

Restoring Your Woody-Invaded Prairie to Conservation Prairie



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Cover photo taken at Bluestem Prairie by Justin Meissen.



Restoring Your Woody-Invaded Prairie to “Conservation Prairie”

In this guide, you will learn the basic steps to restoring a degraded prairie invaded by woody species (trees and shrubs) to conservation prairie. The precise restoration actions will depend on the particular features of your site as well as your budget, preferences and project goals.

When planning your restoration, we recommend that you consult with restoration professionals to evaluate your site’s unique characteristics. Please visit nature.org/MNPrairieRestorationGuides for more information on who to contact or other publications that cover site assessment protocols.

What is conservation prairie?

Conservation prairie is designed to closely mimic native prairie using a seed mix that has many different native species adapted to the restoration site. This diversity provides habitat and food for native insects, including pollinators, and wildlife. A wide variety of flowering plants and grasses is also visually interesting to people. Conservation prairie is not suitable for forage production, commercial uses or high-impact recreational activities such as driving ATVs.

Compatible land uses include:

- Carefully managed grazing for habitat goals
- Haying for habitat goals
- Occasional seed harvest
- Low-impact recreational activities, such as hiking, photography, or hunting

Conservation benefits include improved water quality, soil stabilization, and habitat for birds, animals and insects. Conservation prairie can also buffer high-quality native prairies and support threatened and endangered plants and animals that depend on large contiguous areas of grassland.

Why restore woody-invaded prairies?

Prairies that are not burned, grazed or mowed are often invaded by woody trees and shrubs. In Minnesota, the prairie-forest border shifts over time in response to changes in climate and fire frequency. Plentiful moisture and no fire favors woody species. Prairies are commonly invaded by red cedar, sumac, ash, boxelder and Siberian elm. As trees and shrubs take over grassland they create shade conditions more suitable for woody species and less suitable for prairie species. Controlling trees and shrubs in prairies is essential to protect and maintain functioning prairie systems.

For the purposes of this guide, we define a woody-invaded prairie as having a canopy cover of more than 10% trees and shrub thickets, and an understory dominated by native species (>75% cover), although this native understory may be sparse as a result of shading by trees and shrubs¹. Prairies are also often invaded by herbaceous (non-woody) perennial weeds. This guide assumes that woody invasion is the greater threat on a site, but if other invasive species are abundant (greater than 25% cover) they will also require control measures.²

Woody seedlings and saplings may be controlled by herbicide applications and fire, in a manner similar to invasive perennial weeds, but larger trees and dense shrub thickets require mechanical removal. The bare or sparsely-vegetated patches left behind after

¹ Woody-invaded prairies are not the same as oak savannas. Oak savannas have a mature oak canopy and prairie/savanna understory, and are a rare and highly-valued landscape.

² Refer to restoration guide “Restoring your Mixed Native-Invasive Grassland to Conservation Prairie” for more information on selective control of invasive perennial weeds.

woody species removal are vulnerable to invasion by exotic species. Reintroducing prescribed burns will help promote greater biomass production and cover of prairie species. Interseeding may also prevent the encroachment of invasive plants by more quickly filling in the gaps left behind by tree removal.

This guide assumes that your site has moderate to dry soil moisture and has not been drained. Relatively wet fields that have been drained via drainage tiles or ditches are better suited for restoring to wet meadow. This may require additional steps to restore the hydrology³.

What will it involve?

Prairie restoration typically includes these basic steps:

- **Site Assessment**— Identify the site characteristics and define goals for the restoration.
- **Vegetation Removal** – Remove existing weeds and undesired vegetation from the site to prevent aggressive weedy species from out-competing native prairie plants.
- **Seedbed Preparation** – Prepare a seedbed to ensure good seed-soil contact and promote germination of planted seeds.
- **Seeding/Planting** – Select seed mixes and seeding methods that are well suited to the site and project goals. Or, in the case of small sites of less than half an acre, consider hand planting plugs for quicker results⁴.
- **Establishment and Aftercare** – Control weeds and promote the establishment and growth of prairie plants through the first few years after seeding.

- **Long-term Management** – Maintain the health and diversity of native prairie into the future.

How long will it take?

Removal of invasive woody species from a given management unit can be accomplished within a single growing season, depending on the extent of the invasion and resources available. Removal should precede interseeding with native species. The more you invest in weed control up front, the less time and effort you will need to spend controlling weeds in the long term. After the year it's seeded, expect to spend at least three to five years on aftercare to ensure good establishment of the conservation prairie. This period is referred to as the establishment phase of restoration.

After establishment, often after year 5 for conservation prairie, the long-term management phase begins. Management actions are typically less frequent and intensive than during the establishment phase, but are critical for maintaining the health and diversity of the prairie into the future.



Cattle on a conservation prairie near Sheepberry Fen © TNC\Susan Chaplin

³ Refer to the restoration guide “Restoring your Crop Field to Conservation Wet Meadow” for more information on hydrologic restoration.

⁴ Plugs are young plants sold in 4- or 6-packs. Plugs cost substantially more than seed, but they establish rapidly and can produce a resilient and visually appealing meadow more quickly than seeding, so it is often a preferred option for smaller sites.

What will it cost?

The cost of the restoration will be influenced by:

- Management level required to control woody species and other weeds
- Species and number of species selected for the seed mix
- Cost of seed, which fluctuates from year to year
- Labor and equipment available for the project

The cost estimate in this document will give you a baseline for what you can expect to spend through the early establishment phase of your restoration (i.e. through three years after seeding). It may be tempting to cut costs by reducing the number of species planted or the frequency of weed control activities. Be aware that these investments on the front end can actually save costs in the long run. A healthy and diverse prairie will be more resilient to disturbance, invasion by exotic species, and extreme weather events such as drought.



Cedar invaded prairie near Ordway
Prairie Preserve ©TNC\Steve Chaplin

Woody-Invaded Prairie to Conservation Prairie Restoration Guidelines

Site assessment

A successful prairie restoration is highly dependent on specific characteristics of a site. Important considerations when planning a restoration include:

- Has the site had herbicide treatments that would prohibit seed from germinating?
- Is there a risk of herbicide drift from neighboring cropfields?
- Are the soils dry, moderate or wet?
- Are there steep slopes that may be vulnerable to erosion?
- What types of vegetation are currently present on the site?

If you are new to prairie restoration, we strongly encourage enlisting someone who has restoration experience to help you assess the characteristics of the site and develop a restoration plan suited to your site's specific features and your project goals.

Vegetation removal

Woody-invaded prairies typically require a combination of mechanical removal, selective herbicide treatments and prescribed fire to control invasive trees and shrubs, and prepare the site for interseeding native prairie species. Tree seedlings and smaller saplings (diameter <math>< \frac{1}{2}</math> in.) can often be managed by reintroducing controlled burns, but larger trees require mechanical removal. In most cases, chemical stump treatment is also needed to prevent resprouting.

Equipment options include brush hogs, slashers, brush cutters and chain saws. The most efficient and effective methods of tree and shrub removal will depend on the species, size, density and spatial pattern of the targeted species. Degraded prairies that are invaded by trees and shrubs will often also have some herbaceous invasive perennials and other weed problems as well. If invasion is minimal (as we will assume for this restoration plan), they may also be controlled effectively with prescribed fire. However, if invasive perennials are vigorous and spreading, they may require selective herbicide treatments⁵.



Native remnants should be divided into multiple management units in order to preserve local habitat for resident wildlife. Ideally, not more than one third of the site will be burned in a given season. For a given management unit, woody removal and site preparation can be carried out in a single season prior to interseeding conservation prairie.

Recommended protocol:

- Cut dense brush thickets that are unlikely to be controlled by fire alone.
- Cut trees more than 1 inch in diameter with chainsaws or slashers.

⁵ Refer to restoration guide "Restoring your Degraded Grassland to Conservation Prairie" for more information on selective control of invasive perennial weeds.

- Treat stumps with appropriate herbicide, e.g. Triclopyr (Garlon 4), Picloram (Tordon), and glyphosate (Roundup).
 - Exception: red cedar does not resprout, so stump treatment is not needed.
- Haul and pile woody slash using tractor-mounted skid steers or grapple attachments.
- If woody invasion is more extensive, slash should be piled and burned, or chipped in a woodchipper and removed.
 - If woody cover is relatively low (<10%), slash may be distributed and left to rot or burn during a prescribed fire.
- Invading stands of clonal species, such as aspen, may be controlled more gradually by girdling.
- Divide remnant into multiple burn units in order to preserve local habitat for resident wildlife. Avoid burning more than ½ of the site in any one season. Burn unit to kill woody seedlings and remove thatch in the fall or spring prior to seeding.
- Cropping and disking are not recommended for woody-invaded prairies and native remnants.

Seedbed preparations

Minimal seedbed preparation is recommended when interseeding into existing vegetation. This will avoid disturbing established natives, and bringing additional weed seeds and rhizomes to the soil surface. If adding species to low-diversity planted prairies, selective disking or tilling (i.e. in nodes or strips covering 25-50% of the site) is sometimes used to reduce competition from established natives. If invasive species are common on site, this approach should be used with caution. Native remnants (unplowed prairie) should never be tilled or disked. Instead, seeds should be broadcast directly into established vegetation following a burn.

Recommended protocol:

- Forgo seedbed preparations to minimize soil disturbance and reinvasion.
- Burn prior to seeding to remove thatch (see vegetation removal).

Seeding

The key to establishing a successful prairie is to maximize seed to soil contact during planting. Upland prairies can be interseeded either using a no-till drill or broadcast using a spreader mounted to a tractor or ATV. Broadcast seeding is recommended for interseeding conservation prairies, because it avoids disturbing the soil and it favors forb (flowering plant) species, which contribute much of the diversity and value in a conservation prairie. Broadcasting also allows access into difficult site conditions, such as rocky or uneven soils, and allows for the use of raw, uncleaned seeds, which can be helpful when using wild-harvested seed. Drilling into an untilled prairie can disturb the soil conditions and be hard on the drill. The use of no-till drills on remnant prairies should be limited to large, low-diversity sites with few remaining native species.

Seeding prairie remnants should be undertaken with caution to avoid negatively impacting remnant vegetation, soil communities and wildlife. Seed mixes should be tailored specifically to the site to avoid introducing aggressive species that may outcompete existing vegetation. In general, species already present on site should not be planted unless the seed is harvested on site. Whenever possible, locally-harvested seed should be used, and species selection should be based on historical records and/or reference sites. If purchasing pre-designed seed mixes, consider the following modifications:

- Species already present on the site, or not appropriate for the site, should be eliminated from the mix.
- Relative rates of conservative to common species will be increased.
- Locally-harvested seeds will be prioritized over commercially-produced seed.



Native seed mixes should be planted with equipment designed to handle different-sized seeds ©Justin Meissen.

If broadcasting seed, native-seed broadcasters such as a Vicon seeder should be used. They are designed to spread mixes with different sized seeds. If planting with a drill, use a seed drill designed specifically to plant prairie grasses and flowers.

Recommended protocol:

- How to seed:
 - Broadcast seeds into existing vegetation using an agitating spreader such as a Vicon seeder mounted to a tractor or ATV. Or plant by hand if selectively seeding small patches.
 - Incorporate the seeds into the soil with a light drag, such as a piece of chain link fence, or packer pulled behind the tractor/ATV while broadcasting.
 - Note: If frost or snow seeding, late fall through early spring, or ash seeding, sowing into ash immediately following a burn, mechanical incorporation may not be needed. Freeze-thaw, snowmelt and rainfall action may naturally incorporate seeds into the soil.
 - An alternative seeding method is to drill seeds into existing vegetation with no-

till drill such as a Truax following a burn or mowing/haying to remove thatch.

- When to seed:
 - Planting dates will vary depending on the weather and location within the state. Consult with native seed suppliers or restoration specialists to determine the best planting dates for the year.
 - Growing season plantings should occur May 1 to July 1 OR when the soil temperature is at least 60 degrees F⁶. Spring/early summer seeding promotes warm season grasses.
 - Dormant seeding should occur Dec. 1 to April 30 OR after soil temperatures fall below 50 degrees F for a consistent period of time⁷. When possible, timing the seeding before a snowfall may help prevent loss of seed that is consumed by wildlife over the winter months. Dormant seeding in late fall, also known as frost seeding, can be done with a seed drill or until the ground is frozen. Seed can also be broadcast over snow in winter/early spring, although results of snow seeding are more variable and dependent on weather conditions. Dormant seeding promotes cool season grasses and flowering plants.

⁶ Summer seeding after July 1 leads to poor seedling survival and is not recommended for prairies.

⁷ Early fall seeding is not recommended for prairies, because seed may germinate too early and not survive over winter.

- Seed mixes will vary but should take into account:
 - Consider soil moisture conditions of the site.
 - Include species that provide habitat value for wildlife and insects, including mixed-height grasses and a diversity of flowering plants.
 - Select a mix of both warm- and cool-season species and species that bloom in spring, summer, and early fall to encourage resilience to disturbances and ensure year-round habitat resources and visual interest⁸.
 - Cover/nurse crops are not recommended for interseeding.
- Design:
 - If the site has either dry or mesic soils throughout, sow a single seed mix evenly across the site.
 - If soil moisture varies across the site, apply separate seed mixes suited to the different soil moisture conditions. For example:
 - Sow a dry conservation prairie mix onto dry ridge tops.
 - Sow a mesic mix into areas of more moderate soil moisture.
 - If there are wet to wet-mesic soils on the site, select a wet prairie or meadow seed mix for these seeding zones⁹.
- Seed rate:
 - Plant at a minimum of 40 seeds/sq. foot to reduce risk of weed invasion.
 - If there is minimal weed pressure and excellent site preparation, the rate can be reduced to 30 seeds/sq. foot.
 - Increase rate to 50 seeds/sq. foot on steep slopes (3:1 grade).
 - Seeding rates may need to be increased by 25% for dormant seedings to account for lower germination rates and loss of seed to wildlife.
- Conservative seeding option (for native remnants): seed remnants in two phases:
 - 1) Sow only seeds collected on site, in conjunction with management to encourage recovery of existing vegetation (e.g. prescribed fire). Monitor vegetation response to determine additional seeding needs.
 - 2) Add new species using local-ecotype seed, either from a nearby reference site or locally-sourced nursery seed.

Post-seeding aftercare and long-term management

Establishment of interseeded prairie species, particularly conservative forbs, may take at least 5-7 years. However, this will vary depending on competitive pressure, soil moisture and climate conditions. Early management (aftercare) is critical to reduce competition from existing vegetation and prevent re-invasion of woody species and invasive perennial weeds.

Maintaining control of reinvading trees and shrubs and other weeds is the primary management concern in interseeded prairie restorations. However, existing prairie vegetation should also be carefully managed to promote rapid establishment of planted natives.

Post-seeding aftercare goals include discouraging weeds and encouraging rapid and robust establishment of native species. The restoration site should be divided into management units for burning on a rotational basis to maintain diversity and wildlife refuges.

⁸ See [nature.org/MNPrairieRestorationGuides](https://www.nature.org/MNPrairieRestorationGuides)] for more information on seed mix design and examples of conservation prairie seed mixes for different regions and soil moisture.

⁹ See [nature.org/MNPrairieRestorationGuides](https://www.nature.org/MNPrairieRestorationGuides) for examples of conservation meadow seed mixes appropriate for wetter soils.



Prescribed fire is an important tool in maintaining a conservation prairie ©Chris Helzer/TNC

Management strategies during the establishment phase include:

- Mowing or haying to reduce competition
- Selective use of herbicide to control invasive perennials
- Prescribed fire to promote native prairie species and discourage further invasion
- Monitoring vegetation to evaluate establishment of prairie seedlings

Throughout the establishment phase and beyond, adjust management plans as necessary, including the option to reseed, to achieve the desired species composition and diversity.

Recommended management protocol:

Year 1:

- When vegetation reaches a height of 12-18 inches, selectively mow to a height of 4-6 inches to reduce competition from established natives and minimize thatch build-up. Most newly planted prairie plants will not reach this height in first year and will not be damaged by a mower. The frequency of mowing will depend on the height and density of weeds and how much they are competing with the prairie seedlings for light and moisture.
 - Optional: Mow in strips or patches not exceeding 25-50% of site.

- If conservative species are present on site, protect from mowing or forgo mowing treatments entirely and expect lower and slower establishment of interseeded species.
- If resprouting woody trees and brush are too dense to control via mowing, spot-control with brush cutters or cut-stump treatments.

Year 2:

- Locate and spot-control woody species as needed.

Years 3-5:

- Begin prescribed burns after three growing seasons or as soon as biomass accumulation is sufficient to carry a burn.
- Rotate burns in management units, burning no more than one third of site (one half for small sites) at a time to maintain diversity and a local refuge for wildlife.
- Burn at an interval of every 3-5 years. If desired, burn each management unit more frequently (every 1-2 years) through the initial establishment phase in order to promote rapid establishment of prairie plants.
- Spot-control woody species as needed. When using herbicide, use dormant season applications and/or back-pack sprayer/wick applicator to minimize damage to native species.
- Conduct stand evaluation to assess seedling establishment outcomes. If native plant

density is less than 1 plant per square foot, interseed to increase cover and diversity.

Year 6 & beyond (long-term management phase):

- Burn every 3-5 years to stimulate productivity of native prairie plants and prevent invasion of herbaceous perennial weeds and woody trees and shrubs.
 - Continue to burn in rotations, up to one third of site per season.
 - Adjust seasonality of burning to maximize diversity. For example, alternate between spring and fall burns on individual management units.
 - If conservation grazing is used, graze in rotations at low to moderate intensities, or at stocking rates prescribed by a grazing management plan written to meet the objectives of the conservation prairie. Avoid grazing in saturated conditions.
 - Every 1 to 3 years, monitor vegetation composition and diversity.
- Interseed as needed to increase native cover and diversity if native species are declining.
 - Adjust management plan, such as frequency and intensity of burning or grazing, if:
 - cover of native species is declining
 - desired composition is not being maintained
 - cover of invasive species or undesired woody species is increasing
 - Spot-treat weeds as needed by hand-pulling, back-pack sprayer, wick-applicator or dormant-season application.
 - Temporarily increase burn frequency, such as annual burns for 2 years, if woody invasions increase in cover. Note that sustained burn intervals of less than 3 years will negatively impact cool-season natives and wildlife.



Restored conservation prairie at Eden Valley WPA
©USFWS Beverly Meyer

Cost estimate

The estimated cost to restore woody-invaded prairie to conservation prairie is \$2,205 per acre, based on 2013 prices. Costs associated with site assessment and project planning are excluded from this estimate. This cost estimate assumes vegetation removal includes cutting trees and shrubs, piling and burning the slash and conducting one controlled burn on each of two management units. The estimate also assumes the site is broadcast-seeded and cultipacked.

Post-seeding management costs include aftercare activities through year 3, specifically: 10 mowing treatments, one selective herbicide treatment (spot-spray) of invading exotic perennials and/or woody resprouts that are not effectively controlled by fire, and three controlled burns (one on each management unit, burning no more than one third of the site per season).

Actual project costs will be lower if a less-frequent mowing schedule is required. Long-term management costs are not included in this cost estimate but can be quite variable depending on site needs. Costs assume services and seed are purchased from restoration contractors and native seed nurseries.



Pollinator populations can benefit from prairie restoration © TNC\Sue Chaplin

Useful references

Going Native: A prairie restoration handbook for MN Landowners – MN Dept. of Natural Resources
<http://files.dnr.state.mn.us/assistance/backyard/prairierestoration/goingnative.pdf>

Guidelines for inter-seeding to restore or enhance native species diversity – Minnesota Board of Water and Soil Resources
www.bwsr.state.mn.us/native_vegetation/inter-seeding.pdf

Invasive Plant Species Management & Identification – MN Dept. of Natural Resources
www.dnr.state.mn.us/invasives/terrestrialplants

Native Vegetation / Seed Mixes – MN Board of Water & Soil Resources
www.bwsr.state.mn.us/native_vegetation

Prairie Management: Woody Species Control [Video] – Tallgrass Prairie Center
www.youtube.com/watch?v=Tk_46D46Dg

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The Tallgrass Restoration Handbook for Prairies, Savannas, and Woodlands. S. Packard and C. F. Mutel, editors. 2007. Island Press, Washington, D.C.