



# Building Meadows

a Practitioner's Guidebook



2026

## About Pennsylvania Environmental Council

The Pennsylvania Environmental Council (PEC) works to protect, restore, and enhance the Commonwealth's natural and built environments through innovation, collaboration, and strategic leadership. For more than half a century, PEC has brought together communities, land managers, scientists, and policymakers to advance practical, science-based solutions that strengthen Pennsylvania's landscapes and the people who depend on them. This meadow-building guide, commissioned by PEC and developed by ArcheWild®, reflects that commitment—providing clear, actionable guidance to help land stewards create resilient, biodiverse meadows that support wildlife, enrich public spaces, and contribute to a healthier ecological future for Pennsylvania.

## About ArcheWild®

ArcheWild® is a leading ecological restoration firm known for its scientific rigor, authenticity, and deep practical experience across the landscapes of the Mid-Atlantic. Drawing on decades of fieldwork, applied research, and hands-on project delivery, ArcheWild® helps land stewards design, build, and sustain resilient native ecosystems that reflect both ecological integrity and real-world constraints. Their team brings a rare combination of technical expertise, horticultural precision, and operational pragmatism—ensuring that every meadow, woodland, and habitat they help create is grounded in sound science, shaped by place, and built to thrive.

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# INTRODUCTION

## Who is this document written for?

This document is written for land managers, park managers, natural resource managers, and anyone else that is responsible for large land parcels who wants more information and guidance on the meadow building process than what is currently available in the available literature, or online.

## How does this document complement the existing literature?

Existing literature frequently focuses on “why” someone might want to build a meadow and on the steps that a person should follow to build one. The literature accurately describes the importance of selecting an appropriate site, but not “how” to select one. Most existing meadow guides describe the importance of controlling weeds and invasives, but few provide enough information for someone to confidently perform the work. Selecting species for a meadow is a critical step, but few guides describe the process for doing so, outside of buying a premade mix on the internet. Even fewer guides talk about how to choose a sowing method or the exact steps required to successfully operate a seed drill, partly because there are so many models available.

This guide is designed to go behind the scenes and take a close look at how an experienced meadow building team performs their work step-by-step, to reveal key decision points, nuanced techniques, and the technology they use to deliver professional results.

*Note: this tool kit is not a meadow “design” guidebook. There is no information in this document about individual species, there are no plant lists, and no seed mix recommendations. There are no tables of bloom time and color, leaf texture, height, or any other horticultural information.*

## How was this document written?

This document was written to mirror the thought processes, decisions, and actions that professional meadow builders follow every day; this document reveals their processes and their technology.

Links are provided to third-party information sources where a topic is well-covered elsewhere, such as obtaining your pesticide applicators’ license.

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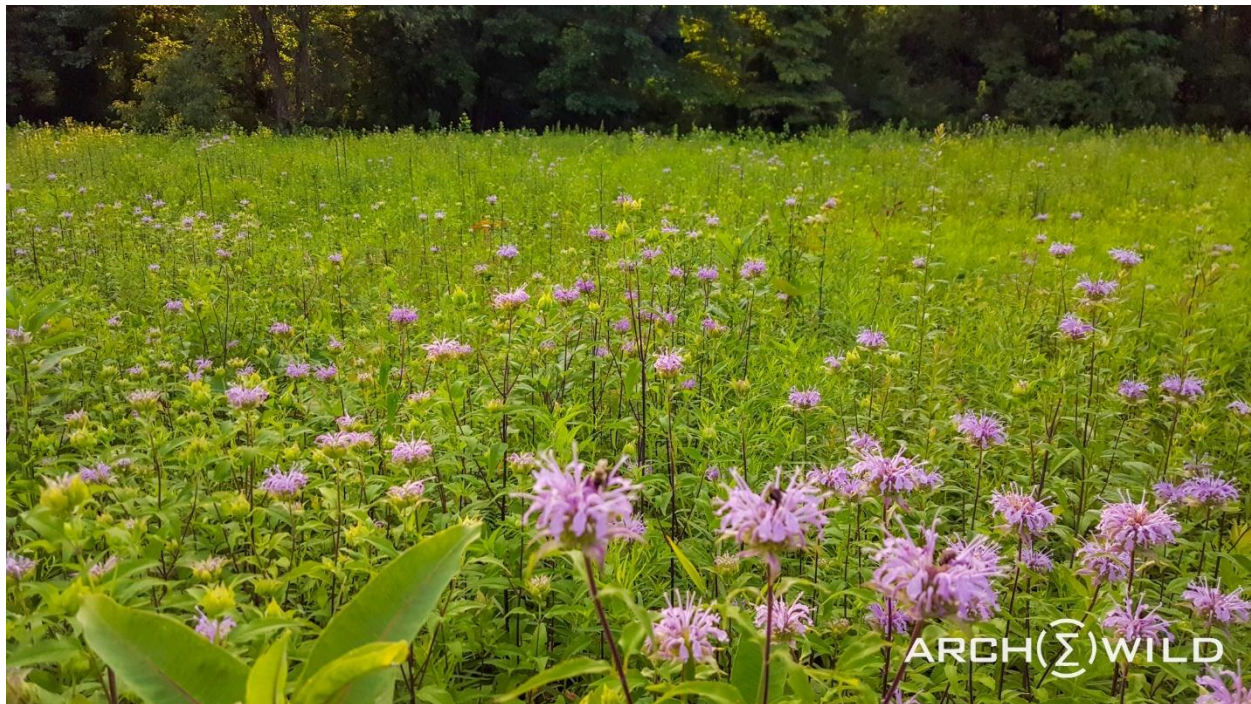
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# KEY CONCEPTS

Before beginning to understand the work that goes into creating a meadow, it's important to understand key terms and ideas. This way, you will know why these ecosystems are so important and therefore why there is a push for more of them to be installed throughout Pennsylvania.

## Definitions

A plant species that is '[Native](#)' to a particular geographical area has evolved to the unique conditions present in that area over a period of hundreds or thousands of years. An example of a common native plant here in Pennsylvania is Common Milkweed, *Asclepias syriaca*. This species has thrived in much of the Eastern U.S. and Canada for millennia and in that time has become a vital host plant to Monarch Caterpillars, helping them to complete their life cycle. On the other hand, a popular plant in large nursery centers, Burning Bush, *Euonymus alatus*, is considered '[Invasive](#)' in much of the U.S. because it is originally from Eurasia but unfortunately easily spreads into wild spaces here, creating a monoculture and pushing out important native species.



Just because a native plant grows in Pennsylvania, though, does not mean that it grows just anywhere. Remember, all plant species have evolved to survive under certain conditions, and these conditions are only found in certain '[Ecoregions](#),' or geographical areas defined by their physical characteristics including geology, soils, altitude, and climate. Within each ecoregion, different species, or varieties of the same species, have adapted to these unique characteristics and make up unique [Plant Communities](#) that are important for the

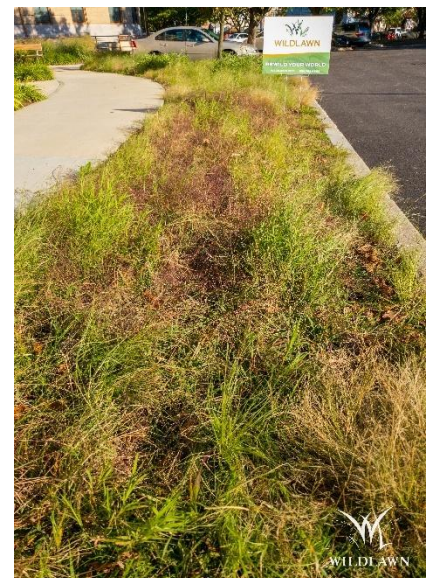
other flora and fauna that have evolved alongside them.



And this state isn't called "Penn's Woods" just for fun. Thanks to the natural conditions found here, while plants differ across different ecoregions throughout the state, Pennsylvania is dominated by forest with very little room left for much else. For a 'Meadow,' an ecosystem dominated by grasses and forbs (flowering plants), to exist several underlying conditions need to be met. For one, meadows need a lot of sun, more than eight hours of direct sunlight every day. Secondly, they need fairly flat ground or gentle slopes. And thirdly, they need to be exposed to one of three extremes of soil moisture: very dry, very wet, or extreme variation in these two soil moistures throughout the year. Only under these conditions can a meadow survive without interference because larger species like trees and shrubs simply cannot handle these extremes.

### Benefits of a Meadow

So, if they're so rare in Pennsylvania, why are we building meadows? Great question, reader! There is one other situation that could cause a meadow to form here historically: a natural disaster. As a hurricane or a fire or a flood ripped through an area, trees and shrubs could be toppled or destroyed in the process and leave behind large canopy gaps in their place. And the seeds of plants can be quite tenacious, lasting in the soil for decades sometimes! Some even need fire to complete their life cycle. The moment that canopy gap would open, the seeds of herbaceous plants like grasses and forbs would begin to germinate, and in only a few short years there would be a thriving meadow. Of course, this meadow was short-lived



as the seeds of trees and shrubs would also germinate and eventually shade out the shorter herbaceous plants. Nevertheless, in that short time, this would be an irreplaceable ecosystem.

Keep in mind that it was not only plants that evolved alongside each other in different ecosystems, but also a plethora of birds, insects, fungi, and so on. Some of these relationships became so specific that certain species relied on only one or two other species to survive (like Monarch Caterpillars relying on species of Milkweed). And the species that thrived in a meadow ecosystem did so because they had access to food in the forms of nectar, seeds, and other species, they had access to materials to provide shelter, and they had access to large amounts of these vital resources.



You can see where this is going... These days, meadow ecosystems are even more rare than they were historically, and those that persist are highly threatened because of habitat loss, invasive species encroachment, and climate change. This is leading to a loss in biodiversity (variety of life) on all sides, which in turn makes meadows less productive. Restoring high quality meadows, and other natural ecosystems throughout Pennsylvania can help to slow this loss or even reverse it. And these ecosystems come with many other benefits, for man and wildlife alike.

Before getting into additional benefits, it's also important to differentiate between a meadow and a garden at this stage using four main factors. First, meadows are larger than gardens, spanning a space of at least a ¼-acre. Meadows also appear 'naturalized,' whereas gardens tend to be manicured to achieve a cleaner aesthetic. It's important for meadows to be regionally authentic as well, only containing species that naturally occur in the area. And finally, the conditions of the site for a meadow are not altered in any way, while often garden creation includes tasks such as adding fertilizers or soil amendments to the area.



These four factors together increase all the benefits of these habitats. Aside from wildlife benefits, meadows help to meet important climate goals by sequestering carbon and other greenhouse gases and slowing down water runoff, leading to reduced downstream flooding and increased water filtration. They also reduce long-term maintenance costs associated with lawns such as the need for fertilization, aeration, or irrigation, the need for regular mowing, and large pesticide inputs. And of course, they also open areas for recreational opportunities like hiking/exploring, wildlife observation, and environmental education, among many others.

You will find at first that the creation of these ecosystems seems daunting as there are many factors to consider when choosing to do so. With some upfront understanding and thorough planning, the benefits of creating a new meadow far outweigh the risks and challenges.

# IS THIS A VIABLE MEADOW OPPORTUNITY?

**A**

## KEY QUESTIONS

- Does the site have the ecological factors to support a meadow?
- Is there room for a continuing maintenance budget for the meadow?
- Is there support from right people to build the meadow?
- What are the goals behind creating a meadow?

## OVERVIEW

Before deciding to install a meadow in a yard or open parcel of township land, it is imperative to understand the steps involved in establishing a meadow by reading this and other supporting documents. First and foremost, in this decision there are the following factors: ecology, support, and goals.

## CHECKLIST

STEP	TITLE	SUMMARY NOTES	DATE
1	<b>Ecology</b>	e.g., are the right conditions for a meadow present?	
2	<b>Financial Support</b>	e.g., does the budget exist for all steps in the meadow-building process	
3	<b>Cultural Support</b>	e.g., support from neighbors, residents, staff	
4	<b>Contractor Support</b>	e.g., is there an organization or business to assist in any or all steps of meadow-building	
5	<b>Maintenance Support</b>	e.g., do you have the staff/equipment/budget to maintain the meadow?	
6	<b>Environmental Goals</b>	e.g., is a meadow your best environmental option for the space?	
7	<b>Cultural Goals</b>	e.g., if you decide a meadow is for you, what else should be included?	
8	<b>Decide</b>	Ask again, is this a viable meadow opportunity?	

## SUMMARY AND SIGN-OFF

### HOW TO KNOW WHEN YOU ARE FINISHED

This task is complete once all factors of ecology, support, and goals have been thoroughly looked over and those that pertain to the meadow are agreed upon.

If there is disagreement or mismatching goals, a decision on if and how to continue must be made.

### MANAGER/CONSULTANT SIGNOFF

FIELD MANAGER SIGNATURE

DATE

PROJECT MANAGER SIGNATURE

DATE



### Decide if Conditions Exist for a Meadow

Naturally occurring meadows are rare in Pennsylvania because the ecological conditions in which they thrive are rare. Indeed, meadows only persist where conditions are too dry, too wet, or where soils are thin, or too acidic or calcareous, or a combination of the these, for larger species like trees and shrubs to survive.

This does not mean that you cannot establish a meadow if the site does not have these conditions. In fact, as mentioned in “Key Concepts”, meadows are generally part of the natural succession of a forest ecosystem. If a canopy opening is suddenly made, herbaceous species are the first to pop up. Nevertheless, that canopy gap will only last until new shrubs and eventually trees take over.

Because of this, if the desire is to maintain a long-term meadow where the proper conditions technically do not exist, this will involve continued management of the space for the foreseeable future.

Browse the PANHP link to gain more insight into the ecological conditions that are present at the six different “Terrestrial Herbaceous Openings” found in Pennsylvania.



Figure 1 - Dry, calcareous conditions support a naturally occurring meadow

### Look for these Characteristics

When you are searching for or have a location in mind, there are several parameters that can quickly be observed at the site to decide if a meadow, even one that will need continued maintenance, will be possible:

- *Full Sunlight* – while meadows can and do exist in areas with canopy cover, this is a very difficult structure to maintain. Therefore, you want a location that receives full sun (at least six hours of direct sunlight/day) during the growing season
- *Varying Topography* – naturally occurring meadows look best and have a better chance of long-term success if there are a variety of site conditions. Hummocks, swales, depressions, rocky area, wet areas, and even different soil types all contribute to having a meadow complex that

[PA Natural Heritage List of Plant Communities](#)

Ecology

	<p>can recover from environmental shocks. A highly homogenous site generally support only a small number of species, which might or might not be what you want</p> <ul style="list-style-type: none"> <li>o <i>Limited Invasive Pressure</i> – this one may take some time for you to figure out when you first start this journey but is crucial. This is especially the case for the areas surrounding the possible meadow location. If the surrounding area is heavily invaded, and what’s more, if you are unable to treat these areas for budget or property reasons, this will decrease the success of your meadow as these species are likely to get a foothold while you are waiting for the seeds to germinate.</li> </ul>	
<p><b>Financial Support</b></p>	<p><b>Do you Have Sufficient Financial Resources to Build and Maintain a Meadow?</b>  There are multiple types of support that any land manager should have in place before beginning a new meadow project, the first of these being financial support. Without the appropriate amount of financing to establish a meadow, it is quite possible that the project eventually fails.</p> <p>Meadows are natural infrastructure projects, like a solar farm project. A meadow project has a sizable upfront capital cost followed by a long tail of operational costs until it stabilizes. In the long-term, a meadow can save mowing expenses, but it’s often an expense endeavor. While some maintenance will be needed every year, and the overall costs will differ based on whether you own the machinery needed for mowing.</p> <p>Still, too often meadow projects get installed with little or no plans for establishment and continued maintenance, eventually falling back to unkempt land that becomes home for invasive species, or becomes mowed regularly like a lawn again. To ensure that this does not happen, reading through this guide and getting an idea of what the overall costs are for creating and maintaining a meadow is crucial.</p> <p><b>Explore Grant Programs to Help with Funding</b>  There are several ways now to receive funding assistance with these projects from both the state and federal level, such as PA DCNR’s Lawn to Habitat Program or the Community Conservation Partnerships Program (C2P2) grants, and these should be considered to make these and other green infrastructure projects more feasible. It often helps involved parties to hear that grant funding of some kind will help to fund the project as well.</p>	<p><a href="#"><u>Costs of a Lawn vs. a Meadow</u></a></p> <p><a href="#"><u>Lawn to Habitat Grants</u></a></p> <p><a href="#"><u>C2P2 Grants</u></a></p>

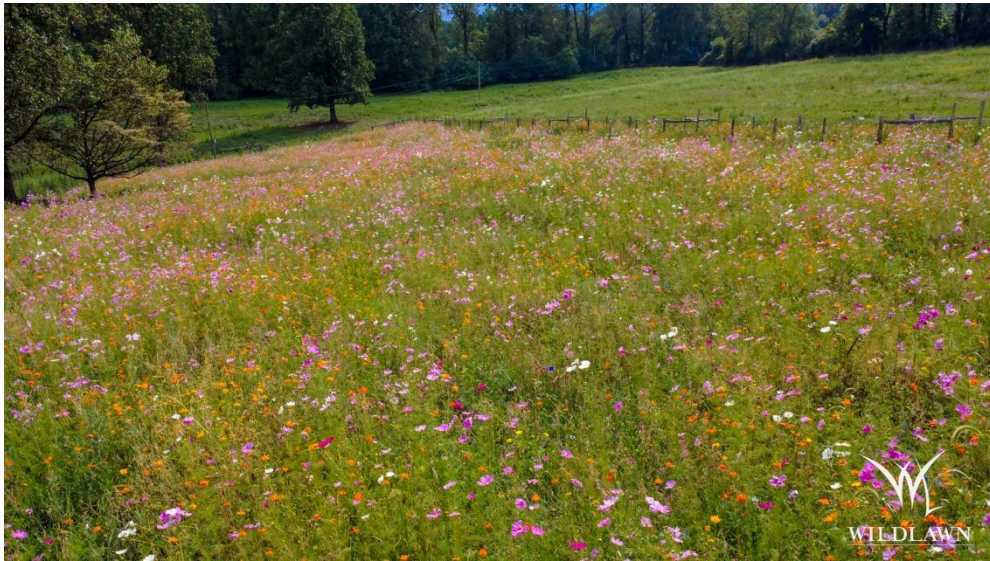
**Cultural Support**

**Do you have Broad Community and Municipal Support?**

Having ample support from the people around you to complete a meadow project is very important. For landowners, municipalities, conservation organizations, and other land managers, this means discovering whether direct neighbors, nearby residents, and even the staff that will be maintaining the meadow are on board with a project can help to ensure the implementation runs smoothly. If your Parks Board doesn't want a meadow, for example, it is unlikely that they will invest the time to properly establish and steward a meadow through its early stages to maturity.

**Has the Community been Counseled on Herbicides, Ticks, and Hay Fever?**

The last thing any project manager wants is to have everything put in place to implement a new meadow only to be caught off-guard by a last-minute concern and then have the work come to a stop. Common concerns include the use of herbicides, the harboring of ticks, and the meadow causing hay fever; it is generally better to hear out these concerns as early as possible. As will be repeated throughout this document, thoroughly communicating the plan and the process of a project needs to always be a priority.



*Figure 2 - Infinitely-blooming meadows aren't possible in the long-term. Take care to properly educate your constituents about the type of meadow your site can realistically support*

### Do you have Contractor Support for Key Activities?

While this guide has much of the information needed to successfully complete a meadow project, having an experienced contractor to consult with or to help with an implementation or two can take the worry out of the project.

This can be especially helpful for some of the more technical tasks including Site Evaluation, Species Selection, and Choosing a Vegetation Management Strategy. This guide will be a great first step to ensure that establishment and maintenance of meadows are successful, but there is no getting around some of the nuances such as plant ID and proper vegetation management strategies and timing.



*Figure 3 - Experienced contractors can help your project run smoothly by helping with site analysis, species selection, preparing your site, and providing crucial establishment support. Meadows are sometimes too risky to “go it alone.”*

Meadows are often perceived as one of the more accessible and easy-to-implement forms of environmental restoration. The truth is that meadows are the most technically demanding. While anyone can build a meadow, the skills to efficiently build an authentic, durable meadow come with time; this guide was conceived to help anyone improve their chances of success, along with additional training. Experienced contractors can assist with training or fill any gaps in your capabilities.

If there are questions remaining as to whether you have the necessary support to make the project a success, step back and think about if you are truly ready to begin. It is always better to wait until you are fully ready than to wing it and hope for the best.

**Contractor  
Support**

**Do you Have Sufficient Knowledge and Equipment for Proper Maintenance?**

Meadows require constant stewardship once established, and often require specialized or dedicated equipment.

Meadow maintenance requires skills beyond what most landscapers can provide. Key considerations include:

- *Dedicated Mower Deck* – Do you have a mower deck that you can dedicate to maintaining meadows? These aren't simple lawn-mowers but mulching brush hogs that are kept meticulously clean with sharpened blades. Landscaper mowers are probably the #1 source of new invasive plant infestations, so you'll want total control over the equipment used to maintain your meadows
- *Plant ID and Treatment Specialist* – Do you have access to someone that can assess the meadow at least once a season that can identify potential problems and prescribe an appropriate remedy? Meadows are constantly under threat from both invasive species and woody encroachment. Left alone for a few years, these threats can cause significant damage to a meadow or become a major expense. Regularly assessments and small treatments to keep a meadow healthy are important maintenance considerations
- *Wildlife Specialist Support* – While meadows provide important soil and water conservation services, they are also intended to provide wildlife habitat to protect our insect and bird populations. Access to someone with sufficient knowledge of the lifecycles of the wildlife your meadow is likely to support can help guide maintenance activities to maximize the meadow's wildlife value. When to not mow? Which chemicals to avoid? Which bird or bat boxes to install, and where? When to avoid public use of the meadow? Which gamebirds to stock? Which shrubs to keep? A wildlife specialist can help teach and guide a wide range of maintenance activities.

**Maintenance Support**

**Establishment**

**Maintenance**



*Figure 4 - Native shrub incursion into a meadow can become a real problem if ignored for a few years. Cultivate relationships with people that have specialized skills that can help guide meadow maintenance.*

**Environmental Goals**

**Is Building a Meadow the Best Use for your Space?**

This is a non-trivial question because most places on the East Coast want to become forests or shrubland, which provide their own ecological, environmental, and community benefits. The cost of establishing a high-quality meadow is on par with your other options, so be sure ask yourself and your community, “Why do I want a meadow here?”

While there are many environmental benefits of building a meadow (as mentioned in “Key Concepts” and further discussed in the Xerces link to the right), there are other green projects that might be better able satisfy your conservation or environmental goals. For instance, if the goal of a meadow project is to mitigate downstream flooding or soil erosion along a stream, then performing a streambank restoration and shrubland and/or planting a riparian forest buffer planting could be a better fit.

Or perhaps there is an interest in developing financial opportunities on the land, in which case a forestry management plan including plans to plant trees for timber harvesting may make more sense.

If the main goals revolve around increasing bird habitat and pollinator populations then a meadow is probably the right decision.

**Ensure your Goals Match a Meadow**

Make sure to have a clear picture of the short and long-term plans for your space and document your decision that a meadow is in fact the best use of that space. Documenting the decision could help avoid premature abandonment or conversion to another land use in the future.



*Figure 5 - This meadow was designed, built, and is maintained to support small bird populations*

[Xerces](#)

[Riparian Forest Buffers](#)

<p><b>Cultural Goals</b></p>	<p><b>Have you Documented any Cultural Goals?</b>  For municipalities and conservation organizations, while some preserved land is meant to stay protected as a sanctuary for wildlife, it is often the case that open spaces will need to provide access for human purposes, including recreation. You will need to talk to the community to discover their expectations and requirements.</p> <p>A meadow designed to be consistent with flying model airplanes or flying kits might be different from a meadow designed to support gamebird hunting. A meadow designed to attract the maximum number of migrating songbirds might be different from a meadow designed to support a maximum number of insect pollinator species. A meadow designed for dog-walkers might be different from a meadow designed for bird watchers. Building a tall meadow behind houses in an HOA might be inconsistent with children being able to find their soccer balls. Knowing your cultural (i.e., people) requirements, along with a thorough analysis of the type of meadow your site can support, can help you assess whether there is enough alignment to proceed with a meadow project.</p> <p><b>Can you Afford Associated Amenities?</b>  The project might also require additions such as bird houses, trails, benches, educational signage, and trees planted along an existing path that borders the meadow, etc. These amenities, if required, can increase the cost of building a meadow that is beyond your means.</p>	
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<p><b>Decide</b></p>	<p><b>Do you Have a Viable Meadow Opportunity?</b>  Review your answers to each question above and honestly assess whether or not a meadow is the best use of your space, time, and money.</p>  <p><i>Figure 6 - This 25-acre meadow project ultimately failed due to a poor understanding of the type of meadow that was possible and the desire of the Park Manager to keep it short and avoid the use of herbicides. A very expensive mistake.</i></p>	
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## **DECISION POINT #1**

You have worked through all relevant needs for support and understand the goals that your stakeholders have for the space. Ideally, you will have also read through this document to understand what goes into building a successful meadow from start to finish. This brings up the first important decision: do you have all the necessary support to properly build this meadow?

It is vital that you be perfectly honest in this decision as straying from what is outlined in this document can lead to eventual issues or even project failure. If you are unsure whether you will have the correct support at any stage throughout this process, holding off on the project until all the necessary support is in place can be the best decision for you in the long run.

As will be mentioned throughout this document, meadows can take up to seven years to establish, and this time is only exacerbated by pushing forward with a project without procuring the needed support.

# SITE EVALUATION – ECOLOGICAL ZONES

**A**

## KEY QUESTIONS

- What major ecological zones or eco-tones does your new meadow site currently have?
- Where is the soil drier, and where is it wetter?
- Do I have any shady edges, or sections near a road?
- What is the history of the site? Is it an old factory or oiling station? An old strip mine? Or a filled wetland?
- What are the existing vegetation patterns, if any? Sometimes even park lawns will reveal their different zones when you look close enough.
- Plan to visit the meadow site both in March/April, and in August

## OVERVIEW

Meadows are usually heterogeneous. They have low spots, high spots, sunny spots, and shady spots. Large meadow sites can flow up and down large grades and hills. And even small meadows can cross multiple underlying soil types, each with their own limitations.

Each combination of soil type, moisture pattern, and light availability should receive its own seed mix, which often improves performance while reducing costs. But you need to find and map each zone.

## CHECKLIST

STEP	TITLE	SUMMARY DELIVERABLE	DATE
1	<b>Light Map</b>	A project map that indicates, with shapes, the different number of hours of daylight in July.	
2	<b>Water Map</b>	A project map that indicates, with shapes, any observable moisture conditions	
3	<b>Soil Map</b>	A copy of the USGS soil survey for the project. Pictures of shallow soil pits are helpful for each soil type.	
4	<b>Plant Map</b>	A project map that indicates, with shapes, where there are obvious differences in vegetation, including weeds	
5	<b>Historical Map</b>	Notes of any prior uses (e.g., farm, parking lot, ball field, etc.)	
6	<b>Zone Map</b>	A combination map that weaves the light, water, soil, and plant map together in clearly marked ecological zones	
7	<b>Zone Data</b>	Fill out a form to document each zone, and include at least one representative GPS coordinate for each zone	
8	<b>Use Evaluate™</b>	Set up your project zones in Collector™ or in Evaluate™. Alternatively, send your zone data sheets out for analysis	

## SUMMARY AND SIGN-OFF

HOW TO KNOW WHEN YOU ARE FINISHED	MANAGER/CONSULTANT SIGNOFF	
<p>You should have identified at least three different ecological zones for any meadow project under 10 acres. Larger meadow projects can have many more.</p> <p>You will know that you have the right ecological zones when you can take someone on a tour through the meadow site and easily point out and explain zone to someone else not closely involved with the project.</p>		
	FIELD MANAGER SIGNATURE	DATE
	PROJECT MANAGER SIGNATURE	DATE

# SITE EVALUATION – ECOLOGICAL ZONES

**B**

**TITLE**

**DESCRIPTION**

**LINKS**

Performing a Site Evaluation to identify your Ecological Zones is primarily a mapping exercise. Google Earth is a suitable desktop useful tool that can be learned with a little bit of YouTube training. Paper maps can be just as effective. Using PowerPoint is also effective.

Follow the steps below to evaluate your site and to define your ecological zones.

An ecological zone is a type of area that functions in a particular way and that supports a different vegetation system growing in them (if not a lawn). There can be multiple instances of an ecological zone within a meadow project site.

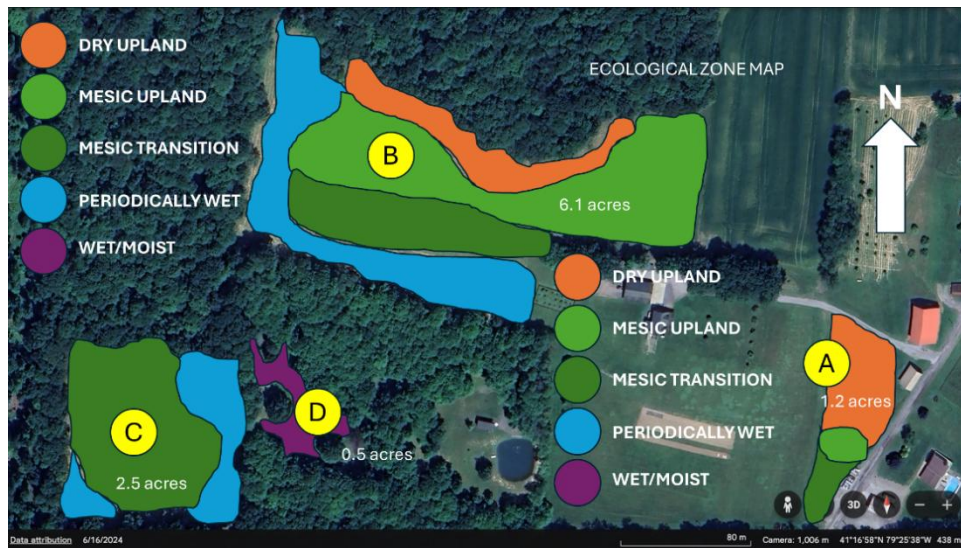


Figure 7 - Example of a meadow project with each of the ecological zones mapped and labelled

The map above represents the culmination of a site evaluation exercise that identified five distinct ecological zones for a single meadow-building project.

Each color represents a different ecological zone. An ecological zone can appear in multiple places, such as the DRY UPLAND [orange-colored] zone. This map was produced in PowerPoint, which is also useful as a mapping tool.

Each ecological zone receives its own seed mix design. For example, the species that are appropriate for the DRY UPLAND zone would be quite different than the seed mix for the PERIODICALLY WET zone.

**Introduction**


[Google Earth Training](#)

**Light**

**Produce a Light Map**

While most of your meadow is likely in full sun, tree canopy often creates distinct ecological zones. Mark all the areas impacted by shade.

Start the mapping process by printing out a screenshot of your meadow site (use Google Maps or Google Earth) and draw a thick line around the entire boundary.

<p><b>Light</b></p>	<p>Alternatively, you can use an open-source or paid GIS system to indicate the boundaries of the project. Google Earth has some basic GIS functionality, and it is free, so try to use it instead of paper maps.</p> <p><b>Mark the Full-Sun Areas</b> Mark out the areas of the meadow that you expect to be in full sun all day long, which are the areas well away from any trees or steep slopes. Most of your meadow projects should be in full sun.</p>  <p><i>Figure 8 - This meadow was designed to feature warm-season grasses, but the designer failed to consider the role of trees along the southern edge. The result is still beautiful but not what was intended.</i></p> <p><b>Identify and Mark the Areas with Substantial Shade</b> Then look for trees or shrub thickets inside the meadow area and look for forest or woods' edges. The areas to the north of such features will be in the shade for some part of the day and these are certainly a different ecological zone from the open, full sun areas. The same goes for buildings more than one story tall.</p>	<p><a href="#">QGIS</a></p> <p><a href="#">Google Earth</a></p> <p><a href="#">Evaluate™</a></p> <p><a href="#">Collector™</a></p> <p><a href="#">ArcGIS</a></p>
<p><b>Moisture</b></p>	<p><b>Produce a Moisture Map</b> Understanding the presence and role of moisture in your meadow is extremely important. The presence of water, and how much is present, can have major implications for your site preparation activities (e.g., herbicide choice and legal use), when you can use certain pieces of equipment (e.g., no tractors in wet soil), and on your seed mix design (e.g., very dry areas feature warm season grasses, while wet areas feature sedges).</p> <p><b>Visit Meadow in Early Spring</b> The first visit should be in early spring; March is often ideal. You need to walk around the entirety of the project site and look for any place that is soft, squishy, or muddy underfoot. Sometimes you can even see standing water shortly after rain. Note these areas of elevated moisture so you can draw them on your paper or PowerPoint map or show them in Google Earth or your GIS system.</p> <p><b>Visit Meadow in Late Summer</b> The second visit should be in August, or whenever the driest time of year is for your area. This is usually a great time to find those areas of the meadow that tend</p>	<p><a href="#">QGIS</a></p> <p><a href="#">Google Earth</a></p> <p><a href="#">Evaluate™</a></p> <p><a href="#">Collector™</a></p> <p><a href="#">ArcGIS</a></p>

to dry out severely in the summer. The best place to start is any place that is higher up than the rest of the meadow or find any south-facing steep slopes in the middle of the field (e.g., a berm or bump). And look for bare patches of soil caused by excessive mowing or walking, or where there is clearly a lot of excess gravel or stone in the soil. Another way to find your dry spots is to look for plants that don't occur anywhere else in the meadow area. These plants could be a certain type of weed, or a native dry-soil plant species (e.g., poverty oat grass), or where the plants are shorter.



*Figure 9 - This dynamic meadow system features a mosaic of moisture zones, each of which will support a different type of meadow species*

Late summer is also a great time to revisit the previously identified wet spots to see if they are still wet. If they remain wet, or moist, then you can label those zones as permanently moist. If the wet areas you identified in Spring are dry and cracked in the summer, then you have a bi-modal ecological zone and this must be noted on your maps to drive seed mix design; bi-modal ecological zones have unique challenges that require a specific set of species.

**Record your Findings on Your Map**

With practice, finding your wet spots and your dry spots becomes easier. Be sure to mark these two extremes on your map as these areas will perform very differently from the rest of the meadow.

**Soil**

**Download the Soil Map**

Soil maps are easy to download. Simply go to the California Soil Resource Lab (CaSoilWeb) website, find your project site, zoom in or out until you can see all the soil types in your meadow, and hit print screen.

If you use Google Earth or GIS, the USGS provides soil series layers free of charge. Simply download the layer for your part of the country as a base layer.

Different soil types can have wildly different characteristics that are important to plants. The soil map for your meadow will have embedded information related to soil depth, bulk density, depth to bedrock, the maximum amount of water it can

hold, the normal amount of organic matter, drainage capability, and lots of other things.

### Read the Soil Map

Click on and look at each soil type. You are looking for a few key metrics to determine if you have a mosaic of different soil types or just one large homogenous soil layer. Find the pH, Ksat, PAW, hardpan depth, drainage class, and hydric rating for each soil type in your meadow.

Sometimes the only major difference between soil types is slope. Sometimes, the underlying chemistry is completely different. You might need to make a judgement call about whether each soil type is sufficiently different from the adjoining types to justify a different ecological zone.

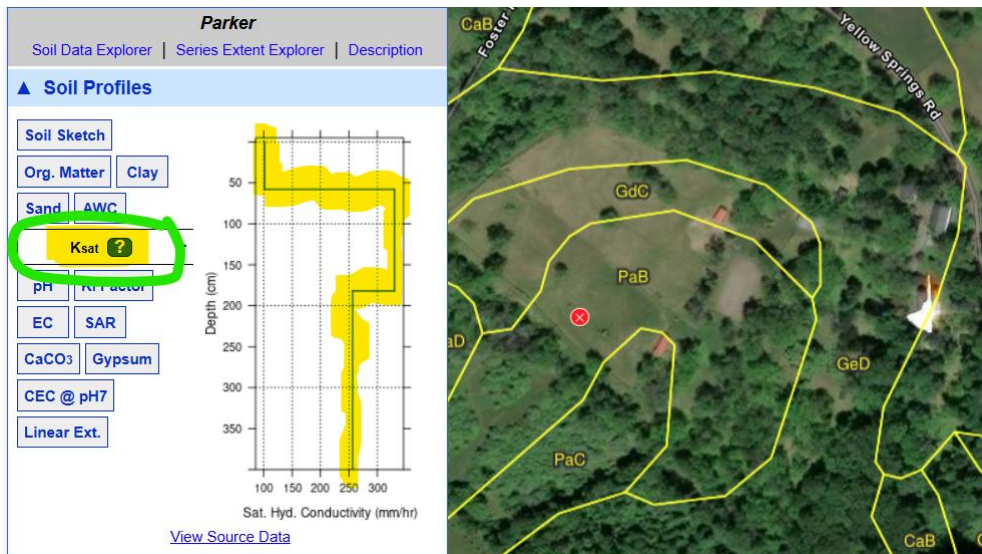


Figure 10 - This meadow site spans three different soil types, and each has its own mechanical, hydrologic and chemical attributes. These attributes play a large role in determining which species are appropriate for each.

### Add a Soil Map Overlay to your Site Evaluation

Map the 'different' soil types onto your ecological zone map and see how the soil map boundaries line up with your moisture zones; often they line up fairly closely, and sometimes not at all. The importance here is that topography and point sources of water interact with different soils in different ways. Expect a new ecological zone each time a single soil map shape overlays a moisture zone.

Few people have PhDs in soil science, so you don't need to worry too much about mastering what the different soil characteristics mean. You are looking for key differentials. Soil map analysis is built into Collector™ and Evaluate™ if you are using those software products.

[CaSoilWeb](#)

[QGIS](#)

[Google Earth](#)

[Evaluate™](#)

[Collector™](#)

[ArcGIS](#)

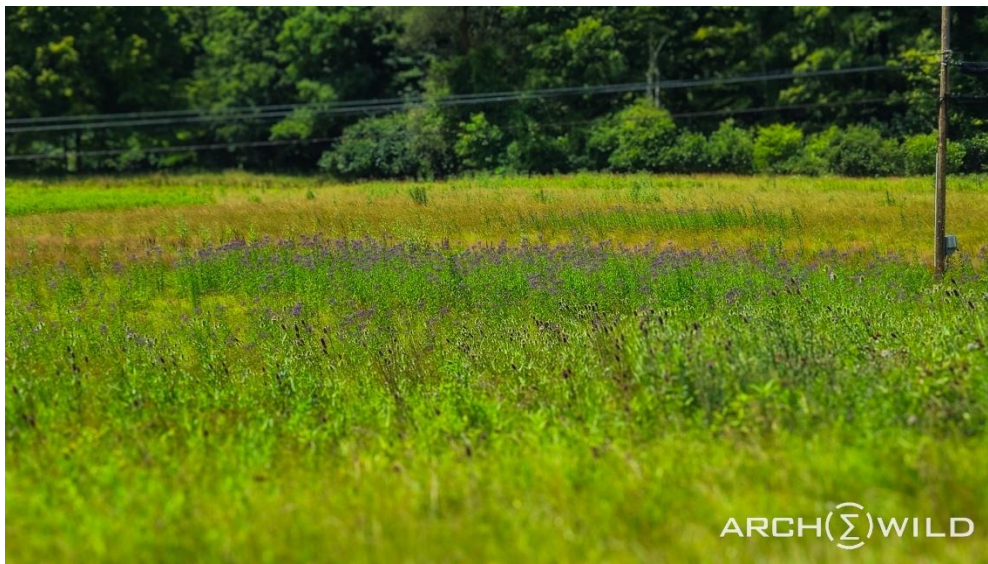
**Plants**

**Produce a Vegetation Pattern Map**

Observing the plants that are already growing in a new meadow site is a fantastic diagnostic tool. This evaluation is best performed if the meadow area hasn't been mown for about six weeks, so you'll want to talk to the landowner and ask them to stop mowing around the middle to the end of June.

Mapping the plants already growing in a future meadow can tell you a lot about where the ecological zones are located and how many you have. Each native plant species has a set of definable conditions that it performs best in and many more types of conditions in which it struggles or fails. Certain species will congregate into areas that are ideally suited for their reproductive success and retreat from areas that are not. The result is often a mosaic of different plants growing in different places.

Go out into your meadow to detect and map these vegetation patterns and include them on your ecological zone map. Every time you see that the plants change substantially, even in a park setting, you are likely to observe a different ecological zone. The image below reveals several ecological zones, including a dry/mesic zone dominated by grasses (brown areas), an interior wet area (purple flowers), and weedy zone (foreground).



*Figure 11 - Note the vegetation patterns in this future meadow project. The bands and patches can often reveal the underlying ecological conditions. The naturally occurring vervain indicates moist soils.*

Record your observations in a notebook, take pictures, or set up your zones directly into Collector™ or Evaluate™. Overlay your vegetation maps onto your ecological zone map to detect the major ecological zones within your meadow.

For IDing plants, we always recommend using a good guidebook like Newcomb's Wildflower Guide, but plant ID apps, like iNaturalist, are also available.

[QGIS](#)

[Google Earth](#)

[Evaluate™](#)

[Collector™](#)

[ArcGIS](#)

[iNaturalist](#)

[Newcomb's  
Wildflower  
Guide](#)

[Peterson's  
Tree Guide](#)

### Produce your Final Ecological Zone Map

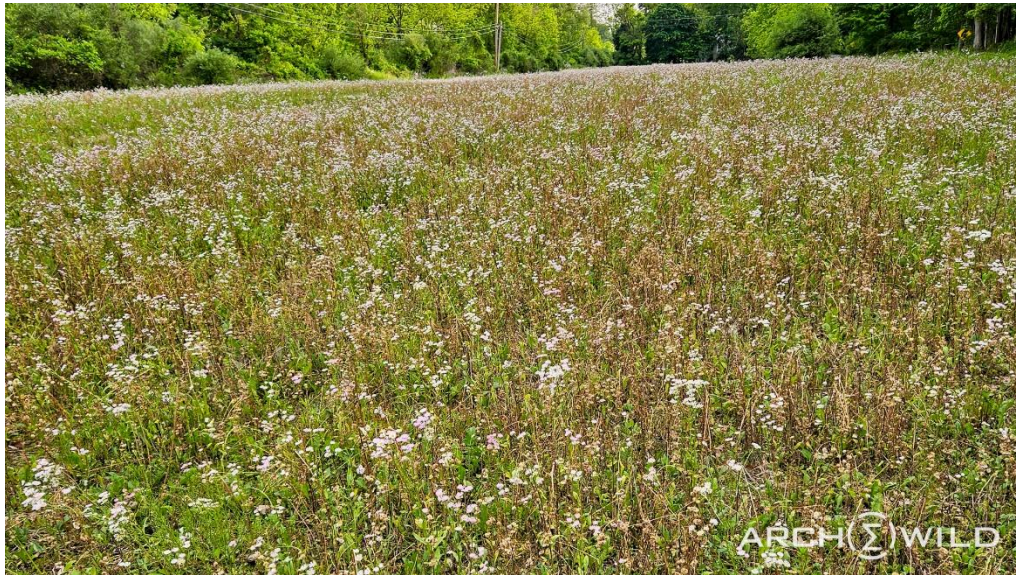
For this step, there is no algorithm or software tool to help decide how many ecological zones you have, where they are, or what to call them.

But if you did your best to follow the steps outlined above, you should already have a pretty good sense of how your meadow site is currently functioning, how many truly distinct ecological zones you have, and where they are on a map.

Simply review your light, soil, water, and plant maps and use your best professional judgement to decide how many that you have and where they are. Try to identify at least three; nearly every meadow project has at least three ecological zones.

But try to be reasonable about how many ecological zones that you identify and represent on a map. Too many becomes difficult to manage and the seed mixes between zones that function very similarly won't be very different from another. As a rule of thumb, each ecological zone should be at least 0.5 acres in total size; any smaller doesn't make sense.

### Zone Map



*Figure 12 - This meadow is largely homogenous and has only one ecological zone throughout, hence the lack of diversity in its native vegetation.*

Sometimes you will decide that your meadow only has one ecological zone, as depicted in the image above. There were no meaningful observational differences in soil type, light availability, moisture, or vegetation patterns in this meadow – it truly seemed to function identically throughout the entire 25 acres. This makes designing seed mixes easier (i.e., just one) but will likely make for a boring meadow.

<p><b>Zone Data</b></p>	<p><b>Describe Each Ecological Zone</b>  After you have decided how many ecological zones you have, you must describe them using a standard form that ecologists use. The form is simple to use – answer about ten questions for each ecological zone. These zone descriptions allow you to communicate with others, including consultants, the core characteristics of each zone and what makes each ecological zone unique.</p> <p><b>Ecological Zone Data Form</b>  You should record and be prepared to share with others the following minimum information for each zone:</p> <ul style="list-style-type: none"> <li>○ Size,</li> <li>○ GPS coordinate,</li> <li>○ Slope,</li> <li>○ Aspect,</li> <li>○ Canopy cover %, <ul style="list-style-type: none"> <li>○ The type of canopy <ul style="list-style-type: none"> <li>● Herbaceous = mostly grasses and flowers,</li> <li>● Shrub = mostly shrubs, with grasses and flowers,</li> <li>● Deciduous Forest = mostly trees with leaves,</li> <li>● Conifer Forest = mostly trees with needles,</li> <li>● Mixed Forest = a substantial mix of deciduous and conifer trees</li> </ul> </li> </ul> </li> <li>○ The % of the forest that is comprised of conifers (approximate)</li> <li>○ Height of the canopy cover (m), if any. Open lawns and pastures are recorded as 0.25m. Use a phone-based tree height app to measure the height of trees.</li> <li>○ O/A soil layer depth,</li> <li>○ Approximate % of aggregates, and aggregate size, in a few shovels full of soil,</li> <li>○ Any nearby permanent sources of water</li> </ul> <p>A form for recording your ecological zone characteristics is in the Appendix of this guidebook. Feel free to share your ecological zone characteristic forms with your collaborators, your consultants, and your seed vendors to develop a seed mix design</p> <p>Evaluate™ users can record their zone characteristics directly into the software.</p>	<p style="text-align: center;"><b>Appendix</b></p> <p style="text-align: center;"><b><u>Arboreal Tree Height Measurement App</u></b></p>
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Users of Evaluate™ can record their ecological zone characteristics directly into the software to facilitate analysis and seed mix design. The form below depicts a portion of the ecological zone form in Evaluate™.

Use Evaluate™

Once you've completed the form, please

Evaluate™

Watch the Evaluate™ training video to see if it right for you.



Figure 13 - A beautifully designed meadow with layers and sweeps of color. This meadow lasted three years before succumbing to natural forces. Today, a completely different set of plants now occupies this meadow, and the space does not resemble what was proposed, and sold, to the client. The designer ignored or overlooked several ecological realities.

# SPECIES SELECTION – SEED MIX DESIGN

**A**

## KEY QUESTIONS

- Do I want a native meadow? What is the core set of species for each ecological zone in the new meadow?
- Can I find nearby and naturally occurring meadows (not seeded meadows) that closely resemble my site conditions and use the species growing there as the basis for my seed mix design, by zone?
- How much am I willing to spend on a per-acre basis to establish a new meadow? What are my budget constraints?
- How much do I care about genetics?
- Do I have a consultant that can help with design?

## OVERVIEW

Studies show that native species mismatched to a site’s conditions will be outcompeted by weeds sooner than later. Seasoned practitioners concur.

Internet-sourced seed mixes with multiple dozens of species are designed to “mask” the site suitability problem by charging you for seed that will never be a part of your long-term meadow and can mislead clients.

Instead, the preferred method is to focus on choosing the 8-12 species known to survive each ecological zone.

## CHECKLIST

STEP	TITLE	SUMMARY DELIVERABLE	DATE
1	<b>Meadow Type</b>	I have consulted with stakeholders and they understand the meadow will be of a type that the site can naturally support	
2	<b>Literature Review</b>	I have reviewed relevant academic publications that describe local meadows in enough detail to be useful for seed mix design	
3	<b>Reference Sites</b>	I have visited nearby natural meadows to find reasonable comparative examples to my site and ecological zones	
4	<b>Genetics</b>	I have agreement on the guiding principles for meadow genetics	
5	<b>Budget</b>	I have established a seed budget based on my grant or on what my organization is willing to spend	
6	<b>Recommendations</b>	I have solicited at least one recommendation from a meadow consultant or a local ecologist	
7	<b>Seed Mix Design</b>	I have a distinct seed mix for each of my ecological zones.	
8	<b>Carrier Selection</b>	I have made a conscious decision about the use and selection of seed carriers.	

## SUMMARY AND SIGN-OFF

### HOW TO KNOW WHEN YOU ARE FINISHED

### MANAGER/CONSULTANT SIGNOFF

You are finished when you feel comfortable that you have an appropriate seed mix design for each of the major ecological zones that has, ideally, been validated by a third-party or by a decision-support software tool.

Alternatively, you have selected a pre-designed seed mix based on the information provided on the vendors’ website and have decided the number of pounds that you can buy that is within your budget.

FIELD MANAGER SIGNATURE	DATE
PROJECT MANAGER SIGNATURE	DATE

<b>SPECIES SELECTION – SEED MIX DESIGN</b>		<b>B</b>
<b>TITLE</b>	<b>DESCRIPTION</b>	<b>LINKS</b>
<b>Introduction</b>	<p>Contrary to contemporary meadow design philosophies (e.g., the kitchen-sink approach, or designing in layers), the harsh reality is that the only true meadow designer is Nature itself.</p> <p>Designing a seed mix is not an opportunity for self-expression. Your best chance at leaving your personal mark on a meadow is how well you prepare the site by ruthlessly removing all competing vegetation and performing an accurate ecological zone analysis.</p> <p>When it comes to seed mix design, you have few options and very little influence over how your future meadow evolves and matures. Your source of pride should derive from how well you performed your technical analysis and not from your personal choices of seeds. Popular blog posts, podcasts, and landscape design books will mislead you into thinking that you can “leave your mark” on the landscape by designing the “perfect” meadow. This is an illusion. Your job as a meadow builder is to discover the species that can survive your meadow site’s conditions and successfully reproduce; that’s it.</p> <p><b>CAUTION:</b> <i>Be wary of prepackaged, predesigned seed mixes. They often contain species that are unsuitable for your meadow. For example, purple coneflower (<i>Echinacea purpurea</i>) is a frequent seed mix component, yet it does not exist naturally on the east coast. The closest stable, natural population is a dry, barren cedar glade on the Kentucky-Ohio border. So, unless your meadow functions nearly identically to a southern cedar glade barren, purple coneflower will struggle to persist in your meadow. See the Appendix for a list of <a href="#">species to avoid</a> in your Northeast or Mid-Atlantic meadow.</i></p>	
<b>Stakeholder Input</b>	<p><b>Hold a Meeting and Get Stakeholder Input</b></p> <p>A general good practice is to consult with your stakeholders to get an understanding of what type of meadow they expect to see in the future. Expect a wide range of answers; here is a list of some common responses:</p> <ul style="list-style-type: none"> <li>○ “I want to see a field full of color from early spring through the end of autumn,”</li> <li>○ “I want only a short meadow because I am concerned about ticks,”</li> <li>○ “Anything except goldenrods. I suffer from hay fever in the fall,”</li> <li>○ “I want maximum biodiversity and botanical curiosities in the meadow,”</li> </ul> <p>Write down everything you hear. Take a keen interest in what people are sharing with you, and why. When finished, repeat back everything you heard and then say, “we’ll do the best we can to achieve these goals but we first need to build a meadow that can resist weeds without us having to treat it like a garden because we don’t have the time or money to treat it like a garden. Over time, we can make adjustments when the opportunity arises.”</p> <p>Remember that your meadow is going to mature into whatever your meadow wants to be and you have little control over the process. Try to avoid committing to any specific meadow design objective. And avoid publishing your stakeholders’ desires.</p>	

<p><b>Literature Review</b></p>	<p><b>Perform a Basic Literature Review</b>  A good first step in designing the seed mix for a meadow is to survey which well-documented natural, native meadows exist in your area. Conservancies are often a good resource as they tend to list any meadow easements or conservation areas on their website. County and state parks, too, can host native meadows of the type that your region can support. Make a list of where they are, because you are going to visit each one of them in the next step.</p> <p>Check online for botanical reports and species lists for the meadows on your list or ask the conservancy or park manager for a list, if they have one. JSTOR is a popular repository for academic papers, research articles, old reports and books that can have lists of species for your nearby meadows.</p> <p>An old-fashioned internet search can sometimes yield good results. A good set of search terms would be:  [the name of the preserve] + “species list” + “botanical report” + “PDF”. You can also query one of the many online research tools available and ask for a species list.</p> <p>If you find literature about a nearby meadow, your next step will be to go visit it, at which point it becomes a “reference site.” [See Reference Sites]</p> <p><b>Check NRCS-ESD Descriptions</b>  The National Resources Conservation Service (NRCS) has been working towards defining vegetation types by US EPA Ecoregion. While not every ecoregion has been thoroughly profiled, there are quite a few provisional descriptions for the east coast. Becoming familiar with NRCS-ESD literature can be beneficial to your project. Note, however, that the NRCS-ESD cannot be used to predict which type of meadow your site is likely to support; it is more useful for understanding what your meadow cannot be.</p> <p><b>Understand your State’s Natural Meadow Types</b>  Similarly, state Natural Heritage Programs (NHP) also provide some useful literature on the major, naturally occurring vegetation types that exist in each state. They define and describe the various “plant communities,” including meadows and grasslands, that occur throughout each state. If you don’t find the meadow type that you want in their plant community descriptions, then perhaps your site cannot support it. Note that NHP plant community types cannot be used to prescribe or design a meadow.</p>	<p><a href="#"><u>JSTOR</u></a></p> <p><a href="#"><u>Gemini</u></a></p> <p><a href="#"><u>NRCS-ESD</u></a></p> <p><a href="#"><u>PNHP</u></a></p>
<p><b>Reference Sites</b></p>	<p><b>What is a Reference Site?</b>  Reference sites are places where native, natural vegetation already exists and persists with minimal human intervention. For a site to qualify as a reference site, it cannot have been previously sown as part of a meadow or restoration project. Studying seeded meadows, particularly ones that have been seeded recently, can provide many false signals and potentially even confuse. So, it’s best to only evaluate meadows that have been in their current state for a long time.</p>	

### Analyze the Reference Site

What you want to do while visiting a reference site is to perform another ecological zone analysis (See Site Evaluation – Ecological Zones), including filling out the provided form (see Appendix) or use Evaluate™.

Once you have completed your ecological analysis for the reference meadow, compare the zones you identify to all the zones for your new meadow project to see where there is some alignment. Be sure to pay close attention to the CaSoilWeb soil charts and data. Major differences between the soil series at your new meadow site and the reference site that you are studying could mean that the plant species growing at the reference site might be unsuitable for your new meadow.

You might need to visit many different reference sites until you find a set of ecological zones that closely match those in your new meadow.

Celebrate if you find an ecological zone at a reference meadow that reasonably matches one or more zones at your new meadow because that means you can take the next step in the reference site analysis. Note that the farther away you travel from your meadow project site, the less likely you can find a close match. Meadows in North Carolina, for example, should not be used as reference sites for projects in Massachusetts.



*Figure 14 - This naturally occurring meadow in Bucks County is a good reference site as it shows two ecological zones, with Eutrochium and Vernonia populating the moist swale (foreground). Finding these can help you decide what is regionally appropriate and accurate for your meadow.*

### Document Species in Matching Ecological Zones

Here's what you do when you find a match in ecological conditions at a reference site:

1. Have a copy of Newcomb's Wildflower Guide in hand, or download your favorite plant ID app onto your phone,
2. Walk through the ecological zone and identify as many species as you can using Newcomb's or your phone app. Take pictures and write down what you think you are seeing in a notebook. If you know your natives well, you can record your observations in iNaturalist. If you are a botanist or ecologist, consider using Collector™ as your online notebook as it allows you to make more useful observations as you go than other applications,

[CaSoilWeb](#)  
[NatureServe](#)  
[iNaturalist](#)  
[Collector™](#)

3. Once you have written down the species that you see, write them down again in descending order of how common they are in the meadow, with the most common species at the top of the list and the least common species at the bottom. **This ranked list is very important so keep it safe,**
4. The next step is to assign a letter value to each species on your list. This letter is sometimes called the “element occurrence” value and is an indicator of the viability of each species at that site. Here’s the scoring table, from NatureServe.

**Table 5.1 - Basic EO Ranks**

EO Rank	Description
A	excellent estimated viability
B	good estimated viability
C	fair estimated viability
D	poor estimated viability
E	verified extant (viability not assessed)
H	historical
F	failed to find
X	extirpated

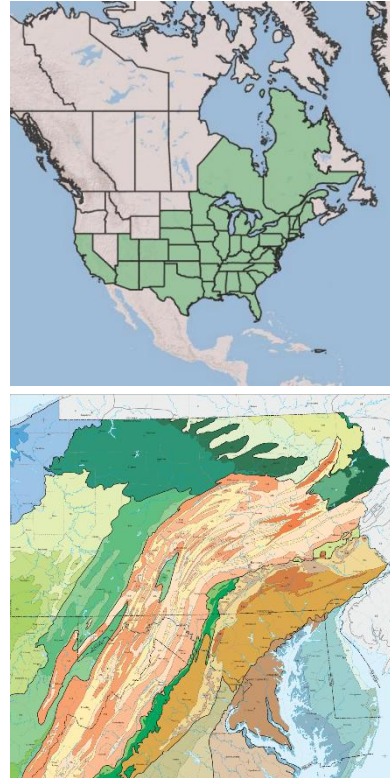
5. Repeat this process for other naturally occurring meadows that have candidate ecological zones,
6. After you have visited all the meadows you can visit, combine all the lists together into a master species list and assign an element occurrence score to each species, based on your notes and images. There is a methodology for how to combine the lists and assign an overall element occurrence score for each species, but that methodology is beyond the scope of this guide. For now, just do your best because it will be the best guidance you can obtain without hiring an ecologist.

*Final Note: If you are designing an upland meadow in Westchester County NY, then your best reference site is going to be a naturally occurring meadow fragment from the same county or ecoregion. No need to rely on vendors; they don’t know your site. Resist the temptation to delegate the responsibility of meadow design to a seed mix marketing company.*

## Introduction to Native Plant Genetics

Native plant genetics is a complicated topic, but we can simplify it greatly with a few key concepts.

**First**, many native plants can be found throughout the United States. Butterfly milkweed (*Asclepias tuberosa*), for example, can be found in all but seven states, plus Ontario and Quebec. But just because the species seemingly grows everywhere, seeds from anywhere might not work or be appropriate for your meadow. This is because a species growing at a location will “tune” itself genetically to its surroundings. A butterfly milkweed population growing in Arizona might lose its ability to survive long, cold winters but develop an extra thick cuticle and deeper roots to survive in the desert. But butterfly milkweed growing along the shores of the St. Lawrence River might have adapted to survive the conditions there, with a short growing season, and have lost its ability to survive any appreciable drought.



**Second**, the Environmental Protection Agency (EPA) produced a wonderful map in the 1980s that attempted to define regions of the United States that function in a similar way, ecologically. This map is called an Ecoregion Map, which has proved useful in understanding how far away or from what part of the country it is safe to source seeds and plants. The map ignores political boundaries so seeds or plants growing in Maryland might be perfectly suitable for a location in Pennsylvania if both locations are within the same ecoregion.

EPA

Decide the  
Genetics and  
Provenance  
Policy



*Figure 15 – Avoid this common scenario. An off-the-shelf showy wildflower seed mix was used for this meadow. Inappropriate midwestern genetics not only overwhelmed this site but looks ridiculous. Flowers have all but disappeared. Inappropriate genetics ruined this meadow.*

The implication of these concepts for your meadow, therefore, is “where do you want your seeds to come from?” This should be a conscious decision that you make on behalf of your community and shouldn’t be decided for you by an online seed store.

### **Three Case Studies**

There are cases when paying close attention to the genetic origin of your meadow seeds is critically important, and there are cases where it doesn’t matter much at all. Below are three case studies designed to illuminate the importance of genetics under different scenarios.

#### **Case A**

*You are planning a large meadow in a natural setting, like a state or national park, where the meadow is intended to become a core habitat feature to support migrating birds and other wildlife. There are naturally occurring meadow fragments all around you.*

If this is your situation, you will probably want to be very specific about where your seeds come from. You might even want to collect the seeds yourself from neighboring meadows (ensure you have permission to collect them, if needed). Try to find seed vendors that offer seeds with ecoregion source coding so that you can choose seeds from the ecoregion of your meadow project.

#### **Case B**

*You are working on a construction project or a public works project in a semi-natural area, like a sparsely populated Township or County. There aren’t many native meadows nearby, but there could be.*

If this is your case, sometimes close is close enough. Look for seed vendors that have species on your list (see Reference Sites) that are sourced from your state or from an immediately adjacent state. You still want to try to purchase seed sourced from your ecoregion, but failing that, you can just go with your state. If your meadow project is in Pennsylvania, you will want to avoid buying seeds from Kansas. Pennsylvania isn’t Kansas and we don’t need or want their plant genetics over here, no matter how much money you might save.

#### **Case C**

*You are working in a public park in the middle of a dense urban or suburban area where there are few to no natural systems around you, particularly meadows.*

If this is your case, you probably have the most flexibility of where you source your seeds because the meadow you build probably will have little chance to negatively interact with other meadows (an effect called “outbreeding depression”). Pollen and seeds are unlikely to move very far and mix with local gene pools.

### **Why Genetics Matter**

“Outbreeding depression” is a term for describing the normally detrimental effects of mixing plant genetics from faraway places. The idea is that if you were to mix the genetics of an Arizona-sourced butterfly milkweed with the genetics of the Quebec-sourced butterfly milkweed by planting them together and collecting the seeds, then the resulting plants might not be able to survive either location. This is the

scientific reason why most meadow builders try not to move native plants around the country too much because of the potential for long-term negative results.

There is also the issue of plant “phenology,” which is the timing of spring emergence, bloom time, seed set, and the like. If a species sourced from a faraway place performs on a different schedule from its local counterparts, then insects, birds, and other pollinators might not even be able to use the plant at which point that plant is simply decoration.

### **Set the Genetics and Provenance Policy**

Your job is to think through these topics and decide the seed sourcing policy for your new meadow. Academics will say that plant genetics are complicated, and they are, but that using local seed sources, in the absence of any other information, is probably better than using seeds from far away.

Try to use local native seed vendors as much as possible. Their growing conditions are probably closer to your meadow conditions than a faraway seed vendors’ conditions. The Northeast has several high-quality native seed growers with enough scale and scope to support most meadow projects:

- [Eco59/Northeast Seed Collective](#) – Works with a variety of local farmers to grow genotyped native seeds for the Northeast
- [Native Bee-Ginnings](#) – A highly experienced native seed farm focused on the genetics of western Pennsylvania and eastern Ohio
- [Pinelands Nursery](#) – A well-rounded native nursery with their own seed farm, focusing on the genetics of southeastern PA, New Jersey, Delaware, and Long Island
- [Ernst Conservation Seeds](#) – A large commercial native seed farm with a broad set of offerings frequently specified by engineers for large land recovery projects. Focused on central Pennsylvania grassland genetics but also offers species and genetics from around the country
- [Long Island Native Plant Initiative](#) – Grows seeds originating exclusively from the Island for local meadow restoration projects

Check online or your state’s native plant society to find low-volume specialty seed providers, of which there are many.



*Figure 16 - Eragrostis spectabilis seed plot at Native Bee-Ginnings, featuring genetics specifically selected for projects in eastern Pennsylvania*

**Setting a Budget**

**Introduction to Seed Prices**

Setting a budget for your new meadow can be challenging. Seeds are expensive because of how hard it is to grow, harvest, clean, store, and ship them.

The easiest to harvest, clean, and store seeds are warm-season grasses like Little Bluestem (*Schizachyrium scoparium*) and Indiangrass (*Sorghastrum nutans*). They can be sown and harvested almost as easily as wheat and barley, so they are inexpensive, and are usually in the \$25-\$50/pound range (2025).

Most species are difficult to grow, or they don't live very long and/or their seeds are difficult to harvest and clean. Species like asters and goldenrods are in this category and their seed prices can be in the \$250-\$500/pound range (2025). It's important to note that these species are used at lower rate than species like grasses, generally, due to their cost.

Some species cannot be produced via mechanized processes in a farm field. These species must be hand-collected from wild or cultivated places, and their pricing can be in the \$2,500-\$5,000/pound range (2025).

**Introduction to Seed Budgeting**

Usually, seed budgets for meadows are established on a per-acre basis. Meadows built with grant funding will often come with documented budgetary limitations. Your grant contract might say that you are only allowed to spend up to \$500/acre on seeds for your meadow, or maybe even as low as \$50/acre in the case of some federal programs.

Privately funded meadow projects have no predetermined budget but it's good to set an upper limit at the beginning so you have a clear limit to work within.

Note that more expensive seeds or a higher budget per acre don't necessarily translate into a better meadow. A lack of budget is rarely a top reason for meadow failure. **Poor species selection is usually the #1 or #2 reason for a failed meadow, not budget.** Some of the most ambitious meadow projects to have been undertaken in Pennsylvania have failed despite having access to very large seed and design budgets. Again, selecting the correct species is far more important than having a large budget.

**Setting a Per-Acre Seed Budget**

Here are some rules of thumb for thinking about setting a budget limit per acre for your project:

*NRCS-funded conservation meadows* – Expect to work within a \$100/acre cap, unless you have the money to buy seed on your own. These are generally for cornfield conversions to native grasses.

*NGO-funded conservation meadows* – Expect to operate within a \$500/acre budget. A conservation meadow is a meadow project designed to simply start the meadow process with the correct species in a fiscally responsible manner.

*Publicly-funded restoration meadows* – A good operating seed budget is around \$2000/acre. Restoration meadows differ from conservation meadows in that their objectives can be quite different. Rather than simply replacing a corn/soy rotation

	<p>with native species, a restoration meadow usually has other objectives such as ecological value, wildlife value, and aesthetic value. These types of meadows usually require expensive seeds in higher proportions than conservation meadows.</p> <p><i>Privately-funded restoration meadows</i> – These meadows usually have ambitious ecological goals and are normally meant to host uncommon or rare species that the planner wants to reintroduce to local ecosystems. The primary budget difference is the inclusion of some very expensive seed that can drive the overall seed budget per acre up to around \$5000/acre.</p> <p>\$5000/acre is considered the upper justifiable limit on seed purchases. Meadow designs that call for species whose seed is extremely expensive should probably consider using plugs instead of seed for those species. Contact your local native nursery to contract-grow these species. The Northeast and Mid-Atlantic have many native plant nurseries that specialize in growing local-ecotype species.</p> <p><b>Establish a Per-Acre Poundage Target</b>  Another key seed mix design parameter is how many total pounds of seed per-acre you should sow. There are no general-purpose guidelines for how many pounds of seed should be sown for a meadow because every context is different and the number of seeds per pound can range from several hundred to several million. But here are some rules of thumb that can be useful for deciding if you have budgeted for enough seed:</p> <p><i>Conservation seeding, or up to 10#/acre</i> – suitable if you are seeding into an already-established meadow or are performing a pasture-to-meadow conversion or a corn-to-meadow conversion. This low application rate tends to leave ample room for weeds that will need to be treated out during establishment</p> <p><i>Restoration seeding, or up to 20#/acre</i> – suitable for situations where you are seeding into a previously weedy area or where there are multiple pressures including deer, perimeter weeds, people walking, or other anticipated disturbances. Primarily used for restoration settings, public parks, and HOA meadows. This amount of seed per acre generally matures more quickly to better resist weeds and can support a higher number of species</p> <p><i>Performance seeding, up to 40#/acre</i> – suitable for intentional meadows designed to function as core aesthetic landscaping elements, such as in front of an office building or on a college campus. This amount of seed is also suitable when follow-up herbicide applications are impossible or forbidden. The dense initial seedling emergence helps to prevent weeds and often allows for a generous amount of annual and biennial flowers during the first and second years</p> <p>If you are a user of Evaluate™, you will need to specify both a Target Per-Acre Budget and a Target Pounds Per-Acre in the workflow.</p>	
	<p><b>Consider Seeking Third-party Assistance</b>  Seed mix design is an inherently complicated process. You need to discover the ecological zones present at your new meadow site and find comparable or “reference” meadow sites and understand the ecological zones at each one. Then you need to identify the species at those other sites, force rank them and assign</p>	

**Getting Help**

element occurrence values. Then you need to think about your seed budget and from whom you should purchase seed. That’s a lot of work!

If you don’t have the time to go through all those steps yet don’t want to risk using an online seed mix, then consider getting some help. Here are some dos and don’ts for soliciting recommendations from others.

Do seek recommendations from:

- o *A local organization* – often with many years of building meadows in your area. You might have to network around to find them, but they will likely have encountered many failures on their way to learning what works best for your region. There is no need to replicate their experiences on your own. These organizations can be watershed groups, environmental advisory councils, educational centers, and botanical gardens. You might even have a local contractor that specializes in building native meadows.
- o *Local ecologists or academics* – Pennsylvania is blessed with many colleges and universities, and most have some kind of biology, ecology, or plant sciences programs. Often, there is at least one person at each institution that has built up enough experience to lend a hand with helping you design your meadow,
- o *State and National organizations* – NRCS, Xerces Society, and the Pennsylvania Department of Conservation and Natural Resources (PA DCNR) frequently have representatives in your area that can help with designing a meadow, or they can recommend someone to you with specialized or local knowledge for your context

WILDFLOWERS	
Botanical Name (Common Name)	% by wt.
Agastache foeniculum (Anise Hyssop)	0.88
Allium stellatum (Prairie Onion)	2.21
Antennaria neglecta (Prairie Pussytoes)	0.44
Aquilegia canadensis (Columbine)	0.44
Asclepias tuberosa (Butterfly Weed)	2.65
Asclepias verticillata (Whorled Milkweed)	0.88
Asclepias viridis (Spider Milkweed)	0.66
Baptisia bracteata (Cream Wild Indigo)	0.66
Callirhoe bushii (Bush's Poppy Mallow)	0.88
Camassia scilloides (Wild Hyacinth)	0.88
Chamaecrista fasciculata (Partridge Pea)	10.59
Coreopsis lanceolata (Lance-leaf Coreopsis)	3.53
Dalea candida (White Prairie Clover)	3.53
Dalea purpurea (Purple Prairie Clover)	6.62
Dodecatheon meadia (Midland Shooting Star)	0.35
Echinacea angustifolia (Narrow-leaved Coneflower)	3.97
Gentiana flavida (Cream Gentian)	0.44
Heuchera richardsonii (Prairie Alumroot)	0.33
Liatris scariosa var. nieuwandlii (Northern Blazing Star)	1.76
Lupinus perennis subsp. perennis (Sundial Lupine)	2.21
Monarda punctata (Spotted Bee Balm)	0.79
Pedicularis canadensis (Wood Betony)	0.44
Penstemon grandiflorus (Large-flowered Beardtongue)	1.32
Penstemon hirsutus (Hairy Beardtongue)	0.35
Phlox pilosa (Prairie Phlox)	0.35
Pycnanthemum verticillatum var. pilosum (Hairy Mountain Mint)	0.22
Rudbeckia hirta (Black-eyed Susan)	5.29
Ruellia humilis (Wild Petunia)	0.88
Solidago nemoralis (Old Field Goldenrod)	0.44
Symphyotrichum oblongifolium (Aromatic Aster)	0.53
Symphyotrichum turbidum (Prairie Aster)	0.88
Tradescantia ohioensis (Ohio Spiderwort)	1.32
Verbena stricta (Hoary Vervain)	1.76

*Figure 17 - This actual seed mix design makes no ecological sense whatsoever; many of these species would never be found in the same place with the others on the list, and most are not even from the same parts of the country. Be extremely wary of seed mix designs assembled by non-ecologists*

Avoid seeking recommendations from:

- o *Online seed mix marketers* – These organizations might or might not have representatives living in your area that understand your local ecology well enough to make recommendations. Online seed mix marketers cannot be held liable for the performance of their seed mixes. This is because they are not familiar with your meadow site, its ecological zones, or what your objectives are, or which weeds you have. Proceed with caution if you seek recommendations from seed mix marketers,
- o *Landscape and garden designers* – Experiences in the built landscape do not translate well to the meadow context. The differences in the ecological, cultural, and financial context between gardens and natural systems are vast. Some landscape and garden designers are trying to extend their

**Xerces Society**

**PA DCNR  
Lawn to Meadow**

**NRCS CRP**

**Evaluate™**

	<p>offerings to meadow design, but they are struggling to succeed. Ask to tour some of their meadow projects that are at least 5 years old and compare the results to the original design,</p> <ul style="list-style-type: none"> <li>o <i>Engineers and landscape architects</i> – are inherently risk averse and rarely have experience building meadows themselves. Protecting the public is their primary responsibility so they have well-developed processes to transplant success from one project to every project thereafter. This is good; this keeps us safe from infrastructure failures and disasters. However, this institutional bias works against the ecological realities of building meadows, where the meadow context is different every time. Just because a seed mix worked on the last project doesn’t mean it will work on this project. If you are provided with a blueprint that specifies a seed mix design by its product code, think twice before committing to its use.</li> </ul> <p>An alternative to seeking outside counsel is using the Evaluate™ software designed and built by a company that builds meadows for a living. Seed mix recommendations are provided based solely on your observations about your new meadow site and on a vast library of naturally occurring meadows across the country. It uses the latest data models and scientific methods to narrow your seed choices to those species that are most likely to work.</p> <p>But trusting a piece of software to design a new meadow carries its own risks. You’ll probably want to involve an ecologist at some point, just to be safe.</p>	
<p><b>Seed Mix Design</b></p>	<p><b>Design your Seed Mixes</b>  Ultimately, and eventually, you will want to create a seed mix design for yourself or hire someone to create it for you.</p> <p>The process of designing the seed mix is relatively straight-forward at this point, if you followed all the previous steps. Here’s what you do:</p> <ol style="list-style-type: none"> <li>1. Open Excel or Google Sheets or your favorite spreadsheet program,</li> <li>2. Put the name of the meadow project near the top, the GPS coordinates of the meadow, the list of zones, and the acres for each zone,</li> <li>3. For each zone, do the following:</li> <li>4. Type in all the species from your reference site analysis, literature search, or from your consultant, and sort them from top to bottom based on their element occurrence score (the most common species at the top and the least common at the bottom),</li> <li>5. Create a new column for each of the seed vendors you plan to use, based on the decisions made related to meadow type and genetics. If you have three preferred vendors, create a column for each one,</li> <li>6. Go to the vendor websites and look up their seed price list, which can take many forms. Key in the per-pound prices for each species in your sheet, for each vendor. If the vendor does not carry a species, leave the cell for the price blank; do not enter a ‘0’ in the cell,</li> <li>7. Create a new column to hold a %. This percentage will reflect the relative abundance or prevalence of that species in the overall design. Then key-in the starter %s for each species. Species at the top of the list should be in the 10-25% range. Species in the middle of the list should be between 5-10%. Species at the bottom should start at 2%,</li> </ol>	<p><b>Evaluate™</b></p>

8. Create a SUM() cell at the bottom of the column with the %s to see what all the percentages add up to. If over or under 100%, you will eventually need to adjust those %s to get to 100%,
9. Create a new column and key in the following formula (assumes you are using three vendors):  
 $\text{MIN}(\text{PRICE A, PRICE B, PRICE C}) * (\text{SPECIES \%}) * (\text{ZONE ACRES})$ . The resulting answer is how much the seed for that species will cost based on your list of species, the % of that species in the mix, and the size of the ecological zone,
10. Create a new SUM() cell at the bottom of that column to represent the total cost of all the seed,
11. Create a new cell below the SUM() and key in the following formula:  
 $\text{SUM}() / \text{ZONE ACRES}$ . This gives you the seed price per acre for your current seed mix design. You can use this value to compare to your budget limit set previously,
12. Now, go back and adjust the %s in the seed mix so that the total % = 100% and so that the total budget per acre is at or below the maximum that you previously established,
13. Congratulations! You now have a seed mix design that is based on your design parameters and that follows good ecological practices,
14. The next step is to create one more column to hold the seed weights. Use this formula:  $(\text{SEED PRICE}) / \text{MIN}(\text{PRICE A, PRICE B, PRICE C})$ . This calculates the total pounds of seed you need for each species,
15. Next, copy paste the species and pounds for each zone, into a new tab in the spreadsheet. This is what you are going to send to seed vendors for pricing and availability,
16. When you get a reply from the seed vendors, update your spreadsheet accordingly with prices and availability. Update the price per pound based on what they quoted and [delete] any prices for species that they do not have available. If your seed vendors do not have a species in your design, be sure to delete the % for the species. Doing these steps will automatically update your spreadsheet,
17. Re-evaluate the entire seed mix and update %s so that you still have 100% and check that you are not exceeding your price/acre overall budget,
18. Your seed mix design is now ready for manager approval,
19. Upon approval, you can send your final species and poundage requirements to each seed vendor for a final quote, or you can just start ordering seed.
20. Remember to do this process for each ecological zone (see Site Evaluation – Ecological Zones).

Be sure to double-check a few things before moving on from seed mix design:

- Is the total number of species in the seed mix in the 8-12 range, more or less?
- Is your seed mix design within the overall budget for the project? Have you satisfied any per-acre or per-pound budget requirements?
- Is the total number of pounds per acre broadly suitable for your type of project?
- Have you double-checked that foreign or far-away genetic strains have been removed from the seed mix?
- Are you certain that there are no non-native, weedy native, or non-local species included in your seed mix?

	<ul style="list-style-type: none"> <li>○ Are you certain that the core species in your design will be available at the time of purchase?</li> </ul> <p>Users of Evaluate™ can use the software to automatically create and adjust seed mixes and to create PDFs with their seed mix design for easy communication with the community, managers, and seed vendors.</p>	
<p><b>Carrier Selection</b></p>	<p><b>Introduction to Seed Carriers</b>  Seed carriers help a native seed mix to “flow” more easily and consistently through a seed drill or broadcast seeder. Carriers can be inert or another seed product.</p> <p>Inert carriers generally do not interact with your seed or impact the performance of the seed, but they can be expensive. If you are planning to use an inert carrier (e.g., sand, kitty litter, rice hulls), please refer to the Calibrating a Seed Drill section, or watch the accompanying YouTube video. If you plan to use a type of seed as your carrier, please continue reading.</p> <p>Sometimes it makes sense to use another seed as a carrier for your seed mix. While recommending a specific seed carrier for your meadow is beyond the scope of this guide, here are some generally useful guidelines:</p> <p><b>Choose a Seed Carrier</b>  <i>Rolled or crimped oats</i> – this can be a good all-purpose carrier and is normally easy to buy locally. Rolled or crimped oats have been flattened, which creates a lot of surface area and a little bit of tack to hold your seeds as they flow through the drill. Oats are more nutritious than your native seeds and can act as a sacrificial seed to feed hungry birds, mice, and voles. Rolled or crimped oats usually do not germinate.</p>	

*Whole oats, winter wheat, or rye* – these live, intact grains are used to “bulk up” budget seed mixes because they mask the fact that relatively few native seeds are being planted. Their role is to germinate quickly in the spring to hold soil, give a little bit of shade to the native seeds, and to give the client something to look at while the rest of the meadow is still deciding if it wants to germinate. Live grain carriers can grow densely and become unsightly to the point of requiring additional mowings, so be cautious about over-using them.



*Figure 18 - This low-poundage conservation native meadow mix was “bulked up” with winter rye to make up for the low seed count, and to help stabilize soil while slow-germinating species wait to grow*

*Annuals* – adding inexpensive annual and biennial species to the seed mix is a common tactic used when building meadows in public parks, side yards, and along highways. They basically play the same functional role as oats and wheat but are more colorful. Adding annuals can greatly improve initial public reaction and acceptance. Non-native annuals are widely considered to be “ok” to use, even in a restoration setting because they are not expected to survive past year 2.

*Inexpensive Natives* – Sometimes the best carrier is another native seed itself and, ideally, a species that should anyway be a part of the seed mix. Native carriers should be species that germinate readily, which often means they don’t require conditioning beyond a dry storage period. Native seeds are much more expensive, however. Here are some useful examples:

- For upland, mesic sites, consider using path rush (*Juncus tenuis*) and black-eyed Susan (*Rudbeckia hirta*) as carriers,
- For upland, dry sites, consider using purpletop (*Tridens flavus*) or brown-eyed Susan (*Rudbeckia fulgida*) as carriers,
- For lowland mesic sites, consider using deertongue (*Dicanthelium clandestinum*) or broomsedge (*Andropogon virginicus*) as carriers,

- For lowland wet or nearly saturated sites, consider soft rush (*Juncus effusus*) and fox sedge (*Carex vulpinoidea*) as carriers



Figure 19 - *Rudbeckia hirta* is a great filler species on upland dry sites, but it can be expensive and it fades out of a meadow very quickly

**Finalize  
Species List**

**Finalize Your Seed Mix**

By the end of this extensive exercise, you should have a functional seed mix design with enough information to defend each selection. If, for any reason, changes occur between the creation of the list and the ordering of the seed, ensure these changes are properly accounted for and approved by all necessary parties.

Maintain all your seed and seed mix purchase records and retain the labels from all bags of seed. Grant programs often require you to prove that you purchased the correct species in the proper amounts. Plus, you, or someone after you, will want to know exactly what was planted so that they can understand what worked or did not work.



## DECISION POINT #2

By this point it should be clear that designing and planning a meadow is not simple. But the core ecological analysis that you just completed makes it substantially easier because you now truly understand what species your site can support. This brings up a key decision point, though: Can you and your stakeholders get on board with planting the species in this list?

It is quite possible that this species list differs from what might have been in mind for the space and that serious thought needs to be given as to whether this change is okay for those involved. As noted above, while this species list is not gospel, diverting from it significantly can and will lead to issue down the road.

Trying to fight site conditions by installing plant species that do not match will only end with the project failing because these species will not last and the meadow will return to invasive species.

For example: On the left below is an example of a project where the organization wanted a warm-season grassland meadow despite the conditions being far too wet for that to be successful. In the end, the grasses either rotted out, or the seed never even germinated, and it returned to invasive cool-season grasses. On the right, however, the conditions for these grasses was perfect and now they dominate the landscape..

# CHOOSE VEGETATION MANAGEMENT STRATEGY

**A**

## KEY QUESTIONS

## OVERVIEW

- Which noxious species are present? If present, what's the age and scope of the infestation?
- What's the size of the project area and site preparation budget?
- What's the desired timeline for control?
- Are there relevant environmental factors that would impact preparation strategies?

The first important factor to any successful meadow project is effective and comprehensive weed management. Implementation strategies will differ by project, but the outcome should be a project area with adequate control of non-desirable species and supports the planting strategy. This page will discuss the key site preparation considerations and methodologies.

## CHECKLIST

STEP	TITLE	SUMMARY NOTES	DATE
1	<b>ID Noxious Weeds</b>	Simple turfgrass scenario with no evidence of stilt grass or mugwort	
2	<b>Build your Vegetation Management Calendar</b>	Based on the weeds present in the meadow, I have created a guide that best lays out how and when to treat these species	
3	<b>Consider Alternatives to Chemicals</b>	Using sod removal as a first step to help lower the use of herbicides	
4	<b>Control Timelines</b>	Cool-season turfgrass, so planning for at least one growing season	
5	<b>Environmental Factors</b>	ark board has signed off on the use of glyphosate	
6	<b>Accessibility and Tools</b>	Three rounds of herbicide treatment; subcontracted	

## SUMMARY AND SIGN-OFF

### HOW TO KNOW WHEN YOU ARE FINISHED

### MANAGER/CONSULTANT SIGNOFF

You are finished with this step once you are confident that you have identified all the invasives in and around your meadow and have confirmed that you have the time, budget, and community support to treat them all effectively.

The best practice is to keep all your constituents informed of your activities to avoid concerns and complaints.

FIELD MANAGER SIGNATURE

DATE

PROJECT MANAGER SIGNATURE

DATE

# CHOOSE VEGETATION MANAGEMENT STRATEGY **B**

TITLE	DESCRIPTION	LINKS
<p><b>Introduction</b></p>	<p>Inadequate suppression of competing vegetation, particularly annual and perennial grasses, is often cited as the #1 or the #2 root cause of meadow project failures. Poor species selection is the other common reason for failure.</p> <p>Vegetation management can be much more nuanced than it first appears. Interactions between the choice, timing, action, and efficacy of various control techniques directly impact when it is safe to consider seeding a meadow. Hence, the need for a plan.</p> <p>Economizing or experimenting with vegetation management is not recommended because it can put an entire project at risk. This section explores the use of synthetic herbicides and some other options for controlling unwanted vegetation. The effects of choosing a control method on the timing of follow-up activities, including seeding and establishment, are also discussed.</p> <p>The preferred vegetation management strategy is nearly always going to be the application of herbicides by licensed professionals with ample experience with building meadows; they know which herbicides to use, how much to use, how to apply them, and when. Hiring out the vegetation management to a professional meadow-building contractor is often the least expensive and least risky option.</p>	
<p><b>Noxious Weeds and Existing Natives</b></p>	<p><b>Identify All of your Noxious and Problematic Weeds</b></p> <p>Review your documentation from the Site Evaluation step to see what invasives and other weeds were present and make a list. If it has been more than a year since you performed the site evaluation, or you didn't record the weeds, go back to the meadow project site and create a list of all the noxious weeds, invasives, pasture grasses, and annual grasses present in each ecological zone. It is important to record weeds by ecological zone because of the implication of proximity to water or the presence of standing water or saturated soils.</p> <p>For help in understanding noxious and problematic weeds, consult your state extension agency or state Department of Agriculture websites. The Pennsylvania resources are listed in the column to the right.</p> <p>Each invasive that you identify poses a threat to your future meadow and will need to be thoroughly removed during site preparation activities. Some invasives require several years to fully suppress, so incorporate this time into your overall site preparation schedule.</p> <p>Weeds do not respect property lines, so it is in your interest to talk to and ask neighboring property owners if you can identify and control invasive and noxious weeds on their property, too.</p> <p><b>Double Check for Existing Native Vegetation</b></p> <p>List any existing native plant species in your meadow that you would like preserve. Many meadow projects already have ample native plant species populations that you might or might not recognize. It is generally considered to be a waste of resources to spend money to kill native plants in a meadow only to spend money to buy seed and replant them.</p>	<p><a href="#"><b>Herbaceous Weed Treatment</b></a></p> <p><a href="#"><b>Plant Identification and Weed Management</b></a></p> <p><a href="#"><b>Penn State Extension Invasive Plants</b></a></p> <p><a href="#"><b>PA Controlled Plant and Noxious Weed Lists</b></a></p> <p><a href="#"><b>Invasive.org</b></a></p>



*Figure 20 - This meadow was scheduled for a complete burndown (e.g., glyphosate) before it was saved by a staff ecologist. The vegetation management strategy had to be completely changed to preserve the native vegetation*

The image above shows a field scheduled to become a native meadow, but it already had many desirable native meadow species present within it. A typically prescribed glyphosate application would have removed all the existing natives from this meadow and required replacement, benefiting only the chemical companies and the seed mix marketers. Always check for the presence of desirable natives in your new meadow before deciding your vegetation control strategy.

**Assess the Surrounding Vegetation**

Assess the natives growing in the periphery of your new meadow and answer these questions because the answers could impact your control plan.

- Are there desirable native plants that should be protected from herbicide?
- Is there wildlife nearby that will be impacted by specific herbicides but not others, or by the addition of adjuvants (other additives used to aid application in some way)?
- Are native plants located separately from the invasives we are targeting or are they mixed in? There may be ways to avoid “friendly fire” through proper herbicide selection, adjusting timing, or choosing the right application method.

[Penn State Invasive Control Strategy Resources](#)

[National Invasive Species Information Center](#)

[Best Management Practices for Wildland Stewardship](#)

**Build Your Vegetation Management Calendar**

Confirm the invasives and weeds you will be targeting with an outside consultant. Missing a problematic plant in your control plan could be a costly mistake. Understand how the use of chemical controls might impact adjacent native plant populations and wildlife even if they are not directly treated.

Make an EXCEL list that lists each species to be controlled and assign each to a category: annual graminoid, perennial graminoid, herbaceous plants (non-grasses/sedges/rushes), woody shrubs and vines, and trees.

Consult external resources for preferred control methods for each species that you need to control, and which control methods you should avoid using given

[Herbaceous Weed Treatment](#)

[Plant Identification and Weed Management](#)



<p style="text-align: center;"><b>Consider Alternatives to Chemicals</b></p>	<p><b>Consider Alternatives to Chemical Control</b>          If building a meadow under 0.5-acres, consider alternatives to using synthetic chemicals to control unwanted vegetation.</p> <p>There are scenarios where stakeholder preferences, HOA rules, government regulations, and other factors might prohibit the use of herbicides to prepare a site for a new meadow. Or you might simply want to avoid the use of chemicals in building a small meadow. This section briefly evaluates the commonly cited alternatives to chemical controls:</p> <p><i>Note: The most cost-effective and efficacious method for controlling unwanted vegetation is the proper use of herbicides applied by an experienced, licensed technician or specialized meadow building organization. Other methods do work but can be expensive or take many years to achieve effective control.</i></p> <p><b>Consult with Stakeholders</b>          Consult with the public or other interested stakeholders about your weed control plan and solicit their feedback and support.</p> <p>You want to avoid the unpleasant situation of being confronted by an angry homeowner or resident during the application of synthetic herbicides. In some cases, a resident or user of the space can cause a temporary or permanent cessation of meadow building activities. Take the time to solicit public input and take their concerns seriously when planning your vegetation control.</p> <p><b>Tilling/Cultivation/Soil Removal</b>          Repeated cultivation and sod removal are intrusive techniques that require heavy equipment and large vehicles to remove large amounts of material. Cultivation and sod removal is considered appropriate only for very small backyard meadows in highly residential areas or where public sentiment is strongly against the use of herbicides. The cost for these techniques can exceed the value of the meadow due to the number of times that the technique must be used, associated erosion control materials, and permitting costs.</p>  <p><i>Figure 22 - This half-acre meadow was repeatedly tilled and covered with straw due to the public's concern with the use of herbicide. The meadow eventually failed due to its extensive Japanese stilt grass seed bank, which quickly overran it</i></p>	<p><a href="#"><b>NRCS Control Mechanisms</b></a></p> <p><a href="#"><b>PA E&amp;S Plan Resources</b></a></p> <p><a href="#"><b>PA Pesticide Applicator Resources</b></a></p>
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*Note: Be sure to communicate with your County Conservation District if soil disturbance is part of your vegetation management plan as you might need to submit an Erosion & Sediment Control (E&S) Plan that could interfere with the building of your meadow. Seed drills are considered safe to use and generally do not require permits.*

### **Solarization**

Solarization is the practice of laying down plastic sheeting or tarps over the ground to suppress all perennial and annual vegetation. Solarization is a popular technique amongst hobbyists and homeowners but is quite expensive on a large scale. It costs about \$5000 per acre to install ground cloth, and it must remain in place for at least two years for adequate control. In some instances, ground cloth alone cannot fully suppress some pasture grasses and other weeds (they just go dormant) and the need for an herbicide follow-up treatment is often required. Solarization might not heat the soil to sufficiently high temperatures to damage seeds enough to prevent future germination. It is not uncommon for a recently solarized field to erupt in annual weeds, which require frequent mowings or chemical controls.



*Figure 23 - Solarization of a meadow site can be performed and is occasionally successful, but takes a long time and can become quite expensive for large sites*

### **Sheet Mulch**

The sheet mulch technique employs a degradable form of soil covering, usually cardboard or kraft paper, with a layer of clean soil spread on top of the paper. Seeds are sown into the soil covering where they can germinate when irrigated sufficiently. If the paper layer is thin enough, the roots of newly germinated seeds might penetrate the paper and enter the soil profile where they can continue to grow normally. The paper must also be dense enough to prevent pre-existing vegetation from growing through the layer. This technique works best if some other technique is used to terminate or sufficiently damage the existing vegetation so that it cannot grow through the paper. This technique works well on a small scale but is generally considered inappropriate for building meadows due to its very high cost per square-foot.

**Control  
Timelines**

**Evaluate Control Timelines**

Different invasive species or unwanted plant species infestations respond differently to different control methods and might require retreatment. The number of retreatments is highly specific to the species themselves, the site's conditions, the available control techniques, and how long the invasives have been present at the site. While this guide cannot provide definitive guidance for every situation, read through the following commonly encountered scenarios, find the best match, and then incorporate the number of anticipate retreatments in your vegetation control plan.

**Clean Turf-to-Meadow Conversion**

For well-maintained turf and pasture areas with limited-to-no Stilt Grass (*Microstegium vimineum*), Carpgrass (*Arthraxon hispidus*), or Basketgrass (*Oplismenus undulatifolius*) infestations, you should be able to complete weed suppression in as little as 3 months, and almost always within a single season. Start chemical treatment in June/July and repeat as necessary to suppress all vegetation through November, at which point you should be safe to seed.

**Clean Pasture-to-Meadow Conversion**

For clean, well-maintained pastures and fields without notable populations of perennial and annual herbaceous weeds, expect weed control to take about 6-9 months to treat both the cool and warm-season grasses and other perennials. If you start weed control in April of a given year, you should be able to seed in November of the same year.

**Weedy Pasture-to-Meadow Conversion**

For weedy pastures and fields that have notable populations of mugwort (*Artemisia vulgaris*), Thistle (*Cirsium ssp.*), Teasel (*Dipsacus*), Reed Canary Grass (*Phalaris*), and other annual or perennial weeds and woodies, expect weed control to take a full 18-month duration or two growing seasons. If you start weed control in April of a given year, you should be able to safely seed in the winter of the following year. Sowing a sacrificial annual ryegrass or oat covering in the spring of the second year can help to reduce erosion and limit the number of annual weeds.



Figure 24 - Extensive reed canary grass (RCG) infestations can take several years of aggressive controls before it is safe to seed a new meadow

[Weeds &  
Herbicides  
Intro](#)

	<p><b>Heavy Stilt Grass and Annual Invasives</b>  For areas with intensive annual invasive pressure such as Stilt Grass (<i>Microstegium vimineum</i>), Carpgrass (<i>Arthraxon hispidus</i>), or Basketgrass (<i>Oplismenus undulatifolius</i>), it is safer to assume that weed control will last at least two full growing seasons and sometimes even three years.</p> <p>There are special site preparation techniques that might be required for areas with intensive annual invasives that can include a combination of herbicides, temporary conversion to turf, or employing a different seeding strategy. Consult with an experienced meadow builder before planning weed control for an area with a heavy annual invasive infestation.</p> <p><b>Woody Invasives</b>  Some perennial woody weeds, like Olive (<i>Elaeagnus umbellata</i>), Barberry (<i>Berberis ssp.</i>), Honeysuckle (<i>Lonicera ssp.</i>), and others often require multiple seasons for complete control. But unlike herbaceous weeds that are very difficult to control once the meadow is growing, you can normally continue to treat woody invasives one by one at any time. If you start control in the spring, you should be able to seed in the same fall.</p> <p><b>Special Cases</b>  Determine if you have a significant number of invasives that do not respond well to normal herbicides, solarization, tilling, or sheet mulching. These invasions often require highly specialized chemicals that can cause significant environmental damage if misused. Below is a partial list of invasives that might require special control techniques that you might not want to attempt yourself.</p> <ul style="list-style-type: none"> <li>o Japanese knotweed,</li> <li>o Lesser celandine,</li> <li>o Black swallow-wort,</li> <li>o Leafy spurge,</li> <li>o <i>Corydalis incisa</i></li> </ul> <p>Remember that you DO NOT want to plan any seeding event until your invasive and noxious weeds, including annuals, are around 98% controlled. If you rush a meadow planting the quality of your meadow is likely to be substantially reduced and might have to be rebuilt.</p>	
<p><b>Environmental Factors</b></p>	<p><b>Evaluate Potential Environmental Concerns</b>  In most terrestrial cases most herbicides labelled for use in turf and rangeland are suitable for weed suppression during meadow building, if there are no open water sources nearby or where groundwater does not approach the soil surface.</p> <p>But if you have ponds, streams, wetlands, vernal pools, or any areas within 500’ of permanent or temporary open water, your herbicide options will be restricted by law and the amount of time required to achieve effective control can take years using alternative techniques. Open water sources or ground water can also limit mechanical techniques as these activities may cause excessive soil erosion or may be wholly impossible due to machinery weight.</p> <p>NOTE: In some municipalities with high water tables, several herbicides are completely prohibited. You MUST thoroughly read the label of any herbicide that</p>	

you plan to use. DEP fines and other associated legal costs are HIGH if you are found to have applied an herbicide in an area for which its use is restricted.

Controlling weeds near open water sources often requires the use of herbicides with lower effectiveness than what might otherwise be used and can extend the amount of time required to achieve effective control by a season or two.

For example, pre-emergent herbicides effective against annual weeds are prohibited for use near water. And, reed canary grass (*Phalaris arundinacea*) and phragmites (*Phragmites ssp.*) are challenging species to control effectively and their proximity to water limits your choice of herbicides. Repeated applications may be required, for up to two years with these two species, to achieve effective control.

Remember to consider these factors when planning a meadow project and include an appropriate amount of time in your site preparation plan.



*Figure 25 - Steep slopes, soggy areas, groundhog holes, rocks, excessive organic matter, logs, trees, and fences are just some of the challenges facing a seed drill operator. Always thoroughly walk your meadow site before transporting and deploying your seeding equipment*

**Accessibility & Tools**

**Assess Site Accessibility**

Evaluate any impact the site itself might impose on your vegetation control calendar. While the physical configuration of your new meadow site doesn't affect your choice of control methods much, certain features and limitations could affect HOW you implement your control plan.

If the site has limited access in any way, you might be forced to downsize your control equipment from large spraying equipment to backpacks and hand work. Performing vegetation control using small equipment can greatly extend the amount of time required and drive costs up significantly and should be reflected in your control calendar.

Common questions to ask include: What is the topography like? Is it flat or steep? Are there large rocks, downed trees, gully/depressions, or waterways that will be difficult to cross? How many acres are you treating? Are conditions uniform across the whole site or are some areas more accessible than others? Look at the landscape through the lens of a future version of yourself applying herbicide. Site accessibility will influence equipment choice, labor needs, application method, and overall feasibility of certain treatments.

**Choose Your Tools**

For each treatment line item on your control plan, note the specific technique or tool that you plan to use. Very large equipment is appropriate for very large spaces and a broad-spectrum chemical application, but small equipment might be more appropriate for spot spraying, and hand-treating might be best for nuisance plants that pop up here and there.

Here are the most common techniques/tools used during vegetation management and when they are most commonly employed:

*Tractor and Large Boom* – For large spaces over 10 acres where the control plan is to apply a simple broad-spectrum herbicide, a traditional agricultural tractor with a boom sprayer setup is normally the most efficient option. Boom sprayers offer fine dosage controls and wide, even coverage. Use when you are trying to suppress or terminate 100% of all competing vegetation. Avoid using near areas with native vegetation or close to hedgerows to limit damage due to drifting spray.

The typical case is an old hayfield or corn/soy field that you are converting to a meadow and there is little to no expectation of protecting any natives already present.

*UTV and Small Boom* – For smaller spaces up to 10 acres where you want the efficiency of a boom but the flexibility of a smaller rig to weave in and out of native vegetation areas, wet spots, or other features that you want to avoid or protect. Small booms have lightweight arms and valves that allow you to turn off and flip up and arm to get into tight spaces, maneuver around trees, or navigate gaps in hedgerows.

The typical case is a lawn-to-meadow conversion.

*UTV and High-Pressure Wand* – This setup is most appropriate for spot spraying over a large meadow project. The UTV allows you to travel between infestation areas quickly and the high-pressure wand provides efficient coverage of your control target.

The typical case is the rapid removal of non-native or invasive vegetation from a field that has at least 30% natives already present to prepare it for overseeding or reseeded.

*UTV and Low-Pressure Wand* – This setup is for large-acreage, low-volume applications, usually when treating a specific invasive from the meadow, and is generally not used to prepare an overall meadow project.

A typical use case would be the post-implementation treatment of mugwort or thistle from a new meadow.



*Figure 26 - Low-volume, low-pressure setup for spot treating large meadows in remote locations*

*Backpack* – Backpacks are designed for small-acreage, low-volume applications, usually when treating a specific invasive from the meadow, and is generally not used to prepare an overall meadow project.

A typical use case would be the post-implementation treatment of mugwort or thistle from a new meadow.

	<p><i>Battery-Powered Tanks</i> – These small, handheld battery-powered sprayers are excellent for precise applications of herbicide to individual plants that are deemed a threat to a new meadow. An alternative to hand-pulling. Normally used to apply a specialty herbicide with limited action.</p> <p><i>Hand-Pulling</i> – Yes, hand-pulling remains a viable technique to remove small, recent incursions of invasives into a meadow, especially when the use of herbicides could create openings for new invasions. Not suitable for preparing a new meadow.</p>	
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<b>PREPARING TO SPRAY</b>			<b>A</b>
<b>KEY QUESTIONS</b>		<b>OVERVIEW</b>	
<ul style="list-style-type: none"> <li>○ What kind of plants are being targeted? (forb, grass, woody)</li> <li>○ What non-target species are present and what is the degree of mixing with invasives?</li> <li>○ What is proximity to water?</li> <li>○ How accessible is the site?</li> </ul>		<p>Proper herbicide selection can be as easy and effective as applying an all-purpose glyphosate once at a single rate. More complicated scenarios may involve a collection of various herbicides tailored to different kinds of plants, applied together or separately, at various rates and times of year, and with multiple application methods. Thinking through the best approach is like preparing to wage war. You must know your enemies, when they are weakest, and how they can best be subdued while not causing undue destruction to the surrounding community.</p>	
<b>CHECKLIST</b>			
<b>STEP</b>	<b>TITLE</b>	<b>SUMMARY NOTES</b>	<b>DATE</b>
1	<b>Reassess Surrounding Native Species</b>	e.g., some mixing of stilt grass with desirable native forbs, especially in upland areas. Nearby willow trees.	
2	<b>Choose Products</b>	e.g., attempt pre-emergent application of Prodiamine for stilt grass. If greater than 20' from stream, use grass-specific herbicide	
3	<b>Read the Label</b>	e.g., Prodiamine 65 WDG	
4	<b>Choose Adjuvants</b>	e.g., add non-ionic surfactant to aquatic glyphosate; add crop oil concentrate to Clethodim.	
5	<b>Reassess Proximity to Water</b>	e.g., project area in close proximity to a streambed that is seasonally wet. At the moment, it is dry.	
6	<b>Confirm Chosen Application Method &amp; Equipment</b>	e.g., backpack sprayers for all project areas given accessibility.	
7	<b>Determine Application Rate</b>	e.g., Prodiamine at 1.5-3 pts/acre	
<b>SUMMARY AND SIGN-OFF</b>			

<b>HOW TO KNOW WHEN YOU ARE FINISHED</b>	MANAGER/CONSULTANT SIGNOFF	
<p>You are finished with this step once you have determined which herbicides and adjuvants you will be using, how many times and when you will be using them, at what rates, and using what application method. This will be an iterative process of making best-practice decisions about the targeted species, evaluating year 1 success, and adjusting accordingly.</p>		
	FIELD MANAGER SIGNATURE	DATE
	PROJECT MANAGER SIGNATURE	DATE

# PREPARING TO SPRAY

**B**

**TITLE**

**DESCRIPTION**

**LINKS**

**Reassess Surrounding Native Species**

**Reassess Nativity of Surrounding Vegetation**

Even if you have already performed a thorough site evaluation and fully documented your native species, it is useful to return to the site in advance of herbicide application for this purpose. Look to see if there were native species you missed on your prior visits, especially if your site evaluation occurred during a time of year when many species were dormant or challenging to identify.

**Denote No-Spray Zones**

If there are significant populations of predominantly native species, use spray paint or other markers to demarcate these as areas to avoid herbicide application. If there are individuals of high ecological value mixed in to a largely invaded area, denote them with brightly colored flagging tape. Do the same for any bird nests or other clearly visible animal homes. If you are not the applicator, make sure the field lead knows to avoid these spots.

**Observe Native Wildlife**

Observe native wildlife species using the site, especially birds, insects, and amphibians. Note areas with high pollinator activity, nesting behavior, or frequent animal movement. If significant populations are present, find out at what point in the season they are most likely to be foraging or breeding. Find out when plants in your meadow are most likely to be flowering. Consider timing throughout a given day- many insects are most likely to be active during the period of day from mid-morning to early afternoon.

**Employ Your Observations**

Use your observations of native plants and wildlife to guide product selection, application method, and timing. For example, delay spraying until after flowering has finished, switch from broadcast to spot treatment in areas with high animal activity, or delay spraying until quieter periods of the day. Consider selective herbicides that you may be able to apply on invasive weeds while not affecting nearby native species, such as a graminicide for Japanese Stilt Grass in a field where it cohabitates with native forbs like Goldenrod.

**Best Management Practices for Wildland Stewardship**



*Figure 27 - Use highly visible devices to mark areas that should be protected during spraying or mowing activities*

<p><b>Choose Your Product</b></p>	<p><b>Choose Your Product</b></p> <p>Once you have updated your vegetation management calendar and re-assessed invasive plant form, surrounding vegetation, water proximity, and timing, select herbicides that are both effective against the target species and appropriate for the site constraints. The provided link explains which herbicides to use based on these considerations. It also recommends frequently used combinations of herbicides, such as Glyphosate and Triclopyr or Prodiamine and Imazypic. Missing from their discussion, however, is Clopyralid, which may be used for control of Thistle, Mugwort, and other invasive herbaceous species in the Aster family but, much like Imazypic, can stay active in the soil for months after treatment.</p>	<p><b>Herbicide Selection and Use</b></p>
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<p><b>Read the Label</b></p>	<p><b>Read the Label</b></p> <p>Every herbicide comes with a “label.” The word label is an inappropriate term considering its length is more like a short novel. Unfortunately, it will probably be the driest and most tedious novel you ever read. That doesn’t mean you get to skip this part though. Every herbicide label contains vital information you will need to know before you even think of opening the container. Download the label online or use the hardcopy attached to every new container.</p> <p><b>Elements of a Label</b></p> <p>There are too many elements of the herbicide label to list here, but some of the most useful are:</p> <ul style="list-style-type: none"> <li>• <u>EPA registration number</u> (you will probably have to write this down on a sign someday)</li> <li>• <u>Active ingredient</u> (this is different from the brand name and describes the actual chemicals the herbicide contains)</li> <li>• <u>Acute toxicity</u> (describes how toxic the product is to humans and animals)</li> <li>• <u>First Aid statement</u> (describes what to do if someone is accidentally poisoned)</li> <li>• <u>Directions for mixing and applying</u> (we will cover this in subsequent steps)</li> <li>• <u>When people/pets can re-enter the premises after spraying concludes</u></li> <li>• <u>How to store and dispose of the product</u></li> </ul> <p>For a full guide to reading herbicide labels, consult the attached link. <b>DO NOT</b> skip reading the herbicide label and <b>DO NOT</b> wait to read the herbicide label until spray day. There is important information in the label that will inform planning and the acquisition of additional chemicals and materials.</p>	<p><b>Reading a Pesticide Label</b></p>
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Figure 28 - Herbicide labels provide signal words, legal dosage rates, and approved weeds

### Choose Adjuvants

Many herbicides require the addition of an adjuvant used to improve herbicide performance. Most of the time only two adjuvants are used: a non-ionic surfactant, which helps herbicide stick to leaf surfaces, and an indicator dye, which colors the herbicide so you can see where you sprayed. Read the label thoroughly to understand what is recommended and what safety precautions you need to take. Oftentimes adjuvants pose greater health risks than the herbicide itself.

### Adjuvant Types

Here is a brief list of different adjuvants, their function, and under what conditions to use them.

- Non-ionic surfactants (NIS): Improve spray coverage and help herbicide stick to leaf surfaces. Commonly used with foliar applications.
- Crop oil concentrates (COC) / methylated seed oils (MSO): Enhance penetration through waxy or thick leaf cuticles. Often used for tougher grasses and woody species, but can increase risk of non-target damage and should be used carefully
- Drift reduction agents: Increase droplet size to reduce off-target movement, which can be particularly important near waterways or sensitive plantings.
- Sticker-spreaders: Help spray spread evenly across foliage and resist wash-off from rain or irrigation.
- Indicator dyes: Highly recommended for most applications to show treated areas and reduce overlap or missed spots. Blue dyes are easiest to see in the field. Avoid using green dyes, as these tend to blend in well with plants. There may be guidelines on the bottle specifying how much to use per gallon of water, however there is no reason besides cost to restrict dye usage. Using high concentrations of dye will enable you to clearly see where you have sprayed vs where you haven't sprayed which will speed up the process and likely reduce how much you need to spot spray when you return.


Understand which adjuvants you will need, how much, and what their cost will be. Incorporating them can quickly increase the material cost of your weed control.

**Choose Adjuvants**

**Adjuvants with Herbicides. When and Why They Are Needed.**



Figure 29 - A surfactant is a relatively benign product that improves the efficacy of many herbicides

<p><b>Reassess Proximity to Water</b></p>	<p><b>Reassess Proximity to Water</b>          Before spraying, identify the nearest standing or flowing water and confirm current site conditions. If water is within your spray zone, pause and verify that your product is labeled for aquatic use- otherwise, do not apply. Many products require buffers of 50 feet or more, so always defer to label requirements.</p> <p>If working near a dry streambed, confirm there is no standing water present and check the short-term weather forecast. Avoid non-aquatic products if rain is expected. When water is nearby, adjust your plan by switching to aquatic-labeled products, tightening spray patterns, using wicks or spot treatments, or postponing work until conditions are suitable.</p>  <p><i>Figure 30 - Project manager reinforcing the rules related to the use of herbicides near water</i></p>	<p><b><u>Applying Herbicides in and Around Water</u></b></p>
<p><b>Confirm Chosen Application Method &amp; Equipment</b></p>	<p><b>Do the Application Method &amp; Equipment you chose still fit the project?</b>          Inevitably during the process of planning, things change. New obstacles arise. Certain equipment breaks, or is no longer available for rental, or opinions change and a client no longer wants to use herbicides. Before you can begin your chosen strategy, you must ensure that your previous choice still works, that it has the support of the land manager and that it is a viable strategy that will lead to suppression of the target weeds.</p> <p>If you need to change your strategy, revisit the previous section and choose the next best strategy that works for your project.</p>	<p><b><u>Pesticide Application Equipment and Methods</u></b></p>

**Determine Application Rate**

**Select the Appropriate Application Rate**

Consult the label again. Start by selecting an application rate within the labeled range for the chosen herbicide and method. Product labels typically provide a range (for example, 2.0-4.0 oz per acre). Where you fall within that range should be based on target species sensitivity, infestation density, plant growth stage, and whether the area has been treated previously. Lower rates are often appropriate for light infestations or early growth, while higher rates may be needed for dense or established populations. In some cases, rates can also be adjusted to reduce impacts to desirable species. For example, when treating Japanese stilt grass interspersed with native forbs near wetlands, choosing a lower rate (such as ~30 oz/acre for labeled products) may suppress stiltgrass while minimizing collateral damage.

**Calculating Multiple Products**

When tank mixing multiple herbicides, confirm on each label that mixing is allowed. Select rates for each product independently based on target species, For example, if applying 2 oz/acre of Product A and 4 oz/acre of Product B at 20 gal/acre, add both to the same 20-gallon batch. Calculate each product separately, then combine. Never assume that rates can be reduced simply because products are combined.

Always confirm that your selected rate falls below the product’s maximum annual application limit, which exists to protect surrounding ecosystems and water quality.

**Calibrate Your Sprayer**

Once a target rate is chosen, determine your spray volume (gallons per acre). This requires calibrating your equipment using water. For tank sprayers, spray volume depends on pressure and walking speed. For boom sprayers, it depends on nozzle output, boom width, and vehicle speed.

Example: If your label calls for 2 oz/acre and your calibrated sprayer applies 20 gallons per acre, you would add 2 oz of product to every 20 gallons of water. Accurate calibration ensures you deliver the preferred rate without over or underapplying.

Taking the time to calibrate and calculate rates properly is one of the most important steps in vegetation management- it improves control, protects non-target species, and prevents wasted product.

[Backpack Sprayer Calibration for Woodland Applications](#)

[Boom Sprayer Calibration](#)

[USFS Sprayer Calculations](#)

**APPENDIX K  
CALIBRATIONS, CALCULATIONS, & CONVERSIONS**

**SPRAYER CALIBRATIONS AND CALCULATIONS<sup>1</sup>**

**TABLE K - 1. SPRAYER CALIBRATIONS AND CALCULATIONS**

Calculation	Example	Formula
<b>1. Determining the Gallon per Minute (GPM) required of nozzles to achieve a given Gallon per Acre (GPA)</b>	<b>Example 1</b> You want an output of 20 GPA. Your nozzles are 20 feet apart. Your field speed is 5 MPH. How much do you need to collect from each nozzle to achieve 20 GPA?  $20 \text{ GPA} \times 5 \text{ MPH} \times 20 = \frac{2000}{5940}$  = 0.336 GPM per nozzle	<b>Formula 1</b> $GPM = \frac{GPA \times MPH \times W}{5940}$  GPM = Gallons per minute from one nozzle GPA = Gallons per acre  W = nozzle spacing (inches) or: = spray width (inches) if using a broadcast or = row spacing (inches) divided by the number of nozzles per row. MPH = Field speed in Miles Per Hour 5940 = a constant
	<b>Example 1a - Convert Gallons per Minute (GPM) to Ounces per Minute (OPM)</b> From Example 1 you have collected 0.336 GPM from each nozzle.  $0.336 \times 128 = 43 \text{ OPM per nozzle}$	<b>Formula 1a</b> $OPM = GPM \times 128$
	<b>Example 1b - Convert OPM to GPM</b> You have collected 43 OPM from each nozzle.  $43 \text{ OPM} / 128 = 0.336$	<b>Formula 1b</b> $GPM = OPM / 128$

*Figure 31 - Excerpt from a calibration calculator by the USFS*

# CHOOSE A PLANTING STRATEGY

**A**

## KEY QUESTIONS

- What species dominate the list? Are these species commercially available?
- What is the size of the project site?
- What is the timeline for establishment?
- What are the popular planting methods?
- What is the budget for planting?
- What are the site conditions?

## OVERVIEW

Once the species list has been created and before it can truly be finalized, it's important to understand how the meadow is going to be planted. This section will evaluate key factors in helping to narrow down the planting strategy that best fits the project site.

## CHECKLIST

STEP	TITLE	SUMMARY NOTES	DATE
1	<b>Timeline for Establishment</b>	e.g., there is not a push for immediate aesthetics	
2	<b>Understand Seeding Strategies</b>	e.g., drill seeding is the best strategy thanks to the site's size and open access	
3	<b>Site Conditions</b>	e.g., the site is on a gentle slope with low soil moisture	
4	<b>Seeding Timing</b>	e.g., vegetation management is currently planned to be finished in the fall	
5	<b>Choose your Strategy</b>	e.g., based on site conditions and project size, no-till drill seeding works	

## SUMMARY AND SIGN-OFF

HOW TO KNOW WHEN YOU ARE FINISHED	MANAGER/CONSULTANT SIGNOFF	
<p>This task is complete once all steps above have been closely evaluated and a planting strategy or strategies have been chosen.</p> <p>At this juncture, there may need to be a change in the species list to accommodate the chosen planting strategy.</p>		
	FIELD MANAGER SIGNATURE	DATE
	PROJECT MANAGER SIGNATURE	DATE

# CHOOSE A PLANTING STRATEGY

**B**

TITLE	DESCRIPTION	LINKS
<p><b>Timeline for Establishment</b></p>	<p>It's important to remember as you're planning your approach to seeding that the establishment process takes time and will not always look beautiful, especially for the first couple of years. Make sure to remind your stakeholders of this as well as to understand if they have any concerns. There are approaches to seeding that can shorten this timeline. Below are several different scenarios that may require different approaches:</p> <p><b>Remote Project Site</b> – for a project site that is far from many prying eyes, such as one on a large tract of private land, there may be little consideration for aesthetics. In this scenario, a simple seeding with a cereal cover crop with plans for mid-season mows (Rye or Oats) may suffice as the landowner knows that it will take time for the grasses and forbs to germinate and establish.</p> <p><b>Suburban Project Site</b> – because there are prying eyes in a suburban setting, there may be more consideration that has to go into creating more aesthetic appeal in those first couple of years of establishment. After all, very few people like the look of seven-foot-tall cereal grains. In this case, using a showier cover crop such as a quickly germinating native forb (Black-eyed Susan, for example) can help to alleviate the stresses from stakeholders and passersby when the meadow is blooming yellow in the early Summer in its first couple of years. These do eventually fade out but will be replaced by the species that take longer to germinate and/or establish, such as Wild Bergamot (<i>Monarda fistulosa</i>) or New England Aster (<i>Symphotrichum novae-angliae</i>).</p> <p><b>Urban or Residential Site</b> – where there are perhaps even more prying eyes and therefore even higher standards for aesthetics, such as at an office building or town center, serious consideration may need to be given to shortening that timeline for establishment even more while also adding more color. While establishing the bulk of the planting cannot be pushed forward, there are alternative ways to get more color, more quickly.</p> <p>It is feasible to incorporate non-native annuals or even plugs to help speed this process along. These strategies are often not used because they are rather expensive, they are indeed upgrades. Still, they can be utilized for smaller sites, like the ones mentioned above.</p> <p>Non-native annuals do have to be seeded in the Spring as they don't survive Pennsylvania winters, however, they quickly germinate and provide lasting color throughout the first year of a meadow.</p> <p>Alternatively, plugs may also be used, usually as accents or focal points. These plugs are generally made up of some of the same species that were seeded in the meadow, but will guarantee some color from first-year blooms.</p>	<p><a href="#">Re-educate your Stakeholders</a></p> <p><a href="#">Establishment from Seed</a></p>

When it comes to seeding meadows there are several strategies that are used the most often. Choosing your seeding strategy is half the challenge, though. There are countless models of seed drills, tractors, broadcast seeders, UTVs, trailers, etc., which can be used to seed a meadow.



Figure 32 - Seed drills come in all shapes and sizes and are usually "tuned" for a specific type of project. Each has its own nuances, pros, and cons. Adapting your techniques to the capabilities of the drill is an essential skill

**Understand  
Seeding  
Methods**

**1. No-till Drill Seeding**

This is a seeder that attaches to a vehicle and contains one or several seed boxes along with blades to open the ground, channels to direct the seed into the opening, and wheels to close the opening once seed has entered.

When calibrated correctly, this allows for precision, leading to species being evenly spaced. Some other benefits of drill seeding include:

- Little to no soil disturbance
- Seeds get covered by a light layer of soil, the perfect conditions for germination and protection from predation
- Can seed areas quickly, especially large areas

The best drill is the one best sized to your site. Think about your site, is it:

- Greater than 1 acre?
- Straight edged, and regularly shaped?
- Are weight restrictions for access unlimited?

If the answer to these questions is "YES" then opt for a large (6ft or greater) seed drill. Purpose built machines, like those produced by Truax are optimal.

There are some cons to using large seeders like this. Given the scarcity and high cost of this style, they are not frequently available to rent. On top of this, transporting equipment this size can be complicated and also quite costly. Some farmers may have this equipment and may be contracted to seed the site. Local conservation districts will be able to provide insight to their local network. Medium-to-large sized restoration contractors will have this equipment and the operators to run it. Still,

**Seeding  
Methods**

unless your project is rather large, it may not be cost-effective to go this route.

If any of these questions are answered with a “NO” it is more appropriate to source a smaller width drill. These drills are not purpose built for these projects and are typically referred to as grain drills. Many conservation districts in Pennsylvania have these smaller drills for rent.

Their smaller sizes make it easier to transport these as well as the matching vehicle to pull them. They are also easier to operate, so running this setup on your own is therefore easier.

That being said, using these drills may require additional passes over the site, as all seed types may not be able to be combined because they won't pass through the seeder at the same pace. This can lead to increased time to complete seeding but still allows for precise calibration and species distribution.

It is possible to seed sites larger than 1 acre with a small drill, but the time costs can rapidly increase and is not recommended unless project limitations require it.



*Figure 33 - Specialized broadcast seeders simulate the natural falling and settling of seed and can help prevent planting too deeply*

## 2. Broadcast Seeding

This approach can be done by hand or with walk-behind devices but is most frequently completed using tow-behind models due to their larger capacity and therefore quicker coverage. This method is a good fit for small, less than 1-acre meadows.

Some benefits of using broadcast seeders include:

- Readily available for rental from various suppliers at reasonable prices, including local conservation districts
- Easily transported due to low weight and small size
- Even distribution of seed
- Easily pulled behind by many different vehicles, including a UTV, truck, or tractors

Aside from site size restrictions, there are other caveats to using broadcast seeders, such as:

- Increasing soil contact using a harrow or other machine before seeding, which also increases the likelihood of erosion,

- Performing multiple passes with different sized seeds, possibly even needing to spread fluffy seed by hand,
- Using a cultipacker or other device to press seed into the soil, and
- Spreading of straw or mulch to reduce erosion control

All these extra steps can greatly increase the time and finances needed to complete seeding. It is possible to simply broadcast seed and then pack it down with a cultipacker or lawn roller, but this often does not lead to sufficient soil contact and can therefore lead to poor germination.

Note on Straw Blowers:

Straw blowers are used to mulch post seeding and are efficient for large areas. The model should be chosen based on the size of the meadow site (1, 5, 10, 100 acres, etc.), the locally available bale type (small bale, large square, round bale). Small blowers, suitable for sites less than 10 acres, may be rented from rental equipment stores.

Local cattle/livestock farmers may have equipment suitable for larger meadow projects. Consult your local conservation district.

### 3. Hydroseeding

This method combines the seed you're using with water, mulch, fertilizer, and/or a tackifier (help the mixture stick to soil) and then this mixture is literally sprayed onto the desired area. While almost exclusively used in seeding lawns and areas along roadways it can be used for seeding meadows. Hydroseeding natives requires a two-step process – first spray your seed mix, then spray the covering.

Hydroseeding can provide:

- Good soil contact,
- Reduced predation, and
- Reduced erosion,

Still, hydroseeding comes with some major considerations:

- Requires access to large amounts of water (makes up 70%-85% of mixture)
- High winds blow the mixture around and may cause delays
- May require continued watering after installation
- Experience is needed to operate equipment, and hiring a company to do so can be expensive

While hydroseeding has the potential to be an efficient option, it can be very expensive and there is not enough information currently available to assess its viability in meadow building.

### 4. Drop Seeders

Drop seeders can be used if seed drills cannot be accessed. Consult the local conservation district to see if they have equipment available to rent or if they know a local contractor. This method has similar benefits to broadcast seeding:

- Readily available for rental from various suppliers at reasonable prices, including local conservation districts

	<ul style="list-style-type: none"> <li>• Easily transported due to low weight and small size</li> <li>• Even distribution of seed</li> <li>• Easily pulled behind by many different vehicles, including a UTV, truck, or tractors</li> </ul> <p>Like broadcast seeders, though, drop seeders also come with multiple extra steps:</p> <ul style="list-style-type: none"> <li>• The site needs to be prepped with a harrow, which allows for more soil contact but also increases the possibility of erosion,</li> <li>• Multiple passes will be required to evenly distribute species,</li> <li>• A device like a cultipacker must be used to press seeds into soil, and</li> <li>• Depending on topography there may need to be erosion control (straw, mulch, etc.) added on top</li> </ul> <p>All this to say that using a drop seeder comes with many step that can greatly increase the time to complete seeding and increase the cost of seeding considerably. This option should only be considered if there are issues with access for a drill seeder.</p>	
<p style="text-align: center;"><b>Site Conditions</b></p>	<p>There are several main site conditions that play a major role in deciding on a seeding strategy.</p> <p><b>Topography</b> Gentle slopes are of course always preferred on any type of project, but project locations will not always be on gentle slopes. It may even be the case that some areas of a project have gentle slopes while other areas are quite steep. Areas of steep terrain will limit your choices on seeding strategies:</p> <ul style="list-style-type: none"> <li>• No-till Drill Seeders – these are attached to a vehicle and are rather heavy, making them dangerous and potentially unmovable on steep terrain.</li> <li>• Broadcast and Drop Seeders – some of these are attached to vehicles, but smaller units can be walked behind or even hand-held. These smaller units can be viable; however, it will be a slow process to prepare the area, spread the seed, and lay down erosion control (straw, mulch, etc.)</li> <li>• Hydroseeding – if there is available access near the steep area, this strategy could be viable as the seed can be spread quite far from the vehicle holding the “slurry.” Still, this is not a cost-effective approach.</li> </ul> <p><b>Soil Moisture:</b> Similarly, if the ground at the site stays quite moist, this could limit your seeding strategy choices as well:</p> <ul style="list-style-type: none"> <li>• Drill seeders and the vehicles that pull tow-behind drop and broadcast seeders could get stuck in the muck</li> <li>• Hand-broadcasting would be time-consuming as it would include exposing bare soil, spreading the seed, and then spreading erosion control material. Still, it may be the most viable and cost-effective option for seeding these moist areas.</li> <li>• Hydroseeding is possible, but again, it only becomes cost-effective at scale</li> </ul>	<p style="text-align: center;"><b>Site Evaluation</b></p>

**Site  
Conditions**

**Proximity to Water**

Not only do you have to keep general soil moisture in mind when a project site is near water, but you also have to know whether the area is a threat for flooding as this can be a big risk when you're planting expensive seed:

- If possible, drill seeding is the preferred option near water as this will allow for the seed to be protected by soil and therefore less likely to wash away. Remember that this is not practical for small areas, though
- Broadcast, drop, and hydroseeding will more than likely require erosion control beyond straw or mulch as these will wash away with the seed. In these cases, a biodegradable product, like coconut coir, could help, but there is still a risk of seed being washed away. Not to mention, this is only feasible on a small scale as these products are not inexpensive.



*Figure 34 - Streamside meadow installations often require using techniques to hold seed in place during flooding events, such as coir matting along streambanks*

**Access:**

If there is nowhere on site to get a large machine like a tractor, UTV, or truck in, this will also play a role.

- Large drill seeders will also then be unable to access the site
- Smaller broadcast and drop seeders should fit, but tow-behind units will need something to pull them. Otherwise, you may be stuck broadcasting with a walk-behind unit or by hand
- If there is somewhere outside the area where a vehicle can park and is near enough that a hose could reach, hydroseeding may be a good option

Keep in mind that broadcasting and drop seeding are time-consuming and material-heavy activities and become especially so at scale. If your site is over a half-acre, it will behoove you to find a way to access it with a drill-seeder. If access to the site is limited, see if neighboring properties have access and see if you can procure an agreement to use that access point.

You may even find at the end of this checklist that you will in fact need to incorporate more than one seeding strategy, and this is a normal occurrence. Every project site has its areas with differing terrain, soil moisture, or access, and you may have to choose the right strategy for several different areas.

<p style="text-align: center;"><b>Seeding Timing</b></p>	<p>Timing a meadow seeding is not as simple as choosing Fall or Spring and planning the work around that. There are factors that impact timing as well as advantages and disadvantages to seeding at different times of year, and understanding these is crucial to ensure you time the seeding of your meadow correctly. The below sections discuss different factors that impact your choice of timing:</p> <p><b>Invasive Pressure</b> As has been previously discussed, no seeding should happen if there is continued substantial invasive pressure in the project area. Even if this means holding seeding off for another season or two, this delay will be better than trying to manage this invasive pressure after the fact. Many meadows have failed or been abandoned because the project was rushed and seeded before there was thorough vegetation management.</p> <p><b>Herbicide Residual Effects</b> Just as with invasive pressure, it's important to delay seeding if there are concerns of herbicide continuing to linger in the soil. This is only a concern with herbicides with long-term soil activity, such as pre-emergents, Clopyralid, and Imazapyr.</p> <p><b>Wintertime Temperatures</b> Depending on the type of seed you are planting, there are important considerations to keep in mind. For some of our native plants, stratification, the process through which seeds are exposed to a freeze-thaw cycle, is one of these. This process naturally happens over the late Fall, Winter, and Early Spring.</p> <ul style="list-style-type: none"> <li>• Forbs (flowering plants) – many of our native forbs need to be exposed to this cycle to break dormancy and therefore to germinate. If you are planning to seed in Spring, it is suggested that you artificially stratify species that need to go through this process, so they are ready to germinate right when they hit the soil. Without going through this process before being seeded, these plants may not germinate until after the following winter and it is possible to lose a large amount of seed to rot and predation over that year</li> <li>• Grasses and Native Annuals – many of our grasses, sedges, and native annuals do not need to go through this cycle. This means the moment they hit the soil in Spring and temperatures begin to rise to their ideal, they will begin to germinate. If you are planning a fall seeding, you may lose some grass or annual seed to rot and predation. Remember, though, that most of these species drop seed in the Fall, so they can certainly survive the Winter before germinating</li> <li>• Non-native Annuals – for times when appearance is very important for a new meadow, some folks may elect to use more expensive non-native annuals over traditional cheap, but unaesthetic cover crops. These do not survive our winters, which is important, especially if you are planning a Fall seeding, as you will need to plan to return to the site to seed the non-native annuals in the Spring</li> </ul>	<p style="text-align: center;"><b>Fall vs. Spring Seeding</b></p>
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	<p><b>Three-Pass Method</b></p> <p>A scenario in which partial seeding may occur is if there is still a large amount of broadleaf weed pressure in the project site.</p> <ol style="list-style-type: none"> <li>1. In this case, the first pass made is the seeding of the grasses that are to be included in the meadow, and this may occur in Spring or Fall. This allows these grasses to begin growing while also allowing the rest of that following growing season to manage broadleaf weeds using a broadleaf-specific herbicide.</li> <li>2. The second pass, therefore, would be a follow-up seeding of all broadleaf plants in the meadow if you have finally obtained sufficient control of those broadleaf weeds and the grasses are well-established.</li> <li>3. The third pass would be the addition of any plug species that could not be found commercially available or contain highly valuable local genetics. This may of course not be applicable to your project.</li> </ol> <p>And it is important to remember that splitting up seeding events will increase the overall budget of the project.</p>	
<p><b>Choose your Strategy</b></p>	<p>Before proceeding you should know:</p> <p><u>Species Availability:</u> What species from your list are available and from which vendors</p> <p><u>Budget:</u></p> <ul style="list-style-type: none"> <li>• The costs of your seed – this includes the quotes from vendors, the cover crop or carrier, and shipping <ul style="list-style-type: none"> <li>○ Decided partly upon information in “Timeline for Establishment”</li> </ul> </li> <li>• The costs of your seeding method – this includes the cost to rent any necessary equipment and the cost of any necessary materials (straw, coir, etc.) <ul style="list-style-type: none"> <li>○ Decided partly upon information in “Understand Seeding Methods” and “Site Conditions”</li> </ul> </li> </ul> <p><u>Seeding Timing:</u> The ideal time for seeding and how that relates to the chosen vegetation management strategy and its timeline.</p> <p><b>Seeding Strategy:</b> Ultimately, you should know which strategy or strategies work best for your site based on the factors listed above.</p>	

# SOCIALIZE AND SET EXPECTATIONS

**A**

KEY QUESTIONS	OVERVIEW
<ul style="list-style-type: none"> <li>○ Who is likely to notice or be affected by this work? (neighbors, park users, staff, volunteers, etc.)</li> <li>○ Is there a risk of confusion, concern, pushback if work proceeds without explanation?</li> <li>○ What aspects of the process will raise the most eyebrows? (herbicide, meadow height, access?)</li> <li>○ Who is responsible for communicating, and when/how often should it occur?</li> </ul>	<p>Hopefully, by this point you have engaged with enough stakeholders that there are no major surprises with public perception and support for your meadow. Up until this point however, there has not been a concrete plan for how creation of the meadow will proceed. Now armed with that implementation plan, it is up to you to decide how- and to what extent- to best communicate it. This can be a delicate balance, especially if there are people from many backgrounds involved. The goal at this stage is to set clear expectations, reduce confusion, and proactively address frequently raised issues.</p>

## CHECKLIST

STEP	TITLE	SUMMARY NOTES	DATE
1	<b>Identify Stakeholders and Concerns</b>	e.g., adjacent landowners wary of herbicide usage, site users who already enjoy the land the way it is	
2	<b>Select Communication Method</b>	e.g., set up a meeting with stakeholders, send an email with an abridged version of the plan and ask for feedback	
3	<b>Communicate Vegetation Management Approach</b>	e.g., using broad-spectrum herbicide to suppress an infestation of Japanese stilt grass over multiple spray events	
4	<b>Communicate Planting Approach</b>	e.g., meadow will be seeded with a no till drill in late November using a mix of warm season grasses	
5	<b>Communicate Establishment Timeline</b>	e.g. 3 years before invasives will be under control, 7 years until established	
6	<b>Communicate Desired Project Outcome</b>	e.g., will serve as habitat for meadowlarks, will be kept at a maximum of 4' tall	
7	<b>Document Feedback &amp; Confirm Readiness</b>	e.g. project stakeholders are unanimously opposed, cannot proceed	

## SUMMARY AND SIGN-OFF

HOW TO KNOW WHEN YOU ARE FINISHED	MANAGER/CONSULTANT SIGNOFF	
<p>If no communication is required with outside stakeholders, this step may be completed immediately, and no further action is necessary. If communication is required to proceed, you are finished once you have relayed the implementation plan, addressed concerns, and set expectations for anyone whose objections could delay, alter, or otherwise derail the project.</p>		
	FIELD MANAGER SIGNATURE	DATE
	PROJECT MANAGER SIGNATURE	DATE

# SOCIALIZE AND SET EXPECTATIONS

**B**

TITLE	DESCRIPTION	LINKS
<p><b>Identify Stakeholders and Concerns</b></p>	<p><b>Find Your Stakeholders</b> Up to this point, if you have not identified and/or engaged with relevant stakeholders, this is the time to do so: before work commences. Stakeholders might be neighbors adjacent to the meadow, regular visitors to the site, researchers working in the area, or any organizations connected to broader land-use or management networks. Figure out who these people are and how to get in touch with them.</p> <p><b>Predict Their Likely Concerns</b> Document each group and their likely concerns, such as herbicide use, changes to site aesthetics, or excitement about habitat restoration. Identify potential advocates within the community, as well as stakeholders whose support is especially important to project success. When conflicts arise, you will want to give added weight to the opinions of those most directly impacted or most critical to implementation.</p> <p>Understanding who will be affected and what their main concerns are will be important for determining what aspects of the project you proactively communicate, in what format, and how frequently.</p>	<p><a href="#"><u>Sharing knowledge to improve ecological restoration outcomes</u></a></p>
<p><b>Select Communication Method</b></p>	<p><b>Convene a Meeting</b> If there are a few stakeholders who are important to the success of the project but who have not been involved in the planning stage up until this point, convene a meeting in which you discuss the details of the project with the group in a manner that encourages feedback and shows receptiveness toward incorporating that feedback. [include picture of ArcheWild in a meeting]</p> <p><b>Or Send an Email</b> If there is a large contingent of people who may be impacted by the project, but who have not expressed strong interest up until this point, you may instead address them through an amended version of the plan sent via email.</p> <p>An email may also be a useful way to engage someone who could otherwise disrupt planning in a group setting. For example, if one of the stakeholders is a neighbor who has a strong knowledge of the environment and local ecology but is also vehemently opposed to the use of herbicides, giving this person a public forum to debate the efficacy of your herbicide-based vegetation management approach could do more harm than good for achieving public support.</p> <p><b>Decide Your Non-Negotiables</b> However you decide to communicate, decide in advance what aspects of the project are non-negotiable before soliciting feedback from the group. For example, successful meadow establishment at your site may require multiple years of weed suppression before seeding can occur. Be prepared to defend that position and what your course of action will be if you receive pushback.</p>	<p><a href="#"><u>Principles and Guidelines for Ecological Restoration. Section 4.1.3.1 Engagement &amp; Communication</u></a></p>

<p><b>Communicate Vegetation Management Approach</b></p>	<p><b>Communicate Need for Herbicide</b>  This is the area that is likely to elicit the strongest negative emotions surrounding the implementation of a meadow. There are many people who are broadly in favor of ecological restoration and want to see the creation of new meadows, but who are adamantly opposed to the inclusion of any non-organic herbicides.</p> <p>Come prepared to any conversation with an understanding of what risks are posed by the herbicide, why that herbicide is important to the creation of the meadow, and what safety precautions you will take to adequately minimize non-target effects on plants, wildlife, and human health and safety.</p> <p><b>Communicate Herbicide Specifics</b>  Also be prepared ahead of time with how much information you are comfortable revealing about specific herbicides you will be using. You will likely be required to post signage after the spray event detailing what kind of herbicide was used and when it will be safe to re-enter the premises, so there is little reason to conceal that information from the public early on. In fact, being upfront about exactly what you are using may earn you some goodwill.</p> <p>Explaining, for instance, that Glyphosate has very minimal soil persistence may alleviate some public fears about the toxicity of your approach. Vegetation management approaches that rely on organic herbicides or physical control methods are generally subject to far less public scrutiny.</p>	<p><b><u>Why We Recommend Herbicide</u></b></p>
<p><b>Communicate Planting Approach</b></p>	<p><b>Communicating Planting Approach</b>  This topic covers the three most important aspects of a planting strategy: planting method, timing, and species involved. None of these topics typically elicit much controversy among the public.</p> <p>Most people are passively interested to know whether you will use a no-till drill, hand seeding and raking, or some other application method.</p> <p>People are also generally ambivalent about the timing of seeding, though they may be surprised to learn that the best time for seeding is in late fall right before a snowfall. Explain why.</p> <p>Stakeholders, however will generally be very curious to know what kind of species you intend to include. This can be a good opportunity to show off your knowledge of species selection. Explain how each species will fit into the broader meadow plan and what kind of wildlife it will benefit.</p> <p><b>Prepare for Species Requests</b>  At times, people will request specific plant species that they are fond of and would like to see growing in the meadow that you have not already included. A common one is cardinal flower. If cardinal flower does not make sense ecologically, this may be a non-starter, and you can explain why it would not work. Alternatively, you may elect to use a small quantity of it in a specific area, such as a depression in the soil near a shady wooded edge where it has higher odds of success.</p>	

<p><b>Communicate Establishment Timeline</b></p>	<p><b>Communicate Establishment Timeline</b>  After vegetation management, the establishment timeline is the topic that induces the greatest public outcry. This is likely your final hurdle. Many people will assume that meadows complete their establishment within a three-year timeframe. In most situations, the timeline is closer to five-to-seven years.</p> <p>Communicate to stakeholders that not only will it take many years before the meadow becomes a self-sustaining ecosystem, but that the first two to three years of that timeline will likely be a period of deeply unappealing aesthetics.</p> <p><b>Provide Images of What to Expect</b>  Providing images and descriptions of what to expect in each year of meadow establishment will undoubtedly help you later on, for example when there is a sudden surge of Yellow Foxtail overtaking your new meadow seedlings and it would otherwise be assumed that the project has fallen completely off the rails.  [show image of a Year 1 meadow]</p> <p><b>Emphasize Positives</b>  Remember to emphasize at least one positive thing that people can expect to observe in each year of the meadow’s trajectory and reiterate that seeing invasive species and/or a lack of native germination in the first couple of years is not necessarily cause for alarm. Set expectations low, and let people be pleasantly surprised when they see butterfly milkweed flowering a year before you told them it would appear.</p>	
<p><b>Communicate Desired Project Outcome</b></p>	<p><b>Communicate Desired Project Outcome</b>  Perhaps most important is reaching consensus with stakeholders about the goals of the project and what is realistic. If that hasn’t already been accomplished, now is the time. Make sure you are all in alignment about this question: “What does success look like?” Break this question down into a few categories such as</p> <ul style="list-style-type: none"> <li>○ <b>The meadow’s primary ecological objectives</b> (e.g., improved native plant species diversity)</li> <li>○ <b>How wildlife are using the meadow</b> (e.g. habitat for threatened raptor species)</li> <li>○ <b>How people are using the meadow</b> (e.g. observing it from a designated lookout)</li> <li>○ <b>How the meadow looks when it’s established</b> (e.g. pockets of wildflower color in a sea of grasses)</li> <li>○ <b>How the meadow contributes to local ecosystem services</b> (e.g. reduces stormwater runoff)</li> </ul> <p>Refer to “Is This a Viable Meadow Opportunity?” for further elaboration on these topics.</p> <p>Being aligned on these larger goals can be an important factor in finding common ground on the nitty gritty. If establishing native habitat for</p>	

	<p>meadowlarks is deeply important to a stakeholder and the project is clearly in service of that goal, you will likely face less opposition to your choice of vegetation control methods and expected timeline.</p> <p>On the other hand, if a stakeholder who is critical to the project’s success likes having a native meadow in theory, but in practice would like it to look and behave more like a formal garden, those are two very different project outcomes. Such a disagreement may require going back to the drawing board to find areas of alignment before the meadow can proceed.</p> <p><b>When To Talk About Outcomes</b>  If there is uncertainty about stakeholder expectations for the overall outcome, bring this conversation forward earlier rather than later. It is included here at the end because it can be a great way to end the discussion on a positive and harmonious note after likely disagreements about smaller details of the plan.</p>	
<p><b>Document Feedback &amp; Confirm Readiness</b></p>	<p><b>Document Stakeholder Feedback</b>  You may not alter your plan, but if you are soliciting feedback, it is important to document it for future reference. You may find ways to incorporate it later or identify resources that help alleviate stakeholder concerns.</p> <p><b>Identify Small, Feasible Requests</b>  Some feedback will be relatively easy to implement and should be flagged for consideration during implementation. For example:</p> <ul style="list-style-type: none"> <li>• A neighboring landowner may want you to avoid boom spraying along the boundary of the meadow to minimize spray drift onto their property.</li> <li>• A neighbor may request that a slightly different seed mix, devoid of taller or more aggressive species, be used along the property edge.</li> <li>• A park visitor may request that herbicide application be restricted to certain days or times when the public is less likely to be present.</li> </ul> <p>Accumulating and addressing these small, achievable concerns can be a powerful way to build project support and avoid misunderstandings.</p> <p><b>Compile and Communicate Decisions</b>  Compile all input into a brief stakeholder summary, confirm which requests will be implemented, communicate those decisions back to stakeholders, and proceed only once expectations are clearly aligned. If you are not the one implementing the project, make sure this information is passed along to the person who is.</p>	



## **DECISION POINT #3**

You have now made many of the most important decisions: species selection, how to plant, how to manage undesired vegetation, and so on. And now you have presented all this information to the relevant stakeholders with your reasoning. But what was their feedback? Did they give a resounding approval or did major questions on your choices arise? Did any issues arise and were they resolved?

Your stakeholders don't have to love the plan, but they do need to agree to it. Remember that the end goal is near-complete control of undesired vegetation and a thriving ecosystem composed of the right plants for your site. If there is fear that the only available options will lead to a less-than-ideal product, serious consideration should be given as to whether the project should continue.

Again, without proper preparation and planning, any meadow seeding will become overwhelmed with undesired species and ultimately fail as trying to manage those species after the fact becomes exorbitantly more difficult, and exorbitantly more costly.

# PERFORM VEGETATION MANAGEMENT

# A

## KEY QUESTIONS

- Do you own or do you have to set up rental of the equipment you will be using?
- Is your equipment properly calibrated and ready to use?
- Do you have all the necessary protective equipment for the strategy you're using?
- Have you communicated your timeline with the necessary parties?
- Have you completed all necessary documentation?

## OVERVIEW

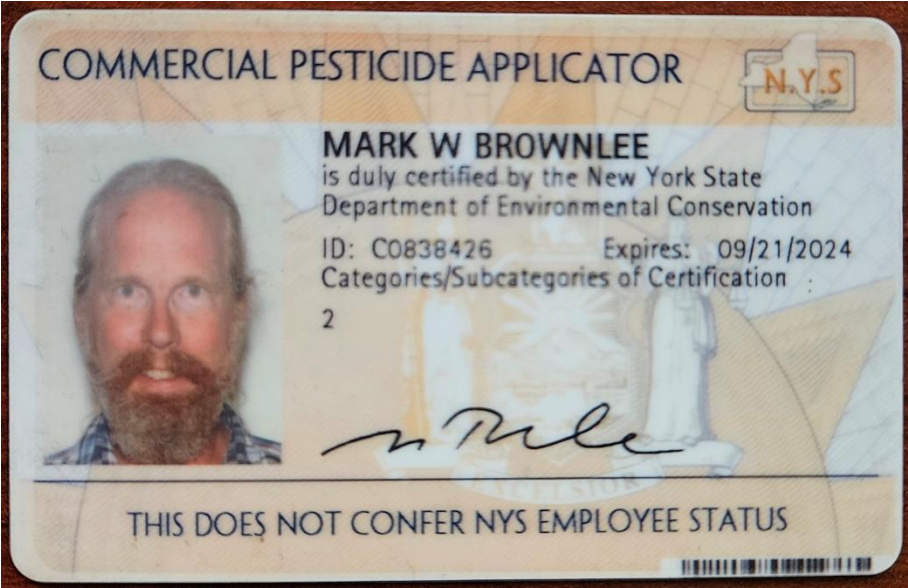
Finally, the project start is close at hand. But there are a few more important tasks that need to be completed before work can begin. This page will discuss the decisions and plans that need to go into preparing to perform and then ultimately performing vegetation management.

## CHECKLIST

STEP	TITLE	SUMMARY NOTES	DATE
1	<b>Check Necessary Paperwork</b>	e.g., Pesticide Applicator License is up to date	
2	<b>Communicate Timeline (Far in Advance)</b>	e.g., we are planning to begin work at the site the week of 4/10/26	
3	<b>Check Materials</b>	e.g., reviewed materials lists and noted one	
4	<b>Check Calibration</b>	e.g., sprayer is calibrated at correct PSI	
5	<b>Communicate Timeline (Days in Advance)</b>	e.g., now that everything is in order, we will begin work this Tuesday, 4/14/2026	
6	<b>Perform Strategy</b>	e.g., spray 20 acres with boom sprayer	
7	<b>Document Everything</b>	e.g., take photos, complete herbicide logs, send updates to client	
8	<b>Check Efficacy</b>	e.g., returned to the site two weeks after first treatment, about 80% efficacy	
9	<b>Plan your Next Treatment</b>	e.g., saw good results from first treatment, follow up with spot treatment of persistent weeds	

## SUMMARY AND SIGN-OFF

HOW TO KNOW WHEN YOU ARE FINISHED	MANAGER/CONSULTANT SIGNOFF	
<p>You are finished with vegetation management once you have confirmed that you have reached the suppression goal (e.g. 90% vegetation suppression) that you've set for the project and all activities have been properly documented and communicated with all necessary parties.</p> <p>Remember that adequate time is needed to check efficacy of overall treatment. If there is any uncertainty, more time should be allowed to monitor efficacy.</p>		
	FIELD MANAGER SIGNATURE	DATE
	PROJECT MANAGER SIGNATURE	DATE

<b>PERFORM VEGETATION MANAGEMENT</b>		<b>A</b>
<b>TITLE</b>	<b>DESCRIPTION</b>	<b>LINKS</b>
<p><b>Check Necessary Paperwork</b></p>	<p><b>Check Licenses/Permits</b>  As a reminder, examples of permits include a Pesticide Applicator’s License if you plan to apply herbicide or an Erosion &amp; Sediment (E&amp;S) Control Permit if you plan to disturb a large amount of soil during this process. Without these permits in place and up to date, you can receive hefty fines and face project delays or even loss of the project. Resources for these documents are linked to the right.</p>  <p><b>Check Hypersensitivity Registry</b>  If you are applying herbicide, it will also be crucial to check the “Hypersensitivity Registry,” which lists people that are to be notified in advance in the case that spraying will be occurring near their home. Each state has this list as well as their own definitions on who needs to be notified and when. You must check this list, ideally weeks in advance, to see if there is anyone near the site that is on it and if they need to be notified (usually based on proximity to the project site) and how far in advance they need to be notified (usually somewhere between 24 and 72 hours in advance).</p> <p>Like licenses and permits, you can face hefty penalties for failing to properly notify someone on this list.</p>	<p><a href="#">PA E&amp;S Plan resources</a></p> <p><a href="#">PA Pesticide Applicator Resources</a></p> <p><a href="#">PA Hypersensitivity Registry</a></p>
<p><b>Communicate Timeline (Far in Advance)</b></p>	<p><b>Give Stakeholders Notice of Planned Timeline</b>  Giving advanced notice to the client or stakeholders of your proposed timeline for vegetation management is always necessary. You do not want them to reach out to you asking when you’ll be starting. Plan to give AT LEAST several weeks’ notice and a timeframe if possible. This communication should include other relevant information also, such as where vehicles and equipment will be parked when not in use, where the project site will be accessed, estimated times when workers will be on site, and so on. An example of communication is below:</p>	

	<ul style="list-style-type: none"> <li>• We are reaching out to inform you of our intention to begin herbicide application on the project site in three weeks, the week of 4/13/26. This work should take two days to complete. We will reach out again in two weeks to inform you of the exact date that we will begin.</li> <li>• As discussed in previous conversations, we will be using a tractor-mounted boom sprayer to treat all twenty acres within the project site, as marked on the provided map. We will also be using the same sprayer with a hose attachment to treat ten feet into the wood line along the Northern and Eastern borders of the site. The equipment will be parked at the South end of the project site, near the parking lot, until we are finished. We will be on the project site between the hours of 8am and 5pm only.</li> </ul>	
<p><b>Check Materials</b></p>	<p><b>Check Materials</b></p> <p>In the weeks leading up to beginning of work, you should have long procured or reserved all the materials needed for your chosen vegetation management strategy. Still, it is always a good idea to run back through your list and make sure that there are no additional materials needed, no materials are missing, have been damaged, or otherwise need to be replaced. Doing so several weeks or more in advance should allow you time to procure these items. As an example, if you are planning to spray with a boom sprayer attachment on a UTV your materials list may include:</p> <ul style="list-style-type: none"> <li>• Herbicide (Triclopyr, Glyphosate) and quantities</li> <li>• Adjuvants (marking dye, ionic surfactants) and quantities</li> <li>• Boom sprayer</li> <li>• Spare sprayer parts (nozzles, hoses, fittings)</li> <li>• PPE (safety glasses, gloves, muck boots, ear plugs)</li> <li>• Fuel for pump</li> <li>• Signage to denote spraying event</li> <li>• Herbicide log, if not filling out on a device</li> <li>• Backpack sprayer (for remaining herbicide in tank)</li> </ul>	
<p><b>Check Calibration</b></p>	<p>As mentioned previously, precise calibration of equipment is essential. For machinery with moving parts, understanding proper operation and calibration will lessen the chances of errors or broken parts. This goes for herbicide application as well; however, herbicide equipment calibration is also important for ensuring the right amount of product is used. If the device is calibrated wrong, there could be too much or too little herbicide being used during vegetation management. Too little and it may be found that that round was ineffective. Too much and at the least an expensive product is being wasted; at the most it could expose the site and surrounding area to contamination.</p> <p><b>Machinery with Moving Parts</b></p> <p>Refresh yourself on how the machine is supposed to operate. This includes knowing how to operate the machine, how to properly activate and deactivate the attached implement (often at a particular RPM), and at what speed the implement should be used (also often a particular RPM). Before beginning, ensure the machine is operating properly and there are no obstructions to any moving parts.</p>	<p><b><u>Pesticide Sprayer Calibration Techniques</u></b></p> <p><b><u>Proper Sprayer Cleaning</u></b></p>

	<p><b>Herbicide Applicators</b> Calibrating spraying equipment involves a multitude of steps and depends on the chosen method, as discussed in “Choosing an Herbicide.” Careful and accurate calibration is key, so verify that your application equipment is still correctly calibrated.</p> <p><b>Ensure Equipment is Clean</b> At this time, it is also suggested that the equipment be cleaned of any debris and dirt as best as possible. A dirty machine can have seeds and other plant parts on it that can further spread invasive species.</p> <p>Ideally, cleaning will be completed using a pressure washer or other tool that can remove stuck on dirt and debris.</p> <p>With herbicide equipment you also want to check that any tanks are cleaned out from previous applications. Herbicide sprayers should be cleaned after every use, so this shouldn’t be a problem, but it is always worth checking. Depending on the previous herbicides used and the concentration, there could be residual effects if not properly cleaned. Not to mention, herbicide residues more quickly break down sprayer parts. A triple rinse, as described in the cleaning procedures to the right, should be sufficient in cleaning the sprayer.</p>	
<p><b>Communicate Timeline (Days in Advance)</b></p>	<p>After confirming that all materials and equipment have been arranged, are clean, and are working properly, vegetation management is finally ready to commence.</p> <p>Before that can happen, it is imperative to yet again communicate the plan and at this point offer an exact date and at least estimated time of the work. This is also when you need to notify anyone on the PA Hypersensitivity Registry that is within the designated proximity of your project. An example communication is below:</p> <ul style="list-style-type: none"> <li>• We are reaching out to confirm that we will begin vegetation management at the project site starting this coming Tuesday, 4/14/26. We will be treating the entire 20-acre space over two days. This timeline is subject to change based on weather conditions. If you have any questions before we begin, please let us know.</li> </ul>	<p><b>PA Hypersensitivity Registry</b></p>
<p><b>Perform Strategy</b></p>	<p><b>Refer to your Treatment Calendar</b> As discussed in “Choose a Vegetation Management Strategy,” the exact timing of management will depend on the dominant species in the project area. For example, managing Stilt Grass with a post-emergent in March will yield poor results as the plant has not even germinated at this time, while this is the perfect time to manage Lesser Celandine.</p> <p>Verify that you have a plan to time treatments of different species based on your calendar and stick closely to this calendar.</p>	<p><b>Proper Sprayer Cleaning</b></p>

### Observe Site Conditions

Before work can begin there are several conditional factors to keep in mind and to check before and during the implementation of your chosen strategy.

- Precipitation – always keep an eye on rain. If it's been raining, it will be raining during the time you've chosen to treat, or it will be raining shortly thereafter, many strategies will not be effective and should be delayed. This is especially the case for herbicide applications but also includes strategies that require soil disturbance.
  - Rain significantly lowers the efficacy of herbicide and can cause it to wash off altogether
  - Wet soil can also cause machines to create ruts or bare patches, or to get stuck
- Wind – this can cause herbicide drift, especially high wind. If you see winds higher than 10 mph, you may have to delay spraying
- Extremes of temperature – a lot of herbicides are most effective only within a certain temperature range and lose efficacy quickly outside of this range. Make sure it's not too hot or too cold for the chosen herbicide to avoid these issues

### Observe Equipment Function

By this time, you should have a strong understanding of how the device or machine you are using operates. Despite being well prepared, it's important to regularly observe how the equipment runs. Spotting problems early is always better, as is ensuring there have been no changes to calibration or system functions during transport. Observe how the device is working and keep an eye out for needed adjustments.

Functions to observe for boom sprayers:

- *System pressure* – is it correct? Is it stable?
- *Marking dye* – is it visible enough?
- *Nozzle spray* – are all nozzles spraying normally?
- *Sprayer height* – is the sprayer too close or too far from the ground?
- *Nozzle angle* – have any nozzles changed angles? (This can happen for long boom sprayers if the outer nozzles hit the ground on uneven terrain or objects along the outer edge of the spraying area)



Figure 35 - Technician setting up a truck-mounted boom sprayer

There are functions to keep an eye on no matter your management strategy, and inevitably there will be issues that arise and that need fixing.

**Install Herbicide Signage**

Signage must be installed immediately following any herbicide use and cannot be taken down until the timeframe denoted in your state’s code has ended.



Figure 36 - All licensed herbicide applicators are required to post an area as being treated. It is good practice for everyone to post that an herbicide has been sprayed

**Install needed Erosion Control**

Installation of water erosion control methods must immediately follow the cessation of soil disturbance strategies.

**Clean Equipment**

Once the work is complete, it’s important to again clean any equipment thoroughly, including triple rinsing any sprayer equipment. If this can be done somewhere on the project site that is not in the area that was just treated, this is ideal. It can be completed offsite but should be done as soon after completion as is possible to prolong the life of the sprayer.

**Document Everything**

No supervisor likes hearing that you didn’t do an adequate job of documenting different phases of the project. This includes all parts, transporting the equipment, preparing the machine for use, performing the task, cleaning up, and so on. It’s always better to have more documentation than not enough, even if that mostly consists of photos or videos.


**Legal Documentation**

It is especially crucial to document herbicide use. Like communicating herbicide use ahead of time, each state has different regulations on how to properly document its use. This generally includes denoting the project site, herbicide used, amount of total solution, and more information. The link to the right includes a downloadable record keeping manual.

Depending on partner organizations, there may be a requirement to send them proof of herbicide application. For instance, some organizations require copies of your herbicide logs while others have their own forms that you will need to fill out. Some organizations also require, or at least ask for, photos and/or videos.

Communication with partner organizations should be prompt. Indeed, some even have specific timeframes of when paperwork should be submitted following the completion of a task.

**[Herbicide Record Keeping Manual \(also contains other useful information for pesticide applications\)](#)**

	<p><b>Recommended Additional Documentation</b></p> <p>Even if partner organizations or other stakeholders are not asking for photos or videos, it is always recommended to take plenty as these can be important down the road for verifying treatments, studying efficacy of methods used, as well as marketing purposes.</p>	
<p><b>Check Efficacy</b></p>	<p><b>Monitor Treatment Success</b></p> <p>Depending on the strategy, when signs of effectiveness will show may differ. Generally, after a soil disturbance event (tilling, sod removal, etc.) some plants may spring up quickly, but it may take a month or more to see how effective the work was. This depends on time of year as well as higher precipitation in Spring and Fall will cause quicker regrowth.</p> <p>The timeline for seeing effective control from herbicide use depends on the type of herbicide used. For post-emergent herbicides, it usually takes a matter of two to three weeks to see the effects. By this time, the difference between those plants that were affected and those plants that were not affected enough or were altogether unaffected will be clear. Those plants that were affected will be turning brown or will be completely brown after these few weeks. If you chose a viable strategy earlier, which may have included the use of multiple types of herbicides, these treatments should prove quite effective.</p> <p>Plan to revisit the site two weeks after the first round of soil disturbance or post-emergent herbicide application and again around a month after to check efficacy.</p>  <p><i>Figure 37 - This riparian buffer meadow has been adequately prepared for seeding. The last treatment was five weeks prior to the photo being taken, documenting complete suppression</i></p> <p>For pre-emergent herbicides the timeline to see effective treatment will be longer as these are applied well in advance of annual weeds germinating. You'll want to plan for bi-weekly monitoring visits starting around a month after application to see how effective the treatment was. If the treatment was timed properly and the right amount of herbicide was used, you should see good results. If not, it will be obvious as you see a flush of germination.</p> <p>If solarizing, you'll want to wait until the end of the growing season to monitor results.</p>	<p><b>Issues that Arise During Meadow Establishment</b></p>

	<p><b>Collect Data</b></p> <p>For strategies that involve soil disturbance, especially tilling, expect to see a lot of regrowth due to disturbance of the seed bank and re-rooting of existing vegetation. It is advisable that these strategies be combined with another, such as herbicide application, to better suppress the current vegetation.</p> <p>Again, for herbicide applications the success of the treatment should be fairly clear as the treated plants should be brown or turning brown, or there should be little germination. If the vegetation is mostly green, refer to your data on how vegetation management was performed, more than likely there was an error somewhere in the process. Still, it is likely that you will see a flush of weeds, likely unrelated to your treatment, after this first treatment. This is normal as seeds in the soil take advantage of the space now available. This is why at least three applications are recommended, although the timing of these applications depends on the species.</p>	
<p><b>Plan your Next Treatment</b></p>	<p><b>Follow-up Treatment Intensity</b></p> <p>No matter how effective the first round of management was, and regardless of the strategy used, there will be vegetation that regrows after the first round. This is why it is recommended to plan for multiple rounds of management over multiple seasons, possibly years, to fully prepare a site for planting.</p> <p>How intensive these follow-up rounds of treatment will be depends on the present noxious weeds and the efficacy of previous treatments. Some noxious weeds, like Stilt Grass or Thistle, are difficult to suppress and will most likely require multiple intensive rounds of treatment. For a site dominated by turf made up of cool-season grass may only require several rounds of treatment that become less intense each time. For example, you may have to use a boom sprayer over the whole area for the first treatment, but then only over part of the area for the second and finally spot treatment with a hose for the third.</p> <p><b>Follow-up Treatment Timing</b></p> <p>This also depends on the present noxious weeds as some weeds can only be sprayed at certain times of year. Cool-season grass should be treated during the cool seasons, of course. And, continuing with Stilt Grass, post-emergent treatments will need to occur only during the warm season. Annuals like Stilt Grass will also most likely require multiple years of treatment before you can successfully suppress the seed bank.</p> <p>Refer again to your treatment calendar and ensure that you are only planning vegetation management for the species at your site at times that will be the most effective.</p>	

### **Don't Sleep on Vegetation Management**

Rushing this step to get to seeding is one of the top causes of meadow failure. It is imperative that you have strong suppression of any noxious weeds within your project area before moving on. If timelines for treatment get pushed back, or treatments are not as effective as planned, communicate with your stakeholders and discuss with them the importance of getting this step right, regardless of its impact on the project timeline. DO NOT move forward until invasive competition is minimal.



*Figure 38 - This meadow was seeded long before effective control was achieved. Weeds and undesirable weeds returned vigorously and ruined the meadow. The municipality did not have the budget to redo the meadow, and it remains an unsightly mess*

# SECURE YOUR SEEDS AND EQUIPMENT

**A**

KEY QUESTIONS	OVERVIEW
<ul style="list-style-type: none"> <li>○ Where are you sourcing your seed?</li> <li>○ What types of seed are you using?</li> <li>○ How are you seeding? Do you need a seed drill or a broadcast seeder?</li> <li>○ What type of drill are you using?</li> <li>○ Where is your drill? Are you subcontracting it?</li> <li>○ Who is operating your drill?</li> <li>○ Do you need a carrier?</li> <li>○ Are you using a cover crop?</li> </ul>	<p>With a plan in hand, acquiring the seeds and equipment becomes the next step in creating a meadow. Navigating different types of seeding equipment and methods and purchasing from a seed vendor does not need to be a complex task but should consider some key elements promoted by the questions to the right.</p>

## CHECKLIST

STEP	TITLE	SUMMARY NOTES	DATE
1	<b>Check Seed Availability</b>	Reviewed regional sources for seed availability and quantity needed	
1	<b>Choose Desirable Genetics</b>	Vendor X has <i>Andropogon virginicus</i> seed harvested from 300 miles away, in a different ecoregion than your project. Vendor Y, has seed available from 40 miles away. Buy from Vendor Y.	
2	<b>Order Seed</b>	Ordered seed as single species rather than mix	
3	<b>Store Seed</b>	Stored seed dry and chilled prior to sowing	
4	<b>Secure Seeding Equipment</b>	Local conservation district has a drill for rent, and we can use our own tractor with experienced operator.	
5	<b>Transport/Hauling</b>	A seed drill has been rented from the local conservation district, you need to safely pick it up and move it to your planting site.	

## SUMMARY AND SIGN-OFF

HOW TO KNOW WHEN YOU ARE FINISHED	MANAGER/CONSULTANT SIGNOFF	
You are finished with securing seed once you have figured out where seed will be stored, how it will be organized, and have then placed the order.		
	FIELD MANAGER SIGNATURE	DATE
You are finished with securing your seed drill once you have a seeder reserved, other necessary equipment reserved, and know how all equipment is getting to the site.		
	PROJECT MANAGER SIGNATURE	DATE

# SECURE YOUR PLANTS AND EQUIPMENT

**B**

TITLE	DESCRIPTION	LINKS
<p><b>Verify Seed Availability</b></p>	<p>To verify your list as well as to receive quotes for these species, if desired, you will have to complete the following steps:</p> <p><b>Reference Known Seed Vendors</b> (some local to PA are listed to the right)</p> <p>Most vendors have websites with either their available species listed and/or the ability to search for specific species. This can be a good starting point, but understand that the sites may not be completely up to date, may not display pricing, or the pricing may vary from what is displayed</p> <ul style="list-style-type: none"> <li>• Ideally, you’ll reference the most local vendors first, especially if plant genetics are important to you, working your way further away as you go. Still, when deciding on vendors to contact, keep geography in mind and count out those you consider too far away. For example, a vendor in Minnesota might have the species you want, but those genetics may not be compatible with Pennsylvania conditions.</li> <li>• If you’re using Evaluate™ to create your species list, some of these vendor databases are already worked into the software so you can quickly see if these species are available and from where. If they’re not, you can easily change to another species that fits your site and continue the process.</li> </ul> <p><b>Contact Seed Vendors</b></p> <ul style="list-style-type: none"> <li>• To truly know what is available, though, you must call or email the vendors with your list ready for reference, which should include several alternative options. They can let you know if a species is currently available, the actual cost per pound, and sometimes even what weed seed might also be present and how much. They’ll also give you a quote for the cost of each seed and shipping.</li> <li>• NOTE: If there is considerable weed seed or a particularly noxious weed mixed in with the desired seed, it may be necessary to look elsewhere for the species or ask about an alternate species.</li> </ul> <p>Contact each vendor to verify the quotes received in the “Choosing your Planting Strategy”. If alternate species need to be selected, return to the “Choosing your Planting Strategy” and follow the appropriate steps.</p> <p>Utilizing one of the many seed vendors in the mid-Atlantic and northeast can expand the size and diversity of the planting. The link to the left may be used to search for local, regional, and national sources.</p> <p>Vendors will be able to quickly verify species availability when prompted. Call or email them to discuss and get a quote for the seeds required. Provide an excel sheet with species botanical and common names and quantity to request a quote.</p>	<p><a href="#"><u>Native Plant, Seed and Services Directory</u></a></p> <p><a href="#"><u>Pinelands Nursery</u></a></p> <p><a href="#"><u>Native Bee-ginnings</u></a></p> <p><a href="#"><u>Ernst Seed</u></a></p>

Seeds may be sourced from as many vendors as necessary. Do not make substitutions on your species list unless no vendor can be found.

Some desirable species may not be available as seed from any vendor. If this occurs, search for commercial availability of the species as plugs, or a local population of the species which may be harvested and grown into plugs for incorporation post-planting.

The varied ranges of species may or may not be reflected in the availability of a seed vendor. The highest quality of vendor maintains consistent and precise records of where material was harvested from when any seed farm crop is started. Recognize the importance of geography and **ecotype** in seed selection.

Little bluestem seeds harvested from the mid-west may not be as resilient to a Rhode Island climate as seeds harvested from a crop from in-state. Species evolve in their own geographies and their ability to thrive is based on their ability to adapt. These differences can occur over remarkably short differences.

Always select the seed that is most local to you. Use the EPA Level IV ecoregion map to select ecotypes from the same ecoregion as your project. If none are available, use the EPA Level III ecoregion.

**Choose Desirable Genetics**

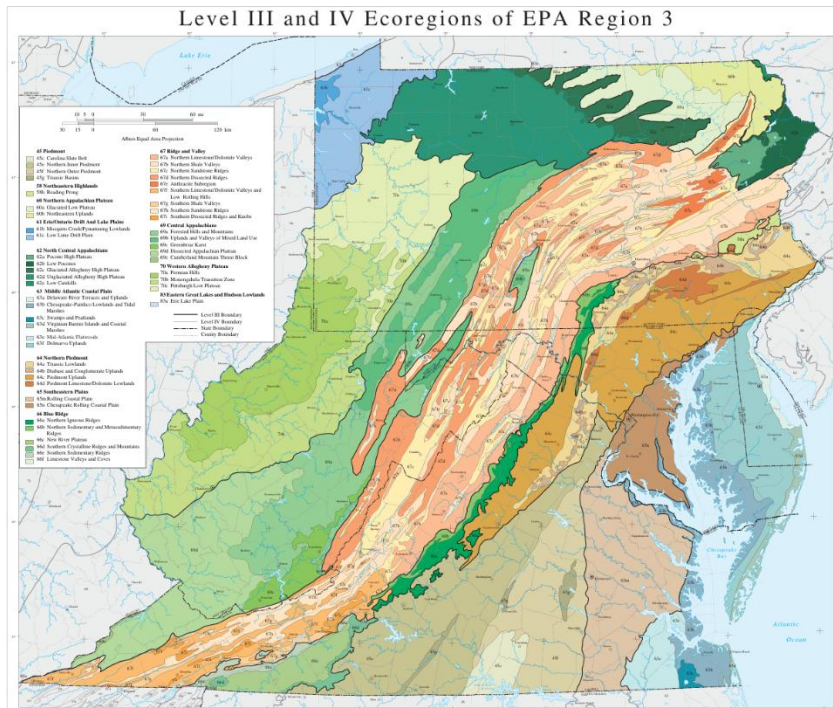


Figure 39 - EPA ecoregion map for Region 3. Seeds needn't originate from your state, just your ecoregion

EPA Level II ecoregion may be considered if no Level III source is available. High variance species may be sourced from more disjunct areas while species with limited ecological variance may be considered for substitution (refer to Meadow Design) or expanded search for plug material than using distant ecotypes.

**Genetic Considerations**

**EPA Ecoregions**

With the quotes verified, submit your orders to the selected vendor/s. Submission via email with scientific names listed rather than common names can increase clarity for the vendor. Users of Evaluate software will have a ready-made PDF file of their designed seed mix.

Federal and state law requires the listing and quantification of noxious species within a seed mix on a label. Reputable vendors will be able to supply this information prior to purchase if prompted. Inclusion of one noxious species or another, like musk thistle, may be so detrimental that alternate sourcing should be done.

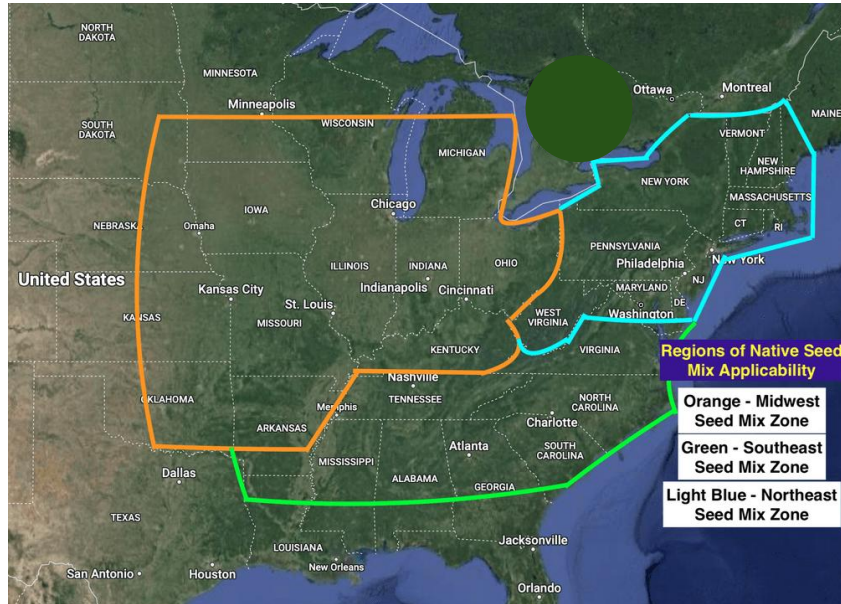


Figure 40 - Seed mixes marketed in this manner should be avoided entirely. There is no ecological relationship between meadows on Cape Cod and those in the Appalachian Mountains...it is much safer to consult with an ecologist on seed mix designs

If no substitution may be made, strategies should be developed to manage introduced weed seeds early on, review “Choose Vegetation Management Strategy”.

This only applies to noxious weeds and not all invasive plant species are legally identified as noxious, so be prepared for unexpected guests.

You should have already selected an appropriate carrier and quantity in the “Seed Design” section. Carriers may be sourced from the larger native seed vendors, or they can be sourced locally from agriculture supply stores and grain mills. The same laws of listed noxious weeds and quantification apply here.

If you’re planning to plug part or all your meadow, your plant order should be up to 2 years in advance for locally sourced seed, contract grown plugs. Other orders should be made as soon as you have decided on a species list and determined the need for plugs.

[Native Plant Nursery and Seed Directory](#)

[Seed Fillers and Carriers for Planting Native Warm-Season Grasses and Forbs](#)

[Restricted Weed Seeds - PA Code](#)

[Understanding the Seed Tag](#)

**Order Seed**

**Store Seed**

Seeds generally enter a dormant state upon maturation or dispersal from the parent plant. This state prevents seeds from germinating in adverse conditions, reduced length of sunlight, extreme cold,

[Seed Storage and Viability](#)

	<p>conditions that would terminate a seedling. The proper combination of environmental conditions (e.g. sunlight, humidity, moisture, temperature, etc.) break seed dormancy and trigger germination.</p> <p><i>Ideal storage increases the longevity of stored seeds by mitigating these dormancy breaking factors. It is also critical to secure the seeds from mold, rodents, and birds.</i></p> <p>Review the guidance below to ensure your seed storage solution is effective.</p> <p><b>Do</b></p> <ul style="list-style-type: none"> <li>○ Store in a cool, dry and dark space with a temperature and humidity sum below 100 (i.e. 40 degrees and 30% humidity). A basement or refrigerator are good locations.</li> <li>○ Use thick plastic latching boxes to store seed bags, preventing spills and rodent damage</li> <li>○ Desiccant packs may be added to storage boxes to continue to reduce humidity</li> <li>○ Separate species into bags</li> <li>○ Keep components of a mix together and store with the mix sheet</li> <li>○ Keep similar seed types in a mix together. Store small seeds with small seeds, fluffy with fluffy. This can improve efficiency when seeding time occurs.</li> </ul> <p><b>[image of good seed storage]</b></p> <p><b>Don't</b></p> <ul style="list-style-type: none"> <li>○ Let delivered seed sit outside overnight</li> <li>○ Store seed in bright, sunny, and warm spaces</li> <li>○ Store in spaces with high humidity</li> <li>○ Store seed exposed to natural elements</li> <li>○ Store seed loose in boxes, have two layers of protection against spills and elements.</li> </ul> <p><b>[image of wet/moldy seed]</b></p> <p><b><u>Never</u></b></p> <ul style="list-style-type: none"> <li>○ Store seed unlabeled</li> <li>○ Store seed unprotected from rodents</li> <li>○ Store seeds near heat</li> </ul>	
<p><b>Secure Seeding Equipment</b></p>	<p><i>Purchase of any seeding implement should only be considered if meadow building is a core aspect of your mission.</i></p> <p><i>Purchasing or upgrading a tractor should be considered if it meets multiple organizational needs (increased equipment needs, etc.).</i></p> <p>Appropriately sized equipment for most small to medium (0-25 acre) meadow building projects may be rented.</p>	<p><b><u>PA Assoc. of Conservation Districts</u></b></p>

	<p>Many local conservation district offices have seed drills available to rent. These are primarily grain-type drills, but some have multiple boxes suitable for multiple seed types. Consult your local conservation district for rental rates.</p> <p>Conservation district staff build relationships with local farmers and contractors. If they do not have the equipment available, they may have a local contact who can do the work or has the equipment. Ask if you need to, district staff are often happy to help.</p>	
<p style="text-align: center;"><b>Towing Equipment</b></p>	<p>Each implement must be driven by another piece of machinery, either a truck, tractor, or UTV. The type of towing equipment is defined by that seeding implement</p> <p>Review your seeding implement manual for a description of requirements like:</p> <p><b>Ground Driven or PTO Driven.</b></p> <ul style="list-style-type: none"> <li>• <b>Ground driven</b> equipment is typically mounted on a 3-point hitch. There is a gear system that drives the mechanics when in contact with the ground.</li> </ul> <p><b>[image of ground driven system on ground]</b></p> <ul style="list-style-type: none"> <li>• <b>PTO driven</b> equipment must be mounted via a 3-point hitch. A PTO shaft drives the seed mechanism with power from the tractor.</li> </ul> <p><b>1-point or 3-point hitch mounting</b></p> <ul style="list-style-type: none"> <li>• <b>1-point</b> mounting equipment may be mounted with a simple single point hitch typical for UTVs, trucks, and small utility tractors.</li> <li>• <b>3-point</b> hitch mounts are typical on compact utility tractors or those of greater size</li> </ul> <p><b>Horsepower Required</b></p> <ul style="list-style-type: none"> <li>• Towing equipment must have equal or larger horsepower than the stated requirement on the implement</li> </ul> <p>Options for towing equipment include:</p> <p><b>UTV</b></p> <ul style="list-style-type: none"> <li>• Single point hitch</li> <li>• Low horsepower</li> <li>• Small &amp; agile</li> <li>• High rental availability</li> <li>• Best for broadcast seeding small (1 acre or less) sites</li> </ul> <p><b>Truck</b></p>	

	<ul style="list-style-type: none"> <li>• Single point hitch</li> <li>• High rental availability</li> <li>• Appropriate only for gravity driven broadcast seeding small sites (1 acre or less)</li> </ul> <p><b>Compact Utility Tractor</b></p> <ul style="list-style-type: none"> <li>• Single point and 3-point hitch</li> <li>• 25-50 horsepower</li> <li>• If PTO is available, it may be underpowered</li> <li>• Small &amp; agile</li> <li>• High rental availability</li> <li>• Best for 0-5 acre sites with grain drill or broadcast seeding</li> </ul> <p><b>Utility Tractor</b></p> <ul style="list-style-type: none"> <li>• Single point and 3-point hitch</li> <li>• 50-250 horsepower</li> <li>• PTO is adequately powered for large implements</li> <li>• Adequate towing capacity</li> <li>• User comfort (enclosed cab, Bluetooth, GPS, etc.)</li> <li>• Less rental availability</li> <li>• Increased transport requirements</li> <li>• Best for 5-75 acre projects</li> </ul> <p><b>Row Crop Tractors</b></p> <ul style="list-style-type: none"> <li>• Single point and 3-point hitch</li> <li>• 100-450 horsepower</li> <li>• Adequate PTO capabilities</li> <li>• Adequate towing capacity</li> <li>• User comfort (enclosed cab, Bluetooth, GPS, etc.)</li> <li>• Low to no rental availability</li> <li>• Highest transport requirements</li> <li>• Best for 75 acre and larger projects</li> </ul>	
<p><b>Transport/Hauling</b></p>	<p>Review state and federal regulations for commercial driver’s license transport in the factsheet to the left.</p> <p>If a CDL is required and the capability is not present on staff, local and national logistic firms may be able to assist with deployment of the seeding equipment to the site. Equipment rental stores may also be able to deliver to a site for a fee.</p> <p>If a CDL is not required, you can proceed with an appropriately sized towing set-up. Review the Comprehensive Guide webpage to the left for additional information on towing capacity, load ratings, and safety.</p> <p>Load your cargo and be sure it is appropriately secured. Even though you may not need a CDL, best practices should be followed. Inadequate loading or securing, may result in significant or death.</p>	<p><a href="#"><b>PA Commercial Driver’s License Factsheet</b></a></p> <p><a href="#"><b>A Comprehensive Guide to Proper Towing Techniques and Equipment</b></a></p> <p><a href="#"><b>Cargo Securement Brochure</b></a></p> <p><a href="#"><b>Pre-Trip Towing Safety Checklist</b></a></p>



*Figure 41 - Tractor and seeder properly loaded and secured*

If you are not comfortable with loading and securing heavy equipment, **take a class** or seek guidance and learning from knowledgeable individuals.

Prior to departure, conduct a pre-trip safety checklist.

# PLANT YOUR MEADOW

**A**

## KEY QUESTIONS

- How are you planting the meadow? Seed or plugs?
- Are you broadcast seeding? Are you drill seeding? What type of drill are you using?
- Do you have an experienced operator?
- What type of seeds are you sowing?
- Is the site ready for seeding?

## OVERVIEW

The individual characteristics of each site and seed mix will affect how seed will be distributed via a seed drill. Calibration ensures that the mix is applied by the specific machine, at the specific site, at the specific rate intended.

Uncalibrated sowing may result in poor coverage, time inefficiency, and increased costs.

## CHECKLIST


STEP	TITLE	SUMMARY NOTES	DATE
1	<b>Site Review</b>	e.g. seeding implement is hooked up and tractor is in a good condition	
2	<b>Equipment Review</b>	e.g. equipment is intact and hooked up properly	
3	<b>Calibration</b>	e.g. the site is free of weeds, debris and other obstacles	
4	<b>Tractor Operation</b>	e.g. seed, drill, and tractor are ordered, secured/operational	
5	<b>Seed Mixing and Loading</b>	e.g. arrive on site and calibrate	
6	<b>Plant</b>		


## SUMMARY AND SIGN-OFF

HOW TO KNOW WHEN YOU ARE FINISHED	MANAGER/CONSULTANT SIGNOFF	
When you've arrived at the site and adjusted the machine to drop seed at the desired rate, you can proceed to seeding.		
	FIELD MANAGER SIGNATURE	DATE
	PROJECT MANAGER SIGNATURE	DATE

# PLANT YOUR MEADOW

**B**

TITLE	DESCRIPTION	LINKS
<p><b>Site Review</b></p>	<p>At this point, your seed and necessary equipment is on-site, and any site prep has been effectively completed. You are left with a weed free site and are ready to begin.</p> <p>Before hooking up the seeder, take a walk. Review the planting site with the operator looking for any debris, obstacles, steep grades, swales, and ditches that need to be avoided or considered. Use marking flags to mark obstacles.</p>	<p><a href="#">Planting Strategy</a></p>
<p><b>Equipment Review</b></p>	<p><b>Examine the Equipment</b></p> <p>A journey on the flatbed trailer or long-term storage can reduce the operability of seeding equipment. It is best to verify working conditions prior to starting.</p> <p>Examine that the seed boxes on the implement are dry, any chutes are open, moving parts are well greased, any agitators/paddles are functional, and that any tires are inflated.</p> <p>If all aspects appear operational, then proceed to hook up the implement and begin calibration.</p> <p>If any damage or poor condition is present, assess if it can be repaired in the field (e.g. more grease is needed or seed boxes need to be dried) or if seeding must be delayed for repair (e.g. the welds on the implement hitch points are showing signs of failure).</p> <p><b>Hook up the Implement</b></p> <p>If using a 1-point hitch, extend or retract the tongue so that the seeding implement is level with the ground and not overly pressuring the hitch tongue.</p> <p>If using a 3-point hitch and an implement with a draw bar, raise or lower the hitch so that the draw bar is level with the ground.</p>  <p><i>Figure 42 - Tractor with seeder attached via a draw bar connected to a 3-point hitch, which is the standard setup</i></p>	

	<p>With the implement attached and in the activated position (if applicable), examine the tractor and implement for overall operability, condition, and signs of damage.</p> <p>If you need to review the manual, do so now, prior to starting.</p>	
<p><b>Calibration</b></p>	<p>Careful calibration is vital to ensure you are spreading seed at the required rate. There's no worse feeling than getting close to finishing the seeding of a site only to find you've run out of seed. Similarly, you don't want to find yourself with an abundance of seed left over either.</p> <p>The seed mix design will have an intended amount of seed mix to put out per acre, 5, 10, 25 lbs/acre, etc. The calibration process is one of mixing proportions of the seed mix with carrier to so that the seeding implement is dropping the seed mix and the intended amount.</p> <p>Review the Advanced Calibration video to the left for a step-by-step process on how to calibrate a seed drill and to your implement's manual for model specific instructions.</p> <p>More experienced operators may be to ballpark the calibration process off-site with only minor adjustments needed upon arrival.</p> <p><b>Carriers</b> Carriers are an important part of seed mix design and calibration, they are used to bulk a final seed mix so that the expensive seed mix is dropped at a consistent, intended and designed rate. Inert carriers are non-viable additives, like cracked corn, kitty litter, rice hulls, etc., refer to the "Seed Mix Design" section for a discussion of active carriers. There are few differences between the performance of inert carriers and is often reliant on operator preferences with the seeding implement. It is beyond the scope of this document to discuss those varied preferences.</p>  <p><i>Figure 43 - Grains are accessible in most feed stores including Tractor Supply and can make effective carriers. Each grain has different features and performs differently so experiment to discover which is best for your seed mix</i></p> <p>If there is too little carrier, the expensive seed mix will run through the seeder and you will run out before you've finished planting the field. If there is too much, you will find yourself making multiple passes in the field to get the seed out.</p> <p><b>Supplemental Calibration</b> Some seeding implements have other mechanisms that must be calibrated. Drill seeders must have their blades adjusted to the proper depth, too shallow or deep has been the death of many meadow projects. Review the manual for any such mechanisms.</p>	<p><a href="#"><u>Advanced Calibration</u></a></p> <p><a href="#"><u>Calibration of Grain/Seed Drills</u></a></p> <p><a href="#"><u>Calibration of Broadcast Seeders</u></a></p>

Using the same speed as your calibration process, begin seeding.

If the site is flat, debris-free, or a retired agriculture field:

- Operate in the medium transmission range on your vehicle (if applicable)
- Drive at 3 miles per hour

If the site is uneven, steep, slippery, or has many obstacles:

- Drive at 1.5 miles per hour
- Operate in the lowest transmission range on your towing vehicle

Always:

- Operate in the medium or low transmission ranges, NEVER in the high range
- Regularly check the seeding implement to ensure calibration consistency, blockages, and agitator operation
- Smartly navigate contours and grades (i.e. do not drive straight up a steep grade, take the longer more gradual route and drive *down* the steep grade.)
- Lift the seeding implement when navigating swales and ditches. Though the chassis or frame may appear strong, the mechanism of seeding implements is delicate. Bumps and jostling may alter the calibration state or break the mechanism
- Continually scan for obstacles in front of the towing vehicle
- Give obstacles a wide berth, there's no need to take risks for a few extra square feet of seed

## Tractor Operation



*Figure 44 - View from inside a tractor while seeding. Stop, get out, and check the operation of the seeder, and your seed rop rate, about every 30 minutes*

Have a second person on site to **capture media of the planting**, conduct the regular checks for debris and calibration, and to mix and refill the seed box.

When driving on the open road to a seeding site, display an abundance of caution. Lift the seeding implement off the road and activate all lights and flashers. Be sure to disengage 4-wheel drive and drive under 20 miles per hour. Park in a safe place and lock any doors when leaving the implement and vehicle for any amount of time.

<p><b>Mixing and Loading Seed</b></p>	<p>For larger projects where more than one seed box will need to be used to seed, a second person should be on-site to pre-mix the seed and refill the implement.</p> <p><b>Mixing Seed:</b> From the seed mix design and the calibration process you know the amount of seed mix and carrier needed for an acre; you know the ratio of seed mix to carrier. Using a bucket, hanging scale, and a large mixing bin (or trash can), you can begin to weigh out each seed and carrier. <i>Do not just dump all the seed in and then all the carrier.</i> Create the final mixture by starting with a layer of carrier and then alternating measures of seed mix and carrier. Once a mixing bin is full, it can be transported to the seeding implement and loaded.</p> <p>You can increase the speed of this process by marking the weight of seed mix and carrier on the inside of a measuring bucket.</p> <p>[image of tape on bucket from calibration video]</p> <p><b>Loading seed:</b> Larger seeding implements have multiple ‘cells’ which hold separate agitators or chutes. A seeding mix should be even distributed between each cell. Use a separate, smaller vessel to distribute an even measure into each cell when loading a seed mix.</p> <p>[image of loaded seed]</p>	
<p><b>Planting</b></p>	<p>Continue to lay down seed until you have none left.</p> <p>If a second pass needs to be made over the site, with a different seed mix, run in the perpendicular direction if feasible.</p> <p>Any small amount of leftover seed should be used to bulk potential problem areas, areas near a particular invasive plant, poor soils, increased erosion areas, etc. to give the best chance of meadow success in that area.</p>	

# REVIEW THE PROCESS AND STAY PATIENT

**A**

## KEY QUESTIONS

## OVERVIEW

- Did you follow all recommendations during the Site Evaluation and Planning Stage?
- Did the implementation team follow recommended procedures during site preparation, calibration (if necessary), and installation?
- How do we prepare for variable external factors?
- Have we communicated an adaptive management approach to stakeholders?

There are many factors that determine the outcome of any meadow installation, most of which practitioners have at least some control over (species selection). These controllable factors are largely deterministic and should be thoroughly developed at each stage. However, there are elements of meadows that practitioners can't influence, such as weather, that may impact meadow establishment. This page reinforces the necessity for proper planning and adaptability, and considers new variables.

## CHECKLIST

STEP	TITLE	SUMMARY NOTES	DATE
1	<b>Planning</b>	e.g. considered multiple scenarios to evaluate optimal strategy	
2	<b>Cultural</b>	e.g. effectively communicated techniques, expectations, budgets, etc. with stakeholders	
3	<b>Ecology</b>	e.g. effectively developed strategies with recommended ecological principles	
4	<b>Implementation</b>	e.g. used a calibrated Truax no-till drill and sprayed the right number of times with the right chemical	
5	<b>Communication</b>	e.g. consistently and effectively communicated timelines and expectations	
6	<b>Establishment</b>	e.g. planning included budget and time allocations for establishment-related activities	
7	<b>Maintenance</b>	e.g. planning included budget and time allocations for maintenance-related activities	
8	<b>Patience</b>	e.g. confidence to communicate timeline 6-weeks following seed installation	

## SUMMARY AND SIGN-OFF

### HOW TO KNOW WHEN YOU ARE FINISHED

### MANAGER/CONSULTANT SIGNOFF

You are finished with this step once germination has occurred in more than 90% of the project area and establishment activities are under way.

This step can take more than 12 months in many cases. If you missed, or decided to skip, any steps, you will know soon thereafter.

FIELD MANAGER SIGNATURE

DATE

PROJECT MANAGER SIGNATURE

DATE

# REVIEW THE PROCESS AND STAY PATIENT

**A**

TITLE	DESCRIPTION	LINKS
<p><b>Planning</b></p>	<p>‘Meadow Building 101: How-to Guide’ outlines critical information for every step of the meadow process. Familiarize yourself with every step of the process BEFORE proceeding. Do not gloss over sections, even if you have some familiarity with the subject matter.</p> <p>If any of the information seems too challenging or daunting, consult an expert before proceeding.</p> <p>There won’t be an easy opportunity mid-flight to correct changes. Take your time and be thorough.</p>	
<p><b>Cultural</b></p>	<p>There are important cultural factors to consider before implementation and before ecological analysis, as outlined in ‘Meadow Building 101: How-to Guide’. These cultural steps aim to mitigate future concerns about technique and result, both of which can easily de-rail meadow projects.</p> <p>Throughout the Site Evaluation and Planning stage, cultural factors should be given high priority status and taken seriously. Communicating an informed ecological plan can solve future problems and set the project up for success.</p> <p>Council stakeholders toward optimal decisions rather than proceeding without consent.</p>	<p><a href="#"><u>Viable Meadow</u></a></p>
<p><b>Ecology</b></p>	<p>The recommended approach in ‘Meadow Building 101: How-to Guide’ establishes critical ecological steps during the evaluation and planning stage related to site characteristics, species selection, implementation strategy, and site preparation. These revolutionary steps remove guesswork from the process and improve outcomes. Stronger ecological decision-making reduces the necessity for adaptive management and ‘praying’ after implementation.</p> <p>If you haven’t already, re-review the ecology outline in the guide and do NOT move forward until you have discussed your strategy with two ecologists.</p>	<p><a href="#"><u>Site Evaluation</u></a></p> <p><a href="#"><u>Species Selection</u></a></p>
<p><b>Implementation</b></p>	<p>Poor practices during implementation can cause short- and long-term problems in your meadow. Installers mis-identified an invasive plant, skipped a round of site preparation, decided not to calibrate the application equipment, picked the wrong herbicide, etc. Errors during implementation can be deterministic and drastically reduce the overall outcome of the meadow project.</p> <p>It’s imperative that trained individuals manage the implementation process to reduce the opportunity for correctable errors.</p>	<p><a href="#"><u>Perform Vegetation Management</u></a></p> <p><a href="#"><u>Drill, Baby, Drill</u></a></p>
<p><b>Communication</b></p>	<p>Keeping stakeholders (board, residents, supervisor, committee, etc.) well-informed using foundational communication strategies will reduce the potential for issues during project implementation and maintenance. The primary project point of contact should take a proactive approach to project communication so stakeholders have real expectations for timelines, outcomes, and approaches.</p> <p>As the primary project point of contact, you should anticipate potential conflicts and attempt to communicate ahead of time.</p>	<p><a href="#"><u>Socialize the Process</u></a></p> <p><a href="#"><u>Communication Strategy</u></a></p>

	As this guide outlines, the meadow process is predictable and can be communicated.	
<b>Establishment</b>	<p>The meadow process doesn't end after seed installation. Your planning, cultural, and ecology steps should have accounted for the establishment phase. Interventions during the establishment phase help to reduce concerns from stakeholders and improve the overall meadow health by controlling non-desirable vegetation.</p> <p>The establishment phase should be communicated and budgeted for ahead of time.</p>	<b><u>Establishment</u></b>
<b>Maintenance</b>	<p>The meadow process doesn't end after seed installation. Your planning, cultural, and ecology steps should have accounted for the maintenance phase. Interventions during the maintenance phase help to reduce concerns from stakeholders and improve the overall meadow health by controlling non-desirable vegetation.</p> <p>The maintenance phase should be communicated and budgeted for ahead of time.</p>	<b><u>Maintenance</u></b>
<b>Patience</b>	<p>As you should have discovered during the planning phase, mature native meadows can take years to develop into the space most people envision. If your meadow has accounted for the previous seven items, then you should be confident that your project will eventually become the space you promised.</p> <p>Many factors influence the timeline for meadow establishment and your plan should have accounted for those factors.</p> <p>As long as you were comprehensive in your preparation and species selection, and have an establishment plan in place, you shouldn't fear a two-week drought because you will have accounted/budgeted for re-enforcement efforts.</p>	<b><u>Basic Seed Stratification</u></b>

# RE-EDUCATE YOUR STAKEHOLDERS

**A**

## KEY QUESTIONS

- Have we sent a quarterly reminder to all stakeholders reinforcing the outcome that we collectively aspire to achieve (which takes seven years)?
- What level of investment and specification was provided during the evaluation and planning process associated with timelines?
- What elements of the growth stage predictably lead to negative feedback and how can we address those?
- Was our planning, evaluation, site prep, and planting strategy implemented correctly, based on this guide?

## OVERVIEW

Meadows are dynamic spaces that can shift and change from season-to-season, but they usually stabilize and mature into their near-terminal vegetation complex in about seven years. The meadow maturation process can be burdensome for many due to the early growth stages that commonly raise concerns. Proactive, consistent, accurate, and confident communication and expectation management alleviates these concerns and aid in the successful meadow maturation.

## CHECKLIST

STEP	TITLE	SUMMARY NOTES	DATE
1	<b>Follow Meadow Protocols</b>	e.g. your meadow can only mature properly if you have followed the guide up until this point.	
2	<b>Develop Media Assets</b>	e.g. create media assets that support the outcome and/or process you have described to stakeholders	
3	<b>Monitor Project Area</b>	e.g. the primary point person should regularly monitor their project to ensure compliance with project plan and inform necessary adaptive management	
4	<b>Schedule &amp; Deliver Annual Meeting</b>	e.g. re-engage with all stakeholders at least once per year to zoom out and discuss outcomes and timelines	
5	<b>Identify &amp; Engage New Stakeholders</b>	e.g. always be prepared to engage and educate new stakeholders that could influence the project	
6	<b>Closeout Communication</b>	e.g. review the project for educational opportunities that might be used on the next project	

## SUMMARY AND SIGN-OFF

### HOW TO KNOW WHEN YOU ARE FINISHED

The project site looks and functions the way it has been communicated every year for the last seven years and all relevant stakeholders know that.

### MANAGER/CONSULTANT SIGNOFF

FIELD MANAGER SIGNATURE

DATE

PROJECT MANAGER SIGNATURE

DATE

# RE-EDUCATE YOUR STAKEHOLDERS

**B**

TITLE	DESCRIPTION	LINKS
<b>Follow Meadow Protocols</b>	This is a reminder that the seven-year rule only applies to meadow projects that followed the outline described in this document. Without following the protocols and best management practices described in the guide, you can't confidently communicate an outcome or timeline.	
<b>Develop Media Assets</b>	<p>Regularly capturing the meadow building process or project area with photos or videos allows the primary 'project manager' to control messaging and narrative. A seven-year project will have many, many life cycles and you need to be prepared to address every hurdle and accomplishment along the way.</p> <p>It's helpful to keep a project in front of mind to ensure it receives adequate investment and support. The media assets can help defend new or repeated requests. As the years go on, new priorities will emerge and you should be ready to support your project.</p> <p>Keeping media assets up to date also ensures you maintain a presence at the site which can support an adaptive management strategy.</p>	
<b>Monitor Project Area</b>	<p>Meadow practitioners should be in control of the growth and development of the meadow system. Control is largely attained during the initial phases of planning, preparation, and implementation, but a near-constant presence enables the primary 'project manager' to address ecological or cultural issues before stakeholders identify them.</p> <p>By regularly visiting the project, you maintain control over the process and can implement a communication strategy that supports your outcome and timeline.</p>	
<b>Schedule &amp; Deliver Annual Meeting</b>	<p>At least once per year, you should gather all stakeholders to take inventory and re-focus the group on the macro-level outcomes of the project. The meadow process should have been described to stakeholders previously during project socialization, but stakeholders should be reminded that the process takes a minimum of seven years to complete.</p> <p>This is a chance to discuss obstacles and challenges, but this conversation should aim to alleviate those concerns because they will be addressed prior to the end of year seven. This is also an opportunity to adjust strategies, if needed, to work towards the desired outcome all stakeholders approved of.</p> <p>As priorities and people shift and evolve, it's best practice to make sure your priorities are constantly being considered and evaluated.</p>	<p><a href="#">Stakeholder Management</a></p> <p><a href="#">Communication Strategy</a></p>
<b>Identify &amp; Engage New Stakeholders</b>	It's inevitable that, over a seven-year process, the people engaged in the project will change, or their priorities will change. Stay alert for new stakeholders, especially those with differing priorities, and leverage connections and media assets to include their priorities in the project strategy.	<p><a href="#">Stakeholder Management</a></p> <p><a href="#">Communication Strategy</a></p>
<b>Closeout Communication</b>	<p>If your meadow project followed the steps outlined in this guide, your project will likely approach maturation around year seven.</p> <p>Conduct a formal or informal survey and share the results with others so that meadow practitioners continue to grow their knowledge base.</p>	<p><a href="#">Stakeholder Management</a></p>

# ESTABLISHMENT (YEARS 1-7)

**A**

## KEY QUESTIONS

- How successful was germination?
- Is reseeding necessary and if so what should change?
- What weeds are appearing and how pervasive?
- How frequently should you mow?

## OVERVIEW

Meadow maintenance should decrease in intensity every year. In the first year, keeping it on track will feel like a full time job: multiple mowings, weed surveys and control efforts, possible reseeding, and consistent evaluation of what worked and what didn't. Doing a thorough job in each of these areas the first couple of years will set you up for success. Gradually, mowing frequency should decrease, gaps will be filled by the meadow itself, and species will naturally find their niches within the meadow. Your job is to steward it along. The following sequence is a hypothetical one for a meadow that has a high population of both cool- and warm-season weeds. Establishment protocols should be tailored to each specific meadow.

## CHECKLIST

STEP	TITLE	SUMMARY NOTES	DATE
1	<b>Meadow Documentation</b>	e.g., evaluated and photographed meadow for invasives and germination success	
2	<b>Write the Meadow Stewardship Plan</b>	e.g., write out all necessary steps to keep the meadow successful	
3	<b>Specify your Mowing and Rotation Plan</b>	e.g., planned mid-season mow to combat Foxtail, planned winter mow of entire meadow except 1/3 in Northeast section	
4	<b>Announce your Weed Control Plan</b>	e.g., two inspections during warm season planned to combat Foxtail	
5	<b>Review Germination Success</b>	e.g., seeing strong germination of these species, low germination of others	
6	<b>Collect Seed</b>	e.g. by year three or so, you may be able to collect seed from valuable species	
7	<b>Decide Next Year's Management Approach</b>	e.g., treatments this year were effective but Foxtail still lingers, plan to continue weed control next year	

## SUMMARY AND SIGN-OFF

HOW TO KNOW WHEN YOU ARE FINISHED	MANAGER/CONSULTANT SIGNOFF	
Establishment is finished when the meadow can function with minimal human intervention. This means insignificant populations of invasive weeds that can be easily controlled and native herbaceous coverage that is self-seeding over >95% of the meadow area. Achieving this will likely take up to 7 years. Remember that everything should be documented.		
	FIELD MANAGER SIGNATURE	DATE
	PROJECT MANAGER SIGNATURE	DATE

# ESTABLISHMENT (YEARS 1-7)

**B**

TITLE	DESCRIPTION	LINKS
<p><b>Meadow Documentation</b></p>	<p><b>Perform a Meadow Inspection</b>                      Meadows are major capital investments in the health of our communities, and they consume an ongoing annual operating budget.</p> <p>Meadows protect water quality and provide critical habitat for insects, birds, and other animals. They are critical pieces of natural infrastructure, and they serve the community just like bridges and roads.</p> <p>But meadows can change rapidly from year-to-year and should be inspected regularly, just like bridges and roads. While meadows can get better with time, they can often get worse as well.</p> <p>Performing a regular inspection of your meadows benefits you for several reasons:</p> <ol style="list-style-type: none"> <li>1. Meadows can become invaded with detrimental plants like Multiflora Rose, and annual reports can help document their expansion, or their effective treatment,</li> <li>2. People can, and do, dump garbage in meadows, or drive through them on ATVs and snowmobiles, causing damage,</li> <li>3. Meadows can evolve in a way that you didn't expect or in a way inconsistent with its intended use.</li> </ol> <p>Use the meadow documentation form included in the <a href="#">Appendix</a> to perform your regular inspections of your meadow. Someday, you'll be glad that you did, especially when defending a budget request to perform stewardship, or to intervene, reset, or retire the meadow.</p> <p>Regular inspections create an opportunity for long-term learning and for sharing your meadow experience with others, especially at conferences or during internal training sessions. Your annual inspections can inform the design of future meadows in your community.</p> <p>Fixed photo stations and overhead drone footage can be valuable tools in documenting a meadow's evolution.</p>	<p><a href="#">Planting Strategy</a></p> <p><a href="#">Successful Community Science Photopoint Program</a></p>
<p><b>Meadow Stewardship Plan</b></p>	<p><b>Write/Update the 3-year Stewardship Plan</b>                      After your first meadow inspection, write your 3-year meadow stewardship plan based on your observations. This plan needn't be more than a paragraph or two that explains your plan and refers back to the meadow inspection document.</p> <p>There are only three commonly recurring meadow stewardship activities that need performing annually – mowing, weed control, and supplementation. Your stewardship plan should describe what your plan is for the meadow for next year, and the following two years.</p>	<p><a href="#">Managing Woody Encroachment</a></p> <p><a href="#">PGC Mowing Guidance</a></p> <p><a href="#">Mid Atlantic Native Meadows, Maintenance</a></p>

	<p>Burning isn't a stewardship activity; it's a major intervention and performed only when there is a compelling science-backed case for burning.</p>	
<p><b>Specify your Mowing and Rotation Plan</b></p>	<p>Mowing is, by far, the most common stewardship activity. The role of mowing is two-fold – one, to cut back encroaching woody plants, both shrubs and trees, whether native or not, and two, to clean it up aesthetically if it is frequented by the public.</p> <p>Mowing is best performed with a flail mower or a 50+hp tractor and a brush hog attachment. These machines can easily cut through meadow detritus and cut down one and two-year old saplings and shrubs. You will want to sharpen your blades before mowing to make the process easier and cleaner.</p> <p>Mow at a height no lower than 6” or so. You want to avoid scalping the ground as that can damage or kill the crowns of some grasses and create bare soil spots that become a vector for weeds. A simple mowing should take care of your woodies for an entire year and give the public a nice clean appearance to ward off complaints. Using a mulching mower deck could help to break up detritus into finer particles for faster decomposition.</p> <p><b>Winter Mowing</b></p> <p>Mow large meadows in natural areas in sections and on a rotation. The prevailing best practice is to delineate your meadow into three or four sections and only mow one section each year. This maintains the ability of your mower to cut trees and shrubs while limiting the impact on overwintering insects and animals. Most insects, including moths and butterflies, overwinter either in the hollow leafy stems or in the tufts of grasses. Mowing on a three or four-year rotation allows insects to adequately complete their life cycles.</p> <p><b>Mid-Season Mowing</b></p> <p>During the first two growing seasons, plan for at least one mid-season mow, but up to three if needed. Mowing can help keep annual weeds from establishing and limit perennial weeds to a manageable height before targeting them with herbicide.</p> <p>Time your mow to occur once vegetation reaches a height of 12-18”, and mow to a height of 8” - high, enough to spare the basal leaves of native perennials but low enough to decapitate annual weeds. You may mow multiple times but should cease by mid-fall to allow plants to harden off for winter.</p> <p>[include image of summer mowing]</p> <p><b>CAUTION:</b> Mowers and other contractor equipment are major sources of invasive weed infestations. Either use a dedicated mower for your meadows or thoroughly wash your mower deck and tractor before mowing your meadows. Do not allow landscape contractors to mow your meadow unless they sign a contract that compels them to power wash all equipment before they enter the meadow. If you do not have the equipment to mow your meadow, consider hiring the work out to a specialized meadow building organization.</p>	

	<p>Dirty contractor equipment and rushed mowing operations are also a major vector for weeds, so the number of weeds you need to treat each year is a direct reflection on the quality of your mowing contractor. A good contractor that understands that they are performing maintenance in a natural area will commit to cleaning their equipment thoroughly before mowing. The operator will avoid rough movements and turns that tear at the soil and damage the meadow plants.</p> <p>An irresponsible contractor simply rushes from jobsite to jobsite passing each property's weeds to the next and creating bare spots for new weeds.</p> <p>Your best alternative to a specialized contractor for meadow mowing will be a local farmer, who probably shares your interest in preventing the spread of weeds and invasive plants.</p> <p>Avoid using the same equipment used for roadside mowing in a meadow. Too many weed seeds can be inadvertently planted into the meadow.</p>	
<p><b>Announce your Weed Control Plan</b></p>	<p>Even well-developed meadows can occasionally suffer from weed infestations, particularly after a cold wet winter or a long, dry and hot summer that created open spots in the meadow.</p> <p>If you find that invasives are in the meadow or encroaching from an edge, add invasive control to your stewardship plan. Use the same form and process as described in the Plan Your Vegetation Management Strategy section.</p> <p>Note that the below sections will only be necessary if there are relevant weeds to suppress. If you only have cool-season weeds, for example, you may not need an early inspection for warm-season weeds. Still, you may need a second inspection for cool-season weeds.</p> <p><b>Early Inspection #1 – Inspect for Cool Season Weeds</b></p> <p>During your first meadow inspection, consult your site evaluation notes for mentions of cool-season weeds. Survey the meadow in March and early April for species such as Bromus species, Orchard Grass, first-year Thistles, and Plantain.</p> <p><u>Survey Strategy</u></p> <p>Use consistent, repeatable and easy to remember survey protocols to ensure they are done at regular intervals. Walk transects for a thorough and more empirical approach, but a meandering walk can be just as effective of a strategy to identify overall condition. However, during your survey, ensure you are keeping consistent and thorough notes.</p> <p>Another helpful tactic is to assign photo points from different angles to repeatably compare from season to season and year to year.</p>	<p><a href="#"><b>Meandering Walk Survey Protocol</b></a></p> <p><a href="#"><b>See Vegetation Management Sheet</b></a></p>

### **Rapid Response #1 - Control Strategy**

Following the creation of the stewardship plan, if early-season weeds are present at concerning levels, initiate control immediately. Spot spraying is typical, but mechanical methods are also possible, especially if the infestation is small. Avoid pulling weeds though, since this can create soil disturbance that just promotes the proliferation of more weeds by bringing their seeds to the surface. Instead, cut from the base.

Rapid response is critical; issues cannot be left to deal with for a year or two after being identified. And remember that you want to effectively suppress these weeds, so use a method that will keep them from coming back. Cutting Mugwort at the base each year will only cause it to spread via rhizomes (underground runners), so its spread will continue.



*Figure 45 - An herbicide specialist treats remnant reed canary grass patches in a previously seeded wet meadow*

### **Early Detection #2 (following regrowth)**

In late Spring if no mowing occurred, or about 2-4 weeks after the first mid-season mow, return to perform an additional weed detection event. Now you will be looking for warm-season weeds. The main targets will be species such as Stilt Grass, Foxtail, Mugwort, second year Thistle, Bindweed, and woody invasives like Wineberry and Multiflora Rose. Document which species you find and their relative abundance.

### **Rapid Response #2**

Immediately treat detected invasives with herbicide or by cutting back to base. See the Vegetation Management and Preparing to Spray sections for guidance on choosing herbicide products, rates, and methods of application.

Make sure you wait 2-4 weeks after mowing before conducting an herbicide application. This allows regrowth of the leaf surface, which is critical for applying foliar herbicides.

You may repeat the sequence of mow>early detection>rapid response many times in the first year or two of the meadow.

	<p><b>Further Inspections</b></p> <p>You may also add an additional inspection for warm-season weeds in late Summer and/or for cool-season weeds in mid-Fall. This will generally only be necessary in instances of severe infestations of these weeds.</p>	
<p><b>Review Germination Success</b></p>	<p>This review can happen in concurrence with the planned inspections of the meadow as some species in the meadow will also be germinating at the same time as the weeds, depending on whether they are cool or warm-season.</p> <p><b>Ask 6 Key Questions</b></p> <p>At the end of the growing season take stock of each species you seeded and ask the following questions:</p> <ul style="list-style-type: none"> <li>• Which species are doing well?</li> <li>• Which species are not?</li> <li>• For species that are doing well, what patterns can you discern in germination success? For example, are some species doing well in certain microhabitats but not others?</li> <li>• Are some species that you would expect to see not appearing at all?</li> <li>• How does the meadow generally look and does it align with your expected timeline?</li> <li>• If germination did not meet expectations, what was the likely root cause?</li> </ul> <p><b>Check Expected Germination Timelines</b></p> <p>Consult the germination timelines for each species- you may not see Milkweeds <i>Asclepias ssp.</i> or Wild Bergamot (<i>Monarda fistulosa</i>) until the third year, for example, and they may not flower until the fourth. If you are only in your first year of maintenance and those species are nowhere to be found, it is too early to conclude that they were ill-suited to this environment.</p> <p>Biennials such as Black-eyed Susan (<i>Rudbeckia hirta</i>) should appear in year 1 as basal rosettes and grasses should appear in year 2. Their absence at these junctures could indicate poor species selection, smothering by invasives, or improper seeding.</p> <p>If germination success is only poor in sections of the meadow, follow the below guidelines:</p> <p><b>Find Dead Zones</b></p> <p>Use your germination review to identify “dead zones” or areas of low diversity. If a patch of bare dirt is bigger than the size of a hula hoop it is a potential risk site for reinvasion.</p> <p><b>Amend Seed Mix if Necessary</b></p> <p>If reseeding is necessary, decide if your species mix should be amended. Base this on the findings in your germination review. If, for example, you are reseeding primarily wet areas, revise your mix to lean into species that are tolerant of moister soils.</p>	<p><a href="#"><u>PA Prescribed Fire Council</u></a></p> <p><a href="#"><u>Longwood Gardens Prescribed Burn</u></a></p> <p><a href="#"><u>Using Prescribed Fire to Manage Native Grass Forages in the Mid-South</u></a></p>

### Consider Plugs

Consider using plugs as an alternative to seed. Large sized plugs can give native plants a 2-year head start over weeds. Use them for stubborn areas where seeds have failed twice or for high-visibility "focal points." Plugs can also be useful if you want to employ species that are too difficult/expensive to procure from seed.

If that's not the case, however, and the majority of your site is seeing poor germination and invasive species encroachment, you may be at a point where you need to reset your meadow entirely.



*Figure 46 - Yes, meadows can be installed using tightly spaced plugs, as shown in this image. This technique is best for meadows under an eighth of an acre*

### Decide if the Meadow Needs Resetting

Why would you want to reset a meadow? Good question!

Sometimes meadows don't turn out the way that anyone intended, and this can happen for a variety of reasons. Here are the top three reasons why meadows fail to establish properly and become candidates for a complete reset:

1. Inadequate Preparation – this is the most common reason why people decide to give up on a meadow and start over. Japanese Stilt Grass, basket grass, turf and pasture grasses, Mugwort, Thistle, Reed Canary Grass, Purple Loosestrife, and Phragmites are the principal culprits. If these weeds were present in the meadow area prior to building it and weren't completely cleaned, they could quickly overwhelm a new meadow. When this happens, your only reasonable recourse is to start over,
2. Poor Species Selection – The use of inappropriate species for a new meadow is probably the #1 reason why people can get frustrated or become disappointed with their meadows. Choosing species for a meadow is the purview of ecologists, not landscape designers. If a meadow was "designed" to host 80 beautiful and rare species then it was destined to fail from the very beginning. A meadow that results from poor species selection might not be a "bad" meadow, but it

probably won't be the one that you wanted, especially if it is dominated by goldenrods. In this scenario, a limited reset and reseed of the meadow could be warranted, and

3. **Incorrect Seeding Technique** – a much under-discussed source of meadow failure is the seeding technique. Choosing a seeding technique is a tri-lateral decision based on the equipment available, the type of seed, and the soil and hydrological conditions of the site. Choosing an inappropriate seeding technique can lead to only a few species germinating and growing, which can lead to a spotty meadow and significant weed incursions. The most common error is the use of a grain drill that buries warm season grasses and Asters too deeply into the soil. If the meadow was seeded improperly, you might or not need to reseed, but a reset is certainly in order. Check with a local meadow consultant on the techniques that might be able to recover the meadow, or if reseeding is inevitable.

Resetting a meadow can be almost as expensive as it was to install the meadow in the first place. It is generally difficult to secure budget to reset a meadow, so you'll want to follow the instructions in this guide as closely as possible to avoid this scenario altogether.

#### **Be Honest and Document “Why?” a Reset is Required**

If you do decide to reset the meadow, first perform a thorough analysis as to “why” you have decided to reset the meadow. Is it for one or more of the reasons above, or something else. You'll want to perform a root cause analysis, or ask someone to perform it for you, so that you can avoid committing the same errors on your next attempt.

In addition to documenting “why” a meadow project requires a reset, craft a new budget based on an updated vegetation management plan and a seed mix design. Hopefully, your second attempt incorporates your learnings into the new approach and design.

#### **Special Section on Burning – Decide if Burning is for You**

Interest in using burning as a meadow reset technique is at an all-time high. The most common case for burning is trying to sustain a warm season grass meadow in a place where a warm season grass meadow cannot sustain itself naturally. Burning is sometimes used to suppress large shrub infestations, but it is better to treat the shrubs before burning.

While the role of burning is well understood for the maintenance of warm season grasslands in the Midwest, the effects of burning forb-dominated meadows on the east coast are under-studied. At best, burning can reduce thatch to improve access to the soil for treating weeds and seeding. At worst, burning can dramatically shift vegetation patterns in an undesirable direction. Yes, there are now many people qualified to plan and implement a burn, but precious few that can properly prescribe one and articulate its long-term effects.

There are many considerations to account for when planning a burn. What time of year? Pre-mow or not? Treat invasives prior to burning, or after? How hot do we want the fire, or can it even get hot enough to have the desired effect? What to do if a burn is scheduled but cancelled due to weather conditions? How do we protect insects, birds, animals, and hard-to-replace species from the effects of burning?



Figure 47 - This meadow is being repeatedly burned in a failing attempt to force this wet meadow area to support warm season grasses. Burning cannot compensate for poor species selection

Burning is not a cure-all – burning should be treated as a very specific tool to accomplish a very specific effect. If that specific effect cannot be articulated, then rethink the need for a burn.

Burns are fun, but that’s no reason to reset a meadow.

Once native meadow plant populations have established, you may begin to collect seed. Seed can be used to help jumpstart a different meadow project or be used to fill in gaps within the meadow that are taking a long time to establish

Collect Seed



Figure 48 - Hand collected seeds from a successful meadow. These seeds will be used to start a new meadow

**Xerces  
Society,  
Collecting and  
Using Your  
Own  
Wildflower  
Seed**

	<p>naturally. If these seeds are from locally sourced plant populations, they can also be collected to be contract grown into plugs by a native plant nursery.</p>	
<p><b>Decide Next Year's Management Approach</b></p>	<p>At the end of each year, it's important to review the steps you took throughout that year and review as to whether they were effective.</p> <p><b>Ask 4 Important Questions</b>  Review how well your maintenance plan worked in the previous year. Answer the following questions:</p> <ol style="list-style-type: none"> <li>1. Did you time your treatments correctly or did you miss a treatment window for an important weed?</li> <li>2. If spraying herbicide, did your spray rates effectively control species or should they be altered?</li> <li>3. Was the number of mowings during the previous year adequate to control annual weeds and preserve aesthetics? Should next year have more, less, or the same number of mowings?</li> <li>4. Are you generally seeing a reduction in invasive species from the previous year?</li> </ol> <p>Revise and document your management plan according to your answers.</p>	

# MAINTENANCE (YEARS 8+)

**A**

## KEY QUESTIONS

- What weeds are present and at what level?
- What is your early detection protocol?
- Are your goals still clear?
- Will a burn be helpful?
- How are desirable species responding? Are they still present?
- Was your species selection right?

## OVERVIEW

Once you've reached a point where there are minimal invasives present and native plants are re-seeding roughly 95% of the meadow, your job does get easier, but it never stops. Remember, regular maintenance actions must be taken to preserve a meadow. Luckily, maintenance efforts are only establishment efforts done less frequently, so you should be pretty comfortable with these tasks.

## CHECKLIST

STEP	TITLE	SUMMARY NOTES	DATE
1	<b>Meadow Documentation</b>	e.g. I walk the meadow at least once per year and complete an assessment form to track changes over time.	
2	<b>Update Meadow Stewardship Plan</b>	e.g. I conduct regular maintenance activities like mowing, weed suppression, and supplementation.	
3	<b>Meadow Intervention</b>	e.g. have decided to allow a stand of wetland shrubs persist in the Southwest corner of the site	

## SUMMARY AND SIGN-OFF

### HOW TO KNOW WHEN YOU ARE FINISHED

You're never finished with maintenance! Tasks every year should include succession interruption (mowing/grazing), surveying, and refined management actions.

### MANAGER/CONSULTANT SIGNOFF

FIELD MANAGER SIGNATURE	DATE
PROJECT MANAGER SIGNATURE	DATE

# MAINTENANCE (YEARS 8+)

**B**

TITLE	DESCRIPTION	LINKS
<p><b>Meadow Documentation</b></p>	<p><b>Perform an Annual Meadow Inspection</b> Even once you’ve reached the stage of a well-established and fairly self-sufficient meadow, the work is never done. You may not need to complete multiple inspections per year anymore but should still complete at least one thorough meadow inspection every year.</p> <p>Again, it only takes a year or two for an invasive species to encroach on a meadow to the point that you’ve now got a real fight on your hands to get it back to where it had been.</p> <p>You can continue to use the meadow documentation form included in the <a href="#">Appendix</a> to perform an annual inspection of your meadow.</p> <p>Remember, annual inspections create an opportunity for long-term learning and for sharing your meadow experience with others. These annual inspections can even inform the design of future meadows in your community.</p> <p>And keep up with photos and videos, not just for social media, but to continue to see changes over time and understand what those changes mean.</p>	<p><a href="#">Meandering Walk Survey Protocol</a></p> <p><a href="#">Planting Strategy</a></p> <p><a href="#">Successful Community Science Photopoint Program</a></p>
<p><b>Update Meadow Stewardship Plan</b></p>	<p><b>Update the 3-year Stewardship Plan</b> After performing your annual meadow inspection, update your 3-year meadow stewardship plan with the same information as has been in previous plans:</p> <p><b>Specify your Mowing and Rotation Plan</b> Mid-season mows have long-since stopped but winter mowing on a rotation is still vital to the continued health of your meadow.</p> <p><b>Announce your Weed Control Plan</b> At this point also a smaller task, and yet still a vital one, especially with the continued introduction of new invasive species. Be thorough and ensure you know all of the plants you’re looking at in your meadow.</p> <p><b>Collect Seed</b> Also, at this point you are hopefully able to collect a large amount of seed from several different species, and hopefully ones with local genetics.</p>	<p><a href="#">Managing Woody Encroachment</a></p> <p><a href="#">PGC Mowing Guidance</a></p>
<p><b>Meadow Intervention</b></p>	<p><b>Decide if you Need an Intervention</b> Each year or so, during one of your annual inspections, you’ll want to step back and look at the meadow as a whole and ask yourself, “does the meadow look like it should, or is there something happening that has significantly changed its character?”</p> <p>Be sure to check your previous reports and review photos and drone footage because several things can happen over the course of a year that might be difficult to discern with a simple annual walk-through inspection, such as:</p>	<p><a href="#">Managing Woody Encroachment</a></p> <p><a href="#">PGC Mowing Guidance</a></p>

1. A stand of Cedar, Birch, Maples, or Dogwood have heavily encroached on one edge of the meadow,
2. The number of Olive, Honeysuckle, or Rose shrubs have greatly increased since last year,
3. A gulley has formed where there wasn't one before and you are losing soil,
4. A region of particularly high plant diversity is being overtaken by a goldenrod,
5. A beautiful stand of grasses has become much smaller or has disappeared altogether,
6. A particularly beautiful plant, like Foxglove Beardtongue (*Penstemon digitalis*) or New York Ironweed (*Vernonia noveboracensis*), is expanding rapidly in one section of the meadow.
7. Walkers have worn a path through the meadow and stilt grass thatch is forming on either side
8. Etc...

These types of stand-back observations, positive or negative, could give rise for making a specific intervention each year that could help to keep your meadow on track and healthy. Here's a glimpse into how the above observations might inspire an intervention in a meadow

OBSERVATION	POTENTIAL INTERVENTIONS
Trees or Shrubs Encroaching on an Edge.	Remove the encroaching vegetation and thin or remove some of the nearby sources of seed.
Invasive Shrubs are on the rise	Hire a meadow maintenance team to come in and treat the invasive shrubs instead of relying just on mowing.
A Gulley Formed	Install erosion control devices like silt socks to disperse concentrated flows. Regrade or install check dams.
Goldenrods Taking Over	Suggestive of a problem with the original seed mix design. Hire a team to assess the Goldenrod, suppress if necessary, and to reseed with a more resistant set of species in the affected areas. Sometimes a different mowing regime can be effective.
Grasses Have Waned	Usually, a sign of improper seed mix design, or a series of unusually wet seasons. Design a new seed mix for the affected areas and reseed.
Beautiful Flowers Expanding	Learn more about the conditions the species thrives in and look for more areas that are functioning similarly in the meadow. Add some additional seed of the species to improve aesthetics and function.
Worn Paths and Stilt Grass Problem	Intentionally close the trail with a sign, suppress the stilt grass, and reseed the trail with a seed mix that can tolerate compaction.
Etc...	There are too many potential observations and intervention options to list them all here. If you see something, say something, and contact your local meadow expert to take a look.

	Share your observations and your recommended interventions with your manager, secure budget, and include in your 3-year stewardship plan.	
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# KEEPING A MEADOW, OR NOT...

**A**

## KEY QUESTIONS

- How does one that has a meadow keep it a meadow?
- What does keeping a meadow as a meadow entail?
- Can a meadow even be kept as a meadow?
- Why doesn't my meadow look like it used to?
- How do I get my meadow back to the point when it was full of flowers all year?
- Why doesn't my meadow look like I thought it was going to look?
- Weeds have taken over, especially Goldenrod; what do I do now?
- How do I decide when to let the meadow go?

## OVERVIEW

Meadows will become whatever they are meant to become; that's what nature does. Keeping a meadow as a meadow means that you will need to arrest natural processes, particularly the emergence of trees and shrubs.

Keeping a meadow as a certain "type" of meadow is particularly challenging as doing so requires fighting against nature's processes, which can be expensive. Ultimately, you might decide you don't need a meadow any longer and just let it go.

## CHECKLIST

STEP	TITLE	SUMMARY DELIVERABLE	DATE
1	<b>Meadow Retirement</b>	I have reviewed and documented my meadow, or had it reviewed and have the documentation in hand	
2	<b>Transition to Shrubland?</b>	I know what I will do to steward my meadow this year, and for the following two years.	
3	<b>Transition to Forest?</b>	I have decided whether my meadow needs more than simple maintenance, or not. I need to do this one big thing in Year XXXX to deal with a particularly large problem.	

## SUMMARY AND SIGN-OFF

### HOW TO KNOW WHEN YOU ARE FINISHED

You have made all your major decisions for the meadow, which you repeat annually. You know what your stewardship activities will always be for three years.

You have consciously decided to intervene, reset, or retire the meadow each year, and socialized your decisions. You have secured extra budget and schedule for activities that require supplemental funding.

### MANAGER/CONSULTANT SIGNOFF

FIELD MANAGER SIGNATURE

DATE


PROJECT MANAGER  
SIGNATURE

DATE

# KEEPING A MEADOW, OR NOT...

**B**

TITLE	DESCRIPTION	LINKS
<p><b>Meadow Retirement</b></p>	<p><b>Make a Conscious Decision Each Year to Retire, or Not to Retire, the Meadow</b>            Should meadows be forever? Probably not, unless you already have a stable, naturally occurring meadow site. Meadows excel at building soils and acting as a nursery for shrubs, and then trees. Increasingly, the meadow is going to try “hard” to transition to the next stage of its development. No one can precisely predict when a meadow is ready to transition, but it should be obvious when it is.</p> <p>The Northeast has relatively few “built” meadows and even fewer have been studied intensively enough to draw any conclusions about when its time to let it develop naturally into a shrubland or forest. Until there is accepted guidance on the topic, keep it as a meadow until it becomes obvious that an annual mowing and a little bit of herbicide can no longer keep it functioning as a meadow.</p> <p>There might come a time when a park or township is tired of maintaining their meadow, or the meadow no longer serves the purpose it once held. This is when you make the conscious decision to “retire” the meadow and allow it to progress to its next ecological state. NRCS might have a state-and-transition model built for your ecoregion and it would be good to consider another ecological state, the species that should be growing in it, and the transition model. An example model below:</p> <div data-bbox="397 1008 1234 1669" data-label="Diagram"> <p>State-Transition model: MLRA 42, SD-2. Upland sandy site group: Sandy</p> <p>1a. Climate change and/or overgrazing, moderate soil degradation. 1b. Restoration of soil fertility (if climate not involved).          2. Extinction of black grama, severe soil degradation. 3a. Introduction of mesquite sees, reduced grass competition, lack of fire.          3b. Shrub removal, restoration of fuel loads and fire. 4a, 5a. Mesquite invasion. 4b, 5b. Shrub removal, restoration of fuel loads and fire.          6a. Black grama extinction due to mesquite competition and grazing. 6b. Shrub control with black grama restoration.          7. Continued grass loss (e.g., overgrazing), inter-shrub erosion, soil fertility loss, high soil temperatures, small mammal herbivory.          8. Dune destruction, mesquite removal, soil stabilization, nutrient addition, seeding during wet periods.          9. Reseeding, replanting with restoration of soil fertility.</p> </div> <p>State and transition model taken from the Natural Resource Conservation Service's Ecological Site Description for a Sandy Upland site in Major Land Resource Area (MLRA) 42, Southern Desert (SD) region 2 viewable at <a href="http://esis.sc.egov.usda.gov/esis_report/fsReport.aspx?id=R042X B012NM&amp;rptLevel=all">http://esis.sc.egov.usda.gov/esis_report/fsReport.aspx?id=R042X B012NM&amp;rptLevel=all</a>.</p>	<p><a href="#">NRCS-ESD</a></p>
	<p>Retiring a meadow doesn't mean abandoning the meadow. It means intentionally helping it to transition to its new state, either a shrubland or a forest.</p>	

<p><b>Transition to Shrubland</b></p>	<p><b>Decide to Transition to Shrubland</b>          To establish a new shrubland for Turkeys, Woodcocks, and other birds, you will want to reintroduce the shrubs that are attuned to the ecological zones in your meadow to maintain its regional authenticity. Shrublands are relatively inexpensive and can be clustered for a more natural aesthetic that can expand outwards over time.</p> <p>Shrublands are more associated with moist to saturated soils, which are places where most trees struggle. If you are retiring a meadow in a moist or saturated area, first consider shifting to shrubs such as Cornus, Viburnum, Spiraea, Cephalanthus, Alnus, and Salix.</p>  <p><i>Figure 49 - A properly designed and planted riparian buffer, using shrubs</i></p> <p>If you are a user of Evaluate™, you can get shrub recommendations right from the software.</p>	
<p><b>Transition to Forest</b></p>	<p><b>Decide to Transition to Forest</b>          To move directly from a meadow to a forest involves planting trees, up to 500 per acre if unprotected or about 150 per acre if caged or tubed. There are many resources online, and several grant programs, that will help you to plant trees into your meadow to create a new forest-like area.</p> <p>You'll want to use the correct species, of course, for healthy long-term performance. Check out Evaluate™ for tree recommendations for your ecological zones.</p>	



# SUMMARY

If you've made it through this entire document (go you) it should be plain to see that building a meadow is not something that happens over a few days with a couple buddies and a case of beer. Indeed, the main point we'd like you to take away is that building an authentic, productive meadow, or any natural space for that matter, requires careful planning and decision-making to become a success. We harp on this because we've been there more times than we care to admit and don't want you to make the same mistakes. And we harp on this so much because we want to see nothing less than a thriving ecosystem where bees and birds, humans and fungi can all roam together.

Learn from our mistakes and you'll find yourself surrounded by bees buzzing and flowers blooming in only a couple of years. Ignore our mistakes and you'll find yourself doing exactly what we've done: pulling your hair out, crying in despair because you have to start all over. Okay, maybe that was just me. But seriously, skip the disappointment altogether by being thorough and methodical. Oh, and did we mention communicating and documenting everything?

# APPENDIX

# ANNUAL NATIVE MEADOW INSPECTION FORM

For ecological restoration, adaptive management, and long-term meadow stewardship

## SITE INFORMATION

Property / Project Name: \_\_\_\_\_  
Location: \_\_\_\_\_  
Inspector(s): \_\_\_\_\_  
Date of Inspection: \_\_\_\_\_  
Weather Conditions: \_\_\_\_\_

## MEADOW OVERVIEW

Meadow Type:  Seeded  Plug-planted  Hybrid  
Year Established: \_\_\_\_\_  
Total Meadow Area: \_\_\_\_\_ acres / sq ft  
Management Zones (if applicable):  
\_\_\_\_\_

## VEGETATION COMPOSITION, PERFORMANCE & GENOTYPE INTEGRITY

### Native Species Survey (Compared to Original Seed Mix)

Original seed mix available?  Yes  No  
Species expanding: \_\_\_\_\_  
Species contracting: \_\_\_\_\_  
Species no longer observed: \_\_\_\_\_  
New species introduced by wildlife (e.g., birds):  
\_\_\_\_\_  
Overall native species richness: \_\_\_\_\_ species observed  
Notes:  
\_\_\_\_\_

## Seed Mix Performance by Ecological Zone

Evaluate the performance of the seed mix for each ecological zone.

ECOLOGICAL ZONE	EXPECTATIONS MET	NOTES
	<input type="checkbox"/> Met <input type="checkbox"/> Partially <input type="checkbox"/> Not Met <input type="checkbox"/> Failed	
	<input type="checkbox"/> Met <input type="checkbox"/> Partially <input type="checkbox"/> Not Met <input type="checkbox"/> Failed	
	<input type="checkbox"/> Met <input type="checkbox"/> Partially <input type="checkbox"/> Not Met <input type="checkbox"/> Failed	
	<input type="checkbox"/> Met <input type="checkbox"/> Partially <input type="checkbox"/> Not Met <input type="checkbox"/> Failed	
	<input type="checkbox"/> Met <input type="checkbox"/> Partially <input type="checkbox"/> Not Met <input type="checkbox"/> Failed	
	<input type="checkbox"/> Met <input type="checkbox"/> Partially <input type="checkbox"/> Not Met <input type="checkbox"/> Failed	

Overall Performance Observations:

---

## Genotype Integrity Check

Warm-season grasses present:

Big bluestem  Little bluestem  Indiangrass  Switchgrass

Signs of non-local genotypes (height, phenology mismatch, aggressive spread):

---

Genotype concerns requiring action:

---

## INVASIVE SPECIES & ENCROACHMENT

Perform an annual inspection of invasive species. Write in the species observed as well as invasives observed during previous inspections.

### Invasive Species Checklist

INVASIVE SPECIES	ABUNDANCE	NOTES
	<input type="checkbox"/> Absent <input type="checkbox"/> Low <input type="checkbox"/> Medium <input type="checkbox"/> High	
	<input type="checkbox"/> Absent <input type="checkbox"/> Low <input type="checkbox"/> Medium <input type="checkbox"/> High	
	<input type="checkbox"/> Absent <input type="checkbox"/> Low <input type="checkbox"/> Medium <input type="checkbox"/> High	
	<input type="checkbox"/> Absent <input type="checkbox"/> Low <input type="checkbox"/> Medium <input type="checkbox"/> High	
	<input type="checkbox"/> Absent <input type="checkbox"/> Low <input type="checkbox"/> Medium <input type="checkbox"/> High	
	<input type="checkbox"/> Absent <input type="checkbox"/> Low <input type="checkbox"/> Medium <input type="checkbox"/> High	

### Edge Encroachment (Trees & Shrubs)

Encroachment present?  Yes  No

Species involved: \_\_\_\_\_

Encroachment severity:  Low  Moderate  High

Distance encroached into meadow: \_\_\_\_\_ ft

Recommended action:

Cut back  Remove saplings  Maintain edge buffer  No action needed

## HUMAN-CAUSED DISTURBANCE

### Damage Assessment

Informal / social trails:  Present  Expanding  Not present

Trampling:  Localized  Widespread  None

Vehicle damage:  Yes  No

Dumping / debris:  Yes  No

Unauthorized mowing or cutting:  Yes  No

Notes:

\_\_\_\_\_

## Opportunities to Formalize Paths

Informal paths suitable for formalization:

---

Potential path alignments:

---

Recommended surfacing / edging:

---

## MEADOW CONDITION & HABITAT FUNCTION

Flowering abundance:  High  Moderate  Low

Pollinator activity:  High  Moderate  Low

Bird use:  Nesting  Foraging  Minimal

Bare ground exposure:  <5%  5–20%  >20%

Erosion:  None  Minor  Moderate  Severe

Hydrology issues:

---

## MANAGEMENT REVIEW

### Weed Control Actions Completed

Methods used:  Hand removal  Mowing  Herbicide  Solarization

Effectiveness:  High  Moderate  Low

Follow-up needed:

---

### Mowing / Cutting

Timing aligned with ecological goals:  Yes  No

Notes:

---

### Overseeding / Planting Needs

Additional seeding recommended?  Yes  No

Priority species to add:

---

## PHOTOGRAPHIC DOCUMENTATION

Photo points established?  Yes  No

Photos taken this year?  Yes  No

File folder location:

---

## SUMMARY & RECOMMENDATIONS

Overall meadow condition:  Excellent  Good  Fair  Poor

Key successes this year:

---

Priority actions for next 12 months:

---

Additional notes:

---

## Species to Avoid Using in Mid-Atlantic and Northeast Meadows

This list of species should be avoided when designing seed mixes. While it is perfectly “ok” to include these species to provide diversity, color, or botanical interest, you should know that they do not naturally occur in meadows in the Mid-Atlantic and the Northeast, except in very specialized conditions that you likely do not have. Expect each of these species to fade out of your meadow completely within a few years. Some are listed because they are not considered native to the region (e.g., *Echinacea purpurea*) or are too weedy to be safely used (e.g., *Panicum virgatum*). This is not a comprehensive list. Consult with a local ecologist if you need help choosing species native to your area.

<i>Agastache foeniculum</i>	<i>Euthamia caroliniana</i>
<i>Allium cernuum</i>	<i>Gaura biennis</i>
<i>Amorpha canescens</i>	<i>Glyceria canadensis</i>
<i>Amorpha fruticosa</i>	<i>Glyceria striata</i>
<i>Amorpha herbacea</i>	<i>Helenium autumnale</i>
<i>Aquilegia canadensis</i>	<i>Helianthus angustifolius</i>
<i>Asclepias speciosa</i>	<i>Helianthus maximiliani</i>
<i>Aster laevis</i>	<i>Hibiscus moscheutos</i>
<i>Aster lowricanus</i>	<i>Hordeum jubatum</i>
<i>Aster macrophyllus</i>	<i>Iris versicolor</i>
<i>Aster praealtus</i>	<i>Koeleria macrantha</i>
<i>Aster spectabilis</i>	<i>Leersia oryzoides</i>
<i>Astragalus canadensis</i>	<i>Liatris pycnostachya</i>
<i>Baptisia alba</i>	<i>Lupinus perennis</i>
<i>Baptisia albescens</i>	<i>Monarda media</i>
<i>Baptisia australis</i>	<i>Monarda punctata</i>
<i>Baptisia pendula</i>	<i>Panicum virgatum</i>
<i>Blephilia ciliata</i>	<i>Parthenium integrifolium</i>
<i>Bouteloua curtipendula</i>	<i>Penstemon canescens</i>
<i>Carex albolutescens</i>	<i>Phlox drummondii</i>
<i>Carex frankii</i>	<i>Pycnanthemum incanum</i>
<i>Carex lupulina</i>	<i>Ratibida columnaris</i>
<i>Carex shortiana</i>	<i>Ratibida columnifera</i>
<i>Carex stipata</i>	<i>Rudbeckia amplexicaulis</i>
<i>Carex stricta</i>	<i>Rudbeckia fulgida</i> var. <i>speciosa</i>
<i>Chamaecrista fasciculata</i>	<i>Rudbeckia subtomentosa</i>
<i>Chamaecrista nictitans</i>	<i>Scutellaria incana</i>
<i>Chasmanthium latifolium</i>	<i>Silphium asteriscus</i>
<i>Cimicifuga racemosa</i>	<i>Silphium terebinthinaceum</i>
<i>Coreopsis grandiflora</i>	<i>Sisyrinchium angustifolium</i>
<i>Coreopsis lanceolata</i>	<i>Solidago bicolor</i>
<i>Dalea candida</i>	<i>Solidago caesia</i>
<i>Dalea purpurea</i>	<i>Solidago canadensis</i>
<i>Desmanthus illinoensis</i>	<i>Solidago rigida</i>
<i>Echinacea pallida</i>	<i>Sporobolus cryptandrus</i>
<i>Echinacea purpurea</i>	<i>Sporobolus heterolepis</i>
<i>Eupatorium coelestinum</i>	
<i>Eupatorium purpureum</i>	



## **ADDITIONAL REFERENCES**