# Pollinator Habitat Conservation Activity Plan for Boulder County, Colorado

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## Contents

# Conservation Plan Summary

Boulder County's overall goal for this conservation plan is to conserve pollinators in general for all of the benefits they provide and to serve as a model for conserving/enhancing pollinator habitat on farms in the area

Key conservation practices recommended in this plan:

1. Diverse perennial native flowers are a primary pollinator habitat deficiency on the farm, and should be addressed by incorporating perennial habitat composed of native flowers and grasses. Temporary flowering habitat, such as insectary plantings, could also be incorporated.

2. The current deficiency in an abundance and diversity of nesting sites for cavity-nesting bees on the farm could be addressed by planting a variety of early-blooming, native flowering shrubs (either in a hedgerow/windbreak, or dispersed). Such plantings would also increase the abundance of very early spring-blooming plants on the farm, which provide critical resources for natural enemies such as adult lady beetles and pollinators like bumble bees, honey bees, and early flying solitary bees.

3. Take steps to reduce direct pesticide impacts to pollinators and predatory and parasitoid beneficial insects and to avoid contamination of habitat.

# Part One: Property Location and Background

The information in this conservation plan was developed in the context of the Ertl Farm, located on the SE corner of Highway 287 and Oxford Road, 7042 N 107th St, Longmont, CO 80504 (Figure 1; GPS coordinates: 40.1095158, -105.0972175). This plan is also intended to serve as a template for other farms in Boulder County, and to that end we provide specific guidance for the Ertl Farm in this document, as well as general guidance that can be applied to other farms in the region.

Boulder County recognizes the importance of good land stewardship and strives to use sustainable management practices. The County would like to expand efforts by incorporating additional conservation practices on the property, including habitat improvements and management strategies that will better support pollinators, beneficial insects, and other wildlife.

**Figure 1. Landscape Map of Ertl Farm**


## Farm Background and History

Ertl Farm is a family farm near Longmont, CO, operated by Keith Bateman since 2015. The farm is approximately 400 acres, including acres in silage corn, alfalfa, wheat, mixed alfalfa and grass, and pasture. A portion of the farm, currently planted to alfalfa, is transitioning to organic. There are numerous roads and outbuildings on the property associated with oil and natural gas extraction. The land has been under production for over 100 years, and has been a diversified

crop operation since the early years. At various times, the operation included swine, cattle finishing, and dairy. Past crops included barley and sugarbeets.

The farm is located within a landscape that includes pasture, irrigated and dryland cropland, residential properties, and some natural areas.

## Pollination Needs

Ertl's current crop production is not dependent on pollinators; the majority of the crops currently grown on Ertl are wind pollinated. Corn, for example, is a wind-pollinated plant, and while some species of bees will visit corn to collect pollen if other resources are scarce, bees do not contribute to the transfer of pollen or to seed production. Insect pollinators, particularly bees, are important for seed production of alfalfa, but pollinators play no direct role in hay production.

Crops grown in Boulder County that depend upon insect pollinators include sunflowers, winter squash, summer squash, pumpkins, cucumbers, eggplants, tomatoes, and other vegetables and fruits, in additional to some oilseed crops and dry beans. Pasture and rangeland forage quality can also benefit from pollination services (Chaplin-Kramer et al. 2011).

Growers should consider the needs of pollinators in their farm management and on-farm conservation practices because these insects, especially wild and managed bees, provide a helpful role in crop pollination, increasing quality, shelf life, yields and farm profit (Klatt et al. 2014; Blaauw et al. 2014; Mallinger et al. 2015). In fact, a number of wild bee species are more effective than honey bees at pollinating flowers on a bee-per-bee basis (for a summary, see Vaughan et al. 2015, included in the Appendix). Better pollination by native bees is attributed to many factors, including the collective ability to forage in a wider variety of environmental conditions, faster flight, increased tendencies to perform cross-pollination, ability to buzz pollinate, and other ways in which native bees interact with crop plants, flowers, and pollen (e.g. Garibaldi et al. 2013).

Overall, farms that host a high diversity of native bees are more resilient to extreme environmental conditions that might otherwise jeopardize pollination services. The higher number of pollinator species on a farm, the more likely it is that there will be one or more species that can tolerate variable climatic conditions, like a cold and wet spring (Brittain et al. 2013). Similarly, in situations where sensitive species are extirpated from a site by disease, parasites, pesticides, or habitat loss, farms with high bee diversity are more likely to have less-sensitive species that continue to thrive and ensure that pollination needs are met (Park et al. 2015).

In order to provide crop pollination services, pollinators need stable habitat that can provide food, primarily pollen and nectar from flowers but also host plants for butterflies and moths, as well as shelter. Undisturbed or minimally disturbed ground provides nesting and overwintering habitat for many types of pollinators and beneficial insects, including ground-nesting bees, bumble bees, ground beetles, spiders, and many wasps. The majority of wood-nesting bees

complete their life cycle in beetle tunnels or the centers of shrubs or large forbs. Grassland or areas with shrubs can provide overwintering habitat for butterflies and moths, as well as bumble bees and a number of beneficial insects.

Preserving and restoring natural areas in agricultural landscapes and installing habitat on farms can enhance levels and reliability of pollination services (Garibaldi et al. 2011; Klein et al. 2012). Conservation practices to support wild pollinators can also benefit and strengthen the health of honey bee colonies, helping them to build resilience against pesticide exposure as well as weather conditions that can impact the overwintering success of a colony (Alaux et al. 2010; Decourtye et al. 2010).

Photo: Crop pollination by wild bees. Bumble bee on cucumber (left), (*Peponapis pruinosa*), on squash (center), and bumble bees (*Bombus impatiens*) buzz pollinating tomato (right). Photo credits: Nancy Lee Adamson, The Xerces Society

## Beneficial Insect Needs

Keith expressed interest in strategies to increase wild beneficial insects such as predatory and parasitoid insects that contribute to crop pest control by preying upon or parasitizing crop pests. These insects can be a key component of integrated pest management programs. In order to persist within farm landscapes from year to year, beneficial insects require habitat that can provide sources of alternate prey, alternate food sources like pollen or nectar, and habitat for reproduction or overwintering. Crop fields, which are ephemeral in providing these resources, cannot provide all that beneficial insects need to survive and thrive in numbers large enough to control pest populations. On-farm habitat can be enhanced or installed to support key predators or parasitoids of primary or secondary crop pests (e.g. Mader et al. 2014).

## References for Part One

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Vaughan, M., J. Hopwood, E. Lee-Mader, M. Shepherd, C. Kremen, A. Stine, and S. Hoffman Black. 2015. Farming for Bees. Guidelines for Providing Native Bee Habitat on Farms. The Xerces Society for Invertebrate Conservation.

## Appendix: Part One

*Documents included as part of this conservation plan:*
Farming for Bees

# Part Two. Landowner Objectives

Boulder County has identified the following as objectives for conservation planning on their agricultural lands:

### Pollinator conservation

Boulder County is working to protect pollinators. The ecosystem services provided by pollinators are essential to human wellbeing, agricultural production, and ecosystem health. An estimated 85 percent of the world's flowering plants depend on animals—mostly insects—for pollination. Pollinators sustain wildland plant communities that provide food and shelter for myriad other wildlife. Pollinators are also crucial to agriculture and to our diet. More than two-thirds of crop species are dependent upon pollinators including, crops that produce fruits, vegetables, spices, nuts, seeds, and livestock forage.

### Enhanced crop pollination by wild and managed bees

Pollination provided by bees corresponds to yields of insect-pollinated crops. Pollination also influences taste and appearance, important qualities for marketing fresh produce. Enhancing habitat on farms will increase the abundance and diversity of native bees, which will ensure stable and sustainable crop pollination. In addition, increasing foraging resources will improve the health of any managed honey bee colonies that may be on site; research has shown that managed honey bee colonies are healthier and more resistant to diseases when they have access to diverse and abundant floral resources.

### Enhanced Pest Control

Boulder County is interested in conservation activities that will support a diverse population of beneficial insects (predators and parasitoids) to increase biological control of crop pests. Many pollinators are also important pest control agents during one part of their life cycle. For example, hoverflies feed voraciously on aphids as larvae, and are excellent pollinators as adults. Predatory wasps visit flowers as adults, while also collecting pest insects for their larvae to feed on. Tachinid flies visit flowers as adults, and parasitize pest insects as larvae. Managing habitat for natural enemies (i.e., conservation biological control) can be incorporated into a farm's existing Integrated Pest Management (IPM) plan to further reduce reliance on insecticide application.

### Improve Habitat for Wildlife

Increasing overall biodiversity on the farm and throughout the area is a goal for Boulder County. Many of the habitat enhancements that support wild and managed bees will benefit other

animals such as migratory songbirds and gamebirds. Pollinators such as monarch butterflies, populations of which have declined over 80% in the past twenty years, will also benefit.

### Pesticide Protection and Mitigation

Pollinators and natural enemies need protection from pesticides and other land use impacts (e.g., tillage). Pollinator and natural enemy health can be integrated into existing IPM strategies and land management activities by preventing or mitigating potential negative impacts of pesticides on pollinators and natural enemies.

### Soil Health

Habitat enhancements planned for pollinators can also improve soil health. This plan addresses soil health by selecting plants for habitat enhancements that also improve water infiltration and reduce compaction; and selecting a rotation of cover crops that benefit beneficial insects and also improve organic matter and soil structure.

### Weed Control on Cropped and Non-cropped Land

Several portions of Ertl Farm are heavily invaded, including productive pasture land. Many of these areas are occupied by noxious weeds, which have the potential to also invade cropped areas and impact productivity. Implementing weed control strategies, followed by converting the areas to palatable native species, will help crowd-out weeds, while also supporting grazers and pollinators.

### Pesticide Interception for Organic Land

Pesticide drift from conventional crops onto organic land or into natural areas is a concern. Strategies to reduce pesticide use to protect pollinators are of interest, particularly ways to reduce neonicotinoids used routinely as a seed-coating in corn.

### Additional Objectives (Beatification, Education, Resource Concerns)

In addition to supporting pollinators and other wildlife, habitat features such as wildflower strips and hedgerows will enhance farm aesthetics and education opportunities, such as farm tours and field days. Ertl Farm could have attractive habitat areas that demonstrate their environmental stewardship, and could highlight this to the public through the installation of signage that educates farm visitors about the value of those features to pollinators and beneficial insects.

# Part Three. Existing Farm Conditions

## Site Description

Ertl Farm is composed of multiple crop fields for a total of nearly 400 acres of cropland and pasture. The landscape surrounding the farm includes cropland and residential properties.

## Farm soils

**Figure 2. Soils Map of Ertl Farm**


| Boulder County, Colorado | | | |
|---|---|---|---|
| **Map Unit Symbol** | **Map Unit Name** | **Acres** | **Percent of farm** |
| CoB | Colby silty clay loam, 1 to 3 percent slopes | 113.9 | 28.2% |
| CoC | Colby silty clay loam, 3 to 5 percent slopes | 62.5 | 15.5% |

| | | | |
|---|---|---|---|
| CsB | Colby silty clay loam, wet, 0 to 3 percent slopes | 82.8 | 20.5% |
| GaB | Gaynor silty clay loam, 1 to 3 percent slopes | 1.1 | 0.3% |
| LoB | Longmont clay, 0 to 3 percent slopes | 19.4 | 4.8% |
| WlA | Weld loam, 0 to 1 percent slopes | 41.2 | 10.2% |
| WlB | Weld loam, 1 to 3 percent slopes | 82.3 | 20.4% |
| **Total Area of Interest (AOI)** | | **394.2** | **100%** |

### *Soil properties*

Proposed pollinator habitat enhancement areas are located throughout the farm. The areas range from well drained to poorly drained and nearly level to gently sloping. These soil types have the following properties:

CoB - Colby silty clay loam
*Slope:* 1 to 3 percent
*Depth to restrictive feature:* More than 80 inches
*Natural drainage class:* Well drained
*Runoff class:* Low
*Capacity of the most limiting layer to transmit water (Ksat):*Moderately high (0.20 to 0.60 in/hr)
*Depth to water table:* More than 80 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Calcium carbonate, maximum in profile:* 10 percent
*Available water storage in profile:* High (about 11.4 inches)

CoC- Colby silty clay loam

*Slope:* 3 to 5 percent
*Depth to restrictive feature:* More than 80 inches
*Natural drainage class:* Well drained
*Runoff class:* Low
*Capacity of the most limiting layer to transmit water (Ksat):*Moderately high (0.20 to 0.60 in/hr)
*Depth to water table:* More than 80 inches

*Frequency of flooding:* None
*Frequency of ponding:* None
*Calcium carbonate, maximum in profile:* 10 percent
*Available water storage in profile:* High (about 11.4 inches)

CsB—Colby silty clay loam, wet
*Slope:* 0 to 3 percent
*Depth to restrictive feature:* More than 80 inches
*Natural drainage class:* Moderately well drained
*Runoff class:* Low
*Capacity of the most limiting layer to transmit water (Ksat):*Moderately low to moderately high (0.06 to 0.60 in/hr)
*Depth to water table:* About 24 to 48 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Calcium carbonate, maximum in profile:* 10 percent
*Salinity, maximum in profile:* Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
*Available water storage in profile:* Very high (about 21.1 inches)

GaB—Gaynor silty clay loam
*Slope:* 1 to 3 percent
*Depth to restrictive feature:* 20 to 40 inches to paralithic bedrock
*Natural drainage class:* Well drained
*Runoff class:* Low
*Capacity of the most limiting layer to transmit water (Ksat):*Moderately low to moderately high (0.06 to 0.60 in/hr)
*Depth to water table:* More than 80 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Calcium carbonate, maximum in profile:* 10 percent
*Salinity, maximum in profile:* Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
*Available water storage in profile:* Low (about 5.7 inches)

LoB—Longmont clay
*Slope:* 0 to 3 percent
*Depth to restrictive feature:* More than 80 inches
*Natural drainage class:* Poorly drained
*Runoff class:* Medium
*Capacity of the most limiting layer to transmit water (Ksat):*Moderately low to moderately high (0.06 to 0.20 in/hr)
*Depth to water table:* About 24 to 30 inches
*Frequency of flooding:* Occasional
*Frequency of ponding:* None
*Calcium carbonate, maximum in profile:* 15 percent

*Gypsum, maximum in profile:* 5 percent
*Salinity, maximum in profile:* Slightly saline to strongly saline (4.0 to 16.0 mmhos/cm)
*Sodium adsorption ratio, maximum in profile:* 20.0
*Available water storage in profile:* Moderate (about 8.4 inches)

WIA—Weld loam
*Slope:* 0 to 1 percent
*Depth to restrictive feature:* More than 80 inches
*Natural drainage class:* Well drained
*Runoff class:* Medium
*Capacity of the most limiting layer to transmit water (Ksat):*Moderately low to moderately high (0.06 to 0.20 in/hr)
*Depth to water table:* More than 80 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Calcium carbonate, maximum in profile:* 6 percent
*Salinity, maximum in profile:* Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
*Available water storage in profile:* Very high (about 27.0 inches)

WIB—Weld loam
*Slope:* 1 to 3 percent
*Depth to restrictive feature:* More than 80 inches
*Natural drainage class:* Well drained
*Runoff class:* Medium
*Capacity of the most limiting layer to transmit water (Ksat):*Moderately low to moderately high (0.06 to 0.20 in/hr)
*Depth to water table:* More than 80 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Calcium carbonate, maximum in profile:* 14 percent
*Salinity, maximum in profile:* Nonsaline to very slightly saline (0.1 to 2.0 mmhos/cm)
*Sodium adsorption ratio, maximum in profile:* 5.0
*Available water storage in profile:* High (about 11.3 inches)

## Farm climate

Elevation: 4,900 to 5,500 feet
Mean annual precipitation: 12 to 18 inches
Mean annual air temperature: 48 to 52 degrees F
Frost-free period: 140 to 155 days

## Existing natural plant communities and non-crop vegetation

Ertl Farm is located along the Northern Front Range in Boulder County, Colorado. Historic vegetation of the area was shortgrass prairie, a diverse and productive plant community (CO NAP 1998). Native vegetation of the region includes (but isn't limited to) dominant grasses such as western wheatgrass (*Pascopyrum smithii)*, green needlegrass (*Nassella viridula)*, and blue grama (*Bouteloua gracilis)*; sub-dominant grasses such as needle and thread (*Hesperostipa comata)*, buffalograss (*Buchloë dactyloides)*, and sand dropseed (*Sporobolus cryptandrus)*; wildflowers include purple prairie clover (*Dalea purpurea)*, upright prairie coneflower (*Ratibida columnifera)*, scarlet globemallow (*Sphaeralcea coccinea)*, and dotted blazing star (*Liatris punctata)*; and shrubs such as broom snakeweed (*Gutierrezia sarothrae)*, fourwing saltbush (*Atriplex canescens)*, and winterfat (*Krascheninnikovia lanata)*. This shortgrass plant community evolved with grazing by large herbivores and periodic fires, and is well suited for grazing by domestic livestock.

Assessments of non-crop vegetation on the farm were made during site visits on 17 May 2017 and 14-16 August 2017. Native vegetation is present in low densities on the margins of Ertl Farm. There is a row of willows (*Salix exigua)* along a canal on the east side of the farm, and a row of cottonwood (*Populus deltoides subsp. monilifera)* trees adjacent to an irrigation ditch that runs through the central portion of the farm. Several species of native wildflowers, including scarlet beeblossom (*Oenothera suffrutescens*), annual sunflower (*Helianthus annuus*), and showy milkweed (*Asclepias speciosa*), were observed in low densities along the outer fence line of the farm. There are invasive species such as knapweed (*Centaurea sp.)*, reed canary grass (*Phalaris arundinacea)*, white top (*Lepidium draba)*, teasel (*Dipsacus fullonum)*, and Canada thistle (*Cirsium arvense)* on productive pasture where moisture currently drains off of a corn field or along canal rights of way, and foxtail (*Alopecurus pratensis*), curly dock (*Rumex crispus)*, Russian thistle (*Salsola tragus)*, Russian olive (*Eleagnus angustifolia)*, bindweed (*Convolvulus arvensis)*, mullein (*Verascum thapsus)*, cheat grass (*Bromus tectorum)* and kochia (*Kochia scoparia)* are found along field borders, roadsides, or within the pasture land.

## Pollinator Inventory

Colorado has high species diversity of bees; to date, 964 species of bees have been documented in Colorado. Boulder County, in which 552 species of bees have been recorded, has the highest bee diversity documented thus far in Colorado (Note: Boulder County has had high sampling effort, so as more counties are sampled further, more may be known about the diversity of other counties). This bee diversity is due to the diversity of habitats and elevational changes found across the county, as well as the high plant diversity found in the region (~1,600 species in the Northern Front Range). For additional information, including a list of bee species found in Colorado, please see Scott et al. 2011 (also found in the Appendix of this section).

During site visits to Ertl Farm on 17 May 2017 and 14-16 August 2017, two species of bees were observed: the two spotted longhorn bee (*Melissodes bimaculatus*) and the European honey bee (*Apis mellifera*). Volunteers with Boulder County conducted bee monitoring at six

locations on Ertl and observed six individuals of *Apis mellifera* in 2015 and two individuals in 2016. No butterflies, or pollinating moths, flies, wasps, or beetles were observed.

## Pollinator Habitat Assessment

The Xerces Society's *Pollinator Habitat Assessment Form and Guide was* used to evaluate the condition of pollinator habitat on Ertl Farm. The assessment provides a 'before' score based on current conditions and this score can be used to prioritize conservation actions and determine if there is a resource concern. (Note: 'before" score less than 100 indicates a resource concern. Pollinators are wildlife and pollinator habitat is within the NRCS resource concern Inadequate Habitat for Fish and Wildlife). Conservation actions are planned to increase the 'after' score. Ideally, landowners should strive to achieve an overall score of 100, and planned improvements of at least 40 points. A summary of Ertl Farm's habitat assessment scores is provided in Table 1 and the completed Pollinator Habitat Assessment Form and Guide is found in the Appendix.

**Table 1. Summary of Ertl's Pollinator Habitat Assessment**

| POLLINATOR HABITAT ASSESSMENT FOR ERTL FARM | | |
|---|---|---|
| **Conditions Assessed** | **Existing** | **Planned** |
| Section 1: Landscape Features (max score 20) | 6 | |
| Section 2: Farmscape Features (max score 35) | 10 | |
| Section 3: Foraging Habitat (max score 40) | 10 | |
| Section 4: Nesting Habitat (max score 38) | 12 | |
| Section 5: Farm Practices (max score 80) | 18 | |
| **FINAL ASSESSMENT** | **56** | |

### *Baseline Pollinator Habitat Conditions*

Existing conditions for pollinators/pollinator habitat scored 56 points total. A score below 100 points shows a resource concern regarding pollinators and their habitat. This indicates that critical components of pollinator habitat are absent or insufficient and some farm practices may be detrimental to pollinators. The surrounding landscape is characterized by agricultural fields and pastureland interspersed with residential areas and may function as a source for pollinators. However, on-farm habitat is scarce or degraded and can be improved. There are some favorable conditions, for example, blooming alfalfa provides some forage, but other sources of pollen and nectar are extremely limited throughout the growing season. Sites for tunnel-nesting and cavity-nesting bees are more limited than nesting sites for ground-nesting bees. Plants and vegetative structure for tunnel-nesting bees and bumble bees nests are scarce. IPM techniques that specifically address pollinator protection and mitigate harmful impacts on pollinators and other beneficial insects should be incorporated into management practices. This includes methods for keeping habitat areas pesticide free and reducing the risk of pesticide exposure through direct contact and unintended drift on Ertl Farm.

## Primary pest issues and pest management practices

On Ertl Farm, Russian wheat aphid is the primary pest on wheat, and alfalfa weevil is a major pest on alfalfa. European corn borer is a primary pest of corn. Wheat rust and wheat streak mosaic are fungal pests. Keith typically applies indoxocarb in April or May to conventional alfalfa to control for alfalfa weevil. Topaz (propiconazole) is applied to wheat for fungal control. Herbicides used in conventional alfalfa and alfalfa/hay fields are Raptor (Imazamox) and Velpar (hexazinone); Colt AS (clopyraild) is used in corn and wheat fields, and Cornerstone (glyphosate) and Sterling Blue (diglycolamine salt) are used in corn fields. Insecticide neonicotinoid seed coatings (either imidacloprid, clothianidin, or thiamethoxam) are applied to corn and wheat seeds.

## References for Part Three

Colorado Natural Areas Program 1998. Native Plant Revegetation Guide for Colorado. Volume 3 of Caring for the Land Series. Colorado's Natural Areas Program, Colorado State Parks, Colorado Department of Natural Resources. 258 pp.

Scott, V.L., Ascher, J.S., Griswold, T. and Nufio, C.R., 2011. The Bees of Colorado. *Natural History Inventory of Colorado*. 23:1-100.

## Appendix: Part Three

*Documents included as part of this plan:*
Ertl Farm Pollinator Habitat Assessment Form and Guide
Native Plant Revegetation Guide for Colorado

The Bees of Colorado

# Part Four. Pesticide Risk Mitigation

There are four key steps to understanding pesticide risks to bees and identifying appropriate mitigation strategies.

### Step 1. Identify Pollinator Resource Concern:

Pollinator conservation is an overall goal for Ertl Farm and other farms owned by Boulder County. Although pollinators are not essential to the current crops grown on the farm, future production may be dependent upon pollinators. Additionally, beneficial insects are desired for pest control services throughout the farm.

### Step 2. Identify Potential Risk From Pesticides:

Insecticides, herbicides, and fungicides are in use on Ertl Farm, including the following:

| Type of pesticide | Trade name | Active ingredient |
|---|---|---|
| Insecticide | Various trade names for seed coatings include Gaucho, Crusier, Poncho | imidacloprid<br>clothianidin<br>thiamethoxam |
| Insecticide | Steward | indoxacarb |
| Fungicide | Topaz | propiconazole |
| Herbicide | Raptor | imazamox |
| Herbicide | Velpar | hexazinone |
| Herbicide | Colt AS | clopyraild |
| Herbicide | Cornerstone | glyphosate |
| Herbicide | Sterling Blue | diglycolamine salt |

### Step 2a. Assess pesticide toxicity to bees

Pesticides (insecticides, fungicides, and herbicides) used were evaluated for acute toxicity to bees using the Windows Pesticide Screening Tool (Win-PST) as part of this plan. The insecticides imidacloprid, clothianidin, thiamethoxam, and indoxacarb are rated “Highly Toxic” to bees by Win-PST. Fungicides (propiconazole) and herbicides (imazamox, hexazinone, clopyraild, glyphosate, diglycolamine salt) were evaluated and not found to have an acute toxicity rating (i.e., rated “Relatively Non-Toxic” to bees by Win-PST). We recommend that propiconazole not be mixed in tanks or applied alongside neonicotinoids, due to synergistic effects that amplify the toxicity of neonicotinoids to bees. We also recommend that herbicides be applied to crops or to problematic weeds in the most targeted manner possible and that drift is controlled. Further guidance will not be included for mitigation for these chemicals in this plan.

Mitigation focuses on insecticides rated “Highly Toxic” to “Moderately Toxic” to bees by Win-PST. Win-PST assessment is based on toxicity to honey bees and acute toxicity to native bees may differ from honey bees. When Win-PST identifies a potential risk to honey bees, potential harm to native bees can be assumed. Any active ingredients new to the farm’s pest management program should be evaluated for toxicity to pollinators and other beneficial insects.

### Step 2b. Determine pesticide persistence in the field

Different pesticide active ingredients can last in the field for time periods ranging from a few minutes to several days, and persistence can vary greatly based on specific field conditions. The residual activity of pesticides is often expressed as an $RT_{25}$ value. This is the time that needs to pass for the pesticide to degrade enough that bee mortality is reduced to 25 percent of the initial mortality of the freshly applied product. Cooler temperatures can dramatically increase the time needed for residues to become nontoxic to bees. Temperature and dew point also have a significant effect on the residual toxicity of most insecticides. Cooler temperatures result in much longer periods of toxicity and dewy nights cause the insecticide to remain wet on the foliage. These conditions make insecticides more available and toxic to bees the following morning. Avoid adjuvants that increase persistence.

Clothianidin, thiamethoxam, and imidacloprid can have high persistence/duration of impact in the field. Longevity in the soil or in tissues of perennial plants can extend to months or even years (Goulson 2013). Indoxocarb, on the other hand, has a comparatively shorter residual for honey bees of one day, and three days for bumble bees (Hooven et al. 2013). More information about pesticides and residuals is available in *How to Reduce Bee Poisoning from Pesticides* (Hooven et al. 2013). The full publication is provided in the Appendix.

## Step 3: Identify specific exposure pathways that should be prevented or mitigated

Direct contact exposure pathways require mitigation for insecticides rated highly to moderately toxic. Specific insecticide exposure pathways benefiting from mitigation include direct contact, residue contact, contaminated nest material, and contaminated nesting areas. See the subsections below for more details on the risk of each exposure pathway:

- Direct Contact is the most obvious exposure route, is direct contact from pesticide application onto bees. This contact may occur when bees are actively foraging on flowers or nesting in the ground within a crop field, or when pesticides drift off-site onto adjacent natural habitat.
- Residue Contact may occur when pollinators are exposed to pesticides when they visit flowers, walk on leaves that have been previously treated with pesticides, or gather contaminated pollen and nectar. This is especially problematic when a pesticide has a long persistence in the field. Residue contact can also result from off-site drift of pesticides onto adjacent natural habitat. Residue contact can occur on contaminated insect-pollinated crops and weeds.
- Contaminated Nesting Material may be an exposure pathway when the materials bees use to construct their nests are contaminated. For example some tunnel-nesting bees use chewed pieces of leaves to separate brood cells, while the blue orchard bee (*Osmia lignaria*) separates it brood cells with walls of mud. Both the leaf pieces and mud may be contaminated with pesticide residue.
- Formulation Wettable powders, dusts, and microencapsulated formulations pose a unique exposure risk because they are pollen-like and adhere easily to the hairs on bees and other pollinators (especially dusts and microencapsulated formulations). They also typically remain toxic in the field longer than liquid formulations.
- Contaminated Nesting Areas are created when pesticides are applied to or drift onto areas of bare ground, even within fields, which may contaminate potential nest sites for ground-nesting bees. Similarly, drift into adjacent shrubby habitat may poison potential nest sites for wood-nesting bees, and drift into adjacent overgrown habitat or forest edges may contaminate potential bumble bee nesting sites.

### Step 4. Pesticide hazard mitigation plan:

To mitigate potential risks to pollinators and beneficial insects that contribute to pest control, it is critically important that Ertl Farm prevent exposure through direct contact with pesticides and/or drifting pesticides, and ensure that any pesticide application be as targeted as possible. This will help reduce non-target impacts of pesticides caused by direct contact, contamination of food or nesting sites/materials, and off-site pesticide drift onto adjacent wildflowers, hedgerows, field borders, weeds, or wildlife nesting habitat.

Applications of pesticides should be made when there is a demonstrated need, using pest scouting and economic thresholds to determine when chemical action to manage pests is warranted. The use of pesticides should be part of an integrated management program (IPM), and used only when necessary. Other important strategies to reduce pests include the use of mating disruptors whenever possible, practicing good sanitation, regular crop rotation, and the planting of resistant crop varieties. Ertl Farm should continue to build an IPM strategy and incorporate pollinator protection.

There are two primary risks to pollinators from insecticides at Ertl Farm. The first comes from the insecticidal dust from seed coatings during planting of corn and wheat. Clothianidin, thiamethoxam, and imidacloprid, insecticides applied as seed coatings to wheat and corn seeds, have high toxicity to bees. These chemicals are uptaken throughout the plant and small quantities are present in corn pollen and wheat pollen. Despite the fact that corn and wheat are wind-pollinated plants, and thus have low quality pollen, some species of bees will visit these crops to collect pollen if other resources are scarce. Consuming contaminated pollen can significantly reduce reproduction and longevity of solitary bees and bumble bees, even at very low levels of residues (e.g. 2ppb or less) (Sandrock et al. 2014; Moffat et al. 2015; for a summary of research, see Hopwood et al. 2016). In addition, during planting, a portion of the seed coatings are abraded during the planting process and become airborne as insecticidal dust. The planter dust can contaminate adjacent habitat, and can travel up to 100 meters from a field's edge (Krupke et al. 2017). The dust is highly toxic to honey bees and native bees who may encounter the dust in flight or on vegetation (Krupke et al. 2012; Rundlof et al. 2015) and to developing monarch butterflies (Pecenka and Lundgren 2015). Researchers have collected native bees in Colorado that were contaminated with neonicotinoids: thiamethoxam was found in 46% of bees, clothianidin in 24%, and imidacloprid in 13% (Hladik et al. 2016).

There may be an opportunity to eliminate the risk seed coatings pose without compromising yields, because seed coatings likely do not always control the major pest issues on Ertl. In some cases, they may be creating secondary pest issues.

Planting varieties of wheat that are resistant to Russian wheat aphid will eliminate or reduce the need for insecticide use. Other practices that minimize the need for insecticide use to control Russian wheat aphid include planting winter wheat as late as possible, and reducing stress on the crop. Additionally, western wheatgrass (*Pascopyrum smithii*) can serve as an alternate host for the Russian wheat aphid, so it should not be included in any conservation plantings to support pollinators or beneficial insects. Plant treated seed only when there is a need, such as when risk of fall infestation is high or if the farm has a history of fall infestations. Seed coatings on fall planted wheat may not provide protection against Russian wheat aphid, due to the efficacy of seed treatments, timing of planting, and emergence of the pest.

In corn, European corn borer populations can be reduced by planting hybrids resistant to borers, planting longer season hybrids, and by planting corn later in the season (early planted corn is the most vulnerable). Some hybrids have resistance to the first generation European corn borers, which feed in the whorls and later enter the stalk. Some hybrids tolerate stalk and shank boring and thus are less likely to lodge or lose ears. Seed companies can provide information on these traits in their hybrids. Early planted corn is more susceptible to first generation of European corn borers while late planted corn is more susceptible to the second generation. Adjust harvest dates according to which generation tends to be more of an issue. Fields with high stalk damage should be harvested early.

Use of neonicotinoid seed treatments are associated with secondary pest issues, such as spider mite outbreaks (e.g. Smith et al. 2013; Szczepaniec et al. 2013). Additionally, imidacloprid seed

treatments reduce predator abundance in corn fields, including heteropteran predators, which may increase incidence of corn borer (Albajes et al. 2003). Finally, imidacloprid seed treatments may not be very effective against corn borer (Yue et al. 2003).

Timing is challenging for foliar applications of insecticides. Chemical insecticides have been found to provide ~60-95% control of first generation larvae and 40-80% of second generation larvae, but only when timed well based on careful monitoring every 3 to 5 days. Granules applied by ground and air, as well as some center-pivot applied liquids, have given the best first generation control results in CSU tests, but granules are less effective against second generation larvae. Spinosad, an organic pesticide, is effective against European corn borer with well-timed applications. Chemical applications for control of second generation larvae are often associated with spider mite outbreaks.

Monitoring protocol for European corn borer: Examine five sets of 20 plants per 50 acres of corn – any fewer samples will increase the chance for incorrect treatment decisions. Chemical control of the first generation is likely to be economical when 25 percent of the plants have feeding damage and live larvae are present in the whorls (check five whorls for live larvae at each sample site). However, once larvae have entered the stalk, control is impossible. For the second generation, treatments should only be considered when weekly scouting finds more than 25 percent of plants with egg masses before or during pollination, or more than 50 percent of plants with egg masses after pollination. See https://wiki.bugwood.org/HPIPM:European_Corn_Borer_FC for more detailed monitoring information.

Information about using pest scouting to inform corn neonicotinoid seed treatments use is found in the Appendix of this section, as well as information on scouting and IPM in wheat to control Russian wheat aphid.

If neonicotinoid-treated seeds for either crop are used, some steps to reduce offsite movement of insecticidal dust during planting include:

- planting on days with low wind speeds to reduce the distance dust will travel,
- using no-till planting to reduce field dust generated during planting,
- if using a vacuum planter, filtering the air intake to reduce dust coming into the planter (which can increase seed coating abrasion) and filtering the air exhaust to reduce the insecticidal dust released.

On Ertl, foliar applications of indoxacarb to alfalfa could pose a potential risk to pollinators due to indoxacarb's high toxicity to honey bees and wild bees. Additionally, the residual toxicity of indoxacarb is much longer for bumble bees than for honey bees, making indoxocarb more problematic for bumble bees if they are exposed. If it must be used, reduce exposure to bees by applying indoxocarb at dusk when pollinators are not active, and apply when alfalfa is not in bloom.

Alternative strategies for managing alfalfa weevil include:

1. Early harvest is the best intervention method to avoid the use of an insecticide. If weevil numbers are high and the crop is beginning to bloom, harvest rather than spray.
    a. If an economically critical infestation of third and fourth instar larvae is found when the plants are at 10 percent bud break stage or later (e.g. around 7 to 10 days before bloom), an early cutting is an alternative to insecticide use. Rapid removal of hay will accelerate larval mortality due to desiccation by direct sunlight.
    b. After cutting, examine the stubble for larval survival. If larval survival under the windrows is high and baling is delayed (e.g., due to rainfall), there may be increased damage to regrowth.
2. Biological control is a helpful tool for maintaining lower weevil pressure. Several species of parasitic wasps have been introduced for alfalfa weevil control. Control can be variable depending on the population level of these natural enemies, but these species can contribute substantially when present and abundant. These species are negatively affected by insecticide use.
3. The use of resistant alfalfa varieties can help reduce weevil problems. Weevil-tolerant varieties such as Perry and Arc will still produce good yields even after a moderate amount of weevil damage.
    a. Resistant varieties: Arc, Perry, Liberty, Team, Weevlchek
    b. However, note that these varieties tend to have little resistance to Phytophthora root rot, Verticillium wilt, and stem nematode. If these are a problem on your farm, the benefits of weevil resistance may not outweigh the benefits of pathogen resistance.
4. There are well-documented scouting methods and economic thresholds for alfalfa weevil (see Appendix). Use insecticides as a last resort and only when an economically significant number of weevils has been documented in your fields.
    a. There are no insecticides that are low-toxicity to bees and effective for weevil control. If an insecticide must be used, choose one with a low residual time.

If pesticides (fungicides, herbicides, insecticides) are used on Ertl Farm, ensure that the majority of the pesticide emitted from the sprayer ends up on the target plants. Precision spraying helps reduce non-target impacts caused by off-site pesticide drift onto adjacent wildflowers, weeds, or wildlife nesting habitat and saves money. Negative impacts to pollinators can be reduced by avoiding applications on blooming crops; spraying during appropriate weather conditions; using proper application methods; and maintaining un-sprayed setbacks along the edge of crops. See below for details on each of these recommendations.

- Avoid Insecticide Applications to Blooming Crops. In addition to controlling drift, whenever possible, Ertl Farm should ensure that pesticides are applied at times and during environmental conditions that reduce or eliminate potential exposure to bees and other pollinators. Insecticides that are toxic to bees should not be applied to a crop in bloom (including corn that is tasseling, since bees will visit it to collect under some conditions), or to adjacent blooming plants. Where bee-attractive flowering weeds occur, keeping the

areas between crop rows mowed will help prevent bee exposure to pesticides. Insecticides that are categorized as “nontoxic” to bees or that degrade quickly may be applied over flowers when pollinators are not active, such as in the late evening, immediately after bees stop foraging for the day. However, keep in mind that even if a pesticide application doesn’t directly kill the bees visiting the crop, it may have a long residual toxicity and the residues left on the plants still may kill later-visiting bees, especially smaller species.

- Monitor Weather Conditions. The first step in minimizing drift is to apply pesticides when winds are calm, but not totally still. Ideally, winds are blowing at a gentle 2 to 9 mph. When conditions are too windy, the pesticide may be transported by wind currents off site and onto adjacent habitat. When too calm, such as during a temperature inversion, the pesticide may linger in the air and float a longer distance off site compared to gentle wind conditions. Temperature inversions occur naturally, typically in the early morning hours when the ground cools the air layer immediately above it. Inversion conditions occur when warmer air above traps cooler air located near the surface of the ground (and are often characterized by fog). Such conditions are conducive for pesticide drift. Drift that occurs over long distances (over a mile) is most often the result of applications made during temperature inversions.

- Select Best Application Method. To minimize drift, apply insecticides as close to the crop plants as possible. Spray nozzles should be calibrated regularly to ensure that the appropriate amount of pesticide is being applied. With traditional application equipment, proper nozzle selection is important in reducing drift losses. Several manufactures have specially designed nozzles to deliver spray patterns and droplet sizes that are less apt to drift from the application site. Specialized equipment also may help reduce drift. For example, electrostatic spray applicators apply pesticides to the crop with special nozzles that “charge” the droplets which are then electrically drawn to the plant surfaces much more effectively and efficiently than with traditional nozzle technology. This technique typically can reduce off target application (i.e. to the ground or off site drift) by over 50%. Another alternative is to use spray curtains or hooded sprayers that surround the nozzles and crop rows or plants. In this way, the spray is relatively contained around the application area and drift is reduced.

- Maintain Unsprayed Setbacks Along Crop Edges. To minimize drift from the target area, a 25 foot or greater pesticide-free set-back around the edge of the application area is recommended.

## Conservation Biological Control

Conservation biological control describes the natural pest control provided by beneficial insects like lady beetles and parasitoid wasps when habitat is supplied to support their life cycles.

Conservation biological control seeks to protect and enhance those natural enemies already present in the cropping environment and create a favorable environment and expanded habitats for additional insect predators and parasitoids to thrive. In addition, the habitat and flowering resources used by natural enemies also support pollinators and other non-insect wildlife. Conservation biological control is achieved by incorporating reduced-risk pesticide management practices into an IPM plan. Such practices reduce exposure of beneficial insects to harmful pesticides and establish safe habitat for these organisms to exist.

Natural enemies of key pests on Ertl Farm are found in Table 2. Beneficial insects that are generally useful for controlling alfalfa, corn, and wheat pests are listed below:

- Lady Beetles (Coccinellidae): predators of aphids on corn and wheat, pest eggs, and small caterpillars
- True Bugs (Hemiptera): predators of aphids on corn and wheat, corn earworm, European corn borer, pest eggs, small caterpillars, and spider mites
- Hover fly larvae (Syrphidae): predators of corn aphids, small caterpillars, and spider mites
- Ground beetles (Carabidae): predators of caterpillars, corn aphids, grubs, slugs, and wireworm
- Lacewings (Neuroptera): predators of corn aphids, leafhoppers, small caterpillars, and spider mites
- Parasitoid wasps (Hymenoptera): parasitoids of caterpillars, corn aphids, pest eggs, and alfalfa weevil
- Nabids (Hemiptera): predators of aphids, insect eggs, and small caterpillars

**Table 2. Natural enemies of key pests and plants to support these natural enemies**

| Key insect pest | Natural enemies | Plants/Habitat needed for biocontrol |
|---|---|---|
| Russian wheat aphid | Parasitoid wasps (e.g. *Aphelinus varipes, Lysiphlebus testaceipes, Diaeretiella rapae*). | Flowering plants that provide nectar and pollen, food sources for adults |
| | Lady beetles<br>E.g. *Hippodamia convergens* | Diverse plant community with overlapping bloom across seasons; leaf litter or woody vegetation for overwintering habitat |
| | *Nabis* spp. | Cover crops, leaf litter or shrubby habitat for overwintering |
| | Syrphid larvae | Diverse plant community with overlapping bloom across seasons; leaf litter for overwintering |
| Alfalfa weevil | Parasitoid wasps (e.g. *Bathyplectes* spp., *Tetrastichus incertus*) | Flowering plants that provide nectar and pollen, food sources for adults |
| | Lady beetle adults and larvae | Diverse plant community with overlapping bloom across seasons; leaf litter or woody vegetation for overwintering habitat |
| | Lacewing larvae | Diverse plant community with overlapping bloom across seasons; leaf litter or woody vegetation for overwintering habitat |
| | Damsel bugs | Cover crops, leaf litter or shrubby habitat for overwintering |
| European corn borer | Lady beetle adults and larvae | Diverse plant community with overlapping bloom across seasons; leaf litter or woody vegetation for overwintering habitat |
| | Lacewing larvae | Diverse plant community with overlapping bloom across seasons; leaf litter or woody vegetation for overwintering habitat |

There are many ways that growers can manage their farms to support populations of wild, naturally occurring predators and parasitoids. Wildflower meadows provide undisturbed ground for nesting and other activities, as well as important foraging resources. Seed mixes for this purpose should include nectar-rich plant species known to supplement the alternative food requirements of beneficial insects. In Colorado, such species include yarrow (*Achillea millefolium)*, coreopsis (*Coreopsis spp.)*, and milkweeds (*Asclepias spp.),* sunflowers (*Helianthus spp.)*, or asters (*Symphyotrichum* spp.). The inclusion of native bunch grasses in Conservation Cover seed mixes will also contribute to egg-laying and overwintering sites for beneficial insects. These plant species are not known to harbor pests, and their use may contribute to natural pest suppression. Many beneficial insects, including lady beetles, hover flies, lacewings, and parasitoid wasps can be attracted into crop fields themselves with simple single row plantings of common fast-blooming herbs like dill and cilantro. When allowed to flower, both of these example herbs are widely known to attract beneficial insects in abundance, and inter-planted rows of them within vegetable crops may provide a simple and low cost method for immediately attracting beneficial insects into the crop field to enhance pest control. See Hopwood et al. 2016 (in Appendix) for additional guidelines about habitat planning for beneficial insects.

***Benefits of milkweeds, beyond monarch butterflies***

Milkweeds produce high quality nectar in large quantities, and thus are very attractive to pollinators and a variety of beneficial insects. A number of researchers have found them to be the top plants for supporting natural enemies of crop pests, for example. However, some landowners are concerned about milkweeds encroaching into farm fields. By selecting species best adapted for the site, that concern can be addressed.

Frequently asked questions about milkweeds can be found on these webpages:
https://xerces.org/milkweed-faq/

http://www.xerces.org/wp-content/uploads/2015/12/Roadsides_milkweed_XercesSociety.pdf

http://xerces.org/milkweeds-a-conservation-practitioners-guide/

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## Appendix: Part Four

*Documents included as part of this plan:*
Beneficial Insects for Natural Pest Control: Scouting Guidelines
Colorado State Alfalfa weevil scouting guide
Habitat Planning for Beneficial Insects
How Neonicotinoids Can Kill Bees
How to Reduce Bee Poisoning from Pesticides
Making Decisions about Neonicotinoid Seed Treatment Use in Iowa
Protecting Pollinator Habitat from Pesticides Guidelines
Russian Wheat aphid scouting guide
Milkweeds: A Conservation Practitioner's Guide
Are Milkweeds Really Weeds? Fact Sheet

# Part Five. Habitat Enhancement Plan

## Enhancement Areas

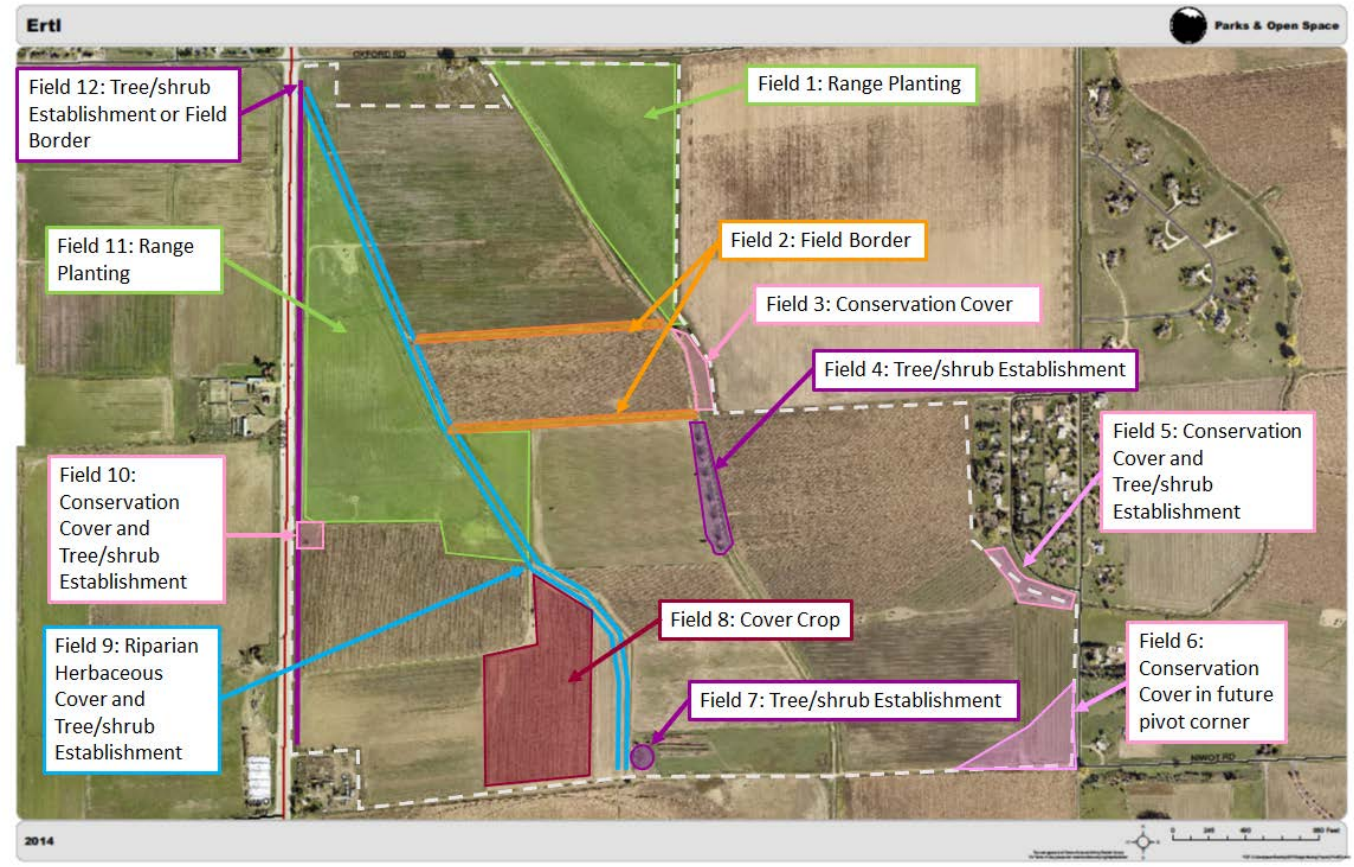
In this planning process, a number of areas of the farm were identified as potential sites to create or enhance habitat that will increase the availability of nectar and pollen and the diversity of nesting opportunities and host plants for pollinators on the farm. Recommendations for practices that mitigate pesticide drift and promote pollinator protection from pesticides were also considered in the planning process. This includes insecticides that may harm pollinators through the exposure pathways listed in Part Four of this plan.

Each practice is described below and guidance and reference documents are provided in the Appendix of this section. For more information on federal enrollment programs to enact these practices, visit your local NRCS field office. NRCS can provide technical assistance with implementation and also offers financial assistance.

### Locations of new pollinator habitat

Areas targeted for habitat enhancement at Ertl Farm include pasture, as well as locations adjacent to, or along the perimeter of, crop fields (e.g., field borders, marginal areas). It is important that habitat areas adjacent to crop fields are able to be protected from herbicide and insecticide drift. For additional information, see Protecting Pollinator Habitat from Pesticides Guidelines (in Appendix). For some practices, converting small amounts of cropland to non-crop habitat may be recommended (e.g. cover crops). Recommended locations for proposed practices are marked on the farm layout map included in Figure 3.

**Figure 3. Map of Pollinator Habitat Enhancements**




A quick guide to finding a particular recommended habitat enhancement can be found here:

**Habitat Creation Practices:**



**Supporting Practices:**

**Habitat Establishment and Management Guidelines:**



## Planning Considerations

### Plant selection overview

The recommended plant species in this plan were selected for the following criteria:

1. Documented or recognized pollinator and beneficial insect value
2. Commercial availability from regional seed producers
3. Native status
4. Lack of host potential for crop pests and diseases, and lack of weed potential
5. Ease of establishment and suitability to local soils, drainage, and other site factors

High densities of diverse native wildflowers that bloom throughout the growing season are recognized as a primary pollinator habitat deficiency on the farm. Species lists for each of the proposed conservation measures are included with every habitat enhancement recommendation. These lists include native flowering plant species known to thrive in this region and expected to do well in the climatic and soil conditions at Ertl Farm.

The addition of native shrubs is recommended to address the deficiency in spring blooming plants. There is often a lack of wildflower species that bloom in very early spring when bumble bee queens and other native bees that are active in cooler weather begin foraging. To create hedgerows for pollinators, a proposed list of native shrubs and grasses was developed for this plan. Species selection for hedgerow enhancements will focus on early blooming shrubs to increase early spring forage.

In addition to the recommended native species, enhancement areas can be supplemented with fast establishing low cost, non-native (but not invasive) flowering species (such as flowering cover crops) described later in this plan). All species recommended in this plan were reviewed to eliminate alternate pest/disease host plants, and potentially invasive species.

A master list of plants native to Boulder County that provide high quality resources for pollinators and beneficial insects is included in the Appendix of this section.

### Addressing nesting habitat

Based on the habitat assessment, nesting habitat for tunnel-nesting bees (e.g. leaf-cutter bees) and cavity-nesting bees (e.g., bumble bees) is more limited than nesting sites for ground-nesting bees. To improve habitat for bees, Ertl Farm should establish woody plants with pithy or

hollow stems to improve the availability of nest sites for tunnel- and cavity-nesting species. Therefore, woody plants selected for enhancements include species that provide nesting habitat (as well as floral resources). Bumble bee nesting habitat on the farm is limited by a lack of vegetative structure. To help address this, the plants selected for enhancements include native bunch grasses (which lodge at maturity creating nesting spaces near the ground). The conservation and/or creation of brush piles (possibly made up of pruned plant materials, such as blackberry canes) can also improve nesting opportunities for bumble bees.

To maintain nesting sites for ground-nesting bees, conserve areas of exposed well-drained soil preferred by ground-nesting species. No-till as practices are strongly recommended, from a pollinator conservation standpoint, in order to protect the existing population of ground-nesting bees on the farm.

## Habitat Creation Practices

### Recommended Practice: Conservation cover (NRCS Practice Code 327)

Conservation Cover is defined as establishing and maintaining permanent vegetative cover. The purpose(s) of Conservation Cover are to reduce soil erosion and sedimentation, improve water quality, improve air quality, enhance wildlife habitat and pollinator habitat, improve soil quality, or manage plant pests. This practice can be applied on all lands needing permanent vegetative cover (cropland, odd areas, corners, etc.). This practice does not apply to plantings for forage production. The intended purpose for conservation cover at Ertl is to address resource concerns regarding pollinator habitat (i.e., inadequate habitat for fish and wildlife).

Species selected for conservation cover plantings will be adapted to soil, ecological sites, and climatic conditions. Seeding rates and methods shall be adequate to accomplish the planned purpose and certified seed shall be used. Site preparation will sufficiently eliminate weeds for establishment and growth of selected species. Timing and use of equipment shall be appropriate for the site and soil conditions.

Currently, Ertl farm has very few flowering plants, establishing wildflower plantings using conservation cover will provide nectar and pollen for foraging pollinator species on Ertl farm. A diverse mix of native wildflowers and grasses should be designed to provide blooms throughout the growing season. These permanent plantings will also provide nesting and overwintering sites for a variety of wildlife, including many pollinators. Supporting practices to help establish, enhance, and maintain this practice include **Brush Management (314)**, **Herbaceous Weed Control (315)**, **Integrated Pest Management (595)**, **Prescribed Burning (338)**, and **Structures for Wildlife (649)**. More information on these practices can be found in the Supporting Practices section.

Areas proposed for conservation cover include:
Fields 3, 5, 6, and 10

**Conservation Cover Habitat Establishment Plan**
Establish wildflower meadow according to the Conservation Cover (327) Practice Standards and Conservation Cover (327) for Pollinators Installation Guide and Job Sheet (see attachments). Establishing a wildflower meadow includes three phases: (1) site preparation; (2) planting, and; (3) management during establishment. Long-term maintenance is required after the meadow is established to maintain its function. Additional information on site prep, planting, establishment management, and ongoing management are provided in the Habitat Establishment and Maintenance section, information on bolded recommendations can be found there.

For areas of conservation cover on Ertl, we recommend the **herbicide method** for site prep because conservation cover areas are not near organic production, some are relatively large, and some are not easily accessible, especially when nearby crop fields are in production.

Both **broadcast** and **drilling** seeding methods will work with areas of conservation cover on Ertl, however, some areas are small or difficult to access and a broadcast seeding method may be more feasible. Areas of conservation cover should be planted during the dormant season (November to March). Due to high weed pressure, we recommend **establishment mowing/shredding** during the first two growing seasons on areas of conservation cover. **Herbicide spot spray applications** can be used for weed species that flower and set seed at low heights (after shredding/mowing) or for areas of weed encroachment that occur after the second growing season. **Ongoing mowing** or **haying** and/or **prescribed burning** of ⅓ to □ of the site annually will help maintain wildflower diversity and abundance on conservation cover plantings while leaving fire-free refuges for pollinators populations that are adversely affected by prescribed burns.

**Conservation Cover Plant Selection**

The recommended plant species for Conservation Cover were selected for the following criteria:
1) documented or recognized pollinator (and beneficial insect) value;
2) butterfly host plants;
3) minimum of three species in each bloom period;
4) commercial availability from regional seed producers;
5) native status (or locally adapted, non-invasive status);
6) lack of host potential for crop pests and diseases, and lack of weed potential; and
7) ease of establishment and suitability to local soils, drainage, and other site factors.

Species substitutions and modifications must be reviewed to ensure alternatives site appropriate and that they meet NRCS practice standards.

The High Plains Pollinator Conservation Seed Mix from Applewood Seed Company is an example of a seed mix appropriate for use on Ertl Farm.

## Conservation Cover Recommended Plants

| Bloom Period | Common Name | Scientific Name | Annual, Perennial, or Biennial |
|---|---|---|---|
| **Grasses** | | | |
| Summer/fall, July-September | Sideoats Grama | *Bouteloua curtipendula* | Perennial |
| Summer/fall, June-August | Green Needlegrass | *Nasella viridula* | Perennial |
| Summer/fall, July-September | Little Bluestem | *Schizachyrium scoparium* | Perennial |
| Fall, August-September | Indian Grass | *Sorghastrum nutans* | Perennial |
| Summer/fall, June-September | Sand Dropseed | *Sporobolus cryptandrus* | Perennial |
| **Forbs** | | | |
| Spring/summer, May-July | White Penstemon | *Penstemon albidus* | Perennial |
| Spring/summer/fall, May-August | Plains Beebalm | *Monarda pectinata* | Annual |
| Spring/summer/fall, May-September | Purple Prairieclover | *Dalea purpurea* | Perennial |
| Spring/summer/fall, May-September | Blanketflower | *Gaillardea aristata* | Perennial |
| Spring/summer, May-August | Lewis flax | *Linum lewisii* | Perennial |
| Spring/summer/fall, May-October | Hairy False Goldenaster | *Heterotheca villosa* | Perennial |
| Summer/fall, June-August | Rocky Mountain Beeplant | *Cleome serrulata* | Annual |
| Summer/fall, June-August | Plains coreopsis | *Coreopsis tinctoria* | Annual |
| Summer/fall, June-August | Hoary Vervain | *Verbena stricta* | Perennial |
| Summer/fall, June-August | Lead Plant | *Amorpha canescens* | Perennial |
| Summer/fall, June-August | Hoary Vervain | *Verbena stricta* | Perennial |
| Summer/fall, June-August | Blacksamson Echinacea | *Echinacea angustifolia* | Perennial |
| Summer/fall, June-September | Wild Bergamot | *Monarda fistulosa* | Perennial |
| Summer/fall, June-September | White Prairieclover | *Dalea candida* | Perennial |
| Summer/fall, June-October | Prairie Coneflower | *Ratibida columnifera* | Perennial |
| Summer/fall, July-October | Prairie sunflower | *Helianthus petiolaris* | Perennial |
| Summer/fall, July-October | Dotted Blazing Star | *Liatris punctata* | Perennial |
| Summer/fall, July-October | White Heath Aster | *Symphyotrichum ericoides* | Perennial |
| Summer/fall, August-October | Stiff Goldenrod | *Solidago rigida* | Perennial |

## Recommended Practice: Range Planting (NRCS Practice Code 550)

Range planting is the establishment of adapted perennial vegetation such as grasses, forbs, legumes, shrubs and trees. Range plantings can restore a plant community similar to its historic climax or the desired plant community, provide or improve forage for livestock, provide or improve forage, browse or cover for wildlife, reduce erosion by wind and/or water, improve water quality and quantity, and increase carbon sequestration. This practice is applicable on rangeland, native or naturalized pasture, grazed forest or other suitable location where the principal method of vegetation management will be with herbivores.

Specified seeding/plant material rates, methods of planting, date of planting and/or species selection shall be consistent with documented guidance cited by Plant Materials Program (see Plant Materials Technical Note 59 - Plant Suitability and Seeding Rates for Conservation Plantings in Colorado - in additional resources), research institutions or agency demonstration trials for achieving satisfactory establishment and historic long-term success. Species, cultivars or varieties selected, must be compatible with management objectives and adapted to climate conditions, soils, landscape position, (e.g., aspect) and range or ecological site(s). Species, cultivars or varieties selected shall provide adequate cover to control erosion by wind and/or water within an acceptable period of time. Seedbed preparation and planting methods will be suitable to meet any special needs for obtaining an acceptable establishment of planted materials. Planting depths, dates, seeding rates, soil amendments and fertilizer needs for establishment, minimum seed quality standards and management during the establishment period such as weed control and deferment from grazing shall be followed to enhance establishment success. Seeding rates will be calculated on a pure live seed (PLS) basis or percent germination. If the range planting is intended to improve habitat for wildlife, the selection of planted species shall meet dietary and palatability requirements for the intended wildlife species. Species will be selected and planted in a designed manner that will meet the cover requirements of the wildlife species of concern.

Range plantings must be protected from grazing for two years following the seeding to allow for plant establishment (flash grazing for weed control is allowed). After establishment, rangeland management is highly recommended. Supporting practices for management include **Prescribed Burning (338)**, **Prescribed Grazing (528)**, **Brush Management (314**), and **Herbaceous Weed Control (315**). More information on these practices can be found in the Supporting Practices section. If only native shortgrass plant species are used, consider using **Restoration and Management of Rare or Declining Habitats (643)** in conjunction with range planting. **Integrated Pest Management (595)** and **Structures for Wildlife (649)** may also be applicable on range plantings, more information on these practices can be found in the Supporting Practices section.

Rangelands can be valuable habitat for many pollinators. Grazed areas that support a diverse community of flowering plants provide food as well as nesting and overwintering sites for many pollinator species. Grazing areas are usually relatively free from pesticides as well, providing important refuge sites for many insect species. On the Ertl farm, range seeding could be used to convert the pastures on the north and south to more productive rangeland, both for livestock

and wildlife. Currently, both pastures are comprised of non-native cool season grasses with significant weed pressure and only provide livestock forage in the cool shoulder seasons. If pastures are restored to a diverse native grassland, grazing would be option throughout the growing season and productivity of these pastures would increase. Some wildflower species are also palatable to livestock and, with proper management, can be an important livestock food source, survive grazing pressure, and provide resources for wildlife as well. Current resources for pollinators on the north and south pasture are scarce and replanting to native grasslands would address the need for food and shelter for pollinators on the Ertl farm.

Areas proposed for conservation cover include:
Fields 1 and 11

**Range Planting Habitat Establishment Plan**
Establish a range planting according to the Range Planting (550) Practice Standards and Range Planting (550) specifications (see attachments). Establishing a range planting includes three phases: (1) site preparation; (2) planting, and; (3) management during establishment. Long-term maintenance is required after the grassland is established to maintain its function. Additional information on site prep, planting, establishment management, and ongoing management are provided in the Habitat Establishment and Maintenance Guidelines section, information on bolded recommendations can be found there.

For conversion of non-native pasture to native range on Ertl, perform a **prescribed burn** in the fall or spring to remove thatch and knock back the cool season grasses, followed by the **herbicide method.** It is imperative to eradicate the non-native grasses and invading weed species as completely as possible before seeding, as control is difficult once native plants are seeded.The cheatgrass (*Bromus tectorum)* invasion on the northern edge of the north pasture should be carefully monitored throughout site preparation and establishment period of range seeding, **herbicide spot spray applications** can be used during the early spring and fall to target any lingering populations of this pernicious weed species and other weeds. Controlling weed populations along the roadsides bordering the north and south pastures with mowing and/or herbicide spot spray applications to prevent weed seed set will significantly reduce weed pressure on the edges of these plantings and increase the likelihood of long term success.

Both **broadcast** and **drilling** seeding methods will work with range plantings on Ertl. Range plantings should be seeded during the dormant season (November to March). We recommend establishment **mowing/shredding** during the first two growing seasons on areas of range plantings. **Herbicide spot spray applications** can be used for weed species that flower and set seed at low heights (after shredding/mowing) or for areas of weed encroachment that occur after the second growing season. **Prescribed grazing** and/or **prescribed burning** of ⅓ to □ of the site annually will help maintain wildflower diversity and abundance on range plantings. Varying the timing and location of grazing and burning through time.

**Range Planting Species Selection**
The recommended plant species for Range Planting were selected for the following criteria:

1) documented or recognized pollinator (and beneficial insect) value;
2) butterfly host plants;
3) minimum of three species in each bloom period;
4) commercial availability from regional seed producers;
5) native status (or locally adapted, non-invasive status);
6) lack of host potential for crop pests and diseases, and lack of weed potential; and
7) ease of establishment and suitability to local soils, drainage, and other site factors.

Species substitutions and modifications must be reviewed to ensure alternatives site appropriate and that they meet NRCS practice standards. See additional resources for species recommendations for Range Planting.

## Range Planting Recommended Plants

| Bloom Period | Common Name | Scientific Name | Annual, Perennial, or | Flower color |
|---|---|---|---|---|
| **Grasses** | | | | |
| Summer/fall, July-September | Big Bluestem | *Andropogon gerardii* | Perennial | |
| Summer/fall, July-September | Sideoats Grama | *Bouteloua curtipendula* | Perennial | |
| Summer/fall, July-October | Blue Grama | *Bouteloua gracilis* | Perennial | |
| Summer/fall, July-October | Hairy Grama | *Bouteloua hirsuta* | Perennial | |
| Spring/summer, May-July | Buffalograss | *Buchloe dactyloides* | Perennial | |
| Summer/fall, June-August | Needleandthread | *Hesperostipa comata* | Perennial | |
| Spring/summer/fall, May-August | Junegrass | *Koeleria macrantha* | Perennial | |
| Summer/fall, June-August | Green Needlegrass | *Nasella viridula* | Perennial | |
| Summer/fall, June-September | Switchgrass | *Panicum virgatum* | Perennial | |
| Summer/fall, July-September | Little Bluestem | *Schizachyrium scoparium* | Perennial | |
| Fall, August-September | Indian Grass | *Sorghastrum nutans* | Perennial | |
| Summer/fall, June-September | Sand Dropseed | *Sporobolus cryptandrus* | Perennial | |
| **Forbs** | | | | |
| Spring/summer, May-July | White Penstemon | *Penstemon albidus* | Perennial | white |
| Spring/summer/fall, May-August | Plains Beebalm | *Monarda pectinata* | Annual | white, pale pink, or rarely purple |
| Spring/summer/fall, May-September | Purple Prairieclover | *Dalea purpurea* | Perennial | rose-purple to purple |
| Spring/summer/fall, May-September | Blanketflower | *Gaillardea aristata* | Perennial | yellow with purple center |
| Spring/summer/fall, May-September | Scarlet Globemallow | *Sphaeralcea coccinea* | Perennial | orange to pinkish |
| Spring/summer/fall, May-October | Hairy False Goldenaster | *Heterotheca villosa* | Perennial | yellow |
| Summer/fall, June-August | Rocky Mountain Beeplant | *Cleome serrulata* | Annual | pink to purplish, rarely white |
| Summer/fall, June-October | Common Yarrow | *Achillea millefolium* | Perennial | white or light pink |
| Summer/fall, June-August | Hoary Vervain | *Verbena stricta* | Perennial | blue or purple |
| Summer/fall, June-August | Lead Plant | *Amorpha canescens* | Perennial | violet |
| Summer/fall, June-August | Hoary Vervain | *Verbena stricta* | Perennial | blue or purple |
| Summer/fall, June-August | Blacksamson Echinacea | *Echinacea angustifolia* | Perennial | pink to purple |
| Summer/fall, June-September | Wild Bergamot | *Monarda fistulosa* | Perennial | purple, pink, or rose-purple, rarely |
| Summer/fall, June-September | White Prairieclover | *Dalea candida* | Perennial | white |
| Summer/fall, June-October | Prairie Coneflower | *Ratibida columnifera* | Perennial | yellow |
| Summer/fall, July-September | Fireweed | *Chamerion angustifolium* | Perennial | pink or rarely white |
| Summer/fall, July-September | Silky Prairieclover | *Dalea villosa* | Perennial | rose-purple to lavendar or pink |
| Summer/fall, July-October | Dotted Blazing Star | *Liatris punctata* | Perennial | purple |
| Summer/fall, July-October | Prairie Sagewort | *Artemisia frigida* | Perennial | green |
| Summer/fall, July-October | White Heath Aster | *Symphyotrichum ericoides* | Perennial | white |
| Summer/fall, July-October | White prairie aster | *Sypmphytotrichum falcatus* | Perennial | white |
| Summer/fall, August-October | Stiff Goldenrod | *Solidago rigida* | Perennial | yellow |

## Recommended Practice: Tree/shrub Establishment (NRCS Practice Code 612)

Tree/shrub Establishment is establishing woody plants by planting seedlings or cuttings, direct seeding, or natural regeneration. Tree/shrub establishment can be used to create forest products such as timber, pulpwood, etc., create wildlife habitat, provide long-term erosion control, and improve of water quality, treat waste, store carbon in biomass, reduce energy use, develop renewable energy systems, improve or restore natural diversity, and enhance aesthetics.

Composition of species planted will be adapted to site conditions and suitable for the planned purpose(s), no plants on the federal or state noxious weeds list shall be planted, planting or seeding rates will be adequate to accomplish the planned purpose for the site, planting dates, and care in handling and planting of the seed, cuttings, or seedlings will ensure that planted materials have an acceptable rate of survival, only viable, high-quality, and adapted planting stock or seed will be used, selection of planting technique and timing will be appropriate for the site and soil conditions, the planting will be protected from plant and animal pests and fire, refer to standard **Integrated Pest Management (595)** to assist with site-specific strategies for pest prevention, pest avoidance, pest monitoring, and pest suppression, each site will be evaluated to determine if mulching, supplemental water or other cultural treatments (e.g., tree protection devices, shade cards, brush mats) will be needed to assure adequate survival and growth.
A precondition for tree/shrub establishment is appropriately prepared sites. **Tree/shrub site preparation (490)** can be used to prepare the site (more information in supporting practices section).

Tree/shrub plantings designed to support pollinators should be composed of flowering shrubs that, in combination, provide a succession of bloom throughout the season, as well as, hollow-stemmed plants that provide nest sites for tunnel-nesting bees. Strips of warm-season grasses and diverse wildflowers can be planted adjacent to or as an understory of tree/shrub plantings to provide nesting sites and food for bumblebees, and refuge/overwintering sites for beneficial insects that prey on crop pests. **Conservation Cover (327)** and **Riparian Herbaceous Cover (390)** are two practices that can be used in conjunction with tree/shrub plantings for diverse understory plantings.

Tree/shrub establishment could be used to increase the number of flowering shrubs and trees on Ertl farm, increasing nectar and pollen resources for pollinators, as well as nesting sites for stem and tunnel nesting bees and wasps. Some native trees and shrubs are some of the first flowers available on the landscape in the spring and are a critical resource for early emerging pollinators.

Areas proposed for tree/shrub establishment include:
Fields 4, 5, 7, 9, 10, and 12

**Tree/Shrub Establishment Plan**

Establish tree/shrubs according to the Tree/shrub Establishment (612) Practice Standard and Tree/shrub Establishment (612) specifications and the Oklahoma Hedgerow Planting (422) Installation Guide (see Additional Resources). Establishing trees and shrubs for pollinators includes three phases: (1) site preparation; (2) planting, and; (3) follow-up management during establishment. Additional information on site prep, planting, establishment management, and ongoing management are provided in the Habitat Establishment and Maintenance Guidelines section, information on bolded recommendations can be found there.

Pairing a Tree/Shrub Establishment planting with **Conservation Cover (327)** will create a diverse, pollinator friendly understory in fields 10 and 5. Pairing **Riparian Herbaceous Cover (390)** and tree/shrub plantings in field 9 could improve bank stabilization, provide season long blooms, and increase habitat for stem nesting bees in that area. Follow site preparation recommendations for conservation cover and riparian herbaceous cover. Use **Brush Management (314)** or **Tree/Shrub Site Preparation (490)** for brush or tree removal or additional site preparation for the tree/shrub planting. **Integrated Pest Management (595)** is an additional supporting practice for mitigating pesticide risk on this habitat.

In field 4, the root systems of the existing desirable trees and the complete understory cover by tenacious Reed Canary Grass (*Phalaris arundinacea*) make pairing a tree/shrub planting with an understory planting of pollinator friendly herbaceous plants difficult. In this area, establishing trees and shrubs without an understory planting is the best option. Plan the number and location of tree/shrubs being installed and do site preparation in 5 foot diameter circle around each transplant location. In the early spring, mow the circles and apply a non-selective, non-persistent herbicide (**Herbaceous Weed Control (315)** may be applicable here). Lay down 4-5 layers of cardboard covering the circle except for a 1 foot diameter circle in the center where the tree/shrub will be planted. Cover the cardboard with 4-6” of wood mulch. Install the tree/shrub in the clear 1 foot diameter center of each area. This method should prevent Reed Canary Grass (RCG) from competing with the trees/shrubs in the establishment years. By the time RCG invades the wood mulch, the trees/shrubs should have established root systems and sufficient height to coexist with the RCG. Over time, the tree/shrub planting may shade out or weaken RCG populations, at that point, reseeding a native, diverse, shade tolerant understory may be possible. This preparation strategy is also applicable in field 7 because limited space is available for an understory planting.

**Transplanting** is the preferred planting method for trees and shrubs. Transplanting can occur anytime the ground can be worked, but should be timed to avoid prolonged periods of hot, dry, or windy weather. Fall is often a good time to transplant shrubs or trees. Regardless of when planting occurs, the transplants should be thoroughly irrigated immediately after planting. Establishment management is included with the details of this planting method and includes mowing/weeding around transplants, irrigation, and protection from herbivores. Once established, tree/shrub plantings require little ongoing management but should be monitored for health.

**Tree/shrub Establishment Plant Selection**

The recommended plant species for Tree/shrub planting at Ertl were selected for the following criteria:
1) woody plants with high value to pollinators;
2) butterfly host plants;
3) a combination of species that bloom early spring through fall;
4) commercial availability from regional nurseries;
5) native status (or locally adapted, non-invasive status);
6) lack of host potential for crop pests and diseases, and lack of weed potential; and
7) ease of establishment and suitability to local soils, drainage, and other site factors.

Species substitutions and modifications must be reviewed to ensure alternatives site appropriate and that they meet NRCS practice standards.See additional resources for species recommendations for Tree/shrub Establishment.

## Tree/Shrub Establishment Recommended Plants

| Bloom Period | Common Name | Scientific Name | Annual, Perennial, or | Flower color | Max. Height |
|---|---|---|---|---|---|
| **For Fields 5, 7, and 10** | | | | | |
| Spring, April-May | Wild Plum | *Prunus americana* | Perennial | white | 26 |
| Spring, April-June | Chokecherry | *Prunus virginiana* | Perennial | white | 20 |
| Spring/summer, May-July | Western Serviceberry | *Amelanchier alnifolia* | Perennial | white | 16 |
| Spring/summer, April-June | Golden Currant | *Ribes aureum* | Perennial | yellow to red | 7 |
| Summer/fall, July-September | Viscid Rabbitbrush | *Chrysothamnus viscidiflorus* | Perennial | yellow | 5 |
| Summer/fall, July-October | Rubber rabbitbrush | *Ericameria nauseosa* | Perennial | Yellow | 6.5 |
| Summer/fall, June-August | Smooth Rose | *Rosa blanda* | Perennial | pink | 7 |
| Spring/summer, April-June | Skunkbush Sumac | *Rhus trilobata* | Perennial | white, yellow | 10 |
| **For Fields 4 and 9** | | | | | |
| Spring/summer, May-July | False Indigo | *Amorpha fruticosa* | Perennial | violet to red-purple with orange-yellow | 10 |
| Spring/summer, April-June | Peach-Leaf Willow | *Salix amygdaloides* | Perennial | yellow/green | 40 |
| Spring/summer, April-July | Coyote Willow | *Salix exigua* | Perennial | yellow/green | 15 |
| Summer/fall, June-August | Wolfberry | *Symphoricarpos occidentalis* | Perennial | white | 4 |
| Spring/summer/fall, May-August | Thimbleberry | *Rubus parviflorus* | Perennial | white | 5 |
| Spring/summer/fall, June-August | Red raspberry | *Rubus idaeus var. strigosus* | Perennial | White | 5 |

## Recommended Practice: Riparian Herbaceous Cover (NRCS Practice Code 390)

Riparian Herbaceous Cover is the establishment or management of grasses, sedges, rushes, ferns, legumes, and forbs tolerant of intermittent flooding or saturated soils, as the dominant vegetation in the transitional zone between upland and aquatic habitats. This practice may be applied as part of a conservation management system to accomplish one or more of the following purposes; provide or improve food and cover for fish, wildlife and livestock, improve and maintain water quality, establish and maintain habitat corridors, increase water storage on floodplains, reduce erosion and improve stability to stream banks and shorelines, increase net carbon storage in the biomass and soil, enhance pollen, nectar, and nesting habitat for pollinators, restore, improve or maintain the desired plant communities, dissipate stream energy and trap sediment, and enhance stream bank protection as part of streambank soil bioengineering practices.

Select perennial plants that are adapted to site and hydrologic conditions and provide the structural and functional diversity preferred by fish and wildlife likely to benefit from the installation of the practice. If planted to increase pollinator and other wildlife habitat, only native species will be used in the riparian planting. Domestic grazing and haying will be deferred for a minimum of two years after planting or until such time as the desired plant community is well established. Determine the width of the riparian herbaceous cover planting based on the geomorphic potential of the site and project purposes, including the life history requirements of local fish and wildlife species, including pollinators. A basic Geomorphic Assessment will be used to determine the geomorphic potential, refer to the practice specification for details and the practice standard for further criteria for this practice.

Converting the weedy western waterway through Ertl farm would provide a corridor for wildlife through the north side of the farm, supply nectar and pollen resources for pollinators, provide permanent cover for nesting and overwintering sites for wildlife, and support beneficial insect species that rely on aquatic or moist habitats. Additionally, eliminating weed populations on these waterways should significantly reduce weed pressure on other areas of the property, including crop fields and areas proposed for range plantings. The riparian planting must be protected from pesticides. Although a portion of the crop fields on the east side of the waterway are converting to organic production, large sections near the waterway are planned to remain in conventional production. At a minimum, leave 35’ of unsprayed crop on the edges of the field nearest the waterway. Flowering trees and shrubs could be planted in conjunction with herbaceous plantings using **Tree/Shrub Establishment (612)**. Additional supporting practices to establish, enhance, or maintain riparian plantings on Ertl include **Tree/Shrub Site Preparation (490)**, **Prescribed Burning (338)**, **Herbaceous Weed Control (315)**, **Cover Crops (340)**, **Prescribed Grazing (528)**, **Brush Management (314)**, **Structures for Wildlife (649)**, and **Integrated Pest Management (595)**.

Areas proposed for riparian herbaceous cover include:
Field 9

**Riparian Herbaceous Cover Establishment Plan**

Establish a riparian planting of permanent vegetation according to the Riparian Herbaceous Cover (390) Practice Standards and Specifications (see attachments). Establishing habitat includes three phases: (1) site preparation; (2) planting, and; (3) management during establishment. Long-term maintenance is required after the planting is established to maintain its function. Additional information on site prep, planting, establishment management, and ongoing management are provided in the Habitat Establishment and Maintenance Guidelines section, information on bolded recommendations can be found there.

Because of the high weed pressure and persistent weed species along the western waterway, site preparation for a riparian herbaceous cover will be a multi-year project. Reed Canary Grass (*Phalaris arundinacea)*, Common teasel (*Dipsacus fullonum)*, and Whitetop (*Cardaria draba*) are found along the western waterway with large populations in the wet area where the waterway has a southern terminus in the center of the farm. Control and eradication plans for these species may extend for 6-10 years before replanting can occur and continued monitoring and spot spraying incoming weed populations are essential continual management activities for the life of the habitat.

Begin site prep with an early spring burn across all riparian areas to remove thatch and expose new growth to herbicides. Alternately, mow or hay the riparian areas in early spring. Use the **herbicide method** throughout the growing season to prevent any additional seed set. Continue herbicide applications into the fall, maintaining the spray regime until Reed Canary Grass (RCG) is no longer greening back up. In mild winters, herbicide applications may continue through the winter whenever there are periods of warm temperatures. Herbicide used in this area must be formulated for aquatic areas (glyphosate -Aquamaster®, Rodeo® and imazapyr -Habitat® are acceptable). Throughout this season, identify the weed species that are continuing to germinate and which areas have high populations of each weed species. Check for surviving RCG infestations by digging up roots, if roots are white and firm, expect further RCG population control in the area, if roots are rotten and/or mushy, RCG control in the area might decrease, although monitoring should continue for new growth from seed or surviving roots.

In order to prevent erosion, a cover crop should be planted in the second growing season. The cover crop will also help with weed suppression. Drill seed a dryland millet after last spring frost. Continue to spray any broadleaf weeds present in the cover crop with a broadleaf specific herbicide. When the cover crop has reached 12” high, terminate with a non-selective herbicide, make sure to also target any regrowth of RCG at this time with the herbicide. Keep the cover crop residue on the field until just before the dormant habitat planting.

If weed pressure has decreased after the first cover crop season (based on observations of germinating weeds) to the level that spot spraying weed populations is possible, conduct a dormant season seeding of native species adapted to moist conditions. If necessary, consult with NRCS staff or other land managers familiar with riparian restoration to determine if weed pressure has decreased enough for establishment of a native seeding to succeed. If weed pressure is still high, consider another cover crop planting for the next growing season. Cover

crop species or mix should be determined by the most pernicious weed species remaining, if broadleaf weeds are more populous than RCG, consider a grass cover crop or mixture such as millet, ryegrass or oats. Then, broadleaf specific herbicide applications can continue through the cover crop season to control those weeds. If RCG or other weedy grasses are dominant, plant a broadleaf cover crop or mixture with clover, peas, vetch, or others and use a grass selective herbicide to continue control of RCG.

Once acceptable levels of weed control are reached, lightly rake the site before dormant season seeding to remove excess residue from cover crop, leaving stem stubble on the ground helps keep seed and soil in place while new plants establish, but leafy detritus that covers the soil surface will prevent seed/soil contact. **Broadcast seeding** or **drilling** will work for this area. Because the seeding rate is doubled with broadcast seeding (80 seeds/$ft^2$), broadcasting may provide a denser stand of plants that are able to compete with weed species. **Establishment mowing/shredding** is recommended to prevent any additional weed seed set in the first two growing seasons and **herbicide spot sprays** of lingering or new weed populations will be essential to maintaining this site. After establishment period, **prescribed burning** and/or **prescribed grazing** in conjunction with nearby range plantings and conservation cover plantings are acceptable but their effects must be monitored and mitigated if excessive disturbance of the riparian areas threatens vegetation diversity and persistence.

**Riparian Herbaceous Cover Plant Selection**

The recommended plant species for Riparian Herbaceous Cover were selected for the following criteria:

1) documented or recognized pollinator (and beneficial insect) value;
2) butterfly host plants;
3) Wetland Indicator status of facultative (species equally likely to be found in wetlands and uplands), facultative wetland (usually found in wetlands), to obligate (almost always occurs in wetlands);
4) minimum of three species in each bloom period;
5) commercial availability from regional seed producers;
6) native status (or locally adapted, non-invasive status);
7) lack of host potential for crop pests and diseases, and lack of weed potential; and
8) ease of establishment and suitability to local soils, drainage, and other site factors.

Species substitutions and modifications must be reviewed to ensure alternatives site appropriate and that they meet NRCS practice standards. See additional resources for species recommendations for Riparian Herbaceous Cover

# Riparian Herbaceous Cover Recommended Plants

| Bloom Period | Common Name | Scientific Name | Annual, Perennial, or Biennial | Flower Color | Wetland Indicator Status |
|---|---|---|---|---|---|
| **Grasses/graminoids** | | | | | |
| Spring/summer/fall, May-September | Alkali Bulrush | *Schoenoplectus maritimus* | Perennial | | OBL |
| Summer/fall, July-September | Alkali Muhly | *Muhlenbergia asperifolia* | Perennial | | FACW |
| Summer/fall, June-September | Alkali sacaton | *Sporobolus airoides* | Perennial | | FAC |
| Summer/fall, June-September | Baltic Rush | *Juncus balticus* | Perennial | | OBL |
| Summer/fall, June-September | Canada Wildrye | *Elymus canadensis* | Perennial | | FACU |
| Spring/summer/fall, May-September | Clustered Field Sedge | *Carex praegracilis* | Perennial | | FACW |
| Spring/summer/fall, May-August | Common spikerush | *Eleocharis palustris* | Perennial | | OBL |
| Spring/summer/fall, May-September | Common threesquare | *Schoenoplectus pungens pungens* | Perennial | | OBL |
| Spring/summer/fall, May-September | Hardstem Bulrush | *Schoenoplectus acutus* | Perennial | | OBL |
| Fall, August-September | Indiangrass | *Sorghastrum nutans* | Perennial | | FACW |
| Spring/summer/fall, May-August | Inland saltgrass | *Distichlis spicata* | Perennial | | FACW |
| Summer/fall, July-September | Marsh Muhly | *Muhlenbergia racemosa* | Perennial | | FACW |
| Summer/fall, June-September | Nebraska Sedge | *Carex nebrascensis* | Perennial | | OBL |
| Summer/fall, June-August | Pale Bulrush | *Scirpus pallidus* | Perennial | | OBL |
| Summer/fall, June-September | Prairie cordgrass | *Spartina pectinata* | Perennial | | FACW |
| Spring/summer/fall, May-September | Softstem Bulrush | *Schoenoplectus tabernaemontani* | Perennial | | OBL |
| Summer/fall, June-September | Switchgrass | *Panicum virgatum* | Perennial | | FAC |
| Summer/fall, June-September | Torry's Rush | *Juncus torreyi* | Perennial | | FACW |
| **Forbs** | | | | | |
| Spring/summer/fall, May-August | Wand Phacelia | *Phacelia heterophylla* | Perennial | white to purplish | FAC |
| Spring/summer/fall, May-September | Canadian Anemone | *Anemone canadensis* | Perennial | white | FACW |
| Spring/summer/fall, May-September | Richardson's Geranium | *Geranium richardsonii* | Perennial | white to pink | FAC |
| Summer/fall, June-August | Heal-all | *Prunella vulgaris* | Perennial | blue to purple | FAC |
| Summer/fall, June-September | Canadian Milkvetch | *Astragalus canadensis* | Perennial | white | FACW |
| Summer/fall, July-September | Swamp Verbena | *Verbena hastata* | Perennial | purple | OBL |
| Summer/fall, July-September | Spotted Joepyeweed | *Eutrochium maculatum* | Perennial | purple | FACW |
| Summer/fall, July-September | Swamp Milkweed | *Asclepias incarnata* | Perennial | pink or rarely white | FAC |
| Summer/fall, July-September | Rocky Mountain Blazing Star | *Liatris ligulistylis* | Perennial | purple | FAC |
| Summer/fall, July-October | Plains Coreopsis | *Coreopsis tinctoria* | Annual | yellow with red center | OBL |
| Summer/fall, July-October | Giant Goldenrod | *Solidago gigantea* | Perennial | Yellow | FAC |
| Fall, August-September | Great Blue Lobelia | *Lobelia siphilitica* | Perennial | blue | OBL |
| Fall, August-October | Western Goldentop | *Euthamia occidentalis* | Perennial | yellow | FAC |
| Fall, August-October | Slenderleaf False Foxglove | *Agalinis tenuifolia* | Perennial | pink to purple or rarely | FACW |
| Fall, August-October | New England Aster | *Symphyotrichum novae-angliae* | Perennial | pink to purple or rarely | FACW |

## Recommended Practice: Field Border (NRCS Practice Code 386)

Field Border is defined as strips of permanent vegetation (grasses, legumes, forbs, or shrubs) established at the edge or around the perimeter of a field. The purpose of field border plantings include protection or improvement of the quality of soil, water, air, and wildlife habitat on the farm. This practice applies on the perimeter of fields (cropland and grazing lands) and can connect other buffer practices within and between fields.The area of the field border is taken out of production and permanent vegetation, including mix of native grasses, legumes, forbs, is established to provide habitat for pollinators.

Field borders shall be established at field edges to the extent needed to meet the resource concern and broader objectives. Field borders shall be planted to grass, forbs, and/or shrubs that accomplish the design objectives. Field borders planted for pollinators must provide food resources and a pesticide-free refuge for beneficial organisms (e.g., predatory and parasitic insects and spiders) that prey on target pests and pollinators. To meet NRCS practice standards, field border must be at least 30 feet wide.

Field borders on Ertl will address pollinator food and shelter resource concerns. Additionally, field borders may help Ertl farm meet organic certification requirements. Field border plantings near crop fields may reduce pest populations and pesticide use by supporting diverse communities of insects that prey on crop pests. Field borders will have floral resources and nesting sites for pollinators and beneficial insects and will enhance the aesthetics on the farm. Supporting practices applicable with Field Borders include **Prescribed Burning (338)**, **Brush Management (314)**, **Herbaceous Weed Control (315)**, **Integrated Pest Management (595)**, and **Structures for Wildlife (649)**.

Areas proposed for field borders include:
Fields 2 and 12

## Field Border Habitat Establishment Plan

Establish a field border of permanent vegetation according to the Field Border (386) Practice Standards (see attachments). Establishing field borders includes three phases: (1) site preparation; (2) planting, and; (3) management during establishment. Long-term maintenance is required after the field border is established to maintain its function. Additional information on site prep, planting, establishment management, and ongoing management are provided in the Habitat Establishment and Maintenance Guidelines section, information on bolded recommendations can be found there.

Field borders can be established using the **herbicide method** or **soil solarization.** For the field borders surrounding the organic field, soil solarization may be the only option for site preparation due to organic regulations.

Both **broadcast** and **drilling** seeding methods will work with for field border plantings on Ertl. Field borders should be planted during the dormant season (November to March). Due to high

weed pressure, we recommend establishment **mowing/shredding** during the first growing season on field border plantings. **Herbicide spot spray applications** can be used for weed species that flower and set seed at low heights (after shredding/mowing) or for areas of weed encroachment that occur after the second growing season. **Ongoing mowing** or **haying** and/or **prescribed burning** of ⅓ to □ of the site a abundance in field borders.

**Field Border Plant Selection**

The recommended plant species for field borders were selected for the following criteria:
1) documented or recognized pollinator (and beneficial insect) value;
2) butterfly host plants;
3) minimum of three species in each bloom period;
4) commercial availability from regional seed producers;
5) native status (or locally adapted, non-invasive status);
6) lack of host potential for crop pests and diseases, and lack of weed potential; and
7) ease of establishment and suitability to local soils, drainage, and other site factors.

Species substitutions and modifications must be reviewed to ensure alternatives site appropriate and that they meet NRCS practice standards. See Conservation Cover species list for species recommendations for Field Border.

## Recommended Practice: Cover Crops (NRCS Practice Code 340)

Cover Crop is defined as crops, including grasses, legumes, brassicas, and other broadleaf species, for seasonal cover and other conservation purposes such as soil health, weed suppression, and increasing biodiversity. This practice can be applied to support one or more if the following purposes; reduce erosion, maintain or increase SOM, reduce water quality degradation, suppress excessive weed pressures and break pest cycles, and improve soil moisture efficiency. This practice is applicable on all lands requiring vegetative cover for natural resource protection and/or improvement. The intended purpose for cover crop planting at Ertl is to address resource concerns regarding pollinator and beneficial insect habitat (i.e., inadequate habitat for fish and wildlife).

Plant species, seedbed preparation, seeding dates, seeding depths, fertility requirements, planting methods, and termination will be consistent with approved local criteria and site conditions. Cover crops may be established between successive production crops, or companion-planted or relay-planted into production crops.

Cover crops on Ertl will support pollinators, beneficial insects, and increase biodiversity. Cover crops will create temporary forage for pollinators, increase habitat for beneficial insects, and improve the soil. Flowering cover crop species that provide pollinator forage and attract beneficial insects should be used. Ensure that the cover crop species are allowed to flower before the required termination time.It is critical that the pollinator habitat area is outside of areas sprayed with insecticide and/or protected from application and drift.On Ertl farm, wheat fields that are summer fallow may be an excellent opportunity for a flowering cover crop that will provide pollinator forage as well as contribute to soil health. Camelina, canola, clover, cowpea, flax, mustard, safflower, turnips, radish, rape, and phacelia are flowering species that could be used singly or mixed with graminoid species for a cover crop. Supporting practices for cover crops include **Integrated Pest Management (595)** and **Herbaceous Weed Control (315)**.

Areas proposed for cover crops include:
Field 8 and with other crop production fields

## Cover Crop Habitat Establishment Plan

Establish a flowering cover crop on fallow fields or as insectary strips between crop rows according to the Cover Crop (340) Practice Standards and supplemental guidelines included in this plan. For a timeline of planting dates and management activities for cover crops, follow NRCS Practice Standard for Cover Crops. For additional information consult SARE Managing Cover Crops Profitably, 3rd Edition (see Additional Resources).

The method of cover crop termination is related to the purpose for implementing cover crops. A variety of termination options exist including frost kill, disking, roller-crimping, or a combination of methods. In general, cover crops grown to provide beneficial insect habitat should be allowed to reach maximum flowering, but terminated before seed is set. Refer to the NRCS Cover Crop Termination Guidelines provided in the additional resources of this plan for more cover crop species-specific information regarding termination.

NRCS is flexible with planting and termination dates but crop insurance may prevent more creative timings of cover crops. Boulder County is in Zone 1 for cover crop termination; cover crops must be terminated 35 days or earlier before cash crop planting (although fall seeded cover crops with an early spring planted cash crop such as corn, spring wheat, or sugar beets can be terminated at or just prior to seeding of cash crop). No-till systems may terminate 7 days later (28 days prior to cash crop planting).

Planting methods will vary depending on the purpose for implementing the cover crops. Typically cover crops are **drilled** with a seed or grain drill but **broadcasting** smaller areas is acceptable. **Establishment mowing** can be used to control weeds that are growing more quickly than the cover crop. **Herbicide spot spray applications** can also be used to control problematic weeds growing within the cover crop.

**Cover Crop Plant Selection**

The recommended plant species for Cover Crop were selected for the following criteria:
1) flowering species, documented or recognized pollinator value;
2) attractive to predators and parasitoids of crop pests;
3) complementary to cropping system;
4) lack of host potential for crop pests and diseases;
5) ease of establishment and suitability to local soils, drainage, and other site factors; and
6) benefits such as soil health, pest and weed suppression, water retention, and biodiversity

Species substitutions and modifications must be reviewed to ensure alternatives site appropriate and that they meet NRCS practice standards. See additional resources for species recommendations for Cover Crop.

## Cover Crop Recommended Plants

| Common Name | Scientific Name | Annual, Perennial, or Biennial | Flower color | Notes |
|---|---|---|---|---|
| Crimson Clover | *Trifolium incarnatum* | Annual | Red | Plant in spring or fall |
| Oilseed Radish | *Raphanus sativus* | Annual | Pink, white, or lavender | Can be planted in shoulder seasons |
| Scorpion Weed | *Phacelia tanacetifolia* | Annual | Purple | Can be planted in shoulder seasons |
| Cowpea | *Vigna unguiculata* | Annual | Pink to purple | Plant in summer |
| Winter Camelina | *Camelina sativa* | Annual | Yellow | Plant in fall, overwinters as rosette, |
| Pennycress | *Thlapsi arvense* | Annual | White | Plant in fall |
| Alfalfa | *Medicago sativa* | Perennial | Purple | Plant in spring or fall |

## Supporting Practices

### Recommended Practice: Brush Management (NRCS Practice Code 314)

Brush management is the removal, reduction, or manipulation of non-herbaceous plants. Brush management can be used to restore natural plant community balance, create the desired plant community, restore desired vegetative cover to protect soils, control erosion, reduce sediment, improve water quality and quantity, and enhance stream flow, maintain or enhance wildlife habitat including that associated with threatened and endangered species, improve forage accessibility, quality and quantity for livestock, and protect life and property from wildfire hazards.

Brush management is most often performed through mechanical and/or chemical means but the use of a biological agent can be used in certain circumstances. If herbicides are used, label instructions must be followed and applications should be as targeted as possible to reduce the risk to valuable vegetation that may be near undesirable tree or shrub infestations. Following initial application, some regrowth, resprouting or reoccurrence of brush is expected. Spot treat individual plants or areas as needed.

Any rangeland, native or naturalized pasture, or hay lands on Ertl which have weedy tree or shrub problems could use brush management. Maintaining open, diverse range, pasture, and haylands is vital to the health of pollinators and other insects.

## Recommended Practice: Herbaceous Weed Control (NRCS Practice Code 315)

Herbaceous Weed Control is the removal or control of herbaceous weeds including invasive, noxious, and prohibited plants. Herbaceous weed control may enhance accessibility, quantity and quality of forage and/or browse, restore or release native or create desired plant communities and wildlife habitats consistent with the ecological site, protect soils, control erosion, reduce fine-fuels fire hazard, and improve air quality. This practice is applicable on all land uses except cultivated cropland and horticultural cropland, including orchards and vineyards.

Follow label guidelines when using herbicides and disposing of weed materials in a manner that will prevent the spread of herbaceous weeds to new sites. Target weed species when they are most vulnerable, apply herbaceous weed control to best protect the health and vigor of native or desirable plant species, and consider the habitat needs of wildlife before applying herbaceous weed control.

Herbaceous weed control may be used in conjunction with other recommended practices on non-cropped areas of the Ertl farm including grazing lands, grassed waterways, farm road edges, and field borders. Herbaceous weed control can be used to prepare a site for planting and for continued management of weeds.

While herbicides do not target pollinators specifically, broad use of herbicides can severely reduce the floral resources available and may be directly toxic to some pollinators. To reduce impacts of herbicides on insects, use a selective approach to herbicide applications, avoiding broadcast sprays or pellet dispersal. Reduce drift to nearby habitat by calibrating equipment, maintaining a buffer, and spraying when winds are 3-9 mph. Additionally, consider timing herbicide sprays for periods when pollinators are less active, early in the morning or late at night, and avoid spraying any plants that are in flower.

## Recommended Practice: Integrated Pest Management (NRCS Practice Code 595)

Integrated Pest Management (IPM) is defined as a site-specific combination of pest prevention, pest avoidance, pest monitoring, and pest suppression strategies. The purposes of IPM include: prevent or mitigate off-site pesticide risks to water quality from leaching, solution runoff and adsorbed runoff losses, prevent or mitigate off-site pesticide risks to soil, water, air, plants, animals, and humans from drift and volatilization losses, prevent or mitigate on-site pesticide risks to pollinators and other beneficial species through direct contact, and prevent or mitigate cultural, mechanical, and biological pest suppression risks to soil, water, air, plants, animals, and humans. This practice applies on all lands where pests are managed. The intended purpose for IPM on Ertl is to modify the existing plan to prevent and/or mitigate on-site pesticide risks to pollinators, beneficial insects, and their habitat through direct contact, drift, or other exposure pathways listed in Part Four: Pesticide Protection and Mitigation of this plan.

IPM strategies (Prevention, Avoidance, Monitoring and Suppression or “PAMS”) shall be employed to prevent or mitigate pest management risks for identified natural resource concerns. A comprehensive IPM plan utilizing PAM’s strategies should be developed in accordance with NRCS practice standards to document how specific pest management risks will be prevented or mitigated. The IPM plan must be crop and/or land use specific and adhere to applicable elements and guidelines accepted by the local Land Grant University or Extension. As previously mentioned, Boulder County is already committed to IPM. The recommendations in this plan are intended to enhance their current IPM strategy to better incorporate pollinator protection.

Preventing or mitigating on-site pesticide risks to pollinators and other beneficial species through direct contact with pesticides and pesticide residues and protecting pollinator habitat from pesticide drift are broad recommendations for Ertl Farm and Boulder County. Specific strategies were designed for this plan based on current practices that should be maintained and additional practices that need to be implemented. New practices were recommended to increase the mitigation index points determined by pollinator natural resource concerns and practices for pollinator risk reduction were identified with the aid of Win–PST. To meet NRCS practice standards, documentation of recommended mitigation practices and techniques is required and records must be submitted on an annual basis for the life of the practice.

This practice is proposed as a whole-farm practice. Priority areas include alfalfa fields and fields adjacent to organic land and to pollinator habitat

Pest Management Considerations in Conservation Planning
The NRCS IPM conservation practice is specifically designed to document the application of IPM techniques that address site-specific natural resource concerns. In this plan the resource concern is wildlife (pollinator) protection. The NRCS IPM conservation practice is not designed to manage pests, as technical assistance for managing pests on cropland is not an identified role for NRCS conservation planners. Therefore, NRCS planners must work closely with the Cooperative Extension Service, producers, and their crop consultants to appropriately integrate all planned pest management activities into the conservation planning process. The goal of the

NRCS IPM conservation practice is to prevent environmental risks with an efficient IPM system, if possible, and mitigate any environmental risks that cannot be prevented. Conservation planners with NRCS can work with the landowner to suggest detailed recommendations on existing risk mitigation practices and techniques to incorporate into pollinator protection into Boulder County's IPM plans, and the required documentation for Integrated Pest Management (595) practice participation.

Review and update the plan periodically in order to incorporate new IPM strategies, respond to cropping system and pest complex changes, and avoid the development of pest resistance. Maintain mitigation techniques identified in the plan in order to ensure continued effectiveness. Calibrate application equipment according to Extension and/or manufacturer recommendations before each season of use and with each major chemical change. Maintain records of pest management for at least two years. Pesticide application records shall be in accordance with USDA Agricultural Marketing Service's Pesticide Recording Keeping Program and site specific requirements.

## Recommended Practice: Prescribed Burning (NRCS Practice Code 338)

Prescribed burning is the use of controlled fire on a predetermined area for multiple purposes including the control of undesirable vegetation, preparation of sites for harvesting, planting or seeding, reduction of wildfire hazards, improvement of wildlife habitat, improvement of plant production quantity and/or quality, distribution of grazing and browsing animals, and the restoration and maintenance of ecological sites.

The following should be addressed prior to ignition; location and description of the burn area, re-burn vegetation cover, resource management objectives, required weather conditions for prescribed burn, notification check list, pre-burn preparation, equipment checklist/personnel assignments and needs/safety requirements, post burn evaluation criteria, firing sequence, ignition method, and approval signatures. All necessary permits must be obtained and a burning plan developed before implementation of the practice. Additionally, burns should be planned with consideration for the needs of pollinators and wildlife, including nesting, feeding, and cover.

Prescribed burning could be an integral management tool for habitat areas on the ERTL farm. Prescribed fire would be an efficient way to remove thatch from grazelands as a site prep method if range planting will occur and should be considered in ongoing management to encourage new plant growth and maintain diversity on site. Prescribed burning may also be an important practice to maintain wildflowers in the locations proposed for conservation cover, as other disturbance management may be difficult in those areas due to accessibility and size.

Performing prescribed burning as an ongoing management tool on only ⅓-⅕ of the site per year provides a refuge for insects to escape fire. Many pollinators will quickly recolonize the burned areas and the benefits to wildflowers from prescribed burns likely outweighs the loss of insects from the burn. Because of the small size of the areas proposed for conservation cover, it may be most effective to burn those entire areas once every 3-5 years in conjunction with the grazed land prescribed burns.

## Recommended Practice: Prescribed Grazing (NRCS Practice Code 528)

Prescribed grazing is the management of the harvest of vegetation with grazing and/or browsing animals. Prescribed grazing can improve or maintain the health and vigor of plant communities, quantity and quality of forage for livestock health and productivity, water quality and quantity, soil condition, and the quantity and quality of food and/or cover for wildlife. This practice may also reduce accelerated soil erosion and provide economic stability through grazing land sustainability.

Landowners will follow a prescribed grazing plan created by NRCS staff to address multiple resource concerns and will address the kind of animal, animal number, grazing distribution, length of grazing and rest/recovery periods, and timing of use to provide sufficient deferment from grazing during the growing period. Best management practices to protect soil, water, air, plant, and animal resources when locating livestock feeding, handling, and watering facilities will be included, as well as guidance on managing grazing animals to maintain adequate vegetative cover on sensitive areas (i.e. riparian, wetland, habitats of concern, karst areas, Mountain Plover habitat). One of the key criteria of prescribed grazing is practicing adaptive management by adjusting stocking rate and duration of grazing by observing the conditions of both plant and animal on the ground as opposed to strictly following calendar dates for resting pasture.

Prescribed grazing is recommended for all grazelands on the Ertl farm and is a recommended practice in conjunction with **Range Planting (NRCS Practice Code 550)** but can be used as a stand alone practice on existing range or pasture as well. Prescribed grazing may work well for this landowner because he manages multiple farms and may have the flexibility to move cattle to other sites if needed to maintain diverse range plant communities on Ertl. Managing grazing will help protect and boost pollinator populations on the Ertl farm in a number of ways. When managed correctly, grazing is an incredibly powerful tool to maintain diverse plant communities, including plant species that provide floral resources or are host plants for pollinating insects. However, grazing does introduce some risks to pollinators, especially if improperly managed. Overgrazed pasture is often devoid of flowers and cover for insects, and ground nesting insects can be harmed from livestock trampling. Following a prescribed grazing plan can alleviate these risks. A grazing plan where only ⅓ to □ of the s
grazing varying across years and section of site is ideal. This can be achieved with rotational grazing using fencing (**Fence NRCS Practice Code 382** can be used for fence construction-guidelines for this practice can be found online or by visiting your local NRCS service center) or by utilizing a patch burn grazing system where prescribed burning is used on ⅓ to □ of the sit
yearly to attract livestock to the area most recently burned.

## Recommended Practice: Restoration and Management of Rare or Declining Habitats - Shortgrass prairie (NRCS Practice Code 643)

Restoration and management of rare or declining habitats is defined as restoring, conserving, and managing unique or diminishing terrestrial and aquatic ecosystems. The purpose of the restoration and management of rare or declining habitats practice is to return terrestrial or aquatic ecosystems to their original or usable and functioning condition and to improve biodiversity by providing and maintaining habitat for fish and wildlife species associated with the ecosystem. Native plant communities considered rare or declining in Colorado include, but are not limited to: fens, shortgrass prairie, tallgrass prairie, and sagebrush-steppe.

General criteria includes control of noxious and invasive weeds, the use of high quality and ecologically adapted plant materials, the maintenance of a disturbance free area, a pretreatment and post-treatment assessment, and optimal seeding rates, methods, and site prep for vegetative survival. A variety of practices will facilitate the restoration and management of rare or declining habitat, including **Range Planting (550), Herbaceous Weed Control (315), Prescribed Burning (338), Prescribed Grazing (528), Brush Management (314), Fence (382),** and **Tree and Shrub Establishment (612)**.

Using this practice is one option to support the restoration of native grasslands onto the Ertl farm. Typically, restoration and management of rare or declining habitats is used in conjunction with **Range Planting (550)** as an added cost share incentive and could be used on the existing non-native pastures to provide forage (forbs, shrubs, and trees) and nesting resources for pollinators. Many specialist pollinators that are closely tied to rare plants or habitats may significantly benefit from efforts to protect rare habitat. In addition, certain rare plants require pollinators to reproduce. This practice would require a complete restoration of either/both pastures and the use of non-native grasses and forbs is not compatible with this practice. However, all disturbance regimes are allowed under this practice type; grazing, burning, and haying are encouraged to maintain a diverse shortgrass prairie system.

## Recommended Practice: Structures For Wildlife (NRCS Practice Code 649)

Structures for Wildlife is defined as a structure installed to replace for modify a missing or deficient wildlife habitat component. The purpose of this practice is to provide structures, in proper amounts, locations, and seasons to enhance or sustain non-domesticated wildlife or modify existing structure that pose a hazard to wildlife. This practice applies to all lands where planting or managing vegetation fails to meet the short-term needs of the species or guild under consideration. The intended purpose for structures for wildlife at Ertl is to address resource concerns regarding pollinator nesting habitat (i.e., inadequate habitat for fish and wildlife). A structure is provided to support the nesting and rearing of smaller targeted species, such as bees, and is directly mounted to a tree, building or other structure. When trees, buildings or other structures are not available, nesting boxes can be attached to a wooden pole.
General criteria states structures will be constructed and installed when the state-approved habitat appraisal method identifies limiting habitat components that cannot be provided within the desired time period with implementation of a vegetation management strategy. The materials used to create structures and location of structures are to meet the needs of target species and not subject individuals to increased risks of injury or mortality.

Enhancing pollinator habitat using constructed nesting sites for wood-nesting and tunnel-nesting wild bees is recommended for Ertl. Native bee nesting structures should be installed in areas where woody vegetation, snags, stumps, and other vegetative structure that provides nesting sites for wild bees are scarce or absent. Priority areas on Ertl for constructed nesting sites are fields 1, 7, and 11.

### Structures For Wildlife Materials Selection and Construction

Common materials used for constructing bee nests include drilled wooden blocks, bundles of reed or bamboo sections (or other hollow stem), bundles of cardboard tubes, and grooved boards (i.e., binder boards). See Xerces fact sheets, “Tunnel Nests for Native Bees”, and “ Nests for Native Bees” in additional resources for additional materials and alternatives.

Nesting blocks: Bee blocks can be made by drilling nesting holes between 3/32” and 3/8” in diameter, at approximate ¾ inch centers, into the side of a block of preservative-free lumber. The holes should be smooth inside, and closed at one end. The height of the nest is not critical—8 inches or more is good—but the depth of the holes is important. Holes less than ¼ inch diameter should be 3-4 inch deep. For holes ¼ inch or larger, a 5-6” depth is best.

Stem or tube nesting bundles: Some plants, like teasel, bamboo, and reeds, have naturally hollow stems. Cut the stems into 6” to 8” lengths. Be careful to cut the stems close to a stem node to create a tube with one end closed. Fifteen to twenty stem pieces tied into a bundle (with the closed ends of the stems together) makes a fine nest. Or, make a wooden frame to hold as many stems as you like. Paper tubes can be used as well.

Logs and snags: Get some logs or old stumps and place them in sunny areas. Those with beetle tunnels are ideal. If beetle tunnels are not present, don the southeast side of each log, drill a range of holes, as outlined above. Place nesting structures with the openings or holes

facing south-southeast. Attached structures to a tree, building, or pole. To make sure nests stay dry, the location can be sheltered from rain or the nest can be placed in a protective shelter.

**Structures for Wildlife Management**

Monitor condition and/or usage of structures twice per year. Implement adaptive management by replacing structures annually with the least disturbance to target species. Install, modify and/or monitor during the season of year or time of day to minimize disturbance to wildlife.

## Recommended Practice: Tree/Shrub Site Preparation (NRCS Practice Code 490)

Tree/Shrub Site Preparation is the treatment of areas to improve site conditions for establishing trees and/or shrubs. Tree/Shrub Site Preparations encourages natural regeneration of desirable woody plants and establishment of new woody plants. Tree/Shrub Site Preparation can include clearing or trampling using heavy machinery, chemical site preparation, prescribed burning, and tilling for site preparation.

The method, intensity and timing of site preparation will match the limitations of the site, limitations of available equipment, and the requirements for establishing the desired woody species. Choose an appropriate site preparation method to achieve the intended purpose and to protect desirable vegetation, and site and soil conditions. Use other complementary practices and measures as needed, to control erosion, runoff, compaction and displacement to acceptable levels. Remove, treat or eliminated slash and debris as appropriate. Refer to the standard Slash Treatment (384) (available online or at local NRCS field offices) for applicable planning criteria. Slash and debris that remains after treatment shall not create habitat for or harbor harmful levels of pests. Remaining slash and debris shall not hinder needed equipment operations or create an undue fire hazard. Refer to the standard **Prescribed Burning (338)** for burning of slash and debris. Implement vegetation management activities to control or protect against locally invasive and noxious species that may arise from site preparation activities. Refer to the standard Pest Management, 595, for applicable planning criteria for chemical suppression activities.

Tree/Shrub Site Preparation can be used on Ertl on any areas considered for **Tree/Shrub Establishment (612)** to ensure a success. Tree/Shrub Establishment is proposed in fields 4, 5, 7, 9, 10, and 12.  fallow area where hay is stacked, along west roadside edge of farm, into existing treelines in center of farm, and near residential area and fenced farmstead area in conjunction with conservation cover, in riparian areas on western waterway with riparian herbaceous cover

# Habitat Establishment and Maintenance Guidelines

## Site Preparation Methods

Habitat creation requires excellent site preparation. Site preparation is one of the most important, though often inadequately addressed, components of project success. It is also a process that may require more than one season of effort to reduce competition from invasive, noxious, or undesirable non-native plants prior to planting. Site preparation should focus on the eradication of invasive, persistent perennial weeds. More effort and time spent eradicating undesirable vegetation prior to planting will result in higher success rates in establishing the targeted plant community. Weed abatement is a critical step in preparing the proposed planting areas. Newly planted areas should be clearly marked to protect them from herbicides, insecticides, and other disturbances. Supporting practices such as **Herbaceous Weed Control (315), Prescribed Burning (338)** and others may be used as guidelines or to provide a cost share on many site preparation activities.

Additional information on site preparation methods can be found in “Pollinator Meadow Installation Guide and Checklist - Upper Midwest” in the additional resources.

### Non-selective, Non-persistent Herbicide

The most effective site preparation method for plantings is a season long regime with a non-selective, non-persistent herbicide. Begin this process in early spring as cool season weeds flourish. Clear existing thatch as necessary before herbicide application to ensure the new weed growth is exposed to herbicide. Raking, harrowing, haying, or burning can be used to remove thatch. Apply herbicide as soon as weeds begin germinating. Repeat herbicide application as needed through the summer and fall (when newly emergent weeds are 4-6”). If weeds are not responding to herbicide applications, consider alternate herbicides and/or mow the site repeatedly through the growing season to prevent any weeds from flowering or setting seed. If the site has high weed pressure, a second season of herbicide application may be necessary to thoroughly suppress weed pressure before planting. Plant seed in the dormant season (November-March).

### Soil Solarization

Soil solarization is a method of controlling weeds by covering the ground with a UV stabilized plastic during periods of high ambient temperatures. The greenhouse effect of the clear plastic produces high temperatures, kills new growth of weeds, and may also kill weed seeds in the upper levels of soil. Purchasing UV stable plastic can be a large cost and this method may be most efficient for small plantings or when plastic can be repurposed before or after soil solarization.
Mow or cultivate the planting site in early spring. Ensure that the planting area is smooth, level, and free from large rocks or brush that would raise or pierce the plastic. Dig a trench at least 4” deep around the planting site. Irrigate the site. Lay the plastic by hand or with equipment, pull

the plastic taut and bury the edges so there is no airflow underneath the plastic. Check the plastic frequently for rips or tears which must be promptly patched using greenhouse tape or clear plastic packing tape (duct tape is not effective). Regularly mow around the area to control weeds and weed set adjacent to planting. Remove plastic in the fall when temperatures begin to drop (e.g. after first killing frost); if there is vegetative growth of perennial weeds, hand weed out those species on the planting site with as little soil disturbance as possible. Plant the site immediately after plastic removal.

## Planting Methods

Planting method will depend on site characteristics, desired species, equipment availability and general farm management. Habitat creation practices may have additional criteria and guidance on planting methods.

Additional information on planting methods can be found in “Pollinator Meadow Installation Guide and Checklist - Upper Midwest” in the additional resources.

### Broadcast Seeding

Broadcast seeding is spreading seed over the surface of the soil by hand or with a broadcast or drop seeder. It is an inexpensive, uncomplicated method of seeding that can accommodate poorly cleaned seed. Broadcasting by hand or with small equipment may be the only option to reseed areas with extreme slopes or poor accessibility.

Sow wildflower and grass seed in the late fall to late winter using the seed mix provided for the practice. Prior to seeding, create a smooth seedbed by removing as much debris, stubble, and thatch as possible from the area to be planted, this can be achieved by raking, harrowing or burning the site. Raking or harrowing the soil can break-up crusted surfaces. Rolling the entire area with a cultipacker or water-filled turf grass roller to ensure a lightly packed and flat seedbed prior to planting is ideal but not crucial. Seed-soil contact is critical for successful establishment. Seed of similar-sizes can be mixed together and bulked up with an inert carrier ingredient such as paving sand, peat moss, vermiculite, or cracked corn. These inert carriers ensure even seed distribution in the mix, visual feedback on where seed has been thrown, and make calibration easier. Divide the seed into small batches, bulk the seed mix with an inert carrier, mix well, and sow each batch separately (walking in perpendicular passes) to ensure that seed is evenly distributed. Regardless of how it is broadcast, do not cover the seed with soil after planting. A cultipacker or water-filled turf grass roller can be used to press the seed into the soil surface if conditions allow. Using a cultipacker after broadcasting increases seed soil contact.

Seedbed can be prepared in late fall and seed may be broadcast anytime from November to March (seeding after a light snowfall is ideal). If using NRCS practices to seed, some practices may require the use of more seeds if broadcasting than if drilling, work with your local NRCS planner to guarantee you are meeting practice standards.

### Drill Seeding

Seed mixes can also be installed using a no-till seed drill (e.g., Truax drill), which would only be appropriate for flat, level surfaces. Sloped areas will still need to be broadcast seeded. Small amounts of stubble and residue can remain on site if using a drill, although excessive residue may limit light penetration to small seedlings and prevents broadcasting small seeds after drilling. If drilling, get all seed packaged separately if possible, so fluffy and fine seed can be separated and loaded into the proper seed bins on the drill. Only drill when soils are dry and do

not stick to machinery. Separate seed into 3 categories, small smooth seed, large smooth seed, and tufted or “fluffy” seed that will not flow smoothly. Bulk up each category of seed using an inert carrier ingredient such as cracked corn, kitty litter, or vermiculite. Ensure that seed is distributed evenly within the inert carrier, not sinking to the bottom nor floating at the top of the carrier mixture. Loosely fill the seed boxes with the appropriate category of seed. Seed quantities that do not cover the agitator can be broadcast seeded as calibration for small amounts of seed is difficult or can be further bulked up using the inert carrier ingredient. Seed should be drilled as shallowly as possible. Do not plant any seed greater than ¼ inch deep. Stop periodically during planting to check depth.Most small seeds require light to germinate and can be broadcasted over the planted area during or after drilling.

Operate drill at less than 5 mph, stopping periodically to check for clogging of planting tubes (usually observed as a seed box that is staying full). Clogging is most common with fluffy or chaffy seed. Avoid backing up the drill as reversing will likely cause clogging.

Calibrating the drill to ensure even seed distribution across the planting site is important. Use manufacturer instructions for the particular drill or search for calibration instructions specific to drill used online. Attached are two general guides for calibrating common drills used in conservation plantings, “Calibrating a Seed Drill for Conservation Planting: Plant Materials Technical Note” and “Calibration of Truax No-Till Grain Drill (Model FLX 1188RD)” (see additional resources).

### Transplanting

Transplant container stock in spring or fall after/before frost periods and avoid planting during prolonged periods of hot, dry, or windy weather. Space woody shrubs at eight foot intervals. Prior to planting, rake or harrow the strip to create a clean surface for installing transplants. Pre-drill the appropriate amount of holes, fill holes with compost, and stage plants before planting. Irrigate transplants thoroughly immediately after planting. Follow-up irrigation may be necessary during the establishment period, depending on the frequency of natural rain events. Transplants should receive at least 1 inch of water per week during the establishment period. In most cases, irrigation can be removed from transplants by the second year after planting.
One-time mulching after planting is recommended to reduce weed competition and retain moisture during the establishment period. Clearly mark (flag) small seedlings after planting and control weeds before they set seed by mowing and/or string trimming around and between seedlings along the entire length of the planting. Mechanical removal of perennial noxious and invasive weed species that appear in the first year, such as Canada thistle, may be necessary. Control weeds within a minimum of one foot around each seedling by mowing, or string-trimming, or hand-weeding for at least two years or until the seedlings are well established. Protect establishing seedlings with fence or animal guards; to prevent rodent damage, do not mulch within one foot of seedling. Control herbivores as needed, but remove tree guards or other materials that can impede plant growth as soon as possible after establishment. Replace dead seedlings during the first two years.

## Establishment Management (Short Term)

Weed control is critical in the first and second year after planting. If the site is well prepared, less effort will be required for weeding after installation. Management practices must be adequate to control noxious and invasive species and may involve tools such as mowing, hoeing, flame-weeding, or hand removal. Weeds should be prevented from going to seed in, or adjacent to, the project area during the first two years after planting to help ensure long-term success. You may not see all the wildflower species in your mix bloom in the first year, as seedlings are putting most of their energy into underground root growth. During this time, it is essential to control weeds that can shade out and out-compete the desired forb and grass seedlings. Habitat creation practices may have additional guidelines and criteria for establishment management. Additionally, supporting practices may also provide guidance or cost share for establishment management activities.

Additional information on establishment management can be found in “Pollinator Meadow Installation Guide and Checklist - Upper Midwest” in the additional resources.

### Herbicide spot spray applications

Spot spraying is the targeted application of herbicide on specific weedy species. The goal is to minimize non-target application and drift to adjacent wildflower species. Backpack sprayers or rope wick applicators are the most commonly used spot-spraying tools. It is important to follow the label instructions when applying herbicides. Most weedy species should be targeted in their active growth stage. Do not use herbicides on weeds when they are blooming, because weeds are least susceptible to herbicides while flowering and spraying blooms could expose pollinators to harmful chemicals. In addition, avoid any herbicides that are toxic to bees (e.g., paraquat and gramoxone). More information on herbicide toxicity to pollinators can be found using the “Bee Precaution Pesticide Rating Tool” from University of California (UC) Integrated Pest Management Program which covers herbicides as well as pesticides (link found with attachments). Guidance on active ingredients that target non-native or invasive weeds and appropriate application timing can be found at the Colorado Parks and Wildlife Resource Stewardship webpage (http://cpw.state.co.us/aboutus/Pages/RS-NoxiousWeedsSpeciesProfiles.aspx) or the Colorado Department of Agriculture Noxious Weed webpage and publications (https://www.colorado.gov/pacific/agconservation/noxiousweeds).

Spot spraying weeds in habitat plantings can be effective, relatively inexpensive, and require minimal labor, even on large plantings (Herbaceous Weed Control - NRCS Practice Code 315- may be applicable here).

### Establishment Mowing / Shredding / String trimming

Mowing, string trimming, can be utilized to keep weedy species from shading out other plants and to prevent them from going to seed. Mowing is especially useful when establishing wildflower plots of perennial species. When planted with perennial seed mixes, the entire planting should be mowed at 6” cutting high whenever weeds reach knee height (18-24”) in the first growing season to eliminate the weed canopy and to prevent annual weeds from going to seed. Reduce ground speed and increase PTO speed to better grind up cut material and to reduce windrowing of cut material. If weed pressure is high initially or persisting, plantings can be mowed at 10-12” in the second growing season whenever weed growth is over 18”. Perennial wildflowers are slow to establish from seed and are usually not harmed by incidental mowing in the first year to second year after planting. Mowing can also be used on plots of re-seeding annuals at the end of the growing season to help shatter wildflower seed pods and to reduce woody plant encroachment.

Mowing and string trimming can also be useful around woody transplants to manage nearby weeds.

### Hand Weeding

While hand-weeding can be time consuming, in some cases it is a highly effective, targeted method. It is particularly well-suited for removal of weedy species that occur in low numbers or are scattered throughout a site. Hand-weeding is often the least invasive way to remove weedy species. Numerous tools can facilitate hand-weeding, from hoes and hula hoes, to pick axes and pulaskis, to shovels and trowels. Wearing gloves and long sleeves gives protection from spiny plants and sap from plants in the carrot family which cause skin irritations. Weeds are often best targeted during active growth stages, before they have flowered and set seed. If the plant only flowers once in its lifetime and flowering already occurred you don't need to remove the entire plant, instead clip off the seed heads and leave the roots in place. Be aware that some weed seeds—like musk thistle (*Carduus nutans*)—are viable almost as soon as the plant has bolted. These weeds will need to be bagged and removed from a site if they have been allowed to flower. For perennial and rhizomatous species, make sure to remove as much of the root material as possible, as they can quickly sprout from small root fragments. Weeding when there is some moisture in the soil can make it easier to remove the entire root structure. However, heavily saturated soils can be easily disturbed by hand-weeding leaving areas for new weeds to recolonize. If weed removal results in large bare patches, consider interseeding the gaps to avoid re-colonization by unwanted species.

### Irrigation

Planting native, locally adapted species that are drought-tolerant will reduce the need for any irrigation, however, when areas experience severe drought, water scarcity can decrease the survival and establishment of drought-adapted species. Additionally, transplants will need

irrigation for 1-2 seasons after planting. Providing just enough water to mimic ‘normal’ rainfall patterns during drought years can greatly improve wildflower germination and persistence. Irrigation is most critical in drought-prone regions during the initial establishment phase (typically 1–3 years); however, supplemental irrigation can be necessary during multi-year droughts. Even in non-drought years, occasional summer irrigation can also be used to prolong the bloom period into late summer and fall in arid regions. When repeated irrigation is anticipated, it can be practical to install an irrigation system. The most efficient and easily installed irrigation systems for pollinator habitat are drip irrigation with in-line emitters or micro- sprinklers. Drip-tubing with in-line emitters on 1' centers can be used and laid approximately 2' apart, so that 1' of dripline will soak about 2 ft. Micro-sprinklers need to be mounted on tall risers (3' or more, depending on height of wildflowers being planted). Adequate water-pressure is essential if micro-sprinklers are to be used, and maximum circumference will vary with nozzle design and water pressure. It is also possible to use overhead impact sprinklers on risers instead of micro-sprinklers. Watering in the evening or at night will minimize evaporation regardless of irrigation method, but is particularly important if using micro-sprinklers. Water every 2–4 weeks, depending on heat and soil moisture conditions. It is helpful if there is an existing irrigation system to hook into. Because wildflowers need significantly less water than most crops and will often die if over-watered, a separate line and shut-off for the habitat areas is necessary. A remote water timer can be programmed for the habitat area. Dripline conversion materials will be needed if hooking into most agricultural irrigation systems. If there is no existing system, water trucks can be used to irrigate as-needed. However, fine nozzles will be necessary to protect seeds and small seedlings from the force of the water.

## Operations and Maintenance (Long Term)

The following actions shall be carried out to insure that this practice functions as intended throughout its expected lifetime. These actions include normal repetitive activities in the application and use of the practice (operation), and repair and upkeep of the practice (maintenance). Wildflower plantings require careful management and maintenance for performance and longevity. Wildflower plantings also need to be managed over time to maintain open, early successional characteristics. Habitat creation practices may have additional guidelines for ongoing management. Supporting practices like **Prescribed Grazing (528)**, **Prescribed Burning (338)**, and others may also have criteria and/or cost shares available for ongoing management activities.

Additional guidance for ongoing management can be found in the additional resources document “Maintaining Diverse Stands of Wildflowers Planted for Pollinators.”

### Ongoing Mowing

Mowing across patches at different times of year can help maximize diversity within pollinator habitat by favoring different sets of species and reducing dominance of some species. For example, mowing in the early spring can reduce vegetation that would compete with later-blooming wildflowers, thus allowing for potentially increased germination, growth or flowering of later-blooming species. However, mowing the entire site in the spring could prevent early-blooming species from flowering, leading to a decline in their populations. We therefore recommend mowing only small areas, either in patches or strips, at any given time. This heterogeneous mowing strategy can help prevent gaps in bloom and enhance diversity of flowering species across the site. Breaking the site into 3–5 segments and rotating mowing regimens through them (at different times of year) can also help bolster diversity. It is important to keep track of which areas were mowed to avoid mowing the same area during the same time period in sequential years. Conversely, if the goal of mowing is to reduce dominance of a species, continue mowing during time period that has the largest impact. When mowing does occur before a species is able to bloom, expect varied responses based on the species. In some cases an early mow during a vegetative state can trigger a plant to go into bud, with flowers forming closer to the ground than their normal growth pattern. If this occurs, the plant is still able to set seed and persist in the site. While most perennial wildflowers will recover from a mowing event (particularly if the mow height is above 12"), some may not be able to flower and re-seeding in the same year of a mowing event and thus will not increase their populations. Some annuals are sensitive to mowing. If mowed before they bloom, many are unable to recover in time to bloom at a later date, and may subsequently disappear from a site.

### Ongoing Haying

Like mowing and other disturbance regimes, conservation haying is an important management tool for enhancing plant diversity and suppressing the growth/encroachment of woody vegetation in a prairie setting. Conservation haying also reduces light competition from tall

grasses, allowing spring blooming flowers and other shorter-statured plants to thrive. Haying differs from mowing in that the resulting thatch is removed from the site. As such, haying can be even more effective than mowing at promoting wildflowers and mining excess nutrients (e.g., in an effort to build soils that better favor desired plant communities over weeds). Moreover, haying can provide direct economic value from pollinator habitat, since the cut and dried herbage can be sold or used as livestock forage, bedding, or mulch.

While haying can benefit plant communities, it can also pose risks to pollinators and other wildlife by abruptly removing flowers at a site. Careful consideration of scale, technique, and timing can help protect pollinators from these impacts. Mow in strips or patches, instead of haying an entire site, to leave refuges for pollinators. Another common method is to divide an area in thirds and cut only one third each year, rotating the cut area annually, such that each parcel is cut every three years. Cutting should occur at reduced speeds (less than 8 mph) in order to give pollinators and other wildlife more time to disperse. Use of a flushing-bar on the mower can also help minimize risk to pollinators. Set the mower blades at a high height (12–16"), in order to maximize the vegetative structure (nesting/overwintering habitat) that is left on site.

Cutting late in the summer or fall (after peak bloom) is recommended for pollinators, since cutting at this time can minimize sudden reductions in nectar and pollen resources, and also ensures that most plants have set and dropped seed. However, if hay is to be harvested for livestock forage, these objectives may need to be balanced with the protein content and other nutritional qualities of the hay. Note that some wildflower species like wild buckwheat (*Eriogonum* spp.) and buttercups (*Ranunculus* spp.), and some weedy species like hemlock (*Conium maculatum*) and St. John's wort (*Hypericum* spp.) may be toxic to livestock. If conservation haying is planned, do not plant toxic species and make sure that toxic weeds are adequately treated before haying or are not present. Consider occasionally interseeding additional desirable native grasses and forbs into the site by broadcast seeding the area immediately after haying. This will help mitigate the loss of natural seed drop by wildflowers that are cut during the haying process.

### Prescribed Burning

Prescribed fire is an excellent tool for managing pollinator habitat. Fire is a natural component of many native plant communities, particularly those with native grasses that can carry fire. Fire can be used for many purposes: to reduce thatch, suppress woody species, release nutrients, open space for new growth, stimulate germination of some seeds, enhance flowering, and reduce weedy competition. Fire can be the most effective tool for combating invasives while invigorating growth of native species, particularly when compared with strip disking, herbicide, or hand-pulling. The value of prescribed fire, however, depends on specific site conditions, timing of burn, and plant community composition. For example, a few invasive species can benefit from fire or carry a hotter, more damaging fire than the native plant community; therefore, fire should be avoided when these kinds of species are present—such as cogongrass

(*Imperata cylindrica*), cheatgrass (*Bromus tectorum*), and Chinese bushclover/sericea lespedeza (*Lespedeza cuneata*).

As with other habitat management techniques, it is best to spread management across several years, trying not to disturb more than one third of the managed area at any one time. This ensures refuge for wildlife and supports quicker recolonization of previously disturbed areas. Refuge from disturbance also helps sustain healthy populations of pollinators and natural enemies of crop pests close to crop fields. Training and permits will likely be needed for burning, and a prescribed burn should be conducted by a trained professional. Before using prescribed fire, consult with local forestry or natural resources departments to find out if state permits and/or training are required. Always include fire breaks— paths cleared of leaves or other dry plant material to expose green vegetation, bare soil, rock, or bodies of water— when using prescribed fire. If fire is planned as an ongoing management technique, include fire breaks in the planting and management design process by incorporating clovers, cool season grasses, or other plant groups along the edges of the habitat, they have a green period during the typical burning windows in the spring and fall. We recommend splitting the site into three to five sections, with the aim of burning one section per year.

### Grazing

Selective grazing in pollinator habitat can help decrease the cover of non-native grass species. Grazing may not be right for every site; for example, it is more effective in larger sites. Improperly managed grazing can reduce or eliminate wildflower cover in habitats where non-native grasses are not a primary concern or grazers are allowed to overgraze the site. Cattle are the preferred grazing livestock in pollinator habitat because at low stocking rates they generally prefer grasses over wildflowers; however, be aware that cattle do find some wildflower species palatable—such as prairie clover (*Dalea* spp.). Check to see which wildflower species are highly palatable before choosing grazing as a management strategy to avoid adverse impacts on desirable plants. We also recommend determining whether any plants in the area to be grazed are toxic to livestock before deciding whether grazing is an appropriate technique.

Goats and sheep are less selective grazers and will consume both wanted and unwanted species; they are therefore less preferred grazers for pollinator plantings. Sheep or goat grazing is often more appropriate for areas dominated by woody plants or non-native and aggressive forbs. For example, goats are increasingly being used in the Midwest to manage invasive buckthorn shrubs, as well as Canada goldenrod, a native wildflower that often dominates wildflower plantings and can require management to set it back so that other species can thrive.

A light stocking rate helps ensure that livestock are only eating their preferred forage, and that they are not overgrazing a site. Alternatively, a heavy stocking rate for a short time (mob grazing) can ensure that all areas of the site are quickly grazed. Consider the duration of grazing period when planning for an appropriate stocking rate that favors pollinator plants; grazers will consume more forage and become less selective the longer they are kept in an area. Avoid overgrazing as an overgrazed pasture is vulnerable to weed incursion. If an area is

accidentally overgrazed it may require interseeding to restore any wildflower species consumed by grazers. Timing of grazing can help address different site conditions. For example, to reduce the dominance of cool season grasses, graze in early spring (before warm season grasses are active) or in the fall (after warm season grasses have set seed). To combat warm season grasses, graze in late spring or early summer. Whether controlling either warm or cool season grasses, try to graze unwanted grasses especially hard during their active growth stage prior to bloom. If the overall goal is to increase wildflower biodiversity without targeting a specific non-native grass species, use a light stocking rate and rotational grazing. As with prescribed fire, a rotational grazing system splits the site into three to five segments that are grazed at different times and with varied intensity and duration across years. Such a grazing pattern promotes site heterogeneity.

## Regional native plant material vendors

Most growers are outsourcing collection and production of native species. Most growers are happy to provide as much information as possible on species collection locations, growing locations, and age since wild collection. Seed that is collected and grown within the region is preferred for pollinator plantings. Seed lots that are closer in time/generation to wild collection are preferred, especially if grown in a distant location.

**Applewood Seed Company - http://www.applewoodseed.com/**
5380 Vivian St # B
Arvada, CO 80002
(303) 431-7333
-Native species collected in Colorado, grown out in various locations worldwide including Washington and Oregon

**Arkansas Valley Seed - http://www.avseeds.com/**
4300 Monaco St
Denver, CO 80216
(303) 320-7500
- Native species collected and grown out in Utah

**BBB Seed Company - https://www.bbbseed.com/**
6595 Odell Place, Unit G
Boulder, Colorado 80301
(303) 530-1222
-Some native species wild collected in Colorado and intermountain region, all seed grown out in Oregon and Washington

**Buffalo Brand Seed - http://www.buffalobrandseed.com/**
101 East 4th Street Road
Greeley, Colorado 80631
(800) 421-4234
-Native species wild collected in the intermountain region, seed grown out in locations across the continental US

**Chelsea Nursery - http://chelseanursery.com/**
3347 G Road
Clifton, Colorado 81520
(970) 434-8434
-Only plants available, all plants grown on site, some plants grown from wild collected seed from Colorado, no records of location or age of seed collection, other plants grown from seed bought from other vendors

**Colorado State Forest Service Nursery - https://csfs.colostate.edu/seedling-tree-nursery/**

3843 Laporte Ave
CSU Foothills Campus, Building 1060
Fort Collins, Colorado 80521
(970) 491-8429
-Colorado native tree species grown on site from wild collected seed or cuttings, some seeds or cutting may be purchased from other vendors, records on wild collection locations and age available

**Harlequin's Garden - http://www.harlequinsgardens.com/**
4795 North 26th St
Boulder, Colorado 80301
(303) 939-9403
-Only plants available, some plants are grown from wild collected seed or cuttings, some seed and cuttings are purchased from other regional vendors, records on wild collection locations and age available, many plants grown on site but some obtained from regional producers, no pesticides or neonicotinoids used on site or on purchased plants/seeds from other vendors

**Granite Seed and Erosion Control - https://graniteseed.com/**
490 East 76th Ave., Unit A
Denver, Colorado 80229
(720) 496-0600
-Some native species are hand collected within the region, seed production in Montana, Washington, and other locations in the continental US. Some species may be grown internationally

**Pawnee Buttes Seed Inc. - https://pawneebuttesseed.com/**
605 25th St, Greeley,
CO 80631
(970) 356-7002
-Wild collections from around the region-date of those collections is unknown, seed grown mostly in the continental US (OR, WA, KS, NE) but some grown internationally

**Southwest Seed Inc - http://www.southwestseed.com/**
13514 County Road 29
Dolores, CO 81323-9356
(970) 565-8722
-Native seed collections from region, some species grown in Montezuma County Co (3-4 species per year) but most production from around the US and some from Canada and other international locations, age of collections may not be available

**Sunscapes Rare Plant Nursery - http://www.sunscapes.net/**
4028 Nature Center Road
Pueblo, CO 81003
(719) 546-0047

-

**Tagawa Gardens - http://www.tagawagardens.com**
7711 S. Parker Road
Centennial, CO 80016
(303) 690-4722
-

**Western Native Seed - http://www.westernnativeseed.com/**
PO Box 188
Coaldale, CO 81222
(719) 942-3935
-Many wildflower species are wild collected in the region and directly sold, species that are collected and grown out are produced in western Colorado or Washington state

## Appendix: Part Five

***Documents included with this plan:***
Calibrating a Seed Drill for Conservation Planting
Calibration of a Truax No-Till Grain Drill
Cover Cropping for Pollinators and Beneficial Insects
Field Guide for Managing Teasel in the Southwest
Field Guide for Managing White Top in the Southwest
Habitat Development for Beneficial Insects Technical Note - Colorado
Managing Cover Crops Profitably
Maintaining Diverse Stands of Wildflowers Planted for Pollinators
Nests for Native Bees Fact Sheet
Pollinator Meadow Habitat Installation Guide - Upper Midwest
Reed Canarygrass Weed Profile
Reed Canarygrass Weed Report
Seeding Rates for Conservation PLantings in Colorado (NRCS)
Tree/Shrub Establishment and Hedgerow Installation Guide - Oklahoma
Tunnel Nests for Native Bees: Nest Construction and Management
USDA NRCS Colorado Major Land Resource Areas Map
What To Do with Irrigation Pivot Corners
White Top Weed Profile

***NRCS Practice Standards referenced in this plan:***
Grass Seeding Planned and Applied Worksheet
NRCS Conservation Practice Specification: Brush Management
NRCS Conservation Practice Specification: Riparian Herbaceous Cover

NRCS Conservation Practice Specification: Tree/Shrub Site Preparation
NRCS Conservation Practice Specification: Prescribed Grazing
NRCS Conservation Practice Specification: Range Planting
NRCS Conservation Practice Specification: Tree and Shrub Establishment
NRCS Conservation Practice Standard: Integrated Pest Management
NRCS Conservation Practice Standard: Rare or Declining Habitat
NRCS Conservation Practice Standard: Tree and Shrub Establishment
NRCS Conservation Practice Standard: Range Planting
NRCS Conservation Practice Standard: Tree/Shrub Site Preparation
NRCS Conservation Practice Standard: Riparian Herbaceous Cover
NRCS Conservation Practice Standard: Brush Management
NRCS Conservation Practice Standard: Structures for Wildlife
NRCS Conservation Practice Standard: Hedgerow Planting
NRCS Conservation Practice Standard: Prescribed Burning
NRCS Conservation Practice Standard: Weed Control
NRCS Conservation Practice Standard: Conservation Cover
NRCS Conservation Practice Standard: Cover Crop
NRCS Conservation Practice Standard: Field Border
NRCS Cover Crop Termination Guidelines

# Part Six. Supporting Documents

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## Master Appendix

***Supplementary documents included in this conservation plan include:***

Are Milkweeds Really Weeds? Fact Sheet
Beneficial Insects for Natural Pest Control: Scouting Guidelines
Calibrating a Seed Drill for Conservation Planting
Calibration of a Truax No-Till Grain Drill
Colorado State Alfalfa weevil scouting guide
Cover Cropping for Pollinators and Beneficial Insects
Ertl Farm Pollinator Habitat Assessment Form and Guide
Farming for Bees
Field Guide for Managing Teasel in the Southwest
Field Guide for Managing White Top in the Southwest
Grass Seeding Planned and Applied Worksheet
Habitat Development for Beneficial Insects Technical Note - Colorado
Habitat Planning for Beneficial Insects
How Neonicotinoids Can Kill Bees
How to Reduce Bee Poisoning from Pesticides
Maintaining Diverse Stands of Wildflowers Planted for Pollinators

Making Decisions about Neonicotinoid Seed Treatment Use in Iowa
Managing Cover Crops Profitably
Milkweeds: A Conservation Practitioner's Guide
Native Plant Revegetation Guide for Colorado
Nests for Native Bees Fact Sheet
NRCS Conservation Practice Specification: Brush Management
NRCS Conservation Practice Specification: Prescribed Grazing
NRCS Conservation Practice Specification: Range Planting
NRCS Conservation Practice Specification: Riparian Herbaceous Cover
NRCS Conservation Practice Specification: Tree and Shrub Establishment
NRCS Conservation Practice Specification: Tree/Shrub Site Preparation
NRCS Conservation Practice Standard: Brush Management
NRCS Conservation Practice Standard: Conservation Cover
NRCS Conservation Practice Standard: Cover Crop
NRCS Conservation Practice Standard: Field Border
NRCS Conservation Practice Standard: Hedgerow Planting
NRCS Conservation Practice Standard: Integrated Pest Management
NRCS Conservation Practice Standard: Prescribed Burning
NRCS Conservation Practice Standard: Range Planting
NRCS Conservation Practice Standard: Rare or Declining Habitat
NRCS Conservation Practice Standard: Riparian Herbaceous Cover
NRCS Conservation Practice Standard: Structures for Wildlife
NRCS Conservation Practice Standard: Tree and Shrub Establishment
NRCS Conservation Practice Standard: Tree/Shrub Site Preparation
NRCS Conservation Practice Standard: Weed Control
NRCS Cover Crop Termination Guidelines
Pollinator Meadow Habitat Installation Guide - Upper Midwest
Protecting Pollinator Habitat from Pesticides Guidelines
Reed Canarygrass Weed Profile
Reed Canarygrass Weed Report
Russian Wheat aphid scouting guide
Seeding Rates for Conservation PLantings in Colorado (NRCS)
The Bees of Colorado
Tree/Shrub Establishment and Hedgerow Installation Guide - Oklahoma
Tunnel Nests for Native Bees: Nest Construction and Management
USDA NRCS Colorado Major Land Resource Areas Map
What to Do with Irrigation Pivot Corners
White Top Weed Profile

## Master Plant List. Recommended Pollinator Plants for Boulder County

| Bloom Period | Common Name | Scientific Name | Annual, Perennial, or Biennial | Flower Color | Max. Height (feet) | Water Needs | Notes |
|---|---|---|---|---|---|---|---|
| **Native Forbs** | | | | | | | |
| Summer/fall | Common Yarrow | *Achillea millefolium* | Perennial | white or light pink | 2 | dry to medium | Quick establisher, can spread aggressively by rhizomes, does not tend to persist in great numbers |
| Fall, August-October | Slenderleaf False Foxglove | *Agalinis tenuifolia* | Perennial | pink to purple or rarely white | 1.5 | medium | Partially parasitic on neighboring root structures, larval food source for common buckeye butterfly |
| Summer/fall, July-September | Blue Giant Hyssop | *Agastache foeniculum* | Perennial | blue to violet | 4 | dry to medium | Uncommon in forest openings, tea plant |
| Summer/fall, June-August | Lead Plant | *Amorpha canescens* | Perennial | violet | 3 | dry to medium | Subshrub, thrives in poor quality soils, silvery foliage, butterfly and moth host plant, tea plant |
| Varied | Windflower | *Anemone spp.* | Perennial | varied | varied | varied | Some anemone species are the first blooming species in spring, important for early season pollinators, *A. canadensis, A. cylindrica, A. multifida, A. marcissiflora*, and *A. patens* found in Boulder County |
| Summer/fall, July-September-October | Sagebrush | *Artemisia spp* | Perennial | yellow to green to brown | varied | varied | *A. artica, A. campestris, A. cana, A. dracunculus, A. filifolia, A. frigida, A. ludoviciana, A. scopulorum* and *A. tridentata* native to Boulder county |

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| Spring/summer, May-July | Antelopehorn | *Asclepias asperula* | Perennial | white and reddish violet | 2.5 | dry | Found in sandy or rocky soils |
| Summer/fall, June-August | Engelmann's Milkweed | *Asclepias engelmanniana* | Perennial | green to yellowish-green | 4 | dry | Erect milkweed, known monarch host |
| Summer/fall, July-September | Swamp Milkweed | *Asclepias incarnata* | Perennial | pink or rarely white | 5 | medium to wet | Excellent nectar plant |
| Summer/fall, June-August | Showy Milkweed | *Asclepias speciosa* | Perennial | purple to pink or rarely white | 4 | dry to medium | Easy to establish, deep tap root, nectar plant, monarch host |
| Summer/fall, June-August | Butterfly Milkweed | *Asclepias tuberosa* | Perennial | orange to yellow-orange | 2 | dry to medium | Showy nectar plant and monarch host |
| Summer/fall, June-August | Green Comet Milkweed | *Asclepias viridiflora* | Perennial | green to yellowish-green | 2 | dry to medium | Bumblebee attractor |
| Varied | Milkvetch | *Astragalus spp.* | Annuals and perennials | varied | varied | varied | *A. agrestis, A. alpinus, A. australis, A. bisculatus, A. canadensis, A. ceramicus, A. crassicarpus, A. drummondii, A. eucosmus, A. falcatus, A. flexuosus, A. gracilis, A. laxmannii, A. lotiflorus, A. miser, A. missouriensis, A. parryi, A. racemosus, A. shortianus, A. sparsiflorus, A. tenellus,* and *A. tridactylicu*s found in Boulder County |
| Spring/summer, May-August | Winecups | *Callirhoe involucrata* | Perennial | pink to red-purple or rose | 1 | dry to medium | Sprawling, mat forming plant with bright flowers, often used in landscapes |
| Spring/summer/fall, May-August | Dustymaiden | *Chaenactis douglasii* | Biennial or perennial | white to pink | 1.5 | dry | Early colonizer of disturbed sites |
| Summer/fall, July-September | Fireweed | *Chamerion angustifolium* | Perennial | pink or rarely white | 6.5 | medium | Especially abundant after fire |

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| Summer/fall, June-September | Thistle | *Cirsium* | Biennials and perennials | pink to lavendar to purple, white | varied | varied | Important nectar source, *C. canescens, C. clavatum, C. eatonii, C. flodmanii, C. ochrocentrum, C. scariosum, C. scopulorum,*and *C. undulatum* found in Boulder County |
| Summer/fall, June-August | Rocky Mountain Beeplant | *Cleome serrulata* | Annual | pink to purplish, rarely white | 5 | dry | Will reseed, common on roadsides or rangelands |
| Summer/fall, July-October | Plains Coreopsis | *Coreopsis tinctoria* | Annual | yellow with red at center | 2.5 | dry to medium | Cost effective seed, used to make dye |
| Summer/fall, June-September | White Prairie Clover | *Dalea candida* | Perennial | white | 3 | dry to medium | Nitrogen-fixing plant |
| Spring/summer/fall, May-September | Purple Prairie Clover | *Dalea purpurea* | Perennial | rose-purple to purple | 2.5 | medium | Nitrogen-fixing plant |
| Summer/fall, July-September | Silky Prairie Clover | *Dalea villosa* | Perennial | rose-purple to lavendar or pink | 2 | dry | Nitrogen-fixing plant, silvery foliage |
| Summer/fall, June-August | Blacksamson Echinacea | *Echinacea angustifolia* | Perennial | pink to purple | 2 | dry to medium | Important plant for many pollinators |
| Varied | Wild Buckwheat | *Eriogonum spp.* | Annuals and perennials | varied | varied | varied | *E. alatum, E. annuum, E. arcuatum, E. brevicaule, E. effusum, E. flavum, E. jamesii, E. umbellatum* found in Boulder Co. |
| Fall, August-October | Western Goldentop | *Euthamia occidentalis* | Perennial | yellow | 6.5 | medium to wet | Attracts numerous pollinators and beneficial insects |
| Summer/fall, July-September | Spotted Joepyeweed | *Eutrochium maculatum* | Perennial | purple | 6.5 | wet | Attracts many butterflies, can spread aggressively |
| Spring/summer/fall, May-September | Blanketflower | *Gaillardea aristata* | Perennial | yellow with purple center | 2 | dry to medium | Easy to establish, great for native bees |
| Spring/summer/fall, May-August | Rocky Mountain Geranium | *Geranium caespitosum* | Perennial | pink or purple | 1.5 | dry | Stems are often red |

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| Spring/summer/fall, May-September | Richardson's Geranium | *Geranium richardsonii* | Perennial | white to pink | 2 | medium to wet | Found in moist meadows, along streams and in aspen forests |
| Summer/fall, June-August | Sticky Purple Geranium | *Geranium viscosissimum* | Perennial | pink or purple | 3 | dry to medium | Foliage turns red in the fall, protocarnivorous-can dissolve insects caught on it's sticky leaves |
| Spring/summer, May-July | Utah Sweetvetch | *Hedysarum boreale* | Perennial | purple-red to pink, occasionally white | 2 | dry to medium | Nitrogen-fixing plant, tolerant of a wide range of soil pH |
| Summer/fall | Sunflower | *Helianthus spp.* | Annuals and perennials | yellow | varied | varied | *H. annuus, H. nuttallii, H. petiolaris, H. pumilus,* and *H. rigidu*s found in Boulder County |
| Spring/summer/fall, May-October | Hairy False Goldenaster | *Heterotheca villosa* | Perennial | yellow | 2 | dry | Long season of bloom, abundant in sandy or gravelly soils |
| Summer/fall, July-October | Blazing Star | *Liatris spp.* | Perennial | purple, pink, or rarely white | 2.5 | varied | *L. ligulistylis* and *L. puncata* found in Boulder county, *L. ligulistylis* is very attractive to monarch butterflies |
| Spring/summer/fall, May-September | Lewis Flax | *Linum lewisii* | Perennial | blue or whitish-blue | 2.5 | medium | Establishes easily from seed |
| Fall, August-September | Great Blue Lobelia | *Lobelia siphilitica* | Perennial | blue | 0.5 | medium to wet | May form colonies |
| Spring/summer/fall, May-September | Prairie Aster | *Machaeranthera tanacetifolia* | Biennial | blue or purple | 3 | dry | Extremely drought tolerant |
| Summer/fall, June-September | Wild Bergamot | *Monarda fistulosa* | Perennial | purple, pink, or rose-purple, rarely white | 4 | dry to medium | Attracts numerous pollinators and beneficial insects |
| Spring/summer/fall, May-August | Plains Beebalm | *Monarda pectinata* | Annual | white, pale pink, or | 1.5 | dry | Fragrant plant, easily reseeds |

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| | | | | rarely purple | | | |
| Varied | Pricklypear | *Opuntia spp.* | Perennial | yellow to magenta | varied | dry | Great for native bees, *O. fragilis, O. macrorhiza, O. phaeacantha*, and *O. polyacantha* found in Boulder County |
| Varied | Beardtongue | *Penstemon spp.* | Perennial | varied | varied | varied | *P. albidus, P. angustifolius, P. glaber, P. gracilis, P. halii, P. procerus, P. rydbergii, P. secundiflorus, P. strictus, P. virens, P. virgatus*, and *P. whippleanus* found in Boulder County |
| Spring/summer/fall, May-August | Phacelia | *Phacelia heterophylla, P. hastata, P. sericea* | Perennial | white to purplish | 4 | dry | Quick establisher |
| Summer/fall, June-August | Heal-all | *Prunella vulgaris* | Perennial | blue to purple | 2 | medium to wet | Generous nectar producer, good native groundcover |
| Summer/fall, June-October | Prairie Coneflower | *Ratibida columnifera* | Perennial | yellow | 3 | dry to medium | Hardy nectar plant |
| Summer/fall, July-October | Goldenrod | *Solidago spp* | Perennial | yellow | varied | varied | *S. canadensis, S. gigantea, S. missouriensis, S. mollis, S. multiradiata, S. nana, S. nemoralis, S. rigida, S. simplex, S. speciosa,* and *S. velutina* native to Boulder county |
| Spring/summer/fall, May-September | Scarlet Globemallow | *Sphaeralcea coccinea* | Perennial | orange to pinkish | 1.5 | dry | Important plant for many species of wildlife, widespread distribution |
| Summer/fall, July-October | Aster | *Symphyotrichum spp* | Perennial | varied | varied | varied | *S. ascendens, S. boreale, S. ciliatum, S. ericoides, S. falcatum, S. fendleri, S. foliaceum, S. laeve, S. lanceolatum, S. novae-* |

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| | | | | | | | *angliae, S. porteri* and *S. spathulatum* found in Boulder county |
| Summer/fall, June-September | Greenthread | *Thelesperma filifolium* | Annual | yellow | 1.5 | dry | Readily self seeds |
| Spring/summer/fall, May-August | Prairie Spiderwort | *Tradescantia occidentalis* | Perennial | purple to blue or magenta | 2 | dry to medium | Can form colonies |
| Summer/fall, July-September | Swamp Verbena | *Verbena hastata* | Perennial | purple | 4 | medium to wet | Short lived perennial that reseeds |
| Summer/fall, June-August | Hoary Vervain | *Verbena stricta* | Perennial | blue or purple | 4 | dry to medium | Vigorous grower, found in disturbed areas |
| Fall, August-October | Golden Crownbeard | *Verbesina encelioides* | Annual | yellow | 2 | medium | May be toxic to livestock in large quantities |
| **Shrubs and Trees** | | | | | | | |
| Spring/summer, May-July | Western Serviceberry | *Amelanchier alnifolia* | Perennial | white | 16 | medium | Edible berries |
| Spring/summer, May-July | False Indigo | *Amorpha fruticosa* | Perennial | violet to red-purple with orange-yellow anthers | 10 | medium to wet | Can form thickets |
| Spring/summer/fall, May-August | Kinnikinnick | *Arctostaphylos uva-ursi* | Perennial | white or pink | 1 | dry to medium | Likes exposed open sites. Tea plant. |
| Spring/summer/fall, May-August | Fourwind Saltbrush | *Atriplex canescens* | Perennial | yellow to yellow-green | 6.5 | dry | Tolerates a wide range of soils |
| Varied | Ceanothus | *Ceanothus spp.* | Perennial | white | varied | dry to medium | *C. fendleri, C. herbaceous,* and *C. velutinus* found in Boulder County |
| Summer/fall, July-September | Viscid Rabbitbrush | *Chrysothamnus viscidiflorus* | Perennial | yellow | 5 | dry to medium | Visited by many butterfly species |

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| Summer/fall, June-September | Shrubby Cinquefoil | *Dasiphora fruticosa* | Perennial | yellow | 2.5 | medium | Also known as *Potentilla fruticosa*, many cultivars used in landscapes |
| Summer/fall, July-October | Rubber Rabbitbrush | *Ericameria nauseosa* | Perennial | yellow | 6.5 | dry to medium | Vigorous spreader |
| Spring/summer/fall, May-September | Apache Plume | *Fallugia paradoxa* | Perennial | white | 6.5 | dry to medium | With abundant moisture, will flower profusely for many months |
| Spring/summer, April-June | Oregon-Grape | *Mahonia repens* | Perennial | yellow | 1 | medium | Evergreen shrubs, can be used for groundcover, also known as *Berberis repens* |
| Spring/summer, April-June | Cherry; Peach; Plum | *Prunus spp.* | Perennial | white | varied | varied | *P. americana, P. pensylvanica, P. pumila var. besseyi,* and *P. virginiana* found in Boulder County |
| Spring/summer, April-June | Skunkbush Sumac | *Rhus trilobata* | Perennial | white, yellow | 10 | dry | Can form thickets |
| Varied | Currant; Gooseberry | *Ribes spp.* | Perennial | varied | varied | varied | *R. aureum, R. cereum, R. coloradense, R. inerme, R. lacustre,* and *R. montigeum* found in Boulder County |
| Summer/fall, June-August | Prickly Rose; Prairie Rose; Smooth Rose | *Rosa acicularis, Rosa arkansana, Rosa blanda* | Perennial | white to pink to rose | 2-5 | dry to medium | Fragrant flowers, primarily a pollen plant, roses can be aggressive spreaders |
| Spring/summer/fall, May-August | Thimbleberry | *Rubus parviflorus* | Perennial | white | 5 | medium | Provides nesting structure for native bees |
| Varied | Willow | *Salix spp.* | Perennial | varied | varied | medium to wet | Important resource for early season pollinators, *S. amygdaloides, S. bebbiana, S. brachycarpa, S. drummondiana, S. eriocephala, S. exigua, S. geyeriana, S. glauca, S. irrorata, S. monticola, S. lasiandra, S. monticola, S. petrophila, S. planifolia, S.* |

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| | | | | | | | *reticulata, S. wolfii* found in Boulder County |
| Summer/fall, June-August | White Snowberry; Wolfberry; Mountain Snowberry | *Symphoricarpos albus, S. occidentalis, S. rotundifolius* | Perennial | white to pink | 5 | medium | Great nectar plant, popular with other wildlife |
| **Native Grasses** | | | | | | | |
| Spring/summer, May-July | Indian Ricegrass | *Achnatherum hymenoides* | Perennial | N/A | 3 | dry to medium | Cool season bunchgrass, fibrous root systems, erosion control, food for wildlife, slow establisher |
| Summer/fall, July-September | Big Bluestem | *Andropogon gerardii* | Perennial | N/A | 5 | dry to medium | Warm season bunchgrass, slow to establish, drought tolerant |
| Summer/fall, July-September | Sand Bluestem | *Andropogon hallii* | Perennial | N/A | 6.5 | dry | Warm seson bunchgrass, sandy soil stabilizer, |
| Summer/fall, July-September | Sideoats Grama | *Bouteloua curtipendula* | Perennial | N/A | 3 | dry to medium | Fast establishing, tolerates a wide range of soil conditions, warm season |
| Summer/fall, July-October | Blue Grama | *Bouteloua gracilis* | Perennial | N/A | 2 | dry to medium | Forms dense clumps, foliage can be colorful in fall, warm season grass |
| Summer/fall, July-October | Hairy Grama | *Bouteloua hirsuta* | Perennial | N/A | 1.5 | dry | Larval host plant for green skipper |
| Summer/fall, July-September | Nodding Brome | *Bromus porterii* | Perennial | N/A | 3 | dry to medium | Cool season grass |
| Spring/summer, May-July | Buffalograss | *Buchloë dactyloides* | Perennial | N/A | 1 | dry | Drought resistant, can be used as a lawn grass, warm season grass |
| Varied | Sedge | *Carex spp.* | Perennial | N/A | varied | varied | Important graminoid component of many sites, incredible diversity of species |

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| | | | | | | | present in Boulder County, several species are commercially available |
| Summer/fall, June-September | Parry's Oatgrass | *Danothonia parryi* | Perennial | N/A | 2.5 | dry to medium | Bird attractant, cool season grass |
| Summer/fall, July - September | Tufted Hairgrass | *Deschampsia cespitosa* | Perennial | N/A | 5 | medium | Cool season grass, used as an ornamental plant |
| Spring/summer/fall, May-August | Desert Saltgrass | *Distichlis spicata* | Perennial | N/A | 2 | medium to wet | Salt tolerant |
| Spring/summer/fall, May-August | Common Spikerush | *Eleocharis palustris* | Perennial | N/A | 4 | wet | Food source for wetland birds |
| Summer/fall, June-September | Wildrye | *Elymus spp.* | Perennial | N/A | varied | varied | Cool season grasses, *E. canadensis, E. elymoides, E. glaucus, E. lanceolatus, E. scribneri,* and *E. trachycaulus* found in Boulder County |
| Fall, August-October | Purple Lovegrass | *Eragrostis trichoides* | Perennial | N/A | 2 | dry | Warm season grass, seed heads are light to bright purple |
| Summer/fall, July-September | Idaho Fescue | *Festuca idahoensis* | Perennial | N/A | 3 | dry | Cool season grass, used as an ornamental plant |
| Spring/summer/fall, May-August | Needle and Thread | *Hesperostipa comata* | Perennial | N/A | 3 | dry | Cool season grass, seeds are spear-like and drill themselves into the ground |
| Summer/fall, June-August | Porcupinegrass | *Hesperostipa spartea* | Perennial | N/A | 3 | dry | Cool season grass, seeds are spear-like and drill themselves into the ground |
| Summer/fall, June-September | Arctic Rush, Torrey's Rush | *Juncus balticus, Juncus torreyi* | Perennial | N/A | 3.5 | wet | Rhizomatous roots can help control erosion on wet sites |
| Spring/summer/fall, May-August | Junegrass | *Koeleria macrantha* | Perennial | N/A | 2 | dry to medium | Cool season, clump-forming grass |
| Summer/fall, July-September | Scratchgrass | *Muhlenbergia asperifolia* | Perennial | N/A | 3 | medium to wet | Tolerates alkaline soils |
| Summer/fall, July-September | Mountain Muhly | *Muhlenbergia montana* | Perennial | N/A | 2.5 | dry to medium | Warm season bunchgrass, great for wildlife |
| Summer/fall, July-September | Marsh Muhly | *Muhlenbergia racemosa* | Perennial | N/A | 3.5 | medium-dry | Can spread aggressively |

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| Summer/fall, July-September | Pine Dropseed | *Muhlenbergia tricholepsis* | Perennial | N/A | 2 | dry to medium | Cool season grass |
| Summer/fall, June-August | Green Needlegrass | *Nasella viridula* | Perennial | N/A | 4 | dry to medium | Cool season, clump-forming grass |
| Summer/fall, June-September | Switchgrass | *Panicum virgatum* | Perennial | N/A | 10 | medium to wet | Cool season, clump-forming grass, winter food source for birds |
| Spring/summer/fall, May-August | Muttongrass | *Poa fendleriana* | Perennial | N/A | 2 | dry to medium | Cool season grass |
| Spring/summer/fall, May-August | Sandberg Bluegrass | *Poa secunda* | Perennial | N/A | 4 | dry to medium | Cool season grass |
| Summer/fall, July-September | Little Bluestem | *Schizachyrium scoparium* | Perennial | N/A | 3 | dry to medium | Warm season grass, ornamental plant with great fall interest |
| Spring/summer/fall, May-September | Naked-stemmed Bulrush | *Schoenoplectus spp* | Perennial | N/A | varied | wet | *S. acutus, S. americanus, S. pungens,* and *S. tabernaemontani* found in Boulder county |
| Summer/fall, June-August | Panicled Bulrush, Cloaked Bulrush | *Scirpus microcarpus, Scirpus pallidus* | Perennial | N/A | 5 | wet | Can help control erosion in wet areas |
| Fall, August-September | Indian Grass | *Sorghastrum nutans* | Perennial | N/A | 8 | dry to medium | Warm season grass, beautiful fall color |
| Summer/fall, June-September | Prairie Cordgrass | *Spartina pectinata* | Perennial | N/A | 7 | medium to wet | Colony forming |
| Summer/fall, June-September | Dropseed | *Sporobolus spp.* | Perennial | N/A | varied | dry to medium | *S. airoides, S. compositus, S. cryptandrus,* and *S. heterolepis* found in Boulder County |
| Summer/fall, June-September | Broadleaf Cattail | *Typha latifolia* | Perennial | N/A | 11.5 | wet | Important plant for many species of wildlife |
| **Cover Crops** | | | | | | | |
| | Crimson Clover | *Trifolium incarnatum* | Annual | Red | 2 | dry to medium | Nitrogen fixing, weed suppression, green manure |

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| | Oilseed Radish | *Raphanus sativus* | Annual | Pink, white, or lavendar | 3 | dry to medium | Biotillage, nitrogen scavenger, weed suppression, suppresses soil pests (trap crop for soybean cyst nematode), can be stinky when taproots rot in the spring |
| | Scorpion Weed | *Phacelia tanacetifolia* | Annual | Purple | 3 | dry to medium | Low water use, nitrogen catch crop, attracts bees and beneficial insects |
| | Cowpea | *Vigna unguiculata* | Annual | Pink to purple | varies by subspecies; 1-7 ft (with supports) | dry to medium | Nitrogen fixing plant, excellent drought resistance, shade tolerant |
| | Winter Camelina | *Camelina sativa* | Annual | Yellow | 3 | dry to medium | Oilseed could be marketable, weed suppression, reduce soil erosion over winter |
| | Pennycress | *Thlapsi arvense* | Annual | White | 3 | dry to medium | Oilseed could be marketable, weed suppression, reduce soil erosion over winter |
| | Alfalfa | *Medicago sativa* | Perennial | Purple | 3 | dry to medium | important honey plant, nitrogen fixing species |