

Developing a Plan to Restore and Enhance Native Habitats for Pollinators Along Tennessee's Interstate and Highway Systems

Research Final Report from Southeastern Grasslands Initiative/Austin Peay State University | Cooper Breeden and Dwayne Estes | September 30, 2021

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16. Abstract <p>Tennessee once contained millions acres of grasslands. These ecosystems occurred in all ecoregions of the state. Unfortunately, most of the state's grasslands have declined by greater than 90 percent, and some types have experienced losses exceeding 99.9 percent. The remnants that still exist now persist only in powerline corridors or along roadside margins where periodic mowing maintain open conditions. But even these are rapidly declining because of shifts in management techniques. The decline in grasslands is leading to ecological collapse and spells disaster for many animal species that depend on these systems, including pollinators. To address the alarming biodiversity crisis, the research team proposed to initiate a project that would initiate conservation projects at ecologically significant habitats on Tennessee's highway system. The intended purpose of the project was to locate and document areas on rights-of-way that consist of either high quality grassland remnants or areas that are candidates for restoration, and then to suggest strategies for conserving these important sites. The proposal consisted of three objectives. The first was to conduct a status assessment of native roadside pollinator habitat along Tennessee's interstate and highway system. One of the approaches entailed the development of a Community Science program whereby volunteers were trained to recognize remnants and collect ecological data throughout the state. The second objective was to suggest strategies for how to better manage and restore native roadside pollinator habitat in the various regions of Tennessee. The third objective was to install a highly visible prairie restoration that would serve to enhance public awareness of the importance of transportation corridors to pollinators, wildlife, and native plants. To conclude the project, the research team endeavored to lay the groundwork whereby multiple ecologically significant sites would be protected through conservation-friendly management and restoration practices.</p>			
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Executive Summary

Prior to European settlement, Tennessee contained millions of acres of naturally open grasslands in all ecoregions of the state, from the Mississippi Alluvial Plain to the top of the Blue Ridge Mountains. Unfortunately, the state has lost the vast majority of those, and the remnants that still exist now persist only in powerline corridors or along roadside margins where periodic mowing maintain open conditions. Even these are rapidly declining because of shifts in management techniques of these rights-of-way, especially in the widespread use of herbicides. In its current state, this will contribute to ecological collapse that will spell disaster for many animal species that depend on these systems, from mammals to birds to pollinators. To address the alarming biodiversity crisis, the Southeastern Grasslands Initiative (SGI) proposed to initiate a project that would initiate conservation projects at ecologically significant habitats on Tennessee's highway system. The intended purpose of the project was to locate and document areas on rights-of-way that consist of either high quality grassland remnants or areas that are candidates for restoration, and then to suggest strategies for conserving these important sites. SGI's proposal consisted of three objectives: 1) to conduct a status assessment of native roadside pollinator habitat along Tennessee's interstate and highway system, 2) to develop a strategy for how to better manage and restore native roadside pollinator habitat in the various regions of Tennessee, and 3) to install a highly visible prairie restoration that would serve to enhance public awareness of the importance of transportation corridors to pollinators, wildlife, and native plants. By the end of the project, SGI strived to have laid the groundwork whereby multiple ecologically significant sites would be protected through conservation-friendly management practices.

SGI staff and Community Science volunteers were successful in locating and collecting data for many remnant sites along Tennessee's highway system. In coordination with the TDOT staff, SGI determined that the best short-term strategy for conserving these sites would be to work with regional TDOT staff, especially the maintenance supervisors, to determine management prescription for each site. SGI was able to successfully carry this out on a single site in Franklin County and has begun conversations at other sites.

While conducting assessments, it became apparent that there are areas that may not be categorized as high quality remnants but are candidates for restoration or re-creation. This is especially true in areas where there is high visibility or access to the public. Such areas include National Scenic Byways or State Park roads. In some cases, there exist opportunities to facilitate many acres, if not hundreds of acres, of grassland ecosystem (including pollinators) restoration, such as the wide swaths of mowed ROWs along the Natchez Trace Parkway.

This project laid the groundwork for how TDOT can begin to proactively mitigate its ecological impact. In collaboration with TDOT staff, including those involved in the Pollinator Habitat Program, SGI developed a blueprint that will allow for the protection and conservation of ecologically important sites. SGI identified sites where there are opportunities for unique partnerships that would allow TDOT to amplify their impact on biodiversity conservation, including on pollinators. SGI also made suggestions for how TDOT could expand their positive impact on conservation by recommending specific conservation partnerships. In joining such partnerships, TDOT would not only protect specific sites on highway rights-of-way, but in

protecting these sites, they would amplify the conservation impacts in projects in other nearby natural areas such as at State Parks or State Natural Areas.

Key Findings

- With the appropriate training, Community Science volunteers can be relied upon for useful ecological data. In this program, most of the volunteers were amateurs of varying levels. While the learning curve to learn how to identify target ecosystems is steep, with the appropriate guidance, volunteers can produce great results.
- Current maintenance practices are not conducive to native remnant habitat. The most damaging are broadcast herbicide application and frequent mowing regimes. This impacted the research team's ability to locate remnants as many areas that were targets for surveys had recently been mowed, making it impossible to distinguish the habitat.
- There are many remnant habitats that still exist on Tennessee's highway system, but action will need to be taken soon to prevent them from degrading or disappearing. Invasive species are an increasing problem. Further, the more consistent the herbicide or mowing, the more likely it will be replaced with weedy and invasive plants, leading to a dense thicket that is not as beneficial to wildlife.
- The conditions of each site are unique and may require a specially tailored management prescription. This may be due to terrain, degree of invasion, soil, or other factors.

Key Recommendations

- While many remnant habitat sites on Tennessee's roadsides were located throughout the course of this program, the research team believes there are many more yet to be discovered. A follow up survey effort ought to be pursued to locate more sites.
- There are many areas where wide swaths are being frequently mowed but given their proximity to natural and/or public areas, there exists an opportunity to enhance the scenic and educational value by either changing the management and/or restoring the site into a long grassland pollinator corridor. This would create a scenic conservation corridor.
- There are ample opportunities to forge partnerships with a variety of partners by which TDOT can magnify its impact on grassland ecosystem conservation. This will not only increase their impact on pollinator conservation, but on the greater ecosystem that depends on grasslands. Minimally, this would entail working with conservation stakeholders to protect unique sites but could involve other projects like the grassland installations TDOT has pursued at Exit 1 with SGI or at other State Parks.

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Glossary of Key Terms and Acronyms

BLM: Bureau of Land Management

Community Science: Refers to the involvement of amateurs in scientific research. Once referred to as “Citizen Science” but was changed because “citizen” was regarded as noninclusive of people who may not happen to be citizens but still provide valuable contributions to science.

Ecotype: A variant of a species that has adapted to a particular region or habitat. Often used interchangeably with “local genotype.”

Local genotype: A group of genetically related organisms that occur in the same place. Most commonly used in the context of restoration where there is a growing movement to only use plant material sourced from the same region in which a project takes place. Often used interchangeably with “ecotype.”

Remnant: A habitat that has remained relatively undisturbed by anthropogenic forces and therefore consists primarily or solely of native species.

ROW: Right-of-way, as in a powerline or highway right-of-way.

MLNM: Meriwether Lewis National Monument

NPS: National Park Service

SERNEC: Southeastern Regional Network of Expertise and Collections. SERNEC is a consortium of herbaria in the Southeast that has worked together to digitize herbarium records for use in research, management, and planning.

SGI: Southeastern Grasslands Initiative

TDNA: Tennessee Division of Natural Areas. The state agency dedicated to the protection and proper management of native plants, animals, and natural communities across Tennessee.

USDA NRCS: U.S. Department of Agriculture Natural Resources Conservation Service

USFWS: U.S. Fish and Wildlife Service

Chapter 1 Introduction

Tennessee once contained approximately 7.1 million acres of naturally open grasslands prior to European settlement. These ecosystems occurred in all ecoregions of the state, from the Mississippi Alluvial Plain to the top of the Blue Ridge Mountains. Unfortunately, most of our grasslands have declined by greater than 90 percent of their original pre-settlement distribution, and some types have experienced losses exceeding 99.9 percent. The remnants that still exist now persist only in powerline corridors or along roadside margins where periodic mowing maintain open conditions. But even these are rapidly declining because of shifts in management techniques of these rights-of-way in recent decades. The decline in grasslands is leading to ecological collapse and spells disaster for many animal species that depend on these systems, from mammals to birds to pollinators.

To address the alarming biodiversity crisis, SGI proposed to initiate a project that would initiate conservation projects at ecologically significant habitats on Tennessee’s highway system. *The intended purpose of the project was to locate and document areas on rights-of-way that consist of either high quality grassland remnants or areas that are candidates for restoration, and then to suggest strategies for conserving these important sites.* The proposal consisted of three objectives. The first objective was to conduct a status assessment of

“The intended purpose of the project was to locate and document areas on rights-of-way that consist of either high quality grassland remnants or areas that are candidates for restoration, and then to suggest strategies for conserving these important sites.”

native roadside pollinator habitat along Tennessee’s interstate and highway system. SGI embarked on a multipronged approach to complete this assessment. First, SGI developed a Community Science program whereby volunteers were trained in how to recognize remnants and collect ecological data at sites throughout the state. The research team also drew from multiple data resources to assist in efforts to locate these remnant habitats. The second objective was to suggest strategies for how to better manage and restore native roadside pollinator habitat in the various regions of Tennessee. The third objective was to install a highly visible prairie restoration that would serve to enhance public awareness of the importance of transportation corridors to pollinators, wildlife, and native plants. By the end of the project, SGI hoped to have laid the groundwork whereby multiple ecologically significant sites would be protected through conservation-friendly management practices.

TDOT Beautification’s Pollinator Habitat Program was interested in learning about the quality of pollinator habitat on the state highway system. High quality and remnant grassland habitat is synonymous with high quality pollinator habitat because it provides both the food and structure necessary for nesting for butterflies, bees, or other pollinators. This project laid the foundation to identify current high quality remnants and areas where restoration would be practical. It also provided a blueprint for how TDOT can begin to protect these ecologically sensitive areas. Further, SGI provided recommendations for how TDOT can collaborate with other conservation partners to multiple their conservation impact. By protecting specific sites on highway rights-of-way, this would provide ecological corridors that connect larger habitats. It would also provide

the seed resources of increasingly rare plants for conservationists to use nearby in other conservation projects.

In the following sections, the severity of the biodiversity crisis will be expounded upon by providing a more thorough history of grassland loss followed by a review of the far-reaching impacts of grassland loss on the region's flora and fauna. Following this review, the methods by which the status assessments were conducted will be described. The report will conclude with a discussion of the results of the project and make recommendations for some potential strategies by which TDOT can increase its conservation impact.

Chapter 2 Literature Review

Long before wagons and automobiles, a succession of large mammals from mammoths and rhinoceroses to elk and bison roamed Tennessee, moving from one large grazing area to another along networks of crisscrossing paths called traces or through extensive areas of open grassland landscapes. Later in the state's history (1540-1820s), many of Tennessee's grasslands served as major thoroughfares for westward expansion. The first longhunters in the 1750s-70s, following some of these traces, entered the Mid-South via the grassy valleys of southwestern Virginia and northeastern Tennessee. After passing west through the forested Cumberland Gap, they again found open grasslands in central Kentucky and Tennessee. Soon after the founding of Nashville in the 1780s, explorers and settlers began traversing the Cumberland Plateau where they encountered extensive savannas. Bison traces once radiated outward from where downtown Nashville now sits. Current highways, such as Hillsboro Pike, Clarksville Pike, Murfreesboro Pike, and US Hwy 70 were all originally traces that traveled through open savannas, grassy woodlands, and extensive meadows. To the north of Nashville, these traces connected to the 3.7 million-acre Pennyroyal Plain Prairie. West of Nashville they connected to extensive oak savannas and small prairies of the Western Highland Rim. In about 1820, West Tennessee opened for settlement and settlers poured into the western third of the State from Middle Tennessee, settling first in the extensive savannas and open prairies. These extensive grasslands were quickly converted into some of the richest agricultural districts in the country and were rapidly converted to fields of cotton.

Tennessee was riddled with several million acres of naturally-open grasslands at the time of European settlement (Estes et al. 2016). Approximately 7.1 million acres of grasslands are estimated to have existed in Tennessee prior to 1800 (Figure 1). Grasslands existed in all ecoregions of the state, from the Mississippi Alluvial Plain to the top of the Blue Ridge Mountains and their existence has been documented as early as 1540. Below is a selection of quotes from west to east across the three grand divisions of Tennessee that describe the historical grasslands that helped to facilitate travel and settlement.

Weakley Co.: *"a considerable portion of the eastern half of the county was almost treeless, and was known in our early history as 'barrens'...some of these barrens [covered] thousands of acres of level or gently undulating land, so nearly bare of timber that in some places you could see a horseman several miles...large bodies of these barrens lay southeast of the Middle Fork of Obion [River], in the neighborhood of Capt. James Smith's, extending to the Henry county line, and to where McKenzie now stands."* -Col. John A. Gardner, 1893

Lewis Co.: *"the wild grasses upon the broad areas of flat lands grow with spontaneous luxuriance.... A mile or two out from the streams the lands become flat and open. There is a belt of such land, three miles wide, running diagonally through the county from south-east to north-west. This strip is unbroken, and is covered, for the most part, with scraggy blackjacks and barren grass, which last furnishes good grazing from April to November"* -J. B. Killebrew & J. B. Stafford, 1874

White Co.: *"...came to an open country called barrens, to a place since called Price's Meadow, in what is now called Wayne County [Kentucky]" and they hunted their way south to the Caney Fork River near modern-day McMinnville, Tennessee. "All the country through which these hunters passed was covered with high grass, which seemed inexhaustible...."* -John Haywood, 1891 (Haywood 1891)

Cumberland Co.: *"The top of the mountain is...a vast upland prairie, covered with a most luxuriant growth of native grasses, pastured over as far as the eye could see, with numerous herds of deer, elk and buffalo, gamboling in playful security over these secluded plains..."* -J. G. M. Ramsey, 1853 (Ramsey 1853)

Monroe Co.: *"we next reached a grass-grown, mostly level region but sparsely covered with hickory, oak, and pine...an amazing extensive plains about us, covered with high grass. The plains are partly good bottoms, partly more elevated...trees were scattered, and we noticed pine, hickory...everywhere was the high grass...a great treeless plain appeared..."* [on the Hiwassee River] -Steiner and De Schweinitz, 1799 (DeSelm et al. 1969)

Broadly defined, grasslands include "any natural community or ecosystem in which the herbaceous layer is dominated by grasses, other graminoid (grass-like) plants such as sedges, and associated forbs (other herbaceous flowering plants)" (Noss 2013). This definition encompasses traditional concepts of native habitats such as prairies, barrens, savannas, and grass balds, but it can also include canebrakes, rocky glades, open wetlands such as bogs, fens, certain seepage communities. Wet meadows and some types of marshes can also be considered grasslands. It is important to note that many types of grasslands are "treed" or shrubby and may include a canopy cover from less than 10 to over 50 percent, thus encompassing some types of open grassy woodlands. Equally important is the realization that these communities are more than just grass but are home to an exceptional array of flowering herbs. For their size, they are often richer in biodiversity than adjacent forested areas and may harbor hundreds of species of plants, insects (including pollinators), birds, reptiles and amphibians, small mammals, and even burrowing crayfish.



Figure 1 Remnant grasslands in Rights-of-Way. Powerline ROW in Van Buren County (left) and railroad corridor in Coffee County (right).

Most of our grasslands have declined by greater than 90 percent of their original pre-settlement distribution, and some types have experienced losses exceeding 99.9 percent. Today, barely discernible remnants dot the landscape, obscured by 230+ years of land use changes, fire suppression, succession to closed-canopy forests, infestation by nonnative species, and the loss of large native grazing mammals such as bison and elk. Many are a fraction of an acre in size but

a few are larger. The remnants that remain have been pushed to the edge of existence and a large percentage now persist only in powerline corridors or along roadside margins where the periodic mowing to maintain open conditions effectively mimics the historical effects of grazing and fire that once maintained the original grasslands (See Figure 1). These remnants are perilously hanging on, but many are steadily degrading. In the past two to three decades, shifts in the way energy and transportation corridors are managed have led to heightened degradation of our remaining grassland remnants. This includes much more frequent mowing regimes which prevent native species from flowering or producing seed. In other cases, the use of herbicides to manage rights-of-way (ROW) has increased dramatically, leading to the immediate destruction of countless remnants.

The loss of our grassland habitats is leading to ecological collapse. NatureServe (2016) tracks 1,213 rare (G1- G3 ranked) plant communities from the southeastern United States; of these, 49% are grassland habitats. Dozens of these occur within Tennessee. Of the 440 rare plants tracked in Tennessee as special concern, threatened, or endangered, 60 percent require or preferentially grow in grasslands (Crabtree 2016). Out of more than 60 federally listed plants in the greater Mid-South region protected by the Endangered Species Act, 87% require or occur preferentially in grasslands. In Tennessee, 34% of terrestrial vertebrate animals require or preferentially utilize grasslands (Withers 2016).

Despite already knowing so much about what there is to lose, Tennessee grassland remnants are still very much yielding previously undiscovered species. In November 2017, a new endemic lily (*Stenanthium tennesseense*), was described from Coffee, Franklin, and Grundy counties where it is found in wet grasslands, including ROW (Sorrie & Weakley 2017). In 2015, 21 new species of grasshoppers were described from Southeastern grasslands, including a new grasshopper from rocky grasslands at Cedars of Lebanon State Park in Wilson County (Hill 2015). Currently, research is underway to study and name a new species of mouse from the grassy balds atop Roan Mountain in Carter County (Malaney, in prep.).

There is now stark realization among the conservation and scientific community that countless species are experiencing widespread crashes in their populations across what once were extensive ranges due primarily to ecological collapse associated with habitat loss of native grasslands. According to the 2016 Partners in Flight report, the Northern bobwhite quail's existing U.S. population will decline by half by 2032 (Rosenberg et al. 2016). Dozens of other grassland birds are experiencing similar declines due to loss of suitable habitat. Likewise, we are now in the midst of the "Great Insect Die-Off" according to the E.O. Wilson Foundation. Thousands of species are at risk of extinction due to the loss of suitable habitat, which should be rich in native plants that serve as food sources or host plants. This problem is especially dire with respect to many groups of pollinators, especially native bees, butterflies, and moths. For example, as of 2014 the monarch butterfly's population has declined by 48% of the 18-year average (Jepsen et al. 2015). Additionally, the rusty patched bumblebee, once common across portions of eastern Tennessee, has declined by 87% in the past 20 years across its range (USFWS 2018). In light of this, the rusty patched bumblebee was listed by the U.S. Fish and Wildlife Service as an endangered species in 2017.

With the understanding that an overwhelming percentage of our native biodiversity is threatened with extinction or in severe decline, it is important that immediate measures are put in place by

federal and state agencies to slow and hopefully reverse this troublesome trend. The Saving America's Pollinators Act of 2015/2017 (H.R.1284 and H.R.3040) and the Highways, Bettering the Economy and Environment Pollinator Protection Act (H.R.2738) were introduced to work toward stopping this decline, however none have been passed in the federal legislature. Despite this, several states have already enacted legislation regarding pesticide use, habitat protection, and research/outreach.

TDOT has the potential to lead the way in addressing this critical problem, which many scientists and conservationists consider to be the greatest threat facing terrestrial biodiversity of eastern North America. The good news is that there is still time to make an immediate impact just by recognizing the potential of existing transportation corridors to flourish as pollinator habitat. This can be achieved by making simple management alterations such as reducing the frequency of mowing, limiting mowing to specific seasons, and in abandoning the use of herbicide to manage select sections of our interstate and highway systems.

This project proposed an approach that TDOT can take to begin addressing this massive biodiversity problem. In addition to performing a baseline status survey of native grassland and pollinator habitats along our state's highway/interstate systems, the research team developed recommendations for specific sites where there is an opportunity to leverage partnerships and resources to increase the conservation impact at these sites. Additionally, the installation of a highly visible prairie was coordinated.

Chapter 3 Methodology

SGL had three objectives in this grant: 1) Status Assessment, 2) Management Plan, and 3) Demonstration Prairie.

3.1 Status Assessment

First, a baseline inventory of Tennessee's interstate and highway system was conducted. The purpose of the inventory was to identify and document remnant grassland habitat as well as other areas to target for restoration and/or re-creation. By definition, a remnant habitat is one that has remained relatively undisturbed by anthropogenic forces. As such, the conservation of these sites would only entail an alteration of management, such as reduced mowing or herbicide practices. On the other hand, areas that are candidates for restoration or re-creation could span a variety of ecological conditions ranging from minimally disturbed sites with few threats (e.g. invasive species) to areas that are highly degraded and consist mostly of exotic species. In the case of the latter, these areas would most likely be targeted for restoration/re-creation because of some unique circumstance of their position. Examples of these circumstances might include wide swaths of greenspace along a scenic byway or along an entrance to a state park. In these examples, a restoration/re-creation could create an opportunity to enhance the scenic value of a public area or even provide educational opportunities.

*"...a **remnant habitat** is one that has remained relatively undisturbed by anthropogenic forces."*

Since SGL's goal was to identify and document grassland habitats of various sorts and qualities, they initially limited the searches to the areas considered to be historic grassland regions (Southeastern Grasslands Initiative 2021). Using geospatial tools (ESRI ArcGIS Pro), SGL clipped a spatial layer consisting of all TDOT managed roads (highways, interstates, and state park roads) to the historic grassland polygons in order to narrow down the survey areas. SGL also applied other data layers to further hone in on areas that would likely be of ecological interest. These additional data layers served as indicators of high quality grassland and pollinator habitat. These data layers consisted of the following:

- a) Rare (federally or state-listed) grassland-dependent plant occurrence data obtained from the Tennessee Division of Natural Areas (TDNA)
- b) Occurrence data of grassland-dependent plants obtained from the Southeastern Regional Network of Expertise and Collections (SERNEC). SERNEC is a consortium of herbaria in the Southeast that has worked together to digitize herbarium records for use in research, management, and planning.
- c) Previous finer-scale mapping efforts of Middle Tennessee cedar glade grassland systems by Dr. Dwayne Estes
- d) Hal DeSelm vegetation plot data. Between 1993 and 2002, the late University of Tennessee professor Dr. Hal DeSelm collected vegetation data from thousands of plots across the state where he recognized unique habitats (Mains 2016)

A large component of the status assessment consisted of developing a Community Science program which SGL called Rubbernecking for Roadside Grasslands. In this program, SGL created

a training curriculum and field guide for Community Science volunteers across the state. The training provided instruction on how volunteers could aid SGI in conducting status assessments along Tennessee's highways. In an effort to make the training as approachable as possible to amateur Community Scientist volunteers, SGI used two different free, and easy-to-use platforms: iNaturalist and Google Forms. iNaturalist is a free web application and social network that allows user to share biodiversity information by taking photos of organisms (plant or animal) and uploading them into the iNaturalist system. The observations are georeferenced and visible (unless otherwise indicated) to the whole iNaturalist user community. The iNaturalist website includes a project creation tool that allows anyone to create a project and set up polygons as project areas in which users can make observations. For this project, SGI created polygons along all of the Tennessee highway rights-of-way that fall within the historic grasslands such that any observation made by a user within those polygons was included in the project. By creating a Tennessee Highway Grassland Project (<https://www.inaturalist.org/projects/tennessee-highway-grassland-project>) on iNaturalist (see Figure 2), volunteers could view the roadsides near their location and plan a trip accordingly.

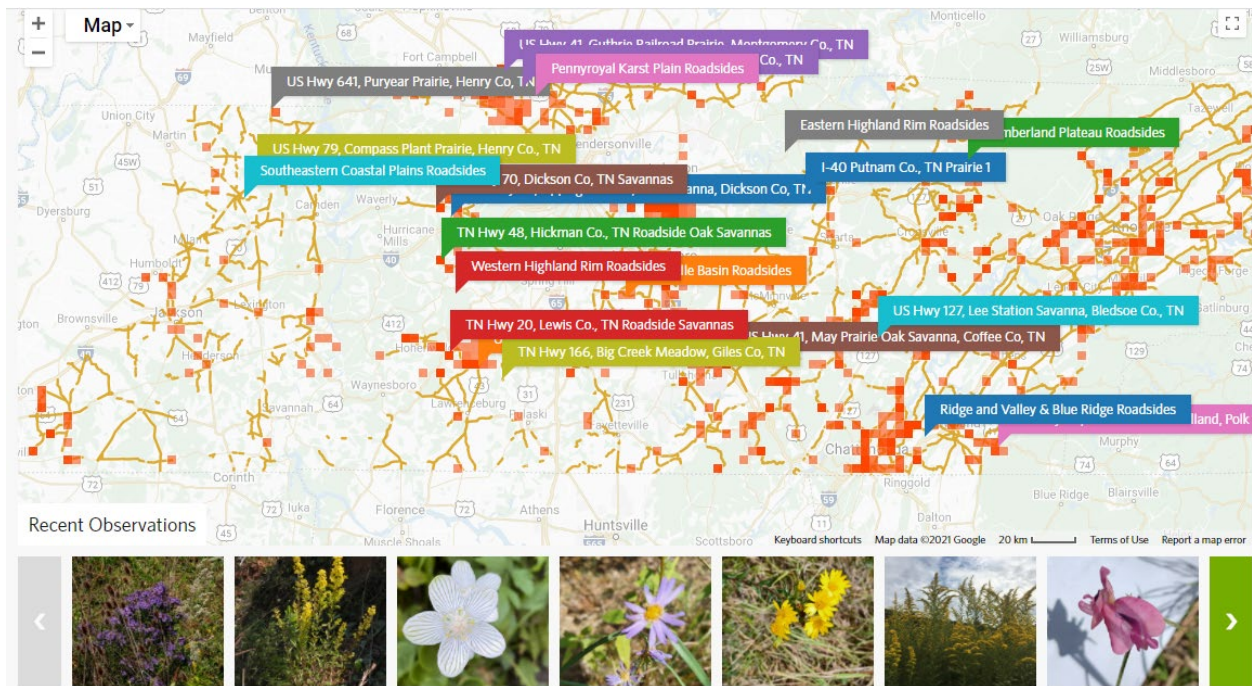


Figure 2 iNaturalist Project Map Example. This is a screenshot from a project page on the iNaturalist website. The yellow lines denote the roadside project areas, the orange squares are individual observations made by iNaturalist users (the strip of photos at the bottom contains photos from those observations), and the labels in variously colored boxes on the map denote specific projects.

The training curriculum consisted of a classroom and field portion. In the classroom, volunteers were instructed how to use iNaturalist to plan a survey trip. SGI also provided suggestions for field supplies and discussed safety considerations when conducting a survey on the roadside. The volunteers were also provided with some more technical advice on how to conduct a rapid survey, how to make high quality iNaturalist observations using a smart phone, and crash course in field botany. Once volunteers had completed their surveys, they were to submit a set of basic

data via a Google Survey form online. The final component of the training consisted a field trip to a natural area to put the lessons learned in the classroom to use. The Rubbernecking for Roadside Grasslands can be made available upon request or accessed from SGI's website at <https://www.segrasslands.org/rubberneckingresources>.

In addition to the Community Science volunteers, SGI staff also worked to conduct status assessments to supplement the data from volunteers.

3.2 Management Plan

The second objective consisted of the preparation of a management plan for how to better manage and restore native roadside grassland and pollinator habitat in the various regions of Tennessee. The implementation of a statewide management plan would be a long-term undertaking that would require review and approval across all divisions, a process that would likely be a lengthy one and extend beyond the grant period for this project. For that reason, SGI opted for a more short-term approach that would allow for protection and conservation of specific sites in the short term. The strategy consisted of identifying ecologically important sites and working with the appropriate regional TDOT staff to deliver management and protection recommendations for those key sites. Management recommendations would likely require some combination of altering the mowing regimes, altering or abandoning the use of herbicides, and/or the application of controlled burns. Other protection measures could include the installation of appropriate signage or training programs for roadside maintenance crews.

In the cases where the status assessment yielded a site where a grassland restoration or recreation would be appropriate (as opposed to the protection of a remnant), such as along a scenic byway or state park road, the management recommendations would also include guidance on restoration and/or installation. Such recommendations could include seed mix or site preparation recommendations, among other things.

3.3 Demonstration Prairie

The third objective was to install a highly visible prairie restoration that would serve to enhance public awareness of the importance of transportation corridors to pollinators, wildlife, and native plants. This prairie was to be similar in design and species composition to one of SGI's ongoing restoration project that was initiated in 2017 nearby at Dunbar Cave State Park in Clarksville (see Figure 3). A mix of 50 species of native grasses and flowering herbs was used for that project and proposed to do the same for this one. The mix is especially rich in native wildflowers needed by pollinators. More than 90 percent of the species used in the mix are derived from local genotype sources available from Roundstone Native Seed Company (Munfordville, KY). Roundstone was a key partner in this objective and was contracted to carry out much of the work needed to successfully install this prairie. This aspect of the project entailed preparing the site for planting

by applying herbicide on the exotic and invasive species that dominated the site in spring 2020 and then planting the seed mix following the herbicide treatments.



Figure 3 Prairie Installation at Dunbar Cave State Park.

Chapter 4 Results and Discussion

4.1 Status Assessment and Management Plan

TDOT shared a shapefile consisting of all TDOT managed roads, which totaled 13,238 miles. Using the historic grassland shapefile, there was determined to be 6,393 miles of roads that intersected the historic grassland polygons. This was the starting point for conducting assessments along the highways, but the assessment was not limited to those polygons. The shapefile used to denote historic grassland regions (Southeastern Grasslands Initiative 2021) is based on knowledge of the terrain, geology, soils, floral diversity, and ecosystem processes that contribute to the formation of grassland ecosystems. However, research conducted by SGI staff as well as by a broader scientific community continually sheds new light on better understanding of grassland ecology. As such, there is a recognition that there are likely historic grasslands outside of the shapefile currently being used to denote the location of those ecosystems. Due to this, some of the points of interest do fall outside of the current version of the Historic Grasslands of the MidSouth—at some point, the shapefile will be revised to reflect the new understanding of historic grasslands.

Once the mapping of the project focal areas was complete, the extra data layers described in section 3.1 were then used to further hone in on potential areas of interest. Figure 4 provides a snapshot of these data layers in relation to the highways that intersect the historic grassland regions of Tennessee. In the Community Science training, volunteers were encouraged to reach out to SGI staff if they needed more guidance as to where to conduct a survey. It was in these cases that the extra data layers proved to be most useful as it provided a specific target site for a volunteer to begin their survey.

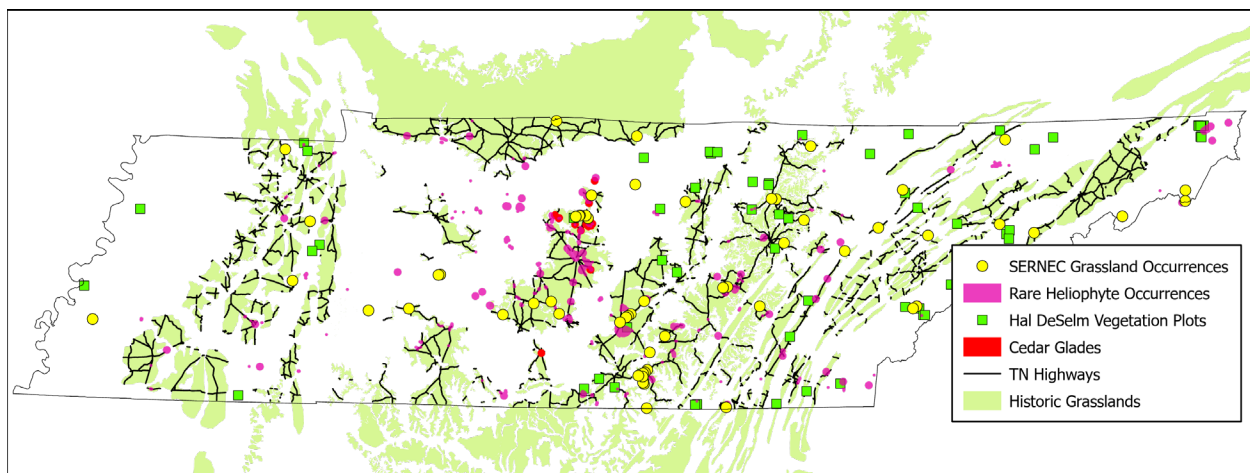


Figure 4 Mapping Data Layers. The map shows the TDOT managed roads (black lines) within the historic grassland regions of the Mid-South (light green polygons). Other layers are different data sources that were used to help identify ecologically significant areas.

Over the course of the project, SGI had at least 25 Community Science volunteers participate in the roadside surveys in 2019 and 2021. They contributed over 160 hours of their time and drove over 3,000 miles. However, these numbers are conservative estimates. When working with volunteers, it never fails that a small percentage will not follow reporting protocols exactly as instructed, sometimes because of reasons beyond their control. This is especially true when

technology (websites, apps, etc.) is required in the volunteer work. While the research team was diligent in communicating with volunteers, there were cases where not all some volunteers' data was captured, despite their important contributions to the project. Of course, the global pandemic also dramatically affected SGI's ability to carry on with the volunteer component in 2020. Volunteers were not involved in data collection in 2020 and it was not until Spring 2021 when the public health situation became more stable that SGI began to rely on the volunteers' generous contributions again.

The data collected by Community Science volunteers and SGI staff resulted in 31 remnant sites along Tennessee's highways and interstates (see Figure 5 and Table 1; geospatial data available upon request). This is by no means a comprehensive list of all remnants, but it is a list of sites that have been well documented and confirmed to be unique remnant grassland ecosystems and would be ecologically significant pollinator habitats due to the diversity of species and structure present at these sites. Aside from being remnant habitat, many of these sites have other features that make them unique including the presence of rare plant species and opportunities for collaborative partnerships and/or educational opportunities. In the case of rare plant species, this puts conservation of these sites at a higher priority. In many cases, the rare species found at these sites were previously unknown occurrences.

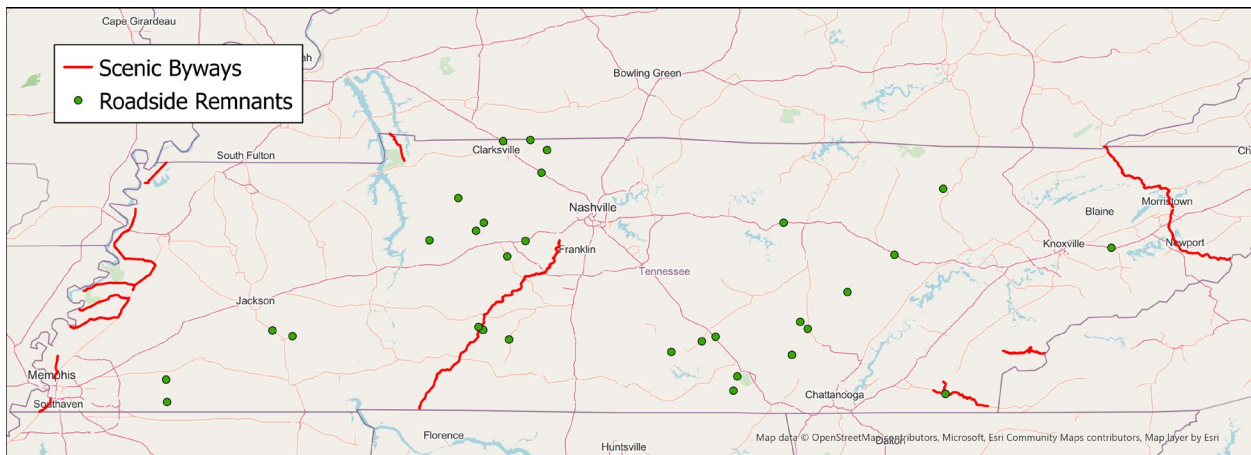


Figure 5 Roadside Remnants and Scenic Byways. Areas of interest that resulted from the survey efforts of Community Scientists and SGI staff.

Many of the sites create an opportunity for collaborative partnerships of different sorts. Most of them occur in a powerline ROW, which gives the opportunity to collaborate with the utility that manages the ROWs. In some cases, the sites are on or adjacent to other public sites such as National Parks, State Parks, State Natural Areas, State Forests, or Universities. This creates an opportunity to leverage resources to conserve these sites. In many cases, these sites are in highly visited public areas

When a relatively small roadside remnant with a diverse assemblage of increasingly uncommon plants is preserved, it allows conservationists to collect seed which they can then use in other restoration projects in the region, which will ultimately bolster pollinator habitat conservation on a regional scale.

which would increase the visibility of the site and may also provide for educational opportunities. Certain sites are closely tied to active conservation projects happening nearby. The protection of these roadsides might improve the effectiveness of those conservation projects. For example, altering the mowing regime of the two Fayette County sites (see below Section 4.2) will allow partners to collect seed of the Trumpet Beardtongue which they can then propagate and incorporate into prairie restorations nearby. *When a relatively small roadside remnant with a diverse assemblage of increasingly uncommon plants is preserved, it allows conservationists to collect seed which they can then use in other restoration projects in the region, which will ultimately bolster pollinator habitat conservation on a regional scale.*

In addition to the conservation of remnant sites, there are also opportunities for habitat restoration or re-creation projects. In some cases, these sites may not be high quality remnant habitats, but could be worth an investment in restoration/re-creation because of opportunities afforded by its location, such as National Scenic Byways or along rights-of-way in State Parks. Such projects may enhance the scenic value and educational opportunities to visitors of these areas. Figure 5 shows the six National Scenic Byways in Tennessee as red lines. From SGI's standpoint, restorations or re-creations at key locations along these National Scenic Byways or within State Parks could be highly effective projects due to the increased visibility at these sites, not to mention their conservation value.

Table 1 LIST OF REMNANT SITES

<i>ID</i>	<i>County</i>	<i>Road</i>	<i>Site Details</i>
1	*Madison	TN 45	Location of the extraordinarily rare Whorled Sunflower. SGI will be working with a Pollination Ecologist to study the pollinators associated with this rare sunflower.
2	*Franklin	TN 56	Barrens adjacent to State Natural Area/State Park containing federally rare Morefield's Leatherflower. First official collaboration with regional TDOT office to protect an ecologically significant roadside.
3	*Dickson	TN 70	Known as the "Piccadilly Prairie." Long stretch in TVA powerline ROW containing rare and unique species.
4	*Lewis	TN 20	Road frontage of Meriwether Lewis National Monument adjacent to park entrance containing rare species. There have been previous conversations with NPS Natural Resource Specialist about collaborating on conservation of these roadsides.
5	Bledsoe	TN 101	Powerline ROW in Bledsoe State Forest.
6	Morgan	TN 52	Powerline ROW near Big South Fork.
7	Coffee	TN 41	Long stretch adjacent to May Prairie State Natural Area containing rare species.
8	Montgomery	TN 41	Narrow strip between highway and railroad with unique plant community. Near the historic Trail of Tears. There

			have been previous conversations with CSX Transportation to preserve this area.
9	Chester	TN 100	Long powerline ROW adjacent to a TDOT maintenance station. Only occurrence in TN of the Prairie Snoutbean.
10	*Lewis	TN 20	Powerline ROW near the Natchez Trace and Meriwether Lewis National Monument.
11	Putnam	I-40	Large swath of prairie remnant highly visible from I-40.
12	*Fayette	TN 57	Location of Trumpet Beardtongue, a rare species and early-blooming plant important for spring pollinators. Currently aiming to collect seeds for this species as a collaborative conservation project between SGI, Memphis Botanic Garden, TN Wildlife Resources Agency, and TN Division of Natural Areas.
13	Williamson	TN 96	Corner of Hwy 96 and I-40 onramp.
14	*Dickson	TN 235	Lengthy powerline ROW containing rare species.
15	Houston	TN 49	Powerline ROW with remnant grassland barren ecosystem.
16	Humphreys	TN 230	Diverse wildflower meadow on wide swath.
17	Lawrence	TN 43	Remnant savanna with important prairie savanna ecosystem.
18	Hickman	TN 7	Powerline ROW with unique prairie savanna.
19	Sevier	TN 139	Very unique barrens grassland in powerline ROW containing unique prairie assemblage.
20	Montgomery	I-24	Exit 1 of I-24 and site of prairie installation associated with this grant.
21	Cumberland	TN 1	Unique floral assemblage in powerline ROW.
22	Robertson	TN 41	Increasingly rare wet meadow ecosystem.
23	Robertson	I-24	Interstate wet meadow with abundant Swamp Milkweed, the host plant for the Monarch Butterfly.
24	*Fayette	TN 76	Highly diverse prairie in powerline ROW containing Trumpet Beardtongue, part of the project mentioned above in the TN 57 site.
25	Franklin	TN 41	Along broad roadside near Sewanee and adjacent to popular hiking trail.
26	Coffee	TN 55	Unique barrens ecosystem containing rare species.

27	Moore	TN 55	Roadside adjacent to Motlow State Community College with whom SGI is developing a partnership on other restoration projects.
28	Grundy	TN 108	Adjacent to barrens ecosystem in powerline ROW and containing rare species.
29	Sequatchie	TN 8	Site with a mix of wetland and upland prairie containing a unique species assemblage.
30	Sequatchie	TN 8	Extraordinarily unique wetland community with highly diverse and appealing wildflower assemblage.
31	Polk	TN 64	Unique savanna restoration site on the Ocoee Scenic Byway in the Cherokee National Forest.

*Sites which are discussed more extensively in Section 4.2.

Section 4.2 will highlight a few different sites, why they are important for conservation, and how they may present unique opportunities for TDOT. These sites only consist of a handful of the sites identified throughout the project, not to mention the other remnants that remain undocumented across the state. These sites were selected because they highlight diverse opportunities for TDOT and create potentials to have a large impact on conservation of both pollinator habitat and, more broadly, on grassland ecosystems.

4.2 Remnant Site Profiles

SGI Seed Program. Before highlighting the site profiles, it is worth expounding on one common theme that is applicable to all of the site profiles below: their importance as a seed source for rare or increasingly uncommon plant species which serve as the foundation for pollinator habitat. This is not only relevant to plant conservation, but also more broadly to the conservation of whole ecosystems, which includes pollinator conservation. There is a growing movement, both nationally and internationally, toward the use of native plants in public projects. More specifically, the movement is increasingly trending toward the use of local genotype seeds—this refers to the use of seeds that are sourced from the specific region in which they are used. For example, a large portion of the seeds used in the Exit 1 Demonstration Prairie were local genotype because they were harvested from local sites at Fort Campbell, after which Roundstone Native Seed used those collections to increase the amount of seed at their facilities which were then planted at Exit 1.

TABLE 2: SGI SEED PROGRAMS

<i>Program</i>	<i>Purpose</i>	<i>Funding Sources</i>
Conservation Seed Bank	Conserve vulnerable populations of rare and declining species.	Google, Garden Club of Nashville, BAND Foundation
Seeds of Success Southeast	Establish a 10-state collection program targeting species that represent important components to regional ecosystems. Work with seed producers to facilitate an increase in availability for native seeds in conservation and restoration projects.	BLM, USFWS (5 year funding)
Plant it Forward	Collect native grassland seeds from across Tennessee to be used in conservation projects.	USDA NRCS (5 year funding)
Regional Seed List Development	Working with more than 30 National Parks throughout the Southeast to develop regional seed lists that comprise species appropriate for restoration within these parks. By extension, this will be more broadly application to projects within the greater region.	NPS

SGI has recently acquired major funding from multiple agencies, foundations, and corporations to develop a native seed conservation program in the Southeast through collaborative projects. This includes the programs described in Table 2. All of these programs have the goal of increasing local genotype seed availability for restoration, re-creation, and conservation projects. As these seed conservation efforts expand throughout the region, this will result in more native habitat restoration projects, which ultimately will increase pollinator conservation impact.

Carter Cave State Natural Area, Franklin County. Refer to Site 2 in Table 1. This site along Hwy 56 is adjacent to the Carter Cave State Natural Area and is unique for a few reasons. For one, it has several rare plant species such as Cumberland Rosinweed and Eggert’s Sunflower, but most significantly there is an occurrence of the federally endangered Morefield’s Leather-flower (see Figure 6).



Figure 6. Hwy 56 Roadsides in Franklin County. Clockwise from top left: steep slope with unique grassland barrens system; the federally endangered Morefield’s Leatherflower; Eastern-Tailed Blue on a Pale Spiked Lobelia; prairie strip with many important plants for pollinators including the Gray-headed Coneflower; steep and rocky barrens with many important pollinator plants including Dense Blazingstar (foreground) and Butterfly Milkweed.

The sites also have a high concentration of species with a high affinity for high quality grassland remnants. This includes the rare species, but also some less rare species, many of which are important pollinator plants, including Butterfly Milkweed, Purple Coneflower, Dense Blazingstar, several types of goldenrod, and many more.

This site where SGI first worked with multiple partners to develop a strategy for protecting a roadside remnant. Previously, the site had been treated with herbicide in the course of routine maintenance—the operators were not aware of the site’s significance. Surprisingly, the habitat

was not greatly impacted. This incident prompted a meeting among representatives from SGI, TDOT (regional maintenance staff and from Beautification who serve as the lead for this grant), TDNA, and Tennessee State Parks to discuss a way to prevent this from happening in the future. In this meeting, the partners developed a simple strategy to protect this site that consisted of installing appropriate signage at multiple points along the road. In this case, since the site is a narrow ROW with a steep slopes or outcrops, the only alteration of management that was needed was to avoid the application of herbicide at these sites. Figure 7 shows the No Spray sign (left photo) that was installed. TDOT routinely (>annually) manages woody (tree and shrub) growth along the outcrop with a chipper but does not mow the site due to its steep and rocky terrain which is apparent in the photos in Figure 6. The maintenance of woody trees and shrubs will benefit the ecosystem in this site since it will prevent trees or shrubs from shading out the herbaceous vegetation.



Figure 7. Roadside Signage. On the left is the No Spray sign installed at the Hwy 56 sites. The sign on the right was a new sign concept developed by TDOT staff in 2020 for other sensitive sites.

The incident of the unfortunate—albeit accidental—herbicide application and the subsequent meeting gave rise to a promising and simple model by which TDOT and other partners can work to protect more sites throughout the state. The model would be to simply work with the relevant TDOT staff to protect ecologically important sites by way of agreeing on altered management practices, appropriate signage, etc. As of the time of this report, this site on Hwy 56 is the only one where such an agreement with TDOT and other relevant partners has been arranged. However, conversations have begun to pursue this at other sites. TDOT staff developed a new sign that can be installed at other sensitive sites (the sign on the right in Figure 7). While the work

on this particular contract has been completed, SGI plans to pursue this model, either through future research opportunities with TDOT or other agencies.

Natchez Trace vicinity, Lewis County. Refer to Site 4 and Site 10 in Table 1. Lewis County contains many unique grassland ecosystems, from tallgrass prairie to oak savannas to small wetlands called seepage fens, all of which contain a unique assemblage and diversity of herbaceous plants and vegetation structure that are important for pollinators and wildlife of all sorts. Lewis County also has a higher concentration of remnant ecosystems remaining—relative to many areas of Tennessee—and this provides ample opportunities for grassland and pollinator conservation. This is expounded by the presence of the National Park Service (NPS) lands, namely the Natchez Trace (a National Scenic Byway) and Meriwether Lewis National Monument (MLNM). Currently, all of the road frontage of both Meriwether Lewis and the Natchez Trace are mowed regularly, despite their remnant conditions. Potential projects in this area could include a combination of remnant conservation as well as restorations/re-creations along the Natchez Trace.



Figure 8. Natchez Trace Roadsides. These large swaths of open areas are regularly mowed along the Natchez Trace but could serve as ideal locations for conservation of remnants in some sites or restorations/re-creations in others.

The Natchez Trace provides ample opportunity for restoration and re-creation. Considering the high visibility, it would also provide for educational opportunities through interpretational signage or ranger- or ecologist-led events to showcase the importance of remnant grassland habitat for pollinator habitat. The Natchez Trace appears to be regularly mowed, though there are long stretches of wide-open swaths that would be ideal for grassland projects (Figure 8). In some of these areas, there is a largely native vegetation structure already present, and the only thing required to maintain it as a native wildflower grassland would be an altered management regime. Depending on the quality of site, it may also be appropriate to supplement with an appropriate seed mix. If a seed mix was appropriate, SGI’s quickly burgeoning seed program could be of assistance and supply regional ecotype seed. In other areas along the Natchez Trace, some site preparation, e.g. controlling invasive or exotic species, may be necessary prior to

installing a seed mix. Figure 8 shows a few examples of the roadsides in between Hwy 20 and Hwy 412. There are opportunities for open grasslands as well as savanna habitats as apparent in the third photo.

There are also remnant habitats surrounding the Natchez Trace lands. One such significant remnant is along Hwy 20 just west of the entrance to MLNM (see Figure 9). Conservation and appropriate management of the MLNM remnant that occurs here would be especially beneficial due to the occurrence of two rare plant species that occur there, the Dwarf Sundew and Barbed Rattlesnake Root. Such actions would not only conserve this unique and disappearing grassland ecosystem but would benefit the rare plants that occur there.



Figure 9. Merriwether Lewis National Monument Road. This is the NPS road frontage along Hwy 20 that includes oak savanna habitat (left) as well as open barrens systems (center) and a few examples of key indicator species, Maryland Golden-aster (top right) and Milkwort (bottom right). In these photos, the roadside is freshly mowed.

Lastly, there are other scattered remnants along Hwy 20 that are not on NPS land, many of which occur in powerline ROWs along Hwy 20. There is ample opportunity to collaborate with the utility company that manages these ROWs.

Because of the multiple stakeholders present in the area, there are many unique opportunities for conservation available to TDOT. In the process of conducting assessments, SGI staff met with the Natchez Trace Natural Resource Specialist who expressed interest in collaborating on conservation-focused projects on these NPS lands. Aside from NPS, there are opportunities in the broader community in and around Hohenwald, Summertown, and greater Lewis County. Summertown itself is unique in that there is a conservation-minded community with organizations like the Swan Conservation Trust and the Farm Community that have embarked on many large conservation projects. In fact, both the Farm Community and the Swan Conservation Trust manage tallgrass prairie and oak savanna habitat the likes of which do not exist anywhere else in the region. These areas also serve as an ideal seed source for any projects within the area. Overall, there is much conservation potential within a condensed area centered

on the Natchez Trace. There are abundant opportunities for TDOT to collaborate with SGI and other conservation-minded partners to improve protected grassland and pollinator habitat.

Whorled Sunflower, Madison County. The Whorled Sunflower (*Helianthus verticillatus*) is a federally endangered plant that only occurs in 5 places worldwide, two of which are in Tennessee. All of the populations except for one in Georgia are in highly vulnerable areas such as the edge of soybean fields, on heavily eroded agricultural stream banks, or on regularly herbicided roadsides. To make matters worse, most of the populations only contain a handful of individuals, and one contains only a single individual. This is unfortunate because it is a species that requires cross pollination with other individuals to produce seed. When there are just a few individuals, that puts it in an especially imperiled position since the chance of cross pollination is reduced.

One of the Whorled Sunflower's occurrences in Tennessee is on the side of Hwy 45 just south of Pinson in a powerline ROW (see Figure 10). This population has been herbicided multiple times by the utility company, the most recent of which was in 2020. In the monitoring efforts of 2020 following the herbicide application, many of the individuals that have been tracked for years were not found. With any luck these plants will come back this year in 2021.



Figure 10 Whorled Sunflower Site. One occurrence of Whorled Sunflower occurs on this Hwy 45 roadside south of Pinson and is highly vulnerable to herbicide and invasive species that dominant the area.

Fortunately, SGI has spearheaded a multipronged conservation effort that includes, among other actions, the collection of seed that can be used to grow more plants for introduction into protected sites. SGI is working with TDNA, University of Memphis researchers, and horticulturists at Cheekwood Estates and Gardens on different aspects of these conservation efforts. SGI will also be working with a pollination ecologist from Auburn University to learn more about the bees that use and depend on the Whorled Sunflower both for habitat and pollen.

TDOT has an opportunity to participate in impactful conservation by joining in as a partner in projects like this. Most urgent is the need to protect any of the roadside occurrences (it is currently only known from Hwy 45). But there is also an opportunity to play a greater role by supporting some of the larger efforts like learning more about its pollination ecology or in its introduction into protected areas. SGI is working with TDNA on a restoration at Pinson Mounds State Archaeological Park specifically for the purpose of introducing the Whorled Sunflower.

There could be an opportunity for TDOT to be involved in the project by joining the restoration, much in the same way that TDOT has conducted pollinator plantings at other State Parks.

Trumpet Beardtongue, Fayette County. The Trumpet Beardtongue (*Pentemon tubaeflorus*) is an early flowering plant that is state listed and only known from four occurrences, two of which are on Tennessee highway roadsides (see Figure 11). As with the Whorled Sunflower, the Trumpet Beardtongue has a group of insects that depend on it. This makes the conservation of these sites important for pollinator conservation since there are several groups of bees and wasps that specialize on the pollen of Beardtongues. For both the Whorled Sunflower and Trumpet Beardtongue, this emphasizes the importance of remnant habitats like these on roadsides. In both cases, the plants are known from only a small handful of occurrences, some of which are on roadsides.



Figure 11. Roadside on Hwy 76 in Fayette County. This site is a floristically diverse sites in a powerline ROW. Important nectar sources are apparent such as Yellow Crownbeard (left) and Butterfly Milkweed (center). The Trumpet Beardtongue (right) also occurs here.

This gives TDOT a huge opportunity to protect sites like this as important and unique pollinator conservation sites. From a broader prospective, this also provides TDOT the opportunity to partner with other conservation partners on their projects that incorporate these unique roadside occurrences. By way of example, SGI has a Conservation Seed Bank for the purpose of conserving the genetic integrity of rare and declining grassland species, especially vulnerable populations like these roadside occurrences of Trumpet Beardtongue. Throughout the course of this project, SGI has worked with volunteers to monitor roadside occurrences like these. This year, an SGI volunteer in West Tennessee served as the eyes on the ground and agreed to keep an eye on these small populations. When the plants mature, the volunteer will collect seeds which will then be used for broader restoration efforts. Similar to the Whorled Sunflower project, SGI is partnering with Memphis Botanic Garden horticulturists to grow this species from this collected seed, and will ultimately work with other partners to introduce the plants into a protected area. One prospect being considered is whether some of the managed prairies at Wolf River Wildlife Management Area just down the road from these occurrences might serve as appropriate

introduction and conservation sites for these unique and rare species that serve such an important resource for pollinators.



Figure 12. Picadilly Prairie. Top row: extensive roadside looking both directions at the Piccadilly Prairie. Center, left to right: three important grassland indicators—Narrowleaf Rose-pink, Ashy Sunflower, and Prairie Phlox. Bottom, left to right: the rare Barbed Rattlesnake-root with a Bumble Bee scarcely visible nectaring on the left flower; a large stand of Narrow-leaf Sunflowers.

Picadilly Prairie, Dickson County. The Picadilly Prairie (spelling of “Picadilly” varies among sources), as it has been known in the ecological community since the botanist Augustin Gattinger documented the ecosystems of Tennessee in the late 1800s (Gattinger 1887), was once a large prairie and savanna west of Dickson off of Hwy 70. Unfortunately, a large section of it was severely degraded years ago as the city of Dickson and the surrounding area expanded and became developed. Currently, one of the best known remnant holdovers from the Picadilly Prairie is a relatively extensive roadside in a Tennessee Valley Authority powerline ROW along the south side of the highway (refer to site 3 in Table 1). While this particular stretch is the highest quality remnant, there are others in the region that are ecologically similar, e.g. site 14 in Table 1.

Like some of the other sites in other parts of the state described above in this section, these remnants serve as important conservation sites because they host unique plants that are increasingly uncommon in the wild because of anthropogenic impacts. This includes species such as Rosepink and Prairie Phlox (Figure 12). Similarly, Picadilly Prairie also has rare species like the Barbed Rattlesnake Root, a desired nectar source for Bumblebees.

As with the other sites, TDOT has the opportunity to preserve the Picadilly Prairie as a remnant habitat chalk full of plants that are important for pollinators. In addition, conservation of this site, by way of altered mowing and spraying practices, would allow for the collection of seed, which ultimately will result in an exponential impact since the seed would be used in other conservation projects in the area.

4.2 Demonstration Prairie

SGL worked closely with Roundstone Native Seed Company, a company that specializes in growing and supplying regionally adapted and native seed, to install a prairie within each of the four interchanges of Exit 1 of I-24 in Clarksville. Due to the dominance of exotic and invasive plants at the Exit 1 site, a heavy amount of site preparation consisting of broadcast herbicide was required to eliminate the noxious species.



Figure 13. Exit 1 Prairie Installation in Montgomery County. An impressive showing of Lance-leaved Coreopsis (left), Smooth Beardtongue (top right) and Butterfly Milkweed (bottom right) in June 2021, one year after the installation. Photos by Rebecca Johnson.

In the Fall of 2019, Roundstone applied their first herbicide treatment and then planted a cover crop to prevent erosion during the dormant season. In Spring 2020, Roundstone applied two more herbicide treatments because Johnson Grass, a highly invasive grass species, had aggressively re-emerged. In June 2020, Roundstone planted a seed mix consisting of 24 species. The majority of the seeds included in the mix were ultimately sourced from Fort Campbell less than 20 miles to the west. Following the installation, Roundstone continued with yet another round of herbicide application to treat patches of Johnson Grass that continued to emerge. Fortunately, even after this application there was a high rate of germination of the native seeds (see Figure 13).

In the near future, the site will need some careful management to prevent Johnson Grass and other invasive species from encroaching into the planted area. This will entail two different management considerations. First, periodic treatment of some of the remaining small patches of Johnson Grass and other invasive species within the prairie will be necessary. Second, it will be necessary for maintenance crews to exercise some diligence in mowing the unplanted areas in the margins of the interchange to prevent the extant Johnson Grass from maturing and going to seed, which could be spread into the planted prairie.

Chapter 5 Conclusion

Prior to this project, there has never been a comprehensive survey of all of the roadside remnant habitat in Tennessee as far as SGI staff are aware. However, through various sources, whether that be anecdotal accounts from ecologists, correspondence, publications, or herbarium specimens, many ecologists in the region have been aware of high quality habitats throughout the state, including on roadsides. The Picadilly Prairie is a great example of that, having been documented and discussed for well over a century. Unfortunately, these same ecologists have provided anecdotal evidence that these remnant sites are in steep decline due, in many cases, to maintenance routines that are not conducive to healthy habitat. Most damaging are the indiscriminate, broadcast herbicide applications that can destroy a millennia-old habitat with one single application. However, improperly timed mowing regimes will take its toll eventually, as well. This doesn't only impact the plants, but the whole ecosystem. Rights-of-way serve as the last bastion of grassland habitat in many areas, and they serve as corridors that can support the many increasingly rare grassland-dependent animals, from butterflies to bobwhite. TDOT has an enormous opportunity to play a leading role in the conservation of these unique habitats by conserving these remnant sites.

SGI's goal in this project was to conduct a statewide assessment of the grassland and pollinator habitat on the Tennessee highway system and locate areas where there are opportunities to conserve, restore, or re-create these unique places. While the global pandemic did cut down on the capacity to complete these assessments, the attempts to document the high quality areas throughout the state were nevertheless successful. This attests to the fact that volunteers, when trained appropriately, can be relied upon to gather valuable ecological data. The challenge now will be to forge the partnerships with the appropriate entities necessary to conserve these sites appropriately. In some cases, working with the regional TDOT offices will be sufficient. However, in other cases there are other stakeholders to engage, e.g. utility companies or other state/national agencies that share the ROW. Ultimately, what is needed to conserve these unique remnants in the long term is a change in policy that is more beneficial to native plants in general and is also more scientifically informed. Until then, the strategy that was developed as part of this grant is a positive way forward. This involves making the relevant TDOT connection within the region where a remnant or other sites of interest occurs and coming up with a solution by which to conserve that site, whether through altered mowing regimes, herbicide application regimes, or other such practices.

While the research team was successful in locating many remnant and promising restoration sites, it is believed there are many more out there. It is recommended that TDOT continue to build on this project by establishing mechanisms to protect known sensitive areas, but also continue to identify new sites before they disappear due to inappropriate management. Further, TDOT should consider how it might be able to do more to develop "grassland corridors" in such places as scenic byways. These would serve to provide grassland habitat for pollinators and other wildlife. To accomplish this, collaborative partnerships will be essential. In the site profiles in Section 4.2, just a few unique opportunities were provided. Similar opportunities like this exist at most of the sites throughout the state. For instance, the Hwy 41 site in Montgomery County (refer to Site 8 in Table 1) has an opportunity to work with CSX. Previously, there have been conversations between TDNA and CSX to officially preserve this site because of its ecological and

historical value (it is along the Trail of Tears). In other examples, such as near Sewanee (site 25 in Table 1) or Motlow State Community College (site 27 in Table 1), there exist opportunities to work with universities with which SGI has developing or lasting partnerships. As this model is pursued, SGI can begin to develop a set of management recommendations, guidelines, or agreements at each site.

Through SGI's work with other organizations in the region, a strategy at the Georgia Department of Transportation was learned about. See Appendix I for an example of a form which they refer to as an ESA Management Agreement. While theirs is focused primarily on rare plants, such a form could be adapted to fit the unique circumstances of a site in Tennessee, e.g. unique pollinator host plants, partnership opportunities, etc. SGI hopes to continue to be able to work with TDOT on these ideas to continue to build on the foundation established in this Research opportunity. If TDOT continues to invest in such efforts, it could become a national leader in conservation. This will become increasingly true as governments continue to seek solutions to the looming biodiversity crisis resulting from climate change.

SGI is appreciative to TDOT for their interest in conserving the unique places on the roads that they manage. This project hopefully serves as a starting point from which more future conservation efforts will flow. SGI looks forward to future collaborations with TDOT and is grateful for the opportunity provided.

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Appendix I: GDOT ESA Agreement

Georgia Department of Transportation ESA Agreement

Original Date:

Revision Date:

Ecology Environmental Sensitive Area (ESA) Management Agreement

Section 1 – Guidance/Information for Districts and Contractors

Species & Location Information: *Confidential, unavailable for open records requests.*

Species:

Common Name:

Road Name:

County:

Mile Post Start:

Mile Post End:

GPS Start:

GPS End:

ESA Sign: Y/N

ESA Sign Location (GPS):

Construction/Maintenance Restrictions:

Activity	Restrictions (Y/N/NA)	Restrictive Period	Notes
Herbicide Pesticide			
Mowing			
Woody Veg Clearing			
Ground Disturbance			
Other			

N = No; Y = Yes; NA = Not Applicable

Important: If any of the proposed construction/maintenance activities are in conflict with the above mentioned requirements, the district will contact and consult with the OES.

OES POC: _____ District POC: _____

Map:

Include a high quality GIS Map that includes

- limits of the ESA (not the EO)
- ESA sign locations.

Note where the GIS files are saved.

Photos:

Include pictures of the:

- ESA signs
- Habitat (picture taken from one of the perspective of one of the ESAs signs)
- Species – include a picture of the species photographed on site

Ecology Environmental Sensitive Area (ESA) Management Agreement

Section 2 – Background Information & Coordination Efforts

Purpose:

Provide a short summary explaining why species management is needed, including legal requirements, rare species and habitat benefits, and ROW-management benefits.

Population Discovery:

Record when the population was identified and by whom.

Discovery Date:

Discovered by: Include name, title, and agency.

Coordination & Construction/Maintenance Requirements:

Record who was involved with any preliminary discussions regarding population management, including details of the discussion and construction/maintenance requirements.

Initial Coordination Date:

Initial Coordination POCs: Include name, title, agency

Coordination Notes/Results:

Ongoing Coordination & Monitoring:

Record which representatives should check in with each other, and how often. If future coordination efforts establish that changes are required to the current management agreement and construction/maintenance requirements, a discussion of the proposed changes will be documented.

OES POC: _____ District POC: _____

DNR POC: _____ USFWS POC: _____

NMFS POC: _____ CRD POC: _____

Coordination Plan: