadside plantings is not recommended, because that might lead to genetic contamination of the native populations. Introducing seed of rare species from other states where they may be more common or from cultivated seed sources may be detrimental to the species over the long term. From a conservation perspective, it is best to have rare species occurrences only in known wild populations (and not introduced to the area in plantings) to prevent any confusion with the conservation status and origin of the plants.

“The issue comes down to any [rare] plant found near a roadside or near a development, etc. is questioned (as to its nativity). However, these [rare] plants are fully capable of growing in a roadside forest and this creates the possibility that wild populations do not receive conservation effort because they are believed to be nonnative. The more frequently planted the [rare] species is, the more question is applied to it (such that plants found away from roadsides are thought to possibly be derived from roadside populations, etc.).”

For example,

- Great Plains wild-rye (*Elymus canadensis*) is rare in some northern New England states and should not be planted outside of southern New England.
- Yellow wild indigo (*Baptisia tinctoria*) should not be used in Maine, where it is rare.

- Fall sneezeweed (*Helenium autumnale*) has restricted distribution in northern New England and is absent in New Hampshire; its introduction to these areas should be avoided.
- Hairy bush-clover (*Lespedeza hirta*) has restricted distribution in northern New England (e.g., extreme southern Maine); its planting should be coordinated so as not to introduce this species to other regions of the state where it does not occur naturally.

Figure 1.13 One of the most popular native plants, butterfly milkweed (*Asclepias tuberosa*) (left photo), should be used only in Connecticut and Massachusetts, since it is rare or absent in other New England states. Its subspecies *Asclepias tuberosa* subsp. *interior* should not be used, as it is historically occurring; using this subspecies would create confusion over which populations are native.

Indian grass (*Sorghastrum nutans*) (right photo) is not a common grass in the northern New England states, where it has a "rare" designation, and should not be used in that region, to avoid confusion with native populations.

When including a new species into a mix, its conservation status should be checked on the GoBotany website and by consulting the most recent state conservation lists generated by the Natural Heritage program or its equivalent of the state you are working in.

New England Distribution and Conservation Status

Distribution

Connecticut	present
Maine	present
Massachusetts	present
New Hampshire	present
Rhode Island	present
Vermont	present

Conservation Status

Exact status definitions can vary from state to state. For details, please check with your state.

Massachusetts	unranked (S-rank: SNR)

var. bipinnata

Massachusetts	unranked (S-rank: SNR)

var. laciniata

Massachusetts	unranked (S-rank: SNR)
Rhode Island	extremely rare (S-rank: S1), state threatened (code: ST)

Direct links to the rare plant species lists for each state:

Connecticut http://www.ct.gov/deep/lib/deep/wildlife/pdf_files/nongame/ets15.pdf

Maine http://www.maine.gov/dacf/mnap/features/rare_plants/plantlist.htm

Massachusetts http://www.mass.gov/eea/agencies/dfg/dfw/natural-heritage/species-information-and-conservation/mesa-list/list-of-rare-species-in-massachusetts.html

New Hampshire http://www.nhdfl.org/library/pdf/Natural%20Heritage/TrackingList-PlantGeneral.pdf

Rhode Island http://rinhs.org/wp-content/uploads/2012/05/ri_rare_plants_2007.pdf

Vermont http://www.vtfishandwildlife.com/common/pages/DisplayFile.aspx?itemId=229833

Also, the state's Natural Heritage program or its equivalent should be consulted for species rarity status. The state programs are linked to the New England Wild Flower Society website at http://www.newfs.org/conserve/collaborations/state-natural-heritage-programs/.

""*One should be especially cautious when planting in Rhode Island, where many species that are common elsewhere in parts of New England are considered rare*."

William E. Brumback, Conservation Director, New England Wild Flower Society

Rarity information is constantly changing as botanists find new populations or fail to relocate previous populations, which consequently become historical. Establishing a working relationship with the official state botanist is the best way to stay up-to-date on rare plant distribution information. It takes some time to list a new species due to the complicated legal process that is often involved in listing an organism as endangered, threatened or rare.

Moreover, it is also important to take into consideration not only the status of the species but also the status of varieties and subspecies (intraspecific taxa). For example, regarding green-headed coneflower (*Rudbeckia laciniata*), it is recommended to plant var. *laciniata*, because var. *bipinnata* is less common and primarily restricted to southern New England. When including wild bee-balm *(Monarda fistulosa*) in the planting mix, var. *fistulosa* should be used, as there are two other varieties, of which var. *rubra* is nonnative and var. *mollis* is less common in New England.

Figure 1.14 Two species, which are commonly included in native seed mixes but are in fact rare in parts of New England, are sideoats grama (*Bouteloua curtipendula*) and sundial lupine (*Lupinus perennis*). These species should not be used in our region for plantings.

When using common wrinkle-leaved goldenrod (*Solidago rugosa*), it is recommended to plant subsp. *rugosa*, as subsp. *aspera* is rare in several New England states. *While most of these varieties are not available in the trade, or a supplier would not know what variety they really have, the status of intraspecific taxa should be an important consideration when starting local seed production.*

Table 1.2 Species that are rare in one or more New England states, but which may be common in native mixes from other regions of the country. The status and distribution of these species should be verified on a state-by-state basis; if they are considered to be rare in some New England states they should be excluded there from roadside mixes.

Botanical Name	**Common Name**
Forbs	
Actaea racemosa	black bugbane
Asclepias tuberosa	butterfly milkweed
Lathyrus maritimus	beach vetchling
Liatris novae-angliae	northern blazing star
Lobelia siphilitica	blue lobelia
Lupinus perennis	sundial lupine
Mimulus ringens	Allegheny monkey-flower
Monarda punctata	spotted bee-balm
Penstemon hirsutus	northeastern beardtongue
Solidago speciosa	showy goldenrod
Symphyotrichum dumosum	bushy American-aster
Symphyotrichum prenanthiodes	American-aster
Grasses	
Bouteloua curtipendula	sideoats grama
Bromus kalmii	Kalm's brome
Dichanthelium sphaerocarpon	round-fruited rosette-panicgrass
Sporobolus heterolepis	prairie dropseed

Any recommended native planting list for New England or the Northeast should be cross-checked with the species data for your state. For example, the NRCS Guide to Conservation Plantings on Critical Areas for the Northeast (Salon and Miller, 2012) recommend the following species to be included into the mix: panicled tick-trefoil (*Desmodium paniculatum*), Virginia mountain-mint *(Pycnanthemum virginianum*), northern wild senna (*Senna hebecarpa*), white vervain (*Verbena urticifolia*). However, all these species are considered either rare throughout all New England states (as *Senna hebecarpa*), or rare at least in some New England states (*Pycnanthemum virginianum is* rare in New Hampshire and limited in Maine, and *Verbena urticifolia* is rare in Maine) and should not be included into the mix for these states.

1.6. Origin of seed

Many native species are widely distributed across broad geographical regions. However, numerous studies indicate that focus on the seed source, or seed origin, is a very important consideration during any restoration project, and conservation oriented native plant programs emphasize their significance and strongly encourage using local seed sources.

Seed source. As much consideration should be given to the origin of seed as to the species selection when buying seed or plant material from a commercial source. The use of local seed protects the genetic resources of local plant communities, prevents the introduction of regionally inappropriate genetic material and diminishes potential for genetic contamination, or "swamping," of local native gene pools. When nonlocal plants with high vegetative vigor, competitive ability, and fecundity are introduced, they adversely impact local populations through direct competition and displacement. Nonlocal plants can influence local gene pools of these species, resulting in outbreeding depression (when progeny from crosses between individuals from different populations have lower fitness than offspring from crosses between individuals from the same population). An important role of roadside planting is to create corridors and to connect fragmented native populations. In this context it is especially important to prevent loss of fitness of native populations through the addition of nonlocal genes from plants used in the corridors.

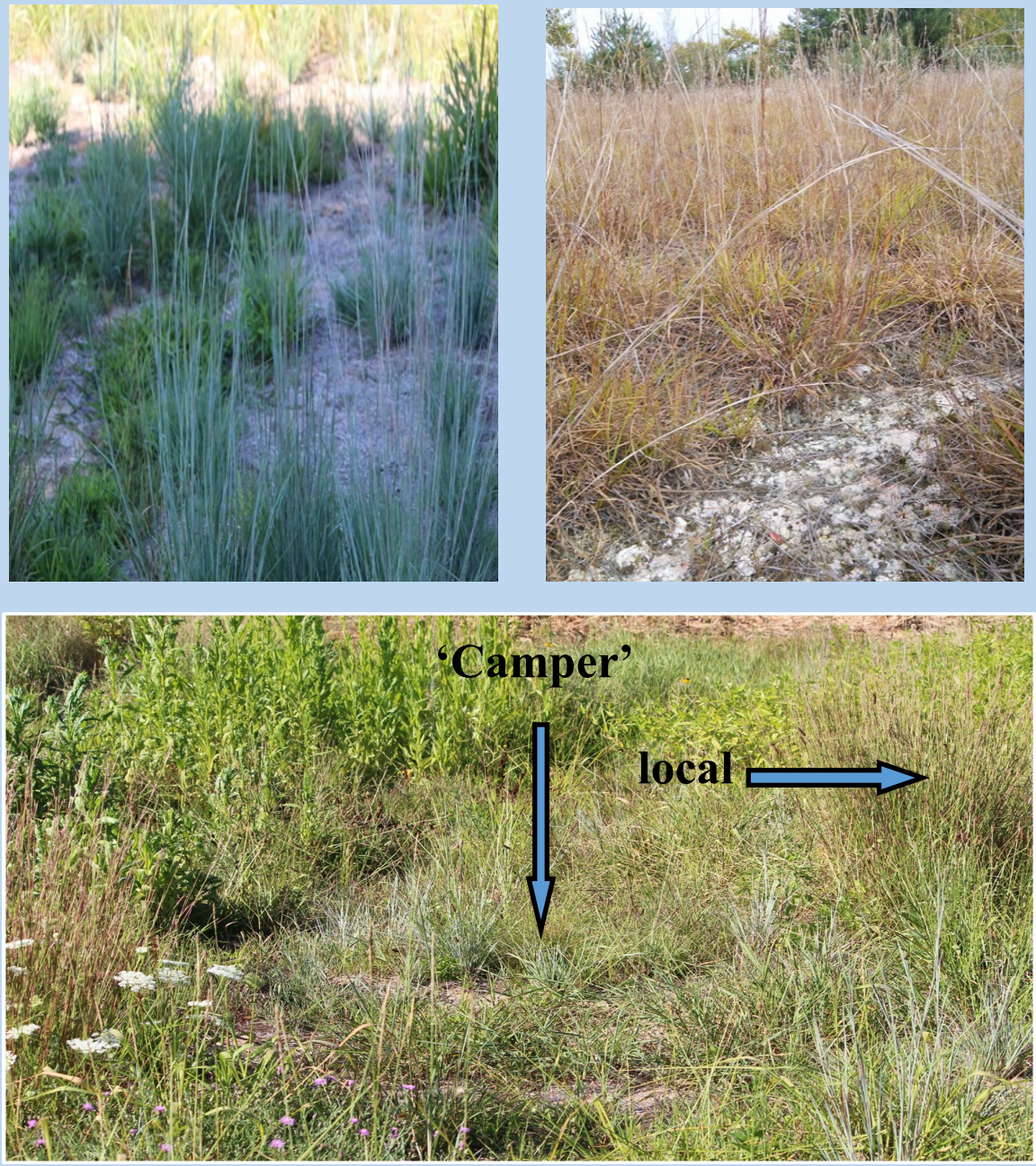


Figure 1.15 Native plants are occasionally represented by commercial cultivars characterized by low genetic diversity levels. Usually cultivars of native species can be very difficult to distinguish from local genotypes. However, the little bluestem cultivar 'Camper' (Ernst Conservation Seed, Inc.), which was used in the demonstration plantings along Route 6, had a distinct bluish foliage (top left photo), while our native little bluestem has yellow-green leaves (top right photo) and is easily recognizable.

Box 1.3 *Switchgrass genotypes*

Source material (seed) for switch panicgrass (*Panicum virgatum*) should come from the lowland genotype from the New England coastal region, as these populations most likely represent the local genetic line. New England forest climax ecology may have influenced the fact that the New England regional genotype is typically found along coastal regions.

The Southern New England Lowland Tetraploid (SNELT) genotype ('Hammonasset') was identified by Geoffery Ecker and Carol Auer from the University of Connecticut, and the Colonial Seed Co. and Lemek Greenhouses, Tolland, CT, are establishing its seed source. This genotype comprises the majority of switchgrass populations in the New England coastal areas, but also occurs throughout its inland regions.

Map of Connecticut and Rhode Island showing distribution of switchgrass genotypes (from Ecker, G., Juan Z., and C. Auer. 2015. *Switchgrass (Panicum virgatum L.*) genotypes differ between coastal sites and inland road corridors in the Northeastern US (PLoS ONE 10.6)). Green dots represent plants identified as SNELT or other tetraploid genotypes; red dots represent octoploid genotypes; yellow dots represent individuals that could not be assigned to a specific group.

The genotypes, often growing in fields and roadsides, are most likely introduced genetic lines represented by octoploid plants. It is likely that the local genotype, which is tetraploid, will prove to spread much less aggressively than the commercial cultivars of introduced genotypes.

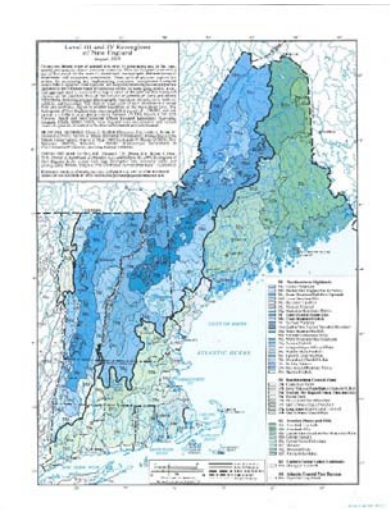
A comparison of a Massachusetts DOT planting of Midwestern-sourced *Panicum virgatum* (left photo by T. Mitchell) and a natural population of SNELT genotype (right photo by G. Ecker) demonstrates the low stature of the native genotype.

1.7. Ecoregion approach

Guidelines for the acquisition of seed for roadside establishment take different approaches—from the "as close to the project as possible" recommendation to absolute distance recommendations (e.g., within a 50-, 100-, or 150-mile radius). The best method is to use an ecoregion approach to identify appropriate sources of native seeds to ensure that locally adapted materials are used for optimum results.
The ecoregions represent areas of relatively uniform environmental conditions with similar geologic, physiographic, hydrologic, soil, climatic (rainfall, maximum and minimum temperatures), vegetative, and wildlife characteristics (http://archive.epa.gov/wed/ecoregions/web/html/new_eng_eco.html).

The map developed by the US Environmental Protection Agency (EPA) has four levels, from coarse (Level I) to fine (Level IV) with each level representing increasing degrees of detail. The US EPA ecoregion map at Level III divides the continental United States into 104 ecoregions and the contiguous United States into 84 ecoregions. The ecoregion map at Level IV further subdivides Level III ecoregions.

There are 5 Level III ecoregions located throughout the New England states: the Atlantic Coastal Pine Barrens; the Eastern Great Lakes and Hudson Lowland; the Acadian Plains and Hills; the Northeastern Coastal Zone; and the Northeastern Highlands (ftp://ftp.epa.gov/wed/ecoregions/ma/new_eng_eco_pg.pdf). In addition, there are 40 Level IV ecoregions within New England.



Even though variation of adaptive traits in plants is continuous across a specific area without displaying distinct boundaries, the ecoregion approach is most practical when making decisions about the distance from a project site that the seed may be transferred. Since each ecoregion is characterized by relatively uniform environmental conditions, plant seed collected within a project ecoregion at the Level III scale can be transferred with minimal risk of being poorly adapted.

Another critical aspect that should be taken into consideration when procuring or developing local seed production is genetic diversity within each species.

Genetic foundation. Maintaining genetic diversity (a number of genetically distant parent plants) to preserve a broad genetic base in populations established during revegetation should also be considered when collecting seed from local populations. Genetic variation of the established plants is significantly reduced when plants are propagated from a very small sampling of the population. This could have potentially significant consequences for the viability of revegetation efforts. Genetic diversity is important for plant populations to be able to adapt to new stresses and to resist short - and long-term environmental changes while providing for the long-term sustainability of revegetation efforts.

The number of parents required to capture most of the genetic variation in a population should be considered when collecting native plant materials, and a similar amount of seed should be collected from each parent. Reproductive strategies vary between species, and there are different seed collection protocols for each species to ensure the genetic integrity of each species. A sufficient number of unrelated seed parents (in outcrossing species) must be included in the seed mix to conserve sufficient genetic diversity and to prevent inbreeding problems in future. Also, to thoroughly represent the populations within a region, in addition to the numbers of parents sampled from each site, seeds should be collected from multiple sites within the region to allow cross-pollination by various parents. Seed collection, transfer, and propagation guidelines to conserve sufficient genetic diversity have been developed for native plants (Withrow, Robinson, and Johnson, 2006).

1.8 Sources for local seed

In both the public and private sectors, seed producers recognize the need for local seed and have been developing local seed production programs to meet this requirement. Seeds that are available from seed companies and nurseries are increasingly identified by their source, or origin, which facilitates the purchase of appropriate materials for specific projects.

A seed industry for some of the species listed in Chapter 6 already exists in other regions of the United States, simplifying the adoption of seed production protocols at the local and regional levels. However, little is known about the propagation protocols for other species. These species should be marked with the "development status" until propagation protocols are established and field trials prove their successful performance along roadsides.

While the technological capacity of native plant propagation and subsequent outplanting of local genotypes has significantly increased over the past decade, challenges remain to obtaining appropriate materials for revegetation projects. The main challenge for New England is simply that the volume of seed required for a revegetation project is large, but local seed is not available in sufficient quantities in our region.

Local seed is very limited in New England, and only a few sources offer an incomplete selection of local plants. They are listed below:

- Nasami Farm Nursery (New England Wild Flower Society, Whatley, MA) collects local seeds throughout the region and works with some nurseries to propagate plants.
- New England Wetland Plants, Inc. (Amherst, MA)
- Colonial Seed Co LLC (Windsor, CT)
- Project Native (Housatonic, MA)
- Earth Tones LLC (Woodbury, CT)

Also, Ernst Conservation Seed, Inc. (Meadville, PA) offers limited selections of native seed from New England ecotypes.

Figure 1.16 The research nursery of the Colonial Seed Co. LLC (Windsor, CT) where the company is conducting trials for native grasses.

"It is important that the seed used for restorations and plantings along roadsides in New England come from a local source, i.e. locally adapted seed. Seed from local sources, especially in the quantities for roadsides, is not likely to be found. I would suggest that local seed sources be collected through contracts, planted in appropriate sites, and then used as sources for future plantings. As your plantings increase, so would your seed sources."

William E. Brumback, Conservation Director, New England Wild Flower Society

An important recommendation is that foundation plots of native seed be established, and native plants be available to state commercial seed growers in New England. This would lead to the expansion of the industry and availability of native seed for future restoration projects. Also, the possibility of contracting for "local" seed to be collected on a project basis should be considered in the meantime. This would have a shorter lead time than trying to organize the establishment of foundation plots to get commercial growers producing quantities. In both cases local seed sources ensure that restoration plantings are conducted under the strict terms recommended by plant conservation organizations.

Chapter 2: Site Assessment and Inventory

John Campanelli and Cristian Schulthess
University of Connecticut

Scientists assess a site along US Route 6.

One of the main goals in transitioning roadsides to native plant communities is to create sustainable landscapes that require minimal long-term maintenance. Achieving such sustainability requires matching the cultural requirements of the plantings to specific site conditions. Since roadside conditions can vary tremendously, no singular plant palette or establishment method exists that can accommodate every roadside. Determining which plants will persist and which planting method will succeed requires thorough site assessment.

The Site Assessment and Inventory method presented in this chapter includes analysis of the following categories:

2.1 Protected Areas Surrounding Site
2.2 Roadside Limitations
2.3 Roadside Topography
2.4 Soil Conditions
2.5 Existing Vegetation

Site Inventory and Assessment Checklist Title Page

Site name _____

Persons conducting inventory:_____

_____

Site location: _____

EPA ecoregion -

(https://archive.epa.gov/wed/ecoregions/web/html/new_eng_eco.html):

_____

Cold hardiness zone (http://planthardiness.ars.usda.gov/PHZMWeb/)

Zone 3____ Zone 4_____ Zone 5 ____ Zone 6____ Zone 7____

Route name or #:_____

Route mile points :_____ **Town:**_____

GPS coordinates: _____

Total acreage of site being analyzed_____

Soil map using web soil survey (WSS) website -

(http://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm):

Use the site location information obtained above to find and print a satellite map using the Web Soil Survey website. Search surrounding areas for protected areas and include them within the parameters of the map.

2.1 Protected areas surrounding site

Protected lands surrounding the site may influence site preparation methods, including herbicide use, as well as seed mixes. For example, if remnant native plant communities of rare species exist nearby, inclusion of these species would be forbidden in new roadside revegetation projects, to prevent contamination of the remnant population. The nearby presence of wetland areas or protected wildlife habitats could severely restrict the use of herbicides and insecticides. If any of the following protected areas are within 0.5 miles of the site, contact the state Department of Environmental Protection and/or Natural Heritage Program. The definitions following some of the protected land categories are those used by the International Union for Conservation of Nature (IUCN):

- **Wetland Areas**

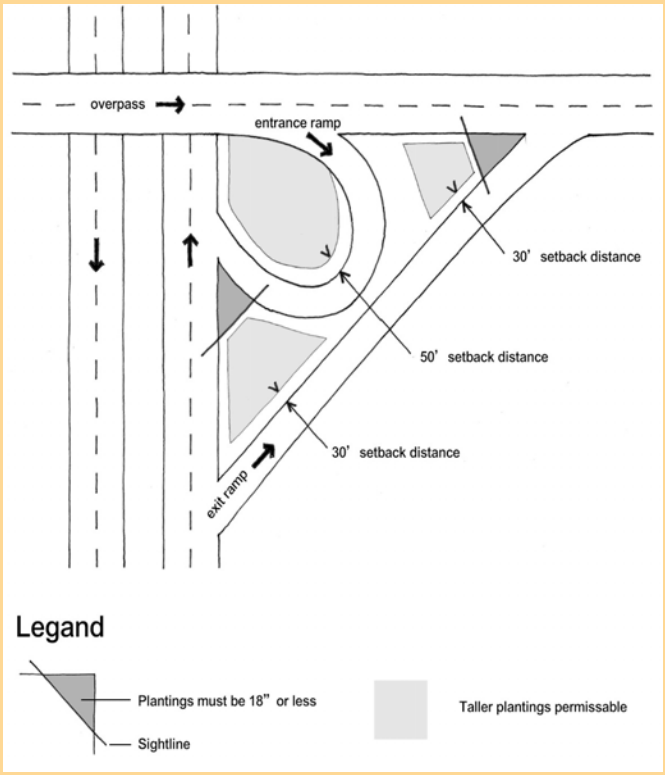
- **Strict Nature Reserves:** strictly protected areas set aside to protect biodiversity and also possibly geological/geomorphical features, where human visitation, use and impacts are strictly controlled and limited to ensure protection of the conservation values.

- **Wilderness Areas:** large unmodified or slightly modified areas, retaining their natural character and influence without permanent or significant human habitation, which are protected and managed so as to preserve their natural condition.

- **National Parks:** large natural or near natural areas set aside to protect large-scale ecological processes, along with the complement of species and ecosystems characteristic of the area, which also provide a foundation for environmentally and culturally compatible, spiritual, scientific, educational, recreational, and visitor opportunities.

- **Natural Monument or Feature:** a specific natural monument, which can be a landform, sea mount, submarine cavern, geological feature such as a cave or even a living feature such as an ancient grove.
- **Habitat/Species Management Areas:** Areas designated for the protection of a particular plant or animal species or habitats .
- **Protected Landscape/Seascape:** A protected area where the interaction of people and nature over time has produced an area of distinct character with significant, ecological, biological, cultural and scenic value.
- **Protected areas with sustainable use of natural resources:** Protected areas that conserve ecosystems and habitats together with associated cultural values and traditional natural resource management systems. They are generally large, with most of the area in a natural condition, where a proportion is under sustainable natural resource management and where low-level non-industrial use of natural resources compatible with nature conservation is seen as one of the main aims of the area.
- **Not within 0.5 miles of a protected area**

2.2 Roadside limitations



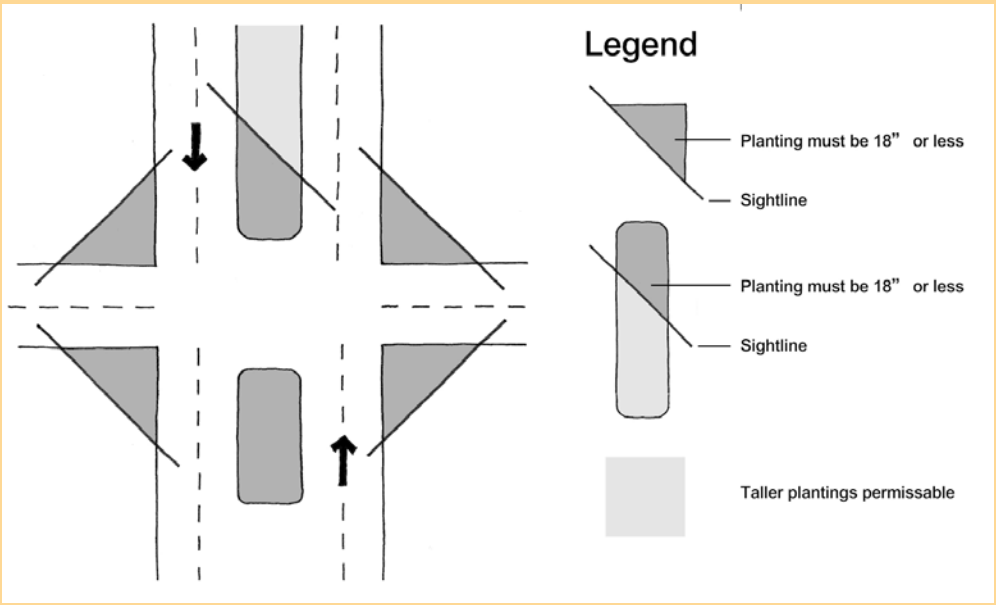


Figure 2.1 Preserving safe intersections, exits, on-ramps, and medians. Illustrations by Boya Yuan.

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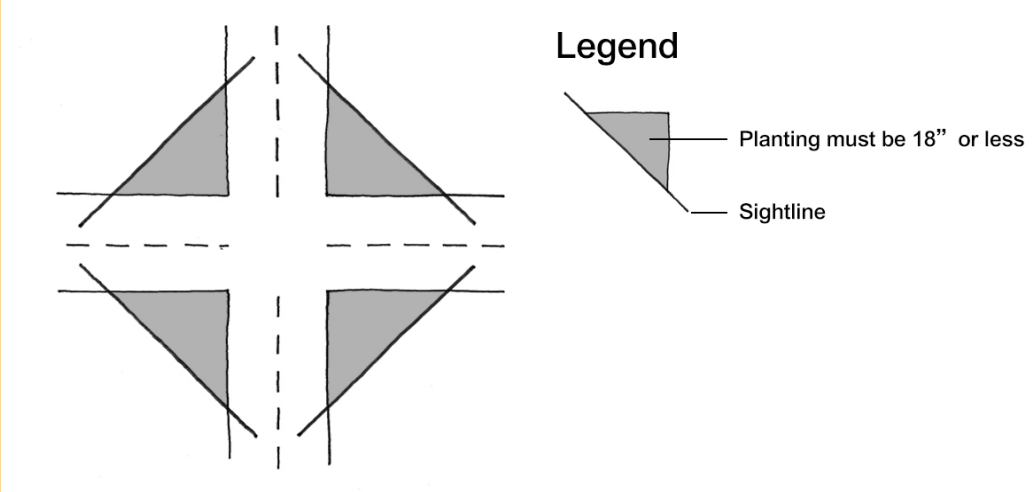

Figure 2.1 (continued) Preserving safe intersections, exits, on-ramps, and medians. Illustrations by Boya Yuan.

The top priority for any DOT is to provide a safe and efficient transportation system. Plant selection and location design help contribute to safe travel by maintaining sight lines and clear zone recovery areas. *Delineating the following roadside zones on the WSS map will help with plant selection and seed calculation.*

Lines of sight.

Maintaining clear lines of sight is essential for safe driving. If any portions of a planting site are located near the following road interchanges of structures, choose low-growing plants that grow no more than 18" tall and avoid any species that can grow tall, such as grasses like big bluestem (*Andropogon gerardii)* and forbs like spotted Joe-pye weed (*Eutrochium maculatum*). Of special concern are:

☐ Sites within or near **an exit** or **on-ramp**

☐ Sites near **an intersection**

☐ **Medians**

☐ No site restrictions apply

Presence of guardrails, barrier curbs, and directional signage. It is important that roadside plantings do not interfere with the visibility of guardrails, barrier curbs, and directional signs. Overgrown vegetation can obscure visibility of these structures, creating hazards for drivers. Planting especially low-growing vegetation around these structures will help minimize the amount of time-consuming maintenance such structures usually require.

☐ **Guardrail** Yes No (Length: _____ feet)

☐ **Barrier curb** Yes No (Length: _____ feet)

☐ **Directional signs** Yes No # of signs at site _____

☐ No guardrails, barrier curbs, or directional signs in area being assessed.

Utility structures.

Plans for planting should take into consideration the need for maintenance of and access to utility structures. Planting around these structures with low-growing vegetation and grasses that can withstand frequent mowing will help insure proper access to utility installations.

☐ Above-ground high-voltage electric wires

☐ Control boxes requiring access

☐ No utility structures in area being assessed

Stormwater drainage.

The presence of stormwater drainage conduit openings will greatly affect soil drainage capabilities. Documenting the location of stormwater drainage conduit openings on the WSS Map will help to clarify the site's hydrology by outlining those areas on the site that experience more frequent periods of flooding or, in the case of catch basins, help document the patterns by which stormwater travels across and is removed from the site. It is important to select species that help facilitate desirable hydrology. Plantings relative to these structures should help increase stormwater soil infiltration, help prevent soil erosion, and not impede drainage into these structures.

☐ **Stormwater drain outlet**s that empty stormwater onto site: # on site _____

☐ **Pipe culverts** that allow water to flow under a road onto site: # on site _____

☐ **Stormwater drain inlet/Catch basins** that remove stormwater from site:

on site _____

☐ No stormwater drainage structures in area being assessed

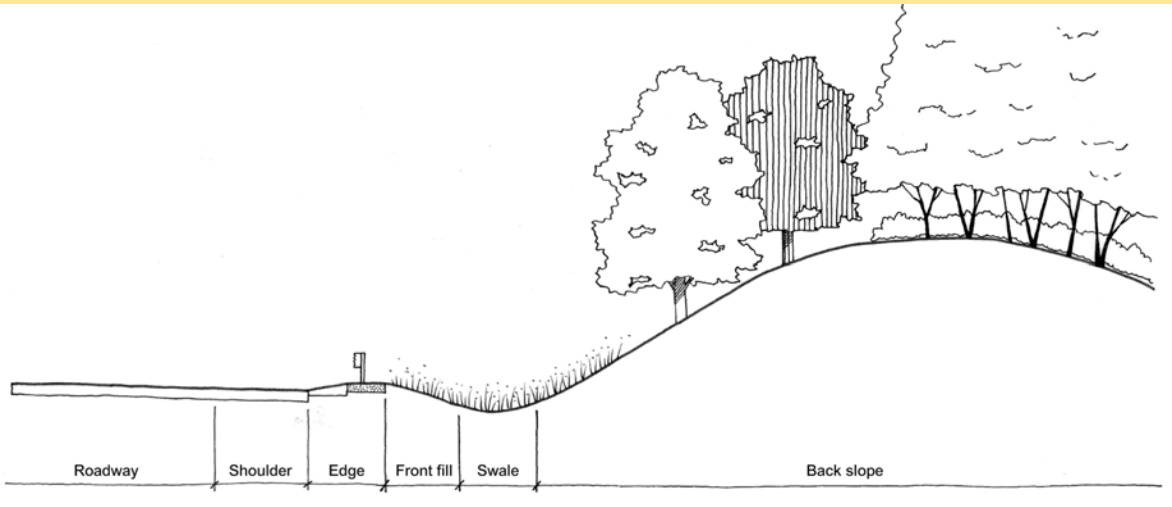

Figure 2.2 Roadside zones. Illustrations by Boya Yuan.

Roadside zones. Depending upon location, speed limit, and roadside topography, roadsides typically contain up to five roadside zones. These zones play important roles in maintaining driver safety and influence landscape structural integrity by preventing soil erosion and assuring stormwater drainage.

- Clear zones provide areas along the roadside for drivers to pull over in case of emergency or for errant vehicles to regain control after running off the road. The **shoulder/approach** and **border/edge zones** especially require proper clearance to provide a safe environment for vehicles. Even after roadside mowing regimes become less frequent, the border/edge zone will still require frequent mowing. Tall grasses within the border/edge zone can be fire hazards resulting from the heat of vehicle engines, undercarriages, or exhaust pipes. Border/edge zones planting should continue to consist of grass species that can withstand multiple mowings each year.

- Slopes and swales play roles in the removal of stormwater from roads. Swale zones require the planting of species that can withstand temporary flooding.
- Plantings on front slopes, such as warm-season grasses, help slow runoff and increase water infiltration.
- Back slopes are usually steeper than front slopes and will require plantings that prevent soil erosion.

If any of the following zones exist at a site, delineate them on the WSS map. This will help with measuring the size of the areas each encompasses and will help with seed mix calculations. For example, the portion of the landscape through which the swale zone runs will require a proportional amount of seed of species adapted to temporary flooding. Sloped portions of the site will require seeding that can quickly insure erosion control, especially if it follows new construction. In addition, slopes will require greater quantities of seed to compensate for seed dislodgement following rain events.

☐ Shoulder/approach zone

☐ Border/edge zone

☐ Front/fill zone: area covered _____

☐ Swale/ditch zone: area covered _____

☐ Back slope/cut slope: area covered _____

2.3 Roadside topography

Sun exposure. Sun exposure may vary from site to site depending upon the relationship of the area to a woodland's edge or transportation structures, such as bridges. If such exposure differences exist, delineate them on the WSS map.

Full sun (up to 20% of ground is shaded): total area_____
Partial sun (20%–70% of ground is shaded): total area_____
Shade (more than 70% of the ground is shaded): total area_____

Slope grade. Slope grade will influence mulch, cover crop, and erosion control requirements. Delineate and designate the variance in steepness on the WSS map.

Flat to 1:20 (5%) slope: total area_____
1:20 (5%) to 1:10 (10%) slope: total area_____
1:10 (10%) to 1:3 (33%) slope: total area_____
Steeper than 1:3 (33%) slope: total area_____

Slope aspect. Steep south- and west-facing slopes, which receive more direct sun, are hotter and drier while steep north- and east-facing slopes, which receive less direct sun, and are wetter and shadier.

Circle all aspects that exist on the site. In addition, label the aspect of each slope on the WSS map.

North East South West

2.4 Soil conditions

Herbicide use on site within 3 years of seeding. Carryover from applications of particular herbicides may adversely affect native seed germination. If any of the following herbicides have been used within 3 years prior to seeding, note locations on the base plan where the herbicides were used and wait to install native seed in these areas until the sites are free from carryover. Use temporary erosion control cover crop, which are usually less susceptible to herbicide carryover, until these areas are ready for seeding.

Check if any of these herbicides were used within the last 3 years from present date: _____

☐ **Aminopyralid** (Milestone®, Chaparral®, CleanWave®, ForeFront®, GrazonNext®, Opensight®)

☐ **Picloram** (Tordon®, Grazon®, Access®, and Pathway®)

☐ **Clopyralid** (Stinger®, Transline®, Reclaim®, Curtail®, Confront®, Clopyr AG®, Lontrel®, Millennium Ultra®, Millenium Ultra Plus®, and Redeem®)

☐ **Atrazine**

☐ Other_____

☐ None were used in last 3 years

☐ Not known

Selecting tests for determining soil characteristics. Soil tests provide important information when selecting native plants for a site. One of the advantages of using native plants is their adaptation to a region's soils and climate. However, not all native New England species are able to thrive under every soil or climatic regime. Therefore, matching seed mixes to a site's particular soil profile is essential for plants to persist longer and prevent the need for soil amendments. This checklist describes four different soil tests from which to choose. The following list is prioritized in the order in which they are recommended:

☐ **State Cooperative Extension Soil Test**

☐ **Percolation Tests**

☐ **Texture by Feel Test**

☐ **Redoximorphic Features**

It is highly recommended that the first two tests—the State Cooperative Extension Soil Test and Percolation Test—be conducted at each site.

Together, these tests should provide sufficient data when selecting plant species. For example, if percolation test results indicate that a portion of a site has poorly draining soil, a seed mix for that area would need to include species that are able to withstand extended periods of moisture. In addition, soil test results pointing to a mesic soil regime implies potentially greater weed pressure after seeding than would occur at a drier site. Furthermore, soil tests conducted by the extension service may show extremely low levels of nutrients. In such cases, it is important to include plant species that can tolerate nutrient poor soils. Perhaps, only warm-season grasses and a few forbs would establish on such a site.

State Cooperative Extension soil test. Soil tests analyzed by state land grant university cooperative extensions provide extensive soil information for an affordable fee. Search online for the forms for your state and the method for collecting and sending soil samples. Document the results of the test below or staple the results to this checklist.

Soil texture. If a site has large areas with varying topographical features, more than one soil test may be required. Delineate and designate any changes in soil texture on the WSS map of the site. Measuring the total area covered by each texture class will help when calculating seed mix amounts suitable for that soil texture. Each state has different test result formats. Some states do not include optimal nutrient or organic matter ratings.

☐ Sand: total area _____

☐ Sandy loam: total area _____

☐ Loam: total area _____

Clay loam: total area _____

Clay: total area _____

Other: total area _____

pH: _____

Organic matter content: _____%

☐ Low (< 4%) ☐ Medium (4%–8%) ☐ High (> 8%)

Soluble salt level: _____ms/cm

- **< 0.4 ms/cm**: low, safe for most all plants
- **0.4–0.8 ms/cm**: may cause damage to saline sensitive plants
- **0.81–1.2 ms/cm**: will restrict the growth of many plants
- **> 1.2 ms/cm**: likely to cause plant damage

Calcium: _____ppm

Very Low Low Optimal High Very High

Magnesium: _____ppm

Very Low Low Optimal High Very High

Potassium: _____ppm

Very Low Low Optimal High Very High

Phosphorus: _____ppm

Very Low Low Optimal High Very High

Percolation tests. "Perc" tests measure the rate at which water moves through a soil profile. These tests are rather straightforward and can be conducted by any trained field person.

The macroporosity of a site's soil will influence the rate of water flow. The higher the soil porosity, the greater the soil aeration as well as the rate of soil water infiltration. Relative soil moisture infiltration will influence site plant selections. Perc tests resulting in particularly slow water infiltration can pose serious problems for plant establishment because a site's soil may display high surface runoff, soil erosion, seed loss, and hypoxic (low oxygen) conditions.

Performed by_____

Date: _____ Time:_____

Tools used:_____

Notes (such as initial moisture and other relevant information):

Box 2.1 How to conduct a percolation test

- **The best time to conduct a perc test is after a significant rain event, when the soil is moist.** This factor is important because, if the soil surrounding the test hole is dry, the adhesive forces of the dry soil will pull the soil water laterally. Therefore, if it is not possible to conduct the test following rainfall, it is critical that the soil within a foot or two of the hole be as wet as possible.
- **If the soil is particularly dry**, fill the hole several times with water and thoroughly wet a one-foot area surrounding the hole.
- **Start by first removing the turf in the area being tested and dig a hole** with an opening measuring around one square foot. Dig down 12-18 inches, making sure to remove the soil.
- Once the soil surrounding the hole appears saturated, **fill the hole to the soil surface with water. Immediately measure the height of the water** in the hole using a yardstick.
- **Wait 15 minutes** and **once again measure the height of the water**.
- **Subtract the second reading from the first one** to determine the rate of drainage over 15 minutes. **Multiply this rate by 4 to determine inches drained per hour.** Since some water will still be pulled horizontally, the resulting calculation will likely be an overestimation.

Soil Drainage Rates:

- < 1 inches/hour = **poor drainage**
- 1 to 4 inches/hour = **moderate drainage**
- > 4 inches/hour = **excessive drainage**

On-site texture by feel test (Figure 2.3). This is a good, inexpensive preliminary test that is particularly helpful if portions of a site appear to have more than one soil texture. When conducting the test, collect samples from the top 3 inches of soil since this is the depth at which seedlings will take root. If soil compaction is suspected, collect soil from the top 6 inches of soil.

Since this is a quick and easy test to conduct, it is recommended that several tests be carried out, especially if the site has varying elevations or distinctively different plant communities. If more than one textural class is found, you can determine whether several extension or percolation tests need to be conducted on these different areas. If you conduct more than one texture-by-feel test and find varying textural results for different areas at the site, document the results found on that area of the WSS map. This information will help with plant selection.

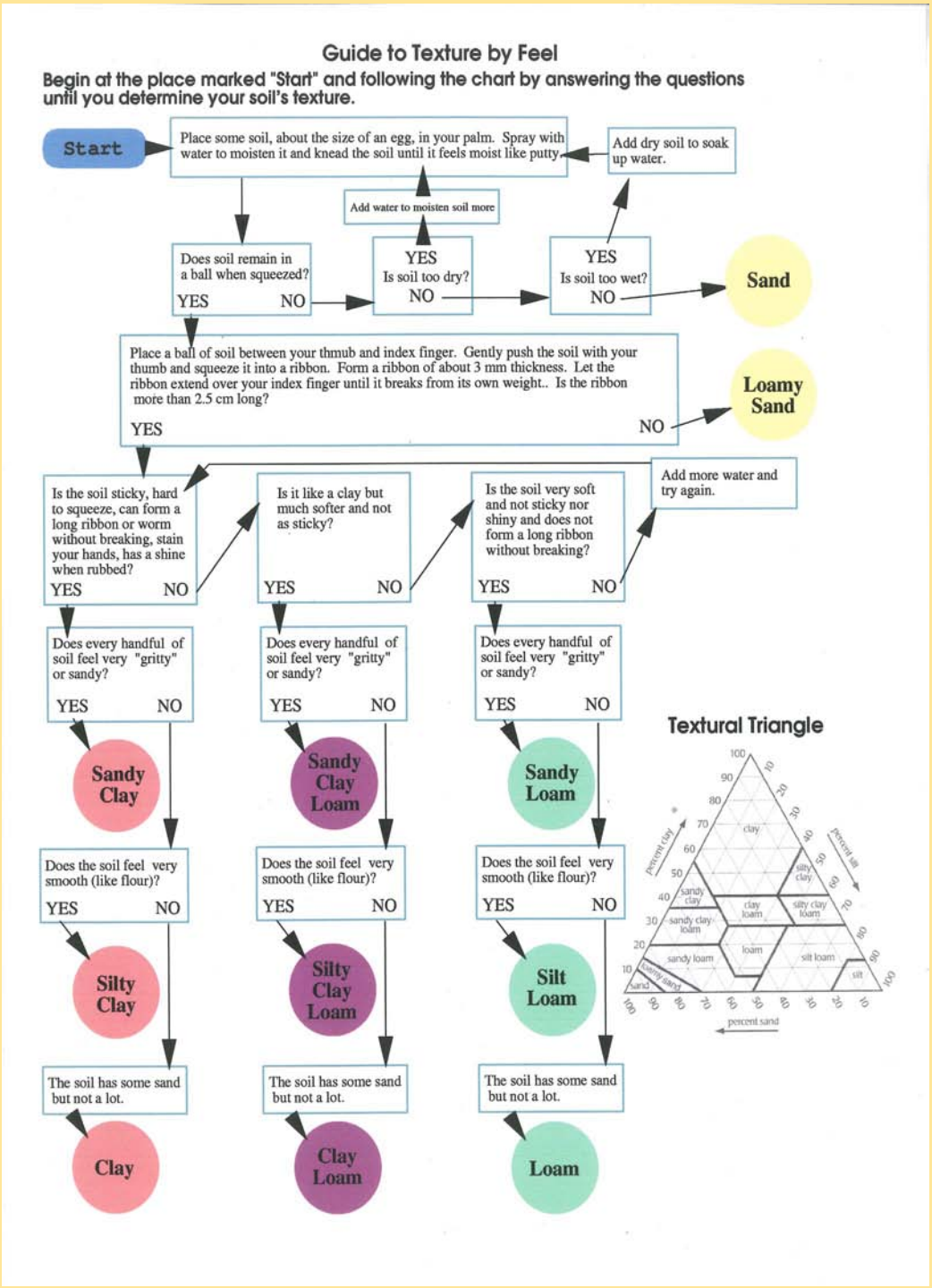

Figure 2.3 Adapted by University of California Cooperative Extension Master Gardener Program from: Thien, Steve J. 1979. "A Flow Diagram for Teaching Texture-by-Feel Analysis." *Journal of Agronomic Education*, 8:54-55.

Figure 2.4 Soil scientist Cristian Schulthess conducts redoximorphic feature soil test at site along U. S. Route 6 in Connecticut.

On-site test of redoximorphic features. Tests of redoximorphic features should be reserved for more problematic sites that display either poor seedling establishment or extremely poor drainage. This test usually requires a trained soil scientist to conduct— although, with proper training, a field person can learn how to properly conduct this test.

Tests of redoximorphic features help determine soil drainage classes by examining the specific coloration of soil layers, known as mottles. The specific soil color provides information concerning the reduction of particular minerals resulting from seasonal levels of soil water saturation.

Since this test requires a higher level of expertise to conduct, it is probably the most expensive. However, it will likely provide some of the most valuable information for determining drainage classifications and soil texture. Contact your state's land grant universities or NRCS offices to find soil scientists trained to conduct such tests.

2.5 Inventory of existing vegetation

- The best time to conduct plant inventories in New England is usually from early August to the beginning of fall when warm-season grasses have begun to flower. It is usually easier to identify plant species, especially grasses, from their flower and inflorescence morphologies rather than from their leaf morphology.
- While a botanist trained in identifying plant species would be the first choice for conducting a plant inventory, few DOTs have access to one. Those persons conducting site inventories will require training to identify regional roadside plant species. Existing Plant Species tables include a space for documenting Wetland Indicator Status (WIS). While not a perfect method, WIS can help point to classes of species that thrive under similar conditions. However, it should be noted that cataloguing plant WIS is not a substitute for soil testing or an indicator of a site's wetland status.
- Plant species require specific soil and climatic conditions to thrive. Therefore, if an inventory of a site's vegetation reveals, for example, a collection of plants best adapted to dry, sandy soils, then the seed mix should include species that can thrive under similar conditions. Species composition can change within a site depending on hydrologic and climatic conditions. For example, low lying areas and those exposed to drainage outlet runoff may be populated by species that can withstand temporary flooding. It is important to delineate these varying site conditions on the WSS map. If a site has more than one set of soil or climatic conditions, it might be beneficial to print more than one set of Existing Plant Species tables.

- If an inventory reveals colonies of native species, then site preparation should use techniques provided in Chapter 3 ("Establishment Methods") that help preserve these native colonies. This not only saves time and money, but also preserves local populations that have already adapted best to the region's climatic conditions.

Existing plant species tables

Native New England plant species	Estimation of coverage (%)	Wetland indicator status

Undesirable plant species (other than invasive plant species)	Estimation of % Coverage	Wetland Indicator Status

Invasive species growing within site to be planted

- List below the invasive species growing within the site and note the extent of each species on the WSS map.
- High invasive species cover will require significant site preparation to eliminate or minimize invasive species pressure prior to planting.
- Consult state invasive species experts and manuals for guidance in combatting particular invasive species before planting new vegetation.

Invasive species (I.S.) growing within site to be planted	**Cover (%)**	**Estimated surface area covered by I.S.**	**Will I.S. roots and seed be removed prior to seeding?**

Invasive species growing adjacent to site

- Although invasive species may not exist within the boundaries of the site, their aggressive ability to spread puts new plants at risk if colonies of invasive species border the new planting site. Eliminating or using methods to control these adjacent invasive colonies will help to prevent their overwhelming the newly revegetated site.
- List in the table below the invasive species growing adjacent to the site.
- When delineating the Areas of Interest while creating the WSS map, be sure to include portions of surrounding areas where invasive species colonies exist.
- Consult state invasive species experts and manuals for guidance in combatting particular invasive species before planting new vegetation.

Invasive Species (I.S.) growing adjacent to site	**Cover (%)**	**Estimated surface area covered by I.S.**	**Will I.S. roots and seeds be removed prior to seeding?**

Indicators of stress on existing species

- ☐ Interveinal chlorosis
- ☐ Chlorosis
- ☐ Leaf wilting
- ☐ Marginal leaf scorch
- ☐ Premature fall coloration
- ☐ Stunted growth

Species affected by stress	Stress symptoms

Chapter 3: Establishment Methods for Native Plant Communities

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While native plant communities provide longer-term ecological and economic benefits compared to nonnative cool-season turfgrasses, the establishment of biodiverse native plantings requires more intensive protocols than monocultural turfgrasses. Unlike cool-season turfgrasses, which can be seeded and established within one growing season, native warm-season grasses and forbs germinate more slowly, and a community of native herbaceous plants can take three to five years to fully establish.

The establishment of native species requires consideration of the three following components:

- Site preparation
- Seeding
- Post-establishment monitoring and maintenance

This chapter covers each of these components and describes various factors that need consideration in the course of native plant community establishment.

3.1 Site preparation

Figure 3.1 Site along US Route 6 sprayed with glyphosate in preparation for no-till drilling.

It's essential to survey a site well before planting takes place to develop an approach to the establishment of natives and to allow adequate time to complete successful site preparation. The composition and density of the existing vegetation will determine the amount of site preparation required.

The biggest challenge when establishing native plant communities is frequently competition from nonnative vegetation, whether from cool-season turfgrasses that DOTs have established intentionally or weedy and invasive species that have infiltrated roadsides inadvertently. Undesirable species compete with native plants for resources, including light, soil space, nutrients, and water. A thorough plant inventory of a site will provide useful information concerning the level of noxious and aggressive weeds and/or invasive plants present. If significant quantities of undesirable vegetation exist, it may take a year or more to control them before planting, especially if planting in a large area. Weed species commonly found along roadsides readily adapt to ruderal environments —*disturbed* habitats where soil or natural vegetative cover frequently gets damaged, usually as a result of vehicular intrusions. In fact, disturbances give weed seeds the resources they need—especially light—to germinate and outcompete non-

weedy species.

To achieve optimal results, it is best to start weed control at least a year before planting, whether using herbicides or especially when herbicides are prohibited. It is also important to keep in mind the time at which seeding will occur. Successful planning considers the species to be included in the seed mix, the most favorable time for seeding within the framework of the overall plan, and which equipment will be used for seeding. Working backwards, determine what steps can be taken beforehand to insure that the planting area is as well-prepared and weed-free as possible.

Box 3.1 Allotting enough time for site preparation

Mark Brownlee, a principal with the ecological restoration firm ArcheWild, has extensive experience establishing native plant communities as part of ecological restoration projects for both government and private clients. Mark believes that site preparation should not be rushed—"Prep can be expedited but with significant risk"—and sees a year or more of site preparation as time well spent. Mark believes that two years of site preparation play a valuable role in successful site establishment. Those two years of prep help to prevent later challenges resulting from weed pressure. When his firm was establishing a 31-acre research meadow in New Jersey, they used the following site-prep timetable:

Year 1: Spray—spray again—till—cover crop—mow

Year 2: Spray— spray again—till—cover crop—mow

Year 3: Plant

Waiting two years before planting seed may seem excessive for a government agency like a Department of Transportation, especially compared to the relatively short timeframe it takes introduced cool-season grasses to establish. However, if this extra time guarantees more successful native plant community establishment, thus preventing the waste of time, effort, and money resulting from establishment failure, then that is time well spent.

Two main scenarios exist for native plant revegetation:

- **Establishing native vegetation on bare soil following construction**
- **Transitioning existing roadside vegetation to native plantings**

Each scenario presents different challenges.

3.1.1 Establishing native vegetation on bare soil following construction

Prior to construction, work crews remove existing vegetation when skimming the topsoil surrounding a construction site. After construction completion, either the stockpiled topsoil is returned to the site or "weed-free" topsoil is brought in from another source. Rarely is weed-free, vegetation-free topsoil to be found. Determining the amount of weed propagules present in the topsoil will help guide the decisions for effectively preparing a site for planting. Since construction subjects a site to major disturbance, weeds may overwhelm the site following construction completion if the soil is full of weed seeds or viable roots. If noxious or aggressive weeds are not suppressed prior to planting, these weeds could be very difficult to kill in a new planting without destroying the newly established native plants.

Site preparation will depend upon when in the calendar year the construction ends. If construction ends during a less-than-optimal time for native seeding, a cover crop may be needed for erosion control and/or to prevent re-encroachment of weedy species. It is important to chose a temporary *annual* cover crop—grain oats (*Avena sativa)* from spring to August 1; cereal rye (*Secale cereale*) thereafter. Then, the following year, plant the native grasses.

3.1.2 Transitioning existing roadside vegetation to native plantings

Part of the site analysis requires an inventory of existing vegetation followed by determination of which establishment method best suits the particular site conditions. Preparation for a site with existing vegetation will depend upon the presence of native species populations and the composition of these populations. There are two scenarios:

- Transitioning predominantly nonnative existing roadside vegetation to native plantings
- Augmentation of existing native plant communities

3.1.3 Transitioning predominantly nonnative existing roadside vegetation to native plantings

If a section of roadside does not have existing high-density native communities, it can be transitioned to a native planting. In such a case, it is essential to eliminate existing vegetation before planting to reduce competition.

The existence of cool-season turfgrasses and weeds create a considerable barrier for warm-season plant establishment. Since cool-season plants start to grow at temperatures lower than those required for warm-season plants, they have a head start of several weeks to compete for limited resources. In addition, warm-season grasses are slow to germinate and exhibit less seedling vigor than cool-season grasses and weedy species.

Unfortunately, eliminating undesirable vegetation is not a one-step process. Even if cool-season grass and weeds are killed with an application of broad-spectrum herbicide before warm-season grass break dormancy, weed pressure can still come in the form of warm-season weeds such as crabgrass (*Digitaria sanguinalis*), goosegrass (*Galium aparine*), barnyardgrass (*Echinochloa crus-galli*), yellow foxtail

Box 3.2 Efficacy of herbicide use during site preparation

When people interested in establishing native plant communities hear that some of the most effective and cost-conscious methods for site preparation involve the use of nonorganic herbicides, quite frequently they raise concerns. Many municipalities and state governments not only discourage but outlaw their use. In such cases, there are alternatives, including tilling, organic herbicides, and flame guns for spot-weeding. While viable, these methods require greater amounts of time and money and have proven less effective.

Though herbicides do play a role in native plant establishment, the majority of their use occurs on the front end of the process—usually in the first 3 years. Thereafter, herbicide applications decrease greatly.

Because the first year in the establishment process requires the elimination of undesirable vegetation, it uses the greatest amount of herbicide, usually in the form of a broad-spectrum like glyphosate or the selective Plateau®, which works especially well in grassland establishment. When using the two-step process of first establishing stands of warm-season grasses alone and incorporating forbs later, a follow-up application of a selective herbicide that targets dicots might be warranted.

Otherwise, most herbicide applications would spot-treat any weed infestations. As native plantings become more dense, weed pressure would decrease.

In addition, incorporating mechanical methods as part of site preparation can minimize the amount of herbicide used. For example, a site infested with an invasive species that spreads vegetatively, such as common reed (*Phragmites australis*) or mugwort (*Artemisia vulgaris*), can first be uprooted with tilling or exhausted with repeated mowings. Any seedlings that germinate as a result of soil disturbance or new vegetation that develops on mowed plants can be sprayed with herbicide, albeit at a rate lower than if applied to the mature plant stand.

(*Setaria pumila*), common purslane (*Portulaca oleracea*), pigweeds (*Amaranthus* sp.), lambsquarter (*Chenopodium album*), carpetweed (*Mollugo verticillata*), and prostrate knotweed (*Polygonum aviculare*). Since these weeds usually grow faster, they can rapidly outcompete warm-season grasses and forbs. In addition, since weeds by definition tend to produce abundant amounts of seed that can remain viable in the soil for many years, any disturbance created during site preparation will result in germination of existing weed seed banks.

Choosing a herbicide. Choosing a herbicide will depend upon the composition of existing vegetation as well as the time of the year when the herbicide is applied.

If no native plant communities exist, choose a nonselective herbicide such as **glyphosate**. Glyphosate can also be used where desirable native warm-season grasses exist if it is applied before warm-season grasses break dormancy. As long as warm-season grass blades have not started to emerge, glyphosate can safely be used without damaging dormant plants. For extremely vigorous turf or weeds, one application of herbicide in early fall, followed by another the next spring before planting is recommended.

The selective herbicides **Plateau®** or **Panoramic®**, imazapic-based herbicides, are well suited for native plant establishment. Plateau® and Panoramic® kill plants with faster metabolisms. Most native warm-season grasses and native forbs, such as partridge pea, black-eyed Susan, yarrow, and perennial lupine, are tolerant of Plateau® or Panoramic®, when used at the proper concentrations.

Because of their selectivity, Plateau® and Panoramic® can be used during either the fall or in the spring. In the fall, it is best to be used mid-to-late in the season, when perennial plants are translocating nutrients to their roots for winter dormant storage. Mid-autumn spraying of Plateau® or Panoramic® has the advantage of giving the remaining native plants time to take advantage of the extra soil space left open once the undesirable vegetation has been eliminated.

In the spring, glyphosate, Plateau®, Panoramic® or **Journey®** can be used. Because Journey® contains both imazapic and glyphosate, some studies have suggested that it works as both a post- and pre-emergent (Bahm 2015), thus eliminating pre-existing vegetation and suppressing the re-emergence of competitive nonnative grasses and weeds. If applying herbicide in the spring, it is best to apply one of these herbicides

just before native warm-season grasses emerge. Native warm-season grasses, such as little bluestem, purpletop, and switchgrass, break from dormancy when the soil temperature is about 65°F. Such temperatures usually occur when daytime air temperature reaches around 80°F. Nighttime temps also provide a good indicators of the soil temps. When nighttime temps are between 65°F and 70°F, soil temperatures will likely be very close to the same temperature. In New England, these ranges temperatures arrive in early to late May. A good phenological indicator that precedes warm-season native grasses breaking their dormancy is when the buds of the sugar maple (*Acer saccharum*) are just starting to open.

Selective herbicides usually work by targeting either monocots (grasses and grass-like species, such as sedges) or dicots. Since the most ecologically balanced native plant communities consist of both monocots and dicots, it may be challenging to plant both grasses and forbs in the same mix, especially if existing weed communities have not been fully eradicated. If the pre-existing plant community contains warm-season dicot weeds, it may be advisable to use the spring to establish just the warm-season grasses and plan to conduct a dormant seeding of forbs in the fall. Following warm-season grass establishment, if broadleaved weeds or invasive species emerge, a selective herbicide that targets dicots may be used for spot treatment. Usually, grass seedlings need to be at the 4- to 5-leaf stage prior to a broadleaf contact herbicide application to avoid herbicide injury.

Herbicide carryover. Carryover from herbicide treatments in prior years can pose a threat to new plantings. Seedlings are particularly sensitive to herbicide carryover. Glyphosate and Plateau® have very short persistence and generally do not pose a risk for carryover. Other herbicides such as atrazine have medium-to-long persistence and can pose a risk of carryover. The persistence of herbicides is affected by factors such as soil pH, organic matter, texture moisture, and chemical half-life. Before applying more herbicide, it is helpful to know which, if any, herbicides were applied previously to a site and when.

If time permits, conduct a bioassay by potting some of the soil and planting a small portion of the seed mix to observe the impact. In conducting the evaluation, check both the roots as well as the top growth for any carryover damage.

Using organic herbicides. One of the most commonly suggested organic herbicides is vinegar-based herbicide. Horticultural vinegar contains 20% acetic acid. To be fully effective, vinegar-based herbicides require at least three applications over a growing season. However, many who, either by choice or by regulation, have turned to organic herbicides have found that acetic acid is effective only on seedlings. When applied to mature, established vegetation, acetic acid only kills the upper portion of the vegetation and leaves the root zones intact, ready to regenerate.

Other organic herbicides include such active ingredients as pelargonic acid (Scythe®), citrus oil (Avenger ®), clove and cinnamon oil (Weed Zap®), and coconut- and palm-derived caprylic and capric acids (Suppress®).

Tilling. One of the best ways to kill existing vegetation without herbicides is to till the soil, thus uprooting and burying the existing vegetation. While this procedure can effectively kill existing vegetation, it does involve soil disturbance, resulting in germination of weed seeds.

Unless weed seed reserves have been exhausted, weed pressure will present a future challenge. Exhaustion of weed seed reserves requires **several rounds of tilling** spaced several weeks apart in order to kill the weeds that will germinate as a result of the tilling. This method is recommended when municipalities prefer not to use herbicides. Exhausting weed seed banks as part of site preparation can help minimize herbicide use later in the process.

Cultivation is usually less effective than herbicides for killing heavy sod or persistent weeds. Also, bare ground produced by cultivation may be vulnerable to erosion especially slopes. For this reason, non-herbicidal methods are recommended mainly for level ground.

An initial tilling at a depth of 3-6 inches kills most weeds. Subsequent shallow tillings at approximately 2-3 inches deep will eliminate newly germinated weed seedlings. This gradually reduces the amount of weed seed present in the soil. It is important to keep

subsequent tillings shallow to prevent more deeply buried weed seeds from being brought to the surface.

This method often requires several tillings spaced out over several weeks and months. Usually one tilling is conducted every three weeks. It would be important to start these tillings early in the season so that many passes can occur. Only when weed seed germination has been minimized will the field be clean enough for native plant establishment.

Since this process should take the entire growing season, it may be best to plant a cover crop following each tilling to prevent weed encroachment and soil erosion. In the summer, plant buckwheat (*Fagopyrum esculentum*). In the fall, plant cereal rye (*Secale cereale*) or winter wheat (*Triticum aestivum*). Native plant seeding can then take place either at the end of fall as a dormant seeding or late spring of the following year.

Using flame guns for spot-weeding. Some Midwestern, Western, and Southern DOTs use controlled or prescribed burning to manage invasive plant species encroachment into roadside native grasslands, wetlands, and woodlands. Many native ecosystems have evolved with fire as a contributor to habitat vitality and renewal. However, while many New England conservationists use prescribed fire as a tool to renew habitats for threatened animal species, such as the New England cottontail, or to renew remnant native plant communities, such as the world's largest population of northern blazing star (*Liatris novae-angliae*) in Maine's Kennebunk Plains, this manual does not recommend using prescribed fire along New England highway roadsides. Considering the traffic density on most New England highways, the smoke resulting from prescribed burning would obscure visibility and cause safety issues for drivers.

Nevertheless, for those DOTs concerned about using herbicides during the monitoring and maintenance portion of native plant community establishment, flame guns powered by a butane gas canister provide a non-chemical method to burn off the sprouting tops of weeds. The heat of the fire boils the water in the plants' cells, causing them to burst and die. This method works best against annuals and woody seedlings, and has the added advantage of burning some of the weed seeds lying close to the surface. This technique requires just a quick swipe over the weeds, which immediately boils the water inside the plants' tissues.

3.1.4 Augmentation of existing native plant communities

Pros:

- Increases populations of local, genetically adapted plants
- Lower in cost and faster than establishing new plantings using seeds or plugs
- Less time, labor, and resource intensive

Cons:

- Challenging to preserve populations of native cool-season grasses and forbs that co-exist with native warm-season grasses

New England roadsides have the distinct advantage, especially compared to those in other regions of the United States, of having an abundance of pre-existing, local native plant communities, often consisting of little bluestem, purple love grass, goldenrods, asters, and other species. When the density of these populations is high, it is practical to preserve and increase these communities. This approach to revegetation involves promoting natural regeneration rather than introducing new plant material—whether in the form of seed or plugs—which require more time, labor, and resources.

The strategy of revegetation by way of augmentation of existing native plant communities should always take priority over planting new native plant communities. Not only is this more economical, but it is ecologically sound. This approach preserves and increases the pool of local plants that has adapted best to the New England climate, and it provides an effective path forward in transitioning to native plantings while the supply of regional ecotypical native plant seed remains limited.

The following method for augmenting pre-existing native communities involves:

1. Identifying existing native plant communities
2. Delineating existing native plant communities
3. Applying herbicides at the appropriate time to eliminate undesirable vegetation interspersed with the desirable native plant communities
4. Reducing mowing.

Identifying existing native plant communities. In many cases promoting native plants already present at the site is sufficient to revegetate an entire portion of roadside. The selection of this option should be based on the abundance of native plants on a site determined during site assessment.

Identifying native plants can be difficult. One of the best strategies for identification involves becoming familiar with a species' flowers or, in the case of grasses, their inflorescences (flower clusters). An ideal time in New England for finding existing native grass communities is usually toward the end of August and into the fall. A good time to scout for native plant communities is when purple lovegrass (*Eragrostis spectabilis*) comes into bloom. Purple lovegrass is a low-growing grass. Before it flowers, it is easy to mistake its leaf blades for those of crabgrass. However, once it blooms, its inflores-

Figure 3.2 Purple lovegrass (E*ragrostis spectabilis*) in bloom along US Route 6.

cences create seas of dusty lavender clouds, often right along the borders of the road itself. During this time, many other native warm-season grasses flower, such as little bluestem (*Schizachyrium scoparium*), purpletop (*Tridens flavus*), switchgrass (*Panicum virgatum*), broom sedge (*Andropogon virginicus*), and Indiangrass (*Sorghastrum nutans*).

Box 3.3 Augmentation of existing native plant communities

Left: A population of little bluestem (*Schizachyrium scoparium*) infested with spotted knapweed (*Centaurea stoebe*) along US Route 6 in Connecticut.

Right: Population of little bluestem augmented by the elimination of spotted knapweed.

Throughout our demonstration trials, we often learned—as is often the case in scientific trials—either from unintended consequences or even failures. We discovered the method we now term *augmentation of existing native plant communities* as a result of our attempts to establish native plants communities from scratch.

At our sites along US Route 6, we noticed that two different-colored varieties of little bluestem had emerged after applying herbicide and seeding. The taller, more robust plants were green, while smaller seedlings were grayish-blue. We soon realized that the grayish-blue variety looked like the little bluestem cultivar *Schizachyrium scoparium* 'Camper', which originates from the Midwest and was included in our mix. The green plants were local varieties that already existed along the roadside.

We also noticed that the green little bluestem plants that existed within our test plots were taller and their populations more dense than the green little bluestem outside our test areas, which were not sprayed with herbicide. The existing little bluestem outside the test plots were crowded by great numbers of weeds. As summer started to end, these little bluestem started to turn reddish-brown sooner than those within our test plots, suggesting the possibility that competition for nutrients and water with weedy species catalyzed senescence in those grasses outside the test plots.

We realized that our specifically timed application of herbicide, which killed cool-season grass and weed competition, benefited not only the newly introduced plants but also the pre-existing ones. To test our assumption, we conducted several trials.

Box 3.4 Augmentation trials

We scouted for pre-existing populations of little bluestem infested with other weedy species and found populations infested with either spotted knapweed (*Centaurea stoebe*) or birdsfoot trefoil (*Lotus corniculatus)*. We then cordoned off three 10' by 10' plots next to each other. One plot was sprayed with Plateau© in the fall, one was sprayed with glyphosate in the spring, and one was left untreated and used as a control.

Above left: Population of birdsfoot trefoil eliminated in the fall with Plateau®.

Above right: Birdsfoot trefoil eliminated in spring using glyphosate.

Left: Control of birdsfoot trefoil.

The density of the birdsfoot trefoil population left large patches of exposed soil, which allowed nearby spotted knapweed to infest the area the following year.

Our results were encouraging. For those test plots where the populations of little bluestem were already relatively dense—approximately 30%–50% of the vegetation cover—the treated populations became both denser and more vigorous than those in the control plots. However, when the weedy populations were especially dense, which was the case with the birdsfoot trefoil, the remaining little bluestem plants were larger; but because the ground surrounding them was disturbed and exposed, weedy species, especially spotted knapweed, re-encroached upon the test plots the following season. This situation required a second application of herbicide on the newly established knapweed plants the second year while the little bluestem continued to spread.

In all the test plots that were surrounded by invasive species, these invasives continued to intrude. However, on our larger test plots, where we had eliminated invasive species from surrounding areas, such intrusion was lessened.

Experienced botanists are able to identify native cool-season grasses, such as poverty grass (*Danthonia spicata*), slender oatgrass (*Danthonia compressa*), rough bentgrass (*Agrostis scabra*), and autumn bentgrass (*Agrostis perennans*), and the many sedges (*Carex*) native to the New England region. If a site is replete with native cool-season grasses and grass-like plants, the following techniques for augmentation through herbicide application are not advisable. The recommended herbicides will not insure preservation of these species.

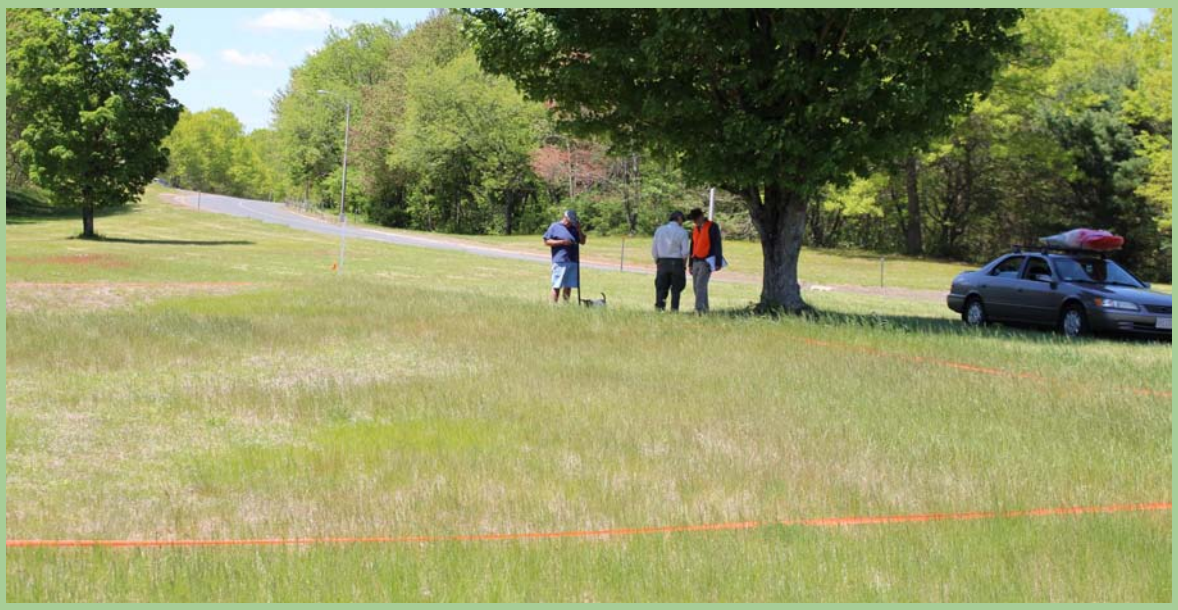

Figure 3.3 Existing population of little bluestem delineated for later application of herbicide.

Delineating Existing Plant Communities. Since identification of native plants along roadsides will usually occur in summer, herbicide treatment of these sites will happen toward the middle and end of fall or mid-spring in the following year. It is important to set up markers that will delineate native plant communities. This is especially important because DOT maintenance crews often mow during the fall months. Once a field is mowed and the flowers and inflorescences are removed, it is very difficult for anyone but trained botanists to identify existing vegetation.

Check with DOT regulations concerning the placement of markers along roadsides.

Some DOTs will not allow the use of any markers that interfere with mowing regimens. Therefore, it is often best to use brightly colored plastic stakes with large heads that can be pounded flat into the soil. The large heads and bright colors will make it easier to find them in case they are buried beneath overgrown stands of vegetation.

Reduced mowing. When native plant communities exist at a site and state law prevents the use of herbicides to help increase the density of the native stands, reduced mowing can be implemented at the site during warm-season grass growth, giving the native grass and perennial wildflower stands a chance to outcompete any cool-season grasses and weeds. Mowing should be done in early spring and late fall only. The later a mowing can be delayed in the fall, the more likely it is that native warm-season grasses and late blooming wildflowers will be able to disperse seed and increase the population size.

Applying herbicides for augmentation of existing populations. Herbicides should be applied either during the mid-to-late fall or in spring prior to the emergence of warm-season grasses—usually early to mid-May in New England, depending upon that year's soil temperatures. It is helpful to monitor soil temperatures to insure that any herbicide applications do not kill any existing native warm-season grasses emerging with the warming soil. Warm-season grasses break dormancy or start to germinate when soil temperature is about 65°F.

Applying herbicide from mid-to-late fall. When applying herbicide during the fall to augment existing native plant populations, only two imazapic-based herbicides—Plateau® and Panoramic®—should be used. (See previous section on *Applying Herbicides* for more information concerning use of Plateau® and Panoramic® in the fall).

Applying herbicide before native warm-season grasses break dormancy in the spring. When applying herbicide before native warm-season grasses break dormancy in the spring to augment existing native plant populations, the herbicides recommended for use are either glyphosate or imazapic-based Plateau®, Panoramic® or Jouney®, which contains both imazapic and glyphosate. (See previous section on Applying Herbicides for more information concerning use of herbicides in the spring).

3.2 Seeding

Basic steps to successful seeding require:

- Familiarity with proper timing for successful seed germination.
- Ensuring that the native seed has direct contact with the soil. When possible, pack seeds tightly to the soil. Seeds should be buried no more than ¼" deep.
- Where necessary, include erosion control measures, especially when seeding slopes, to prevent soil destabilization and dislocation of seed.
- Mow weeds when they reach a height above 8" during the first growing season to prevent annual weeds from flowering and setting seed, and to insure proper light for native seed germination and establishment.

3.2.1 Timing of warm-season grass seeding

A significant portion of native grasses are warm-season species. The timing of their planting differs greatly from that of nonnative cool-season turf-grasses.

Cool-season nonnative grasses, such as fescues and ryegrasses, germinate best when soil temperatures are between 50° and 65°F. Such soil temperatures usually occur when daytime air temperatures are between 60° and 75°F. As result, the optimal time for turfgrass seeding spans from early spring to early summer or early to late fall. Some cultivated cool-season grasses can even be dormant seeded in early winter for the following spring.

Unfortunately, successful warm-season grass establishment does not have as much flexibility when it comes to timing. Due to slow initial growth, warm-season grasses, which ideally should have a growing season of 100–120 days to establish roots prior to winter, typically are seeded in New England within a window spanning from late spring to early summer.

Seeds for native warm-season grasses such as little bluestem, purpletop, and switchgrass germinate best when the soil temperatures are about 65°F. Such temperatures usually occur when the daytime air temperature reaches around 80°F. Nighttime

air temperatures also provide good indicators of the soil temperatures. When nighttime temperatures are between 65° and 70°F, soil temperatures will likely correlate closely to the same temperatures. Cooler temperatures can inhibit germination and cause adult plants to go dormant. Therefore, planting in the fall carries more risk because of potential damage to smaller seedlings from an early frost or freeze.

In New England, the optimal period for warm-season seed establishment happens between mid-May to late June. Specific timing will vary depending upon the hardiness zone in which the planting takes place. However, while warm-season native grasses—

especially those grown from local seeds—are usually better adapted to the local climate and soil conditions, germination can suffer from insufficient moisture. The later the planting occurs in the summer months, the greater the likelihood that high temperatures and drought will deprive the seeds of sufficient moisture. In such a situation, irrigation may need to be brought to the roadside site to prevent seed establishment failure.

Dormant seeding. Dormant seeding is especially well-suited for forb/wildflower establishment, which often benefits from the period of cold stratification during the winter months. Protect dormant seeding sites by mulching or applying erosion control blankets. These practices will not only protect the site against erosion; they will reduce freeze/thaw cycles and protect emerging seedlings from wind desiccation in the spring. Dormant seeding of native cool-season grasses, sedges, and legumes should occur just before the soil freezes.

Some practitioners have found success with dormant seeding warm-season grasses when they are included in a mix with native cool-season bunch grasses, such as wavy hair grass (*Deschampsia flexuosa*), which will establish first in the spring and prevent weed and nonnative cool-season turfgrass competition. In such cases, conduct thorough site preparation to kill all weed and turfgrasses present.

Hydroseeding works well with dormant seeding. Snow helps break down the mulch, and the heaving of the soil from freezing and thawing helps create good seed-to-soil contact.

Increase seeding rates by 40% to 50% when dormant seeding to compensate for

Box 3.5 Seeding calendar

While May and June are ideal seeding months for warm-season grasses in most of New England, road construction projects rarely are completed before this optimal seeding window. The following seeding calendar provides suggestions for protecting slopes and improving seeding success throughout the year.

January to mid-March

Occasionally, winter months provide windows of opportunity for frost seeding, a way of incorporating native seed into the soil if no-till seeds drills are unavailable. This practice of spreading seed over bare soil can take place when the soil becomes friable—loose or porous—following cycles of freezing and thawing.

Timing is essential for successful frost seeding:

- It requires a readiness of materials and a willingness to jump at the opportunity when the proper conditions are present.
- Addition of grain oats (*Avena sativa*) as a cool-season nurse crop to native seed mix is recommended.
- Avoid frost seeding areas covered with ice or snow. Occasionally native seed can be sown on top of snow. This is not technically frost seeding, but serves as an effective seeding method on relatively level sites. Frost seeding is not recommended on slopes.

Late March through April

As long as proper soil conditions exist—the soil is neither frozen nor muddy—this time could possibly allow for successful seeding. The site would have to been prepared with a fall herbicide application to eliminate cool-season grass and weed competition. Oats would need to be included in the native seed mix as a cool-season nurse crop. Warm-season grasses will not germinate until soil temperatures reach 65°F.

May and June

As previously mentioned, these months provide optimal soil temperature and moisture conditions for the germination and survival of warm-season grasses and forbs.

July and August

Although successful plantings could theoretically occur during these months, hot, dry summer conditions are generally less conducive for planting natives and will require more inputs, especially added irrigation. Consider using a placeholder temporary seeding of a cover crop at this time, which could help prevent weed and invasive species encroachment until permanent, native seeding can take place in the fall or the following spring.

If work schedules require native seeding during these months:

- Drill, rather than hydroseed, for maximum seed-to-soil contact. Hydroseeding needs moisture to break down the mulch and the seeds could dry out while sealed beneath the hyrdoseed mulching.
- Increase seeding rate by 25%, since germination will be decreased due to seed desiccation.
- Include appropriate nurse crop: grain oats (*Avena sativa*) can be used until August 1; grain rye (*Secale cereale*) thereafter.
- To maintain consistent moisture, mulch with straw, crimping or tacking the straw into place. Insure that outside irrigation can be brought to the site.

September and October

Native seed planted this late in the season will unlikely develop extensive root systems to overwinter. Nevertheless, some of these plantings do succeed, perhaps because a large proportion of the seed will not germinate until spring. Only experimentation within each ecoregion will reveal whether this is a viable time for seeding.

- Stabilize erodible sites with inclusion of grain rye (*Secale cereale*) as a cover crop.
- Increase seeding rates by 25%.

November and December

Dormant seeding may be a viable option on level ground but may not work on erodible slopes. Cover crops seeded this late won't provide erosion control until spring. The majority of native seed will remain dormant over winter. While some forb species that require stratification do better when dormant seeded, some native grass seed planted at this time will deteriorate over winter.

- Erodible sites should be stabilized with hydromulch or crimped/tacked straw.
- Increase warm-season grass rate 25%.

reduced germination, soil-borne disease, and insect predation. Fungicide seed treatments may benefit dormant seedings. In the Northeast, working the soil becomes difficult late in the season due to increased soil moisture. Consider conducting final grading or seedbed preparation earlier in the year while the soil moisture content remains at levels conducive to soil penetration.

No-till drilling or broadcasting with mulch may be possible alternatives if the soil surface is dry enough to allow for tractor traffic. Avoid using tractors or other heavy machinery if the soil remains excessively moist. Mechanical disturbance and compaction could result in greater weed and invasive species pressure the following spring.

3.2.2 Seeding methods

Selection of seeding method and equipment will depend upon:

- Site characteristics, including:
    a. Slopes
    b. Soil drainage
    c. Size of area
- Type of seed
- The quality and extent of site preparation
- Availability of equipment

The seeding methods include:

1. Drill seeding
2. Hydroseeding
3. Sawdust as seed mulch
4. Broadcast seeding

3.2.2.1 Drill Seeding

Figure 3.4 Truax no-till drill.

Pros

- Convenient for planting large areas
- Seed drills have seed box agitators and depth controls designed specifically for planting small and fluffy native seeds at optimal rates and depth
- Allows planting into a light stubble layer
- Some models plant seeds in even rows, allowing for easier seedling recognition
- Plants seeds at optimal depths when correctly calibrated, thus eliminating the need to press seed into the soil surface after planting (e.g., cultipacking)

Cons

- Not suitable for slope seeding
- May be unsuitable for excessively rocky soils
- Seed drills are expensive and not readily available in many areas
- Requires a tractor and an experienced operator to set planting controls
- Seed with a lot of chaff, such as those of little bluestem, can clog delivery tubes

No-till seed drills, such as those produced by Truax, John Deere, Marliss, Tye, and Great Plains or the Greenscape Conservation Seeder, provide some of the fastest and most efficient methods for planting native seeds because they drill seed to correct, uniform depths.

Native grass drilling is the preferred method on level right-of-ways. However, drills do not work on steep slopes. At 3:1 or steeper, the drill will likely slide sideways, causing the disk openers to dig in and bury the seed at an incorrect depth. Working on projects with silt fences present the added challenge of maneuvering the tractor and drill around these fences. Under such circumstances, hydroseeding provides the preferred method of seeding.

Each brand of drill has different features and size ranges to suit particular situations. Designed for no-till seeding, native seed drills work by cutting through a variety of residues. Seed drills usually have multiple hoppers designed to accommodate different seed types and sizes: small seeds, fluffy seeds, and cool-season/grain seeds. Separating seeds by type and size helps to optimize seed soil contact by controlling seed depth. Drill calibration provides accurate and uniform rates for distribution of seed, resulting in uniform rows. Greenscape drills include a culti-

Figure 3.5 No-till drill features.

Disk coulter blades cut furrows through vegetation residue.

Fluffy seed box.

Rice hull carrier mixed with seed.

packer, which rolls over the newly planted seeds and improves seed-to-soil contact. Its incorporation into the drill helps eliminate the extra step of cultipacking and decreases the amount of labor expended on each project.

Grass species with fluffy/chaffy seed, such as little bluestem, broomsedge, Indiangrass, and big bluestem, require seed drills with specialized seed hoppers. Some seed growers remove – or debeard – the fluffy awns on a seed that make them chaffy. When seeding debearded seed using conventional seed hoppers, the seed may still bridge above openings and clog the drill's tubes. Therefore, it is important to monitor the seeding operation. However, if debearded seed is used in specialized native drill seed hoppers designed for fluffy seeds, the seed may flow faster than anticipated, posing problems when calibrating for low seeding rates. It is advisable to calibrate seeding equipment using a sample of the actual seed purchased along with any carrier planned for use. Mixing with a carrier can be used to help obtain better distribution of small-seeded species.

Seed carriers. Because seed drills require calibration to achieve optimal seeding rates, placing seed alone in the hoppers will make it difficult to control distribution rates. Variance in seed size, weight, and shape can prevent uniform distribution rates. In such cases, it is best to use a seed carrier.

A good carrier adds weight, increases bulk density, and separates the seed, making it flow in a more predictable and manageable manner. Carriers are typically inert material that can easily pass through the drills blades and tubing. Common seed carriers include rice hulls; cracked grain; dry, coarse, washed sand; pelleted or granulated lime; soybean meal; hard seeds such as wheat, dry screened sawdust; or clay-based cat litter. Any carrier should be dry and flowable to insure that it passes easily through the equipment and it does not moisten the seed. The weight and hardness of a carrier can help keep drill boots free of bulky seed trash.

Desirable features in native grass drills:

■ Seed hoppers for fluffy/chaffy seed, small grain seeds, and legumes

■ Chaffy seed boxes with seed agitators and picker wheel feed

■ Large, wide, straight drop tubes—2” minimum diameter—from the chaffy box to the row openers

■ Double disc row openers with removable/adjustable depth bands used for depth control

■ Convenient, user-friendly calibration and depth control systems

■ Adjustable pressure packer wheels for closing seed furrow

■ Sturdy, heavy frame

■ Built-in cultipacker

■ Brackets to add weights for penetrating firm soil

Seed drills require proper training in use and calibration. This manual provides only guidelines and methods to optimize seed drill usage when planting native plant communities.

- Plant only when the soil is dry enough to prevent seeds from sticking to the coulters, the cutting blades that make the furrows in the soil for the seed. Under wet conditions, small seed will stick to mud-caked parts of the drill, rather than the ground.
- Keep seed separated by species until ready to plant. Prior to planting, organize seed into batches of large smooth seeds, small smooth seeds, and fluffy/chaffy seeds that do not flow easily. Loosely fill—*do not compact*—seed boxes with the appropriate seed batch for each box. If seed quantities do not cover the agitator, it is best to use a seed carrier to insure proper distribution since seed drills are difficult to calibrate for small volumes of seed.
- As a general rule, the planting depth for a particular seed should be no more than 1.5 times its diameter. To achieve this for most forb seed, set the depth controls to plant no deeper than ¼”. Most native seed is relatively small and lacks the energy to emerge if planted too deep. For best results, consult with the seed vendor for specific guidelines for seed depth calibration, especially on very sandy soils. Stop periodically to check planting depth by placing a ruler into the groove created by the coulter.

- Extremely small seeds, such as those for purple love grass, blue lobelia, or rushes, should be planted on the soil surface. The depth should not exceed ¼". Such tiny seeds often tend to flow quite rapidly, disbursing fully before the whole field of planting has been covered by the seed drill. In addition, the agitation from the machine frequently will sift and separate these smaller seed to the bottom of a seed mix. If the seed drill does not appear able to properly distribute extremely small seed, combine the seed with a carrier, such as fine, dry sand and to hand broadcast the seed. Because the seed is so small and only requires surface planting, the weight of the seed carrier will be enough to insure proper soil contact.

Drill seeding tips:

- When calibrating the drill, it might be safer to set the rate a little lighter than the rate desired. Bouncing over the ground, a drill set at 6.5 lb. to the acre might actually seed 8 lb. to the acre.
- For uniform coverage, it is best to drill seed at a lighter rate and go over the area two or three times. This will help insure that the seed does not run out before the job is completed.
- Multiple passes pack the seed well and create more rills that hold seed and interrupt water flow.
- The trash plow attachment on a native grass drill should just scratch the surface. If it's making furrows, it's planting too deep.

3.2.2.2 Hydroseeding

Figure 3.6 Hydroseeded slope along US Route 6.

Pros:

- Hydromulch reduces soil erosion, especially on slopes
- Hydroseeding is ideal when bare, weed-free topsoil is used following new construction
- The risk of seeding too deep is decreased
- The colored mulch on the soil makes a positive impression on the public by indicating that revegetation will soon occur

Cons:

- Mulch can be expensive, usually doubling the cost of a seeding
- Seeds may not have enough soil contact if the proper procedures are not followed
- The seeding rate can be hard to control
- Hydroseeding requires bare-ground application

Hydroseeding—one of the most commonly used methods for cool-season turfgrass seeding—is a type of broadcast seeding that distributes seed, soil amendments, and mulch in a suspension of water. It is especially well-suited for steep (> 2:1) slopes or areas inaccessible for a seed drill or other mechanized equipment. Hydroseeding

equipment uses a continuous agitation system that keeps all the materials in uniform suspension throughout the mixing and distribution cycles.

An integral part of hydroseeding is hydraulic mulch, which includes cellulose fiber (paper) mulch, wood fiber mulch, blended (cellulose and wood), or bonded fiber matrix, as well as stabilizing emulsion and tackifier, which help bind the mulch to the soil. Hydraulic mulch helps protect exposed soil from erosion by raindrop impact or wind.

Because native warm-season grasses and forbs require soil contact to germinate, the method required to hydroseed native plant seeds differs from the common method used when hydroseeding cool-season turfgrass seed. Hydroseeding has become common for cool-season turfgrass establishment because it can be carried out in a one-step process. The seed, mulch, tackifiers, and water are all combined in the tank together and then sprayed as one layer of seed-infused mulch on the soil. During this process, the seed is suspended in the mulch and often does not have direct contact with the soil. In the case of cool-season turfgrass, the lack of direct soil contact does not inhibit seed germination. However, if this method is used with warm-season grass, the vast majority of seed will not germinate for lack of soil contact.

Figure 3.7 Hydroseeding components.

Tackifier used to bind mulch to the soil.

Wood fiber mulch and Hydro Sweet, used to neutralize acid soil conditions.

Mechanical paddle agitated hydroseeding equipment used with wood mulch.

Hydroseeding is ideal for bridge approaches, cleanouts, culverts and wet or steep slopes. In most cases, the entire project can be hydroseeded from the shoulder.

Hydroseeding warm season grasses. The most effective method for hydroseeding warm-season grasses involves three separate steps:

- For the first pass of hydroseeding, mix and apply the seed, soil amendments, and 5% –10% of the total fiber mulch with tackifier. This is especially effective on slopes, because the tackifier helps bind the seed to the slope, thus preventing it from sliding down the incline. On flatter land, some advocate broadcasting the seed without the mulch to ensure better soil contact.
- Improve seed to soil contact by incorporating the mixture with a cultipacker, roller, or bulldozer cleats.
- For the second pass, apply the balance of the mulch plus tackifier or bonded fiber matrixes.

Unlike the common one-step process used with cool-season turfgrass, this three-step method insures that seed has good soil contact and is not suspended in the fiber mulch. To prevent clumping when using a hydraulic seeder, chaffy/fluffy seed that still have their awns attached, such as bluestems, indiangrass, or sideoats grama, should be added very slowly in small portions into the mix.

Fertilizer, tank agitators, and seed interaction. Seed left in the hydroseeder tank for periods of over one hour can be damaged by the fertilizer and tank agitator. Centrifugual pump agitation systems are more damaging than paddle systems. All wood fiber-based mulches need mechanical paddle agitated equipment, while cellulose mulch can be agitated with the centrifugal pump used for spraying.

It is best to spread lime prior to hydroseeding. Using the hydroseeder to apply the required amount of lime needed to amend the soil profile can damage the seeds as a result of abrasion and settling. However, a *small* amount of specialized liming material is sometimes required to adjust the slurry pH when seeding legumes. It is advised not to use burnt or hydrated lime in the hydroseeder.

Hydroseeding legumes. Legumes require species-specific bacterial inoculation. When mixed with the hydroseeding slurry, the inoculant bacteria can be adversely affected by the chemicals included within the mix. Therefore, it is advisable to add the inoculant to the slurry just prior to spraying and add four times the rate of inoculants recommended when using a seed drill. As with all slope planting, the rate of legume seed should also be increased by 20%-–25%. To improve the survival of the rhizobial bacteria and the subsequent ability of the hydroseeded legumes to fix nitrogen, add to the mix a small amount of hydroseeding liming product or pulverized limestone that has passed through at least a 200-mesh sieve.

Temporary seeding. If a construction project ends before the optimal time for native species and soil will be exposed for more than 2 months but less than 12 months, the best choice is to establish temporary cover to provide short-term protection on disturbed areas. Temporary cover can be accomplished using cover crops, such as grain oats (*Avena sativa*) from spring to August 1 or cereal rye (*Secale cereale*) thereafter. If the topsoil at a construction site is expected to have many weed seeds, it may be best to plan for a series of cover crop plantings that will help to smother the germination of weed seeds: start with buckwheat (*Fagopyrum esculentum*) followed by fall planting of cereal rye (*Secale cereale*) or winter wheat (*Triticum aestivum*). Buckwheat has the added advantage of providing pollinators rich forage. However, buckwheat should be mowed soon after flowering to prevent seed production.

When a temporary or permanent seeding cannot be completed in a timely manner, it is advisable to stabilize the soil by applying a temporary cover of mulch alone, without the inclusion of seed. Under such circumstances, it is important to refer to the mulch manufacturer's literature for application rates and methods.

Hydroseeding tips. The usual one-pass application of hydromulch is ill-suited to native grass seeding. While such a technique saves time and effort, it will waste the seed and labor used to apply it because it will prevent proper soil contact. The "three-step" method—(1) seed application, followed by (2) cultipacking, followed by (3) hydromulching—results in better establishment.

- In an effort to conduct hydroseeding in one pass, some practitioners have doubled the amount of seed they calculated they would normally would need. This increase

in seeds would result in a greater amount of seed-to-soil contact. They estimate that the time and money saved on labor would pay for the extra seed.

- Seeding works best after it has rained, not just before. Seed and mulch adhere best to moist soils. This will also help capture moisture under the mulch. It is also important to hydroseed several days before it again rains, thus allowing the mulch time to properly set before it rains.
- Seeding rates should be increased by at least 25% to compensate for seed damaged by hydroseeder mechanics and for seed that remains suspended in the mulch. This increase should be on top of the 20%–25% increase for slopes. The steeper the slope, the greater should be the percentage of seed increase within the mix.
- "Shadow areas" behind larger dirt clods sometimes receive no seed from the hydromulch nozzle stream. To insure better coverage, conduct two passes, one from each direction. So as not to double the seeding rate, decrease the seeding rate to 7–8 mph, with flow rate reduced.
- An 800-gallon hydroseeder is the minimum recommended size. A 1,500-gallon hydroseeder can cover 1/3 acre per load. With a machine of this size, seven 50-lb. bales, or 350 lb. of mulch per load, yields about 1,000 lb./acre.
- To prevent disturbance to newly seeded ground, start by seeding the area farthest from the road first.
- On steep slopes, embed the seed into the soil by holding the gun at a sharper angle and using a more concentrated stream.
- To reduce soil erosion, seedbeds can be left rougher.
- Steep slopes can be ripped with a wide-track dozer.
- Directional tracking—the process of creating ridges with tracked vehicles on unvegetated slope—scan be used to interrupt water flow.
- Work the site perpendicular to the slope to interrupt water flow.

Hydromulching rates:

1,000 lb./acre—a token amount to help carry the seed and show what area has been seeded

2,000 lb./acre—appropriate for most 3:1 slopes

3,000 lb./acre—very heavy rate for long, steep slopes

3.2.2.3 Sawdust as seed mulch

Figure 3.8 Sawdust mulch mixed with native seed and spread evenly along ground.

Pros:

- Well-suited for use on narrow medians and below guardrails
- Does not required specialized training and equipment
- Helps suppress weeds that thrive on high levels of soil nitrogen
- Has shown greater rates of warm-season grass establishment
- Helps retain moisture

Cons:

- Not enough testing with native cool-season grasses, such as wavy hair grass (*Deschampsia flexuosa)*

Susan Barton from the University of Delaware has developed a method of native species establishment that uses sawdust as a medium for distributing seed mixes (pers. comm., January 2015). This establishment method has proven effective because the sawdust appears to decrease the emergence of weeds while providing a mulch-like medium in which the native seed can set down roots.

This method can be used on vegetation-free topsoil following new construction or sites where vegetation existed but has been killed either using herbicides or non-herbicide methods. After applying herbicide, mow the treated vegetation to the shortest possible height available on the mower.

It is best to use decomposed sawdust for this application. Sawdust, which has high carbon content, breaks down rapidly and can rob the soil of nitrogen. While decomposed sawdust will still help to inhibit weed emergence, it will allow enough nitrogen to remain for successful warm-season grass seed germination.

The layer of sawdust should not be more than 1" deep. To calculate the amount of sawdust required to cover the area 1" deep:

1. Measure the square footage of the area to be planted.
2. Multiply the square footage by 1/12 of a cubic foot.

FOR EXAMPLE: 1000 SQ. FT. × 1/12 CU. FT. =

1000/12 CU. FT. OR 83 1/3 CU. FT. OR 9 ¼ CU. YD. OF SAWDUST

Calculate the amount of seed required for the area to be planted.

Next, thoroughly combine the seed mix with the sawdust. The technique used to combine the seed and sawdust will depend on the size of the area to be planted, the equipment available for mixing, and the site where the mixing will take place.

For **larger sites**, there are two methods that can be used—one **off-site** and one **on-site**.

Off-site: This technique requires using the bucket of a front-end tractor loader to mix. On a flat concrete pad, dump the sawdust from a truck tailgate in stages. After dumping a portion of the sawdust, rack in an equal portion of the seed mix. Continue to dump and mix equal portions of sawdust and seed until the two quantities are com-

bined. Use the bucket of the front loader to mix the sawdust/seed until it appears well combined. Use the bucket of the front loader to mix the sawdust/seed until it appears well combined. Load the seed-filled sawdust onto a truck to be transported to the planting site.

On-site: This technique involves mixing the seed into the sawdust as the sawdust is being unloaded at the planting site. If the truck delivering the sawdust has a dumping bed and does not weigh so much as to create deep tire tracks, have the driver dump the sawdust in small piles as the truck moves forward. If the truck is too heavy or too large to access the site, have workers unload the sawdust using wheelbarrows. Evenly sprinkle the seed on top of the sawdust piles and incorporate the seed into the sawdust while raking the sawdust evenly over the site. Using a water-filled turfgrass roller or cultipacker over the layer of sawdust helps insure better root soil penetration.

Figure 3.9 Sawdust brought to site along US Route 6 using a dump truck.

Box 3.6 Sawdust as Seed Medium

Populations of warm-season grasses are more dense within red-lines, established using sawdust

We tested the establishment technique promoted by Susan Barton from the University of Delaware that uses sawdust as a medium for planting native seed and our initial trials have shown promising results.

For our first test plot, a local lumber mill delivered a dump truck of sawdust to one of our demonstration plots along Route 6 in Connecticut. The dump truck drove onto the exit roundabout planting site and distributed the sawdust onto the field we had prepared with an application of glyphosate followed by mowing. The driver tilted the truck bed and slowly moved forward, allowing the sawdust to spill upon the designated area. Our team followed close behind, spreading the sawdust evenly using rakes. We then incorporated the seed mix into the sawdust using rakes.

We probably used more than the optimal amount of sawdust. The ideal depth is ½"–1". Our plots measured between 2.5"–3". Although we saw significant initial seed germination, we later observed seedling decline, especially for legumes and forbs. We attributed the seedling demise to an especially dry summer season and the inability of the seedling roots to penetrate the sawdust and establish in the soil.

While we observed less weed pressure at the planting site compared with our hydroseeding and broadcast demonstration plots, a population of crabgrass did blanket the site. However, the decrease in crabgrass density appears to have resulted in a greater rate of seedling survival, especially for little bluestem and purpletop grasses. Meanwhile, we noticed that the grasses planted using sawdust were more mature and vigorous than those established at other sites. Most plants displayed increased numbers of blades and taller heights.

Although we now know that the sawdust worked as an effective planting medium, we initially thought otherwise. When we observed late-season seedling demise at the end of the first growing season and saw little more than a mat of dead crabgrass at the beginning of the second growing season, we believed our trial had failed. We tried to salvage half of the site by removing the layer of dried crabgrass blanketing it. Only later in the second season did we realize that our removal of the crabgrass thatch would unexpectedly impact the survival rate of various species in the mix. On the half where we removed the dead crabgrass, little bluestem constituted the majority of the plant community. On the half where the dried crabgrass remained, purpletop dominated the plant population. We attribute the difference in species survival rates to the moisture requirements for each grass species. Little bluestem thrives in drier sites, while purpletop thrives in slightly more moist sites. The crabgrass appears to have acted as a moisture-retaining mulch cover that favored purpletop survival over that of little bluestem.

3.2.2.4 Broadcast seeding

Pros:

- Inexpensive
- Easy to carry out
- Well suited for smaller areas
- Prevents finer-seeded species from getting buried under too much soil
- Broadcasting equipment more compact than a no-till drill and easier to get in and out of ditches
- Can be backed up to silt fences to sling seed on both sides.
- Many models and sizes of broadcasters currently exist, including hand-held crank and larger tractor or ATV-mounted models
- Many state agencies and subcontractors already own broadcasting equipment

Cons:

- Requires a smooth seedbed or one where the stubble has been closely scaled
- Requires the added step of pressing the seed into the soil after planting
- Difficult to calibrate when using seed other than that for cool-season turfgrass
- Hard to carry out using fluffy/chaffy seed
- Some broadcast seeder models cannot accommodate large seeds

Broadcast seeding works best when seed can readily reach the soil surface, uninterrupted by existing vegetation. If the topsoil is not exposed, remove as much stubble as possible prior to seeding, creating a smooth, lightly packed seedbed. While the soil surface can be lightly hand-raked or harrowed to break-up crusted surfaces, avoid cultivating the site. The greater the disturbance, the more likely it is that weeds will be exposed to light and moisture, thus leading to their germination.

Broadcast seeding results in greater variability of seed depth compared to seed drilling. Due to this variability, it is important when broadcasting to increase seeding rates by 25% relative to those used when drill seeding. When broadcasting with little seedbed preparation and limited ability to track the seed if no inert carrier is included in the mix, increase seeding rates by 50% to 75%. This increase helps to compensate for the inability of seed to germinate as a result of poor soil contact or the loss of seed to predators.

If the landscape varies in terms of light, soil type, or sloping, manual broadcast seeding does offer the opportunity to spot-seed microsites using different seeding rates and seed mixes.

With the development of commercially available techniques for producing cleaner, less -fluffy native seed, broadcast seeding has become a more viable seeding option. Debearded seed flows better and slings farther than in the past when applied with broadcast seeding equipment. However, if the seed is not debearded, broadcast seeding has some limits. Inert carrier ingredients, such as dry sand, rice, rice hulls, fine-grained vermiculite, clay-based kitty litter, gypsum, fine cornmeal polenta, or dry flowable sawdust may help to condense the chaff of native seed enough to allow it to pass through some broadcast mechanics. Conventional spinner-type pendulum spreaders may work best, since they have large enough openings to prevent clogging as a result of the fluffy chaff.

Inert carriers can also help with machine calibration, especially when seed quantities are small. Use two to three parts inert carriers for each part seed, by volume. These bulking agents also ensure even seed distribution and visual feedback as to where seed has been thrown.

Since smaller seeds will tend to sift down to the bottom of a mix when combined with larger seeds, it is best to plant smaller and larger seeds separately to ensure even distribution. The most effective broadcast seeding equipment has an internal agitator and flow gate opening able to be closed small enough to provide a slow, steady flow of the smallest seed. Begin planting the smaller seed with the flow gate set to the narrowest opening, thus allowing at least two perpendicular passes over the seedbed for even distribution. Plant very large seed separately with the flow gate set to a wider opening.

For sites smaller than 1–2 acres, seed can also be hand broadcast. To insure even seed distribution, bulk the seed mix with an inert carrier, divide the seed into two equal batches, and sow each batch separately. Scatter the first batch evenly over the site, walking back and forth in one direction (say north to south). Then scatter the second batch by walking perpendicular to the previous pass (say, east to west).

Regardless of the manner in which the seed is broadcast, avoid covering the seed with soil after planting. Use a water-filled turfgrass roller or a cultipacker to press the seed into the soil surface. Natural precipitation or light overhead irrigation also can help ensure good seed-to-soil contact.

Box 3.7 Coated fluffy seeds

The bearded seed awns of native warm-season grasses such as little bluestem and broomsedge provide these species an apparatus by which they can disperse in nature via wind. However, while these light, feathery structures play an important role in the natural spread and survival of these grasses, they also complicate human attempts to establish these species. One of the most critical factors in successful native seed establishment is seed-to-soil contact. Not only does the down of the awn provide a cushion that suspends the seeds above the soil surface, but these fluffy structures interfere with the ability of these native grass species to flow effectively out of common grain drills and turfgrass seed spreaders, which were developed to plant clean, hard, relatively heavy, free-flowing seeds, such as wheat, soybeans, alfalfa, cowpeas, fescues, and ryegrasses.

Hairy little bluestem seeds

Many native seed growers try to remove as much of the awns along with other chaff during the seed cleaning process. However, removal of all awns material is difficult and prohibitively expensive.

Colonial Seed Company of Windsor, Connecticut, has developed a proprietary seed enhancement called Colony CoatTM that helps address some of the challenges created by fluffy awns for native warm-season grasses. Colony CoatTM encases the seed in a moisture-holding gel polymer, which doubles the weight of the seed and increases the seed delivery ballistics, which helps to improve seed-to-soil contact. In addition, the coating inoculates the seed with endomycorrhizae, which helps young plants capture nutrients essential for establishment.

3.2.3 Cover crops, nurse crops, and companion plants

Figure 3.10 Hillside along U.S. Route 6planted with winter rye (*Secale cereal*)e after cleared of brush to prevent encroachment of invasive species while waiting for spring native warm-season grass seeding.

Cover crops are divided into two groups:

1) Nurse crops or companion crops, which are planted along with the permanent seed mix.

2) Temporary seedings or stabilizer crops, which are planted alone pending an optimal time to plant the permanent mix or to smother weeds as part of site preparation.

Nurse crops help reduce weed pressure, prevent erosion, and prevent excessive sunlight from reaching tender seedlings. However, if allowed to grow too tall—as often happens with cereal rye (*Secale cereale*)—some nurse crops can shade native seedlings. Therefore, mow nurse crops to 6” once they start to exceed 8”.

Cover crops used as stabilizing placeholders are recommended on slopes 3:1 or greater. Oats (*Avena sativa*), annual rye (*Lolium multiflorum*) and winter wheat (*Triticum aestivum*) work especially well as cover crops; they are inexpensive, establish easily, and do not outcompete the native perennial species.

Box 3.8 Recommended nurse crops/companion crops and temporary seedings/ stabilizer crops

Adapted from: Brandt, J, K. Henderson, and J. Uthe (2015). *Integrated Roadside Vegetation Management Technical Manual: Iowa's Roadside Resource*. (Ed. Maria Urice.) USDA-Natural Resources Conservation Service/Iowa DOT's Living Roadway Trust Fund.

Nurse crops/companion crops (seed quantity per acre)

Spring

• 1.5 bushels oats or
• 1 bushel oats and 5 lb. annual rye

Summer

• 2 bushels oats or
• 1 bushel oats and 10 lb. annual rye

Fall

• 30 lb. winter wheat

Temporary seedings/stabilizer crops for use prior to native seeding the following spring (seed quantity per acre)

Summer

• 1 bushel oats plus 10 lb. annual rye and one of the following warm-season species:
5 lb. piper sudangrass
10 lb. millet (Japanese or pearl varieties)
30 lb. sorghum (grain or forage)

Fall

• 20 lb. annual rye or
• 60 lb. winter wheat

Caution: For native plantings, many practitioners recommend winter wheat (*Triticum aestivum*) over winter rye (*Secale cereale*). Winter rye* is taller, more persistent and possibly allelopathic, chemically inhibiting the growth of forbs.
Do not seed piper sudangrass, millet, or sorghum too heavily. A single heavy rain can cause mass germination.

*It is important to distinguish among the various species of rye:

- annual rye (*Lolium multiflorum*)
- perennial rye (*Lolium perenne*)
- winter, cereal, or grain rye (*Secale cereale)*

Box 3.9 Profiles of cover crops

Adapted from: Salon, P. R. and C. F. Miller, 2012. *A Guide to: Conservation Plantings on Critical Areas for the Northeast.* USDA, NRCS, Big Flats Plant Materials Center, Corning, NY.

Cereal rye (*Secale cereale*)—also called winter rye or grain rye—can be planted later in the season than all other temporary covers. The crop prefers well-drained soils but tolerates poorly drained soils, and can even grow in heavy clay or sandy soils. It also tolerates a wider range of pH—from 4.5 to 8.0—and lower fertility soils than do other winter grains. Cereal rye's well-developed fibrous root system reduces leaching of soil nitrates. Its top growth provides soil cover and suppresses weeds. However, its productive spring growth can be difficult to manage. Some research indicates cereal rye exhibits allelopathy, wherein its plant tissues and root exude compounds that inhibit germination and growth of weed seeds. However, these same compounds can impact small seeded crops if planted immediately following incorporation of cereal rye residue into soil.

Oats (*Avena sativa*), a spring grain crop, produces abundant biomass when planted from early August to the beginning of September. Since oats will winter kill, they provide less of a spring management problem than will cereal rye. However, they will not recycle nitrogen. Because their residue degrades quickly in the spring, oats offer limited soil erosion protection. They work well as a nurse crop for cool season species and, at reduced rates, for warm-season grasses and forbs. Oats prefer well-drained, fine sandy loam to clay soils, and tolerate pH of 5 to 8.5.

Wheat (*Triticum aestivum*), an annual, is planted in the fall to germinate and develop into young plants that remain in the vegetative phase during the winter and resume growth in early spring. Since wheat requires slightly higher soil temperatures to germinate and grow, it should be seeded at least a week earlier than cereal rye. While wheat prefers well-drained silt loam or clay loam soils, it will grow in fine sandy loam to clay soils and tolerates a pH of 5 to 8.5. Because wheat produces less biomass in the spring than cereal rye, less biomass remains for killing or interfering with seeding in the spring. As it is susceptible to Hessian flies, wheat should not be grown in the fall prior to the Hessian fly free date. If a roadside site borders wheat production fields, consider using crops Hessian flies will not damage, such as rye, barley, or triticale (× *Triticosecale*), a hybrid of wheat (*Triticum*) and rye (*Secale*).

Barley (*Hordeum vulgare*), a spring or winter annual, is not typically grown as a winter cover north of Plant Hardiness Zone 7 because young seedlings undergo winterkill at temperatures around 15°F. Therefore, spring cultivars should be used and planted in the spring, unless planted early and able to tolerate some winterkill. It prefers well-drained loamy soils and tolerates drought better than the other cereal grains. While it tolerates salinity and alkalinity better than other cereal ryes, it is less tolerant of acidic soils, requiring a pH of 6 to 8.5. Although it hosts the barley yellow dwarf virus, which can also infect wheat, it is not susceptible to Hessian fly, another wheat pest.

Foxtail or German millet (*Setaria italica*), a warm-season annual grass, can be used as a smother crop that produces less biomass than sorghum-sudangrass. Foxtail millet grows 2'–5', and should be cut before seed matures to avoid becoming a weed problem. It grows well on well-drained loamy soils with a pH of 5.5–7.5. It does not tolerate waterlogged or extremely droughty, coarse, sandy soils. Plant in a firm, well-prepared seedbed after soils have warmed and tillage can control the first flush of weeds. A carrier of both the wheat spindle streak mosaic virus and the wheat curl mite that transmits the disease, foxtail millet can serve as an over-summering host, despite not being bothered by these pests.

Teff (*Eragrostis tef*), a warm-season grass, can suppress weeds when successfully established at high densities. Teff, which has very fine seed, with 1.3 million seeds per pound, requires a low seeding rate of 5–8 lbs. per acre. To assure good germination, prepare a firm seedbed and seed at very shallow depth. Plant once soils have warmed and tillage can control the first flush of weeds. Teff tolerates dry conditions better than buckwheat or sudangrass, and requires less maintenance (buckwheat requires more when it matures and sudangrass requires mowing). Teff needs minimal mowing and, since it generally does not produce seed, volunteers do not become an issue.

Sorghum-sudangrass (*Sorghum bicolor* x *S. sudanense*), a cross between forage or grain sorghum and sudangrass, is a warm season annual grass that grows well in hot, dry conditions. Able to reach 6'–10', sorghum-sudangrass produces large quantities of biomass useful for soil organic matter enhancement. Apply at least 50 lb./acre to improve biomass production on nitrogen-deficient sites. While it grows in well-drained to somewhat poorly drained soil, it has low flood tolerance. It achieves optimum production between pH 6.0 and 6.5, but tolerates pH 5.0–8.0. Sorghum-sudangrass, which displays allelopathic properties, suppresses weeds very effectively. Its roots help control erosion, forage exceptionally well for soil nutrients (especially nitrogen), and reportedly are highly effective in remediating soils compacted by construction equipment. Mowing is recommended when it reaches 3'. Allowed to grow taller, it can produce a large amount of residue, becoming a management problem for subsequent seedbed preparation. Sudangrass, which has more narrow stems, is easier to manage and suppresses weeds better.

Buckwheat (*Fagopyrum esculentum*), a very rapidly growing broadleaf summer annual with many lateral branches and fibrous superficial roots, grows to 2.5' in height. With a pH range of 4.5–7.5, buckwheat tolerates acidic and infertile soil better than any other grain crop. Best suited to light- to medium-textured, well-drained soils, such as sandy loams, loams and silt loams, it tolerates poorly drained soils but not flooding. Buckwheat does not break up hardpan and does not grow well on compacted soils. In Plant Hardiness Zone 5, it can be sown from late May to early August. As a smother crop, drill at a rate of 50 lb./acre, or broadcast at 70 lb./acre; then shallowly incorporate to 1" deep. Within 40 days, it will develop an excellent weed suppressing cover. However, weeds will grow in any gaps wider than 10". Buckwheat flowers in 4–6 weeks, providing attractive forage to both insects and pollinators. Buckwheat solubilizes and takes up phosphorus that is otherwise unavailable to other crops, then releases these nutrients to later crops as the residue breaks down. Buckwheat's main disadvantage is that it sets seed quickly and, if not mowed or tilled, goes to seed and becomes a weed problem in subsequent crops.

3.2.4 Mulching

While plants ultimately provide site stabilization, mulch initially provides temporary erosion control until seedlings are established and plays several roles in the establishment of native plant communities. Like vegetation, mulch prevents erosion by protecting the surface from raindrop impact and by reducing the velocity of overland flow.

Mulch also:

- Prevents seed predation by birds and other consumers
- Retains soil moisture to aid seed germination and plant survival
- Reduces weed pressure
- Moderates soil surface temperature fluctuations
- Reduces frost heaving
- Adds organic matter
- Improves water infiltration by reducing surface compaction or crusting

Common mulching practices work well in aiding the establishment of cool-season grasses in the spring and fall by keeping seeds and soils moist and soil temperatures well modulated. However, native warm season grass and some native forbs seeds have evolved to germinate under the warmer conditions of late spring and early summer. Thus, if improperly applied, mulches can delay their germination, thus increasing the risk of failure. Apply mulch to a density that protects the soil from erosion while providing enough water and light penetration to allow seedlings to emerge.

Box 3.10 Types of mulch

Adapted from Salon, P.R. and C.F. Miller. 2012. *A Guide to: Conservation Plantings on Critical Areas for the Northeast.* USDA, NRCS, Big Flats Plant Materials Center, Corning, NY.

The following types of mulch help achieve these goals to different degrees and at varying costs.

Hay vs. straw vs. salt marsh hay

Hay is an assortment of forage grasses that usually includes seeds of grasses and broadleaf weeds. Therefore, it is better suited for feeding livestock than for mulching, and should be avoided.

Hay is an acceptable straw alternative only if weed seed content does not affect the site objectives. Considering the price differential between straw and hay—hay is usually cheaper than straw—hay may appear the more attractive short-term choice. However, weed and forage crop seed can overwhelm the desired vegetation, thus creating costly, long-term challenges. Hay tends to break down faster than straw, requiring heavier application rates. It also requires anchoring on sites subject to wind. Furthermore, hay is more likely to contain mold that can be an allergy problem for workers.

Salt hay, or salt marsh hay, consists of grasses harvested from salt marshes. Their wiry stems do not mat down or rot as quickly as straw, and any seeds present will not germinate because they require wet, saline soil.

Salt hay is usually the most costly of the three grass/grain-based mulch alternatives. However, it can also be the most effective, because the seeds will not germinate without salt water and will instead break down and add organic matter to the soil. Apply at the same rate and in the same manner as straw.

Straw is a collection of the stems of cereal grains—oats, wheat, barley, rye, or triticale—and is popular as a mulch because is readily available and it rarely contains weed seeds.

Straw benefits plant growth at a relatively affordable price. Apply straw mulch at the rate of two tons per acre (90 lbs. per 1,000 square feet). Spread mulch uniformly by hand or by mechanical methods immediately following seeding, covering approximately 85% of the soil surface. This provides erosion protection and allows adequate light penetration for seedling emergence. For most applications, anchor the straw immediately after placement to avoid movement by wind or water. Straw can be tacked with wood/cellulose fiber spread by hydroseeder at 500–750 lb./acre. For additional protection, add tackifying agents following manufacturer's recommendations.

Hydraulic mulch types

The term **hydraulic mulch** refers to mulches made of one or more of the following types of material: cellulose (paper), shredded wood fiber, blended (wood and cellulose) or bonded fiber matrix. Tackifiers help adhere the mulch to the soil surface and dye provides visual aid during application. The rates at which they are applied range from 2,000 to 4,000 lb./acre, depending on the material, additives, soil/site conditions and time of planting. Hydraulic mulches usually last from 3 to 12 months and are used to temporarily protect exposed soil from erosion by wind, raindrop impact and sheet flow while seeding establishes. Additives can extend their longevity. Hydraulic mulching equipment—usually referred to as **hydroseeders**—mix and continuously agitate hydraulic mulches to form and maintain a homogeneous slurry. Wood fiber based mulches require mechanical paddle agitated equipment and their slurry should be sprayed under pressure, uniformly over the soil surface at the material application rate based on slope grades as recommended by the manufacturer.

Cellulose fiber mulch is made from recycled newspaper, magazines, or other paper. One of the least expensive fiber mulch, cellulose fiber mulch uses a tackifier to tack straw at 500 to 750 lb./acre. It has one of the shortest expected longevities—no more than 3 months. It usually comes in bales. However, it also comes in more expensive pelletized forms, which pours easier into hydroseeders or can be broadcast without a hydroseeding machine. When broadcast, the pellets must be watered afterwards to expand the pellets and secure them in place. When used on flat surfaces for turf applications to aid with germination during optimum seeding windows, apply at 1,500 lb./acre. Do not over apply cellulose mulch; it can create a consistency of papier mâché, reducing infiltration and air exchange, thus inhibiting seed germination and establishment. When erosion control is a concern, use a mixture of wood and cellulose fiber mulch.

Wood fiber mulch, manufactured from recycled wood or virgin wood fibers, performs best when applied with tackifiers and has an expected longevity of 3–2 months. Wood fiber mulches retain water with interlocking fibers and are used to control erosion for slopes up to 3:1.

Blended wood/paper mulches consist of 50%–70% wood fiber, 30%–50% paper fiber and have an expected longevity of 3–12 months. They will provide some erosion control for slopes from 6:1 to 4:1, depending on additives, soil/site conditions, and time of planting. For highly erodible sites, it best to use either wood fiber or bonded fiber matrix mulches with tackifiers.

Bonded fiber matrix (BFM) consists of a continuous layer/matrix of elongated wood fiber strands held together by water-resistant bonding agents such as soil flocculants, crosslinked hydrocolloidal polymers, or cross-linked tackifiers. Its expected longevity ranges from 3 to 12 months. It forms a lofty, interlocking matrix that creates air and water absorbing cavities, which improve seed germination, reduce the impact of raindrop energy, and minimize soil loss. BFM can be used on slopes up to and including 2:1. To provide effective erosion control, do not apply immediately before, during, or immediately after a rainfall, or when the soil is saturated, since it typically requires 24 hours to dry before rainfall occurs.

Mechanically bonded fiber matrix (MBFM), produced from strands of elongated wood fibers and crimped synthetic fibers and combined with additional binding agents, creates an interlocking mechanism between the fibers. It has excellent longevity: 12 months or greater. Since MBFM requires no cure time to develop surface protection, it provides immediate protection against erosion and may be used on slopes up to and including 2:1.

Soil stabilization matting. Erosion control matting and rolled erosion control blankets provide immediate erosion protection. Many are specifically designed to handle higher velocities in concentrated water flow areas, such as swales connected to drainage pipes, and to provide more extended periods of erosion control. These typically use straw or coconut fiber mulch between layers of jute (biodegradable), UV-degradable or nondegradable netting. Some include a nondegradable fiber layer with 95% pore space, which provides more structure for hydraulic seeding over the top. They should be installed up and down the slope, never on the contour. Following manufacturer's recommendations, it is important to staple the mats to achieve a firm, continuous contact between the material and the soil. Typically more expensive than most hydraulic mulching options, these mats vary in cost based on longevity.

Mulch anchoring. Once mulch is applied, it needs to be anchored in place for the time needed to establish a seeding and protect the soil. The following section details the different types of mulch anchoring systems.

Box 3.11 Mulch netting

Mulch netting is used as a cover for seed; it is made from UV degradable plastic, jute, or cotton netting. Coconut fiber has been used as a longer-lasting natural material, bridging the gap between man-made fiber and plant-derived fibers for biodegradability. Individual rolls of netting should be applied up and down the slope, never along the contour. Bury the upper end of the netting at the top of the disturbed area in a trench at least 6– 8" deep. Lay out rolls so edges overlap each other by at least 4". When more than one roll is required going down slope, the ends going down the slope should overlap by at least 1'. Steel staples are used to fasten these materials to the surface. Installation is difficult on rocky sites. Staple the netting in place using wire staples according to manufacturer's recommendations.

Straw netting erosion control blanket on slope along US Route 6.

3.3 Post-establishment monitoring and maintenance

Monitoring during the first year. One of the biggest challenges encountered when transitioning to native roadside vegetation involves changing the expectations of what constitutes successful establishment. The manner in which biodiverse native plant communities establish differs greatly from the manner in which cool-season turfgrasses establish.

Cool-season sod-forming grasses germinate and grow relatively quickly. Small green seedlings quickly sprout all over the field and grow to relatively uniform heights, resulting in a field with an even, clean appearance. Within several weeks, if successfully established, turf has the appearance of a green carpet. By the end of the first growing season, turf has developed. On the other hand, native plant communities consisting of warm-season grasses and perennial forbs usually take 3–5 years to establish. It takes several years for practitioners to learn the skill set required to establish, evaluate, and maintain successful native stand development.

First-year native seedlings are small and grow more sparsely and less uniformly than turf seedlings. As a result, people often worry or assume their plantings have failed. While the aboveground growth of newly planted, warm-season grasses may appear subpar, in fact native warm-season grasses during their first year put most of their energy into developing extensive root systems. Leaf and stem growth rarely reach more than one foot high by the end of the first growing season. In many cases, relatively little flowering occurs the first year. Not until the second or third growing season does considerable aboveground biomass develop, finally resulting in grasses flowering and producing seed. If seedling density appears sparse, don't panic. An adequate, mature stand of native warm-season grass might have as few as one plant per square foot. Individual plants grow quite large, and may fill in poor stands by self-seeding or spreading vegetatively. A mature little bluestem clump eventually can measure one foot in diameter.

It is not uncommon for first-time growers of native plant communities to think their planting efforts were a waste of time. During the first year, the field is usually not pretty or uniform or green all over, as we have all come to expect with turfgrass. Expect some undesirable weeds growing among fields of desirable native seedlings.

Because native seedlings frequently grow among weed seedlings, it is important to develop the ability to distinguish weed seedlings from desirable native seedlings. People unfamiliar with native warm-season grass seedlings often conclude a planting has failed because they have not yet developed the ability to properly identify and distinguish between the various species within a planting. This is especially true when seeds are broadcast rather than planted with a no-till drill, which creates rows of plants that help guide the eye to where the new seedlings will appear. One approach helpful in identifying native seedlings involves digging up a few new seedlings and looking at the attached seed. This requires creating a chart of the seeds that were included in the original mix.

Most native warm-season grass seedlings look like small fountains and, on average, do not grow closely together. Frequently during the first growing season dicot seedlings are mistakenly identified as weeds when they are actually desirable, perennial forbs that only grow rosettes their first year. Many perennial plants take two or even three years before they flower. However, some seedlings in fact may be undesirable and need to be removed before they flower and add to the field's seedbank.

Tips for monitoring and evaluating new plantings:

- Inspect the seeded site at least three weeks following the seeding.
- Evaluate weed pressure. If heavy, plan and implement all necessary weed control treatments. The degree and rate of success of any seeding project will depend on weed control during the establishment period.
- Make additional inspections:
    - Following major rain events or for areas with expected high velocity and concentrated volumes of water.
    - On steep slopes.
- Where erosion is evident, repair areas by reseeding and mulching.
- If erosion control matting exhibits significant movement, reinstall and staple as needed.

Figure 3.11 Inspecting seed germination.

Top left and right: if using no-till drill, look for new seedlings by following the furrows created by coulter blades.

Bottom left: wild bergamot (*Monarda fistulosa)* plants emerging second year after seeding

- If the site was drill-seeded, examine the rows and look for a pattern of similar seedlings. This helps develop an eye for distinguishing between desirable and undesirable seedlings.
- Use seedling ID books or take a computer tablet to the field and use the plant profiles in this manual. Have a list of what was planted and find seedlings pictures for the species included in the mix.

- If uncertain about the success of a planting, consult a botanist for help identifying seedlings.
- Unless heavy rains wash away a planting, allow two full growing seasons before giving up and starting over.

Weed control and establishment mowing. Because native warm-season grass seedlings initially grow slowly, competition from grass and broad-leaf weeds can be detrimental to native seedling establishment. Weed control must take priority. The three basic methods for controlling weeds in new establishments are:

1. Mowing
2. Digging and pulling weeds
3. Spot treatment using selective herbicides
4. Flame guns for spot weeding

Mowing. Mowing helps control weeds by:

1. Controlling cool-season grasses and weeds during the first three years after seeding
2. Helping prevent tree and shrub encroachment

When choosing mowing equipment, consider both the terrain on which the planting occurred and the height of the mowing. Mowing for weed control is conducted at heights higher than those used for turf mowing. Generally, turf is mowed at heights ranging from 1" to 4". Native plant stands, on the other hand, require heights ranging from 6" to 12" during the first two years of establishment. Therefore, while heavy duty riding lawnmowers, wheeled brush mowers, string trimmers, and tractor-mounted mowers can all be used for weed control mowing, the equipment must be adjusted to the right height. String trimmers work best in many situations—for small areas, for spot weeding, and where other equipment cannot be used, such as steep slopes and

low wet areas. In addition, they can mow at a variety of heights and, unlike many mowers, they lay down the cut material gently without clumping, which can suffocate seedlings.

First year: Mow weeds to a height of 6" early in the first year and to 12" later in the year if the native grasses grow higher than six inches tall. Mow just above the tops of the native grasses. This prevents weeds from shading the shorter grass seedlings and setting seed, thus reducing weed pressure in following years. Expect to mow two to three times in the first year. Do not allow the weeds to grow over 12" tall before mowing; otherwise, the mowed material can smother the small seedlings.

Second year: Mow annual and biennial weeds in mid- to late June at a height of 12" to prevent annual and biennial weeds from forming seeds. Many native grasses begin growing vigorously during the second growing season. If weeds continue to cause a problem later in the second year, mow again just above the tops of the warm-season grasses. Since many warm-season grasses start to flower and set seed during the second year, it is important not to mow off their flowers before their seeds have ripened. Flail-type mowers work best in these situations because they chop the material, allowing it to dry rapidly without smothering the smaller grass seedlings below. Rotary mowers usually leave the cuttings in piles, creating a thick mat of clippings that can smother the young native plants.

Third year and beyond: One of the most effective methods for controlling weed during the third year of native prairie establishment in the Midwest is the use of prescribed fire in the spring. Since prescribed fire would create safety issues for New England roadsides, mowing must be conducted in a way that would best mimic how prescribed burning works. Since prescribed burning works by removing dead plant growth from the previous year, mow in the spring and rake off the cut material, which helps expose the soil and accelerates soil warming, which favors warm-season grasses and forbs. Mow as close to the ground as possible, right down to the soil surface, if possible. This achieves an effect similar to burning by giving warm-season native plants an advantage over cool-season weeds and grasses.

Timing of spring mowing. The best time to spring-mow a native plant stand varies from year to year. For controlling cool-season grasses and weeds, the best time is mid-spring, usually between April 15 and May 15, although this period will vary based up-

on latitude and the weather in any given year. A good indicator for when to spring-mow is the buds of the sugar maple (*Acer saccharum*) just start to open in spring. This corresponds to the time when warm-season native herbaceous plant species are also just beginning to emerge from winter dormancy. Since these plants have grown little by this point, they remain unharmed by mowing.

To control woody plant encroachment, a late spring mowing will inflict more damage to them than a mid-spring mowing. Mow once all trees and shrubs have fully leafed out, which generally occurs in mid to late May. Although grasses and forbs may suffer slightly from such a close mowing at this time, a late mowing will severely damage most woody plants. The herbaceous plants will grow back rapidly, but the woody plants recover more slowly.

Digging and pulling of weeds. Problem weeds, especially those with taproots, can be carefully pulled or dug beginning in the second growing season. Pulling and digging is not recommended in the first year of establishment because the small native seedlings, which have not yet rooted well, can be easily disturbed and killed. By the second year, established biennial and perennial weeds will be evident. For biennial weeds, carefully pull the plants, or cut them at the base during flowering to kill them. Remove plants prior to setting seed to prevent reinfestation in future years.

When pulling weeds that have taproots, hold the weed firmly between the feet and pull straight up. This holds the soil in place around the roots, and minimizes disturbance to adjacent young native grasses and forbs. Firmly tamp down any loose soil back into place around desirable plants that may have been disturbed. Weed pulling is easiest just after rain has moistened the soil. Pulling weeds from dry soil usually results in broken off roots that will re-grow and require future attention.

Spot treatment using selective herbicides. It is never recommended to *spray* glyphosate-based herbicide, such as Roundup®, in a native plant stand since, as a broad-spectrum systemic herbicide, its drift will kill the surrounding desirable plants. An alternative approach to spot-treat specific plants with Roundup® or a specific selective herbicide using something termed the “Glove of Death” or “Tongs of Death.” Both techniques involve soaking an absorbent material with an appropriate herbicide and

carefully targeting undesirable plants, thus preventing drift from killing neighboring desirable plants.

To conduct either of these techniques, first protect your arms and hands with heavy-duty, long, rubber herbicide application gloves. For the “Glove of Death” method, place a larger-size, absorbent cotton glove over the herbicide glove on one hand. Soak the glove with herbicide by moistening it using a small sprayer bottle set on “stream” rather than “mist.” Soak the glove until saturated, but not dripping, with the herbicide. Then wipe the glove on the target plants, making sure to uniformly apply the herbicide to the leaves. To prevent damaging nearby desirable vegetation, move them to the side with your feet or the hand without the herbicide glove.

The “Tongs of Death” utilizes the same technique, except the end of a set of tongs gets wrapped in old cotton socks or other absorbent material. Apply herbicide to the tongs from a bucket, or by spraying from a bottle, as with the “Glove of Death” method.

For both techniques, it might be advisable to use a spray bottle along with an empty bucket. Spray the absorbent material over the bucket so as to minimize drift. In addition, this technique may avoid unwanted spilling that could result if an open container of herbicide accidently tips over.

Controlling broadleaved weeds. Targeting broadleaved weeds using herbicides that kill only broadleaf plants will leave grasses unharmed. However, most broadleaf weed killers will also kill most desirable native forbs. Therefore, it is not recommended to spray a native plant establishment that includes both grasses and forbs with a broadleaf herbicide, since this will kill the native wildflowers. However, if using the two-step process of establishing native grasses during one season and native forbs a following season, applying a broadleaf herbicide across an entire field to help increase the density of the grass stand before the forbs have been added is a an affordable and effective technique.

Box 3.12 Mosaic mowing to achieve multiple ecological goals

Mowing plays an essential role in transportation infrastructure maintenance. Mowing improves driver visibility, provides a safe clear zone for vehicles to pull off the road, and prevents encroachment of woody shrubs and trees. In fact, 8–10' from the shoulder or road need to be mowed several times a year to provide drivers a safe clear zone.

However, as explained in Jennifer Hopwood's publication for the Xerces Society, "Pollinators and Roadsides: Managing Roadsides for Bees and Butterflies," excessive mowing may have contributed to a decrease in flowers and resulted in a decrease in wild bees in Belgium (Rasmont et al., 2006). Other research from the Netherlands found that mowing roadsides twice a year, early and late in the season, resulted in higher plant diversity (Forman et al., 2003) and greatly benefited flower-visiting insects (Noordijk et al, 2009). A study conducted in the Midwest found that mowing once a year in July promoted wildflower growth by knocking back dominant grasses (Collins et al.,1998). Nevertheless, mowing in July in New England may affect the buds of fall-flowering wildflowers, such as as asters and goldenrods, that provide essential forage for pollinators.

Thus, the timing and manner in which the remaining portion of the roadside is mowed can have significant ecological impacts.

Heather McCargo from Wild Seed Project in Maine has suggested that strategic roadside mowing can achieve several ecological goals. Heather warns against mowing all roadsides at the same time of the year. Instead, alternate portions of the roadside should be mowed at different times of the year to insure that vegetation always exists for pollinators to either forage or overwinter in the dead stems and leaves of plants.

One way to achieve this "mosaic" approach, as Heather has dubbed it, would be to divide portions of roadsides by using exits or structures such as bridges, overpasses, or even signs between long expanses of road as demarcations for each mowing zone. Each zone would be mowed at different times in the year or in alternating years. Some zones would favor spring or early summer flowering species. Others would favor fall flowering species. Yet others would allow for dead vegetation to remain standing to provide winter habitats for pollinators and wildlife, such as birds. For those portions that favor fall flowering species, the mowing can take place from mid-May to early June. Mowing during this period will insure that the buds of fall flowering species are not removed.

Since this approach reduces the overall amount of mowing, Heather suggests that DOTs use the newly available time to target patches of invasive species. DOTs can scout for plots of invasive populations, designating the area they encompass using readily viewed markers. Maintenance departments can mow these infestations several times in a season, making sure that they never go to seed and exhausting the populations by insuring their leaves do not remain sprouted long enough to photosynthesize and provide their roots with energy to grow and remain viable.

Inspection of seeding. Stand evaluation is conducted after all primary weed control measures have been implemented. Evaluate stands when seedlings are approximately 6–12 inches in height. For critical-area seedings of introduced grasses and legumes on slopes of 5:1 or greater, a seedling density of 8–100 seedlings per square foot is desirable. For conservation seedings on agricultural land where erosion control is a concern, a seedling density of 40–50 seedlings per square foot is desirable. For conservation plantings where erosion control is not the primary objective, 20–25 plants per square foot will satisfy most needs. Warm-season grasses can tolerate less density, although early density is important to compete with weeds. It is normal for stands to thin out during the establishment period and stands of 50% of the above densities are acceptable in the spring following seeding. Warm-season grasses can obtain canopy closure after several years with as few as two seedlings per square foot if weeds are controlled. A less-dense stand will lend itself to more species diversity, which is desirable for some conservation objectives. Although some of these species could be considered weeds with the potential to spread to other fields, it is important to carefully evaluate native seedings so that effective management decisions can be made. The use of point-intersect techniques or seedling counts per square foot using a grid system can aid in the systematic evaluation of plantings. For warm-season grasses on soils with areas prone to frost heaving, evaluate again the following spring.

Chapter 4: Focus Groups of New England Departments of Transportation Managers

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Figure 4.1 New England DOT managers examine a site along US Route 6 in Connecticut.

Although emerging research suggests that the use of native warm-season grasses (NWSGs) as a foundation for roadside revegetation practices has potentially greater ecological, environmental, and economic benefits than the planting of nonnative cool-season turfgrasses (Harrison, 2014; Forman et. al, 2003; Barton, 2015), few state DOTs nationwide have successfully transitioned to using NWSGs predominantly in their roadside revegetation practices. Several barriers currently impede such adoption. First, few agencies understand that an alternative exists to traditional cool-season turfgrasses. Second, cool-season turfgrasses establish far more rapidly than NWSGs. Third, changes in maintenance practices require DOT bureaucracies to adapt to new regimes. Such bureaucratic changes rarely come quickly or easily.

A manual providing instructions on how to establish roadside NWSG-based native plant communities will be insufficient in and of itself to insure that new practices will be adopted. Therefore, focus groups of managers from New England Departments of Transportation (DOTs) were conducted to collect information to identify potential roadblocks that might impede successful implementation of new revegetation protocols. The focus group format allowed for the widest range of participants from various departments, thus allowing questions to be answered most thoroughly and authoritatively.

The interviews took place at DOT headquarters in each state. Each focus group included high-level managers from departments whose work involved aspects of roadside vegetation, including landscape architecture, construction, engineering, conservation, and maintenance. Five of the six New England state DOTs availed themselves to focus groups: Connecticut, Rhode Island, Massachusetts, New Hampshire, and Maine. The focus group interview process followed a semi-structured survey instrument (that is, a "script").

The focus groups revealed several challenges that need to be addressed to insure a successful transition to NWSG-based native plant community establishment practices:

- Motivating DOT management and staff
- Addressing structural impediments within DOTs
- Addressing outside structural impediments
- Addressing funding issues

4.1 Motivating DOT management and staff

Stressing that native grass establishment is tied to a federal mandate. When asked "On a scale of 1 to 5, how flexible and willing do you believe your DOT has been at adopting new practices in the past?" a participant responded, "If there's a regulation behind it?" When told yes, the participant answered, "Four. If no regulation, 1."

This answer succinctly captured what several participants stressed repeatedly: the best motivation for changing practices is simply to make such a change a requirement. Under such circumstances, each department will do whatever is necessary to implement new protocols. Whether or not a department wants to or believes it necessary to change a policy, if it is required to do so as a result of new regulations, it will make the change.

If the best motivation comes in the form of directives sent from upper management, the next step requires:

Getting buy-in from upper management. Implementation of these policies would likely gain traction if upper management in each state DOT either felt a pressing urgency or nonnegotiable mandate to do so. Interviewees asserted consistently that adoption of any new policies would most likely originate from DOT landscape design departments, which typically write the revegetation specifications contained in construction contracts. The department that would play an equally critical role in ensuring adoption of new revegetation practices, according to focus group participants, would be vegetation maintenance. Although landscape designers select the species for roadsides seed mixes, the practices maintenance departments use to maintain these stands of vegetation will determine whether they will persist. Continuing the frequent mowing regimens that favor the growth cycles of cool-season turfgrasses would prove detrimental to the establishment of NWSG-based native plant communities.

Several department heads from each state participate on the board of the New England Transportation Consortium (NETC), which commissioned the research for this manual. Their buy-in could go a long way in helping to persuade each state DOT to take the necessary steps to change policies.

However, if the greatest catalyst for policy change comes simply in the form of new regulations, it should be made clear to upper management of each state that this transition to new roadside NWSG establishment practices is not optional but rather mandated by the federal government.

Cost-benefit analysis. While mandates and new regulations most effectively catalyze bureaucratic policy change, persuasive cost-benefit analysis can assist in easing the

transition from a familiar, long-practiced policy to a new, unfamiliar one. In every focus group, at least one participant made the point that management wants to know that a new method can save either money or time, or better achieve a particular objective. One DOT member discussed a meeting where he had to find methods for drastically cutting fuel consumption by department vehicles and equipment for both budgetary and environmental reasons. One of the main objectives of revegetating with NWSG—the reduction of mowing frequencies to once a year or once every other year—would help achieve such cost savings. When focus group participants heard of other benefits provided by NWSGs—such as better erosion and stormwater control as a result of NWSG's deeper, more extensive root systems, restoration of more biodiverse ecosystems from native plant populations, increased forage for native pollinators, and a bulwark against invasive species encroachment—---they expressed a greater openness and willingness to change policies.

While recitation of the qualitative benefits of NWSG did much to win over DOT managers to the efficacy of such a policy change, an even more persuasive approach would come in the form of a quantitative economic calculation that would come with NWSG establishment. An economic impact statement (EIS) can be commissioned through such organizations as Earth Economics, a Seattle-based nonprofit group that calculates the economic and ecological costs and benefits of projects to ecosystem.

Educational program. Any change in policy would require a program to educate workers about the differences between NWSGs and cool-season turfgrasses. Focus group interviews found most participants had a vague understanding of the differences between the two kinds of grasses, but few participants, other than about three or four landscape designers from different states, could talk about them authoritatively. It became clear that to get buy-in from DOT workers required development of a program that would educate workers about the biological differences between NWSGs and cool-season turfgrasses and the ecological, environmental, and economic benefits of using NWSGs. Participants repeatedly stressed the necessity of this step in any transition to a new policy.

Proven establishment strategies as demonstrated through successful projects. Several participants voiced the need to see evidence of the effectiveness of any NWSG establishment protocols. Each state may want to conduct preliminary trials to act as

both labs for their own efforts and to provide easily accessible evidence (demonstration plots) of the effectiveness of the establishment protocols. Considering that one of the drawbacks of NWSG-based native plant community establishment is the longer time it takes for NWSGs to establish compared to cool-season grasses, it is advisable that such trials/demonstration plots be one of the first steps that each state DOT undertake during their transition. Each DOT might consider starting trial programs that explore and document these new vegetation protocols. Concurrently, DOT can start putting in place other facets of the transition, such as those portions dealing with policy changes and education about the new protocols.

An example of a new effective and affordable revegetation practice DOTs can begin to implement and our research shows significant results within one growing season is a technique we term *augmentation of existing native plant communities*, described in Chapter 3.

Tying establishment of NWSGs to elimination of invasive species. At least two focus group participants suggested that tying the establishment of NWSGs to the elimination of invasive species would help make this policy change more attractive to management. After eradicating invasive species, these members suggested that cleared land be re-vegetated with NWSGs and forbs. The newly established native plants can possibly help prevent the re-encroachment of invasive species.

4.2 Addressing structural impediments within DOT

Reformulating the revegetation contracting system following new construction.

A major structural challenge that will need to be addressed when transitioning from cool-season turf to native plant community establishment is the existing contracting system for re-vegetation following new construction.

Currently, all New England state DOTs sub-contract re-vegetation after new construction to private companies. Most contracts for each state for grass establishment follow similar frameworks: the contractor receives half their payment for services at the start of the grass establishment process. Only after a set period of time (usually several months) the contractor will receive the second half of their payment once the plot for

which they were contracted to establish grass has shown satisfactory growth. Considering the relatively short period of time it takes for cool-season turfgrass to germinate, such a system has proven workable for both the DOT and the contractors. However, since the time frame for NWSG establishment can span several growing seasons, such a payment structure and system of accountability may no longer be viable. Formulating a new framework is not immediately apparent and each state may need to develop ones that best suit their states.

Some participants insisted that the only way to insure long-term accountability for proper germination would be moving the process back in-house and have it carried out by each state's maintenance department. Such an approach has several advantages. First, native plant community establishment often requires follow-up during the first few weeks after initial seeding to inspect for and possibly treat any encroaching weeds that may outcompete the NWSGs and forbs during the establishment period. Since DOT maintenance departments will be discouraged from mowing between mid-June to mid-October, maintenance workers could use the time freed from mowing to inspect NWSG establishment progress. In addition, by moving re-vegetation back in -house, funds that had previously left the department can remain internally, helping to bolster a department that, according to several participants, is often the first victim of budget cuts.

Whether or not the process remains privatized or moves in-house, the process of native plant community establishment requires specialized knowledge that will almost certainly require trained individuals, which can be certified in newly developed programs by each state under guidelines similar to those used to certify pesticide applicators, arborists, and turf and ornamental shrub specialists. To receive certification, applicants would need to understand the differences between cool- and warm-season grasses, learn to visually identify and distinguish between common roadside native and nonnative species, properly apply herbicides at the appropriate times in the growing season, become familiar with the different methods available for native plant community establishment, and develop the ability to scout for pre-existing NWSG populations to perform population augmentation. Such certified individuals could act as lead managers of native plant community establishment.

Another complexity that needs consideration is optimal timing for NWSG establish-

ment. Under the current system, cool-season grass seeding occurs immediately after construction ends. While spring and fall are the optimal times for cool-season grass germination, in reality seeding for turfgrass can take place during almost any part of the year except in the middle of winter. Considering the possibility of erosion from bare soil, this flexible establishment schedule has served DOTs well.

Optimal NWSG establishment does not allow for such flexibility as the window during which NWSG establishes most successfully ranges from late spring to early summer and some techniques point to the possibility of successful dormant seeding in late fall. Unfortunately, construction project termination dates do not always coincide with optimal NWSG establishment periods. As such, another establishment formulation would need to accommodate year-round construction.

One participant suggested the following solution: plant cheap placeholder or cover crop as erosion control and then return in late spring and properly establish the NWSGs during their optimal growing period. Either an in-house crew or private contractor could return to establish several plots previously seeded with cover crops to control erosion temporarily. By using a cheaper initial erosion control mix, a portion of the re-vegetation budget can be saved for the later NWSG establishment, thereby only slightly increasing the amount of money required to seed twice. It is an imperfect solution and probably needs more logistical tinkering, but it points to the possibility of resolving one of the main problems for which this research project was funded: the difficulty in establishing NWSGs. However, while the upfront costs and efforts needed to establish NWSG may appear slightly more complicated and costly compared to those required for cool-season grasses, once established the costs and efforts decrease while the benefits increase.

Development of consultant and management positions. Other state DOTs, such as Delaware's, have made similar efforts to change policies, going so far as publishing two manuals (Barton, 2005; 2009), but have experienced a slow process of transitioning (Barton, 2014). Other states that have successfully transitioned to new protocols developed a position for someone who could lead these new efforts. Specifically, Iowa counties created a full-time Roadside Manager position familiar with these new protocols and able to guide roadside managers and their departments during the transitional process (Brandt, 2015).

Originally, the position our team envisioned was a consultant shared by several New England states, who would travel from state to state and advise on new establishment projects. NETC would fund the position, with several states pooling funds together to pay for the consultant's services. However, in the course of the focus groups, several participants envisioned a more expansive role for the consultant. During the first few years of transitioning to new policy, the consultant would work with each DOT and develop educational and training programs related to the new policies and would help reformulate maintenance practices to insure the proper establishment of these new native plant communities. In essence, the consultant would act as a driver within each DOT, insuring the implementation of new policy. This feedback made our team rethink the nature of a consultant position. Eventually we came to believe that the more effective way for each state to commit to new protocols would involve making the consultant position transitional and creating a permanent Roadside Native Vegetation Manager position for each state. The savings that would result from effective protocol implementation would help offset the cost for each state of developing this new position.

4.3 Addressing Funding Issues

The theme most often raised in the course of focus group discussions concerned the need for money to fund any new efforts. Money would be needed for labor, equipment, maintenance, and supplies. Every department within each DOT was stretched thin financially, especially maintenance. Lack of any new money to fund work beyond that which already was taking place limited the scope of any new projects. Therefore, finding funding became paramount.

Funding within the department. The possibility existed that funding might come from savings derived as a result of new practices. Decreased mowing regimens would mean decreased use of fuel and wear on equipment. Such savings could shift toward native plant community establishment practices. Similarly, moving re-vegetation in-house may reduce the costs for each establishment project.

Finding federal programs for the elimination of invasive species and the establishment of native grasses. Since these directives derive from mandates related to

invasive species elimination, the possibility exists that federal funding can help supplement each state's requirement to meet such mandates. However, more direct funding from the federal government came into existence since we conducted these focus groups such as the Fixing America's Surface Transportation (FAST) Act (Pub. L. No. 114-94), which was signed in December 2015.

Reach out to the private sector. Some participants suggested turning to the private sector since they remain more flush financially than the public sector. An urban beekeeper in Boston recommended adapting the Adopt-a-Highway model as a means for financing the establishment of pollinator habitats along portions of the roadside (Wilson-Rich, 2015). Wilson-Rich even offered his non-profit organization free of charge to run such a program. All he asked was that he and other scientists involve in pollinator health research have access to these new sites to study their effectiveness in increasing pollinator populations and general health. Further research revealed that the Missouri DOT created a program called *Grow Native!*, which has adapted the Adopt-a-Highway for funding roadside native plant establishment.

Find non-profit funding for pilot programs. Finding funding from nonprofit groups in the form of grants to fund pilot programs seemed like one of the more promising suggestions provided by the focus groups.

4.4 Other Hurdles

Securing widespread access to no-till drills. No-till seed drills, such as those manufactured by the Truax Company, are some of the most effective pieces of equipment for seeding native plant communities. Currently, only Connecticut and Rhode Island have easy access to Truax no-till seed drills. One of the responsibilities of the previously discussed consultants or Roadside Native Vegetation Managers might be to arrange purchasing or rental relationships between Truax drill owners and state DOTs.

Software to track statewide NWSG colonies and their expansion. As each state locates and augments existing colonies of NWSG and establishes new populations, maintenance departments will need to keep track of these colonies to insure they receive different mowing regimens from those conducted on cool-season grass populations. Not only do native plant populations get mowed less often, they get mowed at a

taller height. It will be important to either find or develop a software program with which maintenance programs can track their mowing regimens.

Chapter 5: Plant Profiles

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This chapter contains the eco-regional list of plants suitable for roadside plantings. The important factors for the selection of native species included the ability to establish quickly under roadside conditions, are of short or moderate stature to allow for sight lines, suitable for full sun or partial shade.

There are profiles of 89 species of forbs and 37 species of grasses and grass-like native species (sedges, rushes etc.) that can be used in roadside plantings in New England to achieve functional and diverse plant communities. Each plant profile contains scientific and common names, New England distribution map, habitat information, plant characteristics, comments on pollinator and wildlife value, as well as photographic images. When compiling plant specifications for each project, this assortment may be narrowed down for each state or even portions of the state based on the species distribution maps.

The following acronyms were used for the Wetland Indicator Code (frequency that a species occurs in a wetland):

FACU Usually occurs in non-wetlands, but occasionally in wetlands.

FACW Usually occurs in wetlands, but occasionally in non-wetlands.

FAC Equally likely to occur in wetlands or non-wetlands.

UPL Occurs only in non-wetlands.

OBL Occurs only in wetlands.

Box 5.1: Forbs (89 species)	
Achillea millefolium	*Krigia virginica*
Actaea racemosa	*Lactuca canadensis*
Ageratina altissima	*Lechea intermedia*
Aguilegia canadensis	*Lepidium virginicum*
Anaphalis margaritacea	*Lespedeza capitata*
Anemone canadensis	*Lespedeza frutescens*
Anemone quinquefolia	*Lespedeza hirta*
Anemone virginiana	*Lobelia cardinalis*
Asclepias exaltata	*Lysimachia quadrifolia*
Asclepias incarnata	*Monarda fistulosa*
Asclepias syriaca	*Nuttallanthus canadensis*
Baptisia tinctoria	*Oenothera villosa*
Bulbostylis capillaris	*Oenothera biennis*
Calystegia sepium	*Parthenocissus quinquefolia*
Capnoides sempervirens	*Penstemon digitalis*
Chamaecrista fasciculata	*Penthorum sedoides*
Chamaecrista nictitans	*Polygonum articulatum*
Chamaenerion angustifolium (synonym: Epilobium angustifolium)	*Potentilla canadensis*
Chelone glabra	*Prunella vulagris subsp. lanceolatum*
Cirsium muticum	*Pseudognaphalium obtusifolium*
Cirsium pumilum var. pumilum	*Pycnanthemum muticum*
Desmodium canadense	*Pycnanthemum tenuifolium*
Doellingeria umbellata	*Rudbeckia laciniata*
Erechtites hieraciifolius	*Sisyrinchium angustifolium*
Erigeron annus	*Sisyrinchium montanum*
Erigeron strigosus	*Solidago juncea*
Eupatorium perfoliatum	*Solidago nemoralis*
Eurubia spectabilis	*Solidago puberula*
Eurybia divaricata	*Solidago rugosa subsp. rugoa*
Euthamia graminifolia	*Solidago sempervirens*
Eutrochium maculatum	*Spiraea alba var. latifolia*
Eutrochium purpureum	*Spiraea tomentosa*
Gentiana clausa	*Symphyotrichum cordifolium*
Geranium maculatum	*Symphyotrichum lanceolatum*
Helenium autumnale	*Symphyotrichum novae-angliae*
Helenium flexuosum	*Symphyotrichum novi-belgii*
Helianthus decapetalus	*Symphytotrichum punicum*
Helianthus divaricatus	*Thalictrum dioicum*
Helianthus strumosus	*Thalictrum pubescens*
Hieracium kalmia	*Tradescantia ohiensis*
Hypericum ellipticum	*Trichostema dichotomum*
Hypericum gentianoides	*Vernonia noveboracensis*
Hypericum punctatum	*Veronicastrum virginicum*
Ionactis linariifolius	*Zizia aurea*
Iris versicolor	

Box 5.2: Grasses and grass-like species (37 species)
Agrostis hyemalis
Agrostis perennans
Agrostis scabra
Andropogon gerardii
Andropogon virginicus
Bromus ciliatus
Calamagrostis canadensis
Carex scoparia
Carex stricta
Carex swanii
Carex vulpinoidea
Coleataenia longifolia subsp. rigidulum
Cyperus bipartitus
Danthonia compressa
Danthonia spicata
Deschampsia flexuosa
Dichanthelium clandestinum
Dichanthelium columbianum
Dichanthelium linearifolium
Elymus riparius
Elymusvirginicus
Eragrostis pectinacea
Eragrostis spectabilis
Festuca rubra subsp. pruinosa
Juncus effusus
Juncus greenei
Juncus tenuis
Leersia oryzoides
Luzula multiflora
Muhlenbergia mexicana
Panicum virgatum
Paspalum setaceum
Schizachyrium scoparium
Scirpus atrocinctus
Scirpus cyperinus
Sporobolus cryptandrus
Tridens flavus

HERBACEOUS FLOWERING SPECIES (FORBS)

Achillea millefolium
common yarrow

New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

FACU

Herbaceous perennial

Photo courtesy of Mark B. Fiely, Ernst Conservation Seeds.©

Photo courtesy of Arthur Haines, New England Wildflower Society ©

Habitat: Widespread/diverse, alpine/ subalpine, cliffs, ledges, meadows, fields, shores of rivers/lakes, occasional wetlands

Flower Color: White to yellowish, pink, red

Bloom Time: Midsummer through early fall

Height: Up to 3'

Leaf arrangement: Alternate

Leaf type: Deeply dissected

Sun Exposure: Full Sun, Part Shade

Soil pH: Acid to alkaline

Notes:

- Relatively short-lived but can spread rapidly - use with caution
- Fibrous horizontal root structure

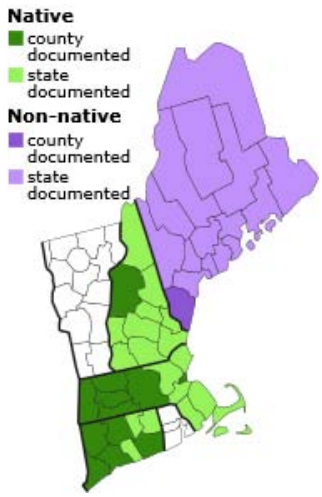
Pollinator and Wildlife Information

Special value to native bees, hoverflies, and butterflies

Larval host to American lady butterfly (*Vanessa virginiensis*)

Benefits for Wildlife: Provides nesting material for birds, and is nectar and pollen for bees, beetles, butterflies, moths, skippers, flies, and wasps

Actaea racemosa
black bugbane



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

Not classified

Herbaceous perennial

Habitat: Forests

Flower Color: White

Bloom Time: June to August

Height: 3'-8'

Leaf arrangement: Alternate

Leaf type: Compound (separated into leaflets)

Sun Exposure: Part Shade, Shade

Soil Moisture: Wet-Mesic, Mesic (Medium)

Seeding rate: 1-5% of mix

Photo courtesy of Mark B. Fiely, Ernst Conservation Seeds. ©

Photo courtesy of Arthur Haines, New England Wildflower Society ©

Notes:

Synonym *Cimicifuga racemosa*

- Plant is deer/rabbit resistant
- Repels insects
- Slow to establish from seed

Pollinator and Wildlife Information

Pollinator Ranking: Very High

Special value *to* native butterflies

Larval host to Appalachian azure (*Celastrina neglectamajor*)

Benefits for Wildlife: Food source for butterflies

Ageratina altissima
white snakeroot

New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

Not classified

Herbaceous perennial

Habitat: Forests, meadows, stream banks

Flower Color: white

Bloom Time: July to October

Height: Up to 4'

Leaf arrangement: Opposite

Leaf type: Simple (not separated into leaflets), toothed margins, somewhat cordate

Sun Exposure: Part Shade, Shade

Soil Moisture: Wet-Mesic, Mesic (Medium), Dry -Mesic

Soil pH: 5.5-7.5

Seeding rate: *1-2% of mix, approx. 2,400,000/lb*

Photo courtesy of Mark B. Fiely, Ernst Conservation Seeds.©

Notes:

Synonym *Eupatorium rugosum*

Toxic if ingested by humans or livestock

Pollinator and Wildlife Information

Special value to native bees and moths

Benefits for Wildlife: Food source for long and short tongue bees and moths

Anaphalis margaritacea
pearly everlasting

New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

FACU

Herbaceous perennial

Habitat: Man-made or disturbed habitats, meadows/fields, shores of rivers or lakes

Flower Color: Yellow with white bracts

Bloom Time: July to September

Height: Up to 3'

Leaf arrangement: Alternate

Leaf type: Simple (not separated into leaflets), margin is entire (without teeth), covered with white hairs

Sun Exposure: Full Sun, Part Shade

Soil Moisture: Dry-Mesic, Dry

Persistence: Low

Soil pH: 6.0-7.5

Seeding rate: Approx. 8,200,000/lb

Notes:

- Lookalikes: *Pseudognaphalium obtusifolium*
- Dioecious (having the male and female flowers on different individuals).

Photos courtesy of Arthur Haines, New England Wildflower Society ©

Pollinator and Wildlife Information

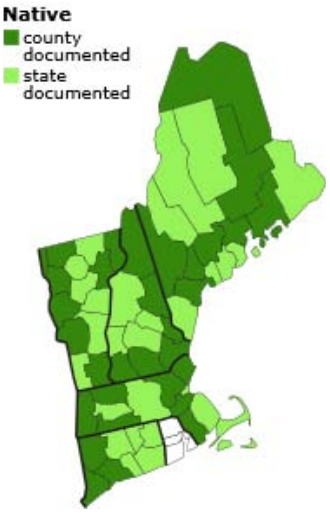
Special value to native butterflies

Larval host to American ladies (*Vanessa virginiensis*) and painted ladies (*Vanessa cardui*)

Benefits for Wildlife: Provides a food source butterfly larvae and butterflies

Anemone canadensis

Canada windflower



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

FACW

Herbaceous perennial

Habitat: Meadows/fields, shores of rivers or lakes, damp prairies

Flower Color: White

Bloom Time: May to August

Height: Up to 2'

Leaf arrangement: Whorled (with three or more leaves per node along the stem)

Leaf type: Simple, basal (the leaves are growing only at the base of the plant)

Sun Exposure: Full Sun, Part Shade

Soil Moisture: Wet-Mesic, Mesic (Medium)

Seeding rate: 1%-5% of a mix

Photos courtesy of Arthur Haines, New England Wildflower Society ©

Photo courtesy of Mark B. Fiely, Ernst Conservation Seeds.©

Notes:

- Can be slow to germinate from seed
- Roots: rhizomatous
- Will spread readily and can overwhelm smaller plants
- Very attractive groundcover
- Lookalikes: *A. virginiana* with seed-like fruits densely woolly hairy in cluster taller than wide (*A. canadensis* with nonhairy fruits as wide as tall).

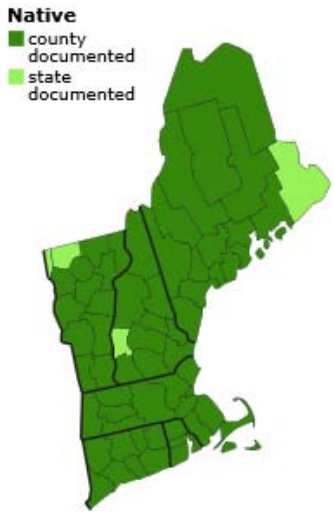
Pollinator and Wildlife Information

Special value to native bees, hoverflies, and butterflies

Benefits for Wildlife: Provides nectar and pollen for short tongue bees, butterflies, and hoverflies

Anemone quinquefolia

wood anemone, wood windflower



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

FACU

Herbaceous perennial

Photo courtesy of Donald Cameron © 2016

Photo courtesy of Arthur Haines, New England Wildflower Society ©

Habitat: Floodplain, forest edges, forests, meadows/fields, shores of rivers or lakes

Flower Color: White

Bloom Time: April to May

Height: 3”

Leaf arrangement: Whorled (with three or more leaves per node along the stem)

Leaf type: Compound, margin has teeth and/or lobes

Sun Exposure: Part Shade, Shade

Soil Moisture: Wet-Mesic, Mesic (Medium)

Notes:

- Roots: Tuberous (small)
- Plant dies back in mid-summer
- Lookalikes: *Anemonella thalictroides*, which has pink blooms.

Pollinator and Wildlife Information

Special value to native bees

Benefits for Wildlife: Provides nectar for short tongue bees

Anemone virginiana

tall anemone, tall windflower

New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

FACU

Herbaceous perennial

Habitat: Man-made or disturbed habitats, cliffs ledges, floodplain, forest edges, forests, shores of rivers/lakes, woodlands

Flower Color: Greenish-white

Bloom Time: June to August

Height: 2'-3'

Leaf arrangement: Whorled (with three or more leaves per node along the stem)

Leaf type: Compound, basal, margins have teeth and lobes, hairy

Sun Exposure: Full Sun, Part Shade, Shade

Soil Moisture: Mesic (Medium), Dry-Mesic

Seeding rate: 1-5% of mix; approx. 448,000/lb

Notes:

- Lookalikes: *A. canadensis* with nonhairy fruits as wide as tall (*A. virginiana* with seed-like fruits densely woolly hairy in cluster taller than wide).

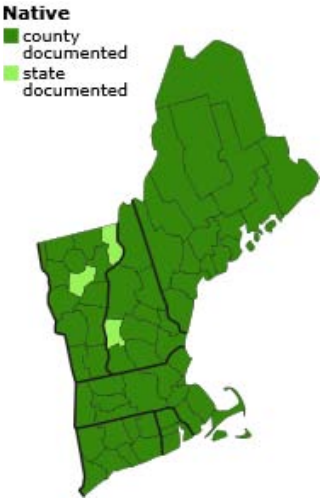
Photos courtesy of Mark B. Fiely, Ernst Conservation Seeds.©

Pollinator and Wildlife Information

Special value to native bees

Benefits for Wildlife: Provides nectar for bees. Provides habitat for animals

Aquilegia canadensis
red or Eastern columbine



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

FACU

Herbaceous perennial

Photos courtesy of Mark B. Fiely, Ernst Conservation Seeds.©

Habitat: Cliffs, ledges, rocky slopes, shores of rivers or lakes, woodlands, dry forests

Flower Color: Red, yellow

Bloom Time: April to June

Height: Up to 2'

Leaf arrangement: Alternate

Leaf type: Compound (separated into leaflets)

Sun Exposure: Full Sun, Part Shade, Shade

Soil Moisture: Mesic (Medium), Dry-Mesic, Dry

Soil pH: 5.0-8.0

Seeding rate: 1-5% of mix; approx. 504,000/lb

Notes:

Plant is deer resistant

Short-lived fibrous roots and vertical underground stem (caudex)

Moist stratification for 3-4 weeks at 40°F may speed up germination

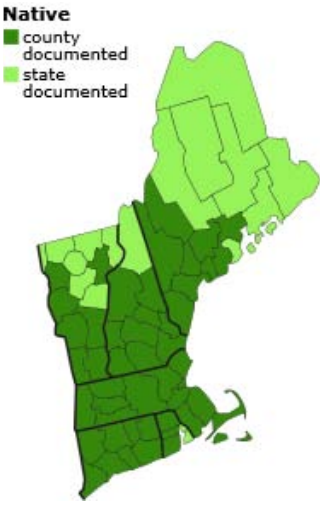
Lookalikes: *A. vulgaris* with blue to purple flowers (*A. canadensis* with red flowers)

Pollinator and Wildlife Information

Special value to native bees, butterflies, and moths

Larval host to Columbine duskywings (*Erynnis lucilius*)

Asclepias exaltata
poke milkweed



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

UPL

Herbaceous perennial

Habitat: Man-made or disturbed habitats, forest edges, forests

Flower Color: White

Bloom Time: June to July

Height: Up to 5’

Leaf arrangement: Opposite

Leaf type: Simple (not separated into leaf-lets), margin is entire, elliptic

Sun Exposure: Part Shade, Shade

Soil Moisture: Mesic (Medium), Dry-Mesic

Photos courtesy of Alexey Zinovjev and Irina Kadis, Salicicola.com. ©

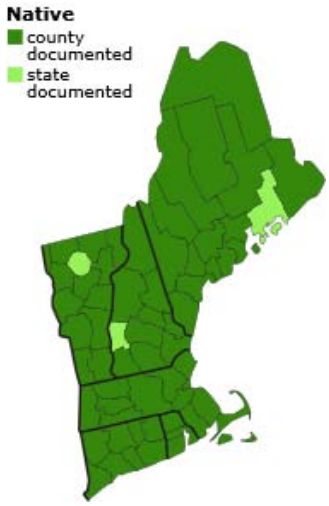
Photo courtesy of Arthur Haines, New England Wildflower Society ©

Pollinator and Wildlife Information

Special value to native bees and butter-flies

Benefits for Wildlife: Provides nectar and pollen for bees, butterflies, and bee-tles

Asclepias incarnata
swamp milkweed



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

OBL

Herbaceous perennial

Habitat: Marshes, meadows/fields, shores of rivers or lakes, swamps, wetland margins, sphagnum bogs

Flower Color: Pale purple to greenish-white

Bloom Time: June to August

Height: Up to 5'

Leaf arrangement: Opposite

Leaf type: Simple (not separated into leaflets), margin is entire, lanceolate

Sun Exposure: Full Sun

Soil Moisture: Wet, Wet-Mesic, Mesic (Medium)

Persistence: Medium

Soil pH: 5.0-8.0

Seeding rate: 1%-5% of mix, approx. 70,000/lb

Notes:

CAN BE TOXIC IF TAKEN INTERNALLY

Roots: Rhizomatous, also spreads via wind-blown seeds

Cold, moist stratification at 35-38°F for 4-12 weeks or hot water soak (190°F) for 12 hours x3 aids germination

Can be bothered by orange milkweed aphid - soap solution or high-pressure water will control

Photo courtesy of Arthur Haines, New England Wildflower Society ©

Photos courtesy of Mark B. Fiely, Ernst Conservation Seeds.©

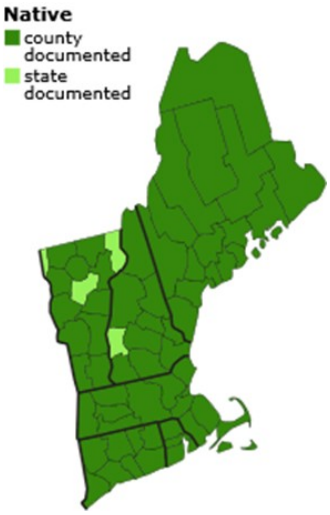
Pollinator and Wildlife Information

Special value to native bees, moths, and butterflies

Larval host to monarch butterflies (*Danaus plexippus*) and queen butterflies (*Danaus gilippus*)

Benefits for Wildlife: Provides nectar and pollen for long and short tongue bee species, beetles, butterflies, moths, skippers, flies, and wasps

Asclepias syriaca
common milkweed



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

UBL

Herbaceous perennial

Habitat: Fields/prairies, roadsides, open ground, forest margins, banks of lakes, ponds & waterways

Flower Color: Pale purple

Bloom Time: June to August

Height: Up to 5'

Leaf arrangement: Opposite

Leaf type: Simple,broadly elliptic, sparsely hairy above, densely hairy below

Sun Exposure: Full Sun, Part Shade

Soil Moisture: Wet-Mesic, Mesic, Dry-Mesic

Persistence: Low

Soil pH: 5.6-7.5

Seeding rate: 1-3% of mix, 70,000 seeds/lb

Photos courtesy of Mark B. Fiely, Ernst Conservation Seeds.©

Notes:

- Can spread rapidly- use with care
- **CAN BE POISONOUS IF INGESTED** by animals/ people
- Deep rhizomatous root structure
- **Fruits:** Spindle-shaped follicles covered with soft hair
- Burning in fall eliminates dead stalks and stimulates new growth

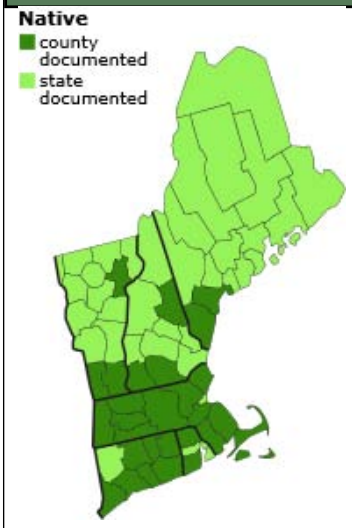
Pollinator and Wildlife Information

Pollinator Ranking: Very High

Special value to native bees, moths, and butterflies

Larval host to monarch butterflies (*Danaus plexippus*), queen butterflies (*Danaus gilippus*), and milkweed tiger moths (*Euchaetes egle*)

Asclepias tuberosa
butterfly milkweed



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

Not classified

Herbaceous perennial

Habitat: Man-made or disturbed habitats, grasslands, meadows/fields

Flower Color: Yellow, red, orange

Bloom Time: June to August

Height: 1'-3'

Leaf arrangement: Alternate

Leaf type: Simple (not separated into leaflets), crowded, lanceolate, 5-10 cm long, shiny green, smooth above, velvety beneath

Sun Exposure: Full Sun

Soil Moisture: Mesic (Medium), Dry-Mesic, Dry

Persistence: Moderate

Soil pH: 4.8-6.8

Seeding rate: 1-3% of mix, 70,000 seeds/lb

Notes:

- Can spread rapidly- use with care
- **CAN BE POISONOUS IF INGESTED** by animals/ people
- Deep rhizomatous root structure
- **Fruits:** Spindle-shaped follicles covered with soft hair;
- Burning in fall eliminates dead stalks and stimulates new growth

Photos courtesy of Mark B. Fiely, Ernst Conservation Seeds.©

Pollinator and Wildlife Information

Special value to native bees, moths, and butterflies

Larval host to monarch butterflies (*Danaus plexippus*), queen butterflies (*Danaus gilippus*), and milkweed tiger moths (*Euchaetes egle*)

Benefits for Wildlife: Provides nectar and pollen for long and short-tongued bee species, butterflies, and moths

Baptisia tinctoria

yellow wild indigo, horseflyweed

New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

Not classified

Herbaceous perennial legume

Habitat: Sand hills, pine flat woods, xeric woodlands, ridges, road banks, coastal plain, piedmont

Flower Color: Yellow

Bloom Time: Midsummer

Height: 2.5'

Leaf arrangement: Alternate

Leaf type: Compound (separated into leaflets) with three lobes/leaflets radiate from common point, grayish-green

Sun Exposure: Full Sun

Soil Moisture: Wet-Mesic, Mesic (Medium), Dry-Mesic, Dry

Soil pH: 5.8-7.0

Seeding rate: 1-5% of mix; 300,000/lb

Photos courtesy of Mark B. Fiely, Ernst Conservation Seeds.©

Notes:

- High drought tolerance
- Extensive, thick, woody deep root structure
- Low seeding success due to weevil predation
- Seed must be scarified and subsequent 24-hour soak will increase germination
- Resents root disturbance once established
- Seeds rattle in seed pods when mature

Pollinator and Wildlife Information

Pollinator Ranking: Medium

Special value to native bees and butterflies

Larval host to frosted elfins (*Callophrys irus*) and wild indigo duskywings (*Erynnis baptisiae*)

Benefits for Wildlife: Provides nectar and pollen to bees, bumblebees, and butterflies.

Capnoides sempervirens
pink-corydalis, pale corydalis

New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

Not classified

Herbaceous biennial

Habitat: Man-made or disturbed habitats, cliffs, ledges, ridges, woodlands

Flower Color: Pink and yellow

Bloom Time: May-July

Height: Up to 3'

Leaf arrangement: Alternate

Leaf type: Compound (separated into leaflets), elliptic to oblong with obtuse tip, greenish-blue

Sun Exposure: Full Sun, Part Shade

Soil Moisture: Dry-Mesic, Dry

Persistence: Low

Soil pH: Acidic

Notes:

Synonym *Corydalis sempervirens*

Seeds dispersed by ants

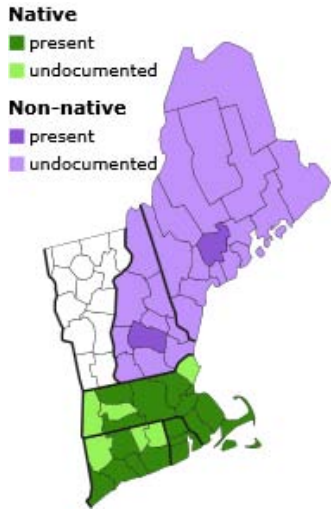
Photo courtesy of Arthur Haines, New England Wildflower Society ©

Pollinator and Wildlife Information

Special value to native bees and butterflies

Benefits for Wildlife: Provides nectar and pollen to bees and butterflies

Chamaecrista fasciculata
partridge sensitive pea



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

FACU

Herbaceous annual/legume

Habitat: Man-made or disturbed habitats, grasslands, fields, riverbanks, sandy flats, railroad cinders, roadsides

Flower Color: Yellow

Bloom Time: July to September

Height: 3'

Leaf arrangement: Alternate

Leaf type: Compound, separated into up to 18 pairs of leaflets in mature plants, small nectary (gland) at base of leaf stem

Sun Exposure: Full Sun, Part Shade, Shade

Soil Moisture: Mesic (Medium), Dry-Mesic, Dry

Persistence: Low

Soil pH: 5.5-7.5

Seeding rate: 1-10% of mix, 65,000/lb

Notes:

- **CAN BE POISONOUS TO CATTLE**
- Moderate drought tolerance
- Can be mistaken for *Senna spp* but *Senna* is larger (up to 6') and has fewer and larger leaflets
- Can be mistaken for *Desmanthus illinoiensis* when young, but *D. illinoiensis* has 8-24 leaflets which are smaller than *C. fasciculata*
- **Fruit**: Pod, 1 ½-2 ½" long, dehiscent

Photos courtesy of Mark B. Fiely, Ernst Conservation Seeds.©

Pollinator and Wildlife Information

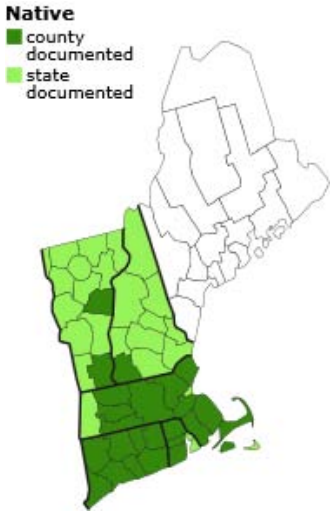
Pollinator Ranking: High

Special value to native bees and butterflies

Larval host to cloudless giant sulphurs (*Phoebis sennae*), orange sulphurs (*Colias eurytheme*), and sleepy oranges (*Eurema nicippe*)

Benefits for Wildlife: Provides nectar and pollen to bees and butterflies

Chamaecrista nictitans
wild sensitive pea



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

FACU

Herbaceous annual/legume

Habitat: Man-made or disturbed habitats, grasslands, meadows/fields, roadsides

Flower Color: Yellow

Bloom Time: June to October

Height: Up to 1 ½'

Leaf arrangement: Alternate

Leaf type: Pinnately compound (separated into leaf-lets), with terminal leaflet, margin is entire

Sun Exposure: Full sun

Soil Moisture: Mesic (Medium), Dry-Mesic

Soil pH: 6.6-7.5

Seeding rate: 1%-5% of mix

Photo courtesy of Arthur Haines, New England Wildflower Society ©

Notes:

PLANT HAS SHARP SPINES

Roots: Tap-rooted

Lookalikes: *C. fasciculata* with flowers 24-40 mm wide with 10 stamens, borne on stalks 8-15 mm long (*C. nictitans* with flowers 8-10 mm wide, 5 stamens, borne on stalks 1.5-4 mm long).

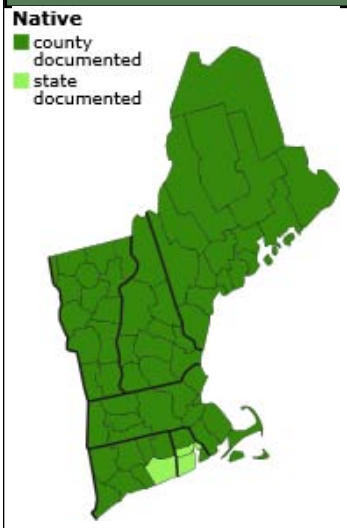
•**Fruit**: Pod, 1 ½-2 ½" long, dehiscent

Pollinator and Wildlife Information

Special value to native bees

Benefits for Wildlife: Provides a food source to bees

Chamerion angustifolium
narrow-leaved fireweed



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

Not classified

Herbaceous perennial

Photos courtesy of Donald Cameron © 2016

Habitat: Man-made or disturbed habitats , meadows/fields

Flower Color: Magenta

Bloom Time: June-August

Height: Up to 4'

Leaf arrangement: Alternate

Leaf type: Simple (not separated into leaflets), elliptic to oblong with an acute tip

Sun Exposure: Full Sun, Part Shade

Soil Moisture: Wet-Mesic, Mesic (Medium), Dry -Mesic

Persistence: High

Notes:
Synonym *Epilobium angustifolium*
Can spread rapidly - use with care

Roots: rhizomatous, with aggressive spread.

Will colonize recently burned areas.

Pollinator and Wildlife Information

Pollinator Ranking: High

Special value to native bees

Benefits for Wildlife: Provides nectar and pollen to long and short tongue bees and syrphid flies

Chelone glabra
white turtlehead

New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

OBL

Herbaceous perennial

Habitat: Man-made or disturbed habitats, shores of rivers/lakes, stream banks, wet woods, swamps

Flower Color: White with pink tips

Bloom Time: July to September

Height: 2'-7'

Leaf arrangement: Opposite

Leaf type: Simple (not separated into leaf-lets), teeth along margins

Sun Exposure: Full Sun to Shade

Soil Moisture: Wet, Wet-Mesic

Persistence: Low

Soil pH: 5.1-6.5

Seeding rate: 1-2% of mix, 1,472,000/lb

Notes:

•Good for shady woods

Photo courtesy of Arthur Haines, New England Wildflower Society ©

Photos courtesy of Donald Cameron © 2016

Pollinator and Wildlife Information

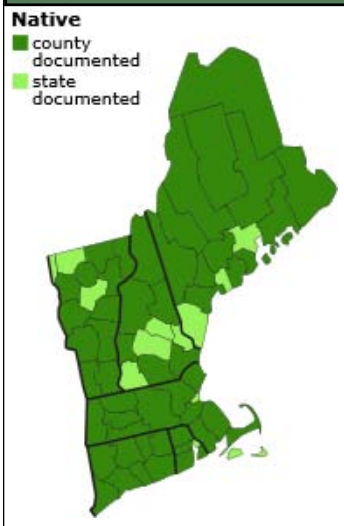
Pollinator Ranking: Medium

Special value to native butterflies and hummingbirds

Larval host to Baltimore checkerspots (*Euphydryas phaeton*)

Benefits for Wildlife: Provides nectar to butterflies and hummingbirds

Cirsium muticum
swamp thistle



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

OBL

Herbaceous biennial

Photo courtesy of Arthur Haines, New England Wildflower Society ©

Photos courtesy of Donald Cameron © 2016

Habitat: Brackish or salt margins and flats, shores of rivers or lakes, wetland margins

Flower Color: Rose-purple

Bloom Time: July to October

Height: Up to 7'

Leaf arrangement: Alternate

Leaf type: Simple (not separated into leaflets), elliptic to ovate with spines along the edges

Sun Exposure: Full Sun, Part Shade

Soil Moisture: Wet, Wet-Mesic

Persistence: Medium

Soil pH: 5.1-6.5

Seeding rate: 1-2% of mix, 1,472,000/lb

Notes:
- Biennial but will reseed under right conditions
- Not as heavily spined as other thistles
- **Lookalikes**: *C. pumilum*

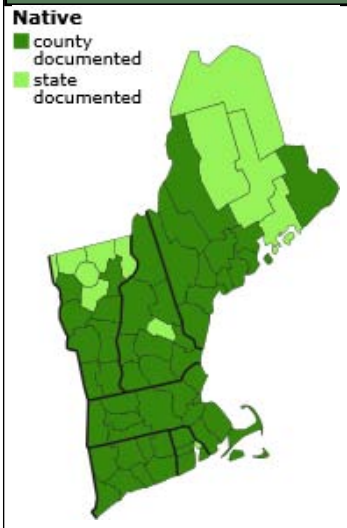
Pollinator and Wildlife Information

Special value to native butterflies, bees, and birds

Larval host to swamp metalmark (*Calephelis muticum*)

Wildlife Benefits: Provides nectar and pollen to long and short tongue bee species and butterflies. Birds eat mature seeds of this plant. Provides habitat and cover for bees

Cirsium pumilum var. *pumilum* pasture thistle



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

Not classified

Herbaceous perennial

Habitat: Man-made or disturbed habitats, meadows/fields

Flower Color: Magenta, white

Bloom Time: June-August

Height: 1'-3'

Leaf arrangement: Alternate, basal

Leaf type: Simple (not separated into leaf-lets), elliptic to oblong with an acute tip, toothed and spiny margin, hairy

Sun Exposure: Full Sun

Soil Moisture: Mesic (Medium), Dry-Mesic

Notes:

- Lookalikes: *C. muticum*

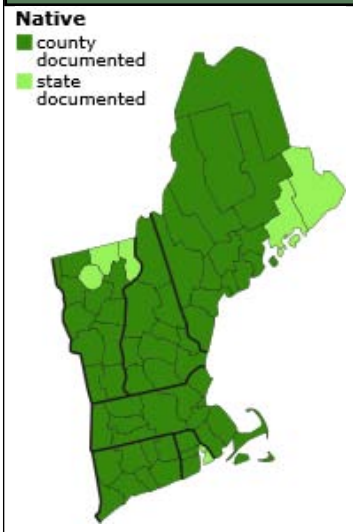
Photos courtesy of Alexey Zinovjev and Irina Kadis, Salicicola.com.

Pollinator and Wildlife Information

Special value to native butterflies, bees, and birds

Wildlife Benefits: Provides nectar and pollen to long and short tongue bee species and butterflies. Birds eat mature seeds of this plant. Provides habitat and cover for bees.

Desmodium canadense
showy tick-trefoil



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

FAC

Herbaceous perennial/legume

Habitat: Man-made or disturbed habitats, floodplain, forest edges, forests, meadows/fields, shores of rivers or lakes

Flower Color: Pink to violet

Bloom Time: July to August

Height: 2'-4'

Leaf arrangement: Alternate

Leaf type: Compound (separated into 3 leaflets), margin is entire, lanceolate to oblong, underside of leaf is fuzzy

Sun Exposure: Full Sun, Part Shade

Soil Moisture: Wet-Mesic, Mesic, Dry-Mesic

Persistence: Medium

Soil pH: 5.6-6.5

Seeding rate: 1-5% of mix, approx. 80,000/lb

Photos courtesy of Mark B. Fiely, Ernst Conservation Seeds.©

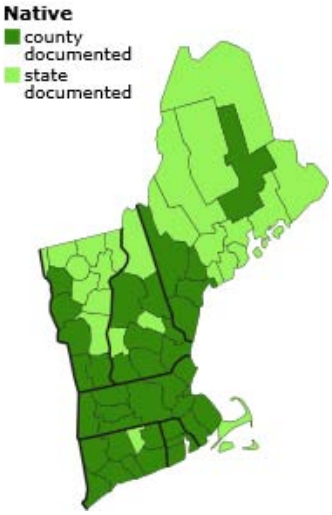
Notes:
Can spread rapidly
Seed pods stick to clothing
Lookalikes: *D. illinoense* with single white inflorescence with few branches; *D. perplexum* with triangular fruit segments and flowers 6-8 mm long (*D. canadense* with pink to violet flowers 8-11 mm long and fruit segments semicircular).
Scarify seed before planting

Pollinator and Wildlife Information

Special value to native bees, butterflies, and birds

Larval host to hoary edges (*Achalarus lyciades*) and silver-spotted skippers (*Epargyreus clarus*)

Desmodium paniculatum
panicled tick-trefoil



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

FACU

Herbaceous perennial/legume

Habitat: Forest edges, forests, woodlands

Flower Color: Purple

Bloom Time: July-August

Height: Up to 4'

Leaf arrangement: Alternate

Leaf type: Compound (separated into 3 leaflets with a terminal leaflet), elliptic to oblong, margin is entire, underside of leaf is hairy

Sun Exposure: Part Shade

Soil Moisture: Mesic (Medium), Dry-Mesic

Persistence: Medium

Soil pH: 6.0-7.0

Seed rate: 1%-5% of a mix; approx. 200,000/lb

Notes:

Seeds should be stratified for 3 months at 34-38°F, then scarified with sandpaper and inoculated with *Desmodium*-specific inoculant.

Lookalikes: *D. perplexum* with central leaflet oblong to broad-ovate, 1.5-4 times as long as wide, 15-30 mm wide (*D. paniculatum* with central leaflet narrow lanceolate to narrow elliptic, mostly 4-10 times as long as wide, 5-15 mm wide).

Scarify seed before planting

Photos courtesy of Mark B. Fiely, Ernst Conservation Seeds.©

Photos courtesy of Donald Cameron © 2016

Pollinator and Wildlife Information

Special value to native bees, butterflies, and birds

Larval host to hoary edges (*Achalarus lyciades*) and silver-spotted skippers (*Epargyreus clarus*)

Doellingeria umbellata
flat-topped aster

New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

FACW

Herbaceous perennial

Photo courtesy of Arthur Haines, New England Wildflower Society ©

Habitat: Man-made or disturbed habitats, forest edges, meadows/fields, wetland margins, swamps

Flower Color: White

Bloom Time: August to late summer

Height: 1'-6 ½'

Leaf arrangement: Alternate

Leaf type: Simple (not separated into leaflets), margin is entire, elliptic to lanceolate with acuminate tip, fuzzy upper surface

Sun Exposure: Full Sun

Soil Moisture: Wet, Wet-Mesic, Mesic (Medium)

Persistence: Medium

Soil pH: 5.6-7.5

Seeding rate: 1-4% of mix, approx. 1,072,000/lb

Notes:

Synonym *Aster umbellatus*

Roots: Rhizomatous

Scarify seed before planting

Pollinator and Wildlife Information

Special value to native butterflies and moths

Larval host plant for several moth and butterfly species

Benefits for Wildlife: Provides a nectar and pollen to long and short-tongued bee species, beetles, butterflies, moths, flies, and wasps

Eupatorium perfoliatum
boneset thoroughwort

New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

FACW

Herbaceous perennial

Habitat: Man-made or disturbed habitats, marshes, river or lake shores, swamps, wetland margins

Flower Color: White

Bloom Time: July to October

Height: Up to 5’

Leaf arrangement: Opposite

Leaf type: Simple (not separated into leaflets), narrow lanceolate, 8” long by 2” across, toothed margin, joined at base

Sun Exposure: Full Sun, Part Shade

Soil Moisture: Wet, Wet-Mesic

Persistence: Low

Soil pH: 5.8-7.8

Seeding rate: 1-4% of mix, approx. 2,880,000/lb

Notes:

WARNING: Can be emetic and laxative at large doses if ingested, may also be harmful to the liver

For direct seeding, sow thickly in fall as germination rates are low

For container production, cold-moist pretreatment at 40°F for 3 weeks-3 months will increase germination

Photo courtesy of Arthur Haines, New England Wildflower Society ©

Photos courtesy of Mark B. Fiely, Ernst Conservation Seeds.©

Pollinator and Wildlife Information

Special value to native bees, butterflies, moths, and birds

Larval host plant for many moth and butterfly species

Benefits for Wildlife: Provides nectar and pollen for bees, butterflies, flies, beetles, skippers, moths, and wasp species. Moth and butterfly larvae use this plant for food. Birds eat mature seeds of this plant.

Eurybia spectabilis
purple wood-aster, showy aster

New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

Not classified

Herbaceous perennial

Habitat: Man-made or disturbed habitats, meadows/fields, woodlands

Flower Color: Violet-purple

Bloom Time: August to October

Height: 1'-3'

Leaf arrangement: Alternate

Leaf type: Simple (not separated into leaflets), oval to lanceolate

Sun Exposure: Full Sun, Part Shade

Soil Moisture: Mesic (Medium), Dry-Mesic

Soil pH: 5.1-6.5

Notes:

Synonym: *Aster spectabilis*

Roots: Rhizomatous but not aggressive

Very drought tolerant

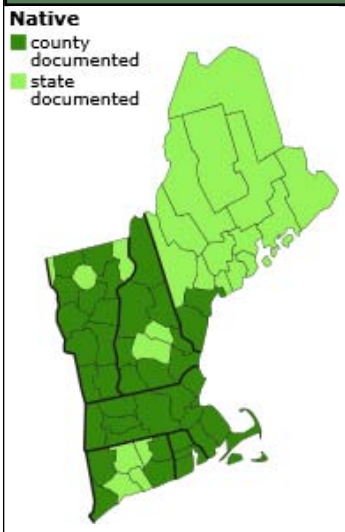
Photos courtesy of Mark B. Fiely, Ernst Conservation Seeds.©

Pollinator and Wildlife Information

Special value to native bees, butterflies, and moths

Benefits for Wildlife: Provides a food source for bees, butterflies, flies, beetles, skippers, moths, and wasp species.

Eurybia divaricata
white wood aster



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

Not classified

Herbaceous perennial

Habitat: Forests

Flower Color: White

Bloom Time: August to September

Height: 1'-2'

Leaf arrangement: Alternate

Leaf type: Simple (not separated into leaflets), strongly heart-shaped, large coarse teeth on margin

Sun Exposure: Part Shade, Shade

Soil pH: 5.1-6.5

Seeding rate: 1-4% of mix, approx. 670,000/lb

Photos courtesy of Donald Cameron © 2016

Photos courtesy of Mark B. Fiely, Ernst Conservation Seeds.©

Notes:

Lookalikes: *E. macrophylla* with flowers tinted with purple and colonies of leaves separate from flowering stem *(E. divaricata* with white flowers and no leaves separate from flowering stem).

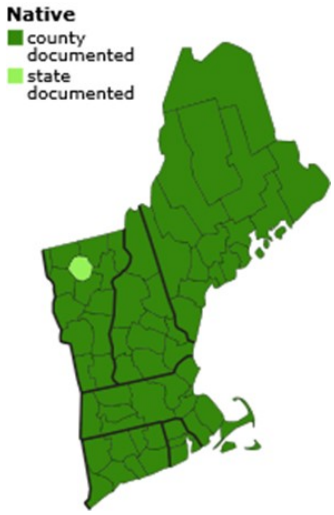
Pollinator and Wildlife Information

Special value to native butterflies

Benefits for Wildlife: Provides nectar for butterflies

Euthamia graminifolia

common grass-leaved-goldenrod



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

FAC

Herbaceous perennial

Habitat: Man-made or disturbed habitats, meadows/fields, river/lake shores, wetland margins

Flower Color: Yellow

Bloom Time: August to September

Height: 2'-3'

Leaf arrangement: Alternate

Leaf type: Simple (not separated into leaflets), no teeth on margins

Sun Exposure: Full Sun, Part Shade

Soil Moisture: Wet-Mesic, Mesic (Medium), Dry-Mesic

Persistence: Medium

Seeding rate: 1% of mix; 5,600,000/lb

Notes:

- Can spread rapidly
- Rhizomatous root structure
- Can be distinguished by narrow leaves which are 11-20x as long as they are wide, have few resinous dots on underside, emit fragrance when crushed
- Fruit: hard, pubescent, indehiscent white nutlet

Photo courtesy of Mark B. Fiely, Ernst Conservation Seeds.©

Photo courtesy of Donald Cameron © 2016

Pollinator and Wildlife Information

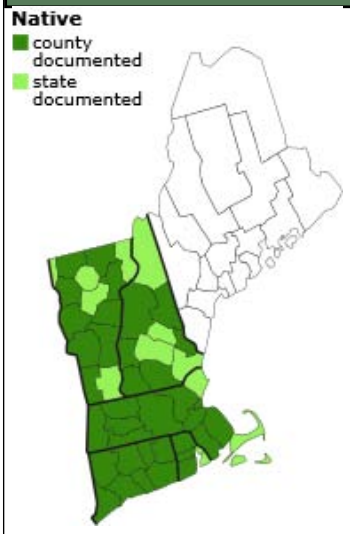
Pollinator Ranking: Medium-low

Special value to native bees, butterflies, and birds

Attracts predatory or parasitoid insects that prey upon pest insects

Benefits for Wildlife: Provides nectar and pollen to Hymenopteran and Lepidopteran species like *Apis mellifera, Junonia coenina,* and *Xylocopa virginica*. Bird species like *Carduelis tristis* and *Melospiza georgiana* feed on its seeds

Eutrochium purpureum
purple Joe pye weed



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

FAC

Herbaceous perennial

Photo courtesy of Arthur Haines, New England Wildflower Society ©

Photos courtesy of Mark B. Fiely, Ernst Conservation Seeds.©

Habitat: Forests, meadows/fields, woodlands

Flower Color: Pale pink or purplish

Bloom Time: July to September

Height: Up to 6 ½'

Leaf arrangement: Whorled (with three or more leaves per node along the stem)

Leaf type: Simple (not separated into leaf-lets), lanceolate to ovate, large, margin is toothed

Sun Exposure: Part Shade, Shade

Soil Moisture: Wet-Mesic, Mesic (Medium)

Seeding rate: 1%-2% of mix, approx. 672,000/lb

Notes:

Synonym ***Eupatorium purpureum***

Clump-forming habit
Deer-resistant

Pollinator and Wildlife Information

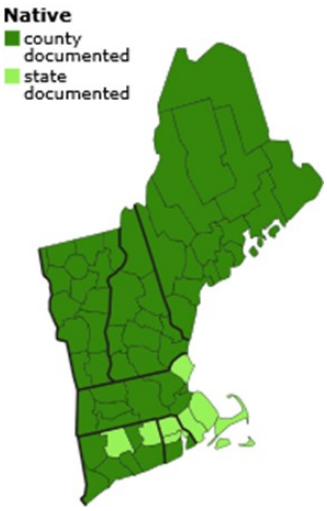
Pollinator Ranking: High

Special value to native bees, butter-flies, and moths

Larval host plant for butterfly and moth species

Benefits for Wildlife: Provides nectar and pollen for butterfly and moth larvae, long tongue bees, butterflies, skippers, and moths

Eutrochium maculatum
spotted Joe pye weed



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

OBL

Herbaceous perennial

Habitat: Man-made or disturbed habitats, marshes, meadows/ fields, shores of rivers/lakes, swamps, wetland margins

Flower Color: Light purple

Bloom Time: July to September

Height: 6.5’

Leaf arrangement: Whorled (with three or more leaves per node along the stem)

Leaf type: Simple (not separated into leaflets), with teeth along margin

Sun Exposure: Full Sun, Part Shade

Soil Moisture: Wet, Wet-Mesic

Persistence: Low

Soil pH: 5.5-7

Seeding rate: 1-2% of mix; 1,440,000/lb

Notes:

- Often has purple spots on stems

Photos courtesy of Mark B. Fiely, Ernst Conservation Seeds.©

Photo courtesy of Arthur Haines, New England Wildflower Society ©

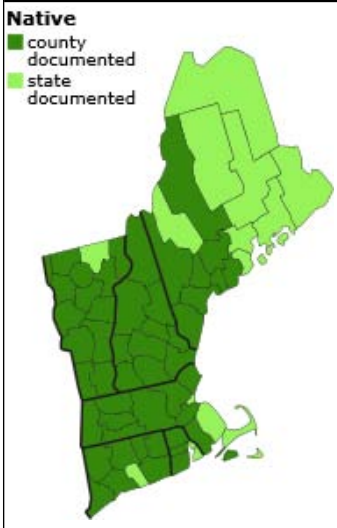
Pollinator and Wildlife Information

Pollinator Ranking: High

Special value to native bees, butterflies, and moths

Benefits for Wildlife: Provides nectar or pollen to long tongue bees, butterflies, skippers, and moths. Moth and butterfly larvae use this plant for food.

Gentiana clausa
meadow bottle gentian



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

FACW

Herbaceous perennial

Habitat: Man-made or disturbed habitats, flood-plain, forests, meadows/fields, stream banks

Flower Color: Purple

Bloom Time: September to October

Height: Up to 2'

Leaf arrangement: Opposite

Leaf type: Simple (not separated into leaflets), margin is entire, lanceolate to ovate with acuminate tip, simple hairs

Sun Exposure: Full Sun, Part Shade

Soil pH: 5.8-7.2

Seed rate: 1%-2% of mix, approx. 2,980,000/lb

Photos courtesy of Mark B. Fiely, Ernst Conservation Seeds.©

Notes:

Lookalikes: *G. linearis* with margins of leaves lacking cilia and leaves narrow-lanceolate (*G. clausa* with margins with abundant cilia and leaves lanceolate to narrow-ovate).

Slight deer resistance

Pollinator and Wildlife Information

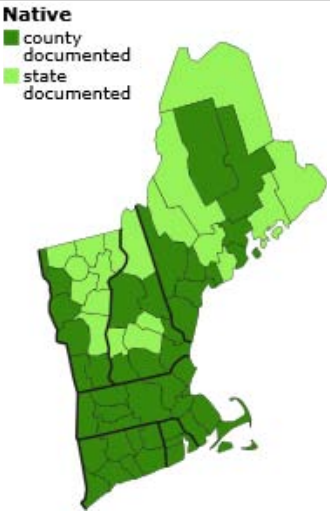
Pollinator Ranking: High

Special value to native bees

Benefits for Wildlife: Provides nectar for bumblebees

Geranium maculatum

spotted crane's-bill, wild geranium



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

FACU

Herbaceous perennial

Habitat: Man-made or disturbed habitats, forests, meadows/fields

Flower Color: Purple

Bloom Time: May-July

Height: 1'

Leaf arrangement: Opposite

Leaf type: Simple (not separated into leaflets), deeply lobed, reniform, fuzzy

Sun Exposure: Full Sun, Part Shade, Shade

Soil Moisture: Mesic (Medium), Dry-Mesic

Seeding rate: approx. 80,000/lb

Photos courtesy of Arthur Haines, New England Wildflower Society ©

Photo courtesy of Donald Cameron ©

Notes:

Spreads readily

Lookalikes: *G. pratense* with petals blue to blue-purple (*G. maculatum* with petals pink to pink-purple and rarely white)

Pollinator and Wildlife Information

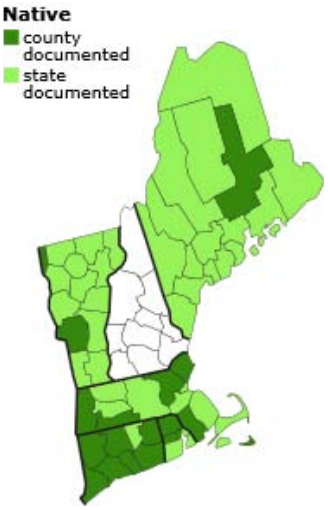
Pollinator Ranking: High

Special value to native bees and moths

Larval host plant for moth species

Benefits for Wildlife: Provides nectar and pollen for bees and beetles

Helenium autumnale
fall sneezeweed



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

FACW

Herbaceous perennial

Habitat: Man-made or disturbed habitats, meadows/fields, shores of rivers or lakes, swamps

Flower Color: Yellow

Bloom Time: August to September

Height: Up to 5'

Leaf arrangement: Alternate

Leaf type: Simple (not separated into leaflets), margin is toothed

Sun Exposure: Full Sun

Soil Moisture: Wet, Wet-Mesic

Persistence: Medium

Soil pH: 4.0-7.5

Seeding rate: 1-4% of mix, approx. 1,464,000/lb

Photos courtesy of Mark B. Fiely, Ernst Conservation Seeds. ©

Notes:

Despite its common name, not an allergy issue as pollen is not wind-borne

Potentially poisonous to cattle

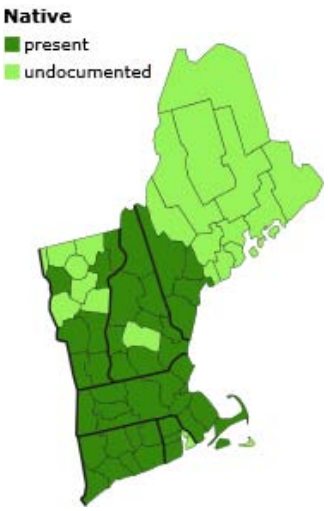
Pollinator and Wildlife Information

Pollinator Ranking: High

Special value to native bees

Benefits for Wildlife: Provides a nectar and pollen for honeybees, solitary bees, and leafcutter bee species

Helenium flexuosum
purple-headed sneezeweed



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

FAC

Herbaceous perennial

Habitat: Man-made or disturbed habitats, marshes, meadows/fields, shores of rivers/lakes, swamps, wetland margins

Flower Color: Yellow with purple-brown center

Bloom Time: July to September

Height: 6.5’

Leaf arrangement: Whorled

Leaf type: Simple (not separated into leaf-lets), teeth in margin

Sun Exposure: Full Sun, Part Shade

Soil Moisture: Wet, Wet-Mesic

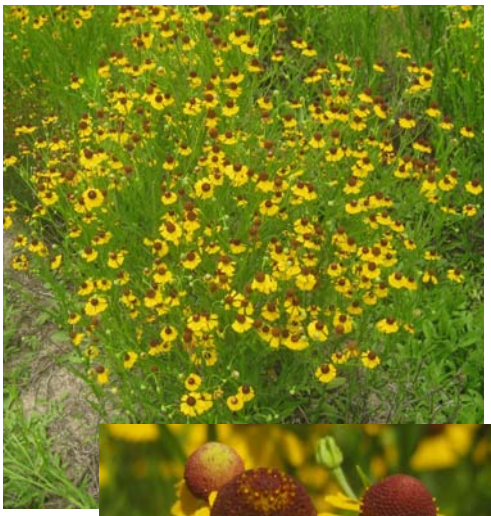
Persistence: Low

Soil pH: 5.5-7

Seeding rate: 1-2% of mix; 1,440,000/lb

Notes:

- Moderate drought tolerance
- Potentially poisonous to cattle



Photos courtesy of Mark B. Fiely, Ernst Conservation Seeds.©

Pollinator and Wildlife Information

Pollinator Ranking: High

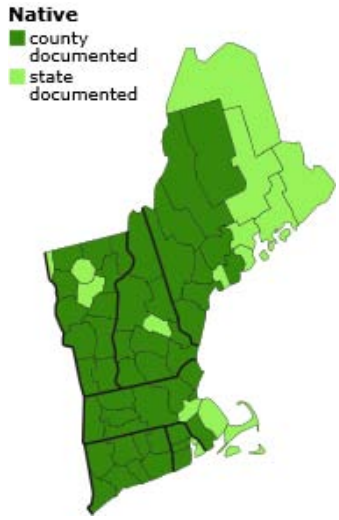
Special value to native bees and butterflies

Larval host to northern metalmarks (*Caelphelis borealis*)

Benefits for Wildlife: Provides a nectar and pollen to honeybees, solitary bees, leafcutter bee species, and butterflies

Helianthus decapetalus

thin-leaved sunflower



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

FACU

Herbaceous perennial

Habitat: Floodplain, forest edges, forests

Flower Color: Yellow

Bloom Time: July to August

Height: Up to 5’

Leaf arrangement: Alternate (upper), opposite (lower)

Leaf type: Simple (not separated into leaflets), lanceolate to ovate, up to 7” long with sharp toothed margin

Sun Exposure: Full Sun, Part Shade

Soil Moisture: Wet-Mesic, Mesic (Medium), Dry-Mesic

Notes:

Roots: Rhizomatous, colony-forming

Somewhat deer-resistant

Drought stress can result in powdery mildew

Lookalikes: *H. strumosus* with leaf stalks 5-30 mm long; *H. tuberosus* with stems hairy and rhizomes ending in thickened tubers (*H. decapetalus* with leaf stalks 15-60 mm, no thickened tubers)

Photos courtesy of Mark B. Fiely, Ernst Conservation Seeds.©

Pollinator and Wildlife Information

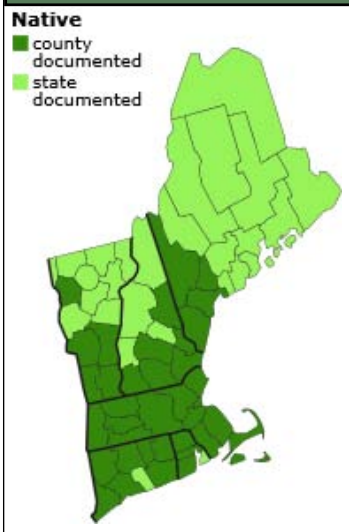
Pollinator Ranking: High

Special value to native bees and butterflies

Larval host plant for silvery checkerspots (*Chlosyne nycteis*) and painted ladies (*Vanessa cardui*)

Benefits for Wildlife: Provides nectar and pollen for butterfly larvae, long and short tongue bees, wasps and butterflies. Mature seeds provide food for native birds

Helianthus divaricatus
woodland sunflower



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

Not classified

Herbaceous perennial

Habitat: Forest edges, meadows/fields, woodlands

Flower Color: Yellow

Bloom Time: June-August

Height: Up to 4’

Leaf arrangement: Opposite

Leaf type: Simple (not separated into leaflets), lanceolate to ovate with acuminate tip, fuzzy

Sun Exposure: Part Shade, Shade

Soil Moisture: Mesic (Medium), Dry-Mesic, Dry

Seeding rate: approx. 76,800/lb

Notes:

Roots: Rhizomatous with vigorous spread

Photo courtesy of Arthur Haines, New England Wildflower Society ©

Photos courtesy of Mark B. Fiely, Ernst Conservation Seeds. ©

Pollinator and Wildlife Information

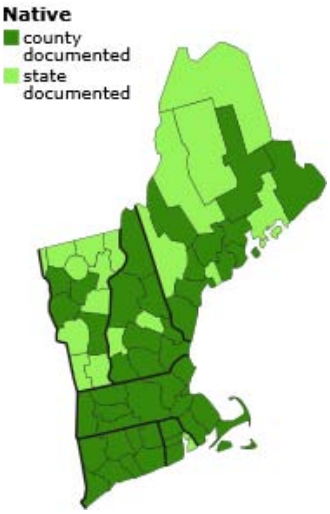
Pollinator Ranking: High

Special value to native bees, butterflies, and birds

Benefits for Wildlife: Provides a food source for long and short tongue bees, wasps and butterflies. Mature seeds provide food for native birds. Provides habitat and cover for wildlife

Helianthus strumosus

pale-leaved sunflower



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

FACU

Herbaceous perennial

Habitat: Man-made or disturbed habitats, forests, meadows, fields, shores of rivers or lakes

Flower Color: Yellow

Bloom Time: July-October

Height: 3’

Leaf arrangement: Alternate/opposite

Leaf type: Simple (not separated into leaflets), lanceolate to ovate with acuminate tip, hairy

Sun Exposure: Full Sun, Part Shade

Soil Moisture: Wet-Mesic, Mesic (Medium), Dry-Mesic

Notes:

Roots: Rhizomatous and vigorous spread

Hybridizes naturally with other species of sunflower, making identification difficult

Lookalikes: *H. decapetalus* with leaf stalks 15-60 mm long (*H. strumosus* with 5-30 mm long leaf stalk)

Pollinator and Wildlife Information

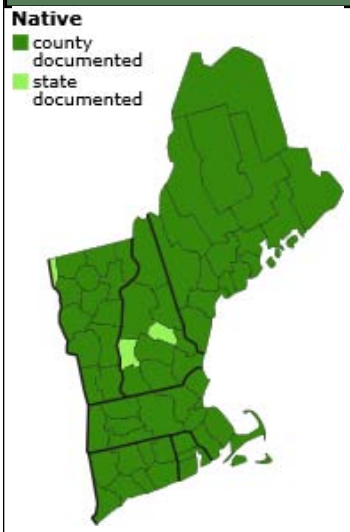
Pollinator Ranking: High

Special value to native bees and butterflies

Benefits for Wildlife: Provides pollen and nectar for long and short tongue bees, wasps and butterflies. Mature seeds provide food for native birds

Hieracium kalmii

Canada hawkweed



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

Not classified

Herbaceous perennial

Photos courtesy of Arthur Haines, New England Wildflower Society ©

Habitat: Man-made or disturbed habitats, cliffs, ledges, forest edges, grassland, meadows/fields, shores of rivers or lakes

Flower Color: Yellow

Bloom Time: July-October

Height: Up to 5'

Leaf arrangement: Alternate

Leaf type: Simple, elliptic to ovate with an acute to obtuse tip, margin is sharply toothed, lower surface hairy

Sun Exposure: Full Sun

Soil Moisture: Mesic (Medium), Dry-Mesic, Dry

Notes:

Lookalikes: *H. scabrum* with leaf blades entire or with minute teeth (*H. kalmii* with leaf blades evidently toothed).

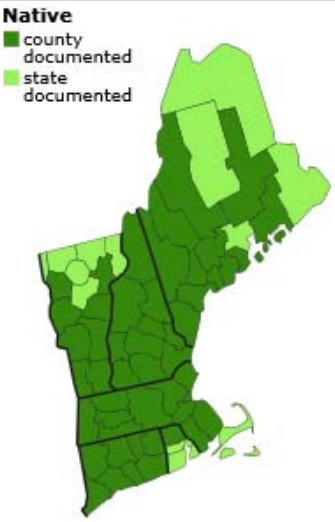
Pollinator and Wildlife Information

Pollinator Ranking: High

Special value to native bees

Benefits for Wildlife: Provides a food source for sweat bee species (*Halictid*)

Hylodesmum glutinosum
pointed-leaved tick-trefoil



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

Not classified

Herbaceous perennial

Photos courtesy of Arthur Haines, New England Wildflower Society ©

Habitat: Man-made or disturbed habitats, cliffs, ledges, forest edges, forests, rocky slopes

Flower Color: Pink

Bloom Time: June-August

Height: 2'

Leaf arrangement: Alternate

Leaf type: Compound (separated into leaflets), orbicular to ovate with acuminate tip, entire margin

Sun Exposure: Part Shade, Shade

Soil Moisture: Mesic (Medium), Dry-Mesic

Notes:

Synonym *Desmodium glutinosum*

Lookalikes: *H. nudiflorum* with flowers on leafless stem on stalks 10-20 mm long, central leaflet of leaf mostly 2-6 cm wide *(H. glutinosum* with flowers on a leafy stem on stalks 3-8 mm long, central leaflet of leaf mostly 6-10 cm wide)

Pollinator and Wildlife Information

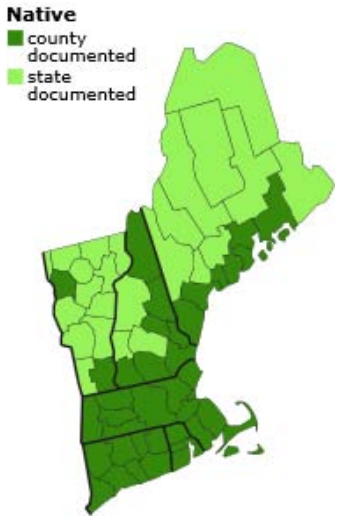
Pollinator Ranking: High

Special value to native butterflies

Larval host plant for silver-spotted skippers (*Epargyreus clarus*)

Benefits for Wildlife: Provides a food source for butterfly larvae and long tongue bees

Hypericum gentianoides
orange-grass St. John's-wort



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

FACU

Herbaceous annual

Photos courtesy of Arthur Haines, New England Wildflower Society ©

Habitat: Man-made or disturbed habitats, grassland, meadows/fields

Flower Color: yellow

Bloom Time: Late spring

Height: Up to 2'

Leaf arrangement: Opposite

Leaf type: Simple (not separated into leaflets), margin is entire, linear with acuminate tip

Sun Exposure: Full Sun, Part Shade

Soil Moisture: Mesic (Medium), Dry-Mesic

Persistence: Low

Soil pH: 4.6-7.0

Notes:
Deer resistance

Pollinator and Wildlife Information

Pollinator Ranking: High

Special value to native bees

Benefits for Wildlife: Provides nectar for long tongue bee species

Hypericum ellipticum
pale St. John's-wort

New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

OBL

Herbaceous perennial

Habitat: Marshes, meadows/fields, shores of rivers or lakes, wetland margins

Flower Color: Yellow

Bloom Time: July to August

Height: Up to 1 ½'

Leaf arrangement: Opposite

Leaf type: Simple (not separated into leaf-lets), margin is entire, elliptic with rounded tip

Sun Exposure: Full Sun, Part Shade

Soil Moisture: Wet-Mesic, Mesic (Medium)

Photos courtesy of Leslie Mehrhoff © 2016 www.discoverlife.org

Photos courtesy of Arthur Haines, New England Wildflower Society ©

Notes:

Tolerates competition best on nutrient-poor soils

Deer resistance

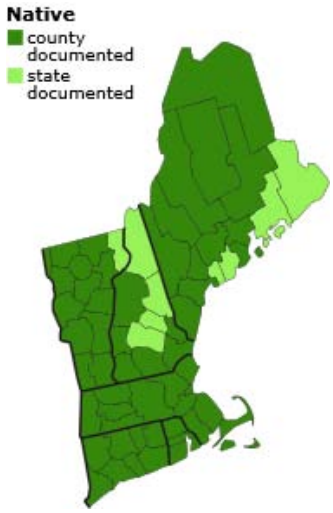
Pollinator and Wildlife Information

Pollinator Ranking: High

Special value to native bees

Benefits for Wildlife: Provides nectar for long tongue bee species

Hypericum punctatum
spotted St. John's-wort



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

FAC

Herbaceous perennial

Habitat: Forests, meadows/fields, flood-plains, thickets, roadsides

Flower Color: Yellow

Bloom Time: Early summer

Height: Up to 3'

Leaf arrangement: Opposite

Leaf type: Simple (not separated into leaflets), margin is entire, elliptic to oblong with rounded tip

Sun Exposure: Full Sun, Part Shade, Shade

Soil Moisture: Mesic (Medium), Dry-Mesic

Persistence: Medium

Soil pH: 4.6-7.0

Seeding rate: 1%-2% of mix

Photos courtesy of Mark B. Fiely, Ernst Conservation Seeds.©

Notes:

Can be distinguished from other *Hypericum* species by dark dots and streaks on upper surface of petals. Other species either lack these, or they are confined to near the petal margins

Deer resistance

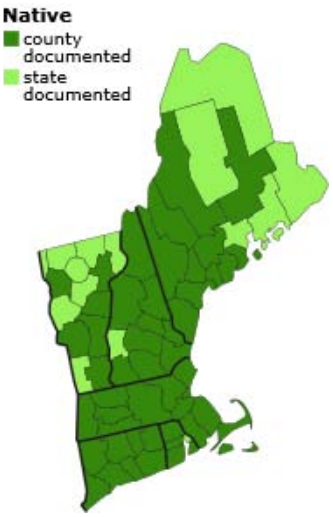
Pollinator and Wildlife Information

Pollinator Ranking: High

Special value to native bees

Benefits for Wildlife: Provides nectar for long tongue bee species

Ionactis linariifolia
flax-leaved stiff-aster



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

Not classified

Herbaceous perennial

Photos courtesy of Arthur Haines, New England Wildflower Society ©

Photo courtesy of Donald Cameron © 2016

Habitat: Man-made or disturbed habitats, grassland, shores of rivers or lakes, woodlands

Flower Color: Violet with yellow center

Bloom Time: September-October

Height: 1'-1 ½'

Leaf arrangement: Alternate (but appear whorled)

Leaf type: Simple (not separated into leaflets), linear and needle-like, entire margins

Sun Exposure: Full Sun, Part Shade

Soil Moisture: Dry-Mesic

Notes:

Plant is disease and pest resistant

Roots: fibrous roots, occasional spreading rhizomes

Can be distinguished from species in the *Symphyotrichum* genus by the combination of long and short hairs on its achenes; can be distinguished from *S. oblongifolium* by its unbranched stems (*S. oblongifolium* has abundantly branched stems)

Pollinator and Wildlife Information

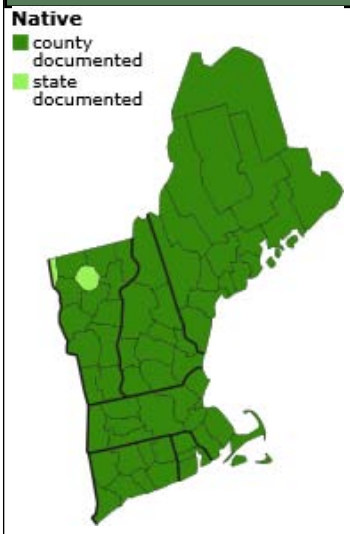
Pollinator Ranking: High

Special value to native bees and butterflies

Benefits for Wildlife: Provides nectar and pollen for long and short tongue bees, butterflies, skippers, and beetles

Iris versicolor

blue iris, bueflag



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

OBL

Herbaceous perennial

Habitat: Man-made or disturbed habitats, marshes, meadows/fields, shores of rivers or lakes, wetland margins

Flower Color: Purplish-blue

Bloom Time: May to June

Height: Up to 2'

Leaf arrangement: Alternate, basal

Leaf type: Simple (not separated into leaflets), linear to lanceolate

Sun Exposure: Full Sun, Part Shade

Soil Moisture: Wet, Wet-Mesic, Mesic (Medium)

Soil pH: 5.0-7.0

Seeding rate: 1-5% of mix, approx. 18,000/lb

Photo courtesy of Donald Cameron © 2016

Photos courtesy of Mark B. Fiely, Ernst Conservation Seeds.©

Notes:

Roots: Corm covered with fibrous roots

Root mass of established colonies provides good shoreline protection

Stratification in moist peat moss for 3 months at 36°F will increase germination

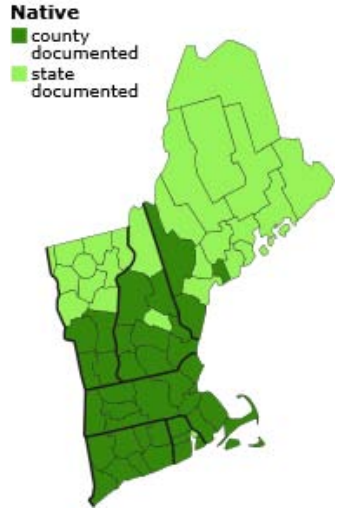
Pollinator and Wildlife Information

Pollinator Ranking: High

Special value to native bees and butterflies

Benefits for Wildlife: Provides nectar and pollen to honeybees, solitary bees, leafcutter bee species, and butterflies

Krigia virginica
Virginia dwarf-dandelion



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

UPL

Herbaceous annual

Photos courtesy of Arthur Haines, New England Wildflower Society ©

Habitat: Man-made or disturbed habitats, cliffs, ledges, meadows/fields, woodlands

Flower Color: Yellow to orange

Bloom Time: June to August

Height: Up to 1'

Leaf arrangement: Basal

Leaf type: Simple (not separated into leaf-lets), 3" long by ¾" across

Sun Exposure: Full Sun

Soil Moisture: Mesic (Medium), Dry-Mesic

Soil pH: Acidic

Notes:

Plant superficially resembles common weed, *Taraxacum officinale* (dandelion), but has smaller flowerheads

Pollinator and Wildlife Information

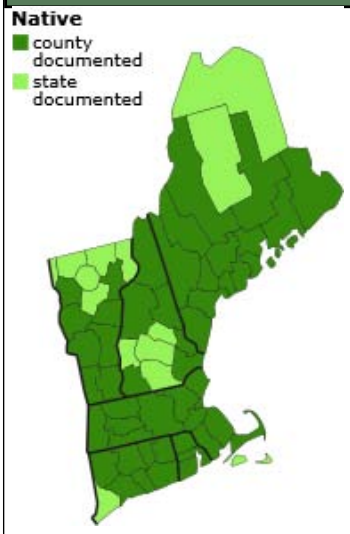
Pollinator Ranking: High

Special value to native bees and butterflies

Benefits for Wildlife: Provides nectar and pollen to honeybees, solitary bees, leafcutter bee species, and butterflies

Lechea intermedia

largepod pinweed, round-fruited pinweed



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

Not classified

Herbaceous perennial

Photo courtesy of Arthur Haines, New England Wildflower Society ©

Habitat: Man-made or disturbed habitats, meadows/fields, woodlands

Flower Color: pink to red

Leaf arrangement: Alternate/whorled

Leaf type: Simple (not separated into leaf-lets) , margin is entire

Notes:

Lookalikes: *L. maritima* with leaf blades hairy on lower surface and somewhat translucent seeds (*L. intermedia* with leaf blades hairy on margin/midrib of lower surface and opaque seeds; *L. pulchella* with 1-3 brown-dark brown seeds in capsule (*L. intermedia* with 4-6 light brown-brown seeds in capsule)

Pollinator and Wildlife Information

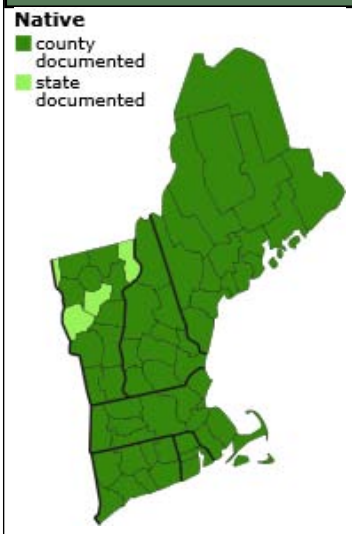
Pollinator Ranking: High

Special value to native bees and butter-flies

Benefits for Wildlife: Provides nectar and pollen to honeybees, solitary bees, leafcutter bee species, and butterflies

Lepidium virginicum

poor-man's pepperweed, wild pepper



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

FACU

Herbaceous annual/biennial

Photo courtesy of Arthur Haines, New England Wildflower Society ©

Habitat: Man-made or disturbed habitats, meadows/fields

Flower Color: White

Bloom Time: May to October

Height: Up to 1.5'

Leaf arrangement: Alternate

Leaf type: Simple (not separated into leaflets)

Sun Exposure: Full Sun, Part Shade

Notes:

Lookalikes: *L. densiflorum* with petals shorter than sepals and axis of inflorescence with straight hairs (*L. virginicum* with petals 1-2 times as long as sepals and axis of inflorescence with curved hairs)

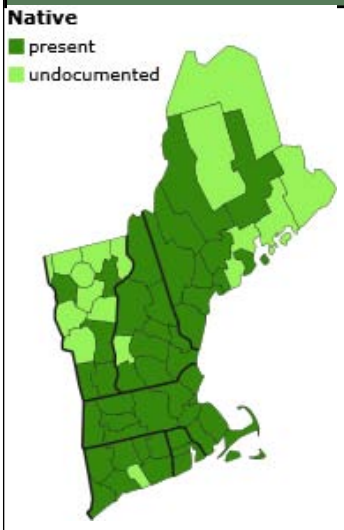
Pollinator and Wildlife Information

Pollinator Ranking: High

Special value to native bees, and butterflies

Larval host plant for cabbage whites (*Pieris rapae*)

Lespedeza capitata
round-headed bushclover



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

FACU

Herbaceous perennial/ legume

Habitat: Man-made or disturbed habitats, meadows/ fields, grasslands, woodlands

Flower Color: Cream

Bloom Time: August to September

Height: 2'-4'

Leaf arrangement: Alternate

Leaf type: Compound (separated into leaflets), edge is entire (no teeth/lobes), fine hairs on margins creating silvery-whitish appearance

Sun Exposure: Full Sun

Soil Moisture: Mesic (Medium), Dry-Mesic, Dry

Soil pH: 5.7-8.2

Seeding rate: 1-5% of mix; 275,000/lb

Photos courtesy of Mark B. Fiely, Ernst Conservation Seeds. ©

Photo courtesy of Donald Cameron © 2016

Notes:

- High drought tolerance
- Deep tap root with multiple branch roots near soil surface
- Fruit: Legume, indehiscent, one-seeded
- Can be mistaken for white prairie clover and leadplant but both have more leaflets (5-9+) and white prairie clover has smooth stems/leaves
- May be susceptible to rust

Pollinator and Wildlife Information

Pollinator Ranking: Low

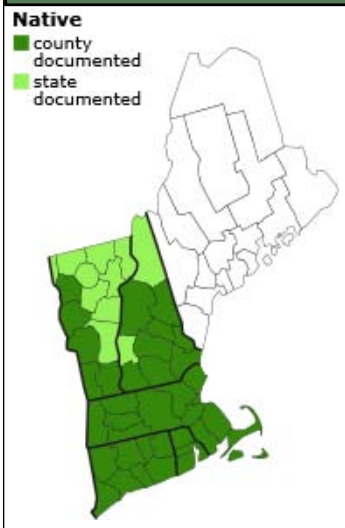
Special value to native bees and butterflies

Larval host for hoary edges (*Achalarus lyciades*), southern duskywings (*Thorybes bathyllus*), and northern duskywings (*Thorybes pylades*)

Benefits for Wildlife: Provides nectar and pollen to bees, butterflies, and birds

Lespedeza frutescens

violet bush-clover, shrubby bushclover



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

Not classified

Herbaceous perennial/ legume

Habitat: Cliffs, ledges, forests, rocky slopes, woodlands

Flower Color: Pink to purplish

Bloom Time: July to September

Height: Up to 3’

Leaf arrangement: Alternate

Leaf type: Compound (separated into leaflets), leaves have a terminal leaflet, elliptic, margin is entire

Sun Exposure: Sun, Part Shade

Seeding rate: 1-5% of mix

Photos courtesy of Alexey Zinovjev and Irina Kadis, Salicicola.com. ©

Photo courtesy of Beverly Walters © 2016

Pollinator and Wildlife Information

Pollinator Ranking: Low

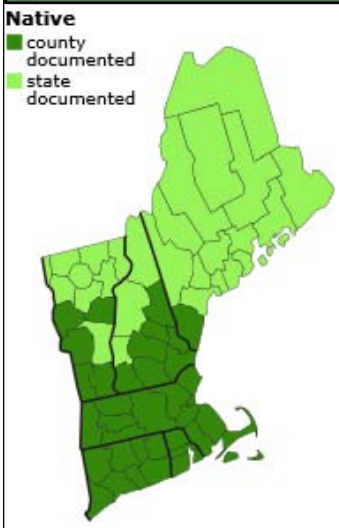
Special value to native bees and butterflies

Larval host for hoary edges (*Achalarus lyciades*), southern duskywings (*Thorybes bathyllus*), and northern duskywings (*Thorybes pylades*)

Benefits for Wildlife: Provides nectar and pollen to bees, butterflies, and birds

Lespedeza hirta

Hairy bush-clover



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

Not classified

Herbaceous perennial/ legume

Photos courtesy of Mark B. Fiely, Ernst Conservation Seeds.©

Habitat: Man-made or disturbed habitats, woodlands

Flower Color: White

Bloom Time: Late summer

Height: Up to 6'

Leaf arrangement: Alternate

Leaf type: Compound (separated into leaflets), have terminal leaflet, elliptic with rounded tip, leaves margin is entire

Sun Exposure: Full Sun

Soil Moisture: Mesic (Medium), Dry-Mesic

Persistence: Medium

Soil pH: 5.8-6.9

Seeding rate: 1-5% of mix, approx. 175,000/lb

Notes:

Lookalikes: *L. capitata* with leaflets 2.5-8 times as long as wide and leaf stalks from near middle of stem and 1-3 mm long (*L. hirta* with leaflets 1.2-1.8 times as long as wide and leaf stalks from near middle of stem and 10-15 mm long)

Pollinator and Wildlife Information

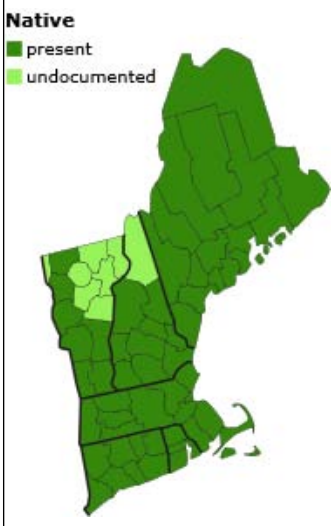
Pollinator Ranking: Low

Special value to native bees and butterflies

Larval host plant for zarucco duskywings (*Erynnis zarucco*)

Benefits for Wildlife: Provides nectar and pollen for bees and butterflies

Lobelia cardinalis
cardinal flower



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

FACW

Herbaceous perennial

Habitat: Marshes, shores of rivers/lakes, wetland margins, wet meadows, swamps, ditches

Flower Color: Crimson red, white

Bloom Time: July to October

Height: 2'-6'

Leaf arrangement: Alternate

Leaf type: Simple (not separated into leaflets), teeth on margins

Sun Exposure: Full Sun, Part Shade

Soil Moisture: Wet, Wet-Mesic

Persistence: Low

Soil pH: 5.8-7.8

Seeding rate: 1-2% of mix; 11,293,000/lb

Photos courtesy of Mark B. Fiely, Ernst Conservation Seeds.©

Notes:

- Moderate drought tolerance
- Deer browsing can badly damage young plants
- Seeds numerous and tiny, require light to germinate
- When mature, produces compound called lobeline which deters herbivores

)

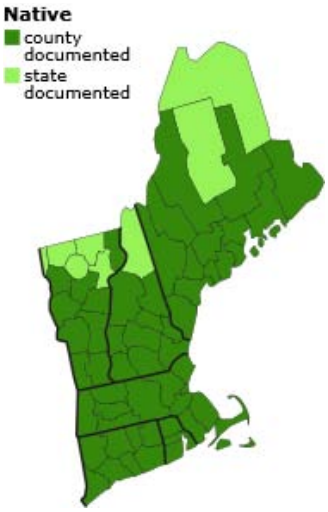
Pollinator and Wildlife Information

Pollinator Ranking: High

Special value to native hummingbirds

Benefits for Wildlife: Food source for hummingbirds

Lysimachia quadrifolia
whorled yellow-loosestrife



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

FACU

Herbaceous perennial

Habitat: Man-made or disturbed habitats, grassland, woodlands

Flower Color: Yellow

Bloom Time: June to August

Height: Up to 2'

Leaf arrangement: Whorled (with three or more leaves per node along the stem)

Leaf type: Simple (not separated into leaf-lets), margin is entire, elliptic to ovate with an acuminate to obtuse tip

Sun Exposure: Full Sun, Part Shade

Photo courtesy of Arthur Haines, New England Wildflower Society ©

Pollinator and Wildlife Information

Pollinator Ranking: Low

Special value to native bees and butter-flies

Benefits for Wildlife: Provides nectar and pollen to bees, butterflies, and birds

Mimulus ringens

Allegheny monkey-flower

New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

OBL

Herbaceous perennial

Habitat: Fresh tidal marshes/flats, marshes, shores of rivers or lakes, swamps, wetland margins

Flower Color: Pale purple to white

Bloom Time: June-September

Height: 2'-4'

Leaf arrangement: Opposite

Leaf type: Simple (not separated into leaflets), lanceolate to oblong with acute tip

Sun Exposure: Full Sun, Part Shade

Soil Moisture: Wet, Wet-Mesic

Persistence: Low

Soil pH: 5.6-7.5

Seeding rate: 1%-2% of a mix; approx. 22,900,000/lb

Notes:

Roots: Rhizomatous

Photos courtesy of Mark B. Fiely, Ernst Conservation Seeds.©

Pollinator and Wildlife Information

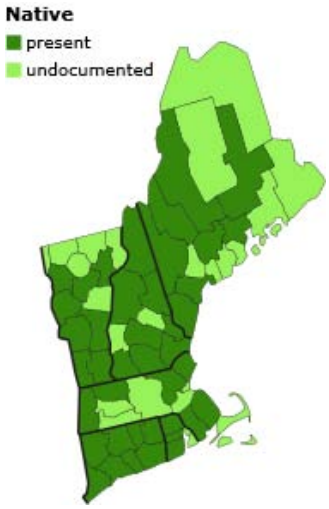
Pollinator Ranking: Low

Special value to native bees and butterflies

Benefits for Wildlife: Provides nectar and pollen to bees, butterflies, and birds

Monarda fistulosa

wild bee-balm, wild bergamot



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

UPL

Herbaceous perennial

Habitat: Man-made or disturbed habitats, fields/meadows, brushy thickets, forests, floodplains, roadsides

Flower Color: Lavender

Bloom Time: June to September

Height: Up to 5'

Leaf arrangement: Opposite

Leaf type: Simple (not separated into leaflets), lanceolate, gray-green, margin with teeth

Sun Exposure: Full Sun, Part Shade

Soil Moisture: Wet-Mesic, Mesic (Medium), Dry-Mesic, Dry

Persistence: High

Soil pH: 6.0-8.0

Seeding rate: 1-2% of mix; 1,272,500/lb

Notes:
Can spread rapidly—regular division and generous addition of organic matter to soil will curb this

- Rhizomatous root structure
- Stems are square and aromatic
- Seeds must be cold stratified below 40° F for a minimum of 3 months
- Larger and with more pungent mint smell than look-alike *Pycnanthemum virginianum*

Photos courtesy of Mark B. Fiely, Ernst Conservation Seeds. ©

Pollinator and Wildlife Information

Pollinator Ranking: Very High

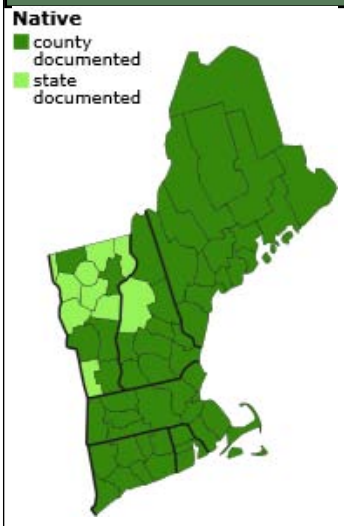
Special value to native bees and butterflies

Larval host to hermit sphinx moths (*Lintneria eremitus*)

Benefits for Wildlife: Food source to bees and butterflies

A sweatbee species (*Dufourea monardae*) relies on this plant

Nuttallanthus canadensis
oldfeld-toadflax, blue toadflax



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

Not classified

Herbaceous perennial

Habitat: Man-made or disturbed habitats, meadows/fields

Flower Color: light blue to blue-violet

Bloom Time: June to August

Height: Up to 2'

Leaf arrangement:

Leaf type: Simple (not separated into leaflets), margin is entire, linear with roundish tip

Sun Exposure: Full Sun

Soil Moisture: Dry

Persistence:

Soil pH: 5.6-6.0

Seeding rate: approx. 1,400,000/oz

Notes:

Requires sandy soil

Photo courtesy of Arthur Haines, New England Wildflower Society ©

Photos courtesy of Alexey Zinovjev and Irina Kadis, Salicicola.com. ©

Pollinator and Wildlife Information

Pollinator Ranking: Low

Special value to native bees and butterflies

Larval host to common buckeyes (*Junonia coenia*)

Benefits for Wildlife: Provides nectar and pollen to long-tongued bees

Oenothera biennis
common evening primrose

New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

FACU

Herbaceous biennial

Photos courtesy of Alexey Zinovjev and Irina Kadis, Salicicola.com. ©

Habitat: Man-made or disturbed habitats, flood-plain, meadows/fields, shores of rivers or lakes

Flower Color: Yellow

Bloom Time: June to August

Height: 3'-6'

Leaf arrangement: Alternate, basal

Leaf type: Simple (not separated into leaflets), elliptic with acute tip, margins have shallow teeth, usually hairy

Sun Exposure: Full Sun

Soil Moisture: Wet-Mesic, Mesic (Medium), Dry -Mesic, Dry

Persistence: High

Soil pH: 5.0-7.0

Seeding rate: 1-2% of mix, approx. 1,376,000/lb

Notes:

Can spread rapidly

Lookalikes: *O. villosa* is densely, uniformly hairy (*O. biennis* variously hairy).

Pollinator and Wildlife Information

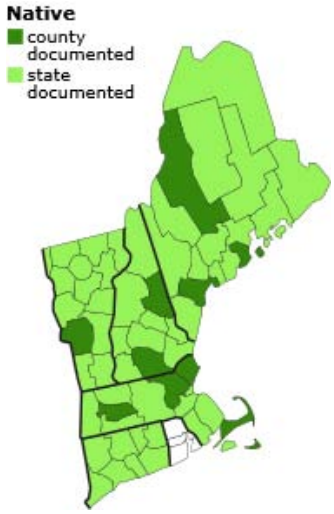
Pollinator Ranking: Low

Special value to native moths, bees, and birds

Larval host to white-lined sphinxes (*Hyles lineata*), proud sphinxes (*Proserpinus gaurae*), juanita sphinxes (*Proserpinus juanita*)

Benefits for Wildlife: Provides nectar and pollen for moths, long and short tongue bees, hummingbirds. Seeds are eaten by songbirds and butterflies

Oenothera villosa
hairy evening primrose



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

FAC

Herbaceous biennial

Habitat: Man-made or disturbed habitats, coastal beaches, dunes, meadows/fields

Flower Color: Yellow

Bloom Time: August

Height: 4’

Leaf arrangement: Alternate

Leaf type: Simple (not separated into leaf-lets), elliptic with acute tip, hairy

Sun Exposure: Full Sun

Soil Moisture: Mesic (Medium), Dry-Mesic

Soil pH: 5.0-7.0

Seeding rate: 1-2% of mix, approx. 1,376,000/lb

Notes:

Does well on poor, dry, stony soils

Lookalikes: *O. biennis* variously hairy (*O. villosa* is densely, uniformly hairy)

Photo courtesy of Arthur Haines, New England Wildflower Society ©

Photo courtesy of Beverly Walters © 2016

Pollinator and Wildlife Information

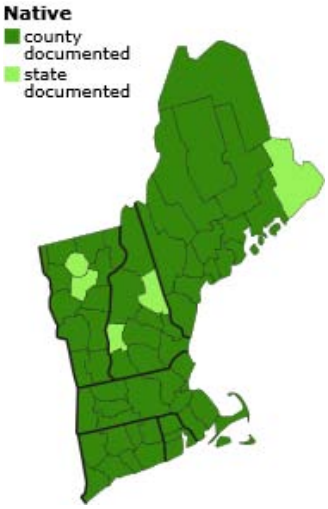
Pollinator Ranking: Low

Special value to native moths, bees, and birds

Larval host to white-lined sphinxes (*Hyles lineata*), proud sphinxes (Proserpinus *gaurae*), and juanita sphinxes (*Proserpinus juanita*), and primose moths (*Schinia florida*)

Benefits for Wildlife: Provides nectar and pollen to bees, butterflies, and birds

Parthenocissus quinquefolia
Virginia-creeper, woodbine



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

FACU

Herbaceous perennial/liana

Habitat: Man-made or disturbed habitats, forests, shores of rivers or lakes, rocky slopes

Flower Color: Green (inconspicuous)

Bloom Time: Spring

Height: Up to 1' (when on ground)

Leaf arrangement: Alternate

Leaf type: Compound with 5 leaflets, pointed, coarse-toothed margins, up to 6" long

Sun Exposure: Full Sun, Part Shade

Soil Moisture: Wet-Mesic, Mesic (Medium), Dry-Mesic

Persistence: Medium

Soil pH: 5.0-7.5

Seeding rate: approx. 17,000/lb

Notes:
Can spread aggressively; salt tolerant
Useful groundcover for erosion control
Stratification aids in seed germination, can also be propagated from hardwood cuttings or layering
Fruits poisonous to humans

Photos courtesy of Alexey Zinovjev and Irina Kadis, Salicicola.com. ©

Pollinator and Wildlife Information

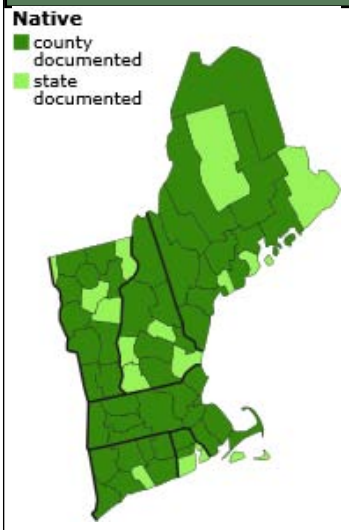
Pollinator Ranking: Low

Special value to native bees, butterflies, moths, and birds

Larval host to Virginia creeper sphinx moths (*Darapsa myron*), pandora sphinx moths (*Eumorpha pandorus*), white-lined sphinx moths (*Hyles lineata*), and abbott's sphinx moths (*Sphecodina abbottii*)

Benefits for Wildlife: Provides nectar and pollen for moths, and long tongue bees. Fruit are eaten by birds in winter. Provides shelter material to leaf-cutter bee species

Penstemon digitalis
foxglove beardtongue



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

FAC

Herbaceous perennial

Photo courtesy of Alexey Zinovjev and Irina Kadis, Salicicola.com. ©

Photos courtesy of Mark B. Fiely, Ernst Conservation Seeds. ©

Habitat: Man-made or disturbed habitats, meadows/fields, roadsides

Flower Color: White

Bloom Time: May to July

Height: Up to 4’

Leaf arrangement: Opposite

Leaf type: Simple (not separated into leaflets), lanceolate to oblong with an acuminate tip

Sun Exposure: Full Sun, Part Shade

Soil Moisture: Mesic (Medium), Dry-Mesic

Persistence: High

Soil pH: 5.5-7.0

Seeding rate: 1%-6% of mix, approx. 400,000/lb

Notes:

Benefits from stratification

Lookalikes: *P. calycosus* with pale purple-purple petals on outer surface *(P. digitalis* with white petals); *P. hirsutus* with inner tube of petals without purple markings (*P. digitalis* with inner petals with purple markings); *P. pallidus* with hairy stems all around (*P. digitalis* with stems without hairs or lines of hairs from leaf bases)

Pollinator and Wildlife Information

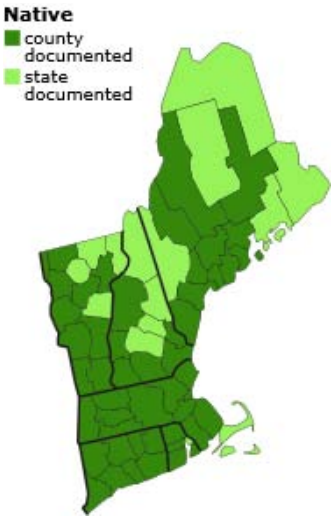
Pollinator Ranking: Low

Special value to native bees, butterflies, and moths

Larval host to chalcedony midget moth (*Elaphria chalcedonia*)

Benefits for Wildlife: Provides nectar and pollen for long and short tongue bees, butterflies, moths, and hummingbirds

Penthorum sedoides
ditch stonecrop



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

OBL

Herbaceous perennial

Habitat: Man-made or disturbed habitats, floodplain, lacustrine, marshes, shores of rivers or lakes, swamps, wetland margins

Flower Color: Yellow

Bloom Time: July to September

Height: Up to 2'

Leaf arrangement: Alternate

Leaf type: Simple (not separated into leaf-lets), elliptic with acuminate tip

Sun Exposure: Full Sun, Part Shade

Soil Moisture: Wet, Wet-Mesic

Persistence: Medium

Soil pH: 5.0-7.0

Seeding rate: 1%-2% of mix, approx. 45,000,000/lb

Notes:

Stoloniferous

Good for erosion control

Seed capsules turn an attractive red in fall

Photos courtesy of Mark B. Fiely, Ernst Conservation Seeds.©

Photo courtesy of Donald Cameron © 2016

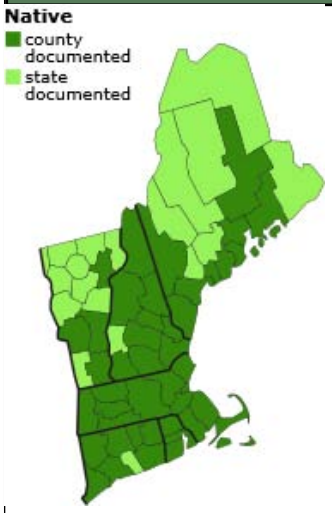
Pollinator and Wildlife Information

Pollinator Ranking: Low

Special value to native bees and butterflies

Benefits for Wildlife: Provides nectar and pollen to bees, butterflies, and birds

Potentilla canadensis
dwarf cinquefoil



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

Not classified

Herbaceous annual

Habitat: Man-made or disturbed habitats, meadows/fields

Flower Color: Yellow

Bloom Time: April to June

Height:

Leaf arrangement: Alternate

Leaf type: Compound (separated into leaflets), elliptic, toothed margin

Sun Exposure: Full Sun

Soil Moisture: Dry-Mesic, Dry

Photos courtesy of Alexey Zinovjev and Irina Kadis, Salicico-

Notes:

Can be indicator of poor soil

Lookalikes: *P. simplex* with flower produced from axil of second well-developed stem leaf and terminal leaflet of leaves usually 2 times as long as wide (*P. canadensis* with flower usually produced from axil of first well-developed stem leaf and terminal leaflet of leaves usually less than two times as long as wide)

Pollinator and Wildlife Information

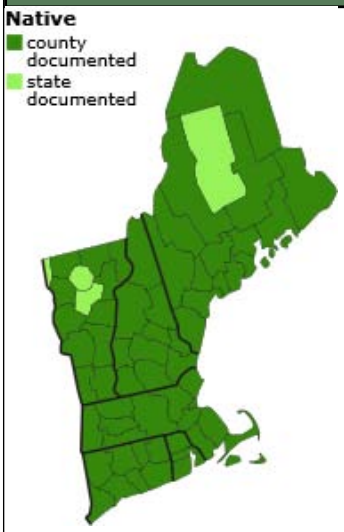
Pollinator Ranking: Low

Special value to native bees and butterflies

Larval host to Grizzled skippers (*Pyrgus centaureae*)

Benefits for Wildlife: Provides nectar and pollen to bees and skippers

Pseudognaphalium obtusifolium
blunt-leaved rabbit-tobacco



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

Not classified

Herbaceous annual/ biennial

Photos courtesy of Alexey Zinovjev and Irina Kadis, Salicicola.com.

Habitat: Man-made or disturbed habitats, meadows/fields

Flower Color: Yellow

Bloom Time: April to June

Height:

Leaf arrangement: Alternate

Leaf type: Compound (separated into leaflets), elliptic, toothed margin

Sun Exposure: Full Sun

Soil Moisture: Dry-Mesic, Dry

Notes:

Roots: Fibrous

Lookalikes: *Anaphalis margaritacea*

Pollinator and Wildlife Information

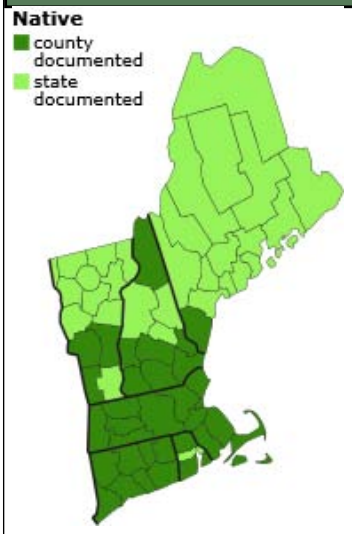
Pollinator Ranking: Low

Special value to native bees and butterflies

Larval host to American lady butterfly (*Vanessa virginiensis*)

Benefits for Wildlife: Provides nectar and pollen to short tongue bees and wasps

Pycnanthemum muticum
broad-leaved mountain-mint



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

FAC

Herbaceous perennial

Habitat: Man-made or disturbed habitats, cliffs, ledges, meadows/fields, woodlands

Flower Color: White

Bloom Time: July to September

Height: Up to 3'

Leaf arrangement: Opposite

Leaf type: Simple (not separated into leaflets), lanceolate with acuminate to acute tip, margin is toothed

Sun Exposure: Full Sun, Part Shade

Soil Moisture: Wet-Mesic, Mesic (Medium)

Seeding rate: 1% of a mix

Photos courtesy of Alexey Zinovjev and Irina Kadis, Salicicola.com.

Notes:

Roots: Rhizomatous, clump-forming

Vigorous grower

Lookalikes: *P. verticillatum* with lanceolate leaves tapering at the base and smaller than *P. muticum* (with lanceolate to ovate leaves which are rounded at the base).

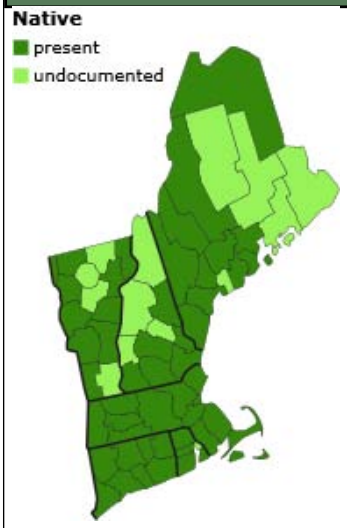
Pollinator and Wildlife Information

Pollinator Ranking: Low

Special value to native bees and butterflies

Benefits for Wildlife: Provides nectar and pollen to bees and butterflies

Pycnanthemum tenuifolium
narrow-leaved mountain-mint



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

FAC

Herbaceous perennial

Habitat: Man-made or disturbed habitats, fields/ meadows, dry soils of prairie/upland woods, moist old fields, floodplains and sandy riverbanks

Flower Color: White

Bloom Time: July to September

Height: Up to 2 ½'

Leaf arrangement: Opposite

Leaf type: Simple (not separated into leaflets), entire margin, 0.15-0.6 in wide by 0.5-2 in long, aromatic

Sun Exposure: Full Sun, Part Shade

Soil Moisture: Wet-Mesic, Mesic (Medium), Dry-Mesic

Persistence: Medium

Soil pH: 5.0-7.5

Seeding rate: 1% of mix

Notes:
Can spread rapidly — use with care

- Taprooted and rhizomatous root structure
- Stems are square and smooth
- Seeds require no pretreatment before planting

Photos courtesy of Alexey Zinovjev and Irina Kadis, Salicicola.com.

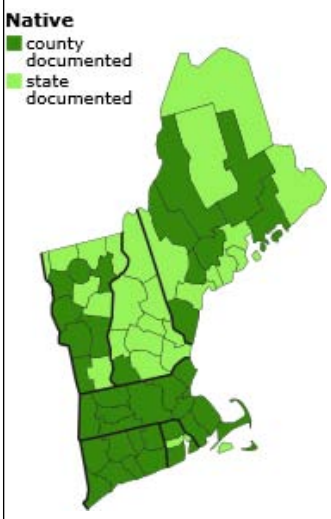
Pollinator and Wildlife Information

Pollinator Ranking: Very High

Special value to native bees and butterflies

Benefits for Wildlife: Provides a food source to Long and short-tongued bee species, beetles, butterflies, moths, skippers, flies, and wasps

Pycnanthemum virginianum
Virginia mountain-mint



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

FACW

Herbaceous perennial

Habitat: Man-made or disturbed habitats, meadows/fields

Flower Color: White

Bloom Time: July to September

Height: 1'-3'

Leaf arrangement: Opposite

Leaf type: Simple (not separated into leaflets), lanceolate to linear with acute tip, margin is entire, underside of leaf is hairy

Sun Exposure: Full Sun, Part Shade

Soil Moisture: Mesic (Medium), Dry-Mesic

Persistence: Medium

Soil pH: 5.0-7.5

Seeding rate: 1% of a mix; approx. 3,872,000/lb

Notes:

Leaves have strong mint scent when crushed

Photo courtesy of Arthur Haines, New England Wildflower Society ©

Photo courtesyof Alexey Zinovjev and Irina Kadis, Salicicola.com.

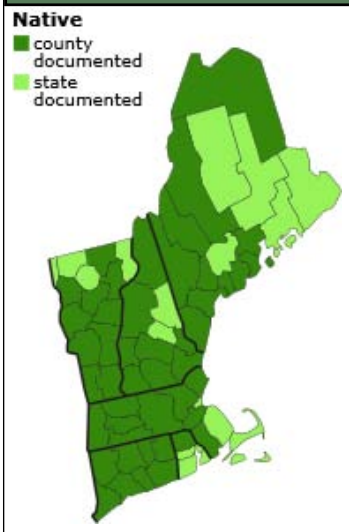
Pollinator and Wildlife Information

Pollinator Ranking: Low

Special value to native bees and butterflies

Benefits for Wildlife: Provides nectar and pollen to bees, butterflies, wasps, and flies

Rudbeckia laciniata
green-headed coneflower



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

FACW

Herbaceous perennial

Habitat: Floodplain, shores of rivers or lakes, swamps, wetland margins

Flower Color: Orange to yellow

Bloom Time: July to October

Height: 7'-8'

Leaf arrangement: Alternate

Leaf type: Simple (not separated into leaflets), lanceolate with acuminate to acute tip

Sun Exposure: Full Sun, Part Shade, Shade

Soil Moisture: Wet-Mesic, Mesic (Medium)

Persistence: Low

Soil pH: 4.5-7.0

Seeding rate: approx. 250,000/lb

Notes:

Roots: Rhizomatous

Can spread rapidly

Photo courtesy of Arthur Haines, New England Wildflower Society ©

Photos courtesy of Mark B. Fiely, Ernst Conservation Seeds.©

Pollinator and Wildlife Information

Pollinator Ranking: Low

Special value to native bees and butterflies

Larval host to bordered patch butterfly (*Chlosyne nycteis*)

Benefits for Wildlife: Provides nectar and pollen for long and short tongue bees, butterflies, and wasps

Sisyrinchium montanum
strict blue-eyed-grass

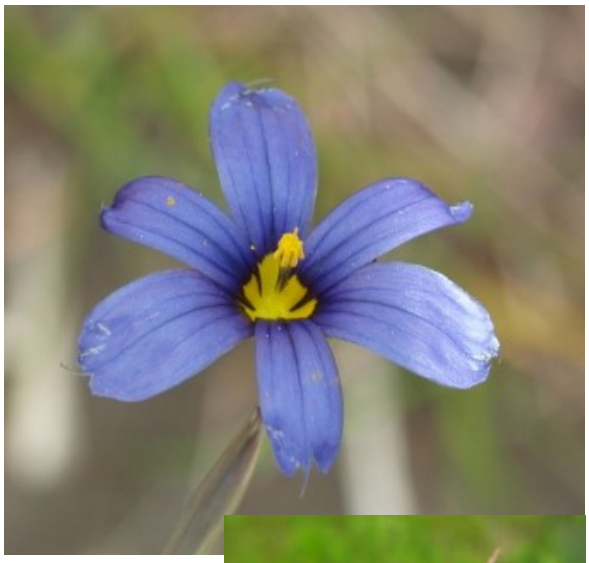
New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

FAC

Herbaceous perennial



Photos courtesy of Alexey Zinovjev and Irina Kadis, Salicicola.com.

Habitat: Forest edges, meadows/fields, shores of rivers or lakes

Flower Color: Blue to purple

Bloom Time: May to June

Height: Up to 2'

Leaf arrangement: Alternate, basal

Leaf type: Simple (not separated into leaflets), linear, with parallel veins

Sun Exposure: Full Sun

Soil Moisture: Mesic (Medium), Dry-Mesic, Dry

Seeding rate: approx. 512,000/lb

Notes:

Lookalikes: *S. mucronatum* with stems mostly 0.9-1.5 mm wide and with a narrow wing margin (*S. montanum* with stems 2-3.7 mm wide and with a conspicuous wing-margin).

Not as popular for insect forage as *S. angustifolium*

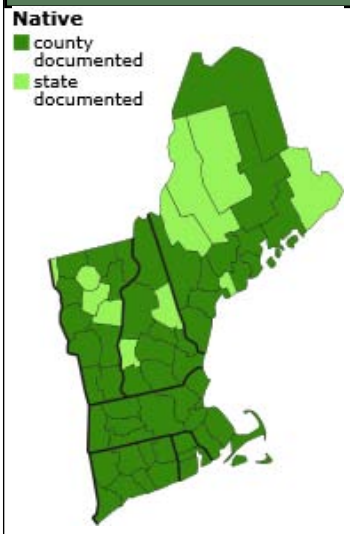
Pollinator and Wildlife Information

Pollinator Ranking: Low

Special value to native bees

Benefits for Wildlife: Provides nectar and pollen to bees

Sisyrinchium angustifolium
narrow-leaved blue-eyed-grass



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

FAC

Herbaceous perennial

Habitat: Meadows/fields, shores of rivers or lakes, wetland margins

Flower Color: Blue to purple

Bloom Time: May to June

Height: Up to 2'

Leaf arrangement: Alternate, basal

Leaf type: Simple (not separated into leaf-lets), linear, with parallel veins

Sun Exposure: Full Sun, Part Shade

Soil Moisture: Wet-Mesic, Mesic (Medium), Dry -Mesic

Persistence: Low

Soil pH: 5.0-7.0

Seeding rate: approx. 757,000/lb

Notes:

Plant can be difficult or slow to germinate from seed

Lookalikes: *S. atlanticum* has stems 0.8-1.9 mm wide and with a narrow wing-margin (*S. angustifolium* has stems 2.3-5 mm wide and with a conspicuous wing margin).

Photos courtesy of Alexey Zinovjev and Irina Kadis, Salicicola.com.

Pollinator and Wildlife Information

Pollinator Ranking: Low

Special value to native bees

Benefits for Wildlife: Provides nectar and pollen for *Halictine* bee species and bumblebees

Solidago juncea
early goldenrod

New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

Not classified

Herbaceous perennial

Habitat: Man-made or disturbed habitats, meadows/fields, woodlands

Flower Color: Yellow

Bloom Time: June to July

Height: Up to 3’

Leaf arrangement: Alternate

Leaf type: Simple (not separated into leaflets), lanceolate with acute tip

Sun Exposure: Full Sun, Part Shade

Soil Moisture: Mesic (Medium), Dry-Mesic, Dry

Persistence: High

Soil pH: 5.5-7.7

Seeding rate: 1%-2% of mix, approx. 2,538,000/lb

Notes:

Earliest goldenrod to bloom—almost a full month before other goldenrods

Photos courtesy of Alexey Zinovjev and Irina Kadis, Salicicola.com.

Pollinator and Wildlife Information

Pollinator Ranking: Low

Special value to native bees, butterflies, and moths

Larval host plant for many moth species

Benefits for Wildlife: Provides nectar and pollen for long and short tongue bees, butterflies, wasps, beetles, flies, and moths

Solidago nemoralis
gray goldenrod

New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

Not classified

Herbaceous perennial

Photos courtesy of Alexey Zinovjev and Irina Kadis, Salicicola.com.

Habitat: Man-made or disturbed habitats, fields/ meadows, ridges, ledges, roadsides

Flower Color: Yellow

Bloom Time: August to September

Height: Up to 3'

Leaf arrangement: Alternate

Leaf type: Simple (not separated into leaflets), pubescent (soft scratch feel), 4" long and ¾" wide

Sun Exposure: Full Sun

Soil Moisture: Mesic (Medium), Dry-Mesic

Persistence: High

Soil pH: 6.5-7.5

Seeding rate: 1-2% of mix; 1,008,000/lb

Notes:
- Prefers dry, relatively poor soil, will grow on sand, clay or gravel soils but can fail in rich soils
- Roots are both caudex and rhizomatous
- Can be affected by spot anthracnose, powdery mildew, rust and fungus in moist conditions
- Seeds must be cold, moist stratified at 40° F for 90 days

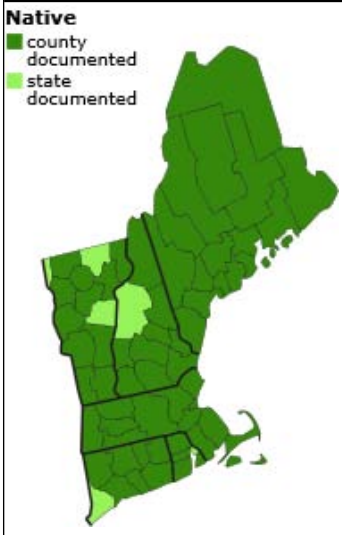
Pollinator and Wildlife Information

Pollinator Ranking: High

Special value to native bees and butterflies

Benefits for Wildlife: Food source for long and short-tongued bee species, beetles, butterflies, moths, flies, and wasps

Solidago puberula
downy goldenrod



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

FACU

Herbaceous perennial

Habitat: Man-made or disturbed habitats, grassland, meadows/ fields, woodlands

Flower Color: Orange, yellow

Bloom Time: August to October

Height: 1'-3'

Leaf arrangement: Alternate

Leaf type: Simple (not separated into leaf-lets), leaf is hairy

Sun Exposure: Full Sun, Part Shade

Soil Moisture: Mesic (Medium), Dry-Mesic

Photos courtesy of Alexey Zinovjev and Irina Kadis, Salicicola.com.

Photo courtesy of Arthur Haines, New England Wildflower Society ©

Notes:

Lookalikes: *S. nemoralis* with array of flower heads arching or nodding near tip and mainly on uppersides of branches (*S. puberula* with array of flower heads not nodding near tip, spirally arranged on branches)

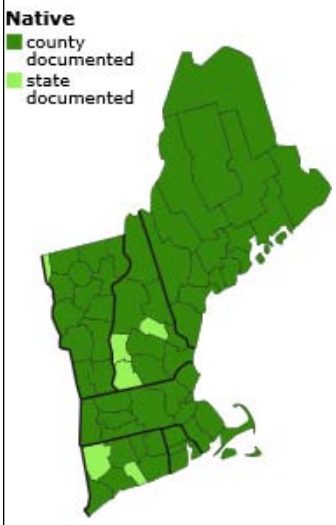
Pollinator and Wildlife Information

Pollinator Ranking: Low

Special value to native bees and butterflies

Solidago rugosa subsp. rugosa

common wrinkleleaf goldenrod



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

FAC

Herbaceous perennial

Habitat: Man-made or disturbed habitats, meadows/fields, swamps, wetland margins

Flower Color: Yellow

Bloom Time: August-October

Height: 1'-3 ½'

Leaf arrangement: Alternate

Leaf type: Simple (not separated into leaflets), elliptic with acute tip, leaf is fuzzy, leaf is wrinkled due to indentations around veins

Sun Exposure: Full Sun, Part Shade

Soil Moisture: Mesic (Medium)

Persistence: Medium

Soil pH: 5.0-7.5

Seeding rate: 1%-2% of a mix; approx. 1,000,000/lb

Notes:

Can spread aggressively

Roots: Rhizomatous

Photos courtesy of Alexey Zinovjev and Irina Kadis, Salicicola.com.

Pollinator and Wildlife Information

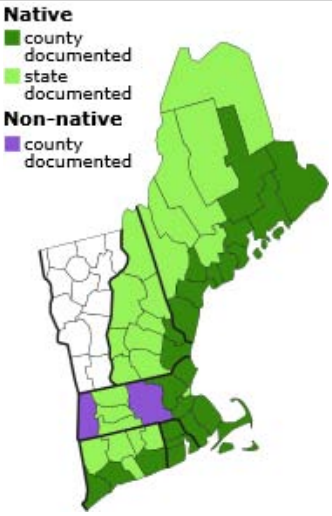
Pollinator Ranking: Low

Special value to native bees and butterflies

Benefits for Wildlife: Provides a food source for bees, butterflies, wasps, and beetles. Mature seeds provide for birds.

Solidago sempervirens

seaside goldenrod



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

FACW

Herbaceous perennial

Habitat: Coastal beaches, dunes, marshes

Flower Color: Yellow

Bloom Time: Late August to early October

Height: Up to 4’

Leaf arrangement: Alternate

Leaf type: Simple (not separated into leaflets), oblong to lanceolate, up to 20” long

Sun Exposure: Full Sun

Soil Moisture: Wet-Mesic, Mesic (Medium), Dry-Mesic

Persistence: Low

Soil pH: 5.5-7.5

Seeding rate: 1%-2% of a mix; approx. 700,000/lb

Photos courtesy of Alexey Zinovjev and Irina Kadis, Salicicola.com.

Notes:

High salt tolerance

Good plant to aid biodiversity in dune restoration projects

Pollinator and Wildlife Information

Pollinator Ranking: Low

Special value to native bees and butterflies

Benefits for Wildlife: Provides nectar and pollen to bees, butterflies, and birds

Spiraea alba var. latifolia
white meadowsweet

New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

FACW

Deciduous shrub

Photos courtesy of Alexey Zinovjev and Irina Kadis, Salicicola.com.

Habitat: Alpine/subalpine zones, man-made or disturbed habitats, marshes, meadows/fields, shores of fivers or lakes, swamps, wetland margins

Flower Color: White

Bloom Time: June to September

Height: Up to 6 ½'

Leaf arrangement: Alternate

Leaf type: Simple (not separated into leaflets), margin is toothed (serrate to dentate, medium to coarse), lanceolate

Sun Exposure: Full Sun, Part Shade

Soil Moisture: Wet, Wet-Mesic

Persistence: High

Soil pH: 4.3-6.8

Seeding rate: 1% of mix, approx. 1,000,000/lb

Notes:
Produces fruit that lasts all winter

Pollinator and Wildlife Information

Pollinator Ranking: High

Special value to native bees and moths

Larval host plant for Virginia ctenuchas (*Ctenucha virginica*)

Benefits for Wildlife: Provides a food source for bees, wasps, and moths.

Spiraea tomentosa
rosy meadowsweet, steeplebush

New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

FACW

Deciduous shrub

Photos courtesy of Alexey Zinovjev and Irina Kadis, Salicicola.com.

Habitat: Man-made or disturbed habitats, marshes, meadows/fields, shores of rivers or lakes, wetland margins, swamps

Flower Color: Pinkish-purple

Bloom Time: July to September

Height: Up to 3'

Leaf arrangement: Alternate

Leaf type: Simple (not separated into leaflets), margin is toothed, lanceolate to ovate, lower surface with woolly white to red-brown hairs

Sun Exposure: Full Sun

Soil Moisture: Wet, Wet-Mesic

Persistence: Medium

Soil pH: 4.5-7.0

Seeding rate: 1%-2% of a mix; approx. 1,100,000/lb

Notes:

Roots: Rhizomatous, but slow-spreading

Lookalikes: *S. alba* with leaves without hairs or with very sparse hairs (*S. tomentosa* with leaves with woolly white to red-brown hairs)

Pollinator and Wildlife Information

Pollinator Ranking: High

Special value to native bees, butterflies, and moths

Benefits for Wildlife: Provides a food source for bees, flies, beetles, moths, and butterflies

Symphyotrichum cordifolium

heart-leaved American-aster

New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

Not classified

Herbaceous perennial

Habitat: Man-made or disturbed habitats, forest edges, forests, meadows/fields

Flower Color: Bluish-purple

Bloom Time: August to September

Height: 2'-3'

Leaf arrangement: Alternate

Leaf type: Simple (not separated into leaflets), elliptic

Sun Exposure: Full Sun

Soil Moisture: Mesic (Medium), Dry-Mesic

Persistence: Low

Soil pH: 5.7-7.5

Seeding rate: 1-5% of a mix; approx. 2,000,000/ lb

Notes:
Synonym *Aster cordifolius*
Lookalikes: *S. undulatum* with middle and upper stem leaves conspicuously expanded and clasping the stem (*S. cordifolium* with middle and upper stem leaves narrowed or stalked at base and not clasping the stem)

Photos courtesy of Alexey Zinovjev and Irina Kadis, Salicicola.com.

Pollinator and Wildlife Information

Pollinator Ranking: High

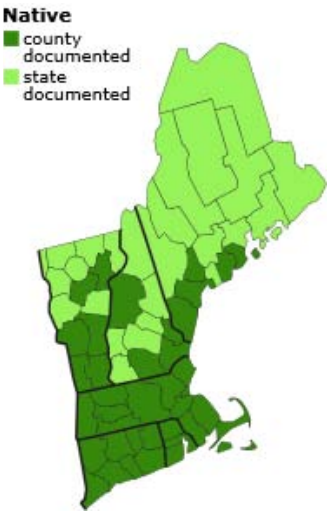
Special value to native bees, butterflies, and moths

Larval host plant for many moth species, as well as silvery checkerspots (*Chlosyne nycteis*) and pearl crescents (*Phyciodes tharos*)

Benefits for Wildlife: Provides a food source for butterfly larvae, moth larvae, long and short tongue bees, butterflies, flies, wasps, skippers, and beetles

Symphyotrichum ericoides

heath American-aster



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

FACU

Herbaceous perennial

Photos courtesy of Alexey Zinovjev and Irina Kadis, Salicicola.com.

Habitat: Grassland, meadows/fields

Flower Color: White

Bloom Time: August-October

Height: Up to 4’

Leaf arrangement: Alternate

Leaf type: Simple (not separated into leaflets), lanceolate, hairy

Sun Exposure: Full Sun

Soil Moisture: Dry-Mesic, Dry

Soil pH: 5.5-7.5

Notes:

Synonym *Aster ericoides*

Lookalikes: *S. pilosum*

Pollinator and Wildlife Information

Pollinator Ranking: High

Special value to native bees, butterflies, and moths

Larval host plant for many moth species, as well as silvery checkerspots (*Chlosyne nycteis*) and pearl crescents (*Phyciodes tharos*)

Benefits for Wildlife: Provides a food source for butterfly larvae, moth larvae, long and short tongue bees, butterflies, flies, wasps, skippers, and beetles. Provides habitat for butterflies

Symphyotrichum lanceolatum

lance-leaved American-aster

New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

FACW

Herbaceous perennial

Habitat: Man-made or disturbed habitats, meadows/fields, swamps, wetland margins

Flower Color: White

Bloom Time: September-October

Height: Up to 5'

Leaf arrangement: Alternate

Leaf type: Simple (not separated into leaflets), elliptic with acute tip, hairy

Sun Exposure: Full Sun

Soil Moisture: Wet-Mesic, Mesic (Medium)

Notes:

Synonym *Aster lanceolatus*

Roots: Rhizomatous, can form large colonies

Lookalikes: *S. racemosum*

Photos courtesy of Alexey Zinovjev and Irina Kadis, Salicicola.com.

Pollinator and Wildlife Information

Pollinator Ranking: High

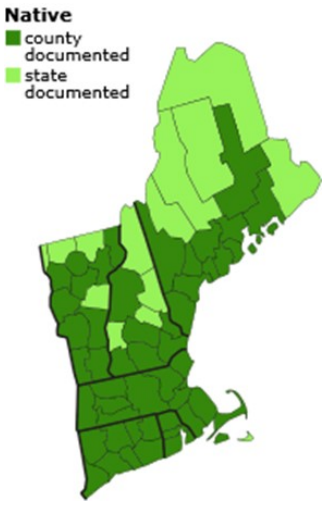
Special value to native bees, butterflies, and moths

Larval host plant for many moth species, as well as silvery checkerspots (*Chlosyne nycteis*) and pearl crescents (*Phyciodes tharos*)

Benefits for Wildlife: Provides a food source for butterfly larvae, moth larvae, long and short tongue bees, butterflies, flies, wasps, skippers, and beetles.

Symphyotrichum novae-angliae

New England American-aster



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

FACW

Herbaceous perennial

Habitat: Man-made or disturbed habitats, fields/meadows, roadsides

Flower Color: Purple

Bloom Time: Late summer

Height: 2'-6'

Leaf arrangement: Alternate

Leaf type: Simple (not separated into leaflets), 4" long by 1" wide, lanceolate to spoon-shaped, hairy, wide base which clasps stem

Sun Exposure: Full Sun, Part Shade

Soil Moisture: Wet-Mesic, Mesic (Medium)

Persistence: High

Soil pH: 5.6-7.5

Seeding rate: 1-4% of mix; 1,100,000/lb

Notes:

Synonym *Aster novae-angliae*

- Seeds require cold stratification at 34°-40° F for 30-40 days for spring/summer seeding
- Stem rot a problem if allowed to remain wet for extended periods; thorough soil cultivation is best preventative
- **Lookalike**: Heath aster similar as seedling but has linear leaves compared to clasping leaves of New England aster

Photos courtesy of Alexey Zinovjev and Irina Kadis, Salicicola.com.

Photo courtesy of Mark B. Fiely, Ernst Conservation Seeds.©

Pollinator and Wildlife Information

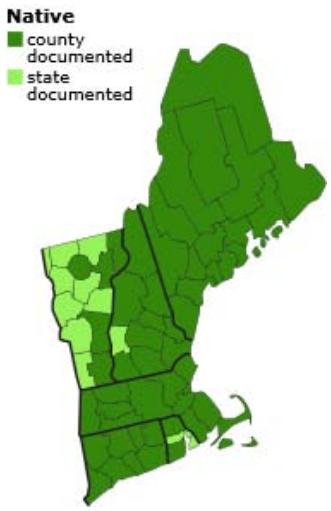
Pollinator Ranking: High

Special value to native bees and butterflies

Larval host to pearl crescent (*Phyciodes tharos*) and checkerspot butterflies

Benefits for Wildlife: Food source for long and short-tongued bee species, beetles, butterflies, moths, flies, and wasps

Symphyotrichum novae-belgii
New York American-aster



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

FACW

Herbaceous perennial

Habitat: Brackish/salt marshes/flats, forest edges, marshes, meadows/fields, shores of rivers or lakes

Flower Color: Violet, blue

Bloom Time: Late July to October

Height: Up to 4 ½'

Leaf arrangement: Alternate

Leaf type: Simple (not separated into leaflets), elliptic to ovate

Sun Exposure: Full Sun

Soil Moisture: Wet, Wet-Mesic, Mesic (Medium)

Persistence: Medium

Soil pH: 5.5-7.0

Seeding rate: 1%-4% of a mix; approx. 700,000/lb

Notes:

Synonym *Aster novi-belgii*

Roots: Rhizomatous, moderate spread

Prone to mildew

Photos courtesy of Alexey Zinovjev and Irina Kadis, Salicicola.com.

Pollinator and Wildlife Information

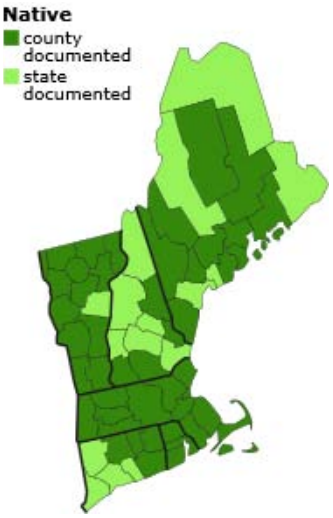
Pollinator Ranking: High

Special value to native bees, butterflies, and moths

Larval host plant for many moth species, as well as silvery checkerspots (*Chlosyne nycteis*) and pearl crescents (*Phyciodes tharos*)

Benefits for Wildlife: Provides a food source for for bees, butterflies, moths, beetles, and flies

Symphyotrichum pilosum
awl American-aster



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

FACU

Herbaceous perennial

Habitat: Meadows/fields

Flower Color: White to pale purple

Bloom Time: After fall frost

Height: 2'-5'

Leaf arrangement: Alternate

Leaf type: Simple (not separated into leaf-lets), elliptic

Sun Exposure: Full Sun, Part Shade

Soil Moisture: Wet-Mesic, Mesic (Medium), Dry -Mesic, Dry

Soil pH: 5.4-7.0

Seeding rate: 1%-2% of a mix; approx. 700,000/lb

Notes:

Synonym *Aster pilosus*

Roots: Rhizomatous

Lookalikes: *S. ericoides*

Photos courtesy of Alexey Zinovjev and Irina Kadis,Salicicola.com.

Pollinator and Wildlife Information

Pollinator Ranking: High

Special value to native bees and butterflies

Larval host plant for many moth species, as well as silvery checkerspots (*Chlosyne nycteis*) and pearl crescents (*Phyciodes tharos*)

Benefits for Wildlife: Provides a food source for long and short tongue bees, butterflies, flies, wasps, skippers, and beetles

Symphyotrichum puniceum

purple-stemmed American-aster

New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

OBL

Herbaceous perennial

Habitat: Man-made or disturbed habitats, meadows/fields, shores of rivers or lakes, swamps, wetland margins

Flower Color: Blue, deep violet

Bloom Time: August to November

Height: Up to 8'

Leaf arrangement: Alternate

Leaf type: Simple (not separated into leaflets), elliptic

Sun Exposure: Full Sun

Soil Moisture: Wet, Wet-Mesic

Soil pH: 4.5-7.5

Seeding rate: 1%-4% of a mix; approx. 700,000/lb

Notes:

Synonym *Aster puniceus*

Roots: Rhizomatous

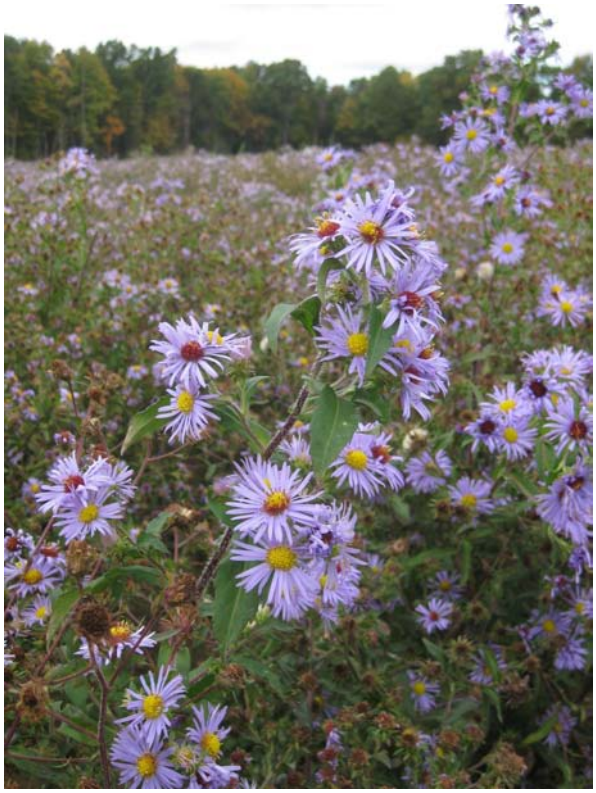


Photo courtesy of Mark B. Fiely, Ernst Conservation Seeds.

Photo courtesy of Alexey Zinovjev and Irina Kadis, Salicicola.com.

Pollinator and Wildlife Information

Pollinator Ranking: High

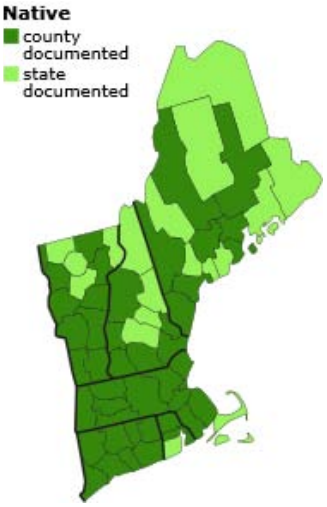
Special value to native bees and butterflies

Larval host plant for many moth species, as well as silvery checkerspots (*Chlosyne nycteis*) and pearl crescents (*Phyciodes tharos*)

Benefits for Wildlife: Provides a food source for long and short tongue bees, butterflies, flies, wasps, skippers, and beetles

Thalictrum dioicum

early meadow-rue



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

FACU

Herbaceous perennial

Photos courtesy of Alexey Zinovjev and Irina Kadis, Salicicola.com.

Habitat: Floodplain, forests, shores of rivers or lakes

Flower Color: Yellowish-green

Bloom Time: April to May

Height: Up to 2'

Leaf arrangement: Alternate

Leaf type: Pinnately compound (separated into leaflets) with terminal leaflet**,** margin is toothed, cordate to reniform

Sun Exposure: Part Shade, Shade

Soil Moisture: Wet-Mesic, Mesic (Medium), Dry -Mesic

Seeding rate: approx. 117,000/lb

Notes:

Lookalikes: *T. pubescens* with leaf segments with 3 lobes and filaments of stamens usually white (*T. dioicum* with leaf segments with 4 or more lobes and filaments of stamens colored).

Pollinator and Wildlife Information

Pollinator Ranking: High

Special value to native moths

Larval host plant for Canadian owlets (*Calyptra canadensis*), borer moths (*Papaipema unimodal*), and straight -lined looper moths (*Pseudeva purpurigera*)

Benefits for Wildlife: Provides a food source for moth larvae

Thalictrum pubescens

tall meadow-rue

New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

FACW

Herbaceous perennial

Habitat: Man-made or disturbed habitats, flood-plain, forests, marshes, meadows/fields, shores of rivers or lakes, swamps, wetland margins

Flower Color: White

Bloom Time: June to July

Height: Up to 6'

Leaf arrangement: Alternate

Leaf type: Pinnately compound (separated into leaflets) with terminal leaflet**,** cordate, margin is entire

Sun Exposure: Part Shade

Soil Moisture: Wet-Mesic, Mesic (Medium)

Seeding rate: 1%-2% of a mix; approx. 192,000/ lb

Notes:

Lookalikes: *T. dioicum* with leaf segments with 4 or more lobes and filaments of stamens colored (*T. pubescens* with leaf segments with 3 lobes and filaments of stamens usually white).

Photos courtesy of Alexey Zinovjev and Irina Kadis, Salicicola.com.

Pollinator and Wildlife Information

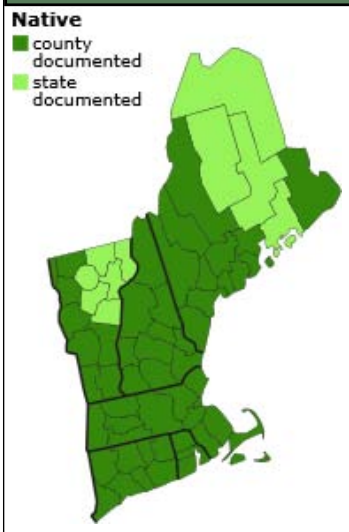
Pollinator Ranking: High

Special value to native moths

Larval host plant for Canadian owlets (*Calyptra canadensis*), borer moths (*Papaipema unimodal*), and straight -lined looper moths (*Pseudeva purpurigera*)

Benefits for Wildlife: Provides a food source for moth larvae

Trichostema dichotomum
forked bluecurls



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

UPL

Herbaceous perennial

Habitat: Man-made or disturbed habitats, grassland, meadows/fields, sandplains and barrens

Flower Color: Purple

Bloom Time: Late summer to fall

Leaf arrangement: Opposite

Leaf type: Simple (not separated into leaflets), elliptic to ovate, margin is entire

Sun Exposure: Part Shade, Shade

Soil Moisture: Mesic (Medium), Dry-Mesic

Persistence: Low

Notes:

Lookalikes: *Clinopodium acinos* has upright flowers 7-10 mm long (*T. dichotomum* is mat-forming perennial with flowers 4-6 mm long

Photos courtesy of Alexey Zinovjev and Irina Kadis, Salicicola.com.

Pollinator and Wildlife Information

Pollinator Ranking: High

Special value to native bees

Benefits for Wildlife: Provides a food source for bees

Verbena hastata

Blue vervain, swamp vervain

New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

FACW

Herbaceous perennial/ biennial

Habitat: Man-made or disturbed habitats, meadows/ fields, marshes, shores of rivers or lakes, wetland margins, roadsides

Flower Color: Blue, violet

Bloom Time: June to October

Height: 2'-5'

Leaf arrangement: Opposite

Leaf type: Simple (not separated into leaflets), lanceolate, 6" long by 1" wide, with toothed margins, leaves are more hairy on bottom than top, hairy stems which can be green or red

Sun Exposure: Full Sun, Part Shade

Soil Moisture: Wet, Wet-Mesic, Mesic (Medium)

Persistence: Low

Soil pH: 5.6-7.5

Seeding rate: 1%-10% of a mix, approx. 1,488,000/lb

Notes:

- **Roots**: Rhizomatous, horizontal roots
- Seeds should be stratified in wet sand or peat moss for 3 months at 38-40F.
- CAN INDUCE VOMITING/DIARRHEA IF TAKEN INTERNALLY IN LARGE DOSES

Lookalikes: *V. urticifolia* with white, 2-2.5 mm uncrowded flowers (*V. hastata* with blue, 2.5-5 mm flowers which are crowded

Photos courtesy of Alexey Zinovjev and Irina Kadis, Salicicola.com.

Pollinator and Wildlife Information

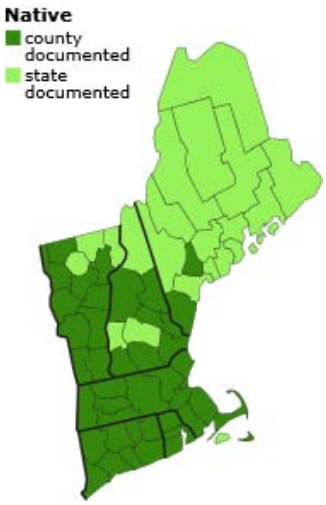
Pollinator Ranking: Medium

Special value to native bees and butterflies

Larval host to common buckeye (*Junonia coenia*)

Benefits for Wildlife: Food source for long and short-tongued bee species, beetles, butterflies, moths, skippers, flies, and wasps. Birds eat the mature seeds

Verbena urticifolia
white vervain



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

FAC

Herbaceous annual/ perennial

Photos courtesy of Alexey Zinovjev and Irina Kadis, Salicicola.com.

Habitat: Man-made or disturbed habitats, flood-plain, forest edges, forests, meadows/fields

Flower Color: White

Bloom Time: June-October

Height: 1'-5'

Leaf arrangement: Opposite

Leaf type: Simple (not separated into leaf-lets), lanceolate to ovate with acuminate to acute tip, margin is toothed

Sun Exposure: Full Sun, Part Shade

Soil Moisture: Wet-Mesic, Mesic (Medium)

Persistence: Low

Soil pH: 6.6-7.5

Notes:

Lookalikes: *V. hastata* with blue flowers, 2.5 -4.5 mm wide across top of petals, close-ly crowded together (*V. urticifolia* with white flowers, 2-2.5 mm wide across top of petals, approximate but not crowded)

Pollinator and Wildlife Information

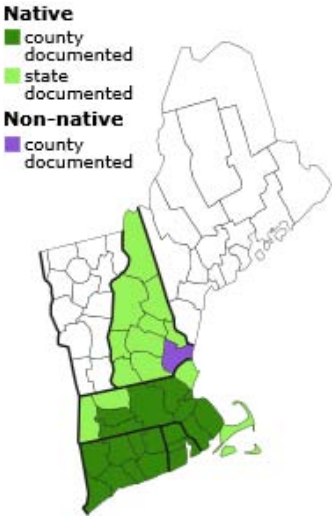
Pollinator Ranking: Medium

Special value to native bees and butterflies

Larval host to common buckeye (*Junonia coenia*)

Benefits for Wildlife: Food source for long and short-tongued bee species, beetles, but-terflies, moths, skippers, flies, and wasps

Vernonia noveboracensis
New York ironweed



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

FACW

Herbaceous perennial

Photos courtesy of Alexey Zinovjev and Irina Kadis, Salicicola.com.

Habitat: Man-made or disturbed habitats, flood-plain, forest edges, forests, meadows/fields

Flower Color: White

Bloom Time: June-October

Height: 1'-5'

Leaf arrangement: Opposite

Leaf type: Simple (not separated into leaf-lets), lanceolate to ovate with acuminate to acute tip, margin is toothed

Sun Exposure: Full Sun, Part Shade

Soil Moisture: Wet-Mesic, Mesic (Medium)

Persistence: Low

Soil pH: 6.6-7.5

Notes:

- Moderate drought tolerance
- Deer and rabbit resistant
- Can spread rapidly in moist conditions
- Short bloom time

Pollinator and Wildlife Information

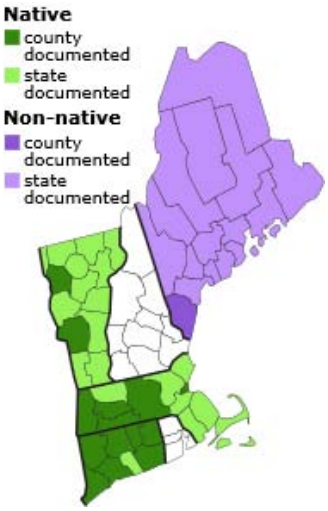
Pollinator Ranking: High

Special value to native bees and butter-flies

Larval host to American lady Bbtterflies (*Vanessa virginiensis*)

Benefits for Wildlife: Food source for butterflies and bees including callirhoe bees (*Mellisodes vernoniae*) and long-horn bees (*Mellisodes denticulata*)

Veronicastrum virginicum
Culver's root



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

FAC

Herbaceous perennial

Habitat: Man-made or disturbed habitats, forests, meadows/fields, swamps

Flower Color: White, pink

Bloom Time: June to August

Height: 2'-6'

Leaf arrangement: Whorled (with three or more leaves per node along the stem)

Leaf type: Simple (not separated into leaflets), up to 6" long, with finely toothed margins, hairy stems

Sun Exposure: Full Sun, Part Shade

Soil Moisture: Wet-Mesic, Mesic (Medium)

Persistence: Low

Soil pH: 6.6-7.8

Seeding rate: 1%-2% of a mix, approx. 7,761,000/lb

Notes:
Roots: Rhizomatous (but not aggressive), tap-rooted
Seed should be stratified in wet sand or peat moss for 90 days at 38-40°F

Photos courtesy of Arthur Haines, New England Wildflower Society ©

Photo courtesy of Mark B. Fiely, Ernst Conservation Seeds.

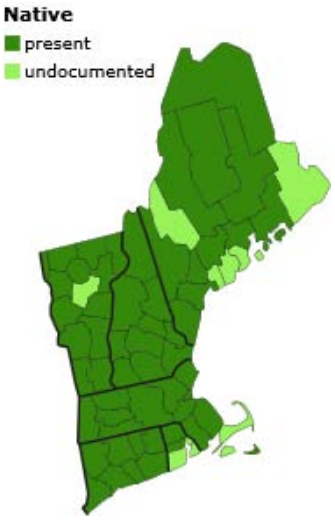
Pollinator and Wildlife Information

Pollinator Ranking: High

Special value to native bees, butterflies, and moths

Benefits for Wildlife: Provides a food source for long and short tongue bees, butterflies, moths, and wasps

Zizia aurea
common golden Alexanders



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

FAC

Herbaceous perennial

Habitat: Man-made or disturbed habitats, forests, fields/meadows, floodplains, shores of rivers or lakes

Flower Color: Yellow

Bloom Time: May to June

Height: Up to 3'

Leaf arrangement: Alternate

Leaf type: Compound (separated into leaflets) , 8 cm long by 5 cm wide, smooth, finely serrated margins, lanceolate

Sun Exposure: Full Sun, Part Shade

Soil Moisture: Wet-Mesic, Mesic (Medium), Dry-Mesic

Persistence: Medium

Soil pH: 6.1-7.8

Seeding rate: 1-5% of mix; 172,000/lb

Notes:

- Can be slow to establish
- Drought tolerant
- Seed needs moist, cold stratification at 40°F for 90
- **Lookalikes**: *Zizia aptera* but there are heart-shaped leaves at base of plant; *Pastinaca sativa* but is taller, blooms later and can cause skin burns

Photo courtesy of Mark B. Fiely, Ernst Conservation Seeds.

Pollinator and Wildlife Information

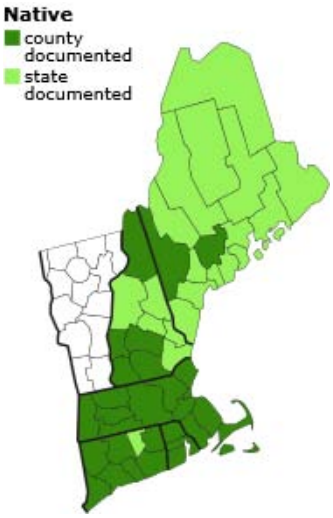
Pollinator Ranking: High

Special value to native bees, butterflies, and moths

Benefits for Wildlife: Provides a food source for long and short tongue bees, butterflies, moths, and wasps

GRASSES AND GRASS-LIKE SPECIES

Agrostis hyemalis
winter bentgrass



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

FAC

Perennial cool-season grass

Habitat: Man-made or disturbed habitats, meadows/ fields, woodlands

Fertility requirement: Medium

Active Growth Period: Spring, Summer, Fall

Bloom Time: Mid-spring

Height: Up to 3 ½'

Root depth (minimum): 8"

Growth form: Bunch

Growth rate: Moderate

Shade tolerance: Intermediate

Soil Moisture: Wet-Mesic, Mesic (Medium) Dry-Mesic

Drought tolerance: Low

Salinity tolerance: Medium

Soil pH: 5.0 – 7.5

Lifespan: Short

Seeding rate: 10-30 lb per acre alone;1%-10% of a mix; approx. 8,500,000/lb

Notes:
Good for moderately drained soils on roadsides
Lookalikes: *A. scabra* which flowers later (June-Nov)

Photo courtesy of Mark B. Fiely, Ernst Conservation Seeds.

Pollinator and Wildlife Information

Special value to native butterflies and birds

Larval host plant for roadside skipper (*Amblyscirtes vialis*), Leonard's skipper (*Hesperia leonardus*), and fiery skippers (*Hylephila phyleus*)

Benefits for Wildlife: Provides a food source for butterfly larvae. Birds eat the mature seeds

Agrostis perennans
autumn or upland bentgrass

New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

FACU

Perennial cool-season grass

Habitat: Man-made or disturbed habitats, forests, shores of rivers or lakes

Fertility requirement: Medium

Active Growth Period: Spring, Summer, Fall

Bloom Time: Midsummer

Height: Up to 3 ½'

Root depth (minimum): 8"

Growth form: Bunch

Growth rate: Moderate

Shade tolerance: Intermediate

Soil Moisture: Wet-Mesic, Mesic (Medium) Dry-Mesic

Drought tolerance: Low

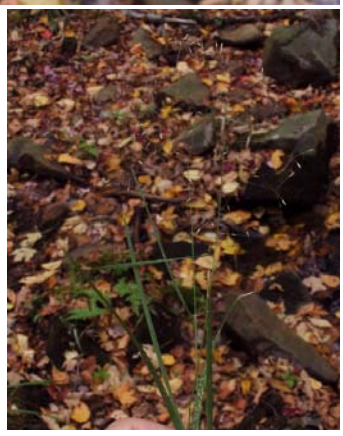
Salinity tolerance: None

Soil pH: 5.5– 7.5

Lifespan: Short

Seeding rate: 20-30 lb per acre alone;1%-25% of a mix; approx. 8,000,000/lb

Notes:
Roots: Rhizomatous



Photos courtesy of Alexey Zinovjev and Irina Kadis, Salicicola.com.

Photo courtesy of Mark B. Fiely, Ernst Conservation Seeds.

Pollinator and Wildlife Information

Special value to native butterflies and birds

Larval host plant for roadside skipper (*Amblyscirtes vialis*), Leonard's skipper (*Hesperia leonardus*), and fiery skippers (*Hylephila phyleus*)

Benefits for Wildlife: Provides a food source for butterfly larvae. Birds eat the mature seeds

Agrostis scabra
rough bentgrass, ticklegrass

New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

FAC

Perennial cool-season grass

Habitat: Man-made or disturbed habitats, fields/meadows, forests, forest edges, shores of rivers/lakes

Fertility requirement: Low

Active Growth Period: Spring

Bloom Time: June to November

Height: Up to 3'

Root depth (minimum): 12"

Growth form: Bunch

Growth rate: Moderate

Shade tolerance: Intolerant

Soil Moisture: Wet-Mesic, Mesic (Medium)

Drought tolerance: Low

Salinity tolerance: Low

Soil pH: 6.0-8.0

Lifespan: Moderate

Seeding rate: 20-30 lb per acre alone; 1%-10% of a mix; approx.. 5,000,000 seeds/lb

Notes:

- Quick to emerge when used for reclamation
- Contributes to long-term stability of seasonally wet areas

Photos courtesy of Alexey Zinovjev and Irina Kadis, Salicicola.com.

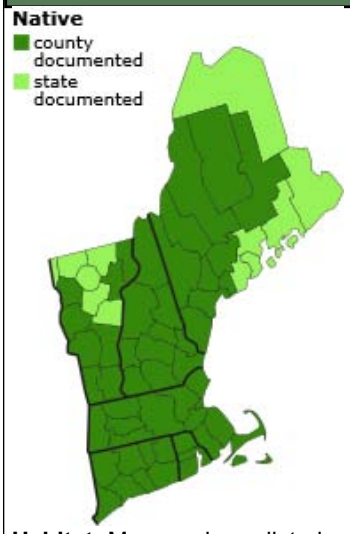
Pollinator and Wildlife Information

Special value to native butterflies and birds

Larval host plant for roadside skipper (*Amblyscirtes vialis*), Leonard's skipper (*Hesperia leonardus*), and fiery skippers (*Hylephila phyleus*)

Benefits for Wildlife: Provides a food source for butterfly larvae. Birds eat the mature seeds

Andropogon gerardii
Big bluestem



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

FAC

Perennial warm-season grass

Habitat: Man-made or disturbed habitats, cliffs, ledges, floodplain, grassland, meadows/fields, shores of rivers or lakes, woodlands

Fertility requirement: Low

Active Growth Period: Summer

Bloom Time: August to October

Height: 5'-7'

Root depth (minimum): 20"

Growth form: Bunch

Growth rate: Moderate

Shade tolerance: Intolerant

Soil Moisture: Wet-Mesic, Mesic (Medium) Dry-Mesic , Dry

Drought tolerance: High

Salinity tolerance: Medium

Soil pH: 6.0 – 7.5

Lifespan: Long

Seeding rate: 8-10 PLS lb per acre alone; 5%-50% of a mix; approx. 144,000/lb

Notes:
Good for erosion control in sand/gravel pits and road-sides
Contributes to diversified biomass production
Leafy foliage turns attractive multiple shades of brown in winter

Photos courtesy of Alexey Zinovjev and Irina Kadis,Salicicola.com.

Pollinator and Wildlife Information

Special value to native butterflies and birds

Larval host plant to Delaware skippers (*Anatrytone logan*), dusted skippers (*Atrytonopsis hianna*), Leonard's skipper (*Hesperia leonardus*), cobweb skipper (*Hesperia metea*), Indian skipper (*Hesperia sassacus*), ottoe skipper (*Hesperia ottoe*), and byssus skipper (*Problema byssus*)

Benefits for Wildlife: Provides a food source for butterfly larvae, grasshoppers and other insects. Provides nest sites for birds like sparrows, wrens, and meadowlarks. Bees utilize plant parts for nesting materials

Andropogon virginicus
broomsedge bluestem

New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

FACU

Perennial warm-season grass

Habitat: Man-made or disturbed habitats, fields/meadows, wetland margins, woodlands

Active Growth Period: Summer

Bloom Time: Late spring

Height: 1 ½'-3'

Root depth (minimum): 14"

Growth form: Bunch

Growth rate: Slow

Shade tolerance: Intolerant

Soil Moisture: Mesic (medium), Dry-Mesic, Dry

Drought tolerance: High

Salinity tolerance: Low

Soil pH: 4.9-7.0

Lifespan: Moderate

Seeding rate: 10 PLS lb per acre alone; 1%-25% of a mix; approx.. 800,000 seeds/lb.

Notes:

- Prefers low fertility, loose, sandy soils
- Seedlings grow quickly but stands take 2-3 years to establish
- Straw-colored (ornamental) through winter

Photos courtesy of Alexey Zinovjev and Irina Kadis,Salicicola.com.

Pollinator and Wildlife Information

Special value to native birds and butterflies

Larval host to zabulon skippers (*Poanes zabulon*)

Benefits for Wildlife: Food source for birds and leafhoppers. Provides shelter and nesting materials for native birds

Bromus ciliatus
fringed brome

New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

FACW

Perennial cool-season grass

Habitat: Floodplain, forest edges, forests, shores of rivers or lakes, swamps

Fertility requirement: Low

Active Growth Period: Spring, Summer

Bloom Time: Spring

Height: Up to 4'

Root depth (minimum): 16"

Growth form: Bunch

Growth rate: Moderate

Shade tolerance: Tolerant

Soil Moisture: Wet, Wet-Mesic

Drought tolerance: Low

Salinity tolerance: Low

Soil pH: 5.5– 7.5

Lifespan: Long

Seeding rate: approx. 236,000/lb

Photos courtesy of Donald Cameron © 2016

Photos courtesy of Steve Matson © 2016

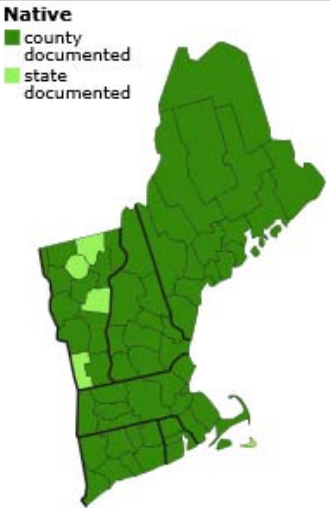
Pollinator and Wildlife Information

Special value to native butterflies

Larval host plant for arctic skippers (*Carterocephalus palaemon*) and western branded skippers (*Hesperia colorado*)

Benefits for Wildlife: Provides a food source for butterfly larvae. Birds eat the mature seeds

Bulbostylis capillaris
tufted hair-sedge



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

FACU

Annual grass

Habitat: Man-made or disturbed habitats, grasslands; well-drained, sandy soils with little other vegetation, gravel of grasslands, roadsides, borrow pits, and waste places

Fertility requirement: Low

Bloom Time: June to August

Height: Up to 1’

Shade tolerance: Intermediate

Soil Moisture: Dry-Mesic, Mesic (Medium)

Drought tolerance: High

Photos courtesy of Arthur Haines, New England Wildflower Society ©

Pollinator and Wildlife Information

Special value to native birds

Larval host to sandhill skippers (*Polites sabuleti*)

Benefits for Wildlife: Food source for deer, game birds, and waterfowl

Calamagrostis canadensis
bluejoint, Canada reed grass

New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

OBL

Perennial cool-season grass

Habitat: Alpine/subalpine, marshes, meadows/fields, mountain summits, swamps, shores of rivers or lakes, wetland margins

Fertility requirement: Medium

Active Growth Period: Spring

Bloom Time: June to August

Height: Up to 5'

Root depth (minimum): 16"

Growth form: Rhizomatous

Growth rate: Moderate

Shade tolerance: Intolerant

Soil Moisture: Wet, Wet-Mesic, Mesic (Medium)

Drought tolerance: Low

Salinity tolerance: None

Soil pH: 4.5-8.0

Lifespan: Long

Seeding rate: 1%-5% of a mix; approx. 3,837,000/lb

Notes:

Roots: Rhizomatous, can spread rapidly

Good for wetland restoration and shoreline/ streambank stabilization.

Lookalikes: *Phalaris arundinacea* which is coarser -textured, has larger smooth seed and produces reddish rhizomes near soil surface

Photos courtesy of Alexey Zinovjev and Irina Kadis,Salicicola.com.

Pollinator and Wildlife Information

Special value to native birds

Benefits for Wildlife: Provides cover and nests to birds and small mammals

Carex scoparia
pointed broom sedge

New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

FACW

Perennial sedge

Photos courtesy of Alexey Zinovjev and Irina Kadis, Salicicola.com.

Habitat: Man-made or disturbed habitats, meadows/ fields, wetland margins, swamps

Fertility requirement: Medium

Active Growth Period: Spring and Summer

Bloom Time: July to August

Height: 8”-36”

Root depth (minimum): 8”

Growth form: Bunch

Growth rate: Moderate

Shade tolerance: Tolerant

Soil Moisture: Wet, Wet-Mesic, Mesic (Medium)

Drought tolerance: None

Salinity tolerance: Low

Soil pH: 4.6-6.9

Lifespan: Long

Seeding rate: 1%-10% of a mix; approx. 1,344,000/lb

Notes:

Inflorescences can be quite variable, from crowded to spread out and stiff to arching

Pollinator and Wildlife Information

Special value to native butterflies, moths, birds

Benefits for Wildlife: Provides a food source for butterfly larvae, moth larvae, waterfowl, and songbirds

Carex stricta
tussock sedge

New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

OBL

Perennial sedge

Photos courtesy of Alexey Zinovjev and Irina Kadis, Salicicola.com.

Habitat: Marshes, meadows/fields, shores of rivers or lakes, swamps

Fertility requirement: Medium

Active Growth Period: Spring

Bloom Time: May to June

Height: Up to 3'

Root depth (minimum): 18"

Growth form: Bunch

Growth rate: Moderate

Shade tolerance: Tolerant

Soil Moisture: Wet, Wet-Mesic

Drought tolerance: Low

Salinity tolerance: None

Soil pH: 3.5-7.0

Lifespan: Long

Seeding rate: 1%-5% of a mix; approx. 1,800,000/lb

Notes:

Lookalikes: *C. haydenii* with leaves usually shorter than the flower stem (*C. stricta* with leaves as tall as or taller than the flower stem)

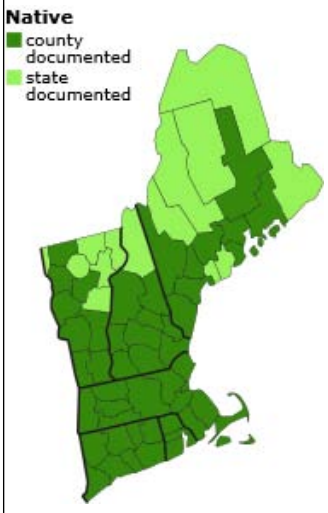
Deer browse on roots

Pollinator and Wildlife Information

Special value to native birds

Benefits for Wildlife: Food source for waterfowl and songbirds. Provides cover for terrestrial birds.

Carex swanii
Swan's sedge



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

FACU

Perennial sedge

Photos courtesy of Alexey Zinovjev and Irina Kadis, Salicicola.com.

Habitat: Forests, woodlands

Active Growth Period: Spring

Bloom Time: May to June

Height: 1'-3'

Growth form: Rhizomatous

Growth rate: Moderate

Shade tolerance: Intermediate

Soil Moisture: Wet-Mesic, Mesic (Medium), Dry-Mesic

Drought tolerance: Low

Notes:

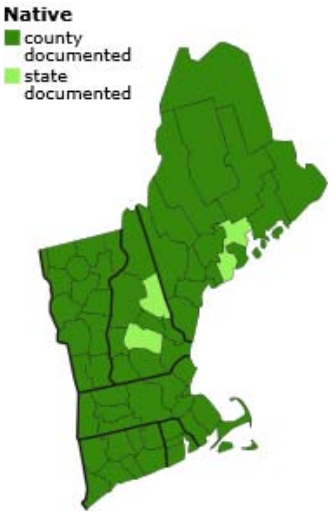
Lookalikes: *C. virescens* with uppermost spike mostly 20-35 mm long and loosely flowered near the base (*C. swanii* with uppermost spike mostly 11-20 mm long and densely flowered throughout)

Pollinator and Wildlife Information

Special value to native birds

Benefits for Wildlife: Food source for waterfowl and songbirds. Provides cover for terrestrial birds.

Carex vulpinoidea
common fox sedge



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

OBL

Perennial sedge

Photos courtesy of Alexey Zinovjev and Irina Kadis, Salicicola.com.

Habitat: Man-made or disturbed habitats, fields/meadows, marshes, roadside ditches

Fertility requirement: Medium

Active Growth Period: Spring

Bloom Time: June to August

Height: up to 3'

Root depth (minimum): 16"

Growth form: Bunch

Growth rate: Moderate

Shade tolerance: Intermediate

Soil Moisture: Wet-Mesic, Mesic (Medium)

Drought tolerance: Low

Salinity tolerance: None

Soil pH: 6.8-8.9

Lifespan: Long

Seeding rate: 1%-30% of a mix; approx., 1,297,000 seeds/ lb.

Notes:

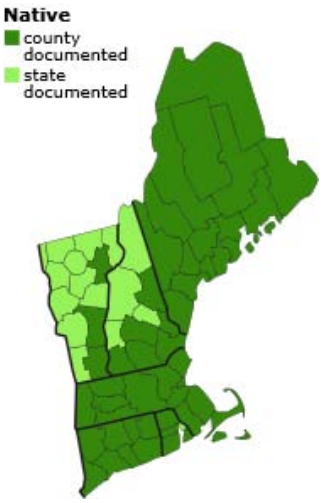
- Spreads rapidly, can spread rapidly — use with care
- Drought tolerant
- Seeds require cold stratification for spring planting
- Distinctive inflorescence resembling fox's tail

Pollinator and Wildlife Information

Special value to native birds

Benefits for Wildlife: Food source for waterfowl and songbirds. Provides cover for terrestrial birds.

Coleataenia longifolia subsp. *rigidulum*
long-leaved redtop panicgrass



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

FACW

Perennial warm-season grass

Habitat: Marshes, meadows/fields, shores of rivers or lakes, wetland margins

Fertility requirement: Low

Active Growth Period: Summer

Bloom Time: August to October

Height: Up to 4'

Root depth (minimum): 6"

Growth form: Bunch

Growth rate: Moderate

Shade tolerance: Intolerant

Soil Moisture: Wet, Wet-Mesic

Drought tolerance: Low

Salinity tolerance: Low

Soil pH: 5.0 – 7.5

Lifespan: Long

Seeding rate: 1%-50% of a mix; approx. 796,636/lb

Notes:

Synonym *Panicum longifolium*

- Attractive seed heads and attractive foliage in late summer and early fall
- Lookalikes: *Panicum philadelphicum* and *Panicum dichotomiflorum*

Photos courtesy of Donald Cameron © 2016

Photos courtesy of Arthur Haines, New England Wildflower Society ©

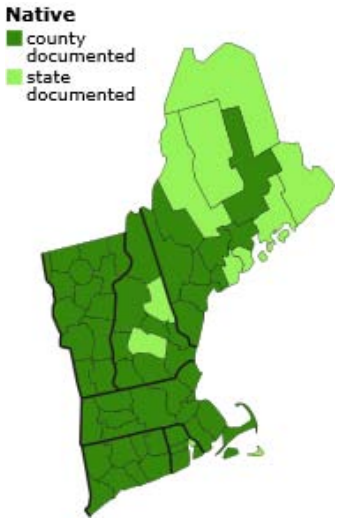
Pollinator and Wildlife Information

Special value to native moths and birds

Larval host plant for flatsedge borer moths (*Diploschizia impigritella*)

Benefits for Wildlife: Provides a food source for moth larvae, waterfowl, and song-birds

Cyperus bipartitus
shining flatsedge



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

FACW

Annual sedge

Habitat: Shores of rivers or lakes, wetland margins

Fertility requirement: Medium

Active Growth Period: Spring, Summer, Fall

Bloom Time: Mid-summer

Height: Up to 5'

Root depth (minimum): 14"

Growth form: Bunch

Growth rate: Rapid

Shade tolerance: Intolerant

Soil Moisture: Wet-Mesic, Mesic (Medium)

Drought tolerance: Low

Salinity tolerance: None

Soil pH: 4.5-6.5

Lifespan: Short

Seeding rate: approx. 3,023,950/lb

Notes:

Lookalikes: *C. diandrus*

Photos courtesy of Alexey Zinovjev and Irina Kadis, Salicicola.com.

Pollinator and Wildlife Information

Special value to native moths and birds

Larval host plant for flatsedge borer moths (*Diploschizia impigritella*)

Benefits for Wildlife: Provides a food source for moth larvae, waterfowl, and songbirds

Danthonia compressa
flattened oatgrass

New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

FACW

Perennial cool-season grass

grass

Habitat: Man-made or disturbed habitats, meadows/fields, forest edges

Fertility requirement: Low

Active Growth Period: Spring

Bloom Time: Late spring

Height: Up to 2 ½'

Root depth (minimum): 10"

Growth form: Bunch

Growth rate: Moderate

Shade tolerance: Tolerant

Soil Moisture: Mesic (Medium), Dry-Mesic

Drought tolerance: Medium

Salinity tolerance: None

Soil pH: 4.8-7.0

Lifespan: Moderate

Seeding rate: approx. 450,000/lb

Photos courtesy of Alexey Zinovjev and Irina Kadis, Salicicola.com.

Notes:

Lookalikes: *D. spicata*

Pollinator and Wildlife Information

Special value to native birds

Danthonia spicata

poverty oatgrass

New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

FACW

Perennial cool-season grass

Habitat: Man-made or disturbed habitats, fields/meadows, ledges, rocky slopes, summits, woodlands

Fertility requirement: Low

Active Growth Period: Spring

Bloom Time: May to July

Height: 6”

Root depth (minimum): 6”

Growth form: Bunch

Growth rate: Rapid

Shade tolerance: Intolerant

Soil Moisture: Dry-Mesic , Dry

Drought tolerance: High

Salinity tolerance: None

Soil pH: 4.5-4.7

Lifespan: Short

Seeding rate: approx.. 25,000 seeds/oz.

Notes:

- Leaves turn curly at the end of the growing season
- Roots fibrous, no rhizomes/stolons
- 71% sulfuric acid treatment aids seed germination; prechilling to 37°F before room temp germination with KNO3 treatment also effective

Photos courtesy of Alexey Zinovjev and Irina Kadis, Salicicola.com.

Pollinator and Wildlife Information

Special value to native butterflies

Larval host to Indian skippers (*Hesperia sassacus*) and Chryxus arctics (*Oeneis chryxus*)

Benefits for Wildlife: Food source for butterfly larvae

Deschampsia flexuosa

wavy hair grass

New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

FACU

Perennial cool-season grass

Habitat: Alpine/subalpine, cliffs, ledges, forests, grasslands, summits, woodlands

Fertility requirement: Low

Active Growth Period: Spring, summer

Bloom Time: Late spring

Height: 12”

Root depth (minimum): 8”

Growth form: Bunch

Growth rate: Moderate

Shade tolerance: Tolerant

Soil Moisture: Mesic (medium), Dry-Mesic

Drought tolerance: Medium

Salinity tolerance: None

Soil pH: 4.8-6.8

Lifespan: Short

Seeding rate: 668,000 seeds/lb.

Notes:

- Inflorescences starting as silvery to purple florets and maturing to apricot

Photos courtesy of Alexey Zinovjev and Irina Kadis, Salicicola.com.

Pollinator and Wildlife Information

Special value to native flies

Benefits for Wildlife: Food source for aphids and leaf-miner flies

Dichanthelium acuminatum
hairy rosette-panicgrass

New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

FACW

Perennial warm-season grass

Habitat: Man-made or disturbed habitats, cliffs, balds, or ledges, grassland, meadows and fields, mountain summits and plateaus, ridges or ledges, shores of rivers or lakes, talus and rocky slopes, woodlands

Fertility requirement: Low

Active Growth Period: Spring, summer

Bloom Time: summer

Height: 1'-2'

Growth form: Bunch

Soil Moisture: Mesic (medium), Dry-Mesic, Dry

Notes:

Synonym *Panicum lanuginosum*

Photos courtesy of Arthur Haines, New England Wildflower Society.

Pollinator and Wildlife Information

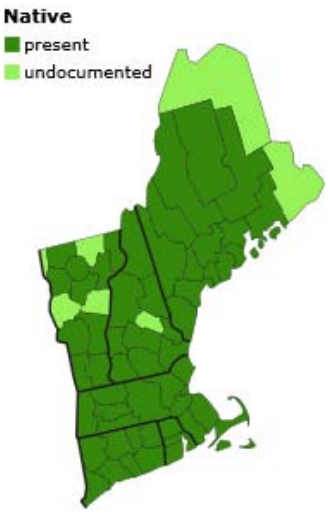
Special value to native butterflies and moths

Larval host to Tawny edged skippers (*Polites themistocles)*

Benefits for Wildlife: Food source for butterflies, moths, and birds

Dichanthelium clandestinum

Deertongue rosette-panicgrass



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

FACW

Perennial warm-season grass

Habitat: Man-made or disturbed habitats, fields/ meadows, forest edges, shores of rivers/lakes, road-sides

Fertility requirement: Low

Active Growth Period: Spring, summer

Bloom Time: summer

Height: 1'-3'

Root depth (minimum): 16"

Growth form: Bunch

Growth rate: Slow

Shade tolerance: Intolerant

Soil Moisture: Mesic (medium), Dry-Mesic, Dry

Drought tolerance: High

Salinity tolerance: Low

Soil pH: 4.0-7.5

Lifespan: Long

Seeding rate: 400,000 seeds/lb.

Notes:

Synonym ***Panicum clandestinum***

Photos courtesy of Mark B. Fiely, Ernst Conservation Seeds.

Pollinator and Wildlife Information

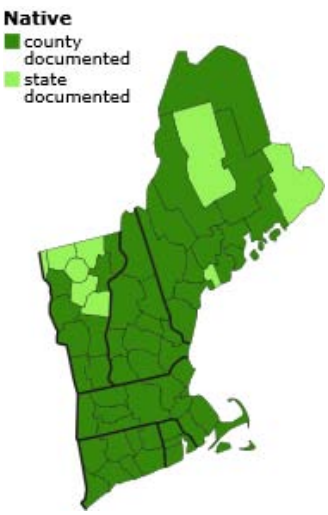
Special value to native butterflies and moths

Larval host to Tawny edged skippers (*Polites themistocles)*

Benefits for Wildlife: Food source for butterflies, moths, and birds

Dichanthelium linearifolium

linear-leaved rosette-panicgrass



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

Not classified

Perennial warm-season grass

Habitat: Cliffs, balds, or ledges, grassland, meadows and fields, talus and rocky slopes, woodlands

Fertility requirement: Low

Active Growth Period: Spring, summer

Bloom Time: summer

Height: 1'-3'

Growth form: Bunch

Soil Moisture: Mesic (medium), Dry-Mesic, Dry

Notes:

Synonym ***Panicum linearifolium***

Photos courtesy of Alexey Zinovjev and Irina Kadis, Salicicola.com.

Pollinator and Wildlife Information

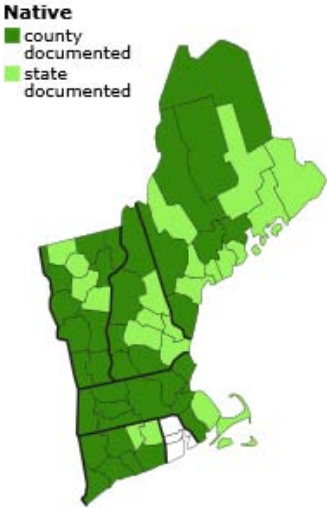
Special value to native butterflies and moths

Larval host plant to skipper butterflies and moths

Benefits for Wildlife: Provides a food source for butterfly larvae, moth larvae, leafhoppers, and birds

Elymus canadensis

Great Plains wild-rye



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

FACU

Perennial cool-season grass

Habitat: Cliffs, ledges, fields, floodplain, forests, shores of rivers/lakes, rocky slopes

Fertility requirement: Medium

Active Growth Period: Spring, summer, fall

Bloom Time: June to August

Height: 3'-6'

Root depth (minimum): 16"

Growth form: Bunch

Growth rate: Rapid

Shade tolerance: Tolerant

Soil Moisture: Wet-Mesic, Mesic (medium), Dry-Mesic

Drought tolerance: Medium

Salinity tolerance: Medium

Soil pH: 5.0-7.9

Lifespan: Short

Seeding rate: 10 PLS lb per acre alone; 1%-25% of a mix; approx.. 114,000 seeds per lb.

Notes:

High seedling vigor/rapid establishment make species valuable for erosion control.

Susceptible to leaf/stem rust and ergot

Lookalike: Can be confused with cover crops, weedy pasture grasses but *Elymus canadensis* seedlings are more erect with leaves held higher on stems; other native grass seedlings have narrower leaves than *Elymus canadensis*

Photo courtesy of Arthur Haines, New England Wildflower Society ©

Photo courtesy of Larry Allain ©

Pollinator and Wildlife Information

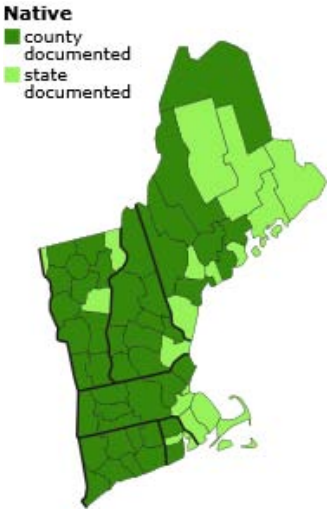
Special value to native butterflies

Larval host to zabulon skippers (*Poanes zabulon*)

Benefits for Wildlife: Food source for birds and small mammals, provides nesting material and shelter

Elymus riparius

eastern riverbank wild-rye



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

FACW

Perennial cool-season grass

Habitat: Forests, shores of rivers or lakes

Fertility requirement: Medium

Active Growth Period: Spring and Summer

Bloom Time: Mid Summer

Height: 3'-5'

Root depth (minimum): 10"

Growth form: Bunch

Growth rate: Moderate

Shade tolerance: Tolerant

Soil Moisture: Wet-Mesic, Mesic (Medium)

Drought tolerance: Low

Salinity tolerance: None

Soil pH: 4.5-7.2

Lifespan: Moderate

Seeding rate: 10 PLS lb per acre alone/1%-25% of a mix; approx. 125,000/lb

Notes:

Good for soil stabilization

Can occasionally form hybrids with other wild-rye species.

Photos courtesy of Arthur Haines, New England Wildflower Society ©

Pollinator and Wildlife Information

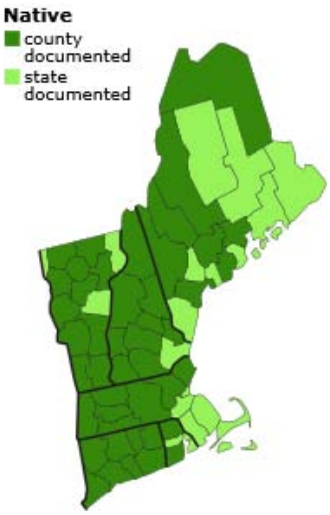
Special value to native moths

Larval host to several moth species

Benefits for Wildlife: Food source for moths, beetles, flies, and waterfowl

Elymus virginicus

common eastern wild-rye



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

FACW

Perennial cool-season grass

Habitat: Cliffs, ledges, coastal beaches, forests, marshes, shores of rivers or lakes, wetland margins

Fertility requirement: Medium

Active Growth Period: Spring

Bloom Time: Early spring

Height: 3'-6'

Root depth (minimum): 12"

Growth form: Bunch

Growth rate: Moderate

Shade tolerance: Tolerant

Soil Moisture: Wet,Wet-Mesic, Mesic (Medium)

Drought tolerance: Medium

Salinity tolerance: None

Soil pH: 5.0 – 7.4

Lifespan: Short

Seeding rate: 10 PLS lb per acre alone/1%-25% of a mix; approx. 73,000 seeds/lb.

Notes:

Often used for soil stabilization and revegetation of wetlands

Lookalikes:. *E. macgregorii*

Photos courtesy of Alexey Zinovjev and Irina Kadis, Salicicola.com.

Pollinator and Wildlife Information

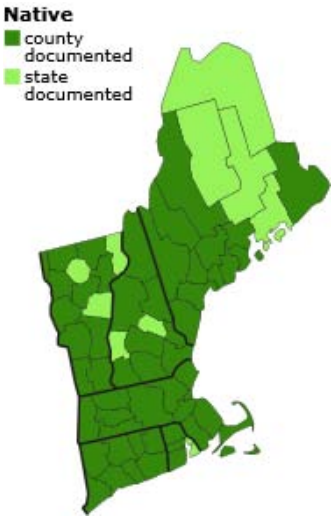
Special value to native moths

Larval host to several moth species

Benefits for Wildlife: Food source for moths, beetles, flies, and waterfowl

Eragrostis pectinacea

tufted love grass



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

FAC

Annual grass

Habitat: Man-made or disturbed habitats, meadows/fields, shores of rivers or lakes

Fertility requirement:

Active Growth Period: Summer

Bloom Time: Mid-summer to Early Fall

Height: Up to 2'

Root depth (minimum):

Shade tolerance: Intolerant

Soil Moisture: Dry-Mesic , Dry

Drought tolerance: High

Photos courtesy of Alexey Zinovjev and Irina Kadis, Salicicola.com.

Notes:

Prefers dry, sandy, gravelly or clayey soils

Lookalikes: *E. pilosa* with branches of inflorescence whorled at 2 lowest nodes (*E. pectinacea* with branches of inflorescence alternate or opposite at 2 lowest nodes).

Pollinator and Wildlife Information

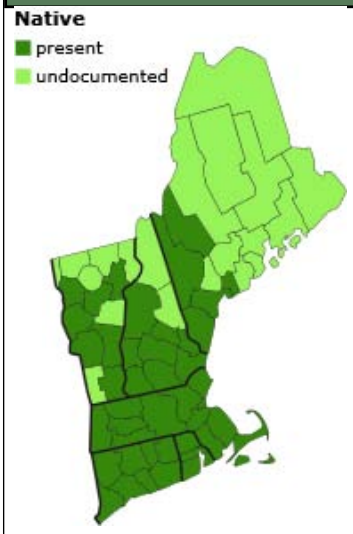
Special value to native butterflies

Larval host to hobomok skippers (*Poanes hobomok*) and zabulon skippers (*Poanes zabulon*)

Benefits for Wildlife: Food source for skippers, leafhoppers, aphids, gall wasps, beetles, and flies

Eragrostis spectabilis

purple lovegrass



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

UPL

Perennial warm-season grass

Habitat: Man-made or disturbed habitats, fields/ meadows, coastal beaches, roadsides, open woods

Fertility requirement: Low

Active Growth Period: Spring

Bloom Time: August to October

Height: 1'-3'

Root depth (minimum): 4"

Growth form: Bunch

Growth rate: Moderate

Shade tolerance: Intolerant

Soil Moisture: Mesic (medium), Dry-Mesic

Drought tolerance: High

Salinity tolerance: Intolerant

Soil pH: 4.0-7.5

Lifespan: Moderate

Seeding rate: 1%-5% of a mix, 1,000,000 seeds/lb.

Notes:

- Can produce slender rhizomes, deeper-rooted alternative to other grasses for erosion control
- Inflorescences are attractive even from a speeding car; plant can be used as ornamental

Photos courtesy of Alexey Zinovjev and Irina Kadis, Salicicola.com.

Pollinator and Wildlife Information

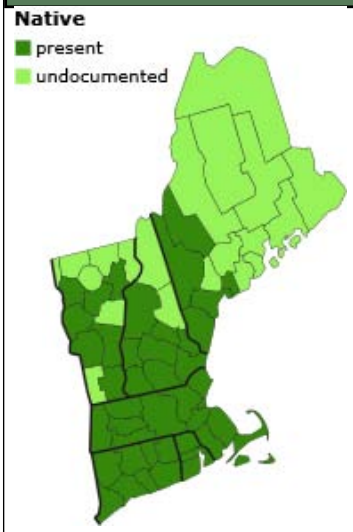
Special value to native butterflies

Larval host to zabulon skippers (*Poanes zabulon*)

Benefits for Wildlife: Food source for butterfly larvae, provides nesting material and shelter for birds

Juncus effusus

common soft rush



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

OBL

Perennial rush

Habitat: Man-made or disturbed habitats, marshes, meadows/fields, shores of rivers or lakes, wetland margins

Fertility requirement: Medium

Active Growth Period: Spring

Bloom Time: July to September

Height: Up to 4'

Root depth (minimum): 24"

Growth form: Bunch

Growth rate: Moderate

Shade tolerance: Intolerant

Soil Moisture: Wet, Wet-Mesic, Mesic (Medium)

Drought tolerance: Medium

Salinity tolerance: Low

Soil pH: 5.5-8.8

Lifespan: Long

Seeding rate: 1%-5% of a mix; approx. 45,359,240/lb

Notes:
Fibrous root systems provide good shoreline protection and nutrient uptake; can often survive polluted conditions.
Moist stratification improves seed germination
Lookalikes: *J. pylaei*

Photos courtesy of Alexey Zinovjev and Irina Kadis, Salicicola.com.

Pollinator and Wildlife Information

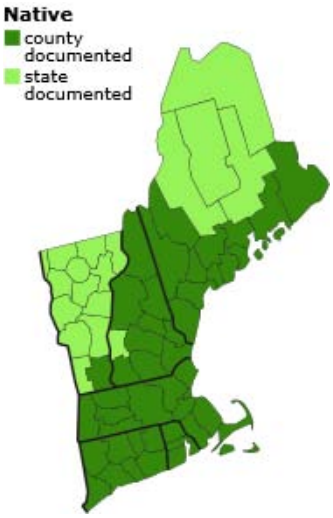
Special value to native butterflies

Larval host to Indian skippers (*Hesperia sassacus*)

Benefits for Wildlife: Food source for butterfly larvae, shelter for birds and small mammals

Juncus greenei

Greene'srush



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

FAC

Perennial rush

Photos courtesy of Alexey Zinovjev and Irina Kadis, Salicicola.com.

Habitat: Man-made or disturbed habitats, cliffs, balds, or ledges, grassland, meadows and fields, ridges or ledges

Fertility requirement: Medium

Active Growth Period: Spring

Bloom Time: July to September

Height: 2'

Growth form: Bunch

Growth rate: Moderate

Soil Moisture: Wet, Wet-Mesic, Mesic (Medium)

Pollinator and Wildlife Information

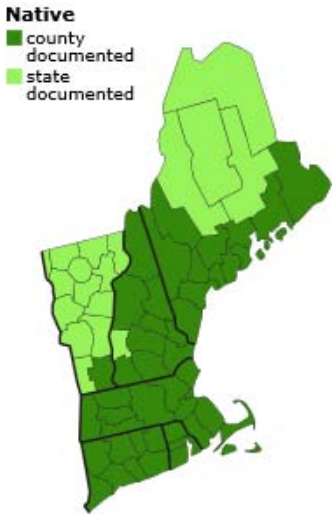
Special value to native moths and birds

Larval host to subflava sedge borer moths (*Archanara subflava*)

Benefits for Wildlife: Food source for moth larvae, waterfowl, leafhoppers, and beetles. Provides nests and cover for wildlife

Juncus tenuis

Poverty rush



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

FACU

Perennial rush

Habitat: Man-made or disturbed habitats, meadows/fields, shores of rivers or lakes

Fertility requirement: Low

Active Growth Period: Spring and Summer

Bloom Time: May to June

Height: 4”-24”

Root depth (minimum): 6”

Growth form: Bunch

Growth rate: Slow

Shade tolerance: Intermediate

Soil Moisture: Wet, Wet-Mesic, Mesic (Medium)

Drought tolerance: High

Salinity tolerance: Low

Soil pH: 4.5-7.0

Lifespan: Moderate

Seeding rate: 1%-3% of a mix; approx. 29,000,000/lb

Notes:

Tolerates foot traffic

Good for streambank/drainage stabilization and as a water plant in a rain garden

Can spread rapidly

Lookalikes: *J. dichotomus*

Photos courtesy of Alexey Zinovjev and Irina Kadis, Salicicola.com.

Pollinator and Wildlife Information

Special value to native moths and birds

Larval host to subflava sedge borer moths (*Archanara subflava*)

Benefits for Wildlife: Food source for moth larvae, waterfowl, leafhoppers, and beetles. Provides nests and cover for wildlife

Leersia oryzoides

rice cut grass

New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

OBL

Perennial cool-season grass

Habitat: Lacustrine, meadows/fields, shores of rivers or lakes, swamps, wetland margins

Fertility requirement: Medium

Active Growth Period: Summer

Bloom Time: June to October

Height: Up to 3'

Root depth (minimum): 14"

Growth form: Rhizomatous

Growth rate: Moderate

Shade tolerance: Intolerant

Soil Moisture: Wet-Mesic, Mesic (Medium)

Drought tolerance: Low

Salinity tolerance: None

Soil pH: 5.1-8.8

Lifespan: Moderate

Seeding rate: 1%-20% of a mix; approx. 610,000/lb

Notes:

Roots: Rhizomatous

Spreading habit makes it ideal for sediment stabilization along stream and lakeshores.

Seed requires moist stratification for 180-270 days; gentle scarification also improves germination

Can spread rapidly

SHARP LEAVES CAN CUT FLESH

Photos courtesy of Alexey Zinovjev and Irina Kadis, Salicicola.com.

Pollinator and Wildlife Information

Special value to native butterflies

Larval host to least skippers (*Ancyloxypha numitor*) and Peck's skippers (*Polites peckius*)

Benefits for Wildlife: Food source for butterfly larvae, waterfowl, katydids, and billbugs

Luzula multiflora

common wood rush

New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

FACU

Perennial rush

Habitat: Man-made or disturbed habitats, forest edges, upland woodland habitats, , meadows and fields

Fertility requirement: The preference to soil containing some clay, rocky material, or sand

Active Growth Period: During the cool weather of spring

Bloom Time: Spring

Height: 18-12”

Growth form: Moderately dense to loose tuft of basal leaves

Soil Moisture: Dry-Mesic

Photos courtesy of Alexey Zinovjev and Irina Kadis, Salicicola.com.

Pollinator and Wildlife Information

Special value to native butterflies

Larval host to least skippers (*Ancyloxypha numitor*) and Peck’s skippers (*Polites peckius*)

Benefits for Wildlife: Food source for butterfly larvae, waterfowl, katydids, and billbugs

Muhlenbergia mexicana

Mexican muhly

New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

FACW

Perennial warm-season grass

Habitat: Man-made or disturbed habitats, forests, swamps, wetland margins

Fertility requirement: Medium

Active Growth Period: Spring, Summer, Fall

Bloom Time: Late summer

Height: Up to 3'

Root depth (minimum): 8"

Growth form: Rhizomatous

Growth rate: Moderate

Shade tolerance: Intermediate

Soil Moisture: Wet-Mesic, Mesic (Medium), Dry-Mesic

Drought tolerance: Low

Salinity tolerance: None

Soil pH: 5.5 – 7.5

Lifespan: Short

Seeding rate: approx. 750,000/lb

Notes:

Lookalikes: *M. frondosa* with stem internodes shiny and without hairs (*M. mexicana* with dull, minutely hairy internodes, ligules 0.4-1 mm long)

Photos courtesy of Arthur Haines, New England Wildflower Society ©

Photos courtesy of Steve Matson ©

Pollinator and Wildlife Information

Special value to native moths

Larval host to grass leaf miner moths (*Elachista brachyelytrifoliella*)

Benefits for Wildlife: Food source for leaf-miner moth larvae flies, aphids, gall wasps, katydids.

Panicum virgatum

switch panicgrass

New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

FAC

Perennial warm-season grass

Habitat: Man-made or disturbed habitats, brackish/ salt marshes, meadows/fields, shores of rivers or lakes, wetland margins

Fertility requirement: High

Active Growth Period: Summer

Bloom Time: July to September

Height: 4'-6'

Root depth (minimum): 12"

Growth form: Bunch

Growth rate: Rapid

Shade tolerance: Intolerant

Soil Moisture: Wet-Mesic, Mesic (Medium), Dry-Mesic, Dry

Drought tolerance: Medium

Salinity tolerance: Medium

Soil pH: 4.5-7.5

Lifespan: Long

Seeding rate: 8 PLS lb per acre alone; 10%-20% of a mix; approx. 259,000/lb

Notes:
Valuable for erosion control, particularly on strip-mine spoils, sand dunes, dikes and gullies.
Can spread rapidly

Grasshoppers, leafhoppers & armyworms can be problematic. Damping off, seedling blight, leaf rust and smut may also cause problems.

Photo courtesy of Alexey Zinovjev and Irina Kadis, Salicicola.com.

Photos courtesy of Mark B. Fiely, Ernst Conservation Seeds.

Pollinator and Wildlife Information

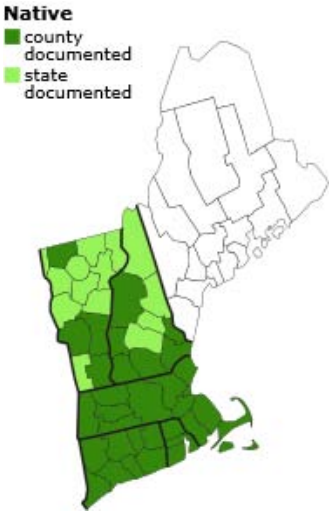
Special value to native moths

Larval host to grass leaf miner moths (*Elachista brachyelytrifoliella*)

Benefits for Wildlife: Food source for leaf-miner moth larvae flies, aphids, gall wasps, katydids.

Paspalum setaceum

sender beadgrass



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

FACU

Perennial warm-season grass

Photo courtesy of Julia Kuzovkina

Habitat: Man-made or disturbed habitats, roadsides, meadows, sandy fields, forest edges

Fertility requirement: Low

Active Growth Period: Spring

Bloom Time: July

Height: 1-3’

Growth form: Bunch with short rhizomes; spreading stems growing from a small base

Growth rate: Rapid

Soil Moisture: Mesic (Medium) Dry-Mesic Dry

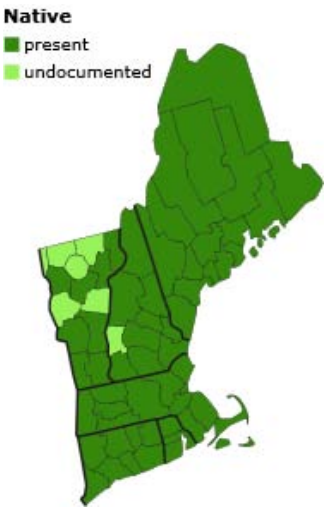
Drought tolerance: High

Pollinator and Wildlife Information

Special value to native birds

Benefits for Wildlife: Food source for birds

Schizachyrium scoparium
little bluestem



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

FACU

Perennial warm-season grass

Photos courtesy of Alexey Zinovjev and Irina Kadis, Salicicola.com.

Habitat: Man-made or disturbed habitats, cliffs, balds, ledges, grassland, meadows, fields, ridges, edges, wetland margins, woodlands

Fertility requirement: Low

Active Growth Period: Summer and Fall

Bloom Time: Summer

Height: Up to 3'

Root depth (minimum): 14", up to 8'

Growth form: Bunch

Growth rate: Moderate

Shade tolerance: Intolerant

Soil Moisture: Mesic (Medium) Dry-Mesic Dry

Drought tolerance: High

Salinity tolerance: None

Soil pH: 5.0 – 8.4

Lifespan: Long

Seeding rate: 8 PLS lb per acre alone; 10%-67% of a mix; approx. 200,000 seeds per lb

Notes: Good native grass for upland meadows where sight lines are important

- Blue-green leaves in summer; after first frost, turns coppery pink
- Purplish seed heads have grayish-green foliage
- Excellent erosion control (deep rhizomatous roots)

Lookalikes: Barnyard grass or foxtail but these will grow to several feet in six weeks, compared to little bluestem's several inches

Pollinator and Wildlife Information

Special value to native bees, butterflies, and birds

Larval host to dusted skippers (*Atrytonopsis hianna*), Indian skippers (*Hesperia sassacus*), crossline skippers (*Polites origenes*), and ottoe skippers (*Hesperia ottoe*)

Benefits for Wildlife: Food source for butterfly larvae and birds, shelter for birds, small mammals, and insects

Scirpus atrocinctus
back-girdled woolsedge

New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

OBL

Perennial sedge

Photos courtesy of Alexey Zinovjev and Irina Kadis, Salicicola.com.

Habitat: Marshes, meadows, fields, shores of rivers, edges of wetlands, streams and ponds

Fertility requirement: Medium

Active Growth Period: Spring

Growth form: Bunch

Growth rate: Moderate

Shade tolerance: Intermediate

Soil Moisture: Wet, Wet-Mesic

Pollinator and Wildlife Information

Special value to native butterflies and moths

Larval host to dion skippers (*Euphyes dion*) and several owlet moth species

Benefits for Wildlife: Food source for butterfly and moth larvae, beetles, aphids, leafhoppers, songbirds and waterfowl

Scirpus cyperinus
common woolsedge

New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

OBL

Perennial sedge

Habitat: Marshes, meadows, fields, shores of rivers, edges of wetlands

Fertility requirement: Medium

Active Growth Period: Spring

Bloom Time: August to September

Height: Up to 5'

Root depth (minimum): 12"

Growth form: Bunch

Growth rate: Moderate

Shade tolerance: Intermediate

Soil Moisture: Wet, Wet-Mesic

Drought tolerance: Low

Salinity tolerance: None

Soil pH: 4.8-7.2

Lifespan: Long

Seeding rate: 1%-3% of a mix; approx. 36,000,000/lb.

Notes:
After planting, water level over seeds should be maintained at one foot for 2 weeks with periodic flooding up to 3 feet until seeds are established

Photos courtesy of Alexey Zinovjev and Irina Kadis, Salicicola.com.

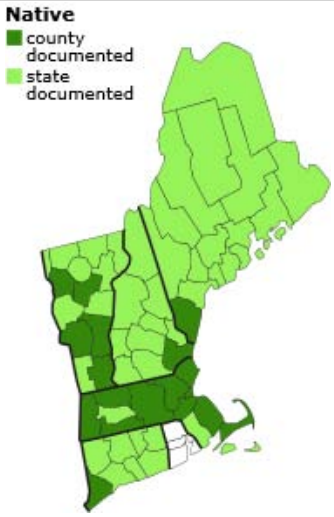
Pollinator and Wildlife Information

Special value to native butterflies and moths

Larval host to dion skippers (*Euphyes dion*) and several owlet moth species

Benefits for Wildlife: Food source for butterfly and moth larvae, beetles, aphids, leafhoppers, songbirds and waterfowl

Sporobolus cryptandrus
sand dropseed



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

FACU

Perennial warm-season grass

Habitat: Man-made or disturbed habitats, cliffs, ledges, grasslands, meadows/fields, woodlands

Fertility requirement: Low

Active Growth Period: Spring

Bloom Time: June to October

Height: Up to 5'

Root depth (minimum): 18"

Growth form: Bunch

Growth rate: Moderate

Shade tolerance: Intolerant

Soil Moisture: Dry-Mesic , Dry

Drought tolerance: High

Salinity tolerance: Medium

Soil pH: 6.6-8.0

Lifespan: Short

Seeding rate: 2%-10% of a mix; approx. 5,600,000/lb

Notes:

Prefers dry, sandy soils

Lookalikes: *S. contractus* and *S. heterolepis*.

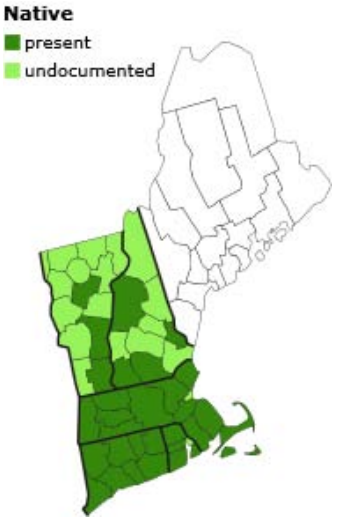
Photos courtesy of Arthur Haines, New England Wildflower Society ©

Pollinator and Wildlife Information

Special value to native bees and birds

Benefits for Wildlife: Food source for songbirds and provides nesting materials for bees

Tridens flavus
Purpletop tridens



New England Distribution MAP

Adapted from BONAP data

Wetland indicator code

UPL

Perennial warm-season grass

Photos courtesy of Mark B. Fiely, Ernst Conservation Seeds.

Habitat: Man-made or disturbed habitats, fields/ meadows, woodlands, roadsides

Fertility requirement: Low

Active Growth Period: Summer

Bloom Time: August to September

Height: 2'-5'

Root depth (minimum): 10"

Growth form: Bunch

Growth rate: Moderate

Shade tolerance: Intolerant

Soil Moisture: Mesic (Medium) Dry-Mesic

Drought tolerance: High

Salinity tolerance: None

Soil pH: 4.5- 6.5

Lifespan: Short

Seeding rate: 10 PLS lb per acre alone; 1%-30% of a mix; approx.. 465,000 seeds/lb.

Notes:

- Can be used for soil stabilization
- Dense stands attractive in flower from cars

Pollinator and Wildlife Information

Special value to native butterflies and birds

Larval host to common wood nymphs (*Cercyonis pegala*), crossline skippers (*Polites origenes*), little glassywings (*Pompeius verna),* and broad-winged skippers (*Poanes viator*)

Benefits for Wildlife: Food source for butterfly larvae, shelter for birds, small mammals, and insects.

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Chapter 6: Conclusions and Initial Actions

The transition toward establishment of native plant communities along New England roadsides will change decades-old policies. Expecting changes to happen overnight would be unrealistic. An achievable, gradual, yet firm implementation of the transition over several years will insure a successful change in practices.

Any preliminary actions require selecting obtainable goals, such as:

1. Augmenting existing roadside native plant communities
2. Establishing demonstration plots of new native plantings following new construction
3. Creating Native Species Roadside Management positions
4. Developing and seeking new funding opportunities
5. Educating DOT personnel concerning the benefits of the policy change
6. Educating the public about the economic and ecological benefits of using native plants along roadsides
7. Developing local seed sources

The writers of this manual believe adoption of these actions, which are summarized below, will provide the most immediate and effective path toward initiating the transition from current vegetation practices to those prescribed in this manual.

1. **Augmenting existing roadside native plant communities**

   Large numbers of native plant communities currently populate New England roadsides (Brown & Sawyer, 2012). Techniques such as decreased mowing and targeted use of herbicides are used to increase these pre-existing populations of native plants. This management approach is more effective than re-establishment of native communities from scratch. It requires less labor and lower costs, and has demonstrated a higher probability of success. It is also ecologically more sensible because it promotes the integrity of locally-adapted populations by limiting the introduction of seed from remote provenances.

It is suggested that DOTs implement pilot projects to develop and test the effectiveness of augmentation. Such a process requires identifying and inventorying existing roadside native plant communities. If DOT personnel have not yet familiarized themselves with native species that commonly populate New England roadsides, it is recommended to partner with local botanists to assist with plant identification. Effective inventorying may require the cessation of mowing for a year to determine which species exist and the quality and density of the remnant populations. Waiting until fall makes identification of existing species, especially grasses, easier since most plants will have flowered, thus providing morphological characteristics other than leaf blades that are more readily distinguishable.

By eliminating nonnative vegetation with applications of specific herbicides, conditions improve for native seed in the seedbank to germinate and for small propagules of native species to proliferate in the soil. Furthermore, altering mowing schedules can also augment native species along roadsides. Adjusting mowing timings can enhance warm-season grasses and inhibit cool-season grasses. For the New England region, such timing requires decreasing mowing between the end of May to mid-October. It is especially important not to mow from July to mid-October since grasses start flowering during this period.

It may require several trials to develop the judgement required to determine what density of existing native populations respond best to each augmentation technique. Killing nonnative vegetation using recommended herbicides will help eliminate competition for existing native populations. However, if the density of the nonnative plant populations far exceeds that of the native population at a particular site and the soil lacks sufficient stability, elimination of the nonnative population could put the structural integrity of the site at risk. In such a case, decreasing the amount of mowing would allow the native warm-season grass populations to increase enough over a season or two to allow their root systems to stabilize the existing soil. It is possible to then augment these native populations using herbicides.

2. Establishing demonstration plots of new native plantings following new construction

A learning curve exists for establishing new native plant communities following new construction. By starting with small projects and forming partnerships with restoration experts in state agencies or local conservation organizations, DOTs with limited restoration experience can develop internal expertise, generate practical information, and save money by confining failures to smaller projects. Once a DOT has developed greater confidence in their new establishment techniques, it can expand the size of their projects.

The two techniques that appear most consistently to deliver effective establishment of native plant communities following new construction involve the use of:

a. No-till seed drills, such as those manufactured by the Truax Company, for larger areas
b. Sawdust for narrow and small zones

Developing techniques for establishment of native plantings along slopes may require a greater number of trials. The two recommended techniques for slopes include:

a. Erosion control netting
b. Hydroseeding using the two-step process

It is important when establishing new communities on slopes that the seed mix includes fast-establishing native cool-season grasses, such as rough bentgrass (*Agrostis scabra*) and upland bentgrass (*Agrostis perennans*).

3. Creating native species roadside management positions

Iowa was one of the first states to transition to using native plants along roadsides. One of the steps Iowa took to transition to these new protocols was creation of a position to lead these new efforts. Specifically, Iowa counties

created a full-time native species Roadside Manager position familiar with these new protocols and able to guide roadside managers and their departments during the transitional process. Some of the responsibilities Iowa expects of their Roadside Managers are:

- Establish and maintain healthy stands of native vegetation
- Perform weed and brush control activities in a timely, effective manner
- Install and maintain erosion control measures
- Save money by conducting more in-house operations
- Stay current with the latest products and technologies (Brandt et. al, 2015)

4. Developing and seeking new funding opportunities

While transitioning roadside vegetation to native plants will save money in the long-term, it will require money upfront for DOTs to learn these new establishment and maintenance techniques. Other states that have made the transition have developed both state and public-private partnership funding streams to support this transition. Some of their efforts include:

a. **License plates**. Both North Carolina and Iowa have specialty plates that support transitioning roadsides. In 2013, for example, North Carolina's program collected $1.5 million for their work.

b. **Adaptation of the Adopt-a-Highway program**. Missouri's *Grow Native!* program has adapted the Adopt-a-Highway program to allow private organizations to adopt and fund a section of roadside right of way to establish native wildflowers and grasses.

c. **Accessing funds from the federal FAST Act**. On December 4, 2015, President Obama signed the Fixing America's Surface Transportation (FAST) Act (Pub. L. No. 114-94) into law, which authorizes $305 billion over fiscal years 2016 through 2020 for highway infrastructure construction. Two sections allow states to access funding to convert their roadside to pollinator habitats:

    - § 319. Landscaping and scenic enhancement

- § 329. Eligibility for control of noxious weeds and aquatic noxious weeds and establishment of native species

However, accessing this funding requires advocates to actively seek the funding. Contact your state's federal Senator or Representatives to access these funds.

5. Educating DOT personnel concerning the benefits of the policy change

Transitioning to the use of native plants along roadsides involves significant change that will disrupt long standing practices. Educating DOT personnel about the reasons for and benefits of making this transition will help ease the change. Such a program should include discussion of:

a. The ecological, environmental, and economic benefits of using native plants
b. The changes involved in establishing and maintaining stands of native plants, including a decrease in mowing
c. The change in responsibilities for those in maintenance, such as using labor hours freed from mowing to manage invasive plants

Not only will educating personnel clarify the reasons for making such an impactful change, but it will also help build buy-in from DOT workers.

6. Educating the public about the economic and ecological benefits of using native plants along roadsides

Transitioning from the use of introduced cool-season turfgrass to native plants involves not just a change in ecological approach for roadsides but also a major change in roadside aesthetics. The public has grown accustomed to the look of mowed turf along roadsides. However, research has shown that the public supports naturalistic scenery along roadsides (Barton et al., 2005; Kaplan & Kaplan, 1989). Nevertheless, making this transition will require educating the

public about the benefits of making this change in landscape management. Since the first few years of establishing roadside meadows can look unkempt, winning the support of taxpayers can be accomplished with an educational campaign using signage, media, tourism campaigns, and print and electronic materials that inform the public that these changes will help the environment, ecology, and pollinators, and save tax dollars over the long term.

DOTs should communicate the economic and ecological benefits of using native plants to the public, especially to adjacent landowners. Transitioning from the use of introduced cool-season turfgrass to native plants involves a change in roadside aesthetics. Efforts might include signage highlighting showy plantings, written print and electronic materials, adopt a highway and license plate programs, as well as tourism campaigns.

7. Developing local seed sources

The use of locally sourced plant material, which improves establishment and persistence of plantings, assures sound conservation practices, and has higher ecological value, should be prioritized.

Achieving functional and conservation priorities along New England roadsides can only be realized through utilization of genetically appropriate plants as the source plant material. It is recommended to use locally sourced plant materials whenever possible, because they have adapted to local conditions and are more likely to establish and flourish over time and protect the genetics of local plant populations. Nonlocal genotypes could establish to such an extent that they become problematic, and the interaction between introduced plants from remote provenances and local native populations results in species interbreeding, which may disrupt locally adapted gene complexes of native species.

However, the short supply of locally sourced native seed represents a serious challenge in New England. Local seed is not available in the quantities required

for a revegetation project in the region. An important recommendation is that foundation plots for native seed be established and native plants be made available to state commercial seed growers. This can be achieved by identifying potential regional seed producers and building collaborative efforts with various organizations, namely: NRCS, EPA, DOT, land grant universities, as well as Agricultural Experiment Stations under the supervision of botanists from the New England Wildflower Society or similar experts. Such an effort would lead to the expansion of the industry and availability of native seed sources for future restoration projects.

In the meantime, the possibility of contracting for "local" seed to be collected on a project basis should be considered, to ensure that current roadside plantings are conducted under the strict terms recommended by plant conservation organizations. This approach would require planning ahead to develop plant specifications for seed mixes, but would require less lead time than trying to organize the establishment of foundation plots so that commercial growers can produce sufficient quantities.

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