



**Restoring Your
Degraded Grassland
to Utility Meadow**

The author of this Restoration Guide is Laura Phillips-Mao, University of Minnesota. Steve Chaplin, MN/ND/SD Chapter of The Nature Conservancy, administered the project and helped with production. Marybeth Block, Minnesota Department of Natural Resources, provided review and editorial comments. Susan Galatowitsch, University of Minnesota, contributed to an earlier version of this guide.

©The Nature Conservancy January 1, 2017

Funding for the development of this restoration guide was provided by the Minnesota Environment and Natural Resources Trust Fund as recommended by the Legislative-Citizen Commission on Minnesota Resources (LCCMR) through grant LCCMR092C. The Trust Fund is a permanent fund constitutionally established by the citizens of Minnesota to assist in the protection, conservation, preservation, and enhancement of the state's air, water, land, fish, wildlife, and other natural resources. Currently 40% of net Minnesota State Lottery proceeds are dedicated to building the Trust Fund and ensuring future benefits for Minnesota's environment and natural resources.

Additional funding for the update and redesign of the guide was provided by a Working Lands Initiative grant from the Minnesota Department of Natural Resources.

Cover photo taken at Pankratz Prairie by Justin Meissen.



Restoring Your Degraded Grassland to “Utility Meadow”

In this guide, you will learn the basic steps to restore a degraded grassland of native and invasive species to a utility meadow. 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 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 utility meadow?

Utility meadow is a wet grassland designed to maximize production and palatability for forage, while still supporting basic conservation goals. It occurs on poorly-drained, wet to moderately wet soils that are saturated up to 8 weeks following snowmelt and are prone to temporary ponding after large rainfall events. Utility meadow often occurs in a transition zone between emergent marsh and upland prairie and may be either sedge-dominated (“sedge meadow”) or grass-dominated (“wet prairie”) depending on the duration of soil saturation. Utility meadow is distinguished from conventional hay fields and pasture by its emphasis on native species and greater diversity.

Compatible land uses include:

- Conservation grazing using cattle or bison¹
- Hay production
- Commercial seed harvest
- Recreational activities such as hunting

Conservation benefits include improved water quality, flood control, and habitat for birds, animals and insects. Utility meadow can also serve as a buffer for other high-quality native meadows and prairies and support threatened and endangered plants and animals that depend on large contiguous areas of grassland.

Why restore degraded grasslands?

Grasslands that have a combination of both desired native species and invasive perennial weeds may be restored to reduce the coverage of invasive species and promote the health of the native meadow community. These sites include:

- Degraded meadow remnants that have never been plowed and have original prairie vegetation
- Low-diversity meadow plantings that have become invaded
- Meadows that were over-seeded with exotic perennials for pasture

The challenge of restoring these sites is to reduce the cover of invasive species while retaining the existing native species and increasing their abundance and diversity.

Reed canary grass is particularly common on wet sites and may require multiple years of repeated treatments to control. Invasive woody species may also be present and require additional removal strategies². Selective vegetation control measures are used to reduce the cover of invasive species while avoiding

¹ Very wet sites are vulnerable to damage by trampling and are dominated by sedges, which are not preferred forage for cattle. Moderately wet sites, which are dominated by grasses and have a shorter duration of seasonal ponding, will generally be more suitable for grazing.

² If invasive trees and shrubs are present on site, refer to the restoration guide “Restoring your Woody-Invaded Meadow to Utility Meadow” for information on controlling woody species.

damage to the natives present. This is particularly important on native remnants, where preserving original meadow vegetation is of paramount importance.

To enhance existing vegetation and increase native cover and diversity, meadow species are sown into the existing vegetation as opposed to into a prepared seedbed. This planting strategy is referred to as “interseeding” or “overseeding”. Special considerations must be made to species selection to avoid harming existing natives.

As a general guideline, consider using selective vegetation control measures on sites that have 25-75% of native meadow species and 25-75% invasive perennials and other undesired species. If any rare or threatened species are present on a site, selective measures should be used to preserve them. If the existing native species have been planted, are of particularly poor quality, or are of questionable origin (e.g. cultivars, or southern ecotypes), the site may be treated as an invasive-dominated prairie and non-selective methods of control may be more effective³.

Additionally, if the site has been drained with drainage tiles or ditches, restoring hydrology by breaking tiles, plugging ditches, and—in some cases—installing water control devices, will be required. This guide assumes that your site is wet to moderately wet and has been drained via tiles or ditches⁴. Sites that have not been drained will not require the additional steps to restore the hydrology.

What will it involve?

Meadow 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 meadow 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 results⁵.
- **Hydrologic Restoration** – Remove drainage features by breaking tile or plugging ditches to restore the site’s original soil moisture and seasonal flooding patterns.
- **Establishment & Aftercare** – Control weeds and promote the establishment and growth of meadow plants through the first few years after seeding.
- **Long-term Management** – Maintain the health and diversity of native meadow into the future.

³ Refer to the restoration guide “Restoring your Invasive Perennial-Dominated Grassland to Utility Meadow” for more information on removing invasive species with non-selective control measures.

⁴ For sites with moderate to dry soil moisture, refer to the restoration guide “Restoring your Degraded Grassland to Utility Prairie”.

⁵ 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.

How long will it take?

On a degraded grassland, the initial site preparation typically requires a full calendar year prior to seeding. After the year it's seeded, expect to spend at least three years on aftercare to ensure good establishment of the utility meadow. This period is referred to as the establishment phase of restoration.

After establishment, often around year 4, 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 meadow into the future.

What will it cost?

The cost of the restoration will be influenced by:

- Management level required to control weeds

- Species and number of species selected for the seed mix
- Cost of seed, which fluctuates from year to year
- Hydrologic factors, such as drainage type, size and depth; soil type and sediment deposits; and whether management of wetland discharge is required
- 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 initial 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 meadow will be more resilient to disturbance, invasion by exotic species, and extreme weather events such as drought.



Degraded meadow near Bluestem Prairie
© TNC\Steve Chaplin

Degraded Grassland to Utility Meadow Restoration Guidelines

Site assessment

A successful meadow 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?
- How long are the soils saturated in the spring?
- Has the site been drained with drainage tiles or ditches?
- Is there a substantial buildup of sediments on site that may require excavation?
- 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 meadow 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

Invasive perennials, such as reed canary grass, can out-compete native wet meadow species. Reed canary grass can continue germinating from the seed bank for 10 years or more, at densities that can rapidly overwhelm planted native vegetation. Restoration of wet prairie and sedge meadow communities almost always involves control and prevention of reed canary grass invasion.

When restoring degraded grasslands, the primary challenge of vegetation removal is to control aggressive invasive perennials with minimal harm to the existing native vegetation. If the native vegetation includes only a few very competitive native species, it may also be important to reduce these species to allow new species to grow and increase the site's diversity.

A carefully timed "spray-burn-spray" approach using glyphosate (Roundup if the site is dry; or aquatic-approved Rodeo if standing water is present) is an effective strategy for controlling reed canary grass and other invasive perennials. Timing is critical—herbicide should be applied in the fall (September) when reed canary grass is still physiologically active in order to affect mature plants and regrowth from rhizomes. Burning and mowing increase light availability and stimulate reed canary grass germination, so they should be followed with a late spring/summer herbicide application to kill emerging seedlings.

A minimum of one full year (fall through fall) of invasion control is recommended prior to seeding utility meadow. Wet meadow restoration requires a certain amount of flexibility, as wet site conditions may preclude necessary management actions in any given year. When possible, it is preferable to delay seeding to allow for the full sequence of reed canary grass control rather than seed with incomplete management.

Recommended protocol:

Year 1:

- Selectively apply glyphosate to reed canary grass in the fall. September is optimal.
 - To minimize damage to natives, herbicide can be "spot-sprayed" into larger patches using ATV-mounted sprayers, applied to smaller patches

with backpack sprayers, or applied with a wicking device to individual plants.

- If standing water is present, use an aquatic-approved formula, such as Rodeo.
- Mark reed canary grass patches for easy relocation during post-seeding management.

Year 2:

- Spring burn to stimulate reed canary grass seed germination.
 - Note: if site is likely to be too wet for a spring burn, burn in fall of year 1 instead.
- Selectively apply second glyphosate application to kill emerging weed seedlings in late spring/early summer.
- Fall: assess re-emergence of reed canary grass from rhizomes. If control is adequate, mow or burn to remove thatch and prepare to seed. Otherwise, repeat spray-burn-spray sequence and seed in Year 3.
- Wait at least 2 weeks following last herbicide application to seed.

Additional notes:

- If invasive woody species are present, saplings less than ½ inch in diameter can be herbicide-treated along with invasive perennials, but larger trees will require mechanical removal⁶.
- Cropping and disking are not recommended for degraded grasslands, especially if the site is remnant (unplowed) meadow. Avoid soil disturbance.

Seedbed preparations

Minimal seedbed preparation is recommended when interseeding into existing vegetation. This helps avoid disturbing the native species on site and bringing additional weed seeds and rhizomes to the soil surface. If invasive species

are minimal and the site is dominated by a few highly competitive native species, selective disking or tilling (for example, in patches or strips covering 25-50% of the site) is sometimes used to reduce competition from existing natives and create openings for seedling establishment. However, if a diversity of native species is present, we recommend avoiding soil disturbance and instead broadcasting seed into newly burned ground after a fall burn. Native remnants (unplowed meadow) should never be tilled or disked.

Recommended protocol:

- Forgo site preparation to minimize soil disturbance and subsequent reinvasion. Dormant seeding or ash seeding may help incorporate seeds into soil.
- Burn prior to seeding to remove thatch (see vegetation removal).

Seeding

The key to establishing a successful meadow is to maximize seed-to-soil contact during planting.

Broadcast seeding with a spreader mounted to a tractor or ATV is recommended for interseeding meadows, because wet soils often cannot support heavy machinery such as seed drills, and many wet meadow species have very small, light-sensitive seeds that can be buried too deeply by a seed drill. Broadcasting also allows access into difficult site conditions, such as rocky or uneven soils, while drilling into an untilled site can disturb the soil conditions and be hard on the drill. However, if the seedbed is dry and firm, grasses may be seeded with a no-till drill, followed by broadcasting forbs (flowering plants) and sedges. The use of no-till drills on remnant meadows should be limited to large, low-diversity sites with few remaining native species.

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

⁶ Refer to the restoration guide "Restoring your Woody-invaded Meadow to Utility Meadow" for more information on controlling invasive trees and shrubs.



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

drill designed specifically to plant prairie grasses and flowers. In some cases, the wettest areas may need to be hand-seeded.

If the site is remnant (unplowed) prairie, seeding should be undertaken with caution to avoid negatively impacting remnant vegetation, soil communities and wildlife. Seed mixes should exclude aggressive species that may outcompete existing vegetation, and 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.

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, following a fall burn or mow to remove thatch. 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.

- Alternative seeding method: If seedbed is dry and firm, drill grass seeds directly into existing vegetation using a no-till drill such as a Truax. Additional mechanical incorporation or packing is not required when using a no-till drill. Broadcast forb and sedge seed.
- For areas that are too wet for a tractor or ATV, a second alternative seeding method is to broadcast seed by hand.
- 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.
 - Dormant seeding is recommended for meadows, because the ground is more likely to be dry and firm in the late fall and early winter⁷. Dormant seeding should occur Dec. 1 to April 1 OR after soil temperatures fall below 50 degrees F for a consistent period of time.

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

Dormant seeding before the ground is frozen, sometimes called “frost seeding”, can be done with a seed drill or by broadcasting. When possible, timing the seeding before a snowfall may help prevent seed loss to birds and wildlife. After the ground is frozen in winter/early spring, seed can also be broadcast over snow, although results of snow seeding are more variable and dependent on weather conditions. Dormant seeding promotes cool season grasses, sedges and flowering plants. Spring and growing season plantings (April 1 – July 1) are not typically recommended for wet meadows because the soils are often too saturated to support equipment, spring flooding may wash seeds away, and overwintering is necessary to trigger germination in many wetland sedges and flowering plants. However, when conditions allow, growing season seeding can yield satisfactory results, particularly for wetland grasses⁸.

- Seed mixes will vary but should take into account:
 - Consider soil moisture conditions of the site.
 - Choose palatable species that can tolerate grazing or haying.
 - Select a mix of both warm- and cool-season species to ensure availability of forage throughout the season⁹.
 - Cover/nurse crops are not recommended for interseeding.
- Design:
 - Apply seed mixes to “seeding zones” on site based on soil moisture conditions and hydrology; for example: seed a wet prairie mix into areas that are saturated 3-4 weeks annually, and a sedge

meadow mix into areas that are saturated 6-8 weeks annually.

- If there are dry to moderately moist soils on the site, select a separate utility prairie seed mix for these seeding zones¹⁰.
- Seed rate:
 - Plant at a minimum of 160 seeds/sq. foot to reduce risk of weed invasion.
 - Seeding rates may need to be increased by 25% for dormant seedings to account for lower germination rates and loss of seed to wildlife.

Hydrologic restoration

Nearly all wet meadow sites in western Minnesota have been impacted by altered hydrology. Restoring hydrology by removing drainage features is a critical component of wet meadow restoration. When planning a meadow restoration, take note of the following recommendations and refer to the [Minnesota Wetland Restoration Guide](#) (BWSR) or [Restoring Prairie Wetlands: an ecological approach](#) (Galatowitsch and van der Valk 1994) for additional information. For further guidance on evaluating and implementing the engineering aspects of hydrologic restoration, consult with experienced restoration professionals or local Soil and Water Conservation District representatives (www.maswcd.org).

Recommended protocol:

- Use a backhoe to break drainage tiles and/or plug drainage ditches.
- Break tile in strategic locations, for example: at the wetland’s outlet (it is usually not necessary to remove the entire length of tile).

⁸ Summer seeding after July 1 leads to poor seedling survival and is not recommended for wet meadows.

⁹ See nature.org/MNPrairieRestorationGuides for more information on seed mix design and examples of utility meadow seed mixes.

¹⁰ See nature.org/MNPrairieRestorationGuides for examples of utility prairie seed mixes appropriate for dry to moderately moist soils.



Breaking drainage tile often requires heavy equipment
©MN BWSR

- Hydrologic restoration should be implemented after vegetation removal. After the site is flooded, access will be limited and herbicide options are restricted to aquatic-approved formulas such as Rodeo.
- Time hydrologic restoration to occur in the fall or early winter in close conjunction with seeding, preferably 1-2 weeks following seeding (after flooding, site access will be limited).
- Reserve a small amount of seed to hand-broadcast over areas disturbed by backhoe operations.
- If transplanting live plant material or plugs, this can be done in the late spring following hydrologic restoration.

Post-seeding aftercare and long-term management

Interseeded utility meadow establishment generally takes 3 to 5 years, but will vary depending on soil moisture and climate conditions. Early management (aftercare) is critical to prevent perennial weeds, particularly reed canary grass, and woody species from re-invading and displacing establishing meadow species.

Maintaining control of invasive perennials is the primary management concern in interseeded meadow restorations. When necessary,

existing native vegetation should also be carefully managed to promote rapid establishment of planted natives. However, saturated conditions may limit management options, preventing access by heavy equipment.

Post-seeding aftercare goals include discouraging weeds and encouraging rapid and robust establishment of native species that can sustain grazing, haying and other uses. Management strategies during the establishment phase include:

- Selective mowing or haying to reduce competition
- Selective use of appropriately-timed aquatic-approved herbicide to control reed canary grass and other invasive perennials
- Prescribed fire to promote native meadow species and discourage further invasion, particularly in wet prairie zones
- Monitoring vegetation to evaluate establishment of meadow seedlings and detect invasive species problems. This is particularly important in wet sites, because site conditions may prevent management in some years.

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:

- Spot-spray reed canary grass in September using aquatic-approved glyphosate, such as Rodeo, using methods that will minimize damage to native seedlings. For example, use a backpack sprayer or wick applicator and avoid windy days to minimize drift.
- Flag and/or map any new patches of invasive perennial weeds for future control.



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

- Optional: Spot-mow to reduce native competition ONLY if possible to avoid reed canary grass patches, and as site conditions allow.
 - When site is dry and firm enough, usually early to mid-summer, 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.
 - Avoid mowing reed canary grass except to prevent going to seed; mowing may reduce effectiveness of herbicide and stimulate seed germination.
 - Note: if mowing is not possible, establishment of planted seedlings may be slower.

Year 2:

- Spot-spray reed canary grass in September using methods that will minimize damage to native meadow species.

Year 3:

- Begin prescribed burns after three growing seasons, or as soon as biomass accumulation is sufficient to carry a burn.
- Begin grazing or haying after three growing seasons, or when native grasses and sedges have achieved dominance.

- Spot-treat reed canary grass (in September) and other weeds as necessary with aquatic-approved herbicide.
- Conduct a 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.
 - Note: if mowing was not done in year 1, establishment rates may be slower. After stand evaluation, postpone burning, haying and grazing until year 5 if necessary.

Year 4 & beyond (long-term management phase):

- Burn every 4-7 years to stimulate productivity of native meadow plants (particularly in the wet prairie zone) and prevent invasion of perennial weeds and woody trees and shrubs.
 - Note: burning more frequently may negatively impact sedges.
- Burn and hay in rotations, disturbing no more than one half of a field at a given time, to maintain diversity and a local refuge for wildlife.
- Graze at low to moderate intensities, or at stocking rates prescribed by a grazing management plan written to meet the objectives of the utility prairie. Avoid grazing in saturated conditions.

- Time burning, haying and grazing to allow sufficient biomass accumulation for each activity, for example: an alternating biennial rotation of grazing and haying with a 4-7 year burn rotation.
- Hay in late July or August to promote diversity and avoid grassland bird nesting season. Leave 6-8 inch stubble and regrowth for winter cover/spring nesting habitat.
- Adjust timing and intensity of burning, grazing and haying to maximize diversity and adjust species composition.
 - Grazing in late spring or early summer will favor warm season grasses.
 - Mid-late summer grazing will favor cool season grasses.
- 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, haying, or grazing, if:
 - cover of native species is declining
 - desired composition is not being maintained
 - cover of invasive species is increasing
 - Spot-treat reed canary grass and other weeds as needed by hand-pulling, backpack sprayer, wick-applicator or dormant-season application. Note that reed canary grass may continue to emerge from the seed bank for 10 years!
 - Temporarily increase burn frequency if woody invasions increase in cover. Note that sustained burn intervals of less than 3 years will negatively impact cool-season natives and wildlife.



Cost estimate

The estimated cost to restore a degraded grassland to utility meadow in Minnesota is \$1,517 per acre plus a \$700 flat rate, for a minimum total of \$2,217, based on 2013 prices. Costs associated with site assessment and project planning are excluded from this estimate.

This cost estimate assumes vegetation removal includes:

- one round of mowing
- two selective herbicide applications (spot-treatment)
- one prescribed burn (whole site)

This cost estimate also assumes the site is broadcast seeded and cultipacked. The \$700 flat rate is a low-end estimate of hydrologic restoration (e.g. tile removal) that assumes a modest mobilization fee and includes the costs to excavate, remove tile, seal the ends, and backfill and compact the trench.

Post-seeding management costs include aftercare activities through year 3, specifically: selectively mowing four times, spot-spraying re-invading perennial weeds three times, and conducting two prescribed burns (burning no more than one half 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.



Native flowers attractive to pollinators can be part of meadow restorations ©TNC/Susan Chaplin

Useful references

Going Native: A prairie restoration handbook for MN Landowners – MN Dept. of Natural Resources

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

Minnesota Noxious Weeds – MN Dept. of Transportation

www.dot.state.mn.us/roadsides/vegetation/pdf/noxiousweeds.pdf

Minnesota Wetland Restoration Guide – MN Board of Water & Soil Resources

www.bwsr.state.mn.us/restoration

Native Vegetation / Seed Mixes – MN Board of Water & Soil Resources

www.bwsr.state.mn.us/native_vegetation

Planting and Maintenance Recommendations for Wetland Restoration and Buffer Projects – MN Board of Water and Soil Resources.

www.bwsr.state.mn.us/native_vegetation/planting-maintenance-recs.pdf

Prairie Seedling and Seeding Evaluation. Bockenstedt, P. 2006. Bonestroo Rosene Anderlik & Associates.

Restoring Prairie Wetlands: An Ecological Approach. Galatowitsch, S. M. and A. G. van der Valk. 1994. Iowa State University Press.

The Tallgrass Prairie Center Guide to Prairie Restoration in the Upper Midwest. Smith, D. 2010. University of Iowa Press, Iowa City, IA.

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