



North Carolina Department of Transportation

Report on List of Native Grasses, Plants, & Seeds Appropriate for the Use in Place of Nonnative Turf Grasses and Nonnative Grasses, Plants, and Seeds Used for the Purpose of Soil and Slope Stabilization for Erosion Control

April 21, 2026

This Report is prepared pursuant to Session Law 2025-47 (Senate Bill 391), Section 20(b)(i);

The Department of Transportation and the Department of Natural and Cultural Resources, in consultation with North Carolina State University and North Carolina Agricultural and Technical State University, shall study and develop (i) a list of native grasses, plants, and seeds appropriate for use in place of nonnative turf grasses and nonnative grasses, plants, and seeds used for the purpose of soil and slope stabilization for erosion control;

Executive Summary

Pursuant to Session Law 2025-47, the North Carolina Department of Transportation (NCDOT), in consultation with North Carolina State University (NCSU) and other partners, conducted a comprehensive review of the existing native grasses, plants and seeds appropriate for use to replace non-native grasses, plants, and seeds for the purposes of roadside soil and slope stabilization for erosion control.

The findings of the NCSU report, *The Use and Feasibility of Native Grass Species for Soil and Slope Stabilization and Erosion Control on NC Roadsides* and prior attempts by the NCDOT, demonstrate that while native species provide ecological benefits, they are not suitable for primary use in roadside slope stabilization or erosion control under current operational, environmental, and economic conditions. Based on their findings, a list of appropriate native grasses, plants, and seeds for the replacement of non-native species for soil and slope stabilization, as requested by Session Law 2025-47, cannot be produced.

Native grasses may still play a role in specific contexts. The NCDOT currently uses native grass and plant species for riparian areas, habitat restoration, and enhancement areas to promote biodiversity and ecosystem enhancement.

The North Carolina Department of Transportation (NCDOT), in coordination with North Carolina State University (NCSU) and other partners, conducted a comprehensive evaluation of the feasibility of using native grasses and plants for roadside erosion control and slope stabilization, as required by Session Law 2025-47 (Senate Bill 391). The resulting findings, fully detailed in attachment 1, the NCSU report *The Use and Feasibility of Native Grass Species for Soil and Slope Stabilization and Erosion Control on NC Roadsides*, and summarized below, indicate that while native species offer ecological benefits, they are not suitable as a primary replacement for use in roadside applications for erosion control and slope stabilization under current operational, environmental, and economic conditions. Additionally, due to significant variability and inconsistency in both performance and availability, NCDOT determined that it is not feasible to produce a reliable, standardized list

of native grasses and seeds appropriate for widespread roadside use, as mandated by the statute. A summary of the findings supporting this position follows.

One of the most significant limitations identified is the slow establishment rate of native grasses. These species often exhibit little to no visible growth for one to two years after planting, with full establishment taking up to four growing seasons. This delayed development conflicts directly with the urgent need for rapid ground coverage in roadside environments to prevent erosion, protect infrastructure, prevent sedimentation damage, and protect water quality. Research cited in the report demonstrates that native grasses frequently fail to meet the minimum 80% ground cover required for effective erosion control per the North Carolina Sediment Commission's Erosion and Sediment Control Delegated Program and the North Carolina General Permit NCG010000 To Discharge Stormwater Under the National Discharge Pollutant Elimination System, sometimes achieving only 40–50% coverage even after several years. In contrast, traditional non-native turf systems can establish adequate coverage within a single growing season, making them far more effective to meet the NCDOT's needs for environmental permit compliance and stewardship.

In addition to slow establishment, native grasses are particularly ill-suited for the steep and erosion-prone slopes commonly found along roadways. Effective stabilization in these environments requires rapid root development, immediate soil binding, and consistent coverage; criteria that native species generally fail to meet without significant intervention. The study concludes that native grasses are not suitable for slope establishment unless supplemented with non-native companion species or structural modifications such as lateral breaks, which undermines the intent of prioritizing native-only plantings.

Seed quality and germination challenges further complicate the use of native grasses. These seeds exhibit low purity and germination rates, often as low as 50%, resulting in a significantly reduced percentage of viable seed. High dormancy rates, sometimes as high as 70%, can delay germination. Successful growth is highly dependent on precise environmental conditions, including temperature and moisture timing, as well as specialized pre-treatment processes. This unpredictability introduces a level of risk that is incompatible with large-scale transportation operations.

From a cost and operational standpoint, native grasses also present notable disadvantages. Seed costs can be higher than those of traditional turfgrasses, and due to lower viability, higher seeding rates may be required than currently prescribed. Establishment often necessitates multiple herbicide applications, precise timing, and intensive site preparation, all of which increase both cost and complexity. Even under ideal conditions, native systems are more expensive per acre and carry a higher risk of failure

compared to conventional alternatives. Some of these costs may be balanced by the necessary reduction in mowing performed from NCDOT operational standards.

Maintenance and safety considerations also pose significant challenges. Mowing tolerance for native grass management may limit mowing to only once per year with many native grasses growing to heights of three to nine feet. This restricted mowing may create conditions which can obstruct driver visibility at intersections and along curves, creating potential safety hazards. Increased vegetation height can also elevate the risk of vehicle-animal collisions by providing more wildlife habitat near roadways. Additionally, taller vegetation may increase fire risk and limit access for roadside maintenance. Common management practices such as prescribed burning or disking are impractical or unsafe in highway environments, further limiting feasibility.

Native grasses are also highly vulnerable to competition from invasive and fast-growing species. Their slow establishment makes them particularly susceptible to being outcompeted by other aggressive invasive species, requiring substantial herbicide intervention during early growth stages.

Supply chain limitations present an additional barrier. The availability of native seeds is often inconsistent and unpredictable, with demand frequently exceeding supply. NCDOT usage for all construction and maintenance activities generally requires in excess of 750,000 pounds of grass seed to revegetate approximately 10,000 acres of disturbed ground or eroding areas. Some species are not commercially available at all, while others are only available in limited quantities or as vegetative stock, which is not scalable for large transportation projects. This makes it difficult for NCDOT to ensure timely procurement, maintain cost control, or achieve consistency across projects.

Despite these limitations, the report acknowledges that native grasses may still play a valuable role in specific, limited contexts. These include flat, low-risk roadside areas outside of the clear recovery zone, non-critical zones not prone to erosion, and locations designated for wildlife corridors or aesthetic purposes. The NCDOT currently performs revegetation with native grass and plant species in riparian areas, habitat restoration sites, mitigation sites, and other enhancement projects to promote ecosystem enhancement and biodiversity. These opportunities represent one avenue that the NCDOT uses to continue its commitment to environmental stewardship in its delivery of the state's transportation system.

Attachment 1

The Use and Feasibility of Native Grass Species for Soil and Slope Stabilization and Erosion Control on NC Roadsides

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The objective of this report is to review literature to identify potential native grasses for use on NC roadside environments as outlined in the Technical Assistance Request Form.

INTRODUCTION

The impetus for this work was SB 391, Sec. 20(b) of SL 2025-47 following SB 628 (2021). The 2021 SB is referenced here because it stated, “the use of seeds and plants the US Department of Agriculture has classified as native to NC”. The SB 391 stated “native grasses” without an authority identifying the plant materials. The USDA defines native plants as “the indigenous terrestrial and aquatic species that have evolved and occur naturally in a particular region, ecosystem, and habitat. Species native to North America are generally recognized as those occurring on the continent prior to European settlement. Native plants include conifer trees, hardwood trees and shrubs, grasses, forbs, and others.” In general, USDA does not maintain a list of plants classified as native although their plant database gives an indication of native, introduced, or non-native vegetation overlaying a US state map. In many cases, various groups, societies, organizations, and producers have presented and proposed their own lists. Most conservative groups do not consider any plant cultivar as native and often refer to native plants that have been selected or bred for a specific trait as a “nativar”, which are a source of controversy among the groups if they represent native plants or not. NC State faculty have previously reported that there are no decisive answers to whether hybrids or nativars should be included in native plant lists (from Ch 12. Native Plants, North Carolina Extension Gardener Handbook).

A search of the USDA Plant Database (<https://plants.usda.gov/>) provided a list of 311 grasses that are indicated as native to NC. Within that list, thirty-three were found to have been used in NC or surrounding states (Table 1) as a turf or pasture. Some of these grasses have only been found commercially available as vegetative plants and others may be available as seeds. A high percentage of these thirty-three grasses have been predominantly planted in small landscape beds, not in larger land areas such as those found on roadsides, which is the reason that many of them are only available vegetatively. There are several surprises from the USDA database, primarily the inclusion of grasses that are commonly considered improved turfgrasses. These include red fescue, carpetgrass, bahiagrass, seashore paspalum, Texas bluegrass, Kentucky bluegrass, and St. Augustinegrass.

Table 1. Grasses in the USDA plant database (<https://plants.usda.gov/>), filtered for being native to NC. Table includes planting material (vegetative, seed, or both) and reported price † checked in January 2026 for a single plant (if available) or pound of seed (if available for seeding). The most common native warm-season grasses are highlighted in bold.

Scientific Name	Common Name	Planting material	\$ / plant & \$ / # seed †
<i>Ammophila breviligulata</i> Fernald	American beachgrass	veg	1.89
<i>Andropogon gerardii</i> Vitman	big bluestem	either	1.59 / 17
<i>Andropogon glomeratus</i> (Walter)	bushy bluestem	veg	1.59
<i>Andropogon ternarius</i> Michx.	splitbeard bluestem	veg	1.59
<i>Andropogon virginicus</i> L.	broomsedge bluestem	either	1.59 / 100
<i>Axonopus fissifolius</i> (Raddi) Kuhlman	common carpetgrass	either	NA / 25
<i>Bouteloua curtipendula</i> (Michx.) Torr.	sideoats grama	either	1.55 / 35
<i>Bromus inermis</i> Leyss.	smooth brome	seed	NA / 3
<i>Calamagrostis canadensis</i> (Michx.) P. Beauv.	bluejoint	veg	1.75
<i>Chasmanthium latifolium</i> (Michx.) Yates	Indian woodoats	veg	1.25
<i>Chasmanthium laxum</i> (L.) Yates	slender woodoats	veg	1.79
<i>Deschampsia cespitosa</i> (L.) P. Beauv.	tufted hairgrass	veg	2.25
<i>Deschampsia flexuosa</i> (L.) Trin.	wavy hairgrass	veg	1.65
<i>Elymus canadensis</i> L.	Canada wildrye	seed	NA / 25
<i>Elymus hystrix</i> L.	eastern bottlebrush	veg	1.72
<i>Elymus virginicus</i> L.	Virginia wildrye	seed	NA / 15
<i>Eragrostis elliotii</i> S. Watson	field lovegrass	veg	2.25
<i>Eragrostis spectabilis</i> (Pursh) Steud.	purple lovegrass	veg	1.62
<i>Festuca rubra</i> L.	red fescue	seed	NA / 8
<i>Muhlenbergia capillaris</i> (Lam.) Trin.	hairawn muhly	veg	1.69
<i>Panicum virgatum</i> L.	switchgrass	either	2.01 / 15
<i>Panicum rigidulum</i> Bosc ex Nees	redtop panicgrass	seed	NA / 50
<i>Paspalum notatum</i> Flueggé	bahiagrass	either	Sod § / 20
<i>Paspalum vaginatum</i> Sw.	seashore paspalum	either	Sod / 22
<i>Phalaris arundinacea</i> L.	reed canarygrass	seed	NA / 15
<i>Poa arachnifera</i> Torr.	Texas bluegrass	seed	NA / 10
<i>Poa pratensis</i> L.	Kentucky bluegrass	either	Sod / 15
<i>Schizachyrium scoparium</i> (Michx.) Nash	little bluestem	either	2.12 / 25
<i>Sorghastrum nutans</i> (L.) Nash	Indiangrass	either	1.75 / 12
<i>Sporobolus heterolepis</i> (A. Gray) A. Gray	prairie dropseed	veg	2.79
<i>Stenotaphrum secundatum</i> (Walter) Kuntze	St. Augustine grass	veg	Sod
<i>Tripsacum dactyloides</i> (L.) L.	eastern gamagrass	seed	NA / 25
<i>Tridens flavus</i> (L.) Hitchc.	Purpletop grass	seed	NA / 45

† prices were estimated based on an average of multiple seed suppliers.

‡ this represents actual seed weight, not corrected for pure live seed.

§ those labeled as sod are in production and sold at market sod price.

TASK 1: LITERATURE REVIEW AND DATA COMPILATION

Germplasm that has been used/studied

The most common and widespread evaluation of native grasses in the southeastern US has been conducted by establishing and maintaining native grasses as cover for wildlife and/or forage for livestock. Auburn University (Keyser et al., 2019), Mississippi State University (Harper et al., 2004; Keyser et al., 2019), University of Arkansas (Jennings et al., 2014?), University of Georgia (Rushing and Lemus, 2024; Keyser et al., 2019), and University of Tennessee (Keyser et al., 2011; Keyser et al., 2019) have co-authored extension publications related to establishing and maintaining native grasses for these uses. Of these publications, “Establishing Native Grass Forages in the Southeast” was supported by a grant from the USDA and “A Landowner’s Guide to Native Warm-Season Grasses in the Mid-South” was co-authored by a USDA-Natural Resource Conservation Service biologist. The authors of these publications represent a wide range of specialties, including native grassland management, wildlife and fisheries management, animal science, forage science, land resource management, and natural resource conservation.

Texas has reported on the performance of native grasses for lawn use compared to non-native turfgrasses (Simmons et al., 2011). Authors of this paper represented ecologists from the University of Texas and the Lady Bird Johnson Center. When reviewing the findings from this study, the differing environmental conditions of Texas (in relation to North Carolina) need to be considered. Similarly, California has been a leader in the study and comparison of non-native and native vegetation, but those papers were generally not included in this review due to the differences in native planting material and environmental conditions, compared to the southeastern US.

Virginia has reported on their experiments of using native vegetation, including grasses, for roadside use (Doak et al., 2003; Askew et al., 2023). The assessment of native plants for roadside use in the Virginia report (Askew et al., 2023) is probably the most comprehensive and applicable to NC DOT. Their work included an assessment of native species currently found on VA roadsides, while considering native plant availability and pricing of planting material. In other VA reports, material evaluation in roadside plantings has been reported (Doak et al., 2003). The VA studies emphasized that adapted cool-season grasses that were planted with native grasses soon overwhelmed the natives.

In 2007-2008, NC State scientists evaluated establishing native vegetation while considering invasive species control on North Carolina roadsides (Roten et al., 2011). This study evaluated locations in NC, planting equipment, and multiple grass species to

determine the ideal planting method and timing as well as specific herbicide regimes for controlling invasive weeds.

These publications will be used for the basis in summarizing the current knowledge on establishing and managing native grasses in the southeast. When known, specifics by germplasm will be included in individual sections.

Table 2. Comparison of key attributes of five important native warm-season native grasses.

Species	Establishment	Wet Site Tolerance	Dry Site Tolerance	Biomass produced
Big bluestem	Moderate-easy	Moderate	Moderate	High
Little bluestem	Easiest	Low	High	Moderate
Eastern gamagrass	Moderate	High	Low	Very high
Indiangrass	Easiest	Moderate-low	Moderate – high	High
Switchgrass	More difficult	High	Moderate	Very high

Adapted from Keyser et al., 2016

Establishment (successes, timeframe, limitations)

Publications have reported that native grasses can be effectively established by either no-till or conventional tillage. No-till seeding into areas with excessive surface residues (50% or more of soil surface covered) is not recommended (Dewald et al., 1996). A key to the success of either method of seeding is to have minimum amounts of thatch and weed competition. The lack of competition from other species such as bermudagrass, johnsongrass, and tall fescue, has been presented as the most important factor in successful establishment. This is normally accomplished with a series of herbicide applications. Keyser et al. (2019) recommended spraying in the fall and again in the spring before a spring planting. The alternative offered was thorough and repeated tillage for conventional planting on well-prepared, fine-textured seedbeds. Target depth for seeding is normally one-eighth to one-quarter inch with a drill seeder or broadcast seeding followed by a light drag and/or a cultipacker to ensure good soil coverage. Seeding rates vary by species. Roten et al. (2011) reported emergence at 0.5-inch depths and greater to be significantly lower in most cases than planting at shallower depths.

Dewald et al. (1996) stressed that seed should be purchased from a reputable seed source on a pure live seed (PLS) basis to ensure good quality seed. Roten et al. (2011) evaluated seed lot viability/germination via tetrazolium testing, which determines if a seed is

biologically active and has the potential to germinate. The range in difference in reported and actual germination/viability was 21 to 64%. This suggests that viability is much lower than the reported germination and should be considered when determining planting rates. It was not known if the differences were due to aging of the seed lots or if the seeds may have been harvested too early and were not mature. Seeds with dormancy issues may eventually germinate but should have a positive tetrazolium test result. In their screening, new seed lots were purchased and when tested, germination percentages for reported and actual germination were consistent.

Issues with seed dormancy, where seed lots had 70 percent dormant seed in some cases, have been reported. In this situation, spring planting may result in poor stands (dormant seeds may germinate after exposure to a critical level of moisture and cold to break dormancy). Some have suggested cold storage and/or pre-soaking before spring planting (Keyser et al., 2019). Targeted planting is mid-April to early June, although there are discrepancies in this suggested period for some species in some areas. Doak et al (2003) reported summer planting is the best time. Roten et al. (2011) reported greater stand coverage in most cases with spring-planted natives (68%) compared to fall-planted (7%). Warm-season native grasses normally begin to germinate at soil temperatures above 60°F. Dewald et al. (1996) indicated that switchgrass and eastern gamagrass should be planted when soil temperatures at 1-inch depth stabilizes in the range of 65 to 80°F.

Roten et al. (2011) attempted to establish native grasses in multiple sites in NC. Their greatest success was in Kinston, where big bluestem, little bluestem, Indiangrass, switchgrass, and tall fescue (control) had excellent establishment after year three. They noted that no emergence was observed in year one or year two. Virginia wildrye (cool-season native grass) was only able to persist through the entire study at the Reidsville location.

An overwhelming negative to using native grasses is the first-year performance. Germination may be minimum in the first 5 weeks post planting. Several publications mentioned success in the first season might be a plant population of at least one plant per square foot for eastern gamagrass, or one plant per 2 to 3 square feet for other species. Seedling numbers are expected to nominally increase by eight weeks after planting. Keyser et al. (2019) reported that native grasses will achieve only about 70 percent of their potential growth by the end of the second growing season.

Seeding year weed management is important during the first summer. Fertilizers are not typically needed for establishment unless the phosphorus and potassium levels are very low. Mowing the weeds at a height above the native grass seedling height may be effective with some weeds. Herbicides may be required otherwise. [Refer to “Study and Evaluate the

Impact of High-Threat Invasive Weed Species on NC Roadsides” by Howell and Richardson, 2026 for a review of this topic]. Like with any non-irrigated planting, weather (rain events) is easily the other biggest factor in determining the success of planting native grasses.

Maintenance parameters (mowing primarily covered)

Burning is often mentioned in native grass management. There is great risk of burning alongside of roads due to smoke visibility issues and the risk of fire unintentionally spreading to nearby properties. Dewald et al. (1996) suggested mowing switchgrass or eastern gamagrass at a 10-to-12-inch height for control of tall weeds during establishment. To maximize their growth, it is recommended they are clipped no lower than 8 inches in early summer of their second year (Jennings et al., 2016). In subsequent years, cutting down to 6 inches may be acceptable for some short native grasses, but may lead to increased weed pressure. Lower cutting heights reduce plant vigor. Tall species of native grasses have elevated growing points and few leaves near the bottom of the plant. Removing this growing point and the leaf surface forces the plant to draw energy from root reserves and can reduce plant stands for an extended period. It is recommended that native grasses be cut only once per year to optimize their use for wildlife habitat and keep weed encroachment to a minimum (Harper et al., 2004).

Soil stabilization and erosion control

Dewald et al. (1996) indicated that native warm-season grasses planted in strips can be excellent for erosion control. The stiff, erect grasses can be used to capture and deposit sediments from runoff when planted in parallel lines across and perpendicular to the slopes. The determinants of success of grass hedge plantings included selection of the proper grass, use of high-quality seed, adequate seedbed preparation, precise planting timing and method, and sound management practices during establishment. The two grasses their study recommended using were switchgrass and eastern gamagrass.

The various extension-based establishment guides generally mention warm-season native grass plantings as a two-year process. This is primarily due to the high percentage of dormant seeds and relatively low percentage of pure live seed as mentioned in the establishment section of this review. In their 2002-2003 annual report, Virginia Tech faculty indicated that after one year of establishment, short native grass percentage ground cover generally exceeded 50% except for little bluestem and sideoats grama plots, which only had coverage of about 40%. The standard mix of hard and tall fescue was superior to all the native species until the second year of the study. In a separate study that paired short native grasses with selected companion species, the best overall native ground cover was 50%, which did not meet erosion control standards. With tall native grass species, the best

was a big bluestem and Indiangrass mixture reaching 50% ground cover. In fact, VA scientists found that the tall native species tested in their trial did not reach the minimum erosion control standard of 70% cover after four years. They attributed the poor coverage to the sandy nature of the slope and early erosion in the plot area that thinned the stand. At a flat site at their research center in Blacksburg, the species performed much better. This slow establishment will limit the use of warm-season native grasses on slopes at minimum and make them less desirable for use on roadsides in general.

Rory et al. (2011) reported findings in NC similar to the VA work. At their most successful site (Kinston, NC), they reported no appreciable coverage in the first two years. Three years after planting, Indiangrass had 74% coverage, big bluestem 70%, little bluestem 69%, and switchgrass 68%. At the Reidsville, NC site, Indiangrass had 81% cover after four years, big bluestem 22%, and little bluestem 5%.

Resistance to invasive species and drought

This subject will be covered in a separate Technical Assistance Request directed by Dr. Rob Richardson. [The NCDOT research summarized in “Study and Evaluate the Impact of High-Threat Invasive Weed Species on NC Roadsides” by Howell and Richardson was consulted in preparing this document.]

Research work in Texas (Simmons et al., 2011) found that under infrequent and erratic rainfall the slower growing native grasses maintained a higher or equivalent leaf density compared to non-native species. This response may be more likely under the very low rainfall patterns of central Texas and not applicable under typical NC rainfall patterns and amounts. The Texas study reported that mixed species (polycultures) of native grasses offered ecological benefits compared to monocultures.

Wildlife and pollinator habitat value

Native grasslands were once part of successional habitat that was largely maintained by fire. Reviewed resources indicate that the benefits of native grasses were for structure of cover for wildlife, not as a food source (Harper et al., 2004). Maintaining the open structure of native grasses is important in allowing mobility for small wildlife (birds, rabbits, young turkeys, etc), while dense vegetation is less desirable. Species, such as big bluestem, Indiangrass, and switchgrass, that are allowed to grow taller, provide great winter cover for rabbits, over-wintering birds, and deer.

The Natural Resources Conservation Service (NRCS) reports that grasses provide essential habitat and shelter for pollinators (Attachment to Biology Technical Note No KS-37, 2011) [[nrcs.usda.gov/plantmaterials/kspmctn10378.pdf](https://www.nrcs.usda.gov/plantmaterials/kspmctn10378.pdf)]. For example, the bunch-nature of some grasses are favorite nesting sites for ground-nesting bees and other insects. Little

bluestem, big bluestem, and switchgrass are caterpillar host plants for banded skippers and satyrs, filling an important resource to complete life cycles of these pollinators. The NRCS suggest incorporating native grasses into pollinator restoration projects to increase abundance and diversity of pollinators.

Aesthetics and safety considerations

Beauty may be relative to the individual. Native grasses usually offer a varied texture and more colors than non-native grasses. Generally, natives will be maintained at a higher height of cut providing less uniformity across expansive plantings. Also, their bunch growth habit usually relates to more openness and greater diversity of plant heights between mowing cycles. Most of the native grasses have more pronounced and interesting seedheads than non-natives. The variety of color, size, and form is more desirable to some people, whereas others may value a more uniform monostand of turf. Neither perspective should be considered right or wrong.

Safety aspects of using one grass type versus another will largely be influenced by maintenance practices that may or may not be dictated by grass selection. The less frequent, higher height of cut with native grasses will encourage wildlife habitat, which in turn may result in a greater number of vehicle and animal interactions. There may also be line-of-sight issues with using native grasses due to their heights. The native grasses would not be as desirable to use immediately adjacent to roadsides (recovery zones) since exiting the roadway (following an accident or if a roadside repair is necessary) would require exiting and parking in taller grasses. In addition, taller grass would be susceptible to ignition if its canopy makes contact with a hot engine or vehicle exhaust.

TASK 2: IMPACT ASSESSMENT

Cost-benefit analysis (germination, growth rates, canopy cover, soil stability, maintenance needs)

Seed quality is often mentioned when discussing native grasses. Seed purity for these species is commonly between 50 and 70% due to the high percentage of stems, leaves, and other debris. Germination rate may be only 50 to 60%. Therefore, pure live seed (PLS) in a container of seed can be 25 to 50%. The seed is already expensive, but the low PLS may require 2 to 4 times the amount of seed be purchased. In contrast, most modern turfgrasses will have a PLS percentage greater than 85% and more commonly, greater than 95%. Some native grasses, such as switchgrass and eastern gamagrass tend to have a high dormancy rate. Some success in overcoming this switchgrass dormancy may be achieved

by pre-treating seeds with moisture and temperature for at least two weeks before planting. Eastern gamagrass requires a six-week chilling process (Harper et al., 2004).

Cost comparisons between using native grasses versus turfgrasses generally considered their planting in high-values landscapes. For our purposes, it did not seem appropriate to compare sodded, irrigated turfgrass lawns compared to native garden establishments. One large establishment site that offered a good cost analysis was an Arkansas study reported by Jennings et al. (2016). In their study they planted a mixture of big bluestem (8 pounds PLS per acre), little bluestem (1 pound PLS per acre), and Indiangrass (1 pound PLS per acre) for a total of 10 pounds PLS per acre in three sites across the state. Site size ranged from 10 - 15 acres. They prepared sites in February, and spring planted in May and June with a calibrated drill seeder. They emphasized the importance of multiple herbicide applications to control existing vegetation before planting. Stand percentages were around 90% at all sites in October. They attributed the rapid establishment to optimum rainfall at all sites between planting and mid-August. In their price analysis, they included cost incurred with seed, herbicides, tillage and/or burning, equipment rental, and bush-hogging. The cost ranged from \$322 to 385 per acre with 39 to 47% of the cost in seed.

Another study provided a cost-benefit analysis of native warm-season grasses for transmission line right-of-way revegetation in Tennessee (Turf et al., 2017). They planted two Tennessee Valley Authority (TVA) transmission line corridor sites with native warm-season grasses along with annual forbs to provide quick cover compared to a more traditional cool-season grass mixture with clover and a cover crop. Their native mix included: switchgrass, Virginia wildrye, little bluestem, big bluestem, Indian grass, fall panicum, purple top, partridge pea, showy tickseed, black-eyed susan, brown top millet, and annual ryegrass. Their comparison was a mixture containing tall fescue, orchard grass, redtop grass, white clover, and spring oats. Seed cost for natives used in their study amounted to \$217 per acre versus \$65 per acre for the cool-season grasses. In the cost analysis, the group indicated they could save \$356 per acre planting the natives by omitting fertilizer and lime applications. The visual inspections indicated that 70% ground coverage was successful within 31 and 60 days for the two sites growing non-natives. Only one site growing the native mix with annual forbs was successful at 68 days, resulting in an assessed failure rate of 40% over all test sites. Their conclusion was that native warm season grasses would cost \$95 more per acre to establish and require a narrow planting window for success. They estimated only 25% of their annual right of way plantings would be good candidates due to site constraints and the required planting window. They also pointed out that inclusion of fast germinating forbs was necessary for quick ground coverage. Unfortunately, addition of these forbs prevents the use of most herbicides for controlling invasive species.

Quantifying maintenance

In terms of designing maintenance plans, it is important to get a sense for how big these native grasses can grow. Big bluestem may reach 8 - 9 feet high. Little bluestem grows 2 - 4 feet in height. Broomsedge bluestem grows 2 - 4 feet in height. Indiangrass is typically 4 - 7 feet in height. Switchgrass typically reaches 3 - 6 feet in height. Sideoats gama grows to a height of 1 - 3 feet. Eastern gamagrass may reach 6 - 9 feet in height. Due to line-of-sight issues on many roadsides, some level of height reduction will be necessary, otherwise these species will need to be planted only in areas where no visibility issues are expected.

The suggested maintenance for native species is to use periodic prescribed burning in late winter, just before spring greenup. This burning reduces litter buildup, sets back succession, increases nutrient availability, and stimulates new growth. If smoke-management from burning is an issue, native grasses can be managed with disking. The disking will set back succession, increase open space at the ground level, facilitate litter decomposition, and stimulate the seedbank. Harper et al. (2004) stated that bushhogging without burning or disking is not a recommended practice for managing native grasses because it increases the litter layer, makes travel through the field difficult for small wildlife, and inhibits the seedbank from germinating.

According to Harper et al. (2004), another management practice often necessary is herbicide applications. These applications create additional open space at ground level and stimulate the seedbank. Spot or broadcast spraying selective herbicides may be necessary to reduce several problem grasses, invasive broadleaf weeds, and woody competition.

As with growing any vegetation, soil fertility can be very important to optimize establishment and performance. Soil testing can inform lime and fertilizer needs for pre- and post-planting.

Seed availability

Native Seed Network (appliedeco.org/nativeseednetwork/) has a “Find Seed” function on their website. It can link one to local or national seed suppliers. The Center for Native Grasslands Management at the University of Tennessee has put together a list of native grass vendors (<https://nativegrasses.tennessee.edu/wp-content/uploads/sites/184/2020/10/SeedVendorList2018.pdf>), including their address, phone number, email address, and website.

During the preparation of this document, online seed sources were readily found. It was noted in some instances that online sellers did not accurately report their availability to purchase seed now, but they would have some quantities of seed available in the future.

In 2023, a study committee appointed by the National Academies of Science, Engineering, and Medicine provided an assessment of native seed needs and the capacity for their supply for ecological restoration and other purposes in the United States (<https://www.nationalacademies.org/read/26618/chapter/2>). The study committee acknowledged that a relatively small segment of the nation’s commercial seed industry produces seeds of native plant species and that public agencies and other users of native seed acquire most of their supply from private growers. Currently, the demand for native seeds, driven by ecological restoration and disaster recovery, often outpaces supply. Buyers indicate that preferred seed is often not available at any price during the timeframe in which the seed is needed. Seed suppliers report that the greatest challenges they face in supplying native seed are unpredictable demand, difficult to grow species, and lack of starter seed for some species. The conclusion is that availability of specific species and amounts is currently unpredictable.

The average amounts of turfgrass seeds used by NC DOT on an annual basis are significant (Table 3). The single greatest species purchased is the cool-season tall fescue. The reason this species has such significant usage is due to its seeding rate in the eastern portion of NC, which at 50# is so much greater than bermudagrass (25-35#) and centipedegrass (10#). In the western parts of NC, Kentucky bluegrass suggested seeding rate is 20# and hard fescue is 75#.

Table 3. NC DOT annual average seed usage (pounds) in 2023 – 2025.

Grass Species	Average Annual Seed Usage (2023-2025)
Tall Fescue	105,455
Hard Fescue	17,300
Bermudagrass	28,291
Centipedegrass	3,281
Bluegrass	13,251
Total Turfgrass Seed Amount	168,251

Cost comparison between native and turfgrass species

Askew et al. (2023) reported that among the native plants most frequently found on VA roadways, seeds were generally unavailable or price prohibitive. They indicated that among the most desirable native grasses for VA that were commercially available, the average cost of seed was \$59 per pound compared to \$2.40 per pound for tall fescue. There may be a wide range of acceptable seeding rates of either tall fescue or the native grasses. For instance, at this price the 100-200 pounds per acre often used by NC DOT for tall fescue

would be \$240 to \$480 per acre for seed. The average seeding rate used by NC DOT for the various native grasses is roughly 8 pounds PLS per acre. Using VA seed cost, that would be approximately \$472 per acre, which would be similar to the higher seeding rate of tall fescue. The seed prices noted in our recent review found the primary six species of native grasses used in this region to be \$21.50 per pound of seed (not corrected for PLS). If we estimate roughly 60% PLS, then the estimated cost would be roughly \$36 per pound PLS, which translates to spending \$288 per acre for seed, which is comparable to the low seeding rate for tall fescue. This illustrates that seed cost, purity, and seeding rate is one way to initially control cost between the two systems. Competition control during establishment will likely increase costs for natives. Reduction in mowing cycles will reduce costs for natives compared to traditional turfgrasses.

TASK 3: MANAGEMENT RECOMMENDATIONS

Suitable native species for the various soil, moisture, and slope conditions across NC

It seems the most common commercially available warm-season native grasses (big bluestem, eastern gamagrass, Indiangrass, little bluestem, sideoats gramagrass, and switchgrass) would be adapted to NC and have reasonable seed availability at any given time. In addition to being sold individually, some of these grasses may be commercially available as a mixture of various native grasses. In general, these seeds are marketed and sold through small regional companies rather than more traditional suppliers representing larger regional, national, and international seed companies. Other native grasses have also been successfully used in some instances, but have more limited availability. These would include purpletop grass, redtop panicgrass, splitbeard bluestem, broomsedge bluestem, and Virginia wildrye. To cross reference with scientific names, refer to table 1.

Establishing native grasses on slopes will be challenging due to their low germination rate and slow rate of coverage. Based on coverage rates reported in the literature, native grasses would not be suitable for establishment on slopes without significant lateral breaks in vegetation across the slope and/or the use of non-native companion plants.

The best use of native grasses on roadsides seems to be in relatively flat areas, not prone to erosion. This would allow for the extended establishment periods required by these grasses. They would also function well in extended strips in flat or minimally sloped areas to serve as travel corridors for wildlife and visual breaks from more typical turfgrass monostands. These strips or block plantings would provide textural diversity and pollinator habitat on the roadsides. The strips or blocks should be in areas that would not result in line-of-sight issues for motorists and far enough from the roadside edge that permit

recovery areas for motorists that must leave the roadway. These areas should require less mowing frequency due to their location along the roadway (line-of-sight) and their adaptation to minimum maintenance once fully established.

Management recommendations of native grass species based on adaptability, availability, and ecological value.

Once established in suitable areas (see comments above), one mowing down to an 8-inch stubble in late summer followed by a light disking.

The University of Maryland Center for Environmental Science reviewed native and non-native grass species to recommend for use along roadsides in Maryland, focusing on six evaluation criteria: Commercial availability and cost, rate of establishment, ease of maintenance, potential for erosion control, ecosystem benefits, and resilience. Unfortunately, their summary did not evaluate many of the native grasses that have been identified by other groups in the southeastern US to be suitable for use on roadsides and pastures. It was also disappointing that their evaluation criteria did not reflect the previously reported limitations related to native grass establishment rates and subsequent erosion due to lack of coverage. Another specific criticism of their evaluation was that their comparisons were made with sodding bermudagrass rather than seeding, which is not realistic for NC roadsides in terms of costs and logistics. A summary of their findings were reported on the Center's website.

OVERALL CONCLUSIONS

Based on the information outlined above, our overall conclusion is that while native species provide ecosystem services and visual appeal, they will be hard to adapt to NC DOT roadside maintenance needs for three main reasons:

- inadequate seed supply of desired species at the amounts and timing necessary
- substantially greater seed costs
- slow establishment rates leaving roadsides vulnerable to excessive erosion
- the inability to use mowing for control of invasive weeds during establishment resulting in dependence on herbicides

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